NATURAL RESOURCES

Low-Temperature Geothermal Resources of Washington

J. Eric Schuster and
R. Gordon Bloomquist

WASHINGTON
DIVISION OF GEOLOGY
AND EARTH RESOURCES

Open File Report 94-11
June 1994

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P.O. Box 47007
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Price	$ 4.16
Tax *(WA residents only)*	$ .34
Total	$ 4.50

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Make checks payable to the Department of Natural Resources.

Printed on recycled paper
Printed in the United States of America

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Low-Temperature Geothermal Resources of Washington

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ABSTRACT

This report presents information on the location, physical characteristics, and water chemistry of low-temperature geothermal resources in Washington. The database includes 941 thermal (>20°C or 68°F) wells, 34 thermal springs, lakes, and fumaroles, and 238 chemical analyses.

Most thermal springs occur in the Cascade Range, and many are associated with stratovolcanoes. In contrast, 97 percent of thermal wells are located in the Columbia Basin of southeastern Washington. Some 83.5 percent are located in Adams, Benton, Franklin, Grant, Walla Walla, and Yakima Counties. Yakima County, with 259 thermal wells, has the most.

Thermal wells do not seem to owe their origin to local sources of heat, such as cooling magma in the Earth's upper crust, but to moderate to deep circulation of ground water in extensive aquifers of the Columbia River Basalt Group and interflow sedimentary deposits, under the influence of a moderately elevated (41°C/km) average geothermal gradient.

Thermal well waters are quite dilute, averaging only 260 ppm total for eight major chemical species (Na, K, Ca, Mg, HCO_3, CO_3, Cl, and SO_4). All thermal well waters have HCO_3 as the dominant anion. The dominant cations are either Na+K or Ca+Mg, with Na+K dominant somewhat more commonly. Thermal springs are less dilute, averaging 1570 total ppm. N+K is the chief cation, and the chief anions are either HCO_3+CO_3 or Cl+SO_4, with the latter somewhat more common.

At least 250 of Washington's thermal wells are publicly owned, and many of these are located near public buildings that might be economically heated through the use of geothermal water-source heat pumps. However, the common collocation of the resource and potential users is no guarantee of development. Today, development is being slowed by a lack of widespread knowledge of the availability of low-temperature geothermal resources, by a lack of knowledge about the reliability and efficiency of geothermal water-source heat pumps, by a legal and institutional framework that does not always facilitate using ground water for space heating, and by the generally high front-end capital costs of geothermal water-source heat pump systems. We suggest ways to lessen some of these limitations.

INTRODUCTION

During the late 1970s and early 1980s, the Washington Division of Geology and Earth Resources conducted a multifaceted program of geothermal resource evaluation. The program was made possible by the financial support and encouragement of the U.S. Department of Energy's State-Coupled Program. At that time, the main focus was the discovery, evaluation, and commercialization of high-temperature geothermal resources that could be used to generate electricity. Thus, the Division's program emphasized the Cascade Range (Fig. 1), where high-temperature geothermal resources probably exist, as evidenced by the stratovolcanoes, Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, and Mount Adams (Plate 1). However, for several reasons, there have been no significant discoveries or development of high-temperature geothermal resources in the Cascades. First, competing energy prices have been low for the last decade or more. Second, the areas around the stratovolcanoes are largely undevelopable because the land is preserved as national parks, wilderness areas, or national monuments or is dedicated to other uses. Third, logistical problems associated with attempts to develop high-temperature geothermal resources near a stratovolcano would be very challenging.

Investigations conducted during the late 1970s and early 1980s included:

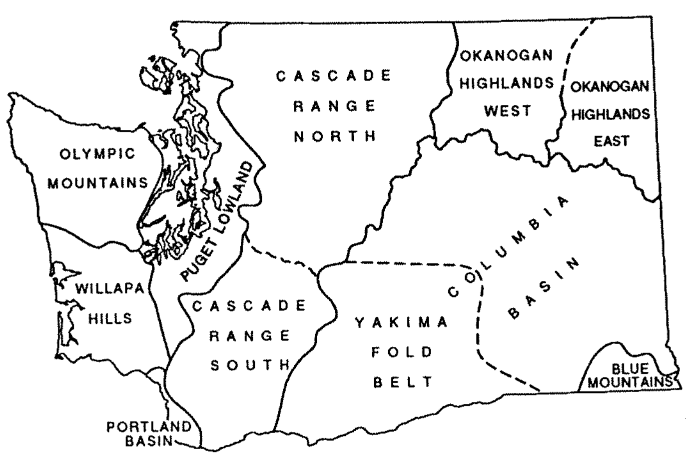


Figure 1. Physiographic provinces of Washington.

- description, sampling, and chemical analysis of thermal and mineral springs,
- several episodes of heat-flow/temperature-gradient drilling in the Cascade Range, which was practically unknown thermally at the time,
- temperature-gradient/heat-flow measurements in the holes drilled for that purpose in the Cascades,
- extensive temperature-gradient measurements in existing drill holes all over the state, but most extensively in the Columbia Basin,
- regional gravity studies in the Cascades,
- geohydrologic studies in the Yakima and Moses Lake–Ritzville–Connell areas of the Columbia Basin (see Plate 2 and Fig. 7),
- geologic mapping and geochemical investigations in areas of young volcanism in the Cascades,
- soil mercury studies in the Mount St. Helens area, and
- the compilation of a bibliography of geothermal reports for Washington State.

These investigations, through 1983, are summarized by Korosec (1984). After 1983, two more U.S. Department of Energy contracts supported temperature-gradient/heat-flow investigations in the Cascades, but the high tide of geothermal exploration had passed.

An important accomplishment of that time was the publication of a 1:500,000-scale map depicting the distribution and nature of geothermal resources in Washington (Korosec and others, 1981). The map data were compiled by the staffs of the Washington Division of Geology and Earth Resources and the Washington State Energy Office, and the map was cartographically prepared and printed through the efforts of the National Oceanic and Atmospheric Administration, all under the sponsorship of the U.S. Department of Energy. Similar maps were produced for most of the western states.

Washington's map locates and provides basic data for 31 thermal springs, 29 mineral springs, and 338 thermal wells. The springs are mostly located in the Cascade Range, many clearly associated with stratovolcanoes. Most of the warm wells are located in the central, southwestern, and southern parts of the Columbia Basin in south-central Washington.

Even though the 1981 geothermal resources map has served very well, there has been a need for several years to make another inventory of geothermal resources. Of the 45 references from which well and spring data were taken for the tables in the appendices, 23 were released after 1981. The most productive of the new or much-expanded sources of data are the unpublished water well reports held in the Yakima and Spokane regional offices of the Washington State Department of Ecology and the U.S. Geological Survey's WATSTORE database.

The large amount of data available now that was not available or not consulted in 1981 is reflected in the size of the geothermal database reported herein. The current database reports only thermal wells, springs, lakes, and fumaroles (except for two cooler wells; see explanation under DATA SOURCES); no nonthermal mineral springs are reported, although they were on the 1981 map. The current database comprises 941 wells and 34 springs, spring systems, lakes, and fumaroles (Table 1). The number of spring systems, lakes, and fumaroles reported here is not much larger than the number reported in 1981, but the number of warm wells is almost 3 times larger. The increase results from the more comprehensive nature of the sources of data consulted for this report and the fact that there are many more wells in existence than there were in 1981.

In some ways it is unfortunate that occurrences cooler than 20°C could not be included in this database. Much can be learned by studying how cold wells are interspersed (or not) with warm wells, and by comparing their relative depths and other attributes. However, adding the cool wells would have added thousands of wells to the database.

This low-temperature geothermal resource assessment was funded by the U.S. Department of Energy, and similar assessments are being done in many of the western states. The program is being administered jointly by University of Utah Research Institute, Idaho Water Resources Research Institute, and Oregon Institute of Technology. Funds available limited field data-gathering, but we sampled 18 municipal, commercial, and school wells for chemical analysis by the laboratory of the University of Utah Research Institute. Therefore, this assessment relied primarily on compilation of a bibliography and index of geothermal resources and development (Christie, 1994) and a thorough review of existing data sources.

Table 1. Thermal wells, springs, lakes, and fumaroles in Washington, by county. The six-county area referred to in the text and below covers Adams, Benton, Franklin, Grant, Walla Walla, and Yakima Counties

County	Thermal wells	Thermal springs lakes, fumaroles
Adams	113	0
Asotin	9	0
Benton	123	0
Chelan	1	0
Clark	2	0
Clallam	0	2
Columbia	5	0
Cowlitz	0	1
Douglas	7	0
Franklin	60	0
Garfield	3	0
Grant	118	0
Grays Harbor	2	0
King	1	3
Kittitas	12	1
Klickitat	35	2
Lewis	8	2
Lincoln	30	0
Okanogan	5	2
Pierce	0	3
Skamania	6	7
Snohomish	0	4
Spokane	13	0
Walla Walla	113	2
Whatcom	1	3
Whitman	15	0
Yakima	259	2
Totals	941	34
Six counties	786 (83.5%)	4 (11.8%)

DATA SOURCES

The limits established by the U.S. Department of Energy for inclusion of data in this database are (1) a temperature at least 10°C above the mean annual surface temperature, here taken as 20°C, and (2) a temperature gradient of at least 25°C/km.

As used in this report, the word *thermal* signifies a water temperature at or above 20°C, and the words *nonthermal*, *cool*, or *mineral* refer to wells and (or) springs below 20°C.

Because regional temperature gradients in Washington exceed 25°C/km everywhere except western Washington (Table 2) and western Washington's regional gradient is almost 25°C/km, we assumed that the gradient limitation would be met for all data and concentrated only on the temperature limit.

The temperature limitation was observed except for two wells (well GR014, the Wahluke School well, and well WA086, the Walla Walla Community College well). These wells are included because temperatures above 20°C were reported in earlier databases, because the Walla Walla Community College well has been used for years as a heat source for a heat pump, and because we sampled both for chemical analyses.

Every well found in every known database that met the 20°C temperature cutoff is listed in the present database, with the exception of oil and gas test wells. There are a few oil and gas test wells in the present database, but they are included by virtue of having been reported in published databases that were used as data sources. More than 400 oil and gas test wells have been drilled in Washington, most of them in western Washington. Inequilibrium bottom-hole temperatures are reported in the oil and gas records of the Division of Geology and Earth Resources for many of these wells. We have not calculated equilibrium temperatures from these data for two reasons. First, western Washington oil and gas wells are in a low temperature-gradient region where the 20°C isotherm is deep and less attractive economically than in higher-gradient eastern Washington. Second, in eastern Washington there are only a few modern wells that would provide good data, so we are probably not missing a significant source of data. Furthermore, temperature gradients for deeper eastern Washington wells in the database fall within the 30°–50°C/km gradient band and seem to be entirely normal (see Fig. 8).

We carefully checked one source of data against another and tried to use the original source or the latest independently generated source of data when data sources were in disagreement. As previously noted, the budget allowed only limited field verification of data. Each chemical analysis reported in Appendix B comes from a single source of data and is a single, not composite, analysis. If an analysis failed to pass a charge-balance test (that is, fall within ten percent of 1.00), it was eliminated from this database. Mass balance was not used as a criterion for rejection of analyses. (See Appendix B.)

We checked the accuracy of the data in Appendix A for 18 wells we sampled, and we found the data to be approximately 80 percent accurate. Some of the references, such as Smith (1901) and Landes (1905), are quite old, and it would be unrealistic to expect that wells reported in these references would still exist, still exhibit the conditions originally reported (particularly with respect to artesian head), or still have the same name or ownership. We included the old wells in the database because they represent thermal conditions that should still exist, even if not precisely as reported in the early literature.

Table 2. Regional temperature gradients and heat flow in Washington. The Northern Rocky Mountains province is shown as Okanogan Highlands west and east on Figure 1, and the Coastal province as the combined Puget Lowland, Olympic Mountains, and Willapa Hills. (From Blackwell and others, 1985)

Physiographic province	Regional temperature gradient (°C/km)	Heat flow, (mW/m^2)
Columbia Basin	41.1	61.1
Northern Rocky Mountains	26.0	74.9
Cascade Range, high heat-flow zone	64	100
Coastal province	24.5	39.8

Readers should verify the data reported here before making significant development decisions. If, for example, a heat-pump installation is contemplated for a particular well reported here, minimum data verification should include:

- determining the temperature and flow from the well,
- measuring pH,
- having a new chemical analysis done to guide the selection of pipe and other materials, and
- verifying that water rights allow the proposed development.

As noted above, an exhaustive bibliography and index of geothermal resources and development in Washington State was compiled as part of the present effort to update the state's geothermal resource database. For the compilation, Rebecca Christie, a staff librarian for the Division of Geology and Earth Resources, used the resources of the libraries of the Division of Geology and Earth Resources, the Washington State Library, the Washington State Energy Office, the Washington State Department of Ecology, the Geo-Heat Center of the Oregon Institute of Technology, and the Geothermal Resources Council in Davis, CA. We recommend the bibliography as a starting point for anyone interested in learning about, searching for, or developing geothermal resources in Washington. We made extensive use of the bibliography to assure that we did not overlook important sources of data.

In order to facilitate assessment and development of geothermal resources in the future, this database has been established on the geographic information system (GIS) of the Washington State Energy Office (WSEO). The GIS allows users to easily combine and evaluate the geothermal data with many other kinds of spatial data. WSEO is, for example, cooperating with the State Superintendent of Public Instruction's office to study the occurrence of warm wells near school buildings, especially those that are about to be remodeled, in order to evaluate the practicality of heating some of the schools with geothermal water-source heat pumps.

ACKNOWLEDGMENTS

We thank Ruth Kroneman and Mike Adams of the University of Utah Research Institute for providing chemical analyses and information and advice about the analyses. Phil Crane and Gene Potts of the Washington State Department of Ecology Central Regional Office in Yakima provided access and help with the extensive collection of water well reports housed in that office, and Dan Weis of Ecology's Eastern Regional Office in Spokane helped with that office's equally extensive collection of water well reports. Luis Fuste of the U.S. Geological Survey's Water Resources Division in Tacoma, WA, sent the latest WATSTORE data. Don Saul of the Washington State Energy Office established the database on the Energy Office's geographic information system and patiently made several updates. He also generated Figure 2. Rebecca Christie helped us to be reasonably confident that we had found all important sources of data. Many well owners allowed us, always cheerfully, to sample their wells for chemical analysis. Carl F. T. Harris did the layout and final cartography on Plates 1 and 2. Jari Roloff and Kitty Reed did editing and report layout. This report benefited from reviews by Gene Culver of Oregon Institute of Technology and Howard Ross of the University of Utah Research Institute. Through their help, all these people have undoubtedly made this report better than it otherwise would have been.

DATA FORMAT

This report is available in three forms: (1) as a paper report, (2) on disk (5.25-inch 1.2MB or 3.5-inch 1.44MB) for IBM-compatible personal computers, and (3) as an ARC-INFO geographic information system (GIS) coverage and associated database. In the IBM disk version, the text is offered in ASCII and WordPerfect 5.1 formats (the figures and plates are not included), and Appendix A (Descriptive and thermal data for wells and springs), Appendix B (Chemical data for wells and springs), and Appendix C (Convectively heated(?) wells) are present as Lotus 1-2-3 ".WK1" files. The Lotus files are readable by most spreadsheet programs. The paper and disk versions are available from the Washington Division of Geology and Earth Resources at the address given for author Schuster. For details about the ARC-INFO coverage, contact the Washington State Energy Office at the address listed above for author Bloomquist.

Appendices A and B form the main body of this report. Generally, both tables include data fields that the University of Utah Research Institute requested all the investigators in the different states to use. The I.D., Site Name, Twp N, Rng, Sec, and Part Sec are repeated from Appendix A so that occurrences can be easily correlated between the two tables. See the notes in Appendix B for information on the significance of charge balance and mass balance and how they were calculated. Briefly, these two calculations are indications of the quality and (or) completeness of chemical analyses.

FLUID CHEMISTRY

New Fluid Sampling

Appendix B presents more than 200 chemical analyses from thermal wells and springs. We collected 18 of these analyses, dated 1994 and with no reference in Appendix B, and the University of Utah Research Institute analyzed them as part of the present investigation. Several criteria guided the selection of the 18 sampled wells. All but one of these wells are in the six-county (Adams, Benton, Franklin, Grant, Walla Walla, and Yakima County) area of the Columbia Basin where most of the state's warm wells are located (Figs. 1 and 2). We concentrated our sampling effort here because

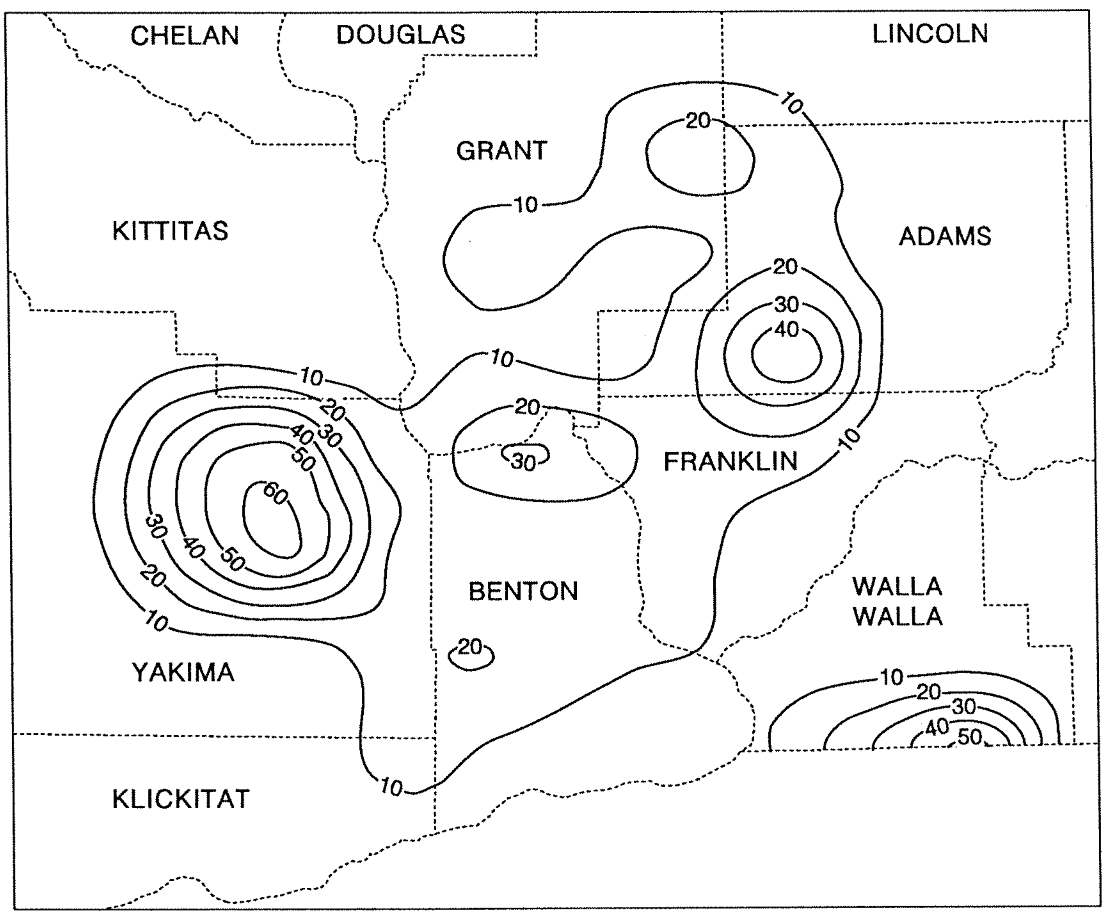


Figure 2. Areal density of thermal well and spring occurrences in Washington. Contours show the number of thermal wells and springs per 500 km^2 (193 mi^2). Only the part of the state shown reaches a density as high as 10 occurrences per 500 km^2.

of the many possibilities for early development that might be assisted by the availability of good chemical analyses and because we could conveniently and economically sample these wells.

Further, we wanted at least some of the samples to come from areas that did not have good chemical representation in the database. We avoided irrigation and domestic wells—irrigation wells because they were not in use during the winter and spring months when we had to do the sampling, and both irrigation and domestic wells because, in many instances, they do not offer much prospect for development because of potential water rights limitations and (or) lack of a significant nearby heat load. Publicly owned (mostly municipal) wells used year-round and located near potential heat loads were attractive targets for sampling because they offer good possibilities for early development.

We sampled 12 municipal wells (AD008, BE022, GR056, GR060, GR063, KS011, YA018, YA050, YA051, YA068, YA074, and YA141), one domestic water association well (FR010), one well at the Washington State University Irrigated Agriculture Research and Extension Center near Prosser (BE039), one school well (GR014), and three wells currently used for their heat, two as heat sources for heat pumps (WA086 and YA226) and one used for a car wash (YA211).

Observations

Several general observations can be made about the fluid chemistry. First, well waters are very dilute. Figure 3 shows the average concentration of eight major chemical species in statewide thermal wells and thermal springs and in cool wells in the six-county area of the Columbia Basin. The average total for these eight major chemical species for thermal wells is only 260 ppm. All of the well waters for which there are analyses in Appendix B are potable, at least with respect to inorganic constituents.

Figure 4 plots Na+K as a percentage of major cations against HCO_3+ CO_3 as a percentage of major anions for statewide thermal springs and wells and for six-county area cool wells and springs. All thermal well waters have HCO_3 as the dominant anion. They may have either Na+K or Ca+Mg as the dominant cation, with Na+K dominant somewhat more commonly.

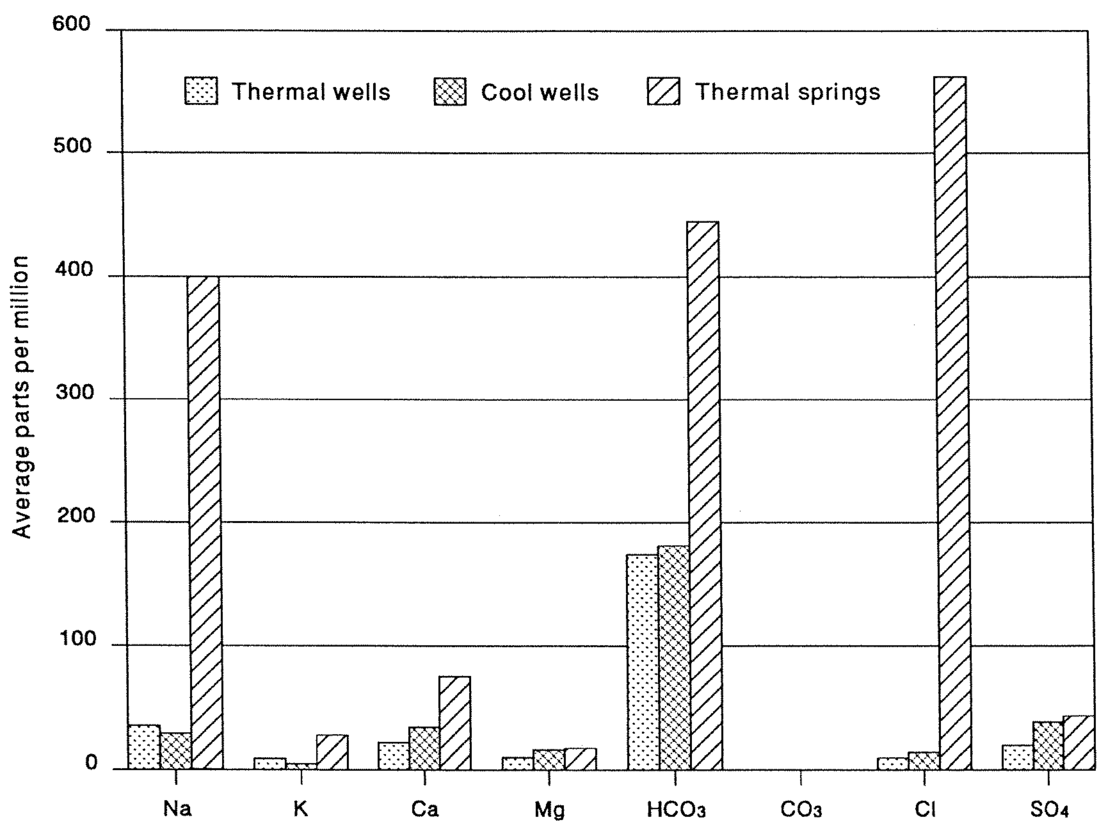


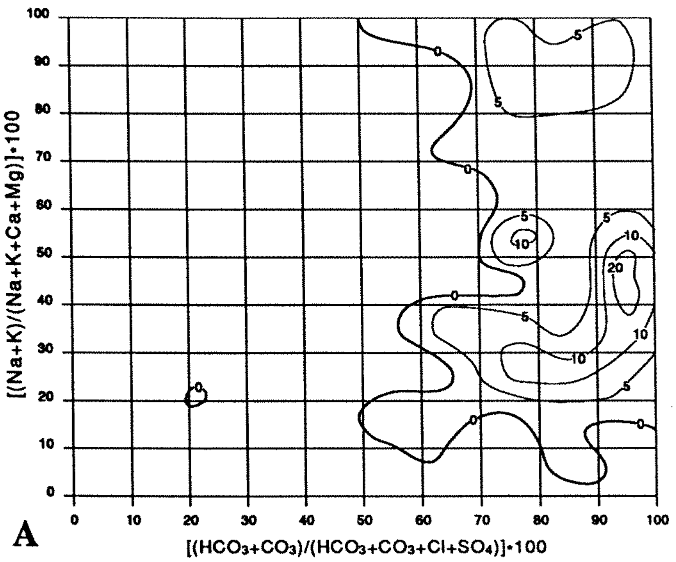
Figure 3. Average concentrations of major chemical species in thermal wells and thermal springs statewide and in cool wells in the six-county area (Adams, Benton, Franklin, Grant, Walla Walla, and Yakima Counties) of the southwestern and south-central Columbia Basin. The graph represents 204 analyses from thermal wells, 134 analyses from cool wells in the six-county area, and 34 analyses from thermal springs.

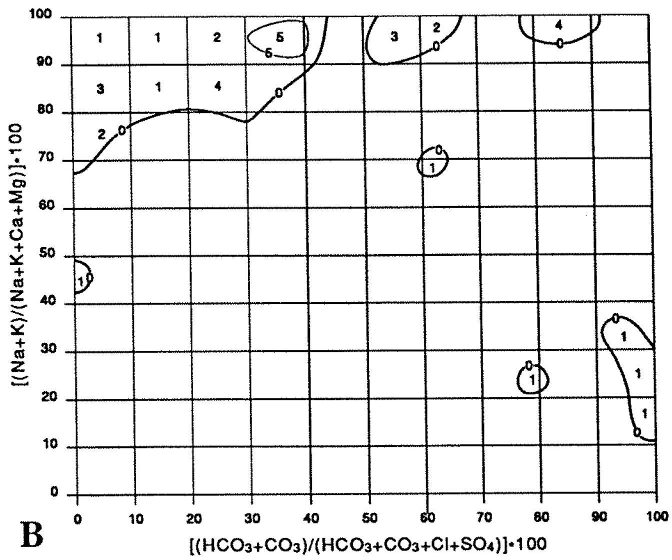
Although they are not tabulated in this report, we plotted 134 water analyses from cool wells in the six-county area in Figure 4C in order to compare them with the thermal wells (Fig. 4A) and springs (Fig. 4B). All of the analyses from cool wells are from Van Denburgh and Santos (1965). The thermal and cool wells are similar. Most of the cool wells are HCO_3 dominated. Like the thermal wells, the cool wells may be dominated by either Na+K or Ca+Mg, but in the cool wells Ca+Mg dominance is somewhat more common.

The thermal springs differ from the wells. Na+K is the chief cation, and the chief anions are HCO_3+CO_3 or Cl+SO_4, with Cl+SO_4 somewhat more dominant. The springs are also much less dilute than the well waters. The major chemical species in the springs have an average total of 1,570 ppm.

The wells and springs are located in different geologic provinces. Most of the springs are in the andesitic volcanic terrain of the Cascade Range, whereas the wells are in the basaltic and continental sedimentary terrain of the Columbia Basin. Because they exceed 20°C at the Earth's surface and are less dilute than the well waters, the springs must be waters that have circulated more deeply in the crust or circulated in areas of higher geothermal gradients or local heat sources. These differences are, presumably, responsible for the differences in chemistry.

We did not concentrate on the interpretation of geothermometers during this investigation. First, the geology of the Columbia Basin (Schuster, 1994a,b; Reidel and Fecht, 1994a,b; Gulick, in press; Schuster, in press) and what is known about the regional geothermal gradient (about 40°C/km; Blackwell and others, 1985) suggest that there are





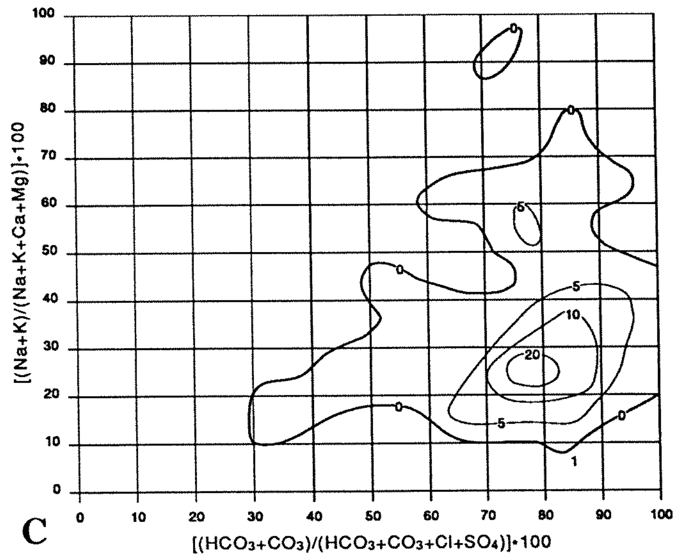


Figure 4. Na+K as a percentage of major cations plotted against HCO_3+CO_3 as a percentage of major anions for statewide thermal wells, statewide thermal springs, and six-county cool wells. Percentages were calculated from concentrations in milli-equivalents per liter. The heavy-line contour encloses all points, and the other contours enclose areas where 5, 10, or 20 points occur per 1 percent of the area of the plot. **A**. Thermal wells, statewide; 204 analyses. **B**. Thermal springs, statewide; 34 analyses. Because there are so few analyses represented, this plot also shows the number of individual chemical analyses that plot in each 1 percent area. **C**. Cool wells, six-county area of Columbia Basin; 134 analyses.

no shallow heat sources (igneous intrusives) beneath the Columbia Basin, and thus no areas with extremely high temperature gradients or other high-temperature geothermal manifestations. The last extrusive igneous activity, the waning flows of the Columbia River Basalt Group, occurred about 6 million years ago (Fig. 5). Also, the dilute ground waters of the Columbia Basin differ from hot-spring waters on which the empirical geothermometers are based, so calculating geothermometers in an effort to try to determine whether high temperatures exist at depth may not be a valid exercise.

The database presented here has been compiled from a variety of sources spanning more than 90 years. The data were collected by many people for many reasons, and there are certainly errors, such as incorrect well depths and chemical analyses representing mixed shallow and deep aquifers, and many other inconsistencies. Taken together, the limitations make this data set a rather poor one to use for making specific interpretations for specific locations. This database is better used on a sort of statistical basis, where one can try to recognize general trends and the "big picture" without trying to get specific.

GEOLOGIC, HEAT-FLOW, AND HYDROLOGIC SETTING

Plates 1 and 2 and Table 1 clearly show that geothermal resources in Washington are not randomly distributed. Thermal springs are largely confined to the Cascade Range (27 of 34 are in the Cascades), and most are spatially associated with a stratovolcano or a fault, where water is heated during deep circulation. Thermal wells, on the other hand, are strongly associated with the Columbia River Basalt Group (Fig. 6) and the Columbia Basin—the Columbia River Basalt Group and the Columbia Basin are almost co-extensive and the terms are used interchangeably herein. This area includes the various subbasins that form the western, southwestern, and south-central parts of the Columbia Basin in Washington. This area of subbasins bounded by faulted folds is referred to as the Yakima fold belt (Fig. 1). Some 97 percent of the state's 941 thermal wells are located in areas underlain by rocks of the Columbia River Basalt Group or suprabasalt sediments.

Because it is not practical to pursue exploration and development of high-temperature geothermal resources in the Cascade Range, and because Washington's thermal wells are strongly concentrated in the Columbia Basin, discussion will focus on the resources of the basin. Moreover, there is a strong tendency for thermal wells to occur in the western, southwestern, and south-central parts of the Washington portion of the Columbia Basin (Fig. 2). Adams, Benton, Franklin, Grant, Walla Walla, and Yakima Counties account for

SERIES	GROUP	FORMATION	MEMBER	ISOTOPIC AGE (Ma)	MAGNETIC POLARITY
MIOCENE upper	COLUMBIA RIVER BASALT GROUP	SADDLE MOUNTAINS BASALT	LOWER MONUMENTAL MEMBER	6	N
			ICE HARBOR MEMBER	8.5	
			basalt of Goose Island		N
			basalt of Martindale		R
			basalt of Basin City		N
			BUFORD MEMBER		
middle			ELEPHANT MOUNTAIN MEMBER	10.5	N,T
			POMONA MEMBER	12	R
			ESQUATZEL MEMBER		N
			WEISSENFELS RIDGE MEMBER		
			basalt of Slippery Creek		N
			basalt of Tenmile Creek		N
			basalt of Lewiston Orchards		N
			basalt of Cloverland		N
			ASOTIN MEMBER	13	
			basalt of Huntzinger		N
			WILBUR CREEK MEMBER		
			basalt of Lapwai		N
			basalt of Wahluke		N
			UMATILLA MEMBER		
			basalt of Sillusi		N
			basalt of Umatilla		N
		WANAPUM BASALT	PRIEST RAPIDS MEMBER	14.5	
			basalt of Lolo		R
			basalt of Rosalia		R
			ROZA MEMBER		T,R
			FRENCHMAN SPRINGS MEMBER		
			basalt of Lyons Ferry		N
			basalt of Sentinel Gap		N
			basalt of Sand Hollow	15.3	N
			basalt of Silver Falls		N,E
			basalt of Ginkgo		E
			basalt of Palouse Falls		E
			ECKLER MOUNTAIN MEMBER		
			basalt of Shumaker Creek		N
			basalt of Dodge		N
			basalt of Robinette Mountain		N
		GRANDE RONDE BASALT	Sentinel Bluffs unit	15.6	N_2
			Slack Canyon unit		
			Fields Spring unit		
			Winter Water unit		
		PRINEVILLE BASALT	Umtanum unit		
			Ortley unit		
			Armstrong Canyon unit		
			Meyer Ridge unit		R_2
			Grouse Creek unit		
			Wapshilla Ridge unit		
			Mt. Horrible unit		
		PICTURE GORGE BASALT	China Creek unit		N_1
			Downey Gulch unit		
			Center Creek unit		R_1
			Rogersburg unit		
			Teepee Butte unit		
			Buckhorn Springs unit	16.9	
lower		IMNAHA BASALT	See Hooper and others (1984) for Imnaha units	17.0	R_1
					T
					N_0
				17.3	R_0

Figure 5. Generalized nomenclature and stratigraphic relations of the Columbia River Basalt Group. Sedimentary interbeds occur at many of the unconformities, shown by jagged horizontal lines between units. Modified from Reidel and others (1989).

786 (83.5 percent) of Washington's thermal wells. Yakima County alone contains 259 thermal wells, and Adams, Benton, Grant, and Walla Walla Counties each contain more than 100, followed by Franklin County with 60.

The Columbia River Basalt Group is a thick succession of tholeiitic basalts that was erupted from fissures in southeastern Washington, northeastern Oregon, and western Idaho between about 17 million and 6 million years ago (Fig. 5). More than 300 lava flows once covered (and mostly still do) an area of about 164,000 km^2 (63,000 mi^2) and have an aggregate volume of about 174,000 km^3 (42,000 mi^3). The largest flows exceeded 2,000 km^3 (500 mi^3) each, and some flows advanced more than 750 km (460 mi) from their source areas to the Pacific Ocean (Tolan and others, 1989). As time went on eruptions became less frequent and generally less voluminous, and part of the basin subsided. The thickest accumulation of basalts is in the area of Richland, Kennewick, and Pasco (Plate 2), close to the geographic center of the area covered by the basalts. Interflow sediments are present between many pairs of flows.

Both during volcanism and after eruptions ceased, the Yakima fold belt developed. The fold belt is a series of sharply defined anticlinal crests that trend northwest, west, and southwest. Most of the anticlines are broken by faults. There are broad, flat, basinal synclines between the fold crests, and some synclines contain as much as 400 m of suprabasalt sediments derived from the Cascades to the west and deposited by the Yakima River and smaller streams and derived from highlands to the north and east and deposited by the Columbia River.

By the end of Grande Ronde Basalt time, about 15.6 million years ago, more than 90 percent of the Columbia River Basalt Group had been erupted (Tolan and others, 1989; Fig. 5). While the gentle westward and southwestward slope of the surface of the Grande Ronde Basalt seen in Figure 7 in the northern and eastern parts of the basin (Pullman–Connell–Coulee City–Cheney area) had already developed and guided the basalt flows toward the west, most of the rest of the structural relief developed after Grande Ronde Basalt time. The eastward slope at the west edge of the area shown in Figure 7 is due to postbasalt uplift of the Cascades, and the culmination in southeastern Washington is the Blue Mountains, which developed after the Grande Ronde Basalt was emplaced.

Flow units of the Columbia River Basalt Group are commonly separated by unconformities (Fig. 5), and, especially near the western margin of the subsiding basin of basalt deposition, sedimentary interbeds between basalt flows are common. In the western, southwestern, and south-central parts of the Columbia

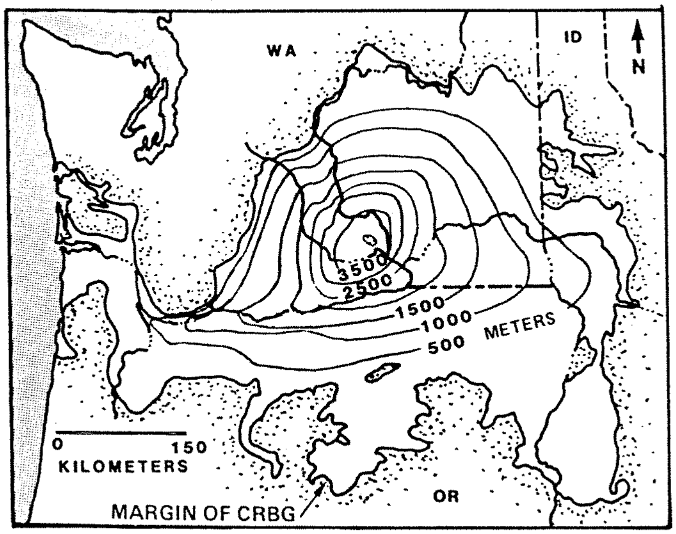


Figure 6. Extent of the Columbia River Basalt Group and thickness of the Grande Ronde Basalt. The Grande Ronde Basalt thickness contours are in meters. From Reidel and others (1989).

Basin in Washington these interbeds and some postbasalt sediments are collectively known as the Ellensburg Formation. Deposition of Ellensburg sediments and younger sedimentary units accounts for as much as 400 m of postbasalt sedimentary rocks in some of the subbasins of the Yakima fold belt.

Within the Columbia River Basalt Group many flow bottoms are pillowed, rubbly, or mixed with subjacent sediments, and many flow tops are rubbly, oxidized, vesicular, and (or) scoriaceous. The flow tops and bottoms and interflow sediments are generally quite porous and permeable and make good aquifers. Many of the flows and the associated aquifers are of great lateral extent. In contrast, the interiors of most flows, although jointed, are of low permeability and act as aquitards.

The recharge areas for these extensive aquifers are on the western side of the basin in the Cascades foothills and on the eastern side in the Palouse hills and the mountains of eastern Idaho. The ridges of the Yakima fold belt are not significant recharge areas because the area is arid.

The combination of basinal shape, laterally extensive aquifers that are confined between relatively impermeable basalt flows, and recharge areas to the east and west means that the hydrologic gradients slope into the deepest part of the basin near Pasco and into the subbasins of the Yakima fold belt. In these areas the deeper aquifers are confined and under artesian pressure.

Columbia Basin heat flow and temperature gradients are certainly factors in the occurrence of warm wells. Table 2 shows the average heat flows and temperature gradients for the physiographic provinces of Washington, and Figure 8 is a temperature-depth plot of Washington's thermal wells and six-county cool wells. Compared to the Northern Rocky Mountains province and the high heat-flow zone of the Cascades province, the Columbia Basin does not have high heat flow. In fact, heat flow in the Columbia Basin is approximately equal to the worldwide average. However, because the thermal conductivity of the rocks is relatively low, the Columbia Basin has a higher-than-worldwide-average temperature gradient. At 41°C/km, it also has the highest regional temperature gradient in Washington except for the high heat flow zone of the Cascades. With this gradient and an average surface temperature of 15°C, which is reasonable for the warmer areas of the basin, the 20°C isotherm can be reached in a well only 122 meters deep. For comparison, if the gradient were only 20°C/km and the average surface temperature 10°C, it would take a well 500 meters deep to reach the 20°C isotherm. A productive aquifer must also be intersected, of course, if a useful well is to be had.

Most of Washington's thermal wells are located in the Columbia Basin, and more particularly, in a six-county area in the western, southwestern, and south-central parts of the Columbia Basin, for the following reasons:

- There are more deep wells than in other parts of the

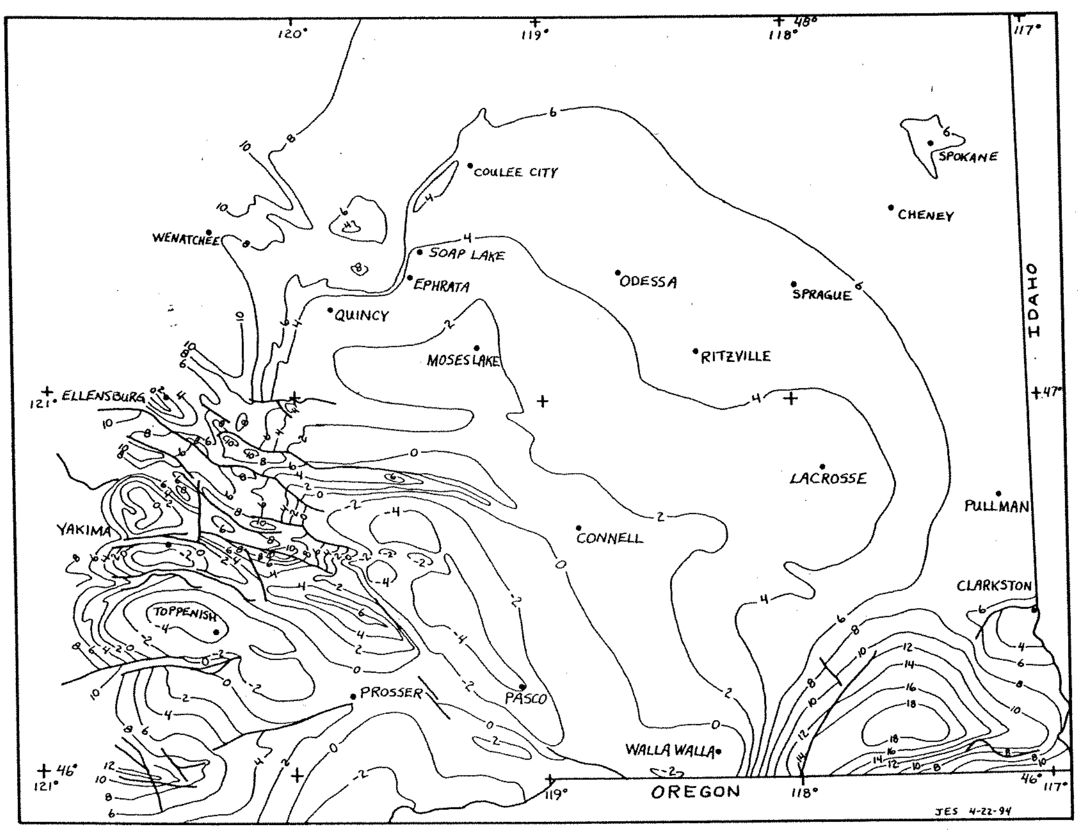


Figure 7. Structure contours on the top of the Grande Ronde Basalt. Contours are in hundreds of meters above sea level. (Modified from Bentley, 1985).

state, which provides more opportunity for penetrating thermal aquifers.

- At 41°C/km, the regional geothermal gradient is favorable.
- The hydrologic setting is favorable. Laterally extensive aquifers, low vertical permeability, complex basinal structural shape, and recharge areas to the west and far to the east provide for the depth of circulation and residence time necessary to produce thermal ground water.

We may generalize to say that the typical thermal well in Washington occurs in the Columbia Basin, especially the six-county area, has a temperature gradient within a normal range of 30°–50°C/km, and is heated by conduction. That is, the heat reached the well by conduction through the Earth's crust from the mantle below, in the same way that heat moves through any solid body, such as a block of steel or concrete.

In addition to these normal or typical thermal wells, there are 192 wells across the state (Appendix C), including 140 wells in the six-county area, that do not fit the scenario above. These wells are too warm to have been heated conductively in a gradient of 50°C/km. More specifically, the wells have temperatures higher than that calculated by the following formula: T = 15°C + (0.05°C/m) (depth), where depth is in meters.

Of the 140 wells, four have "B" gradients (gradients calculated from bottom-hole temperatures and estimated mean annual surface temperatures) in excess of 150°C/km, and errors in the data are suspected. Twenty additional wells (located in Townships 12–14 N. and Ranges 25–27 E.) on the Hanford Reservation of northern Benton County are warm because they have been used for the disposal of heated fluids (S. P. Reidel, Westinghouse Hanford Co., oral commun., April 1994; Newcomb and others, 1972, p. 32-35). These 24 wells are not considered further.

In the remaining 116 six-county wells, the anomalous temperatures may be due to some natural cause. Some of these wells are located in areas where mapped geologic structures might be responsible for the circulation of warmer, deeper water to the higher levels penetrated by the wells. Others occur where there are no mapped geologic structures or significant thicknesses of suprabasalt sedimentary deposits that might provide for enhanced vertical permeability. For these wells no ready explanation for their anomalously high temperatures is currently available. Most of the wells occur in basinal areas of the Yakima fold belt where the available information indicates that many of the wells penetrate mostly suprabasalt sedimentary rocks. Some combination of vertical permeability in these rocks and leakage from the confined basalt aquifers below may be responsible for the abnormal temperatures of the wells.

Perhaps suprabasalt sediments are the most important factor in providing vertical permeability and allowing upward movement of leakage from deeper, confined aquifers. There are "B" gradients and standing water levels in the database for some of the 116 wells, and Table 3 shows their average "B" gradients and standing water levels. In Table 3, these wells are called "convectively heated(?) thermal wells". The table compares these wells with others, both within and outside of the six-county area, whose temperatures can be accounted for by heating under the influence of "normal" conductive temperature gradients between 30° and 50°C/km. Average "B" gradients and standing water levels are significantly higher for the anomalously warm wells.

The higher "B" gradients could be due to errors in the database, local heat sources in the crust, or variations in deep crustal heat flow and temperature gradients from place to place. The higher standing water levels might be due to wells being drilled into shallower aquifers and have no relation to a higher temperature gradient, but if the shallower standing water levels are due to wells being developed in shallower aquifers, these wells should not produce higher average "B" gradients. The higher "B" gradients and shallower standing water levels occurring together suggests that some kind of convective water movement from deeper, warmer aquifers

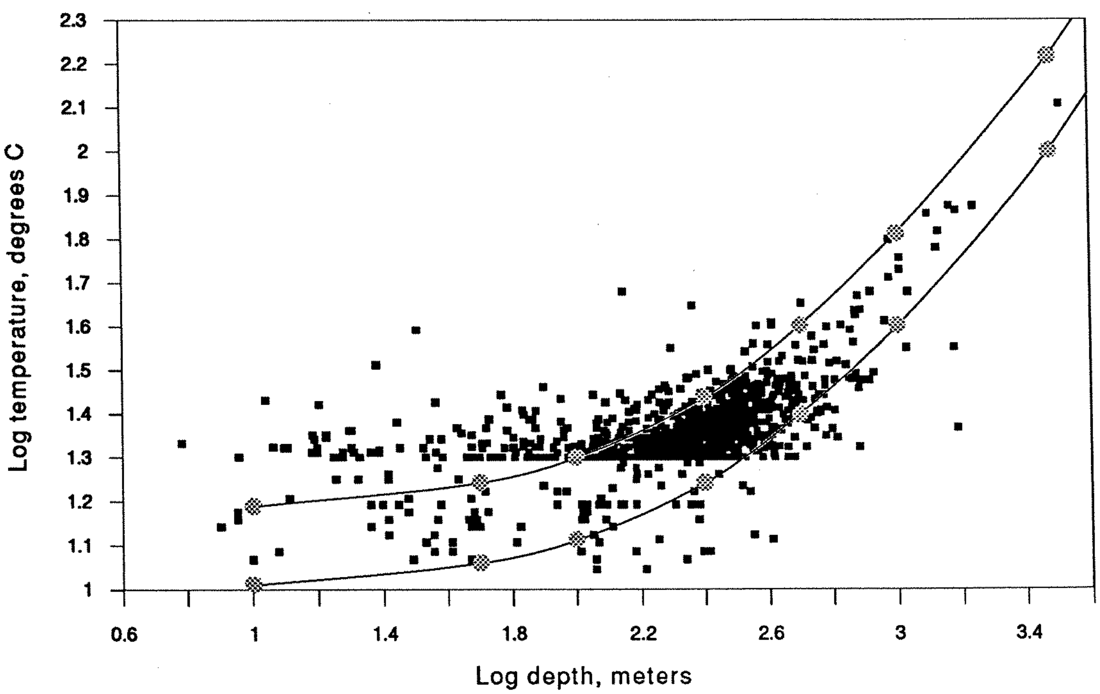


Figure 8. Temperature-depth plot of Washington's thermal wells and six-county cool wells, with the zone of normal temperature gradients, 30°–50°C/km, shown between the two curved lines. Wells falling within the normal gradient zone may be heated by normal, conductive geothermal gradients. Those falling below the zone may be cooled by waters from upper, cooler aquifers flowing down the wells. Wells above the normal gradient band are too warm to have been heated by a normal range of gradients. These wells may be warmed by artificial warm-water recharge or by warm water leaking from deeper aquifers and reaching the wells because of higher-than-normal vertical permeability provided by faults and folds or the inherently greater permeability of suprabasalt sediments.

Table 3. Comparison of "B" gradients and standing water levels from convectively heated(?) thermal wells and from conductively heated(?) thermal wells. "B" gradients are temperature gradients calculated from bottom-hole temperatures and estimated mean annual surface temperatures. *Convectively heated(?) thermal wells* are defined as those in Appendices A and C that are too warm to have been heated by conductive heat transfer under the influence of a conductive temperature gradient in the range of 30°–50°C/km. More specifically, the wells have temperatures higher than yielded by the formula, T = 15°C + (0.05°C/m)(depth), where the well depth is in meters. From this number of wells some were excluded—(1) those on the Hanford Reservation that are known to be warm because of artificial recharge, and (2) wells with "B" gradients higher than 150°C/km, where gradients could be due to errors in the data. *Conductively heated(?) thermal wells* are defined as those in Appendix A that are at or cooler than a temperature that falls within the normal temperature gradient band shown on Figure 8. Their temperatures are equal to or less than those yielded by the formula above. These wells are probably heated by a normal conductive temperature gradient in the range of 30°–50°C/km. Those wells at temperatures below the 30°–50°C/km gradient band of Figure 8 may be cooled by water from a shallow aquifer(s) flowing down the well. n = number of wells; s.d. = standard deviation.

	"B" gradient (°C/km)	Standing water level (meters)		"B" gradient (°C/km)	Standing water level (meters)		"B" gradient (°C/km)	Standing water level (meters)
All wells, statewide	n = 374 mean = 47.5 s.d. = 15.7	n = 524 mean = 63.0 s.d. = 56.5	Convectively heated(?) wells, statewide	n = 40 mean = 79.9 s.d. = 20.1	n = 108 mean = 31.1 s.d. = 35.4	Conductively heated(?) wells, statewide	n = 334 mean = 43.7 s.d. = 9.3	n = 416 mean = 71.4 s.d. = 58.0
All wells, six-county area	n = 319 mean = 47.3 s.d. = 14.4	n = 452 mean = 64.2 s.d. = 55.8	Convectively heated(?) wells, six-county area	n = 33 mean = 76.6 s.d. = 18.4	n = 83 mean = 30.8 s.d. = 35.8	Conductively heated(?) wells, six-county area	n = 286 mean = 43.9 s.d. = 9.1	n = 369 mean = 71.7 s.d. = 56.8
All wells, statewide outside six-county area	n = 55 mean = 49.1 s.d. = 21.3	n = 72 mean = 56.0 s.d. = 60.0	Convectively heated(?) wells, statewide outside six-county area	n = 7 mean = 95.2 s.d. = 20.7	n = 25 mean = 32.0 s.d. = 34.0	Conductively heated(?) wells, statewide outside six-county area	n = 48 mean = 42.4 s.d. = 10.2	n = 47 mean = 68.7 s.d. = 66.5

produces a "mound" of warmer ground water in the areas of these wells. Higher "B" gradients and higher standing water levels would also be produced by injection of warm fluids into the wells, as on the Hanford Reservation.

Whether these anomalous wells are warmed artificially or naturally is not known. We point out their existence to emphasize the fact that some wells in the six-county area, many of which seem to be associated with the suprabasalt sediment-filled subbasins of the Yakima fold belt, have apparent average temperature gradients of about 77°C/km rather than 41°C/km. These wells constitute an even more attractive low-temperature geothermal resource than the "normal" thermal wells because the 20°C isotherm can be reached in a well, on average, only 65 meters deep.

LEGAL AND INSTITUTIONAL SETTING

Geothermal resources are related to water and mineral resources, to the surface and subsurface estates, and to water rights and mineral titles. In establishing the regulatory framework within which geothermal resources are developed, legislative bodies must first describe the physical properties that distinguish geothermal resources from water and mineral resources, thus allowing for a clear establishment of ownership, leasing, taxation, and development regulations, and then establish the relationship between geothermal resources, ground water, subsurface minerals, and other established resources. Ideally, the framework would look forward to future leases, exploration, and development activities while looking backward in order to place geothermal resources into the framework of leases, reservations, and property titles inherited from the past.

Ownership and Leasing

The federal Geothermal Steam Act of 1970 (Public Law 91-581) defines geothermal resources as follows:

> *Geothermal steam and associated geothermal resources means (i) all products of geothermal processes embracing indigenous steam, hot water, and hot brines; (ii) steam and other gas, hot water, and other brines resulting from water, gas, or other fluids artificially introduced into geothermal formations; (iii) heat or other associated energy found in geothermal formations; and (iv) any by-product derived from them (30 U.S.C. 1001).*

On federal lands under the control of the U.S. Forest Service, Bureau of Land Management, or other agency, the federal government claims ownership of all geothermal resources, whether it holds the mineral estate jointly with the surface estate or holds a mineral reservation where the estates have been severed. It is unclear, however, whether federal ownership extends to ground water useful for direct-application purposes where the estates have been severed. The states have primary control of ground water, absent the establishment of a federal enclave.

The Federal Land Policy and Management Act (FLPMA) (15 U.S.C. 1600, et seq.; 43 U.S.C. 170, et seq.) requires the Secretary of the Interior to inventory resources and prepare land-use plans on the basis of those resource assessments. If energy facilities are not included in the plans, conflicting or pre-emptive land uses could prevent development of prime geothermal resource sites. Where energy development is specifically included as an accepted land use, federal agencies must develop a procedure to allow for private energy-resource development. Although FLPMA authorizes sale of public lands for such development, leasing is by far the most common method by which private developers may gain access to public lands.

Surface rights and a priority right to explore, develop, and use geothermal resources on federal lands are acquired through an "Offer to Lease and Leases for Geothermal Resource", issued by the Bureau of Land Management pursuant to the Geothermal Steam Act of 1970 (amended 1988).

In Washington State, the Revised Code of Washington (RCW) defines "geothermal resource" as follows:

> *Geothermal resource means only that natural heat energy of the earth from which it is technologically practical to produce electricity commercially and the*

medium by which such heat energy is extracted from the earth, including liquids or gases, as well as any minerals contained in any natural or injected brines, and associated gas, but excluding oil, hydrocarbon gas, or other hydrocarbon substances (Chapter 79.76 RCW).

Washington's definition thus restricts geothermal resources to those "from which it is technologically practical to produce electricity commercially". Geothermal resources with temperatures below those required for commercial electrical production are considered ground-water resources in Washington, and they are regulated by the Washington State Department of Ecology (DOE). All geothermal resources discussed in this report are considered by the State of Washington to be ground-water resources and are available through appropriation.

The State claims ownership of all ground-water resources underlying State and school lands. In order to gain access to low-temperature geothermal resources below these lands, a commercial lease must be obtained.

The Washington Department of Natural Resources (DNR) manages most State lands—the exception being lands managed by the Washington Department of Fish and Wildlife, Parks and Recreation Commission, and small holdings by other State agencies. Access to non-DNR lands for exploration and development is by permit obtained from the local office of the agency managing the lands.

DNR is responsible for issuing leases on State trust lands for low-temperature geothermal exploration and development for direct use. A Plan of Operation is required by DNR for these activities.

Permitting and Development Requirements

Water rights

In response to the growing concern about the State's ground-water resources, the Washington DOE is legislatively mandated to coordinate the development of ground-water management programs. Local governments are responsible for developing DOE-approved ground-water management plans. Activities within ground-water management areas must comply with ordinances/regulations established as part of a ground-water management plan.

A water-rights permit from DOE is required before any water well can be constructed. When an application is received, DOE will inspect the site, require publication of a public notice of intent, and attempt to resolve any protests that may be filed. A permit allowing construction of the project may be issued if water is deemed to be available, no existing water rights are affected, and the project is found to not be detrimental to the public welfare. Information required for the permit application includes: a section map, identification of the source of the water supply, an explanation of how the water will be used, the exact location of the point of withdrawal, a legal description of the property on which the water is to be used, and the signature of the legal owner. A final certificate of water rights is issued only after the project is complete and the water is put to use.

As of early 1994, DOE was 3 to 4 years behind in adjudicating water rights, and in some areas, a total ban on new water rights is in effect, pending the outcome of legal challenges.

In 1992, the Washington State Energy Strategy Committee recommended that DOE should assess and revise its procedures for granting water rights to protect water resources while allowing development of these geothermal energy resources.

DOE also regulates the drilling of water wells within the state, regardless of land ownership. The construction of water wells must conform to RCW 18.104 to ensure the protection of public resource aquifers. DOE releases the following:

- Minimum Standards for Construction and Maintenance of Wells, Chapter 173-160 WAC;
- Rules and Regulations Governing the Regulation and Licensing of Well Contractors and Operators, Chapter 173-162 WAC; and
- Water Well Construction Act (197), Chapter 18 RCW.

Discharge and reinjection

Disposal of geothermal water after heat extraction is an increasingly important area of concern to the State and developers alike. The National Pollutant Discharge Elimination System (NPDES) or State Waste Discharge Permit, Water Quality Certification, and (or) Short-Term Modification of Water Quality Standards ensure that water quality will not be adversely affected. According to DOE, a NPDES permit is required whenever a discharge will be made into any surface water of the state. The State Waste Discharge Permit is required for virtually all discharges, for example, onto land surfaces or by subsurface injection.

The State Water Pollution Control Act generally prohibits the discharge by any person of any material that "shall cause or tend to cause pollution" of the waters of the state. Pollution is defined broadly to include any alteration of the physical, chemical, or biological properties of water or any *change in temperature*, taste, color, turbidity, or odor, or the discharge of any substance likely to create a nuisance or a detriment to any conceivable beneficial use (RCW 10.48.010). "Discharge of pollutants" has been broadly construed to include discharges of materials that *existed* in the water before it was brought into a facility and used.[1]

The State's policy is to maintain the highest possible standards to ensure the purity of all waters of the state by requiring the use of all known, available, and reasonable methods by industries and others to prevent and control the pollution of Washington's water. Permits issued by DOE under NPDES and the State Waste Discharge Permit Program require the use of "all known, available, and reasonable methods of treatment" (AKART) before discharge. The Water Pollution Control Act requires sources to use AKART regardless of the effect of existing discharges on water quality (Backer, 1992).

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[1] (Crown Zellerbach *v.* State Department of Ecology, Pollution Control Hearing Board (PCHB) Nos. 85-223 and 85-242 [1986].) In this case, the PCHB held that discharge of solids into the receiving water constituted "discharge of pollutants," even though the solids were naturally occurring and were brought in with the plant's intake water.

Some developers have recently indicated that they are not pursuing geothermal direct-use projects because of the difficulty of obtaining a discharge permit and inconsistencies in interpretation of discharge requirements by DOE personnel. If widespread development of the state's low-temperature geothermal resources is to take place, questions relating to obtaining water rights and discharge permits must be resolved.

Secondary Beneficial Uses of Ground Water

In 1982, the Washington State Department of Health allowed the City of Ephrata to reintroduce ground water that had first passed through a heat pump, back into the city's domestic water supply system. This precedent-setting project was the first in the U.S. to receive such permission. Health departments in several other states followed Washington's lead in allowing for the construction and operation of these so-called dual-function water supply systems. Several potential project developers have recently reported that the Department of Health appears to have reversed itself and is now informing developers that such practice is not permissible.

The Washington State Energy Office (WSEO), in response to a recommendation of the Energy Strategy Committee, has recently formed the Energy Strategy Interagency Task Force that will, among other things, address issues relating to the use of the state's low-temperature geothermal resources including:

- water rights,
- discharge of geothermal water and reinjection, and
- secondary beneficial use of geothermal water in domestic water supply systems.

District Heating System Regulation

Washington State has adopted a comprehensive legislative and regulatory scheme to encourage the development of district heating systems that use geothermal and other renewable resources and high-efficiency cogeneration. Washington's legislation and implementing regulations achieve two important objectives for district heating systems that use certain preferred heat resources:

- They grant local government entities clear and broad authority to undertake and finance such systems.
- They provide private district heating developers with a simplified regulatory framework and market incentives to encourage development.

Local governments, including counties, cities, towns, and certain utility districts, are covered by Washington's 1983 "Heating Systems" statute (Washington Revised Code Annotated, Chapter 35.97). The statute authorizes these entities to construct, purchase, acquire, extend, maintain, and operate heating systems using preferred resources such as biomass, *geothermal*, cogeneration, solar, and waste heat to supply their citizens or others with heating services. The statute was amended in 1987 to allow additional local government entities to become involved and additional heat sources, such as sewage effluent, to be included as "preferred resources".

The statute confers on these public entities full power to regulate and control the use, distribution, and price of heat supplied through their systems, free from Washington Utilities and Transportation Commission (UTC) jurisdiction. It also grants expansive authority to finance heating systems through such mechanisms as local improvement-district bonds and warrants, special assessments, and revenue bonds and to exercise other authorities needed to further the statutory objectives. In short, the statute addresses most of the central concerns of local governments considering district heating development and clarifies their authority in areas where uncertainty might otherwise discourage development.

Washington's private district heating developers are subject to a different legislative scheme set forth in the State's 1983 "Heat Supplier" statute (Washington Revised Code Annotated, Chapter 80.62). That statute rests on a legislative finding that traditional public-utility regulation may pose unnecessary barriers to the use of preferred heating resources, but that some minimal regulation may be needed to protect heating-system customers. Reflecting these findings, the statute adopts a streamlined "operating permit" system that is considerably less burdensome to suppliers than traditional regulation, but retains basic customer protections appropriate to the competitive environment for heating services.

Under this system, private suppliers proposing to furnish heat from such resources as *geothermal*, biomass, waste heat, and cogeneration are exempted from the Washington Utilities and Transportation Commission's general jurisdiction. They are subject only to limited jurisdiction conferred by the statute that consists principally of the legislature's direction to the UTC to grant a nonexclusive operating permit to provide heating services within a designated service territory to a prospective heat supplier that demonstrates that:

- It is qualified and financially responsible to provide the services offered.
- Its proposed system design is adequate to provide those services.
- Its proposed customer contract specifies the term of service and the rates or rate formula, and otherwise assures adequate service.

The 1983 statute was amended in 1987 to include additional resources under the exemption.

To minimize regulatory delays and costs, encourage competition, and allow suppliers to earn market-based returns, the statute circumscribes the UTC's authority to approve heating rates. It directs the UTC to base rate approvals not on traditional calculations of the supplier's cost of service or rate of return on investment, but on the reasonableness of the proposed rates in relation to rates charged for comparable heating services available in the area. Instead of imposing the low fixed utility rate of return reflecting the historically low risk profiles of conventional utilities, this approach offers suppliers an incentive to provide low-cost services and capture any corresponding market rewards. To increase this incentive and enhance certainty and predictability, the statute further provides that rates less than 80 percent of rates for comparable services will be automatically approved.

Summary

The legal and institutional framework relating to the development of the state's low-temperature geothermal resources needs serious review and revision if geothermal resources are to play a major role in meeting the state's future energy requirements. If developers cannot obtain water rights or, where available, obtain them in a timely manner, potential projects will be lost or forced to use conventional fuels. Disposal and injection requirements are becoming serious concerns to potential developers and may affect their ability to pursue projects. Equally serious is the apparent reversal of policy by the Department of Health in regard to secondary use of water for domestic purposes once it has been passed through a heat pump. All three of these issues need to be addressed and resolved by the new Energy Strategy Interagency Task Force.

Washington has adopted a comprehensive legislative and regulatory framework to encourage developing district energy systems based on preferred resources such as geothermal. If resolution of the other issues reflects the same desire to encourage development, the resulting framework should be a model for the entire nation.

PAST AND CURRENT LOW-TEMPERATURE GEOTHERMAL USES

The direct use of geothermal resources in Washington State had its modern beginning in the late 1800s, but its benefits had been enjoyed by the native Indians for centuries before. In the early 1880s, Theodore Moritz, a settler in the Quillayute Valley, was out hunting and came across an Indian who had broken his leg. Moritz took the injured man home and nursed him until he could travel. In gratitude, the Indian told him of some wonderful curative "fire chuck" (hot water) that bubbled from the ground where Indians had gone for years to cure their ailments. The Indian led Moritz to what is now Sol Duc Hot Springs, and Moritz later returned to build a cabin and file a claim with the U.S. Land Office. Word spread of the healing waters and mud, and people began making the 2-day horseback trip from Port Angeles.

In 1903, Michael Earles, owner of the Puget Sound Mills and Timber Company, accompanied a group of people to Sol Duc. Earles had been told by his doctor that he was dying. He was advised by his doctor to travel to Carlsbad, New Mexico, but was too weak for the long journey. The mineral water at Sol Duc cured him, and in gratitude he decided to build a facility to help others. In 1910, Earles bought the site from the heirs of Theodore Moritz and founded the Sol Duc Hot Springs Company. Sol Duc soon became the most noted pleasure and health resort on the Pacific Coast. Earles spent a half million dollars creating the resort, which opened on May 15, 1912, and which, during its peak year, handled 10,000 guests from all over the U.S. and as far away as Europe. Guests drank the mineral water and bathed in tubs, showers, mud, or vapor. The temperature of the hot springs was reported to be 60°C, and the waters contained sodium, potassium, magnesium, silicon, iron, and other minerals. The waters were also bottled and sold as delicious draught with marvelous healing qualities to be enjoyed at home (Kellogg, 1975).

In addition to the hotel, a three-story sanitarium, complete with operating room, appliances for surgical cases, a laboratory, and an x-ray machine, had beds for 100 patients.

On May 26, 1916, after only 3 years of operation, the resort was destroyed by fire started when sparks from a defective flue landed on the roof of the main hotel building. When the caretaker tried to put out the fire, he discovered that the water was still turned off for the winter (Kellogg, 1975).

The fire at Sol Duc did not, however, signal the end of the growing interest in hot spring resorts. Although Sol Duc never again achieved its earlier grandeur, it was modestly rebuilt and is now part of Olympic National Park. Nearby Olympic Hot Springs also saw considerable development in the early 1900s, only to be returned to its natural state by the Park Service in 1973. In addition, other resorts were built at Longmire and Ohanapecosh Hot Springs, both now part of Mount Rainier National Park, and at North Bonneville and Carson, both located in the Columbia River Gorge (Bloomquist, 1979).

Renewed interest in Washington's geothermal energy resource began in the mid to late 1970s as a result of the oil embargo of 1973 and, later, the oil crisis of 1979. The primary emphasis was on discovery, evaluation, and commercialization of high-temperature resources that could be harnessed to generate electricity. A majority of the activity was centered in the Cascade Range, where it was thought these resources would be most likely to occur. More than a million acres were once under lease application throughout the Cascade Range of Washington, but due to environmental concerns, delays in completing environmental impact studies by the U.S. Forest Service, and a surplus of low-cost electricity throughout the 1980s, few leases were actually granted, and no major exploration programs were completed by industry.

Direct-use geothermal resources, however, were found to be abundant, widespread, and easy to access and increasingly cost effective. A detailed assessment program carried out by the Washington State Department of Natural Resources, Division of Geology and Earth Resources identified 338 wells throughout the Columbia Basin yielding water at temperatures at or above 20°C (Korosec and others, 1981). WSEO, working cooperatively with DNR, identified a number of promising development projects. In 1980, WSEO began the design of what was to become the nation's first major dual purpose geothermal heat-pump project. The system used water at 30°C from a 550-m-deep municipal well in Ephrata that pumped 140 l/s. In 1980, with assistance from WSEO and the Oregon Institute of Technology Geo-Heat Center, the City of Ephrata applied for a grant under the Department of Housing and Urban Development's Innovative Community Energy Conservation Program. The $468,000 grant made possible the construction of the new geothermal heat pump plant designed to provide all of the heating and cooling requirements of the Grant County Courthouse and Courthouse Annex, the retrofit of the Courthouse complex, and a demonstration project in the nearby June's Court low-income housing project (Bloomquist, 1983).

The heat pump system was designed to remove approximately 7.5°C. The water was then returned to the municipal system. The two-stage heat pump was capable of supplying 52°–65°C water to the Grant County Courthouse's central heating system, which cut its energy consumption by 80 per cent and resulted in an 85 per cent decrease in the courthouse fuel bill. The June's Court project consisted of retrofitting a number of units to use geothermal heat pumps. Both projects were completed in 1983 and received national awards from the U.S. Department of Energy and from the American Society of Heating and Refrigeration Engineers. The uniqueness and importance of the system also resulted in commendations from the Governor and the Washington State Legislature. This project marked the first acceptance by state health regulators of the domestic use of water that had passed through a heat pump, and it was the model for the acceptance of such systems throughout much of the U.S.

The Ephrata project served as the catalyst for several additional projects, including the Yakima County Detention Center, the Washington State Department of Social and Health Services office in Yakima, several schools, including two community colleges, and numerous commercial and residential installations. Studies completed by WSEO and DNR initially identified 22 cities in central and eastern Washington with proximity to geothermal resources that would meet temperature and flow requirements for district heating. Water chemistry was also found to be acceptable for development with only minor concerns related to material selection. Geothermal district heating feasibility studies were completed in six cities by 1985, using HEATPLAN, a computer program developed by WSEO for this purpose. All six cities—Yakima, Ephrata, Moses Lake, West Richland, Grandview, and Sunnyside—were found to have heat-load densities high enough to technically and economically support geothermal district heating systems.

However, 1985 also saw a dramatic decrease in prices of competing energy supplies, with natural gas prices dropping to less than half of projected levels. Low natural gas and oil prices, coupled with a significant surplus in electrical generation capacity, removed any economic incentive for developing capital-intensive geothermal systems or for energy conservation by utilities. In addition, DOE found itself farther and farther behind in adjudicating water rights and, in many areas, a total moratorium on new water rights was put in place, stopping some projects that were still attractive from both energy and economic perspectives.

RESOURCE POTENTIAL AND COLLOCATION OF RESOURCES AND USERS

The 1990s have, however, brought new interest in geothermal resources development in Washington State. California Energy Company has filed lease applications in both the northern and southern Cascades (D. McClain, C E Exploration, Portland, OR, oral commun., 1993). Seattle City Light, the state's largest municipal utility, has begun to reassess its position on future geothermal development. Puget Sound Power and Light, the state's largest investor-owned utility, has agreed to purchase electricity generated from geothermal resources in California. And the Bonneville Power Administration, with support from the Northwest Power Planning Council, initiated a program to demonstrate the technical, economic, and environmental acceptability of geothermal electric generation in the Northwest. In 1993, Conservation and Renewable Energy Systems was founded by a number of public utilities to pursue development of renewable energy projects.

However, by far the greatest interest remains in developing the state's tremendous low-temperature geothermal potential, most of which is in the Columbia Basin (Fig. 1), specifically Adams, Benton, Franklin, Grant, Walla Walla, and Yakima Counties. This new interest stems from the fact that more and more of the state's electrical utilities are discovering that low-temperature geothermal, when coupled with new high-efficiency water-source heat pumps, can be an extremely attractive demand-side measure. Such systems not only reduce total energy consumption in comparison to electrical resistance or air-to-air heat pump heating systems, but can also reduce electricity demand as much as 50 percent, thus significantly reducing the need to build new generation facilities. Water-source heat pumps have also become a major element in many utility programs designed to maintain market share, being the only technology readily available to them that competes favorably with extremely cost-competitive natural gas. Many manufacturers of water-source heat pumps claim coefficients of performance (COP) that exceed 4.5 and, when coupled with geothermal sources, may exceed 6.0. For example, the Grant County Courthouse complex in Ephrata routinely achieves a COP of 5.8.

The future for low-temperature geothermal development in Washington State is extremely positive, especially in light of the abundance and widespread occurrence of the resource and increasing interest in renewable energy development by utilities and state and federal governments. In fact, the Clinton administration's Global Change Action Item #26 gives considerable attention to the need for and desirability of developing low-temperature geothermal heat sources. But probably most important is the renewed interest on the part of the state's public and investor-owned utilities and an increasing desire on the part of state and municipal governments to expand the use of renewable energy resources wherever technically and economically feasible. This common interest on the part of utilities and government provides a natural mechanism for targeting further assessment and development activities.

Because there are still significant problems associated with obtaining new water rights, development activities are being directed toward sites where thermal wells already exist, where such wells are under the control of a government entity, and where the water is used or is usable year-round. Development is also being focused on sites where significant new construction or redevelopment is or will be taking place, for example, educational and correctional facilities. A quick analysis of our database shows that 22 cities of 5,000+ population are located within 8 km of a thermal well. These cities all have significant potential for developing geothermal-based district heating systems. Further analysis locates 24 schools that have construction or remodeling projects planned or under way, totaling about 150,000 m^2 and with an aggregate budget of over $100 million. These 24 schools have a total of 259 thermal wells within 8 km, many of which are owned by the municipality, county, port district, state agency, or the school district itself. In fact, of the 941 thermal wells identified statewide, 250 are under government ownership.

But the availability of low-temperature geothermal resources and the collocation of a need for thermal energy does not guarantee that development can or will take place. Decision-makers, as well as those who advise them, for example, architectural and engineering firms, must be made aware of the availability of geothermal resources and the reliability of the use of geothermal water-source heat pumps. Regulators in the Departments of Ecology and Health must be convinced of the benefits and extremely low risk associated with installations that either reinject the water or use it in a secondary manner once it has passed through the heat pump. And, finally, mechanisms must be put in place that ensure that the generally high front-end capital cost of these systems is not a deterrent to development. Many utilities are adopting incentive programs, either in the form of rebates or long-term lease arrangements, that encourage the development of geothermal heat-pump systems. The cost of such systems can also be significantly reduced through advancements in drilling technology and improvements in system efficiency.

RECOMMENDATIONS

Our top recommendation is to (1) match existing thermal wells, especially publicly owned wells that produce large quantities of water year-round, with closely collocated proposed new construction or remodeling of public buildings, such as schools, (2) determine which projects could make advantageous use of the geothermal resource to heat and/or cool the building, and (3) encourage and facilitate such applications. This work would occur mostly in the Columbia Basin, because most thermal wells are located there, and it would lead to significant development of low-temperature geothermal resources, perhaps without any additional drilling or exploration.

Our second recommendation is to station one or two investigators in the Columbia Basin, especially in Adams, Benton, Franklin, Grant, Walla Walla, and Yakima Counties, to find and visit new wells to (1) measure downhole temperature gradients (or accurate flowing temperatures if gradients cannot be measured, as for example, in flowing artesian wells), (2) obtain well-test data, (3) obtain drill cuttings for measurement of thermal conductivity and geochemistry, and (4) collect water samples for chemical analysis. With the trend toward fully cased and sealed wells that tap a single deep aquifer, this work would facilitate the formulation of a data set that would determine regional and local distribution of heat flow and temperature gradients, better define the chemistry and stratigraphy of the deeper aquifers, build accurate statistics about the volumes and temperatures of water available from wells, and assist formulation of exploration strategies that would minimize unproductive drilling.

Our third recommendation is to institute a long-term effort to (1) inform the people of the state about uses of low-temperature geothermal resources, (2) work with public policy makers to make certain that the legal and institutional framework encourages the wise use of low-temperature geothermal resources, and (3) advocate for use of geothermal resources in place of fossil fuels.

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Appendix A. Descriptive and Thermal Data for Wells and Springs

EXPLANATION OF COLUMN HEADINGS AND ENTRIES:

The **I.D.** number for a site consists of a two-letter county code followed by a three-digit serial number. An "S" at the end means the site is a spring, spring system, lake, lava dome, or area of fumaroles. All other entries are wells. County codes: AD, Adams; AS, Asotin; BE, Benton; CH, Chelan; CL, Clallam; CK, Clark; CO, Columbia; CZ, Cowlitz; DO, Douglas; FR, Franklin; GA, Garfield; GR, Grant; GY, Grays Harbor; KI, King; KS, Kittitas; KT, Klickitat; LE, Lewis; LI, Lincoln; OK, Okanogan; PI, Pierce; SK, Skamania; SN, Snohomish; SP, Spokane; WA, Walla Walla, WH, Whatcom; WT, Whitman; YA, Yakima.

Site name is, in most instances, the name of a city, company, or governmental organization if the site is publicly or company owned, or the name of an individual if the site is a private irrigation or domestic well.

An **asterisk** (*) before the site name column indicates that there is a chemical analysis (or analyses) in Appendix B.

Date: date when one or more of the entries in the table was determined, as reported in one of the cited references.

Latitude (°N) and **Longitude** (°W) are given in decimal degrees. The location of each site was plotted on a scale-stable 1:100,000-scale U.S. Geological Survey topographic base map, usually at the center of the quarter-quarter of a section. If the base map showed a well or spring in that quarter-quarter section, the occurrence was plotted at that location. A transparent gridded overlay was used to identify quarter-quarter boundaries. When all locations had been plotted, they were digitized at the Washington State Energy Office and the latitudes and longitudes calculated by the Geographic Information System. The information was then downloaded back into the Lotus 1-2-3 file that constitutes Appendix A.

Within each county, entries are sorted by **township**, **range**, and **section**.

Partial section: Written as quarter-section of quarter-section, using the system of the U.S. Geological Survey Water Resources Division where the section is divided into 16 quarter-quarters that are lettered in the same manner as sections in a township are numbered. The pattern is shown below.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

NE4, NW4, SW4, and SE4 signify the northeast, northwest, southwest, and southeast quarters of a section, respectively. W2 and E2 are west one-half and east one-half.

Temperature type: B, bottom-hole or near-bottom-hole temperature; F, flowing temperature; M, maximum temperature; S, temperature measured short of well bottom; and "-", other or unknown.

Depth type: D, drilled depth or near drilled depth; L, logged depth; and "-", other or unknown.

Gradient type: A, gradient estimated from linear segment of well temperature log; B, gradient estimated from a bottom-hole temperature or the deepest logged temperature and an estimated or calculated mean annual surface temperature; S, gradient determined by fitting a straight line through "families" of bottom-hole temperatures.

Flow type: N, natural; P, pumped, bailed, or air-driven; "-", other, no flow, or unknown.

SWL: Standing water level, meters from surface. A, flowing artesian.

References: Numbers correspond to the numbered references in the **REFERENCES CITED** section.

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
		ADAMS COUNTY																			
AD001	*	CMSTP&P RR	1961/05/04	46.804	119.342	15	28E	08	E	20.0	B	126	D	-	63	-	-	38	-	73	22,25,26,40,41
AD002	*	US Bureau of Reclamation	1971/10/06	46.794	119.299	15	28E	15	D	24.2	B	264	D	-	46	-	-	795	-	114	22,25,26,40
AD003		DH 4	-	46.757	119.360	15	28E	30	L	75.2	B	1456	D	-	43	31	-	-	-	-	2,22,25,26
AD004		E. Col. Basin Irr. Dist.	-	46.740	119.273	15	28E	35	P	24.4	B	253	D	-	49	-	-	-	-	-	22,25,26,33
AD005	*	Othello City 2	1955/08/02	46.824	119.167	15	29E	03	C	22.8	F	212	D	-	51	-	-	-	-	69	22,25,26,40
AD006	*	Othello City 4	1970/10/27	46.817	119.156	15	29E	03	J	20.8	F	276	D	-	32	-	-	3785	-	69	22,25,26,40
AD007		Othello City 5	-	46.814	119.167	15	29E	03	P	29.4	B	298	D	-	57	65	-	-	-	-	22,25,26,33,37,38,45
AD008	*	Othello City 6	1994/04/07	46.824	119.177	15	29E	04	A	27.8	F	368	D	-	36	-	-	13248	P	60	22,25,26,37,38,40,45
AD009	*	Othello City 1	1942/04/27	46.824	119.177	15	29E	04	A	20.0	B	171	D	-	47	-	-	341	P	73	22,25,26,40,41
AD010		Weaver, Howard	-	46.819	119.206	15	29E	05	-	20.0	F	75	D	-	-	-	-	473	P	-	44
AD011		Taylor, John D.	-	46.789	119.228	15	29E	18	-	20.0	F	77	D	-	-	-	-	170	P	-	44
AD012		Lyle, Elwyn & Rex	-	46.815	118.922	15	31E	04	J	24.4	F	330	D	-	-	-	-	7646	P	95	44
AD013		McKay, Ed	-	46.815	118.954	15	31E	05	L	26.8	B	404	D	-	36	49	-	-	-	-	22,25,26,37,38,45

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
AD014		Lyle, Elwyn	1983/05/26	46.800	118.944	15	31E	08	J	22.5	-	369	-	-	-	-	-	-	-	122	40
AD015		Lyle, Elwyn & Rex	1983/07/29	46.797	118.959	15	31E	08	N	25.0	-	314	-	-	-	-	-	-	-	88	40
AD016		Lyle Bros 3	-	46.803	118.895	15	31E	11	E	20.5	B	214	D	32	34	-	-	-	-	-	6,22,25,26
AD017		DNR Lyle 2	-	46.793	118.922	15	31E	16	A	21.1	F	412	D	-	-	-	-	7055	P	140	44
AD018		DNR Lyle 1	1983/05/26	46.793	118.938	15	31E	16	D	28.5	F	430	D	-	-	-	-	5924	P	134	40,44
AD019		Johnson, Arthur	-	46.779	118.965	15	31E	19	A	27.6	B	342	D	-	40	49	-	-	-	-	22,25,26,33,37,38,45
AD020		Kummer, Clarence, 4	-	46.742	118.959	15	31E	32	M	26.0	B	365	D	-	-	48	-	-	-	-	37,45
AD021		Tomkin	-	46.821	118.753	15	32E	02	A	25.0	B	252	D	-	52	-	-	-	-	-	24
AD022		Damon, Don	-	46.820	118.800	15	32E	04	B	21.9	B	266	D	-	43	49	-	-	-	-	22,25,26,37,45
AD023	*	Phillips, Robert, 4	1983/08/02	46.799	118.838	15	32E	07	J	25.4	F	579	D	-	-	-	-	-	-	181	7,15,40
AD024		Adams, Mrs. M. E.	-	46.806	118.827	15	32E	08	C	22.2	F	182	D	-	-	-	-	378	P	86	44
AD025		Phillips, Robert, 5	1982/08/09	46.803	118.832	15	32E	08	E	26.0	-	604	-	-	-	-	-	-	-	191	40
AD026		Stelger	-	46.788	118.806	15	32E	16	F	20.0	B	180	D	-	44	49	-	-	-	-	22,25,26,45
AD027		DNR Hatton	-	46.785	118.811	15	32E	16	M	21.1	F	457	D	-	-	-	-	2438	P	124	44
AD028		Hart	-	46.743	118.768	15	32E	35	E	27.6	B	310	D	-	50	-	-	-	-	-	22,25,26
AD029		Hart, Cyril	-	46.744	118.758	15	32E	35	G	22.9	B	308	D	-	-	49	-	-	-	-	37,45
AD030		—	-	46.822	118.631	15	33E	02	A	25.0	B	69	-	-	189	-	-	-	-	-	22,25
AD031		Tompkins, Robert	-	46.822	118.632	15	33E	02	A	25.0	B	252	D	-	52	-	-	-	-	-	26,37,45
AD032		Watson	-	46.753	118.528	15	34E	27	R	20.9	S	177	L	-	50	-	-	-	-	-	22,25,26
AD033		Blauert, Fred. A., 2	1983/08/26	46.751	118.302	15	36E	33	A	20.0	-	155	-	-	-	-	-	5678	-	21	40
AD034		Blauert, Fred	-	46.749	118.290	15	36E	34	F	25.4	B	213	D	-	63	-	-	-	-	-	22,25,26,37,38,45
AD035		Chef Reddy Frozen Foods	1983/08/22	46.839	119.172	16	29E	34	D	25.0	-	317	-	-	-	-	-	3861	-	63	40
AD036	*	Othello City 3	1977/05/11	46.829	119.156	16	29E	34	R	25.0	B	275	D	-	49	65	-	5072	P	85	22,25,26,37,40,41,44,45
AD037		Kliphardt, G. W.	-	46.866	119.000	16	30E	24	D	26.1	B	220	D	65	63	65	-	-	-	-	22,25,26,37,45
AD038		Kliphardt, Fredrick	1983/08/30	46.851	119.006	16	30E	26	A	30.0	-	323	-	-	-	-	-	-	-	91	40
AD039		Kliphardt	-	46.851	119.006	16	30E	26	A	26.2	B	192	D	34	72	-	-	-	-	-	6,22,25,26
AD040		Andrews 2	-	46.845	119.028	16	30E	27	J	25.2	B	207	D	91	64	-	-	-	-	-	6,22,25,26
AD041		DNR Damon 2	-	46.830	118.991	16	30E	36	K	20.6	B	211	D	-	40	-	-	-	-	-	22,25,26,37,45
AD042		DNR Damon	-	46.830	118.991	16	30E	36	K	25.8	B	241	D	-	57	65	-	14383	P	54	22,25,26,33,37,44,45
AD043		Damon Ranch	1983/05/24	46.872	118.884	16	31E	14	K	26.0	-	408	-	-	-	-	-	-	-	104	40
AD044		Lyle	-	46.880	118.906	16	31E	15	B	24.1	B	316	D	-	38	-	-	-	-	-	22,25,26
AD045		Lyle, Rex	-	46.880	118.906	16	31E	15	B	22.6	B	201	D	-	-	32	-	-	-	-	37,45
AD046		Wholman	-	46.880	118.916	16	31E	15	D	26.2	B	230	D	59	57	32	94	-	-	-	5,26,45
AD047		Lyle, Rex (South)	-	46.869	118.906	16	31E	15	Q	27.5	B	410	D	-	37	32	-	-	-	-	22,25,26,33,37,38,45
AD048		Brown, Beverly	1982/09/08	46.826	118.933	16	31E	33	P	20.0	-	165	-	-	-	-	-	-	-	105	40
AD049		Damon, Don	-	46.830	118.877	16	31E	35	J	24.4	F	275	D	-	-	-	-	4164	P	118	44
AD050		Phillips, D. E., 12	1983/08/02	46.895	118.768	16	32E	11	D	23.0	F	429	D	-	-	-	-	9084	P	122	40,44
AD051		Phillips, D. E., 12	-	46.894	118.768	16	32E	11	D	28.2	B	321	D	-	51	32	-	-	-	-	22,25,26,33,37,45
AD052		Phillips, D. Everett	-	46.873	118.729	16	32E	13	J	21.7	F	272	D	-	-	-	-	7948	P	98	44
AD053		Phillips, D. Everett	-	46.880	118.751	16	32E	14	A	22.9	F	233	D	-	-	-	-	11355	P	104	44
AD054		Phillips, Beatrice house well	-	46.880	118.763	16	32E	14	C	21.1	B	155	D	-	56	32	-	-	-	-	22,25,26,33,37,45
AD055		Phillips, D. E., 11	1983/05/27	46.880	118.768	16	32E	14	D	24.5	-	399	-	-	-	-	-	4921	-	89	40
AD056		Phillips, D. E., 11	-	46.880	118.768	16	32E	14	D	20.0	B	314	D	-	25	-	-	-	-	-	22,25,26,33,37,45

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
AD057		Phillips, D. E., 17	-	46.880	118.790	16	32E	15	D	34.0	B	440	D	-	49	32	-	-	-	-	22,25,26,33,37,38,45
AD058		Phillips, Robert, 3	1983/08/03	46.876	118.842	16	32E	18	G	26.0	-	469	-	-	-	-	-	-	-	147	40
AD059		Phillips, R. V.	-	46.854	118.832	16	32E	20	N	29.2	B	372	D	-	46	32	-	-	-	-	22,25,26,33,37,45
AD060		Phillips, D. E.	-	46.861	118.811	16	32E	21	E	24.4	F	448	D	-	-	-	-	5488	P	176	44
AD061		Phillips, D. E., 10	-	46.861	118.800	16	32E	21	G	27.4	B	283	D	-	-	32	-	-	-	-	22,25,26,37,45
AD062		Phillips, D. Everett	-	46.865	118.747	16	32E	24	D	20.6	F	252	D	-	-	-	-	3785	P	100	44
AD063		Phillips, D. Everett	-	46.851	118.729	16	32E	25	A	22.2	F	248	D	-	-	-	-	13058	P	102	44
AD064		Phillips, D. E., 2	-	46.850	118.747	16	32E	25	D	29.1	B	432	D	-	40	32	-	-	-	-	22,25,26,37,45
AD065		—	-	46.839	118.747	16	32E	25	N	30.4	B	709	D	-	26	32	-	-	-	-	2,22,25
AD066		Phillips, D. E., 16	-	46.839	118.747	16	32E	25	N	31.4	B	382	D	-	50	32	-	-	-	-	26,37,38,45
AD067		Phillips, D. E., 7	-	46.831	118.790	16	32E	34	E	43.4	B	772	D	70	41	38	-	-	-	-	2,22,25,26,37,38,45
AD068		Phillips, A	-	46.831	118.790	16	32E	34	E	24.0	B	370	D	-	-	-	-	-	-	-	5,45
AD069		Phillips, D. E.	-	46.835	118.764	16	32E	35	C	21.1	F	275	D	-	-	-	-	11355	P	119	44
AD070		Phillips, D. E., 9	-	46.835	118.769	16	32E	35	D	24.2	B	272	D	-	44	32	-	-	-	-	22,25,26,37,45
AD071		Davis, David A.	1983/08/02	46.880	118.700	16	33E	17	B	20.0	-	183	-	-	-	-	-	95	-	124	40
AD072		Baumann Farms	-	46.827	118.470	16	35E	31	Q	22.4	B	600	D	-	-	-	-	-	-	-	37,38,45
AD073		Bauman, Richard	-	46.828	118.461	16	35E	32	N	21.0	B	214	D	-	-	-	-	-	-	-	45
AD074		Phillips, D. E.	1983/05/24	46.997	118.905	17	31E	03	B	23.5	-	415	-	-	-	-	-	-	-	99	40
AD075		Phillips, D. E., C-12	1983/07/29	46.982	118.872	17	31E	12	D	27.8	B	592	D	-	27	27	-	-	-	37	22,25,26,37,38,40,45
AD076		Kulm, Ed	-	46.987	118.798	17	32E	04	Q	22.8	F	274	D	-	-	-	-	8422	P	159	44
AD077		Kulm, Art	-	46.993	118.851	17	32E	06	E	20.0	F	280	D	-	-	-	-	10976	P	120	44
AD078		—	-	46.973	118.739	17	32E	12	P	21.0	B	227	D	-	40	-	-	-	-	-	6,22,25
AD079		DNR CRB	-	46.961	118.766	17	32E	14	M	23.2	B	189	D	43	54	-	68	-	-	-	5,26,45
AD080		Lobe, Gary, 2	1983/08/02	46.999	118.724	17	33E	06	D	26.5	-	366	-	-	-	-	-	-	-	207	40
AD081		City of Lind	-	46.973	118.612	17	33E	12	P	21.0	B	226	D	-	40	-	-	-	-	-	26
AD082		Benge	-	46.942	118.148	17	37E	27	D	21.9	-	168	L	-	59	-	-	-	-	-	22,25,26,38
AD083		Warden Hutterian Brethern	1983/08/03	47.066	118.978	18	31E	07	E	21.5	-	357	-	-	-	-	-	-	-	93	40
AD084		Wollmon, Jaeole K.	-	47.048	118.936	18	31E	16	M	20.0	F	155	D	-	-	-	-	9462	P	31	44
AD085		Hutterites	-	47.055	118.973	18	31E	18	C	21.8	B	240	D	-	37	-	-	-	-	-	6,22,25,26
AD086		Phillips-Lanamn Ranch, Inc.	1983/07/29	47.001	118.942	18	31E	32	R	21.0	-	384	-	-	-	-	-	10598	-	62	40
AD087		Phillips, D. E., C-33	-	47.012	118.937	18	31E	33	D	30.2	B	728	D	-	25	27	-	-	-	-	26,37,38,45
AD088		—	-	47.012	118.937	18	31E	33	D	30.0	B	771	D	-	-	-	-	-	-	-	2
AD089	*	Jungblom Ranch	1983/08/01	47.012	118.937	18	31E	33	D	36.6	F	732	D	-	-	-	-	-	-	64	7,15,40
AD090		Lobe, Gary L.	-	47.084	118.850	18	32E	06	D	22.2	F	270	D	-	-	-	-	3785	P	198	44
AD091		Hutterian Bretheren	-	47.059	118.846	18	32E	07	P	21.7	B	240	D	-	-	27	-	-	-	-	45
AD092		Franz, Agatha	-	47.025	118.802	18	32E	28	C	20.0	F	188	D	-	-	-	-	3785	P	105	44
AD093		Harder, Carl H.	-	47.079	118.041	18	38E	04	N	21.1	F	161	D	-	-	-	-	5602	P	79	44
AD094		Kagele, Norman	-	47.123	118.861	19	31E	24	G	20.1	B	165	D	-	49	-	-	-	-	-	22,25,26,33,37,45
AD095		Weber, Dave	1983/05/23	47.110	118.903	19	31E	27	G	26.0	-	430	-	-	-	-	-	-	-	130	40
AD096		S & K Farms	-	47.121	118.734	19	32E	24	K	20.8	B	243	D	-	35	40	-	-	-	-	22,25,26,37,45
AD097		J & M Farms	1983/07/30	47.117	118.744	19	32E	24	N	32.5	B	695	D	-	30	-	-	-	-	195	2,22,25,26,33,37,38,40,45
AD098		Kagele, Norman	-	47.103	118.850	19	32E	30	N	21.1	B	165	D	-	-	40	-	-	-	-	45
AD099		Graber, Rose	-	47.101	118.752	19	32E	35	A	20.0	F	196	D	-	-	-	-	3974	P	60	44

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
AD100	*	Warden Hutterian Brethern, 7	1983/08/03	47.147	118.709	19	33E	07	R	24.3	F	527	D	-	-	-	-	-	-	133	7,15,40
AD101		Hoefel, Paul, 2	1983/08/30	47.147	118.694	19	33E	08	Q	42.3	B	745	D	-	39	38	-	-	-	177	2,22,25,26,33,37,38,40,45
AD102		Hoefel, Paul	-	47.147	118.694	19	33E	08	Q	20.7	B	231	D	-	36	40	-	-	-	-	22,25,26,37,45
AD103		Kagele, Melvin	1983/08/04	47.130	118.566	19	34E	20	B	22.5	B	341	D	-	34	-	-	-	-	180	22,25,26,40
AD104		Gering, Gale	-	47.153	118.287	19	36E	09	K	21.1	B	229	D	-	41	-	-	-	-	-	22,25,26,37,38
AD105		Galbreath Land & Livestock	1983/08/03	47.129	118.305	19	36E	20	H	20.5	-	314	-	-	-	-	-	5337	-	191	40
AD106		Galbreath Land & Livestock 2	1983/05/26	47.131	118.292	19	36E	21	C	22.5	-	390	-	-	-	-	-	5223	-	170	40
AD107		Heineman, Don, 2	-	47.091	118.276	19	36E	34	N	20.8	B	102	D	-	96	-	-	-	-	-	22,25,26,37
AD108		—	-	47.143	117.972	19	38E	13	F	21.1	-	201	L	83	55	-	-	-	-	-	22,25,26
AD109		Raugust, W. C.	1983/08/30	47.224	118.785	20	32E	15	L	21.0	-	317	-	-	-	-	-	-	-	-	40
AD110		Weber, John	-	47.250	118.501	20	34E	02	Q	21.0	B	202	D	-	50	-	-	-	-	-	22,25,26,37,45
AD111		Hardung	-	47.234	118.447	20	35E	17	D	20.9	B	232	D	90	39	-	-	-	-	-	6,22,25,26
AD112		Ahern, Cliff	-	47.218	118.362	20	35E	24	D	20.5	B	157	D	-	61	-	-	-	-	-	22,25,26,33,37
AD113		Kagele, Richard	1983/08/31	47.204	118.388	20	35E	27	A	22.0	-	384	-	-	-	-	-	-	-	231	40
		ASOTIN COUNTY																			
AS001	*	Washington Water Power Co., 2	1960/05/24	46.369	117.066	10	46E	05	Q	23.3	-	553	D	-	-	-	-	-	-	19	31,40,41
AS002		Washington Water Power Co.	-	46.373	117.082	10	46E	06	J	21.7	F	326	D	-	-	-	-	7570	P	82	44
AS003		Norman, Joe, & Gary Beach	-	46.355	117.066	10	46E	08	Q	20.0	F	79	D	-	-	-	-	772	P	34	44
AS004		Asotin City	-	46.340	117.045	10	46E	16	Q	22.2	F	164	D	-	-	-	-	3028	P	20	44
AS005		Asotin City 1	1982/06/21	46.337	117.055	10	46E	21	D	22.0	-	164	-	-	-	-	-	-	-	20	40
AS006		Washington Water Power Co.	-	46.410	117.062	11	46E	29	A	24.4	F	280	D	-	-	-	-	-	P	-	44
AS007		Washington Water Power Co.	-	46.397	117.069	11	46E	29	P	22.2	F	336	D	-	-	-	-	14762	P	87	44
AS008	*	Washington Water Power Co., 5	1962/10/30	46.398	117.087	11	46E	30	Q	23.3	B	406	D	-	28	-	-	-	-	136	22,25,26,31,40
AS009		Wash. W. Power, Clark. Hts., 7	1983/08/10	46.391	117.076	11	46E	32	E	26.2	B	405	D	36	35	-	56	13248	-	118	5,22,25,26,38,40
		BENTON COUNTY																			
BE001	*	S P & S Ry	-	45.864	119.792	04	24E	03	B	20.6	F	121	D	-	71	-	-	-	-	-	22,25,26,31
BE002		Sandpiper Land Co.	-	45.891	119.714	05	25E	29	G	20.0	F	107	D	-	-	-	-	378	P	52	42
BE003		Sandpiper Land Co.	-	45.884	119.722	05	25E	29	N	20.0	F	75	D	-	-	-	-	144	P	22	42
BE004		Paterson or G. Tom Powers	-	45.953	119.599	05	26E	05	D	26.3	B	305	D	-	47	-	-	5787	P	83	22,25,26,42
BE005	*	US Army Corps of Engineers	1971/09/24	45.941	119.353	05	28E	06	R	21.5	F	170	D	-	56	-	-	1893	-	6	22,25,26,40
BE006		Columbia R.	-	45.991	119.789	06	24E	22	H	22.5	B	195	D	-	44	-	-	-	-	-	6,22,25,26
BE007		Epstein	-	46.008	119.556	06	26E	15	E	23.9	F	293	D	-	-	-	-	14383	P	110	42
BE008		Craig	-	46.004	119.556	06	26E	15	M	24.2	B	210	D	-	58	-	-	-	-	-	22,25,26
BE009		Blair	-	46.010	119.001	06	30E	12	Q	21.1	B	305	D	31	29	-	-	-	-	-	6,22,25,26
BE010		HundredCirclesFarm,IrrigroDiv	-	45.993	119.116	06	30E	19	D	23.3	F	248	D	-	-	-	-	378	P	193	42
BE011		Irrigro	-	45.983	119.116	06	30E	19	N	20.5	S	177	L	-	48	-	-	-	-	-	22,25,26,37
BE012		Horrigan Farms	-	46.111	119.838	07	24E	08	B	23.4	B	338	D	-	36	-	-	-	-	-	22,25,26,38
BE013		Horrigon Farms, Inc.	-	46.066	119.775	07	24E	26	B	20.0	F	162	D	-	-	-	-	757	P	90	42
BE014		DOE Paterson	-	46.045	119.641	07	25E	36	N	30.3	B	222	D	-	83	-	-	-	-	-	22,25,26
BE015	*	WDOE Tst./Obs., Piezometer C	1972/11/01	46.045	119.640	07	25E	36	N	22.0	-	230	-	-	-	-	-	2612	-	114	40
BE016		DNR John Barber	1984/04/18	46.045	119.641	07	25E	36	N	21.5	-	262	-	-	-	-	-	8441	-	113	40

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
BE017		DOE Paterson	-	46.045	119.640	07	25E	36	N	22.5	B	254	D	-	41	-	-	-	-	-	22,25,26
BE018		DNR Baker	-	46.045	119.635	07	25E	36	P	21.8	B	262	D	-	38	-	-	-	-	-	22,25,26
BE019		Moon, John	1982/08/26	46.130	119.587	07	26E	05	B	22.0	-	326	-	-	-	-	-	-	-	130	40
BE020		Moon	-	46.129	119.587	07	26E	05	B	22.1	B	148	D	-	68	-	-	-	-	-	22,25,26
BE021		DOE Horse Heaven	-	46.055	119.373	07	27E	36	A	29.4	B	369	D	-	39	-	-	-	-	-	26,38
BE022	*	Prosser City 5	1994/01/19	46.205	119.749	08	24E	01	K	24.0	F	391	D	-	26	-	-	6813	P	41	2,6,22,25,26,33,40,42
BE023		Bleyhl, Carl	-	46.195	119.832	08	24E	08	H	27.8	F	59	D	-	-	-	-	727	P	0	42
BE024		Long, Tallman, & Long	1982/08/25	46.180	119.801	08	24E	15	F	24.0	-	125	-	-	-	-	-	227	-	64	40
BE025		DNR Gould	-	46.141	119.629	08	25E	36	B	25.9	B	408	D	35	38	-	56	-	-	225	5,26,42
BE026		—	1984/04/18	46.185	119.576	08	26E	16	D	20.0	-	329	-	-	-	-	-	-	-	-	40
BE027		Sharp, Pete	1982/08/27	46.212	119.371	08	27E	01	A	22.5	-	47	-	-	-	-	-	-	-	34	40
BE028		Schleer, Carl	1988/09/15	46.193	119.365	08	28E	07	M	20.5	-	134	-	-	-	-	-	-	-	69	40
BE029		Bar 80 Ranch/Pete Sharp	1982/08/27	46.189	119.359	08	28E	07	P	20.5	-	133	-	-	-	-	-	1514	-	43	40
BE030		St. Joseph's Catholic Church	1988/04/11	46.207	119.128	08	29E	01	F	21.0	-	28	-	-	-	-	-	189	-	-	40
BE031	*	Mott, Studer	1970/11/17	46.168	119.160	08	29E	22	A	23.0	F	244	D	-	45	-	-	-	-	122	22,25,26,40
BE032		Burk, Vern	-	46.159	119.050	08	30E	22	M	21.1	F	69	D	-	-	-	-	492	N	A	42
BE033		Noel, Jim	-	46.156	119.050	08	30E	22	N	21.1	F	69	D	-	-	-	-	-	N	A	42
BE034		Salvinia Farms/Harper Farms	-	46.257	119.827	09	24E	21	D	21.7	F	241	D	-	-	-	-	4542	P	98	42
BE035		WSU Prosser Experiment Station	-	46.294	119.732	09	25E	06	K	27.8	B	366	D	-	43	34	-	5678	P	162	2,22,25,26,38,42
BE036		Goroch, Chester	-	46.278	119.727	09	25E	07	J	21.1	F	215	D	-	-	-	-	2650	P	127	42
BE037		Gammie,William/Whitstran Ranch	-	46.282	119.684	09	25E	09	H	20.0	F	457	D	-	-	-	-	-	-	138	42
BE038		Olsen Bros.	-	46.270	119.657	09	25E	14	DorC	20.0	F	142	D	-	-	-	-	2460	P	15	42
BE039	*	WA State U.,I.A.R.E.C.,well 2	1994/01/19	46.258	119.736	09	25E	19	B	20.0	F	143	D	-	-	-	-	341	P	69	-
BE040		Clark, Roy	-	46.249	119.644	09	25E	23	J	20.0	F	18	D	-	-	-	-	114	P	8	42
BE041		Ball, Lenn and Vern	1983/07/20	46.226	119.689	09	25E	33	AorB	21.0	F	218	D	-	-	-	-	-	N	A	40,42
BE042		Valley View Orchards	-	46.290	119.615	09	26E	06	N	22.8	F	-	-	-	-	-	-	1961	P	157	42
BE043		Bauder, Milo	-	46.255	119.581	09	26E	20	A	23.3	F	209	D	-	-	-	-	7684	P	21	42
BE044	*	Christen	1970/10/12	46.234	119.544	09	26E	27	K	21.5	B	204	D	-	47	-	-	-	-	137	22,25,26,40
BE045		Peterson, Jean	-	46.296	119.405	09	27E	02	E	20.0	F	123	D	-	-	-	-	1041	P	55	42
BE046		Edmunds, Gary	-	46.296	119.400	09	27E	02	F	20.0	F	130	D	-	-	-	-	-	-	43	42
BE047		Gelles, David S.	1988/04/19	46.274	119.469	09	27E	08	N	20.5	-	195	-	-	-	-	-	-	-	-	40
BE048		DNR Benton 40	-	46.270	119.448	09	27E	16	D	23.3	B	94	D	185	122	-	293	-	-	-	5,26
BE049		Harrison 4 W	1982/08/28	46.255	119.449	09	27E	21	D	22.5	-	252	-	-	-	-	-	-	-	-	40
BE050		DNR Kid 3	-	46.248	119.402	09	27E	23	L	29.1	B	370	D	43	46	-	69	-	-	-	5,26
BE051		DNR 79-07	-	46.234	119.387	09	27E	25	M	23.8	B	322	D	-	30	-	-	-	-	-	26,38
BE052		Davin Land & Livestock, Inc.	1983/05/17	46.270	119.331	09	28E	17	AorB	26.7	F	336	D	-	-	-	-	10182	P	52	40,42
BE053		Bauder	-	46.222	119.287	09	28E	34	H	21.1	B	271	D	-	34	-	-	-	-	-	22,25,26
BE054		The Quadrant Corporation	-	46.215	119.255	09	28E	36	P	28.3	F	368	D	-	-	-	-	4542	P	27	42
BE055		DNR Anderson	-	46.312	119.759	10	24E	36	F	29.8	B	273	D	62	65	-	99	-	-	-	5,26
BE056		Nakamura	-	46.326	119.636	10	25E	25	E	20.6	B	184	D	36	45	-	-	-	-	-	6,22,25,26
BE057		J & R Orchards	-	46.305	119.699	10	25E	33	N	21.8	B	276	D	-	36	34	-	-	-	-	2,22,25,26
BE058		Schwendig, Harvey	1983/07/21	46.323	119.568	10	26E	28	L	24.5	-	282	-	-	-	-	-	2763	-	155	40
BE059		Champion Orchards	-	46.315	119.573	10	26E	33	D	22.8	F	255	D	-	-	-	-	1741	P	137	42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
BE060		Inland Desert Fruit Company	-	46.312	119.568	10	26E	33	F	24.4	F	255	D	-	-	-	-	2366	P	126	42
BE061		Hanford 56E4C	-	46.329	119.431	10	27E	28	A	20.9	B	140	D	-	46	-	-	-	-	-	5,26
BE062		Hanford S-30	-	46.357	119.269	10	28E	14	B	39.7	B	605	D	42	42	-	67	-	-	-	5,26
BE063		DH 3	-	46.353	119.269	10	28E	14	G	47.8	B	1080	D	35	33	-	53	-	-	-	2,4,5,22,25,26
BE064		Battelle Pacific Northwest Labs	1988/09/14	46.339	119.279	10	28E	23	E	20.5	-	15	-	-	-	-	-	1893	-	14	40
BE065		Rattlesnake Unit No. 1	-	46.435	119.789	11	24E	15	R	128.0	S	3248	D	37	40	31	60	-	-	-	2,4,5,22,25,26
BE066		DC 12	-	46.468	119.542	11	26E	03	-	53.7	B	1018	D	-	42	-	-	-	-	-	12
BE067		VO-SOC 1	-	46.420	119.592	11	26E	20	N	40.1	B	671	D	37	-	-	56	-	-	-	5
BE068	*	US Government	1970/11/19	46.391	119.534	11	26E	34	R	24.0	F	305	D	-	39	-	-	1317	-	244	22,25,26,40
BE069		Hanford 2-E14	-	46.430	119.276	11	28E	23	D	26.2	B	288	D	39	42	-	60	-	-	-	5,26
BE070		DC 15	-	46.395	119.270	11	28E	35	-	51.5	B	945	D	-	41	-	-	-	-	-	12
BE071		Berk, Delbert	-	46.561	119.798	12	24E	03	B	22.2	F	387	D	-	-	-	-	13414	P	10	42
BE072		Tramel, J. D.	-	46.561	119.835	12	24E	05	A	23.0	B	254	D	-	43	-	-	-	-	-	2,26,37
BE073		Tramel, J. D.	-	46.541	119.814	12	24E	09	E2E2	22.2	F	310	D	-	-	-	-	13475	P	107	42
BE074	*	Roberts Bros.	1970/09/11	46.507	119.850	12	24E	20	N	26.0	F	366	D	-	38	-	-	-	-	-	22,25,26,40
BE075		Robert, Robin	1983/07/28	46.503	119.861	12	24E	30	B	26.0	-	390	-	-	-	-	-	11317	-	35	40
BE076	*	US Government	1977/04/27	46.550	119.573	12	26E	04	N	21.4	F	117	D	-	80	-	-	-	-	108	22,25,26,40
BE077		US Government	1976/04/08	46.546	119.605	12	26E	07	B	20.7	F	126	D	-	69	-	-	-	-	82	22,25,26,40
BE078	*	US Government	1976/04/08	46.536	119.605	12	26E	07	Q	20.4	F	99	D	-	85	-	-	-	-	88	22,25,26,40
BE079	*	US Government	1979/04/19	46.536	119.589	12	26E	08	P	21.2	F	98	D	-	94	-	-	-	-	88	22,25,26,40
BE080	*	AEC	1979/04/17	46.539	119.568	12	26E	09	L	22.0	-	113	-	-	-	-	-	-	-	108	40
BE081	*	US Government	1976/04/08	46.543	119.495	12	26E	12	H	21.0	F	158	D	-	57	-	-	-	-	91	22,25,26,40
BE082		—	1982/04/21	46.532	119.495	12	26E	13	A	20.5	-	-	-	-	-	-	-	-	-	-	40
BE083	*	US Government	1979/04/17	46.528	119.494	12	26E	13	H	20.0	-	38	-	-	-	-	-	-	-	34	40
BE084	*	US Government	1978/04/20	46.532	119.531	12	26E	14	D	21.1	F	117	D	-	78	-	-	-	-	105	22,25,26,40
BE085	*	US Government	1977/04/28	46.532	119.547	12	26E	15	C	21.7	F	134	D	-	74	-	-	-	-	95	22,25,26,40
BE086	*	US Government	1979/04/20	46.525	119.537	12	26E	15	J	21.0	-	98	-	-	-	-	-	-	-	-	40
BE087	*	US Government	1976/04/08	46.528	119.614	12	26E	18	E	20.5	F	177	D	-	48	-	-	-	-	68	22,25,26,40
BE088	*	US Government	1982/04/21	46.528	119.604	12	26E	18	G	21.0	F	85	D	-	103	-	-	-	-	65	22,25,26,40
BE089		—	1981/04/21	46.507	119.509	12	26E	24	N	20.5	-	207	-	-	-	-	-	-	-	-	40
BE090		Maple Leaf Farms, Inc.	-	46.500	119.581	12	26E	29	G	24.4	F	253	D	-	-	-	-	1703	P	52	42
BE091		DB 8	-	46.556	119.482	12	27E	06	-	24.8	B	244	D	-	42	-	-	-	-	-	12
BE092		US Government	1978/04/19	46.525	119.447	12	27E	16	M	20.5	F	65	L	-	131	-	-	-	-	39	22,25,26,40
BE093	*	AEC	1979/04/16	46.532	119.484	12	27E	18	C	21.5	-	51	-	-	-	-	-	-	-	44	40
BE094		DC 7	-	46.484	119.375	12	27E	36	-	72.2	B	1243	D	-	49	-	-	-	-	-	12
BE095		Casper, William	-	46.540	119.362	12	28E	07	M	21.1	F	124	D	-	-	-	-	64	P	113	44
BE096	*	US Government	1970/08/27	46.587	119.769	13	24E	25	E	24.2	F	237	D	-	51	-	-	-	-	-	22,25,26,40,41
BE097		699-52-115	-	46.585	119.759	13	24E	25	-	20.6	B	213	D	-	45	-	-	-	-	-	12
BE098	*	US Govt./Meeker	-	46.586	119.779	13	24E	26	G	20.0	F	215	L	-	43	-	-	-	-	-	22,25,26,41
BE099	*	—	1951/12/01	46.586	119.779	13	24E	26	G	20.0	-	185	-	-	-	-	-	-	-	-	40
BE100	*	US Government	1951/11/29	46.577	119.769	13	24E	36	D	24.0	F	333	D	-	36	-	-	5110	-	66	22,25,26,40,41
BE101	*	US Government	-	46.638	119.639	13	25E	01	N	23.0	F	241	D	-	46	-	-	-	-	-	22,25,26,31

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
BE102	*	US Government	1983/06/03	46.638	119.671	13	25E	03	Q	21.0	-	16	-	-	-	-	-	-	-	12	40
BE103	*	Hanford, 199-B4-4	1977/04/27	46.631	119.644	13	25E	11	H	39.1	F	32	L	-	847	-	-	-	-	23	22,25,26,40
BE104		DB 12	-	46.614	119.694	13	25E	16	-	20.5	B	215	D	-	29	-	-	-	-	-	12
BE105		US Government	1981/04/23	46.580	119.660	13	25E	26	N	20.0	-	183	-	-	-	-	-	-	-	90	40
BE106	*	US Govt./McGee, Chester	1977/04/27	46.586	119.737	13	25E	30	G	30.6	F	338	D	-	44	-	-	5185	-	65	22,25,26,40,41
BE107		699-53-103	-	46.585	119.738	13	25E	30	-	28.7	B	299	D	-	49	-	-	-	-	-	12
BE108		DC 5	-	46.570	119.673	13	25E	34	-	62.8	B	945	D	-	37	-	-	-	-	-	12
BE109		DH 1		46.590	119.499	13	26E	25	AorB	21.9	B	183	D	37	54	-	64	-	-	-	4,5,22,25
BE110	*	US Government	1979/04/17	46.565	119.602	13	26E	31	R	20.0	-	98	-	-	-	-	-	-	-	97	40
BE111		ARH DC 1	-	46.576	119.517	13	26E	35	A	75.0	B	1725	D	-	37	31	-	-	-	-	2,26
BE112		DDH 1	-	46.576	119.517	13	26E	35	A	21.9	S	183	L	37	38	-	-	-	-	-	26
BE113	*	US Government	1969/07/14	46.572	119.517	13	26E	35	H	25.0	-	-	-	-	-	-	-	-	-	-	40
BE114		Hanford DC 6	-	46.586	119.395	13	27E	26	G	60.2	B	1324	D	-	37	31	-	-	-	-	2,26
BE115		—	1984/06/06	46.590	119.443	13	27E	28	C	21.0	-	168	-	-	-	-	-	-	-	-	40
BE116		DB 10	-	46.585	119.461	13	27E	29	-	26.4	B	257	D	-	43	-	-	-	-	-	12
BE117		Hanford 107D-2	1978/04/18	46.700	119.533	14	26E	14	M	32.5	F	24	L	-	854	-	-	-	-	17	22,25,26,40
BE118	*	US Government	1979/04/18	46.693	119.533	14	26E	23	D	24.0	-	28	-	-	-	-	-	-	-	26	40
BE119		Hanford 199-N-15	1977/04/27	46.674	119.565	14	26E	28	G	20.7	F	24	D	-	363	-	-	-	-	16	22,25,26,40
BE120	*	Hanford 199-K-19	1979/04/18	46.656	119.592	14	26E	32	L	22.0	-	16	-	-	-	-	-	-	-	6	40
BE121		US Government	1979/04/18	46.704	119.475	14	27E	18	H	22.5	-	17	-	-	-	-	-	-	-	12	40
BE122		DC-14	-	46.672	119.462	14	27E	29	-	57.2	B	1017	D	-	45	-	-	-	-	-	12
BE123	*	US Government	1979/04/17	46.659	119.438	14	27E	33	G	20.5	-	20	-	-	-	-	-	-	-	10	40
		CHELAN COUNTY																			
CH001		Norco No. 1	-	47.367	120.298	22	20E	26	M	35.7	S	1495	L	28	27	-	62	-	-	-	4,5,22,25,26
		CLARK COUNTY																			
CK001		Evergreen School District 114	1980/08/19	45.613	122.533	02	02E	35	M	22.0	-	77	-	-	-	-	-	1079	-	48	40
CK002		Cody, L.	-	45.638	122.266	02	04E	24	N	24.1	M	90	D	-	-	-	-	-	-	-	5
		CLALLAM COUNTY																			
CL001S	*	Olympic Hot Springs	-	47.977	123.687	29	08W	27	K	48.5	-	-	-	-	-	-	-	-	-	-	19,32
CL002S	*	Sol Duc Hot Springs	-	47.969	123.861	29	09W	32	C	51.0	-	-	-	-	-	-	-	-	-	-	19,21,32
		COLUMBIA COUNTY																			
CO001		Barton, George	-	46.235	117.963	09	39E	22	C	21.1	F	305	D	-	-	-	-	4	P	274	44
CO002		Ferrell, L.	-	46.555	118.005	12	38E	01	E	22.0	-	241	L	-	41	-	-	-	-	-	22,25,26,37
CO003	*	Ferrel, Robert	1961/01/27	46.583	118.017	13	38E	26	E	20.0	F	74	D	-	108	-	-	-	-	-	22,25,26,40,41
CO004		US Army Corps of Engineers	-	46.580	118.024	13	38E	27	J	23.3	F	116	D	-	-	-	-	1060	P	5	44
CO005		US Army Corps of Engineers	1983/08/26	46.580	118.034	13	38E	27	L	23.9	F	116	D	-	-	-	-	1790	P	19	40,44
		COWLITZ COUNTY																			
CZ001S		Green River Soda Springs	-	46.379	122.266	10	04E	02	G	25.0	-	-	-	-	-	-	-	-	-	-	17,22

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
		DOUGLAS COUNTY																			
DO001		Welch	-	47.244	120.011	20	22E	12	B	22.0	B	264	D	26	33	-	41	-	-	-	5,26
DO002		La Bonte, Lloyd L.	1982/07/28	47.241	120.011	21	22E	12	G	20.0	-	234	-	-	-	-	-	5299	-	80	40
DO003		Fleming & Evenhus	-	47.386	120.129	22	22E	19	E	20.0	F	83	D	-	-	-	-	8	P	72	42
DO004		Welch, Dean	-	47.386	120.129	22	22E	19	E	22.8	F	226	D	-	-	-	-	6832	P	176	42
DO005		Sagebrush Flats	-	47.460	119.674	23	25E	27	L	33.0	B	396	D	-	-	-	-	-	-	-	37
DO006		DNR Pixlee	-	47.483	119.594	23	26E	20	D	29.3	S	363	L	-	50	-	-	-	-	-	22,25,26,33
DO007		Isaak, John	-	47.813	119.268	27	28E	26	C	20.0	F	247	D	-	-	-	-	-	P	158	42
		FRANKLIN COUNTY																			
FR001		Dixon, Norman, 2	1988/04/15	46.295	119.143	09	29E	02	G	22.1	F	144	D	-	-	-	-	379	-	34	7,15,40
FR002	*	Pasco Navy Base/Port of Pasco	1970/08/28	46.263	119.098	09	30E	18	HorJ	21.0	F	315	D	-	29	-	-	2271	-	22	22,25,26,40
FR003		N.P. R.R./A. Miller ice plant	-	46.247	119.088	09	30E	20	L	21.1	F	314	D	-	29	-	-	1855	P	20	39
FR004		Western Farm Service	1988/09/07	46.235	119.046	09	30E	27	F	20.5	-	37	-	-	-	-	-	151	-	-	40
FR005		Nakamura	-	46.279	118.985	09	31E	07	E	24.6	-	168	L	33	75	-	-	-	-	-	22,25,26
FR006		Hageman, Marvin	1988/09/14	46.360	119.179	10	29E	09	R	20.0	-	118	-	-	-	-	-	76	-	81	40
FR007		US Bureau of Reclamation	-	46.339	119.012	10	30E	23	H	20.0	F	194	D	-	-	-	-	57	P	81	44
FR008		Jones & Russell,Eddie & Connie	1983/07/20	46.333	118.766	10	32E	23	J	23.0	-	91	-	-	-	-	-	95	-	46	40
FR009		Foster, Chris	1983/05/23	46.470	119.155	11	29E	03	H	22.0	-	168	-	-	-	-	-	95	-	122	40
FR010	*	West 15 Domestic Water, Inc.	1994/01/20	46.461	119.196	11	29E	05	R	28.0	F	305	D	-	-	-	-	360	P	160	40,44
FR011		Bergland Farms	1988/09/09	46.475	119.228	11	29E	06	C	23.0	-	20	-	-	-	-	-	38	-	7	40
FR012		Sunset Domestic Water Assoc.	-	46.444	119.177	11	29E	16	A	22.2	F	293	D	-	-	-	-	246	P	163	44
FR013		White Bluff/Greg Allen	1988/04/12	46.417	119.215	11	29E	20	N	25.0	-	285	-	-	-	-	-	212	-	170	40
FR014		Turner, Richard	1983/07/25	46.390	119.236	11	29E	31	N	24.5	-	227	-	-	-	-	-	-	-	148	40
FR015		Clearwater Domestic Assoc.	-	46.389	119.199	11	29E	32	R	21.1	F	113	D	-	-	-	-	57	P	103	44
FR016		Circle H Land, 3	1983/05/18	46.462	118.942	11	31E	04	P	21.5	-	399	-	-	-	-	-	13248	-	125	40
FR017		Nakamura, H.	-	46.425	118.931	11	31E	21	H	24.8	B	356	D	-	34	-	-	-	-	-	22,25,26,38
FR018		Hummel, Ed.	1988/04/13	46.399	118.937	11	31E	33	B	22.0	-	213	-	-	-	-	-	-	-	53	40
FR019		Rowe Farms	-	46.402	118.842	11	32E	29	N	29.6	B	333	D	-	53	-	-	-	-	-	23
FR020		USBR Drainage Obs.	1988/02/21	46.557	119.128	12	29E	01	E	22.5	-	15	-	-	-	-	-	-	-	-	40
FR021		Stephens, Alvin E.	-	46.555	119.204	12	29E	05	-	20.0	F	136	D	-	-	-	-	76	P	26	44
FR022		Rohfeld, Richard	-	46.554	119.223	12	29E	06	K	20.0	F	72	D	-	-	-	-	-	P	64	44
FR023		Washburn, Hiram E.& Rachel A.	-	46.522	119.191	12	29E	16	N	21.1	F	112	D	-	-	-	-	25	P	87	44
FR024		Casey, Michael	1988/09/12	46.526	119.202	12	29E	17	K	23.0	-	146	-	-	-	-	-	30	-	119	40
FR025		Winebarger, Jim	-	46.518	119.133	12	29E	23	A	22.2	F	175	D	-	-	-	-	23	P	123	44
FR026	*	US Bureau of Reclamation	1953/01/01	46.500	119.186	12	29E	28	F	20.0	F	213	D	-	38	-	-	204	-	150	22,25,26,40
FR027		N. 16 Dom. Water Assoc., Inc.	-	46.489	119.160	12	29E	34	B	21.1	F	169	D	-	-	-	-	91	P	129	44
FR028		Coordes, Henry	1988/09/13	46.538	118.926	12	31E	10	M	22.5	-	293	-	-	-	-	-	-	-	183	40
FR029		Greenfield Farm/Mel McLane	1988/02/27	46.626	119.315	13	28E	09	L	25.0	-	247	-	-	-	-	-	-	-	178	40
FR030		Lowe, Walter	1988/02/26	46.629	119.278	13	28E	11	E	22.0	-	222	-	-	-	-	-	-	-	186	40
FR031	*	US Bureau of Reclamation	1983/07/26	46.608	119.257	13	28E	13	N	29.5	F	341	D	-	46	-	-	322	-	145	22,25,26,40
FR032		US Bureau of Reclamation	1983/07/22	46.629	119.199	13	29E	08	H	20.5	F	138	D	-	-	-	-	114	P	130	40,44

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
FR033		Bailie	-	46.612	119.120	13	29E	13	K	22.6	B	210	D	48	43	-	77	-	-	-	5,26
FR034		Price, Anthon	-	46.618	119.194	13	29E	16	D	23.9	F	227	D	-	-	-	-	303	P	126	44
FR035		Wahluke Water Association,Inc.	-	46.618	119.194	13	29E	16	D	27.8	F	318	D	-	-	-	-	227	P	127	44
FR036		Bailie, Leon	1988/04/14	46.593	119.147	13	29E	23	P	23.5	-	214	-	-	-	-	-	-	-	23	40
FR037		Connell City 8	1983/07/21	46.644	118.875	13	31E	01	E	21.1	F	404	D	-	-	-	-	9118	P	101	40,44
FR038		Loeber, E. C.	-	46.618	118.892	13	31E	14	C	20.6	F	369	D	-	-	-	-	7570	P	102	44
FR039		Connell City, E. C. Loeber	-	46.605	118.883	13	31E	14	R	20.0	F	306	D	-	-	-	-	757	P	107	44
FR040		Pepiots, Inc.	-	46.571	118.909	13	31E	34	G	22.2	F	400	D	-	-	-	-	1136	P	176	44
FR041		Cockrans	-	46.581	118.604	13	34E	30	M	32.2	B	355	D	56	57	-	-	-	-	-	22,25,26
FR042		USBR Block 24 Obs.	1988/09/17	46.677	119.315	14	28E	28	C	21.5	-	6	-	-	-	-	-	-	-	-	40
FR043	*	US Govt./Othello AFB	1967/02/13	46.721	119.178	14	29E	09	A	23.3	B	263	D	58	47	-	-	197	-	172	6,22,25,26,40,41
FR044		Michel, John	1988/09/14	46.681	119.226	14	29E	19	Q	21.0	-	128	-	-	-	-	-	-	-	68	40
FR045		Alexander, H. D.	1988/09/14	46.651	119.215	14	29E	32	N	26.7	F	182	D	-	-	-	-	19	P	130	40,44
FR046		Rathbun, Corrin	-	46.713	118.959	14	31E	08	M	46.8	B	758	D	-	46	38	-	-	-	-	2,26,37,38,45
FR047		Rathbun, Corrin, 3	-	46.713	118.922	14	31E	09	J	22.2	B	332	D	-	28	48	-	-	-	-	22,25,26,37,38,45
FR048		Kummer Farms	-	46.705	118.911	14	31E	15	C	20.3	B	413	D	-	-	-	-	-	-	-	37,38, 45
FR049		Wirth, Earl W.	-	46.669	118.891	14	31E	26	L	22.2	F	274	D	-	-	-	-	265	P	134	44
FR050		Andrews, Clyde	-	46.669	118.901	14	31E	27	J	25.2	B	207	D	-	-	50	-	-	-	-	45
FR051		Connell City	-	46.658	118.860	14	31E	36	H	23.3	F	337	D	-	-	-	-	2790	P	108	44
FR052	*	Connell City 4	1970/09/24	46.655	118.860	14	31E	36	J	25.0	F	337	D	-	39	-	-	-	-	-	22,25,26,40
FR053		Hart, Frank	-	46.722	118.763	14	32E	02	P	27.2	B	242	D	50	63	50	-	-	-	-	22,25,26,37,45
FR054		Hart	-	46.701	118.748	14	32E	13	E	25.6	-	187	L	-	73	-	-	-	-	-	22,25,26
FR055		Hart, Dick	-	46.701	118.748	14	32E	13	E	23.7	B	232	D	-	-	50	-	-	-	-	37,45
FR056		Welch, Norman A. & Dean	-	46.671	118.847	14	32E	30	F	22.8	F	238	D	-	-	-	-	2460	P	91	44
FR057		Connell City 6	-	46.662	118.854	14	32E	31	D	29.4	B	305	D	38	57	50	-	-	-	-	22,25,26
FR058		Hudlow, Floyd S.	-	46.705	118.720	14	33E	18	B	20.0	F	165	D	-	-	-	-	341	P	148	44
FR059		Heider, Walter	-	46.680	118.689	14	33E	21	N	28.2	B	351	D	-	44	50	-	-	-	-	22,25,26,37,38,45
FR060		Gillis, Vernon	1983/08/03	46.680	118.354	14	36E	19	N	29.5	B	287	D	-	42	-	-	76	-	-	22,25,26,40
		GARFIELD COUNTY																			
GA001		Scott, Jim	-	46.521	117.760	12	40E	14	J	21.1	F	317	D	-	-	-	-	34	P	268	44
GA002	*	Pomeroy City 4	1960/05/24	46.476	117.601	12	42E	31	L	23.0	F	304	D	-	36	-	-	-	-	-	22,25,26,40,41
GA003		Burne, Diane	-	46.569	117.543	13	42E	33	G	20.0	F	47	D	-	-	-	-	204	P	-	44
		GRANT COUNTY																			
GR001		Pacific First Bank 2	-	46.645	119.844	13	24E	05	F	25.6	F	457	D	-	-	-	-	-	-	10	44
GR002		Pacific First Bank 1	-	46.645	119.844	13	24E	05	F	26.1	F	393	D	-	-	-	-	-	-	9	44
GR003		Pacific First Bank 3	-	46.645	119.844	13	24E	05	F	24.4	F	461	D	-	-	-	-	-	-	24	44
GR004		DNR East Priest Rapids, 1	1983/07/28	46.706	119.892	14	23E	13	D	23.5	-	296	-	-	-	-	-	-	-	82	40
GR005		Baney, Curt	-	46.692	119.908	14	23E	23	C	21.1	F	195	D	-	-	-	-	-	-	38	44
GR006		Gearhart, Frank	1983/07/27	46.678	119.898	14	23E	26	A	22.5	-	125	-	-	-	-	-	76	-	43	40
GR007	*	US Army/AEC Hanford 90	1971/10/08	46.735	119.639	14	25E	01	D	27.5	F	285	D	-	54	-	-	511	-	55	22,25,26,40,41
GR008		Hanford 93-93	-	46.735	119.639	14	25E	01	D	25.6	B	68	D	-	43	-	-	-	-	-	5,26

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
GR009		Barker, Paul	1983/07/26	46.735	119.655	14	25E	02	C	20.5	-	136	-	-	-	-	-	-	-	17	40
GR010		Arnold, Greg	-	46.696	119.734	14	25E	18	Q	27.8	F	172	D	-	-	-	-	57	P	39	44
GR011	*	US Govt./AEC Hanford 6	1958/01/07	46.692	119.692	14	25E	21	B	22.2	F	159	D	-	63	-	-	984	-	72	22,25,26,40,41
GR012		US Army Corps of Engineers	-	46.674	119.702	14	25E	28	E	22.8	F	198	D	-	-	-	-	946	P	146	44
GR013	*	US Army	1959/10/28	46.691	119.381	14	27E	24	C	30.0	F	425	D	-	42	-	-	379	-	117	22,25,26,40,41
GR014	*	Wahluke School	1994/01/20	46.743	119.898	15	23E	35	R	17.0	F	129	-	-	-	-	-	379	-	107	40
GR015		Mattawa City	1983/07/27	46.740	119.909	15	23E	35	P	21.5	-	303	-	-	-	-	-	3785	-	80	40
GR016		DH 5	-	46.754	119.758	15	24E	25	P	23.3	B	1534	D	-	41	31	-	-	-	-	26
GR017		DH 5	-	46.759	119.820	15	24E	28	-	73.5	B	1525	D	-	41	-	-	-	-	-	12
GR018		Bird, Duane	1982/08/19	46.746	119.644	15	25E	35	H	20.0	-	128	-	-	-	-	-	114	-	104	40
GR019	*	AEC Hanford 7	1958/01/07	46.743	119.425	15	27E	34	L	21.7	F	194	D	-	49	-	-	265	-	83	22,25,26,40,41
GR020		Myrick, Norman A. & Edith E.	-	46.912	119.892	16	23E	01	D	22.2	F	312	D	-	-	-	-	3785	P	200	44
GR021		Grant County PUD, 2	-	46.861	119.941	16	23E	21	J	20.6	F	108	D	-	-	-	-	2044	P	6	44
GR022		Grant County PUD, 2	1983/07/27	46.861	119.941	16	23E	21	J	21.5	-	53	-	-	-	-	-	689	-	3	40
GR023	*	US Government	-	46.908	119.754	16	24E	01	G	23.5	F	244	D	-	47	-	-	-	-	-	22,25,26,41
GR024	*	US Air Force	-	46.908	119.754	16	24E	01	G	24.5	F	279	D	-	45	-	-	-	-	-	22,25,26,41
GR025	*	US Air Force	1963/03/28	46.908	119.754	16	24E	01	G	23.5	-	279	-	-	-	-	-	1154	-	214	40
GR026		Royal City 1	1983/07/27	46.901	119.626	16	25E	01	Q	20.5	-	277	-	-	-	-	-	1893	-	162	40
GR027		Weitzel, Paul	1983/07/30	46.956	119.901	17	23E	23	A	24.0	-	276	-	-	-	-	-	38	-	183	40
GR028		Metro Mortgage	-	46.996	119.633	17	25E	01	F	25.3	B	239	D	-	56	-	-	-	-	-	22,25,26,37
GR029		US Bureau of Reclamation	1982/08/18	46.926	119.490	17	27E	31	D	20.8	F	247	D	-	36	-	-	1211	-	61	22,25,26,40
GR030		—	-	46.993	118.989	17	30E	01	G	23.0	F	299	D	-	37	-	-	-	-	-	22,25,26
GR031		Warden City	-	46.972	119.036	17	30E	10	P	27.8	F	253	D	-	-	-	-	12036	P	53	44
GR032	*	US Government	1982/08/11	46.917	119.054	17	30E	33	K	23.3	-	299	D	-	-	-	-	-	-	-	40,41
GR033	*	US Army Corps of Engineers	1960/01/24	46.917	119.054	17	30E	33	K	23.5	F	306	D	-	33	-	-	946	P	64	22,25,26,40,41,44
GR034		George City	-	47.087	119.857	18	24E	06	A	20.0	F	54	D	-	-	-	-	3785	P	8	44
GR035		Washington	-	47.054	119.680	18	25E	15	E	25.6	F	297	D	-	46	-	-	-	-	-	22,25,26
GR036		Quiney	-	47.054	119.680	18	25E	15	E	22.4	S	270	L	-	39	-	-	-	-	-	22,25,26
GR037		DOE George	-	47.054	119.681	18	25E	15	E	29.3	-	488	L	35	35	-	-	-	-	-	22,25,26,38
GR038	*	WDOE Tst./Obs., Backfilled	1978/02/17	47.054	119.681	18	25E	15	E	25.5	-	491	-	-	-	-	-	4391	-	117	40
GR039		Metro Mortgage 11A	-	47.036	119.644	18	25E	23	J	21.2	-	190	L	-	48	-	-	-	-	-	22,25,26
GR040		Farm Man	-	47.018	119.681	18	25E	27	N	21.2	B	228	D	-	36	-	-	-	-	-	6,22,25,26
GR041		Bradshaw	-	47.029	119.691	18	25E	28	B	22.4	B	212	D	-	49	-	-	-	-	-	22,25,26
GR042		Metro Mortgage	-	47.011	119.612	18	26E	31	F	20.4	B	216	D	46	49	-	-	-	-	-	6,26
GR043		Metro Mortgage 20	-	47.007	119.606	18	26E	31	K	22.5	B	215	D	40	49	-	-	-	-	-	22,25,26
GR044		Clarno, Roy	1983/05/20	47.014	119.590	18	26E	32	C	20.5	-	137	-	-	-	-	-	9311	-	12	40
GR045		Sparks, Dave, 6	1983/05/18	47.007	119.542	18	26E	34	K	21.0	-	20	-	-	-	-	-	681	-	8	40
GR046		Shinn, F.	-	47.005	119.529	18	26E	35	SW4	23.2	B	165	D	50	68	-	79	-	-	-	5,26
GR047		Tokunaga, Joe	1983/07/28	47.024	119.271	18	28E	26	F	22.5	-	244	-	-	-	-	-	7570	-	42	40
GR048		American Potato Company	-	47.078	119.222	18	29E	06	K	20.0	F	210	D	-	-	-	-	4542	P	43	44
GR049		American Potato Company, 2	-	47.075	119.222	18	29E	06	Q	21.7	B	205	D	-	47	45	-	-	-	-	22,25,26,33,37,38,45
GR050		Hirai, Tom	1983/07/29	47.160	119.706	19	25E	08	A	23.0	-	220	-	-	-	-	-	9349	-	6	40

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
GR051		Grant County Land Co.	-	47.095	119.658	19	25E	35	M	20.6	F	223	D	-	-	-	-	7097	P	20	44
GR052		DNR 76-10 East Cole 2	1983/08/29	47.099	119.637	19	26E	36	E	20.0	-	157	-	-	-	-	-	6245	-	76	40
GR053		DNR	-	47.098	119.627	19	26E	36	G	21.1	F	158	D	-	-	-	-	227	P	47	44
GR054		Lauzier, Paul	-	47.101	119.488	19	27E	31	D	25.0	M	233	L	-	56	-	-	-	-	-	22,25,26,33,37
GR055		Moses Lake City 28	-	47.166	119.311	19	28E	04	L	20.9	F	227	D	-	37	-	-	-	-	-	26
GR056	*	Moses Lake City 14	1994/04/07	47.144	119.280	19	28E	15	A	26.7	F	312	D	-	-	-	-	5678	P	85	44
GR057		Moses Lake City 3	1955/08/02	47.133	119.285	19	28E	15	Q	22.2	F	277	D	-	37	-	-	5299	-	8	22,25,26,40
GR058	*	Moses Lake City 7	1960/05/16	47.129	119.274	19	28E	23	D	23.8	B	292	D	-	42	45	-	-	-	4	22,25,26,31,37,40,45
GR059		Moses Lake City 5	-	47.122	119.259	19	28E	23	J	20.0	F	290	D	-	-	-	-	4239	P	31	44
GR060	*	Moses Lake City 10	1994/04/07	47.115	119.291	19	28E	27	C	21.1	F	211	D	-	-	-	-	4353	P	30	44
GR061		Moses Lake City	-	47.111	119.280	19	28E	27	H	20.8	F	319	D	-	-	-	-	7456	P	5	44
GR062		Moses Lake City	-	47.104	119.280	19	28E	27	R	21.4	F	211	D	-	42	-	-	-	-	-	26
GR063	*	Moses Lake City 4	1994/04/07	47.105	119.307	19	28E	28	Q	20.0	F	294	D	-	32	-	-	3785	P	30	6,22,25,26
GR064		Westlake City	-	47.107	119.339	19	28E	29	M	21.1	F	212	D	-	-	-	-	3406	P	1	44
GR065		Moses Lake City 31	-	47.108	119.339	19	28E	29	M	20.6	B	140	D	-	58	-	-	-	-	-	26,37,45
GR066		Fode, Roy, 2	1983/07/29	47.172	119.157	19	29E	03	B	22.5	-	366	-	-	-	-	-	-	-	77	40
GR067		Fode 1	-	47.169	119.162	19	29E	03	F	25.4	B	321	D	-	42	-	-	-	-	-	22,25,26
GR068		Fode, Roy, 2	-	47.169	119.162	19	29E	03	F	29.0	B	322	D	-	-	45	-	-	-	-	33,37,45
GR069		Shinn, Frank, 2	-	47.169	119.173	19	29E	04	H	25.7	B	281	D	-	46	45	-	-	-	-	22,25,26,33,37,45
GR070		Abrams	-	47.151	119.173	19	29E	09	J	20.5	S	98	L	-	88	-	-	-	-	-	22,25,26
GR071		Jett-Aero 2	-	47.136	119.131	19	29E	14	J	21.5	B	218	D	-	44	45	-	-	-	-	26,33,37,45
GR072		Masto Farms	-	47.143	119.152	19	29E	15	A	21.1	B	289	D	-	40	45	-	-	-	-	33,37,38,45
GR073		Carnation	-	47.133	119.189	19	29E	16	N	28.8	B	191	D	-	88	-	-	-	-	-	22,25,26
GR074		Richards, Arch W.	1983/07/30	47.169	119.040	19	30E	03	E	22.2	F	335	D	-	-	-	-	8327	P	112	40,44
GR075		Ottmar, Arthur	1983/09/06	47.150	119.099	19	30E	07	L	23.0	-	284	-	-	-	-	-	7570	-	93	40
GR076		American Potato	-	47.140	118.994	19	30E	13	F	20.6	B	202	D	-	38	-	-	-	-	-	6,22,25,26,45
GR077		Radach Farms	1983/05/17	47.136	119.035	19	30E	15	L	24.0	-	360	-	-	-	-	-	-	-	113	40
GR078		Schmidt, Reuben	-	47.136	119.083	19	30E	17	M	21.9	B	225	D	-	44	45	-	-	-	-	22,25,26,33,37,45
GR079		Abram 1/Jett-Aero 1	-	47.129	119.083	19	30E	20	D	25.8	B	311	D	-	44	45	-	-	-	-	22,25,26,33
GR080		Hagman Construction	-	47.212	119.995	20	23E	19	F	28.9	F	299	D	-	-	-	-	1892	P	6	44
GR081	*	Quincy City 1	1955/08/03	47.236	119.855	20	24E	07	R	21.0	F	131	D	-	69	-	-	4353	-	84	22,25,26,40
GR082	*	Wenatchee Apple Land Co.	-	47.228	119.828	20	24E	09	E	20.0	F	105	D	-	-	-	-	5545	P	69	39
GR083		Auburn Packing Co., Inc.	-	47.178	119.764	20	24E	36	N	20.0	F	64	D	-	-	-	-	1514	P	12	44
GR084		Updegrave, V./Neveal, G.	1983/07/29	47.198	119.516	20	26E	26	JorK	21.0	F	161	D	-	-	-	-	5678	P	65	40,44
GR085	*	Moses Lake City 21	1983/07/29	47.183	119.322	20	28E	32	HorJ	22.2	-	217	D	-	-	-	-	3501	-	33	40,41
GR086		Cole, E. B.	-	47.242	119.215	20	29E	07	H	24.0	B	215	D	-	56	45	-	-	-	-	22,25,26,33,37,38,45
GR087		Reinke Farms	-	47.201	119.120	20	29E	25	C	26.3	B	406	D	-	32	45	-	-	-	-	22,25,26,33,37,38,45
GR088		Powers, Tom	-	47.187	119.130	20	29E	35	A	26.6	B	293	D	-	40	45	-	-	-	-	22,25,26,33,37,45
GR089		Claassen, C. C.	-	47.212	119.056	20	30E	21	F	26.4	B	323	D	54	39	-	-	13248	P	72	6,22,25,26,44
GR090		Claassen, Clint	-	47.212	119.051	20	30E	21	G	28.7	B	470	D	-	34	35	-	-	-	-	22,25,26,37,38,45
GR091		Franz, Herb, 2	-	47.216	119.003	20	30E	23	A	21.9	B	219	D	-	43	35	-	-	-	-	22,25,26,33,37,45
GR092		Franz, Herb, 1	-	47.212	119.019	20	30E	23	E	34.9	B	337	D	101	68	35	-	-	-	-	22,25,26,33,37,45

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
GR093		Jantz, Joe	-	47.190	119.046	20	30E	28	R	28.6	B	181	D	-	91	-	-	-	-	-	22,25,26,45
GR094		Stuckey, J. Jantz	-	47.190	119.046	20	30E	28	R	20.4	B	178	D	-	47	35	-	-	-	-	22,25,26,33,37,45
GR095		Neibaur/West	-	47.180	119.072	20	30E	32	K	21.1	S	383	L	-	-	-	-	-	-	-	33,37,38,45
GR096		Schorzman, Art & L.M. Etienne	-	47.283	119.857	21	24E	30	J	20.0	F	86	D	-	-	-	-	57	P	46	44
GR097		Ephrata City EPW-1	-	47.341	119.583	21	26E	05	Q	32.0	F	-	-	-	-	-	-	-	-	-	24
GR098	*	Ephrata City	1955/07/22	47.330	119.594	21	26E	08	M	30.0	-	305	-	-	-	-	-	2903	-	41	40
GR099		Ephrata City	-	47.330	119.594	21	26E	08	M	30.0	F	305	D	-	59	-	-	-	-	-	22,25,26
GR100	*	Ephrata City 5	1955/07/22	47.326	119.594	21	26E	08	N	28.0	F	137	D	-	116	-	-	2407	-	17	26,40
GR101		Ephrata City	-	47.317	119.524	21	26E	14	L	20.0	F	311	D	-	-	-	-	2725	P	61	44
GR102		Ephrata City 10	1983/09/02	47.320	119.535	21	26E	15	H	25.5	F	564	D	-	-	-	-	10598	P	66	40,44
GR103		Ephrata City	-	47.323	119.556	21	26E	16	A	21.1	F	415	D	-	-	-	-	5299	P	7	44
GR104	*	Ephrata City 2	1955/07/22	47.323	119.562	21	26E	16	B	29.0	-	79	-	-	-	-	-	6056	-	7	40
GR105	*	Ephrata City	1955/07/22	47.305	119.573	21	26E	21	E	25.5	F	188	D	-	72	-	-	-	-	-	22,25,26,40
GR106		Hansen, Charles L.	-	47.349	119.291	21	28E	03	NW4	20.6	F	204	D	-	-	-	-	5678	P	67	44
GR107		Hutterites	1983/09/01	47.343	119.041	21	30E	03	E	22.5	-	408	-	-	-	-	-	-	-	131	40
GR108		—	-	47.325	119.039	21	30E	10	M	30.0	B	640	-	-	28	-	-	-	-	-	22,25
GR109	*	Schell, Harvey, 2	1983/09/01	47.296	119.002	21	30E	23	J	31.1	F	407	D	-	-	-	-	8516	P	117	16,40,44
GR110		Schell, Harvey	-	47.285	119.008	21	30E	26	G	21.4	B	171	D	-	54	35	-	-	-	-	6,22,25,26,45
GR111	*	Soap Lake City	1955/07/22	47.385	119.486	22	27E	19	N	27.0	F	142	D	-	106	-	-	-	-	2	22,25,26,40
GR112		King, Bud	-	47.373	119.007	22	30E	26	G	25.0	B	476	D	35	52	-	-	11355	P	110	22,25,26,33,38,44
GR113		Lester, Edna M.	1982/07/27	47.512	119.412	23	27E	10	B	20.5	-	253	-	-	-	-	-	53	-	231	40
GR114		Schafer, Jerry	-	47.463	119.294	23	28E	27	E	22.8	-	196	L	-	60	-	-	-	-	-	22,25,26,38
GR115		DNR	-	47.494	119.188	23	29E	16	D	20.0	F	285	D	-	-	-	-	9830	P	64	44
GR116		—	-	47.647	119.247	25	28E	24	L	29.2	B	189	-	-	91	-	-	-	-	-	22,25
GR117		Dormaier	-	47.640	119.242	25	28E	25	B	23.0	B	177	D	-	62	-	-	-	-	-	6,22,25,26
GR118		Bolyard, James L.	-	47.640	119.268	25	28E	26	C	24.4	F	72	D	-	-	-	-	6813	P	26	44
		GRAYS HARBOR COUNTY																			
GY001		North Beach School District	1980/07/01	47.233	124.207	20	12W	08	P	20.5	-	71	-	-	-	-	-	-	-	-	40
GY002		VO-MO 1	-	47.238	124.204	20	12W	08	-	35.6	B	1067	L	27	-	-	36	-	-	-	4,5
		KING COUNTY																			
KI001S	*	Lester Hot Springs	-	47.207	121.547	20	10E	21	M	46.5	-	-	-	-	-	-	-	19	-	-	19,21,29,32
KI002		Valley View Christian Church	1987/09/22	47.371	122.177	22	05E	28	C	21.5	-	72	-	-	-	-	-	42	-	59	40
KI003S	*	Goldmeyer Hot Springs	-	47.486	121.366	23	11E	14	B	50.0	-	-	-	-	-	-	-	-	-	-	19,29,32
KI004S	*	Scenic Hot Springs	-	47.711	121.140	26	13E	28	Q	47.0	-	-	-	-	-	-	-	-	-	-	18,19,29,32
		KITTITAS COUNTY																			
KS001		USGS/WDOE Burbank Creek	1978/08/16	46.772	120.436	15	19E	22	L	24.3	B	184	D	-	93	-	-	6056	P	12	2,22,25,26,40,42
KS002		Larson Fruit	-	46.768	120.437	15	19E	22	P	31.5	B	393	D	-	50	-	-	-	-	-	2,26,38
KS003		Larson Fruit Co.	-	46.769	120.426	15	19E	22	R	20.0	F	127	D	-	-	-	-	-	N?	A?	42
KS004		Larson Orchards	1983/07/12	46.769	120.426	15	19E	22	R	26.5	-	390	-	-	-	-	-	8706	-	60	40
KS005		Nash, Chet	-	46.746	120.404	15	19E	35	H	20.0	F	21	D	-	-	-	-	163	P	14	42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
KS006		Badger/Bollinger	-	46.889	120.391	16	19E	12	K	20.0	B	333	D	48	33	-	46	-	-	-	5,26
KS007	*	USGS/WDOE Umtanum	1978/03/02	46.852	120.458	16	19E	28	C	28.6	B	310	D	-	51	-	-	3634	-	7	22,25,26,38,40
KS008		Orcutt, Leland	-	46.991	120.354	17	20E	05	K	22.8	F	137	D	-	-	-	-	2271	P	34	42
KS009S		Clerf Spring	-	46.999	120.372	17	20E	06	A	20.0	-	-	-	-	-	-	-	4164	-	-	36
KS010		Palelek, Ron	1982/07/29	46.937	119.987	17	23E	30	H	26.0	-	61	-	-	-	-	-	114	-	38	40
KS011	*	Ellensburg City, Mt.Stuart well	1994/04/07	47.009	120.556	18	18E	35	E	20.6	F	272	L	-	32	-	-	3217	P	15	22,25,26,38
KS012[1]		Central Washington University	1994/01/18	47.013	120.525	18	18E	36	B	28.4	B	262	D	-	61	-	-	-	-	-	6,22,25,26
KS013		Clerf, Howard	1983/07/12	47.029	120.305	18	20E	27	A	21.0	F	142	D	-	-	-	-	7570	P	67	40,42
		KLICKITAT COUNTY																			
KT001		Bingen City 2	-	45.719	121.467	03	11E	30	H	20.5	M	88	D	-	-	-	-	-	-	-	5
KT002		Heaney	-	45.701	121.410	03	11E	34	K	21.4	M	104	D	37	-	-	58	-	-	-	5
KT003		Mott, J.	-	45.737	121.182	03	13E	21	B	22.4	M	150	D	29	-	-	53	-	-	-	5
KT004		Daniel, L.	-	45.698	121.235	03	13E	31	M	22.1	M	174	D	26	-	-	42	-	-	-	5
KT005		US Army Corps of Engineers	-	45.724	120.693	03	17E	28	C	22.2	F	238	D	-	-	-	-	2271	P	28	42
KT006		Riggleman Orchards	-	45.864	121.463	04	11E	05	E	21.1	F	279	D	-	-	-	-	738	P	226	42
KT007		Jeleniewski, Tom	-	45.825	121.360	04	12E	19	D	21.1	F	47	D	-	-	-	-	57	P	18	42
KT008		J. Neils Lumber Co.	-	45.821	121.151	04	13E	23	E	27.0	F	168	D	-	-	-	-	303	N	A	28
KT009S	*	Klickitat Mineral Springs	-	45.823	121.114	04	13E	24	A	29.0	-	-	-	-	-	-	-	-	-	-	17,22,32
KT010		DNR 81 Klickitat	-	45.821	121.130	04	13E	24	E	20.1	B	120	D	51	56	-	71	-	-	-	5,26
KT011	*	Gas Ice Corp. 10	1966/03/24	45.821	121.114	04	13E	24	H	27.2	F	90	D	-	167	-	-	341	N	A	22,25,26,28,31,40
KT012	*	Gas Ice Corp. 2	1964/10/21	45.824	121.104	04	14E	19	C	23.0	F	61	D	-	177	-	-	-	-	-	22,25,26,31,40
KT013		Barrett, Charles M.	1982/08/25	45.852	120.777	04	16E	11	D	21.5	-	329	-	-	-	-	-	5678	-	-	40
KT014		Barrett	-	45.852	120.777	04	16E	11	D	20.9	-	187	L	-	48	-	-	-	-	-	26
KT015		Goldendale City 1	-	45.827	120.808	04	16E	16	Q	24.6	B	271	D	-	-	-	-	-	-	0	9,38
KT016		Berk Bros.	-	45.894	120.290	05	20E	27	B	23.1	B	276	D	41	43	-	-	-	-	-	6,22,25,26
KT017		DOE Horse Heaven West	-	45.916	120.191	05	21E	16	L	27.6	B	457	D	49	38	-	78	-	-	-	5,26,37
KT018		Matsen	-	45.894	120.035	05	22E	27	A	28.2	B	321	D	42	48	-	-	-	-	-	6,22,25,26,33
KT019		Matsen, A. M.	-	45.894	120.035	05	22E	27	A	22.2	F	262	D	-	-	-	-	6836	P	22	42
KT020		Matsen, A. M.	-	45.894	120.035	05	22E	27	A	21.1	F	236	D	-	-	-	-	3406	P	17	42
KT021		Rinta, John, 1	1983/07/19	45.883	120.045	05	22E	27	P	24.0	-	248	-	-	-	-	-	9463	-	35	40
KT022		Powers, Tom	-	45.915	119.870	05	23E	13	J	27.2	B	330	D	-	43	-	-	-	-	-	22,25,26,38
KT023		Hiner, Gene	1982/03/31	45.911	119.869	05	23E	13	R	25.0	-	442	-	-	-	-	-	10674	-	39	40
KT024		McBride, Clarence	-	45.893	119.968	05	23E	29	D	25.5	B	267	D	-	51	-	-	8024	N	A	22,25,26,38
KT025		McBride Ranch, 2	1983/07/19	45.893	119.989	05	23E	30	D	24.0	-	257	-	-	-	-	-	17600	-	38	40
KT026S	*	Fish Hatchery Warm Spring	-	46.039	121.179	06	13E	04	H	23.8	-	-	-	-	-	-	-	-	-	-	11
KT027	*	Smith, G.	1970/12/11	46.014	119.905	06	23E	11	N	23.3	F	272	D	-	37	-	-	-	-	A	22,25,26,40,42
KT028		Andrews, Robert	1970/12/11	46.014	119.894	06	23E	11	Q	23.5	F	272	D	-	-	-	-	9462	N	A	9,40
KT029	*	Smith, George	-	46.014	119.894	06	23E	11	Q	21.0	F	204	D	-	44	-	-	-	-	-	22,25,26,31
KT030	*	—	1962/04/30	46.014	119.895	06	23E	11	Q	21.0	-	63	-	-	-	-	-	-	-	-	40
KT031	*	Andrews/Smith	1970/10/22	46.006	119.910	06	23E	15	H	21.0	F	193	L	-	47	-	-	1438	-	0	22,25,26,40
KT032		Andrews	-	46.006	119.910	06	23E	15	H	25.2	S	275	L	-	48	-	-	-	-	-	22,25,26
KT033		DNR Feezell	-	45.999	119.942	06	23E	16	P	22.0	F	290	D	-	-	-	-	10787	P	12	9

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
KT034		DNR	-	45.999	119.932	06	23E	16	R	22.2	F	290	D	-	-	-	-	7570	P	20	42
KT035		Andrews, Robert	-	45.988	119.911	06	23E	22	J	23.0	B	318	D	-	35	-	-	-	-	-	26,38
KT036		Andrews, Robert	1983/07/19	45.995	119.874	06	23E	24	B	24.5	-	294	-	-	-	-	-	15140	-	44	40
KT037		DNR Mercer N.	-	45.962	119.879	06	23E	36	F	20.8	B	190	D	49	41	-	78	-	-	-	5,26
LEWIS COUNTY																					
LE001		SU 8	-	46.545	122.847	12	01W	07	A	25.2	B	565	D	33	30	-	36	-	-	-	4,5,22,25,26
LE002		SU 11	-	46.538	122.826	12	01W	08	J	21.3	B	409	D	35	33	-	37	-	-	-	4,5,22,25,26
LE003		SU 12	-	46.538	122.826	12	01W	08	J	25.7	B	578	D	27	31	-	31	-	-	-	4,5,22,25,26
LE004		SU 14	-	46.538	122.836	12	01W	08	L	25.6	B	578	L	34	-	-	36	-	-	-	4,5
LE005		SU 37	-	46.534	122.841	12	01W	08	N	24.7	B	540	D	34	31	-	36	-	-	-	4,5,22,25,26
LE006		SU 4	-	46.535	122.820	12	01W	09	N	28.8	B	760	L	33	-	-	36	-	-	-	4,5
LE007		SU 902	-	46.527	122.826	12	01W	17	H	31.2	B	847	L	33	-	-	36	-	-	-	4,5
LE008		Longview 10	-	46.525	122.833	12	01W	17	-	30.0	-	792	L	26	27	-	-	-	-	-	22,25,26
LE009S		Packwood Hot Spring	-	46.579	121.705	13	09E	32	-	38.0	-	-	-	-	-	-	-	-	-	-	17,22,32
LE010S	*	Ohanapecosh Hot Springs (USGS)	-	46.737	121.561	14	10E	04	C	50.0	-	-	-	-	-	-	-	110	-	-	29
LINCOLN COUNTY																					
LI001	*	Odessa Oil Test Piezometer A	1972/09/13	47.327	118.913	21	31E	10	M	30.5	-	224	-	-	-	-	-	-	-	71	40
LI002		Basalt Explorer	-	47.326	118.913	21	31E	10	M	65.8	S	1343	L	42	40	38	70	-	-	-	4,5,22,25,26,33,37,38,45
LI003		Schafer, Jerry	-	47.299	118.885	21	31E	23	F	21.0	B	293	D	-	-	35	-	-	-	-	45
LI004		Schibel, Don	-	47.303	118.864	21	31E	24	C	20.6	B	194	D	-	-	35	-	-	-	-	45
LI005		Sahible	-	47.287	118.860	21	31E	25	B	28.3	B	195	D	-	84	-	-	-	-	-	22,25,26
LI006		Kissler, Bob	-	47.277	118.960	21	31E	30	R	23.8	B	264	D	-	41	35	-	-	-	-	22,25,26,37,45
LI007		Kissler	-	47.273	118.957	21	31E	32	D	21.1	B	211	D	-	42	-	-	-	-	-	5,6,22,25,26
LI008		Schaffer, Jerry	-	47.301	118.755	21	32E	23	F	24.1	B	299	D	-	41	40	-	-	-	-	22,25,26,37,45
LI009		Fink, Reuben	1983/06/03	47.274	118.840	21	32E	31	C	20.0	-	227	-	-	-	-	-	3785	-	82	40
LI010		Kramer, Robert A.	1983/08/04	47.294	118.539	21	34E	21	K	21.0	-	225	-	-	-	-	-	4164	-	112	40
LI011		Hardung, Joe	-	47.275	118.546	21	34E	33	C	24.9	S	253	L	-	55	-	-	-	-	-	22,25,26,37
LI012		Weizel, LeeRoy	-	47.274	118.511	21	34E	34	A	20.0	F	234	D	-	-	-	-	7229	P	124	44
LI013		Weizel, L. R.	-	47.270	118.511	21	34E	34	H	22.2	F	197	D	-	-	-	-	2650	P	60	44
LI014		Iverson	-	47.329	118.449	21	35E	07	G	20.1	B	128	D	-	65	-	-	-	-	-	6,22,25,26
LI015	*	Sprague City	1983/08/02	47.296	117.985	21	38E	23	L	21.4	F	153	D	-	-	-	-	3217	-	42	7,15,40
LI016		Jantz, Merlin K.	1983/08/05	47.395	118.696	22	33E	17	N	21.5	-	188	-	-	-	-	-	-	-	61	40
LI017		Weishaar	-	47.514	118.787	23	32E	04	J	28.7	B	212	D	-	83	-	-	-	-	-	22,25,26
LI018		Weishaar	-	47.488	118.814	23	32E	17	G	21.2	B	206	D	37	49	-	-	-	-	-	22,25,26
LI019		Zagelow	-	47.499	118.637	23	33E	10	J	21.6	S	232	L	-	46	-	-	-	-	-	22,25,26
LI020		USGS/WDOE Almira	-	47.577	118.933	24	31E	16	E	21.8	B	227	D	48	37	-	-	-	-	-	5,6,22,25,26
LI021		Schmierer, Alvin	-	47.554	118.627	24	33E	23	P	27.0	B	310	D	-	48	-	-	-	-	-	22,25,26,38
LI022		Nealey, Darwin	-	47.538	118.583	24	34E	30	P	21.0	B	231	D	-	43	-	-	-	-	-	26,37
LI023		USGS/WDOE Davenport	-	47.578	118.272	24	36E	16	A	21.9	B	225	D	59	55	-	93	-	-	-	5,26
LI024	*	Wilbur SEC	1983/08/31	47.614	118.754	25	32E	35	P	21.3	F	348	D	-	-	-	-	-	-	79	7,15,40

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m^2)	Flow (l/m)	Flow type	SWL (m)	References
LI025	*	Davenport City 6	1983/08/10	47.648	118.153	25	37E	21	L	24.0	F	297	D	-	-	-	-	8327	P	67	16,40,44
LI026		Davenport City 5	-	47.648	118.154	25	37E	21	L	24.0	S	227	L	-	57	-	-	-	-	-	22,25,26
LI027		Reardan City	-	47.671	117.880	25	39E	15	D	20.0	S	259	L	28	35	-	-	-	-	-	26,37
LI028		Washington Water Power Co.	-	47.870	118.480	27	34E	01	E	25.8	M	151	D	-	-	-	-	-	-	-	5
LI029		DDH-SF15	-	47.819	118.132	27	37E	22	P	31.7	M	258	D	35	-	-	-	-	-	-	5
LI030		Taylor	-	47.816	118.099	27	37E	26	A	23.8	-	358	D	40	36	-	-	-	-	-	5,26
		OKANOGAN COUNTY																			
OK001		DOE TST3	-	48.151	119.675	31	25E	27	Q	22.7	M	44	D	-	-	-	-	-	-	-	5
OK002		Ayres, Bob	-	48.589	119.567	36	26E	28	K	21.1	F	12	D	-	-	-	-	568	P	7	42
OK003		Gildroy	-	48.680	119.498	37	26E	25	NE4	20.6	M	134	D	-	-	-	-	-	-	-	5
OK004S		Poison Lake	-	48.819	119.451	38	27E	05	J	50.0	-	-	-	-	-	-	-	-	-	-	17,22
OK005		Zissel, Charles	-	48.794	119.256	38	28E	14	H	20.0	F	9	D	-	-	-	-	38	P	2	42
OK006		Zosel, Ralph	-	48.962	119.409	40	27E	15	R	20.0	F	9	D	-	-	-	-	19	P	4	42
OK007S		Hot Lake	-	48.973	119.476	40	27E	18	A	50.0	-	-	-	-	-	-	-	-	-	-	17,22
		PIERCE COUNTY																			
PI001S	*	Longmire Springs	-	46.752	121.813	15	08E	29	R	22.0	-	-	-	-	-	-	-	2	-	-	14
PI002S		Mount Rainier Fumaroles	-	46.855	121.756	16	08E	23	K	72.0	-	-	-	-	-	-	-	-	-	-	17,22
PI003S	*	Spring	-	47.114	122.597	19	02E	19	Q	24.4	-	-	-	-	-	-	-	-	-	-	15
		SKAMANIA COUNTY																			
SK001S	*	Bonneville Hot Springs	-	45.656	121.958	02	07E	16	M	36.3	-	-	-	-	-	-	-	80	-	-	17,18,19,22,32
SK002S	*	Rock Creek Hot Springs	-	45.721	121.926	03	07E	27	B	33.5	-	-	-	-	-	-	-	-	-	-	18
SK003		North Bonneville 2	-	45.652	121.960	02	07E	39	E	35.5	B	198	D	143	131	-	190	-	-	-	5,26
SK004		North Bonneville 3	-	45.651	121.958	02	07E	39	K	26.4	B	155	D	91	106	-	120	-	-	-	5,26
SK005		Bonneville drill hole 2	-	45.646	121.955	02	07E	39	Q	28.2	F	-	-	-	-	-	-	-	-	-	18
SK006S		Shiperds Hot Springs	-	45.739	121.805	03	08E	21	C	42.0	-	-	-	-	-	-	-	100	-	-	17,22
SK007		DNR 81-Carson	-	45.735	121.805	03	08E	21	F	27.8	B	113	D	168	166	-	265	-	-	-	5,26
SK008S	*	St. Martin Hot Springs	-	45.728	121.794	03	08E	21	R	49.0	-	-	-	-	-	-	-	-	-	-	14,19,21,29,32
SK009		Green Life 1	-	45.703	121.854	03	08E	31	M	41.0	B	914	D	25	33	-	-	-	-	-	8
SK010S		Collins Hot Springs	-	45.698	121.719	03	09E	31	Q	50.0	-	-	-	-	-	-	-	-	-	-	17,22,32
SK011		Trout Creek Drill Hole	-	45.812	121.954	04	07E	21	P	36.3	B	357	D	89	-	-	141	-	-	-	1,5
SK012S		Mount St. Helens lava dome	-	46.200	122.187	08	05E	09	A	88.0	-	-	-	-	-	-	-	-	-	-	17,22
SK013S		Orr Creek Warm Springs	-	46.344	121.609	10	10E	19	NE4	22.0	-	-	-	-	-	-	-	100	-	-	17,22
		SNOHOMISH COUNTY																			
SN002S	*	Kennedy Hot Springs(USGS)	-	48.119	121.193	30	12E	01	H	38.0	-	-	-	-	-	-	-	-	-	-	29,32
SN003S	*	Gamma Hot Spring	-	48.151	121.062	31	13E	36	D	65.0	-	-	-	-	-	-	-	-	-	-	19,29
SN004S	*	Sulphur Creek Hot Springs	-	48.255	121.180	32	13E	19	C	37.0	-	-	-	-	-	-	-	-	-	-	19,21
		SPOKANE COUNTY																			
SP001		Cheney City 4	-	47.487	117.582	23	41E	13	E	22.2	F	651	D	-	-	-	-	-	-	82	44
SP002		Cheney City 5	-	47.480	117.593	23	41E	14	Q	33.1	B	651	D	-	34	-	-	5488	P	72	22,25,26,38,44

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
SP003		Cheney City	-	47.481	117.593	23	41E	14	Q	29.1	-	341	L	-	56	-	-	-	-	-	22,25,26
SP004		Anderberg, Gary	-	47.505	117.397	23	43E	08	B	20.0	F	154	D	-	-	-	-	757	P	55	44
SP005	*	US Government	1958/07/22	47.556	117.749	24	40E	22	L	20.5	-	105	-	-	-	-	-	-	-	-	40
SP006	*	Fairchild AFB, 2	1958/07/22	47.595	117.628	24	41E	03	N	20.5	-	123	-	-	-	-	-	3785	-	3	40
SP007	*	US Government	1958/07/22	47.660	117.714	25	40E	14	R	20.0	-	109	-	-	-	-	-	-	-	-	40
SP008	*	US Government	1958/07/22	47.616	117.746	25	40E	34	P	21.0	-	60	-	-	-	-	-	-	-	-	40
SP009	*	US Government	1958/07/23	47.687	117.561	25	41E	01	R	20.0	-	127	-	-	-	-	-	-	-	-	40
SP010	*	US Army, Fort George Wright	1958/07/22	47.680	117.472	25	42E	11	E	20.0	-	18	-	-	-	-	-	5678	-	5	40
SP011	*	Washington Water Power Co.,1-3	1977/10/12	47.669	117.306	25	43E	13	A	21.0	-	34	-	-	-	-	-	2460	-	18	40
SP012	*	US Air Force	1958/07/22	47.732	117.536	26	42E	20	N	20.0	-	49	-	-	-	-	-	-	-	-	40
SP013		Fossen & Gisselburg	-	47.708	117.512	26	42E	33	W2	20.0	F	163	D	-	-	-	-	189	P	128	44
		WALLA WALLA COUNTY																			
WA001		Byerly, Richard	1983/05/16	46.024	118.749	06	32E	01	Q	21.5	-	351	-	-	-	-	-	-	-	-	40
WA002S		Warm Spr. Canyon Warm Spr.	-	46.024	118.772	06	32E	02	Q	22.0	-	-	-	-	-	-	-	-	-	-	32
WA003S		Emmett Lynch warm spring	-	46.020	118.770	06	32E	11	B	22.2	-	-	-	-	-	-	-	189	-	-	30
WA004		Fulgham	-	46.026	118.624	06	33E	01	K	31.8	B	305	D	69	67	-	73	2271	P	14	4,5,22,25,26,44
WA005		McDole, Joe	-	46.024	118.723	06	33E	06	R	25.6	F	398	D	-	-	-	-	1552	P	26	44
WA006		Demaris, Eugene & Leland	-	46.012	118.723	06	33E	07	J	20.0	F	46	D	-	-	-	-	1325	P	7 44	
WA007		Fulgham	-	46.017	118.673	06	33E	10	NW4	31.8	B	305	D	70	67	-	-	-	-	-	23
WA008		Herman, J.	-	46.005	118.697	06	33E	16	D	20.0	F	222	D	-	-	-	-	1287	P	5	44
WA009		Miller	-	46.033	118.520	06	34E	02	B	25.1	-	175	L	-	75	-	-	-	-	-	22,25,26
WA010		Bing/Frost Ranch Ltd.	-	46.026	118.577	06	34E	05	J	25.6	F	366	D	-	-	-	-	5867	P	70	44
WA011		Chvatal, Ed.	-	46.033	118.603	06	34E	06	B	36.0	B	484	D	-	48	-	-	-	-	-	22,25,26,33,38
WA012		Chvatal, Ed.	-	46.022	118.613	06	34E	06	N	37.8	F	544	D	-	-	-	-	2650	P	32	44
WA013		—	-	46.018	118.608	06	34E	07	C	40.2	B	407	D	-	64	-	-	-	-	-	6
WA014		Gilbert-Merry	-	46.007	118.608	06	34E	07	P	40.7	B	407	D	78	71	-	-	-	-	-	22,25,26
WA015		Thomas,Sherman/ *dba* Lowden Ranch	1983/08/13	46.008	118.598	06	34E	07	R	45.0	F	506	D	-	-	-	-	3785	P	42	40,44
WA016		Bing/Frost Ranch Ltd.	-	46.018	118.582	06	34E	08	B	40.0	F	366	D	-	-	-	-	4258	P	74	44
WA017		Welch, E. C.	-	46.022	118.369	06	35E	01	R	20.0	F	195	D	-	-	-	-	2971	P	18	44
WA018		Burlingame, E. C.	-	46.022	118.426	06	35E	03	N	20.0	F	416	D	-	-	-	-	38	P	10	30
WA019		Hart, Harley D.	-	46.018	118.453	06	35E	08	A	20.0	F	21	D	-	-	-	-	757	P	3	44
WA020	*	Jaussand, Art	1958/08/01	46.008	118.421	06	35E	10	P	25.0	F	350	D	-	37	-	-	7570	-	50	22,25,26,30,31,40,41
WA021		McAuslan	-	46.015	118.369	06	35E	12	H	21.7	F	214	D	-	42	-	-	757	P	0	22,25,26,30
WA022		Wilson, I. E.	-	46.011	118.380	06	35E	12	L	20.0	F	381	D	-	-	-	-	1703	P	18	44
WA023		Estes or Durand	-	46.006	118.383	06	35E	12	N	24.4	F	180	D	-	56	-	-	1136	P	31	22,25,26,30,31
WA024		Thomas, George	-	46.009	118.372	06	35E	12	R	22.2	F	194	D	-	-	-	-	2271	P	11	44
WA025		Dept. Ecology	-	46.003	118.474	06	35E	18	A	20.3	-	155	L	-	54	-	-	-	-	-	22,25,26
WA026		Dept. Ecology	-	46.004	118.473	06	35E	18	A	36.1	B	396	D	42	61	-	-	-	-	-	22,25,26
WA027	*	WDOE Tst./Obs., Piezometer A	1973/07/12	46.004	118.474	06	35E	18	A	25.5	-	75	-	-	-	-	-	-	-	13	40
WA028		College Place	-	46.004	118.474	06	35E	18	A	26.1	B	399	D	46	35	-	-	-	-	-	26
WA029		—	-	46.004	118.474	06	35E	18	A	21.3	B	399	D	-	46	-	-	-	-	-	6

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
WA030		Walla Walla	-	46.004	118.474	06	35E	18	A	21.3	-	178	L	-	52	-	-	-	-	-	22,25,26
WA031		Crass, Billy J.	-	46.030	118.323	06	36E	04	E	23.3	F	240	D	-	-	-	-	2725	P	78	44
WA032		Hanlon, Terry D.	-	46.022	118.322	06	36E	04	N	22.2	F	195	D	-	-	-	-	57	P	88	44
WA033		Grieb, Bert	-	46.022	118.322	06	36E	04	N	21.1	F	252	D	-	-	-	-	1904	P	88	44
WA034		Richardson, Ross & Zella L.	-	46.026	118.342	06	36E	05	M	21.4	F	188	D	-	48	-	-	1703	P	15	22,25,26,30,44
WA035		Baker	-	46.022	118.328	06	36E	05	R	27.2	F	554	D	-	36	-	-	5980	P	38	22,25,26,30,44
WA036		Courtney, Jess	-	46.026	118.363	06	36E	06	M	22.0	F	186	D	-	54	-	-	1892	P	2	22,25,26,30
WA037		Brown, Lyle R.	-	46.022	118.363	06	36E	06	N	21.7	F	189	D	-	-	-	-	2975	P	3	44
WA038		Barnett, C. W.	-	46.023	118.348	06	36E	06	R	20.0	F	248	D	-	-	-	-	757	P	57	44
WA039		Border, Lester A.	-	46.018	118.353	06	36E	07	B	20.0	F	168	D	-	-	-	-	757	P	33	44
WA040		Ruzicka or Prusia	-	46.018	118.363	06	36E	07	D	22.2	F	171	D	-	58	-	-	1136	P	4	22,25,26,30
WA041		Bossini, Louis	1982/06/23	46.015	118.363	06	36E	07	E	20.0	-	184	-	-	-	-	-	1514	-	37	40
WA042		Logan, John D.	-	46.011	118.363	06	36E	07	M	20.0	F	299	D	-	-	-	-	2176	P	2	44
WA043		Baker	-	46.011	118.315	06	36E	09	L	22.0	F	352	D	-	28	-	-	4542	P	32	22,25,26,30,31
WA044	*	Baker & Baker	-	46.007	118.315	06	36E	09	P	23.2	F	628	D	-	-	-	-	-	P	35	30,31
WA045		OR WA RR & Nav. Co	-	46.101	118.911	07	31E	10	J	22.8	F	123	D	-	-	-	-	659	P	12	44
WA046		Martin, William C.	-	46.120	118.757	07	32E	01	NW4	20.0	F	34	D	-	-	-	-	76	P	15	44
WA047		Pac. Gas Trans. Co., 1	-	46.054	118.843	07	32E	29	N	26.7	F	195	D	-	-	-	-	57	P	47	44
WA048		Pac. Gas Trans. Co., 2	-	46.054	118.843	07	32E	29	N	21.1	F	145	D	-	-	-	-	170	P	47	44
WA049	*	Byerley Farm, Inc.	1971/09/20	46.039	118.747	07	32E	36	QorR	24.0	F	310	D	-	39	-	-	7570	P	24	22,25,26,40,44
WA050		Taggart	-	46.066	118.623	07	33E	24	Q	23.2	-	434	L	-	26	-	-	-	-	-	22,25,26
WA051		Harpe, William	-	46.059	118.639	07	33E	26	H	24.4	F	335	D	-	-	-	-	3406	P	47	44
WA052		Harpe, William	-	46.052	118.640	07	33E	26	R	23.3	F	284	D	-	-	-	-	1355	P	35	44
WA053		L. W. Weidert Farms, Inc.	-	46.053	118.738	07	33E	30	N	25.6	F	276	D	-	-	-	-	6056	P	81	44
WA054		McDole, Joseph and Amalie	-	46.053	118.723	07	33E	30	R	22.8	F	280	D	-	-	-	-	1892	P	51	44
WA055		McDole Farms	-	46.042	118.723	07	33E	31	J	27.8	F	412	D	-	-	-	-	-	-	-	44
WA056		McDole, Joe, 3	-	46.042	118.728	07	33E	31	K	27.7	B	269	D	-	58	-	-	-	-	34	22,25,26,37,44
WA057		Fulgham, Hilda M.	-	46.041	118.644	07	33E	35	K	30.6	F	310	D	-	-	-	-	2839	P	9	44
WA058		Baker, Charles	-	46.051	118.510	07	34E	25	N	20.0	F	336	D	-	-	-	-	1703	P	6	30
WA059		Kelly, Howard J.	-	46.042	118.501	07	34E	36	-	26.7	F	37	D	-	-	-	-	568	P	8	44
WA060		Washington State Penitentiary	-	46.081	118.369	07	35E	13	R	33.3	F	493	D	-	-	-	-	3002	P	125	44
WA061		—	-	46.069	118.406	07	35E	23	M	20.0	B	175	-	-	46	-	-	-	-	-	22,25
WA062		McKinnon, Jack C.	-	46.069	118.406	07	35E	23	M	20.0	F	49	D	-	-	-	-	511	P	7	44
WA063	*	Bonneville Power Admin.	1946/11/21	46.069	118.406	07	35E	23	M	20.0	F	157	D	-	51	-	-	1294	P	18	22,25,26,30,31,40,41
WA064		Hydro Irrigation	-	46.067	118.393	07	35E	23	SE4	20.6	F	174	D	-	-	-	-	3028	P	46	44
WA065		Gluck/BPA	-	46.069	118.385	07	35E	24	M	20.0	B	175	D	-	46	-	-	-	-	-	26
WA066		Arbini, James	-	46.059	118.379	07	35E	25	F	20.0	F	207	D	-	39	-	-	1136	P	5	22,25,26,30
WA067		Columbo	-	46.052	118.379	07	35E	25	P	20.6	F	188	D	-	42	-	-	1325	P	3	22,25,26,30
WA068		Whitman Nat'l. Monument	-	46.044	118.463	07	35E	32	F	25.6	F	230	D	-	-	-	-	291	P	11	44
WA069		Walla Walla College	-	46.044	118.439	07	35E	33	G	21.1	F	232	D	-	-	-	-	3974	P	14	44
WA070		Walla Walla College Farm	-	46.044	118.434	07	35E	33	GorH	22.8	F	305	D	-	-	-	-	5893	P	52	44
WA071	*	Walla Walla College	-	46.044	118.432	07	35E	33	H	24.0	F	217	L	-	55	-	-	-	-	-	22,25,26,31

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
WA072		Walla Walla College Farm	-	46.041	118.442	07	35E	33	L	21.1	F	306	D	-	-	-	-	4164	P	41	44
WA073		DNR Christian	-	46.040	118.421	07	35E	34	L	24.0	S	219	L	47	55	-	-	-	-	-	22,25,26
WA074		State of Washington	-	46.037	118.426	07	35E	34	N	21.1	F	222	D	-	-	-	-	3047	P	30	44
WA075		Walla Walla College	-	46.048	118.390	07	35E	35	A	20.5	B	310	D	27	27	-	-	-	-	-	5,22,25,26
WA076		Walla Walla College	-	46.048	118.390	07	35E	35	A	20.0	F	183	D	-	-	-	-	-	N	A	30
WA077		Walla Walla College Farm	-	46.048	118.400	07	35E	35	C	20.0	F	245	D	-	-	-	-	1173	P	28	44
WA078		Manuel or Magnoni	-	46.047	118.379	07	35E	36	C	20.6	F	195	D	-	41	-	-	378	P	A	22,25,26,30
WA079	*	College Place	1972/05/24	46.044	118.379	07	35E	36	F	20.5	-	213	-	-	-	-	-	1703	-	11	40
WA080	*	College Place City	1960/05/24	46.044	118.379	07	35E	36	F	20.0	-	216	-	-	-	-	-	2801	-	-	40
WA081		Richards	-	46.043	118.379	07	35E	36	F	21.1	F	186	D	-	48	-	-	-	-	A	22,25,26,30
WA082	*	College Place	-	46.044	118.379	07	35E	36	F	20.4	F	247	D	-	34	-	-	568	P	19	22,25,26,30
WA083	*	College Place	-	46.044	118.379	07	35E	36	F	20.6	F	216	D	-	37	-	-	6813	P	A	22,25,26,30
WA084		Stone Creek Sanitarium	-	46.037	118.372	07	35E	36	R	21.1	F	189	D	-	48	-	-	568	P	16	22,25,26,30
WA085		Foundation FM, 3	1982/06/22	46.106	118.291	07	36E	10	B	20.5	-	284	-	-	-	-	-	-	-	-	40
WA086	*	Walla Walla Comm. Coll.	1994/01/20	46.080	118.275	07	36E	14	P	13.0	F	407	L	-	36	-	-	4542	P	-	22,25,26,37
WA087		Walla Walla Golf Course	-	46.084	118.337	07	36E	17	L	39.1	B	716	D	-	36	-	-	-	-	-	6,22,25,26
WA088		Walla Walla Golf Course	-	46.084	118.337	07	36E	17	L	20.9	S	225	L	35	40	-	56	-	-	-	5,22,25,26
WA089		Blue Mountain Asphalt Co.	-	46.073	118.364	07	36E	19	E	20.0	F	48	D	-	-	-	-	114	P	5	44
WA090		D & K Farms	-	46.073	118.358	07	36E	19	F	30.2	B	471	D	-	38	-	-	-	-	-	6,22,25,26
WA091		DKFF	-	46.073	118.358	07	36E	19	F	20.6	B	250	D	-	-	-	-	-	-	-	5
WA092		General Foods Corp.	-	46.073	118.358	07	36E	19	F	24.4	F	343	D	-	-	-	-	3785	P	18	30
WA093		D & K Frozen Foods, Inc.	-	46.073	118.358	07	36E	19	F	21.7	F	69	D	-	-	-	-	643	P	9	44
WA094		Rodgers Can.	-	46.066	118.348	07	36E	19	R	28.8	F	485	D	-	33	-	-	4164	P	29	22,25,26,30
WA095	*	Rogers Canning	1972/05/24	46.066	118.348	07	36E	19	R	26.5	-	485	-	-	-	-	-	4277	-	29	40
WA096		Whitman College	-	46.073	118.327	07	36E	20	H	22.2	F	366	D	-	27	-	-	2680	P	20	22,25,26,44
WA097	*	Whitman College	1972/05/24	46.073	118.327	07	36E	20	H	23.0	-	366	-	-	-	-	-	2680	-	20	40
WA098	*	Walla Walla City 5	1960/07/29	46.051	118.306	07	36E	28	R	23.5	F	332	D	-	48	-	-	6510	-	40	22,25,26,40,41,44
WA099		Walla Walla Country Club	-	46.040	118.348	07	36E	31	J	21.1	F	523	D	-	-	-	-	5678	P	32	30
WA100		Chisholm, J. J.	-	46.037	118.364	07	36E	31	N	20.0	F	183	D	-	-	-	-	1514	P	A	30
WA101		Walla Walla City 7	-	46.048	118.321	07	36E	33	D	30.2	B	425	D	75	40	-	53	-	-	-	4,5,6,22,25,26
WA102		Walla Walla School Dist. 140	-	46.044	118.316	07	36E	33	F	22.2	F	287	D	-	-	-	-	2082	P	40	44
WA103		Smith, Jerry D.	-	46.040	118.306	07	36E	33	J	20.6	F	183	D	-	-	-	-	783	P	39	44
WA104		Peterson, Ross	-	46.177	118.900	08	31E	14	F	24.5	-	336	L	37	37	-	-	-	-	-	22,25,26,37
WA105		Ireland, Ken	1982/08/30	46.155	118.932	08	31E	21	R	22.0	-	38	-	-	-	-	-	114	-	8	40
WA106		McGregor	1970/09/09	46.133	118.912	08	31E	34	H	25.4	F	146	D	-	92	-	-	-	-	-	22,25,26,40
WA107		McGregor Feedlot	-	46.137	118.901	08	31E	35	C	25.6	F	154	D	-	-	-	-	3785	P	46	44
WA108		Gluck, Bill, 2	-	46.153	118.681	08	33E	21	R	31.0	B	237	D	-	-	-	-	-	-	-	37
WA109		Gluck	-	46.155	118.683	08	33E	21	SE4	24.1	B	290	D	38	42	-	60	-	-	-	4,5,22,25,26
WA110		Walla Walla College	-	46.135	118.390	08	35E	35	A	20.5	B	310	L	27	-	-	-	-	-	-	4
WA111		Power	-	46.268	118.753	09	32E	13	C	22.2	B	215	D	35	47	-	55	-	-	-	4,5,26
WA112		Union Pacific RR	-	46.329	118.744	10	32E	24	R	22.2	F	64	D	-	-	-	-	288	P	44	44
WA113		Grote	-	46.426	118.394	11	35E	14	Q	28.4	-	283	L	-	58	-	-	-	-	-	22,25,26

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
WA114		Western Farm Service	-	46.409	118.446	11	35E	28	D	25.0	F	305	D	-	-	-	-	378	P	237	44
WA115		Anderson, Don	-	46.494	118.264	12	36E	26	H	22.5	-	182	L	-	58	-	-	-	-	-	22,25,26,37
		WHATCOM COUNTY																			
WH001S		Dorr Fumarole Field	-	48.788	121.802	38	08E	17	D	90.0	-	-	-	-	-	-	-	-	-	-	17,22
WH002S		Sherman Crater Fumaroles	-	48.770	121.813	38	08E	19	G	130.0	-	-	-	-	-	-	-	-	-	-	17,22
WH003S	*	Baker Hot Springs	-	48.764	121.670	38	09E	20	M	44.0	-	-	-	-	-	-	-	-	-	-	18,19,21,29
WH004		Baker Hot Springs drill hole	-	48.764	121.670	38	09E	20	M	47.9	F	141	D	200	-	-	-	38	N	A	20
		WHITMAN COUNTY																			
WT001		Moehrie, Bill	-	46.505	117.139	12	45E	23	M	20.0	F	79	D	-	-	-	-	30	P	64	44
WT002		Dubois, L. D.	1983/03/29	46.617	118.149	13	37E	15	A	21.5	-	259	-	-	-	-	-	-	-	91	40
WT003		Peterson, Crump, & Kimball	1983/08/26	46.627	117.976	13	39E	07	E	26.5	-	192	-	-	-	-	-	23	-	152	40
WT004		Roy Davis Estate	-	46.619	117.215	13	44E	12	Q	20.0	F	56	D	-	-	-	-	57	P	24	44
WT005		Pullman City	-	46.733	117.166	14	45E	05	B	20.0	F	50	L	-	160	-	-	-	-	-	22,25,26
WT006	*	Pullman City	-	46.733	117.177	14	45E	05	D	20.0	F	50	D	-	-	-	-	-	-	-	31
WT007		Pullman City	-	46.733	117.177	14	45E	05	D	21.0	F	51	L	-	176	-	-	-	-	-	22,25,26,31
WT008		Steiger, Alan	-	46.761	117.504	15	42E	27	H	20.0	F	95	D	-	-	-	-	231	P	63	44
WT009	*	Pullman City	-	46.737	117.177	15	45E	32	N	20.0	-	70	D	-	-	-	-	-	-	-	31
WT010	*	Colfax City, Clay St. well	-	46.896	117.357	16	43E	11	G	23.5	F	183	L	-	77	-	-	-	-	-	22,25,26,31
WT011		Colfax City 4	1983/08/25	46.874	117.368	16	43E	14	N	21.0	-	229	-	-	-	-	-	2120	-	104	40
WT012		Schlomer, John G.	-	46.957	117.878	17	39E	22	AorB	22.2	F	136	D	-	-	-	-	57	P	40	44
WT013		Storment, Daryl	-	46.936	117.859	17	39E	26	K	22.2	F	117	D	-	-	-	-	34	P	-	44
WT014		Colfax City, E. Glenwood well	-	46.930	117.279	17	44E	32	A	21.0	-	-	-	-	-	-	-	-	-	-	31
WT015		Tekoa City	-	47.224	117.072	20	45E	24?	B?	24.4	F	54	D	-	-	-	-	-	-	-	27
		YAKIMA COUNTY																			
YA001		Sharp, Jack	-	46.082	120.017	07	22E	23	B	23.4	B	300	D	35	38	-	-	-	-	-	22,25,26,33
YA002S		Mount Adams Fumaroles	-	46.203	121.493	08	10E	01	Q	50.0	-	-	-	-	-	-	-	-	-	-	17,22
YA003		Mabton	-	46.209	120.000	08	22E	01	G	23.0	B	329	D	36	33	-	-	-	-	-	2,22,25,26
YA004		Flower	-	46.191	120.013	08	22E	11	J	22.0	B	166	D	43	62	-	-	4928	P	-	2,22,25,26,37
YA005		Boast Farms	-	46.169	120.049	08	22E	22	D	20.0	F	266	D	-	-	-	-	-	-	82	42
YA006		Johnson, Ray Y.	-	46.162	120.048	08	22E	22	M	22.2	F	309	D	-	-	-	-	-	-	83	42
YA007		Leyendekker, Arthur	-	46.158	120.048	08	22E	23	N	23.9	F	311	D	-	-	-	-	9462	P	81	42
YA008		Green Acre Farms, Inc.	-	46.301	120.645	09	17E	01	D	27.8	F	572	D	-	-	-	-	6813	P	162	42
YA009		John, Mary	1973/11/27	46.269	120.169	09	21E	15	H	21.0	-	13	-	-	-	-	-	151	-	1	40
YA010		Shinn	-	46.236	120.164	09	21E	26	M	28.5	B	295	D	-	43	52	-	-	-	-	2,6,22,25,26
YA011		Del Monte	1974/05/22	46.232	120.169	09	21E	27	R	22.0	B	35	D	-	286	-	-	-	-	5	2,22,25,40
YA012		—	-	46.279	120.021	09	22E	11	J	20.3	B	166	D	43	43	52	-	-	-	-	2,6,22,25
YA013		Van De Graff Orchards, Inc.	1982/08/19	46.275	120.011	09	22E	12	P	21.0	-	95	-	-	-	-	-	2271	-	6	40
YA014		Ramirez, Christi	-	46.267	120.001	09	22E	13	H	20.0	F	49	D	-	-	-	-	378	P	15	42
YA015		Washington Fruit & Produce	-	46.300	119.880	09	23E	01	B	21.1	F	85	D	-	-	-	-	3535	P	36	42
YA016		Grandview City, well no. 14	-	46.262	119.888	09	23E	13	SW4	22.8	F	291	D	-	-	-	-	7570	P	57	42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
YA017		Grandview City, well no. 4	-	46.250	119.917	09	23E	22	J	21.2	B	429	D	-	-	-	-	-	-	-	2
YA018	*	Grandview City, well no. 15	1994/01/19	46.250	119.928	09	23E	22	L	26.0	F	394	D	-	-	-	-	7570	P	49	42
YA019		John Haas, Inc.	-	46.224	119.991	09	23E	31	F	21.1	F	121	D	-	-	-	-	1325	P	11	42
YA020		White Swan Fairgrounds	1989/09/13	46.377	120.719	10	17E	05	Q	20.0	-	59	-	-	-	-	-	-	-	10	40
YA021		—	-	46.359	120.666	10	17E	14	D	22.0	B	35	D	-	-	-	-	-	-	-	2
YA022	*	Showaway, Ida	1974/04/11	46.359	120.666	10	17E	14	D	20.5	B	23	D	-	370	-	-	-	-	3	22,25,40
YA023		Decker, Bert C., 2	1974/06/13	46.337	120.661	10	17E	23	L	20.3	B	213	D	-	39	39	-	6056	-	29	2,22,25,26,40
YA024		Decker, Bert, Jr., (Decker 3)	1989/09/15	46.323	120.651	10	17E	26	J	24.5	F	305	D	-	39	-	-	3478	-	28	2,22,25,26,40
YA025		Decker, Bert C.	1989/09/26	46.319	120.677	10	17E	27	Q	29.0	B	460	D	-	30	39	-	5678	-	60	2,22,25,40
YA026		Decker & Sons (Decker 4)	1989/09/15	46.330	120.698	10	17E	28	B	24.5	B	268	D	-	39	39	-	6813	-	32	2,22,25,26,40
YA027		Napyer, Louis	1989/09/12	46.330	120.703	10	17E	28	C	20.0	-	99	-	-	-	-	-	64	-	63	40
YA028		Shellenberger, Norman, 3	1989/09/14	46.314	120.657	10	17E	35	B	24.5	B	245	D	-	38	39	-	6435	-	75	2,22,25,26,40
YA029		Green Acre Farms, Inc.	1989/08/23	46.305	120.630	10	17E	36	R	23.5	F	297	D	-	-	-	-	-	-	113	40,42
YA030		Darrow	-	46.377	120.592	10	18E	05	Q	20.6	B	202	D	-	37	34	-	-	-	-	2,6,22,25,26
YA031	*	Decker Ranch (Decker 7)	1989/09/26	46.305	120.624	10	18E	31	N	23.8	B	318	D	-	37	39	-	-	-	82	2,22,25,26,40
YA032		Corpus, Laura	1973/11/27	46.359	120.440	10	19E	16	A	20.0	-	18	-	-	-	-	-	38	-	5	40
YA033		Eisenbeis, Chuck	1992/08/04	46.337	120.446	10	19E	21	K	20.5	-	19	-	-	-	-	-	38	-	3	40
YA034		Oneil, Viola	-	46.319	120.488	10	19E	30	Q	20.2	F	254	D	-	-	-	-	-	-	-	10
YA035		Oneal, Karl	1989/07/19	46.319	120.483	10	19E	30	R	23.0	-	254	-	-	-	-	-	160	-	-	40
YA036		Gibson, Joann	-	46.315	120.477	10	19E	32	D	21.1	F	64	D	-	-	-	-	64	P	8	42
YA037	*	Toppenish City 7	1974/09/19	46.381	120.326	10	20E	04	L	23.5	B	312	D	-	34	-	-	8895	-	-	2,22,25,26,40
YA038		Yakima Indian Nation Land Ent.	-	46.381	120.332	10	20E	04	M	20.0	F	19	D	-	-	-	-	1136	P	3	42
YA039		Gamache, Amos	1992/08/05	46.377	120.371	10	20E	06	N	27.0	-	11	-	-	-	-	-	227	-	4	40
YA040	*	Toppenish City 6	1974/09/19	46.373	120.316	10	20E	09	A	20.6	B	256	D	-	27	-	-	-	-	-	2,6,22,25,26,40,41
YA041		Brownlee, Larry	1992/08/04	46.326	120.332	10	20E	28	E	20.5	-	16	-	-	-	-	-	76	-	3	40
YA042		Duim, Garrett	1983/07/15	46.384	120.168	10	21E	03	H	23.0	-	236	-	-	-	-	-	-	-	21	40
YA043		Granger City	1968/04/16	46.341	120.183	10	21E	22	E	21.1	F	77	D	-	-	-	-	3785	N	A	10,42
YA044	*	Phillips, Lena	1974/05/23	46.316	120.195	10	21E	33	B	21.0	-	13	-	-	-	-	-	227	-	2	40
YA045	*	Sunnyside City 4	1970/10/06	46.325	120.011	10	22E	25	F	20.0	B	480	D	-	-	-	-	4542	-	23	2,40
YA046		Sunnyside City 3	1983/07/19	46.325	120.011	10	22E	25	F	21.0	-	354	-	-	-	-	-	1400	-	4	40
YA047		DNR Snipes Mountain	-	46.326	120.121	10	22E	30	E	20.6	F	270	D	-	-	-	-	6245	P	9	42
YA048		Luther, Joe	-	46.326	120.105	10	22E	30	H	22.2	F	91	D	-	-	-	-	568	P	12	42
YA049		Newhouse, Steve & John	1983/07/19	46.312	120.116	10	22E	31	F	21.5	-	128	-	-	-	-	-	189	-	14	40
YA050	*	Sunnyside City 7	1994/04/08	46.311	120.016	10	22E	36	E	24.4	F	322	D	-	-	-	-	4164	P	3	40,42
YA051	*	Sunnyside City 6	1994/04/08	46.322	119.998	10	23E	30	M	24.0	F	145	D	-	-	-	-	3406	P	A	-
YA052		Evans, Bill	-	46.315	119.875	10	23E	36	A	26.7	B	401	D	-	37	34	-	-	-	-	2,3,22,25,26,37
YA053		White, John	-	46.312	119.880	10	23E	36	G	23.0	B	284	D	-	39	34	-	3785	P	150	2,22,25,26,42
YA054S		Simcoe Soda Springs	-	46.452	120.958	11	15E	09	P	32.0	-	-	-	-	-	-	-	-	-	-	32
YA055		Pace, W. B.	-	46.406	120.762	11	16E	25	Q	25.4	B	333	D	-	40	34	-	-	-	-	2,22,25,26,33
YA056		Goudy, Steve	1989/08/22	46.395	120.803	11	16E	34	K	22.5	-	137	-	-	-	-	-	45	-	106	40
YA057	*	Gowdy, Albert A.	1982/08/18	46.395	120.803	11	16E	34	K	23.5	B	139	D	-	68	34	-	57	-	105	2,22,25,26,40
YA058	*	Mount Adams Seed	1974/06/13	46.473	120.640	11	17E	01	F	24.2	B	358	D	-	34	34	-	2631	-	34	2,22,25,26,40

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
YA059		Decker & Sons 6	1989/08/31	46.466	120.661	11	17E	02	LorP	25.5	B	265	D	-	51	34	-	6435	-	29	2,22,25,26,40
YA060	*	Stephenson, C. and H.	1989/09/14	46.468	120.682	11	17E	03	L	25.5	B	301	D	-	44	34	-	4391	-	59	2,22,25,26,40
YA061		Dufault, Maurice	1974/10/01	46.436	120.656	11	17E	14	Q	21.0	-	-	-	-	-	-	-	-	-	-	40
YA062		Stephenson	-	46.442	120.705	11	17E	16	F	31.6	B	302	D	-	62	-	-	-	-	-	2,6,22,25,26
YA063		Stephenson, C. and H.	1989/08/09	46.443	120.693	11	17E	16	H	20.8	B	233	D	-	38	34	-	76	-	4	2,22,25,26,40
YA064		Adams, Dee	1989/09/15	46.432	120.745	11	17E	19	C	21.5	-	154	-	-	-	-	-	49	-	118	40
YA065	*	Siegner, Monte	1974/10/01	46.450	120.582	11	18E	09	N	23.0	B	122	D	-	90	-	-	-	-	-	2,22,25,26,40
YA066		Poireir, Ray	1974/07/10	46.443	120.588	11	18E	17	H	20.5	-	-	-	-	-	-	-	-	-	-	40
YA067	*	Carlson, Sarah	1974/03/06	46.410	120.535	11	18E	26	L	26.4	B	16	D	-	900	-	-	38	-	4	2,22,25,40
YA068	*	Harrah City	1994/01/19	46.410	120.540	11	18E	26	M	27.5	F	448	D	-	-	-	-	1211	P	7	42
YA069		Rowe, Maurice	1974/07/10	46.407	120.614	11	18E	30	Q	21.5	-	-	-	-	-	-	-	-	-	91	40
YA070		Knight, Rick	1974/07/11	46.396	120.546	11	18E	34	J	22.0	-	-	-	-	-	-	-	-	-	-	40
YA071		Barkes, Ray	1971/03/18	46.392	120.556	11	18E	34	P	20.0	F	156	D	-	-	-	-	-	-	-	10
YA072		CL & Frank	1974/09/30	46.458	120.498	11	19E	07	E	20.5	-	-	-	-	-	-	-	-	-	5	40
YA073		Wapato Irrigation Project	1989/08/25	46.446	120.413	11	19E	14	D	23.0	-	20	-	-	-	-	-	227	-	6	40
YA074	*	Wapato City, well no. 5	1994/01/19	46.439	120.413	11	19E	14	M	21.0	F	305	D	-	-	-	-	5678	P	2	42
YA075		Wapato City	-	46.446	120.419	11	19E	15	A	20.8	B	179	D	-	41	48	-	-	-	-	2,6,22,25,26
YA076		Johnson, F.	1977/09/19	46.467	120.268	11	20E	01	M	28.1	B	457	D	-	38	-	-	-	-	-	2,3,10,22,25,26
YA077		Lynch, B.	1977/06/08	46.464	120.252	11	20E	01	R	21.5	B	351	D	-	27	-	-	-	-	-	2,3,10,22,25,26
YA078		Everts & Walsh, John & Don	1982/06/10	46.471	120.273	11	20E	02	H	23.5	-	206	-	-	-	-	-	132	-	69	40
YA079		Strothers, Kelly	-	46.471	120.294	11	20E	03	H	20.0	F	242	D	-	-	-	-	-	-	111	42
YA080		Young, James	1977/03/22	46.468	120.326	11	20E	04	L	22.2	F	155	D	-	-	-	-	-	-	-	10
YA081		Green, Clayton, & Babcock	-	46.464	120.336	11	20E	05	R	21.1	F	183	D	-	-	-	-	6900	P	53	42
YA082		Peters, Charles A.	1967/03/02	46.475	120.357	11	20E	06	A	22.0	F	190	D	-	49	-	-	-	-	-	10,22,25,26
YA083		Morrison Fruit Co., Inc.	-	46.457	120.304	11	20E	10	F	20.0	F	108	D	-	-	-	-	-	-	46	42
YA084		Narduzzi, Ermanno	-	46.453	120.273	11	20E	11	J	22.2	F	198	D	-	-	-	-	2271	P	27	42
YA085		Rashford, George B.	-	46.453	120.257	11	20E	12	K	22.2	F	248	D	-	-	-	-	1892	P	76	42
YA086		Schmidt Orchards, Inc.	-	46.439	120.268	11	20E	13	M	23.3	F	230	D	-	-	-	-	4731	P	43	42
YA087		Soost Brothers	1977/06/30	46.435	120.252	11	20E	13	R	29.2	S	366	D	-	52	-	-	-	-	-	2,3,10,22,25,26
YA088		Weatherly, B.	-	46.474	120.215	11	21E	05	B	28.5	B	379	D	-	42	40	-	-	-	-	2,22,25,26
YA089		Dahl, T.	-	46.467	120.241	11	21E	06	L	29.2	B	364	D	-	47	40	-	-	-	-	2,3,22,25,26
YA090		Valley Farms	-	46.464	120.241	11	21E	06	P	25.6	F	364	D	-	-	-	-	4164	P	98	42
YA091		Dahl, T.	-	46.464	120.236	11	21E	06	Q	29.6	B	393	D	-	45	40	-	4164	P	-	2,3,22,25,26
YA092		Clyde	-	46.460	120.231	11	21E	07	A	33.1	B	510	D	-	41	40	-	-	-	-	2
YA093		Lynch, Bob	-	46.457	120.241	11	21E	07	F	30.6	F	-	-	-	-	-	-	1400	P	116	42
YA094		Roza Investment Co.	1983/07/15	46.457	120.241	11	21E	07	F	27.5	-	494	-	-	-	-	-	1590	-	149	40
YA095		Garretson	-	46.458	120.223	11	21E	08	NW4	33.1	B	510	D	31	41	34	52	-	-	-	2,5,26
YA096		Clyde, Pat	-	46.446	120.200	11	21E	16	C	24.7	B	269	D	-	-	-	-	-	-	-	3
YA097		DNR Ramsier	1979/11/13	46.435	120.200	11	21E	16	P	28.1	S	427	D	41	52	40	65	-	-	-	2,3,5,10,26
YA098		Clyde	-	46.446	120.216	11	21E	17	B	24.8	B	273	D	41	47	-	-	-	-	-	5,26
YA099		Gammie, W./Lloyd Garretson Co.	1980/11/12	46.446	120.226	11	21E	17	D	36.1	F	593	D	-	-	-	-	2574	P	127	10,42
YA100		Schmidt, Dave	-	46.435	120.216	11	21E	17	Q	28.9	F	489	D	-	-	-	-	1287	P	120	42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
YA101		Leach, Meier, Olsen	-	46.435	120.231	11	21E	18	R	22.8	F	175	D	-	-	-	-	5678	P	60	42
YA102		Schmidt, Dave	-	46.440	120.239	11	21E	18	-	28.9	F	-	-	-	-	-	-	1310	P	120	42
YA103		J J & G Investment	-	46.431	120.210	11	21E	20	A	25.0	F	242	D	-	-	-	-	530	P	98	42
YA104		Baldwin, John	-	46.431	120.226	11	21E	20	D	20.6	F	313	D	-	-	-	-	-	-	82	42
YA105		Hanrahan, P.	1977/06/20	46.424	120.226	11	21E	20	M	22.2	-	207	D	-	54	40	-	-	-	-	2,3,10,22,25,26
YA106		Ambrose Farms	-	46.432	120.195	11	21E	21	B	27.0	B	279	D	-	53	40	-	-	-	-	2,22,25,26
YA107		—	-	46.424	120.189	11	21E	21	J	20.0	F	184	D	-	-	-	-	1665	P	104	42
YA108		Van Leuven, Miles	-	46.432	120.184	11	21E	22	D	20.0	F	261	D	-	-	-	-	-	-	116	42
YA109		Houghton Farms	-	46.428	120.184	11	21E	22	E	20.0	F	261	D	-	-	-	-	1703	P	116	42
YA110		Sandlin, J.	-	46.428	120.174	11	21E	22	G	24.0	B	304	D	33	40	40	-	-	-	-	2,22,25,26
YA111		Sandlin Farms, Inc., 2	1983/06/09	46.428	120.174	11	21E	22	G	35.2	B	553	D	29	42	40	44	4164	P	132	2,3,5,26,40,42
YA112		Best, Peter C.	-	46.424	120.174	11	21E	22	K	25.6	B	335	D	-	43	40	-	1136	P	121	2,22,25,26,42
YA113		De La Chapelle, Charles	1982/08/21	46.413	120.158	11	21E	26	F	25.5	-	291	-	-	-	-	-	3785	-	114	40
YA114		Gay, H.	-	46.395	120.132	11	21E	36	K	21.5	B	213	D	-	45	40	-	-	-	-	2,3,22,25,26
YA115		Monson, Arvid	1982/08/20	46.421	120.121	11	22E	19	N	21.0	-	257	-	-	-	-	-	49	-	126	40
YA116		—	-	46.421	120.079	11	22E	21	N	22.3	B	207	D	-	46	37	-	-	-	-	2,6,22,25,26
YA117		Evans Fruit	-	46.408	120.026	11	22E	26	K	30.7	B	469	D	-	40	37	-	-	-	191	2,3,26,42
YA118		Spauld R.	-	46.409	120.079	11	22E	28	M	21.5	B	210	D	43	43	-	67	-	-	-	5,26
YA119		Rowe Farms	-	46.406	120.100	11	22E	29	N	29.6	B	340	D	-	53	-	-	-	-	-	22,25,26
YA120		Rowe Farms	-	46.406	120.100	11	22E	29	N	29.6	B	434	D	-	-	37	-	-	-	-	2,3
YA121		De La Chapelle, 2	-	46.416	120.116	11	22E	30	C	29.9	B	324	D	49	57	-	79	5299	P	173	5,26,42
YA122		De La Chapelle, C.	-	46.413	120.110	11	22E	30	G	47.8	B	829	D	-	43	31	-	-	-	-	2,22,25,26
YA123		Shelton, C. L.	1973/06/06	46.539	120.773	12	16E	12	N	25.2	B	269	D	-	53	41	-	3558	P	-	2,3,5,10,22,25,26
YA124		White	-	46.531	120.816	12	16E	15	E	21.5	B	179	D	-	59	-	-	-	-	-	26
YA125		Ridout, Tom	-	46.535	120.859	12	16E	17	D	20.0	F	110	D	-	-	-	-	68	P	28	42
YA126		Cohodas-Lancaster-Frank Co.	-	46.553	120.709	12	17E	04	N	24.4	F	340	D	-	-	-	-	3134	P	106	42
YA127		Palmer, Don	-	46.559	120.714	12	17E	05	H	21.7	F	87	D	-	-	-	-	163	P	59	42
YA128		Catlin, Ida	-	46.556	120.714	12	17E	05	J	20.0	F	113	D	-	-	-	-	76	P	68	42
YA129		Hull Ranches, Inc.	-	46.531	120.667	12	17E	14	E	21.1	F	291	D	-	-	-	-	6056	P	31	42
YA130	*	Wiley, Robert	1972/05/22	46.535	120.693	12	17E	16	A	22.2	B	265	D	-	39	41	-	4921	-	21	2,22,25,26,40
YA131		Valley Roz Orchards, Inc.	1989/08/17	46.509	120.540	12	18E	23	N	26.0	-	418	-	-	-	-	-	-	-	-	40
YA132		Eyle, Alex	1989/08/29	46.505	120.535	12	18E	26	C	24.5	-	130	-	-	-	-	-	-	-	117	40
YA133	*	Hansen Fruit	1974/06/14	46.501	120.551	12	18E	27	G	23.6	B	305	D	-	38	34	-	-	-	-	2,22,25,26,40
YA134	*	Hansen Fruit	1974/06/14	46.501	120.546	12	18E	27	H	29.6	B	311	D	-	57	34	-	5450	-	70	2,22,25,26,40
YA135		Keller, Walter	1989/08/30	46.494	120.562	12	18E	27	N	23.5	-	338	-	-	-	-	-	-	-	-	40
YA136		St. Clair, Ray, 2	1965/04/01	46.480	120.610	12	18E	31	R	22.2	B	479	D	-	-	-	-	4164	-	64	2,40
YA137	*	Mount Adams Seed, 2	1974/05/23	46.487	120.588	12	18E	32	H	25.2	B	358	D	-	37	34	-	2631	-	66	2,22,25,26,40
YA138		St. Clair	-	46.484	120.598	12	18E	32	L	27.9	B	379	D	39	40	34	-	-	-	-	2,6,22,25,26
YA139		Nyberg, Herbert	1974/05/23	46.490	120.567	12	18E	33	A	25.6	B	290	D	-	47	34	-	5299	-	64	2,22,25,26,40
YA140		Mount Adams Seed, 3	1970/05/11	46.490	120.572	12	18E	33	B	28.0	B	323	D	-	51	34	-	-	-	-	2,10,22,25,26
YA141	*	Moxee City 1	1994/04/08	46.551	120.382	12	19E	01	Q	31.1	F	396	D	-	45	41	-	2271	P	A	2,22,25,26,40
YA142		East Valley School District	1994/04/08	46.552	120.380	12	19E	01	Q	13.0	F	180	D	-	61	41	-	1041	P	104	2,6,22,25,26,42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
YA143		Odom, Matt	1990/03/01	46.537	120.445	12	19E	09	Q	23.3	F	43	D	-	-	-	-	76	P	6	10,42
YA144		Laird, Robert	-	46.537	120.445	12	19E	09	Q	23.3	F	52	D	-	-	-	-	189	P	6	4 2
YA145		Bruwllett?	-	46.537	120.408	12	19E	11	P	26.7	F	362	D	-	-	-	-	3830	P	33	42
YA146		DNR Gangle	-	46.533	120.440	12	19E	16	A	22.0	B	153	D	-	58	-	-	-	-	-	26
YA147		Miocene Petroleum	-	46.533	120.471	12	19E	17	C	33.3	S	546	L	-	39	-	-	-	-	-	18,26
YA148		Olson, Dale	-	46.519	120.444	12	19E	21	B	20.0	F	-	-	-	-	-	-	2233	P	62	42
YA149		Stark West Orchards	1968/10/03	46.508	120.450	12	19E	21	P	20.0	F	110	D	-	-	-	-	2498	P	56	10,42
YA150		Stepniewski	-	46.494	120.418	12	19E	27	R	20.6	-	163	L	42	47	-	-	-	-	-	26
YA151		Deeringhoff, F. E.	-	46.551	120.325	12	20E	04	P	23.3	F	191	D	-	-	-	-	-	-	-	35
YA152		Buwalda and Haines	-	46.561	120.352	12	20E	05	D	20.7	F	194	D	-	-	-	-	962	N	A	35
YA153		Holland No. 2	-	46.554	120.352	12	20E	05	M	23.7	F	209	D	-	-	-	-	595	N	A	35
YA154		Regimbal	-	46.551	120.342	12	20E	05	Q	22.9	F	210	D	-	-	-	-	1852	N	A	35
YA155		Holland 1	-	46.551	120.342	12	20E	05	Q	24.4	F	224	D	-	-	-	-	3398	N	A	35
YA156		Clark 1	-	46.561	120.357	12	20E	06	A	22.9	F	287	D	-	-	-	-	2277	N	A	35
YA157		Peck, J. W.	-	46.556	120.364	12	20E	06	-	23.3	F	252	D	-	-	-	-	-	-	-	27
YA158		Ellens 1	-	46.544	120.357	12	20E	07	H	22.9	F	255	D	-	-	-	-	221	N	A	35
YA159		Dickson	-	46.548	120.337	12	20E	08	A	21.5	F	160	D	-	-	-	-	-	-	-	35
YA160		Gano, James H.	-	46.547	120.347	12	20E	08	C	25.6	F	259	D	-	-	-	-	-	-	-	35
YA161		Longevin 2	-	46.544	120.347	12	20E	08	F	22.6	F	255	D	-	-	-	-	1370	N	A	35
YA162		Longevin 1	-	46.544	120.346	12	20E	08	F	22.3	F	194	D	-	-	-	-	680	N	A	35
YA163		Haines	-	46.541	120.336	12	20E	08	J	22.3	F	275	D	-	-	-	-	1672	N	A	35
YA164		Sauve, J.	-	46.537	120.336	12	20E	08	R	24.0	F	311	D	-	-	-	-	807	N	A	35
YA165		Walters, David	-	46.542	120.344	12	20E	08	-	27.2	F	366	D	-	-	-	-	-	-	-	27
YA166		Bradford	-	46.548	120.326	12	20E	09	C	22.9	F	190	D	-	-	-	-	1536	P	1	35
YA167		Allwardt	-	46.537	120.325	12	20E	09	P	22.3	F	247	D	-	-	-	-	1087	N	A	35
YA168		Allwardt, Mona and Carl	-	46.537	120.325	12	20E	09	P	20.0	F	294	D	-	-	-	-	2650	P	1	42
YA169		Hill, E. S.	-	46.542	120.322	12	20E	09	-	23.3	F	191	D	-	-	-	-	-	-	-	27
YA170		S. Martinez Livestock, Inc.	-	46.537	120.252	12	20E	12	R	30.0	F	824	D	-	-	-	-	-	-	4	42
YA171		Charron, S.	-	46.522	120.258	12	20E	13	Q	27.9	B	376	D	36	42	40	-	-	-	-	2,3,22,25,26
YA172		Roy Farms, Inc.	-	46.533	120.294	12	20E	15	A	25.6	F	640	D	-	-	-	-	-	-	27	42
YA173		—	-	46.533	120.331	12	20E	16	D	21.0	B	154	-	-	58	-	-	-	-	-	22,25
YA174		DNR Elephant Mountain	-	46.526	120.326	12	20E	16	L	29.2	B	418	D	42	44	40	66	-	-	-	2,5,26
YA175		Brulotte, L.	-	46.533	120.362	12	20E	18	B	20.6	F	316	D	-	-	-	-	5678	P	17	42
YA176		Logan	-	46.497	120.310	12	20E	27	M	27.5	B	409	D	48	35	-	-	-	-	-	2,6,22,25,26
YA177		Logan, W.	-	46.493	120.310	12	20E	27	N	30.8	B	396	D	-	46	48	-	-	-	-	2,3,22,25,26,33
YA178		Clinger, Jasper	-	46.503	120.336	12	20E	29	AorH	24.4	F	118	D	-	-	-	-	4	P	114	42
YA179		Brooks, Lonnie	1983/07/15	46.486	120.357	12	20E	31	H	27.2	F	354	D	-	-	-	-	946	P	57	40,42
YA180		Estes, M.	-	46.479	120.310	12	20E	34	N	25.9	B	274	D	-	51	48	-	-	-	-	2,3,22,25,26
YA181		Estes, Marvin	1978/03/09	46.479	120.310	12	20E	34	N	33.1	B	430	D	-	49	48	-	-	-	44	2,3,10,22,25,26,42
YA182		DNR Cheyne Rd.	1979/10/19	46.479	120.263	12	20E	36	P	29.0	L	547	D	46	49	-	51	2082	P	-	2,3,5,10,26,42
YA183		DNR	-	46.526	120.200	12	21E	16	L	25.1	B	235	D	46	-	-	65	-	-	-	2,5
YA184		DNR Martinez	-	46.526	120.200	12	21E	16	L	26.7	S	230	L	48	55	-	-	11544	P	25	26,42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
YA185		Martinez, D.	-	46.525	120.221	12	21E	17	L	28.3	B	473	D	-	33	-	-	-	-	-	2,3,22,25,26
YA186		S. Martinez Livestock, Inc.	-	46.522	120.221	12	21E	17	P	21.1	F	245	D	-	-	-	-	3936	P	64	42
YA187		Martinez Livestock, Inc., 4	1983/07/14	46.522	120.216	12	21E	17	Q	27.0	-	472	-	-	-	-	-	-	-	5	40
YA188		Martinez, 1	-	46.509	120.234	12	21E	19	SE4	21.7	F	288	D	-	-	-	-	4164	P	64	42
YA189		Martinez, D. T., 1	-	46.518	120.226	12	21E	20	D	24.4	B	315	D	-	39	-	-	-	-	-	2,3,6
YA190		Griswald, P.	-	46.508	120.221	12	21E	20	P	25.2	B	315	D	-	39	40	-	-	-	-	2,6,22,25,26,33
YA191		Martinez, Simon	-	46.511	120.180	12	21E	22	L	21.1	F	202	D	-	-	-	-	8172	P	26	42
YA192		Ekerich, W. M.	-	46.497	120.220	12	21E	29	L	22.2	F	259	D	-	-	-	-	2271	P	122	42
YA193		Marley Orchards	-	46.551	120.022	12	22E	02	R	23.1	-	267	L	-	42	-	-	-	-	-	22,25,26
YA194		Changala, Steve	-	46.521	120.011	12	22E	13	P	30.7	B	518	D	37	40	42	53	7059	P	53	2,5,26,42
YA195		Marley Orch. Black Rock Ranch	-	46.518	120.064	12	22E	21	A	31.1	F	747	D	-	-	-	-	-	-	114	42
YA196		Marley Orchards	1983/07/14	46.508	120.079	12	22E	21	N	23.0	-	436	-	-	-	-	-	-	-	-	40
YA197		Marley Orchards	-	46.507	120.064	12	22E	21	R	22.8	B	270	D	-	-	42	-	5488	P	-	2,3
YA198		Changala, S.	-	46.504	120.090	12	22E	29	B	23.0	B	430	D	-	26	-	-	2650	P	-	2,3,22,25,26,33
YA199		DNR Black Rock 1	-	46.525	119.939	12	23E	16	J	25.6	B	351	D	-	58	42	-	7930	P	136	2,3,26,42
YA200		Black Rock	-	46.525	119.944	12	23E	16	K	25.0	B	225	D	51	-	-	-	-	-	-	5
YA201		—	-	46.522	119.971	12	23E	17	P	20.3	S	206	L	-	40	42	-	-	-	-	2,26
YA202		Pyramid Orchards, 1	1983/07/13	46.601	120.763	13	16E	24	H	27.5	-	448	-	-	-	-	-	2271	-	43	40
YA203		Pyramid Orchards, Inc.	-	46.600	120.771	13	16E	24	-	25.6	F	376	D	-	-	-	-	2332	P	24	42
YA204		Barcott, Mark	-	46.624	120.674	13	17E	11	N	26.7	F	123	D	-	-	-	-	102	P	79	42
YA205		Pyramid Orchards	1983/07/13	46.602	120.758	13	17E	19	E	28.0	-	244	-	-	-	-	-	341	-	107	40
YA206		Clark, Christopher	-	46.602	120.705	13	17E	21	G	20.6	F	107	D	-	-	-	-	140	P	70	42
YA207		Lowary, Kim	-	46.602	120.674	13	17E	23	E	24.4	F	73	D	-	-	-	-	102	P	58	42
YA208		Carrell	-	46.634	120.511	13	18E	12	A	24.8	B	201	D	-	61	-	-	-	-	-	2,6,22,25,26
YA209		Nob Hill Water Co., 3	1983/07/13	46.613	120.621	13	18E	18	K	22.5	F	320	D	-	-	-	-	9932	P	84	40,42
YA210		Yakima County Detention Center	-	46.602	120.621	13	18E	19	G	23.3	F	248	D	-	-	-	-	7040	P	12	42
YA211	*	Yakima Creamery well	1994/01/18	46.598	120.516	13	18E	24	K	27.0	F	513	D	-	43	43	-	-	N	A	2,18,26
YA212		Congdon Orchards	1984/11/08	46.587	120.595	13	18E	29	H	32.8	F	617	D	-	-	-	-	946	N	A	10,42
YA213		Wilson, George	-	46.580	120.600	13	18E	29	Q	26.7	F	386	D	-	-	-	-	1274	N	A	13,35
YA214		Hull Orchards, Inc.	-	46.566	120.632	13	18E	31	N	21.1	F	354	D	-	-	-	-	2324	P	56	42
YA215		Nob Hill Water Assoc.	-	46.575	120.597	13	18E	32	NE4	21.1	F	259	D	-	-	-	-	-	N	A	42
YA216		Yakima City, Kissel Park Well	1991/04/24	46.576	120.547	13	18E	35	D	20.6	F	357	D	-	-	-	-	-	N	A	10,42
YA217		Ostrander, Terry L.	-	46.623	120.463	13	19E	09	N	21.1	F	180	D	-	-	-	-	-	-	105	42
YA218		Yakima Sheep Co.	-	46.623	120.427	13	19E	10	R	20.0	F	104	D	-	-	-	-	-	-	29	42
YA219		Yakima County Dump	-	46.611	120.395	13	19E	13	L	24.4	F	-	-	-	-	-	-	2650	P	101	42
YA220		Terrace Heights	-	46.608	120.390	13	19E	13	Q	25.0	B	251	D	-	47	41	-	-	-	-	2,22,25,26
YA221		Watkins 3	-	46.619	120.405	13	19E	14	A	20.3	B	211	D	27	39	41	39	-	-	-	2,5,26
YA222		Hardy, Dorothy	-	46.619	120.457	13	19E	16	C	20.0	F	146	D	-	-	-	-	1628	P	68	42
YA223		Yakima County, well no. 3	1993/12/13	46.609	120.463	13	19E	16	N	43.3	B	738	D	-	42	-	-	568	N	A	43
YA224		Country Club Dist. Water Co.	-	46.608	120.447	13	19E	16	R	23.9	F	456	D	-	-	-	-	4769	P	31	42
YA225		Cascade Lumber Company (1925)	-	46.614	120.497	13	19E	18	-	21.1	F	764	D	-	-	-	-	568	N?	A?	42
YA226	*	Yakima County (heat pump well)	1994/01/18	46.605	120.505	13	19E	19	D	20.0	F	249	D	-	-	-	-	-	-	12	42

Appendix A. Descriptive and thermal data for wells and springs *(continued)*

I.D.	*	Site name	Date	Lat (°N)	Long (°W)	Twp N	Rng	Sec	Part sec	Temp (°C)	Temp type	Depth (m)	Depth type	Gradients (°C/km) A	B	S	Heat flow (mW/m²)	Flow (l/m)	Flow type	SWL (m)	References
YA227		Yakima Country Club, Inc.	-	46.601	120.437	13	19E	22	F	22.8	F	220	D	-	-	-	-	3596	P	28	42
YA228		Country Club	-	46.594	120.442	13	19E	22	M	20.0	B	82	D	70	91	-	-	-	-	-	2,6,22,25,26
YA229		Rasmussen	-	46.604	120.384	13	19E	24	A	20.0	B	230	D	26	35	41	-	-	-	-	2,22,25,26
YA230		Yakima Sheep Co.	-	46.604	120.389	13	19E	24	B	44.5	B	230	D	-	-	-	-	1514	P	114	2,42
YA231		Sundquist Fruit	-	46.594	120.379	13	20E	19	N	22.1	B	255	D	-	40	41	-	13342	P	80	2,3,22,25,26,42
YA232		Champoux	-	46.601	120.352	13	20E	20	F	23.3	B	215	D	52	52	41	77	-	-	-	2,5,26
YA233		Fay, Gerald	1983/07/13	46.586	120.337	13	20E	28	E	22.5	-	206	-	-	-	-	-	-	-	85	40
YA234		Yergen, R.	-	46.590	120.364	13	20E	30	A	24.2	B	289	D	-	42	41	-	-	-	-	2,3,26
YA235		Clark 4	-	46.568	120.368	13	20E	31	K	22.9	F	293	D	-	-	-	-	335	N	A	35
YA236		Clark 3	-	46.568	120.374	13	20E	31	L	24.2	F	305	D	-	-	-	-	883	N	A	35
YA237		Clark 2	-	46.568	120.373	13	20E	31	L	24.6	F	313	D	-	-	-	-	255	N	A	35
YA238		Coombs	-	46.568	120.331	13	20E	33	L	23.2	B	227	D	39	48	41	-	-	-	-	2,22,25,26
YA239		Coombs, B., 2	-	46.568	120.337	13	20E	33	M	30.2	B	446	D	-	41	41	-	-	-	-	2,3,26
YA240		Larson Fruit	-	46.565	120.336	13	20E	33	N	27.8	F	496	D	-	-	-	-	-	-	45	42
YA241		Smith, Darrell, W.	-	46.564	120.300	13	20E	34	R	21.1	F	184	D	-	-	-	-	341	P	92	42
YA242		Martinez	-	46.572	120.173	13	21E	34	H	21.2	B	290	D	33	40	-	52	-	-	-	5,26
YA243		Martinez, D. T., 2	-	46.572	120.173	13	21E	34	H	23.8	B	313	D	-	41	-	-	-	-	-	2,3,6,22,25,26
YA244		Changala, S., 2	-	46.619	120.009	13	22E	13	B	30.7	B	517	D	-	-	-	-	-	-	-	2
YA245		DNR 81 Tieton	-	46.674	121.029	14	14E	25	E	24.2	B	153	D	93	92	-	87	-	-	-	5,26
YA246		Rowe Farms, Inc.	-	46.697	120.642	14	17E	13	Q	20.6	F	207	D	-	-	-	-	-	-	78	42
YA247		Muzzall, Steve	-	46.689	120.648	14	17E	24	F	23.3	F	75	D	-	-	-	-	57	P	64	42
YA248		Fisher, Harland	-	46.696	120.537	14	18E	14	Q	20.0	F	111	D	-	-	-	-	76	P	36	42
YA249		French, Bruce	1983/07/12	46.700	120.564	14	18E	15	L	20.5	-	235	-	-	-	-	-	95	-	126	40
YA250		Bauman, Ed.	-	46.696	120.564	14	18E	15	P	21.1	F	75	D	-	-	-	-	163	P	19	42
YA251		Zirkle, W. H.	-	46.689	120.601	14	18E	20	G	29.5	B	325	D	-	52	-	-	-	-	-	2,3,22,25,26,37
YA252		Strawn Nursing	1982/06/09	46.660	120.611	14	18E	32	E	20.5	-	24	-	-	-	-	-	341	-	7	40
YA253		Eberle, Robert	-	46.653	120.605	14	18E	32	Q	22.2	F	17	D	-	-	-	-	114	P	1	42
YA254		WA State Hwy. 539	1982/08/17	46.714	120.415	14	19E	11	L	20.0	-	190	-	-	-	-	-	144	-	116	40
YA255		Roche Fruit Company	-	46.695	120.462	14	19E	16	N	23.2	B	268	D	-	46	-	-	-	-	-	2,3,22,25,26
YA256		Roche Fruit Co.	-	46.695	120.478	14	19E	17	P	27.8	F	460	D	-	-	-	-	4164	N	A	42
YA257		—	-	46.688	120.468	14	19E	20	H	21.7	F	123	D	-	-	-	-	2506	P	-	42
YA258	*	US Army, Yakima Firing Cen., 1	1955/10/05	46.677	120.452	14	19E	28	B	21.0	B	183	D	-	54	-	-	-	-	4	2,22,25,26,40,41
YA259		—	-	46.755	120.637	15	17E	25	R	29.2	B	598	-	-	29	-	-	-	-	-	34
YA260		DNR Wenas	-	46.751	120.638	15	17E	36	A	30.1	B	598	D	34	33	30	-	-	-	-	2,26

[1] On January 18, 1994, well KS012 was reported to flow at 7–13°C. by Phil Hamilton, Central Washington University Facilities Manager (oral commun.).

Appendix B. Chemical Data for Thermal Wells and Springs

EXPLANATION OF COLUMN HEADINGS AND ENTRIES:

See the notes in Appendix A for explanations of I.D. and **Partial section.**

Lower-case letters at the ends of I.D. numbers signify different analyses for the same well or spring system.

Date is the date when the water sample was collected for chemical analysis.

Chemical species: nd, not detected; na, not analyzed.

Conduct. is conductivity.

TDS: Total dissolved solids, measured by evaporating a sample to dryness.

Charge balance: An indication of the quality and (or) completeness of a chemical analysis. Analyses with charge balances more than 10 per cent greater than or less than 1.00 have been excluded from this table. Charge balances were calculated using a worksheet from Kindle (1991, p. 113) with a corrected conversion factor for HCO_3 supplied by Mike Adams, University of Utah Research Institute (oral commun., August 10, 1993). Aqueous solutions are electrically neutral, so chemical analyses that are reasonably complete and of good quality should reflect that neutrality by yielding charge balances near 1.00. Charge balance is the ratio of the sums of the negative (anion) and positive (cation) ionic charges, quantified as milli-equivalents per liter, detected in the fluid (Kindle, 1991, p. 109):

$$\text{Charge balance} = \frac{\text{Sum of anion concentrations (meq/l)}}{\text{Sum of cation concentrations (meq/l)}}$$

The conversion factors to convert concentrations in milligrams per liter to milli-equivalents per liter are listed below. For dilute solutions (below about 7,000 mg/l) milligrams per liter and parts per million are approximately equal and may be used interchangeably (Hem, 1985, p. 55).

Anion	Factor
HCO_3	0.0167
CO_3	0.0333
SO_4	0.0208
F	0.0526
NO_3	0.0161
Cl	0.0282

Cation	Factor
Ca	0.0499
Fe	0.0358
K	0.0256
Li	0.144
Mg	0.0823
Na	0.0435

Mass balance is also an indication of quality and (or) completeness of an analysis. Mass balance is the ratio of total dissolved solids, determined by evaporating a water sample to dryness, to the sum of individually analyzed chemical species (Kindle, 1991, p. 109):

$$\text{Mass balance} = \frac{\text{Total dissolved solids (mg/l)}}{\text{Sum of individually analyzed species (mg/l)}}$$

Mass balances were calculated using a worksheet from Kindle (1991, p. 113). A correction factor of 0.4917 was applied to the concentration of HCO_3 because it is partly volatile (Mike Adams, University of Utah Research Institute, oral commun., August 10, 1993). Mass balances should, ideally, approach values of 1.00 for high-quality, complete analyses. When they are significantly greater than 1.00 it may be because SiO_2 (which is non-ionic in solution and does not affect the charge balance calculation) is not reported. When SiO_2 is reported, departures from 1.00 must be caused by failure to report some significant chemical species and (or) analytical inaccuracy. If the charge balance is within 10 per cent of 1.00 and SiO_2 is reported, then departures from 1.00 of the mass balance must be caused by offsetting anion and cation analytical errors, incomplete analyses, or inaccurate SiO_2 or TDS measurements. When no TDS is reported, the mass balance is listed as zero in the table. Mass balance was not used as a criterion for excluding analyses from this table.

References: Numbers correspond to the numbered references in the References Cited section.

Samples dated 1994 were collected for this study and analyzed by the University of Utah Research Institute, Earth Science Laboratory.

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Chemical species (ppm) Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
ADAMS COUNTY																												
AD001	CMSP&P RR	1960/10/18	15	28E	08	E	7.9	416	292	34	10	30	14.0	0.6	-	65	-	-	196	41.0	10.0	0.6	-	0	0.7	1.01	0.97	41
AD002	US Bureau of Reclamation	1971/10/06	15	28E	15	D	7.7	-	316	54	29	10	4.7	-	-	68	0.07	0.34	180	49.0	13.0	0.8	-	-	-	1.10	1.00	40
AD005	Othello City 2	1955/08/02	15	29E	03	C	8.4	-	279	77	13	4	1.8	-	-	54	0.05	-	170	23.0	16.0	-	-	-	-	0.93	1.02	40
AD006	Othello City 4	1970/10/27	15	29E	03	J	8.2	-	288	70	13	8	4.8	-	-	56	0.06	0.02	180	30.0	14.0	1.8	-	-	-	0.99	1.01	40
AD008	Othello City 6	1994/04/07	15	29E	04	A	8.9	455	350	90	9	6	3.8	-	-	86	-	-	161	32.0	20.0	4.2	-	17	-	0.99	1.01	—
AD009	Othello City 1	1942/04/27	15	29E	04	A	-	397	287	78	12	4	3.5	0.0	-	52	-	-	183	28.0	15.0	2.6	-	0	0.1	1.01	1.01	41
AD023	Phillips, Robert, 4	1983/05/20	15	32E	07	J	8.3	348	-	57	7	9	4.9	0.0	-	66	-	-	172	18.0	9.8	1.8	-	0	0.2	1.03	0.00	16
AD036	Othello City 3	1961/05/04	16	29E	34	R	8.6	393	294	81	12	3	0.8	0.0	-	62	-	-	170	27.0	14.0	2.8	-	6	0.0	1.02	1.01	41

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
										Chemical species (ppm)																		
AD089	Jungblom Ranch	1983/05/19	18	31E	33	D	9.3	400	-	89	7	2	0.1	0.1	-	110	-	-	172	12.0	13.0	4.1	-	22	0.1	1.07	0.00	16
AD100	Warden Hutterian Brethern, 7	1983/05/25	19	33E	07	R	8.8	310	-	62	8	4	1.7	0.0	-	66	-	-	172	7.8	6.8	2.6	-	5	0.1	1.08	0.00	16
	ASOTIN COUNTY																											
AS001a	Wash. Water Power Co., 2	1959/10/28	10	46E	05	Q	8.4	-	202	42	10	7	0.2	-	-	65	-	-	110	8.9	7.8	1.1	-	-	-	0.95	1.03	40
AS001b	Wash. Water Power Co., 2	1959/10/28	10	46E	05	Q	8.4	248	199	42	10	7	0.2	0.0	-	65	-	-	113	8.9	7.8	1.1	-	5	0.1	1.04	0.98	41
AS008a	Wash. Water Power Co., 5	1962/10/30	11	46E	30	Q	8.2	-	241	49	11	11	1.0	-	-	66	-	-	130	25.0	12.0	0.9	-	-	-	1.01	1.00	40
AS008b	Wash. Water Power Co., 5	1962/10/30	11	46E	30	Q	8.3	303	-	49	11	11	1.0	0.0	0.20	66	-	-	128	25.0	12.0	0.9	-	2	0.0	1.02	0.00	31
	BENTON COUNTY																											
BE001	S P & S Ry	1966/07/18	04	24E	03	B	8.0	460	306	92	7	9	0.7	1.0	-	48	-	-	225	0.0	34.0	1.6	-	0	0.1	1.02	1.01	31
BE005	US Army Corps of Engineers	1971/09/24	05	28E	06	R	8.2	-	355	98	18	7	1.9	0.0	0.00	60	0.10	0.27	210	35.0	32.0	1.7	-	-	-	0.99	0.99	40
BE015a	WDOE Tst./Obs., Piezometer C	1972/08/03	07	25E	36	N	8.2	-	317	88	14	8	1.4	-	0.01	61	-	-	220	18.0	17.0	1.1	-	-	-	0.98	1.00	40
BE015b	WDOE Tst./Obs., Piezometer C	1972/08/04	07	25E	36	N	8.2	-	321	92	14	5	1.4	-	0.01	61	-	-	230	18.0	18.0	1.2	-	-	-	1.02	0.99	40
BE015c	WDOE Tst./Obs., Piezometer C	1972/10/05	07	25E	36	N	8.2	-	298	81	14	6	1.7	-	0.01	52	-	-	210	24.0	16.0	1.1	-	-	-	1.05	1.00	40
BE022	Prosser City 5	1994/01/19	08	24E	01	K	6.8	505	332	107	13	2	nd	nd	nd	73	0.25	nd	264	nd	13.0	2.3	na	16	na	1.07	0.93	—
BE031	Mott, Studer	1970/11/17	08	29E	22	A	7.3	-	922	58	17	100	72.0	-	-	53	0.03	0.03	180	510.0	16.0	0.4	-	-	-	1.01	1.01	40
BE039	WSU, IAREC, well 2	1994/01/19	09	25E	19	B	6.2	315	222	29	9	21	6.9	nd	nd	43	0.05	nd	162	18.0	7.2	0.6	na	nd	na	1.06	1.03	—
BE044	Christen	1970/10/12	09	26E	27	K	7.8	-	286	32	9	30	12.0	-	-	59	0.16	0.02	160	54.0	12.0	0.4	-	-	-	1.01	1.00	40
BE068	US Government	1970/11/19	11	26E	34	R	8.8	-	394	120	15	1	0.0	-	-	75	0.49	0.02	150	0.0	81.0	8.5	-	-	-	0.93	1.05	40
BE074	Roberts Bros.	1970/09/11	12	24E	20	N	8.0	-	202	21	8	18	11.0	-	-	56	0.02	0.02	170	0.2	3.8	0.6	-	-	-	1.02	1.00	40
BE076	US Government	1977/04/27	12	26E	04	N	7.7	-	262	17	5	43	15.0	0.0	0.10	50	0.02	0.01	170	39.0	8.3	0.4	-	-	-	0.92	1.00	40
BE078	US Government	1976/04/08	12	26E	07	Q	7.7	-	307	28	7	51	16.0	0.0	0.01	39	0.02	0.01	240	30.0	16.0	0.4	-	-	-	0.97	1.01	40
BE079	US Government	1979/04/19	12	26E	08	P	7.9	-	254	23	6	40	11.0	-	-	43	-	-	180	28.0	14.0	0.4	-	-	-	0.99	1.00	40
BE080	AEC	1979/04/17	12	26E	09	L	7.8	-	255	21	6	40	13.0	-	-	47	-	-	180	32.0	7.7	0.4	-	-	-	0.95	1.00	40
BE081	US Government	1976/04/08	12	26E	12	H	8.0	-	270	41	8	25	7.9	0.0	0.01	48	0.03	0.02	180	45.0	3.6	0.6	-	-	-	1.04	1.01	40
BE083	US Government	1979/04/17	12	26E	13	H	7.9	-	272	31	6	35	12.0	-	-	43	-	-	140	59.0	16.0	0.6	-	-	-	0.95	1.00	40
BE084	US Government	1978/04/20	12	26E	14	D	7.8	-	286	21	6	50	15.0	-	-	40	-	-	200	47.0	8.2	0.5	-	-	-	0.95	1.00	40
BE085a	US Government	1976/04/09	12	26E	15	C	7.8	-	276	25	6	41	12.0	0.0	0.01	40	0.02	0.01	210	41.0	7.3	0.4	-	-	-	1.07	1.00	40
BE085b	US Government	1977/04/28	12	26E	15	C	7.7	-	280	24	6	46	14.0	0.0	0.10	44	0.02	0.01	210	34.0	7.7	0.5	-	-	-	0.96	1.00	40
BE085c	US Government	1978/04/20	12	26E	15	C	7.8	-	278	24	6	47	14.0	-	-	42	-	-	210	33.0	7.8	0.5	-	-	-	0.95	1.00	40
BE085d	US Government	1979/04/20	12	26E	15	C	7.8	-	278	25	6	41	12.0	-	-	46	-	-	220	32.0	7.6	0.5	-	-	-	1.07	1.00	40
BE086	US Government	1979/04/20	12	26E	15	J	8.0	-	259	21	5	38	12.0	-	-	45	-	-	200	33.0	6.3	0.4	-	-	-	1.08	1.00	40
BE087	US Government	1976/04/08	12	26E	18	E	7.8	-	203	16	4	28	12.0	0.1	0.01	30	0.02	0.01	140	27.0	16.0	0.4	-	-	-	1.05	1.00	40
BE088	US Government	1979/04/19	12	26E	18	G	7.8	-	220	19	4	32	9.8	-	-	45	-	-	150	24.0	12.0	0.5	-	-	-	1.01	1.00	40
BE093	AEC	1979/04/16	12	27E	18	C	7.9	-	256	31	7	32	11.0	-	-	45	-	-	140	50.0	11.0	0.6	-	-	-	0.92	1.00	40
BE096a	US Government	1951/11/30	13	24E	25	E	7.8	-	233	27	9	19	12.0	-	-	65	-	-	190	1.8	5.8	0.5	-	-	-	1.02	1.00	40
BE096b	US Government	1951/11/30	13	24E	25	E	7.8	291	215	27	9	19	12.0	0.0	-	65	-	-	189	1.8	5.8	0.5	-	0	0.1	1.02	0.92	41

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
										Chemical species (ppm)																		
BE096c	US Government	1970/08/27	13	24E	25	E	8.0	-	212	26	7	18	11.0	-	-	56	0.09	0.02	180	0.2	4.4	0.7	-	-	-	1.01	1.00	40
BE098	US Govt./Meeker	1951/12/01	13	24E	26	G	7.8	292	218	27	7	20	12.0	0.1	-	60	-	-	193	1.5	5.5	0.5	-	0	0.0	1.03	0.96	41
BE099	—	1951/12/01	13	24E	26	G	7.8	-	228	27	7	20	12.0	-	-	60	-	-	190	1.5	5.5	0.5	-	-	-	1.02	1.01	40
BE100a	US Government	1951/11/29	13	24E	36	D	7.7	277	213	29	7	18	11.0	0.0	-	64	-	-	184	1.8	5.4	0.6	-	0	0.1	1.02	0.94	41
BE100b	US Government	1951/11/29	13	24E	36	D	7.7	-	227	29	7	18	11.0	-	-	64	-	-	180	1.8	5.4	0.6	-	-	-	1.00	1.01	40
BE101	US Government	1953/09/21	13	25E	01	N	7.6	296	216	22	11	19	11.0	0.1	-	39	-	-	143	23.0	8.0	0.4	-	0	0.0	1.01	1.06	31
BE102	US Government	1979/04/18	13	25E	03	Q	7.5	-	196	9	5	33	7.5	-	-	37	-	-	120	42.0	3.9	0.2	-	-	-	1.08	1.00	40
BE103	Hanford, 199-B4-4	1977/04/27	13	25E	11	H	7.6	-	218	10	5	43	5.9	0.0	0.10	46	0.02	0.01	120	42.0	6.6	0.2	-	-	-	0.96	1.00	40
BE106a	US Govt./McGee, Chester	1951/12/01	13	25E	30	G	7.8	-	224	30	10	17	9.4	-	-	62	0.05	-	180	1.6	4.8	0.6	-	-	-	1.01	1.00	40
BE106b	US Govt./McGee, Chester	1953/09/02	13	25E	30	G	7.7	289	216	30	6	18	10.0	0.1	-	64	-	-	180	2.1	5.2	0.7	-	0	0.2	1.01	0.96	41
BE106c	US Govt./McGee, Chester	1953/09/02	13	25E	30	G	7.7	-	225	30	6	18	10.0	-	-	64	-	-	180	2.1	5.2	0.7	-	-	-	1.01	1.00	40
BE106d	US Govt./McGee, Chester	1954/10/28	13	25E	30	G	7.4	-	226	30	8	17	9.4	-	-	67	-	-	180	2.1	5.1	0.6	-	-	-	1.03	0.99	40
BE106e	US Govt./McGee, Chester	1956/10/24	13	25E	30	G	8.0	-	220	30	8	17	9.3	-	-	62	-	-	180	0.4	4.8	0.7	-	-	-	1.02	1.00	40
BE106f	US Govt./McGee, Chester	1970/08/27	13	25E	30	G	8.1	-	211	30	9	16	8.9	-	-	56	0.11	0.02	170	0.0	4.4	0.7	-	-	-	0.98	1.01	40
BE106g	US Govt./McGee, Chester	1970/09/08	13	25E	30	G	8.1	-	211	30	8	16	8.8	-	-	57	0.07	0.02	170	0.0	4.5	0.7	-	-	-	0.99	1.01	40
BE106h	US Govt./McGee, Chester	1977/04/27	13	25E	30	G	8.0	-	209	29	8	17	9.2	0.1	0.10	55	0.02	0.02	170	1.4	4.5	0.8	-	-	-	0.99	1.00	40
BE110	US Government	1979/04/17	13	26E	31	R	8.0	-	260	14	4	41	17.0	-	-	43	-	-	120	62.0	20.0	0.4	-	-	-	0.93	1.00	40
BE113a	US Government	1969/05/10	13	26E	35	H	8.5	-	256	79	8	2	0.3	-	-	53	0.06	-	210	0.4	3.9	1.0	-	-	-	0.97	1.02	40
BE113b	US Government	1969/07/14	13	26E	35	H	8.9	-	401	130	3	0	0.0	-	-	67	0.38	-	160	21.0	68.0	11.0	-	-	-	0.98	1.06	40
BE118	US Government	1979/04/18	14	26E	23	D	7.7	-	220	12	4	39	8.4	-	-	40	-	-	110	46.0	16.0	0.2	-	-	-	1.00	1.00	40
BE120	Hanford 199-K-19	1979/04/18	14	26E	32	L	8.1	-	145	3	2	34	4.3	-	-	14	-	-	87	42.0	2.6	0.2	-	-	-	1.07	1.00	40
BE123	US Government	1979/04/17	14	27E	33	G	7.8	-	147	4	3	34	4.5	-	-	26	-	-	120	14.0	2.6	0.1	-	-	-	1.02	1.00	40
	CLALLAM COUNTY																											
CL001Sa	Olympic Hot Springs	-	29	08W	27	K	9.5	-	244	72	1	1	-	-	-	66	0.80	-	175	5.0	11.0	1.2	14.0	-	-	1.06	0.95	32
CL001Sb	Olympic Hot Springs	-	29	08W	27	K	9.5	-	-	72	1	1	LD	-	-	66	0.82	0.04	175	5.0	11.0	1.2	-	-	-	1.06	0.00	19
CL002Sa	Sol Duc Hot Springs (1)	-	29	09W	32	C	7.9	380	-	75	2	1	0.0	-	-	80	1.30	0.10	137	34.0	20.0	1.0	-	-	-	1.06	0.00	21
CL002Sb	Sol Duc Hot Springs (2)	-	29	09W	32	C	8.4	360	-	74	3	1	0.0	-	-	-	1.30	0.10	129	35.0	18.0	1.0	-	-	-	1.03	0.00	21
CL002Sc	Sol Duc Hot Springs	-	29	09W	32	C	9.5	-	-	80	1	1	-	0.0	-	60	1.40	0.05	181	7.0	21.0	1.7	-	-	-	1.08	0.00	19
CL002Sd	Sol Duc Hot Springs	-	29	09W	32	C	9.5	-	262	80	1	1	-	-	-	60	1.40	-	181	7.0	21.0	1.7	10.0	-	-	1.09	0.96	32
	COLUMBIA COUNTY																											
CO003a	Ferrel, Robert	1954/08/02	13	38E	26	E	7.5	-	260	9	3	23	9.6	0.1	0.02	-	0.03	-	122	11.0	10.6	-	-	-	-	1.07	2.07	31
CO003b	Ferrel, Robert	1961/01/27	13	38E	26	E	7.6	-	189	9	6	24	8.8	-	-	67	-	-	140	2.8	2.0	0.5	-	-	-	1.00	1.00	40
CO003c	Ferrel, Robert	1961/01/27	13	38E	26	E	7.6	227	194	9	6	24	8.8	0.0	-	67	-	-	140	2.8	2.0	0.5	-	-	-	1.00	1.03	31,41
	FRANKLIN COUNTY																											
FR002	Pasco Navy Base/ Port of Pasco	1970/08/28	09	30E	18	J	8.6	-	346	120	11	2	0.5	-	-	54	0.10	0.02	280	0.0	15.0	1.8	-	-	-	0.92	1.01	40
FR010	West 15 Domestic Water, Inc.	1994/01/20	11	29E	05	R	6.5	510	320	95	12	2	nd	0.1	nd	47	0.24	nd	154	19.0	46.0	4.8	na	6	na	1.04	1.04	—
FR026	US Bureau of Reclamation	1953/01/01	12	29E	28	F	8.0	-	173	46	6	9	4.6	-	-	-	-	-	120	35.0	11.0	1.0	-	-	-	1.03	1.00	40
FR031	US Bureau of Reclamation	1970/11/10	13	28E	13	N	8.6	-	288	78	17	1	0.4	-	-	67	0.12	0.02	180	19.0	14.0	2.2	-	-	-	1.00	1.00	40

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
										Chemical species (ppm)																		
FR043a	US Govt./Othello AFB	1955/09/29	14	29E	09	A	8.1	-	264	44	8	20	9.9	-	-	55	-	-	190	24.0	11.0	0.9	-	-	-	1.03	0.99	40
FR043b	US Govt./Othello AFB	1956/09/13	14	29E	09	A	8.1	-	269	44	8	20	10.0	-	-	56	-	-	190	25.0	13.0	1.0	-	-	-	1.05	1.00	40
FR043c	US Govt./Othello AFB	1960/10/19	14	29E	09	A	8.0	-	270	43	8	21	11.0	-	-	56	-	-	180	29.0	10.0	1.0	-	-	-	0.98	1.01	40
FR043d	US Govt./Othello AFB	1960/10/19	14	29E	09	A	8.0	411	282	43	8	21	11.0	0.0	-	56	-	-	185	29.0	10.0	1.0	-	-	-	1.00	1.04	41
FR043e	US Govt./Othello AFB	1962/10/09	14	29E	09	A	7.9	-	269	45	8	20	10.0	-	-	57	-	-	190	24.0	11.0	1.0	-	-	-	1.02	1.00	40
FR043f	US Govt./Othello AFB	1964/04/29	14	29E	09	A	7.8	-	280	44	8	22	11.0	-	-	57	-	-	180	33.0	14.0	1.0	-	-	-	1.00	1.00	40
FR043g	US Govt./Othello AFB	1965/01/26	14	29E	09	A	7.9	-	275	43	8	21	12.0	-	-	55	-	-	190	31.0	13.0	1.0	-	-	-	1.03	0.99	40
FR043h	US Govt./Othello AFB	1967/02/13	14	29E	09	A	8.1	-	243	44	8	20	11.0	-	-	28	-	-	180	28.0	14.0	1.0	-	-	-	1.01	1.00	40
FR052	Connell City 4	1970/09/24	14	31E	36	J	8.8	-	273	72	9	3	0.3	-	-	70	0.07	0.02	140	27.0	11.0	1.7	-	-	-	0.93	1.04	40
	GARFIELD COUNTY																											
GA002a	Pomeroy City 4	1959/10/28	12	42E	31	L	8.0	-	157	10	6	16	2.3	-	-	74	-	-	90	3.1	1.8	0.4	-	-	-	1.05	1.00	40
GA002b	Pomeroy City 4	1959/10/28	12	42E	31	L	8.0	162	154	10	6	16	2.3	0.0	-	74	-	-	90	3.1	1.8	0.4	-	-	-	1.05	0.98	31,41
	GRANT COUNTY																											
GR007a	US Army/AEC Hanford 90	1952/08/07	14	25E	01	D	7.9	-	270	47	19	12	4.5	-	-	75	-	-	160	25.0	9.7	0.4	-	-	-	1.00	1.00	40
GR007b	US Army/AEC Hanford 90	1952/08/07	14	25E	01	D	7.9	330	265	47	19	12	4.5	0.2	-	75	-	-	157	25.0	9.7	0.4	-	-	-	0.98	0.98	31,41
GR007c	US Army/AEC Hanford 90	1954/10/28	14	25E	01	D	7.7	-	230	20	12	24	9.3	-	-	61	-	-	140	27.0	6.2	0.5	-	-	-	0.99	1.01	40
GR007d	US Army/AEC Hanford 90	1970/09/17	14	25E	01	D	8.1	-	215	17	11	24	8.6	-	-	56	0.03	0.02	140	24.0	5.0	0.4	-	-	-	1.02	1.00	40
GR007e	US Army/AEC Hanford 90	1971/10/08	14	25E	01	D	7.8	-	238	17	17	24	8.5	-	-	64	0.00	0.11	140	31.0	5.4	0.4	-	-	-	1.02	1.01	40
GR011a	US Govt./AEC Hanford 6	1954/10/28	14	25E	21	B	7.6	313	250	21	7	28	11.0	0.1	-	69	-	-	156	25.0	7.4	0.3	-	-	-	0.99	1.02	41
GR011b	US Govt./AEC Hanford 6	1954/10/28	14	25E	21	B	7.6	-	245	21	7	28	11.0	-	-	69	-	-	160	25.0	7.4	0.3	-	-	-	1.01	0.99	40
GR011c	US Govt./AEC Hanford 6	1958/01/07	14	25E	21	B	7.8	-	173	21	6	30	9.6	-	-	-	-	-	150	23.0	7.0	0.3	-	-	-	0.95	1.01	40
GR013a	US Army	1959/10/28	14	27E	24	C	8.0	457	322	80	26	7	0.4	-	-	63	-	-	216	29.0	12.0	1.2	-	-	-	1.02	0.99	31,41
GR013b	US Army	1959/10/28	14	27E	24	C	8.0	-	325	80	26	7	0.4	-	-	63	-	-	220	29.0	12.0	1.2	-	-	-	1.03	0.99	40
GR014	Wahluke School	1994/01/20	15	23E	35	R	5.9	220	142	6	3	23	8.2	0.1	nd	50	nd	nd	105	15.0	4.8	0.3	na	nd	na	1.01	0.87	—
GR019a	AEC Hanford 7	1958/01/07	15	27E	34	L	7.8	330	262	40	18	13	6.0	0.1	-	-	-	-	152	26.0	8.2	0.4	-	-	-	1.00	1.41	31,41
GR019b	AEC Hanford 7	1958/01/07	15	27E	34	L	7.8	-	186	40	18	13	6.0	-	-	-	-	-	150	26.0	8.2	0.4	-	-	-	0.99	1.00	40
GR025a	US Air Force	1959/11/17	16	24E	01	G	7.7	-	384	45	10	38	24.0	-	-	57	-	-	250	68.0	19.0	0.7	-	-	-	1.01	1.00	40
GR025b	US Air Force	1959/12/12	16	24E	01	G	7.9	-	383	45	10	40	24.0	-	-	50	-	-	250	70.0	18.0	0.8	-	-	-	1.00	1.01	40
GR025c	US Air Force	1960/01/24	16	24E	01	G	7.9	-	383	45	10	40	24.0	-	-	51	-	-	250	69.0	19.0	0.6	-	-	-	1.00	1.00	40
GR025d	US Air Force	1963/03/28	16	24E	01	G	7.9	-	397	49	11	40	24.0	-	-	48	-	-	250	82.0	20.0	0.6	-	-	-	1.01	1.00	40
GR023	US Government	1960/01/24	16	24E	01	G	7.9	566	384	45	10	40	24.0	0.3	-	51	-	-	252	69.0	19.0	0.6	-	-	-	1.00	1.00	31,41
GR024a	US Air Force	1959/11/17	16	24E	01	G	7.7	575	380	45	10	38	24.0	0.2	-	57	-	-	250	68.0	19.0	0.7	-	-	-	1.01	0.99	31,41
GR024b	US Air Force	1959/12/12	16	24E	01	G	7.9	581	366	45	10	40	24.0	0.2	-	50	-	-	254	70.0	18.0	0.8	-	-	-	1.01	0.96	31,41
GR032a	US Government	1960/01/24	17	30E	33	K	8.4	317	270	57	10	9	1.9	0.5	-	79	-	-	161	15.0	6.5	1.3	-	-	-	0.98	1.04	31,41
GR032b	US Government	1960/01/24	17	30E	33	K	8.4	-	263	57	10	9	1.9	-	-	79	-	-	160	15.0	6.5	1.3	-	-	-	0.98	1.02	40
GR033a	US Army Corps of Engineers	1959/10/28	17	30E	33	K	8.4	321	264	57	10	8	2.1	0.2	-	78	-	-	162	15.0	7.2	1.2	-	-	-	0.99	1.02	31,41
GR033b	US Army Corps of Engineers	1959/10/28	17	30E	33	K	8.4	-	262	57	10	8	2.1	-	-	78	-	-	160	15.0	7.2	1.2	-	-	-	0.98	1.02	40
GR033c	US Army Corps of Engineers	1962/10/30	17	30E	33	K	8.2	-	263	59	10	9	2.0	0.0	-	76	-	-	170	14.0	8.0	1.2	-	-	-	1.00	1.00	40

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
										Chemical species (ppm)																		
GR038	WDOE Tst./Obs., Backfilled	1978/02/17	18	25E	15	E	7.0	-	262	50	7	16	6.7	-	-	67	-	-	160	25.0	11.0	1.2	-	-	-	0.97	1.00	40
GR056	Moses Lake City 14	1994/04/07	19	28E	15	A	7.0	370	303	81	10	1	0.9	0.1	-	80	-	0.04	164	6.6	19.0	3.7	-	12	-	1.02	1.03	—
GR058	Moses Lake City 7	1960/05/16	19	28E	23	D	8.4	-	-	56	-	-	-	-	-	-	-	-	160	-	-	-	-	-	-	1.10	0.00	40
GR060	Moses Lake City 10	1994/04/07	19	28E	27	C	7.5	412	317	87	12	3	1.3	-	-	51	-	0.05	180	33.0	20.0	1.2	-	2	-	1.00	1.06	—
GR063	Moses Lake City 4	1994/04/07	19	28E	28	Q	7.0	493	360	92	16	11	5.2	0.0	0.66	56	0.24	0.06	219	41.0	24.0	1.2	-	-	-	0.97	1.01	—
GR081	Quincy City 1	1955/08/03	20	24E	07	R	7.5	-	243	25	4	32	10.0	-	-	50	-	-	150	29.0	17.0	-	-	-	-	0.99	1.01	40
GR082	Wenatchee Apple Land Co.	-	20	24E	09	E	-	-	272	19	4	37	15.0	0.0	-	42	-	-	156	37.0	17.0	0.4	-	-	-	0.97	1.10	39
GR085a	Moses Lake City 21	1951/03/30	20	28E	32	HorJ	8.0	-	238	35	12	17	8.6	-	-	49	-	-	160	25.0	8.9	0.6	-	-	-	1.03	1.01	40
GR085b	Moses Lake City 21	1951/03/30	20	28E	32	HorJ	8.0	315	222	35	12	17	8.6	0.0	-	49	-	-	156	25.0	8.9	0.6	-	-	-	1.01	0.95	41
GR098	Ephrata City	1955/07/22	21	26E	08	M	7.9	-	193	22	3	16	13.0	-	-	46	-	-	150	12.0	7.0	-	-	-	-	1.02	1.00	40
GR100	Ephrata City 5	1955/07/22	21	26E	08	N	7.6	-	168	12	2	19	12.0	-	-	46	-	-	130	6.0	7.0	-	-	-	-	0.99	1.00	40
GR104	Ephrata City 2	1955/07/22	21	26E	16	B	-	-	187	14	5	17	14.0	-	-	50	0.01	-	150	6.0	7.0	-	-	-	-	1.03	1.00	40
GR105	Ephrata City	1955/07/22	21	26E	21	E	8.1	-	191	12	4	17	12.0	-	-	64	0.01	-	130	8.0	7.0	-	-	-	-	1.03	1.02	40
GR109	Schell, Harvey	1982/09/08	21	30E	23	J	8.6	372	-	55	11	16	2.4	0.0	-	68	-	-	130	35.0	20.0	0.9	-	3	0.1	0.98	0.00	7,16
GR111	Soap Lake city	1955/07/22	22	27E	19	N	7.9	-	218	24	5	17	12.0	-	-	58	0.01	-	150	18.0	8.0	-	-	-	-	1.03	1.01	40
	KING COUNTY																											
KI001Sa	Lester Hot Springs (F-1)	-	20	10E	21	M	-	-	-	112	3	8	0.2	-	-	66	-	0.33	-	-	200.0	-	-	-	-	1.04	0.00	21,24
KI001Sb	Lester Hot Springs	-	20	10E	21	M	9.2	-	339	105	2	5	0.0	-	-	61	-	-	61	19.0	115.0	1.6	5.7	-	-	0.97	0.98	32
KI003S	Goldmeyer Hot Springs	-	23	11E	14	B	8.5	-	391	125	3	6	0.0	-	-	56	-	-	61	40.0	130.0	0.9	0.6	-	-	0.95	1.00	32
KI004Sa	Scenic Hot Springs	-	26	13E	28	Q	9.1	-	168	49	1	2	0.0	-	-	44	-	-	75	13.0	22.0	0.7	1.3	-	-	0.97	0.99	32
KI004Sb	Scenic Hot Springs (C-1)	-	26	13E	28	Q	9.3	140	-	32	1	2	-	-	-	37	-	-	44	13.0	14.0	0.6	-	-	-	0.95	0.00	18,24
	KITTITAS COUNTY																											
KS007	USGS/WDOE Umtanum	1978/03/02	16	19E	28	C	8.5	-	157	22	3	14	5.2	-	-	48	-	-	120	1.9	3.3	0.6	-	-	-	1.01	1.00	40
KS011	Ellensburg City Mt. Stuart well	1994/04/07	18	18E	35	E	7.1	185	146	31	2	9	1.3	0.0	-	48	0.07	-	116	1.6	5.0	0.4	-	-	-	1.08	0.93	—
	KLICKITAT COUNTY																											
KT009Sa	Klickitat Mineral Springs	-	04	13E	24	A	5.9	-	-	64	10	120	100.0	-	-	140	-	-	1070	-	4.2	0.3	-	-	-	1.04	0.00	24
KT009Sb	Klickitat Mineral Springs	-	04	13E	24	A	6.1	-	637	34	4	38	38.0	-	-	103	-	-	415	-	4.0	0.8	-	-	-	1.07	1.49	32
KT011a	Gas-Ice Corp. 10	1964/10/21	04	13E	24	H	6.6	1410	964	63	10	120	106.0	11.0	-	121	0.11	-	1060	3.4	3.5	0.4	-	-	-	0.99	1.00	31
KT011b	Gas Ice Corp. 10	1964/10/21	04	13E	24	H	6.6	-	953	63	10	120	110.0	-	-	120	0.11	-	1060	3.4	3.5	0.4	-	-	-	0.99	1.00	40
KT012a	Gas Ice Corp. 2	1964/10/21	04	14E	19	C	6.4	-	319	30	4	27	25.0	-	-	89	0.03	-	280	0.0	3.2	1.1	-	-	-	1.00	1.01	40
KT012b	Gas-Ice Corp. 2	1964/10/21	04	14E	19	C	6.4	429	325	30	4	27	25.0	2.8	-	89	0.03	-	284	-	3.2	1.1	-	-	0.2	0.99	1.01	31
KT026S	Fish Hatchery Warm Spring	-	06	13E	04	H	-	-	-	160	16	110	95.0	2.2	-	-	-	-	1130	2.6	49.0	0.4	-	-	-	0.98	0.00	24
KT027a	Smith, G.	1970/10/21	06	23E	11	N	8.1	-	255	64	15	6	2.4	-	-	56	0.13	0.02	210	0.2	9.1	1.0	-	-	-	1.04	0.99	40
KT027b	Smith, G.	1970/12/11	06	23E	11	N	8.1	-	252	64	15	6	2.7	-	-	52	0.01	0.04	210	0.0	9.2	1.0	-	-	-	1.03	0.99	40
KT029	Smith, George	1962/04/30	06	23E	11	Q	8.1	344	-	55	11	12	4.1	0.0	-	57	-	-	195	2.2	9.8	1.0	-	-	0.6	1.01	0.00	31
KT030	—	1962/04/30	06	23E	11	Q	8.1	-	248	55	11	12	4.1	-	-	57	-	-	200	2.2	9.8	1.0	-	-	-	1.03	0.99	40

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Chemical species (ppm) Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
KT031	Andrews/Smith	1970/10/22	06	23E	15	H	7.9	-	254	64	13	7	2.7	-	-	57	0.07	0.02	210	0.2	8.6	1.0	-	-	-	1.03	0.99	40
	LEWIS COUNTY																											
LE010S	Ohanapecosh Hot Springs (USGS)	-	14	10E	04	C	6.8	-	-	920	52	60	4.9	0.0	-	100	12.00	2.90	1060	170.0	880.0	5.2	-	-	-	1.03	0.00	24
	LINCOLN COUNTY																											
LI001	Odessa Oil Test Piezometer A	1972/08/08	21	31E	10	M	8.2	-	356	100	7	8	2.6	-	-	87	-	-	210	19.0	16.0	13.0	-	-	-	0.99	1.00	40
LI015	Sprague City	1982/07/21	21	38E	23	L	8.4	248	-	34	5	15	3.6	0.0	-	63	-	-	145	5.0	3.0	0.9	-	3	0.2	1.04	0.00	7,16
LI024	Wilbur SEC	1982/09/09	25	32E	35	P	8.2	270	-	39	5	12	5.3	0.0	-	57	-	-	151	7.0	4.6	0.8	-	-	0.1	0.99	0.00	7,16
LI025	Davenport City 6	1982/07/21	25	37E	21	L	8.2	288	-	40	5	15	5.8	0.0	-	50	-	-	174	11.0	4.3	0.9	-	-	0.1	1.07	0.00	7,16
	PIERCE COUNTY																											
PI001S	Longmire Springs	-	15	08E	29	R	7.4	-	-	487	41	492	-	-	-	-	-	-	-	-	1657.0	-	-	-	-	1.00	0.00	14
PI003S	Spring	-	19	02E	19	Q	6.8	95	57	5	1	9	2.9	0.0	-	10	-	-	44	5.4	3.0	-	-	-	0.4	1.00	0.98	15
	SKAMANIA COUNTY																											
SK001Sa	Bonneville Hot Springs (A-3)	-	02	07E	16	M	9.9	790	-	134	1	30	-	-	-	50	-	-	-	72.0	187.0	0.6	-	-	-	0.93	0.00	18,24
SK001Sb	Bonneville Hot Springs	-	02	07E	16	M	9.5	-	505	145	1	31	0.0	-	-	46	2.00	-	39	80.0	180.0	0.7	0.5	-	-	0.94	1.00	32
SK002S	Rock Creek Hot Springs (A-1)	-	03	07E	27	B	9.7	400	-	80	0	12	-	-	-	41	-	-	31	40.0	85.0	0.7	-	-	-	0.93	0.00	18,24
SK008Sa	St. Martin Hot Springs	-	03	08E	21	R	7.0	-	-	291	6	104	-	-	-	20	-	-	-	-	636.0	-	-	-	-	1.00	0.00	14
SK008Sb	St. Martin Hot Springs	-	03	08E	21	R	8.5	-	1210	360	6	76	0.3	-	-	48	2.90	-	19	16.0	690.0	0.7	-	-	-	1.03	1.00	32
SK008Sc	St. Martin Hot Springs (A-1)	-	03	08E	21	R	-	2350	-	360	6	73	0.5	-	-	57	-	0.30	-	-	756.0	-	-	-	-	1.09	0.00	21,24
	SNOHOMISH COUNTY																											
SN001Sa	Garland Min. Sprs (Main) (GLA-1)	-	28	11E	25	C	6.9	17000	-	2640	188	318	90.0	1.0	-	107	24.40	8.10	2050	170.0	4250.0	1.3	-	-	-	1.09	0.00	19
SN001Sb	Garland Mineral Springs	-	28	11E	25	C	6.5	-	-	2500	200	390	87.0	5.4	-	105	64.00	9.40	2600	160.0	3600.0	1.6	-	-	-	1.04	0.00	24
SN001Sc	Garland Mineral Springs	-	28	11E	25	C	6.5	-	8380	2500	200	390	87.0	-	-	105	64.00	-	2600	160.0	3600.0	1.6	-	-	-	1.06	1.00	32
SN002S	Kennedy Hot Springs (USGS)	-	30	12E	01	H	6.3	-	2600	670	72	190	48.0	-	-	175	7.50	-	1660	2.0	625.0	1.2	-	-	-	1.02	1.00	32
SN003S	Gamma Hot Spring	-	31	13E	36	D	6.1	-	-	510	80	71	2.8	-	-	141	9.00	2.80	398	30.0	755.0	1.4	-	-	-	1.01	0.00	19
SN004Sa	Sulphur Creek Hot Springs	-	32	13E	19	C	9.4	-	-	100	2	1	-	-	-	76	0.55	0.14	154	21.0	51.0	3.9	-	-	-	1.04	0.00	19
SN004Sb	Sulphur Creek Hot Springs (A-1)	-	32	13E	19	C	7.6	480	-	102	3	2	0.0	-	-	100	0.60	0.10	102	60.0	54.0	3.0	-	-	-	1.01	0.00	21
	SPOKANE COUNTY																											
SP005	US Government	1958/07/22	24	40E	22	L	7.6	-	201	14	3	30	10.0	-	-	45	-	-	150	21.0	3.8	0.3	-	-	-	1.02	1.00	40
SP006	Fairchild AFB, 2	1958/07/22	24	41E	03	N	7.8	-	166	13	2	21	8.6	-	-	47	-	-	130	10.0	1.8	0.4	-	-	-	1.03	0.99	40
SP007	US Government	1958/07/22	25	40E	14	R	7.5	-	171	14	2	20	12.0	-	-	42	-	-	140	8.1	5.2	0.7	-	-	-	1.02	0.99	40

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Chemical species (ppm) Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
SP008	US Government	1958/07/22	25	40E	34	P	7.2	-	192	16	2	32	7.8	-	-	49	-	-	150	5.2	4.5	0.4	-	-	-	0.93	1.01	40
SP009	US Government	1958/07/23	25	41E	01	R	7.2	-	192	11	2	28	13.0	-	-	47	-	-	170	6.4	2.5	0.3	-	-	-	1.02	0.99	40
SP010	US Army, Fort George Wright	1958/07/22	25	42E	11	E	7.5	-	121	2	1	28	7.8	-	-	13	-	-	110	11.0	3.8	0.3	-	-	-	1.01	1.00	40
SP011	Wash. Water Power Co., 1-3	1977/10/03	25	43E	13	A	7.8	-	138	2	2	32	14.0	0.0	-	-	-	-	150	12.0	1.7	0.1	-	-	-	0.97	1.00	40
SP012	US Air Force	1958/07/22	26	42E	20	N	7.8	-	162	4	2	36	12.0	-	-	17	-	-	150	14.0	3.2	0.1	-	-	-	0.96	1.00	40
	WALLA WALLA COUNTY																											
WA020a	Jaussand, Art	1958/08/01	06	35E	10	P	8.2	226	186	32	9	12	1.7	0.0	-	72	-	-	126	3.2	6.5	0.7	-	-	-	1.02	0.94	31,41
WA020b	Jaussand, Art	1958/08/01	06	35E	10	P	8.2	-	199	32	9	12	1.7	-	-	72	-	-	130	3.2	6.5	0.7	-	-	-	1.05	0.99	40
WA027a	WDOE Tst./Obs., Piezometer A	1973/03/07	06	35E	18	A	8.3	-	229	43	10	6	0.6	-	-	89	-	-	140	4.1	5.2	1.2	-	-	-	1.06	1.01	40
WA027b	WDOE Tst./Obs., Piezometer A	1973/07/12	06	35E	18	A	8.7	-	228	40	8	7	1.1	-	-	93	-	-	120	3.6	4.2	1.1	-	-	-	0.95	1.05	40
WA044	Baker & Baker	1946/11/29	06	36E	09	P	-	186	161	8	3	16	9.8	0.1	-	60	-	-	108	5.7	3.8	0.6	-	-	0.4	1.02	1.00	30
WA049	Byerley Farm, Inc.	1971/09/20	07	32E	36	Q	7.9	-	260	48	16	10	2.9	-	-	80	0.78	0.25	160	3.8	20.0	1.3	-	-	-	1.04	0.99	40
WA063	Bonneville Power Admin.	1946/11/21	07	35E	23	M	-	214	177	31	8	11	2.1	0.0	-	55	-	-	125	3.8	3.6	0.6	-	-	0.1	1.01	1.00	30
WA071	Walla Walla College	1954/08/04	07	35E	33	H	7.6	-	-	17	4	15	5.6	0.1	0.07	-	0.14	-	116	3.8	1.6	-	-	-	-	1.00	0.00	31
WA079	College Place	1970/10/23	07	35E	36	F	8.2	-	190	22	5	19	5.1	-	-	62	-	0.02	130	5.6	3.9	0.5	-	-	-	0.98	1.01	40
WA080	College Place City	1959/10/22	07	35E	36	F	8.2	-	194	21	5	20	5.5	-	-	65	-	-	140	5.4	4.2	0.5	-	-	-	1.04	0.99	40
WA082	College Place	1952/04/20	07	35E	36	F	8.1	233	195	22	6	20	5.8	0.0	-	65	-	-	141	5.8	4.2	0.6	-	-	0.1	1.02	0.98	30
WA083	College Place	1959/10/22	07	35E	36	F	8.2	229	200	21	5	20	5.5	0.0	-	65	-	-	136	5.4	4.2	0.5	-	-	-	1.01	1.03	30,41
WA086	Walla Walla Comm. Coll.	1994/01/20	07	36E	14	P	5.7	165	120	6	2	14	7.0	nd	nd	46	0.11	nd	90	3.2	4.2	0.4	na	nd	na	1.07	0.94	—
WA095	Rogers Canning	1970/10/21	07	36E	19	R	8.1	-	177	23	6	13	3.6	-	-	68	-	0.02	120	3.6	2.8	0.8	-	-	-	1.05	0.99	40
WA097	Whitman College	1970/10/22	07	36E	20	H	8.0	-	192	25	6	17	5.5	-	-	61	-	0.02	140	6.6	1.9	0.9	-	-	-	1.01	1.00	40
WA098a	Walla Walla City 5	1960/07/29	07	36E	28	R	8.2	245	193	29	6	16	5.3	0.1	-	62	-	-	148	5.0	3.0	1.0	-	-	-	1.03	0.97	41
WA098b	Walla Walla City 5	1960/07/29	07	36E	28	R	8.2	-	200	29	6	16	5.3	-	-	62	-	-	150	5.0	3.0	1.0	-	-	-	1.04	1.00	40
	WHATCOM COUNTY																											
WH003Sa	Baker Hot Springs (A-1)	-	38	09E	20	M	7.9	820	-	179	12	6	0.2	-	-	125	3.10	0.40	157	95.0	109.0	3.0	-	-	-	0.93	0.00	21,24
WH003Sb	Baker Hot Springs (Main) (BKA-2)	-	38	09E	20	M	8.3	730	-	146	8	5	-	-	-	105	0.91	0.30	106	95.0	111.0	3.0	-	-	-	1.02	0.00	19
WH003Sc	Baker Hot Springs(B-1)	-	38	09E	20	M	8.0	780	-	154	11	6	0.3	-	-	90	2.70	0.30	124	90.0	99.0	3.0	-	-	-	0.94	0.00	21,24
WH003Sd	Baker Hot Springs	-	38	09E	20	M	8.6	-	-	170	10	6	0.2	-	-	103	2.70	0.36	165	87.0	110.0	3.2	-	-	-	0.98	0.00	19
	WHITMAN COUNTY																											
WT006	Pullman City	1955/06/22	14	45E	05	D	7.8	-	226	14	4	20	15.2	0.1	0.06	-	0.56	-	178	3.4	6.7	-	-	-	-	1.10	1.50	31
WT009	Pullman City	1955/06/22	15	45E	32	N	7.5	-	206	18	4	20	15.7	0.0	-	-	0.01	-	184	2.3	6.7	-	-	-	-	1.05	1.32	31
WT010a	Colfax City Clay St. well	1955/08/18	16	43E	11	G	7.7	-	209	21	2	19	13.5	0.1	0.02	-	0.02	-	172	5.4	3.5	-	-	-	-	1.02	1.40	31
WT010b	Colfax City Clay St. well	1958/06/20	16	43E	11	G	7.4	280	204	22	2	25	9.0	0.1	0.03	-	-	-	185	3.8	4.6	-	-	-	-	1.10	1.29	31

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
										Chemical species (ppm)																		
YAKIMA COUNTY																												
YA018	Grandview City, well no. 15	1994/01/19	09	23E	22	L	7.0	415	310	90	10	0	nd	0.0	nd	84	0.27	nd	166	nd	23.0	4.1	na	19	na	1.02	0.99	—
YA022	Showaway, Ida	1974/04/11	10	17E	14	D	-	-	202	19	5	34	16.0	1.5	-	-	-	-	210	4.9	18.0	1.3	-	-	-	1.04	1.00	40
YA031	Decker Ranch (Decker 7)	1974/05/20	10	18E	31	N	-	-	182	31	5	19	14.0	0.1	-	-	-	-	220	1.6	3.3	0.7	-	-	-	1.07	0.99	40
YA037	Toppenish City 7	1974/09/19	10	20E	04	L	-	-	116	24	5	14	4.2	0.1	-	-	-	-	130	0.7	2.6	0.6	-	-	-	1.03	1.01	40
YA040a	Toppenish City 6	1959/10/19	10	20E	09	A	7.8	-	160	19	4	13	2.2	0.1	-	68	-	-	100	0.3	1.0	0.6	-	-	-	0.98	1.02	40
YA040b	Toppenish City 6	1959/10/19	10	20E	09	A	7.8	171	158	19	4	13	2.2	0.1	-	68	-	-	105	0.3	1.0	0.6	-	-	-	1.03	0.99	41
YA040c	Toppenish City 6	1971/02/03	10	20E	09	A	8.0	-	162	20	4	12	3.5	-	-	68	-	0.02	110	0.0	2.0	0.5	-	-	-	1.04	0.99	40
YA044	Phillips, Lena	1974/05/23	10	21E	33	B	-	-	200	25	4	31	13.0	0.3	-	-	-	-	210	17.0	7.7	0.2	-	-	-	1.07	0.99	40
YA045	Sunnyside City 4	1970/10/06	10	22E	25	F	7.6	-	223	16	7	29	9.7	-	-	62	0.02	0.02	160	16.0	4.8	0.5	-	-	-	1.01	1.00	40
YA050	Sunnyside City 7	1994/04/08	10	22E	36	E	6.5	290	220	21	9	24	10.7	0.1	-	69	-	-	183	-	10.0	0.4	-	-	-	1.05	0.94	—
YA051	Sunnyside City 6	1994/04/08	10	23E	30	M	5.9	322	256	15	7	31	14.5	0.1	-	61	-	-	161	30.00	12.0	0.4	-	-	-	1.03	1.02	—
YA057	Gowdy, Albert A.	1974/06/14	11	16E	34	K	-	-	201	30	5	23	16.0	2.2	-	-	-	-	210	18.0	2.8	0.5	-	-	-	1.00	1.00	40
YA058	Mount Adams Seed	1974/06/13	11	17E	01	F	-	-	-	24	4	18	5.9	0.1	-	-	-	-	140	1.0	5.0	0.7	-	-	-	1.00	0.00	40
YA060	Stephenson, C. and H.	1974/05/21	11	17E	03	L	-	-	145	27	4	16	8.8	0.1	-	-	-	-	170	1.4	4.4	0.8	-	-	-	1.08	0.99	40
YA065	Siegner, Monte	1974/10/01	11	18E	09	N	-	-	142	25	4	20	7.4	0.1	-	-	-	-	160	0.8	4.5	0.7	-	-	-	1.02	1.00	40
YA067	Carlson, Sarah	1974/03/06	11	18E	26	L	-	-	160	21	5	24	10.0	0.4	-	-	-	-	130	22.0	11.0	0.2	-	-	-	0.96	1.02	40
YA068	Harrah City	1994/01/19	11	18E	26	M	6.8	325	218	35	7	19	10.9	0.2	nd	95	0.14	nd	199	nd	6.0	1.1	na	nd	na	0.99	0.80	—
YA074	Wapato City, well no. 5	1994/01/19	11	19E	14	M	5.7	190	158	20	4	12	4.2	0.1	nd	79	0.14	nd	112	na	3.6	0.5	na	nd	na	1.04	0.89	—
YA130	Wiley, Robert	1971/09/23	12	17E	16	A	7.8	-	178	24	4	11	3.4	-	-	71	-	0.03	120	0.0	2.2	0.8	-	-	-	1.06	1.01	40
YA133	Hansen Fruit	1974/06/14	12	18E	27	G	-	-	157	22	4	20	14.0	0.1	-	-	-	-	180	1.5	6.3	0.7	-	-	-	1.01	1.00	40
YA134	Hansen Fruit	1974/06/14	12	18E	27	H	-	-	168	35	5	19	6.8	0.1	-	-	-	-	170	4.1	11.0	1.2	-	-	-	1.04	1.01	40
YA137	Mount Adams Seed, 2	1974/05/23	12	18E	32	H	-	-	136	25	4	19	6.4	0.1	-	-	-	-	140	0.8	10.0	0.7	-	-	-	1.00	1.01	40
YA141a	Moxee City, 1	1962/11/02	12	19E	01	Q	8.4	-	180	56	3	5	0.9	-	-	30	0.01	-	160	0.0	4.5	1.7	-	-	-	1.02	1.00	40
YA141b	Moxee City, 1	1994/04/08	12	19E	01	Q	6.5	260	230	57	3	5	1.0	0.1	-	36	-	-	168	-	7.1	1.4	-	-	-	1.07	1.19	—
YA211a	Yakima Creamery well	1994/01/18	13	18E	24	K	6.6	235	126	49	nd	2	nd	0.1	nd	nd	nd	nd	117	nd	5.4	1.3	na	7	na	1.06	1.03	—
YA211a	Yakima Creamery well, rerun	1994/01/18	13	18E	24	K	6.6	235	126	50	1	1	1.0	nd	nd	20	nd	nd	117	nd	5.4	1.3	na	7	na	1.01	0.87	—
YA211b	Yakima Creamery well	1994/04/08	13	18E	24	K	6.6	210	148	50	nd	2	0.7	nd	nd	31	0.19	nd	129	nd	5.7	1.1	na	3	na	1.07	0.94	—
YA211c	Yakima Creamery well	1994/01/18	13	18E	24	K	6.6	210	146	52	nd	2	0.4	nd	nd	18	0.30	nd	124	nd	6.1	1.1	na	4	na	1.03	1.01	—
YA226	Yakima County (heat pump well)	1994/01/18	13	19E	19	D	7.0	155	92	19	3	11	0.3	nd	nd	40	0.35	nd	75	5.4	4.8	0.4	na	3	na	1.08	0.74	—
YA258a	US Army, Yakima Firing Cen., 1	1951/04/20	14	19E	28	B	8.0	-	187	19	6	15	11.0	-	-	56	-	-	150	0.7	4.1	0.5	-	-	-	1.01	1.00	40
YA258b	US Army, Yakima Firing Cen., 1	1951/04/20	14	19E	28	B	8.0	235	179	19	6	15	11.0	0.0	-	56	-	-	151	0.7	4.1	0.5	-	-	-	1.01	0.96	31
YA258c	US Army, Yakima Firing Cen., 1	1953/09/29	14	19E	28	B	7.8	-	187	19	4	16	11.0	-	-	59	-	-	150	0.7	3.8	0.5	-	-	-	1.01	1.00	40
YA258d	US Army, Yakima Firing Cen., 1	1953/09/29	14	19E	28	B	7.8	244	176	19	4	16	11.0	0.2	-	59	-	-	149	0.7	3.8	0.5	-	-	-	1.00	0.94	31,41
YA258e	US Army, Yakima Firing Cen., 1	1955/10/05	14	19E	28	B	8.1	-	175	19	4	16	9.4	-	-	50	-	-	150	0.2	3.5	0.5	-	-	-	1.05	0.99	40

Appendix B. Chemical data for thermal wells and springs *(continued)*

I.D.	Site name	Date	Twp N	Rge	Sec	Part sec	pH	Conduct. µmhos/cm	TDS (ppm)	Chemical species (ppm): Na	K	Ca	Mg	Fe	Al	SiO_2	B	Li	HCO_3	SO_4	Cl	F	H_2S	CO_3	NO_3	Charge balance	Mass balance	References
YA258f	US Army, Yakima Firing Cen., 1	1959/03/30	14	19E	28	B	7.8	-	177	18	4	17	11.0	-	-	51	-	-	150	0.5	3.5	0.6	-	-	-	1.00	0.99	40
YA258g	US Army, Yakima Firing Cen., 1	1960/09/14	14	19E	28	B	7.9	220	174	19	4	15	11.0	0.0	-	52	-	-	147	0.8	4.0	0.6	-	-	0.2	1.02	0.97	31
YA258h	US Army, Yakima Firing Cen., 1	1960/09/14	14	19E	28	B	7.9	-	178	19	4	15	11.0	-	-	52	-	-	150	0.8	4.0	0.6	-	-	-	1.04	0.99	40
YA258i	US Army, Yakima Firing Cen., 1	1967/02/28	14	19E	28	B	8.1	-	183	20	4	16	10.0	-	-	56	-	-	150	0.4	4.0	0.6	-	-	-	1.03	0.99	40

Appendix C. Convectively Heated(?) Wells

This table lists the wells, statewide, that are too warm to have been heated conductively in a range of temperature gradients between 30° and 50°C/km. The formula, T = 15°C + (0.05°C/m)(depth in meters), calculates the predicted temperature of each well in the table, assuming that the well was heated conductively in a gradient of 50°C/km and the mean annual surface temperature is 15°C. This calculated temperature is a reasonable maximum temperature for conductively heated wells in the Columbia Basin. Warmer wells may be heated convectively, that is, by the movement of warmer waters into the well from below. Other explanations, such as errors in the data, local heat sources, and artificial recharge, are possible. Other information for these wells is included in Appendices A and B. Wells have the same I.D. in all three appendices.

I.D.	Predicted temp (°C)	Measured temp (°C)	Depth (m)
AD010	18.7	20.0	75
AD011	18.9	20.0	77
AD030	18.4	25.0	69
AD037	26.0	26.1	220
AD039	24.6	26.2	192
AD107	20.1	20.8	102
AS003	19.0	20.0	79
BE003	18.7	20.0	75
BE023	17.9	27.8	59
BE024	21.3	24.0	125
BE027	17.4	22.5	47
BE030	16.4	21.0	28
BE032	18.4	21.1	69
BE033	18.4	21.1	69
BE040	15.9	20.0	18
BE048	19.7	23.3	94
BE055	28.7	29.8	273
BE064	15.8	20.5	15
BE076	20.9	21.4	117
BE078	20.0	20.4	99
BE079	19.9	21.2	98
BE080	20.7	22.0	113
BE083	16.9	20.0	38
BE084	20.9	21.1	117
BE086	19.9	21.0	98
BE088	19.3	21.0	85
BE092	18.3	20.5	65
BE093	17.5	21.5	51
BE102	15.8	21.0	16
BE103	16.6	39.1	32
BE108	62.3	62.8	945
BE110	19.9	20.0	98
BE117	16.2	32.5	24
BE118	16.4	24.0	28
BE119	16.2	20.7	24
BE120	15.8	22.0	16
BE121	15.8	22.5	17
BE123	16.0	20.5	20
CK001	18.9	22.0	77
CK002	19.5	24.1	90
CO003	18.7	20.0	74
CO004	20.8	23.3	116
CO005	20.8	23.9	116
DO003	19.1	20.0	83
FR004	16.8	20.5	37
FR005	23.4	24.6	168
FR008	19.6	23.0	91
FR011	16.0	23.0	20
FR015	20.7	21.1	113
FR020	15.8	22.5	15
FR022	18.6	20.0	72
FR023	20.6	21.1	112
FR024	22.3	23.0	146

I.D.	Predicted temp (°C)	Measured temp (°C)	Depth (m)
FR042	15.3	21.5	6
FR045	24.1	26.7	182
FR053	27.1	27.2	242
FR054	24.4	25.6	187
FR060	29.3	29.5	287
GA003	17.4	20.0	47
GR006	21.3	22.5	125
GR008	18.4	25.6	68
GR010	23.6	27.8	172
GR021	20.4	20.6	108
GR022	17.6	21.5	53
GR031	27.7	27.8	253
GR034	17.7	20.0	54
GR045	16.0	21.0	20
GR070	19.9	20.5	98
GR073	24.5	28.8	191
GR083	18.2	20.0	64
GR092	31.9	34.9	337
GR093	24.1	28.6	181
GR096	19.3	20.0	86
GR100	21.9	28.0	137
GR104	19.0	29.0	79
GR105	24.4	25.5	188
GR111	22.1	27.0	142
GR116	24.5	29.2	189
GR118	18.6	24.4	72
GY001	18.6	20.5	71
KI002	18.6	21.5	72
KS001	24.2	24.3	184
KS005	16.1	20.0	21
KS008	21.9	22.8	137
KS010	18.1	26.0	61
KS012	28.1	28.4	262
KT001	19.4	20.5	88
KT002	20.2	21.4	104
KT007	17.4	21.1	47
KT008	23.4	27.0	168
KT011	19.5	27.2	90
KT012	18.1	23.0	61
KT030	18.2	21.0	63
LI001	26.2	30.5	224
LI005	24.7	28.3	195
LI017	25.6	28.7	212
LI028	22.6	25.8	151
LI029	27.9	31.7	258
OK001	17.2	22.7	44
OK002	15.6	21.1	12
OK005	15.5	20.0	9
OK006	15.5	20.0	9
SK003	24.9	35.5	198
SK004	22.8	26.4	155
SK007	20.7	27.8	113
SK011	32.9	36.3	357

I.D.	Predicted temp (°C)	Measured temp (°C)	Depth (m)
SP005	20.3	20.5	105
SP008	18.0	21.0	60
SP010	15.9	20.0	18
SP011	16.7	21.0	34
SP012	17.4	20.0	49
WA004	30.3	31.8	305
WA006	17.3	20.0	46
WA007	30.3	31.8	305
WA009	23.8	25.1	175
WA013	35.4	40.2	407
WA014	35.4	40.7	407
WA015	40.3	45.0	506
WA016	33.3	40.0	366
WA019	16.1	20.0	21
WA023	24.0	24.4	180
WA026	34.8	36.1	396
WA027	18.8	25.5	75
WA045	21.2	22.8	123
WA046	16.7	20.0	34
WA047	24.7	26.7	195
WA057	30.5	30.6	310
WA059	16.8	26.7	37
WA062	17.4	20.0	49
WA089	17.4	20.0	48
WA093	18.4	21.7	69
WA105	16.9	22.0	38
WA106	22.3	25.4	146
WA107	22.7	25.6	154
WA108	26.9	31.0	237
WA112	18.2	22.2	64
WH004	22.0	47.9	141
WT001	19.0	20.0	79
WT003	24.6	26.5	192
WT004	17.8	20.0	56
WT005	17.5	20.0	50
WT006	17.5	20.0	50
WT007	17.6	21.0	51
WT008	19.7	20.0	95
WT009	18.5	20.0	70
WT012	21.8	22.2	136
WT013	20.9	22.2	117
WT015	17.7	24.4	54
YA009	15.6	21.0	13
YA011	16.8	22.0	35
YA013	19.7	21.0	95
YA014	17.4	20.0	49
YA015	19.3	21.1	85
YA020	17.9	20.0	59
YA021	16.8	22.0	35
YA022	16.2	20.5	23
YA032	15.9	20.0	18
YA033	15.9	20.5	19
YA036	18.2	21.1	64
YA038	15.9	20.0	19
YA039	15.6	27.0	11
YA041	15.8	20.5	16
YA043	18.8	21.1	77
YA044	15.6	21.0	13
YA048	19.6	22.2	91
YA049	21.4	21.5	128
YA051	22.3	24.0	145
YA056	21.9	22.5	137
YA057	22.0	23.5	139
YA062	30.1	31.6	302
YA065	21.1	23.0	122
YA067	15.8	26.4	16
YA073	16.0	23.0	20
YA127	19.3	21.7	87
YA132	21.5	24.5	130
YA143	17.1	23.3	43
YA144	17.6	23.3	52
YA178	20.9	24.4	118
YA184	26.5	26.7	230
YA204	21.2	26.7	123
YA205	27.2	28.0	244
YA206	20.3	20.6	107
YA207	18.7	24.4	73
YA228	19.1	20.0	82
YA230	26.5	44.5	230
YA245	22.7	24.2	153
YA247	18.7	23.3	75
YA250	18.7	21.1	75
YA252	16.2	20.5	24
YA253	15.8	22.2	17
YA257	21.2	21.7	123