

5. WATER QUANTITY

Water quantity is the primary focus of watershed planning in WRIAs 55 and 57. This section presents a characterization of the flow of surface water and groundwater. These two domains are interconnected through hydraulic continuity and it is acknowledged throughout the text. A final section in this chapter focuses on specific hydraulic continuity issues, as they are currently understood.

5.1 Surface Water

Watershed planning for WRIA 55 and 57 is primarily being conducted to manage surface water flows. Previous studies and planning efforts in the basin have focused on single issues, such as groundwater flow through the state boundary or transport of specific contaminants into the aquifer and are discussed in the Groundwater section (5.2) below. The purpose of this study is to quantify, characterize and present an initial building block for planned future efforts by looking at the watershed as a whole.

This section will begin with a brief overview of each watershed and the data currently available then go on to discuss streamflow characterization and the factors affecting streamflow and conclude with an analysis of streamflow in each basin including hydrograph analysis, low flows, base flows and instream flow requirements.

5.1.1 WRIA 55 Watershed Overview

The Little Spokane watershed encompasses just under 700 square miles along the eastern border of Washington including areas in Spokane, Pend Oreille and Stevens Counties. Elevations in the watershed range from more than 5,300 feet amsl (NGVD 1929) in the north and east sides of the WRIA to approximately 1,540 feet amsl (NGVD 1929) at the junction of the Little Spokane River (LSR) and Spokane River (SR). WRIA 55 can be broadly split into two regions the Columbia Plateau Province, and the Northern Rocky Mountains Province (see Figure 4.1; Fenneman, 1931). Broad and relatively flat topographic features with deeply incised river drainages characterize the Columbia Plateau Province of the southern portion of the watershed. Steep-sided canyons and relatively straight river courses, characterize the Rocky Mountains province to the north. Evergreen forests are the primary land cover in the mountainous areas to the north and east. Agricultural lands are interspersed throughout the watershed but the majority are found on the south and east sides of the WRIA. The remaining portions of WRIA 55 are composed of urban areas, rangeland, wetlands and barren land (USGS, 1992; Figure 4.16).

Streams in WRIA 55 originate in the northern part of the basin and all feed the Little Spokane River. The river flows 48.6-miles from just south of Newport, Washington to its discharge into the Spokane River, approximately 5 miles north of Spokane city limits. Mean annual flow in the Little Spokane River At Dartford (stun 12431000) is 306 cfs and ranges from 626 cfs to 128 cfs. Peak flows have been recorded at 4,110 cfs and minimum flows as low as 62 cfs (USGS, 2001).

Groundwater is also directly connected to river flows, especially in the alluvial and glacial flood aquifers along Dragoon Creek, at the southern end of the Little Spokane River near the Spokane River, and near the outlet of Deadman Creek. The SVRP Aquifer is closest to the surface near the confluence of the Little Spokane River and Spokane River and many springs can be seen along the southern edge of the Little Spokane River (Jenson and Eckhart, 1987). Inter-basin groundwater flow from the Pend Oreille drainage into the Little Spokane River basin may occur in the northeast corner of WRIA 55, but this is not substantiated (Dames and Moore and Cosmopolitan, 1995; Section 5.2.3.4 for more detail).

There are approximately 22 dams within WRIA 55 the majority of which are small private dams located on tributaries of the Little Spokane River. All of these dams are classified for one of the following purposes: irrigation, recreation and water quality. There are no dams on the main stem Little Spokane River (Ecology, 1998).

5.1.2 WRIA 57 Watershed Overview

The Middle Spokane Watershed (WRIA 57) bounds an area of approximately 290 square miles and includes less than 30 miles of the 100-mile long Spokane River. The Spokane River originates at the outlet of Lake Coeur d'Alene approximately 9 miles upstream of the Post Falls Dam in Idaho and discharges into the Columbia River upstream of Grand Coulee Dam. Lake Coeur d'Alene is fed by the drainages of the St. Maries River, the St. Joe River and the Coeur d'Alene River. The location of the watershed near the border of Washington and Idaho dictates that WRIA boundaries, delineated by the Washington Department of Natural Resources, artificially end at the state line. In reality, the WRIA boundary encompass only a fraction of the contributing area to the Spokane River, with most of the surface water originating in the more mountainous regions of Idaho. The Spokane River is fed by a drainage that extends from the WRIA 57 boundaries to the border of Idaho and Montana, more than 3,700 square miles (Figure 5.1; Bennett and Underwood, 1988).

WRIA 57 varies in elevations from more than 5,400 feet amsl in the northeast to approximately 1,600 feet amsl at the discharge of the Little Spokane River into the Spokane River. Land cover in WRIA 57 is comprised mainly of urban, agricultural, and forested land. Urban Land comprises most of the area to the north and south of the river, with portions to the east interspersed with agricultural land. Forests comprise most of the rest of the watershed, primarily in the northern and southern areas.

Several streams originating within the WRIA do not drain directly to the Spokane River but rather drain across the state line to Idaho or into the SVRP Aquifer. The Blanchard Creek sub-basin in the northeast portion of WRIA 57 is not connected through surface water channels to the Spokane River. Rather, water flowing out of this sub-basin drains via groundwater into Rathdrum Prairie portion of the SVRP Aquifer. Also, in the southern portion of the watershed on the southeast side of Mica Peak, Lake Creek flows southeast and eventually reaches Lake Coeur d'Alene. Mean annual flow in the Spokane River at Spokane (stn 12422500) is 6760 cfs and ranges from 2507 cfs to 12,306 cfs. Extreme flows have been recorded at a minimum of 466 cfs to a peak of 49,000 cfs.

The Spokane River flows over (in areas where the river elevation is above the aquifer groundwater level) and within (in areas where the river elevation is below the aquifer groundwater level) the SVRP Aquifer. The Spokane River is the only river that flows for an extended distance over the aquifer (MacInnis and others, 2000). Most of the streams that feed the Spokane River within WRIA 57 “disappear” into the aquifer as they flow towards the river. These streams recharge the aquifer at its boundaries. The aquifer in turn alternately recharges or drains the Spokane River. The northern and southern boundaries of the SVRP Aquifer and the Spokane River Valley occur at the contact between the aquifer gravels and the crystalline rocks bordering the valley.

There are a total of 11 dams recorded within WRIA 57, the majority of these are small, private dams used for irrigation or recreation. Only 3 of these are on the mainstem Spokane River within the WRIA: the Upriver Dam, the Upper Falls Dam, and the Monroe Street Dam.

5.1.3 Previous studies

Though there have been many studies done on various and distinct components of the hydrologic regime within WRIAs 55 and 57 including habitat analysis, water quality and groundwater flow; few studies have focused on the watershed as a whole. The watershed scale studies completed to date have all occurred within WRIA 55 (referenced in Appendix A1) and include:

- Cline’s 1969 study of groundwater resources within north central Spokane and south east Stevens Counties;
- Chung’s 1975 water resources management study of the Little Spokane River Basin to support instream flow policy; and,
- Dames and Moore and Cosmopolitan’s 1995 Initial Watershed Assessment of WRIA 55 completed for Ecology as a precursor to full scale watershed planning.

Habitat studies have been completed to determine instream flow requirements and habitat availability on both the Little and Middle Spokane Rivers. Water quality studies have been completed within both WRIAs to examine pollutant levels, surface water / groundwater continuity and streamflow effects on water quality. Multiple groundwater studies have been completed on portions of the SVRP Aquifer (see Section 5.2).

5.1.4 Available Data

The primary surface water data necessary for a watershed assessment are streamflow-gaging records. Spokane County has made data available to Golder for more than 80 streamflow-gaging stations within WRIAs 55 and 57. There are 13 continuous USGS gaging stations in and around the study area. Most of the remaining records are bimonthly or random measurements (i.e., “snap-shot” in time) that have been collected by local, state, and federal agencies for various water quality or groundwater studies.

The locations of all surface water stations within the study area are shown on Figure 5.2 a. A table of all stations, their data type, source and period of record is included within Appendix C. While random or less frequent values can be useful for streamflow analysis, streamflow records that are continuous for at least 5 years or more are most useful for surface water analysis and modeling. Table 5.2 summarizes the location, data source, contributing area, river mile, elevation and period of record of continuous streamflow gages with 5 years of record or more. These stations are also distinguished on Figure 5.2a with name call-outs. The reliability and accuracy of USGS data are considered high, based on the internal quality control used by the USGS in recording and maintaining the gages. Monitoring of several gages in this list was initiated or continued temporarily by the Spokane Community College surface water program. This data has been merged with USGS data and is assumed to be of similar quality. Several of the gaging stations, while having a period of record that is useful, do not have a recent period of record or are missing large periods of time and this limits their value.

Other types of data aid in characterizing a surface water system including significant river features, cross-sections, river profile elevations, structures, and impoundments and their operating procedures. A large amount of data was collected for this report and is summarized in Appendix C. Data specific to surface water characterization includes:

WAU Boundaries - WRIA boundaries are subdivided into smaller divisions called Watershed Administrative Units (WAUs). These divisions are developed to further to aid in understanding watershed characteristics. Ideally, a WAU outlines a boundary within which precipitation falls, feeds surface water and is withdrawn and/or discharged without crossing the boundary. WAU boundaries were obtained from the Washington DNR and are illustrated on Figure 1.2 and summarized in Table 5.1. Sub-basin boundaries developed by the USGS, referred to as fifth field Hydrologic Unit Code basins (HUC-5s), closely match WAU boundaries. For purposes of this report WAU boundaries are used to represent individual stream drainage basins within the WRIA.

Minimum Instream Flow Reaches and Control Stations - Minimum instream flow reach outlets and control stations defined under Ch. 173-555 WAC for the Little Spokane watershed are shown in Figure 5.2b. Control stations are used to monitor an affected stream reach. However, three of the control stations are several miles upstream or downstream of the outlet of the affected stream reach. Figure 5.2b shows how the locations of the gaging stations affect the contributing area to the stream reach.

Dam Location and Summary - GIS coverage of distribution of dams was obtained from Ecology (1998) and the National Inventory of Dams (Figure 5.3). A summary of dam facts can be found in Appendix C. Some dam operating data was supplied for the Monroe Street and Post Falls Dams.

5.1.5 Factors Affecting Streamflow

Streamflow is affected by many factors including climate, physical characteristics of the watershed, land use/cover in the watershed and regulation. This section briefly states how

these factors can affect streamflow the following sections discuss how these factors are displayed in general streamflow analysis and finally in the study area.

Climate is often considered the driving factor for streamflow. The climate is spatially and seasonally variable in WRIA 55 and 57. Precipitation falling as rain usually has a direct, relatively immediate affect on streamflow, depending on basin characteristics. Precipitation falling as snow can be held in snow pack for long periods of time and can be released in a relatively short period (freshet) causing seasonal variations in flow. Snowmelt can increase flows in the Little Spokane River by as much as 300% and in the Spokane River by as much as 10,000%.

Physical characteristics of the watershed include soils, geology, topography and areal extent. Soils and geology affect whether water flows on the surface of the ground or infiltrates and how this water then moves towards the river. Areas with highly permeable geologic material may show little response to storm events because much of the water is infiltrated and released slowly over time. Elevation and size of the watershed also influences how much and how quickly water reaches the river. Steep sloped basins often have quick response to precipitation events while a flat basin would not. Basins that are wide with many varying length tributaries would likely have several peak flow periods in response to a storm event or snow melt while a narrow watershed would only show one peak response to an event.

Land use and land cover also affect run-off from snow and precipitation. Developed areas have greater percentages of impervious area, causing rainfall to flow more quickly, and sometimes, directly into surface water. In forested areas some water is intercepted and used (evapotranspired) by trees and shrubs, reducing the total amount of water that reaches the stream. Forested areas also slow the rate at which runoff reaches the stream, decreases peak flows and increases base flows.

Lastly regulation of flows, including dams, withdrawals and discharges, can change a flow regime through changes in timing, size and location of flows. Dam storage and release practices influence streamflows down and up river of the impoundment as well as increase the pressure head, which can affect ground water flows. The same effects apply for any structure on the river (e.g., weirs, bridges and natural obstructions). Withdrawals can change in timing and/or location of flows. For example, waters withdrawn and used for irrigation may infiltrate back to the river but it may take weeks and it may return to the river at a different location from where it was withdrawn.

5.1.6 Surface Water Regulation

WRIA 55 has 22 dams, which are operated for a number of purposes including recreation, irrigation and water quality. The total normal storage available in these dams is approximately 2,100 AF, with a total contributing area recorded to be 32 square miles (Ecology, 1998). Approximately 78% of total storage is held within the 5 structures summarized in the table below.

Dams within WRIA 55 with Large Normal Storage Volume
(Ecology, 1998)

Name	Normal Storage (AF)	Location
Reflection Lake Dam (North and South)	860	Sheets Creek, Tributary of Dry Creek, near confluence with LSR
Ponderosa Lake Dam	357	Beaver Creek, Tributary of W. Branch LSR
Deer Park Waste Water Storage Lagoon	176	Tributary of Dragoon Creek, near Deer Park
Dragoon Lake Dam	157	Dragoon Creek near Deer Park
Kettwig Wildlife Dam	100	Spring Heel Creek, Tributary W. Branch LSR

Operating procedures were not available for dams within WRIA 55. Information on dams is summarized within Appendix C and locations are shown on Figure 5.3.

Within WRIA 57, Spokane River flow is used by three hydroelectric dams (Upriver Dam, Upper Falls Dam, and Monroe Street Dam) with a combined normal storage of approximately 1,030 AF (Ecology, 1998). An additional 8 dams are located on tributaries within the WRIA. The largest of these is the Newman Lake Flood Control Dam (8700 AF). The combined normal storage of all dams within the WRIA is approximately 10,000 AF with a total drainage area recorded to be more than 4,000 square miles (Ecology, 1998). Upstream of WRIA 57, the natural constriction at the outlet of Lake Coeur d'Alene and the Post Falls Dam control the flow in the Spokane River. Downstream of WRIA 57 are Nine Mile Dam and Long Lake Dam. Nine Mile Dam is located on the Spokane River about one mile upstream of the confluence with the Little Spokane River. Long Lake Dam is 23.7 miles downstream and impounds a normal volume of 105,000 AF in a 23-mile long reservoir. Each of these dams is operated for both electric generation and recreation. Dams on the mainstem Spokane River are summarized in the table on the following page.

Upriver, Upper Falls, Monroe Street and Nine Mile Dams are all "run of river" hydroelectric facilities. Run-of-river dams, in this case, are used for hydropower and preferably operate so that outflow is virtually the same as inflow. Reservoir levels at run-of-river projects vary only a few feet in normal operations. Avista Corporation (Avista) operates every dam on the Spokane River, except for the Upriver Dam. The Upriver Dam is operated by the City of Spokane. A summary of dams in and around the study area can be found in Appendix C-1.

Dams Operating on the Mainstem of the Spokane River
(Avista, 2001)

Dam Name	Normal Elevation (ft, Avista Datum*)	Normal Storage (AF)	Approximate River Mile
Post Falls Dam	2128.0	225,000	102
Upriver Dam	1909.9 (amsl)**	200***	79.9***
Upper Falls Dam	1870.5	800	
Monroe Street Dam	1806.0	30	74.2****
Nine Mile Dam	1606.6	3,130	58.1
Long Lake Dam	1536.0	105,000	33.9
Little Falls Dam	1362.0	2,220	29.3

* Subtract 3 feet for the elevation in the datum used in the rest of this document.

** Not Avista datum. (personal communication Mark Cleveland, 2001).

*** Ecology (1998).

**** 74.7 at Control Works

Avista operates its five dams in a coordinated manner to “maximize electricity generation while meeting other upstream and downstream interests” (Avista, 2001).

- Post Falls Dam releases just enough water to provide flow and, typically, maintain summer Coeur d’Alene lake elevations at 2,128 feet (2,125 feet amsl) through at least Labor Day. The Lake can be drawn down during the winter to provide capacity for runoff from the upper watershed by as much as 7.5 feet to the height of the natural outlet of the lake (Avista, 2001).
- The Upriver Dam powerhouse can use approximately 7,500 cfs. When flows exceed this value the powerhouse is bypassed and flow is released.
- The hydroelectric power plant at Upper Falls Dam has a capacity of 2,500cfs.
- Avista uses the Spokane River at Spokane gage (USGS stn 12422500) data to calculate flow through and over the Monroe Street Dam. The Monroe Street Dam is approximately 1 mile upstream of the gage. The powerhouse has a capacity of 2,400 cfs and the storage capacity is 30 acre feet. The dam at the lower falls is 24 feet high.
- Nine Mile Dam is the next dam downstream, immediately upstream of the confluence of the Little Spokane River with the Spokane River. It has a hydraulic capacity of 6,500 cfs. Flashboards raise the height of the dam when flows are low enough, typically in the summer, and are removed as flows increase, usually sometime in the winter. Avista supplied discharge records for 1986-1999. Average discharge from this facility was 6,800 cfs, with maximum flows recorded at 42,194 cfs and minimum flows at 571 cfs.

- Beyond Nine Mile Dam is Long Lake Dam. The elevation of the water behind this dam can theoretically vary by more than 24 feet. During the summer and fall reservoir elevation varies little from normal elevation, less than 1 foot. While during the winter and spring it can be drawn down as much as 24 feet to provide generation and storage capacity. Typically, it is drawn down less than 24 feet.

The Federal Energy Regulatory Commission (FERC) license for the Avista dams on the Spokane River expires in 2007. Avista is beginning to work on this relicensing effort, which requires a formal filing between 5 and 5 1/2 years prior to license expiration.

5.1.7 Streamflow Characterization Methodology

Goals of this project include determining the affect of withdrawals, quantifying aquifer and river exchange flows, and determining how various factors (snow, dams and climate) affect streamflow. Because hydrologic data are highly variable, dynamic, and often come in large data sets, it is common to use some form of aggregation to manage and condense large data sets. There are a few common methods that we have used in this report including correlation, average flows, hydrographs, exceedance curves, and representative years.

5.1.7.1 Correlation

Correlation is a check of the relationship or dependence of two parameters to each other on a defined time step. This report evaluates the interdependence of precipitation and flow on an annual basis. On an annual basis it is expected that any snow falling as precipitation would have melted and reached the river and that any withdrawals would have been discharged. If this were the case, a one-to-one relationship would be expected, or a 45 degree angle if the two parameters were plotted against each other. Generally river flows are not directly responsive to precipitation due to watershed characteristics and surface water and groundwater storage. Groundwater can delay precipitation reaching the river for periods longer than a year, as can surface water storage. Also withdrawals for irrigation are often a net loss from the system because of loss through evaporation. Though a one-to one response may not be seen this analysis is still useful to understand how well correlated the system is, how different tributaries vary and if there are losses of water from the system.

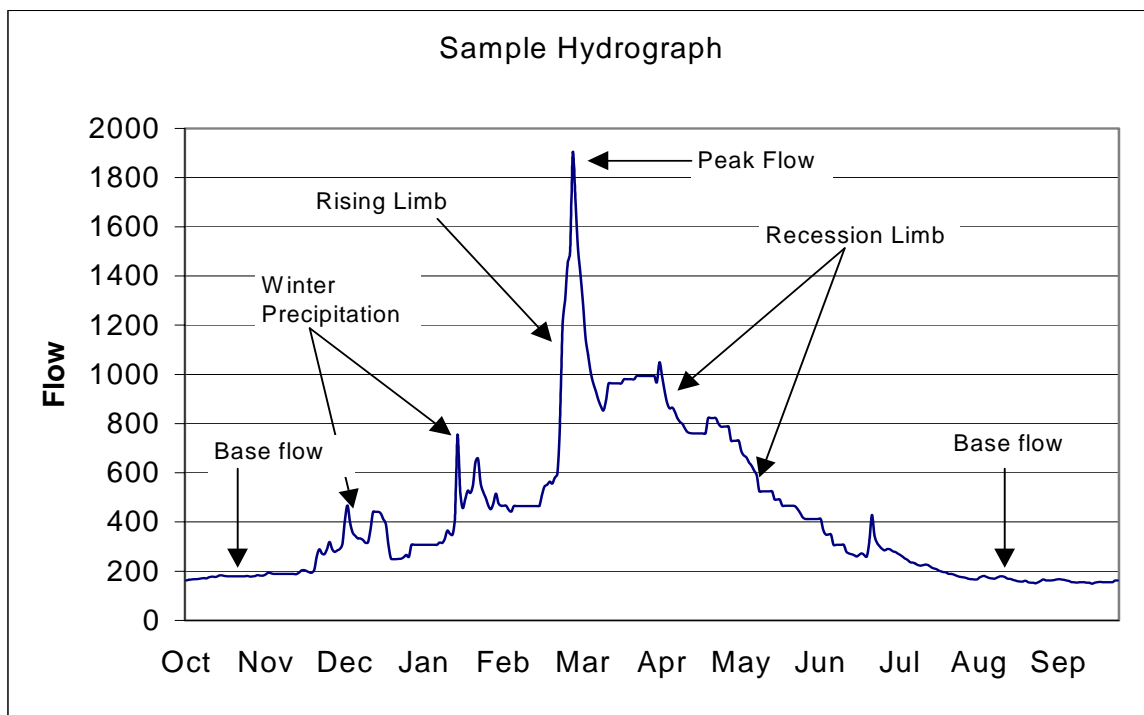
5.1.7.2 Average Flows

Average flows aid in general characterization of the river and evaluation of long-term trends. Comparison of mean annual flows of multiple rivers can indicate their relative size or indicate a wet or dry year. Mean monthly flows may indicate when peak periods occur and how large peaks are, in a simple and compact format. The use of average flows is very general; specific assumptions regarding watershed characteristics should generally not be inferred from this data.

5.1.7.3 Hydrographs

A hydrograph of streamflow (or stage) versus time can provide very detailed information on a watershed depending on its time scale. Hydrographs are used in this report to describe each watershed's response to precipitation, run-off and groundwater inflows. A drawback of hydrograph analysis is that the data is so detailed that it can be impossible to determine long-term trends or be sure that the hydrograph being used is representative of a normal year.

It is important to understand both the elements that a hydrograph illustrates and the driving factors that cause each element's response (discussed in Section 5.1.5). The basic elements of a hydrograph include base flow, rising limb, peak flow and recession limb. All of these elements can be seen in the sample hydrograph.



- Base flow represents streamflow, or runoff, which results from discharge from the groundwater system. It is also referred to as groundwater inflow. It is often the primary source of water during dry periods when there is little or no surface water run-off. The rate and volume of base flow can also be influenced by dam storage and release, well operations, and withdrawals (particularly in the summer). Without analysis, it would be incorrect to consider the total flow during the indicated time (on the sample hydrograph) as base flow because some of it may be run-off from small storm events, discharges and late snowmelt.
- The rising limb represents the period of time when run-off (from snowmelt or rain) begins to reach the stream after flowing overland to the stream and downstream to the gage. The rising limb can be a steep or gradual incline representing a quick or slow

response (run-off period) of the watershed to a storm or snowmelt event. For example if the watershed had high infiltration rates or impoundments in the watershed, the rising limb might be expected to be more gradual.

- Peak streamflow represents the largest volume of streamflow in a certain time period. Peak flows can be dampened by retention of run-off or streamflow in an impoundment and withdrawals or they can be magnified if there is little natural or man-made storage in the basin.
- Finally, the recession limb represents the time it takes for all run-off to reach the stream and ultimately the gaging station. A steeply descending falling limb can also indicate there is little storage in the watershed (quick run-off), dam releases or a radical change in temperature that results in melt of snow pack.

5.1.7.4 Exceedance Curves

Exceedance curves are often used to represent or provide analysis of hydrologic data. These curves present a return period or exceedance probability of a flow or flow volume. The return period signifies the average length of time that elapses between observances of a particular level of flow. Exceedance probability represents the probability that a particular flow will occur in any one year. Exceedance curves are used to set minimum instream flows and water quality criteria. For example, exceedance curves are used in this report to indicate how often a certain low flow can be expected to occur.

5.1.7.5 Representative Years

Representative years are used as a form of aggregation. Rather than aggregating data statistically, data is merged logically with actual data being used to represent each logical group. In this report data from three water years was chosen to represent wet (i.e., 1997), dry (i.e., 1994) and average years (i.e., 1999). Representative years were specifically chosen from the 1990s because there is a reasonable amount of data available for this period for many watershed parameters. Streamflow data for the Elk gaging station is not available for these years and so alternate years were chosen for average (1959) and dry (1968) years based on the magnitude of annual flow volume. No representative wet year was identified within the available period of record for the Elk gage.

5.1.8 **Correlation of Streamflow to Precipitation**

Flows in WRIA 55 At Dartford and Elk were compared to precipitation data from Deer Park 2 E and Newport respectively (see Figure 4.1 for locations). This correlation is displayed in Figure 5.4a.

Flows at the USGS Elk gage appear to be insensitive to annual precipitation indicating that precipitation in the area is either captured and released slowly or captured and withdrawn from the basin. A rainfall-runoff model of this area will aid in answering this question. Dames and Moore and Cosmopolitan (1995) indicated the possibility of inflow from the Pend Oreille River in this area and this could explain the lack of responsiveness of the river to precipitation variations, but this base flow source has not been confirmed by

a comprehensive evaluation. Section 5.2.3 outlines this area, referred to as the Diamond Lake Aquifer Area, more clearly.

Flows at the USGS gage At Dartford in Figure 5.4a are more responsive to precipitation but still display a low correlation. This area is also underlain by aquifers and this could cause a lag in precipitation reaching the stream from year to year. Also, this site is much further downstream from the Elk gage and the drainage area is much greater and more variable in terms of land cover, urbanization and geology. Areas of the watershed between Dartford and Elk are more highly urbanized, which typically improves the response of flows to precipitation. Also several tributaries reach the Little Spokane River which are not underlain by an aquifer but rather flow down from the more mountainous regions where snowmelt acts as primary water storage.

A correlation plot for WRIA 57 is displayed in Figure 5.4b. This correlation plots Spokane River at Spokane flows against data from the Coeur d'Alene weather gage. The relationship is stronger in this plot than the previous two but still weak. There are several influential factors in this basin that would affect this plot. The SVRP Aquifer underlies the entire river, which could cause a delay in river flow response longer than a year. The drainage basin feeding the river is very large and the precipitation gage used does not likely reflect precipitation falling on the entire basin. Also the basin is highly developed which would increase the response of flows to precipitation. Conversely, the fact that Lake Coeur d'Alene regulates the river could improve the correlation through releases that are in response to rainfall, if the rainfall gage is representative of the basin. Additional modeling of the basin will likely help understand the drivers of this system better.

5.1.9 Hydrograph Analysis

Hydrographs discussed in this section were developed for 8 gages in the study area. Figures include daily data for the wet, dry and average year as well as average, maximum and minimum daily flows from the period of record. These gages are represented in the Figure series 5.5 a-h from upstream to downstream.

- (a) Little Spokane River at Elk, Washington
- (b) Little Spokane River, Chattaroy Road, Chattaroy, Washington
- (c) Little Spokane River At Dartford, Washington
- (d) Little Spokane River Near Dartford, Washington
- (e) Spokane River near Post Falls, Idaho
- (f) Spokane River above Liberty Bridge near Otis Orchards, Washington
- (g) Spokane River below Greene Street at Spokane, Washington
- (h) Spokane River at Spokane, Washington (Cochran Street gage)

Detailed gage information and locations are included within Appendix C, and locations are shown on Figure 5.2a.

Gages on the Little Spokane River show many similar characteristics. The rising limb is visible generally from late October or November through winter. The rising limb is

interspersed with small peaks that are likely the result of storm events or possibly early winter snowfall and melt cycles. A strong seasonal peak is most visible in March, but can vary from March through early May. Flows recede (recession limb) from the peak through July to base flow levels, generally by late July or August. Lowest flows occur during late summer (August and September). This pattern is reflective of a snow driven water cycle.

Low flows during the dry summer period from July through November appear to relate to spring peak flows, with higher peak flows indicating higher summer flows. The ratio of peak to low flows (using March 30 and September 15 as peak and low flow respectively) is shown in the following table. This data, with the exception of the Elk gage, suggest that the ratio of low to peak flows is relatively constant except during dry years. Driving factors for this pattern likely include large snowmelt volumes that are infiltrating and being released throughout the summer as base flows. Dry year low summer flows are likely totally supported by groundwater inflows, implying that groundwater reserves are large and can support base flows even during dry years when little precipitation is available to recharge aquifers.

Low Summer Flows as a Percentage of Peak Flows for Representative Years

Year	Elk (stn 2427000)*	Chattaroy (stn 8327Q)	At Dartford (stn 12431000)	Near Dartford (stn 12431500)
Wet Year, 1997		15%	11%	
Average Year, 1999	64%	14%	8%	31%
Dry Year, 1994	90%	29%	35%	

*Using representative years

Comparing flows between the gages provides some perspective of how the river changes downstream. Flows increase steadily downstream from Elk to the Near Dartford station (RM 3.9) due to tributary and groundwater inflows. It should be noted that the data from the station Near Dartford has a short period of record so max daily flows shown to be lower than those At Dartford are not likely to be representative of the actual relationship but more likely reflective of the lack of data at this gage. Comparison of monthly differences between the Dartford station (RM 10.3) and the station Near Dartford indicate that flows Near Dartford during the period of record are on average approximately 1000 cfs greater than flows At Dartford.

The hydrograph for the Elk gage, while showing a similar trend to the other gages, has much smaller peaks as compared to low flows. This is another indication (see Section 5.1.8) that this basin may be less affected by snowmelt and direct run-off than by base flows. The river in this upper reach also has few tributaries and the mountainous areas to the east and west feed the Dry Creek and West Branch Little Spokane, which contribute to the Little Spokane River further downstream.

The Spokane River is also dependent on snowfall for flows but has a slightly different response than that of the Little Spokane River as displayed in the hydrographs. The hydrograph for the Spokane River is not as "spiky" as the Little Spokane River for

individual events. This suggests a dampened system with storage effects and is consistent with the known factors on this river, including: interactions with the SVRP Aquifer, a higher altitude snowpack, and a large drainage area for the Spokane River (see Figure 5.1 for drainage area).

Flows in the Spokane River generally begin to rise in early to mid November, rising slowly throughout the winter. This slowly increasing flow is interspersed with prominent, yet smooth peaks that are likely the response to runoff from storm events within the basin that pass through Lake Coeur d'Alene. These peaks are visible at all four gages downstream indicating that there is little inflow from other sources, relative to the high winter flows (there is inflow from other sources, namely the SVRP Aquifer it is just not big enough to have a spreading or dampening affect on the peaks). Peak flows on the Spokane river system occur later in the year than on the Little Spokane River, generally in April or May. Flows quickly recede from their peak to base flows by late June or early July. Flows are at their lowest for a period, generally in August, and then increase in September and remain relatively constant through October.

Evaluation of flows downstream (comparing multiple graphs) indicate that flows at Post Falls are generally higher than the flow volume near Otis Orchards, indicating a loss of water from the river into the SVRP Aquifer. Data for Greene Street are sparse but indicate that flows in this area are higher than flows near Otis Orchards, indicating SVRP inflows to the river upstream of Greene Street. The net effects of the gains and losses between Post Falls and Spokane are lower flows at Spokane in the winter and spring and higher flows at Spokane during the rest of the year.

These four hydrographs also show a pronounced increase in low flows during the late summer, generally in September. Based on operating data obtained from Avista this is due to releases of water from Post Falls Dam beginning after Labor Day.

5.1.10 Trend Analysis

For an increasingly populated watershed, it is important to determine if streamflow is declining due to over allocation. Previous efforts compared declines in annual streamflow in the Little Spokane River to declines in annual precipitation to postulate that over allocation may be occurring (Dames and Moore and Cosmopolitan, 1995). However, analysis in this report indicates that there may not be a strong enough correlation between streamflow and precipitation to support this comparison. Because streamflow is affected by many factors, including withdrawals, climate and regulation, it is difficult to identify direct cause and effect relationships between these two elements. Annual precipitation and annual flow graphs in Appendix C show a visible increasing trend in annual values since the mid-1990s. Recent studies in climate trends indicate a climate pattern in the mid-1990s that would switch us from a warm-dry period to a cool-wet period (see Section 4.2 for more discussion on this).

5.1.11 Low Flows

Low flow periods generally occur during the late summer after the snow pack has melted and before fall precipitation has begun. Low flow analysis is important for habitat, water quality, water use, recreation, and power generation, among other things. However, the time period of analysis of low flow that is considered important varies among regulatory and interest groups. For example, when calculating effluent discharge permits, Ecology uses the 7-day low flow with a recurrence interval of 20 years (7Q20). For habitat instream flow analysis the 7-day low flow with a recurrence interval of 10 years (7Q10) is generally of more interest. Seven-day low flows are the lowest average of flows over 7 consecutive days in a year. Low flows can vary across a watershed due to precipitation, geologic/hydrogeologic factors, and water use variations in the basin.

The 7Q10 for the Little Spokane River is approximately 35cfs at Elk and about 82 cfs At Dartford (Figure 5.6a). Chung (1975) estimated 7Q10 flows for the West Branch of the Little Spokane River at 2.8 cfs. These differences are likely indicative of differing base flow contributions. The West Branch of the Little Spokane is underlain, in large part, by metamorphic bedrock with low groundwater storage and discharge capacity. Alternatively, the main stem is underlain largely by alluvial and glacial flood deposit aquifers, as well as fed by several springs along its length, that can supply larger base flows.

The 7-day low flows over time for the Spokane River for the gages at Post Falls (ID), Liberty Bridge and Spokane (Figure 5.6b). The 7Q10 is 161 cfs at Post Falls, 117 cfs at Liberty Bridge, and 847 cfs at Spokane. These low flows provide a quick glimpse at how the Spokane River flow is affected and supported by base flows from the SVRP Aquifer. The Spokane River from Post Falls to between Barker Road and Flora Road is a losing reach, where water from the river seeps through the riverbed into the unsaturated sediments above the SVRP Aquifer. Downstream of Flora Road, the Spokane River generally gains flow from the aquifer. However, within this overall gaining reach there are smaller reaches that may seasonally lose water to the aquifer. Low flows per square mile of watershed are not calculated due to the large contributing area and the extensive aquifer contribution to flows.

5.1.12 Base Flows

Base flow is defined as the component of streamflow derived from groundwater inflow. Base flow can have varying importance to streamflow levels. Flow in rivers located in basins with very low snowfall (no water storage in snowfall) and little regulation is derived largely from two components; runoff during precipitation events and slower, sustained discharge of base flow (groundwater). During dry periods, base flow can be the main supply of water to such rivers. In other rivers, snowmelt and regulation have a much larger influence than base flow on sustaining streamflows throughout the year. In these rivers, estimating total base flow effects can be very difficult, requiring more information such as snow pack, snow water equivalent and temperature as well as operating procedures of regulating elements.

In 1999, the Washington Department of Ecology completed an evaluation of base flow contributions to total streamflow at 582 gauging stations across the Washington State, three of which are in WRIA 55. Ecology used several criteria to determine which stations were appropriate to analyze using standard base flow estimation procedures. Criteria included that the station must have:

- At least 3 complete water years of daily mean streamflow;
- A low degree of flow regulation; and,
- Low snowmelt influences.

Both WRIA 55 and 57 have base flow or groundwater contributions affecting streamflow. WRIA 57, while heavily affected by groundwater, does not lend itself to traditional base flow separation techniques as used in the Ecology study due to the summertime use of Post Falls Dam to maintain the elevation of Lake Coeur d'Alene. Base flow analysis of the Spokane River is better suited for focus in the next phase of this project. WRIA 55 on the other hand, is less influenced by anthropogenic sources, barring some irrigation usage, and though snow pack does influence streamflow during the spring thaw, during the rest of the year streamflow is mainly influenced by base flow and direct precipitation run-off. Hydrographs of representative dry, wet and average years have been plotted with average base flows on Figures 5.7 a, b and c (Elk, Chattaroy and At Dartford stations respectively). Base flows for the Elk gage are estimated to comprise between 95 and 98 percent of mean monthly streamflows, 79 to 97 percent for the At Dartford gage, and 84 to 99 percent of mean monthly streamflows for the Near Dartford gage.

Base flow estimates completed by Chung (1975) and Cline (1969) corroborate these percentages with estimates that base flows At Dartford comprise almost all streamflows occurring during summer months. Chung (1975) and Cline (1969) report that 234 cfs are added to the streamflow of the lower Little Spokane River in a four-mile reach of the river up to the confluence with the Spokane River. In addition, the USGS estimates flow, usually within 10 percent accuracy, in the Little Spokane River at its confluence with the Spokane River by multiplying the flow At Dartford by 1.9 and adding a constant of 252 cfs (Dames and Moore and Cosmopolitan, 1995). The constant in this equation represents a large inflow that is independent of the streamflow at any time. This inflow can nearly double the discharge At Dartford considering the average annual discharge measured At Dartford of approximately 300 cfs (Dames and Moore and Cosmopolitan, 1995).

5.1.13 Relation of Actual Flows to Instream Flow Requirements and Base Flows

Instream flows describe the volume of flow required to meet fish needs and other factors (Ecology, 2001; RCW 90.54, Water Resources Act of 1971). Minimum instream flows (MISFs) were set for the mainstem of the Little Spokane River from the headwaters to the confluence with the Spokane River in 1976 and are detailed in Chapter 173-555 WAC (included in Appendix C). MISFs have been established for four points on the Little Spokane River System at the 20% exceedance curve of historical data. The Dartford gage has the longest record (approximately 60 years). Regression analysis between other stations with the Dartford gage was conducted to create representative records.

MISFs are specified for each month of the year at four compliance points (control stations) including the reach from the headwaters to the abandoned Elk gaging station, Elk to Chattaroy, Chattaroy to Dartford, and Dartford to the confluence with the Spokane River. MISFs are summarized in Table 5.3. Currently there are 135 of the water rights that are junior to the MISFs of the Little Spokane River are regulated by the flow at the gage Near Dartford. Junior water right holders were directed by Ecology to not exercise their water rights in 1989, 1994, 1995, and 2001. The pumping of domestic exempt wells is not regulated by Ecology.

Three control stations on the Little Spokane River currently have continuous flow gaging stations nearby; Little Spokane River At Dartford (station 12431000) managed by the USGS, Little Spokane River at Chattaroy Road, managed by Spokane Community College, and the Little Spokane River Near Dartford (station 124315000) managed by the USGS. The Elk control station had a USGS gage collecting continuous records from 1949-1971. Although the gage has been retired, there are more recent bimonthly measurements taken at the Elk gage between 1987 and 1990. The Confluence control station (USGS gage 12431500, Little Spokane River Near Dartford) had monthly flow measurements collected by Ecology and SCCD at periods throughout the 1990's and has been gaged continuously since 1997 by the USGS in cooperation with Spokane County. Figures 5.7a-d display the current instream flow requirements as compared to flows during a reference dry, wet and normal year of precipitation where continuous gage data was available.

Each control station on the Little Spokane River was analyzed for MISF exceedance statistics based on the entire period of record as well as only the summer months. Table 5.4 summarizes the results of this analysis for each control station. A summary is provided here.

- The average exceedance length, in days, at all control stations, ranges from 12 to 22 days.
- The control station at Chattaroy has the highest percent of record below MISF levels with more than 42% of dry season flows below MISF levels.
- Chattaroy also recorded the longest exceedance length, which infringed on more than just the generally accepted "dry season", lasting for 262 days.
- An extremely long exceedance is visible in Figure 5-7 a, b and c (Elk, Chattaroy, and Dartford) for the "dry" year. At Dartford, it can be seen that although estimated average base flows are higher than MISF requirements that flows in a dry year can be well below MISF levels (Figure 5.5c).
- The discrete measurements taken near the Elk Control station (station 9408K) were collected between 1987 and 1990 during the summer months (May - September). During this period there were 39 days recorded, 30 of these days did not meet instream flow levels and instream flows were not met during each year data was collected.

- Discrete measurements collected near the Confluence control station (LSR near mouth @ Hwy 291, station 6205E) show that of 47 days collected year round from 1993-1997, there are 10 exceedances. Most of these exceedances occurred in the summer or fall of each year.

Instream flows have not, at this time, been set for the Middle Spokane River Basin. However, the Washington Department of Fish and Wildlife recommended a minimum flow target of 2,000 cfs at USGS gage station 12422500, Spokane River at Spokane, based on the minimum streamflows recorded at the Spokane gage prior to the construction of the Post Falls Dam. The communication regarding this recommendation is included in Appendix C.

Across the period of record at the Spokane River at Spokane gage (1891-1999) there are flows below the temporary 2,000 cfs level 14% of the time and only 5 years had no flows below 2,000 cfs. The longest continuous exceedance was 231 days beginning in July of 1930. The average length of an exceedance is 22 days. Analysis of the summer months only (June-October) shows that 45% of the record does not meet suggested instream flow minimums and that the average length of an exceedance is 19 days with a maximum length of 132 days. The period from 1920-1946 had the largest number of days below 2,000 cfs. This correlates to a dry period influenced by the Pacific Ocean (Pacific Decadal Oscillation; PDO). Also, after the construction of Post Falls Dam until 1941, Lake Coeur d'Alene was held at an elevation of 2123.5 feet during the summer months. The summer lake elevation has been 2125 feet since 1941. In recent years and in the early 1900's (before 1920) the number of days of exceedances was lower.

5.1.14 Conclusion

Surface water flow within WRIA 55 and 57 is complicated by aquifer interactions, highly variable climate and watershed characteristics. In WRIA 55, an examination of existing data indicates that base flows are very important along almost every stretch of the river, especially during the summer months. Hydrograph analysis indicates that the volume of these base flows varies with the volume of water stored in winter snow pack. Although the average base flows are higher than the MISF, flows below instream flow requirements are frequent. This suggests that the cumulative effects of water use are affecting streamflows, or that minimum instream flows are established at a level inconsistent with natural streamflows. Additional research should be completed to better understand the volume and timing of base flows on the mainstem and tributaries and the factors that affect them. In addition better estimates or continuous gaging on tributaries within the basin could help to better pinpoint where problems originate. The original MISF studies were based on historical streamflow data and did not consider the habitat needs of fish. The Planning Unit has received an instream flow supplemental grant to do evaluate the relevance of existing regulatory flow levels on Little Spokane River flows to the biological needs of fish.

WRIA 57 is also highly supported by base flows, but has many other affects including periodic regulation, a large drainage area, and a high degree of urbanization. The Spokane River flow is regulated by the Post Falls dam during the summer to keep Lake

Coeur d'Alene at 2125 feet, but is also highly supported by the SVRP Aquifer. Surface flow measurements along the Spokane river indicate that flow from Post Falls to Otis Orchards decrease slightly, followed by an increase from Otis Orchards to Greene Street and a decrease from Greene Street to Spokane. The net effects of the gains and losses between Post Falls and Spokane are lower flows at Spokane in the winter and spring and higher flows at Spokane during the rest of the year. Instream flows have not been formally set for the Spokane River but analysis of suggested MISFs indicate that even in wet years the suggested MISF is violated.

5.2 Groundwater

Groundwater is an important water resource within both WRIA 55 and WRIA 57. Because the availability of surface water resources is limited, sources of high quality groundwater are important to maintain the water supply to the existing population and to support community growth. In addition, where groundwater and surface water are in hydraulic continuity, groundwater recharge to surface water as baseflow provides a year round supply of water to maintain instream flows.

Useful quantities of groundwater occur within aquifers, defined as geologic units that are sufficiently permeable to transmit economically viable volumes of water to wells or to springs. Aquitards are low permeability geologic units that transmit water slowly. Aquifers can be confined or unconfined. A confined aquifer is bounded above and below by an aquitard or confining unit. An unconfined aquifer is bounded only at its base by an aquitard.

Within both WRIA 55 and WRIA 57 important groundwater resource aquifers are found in a variety of different geologic units including the crystalline basement rocks, the basalts, and the unconsolidated deposits. A detailed description of these units is included in Section 4.3 of this report. Of these three main water-bearing units, the unconsolidated sediments, and in particular the flood sands and gravels (depicted as Qfs, Qfg and Qfcg on Figure 4.12 and Figures 4.14A through 4.14O) are the most important in terms of water supply. The Spokane Valley – Rathdrum Prairie (SVRP) Aquifer, the main groundwater supply for the southern portion of WRIA 55 and for WRIA 57, occurs within the flood sands and gravels of the Spokane River Valley and Hillyard Trough. The EPA designated the SVRP Aquifer a Sole Source Aquifer in 1978 because it is the water source for most of the residents of Spokane County in Washington and Kootenai County in Idaho.

5.2.1 Previous Studies

Previous hydrogeologic studies relevant to WRIA 55 include:

- A regional study of the north-central portion of Spokane County and southeastern portion of Stevens County based on well and stream flow data (Cline, 1969);
- A detailed study of the Colbert Landfill Superfund site by Landau Associates (1991);

- A groundwater characterization study of the Deer Park area (EMCON, 1992; Anderson, 1986);
- The Phase I wellhead protection plan for the City of Newport, Washington and West Bonner Water District No. 1, Idaho (Welch, Comer and Associates, Inc. and Riley, J.A., 1994).
- An inventory of groundwater, surface water and climate information for WRIA 55 (Chung, 1975; Dames and Moore and Cosmopolitan, 1995);
- A hydrogeologic study of the Green Bluff area for the Washington State Department of Ecology (Ader, 1996);
- A groundwater resource study of Five Mile Prairie (Olson, 1979);
- A uranium mining feasibility study of Peone Prairie (Boleneus, 1978; Boleneus and Derkey, 1996);
- An aquifer delineation study of a portion of north Spokane County (Boese and Buchanan, 1996); and,
- A series of studies of the Spokane Aquifer system (Bolke and Vaccaro, 1979; Bolke and Vaccaro, 1981; Vaccaro and Bolke, 1983; Jensen and Eckart, 1987; Molenaar, 1988; Buchanan and Olness, 1994; CH2M Hill, 1998; CH2M Hill, 2000).

Due to the unique characteristics of the SVRP Aquifer, most of the previous work on the hydrogeology of WRIA 57 has focused on this aquifer. The important categories of work include:

- Research level studies and papers on the formation of the SVRP Aquifer (Bretz, 1930; Bretz, 1959; Purves, 1969; Baker, 1973; Kiver and Stradling, 1985; Jensen and Eckart, 1987; Molenaar, 1988);
- A series of sequential groundwater flow modeling studies (Pluhowski and Thomas, 1968; Drost and Seitz, 1978; Bolke and Vaccaro, 1979; Bolke and Vaccaro, 1981; Vaccaro and Bolke, 1983; Buchanan and Olness, 1994; CH2M Hill, 1998; CH2M Hill, 2000);
- Documents for public education (MacInnis and others, 2000)
- Aquifer sensitivity and wellhead protection studies (MacInnis and others, 2000; CH2M Hill, 1998; CH2M Hill, 2000);
- Hydraulic continuity studies (McDonald and Broom, 1951; Broom, 1951; Miller, 1996; Gearhart and Buchanan, 2000); and,
- On-going aquifer studies (USGS and Spokane County).

5.2.2 Hydrogeologic Units

Important groundwater resource aquifers in WRIA 55 and WRIA 57 occur primarily within the unconsolidated sediments that include the glacial flood deposits and recent alluvium. Important local sources of domestic water supply are also found within glacial lake deposits, the fractured and weathered basalt and crystalline basement rocks. Dense and

unweathered crystalline basement rocks and basalt as well as glacial lake clays and dense Latah sediments act as important local aquitards, restricting vertical and lateral groundwater movement. The crystalline basement aquitard represents the lower hydrogeologic boundary of the region.

The following sections describe the hydrogeologic units of WRIA 55 and WRIA 57.

5.2.2.1 Flood Sand and Gravel Aquifers

The most productive hydrogeologic unit within both WRIA 55 and WRIA 57 are the unconfined and semi-confined aquifers comprising flood deposited sands and gravels. These deposits can be expected to yield hundreds to thousands of gallons per minute (Dames and Moore and Cosmopolitan, 1995). Where unconfined, these aquifers are recharged by infiltration of precipitation and irrigation, by groundwater discharge from adjacent units and by discharge from streams. Groundwater from the flood deposits may also recharge underlying units and streams.

In WRIA 55, the greatest thickness (up to 700 feet or more) of flood sand and gravel deposits (Figure 4.15) occurs on the south side of the Little Spokane River, within the Hillyard Trough. Thick deposits of flood sands and gravels also occur adjacent to the Little Spokane River and within the Deer Park Basin. In the vicinity of the Colbert Landfill (located just east of Green Bluff) and just east of the northern portion of Five Mile Prairie, the flood sands and gravels are over 200 feet thick (Boese and Buchanan, 1996). Within the central portion of the Deer Park Basin, the flood sands and gravels also reach thicknesses of 200 feet. The static groundwater level is often less than 25 feet below ground surface and subject to seasonal fluctuations on the order of 5 feet.

Within WRIA 57 and WRIA 55 south of the Little Spokane River, the flood sands and gravels form the Spokane Valley portion of the SVRP Aquifer. As illustrated on Figure 4.15, the thickness of the flood sands and gravels is greatest (300 to over 700 feet thick) just east of downtown Spokane, within the Hillyard area and within the central portions of the Spokane Valley. The flood sands and gravels thin to a few feet in thickness on the valley sides.

5.2.2.2 Basalt Aquifers

Groundwater flow in the basalts occurs mainly within fractured flow top and flow bottom zones that generally run parallel to the basalt surface. To a lesser extent, groundwater in the basalts flows within vertical fractures and joints. Where the basalts overlie low permeability sediments (such as crystalline basement, Latah or glacial lake silts and clays) groundwater tends to flow along the slope of the contact, either emerging at the surface as springs or recharging downgradient units. These aquifers are recharged by infiltration of precipitation and irrigation in areas where the basalts are exposed at surface, by stream discharge and from underlying and overlying hydrostratigraphic units. Groundwater elevation contours in the north Spokane area indicate that the basalts in this area discharge mainly to surface streams with some leakage to lower units (Boese and Buchanan, 1996).

The basalt aquifers are important locally within WRIA 55 as a source of water for domestic, agricultural and industrial uses. To the west of the Little Spokane River, the aquifer comprises confined and unconfined flows of Grande Ronde Basalt. In the Deer Park Basin of WRIA 55, the Grande Ronde Basalt underlies a large portion of the flood sand and gravel units. Basalt well yields range from very low to sufficient volumes for domestic and stock watering needs and may be artesian. The City of Deer Park well DP-5 yields up to 350 gpm.

To the east of the Little Spokane River, less productive basalt aquifers occur within the Wanapum Basalt of Orchard Bluff (located between Deer Creek to the north and Little Deep Creek to the south), Green Bluff (located between Little Deep Creek to the north and Deadman Creek to the south) and Orchard Prairie (located south of Deadman Creek). Declining water levels in wells led Ecology to complete a hydrogeologic study of Green Bluff (Ader, 1996). The study concluded that a combination of groundwater pumping and precipitation trends were responsible for static groundwater level changes.

In contrast, basalt occurs only in limited areas within the south and central portions of WRIA 57, to the north and south of the Spokane River Valley. The ancestral Spokane River and the Missoula floodwaters eroded the flow basalts that once filled the ancestral Spokane River Valley in WRIA 57. Because of the limited extent of basalt deposits and the high productivity of the SVRP Aquifer, the basalts of WRIA 57 do not supply significant amounts of water. However, the basalt deposits in WRIA 57 may supply sufficient water for domestic wells.

5.2.2.3 Latah and Glacial Lake Aquitards

Latah Formation and glacial lake deposits are usually defined as aquitards and are comprised mainly of silt and clay with minor sands and gravels. Because they are generally fine grained, these units are not tapped for water production (EMCON, 1992). Domestic wells that do extract water from the Latah Formation typically have yields of less than 35 gpm (Cline, 1969). Yields to wells tapping the glacial lake deposits vary widely from 5 gpm to as high as 600 gpm (Cline, 1969). The 600 gpm yield was noted by Cline (1969) for a well located to the south of the Deer Park Basin. The Latah and glacial lake deposits are potentially recharged from three sources: 1) direct infiltration of precipitation and surface run-off; 2) groundwater leakage from overlying units; and 3) groundwater recharge from underlying units.

5.2.2.4 Crystalline Basement

Crystalline basement rocks underlie WRIA 55 and WRIA 57. Groundwater is found generally in fractures and weathered zones near the top of the unit. Where exposed at surface, the crystalline basement rocks are recharged by infiltration of precipitation and steam discharge. Where overlain by other units, the overlying units recharge the basement rocks. Groundwater wells within the basement rocks are typically low yields and tend to be of varying quality. Because well yields range from negligible to 35 gpm (Cline, 1969), basement rock wells are used most often for domestic supply and not for agriculture or industry.

5.2.3 Aquifer Delineations

A schematic illustrating the location of the main aquifers within WRIA 55 and WRIA 57 is presented as Figure 5.8. This figure was originally prepared as a component of Spokane County's Water Quality and Water Quantity report (Spokane County, 1996). For this study, the figure was updated to include the Diamond Lake aquifer area. In terms of population served, the three most important aquifers within WRIA 55 and WRIA 57 are the SVRP Aquifer, the Deer Park groundwater basin and the Little Spokane aquifer area. The Green Bluff, Peone Prairie, Orchard Prairie and Five Mile Prairie aquifer areas provide less volumes of water but are nevertheless important locally.

The following paragraphs present a synopsis of reviewed information on these aquifers.

5.2.3.1 The Spokane Valley – Rathdrum Prairie Aquifer

The Spokane Valley – Rathdrum Prairie (SVRP) Aquifer, shown on Figure 5.8 and in more detail on Figure 5.9, covers a total area of about 320 square miles, 200 square miles of which occur within Idaho and 120 square miles of which occur within Washington. Most of the SVRP Aquifer in Washington occurs within WRIA 57 although the northern portion of the aquifer extends into WRIA 55 and the western portion into WRIA 54. The aquifer is one of the most productive in the United States and serves as the primary water source for more than 400,000 people in Idaho and Washington with more than 180 large purveyor wells pumping water from the aquifer (MacInnis and others, 2000). Because it supplies water to more than 80 % of the population living above and in the vicinity of the aquifer, the EPA designated the SVRP Aquifer as a Sole Source Aquifer in 1978.

As illustrated on Figure 5.9, the SVRP Aquifer extends from the western end of Lake Pend Oreille and from the northern arm of Lake Coeur d'Alene in Idaho, westwards and southwards beneath the Rathdrum Prairie and westwards down the Spokane River Valley to the City of Spokane. On the western side of the City of Spokane, the aquifer is split into an eastern and a western area by the Five Mile Prairie basalt plateau. On the eastern side of the plateau, the aquifer extends northwards beneath the Hillyard neighborhood, to the Little Spokane River. To the west of the plateau, the aquifer continues northwards within the Lower Spokane River valley to Nine Mile Dam. At Nine Mile Dam the aquifer narrows to span the 400-foot gap trough in the basement rock. A small amount of flow from the aquifer continues as groundwater down the valley past Nine Mile Dam. Between downtown Spokane and the Lower Spokane Valley, the aquifer to the south of Five Mile Prairie is restricted to a one mile wide, 300-foot deep channel known as the Trinity Trough. The Trinity Trough is illustrated in Figure 4.14H.

The principle sources of recharge to the SVRP Aquifer are:

- Groundwater inflow from Idaho;
- Direct infiltration of precipitation and irrigation water;
- Seepage from lakes along the perimeter of the aquifer (e.g., Hauser Lake, Newman Lake, Liberty Lake);

- Surface waters that originate in the surrounding uplands and flow onto and infiltrate into the aquifer; and,
- Recharge from the Spokane River.

The SVRP Aquifer in WRIA 57 receives a large percentage of its water from surface and subsurface flow from the high ground immediately adjacent to the Aquifer. Land uses and human activities within these aquifer recharge areas have significant impact on the quantity and quality of water in the Aquifer. The total contribution of water to the SVRP Aquifer from these recharge areas around the Aquifer is estimated by modeling to be about 300 cubic feet per second (cfs; MacInnis and others, 2000). In comparison, the amount of water crossing the Washington – Idaho State Line is estimated by modeling to be about 390 cfs (MacInnis and others, 2000).

The SVRP Aquifer occurs within porous and permeable flood deposited sands and gravels that are bounded by low permeability basalt and crystalline basement rocks. As illustrated in Figure 4.15, this unit ranges in thickness from over 700 feet thick within the central portion of the Hillyard Trough to 500 and 600 feet within the Spokane Valley (DNR, 2001; CH2M Hill, 2000). Within the Trinity Trough area, the flood sands and gravels are up to 300 feet in thickness over a trough cross sectional length of about 1 mile. Pump tests completed by CH2M Hill (1998) support a general decrease in aquifer permeability in a downgradient direction, westwards from the state line and northwards through the Hillyard Trough.

The thickness and subsurface characteristics of the SVRP Aquifer have been investigated using a number of different geophysical methods including gravity (Purves, 1969), seismic refraction (Newcomb, 1953; Hart-Crowser, 1994) and seismic reflection (WA State DNR, 1994; CH2M Hill, 1998; CH2M Hill, 2000). Where available, the thickness of the SVRP Aquifer has been confirmed using well log data. Power company grounding wells that extend through unconsolidated sediments to the bedrock have provided important geologic information on the characteristics of the sediments and depth to bedrock.

In the Hillyard Trough area, recent seismic studies and a review of well logs provide evidence to support the presence of a clay/silt aquitard (CH2M Hill, 2000). The trough is estimated to be between 50 feet and 200 feet thick. It is believed to be relatively continuous across the northern portion of the Hillyard Trough to just north of the Little Spokane River and into the western reaches of the Little Spokane River Valley. This aquitard separates the aquifer system into an upper unconfined portion of the SVRP Aquifer and a lower confined sands and gravel aquifer that is 50 to 150 feet thick (Figures 4.14F and 4.14G). A stratified silt, clay and fine sand layer has also been observed between upper and lower sand and gravel units in the vicinity of the Colbert Landfill (Landau Associates, 1991). The consistent elevation of the silt/clay aquitard unit supports its deposition within a glacial lake environment (CH2M Hill, 2000).

Because the clay/silt confining unit (that divides the Hillyard Trough arm of the SVRP Aquifer into upper and lower units) pinches out to the south, the lower unit below the confining layer receives most of its recharge from the SVRP Aquifer. Confirmation of the presence of the lower sand and gravel aquifer in this vicinity may have important

implications for water rights decisions and for the development of this groundwater resource in the future. At present however, the water quality, hydraulic properties and hydraulic connection of this lower aquifer with the Little Spokane River are not well understood (CH2M Hill, 2000). During pump tests at wells near the Colbert Landfill (Landau Associates, 1991) no response in the upper sands and gravels was observed during pumping from the lower sands and gravels, indicating that the glacial lake sediments act as a vertical hydraulic barrier between the upper and lower sand and gravel units in this area.

The majority of the SVRP Aquifer is unconfined. Groundwater generally flows within the aquifer in an east to west direction, from Idaho and into Washington, discharging into the Little Spokane River and Long Lake (Figure 5.9). At the Idaho - Washington state line, the groundwater table elevation (USGS datum) is about 1,980 feet above mean sea level (amsl). At the discharge of the SVRP Aquifer along the Little Spokane River, located about twenty miles downgradient of the state line, the water elevation is about 1,600 feet amsl. Based on groundwater monitoring completed by CH2M Hill in September 1994, the approximate hydraulic gradient (the slope of the water table surface) within the central portion of the Spokane Valley is 0.002. The approximate hydraulic gradient within the southern portion of the Hillyard Trough is 0.004. The approximate hydraulic gradient within the northern portion of the Hillyard Trough is 0.01. The approximate hydraulic gradient across the Trinity Trough is 0.04.

Within the SVRP Aquifer, the static groundwater level ranges from over 200 feet below ground surface in the Hillyard Trough, to about 150 feet below ground surface at the Washington-Idaho State line, to 40 feet at the eastern Spokane City limits (Spokane County, 1996), to within 20 feet of ground surface in areas within City of Spokane and close to the Spokane River. The depth to groundwater (based on well log data) is illustrated on the geologic cross-sections Figures 4.14G through and including 4.14N. Seasonal changes in the static groundwater level may be minimal in some areas and may reach up to 15 feet or more in other areas. The greater changes in groundwater levels are noted within the western portion of the valley and in the vicinity of the Spokane River.

5.2.3.2 Deer Park Groundwater Basin

As illustrated on Figure 5.8, the Deer Park Groundwater Basin is located within the central and eastern portion of WRIA 55. This groundwater basin comprises two aquifers: 1) a shallow aquifer within the unconsolidated sediments; and, 2) a deeper aquifer system contained within the basalts, Latah sediments and crystalline basement rocks (EMCON, 1992). Geologic cross-sections illustrating the basin are presented as Figures 4.14A, 4.14B and 4.14D.

The thickness of the unconsolidated sediments within the Deer Park Basin (illustrated on Figure 4.15) ranges from less than 50 feet at the margins of the basin to over 200 feet just east of the City of Deer Park. In general, groundwater in the unconsolidated sediments flows from the northwest to the southeast across the basin, discharging into the Little Spokane River to the east and Dragoon Creek to the south. The static water level is shallow (often within 10 feet of surface) and is subject to seasonal fluctuations (EMCON,

1992). Groundwater elevations range from 2,320 feet amsl in the northern portion of the basin to 2,000 feet amsl in the vicinity of Dragoon Creek.

Groundwater within the deeper aquifer system generally flows from the northwest to the southeast from a groundwater elevation of about 2,040 feet amsl to about 1,200 feet amsl in the vicinity of Dragoon Creek (EMCON, 1992).

5.2.3.3 Little Spokane River Aquifer Area

The Little Spokane River Aquifer Area is located within WRIA 55 and covers the area south and east of the Deer Park Groundwater Basin and north of the Little Spokane River and the Spokane Valley Aquifer (Figure 5.8). The aquifer materials are comprised of unconsolidated sediments that range locally up to 400 feet. The most productive units are the flood sands and gravels that range in thickness from 50 feet to 200 feet. In localized areas (e.g., in the vicinity of the confluence of Little Deep and Deadman Creeks with the Little Spokane River, and south to Wandermere Lake) the sand and gravel unit is divided into an upper and lower aquifer by a silt and clay aquitard (Figures 4.14F and 4.14G). Although very limited information is available on groundwater flow elevations and directions, it is likely that groundwater within this aquifer area flows in a southerly direction, discharging to major streams such as Dartford Creek, Deadman Creek and the Little Spokane River. The vicinity of the former Colbert Landfill is the most studied portion of the area and demonstrates the complexity of the aquifers in the Little Spokane area (Landau Associates, 1991). Sand and gravel layers separated by a discontinuous silt and clay aquitard underlie it. The water in the upper unit flows in a southeastern direction while groundwater in the lower unit is divided by lobe of Latah sediments so some flows north and the rest flows south.

A focused assessment of the Pine River Park and lower Dartford Creek areas (in the southern portion of the Little Spokane River Aquifer Area) was completed by CH2M Hill (2000) in support of the Spokane Aquifer Joint Board's (SAJB) wellhead protection plan. Groundwater levels from five Whitworth Water District #2 wells (Rivilla, #8A1, #8A2, #8B and the Shady Slope well) and one Spokane County Water District #3 well (Pine River Park) were measured along with water levels in the Little Spokane River to estimate the localized groundwater flow pattern. This assessment indicated that the Whitworth Water District #2 wells (#8A1, #8A2, #8B) and the Spokane County Water District #3 (Pine River Park well) draw groundwater from a sand and gravel unit that is overlain by 100 feet or more of silt and clay. The groundwater system in this area of the Little Spokane River Aquifer area is believed to have limited hydraulic connection with the aquifer units within the northern portion of the Hillyard Trough. This conclusion is based on apparent differences in hydraulic head, basement rock highs and comparison of stratigraphic relationships between the aquifer units (CH2M Hill, 2000).

5.2.3.4 The Diamond Lake Aquifer Area

The Diamond Lake aquifer area, located within Pend Oreille County, in the northeastern portion of WRIA 55 has not been defined prior to this study (Figure 5.8). The aquifer area comprises sedimentary deposits (primarily flood deposited sands and gravels) located in the vicinity of Diamond Lake and includes the sediments of the Diamond Lake basin and

the Scotia Valley (Figure 4.12). This aquifer area borders the Newport / West Bonner aquifer described in the City of Newport / West Bonner Water District No. 1 Phase I wellhead protection plan (Welch, Comer and Associates, Inc. and Riley, 1994). The western boundary of the Newport / West Bonner aquifer is inferred to run in a southerly direction just west of Newport. However, the Scotia Valley channel, which represents a Pleistocene flood channel, extends in a southwesterly direction from Newport. Because this channel is infilled with unconsolidated alluvial and flood sediments, it may connect the Diamond Lake aquifer area and the Newport / West Bonner aquifer. This groundwater connection has not been confirmed by investigations to date.

Although no information was available on the thickness of the sediments within this area, it is likely that the sediments range between a few feet thick at the aquifer margins to 100 feet thick or more in the central Diamond Lake basin and Scotia Valley. The aquifer area is bounded by crystalline basement bedrock exposures to the south, west and north (Figure 4.12). The unconsolidated deposits of the aquifer extend east toward Lake Pend Oreille, the elevation of which is controlled by the Albeni Falls Dam at about 2,060 ft amsl (immediately upstream of the SR 2 crossing of the Pend Oreille River; Figure 5.3). It is possible that groundwater flows from the Pend Oreille River watershed (WRIA 62) into WRIA 55 in a southwesterly direction through the sediments of the Diamond Lake basin and the Scotia Valley. However, this has not been confirmed by hydrogeological studies.

5.2.3.5 Green Bluff Aquifer Area

Information on the Green Bluff aquifer area is based primarily on an Ecology report describing the hydrogeology of the Green Bluff Plateau (Ader, 1996). The hydrogeologic study was initiated following a report of water level declines. Green Bluff is a four square mile topographic high located in WRIA 55, within the northeastern extent of the Columbia River Plateau, 15 miles north of Spokane (Figure 5.8). Green Bluff rises 400 to 500 feet above the surrounding lowlands and is partially bisected by an unnamed stream that flows into Deadman Creek. The geology is comprised of up to 15 feet of loess overlying up to 50 feet of basalt, which in turn overlies up to 200 feet of Latah sediments (Figure 4.14E; Ader, 1996). The Green Bluff Aquifer occurs within the basalts and is unconfined.

Ader (1996) estimated that 918 AF/yr of precipitation recharges the Green Bluff Aquifer. Groundwater flows downward within the basalts and towards the unnamed creek. Because the sediments below the basalts have a relatively low permeability, about 798 acre-feet of the 918 acre-feet per year of the water that recharges the aquifer, discharges to the stream. Approximately 120 AF/yr of the 918 AF/yr of recharge is estimated to leak down into the deeper Latah sediments (Ader, 1996). Following the 1988 Deadman Creek surface water rights adjudication, 148 acre-feet per year of water from the unnamed tributary were allocated.

5.2.3.6 Orchard Prairie Aquifer Area

Orchard Prairie (located partially in WRIA 55 and partially in WRIA 57) has similar hydrogeologic characteristics to that of Green Bluff. The stratigraphy comprises loess, overlying basalt, which in turn overlies Latah sediments and crystalline basement. This

aquifer area has limited groundwater resources (Spokane County, 1996) and recharge, similar to Green Bluff, occurs primarily via precipitation.

5.2.3.7 Five Mile Prairie Aquifer Area

Information on the Five Mile Prairie aquifer area is based primarily on an Ecology report evaluating the ground water resources of Five Mile Prairie (Olson, 1979). Five Mile Prairie is a four square mile topographic high located partially in WRIAs 55, 56 and 57 (Figure 5.8). Five Mile Prairie rises 375 to 400 feet above the surrounding lowlands and is an erosional remnant of the Missoula Floods. From the ground surface downwards, the geology is comprised of: 1) up to 15 feet of loess; 2) up to 50 feet of Wanapum Basalt; 3) up to 150 feet of Latah sediments; and, 4) up to 250 feet of Grande Ronde Basalt (Figure 4.14H). Groundwater occurs primarily as unconfined and confined aquifers within the basalt flows. Based on well log data, well specific capacities ranged on average between 0.5 to 1.0 gpm per foot of drawdown (gpm/ft). Transmissivity was estimated to range between 1,000 to 2,000 gallons per day per foot (gpd/ft). Storage was estimated at 0.0025. The study concluded that groundwater recharge over Five Mile Prairie was approximately equivalent to withdrawals (wells and spring flows).

5.2.3.8 Peone Prairie Aquifer Area

The stratigraphy of Peone Prairie (located within WRIA 55) comprises up to 300 feet of sediment, including flood deposited sands overlying glacial and pre-glacial lake sediments, which in turn overlie crystalline basement rocks. This aquifer area has limited groundwater resources (Spokane County, 1996) and recharge, similar to Green Bluff, occurs primarily via infiltration of precipitation. Peone Prairie discharges to Deadman Creek, which is closed to consumptive appropriations June 1 through October 31 each year.

5.2.4 **Conceptual Hydrogeology**

This section of the report presents conceptual models that simplify the hydrogeology of WRIA 55 and WRIA 57. The conceptual models are based on review of existing information and are presented as schematics in Figures 5.10a and 5.10b. These schematics illustrate the hydrogeology of typical sections within WRIA 55 and WRIA 57, respectively. Simplification of the hydrogeology is necessary to aid construction of a groundwater flow model for the WRIAs.

As illustrated on Figures 5.10a and 5.10b, groundwater occurs primarily within the units overlying the crystalline basement. Surficial groundwater within the fine-grained Latah and glacial sediments flows slowly downwards to the basalt contact. The groundwater may flow along the sediment-basalt contact and appear at the ground surface as a spring. Similarly, groundwater that flows downwards into the basalts travels along vertical and lateral fracture surfaces and may exit the exposed face of the basalt as a spring. Mass wasting deposits occur on the relatively steep valley sides and are often lubricated by groundwater that flows along the lower contact between the in-situ unit and the slide

deposits. Groundwater within the crystalline basement occurs mainly in the upper weathered zone and within major fractures.

The upper unconfined sand and gravel aquifer within WRIA 55 (Figure 5.10a) occurs mainly adjacent to river channels, above finer grained fluvial and lake deposits. Groundwater within this upper aquifer flows rapidly along the groundwater flow gradient to recharge the river. If the contact between the sands and gravels and the finer grained fluvial and lake deposits is above the river level, a spring may form. Groundwater within the finer grained fluvial and lake deposit flows relatively slowly downwards from higher elevations and may ultimately recharge the river. Groundwater will preferentially flow in the sand and gravel layers that occur within the finer grained sediments. Except where they are in direct contact with stream channels, these lower, discontinuous sands and gravel lenses represent small, confined aquifers. However, because the occurrence of these sand and gravel lenses is difficult to predict, these units are not deliberately targeted for water supply.

The upper unconfined sand and gravel aquifer within WRIA 57 (Figure 5.10b) dominates the groundwater flow system. Over the areas where the level of the Spokane River is higher than that of the aquifer, the river recharges the aquifer. The rate at which the surface water recharge to groundwater takes place is controlled primarily by the thickness and permeability of the finer grained sediments that line the riverbed. In areas where the level of the Spokane River is lower than that of the aquifer, the aquifer discharges to the river, often as springs along the river bank or seeps within the river bed. Though water flows between the river and aquifer near the river, the majority of the aquifer flows under the river, perpendicular to the section (i.e., out of the page in Figure 5.10b), along the regional groundwater flow gradient that runs east-west down the valley.

5.2.5 Hydraulic Properties

An understanding of the hydraulic properties of hydrogeologic units is needed to assign the most appropriate values for these properties to the hydrogeologic units within the study area. These properties may be used to simulate the behavior of these hydrogeologic units within a conceptual or numeric groundwater flow model.

Based on the information reviewed, a compilation of aquifer property information is presented on Table 5.5 and Table 5.6. A brief description of the aquifer properties compiled is included as Appendix D1. The original data sources range from local to regional scale studies. A summary of the transmissivity and hydraulic conductivity ranges for local hydrogeologic units is provided below.

Summary of Transmissivity and Hydraulic Conductivity Data

Hydrogeologic Unit	Aquifer Area	Transmissivity (feet ² /day)	Hydraulic Conductivity (feet/day)
Flood Sand & Gravel	SVRP	4,320 – 11,000,000	500 – 12,000
Flood Sand & Gravel	Little Spokane River	10,000 – 518,400	530 - > 640
Flood Sand & Gravel	Deer Park	722 – 267,400	16 – 6,077
Lower Flood Sand & Gravel	Little Spokane River	10,000 – 40,000	100 - 230
Basalt	West Plains, Little Spokane River, Five Mile Prairie, Deer Park	25 - 193	0.18 – 12.1
Basement	North End of Five Mile Prairie		1 - 86

The large ranges in transmissivity and hydraulic conductivity are due to the large variations in grain size within the aquifers. The larger and more homogeneous the grain size, the larger the transmissivity and hydraulic conductivity. Within the SVRP Aquifer, grain sizes tend to be largest in the east and smallest to the northwest.

Vertical anisotropy is the ratio of the horizontal hydraulic conductivity to the vertical hydraulic conductivity (Appendix D1). Direct measurements have not been made for the Spokane Valley Aquifer. Previous studies on the SVRP Aquifer (Bolke and Vaccaro; 1981; CH2M Hill, 1998) have assumed that the ratio is between 3:1 and 10:1. Bolke and Vaccaro (1981) assumed that for the SVRP Aquifer the horizontal hydraulic conductivity is approximately equal to the vertical hydraulic conductivity because vertical stratification is absent throughout most of the aquifer. CH2M Hill (1998) assumed a vertical anisotropy of 10:1 to provide conservative wellhead capture zone delineations. Lower vertical anisotropy values would tend to produce smaller and deeper wellhead capture zones.

5.2.6 Groundwater Monitoring

Information on groundwater monitoring was compiled and reviewed to determine the coverage of groundwater elevation data for WRIA 55 and WRIA 57. Groundwater elevation data is required to define groundwater flow directions (because groundwater flows from a high groundwater elevation, or hydraulic head, towards a lower groundwater elevation). In addition, groundwater elevation data is needed to calibrate groundwater flow models both spatially and over time (e.g., seasonally). Two types of data were compiled:

- Groundwater elevations from numerous wells measured over a snapshot in time; and,
- Groundwater elevations monitored at single well locations over a continuous time period.

The compilation of groundwater monitoring points is summarized on Figure 5.11. The snapshot data is presented on Tables 5.7 through 5.11. The continuous water level data is summarized on Table 5.12. A brief summary of the data is provided in the two sections below.

5.2.6.1 Snapshot Groundwater Data

Discrete water level monitoring events are performed to provide a “snapshot” of groundwater elevations within an aquifer. The snapshot data reviewed for this study is summarized in the table below. The data is included as Tables 5.7 through and including 5.11. Additional data and available contour maps from the original reports are included within Appendix D2. A brief summary of the data by source is provided in the bullets below.

- EMCON (1992) – groundwater level data collected at 36 wells between September 1991 and April 1992 for the hydrogeologic characterization of the Deer Park Basin (Table 5.7).
- Boese & Buchanan (1996) – groundwater level data collected at 36 wells between April 23 and June 4, 1996 in support of the aquifer delineation and baseline groundwater monitoring investigation of a portion of north Spokane County (Table 5.8).
- CH2M Hill (1998) – groundwater level data collected at 119 wells between September 12 and 16, 1994 and at 114 wells between April 10 and 14, 1995. The data was collected to calibrate the Spokane Aquifer groundwater flow model that was created to delineate well capture zones for the City of Spokane wellhead protection program (Table 5.9).
- CH2M Hill (2000) – additional groundwater level data was collected on October 30, 1996 within approximately five miles of the state line, both in Washington and Idaho. This information was used to refine the 1998 groundwater flow model to allow delineation of the Spokane Aquifer Joint Board (SAJB) wells (Table 5.10).
- USGS (2000) – groundwater level data collected at about 140 wells in March and August 2000 in support of the on-going USGS NAQWA study on the hydraulic continuity between the Spokane Aquifer and the Spokane River. This groundwater level data was collected to provide indications of groundwater level elevations and flow directions during river high and low flow periods (Table 5.11).

Summary of Snapshot Groundwater Elevation Data

Data Source	Monitoring Periods	Aquifers
EMCON, 1992	September 1991 – April 1992	52 wells – West and central LSRA (basalt, sands and gravels, crystalline basement)
Boese & Buchanan, 1996	April – June, 1996	36 wells – Northern SVRP, south and central LSRA (basalt, lower and upper sands and gravels, crystalline basement)
CH2M Hill, 1998	September 12-16, 1994 April 10 – 14, 1995	119 wells – SVRP and 31 sites LSR & MSR 114 wells – SVRP and 31 sites LSR & MSR
CH2M Hill, 2000	October 30, 1996	35 wells – Eastern SVRP
USGS, 2000	March – August, 2000	140 wells – Central and eastern SVRP

SVRP – Spokane Valley Rathdrum Prairie Aquifer

LSRA – Little Spokane Aquifer Area

LSR – Little Spokane River

MSR – Middle Spokane River

The bullets below summarize the important observations made based on a brief review of the snapshot groundwater elevation data.

- Groundwater within the Deer Park Basin unconsolidated (shallow) aquifer flows generally in a southerly direction, discharging to Dragoon Creek, with a component of flow in an easterly direction towards Eloika Lake (EMCON, 1992).
- Groundwater within the Deer Park Basin basalt and basement (deep) aquifer flows generally in a southerly direction with a component of discharge to Dragoon Creek (EMCON, 1992).
- Groundwater from the Deer Park Basin shallow aquifer recharges the deep aquifer (EMCON, 1992).
- Groundwater within the Spokane Aquifer flows in a westerly direction within the Spokane Valley and through the Trinity Trough and in a northerly direction within the Hillyard Trough (CH2M Hill, 1998; CH2M Hill, 2000).
- The hydraulic gradient of groundwater flow with the Spokane Aquifer increases along the flow path. Based on groundwater monitoring completed by CH2M Hill in September 1994, the approximate hydraulic gradient (the slope of the water table surface) within the eastern and central portions of the Spokane Valley is 0.002. The approximate hydraulic gradient within the southern portion of the Hillyard Trough is 0.004. The approximate hydraulic gradient within the northern portion of the Hillyard Trough is 0.01. The approximate hydraulic gradient across the Trinity Trough is 0.04.

- Based on comparison of September 1994 and April 1995 data, groundwater levels in the Spokane Aquifer fluctuate between less than 5 feet to 15 feet seasonally. The highest seasonal fluctuations (greater than 10 feet) were noted within the central and eastern portions of the Spokane Valley and the Trinity Trough. The lowest fluctuations (less than 5 feet) were noted within the northern part of the Hillyard Trough (CH2M Hill, 1998).

5.2.6.2 Groundwater Hydrograph Data

Continuous monitoring information includes data for sixty-five wells provided by Spokane County staff. As indicated in the summary table below, the City of Spokane, Vera Water and Power, Whitworth Water District, Spokane Water District #3, Ecology, USGS and Spokane County collected the original data. A listing of the wells, data periods of records and aquifers is presented as Table 5.12. Hydrographs of the data are included within Appendix D2.

Summary of Hydrograph Groundwater Elevation Data

Original Data Source	Monitoring Points	Monitoring Periods	Aquifer
Spokane County	16 monitoring wells	1998 – 2001	Western, central and eastern SVRP
Vera Water and Power	8 water supply wells	January 1967 – December 2000	Central SVRP
City of Spokane	9 monitoring wells	November 1994 – January 2001	Western SVRP
USGS	18 monitoring wells	June, 2000 – March, 2001	Central and eastern SVRP
	1 monitoring well	1929 – 2001	Central SVRP
Whitworth Water District	8 water supply wells	1955 – 2001	Northwestern SVRP and southern LSRA
Ecology	4 monitoring wells	1978 – 2000	Northwestern SVRP and central LSRA
Spokane Water District #3	1 monitoring well	February 1998 – September, 1998	Central LSRA

SVRP – Spokane Valley – Rathdrum Prairie Aquifer

LSRA – Little Spokane River Aquifer area

All hydrograph data provided by Spokane County Staff

Based on an overview of the hydrographs (included as Figures D2-1 though D2-54 in Appendix D2), the bullets below summarize the important observations. A more detailed description of the data follows these points and is organized according to the source of the data.

- Groundwater levels in the SVRP Aquifer change in response to yearly and seasonal changes in recharge and discharge of the aquifer.
- Groundwater level changes in the SVRP Aquifer correspond to changes in the flow (and stage) of the Spokane River, indicating that the river and the aquifer are hydraulically connected.
- There has been no net groundwater level change in the Spokane Valley Aquifer over a long period of record (as indicated by the 1967 to 2001 period of record for the Vera Water and Power wells and the USGS Inland Empire Paper Well).
- The seasonal changes in groundwater elevations of the Spokane Valley aquifer are generally higher in the western and central part of the aquifer. The magnitude of the seasonal groundwater level changes decrease with: 1) increasing distance from the Spokane River; and, 2) increasing thickness of the unsaturated zone.
- Water level changes in the Hillyard Trough do not respond as closely to discharge in the Spokane River due to the greater distance from the river and due the decrease in the hydraulic conductivity of the aquifer materials in a northerly direction through the Hillyard Trough.
- There is good groundwater elevation data coverage for the Spokane Aquifer within both WRIA 55 and 57 and very sparse data coverage (3 wells) for the aquifer areas (other than the Spokane Aquifer) within WRIA 55.

5.2.6.2.1 Spokane County Hydrograph Data

The data collected by Spokane County comprises the Spokane Valley Aquifer Monitoring network. Since the spring of 1977, Spokane County has been tracking the quality of the Spokane Valley portion of the SVRP Aquifer by sampling a network of public water supply wells (Spokane County, 1998). During the first year of monitoring, the wells were monitored on a monthly basis (Esvelt, 1978). Between the fall of 1978 and the summer of 1983, monitoring occurred generally on a quarterly basis with a number of breaks in the data record. Since the fall of 1983, the network has been monitored consistently on a quarterly basis.

The data provided by Spokane County includes wells located within two miles of the Spokane River from the Mission Street Bridge within the City of Spokane eastwards to Idaho Road (0.25 miles west of the Washington-Idaho state line). The data covers periods from October 1998 through September 2000 and includes: 1) wells monitored by transducers as a part of the regular aquifer monitoring program; and, 2) wells monitored weekly (Gearhart and Buchanan, 2000) in support of a study on the hydraulic connection between the Spokane River and the Aquifer. All of the wells are completed within the flood sands and gravels of the Spokane Valley Aquifer.

The Spokane County aquifer monitoring program data is included as hydrographs on Figure D2-1 through Figure D2-10 in Appendix D2. The information comprises average daily groundwater elevations for the wells listed below and is plotted along with flow in the Spokane River near Post Falls.

Summary of Spokane County Hydrograph Data

Well ID	Well Name	Period of Record	Figure #, Appendix D2
6525R01	Idaho Road near Pipeline	5/1999 – 9/2000	Figure 1
6631M07	CID 11 / Idaho Road	5/1999 – 9/2000	Figure 2
5507H01	Barker Road North / Barker North	11/1998 – 9/2000	Figure 3
5507A04	Barker & Euclid / CID Barker North	5/1999 – 8/2000	Figure 4
5508M02	Barker & Centennial S / Barker South 1	11/1998 – 9/2000	Figure 5
5508M01	Barker & Centennial N / Barker South 2	11/1998 – 9/2000	Figure 6
5517D05	Barker & Mission / CID Barker South	5/1999 – 9/2000	Figure 7
5411R04	Sullivan South	11/1998 – 9/2000	Figure 8
5411R03	Sullivan Park South / Sullivan North 2	11/1998 – 9/2000	Figure 9
5411R02	Sullivan Park North / Sullivan North 1	11/1998 – 9/2000	Figure 10

Data collected by Christina Gearhart (Gearhart and Buchanan, 2000) is included as Figure D2-11 (Barker Road Wells), Figure D2-12 (Sullivan Road Wells) and Figure D2-13 (Upriver Wells) in Appendix D2. The information comprises weekly manual measurements for the following fourteen wells listed below and is plotted along with flow in the Spokane River near Post Falls.

Summary of Gearhart and Buchanan (2000) Hydrograph Data

Well ID	Well Name	Period of Record	Figure #, Appendix D2
5505D01	Trent at Barker Road	12/1998 – 8/1999	Figure 11
5507A04	CID Barker North	12/1998 – 8/1999	Figure 11
5507H01	Barker North	12/1998 – 8/1999	Figure 11
5508M02	Barker South 1	12/1998 – 8/1999	Figure 11
5508M01	Barker South 2	12/1998 – 8/1999	Figure 11
5517D05	CID Barker South	12/1998 – 8/1999	Figure 11
5412M01	Central Pre-Mix Sullivan	12/1998 – 8/1999	Figure 12
5411R02	Sullivan North 1	12/1998 – 8/1999	Figure 12
5411R03	Sullivan North 2	12/1998 – 8/1999	Figure 12
5411R04	Sullivan South	12/1998 – 8/1999	Figure 12
5311H01	USGS @ Upriver Dam	12/1998 – 8/1999	Figure 13
5311D03	Upriver Greenhouse	12/1998 – 8/1999	Figure 13
5311E03	Avista @ Beacon	12/1998 – 8/1999	Figure 13
5309M04	Avista @ Mission	12/1998 – 8/1999	Figure 13

The following key points are noted based on review of the hydrographs presented as Figures D2-11 through D2-13 in Appendix D2:

- The Idaho Road near Pipeline well (located about 1.2 miles north of the Spokane River) had an 8-foot seasonal water level rise between October 1999 and April 2000. The CID 11 Idaho Road well (located about 0.5 miles north of the Spokane River) had an 8.5-foot seasonal water level rise between October 1999 and April 2000. Both wells had similar hydrograph patterns as that of the Spokane River flow at the gage near Post Falls. The groundwater elevation in the Idaho Road near Pipeline well was about 1.5 feet higher than that in the CID 11 Idaho Road well, indicating groundwater flow southwards towards the Spokane River.
- The Barker Road wells also had similar hydrograph patterns to that of the Spokane River flow at the gage near Post Falls. The wells are located between 1.5 miles north and 0.5 miles south of the Spokane River. All the Barker Road wells had an 11-foot seasonal water level rise between September / October 1999 and April 2000.
- The Sullivan Road wells also had similar hydrograph patterns to that of the Spokane River flow at the gage near Post Falls. The wells are located within 0.25 miles north and south of the Spokane River. The Sullivan Road south well (located on the south bank of the Spokane River) had a 13.5-foot groundwater level rise between September 1999 and April 2000. The Sullivan Road north wells (located on the north bank of the Spokane River) both had a 16-foot groundwater level change between September 1999 and April 2000.
- The Upriver wells show a similar pattern. The USGS at Upriver Dam, Upriver Greenhouse and Avista at Beacon wells showed an 8- to 9-foot groundwater level rise between December 1998 and May 1999. The Avista at Mission well showed a 6.5-foot groundwater level rise between December 1998 and May 1999. Again, the increasing and decreasing groundwater levels occurred in concert with the increasing and decreasing flow in the Spokane River at the gage near Post Falls.

5.2.6.2.2 Vera Water and Power Hydrograph Data

The groundwater water level data collected by Vera Water and Power comprises weekly measurements of static groundwater levels between 1967 and 2001 in eight of the district's water supply wells. The wells are completed in the flood sands and gravels and are located within the central portion of the Spokane Valley, between one and three miles south of the Spokane River. Hydrographs for the wells are included as Figures D2-14 through D2-29 in Appendix D2. Figure D2-14 illustrates the 1967 to 2001 hydrograph for Vera Water and Power Well #1. The hydrograph indicates no long term change in the groundwater elevation at this well and that the seasonal changes correspond very closely to the seasonal changes in the flow of the Spokane River near Post Falls. This relationship is also noted for Vera Water and Power Well #s 2 through 8 for the hydrograph periods 1967 through 2001 (see Figures D2-16 through D2-29 in Appendix D2). This indicates that the below average precipitation period that occurred between 1962 and 1995 based on climatic data recorded at the Spokane International Airport (see Section 4.2.4 and Figure 4.10), did not cause a significant reduction in the groundwater elevations of the Vera wells. This suggests that the primary influence on water levels in the wells is the flow of

the Spokane River and not local climatic conditions. Seasonal water levels changes of between 8 to 15 feet were observed.

5.2.6.2.3 City of Spokane Hydrograph Data

The City of Spokane hydrograph information comprises daily average groundwater elevations for nine wells calculated by Spokane County Staff from the original transducer data. The wells are located within the City of Spokane, including the western portion of the Spokane Valley Aquifer, the Hillyard Trough and the Trinity Trough. The City of Spokane wells for which hydrograph data was provided are listed below and are plotted along with Spokane River flows near Post Falls in Figures D2-30 through D2-38 in Appendix D2.

Summary of City of Spokane Hydrograph Data

Well ID	Well Name	Period of Record	Figure #, Appendix D2
5312C01	Felts Field	11/1994 – 1/2001	Figure D30
5314E01	Central Pre-Mix at Yardley	12/1994 – 1/2001	Figure D31
5311J07	Hale's Ales Nested Mid-Well	11/1994 – 11/1999	Figure D32
5322A03	Third & Havana Nested Mid-Well	11/1994 – 11/1999	Figure D33
5308H01	Marietta Monitoring Well	11/1994 – 10/2000	Figure D34
5307M01	Trinity School	3/1995 – 1/2001	Figure D35
5304G01	NE Community Center	11/1995 – 1/2001	Figure D36
5322A03	Franklin Park	1/1996 – 1/2001	Figure D37
5202E01	Wastewater Treatment Plant	1/1995 – 1/2001	Figure D38

The hydrographs indicate that the groundwater elevation changes correspond to changes in the Spokane River flow near Post Falls and that the magnitude of the changes in the wells decreases with increasing distance from the Spokane River. For example, the Felts Field well (located about 0.5 miles south of the Spokane River) shows an 18-foot groundwater level rise between August 1996 and April 1997 whereas the Franklin Park well (located about 2.5 miles north of the Spokane River) shows a 10-foot groundwater level rise between August 1996 and April 1997.

5.2.6.2.4 USGS Hydrograph Data

The USGS hydrograph data includes the Inland Empire Paper Well that has been monitored since 1929 and a series of 18 new wells that were installed in 2000 for the NAQWA hydraulic connection study between the Spokane River and the Aquifer.

The Inland Empire Paper well is located within the eastern portion of the Spokane River Valley, about one mile south of the Spokane River. Hydrographs for this well are included as Figure D2-39 and Figure D2-40 in Appendix D2. The 1929 to 2001 hydrograph (Figure D2-39) indicates the lowest groundwater elevation years in 1929 to 1932 with an overall rise in groundwater elevations between 1932 and 1962, an overall fall in groundwater elevations between 1962 and 1995, and a rise in groundwater elevations from 1995 to 2001. A peak groundwater elevation of 1974 ft amsl is noted in the spring of 1997 and a low of 1941 ft amsl is noted in the winter of 1931.

In comparison to climatic changes (see Section 4.2.4 and Figure 4.10), the Inland Empire Well hydrograph does mirror the low precipitation levels of 1928 to 1932 but does not reflect the 1932 to 1947 period of below average precipitation. However, the well hydrograph does indicate a rise in groundwater elevation between 1945 and 1962, which correlates with the 1947 to 1965 period during which precipitation was above average. In addition, the well hydrograph shows an overall decline in groundwater elevations between 1962 and 1995 when precipitation is noted as below average.

As shown on Figure D2-40, the groundwater elevation within the Inland Empire well is strongly correlated to the Spokane River flow near Post Falls with a lag time on the order of days.

Composite hydrographs for the 18 new USGS wells are presented as Figures D2-41 through D2-46 in Appendix D2. All wells are screened in the flood sand and gravels of the SVRP Aquifer and are located along sections with wells at varying distances north and south of the Spokane River. The locations of the wells are shown on the map included within Appendix D2. The wells indicate varying interchanges between the Spokane River and the Aquifer. Because this data is part of an ongoing USGS study and is in a draft format, no further assessment of the data will be made within this compilation report.

5.2.6.2.5 Whitworth Water District Hydrograph Data

Hydrographs for eight of the Whitworth Water District wells are presented on Figures D2-47 through D2-49 in Appendix D2. Five of the wells are located within the upper sands and gravels of the Spokane Aquifer, in the northern portion of the Hillyard Trough. Three of the wells are located north of the Little Spokane River within sands and gravels that occur below an overlying clay layer. The measurements have been taken randomly, mainly between 1992 and 2001. Because of the low resolution of the data, seasonal and annual trends are not assessed. However, it is noted that the wells located north of the Little Spokane River (see Figure D2-49) show different seasonal groundwater level changes in comparison to the wells located within the northern portion Hillyard Trough. This indicates that portions of the aquifers on opposite sides of the Little Spokane River do not have a high degree of hydraulic continuity in this vicinity, possibly due to the presence of an intervening clay aquitard. However, they are believed to be in hydraulic continuity to the south where the clay layer is absent. These two aquifer areas are both presumed to be recharged by groundwater that originates within the SVRP Aquifer.

5.2.6.2.6 Ecology Hydrograph Data

Spokane County provided long-term groundwater level data for the four Ecology monitoring wells listed below. The hydrographs are included as Figures D2-50 through and including D2-53 in Appendix D2. The groundwater level information for the Dakota Well (Figure D2-51) was obtained from CH2M Hill (2000).

Summary of Ecology Hydrograph Data

Well ID	Well Name	Period of Record	Appendix D2 Figure #
6308F02	Mayfair Well (Whitworth Water District Test Well)	9/1997 – 9/2000	Figure 50
6308B04	Dakota Well (Spokane Water District #3)	5/1998 – 8/1999	Figure 51
8316D01	Chattaroy Observation Well	4/1978 – 3/2000	Figure 52
9233G01	Deer Park Observation Well	4/1978 – 3/2000	Figure 53

The Mayfair and Dakota wells are located in the northern portion of the Hillyard Trough. The Mayfair well is completed in the lower sands and gravels between 452 and 462 feet below ground surface. The Dakota well is completed in the upper sands and gravels to 89 feet below ground surface. The upper and lower sands and gravels of northern Hillyard are separated by up to 100 feet or more of silt and clay (Figure 4.14G). The Mayfair well log notes clay layers from 132 to 317 feet below grade. This silt and clay layer thins and pinches out in a southerly direction until it occurs as only remnant lenses in the central portion of the Hillyard Trough (Figure 4.14I).

Groundwater levels rose three feet in the Mayfair well between September 1998 and May 1999, and about 1.5 feet in the Dakota well over the same time frame (Figures D2-50 and D2-51 in Appendix D2). In addition, the Mayfair well hydrograph (Figure D2-50) shows peaks and troughs that can be correlated to variations in Spokane River flow near Post Falls. These peaks and troughs are not apparent on the Dakota Well hydrograph (Figure D2-51). This suggests limited vertical hydraulic connection between the upper and lower sands and gravels in the vicinity of the two wells. However, because the clay layer that separated the upper and lower aquifer zones pinches out in an upgradient direction, both aquifer zones are recharged by groundwater flowing northwards with the SVRP Aquifer from the downtown Spokane area and believed to be in lateral hydraulic continuity.

The Chattaroy and Deer Park observation wells are completed within the sands and gravels of the Little Spokane Aquifer area and the Deer Park Basin, respectively. The Chattaroy well indicates an overall groundwater level drop from 1978 to 1994 (from 35.5 feet to 44 feet below the measuring point) followed by a groundwater level rise from 1994 to 2000 (from 44 feet to 35.5 feet below the measuring point; Figure D2-52). The Deer Park well indicates steady and slight rise in the overall groundwater level from 43 feet to 36 feet below the measuring point (Figure D2-53).

5.2.6.2.7 Spokane Water District #3 Hydrograph Data

Twelve groundwater elevation measurements are available from February 1998 to September 1998 for the Spokane Water District #3 Chattaroy Hills well. The well is located just west of the Little Spokane River, within the central portion of the Little Spokane River Aquifer area. Although there is insufficient groundwater elevation data to establish a relationship between the river flow and the groundwater elevations, it is apparent that the groundwater elevations are relatively high during times of the year when the river flows are high (Figure D2-54).

5.2.6.3 Groundwater Level Changes

Groundwater level changes within WRIAs 55 and 57 occur over three different time scales:

- Over the short term in areas where the groundwater is in direct hydraulic continuity with surface water. Direct hydraulic continuity between surface water and groundwater is indicated by short-term fluctuations in groundwater levels that can be correlated to short-term changes in river stage and flow with a lag time varying between hours and days. Short term groundwater level changes are illustrated by the Barker Road North Well hydrograph and the Mayfair Well hydrograph (Figures 5.12 and 5.13);
- Over the water year due to seasonal changes in groundwater recharge. Seasonal groundwater level fluctuations are illustrated by the Dakota Well hydrograph (Figure 5.14); and,
- Over long term wet and dry cycles associated with the impact of the Pacific Decadal Oscillations on the climate of the Pacific Northwest (Section 4.2). Decadal groundwater level changes are illustrated by the Chattaroy Observation Well hydrograph (Figure 5.15).

The locations of the Barker Road North, Mayfair, Dakota and Chattaroy Observation Wells are indicated on Figure 5.11

Short-term changes in groundwater levels associated with river flows (and stage) are observed in all the wells completed within the SVRP Aquifer in the vicinity of the Spokane River. The Barker Road North Well hydrograph (Figure 5.12) illustrates this relationship for a well located just north of the Spokane River, along Barker Road in WRIA 57 (Figure 5.11). This is one of the wells monitored regularly as a part of Spokane County's WQMP and was also monitored by Gearhart and Buchanan (2000) for the recent study on the hydraulic connectivity between the Spokane River and the SVRP Aquifer. The groundwater level in the well rises rapidly with increasing Spokane River flow rates (Figure 5.12). The lag time to the groundwater level change that follows the increase in river flow rate is less than one day. Spokane County staff has observed this effect for many of the wells completed within the SVRP Aquifer in the vicinity of the Spokane River.

The Mayfair Well is located about six miles north of the Spokane River and is completed between 452 to 462 feet below ground surface within the lower sands and gravels of the

Hillyard Trough in WRIA 55 (Figure 5.11). The Mayfair Well hydrograph illustrates short-term, muted groundwater level changes associated with hydraulic continuity between the lower portion of the SVRP Aquifer and the Spokane River (Figure 5.13). Although the short-term peaks associated with short-term river flow events do not cause groundwater peaks that are as well defined as those for wells located adjacent to the river (such as the Barker Road wells), a muted response is observed. This indicates that the Spokane River influences the groundwater levels within the lower sands and gravels of the Hillyard Trough at a distance of at least six miles from the river.

The Dakota Well is also located about six miles north of the Spokane River, in the Hillyard Trough area of WRIA 55 (Figure 5.11). However, this well is completed to a depth of 89 feet below ground surface within the upper sand and gravel unit (that is separated from the lower sand and gravel unit by about 200 feet of low permeability clay and silt layers). The groundwater level changes within the Dakota Well illustrate a typical seasonal pattern of high groundwater levels in the spring and early summer, declining levels over the summer to late summer, and rising levels through the winter months (Figure 5.14). These groundwater level variations are related to annual (i.e., seasonal) precipitation changes. In contrast to the lower aquifer zone, the short-term changes in Spokane River flows are not transmitted through the upper aquifer zone (Figure 5.13). Although there is hydraulic separation in the Dakota and Mayfair wells area between the upper and lower sand and gravel units, they are believed to be in hydraulic continuity to the south where the confining clay aquitard pinches out.

Pacific Decadal Oscillations (PDO) are caused by Pacific Ocean influences on the climate of the Pacific Northwest. PDO also has an impact on groundwater levels over a timeframe of decades. The groundwater level changes are caused by changes in groundwater recharge rates during the dry and wet PDO periods. The hydrograph for the Chattaroy Observation Well (Figure 5.15), located within the eastern portion of the Deer Park basin in WRIA 55 (Figure 5.11) illustrates the PDO effect. 1974 to 1994 is characterized as a dry PDO. Groundwater levels in the Chattaroy well show a declining trend during this time period (Figure 5.15). In contrast, the years following 1994 have been characterized by a wet PDO. As illustrated in Figure 5.15, the groundwater levels in the Chattaroy well have risen between 1994 and 2000.

5.2.7 Groundwater Flow Modeling

Groundwater flow modeling within the study area has been limited to the SVRP Aquifer. The driving force behind these models is the need to predict groundwater flow directions and the amounts of groundwater that flow within the aquifer. These models have been developed primarily in support of land development (i.e., groundwater supply), to designate protection areas over aquifer zones that provide water to large water supply wells (i.e., groundwater quality protection), and for academic research purposes.

Groundwater flow models simulate the processes of groundwater flow. Groundwater flow models can be created at different levels of complexity. An analytical equation, such as a water balance calculation, is a relatively simple type of groundwater flow model that aims to estimate the amount of water that passes a certain point or cross section.

Computer code that mathematically represents the aquifer and solves groundwater flow and contaminant transport equations is a more complex type of groundwater flow model. Due to the large number of input variables and the need to predict “what if” scenarios across the Spokane Aquifer, groundwater flow modeling of the aquifer has progressed over time from relatively simple models to complex computer models.

A sequential list and brief description of the SVRP Aquifer groundwater flow models that have been created are provided in the summary table below. Detailed descriptions of the models are provided in Appendix D3.

Summary of Spokane Valley Rathdrum Prairie Groundwater Flow Modeling

Author	Date	Model Type
Pluhowski and Thomas, USGS	1968	Water balance spreadsheet
Drost and Seitz, USGS	1978	Water balance spreadsheet
Bolke and Vaccaro, USGS	1981	2D, finite element groundwater flow model
Painter, IDEQ	1991	Water balance spreadsheet
Buchanan and Olness, Eastern Washington University	1994	3D, finite difference, MODFLOW groundwater flow model
CH2M Hill (for City of Spokane wellhead protection)	1998	3D, finite element, MICRO FEM groundwater flow model
Buchanan	2000	3D, finite difference, MODFLOW groundwater flow model
CH2M Hill (for SAJB wellhead protection)	2000	3D, finite element, MICRO FEM groundwater flow model

5.2.7.1 Groundwater Inflow at the Eastern Model Boundary

An important component of the water balance for WRIA 57 will be to provide an estimate of the quantity of groundwater that flows into WRIA 57 across the eastern (i.e., the upgradient) boundary of the WRIA. The table below provides a summary of the groundwater inflows at the eastern boundary for the SVRP Aquifer modeling efforts completed to date.

Summary of Groundwater Inflow at Eastern Model Boundary

Source	Approx. Location of Eastern Model Boundary	Estimated Groundwater Flow Across Eastern Model Boundary (cfs)
Pluhowski and Thomas (1968)	3 miles west of WA-ID state line	950
Drost and Seitz (1978)	WA-ID state line	800
Bolke and Vaccaro (1981)	WA-ID state line	396 ¹
Bolke and Vaccaro (1981)	3.5 miles east of WA-ID state line	453 ²
Painter (1991)	WA-ID state line	753
Buchanan and Olness (1994)	WA-ID state line	320
CH2M Hill (1998)	WA-ID state line	380
Buchanan (2000)	WA-ID state line	390
CH2M Hill (2000)	WA-ID state line	400

- Note: 1. Calculated by subtracting north and south groundwater inflow from the total groundwater inflow to the model with WA-ID line as the eastern model boundary (i.e., 668 – 145 (north) – 127 (south)).
2. Calculated by subtracting north and south groundwater inflow from the total groundwater inflow to the model with Post Falls Dam as the eastern model boundary (i.e., 668 – 108 (north) – 107 (south)).

As illustrated in the summary table above, recent studies, which are likely to be more accurate because of additional data, indicate that the groundwater flow across the Washington-Idaho state line is approximately 400 cfs.

5.2.7.2 Groundwater Flow Through the Trinity Trough

As illustrated on Figure 5.9, groundwater within the SVRP Aquifer flows in a westerly direction towards the City of Spokane. From about Division Street westwards in downtown Spokane, the Spokane River flows over a basalt outcrop. The basalt diverts most groundwater flow in a northerly direction, towards Hillyard. However, a proportion of the groundwater within the Spokane Valley aquifer flows in a westerly direction through the Trinity Trough. Based on groundwater flow modeling results, Buchanan (2000) and CH2M Hill (1998) estimated that approximately 10 cfs of groundwater flows through the Trinity Trough into WRIA 54.

Using the geologic cross section that runs perpendicular to the Trinity Trough (presented as Figure 4.14H), an estimate of the annual average groundwater flux through the Trough can be made based on an appropriate range of values for aquifer parameters. The range in estimated values is shown in parentheses and are based on the compilation of existing

hydraulic property data for the western portion of the SVRP Aquifer presented on Table 5.6. The hydraulic gradient of groundwater flow across the Trinity Trough was estimated from CH2M Hill's (1998) groundwater monitoring data.

- Saturated cross sectional area (approximately 600,000 square feet);
- Porosity (10-30 %);
- Hydraulic conductivity (500 to 2,000 feet / day); and,
- Hydraulic gradient (approximately 0.044).

Using the equation:

$$Q = K * \frac{dh}{dl} * A * n * \frac{1}{24 * 60 * 60}$$

Where,

- Q = flux (cubic feet per second)
 K = hydraulic conductivity (feet per day)
 dh/dl = hydraulic gradient
 A = cross sectional area (square feet)
 n = porosity

The estimated annual average flow through the Trinity Trough ranges from 15 to 182 cfs. This suggests that the 10 cfs of groundwater flow modeled across the Trinity Trough may underestimate the actual flows because it falls outside the low end of the estimated range.

5.2.7.3 Groundwater Flow Through the Hillyard Trough

Groundwater flow through the Hillyard Trough can be estimated by: 1) the increase in discharge of the Little Spokane River downstream of the SVRP Aquifer because the SVRP Aquifer discharges to the Little Spokane River; and, 2) groundwater model simulations. A summary of the estimated flow through the Hillyard Trough from previous groundwater modeling studies is provided below.

Summary of Estimated SVRP Aquifer Discharge to Little Spokane River

Source	Estimated Annual Average SVRP Aquifer Discharge to Little Spokane River (cfs)
Bolke and Vaccaro, 1981	254
CH2M Hill, 1998 (Spring 1995)	335
CH2M Hill, 1998 (Fall 1994)*	300
CH2M Hill, 2000 (Fall 1994)*	182

*CH2M Hill used additional data in the northern SVRP Aquifer area to recalibrate the model in 2000, resulting in a lower estimate of this value.

Using the same equation as for the Trinity Trough above, along with CH2M Hill's (1998) groundwater monitoring data and the following values for hydraulic parameters:

- Saturated cross sectional area (approximately 4,800,000 square feet);
- Porosity (10 – 30 %);
- Hydraulic conductivity (500 to 3,000 feet / day); and,
- Hydraulic gradient (approximately 0.013).

Using these approximate values and ranges provides a large estimated flow range through the Hillyard Trough of 36 to 650 cfs. Because the modeled flows in the summary table above) fall within the center of this calculated range, it is likely that the 182 cfs to 335 cfs of groundwater flow modeled across the Hillyard Trough simulates actual flows. The increased flow of the Little Spokane River between the At Dartford gage and the Near Dartford gage (Figure 5.2a) is about 250 cfs, which also supports the groundwater model results listed above.

5.2.7.4 Improved Understanding of the Spokane Aquifer

In addition to improving the estimated values for the quantities of water flowing within the aquifer across the state line, groundwater flow modeling has resulted in an improvement in the understanding of the geometry of the aquifer. At the time of Molenaar's 1988 publication on the SVRP Aquifer, it was believed that westerly groundwater flow into the lower Spokane River (WRIA 54) occurred from WRIA 57 across a five-mile wide channel from the southern basalt exposure of Five Mile Prairie to Spokane Falls. Because groundwater elevations simulated by Bolke and Vaccaro (1981) within the Hillyard Trough were significantly lower than the monitored elevations, the model suggested that less volumes of water than those modeled were actually able to flow westwards into WRIA 54. This resulted in additional geologic studies (CH2M Hill, 1998; CH2M Hill, 2000) that identified the Trinity Trough as only a one-mile wide (north-south), 300 feet deep channel through which groundwater within the aquifer could flow in a westerly direction from WRIA 57 to WRIA 54. Also as a result of this work, a deep, confined portion of the Spokane Aquifer in the northern portion of the Hillyard Trough was identified.

Based on review of the groundwater models completed to date for the SVRP Aquifer, the CH2M Hill groundwater flow models (CH2M Hill, 1998; CH2M Hill, 2000) and Bolke and Vaccaro's 1981 groundwater flow model are considered the most accurate. However, the main objectives of the models (and all of the other models described above) were to characterize the SVRP Aquifer for groundwater resource studies and protection. The interaction between surface water and groundwater was not modeled dynamically, partially because surface water impacts were not the primary focus of the projects and partially because the surface water – groundwater interaction program algorithms were at an early stage of development. As a result, these models do not accurately predict changes in the flow of the Spokane River as a result of varying groundwater withdrawals or varying groundwater recharge to the SVRP Aquifer. Because streamflow prediction is a

primary focus of the WRIAs 55 and 57 Watershed Planning process, the Planning Unit chose to select the MIKE suite of programs (see Section 8 for a detailed discussion) as a tool to compare the effects of different water resources management strategies on the surface water and groundwater regimes of the two WRIAs. MIKE is one of the first available packages that includes a module that dynamically couples groundwater and surface water. This attribute along with its ability to take GIS data as input will build upon the modeling efforts of the past and continue to improve the understanding of the system.

5.3 Groundwater and Surface Water Interactions

The continuity of water flow between surface water and groundwater is an important consideration when assessing water availability (for example, the impact that groundwater withdrawals may have on surface water flows) and also in protecting the quality of both surface water and groundwater resources.

Surface water recharge from a river to an aquifer may occur when the surface water level in the stream is higher than the groundwater level in the aquifer. Discharge of groundwater to a stream may occur when the surface water level in the stream is lower than the groundwater level in the aquifer. The rate at which the interchange takes place is dependent on the magnitude of the water level difference and the permeability of the riverbed sediments.

Aquifers that are separated from surface water by depth or distance, are confined and/or are composed of low permeability materials, require longer periods of time for water exchange to occur. This results in attenuation or dampening of the seasonal variability in groundwater and surface water interactions.

Hydraulic continuity occurs between the Spokane River, SVRP Aquifer and Little Spokane River system of WRIA 57 and southern WRIA 55 and has been documented along the alluvial and flood deposited sediments of the Little Spokane River in WRIA 55 (Dames and Moore and Cosmopolitan, 1995). The following sections summarize the available information on these river-aquifer interactions.

5.3.1 Spokane River and Spokane Valley Aquifer Interactions

Along the reach of the Spokane River, from the Coeur d'Alene Lake outflow in Idaho to the Hangman Creek confluence, there are sections of the river that lose water to or gain water from the SVRP Aquifer. In general, the reach from the beginning of the Spokane River at Coeur d'Alene Lake loses water to the SVRP Aquifer until about Flora Road in the Spokane River Valley (MacInnis and others, 2000). From Flora Road to about Greene Street, the Spokane River generally gains flow from the SVRP Aquifer (MacInnis and others, 2000). From Greene Street to the Hangman Creek confluence, the Spokane River generally loses water to the SVRP Aquifer. Although these three reaches can be defined generally as losing and gaining reaches, the two downstream sections (Flora Road to the Hangman Creek confluence) exhibit complex interactions involving variation in magnitude and direction of flow (i.e., gaining or losing). Seasonal and decadal climatic variations affect both the Spokane River and the SVRP Aquifer.

The locations of losing and gaining reaches of the Spokane River and the volumetric interchanges between the river and the aquifer have been investigated for a number of years. Although knowledge of the hydrology of this connected system is improving, considerable uncertainty remains as to the quantities of water exchanged and the seasonal variations in the reaches and quantities of the exchanges.

Appendix D4 presents a summary of the main technical studies that have been completed to describe the relationship between the Spokane River and the SVRP Aquifer. The information is based on a summary of previous investigations presented in Gearhart and Buchanan's 2000 report on the hydraulic connection between the Spokane River and the Spokane Aquifer prepared for the Spokane County Water Quality Management Program. Copies of figures from the Gearhart and Buchanan (2000) report are included within Appendix D4. A compilation of simulated losses and gains in the Spokane River flow based on these previous studies is presented as Table 5.13.

With reference to Table 5.13, the most accurate representations of the interaction between the Spokane River and the SVRP Aquifer include the results of CH2M Hill (1998) and Gearhart and Buchanan (2000). Both these studies place the change in the Spokane River from a generally losing to generally gaining stream between Barker Road and Sullivan Road (Flora Road runs north-south parallel to and between Barker and Sullivan Roads). This has been confirmed by Spokane County based on field observations of springs along the Spokane River bank beneath the Sullivan Bridge. The CH2M Hill (1998) results are based on a steady-state groundwater flow model (described in Appendix D3). The Gearhart and Buchanan (2000) investigation compiled flow, stage and groundwater level data to assess the changes in the location of the losing and gaining reaches with seasonal changes in the flow of the Spokane River and groundwater levels in wells adjacent to the river. Both these studies provide a snapshot of the system at instances in time (CH2M Hill, 1998) and over a period of time (Gearhart and Buchanan, 2000) and do not provide information on how the system may behave dynamically.

The MIKE suite of modeling software includes a groundwater flow modeling module with a coupled surface water – groundwater interaction algorithm and is described in more detail in Section 8 of this report. One of the reasons the Planning Unit selected this tool over others is that it has the ability to dynamically model surface water – groundwater interactions. Details on the model selection process are included in Appendix E of this report.

The USGS is currently working on a Spokane River – Aquifer hydraulic connection study as a component of their National Water-Quality Assessment Program (NAWQA). The purpose of the study is to further improve the understanding of the groundwater / surface water interactions along the losing reach of the Spokane River between Pleasant View Road in Idaho and Harvard Road in Washington. The study also aims to investigate the impacts of the river on the water quality of the aquifer.

To date, the USGS NAWQA study has involved:

- Compilation of a well inventory database;
- Installation of 18 new wells;
- Monitoring at the 18 new wells and 7 pre-existing wells;
- Assessment of pressure and temperature responses in the wells as a result of flow changes in the Spokane River; and,
- Investigation of the water quality differences between groundwater within the aquifer and the surface water of the Spokane River.

Because the work is ongoing, further description of the study and the study results will not be included within the Level 1 Watershed Assessment. However, the study results may be used within the model development stage of this assessment (i.e., Level 2, Phase II).

5.3.2 Groundwater and Surface Water Interaction in WRIA 55

Most of the natural groundwater discharge within WRIA 55 occurs as baseflow to the Little Spokane River. During late summer, when flows in the Little Spokane River At Dartford average about 150 cfs, most of this flow (up to 110 cfs) is derived from groundwater inflow (Chung, 1975). The rest is supplied by tributaries, which also receive most of their water from groundwater inflow. Based on stream gaging at the Elk station (see Figure 5.2a), groundwater inflow (baseflow) is also high in the Little Spokane River upstream of its confluence with the West Branch (Chung, 1975).

Along the Little Spokane River to the north of the Hillyard Trough, the groundwater table is at a higher elevation than the river stage so that the aquifer discharges water to the stream. Based on river flows between Dartford and the confluence with the Spokane River, it is estimated that between 234 cfs (Dames and Moore and Cosmopolitan, 1995) and 310 cfs (Drost and Seitz, 1978) of groundwater from the SVRP Aquifer recharges the Little Spokane River. Groundwater flow models indicate between 182 cfs (CH2M Hill, 2000) and 335 cfs (CH2M Hill, 1998) of groundwater from the SVRP Aquifer recharges the Little Spokane River. Up to 45 cfs of this occurs from five springs (Cline, 1969). Although it is thought that most of this inflow is derived from the SVRP Aquifer, the source of up to 25 % of this inflow may be groundwater originating in the upper portion of WRIA 55 (Cline, 1969). The Little Spokane River baseflow from groundwater nearly doubles the average annual discharge in the Little Spokane River gaged At Dartford (Dames and Moore and Cosmopolitan, 1995). Groundwater inflow along this lower section maintains wetlands and rich riparian vegetation.

Drainage Summary

WAU Name	Average Elevation (ft amsl)	Acres*
WRIA 55 - Little Spokane		
Beaver Creek	2900	47,172
Branch, W	3400	65,972
Dartford Creek	2200	18,679
Deadman Creek	2200	54,047
Deer Creek	3300	66,899
Dragoon Creek	2800	61,899
Ft Spokane	2000	20,924
Little Deep Creek	3100	29,029
Scotia	2800	67,200
Total Acreage of WRIA 55:		431,821
WRIA 57 - Middle Spokane		
Blanchard Creek	3900	41,430
Liberty Creek	3400	22,228
Spokane Urban	3200	89,682
Thompson Creek	3400	30,272
Total Acreage of WRIA 57:		183,612

*Acreage obtained from GIS coverage supplied by the Washington Department of Natural Resources.

Continuous Streamflow gaging Stations with greater than Five Years of Record

Station Name	Source	Period of Record (water year)	River Mile	Drainage Area (square miles)	Mean Elevation (ft ansl, NGVD 29)
Spokane River near Post Falls, ID	USGS	1913 - 2000	100.7		
Spokane River at Liberty Br near Otis Orchard, WA	USGS/ SCC	1930 - 1983, 1994 - 1999*	93.8	388	
Spokane River below Trent Brg Near Spokane, WA	USGS	1949 - 1954	85.3	42	
Spokane River Below Green St at Spokane, WA	USGS/SCC	1949 - 1952, 1993 - 1998*			
Spokane River At Spokane WA	USGS	1892 - 1999	72.9	429	
Spokane River at Long Lake, WA	USGS	1940 - 1999	33.8		
Hangman Creek At Spokane, WA	USGS	1948 - 1999	0.8	689	
Little Spokane River At Elk, WA	USGS	1949 - 1971	~ 37.5	115	
Little Spokane River, Chattaroy Rd., Chattaroy, WA	SCC	1976 - 1996, 1998 - 1999	23.2	312	
Little Spokane River At Dartford, WA	USGS	1930 - 1932, 1948 - 1999	11.4	665	1585.62
Little Spokane River Near Dartford, WA	USGS	1949 - 1951 1998 - 1999	4.4	698	

* SCC monitored from 1993-1998

Minimum Instream Flows (MISFs) at Control Points in the Little Spokane River Basin (cfs).

Month	Day	Elk	Chattaroy	Dartford	Confluence
January					
	1	40	86	150	400
	15	40	86	150	400
February					
	1	40	86	150	400
	15	43	104	170	420
March					
	1	46	122	190	435
	15	50	143	218	460
April					
	1	54	165	250	490
	15	52	143	218	460
May					
	1	49	124	192	440
	15	47	104	170	420
June					
	1	45	83	148	395
	15	43	69	130	385
July					
	1	41.5	57	115	375
	15	39.5	57	115	375
August					
	1	38	57	115	375
	15	38	57	115	375
September					
	1	38	57	115	375
	15	38	63	123	380
October					
	1	38	70	130	385
	15	39	77	140	390
November					
	1	40	86	150	400
	15	40	86	150	400
December					
	1	40	86	150	400
	15	40	86	150	400

Minimum Instream Flow Excursion Summary for WRJA 55

Period Of Record	Elk		Chattaroy		Dartford	
	7/1949 - 10/1971 June - October Only	10/1975 - 09/1996 June - October Only	5/1929 - 9/1932, 1/1947 - 9/1999 June - October Only	June - October Only	June - October Only	June - October Only
Days in Record	8415	7671	3213	20515	8659	
Days of Instream Flow Violations	813	2521	1352	3135	1909	
Number of Continuous Excursions of Instream Flow Levels	71	162	62	205	94	
Percent of Record below Instream Flow Levels	10%	33%	42%	15%	22%	
Max Continuous Days below Instream Flow Levels	153	262	153	245	181	
Average Continuous Days below Instream Flow Levels	12	16	22	15	20	

Spokane Valley Aquifer Specific Capacity Data

Well ID	Owner	Well Name	Reported Yield (gpm)	Specific Capacity (gpm/ft)	Aquifer Saturated Thickness (ft)	Transmissivity (millions ft ² /day)	Hydraulic Conductivity (ft/day)
631701	NW Pipeline Co.		55	11	150	0.00	0
5406f03	Pasadena Park Irr. Dist.	#5 (New well)	1500	34	250	0.02	100
6432Q02	Pleasant Prairie WD		100	19	250	0.03	100
541801	Hutchinson Irr. Dist.	Broadway and Sergeant	550	73	400	0.10	300
5510F01	Delp Place		125	63	400	0.10	300
6318B01	Whitworth College	New Well #2	1000	100	120	0.03	300
6320D01	Whitworth Water Dist. #2	2B	1800	200	175	0.05	300
5401R01	Spokane Industrial Park	Well #4	2500	141	300	0.13	400
6234N03	Fairmont Cemetery	Fairmont Cemetery Well	1500	115	100	0.04	400
6321J01	Acme Materials	Acme Crestline well (B 041)	200	67	150	0.06	400
5505H01	C & L Farms		600	150	250	0.13	500
5402B01	Trentwood Irr. Dist.	Progress #6	1500	341	150	0.09	600
6319A02	Whitworth Water Dist. #2	2A	2250	250	175	0.12	700
5214J01	Fairmont Cemetery Assoc.	Riverside Cemetery	2280	507	150	0.15	1,000
5503N01	Coen		750	375	400	0.50	1,300
6330H02	Holy Cross Cemetery	New Well	1000	500	250	0.33	1,300
5408B01	Millwood WD	Old Park Well	500	500	350	0.52	1,500
6631M06	Consolidated Irr. Dist. (CID)	East Farms, 11C	3008	1,003	400	0.77	1,900
5428M02	Model Irr. Dist.	#5	1150	575	250	0.50	2,000
6535F02	Consolidated Irr. Dist. (CID)	East Farms, 10B	3190	1,063	400	0.80	2,000
5414J01	Vera Irr. Distr #15	New #2 well	5000	1,852	400	1.11	2,800
5415E01	Modern Electric	#5	4000	833	400	1.10	2,800
5502G02	Consolidated Irr. Dist. (CID)	Otis Orchards, 9A	3400	1,700	400	1.13	2,800
5402P01	Kaiser Trentwood	Extraction Well (OH-EW1)	1065	619	200	0.57	2,900
5213B01	Inland Empire Cold Storage		400	667	200	0.60	3,000
5416E01	Modern Electric	#2	4500	900	400	1.20	3,000
5223B01	City of Spokane	Indian Canyon Golf Course	450	450	100	0.40	4,000
5504D01	Consolidated Irr. Dist. (CID)	Otis Orchards, 9A	4500	2,647	250	1.09	4,400
5411N02	Consolidated Irr. Dist. (CID)	Carder, 1B	1600	1,600	250	1.23	4,900
5517D04	Consolidated Irr. Dist. (CID)	Greenacres, 4D	1800	4,500	450	2.67	5,900
5426D01	Vera Irr. Dist #15	#5	1400	1,400	300	1.85	6,200

Note: Data compiled from CH2MHill, 1998.

TABLE 5.6

Compilation of Aquifer / Aquitard Hydraulic Properties Properties

Hydrogeologic Unit	Aquifer Area	Locality	Well	Saturated Thickness (feet)	Pump Rate / Well Yield (gpm)	Specific Capacity (gpm/ft)	Transmissivity (ft ² /day)	Hydraulic Conductivity (ft/day)	Storage	Porosity (%)	Linear Velocity (ft/day)	Source
Alluvium				0 - 40	5 - 600							Cline, 1969.
Flood Sand & Gravel	SVRP											
Flood Sand & Gravel	Deer Park		TW-1	45	90		722	0.1 - 10,000	0.1 - 0.2	10 - 20	30.00	Spokane County, 2001 Draft
Flood Sand & Gravel	Deer Park		TW-2	50	106		6,885 - 20,055	134 - 401				EMCON, 1992.
Flood Sand & Gravel	Little Spokane River	Colbert Landfill					10,000 - 12,000	530 - 640	0.2		3.5 - 6.4	Landau, 1991, Boese & Buchanan, 1996.
Flood Sand & Gravel	SVRP	N Spokane, Francis & Market	N Spokane ID #3	200	800	198	100,000 - 700,000	500 - 3,500				CH2MHill, 2000
Flood Sand & Gravel	SVRP	Kaiser Trentwood - Central Spokane Valley	OH-EW-1	175	1,065		160,000 - 350,000	650 - 1,400				Hart Crowser, 1994 cited in CH2MHill, 1998
Flood Sand & Gravel	SVRP	Valley, Sullivan & Broadway	Vera #2-1	400	2,500	380,000		864	0.10 - 0.15			Bolke & Vaccaro, 1981
Flood Sand & Gravel	SVRP	Below Spokane Falls	Northside Landfill					950				CH2MHill, 2000
Flood Sand & Gravel	SVRP	Kaiser Mead North - North Hillyard Trough	Well No. 6					1,200 - 2,100				CH2MHill, 1988
Flood Sand & Gravel	SVRP	Whitworth - North Hillyard Trough						1,100 - 2,500				Hart Crowser, 1980 cited in CH2MHill, 1998
Flood Sand & Gravel	SVRP	North Hillyard Trough	7C2				4,320 - 172,800	1,100 - 2,500	0.05 - 0.15			Hart Crowser, 1980 cited in CH2MHill, 1998
Flood Sand & Gravel	SVRP	Hillyard		160		400,000		2,500		30	47.00	Boese & Buchanan, 1996.
Flood Sand & Gravel	Little Spokane River	West WRIA 55					172,800 - 518,400	2,592				Drost & Seitz, 1978.
Flood Sand & Gravel	SVRP	Central Hillyard Trough	Central Well No. 2	250 - 300	8,225	1,443	630,000 - 750,000	2,500				Boese & Buchanan, 1996.
Flood Sand & Gravel	SVRP	Downtown Spokane		400	3,400	1,889	800,000 - 1,700,000	2,000 - 4,200	0.10 - 0.15			CH2MHill, 1988
Flood Sand & Gravel	SVRP	Idaho Road & Wellesley	CID #1A	400	18,200	2,563	1,300,000	3,000				CH2MHill, 2000
Flood Sand & Gravel	SVRP	South Hillyard Trough	Nevada Well	400				4,320	0.15 - 0.20			CH2MHill, 1988
Flood Sand & Gravel	SVRP	Central Spokane Valley						6,048	0.15 - 0.20			Bolke & Vaccaro, 1981
Flood Sand & Gravel	Deer Park	State Line to Pines Knoll	Olsen (west)	44	620		267,400	6,077	0.001			Bolke & Vaccaro, 1981
Flood Sand & Gravel	SVRP	Valley, nr Barker & Mission	CID #4B	450	1,975	2,821	1,900,000 - 2,500,000	4,200 - 6,200				EMCON, 1992.
Flood Sand & Gravel	SVRP	State Line		280			3,400,000	12,000		25	64.00	CH2MHill, 2000
Flood Sand & Gravel	SVRP	State Line					11,000,000					Drost & Seitz, 1978.
Flood Sand & Gravel				0 - 700	600 - 20,000							Drost & Seitz, 1978.
Lower Flood Sand & Gravel	Little Spokane River	Colbert Landfill	CP-E1				10,000 - 14,000	100 - 140	0.16	30	0.30	Cline, 1969.
Lower Flood Sand & Gravel	Little Spokane River	Colbert Landfill	CP-W1				30,000 - 40,000	170 - 230	0.0004	30	0.60	Landau, 1991, Boese & Buchanan, 1996.
Glacial Lake Deposits	Deer Park			0 - 300	5 - 600							Landau, 1991, Boese & Buchanan, 1996.
Grande Ronde Basalt												Cline, 1969.
Wanapum Basalt	Columbia Plateau											
Wanapum Basalt	Columbia Plateau							0.005 - 2,522				Boese & Buchanan, 1996.
Basalt	West Plains						0.007 - 5,244	0.18 - 12.1				Boese & Buchanan, 1996.
Basalt	Five Mile Prairie	Colbert Landfill	CP-E2	80			25	0.7 - 1.0	0.01	10	0.40	Boese & Buchanan, 1996.
Basalt	Deer Park	City of Deer park	DP-5				134 - 267	1.7 - 3.3	0.0025			Landau, 1991, Boese & Buchanan, 1996.
Basalt	Five Mile Prairie											Olson, 1979
Basalt	Five Mile Prairie											EMCON, 1992.
Basalt	Five Mile Prairie											Cline, 1969.
Basalt	Five Mile Prairie											Boese & Buchanan, 1996.
Basalt	Five Mile Prairie											Cline, 1969.
Basement Basalt & Basement	West Plains						38					Boese & Buchanan, 1996.
Basement Basalt & Basement	Five Mile Prairie	N. Five Mile Prairie						1 - 86	< 0.05			Olson, 1979

Note: Where an upper flood sand and gravel unit occurs over a lower sand and gravel unit with an aquitard separating the (e.g. in the Hillyard area), the upper unit is referred to as "Flood Sand and Gravel" and the lower unit as "Lower Flood Sand and Gravel".

Groundwater Monitoring Wells with Snapshot Data (EMCON, 1992)

WELL_ID	WELL_NAME	X_WSP_N	Y_WSP_N	STATE	AQUIFER	T	R	S	DATE	GROUND_ELEV _(USGS)	GW_ELEV _(USGS)	GW_FT_BG S
8222N01	ANDERSON	2458962.56018	352657.08784	WA	deep	28N	42E	22	09/04/91	2020	1991	29.00
8222N01	ANDERSON	2458962.56018	352657.08784	WA	deep	28N	42E	22	11/01/91	2020	1991	28.80
8222N01	ANDERSON	2458962.56018	352657.08784	WA	deep	28N	42E	22	01/30/92	2020	1992	27.70
8222N01	ANDERSON	2458962.56018	352657.08784	WA	deep	28N	42E	22	04/03/92	2020	1990	29.50
8203G01	BLY	2460194.26064	364891.97907	WA	deep	28N	42E	3	10/03/91	2110	2093	16.90
8203G01	BLY	2460194.26064	364891.97907	WA	deep	28N	42E	3	10/31/91	2110	2093	16.80
8203G01	BLY	2460194.26064	364891.97907	WA	deep	28N	42E	3	01/28/92	2110	2094	15.80
8203G01	BLY	2460194.26064	364891.97907	WA	deep	28N	42E	3	04/02/92	2110	2094	16.10
8307M01	BOOHER	2475877.91317	362839.14497	WA	deep	28N	43E	7	06/14/91	2151	2119	31.60
8307M01	BOOHER	2475877.91317	362839.14497	WA	deep	28N	43E	7	10/29/91	2151	2120	31.30
8307M01	BOOHER	2475877.91317	362839.14497	WA	deep	28N	43E	7	01/27/92	2151	2119	32.20
8307M01	BOOHER	2475877.91317	362839.14497	WA	deep	28N	43E	7	04/01/92	2151	2118	32.90
8211K01	BROWN	2465285.28921	360622.08415	WA	deep	28N	42E	11	06/20/91	2087	2080	6.65
8211K01	BROWN	2465285.28921	360622.08415	WA	deep	28N	42E	11	11/01/91	2087	2077	9.90
8211K01	BROWN	2465285.28921	360622.08415	WA	deep	28N	42E	11	01/29/92	2087	2079	7.60
8211K01	BROWN	2465285.28921	360622.08415	WA	deep	28N	42E	11	04/02/92	2087	2081	6.10
8213C01	BUNKE	2472593.37861	356187.96249	WA	deep	28N	42E	13	10/10/91	2071	2039	32.20
8213C01	BUNKE	2472593.37861	356187.96249	WA	deep	28N	42E	13	11/04/91	2071	2039	32.40
8213C01	BUNKE	2472593.37861	356187.96249	WA	deep	28N	42E	13	01/30/92	2071	2038	32.80
8213C01	BUNKE	2472593.37861	356187.96249	WA	deep	28N	42E	13	04/03/92	2071	2039	32.10
8203P01	CHRISTCHURCH	2457812.97309	366205.79290	WA	deep	28N	42E	3	06/21/91	2157	2072	84.87
8203P01	CHRISTCHURCH	2457812.97309	366205.79290	WA	deep	28N	42E	3	10/29/91	2157	2096	61.00
8203P01	CHRISTCHURCH	2457812.97309	366205.79290	WA	deep	28N	42E	3	01/28/92	2157	2063	94.00
8203P01	CHRISTCHURCH	2457812.97309	366205.79290	WA	deep	28N	42E	3	04/01/92	2157	2103	54.20
8307C01	COOPER	2478259.20072	361771.67124	WA	deep	28N	43E	7	06/14/91	2075	2020	54.55
8307C01	COOPER	2478259.20072	361771.67124	WA	deep	28N	43E	7	11/01/91	2075	2024	50.90
8307C01	COOPER	2478259.20072	361771.67124	WA	deep	28N	43E	7	01/27/92	2075	2024	51.10
8307C01	COOPER	2478259.20072	361771.67124	WA	deep	28N	43E	7	04/01/92	2075	2024	51.20
9227C01	D_REITER	2460604.82746	376552.07676	WA	deep	29N	42E	27	06/03/91	2138	2132	5.80
9227C01	D_REITER	2460604.82746	376552.07676	WA	deep	29N	42E	27	10/28/91	2138	2128	9.50
9227C01	D_REITER	2460604.82746	376552.07676	WA	deep	29N	42E	27	01/28/92	2138	2130	8.00
9227C01	D_REITER	2460604.82746	376552.07676	WA	deep	29N	42E	27	04/02/92	2138	2131	6.70
8316N01	DOE-16	2484499.81639	357255.43622	WA	deep	28N	43E	16	02/04/92	2012	1971	40.70
8316N01	DOE-16	2484499.81639	357255.43622	WA	deep	28N	43E	16	04/01/92	2012	1971	40.70
9233F01	DOE-33	2453789.41825	370557.80119	WA	deep	29N	42E	33	02/04/92	2170	2129	40.80
9233F01	DOE-33	2453789.41825	370557.80119	WA	deep	29N	42E	33	04/02/92	2170	2127	43.30
9226M01	DP(OLSEN)	2463232.45511	378030.11732	WA	shallow	29N	42E	26	10/03/91	2145	2131	14.00
9226M01	DP(OLSEN)	2463232.45511	378030.11732	WA	shallow	29N	42E	26	10/28/91	2145	2131	13.80
9226M01	DP(OLSEN)	2463232.45511	378030.11732	WA	shallow	29N	42E	26	01/28/92	2145	2132	13.40
9226M01	DP(OLSEN)	2463232.45511	378030.11732	WA	shallow	29N	42E	26	04/01/92	2145	2133	12.20
9331J01	DP/M-10	2474399.87261	369490.32746	WA	shallow	29N	43E	31	06/20/91	2180	2127	52.85
9331J01	DP/M-10	2474399.87261	369490.32746	WA	shallow	29N	43E	31	11/01/91	2180	2128	52.20
9331J01	DP/M-10	2474399.87261	369490.32746	WA	shallow	29N	43E	31	01/27/92	2180	2127	53.00
9331J01	DP/M-10	2474399.87261	369490.32746	WA	shallow	29N	43E	31	04/01/92	2180	2127	53.10
8201B01	DP/M-2	2471197.45142	368012.28691	WA	shallow	28N	42E	1	06/20/91	2189	2129	60.23
8201B01	DP/M-2	2471197.45142	368012.28691	WA	shallow	28N	42E	1	10/29/91	2189	2129	60.30
8201B01	DP/M-2	2471197.45142	368012.28691	WA	shallow	28N	42E	1	01/27/92	2189	2129	60.20
8201B01	DP/M-2	2471197.45142	368012.28691	WA	shallow	28N	42E	1	04/01/92	2189	2129	60.30
8201D01	DP/M-3	2468241.37031	364235.07216	WA	shallow	28N	42E	1	06/20/91	2188	2147	40.53
8201D01	DP/M-3	2468241.37031	364235.07216	WA	shallow	28N	42E	1	10/29/91	2188	2147	41.00
8201D01	DP/M-3	2468241.37031	364235.07216	WA	shallow	28N	42E	1	01/27/92	2188	2147	41.30
8201D01	DP/M-3	2468241.37031	364235.07216	WA	shallow	28N	42E	1	04/01/92	2188	2147	41.10
9332P01	DP/M-5	2478012.86063	372692.74865	WA	shallow	29N	43E	32	06/20/91	2190	2163	27.44
9332P01	DP/M-5	2478012.86063	372692.74865	WA	shallow	29N	43E	32	11/01/91	2190	2163	27.40
9332P01	DP/M-5	2478012.86063	372692.74865	WA	shallow	29N	43E	32	01/27/92	2190	2162	27.90
9332P01	DP/M-5	2478012.86063	372692.74865	WA	shallow	29N	43E	32	04/01/92	2190	2162	27.80
9331N01	DP/M-6	2473496.62561	373021.20211	WA	shallow	29N	43E	31	06/20/91	2202	2146	55.94
9331N01	DP/M-6	2473496.62561	373021.20211	WA	shallow	29N	43E	31	11/08/91	2202	2145	56.90
9331N01	DP/M-6	2473496.62561	373021.20211	WA	shallow	29N	43E	31	01/29/92	2202	2143	59.00
9331N01	DP/M-6	2473496.62561	373021.20211	WA	shallow	29N	43E	31	04/01/92	2202	2145	56.70
8306P01	DP/M-9	2473578.73897	367355.37999	WA	shallow	28N	43E	6	06/20/91	2165	2113	52.26
8306P01	DP/M-9	2473578.73897	367355.37999	WA	shallow	28N	43E	6	10/29/91	2165	2112	52.90
8306P01	DP/M-9	2473578.73897	367355.37999	WA	shallow	28N	43E	6	01/27/92	2165	2112	53.10
8306P01	DP/M-9	2473578.73897	367355.37999	WA	shallow	28N	43E	6	04/01/92	2165	2112	53.40
9234A01	DP-1(34SES)	2461508.07447	368587.08045	WA	shallow	29N	42E	34	10/03/91	2117	2102	15.40
9234A01	DP-1(34SES)	2461508.07447	368587.08045	WA	shallow	29N	42E	34	11/01/91	2117	2101	15.50
9234A01	DP-1(34SES)	2461508.07447	368587.08045	WA	shallow	29N	42E	34	01/29/92	2117	2102	15.10
9234A01	DP-1(34SES)	2461508.07447	368587.08045	WA	shallow	29N	42E	34	04/03/92	2117	2102	15.10
8202D01	DP-2(2N1)	2463807.24866	365466.77262	WA	shallow	28N	42E	2	10/03/91	2113	2094	18.60

Groundwater Monitoring Wells with Snapshot Data (EMCON, 1992)

WELL_ID	WELL_NAME	X_WSP_N	Y_WSP_N	STATE	AQUIFER	T	R	S	DATE	GROUND_ELEV _(USGS)	GW_ELEV _(USGS)	GW_FT_BG S
8202D01	DP-2(2N1)	2463807.24866	365466.77262	WA	shallow	28N	42E	2	11/01/91	2113	2094	18.70
8202D01	DP-2(2N1)	2463807.24866	365466.77262	WA	shallow	28N	42E	2	01/29/92	2113	2095	18.20
8202D01	DP-2(2N1)	2463807.24866	365466.77262	WA	shallow	28N	42E	2	04/03/92	2113	2094	18.70
9235J01	DP-4	2463560.90857	369736.66755	WA	shallow	29N	42E	35	01/29/92	2136	2105	31.10
9235J01	DP-4	2463560.90857	369736.66755	WA	shallow	29N	42E	35	04/03/92	2136	2105	31.00
8213D01	EDWARDS	2472100.69842	358569.25005	WA	shallow	28N	42E	13	06/18/91	2113	2070	43.15
8213D01	EDWARDS	2472100.69842	358569.25005	WA	shallow	28N	42E	13	10/31/91	2113	2068	44.50
8213D01	EDWARDS	2472100.69842	358569.25005	WA	shallow	28N	42E	13	01/29/92	2113	2068	44.90
8213D01	EDWARDS	2472100.69842	358569.25005	WA	shallow	28N	42E	13	04/02/92	2113	2068	45.10
8222K01	FAHLAND	2460358.48737	349783.12010	WA	deep	28N	42E	22	06/18/91	2020	1978	41.50
8222K01	FAHLAND	2460358.48737	349783.12010	WA	deep	28N	42E	22	11/01/91	2020	1978	41.80
8222K01	FAHLAND	2460358.48737	349783.12010	WA	deep	28N	42E	22	01/30/92	2020	1979	41.40
8222K01	FAHLAND	2460358.48737	349783.12010	WA	deep	28N	42E	22	04/03/92	2020	1978	41.80
8210E01	FLUGEL	2461261.73437	362018.01133	WA	deep	28N	42E	10	06/26/91	2130	2106	23.50
8210E01	FLUGEL	2461261.73437	362018.01133	WA	deep	28N	42E	10	10/29/91	2130	2104	26.00
8210E01	FLUGEL	2461261.73437	362018.01133	WA	deep	28N	42E	10	01/29/92	2130	2107	23.10
8210E01	FLUGEL	2461261.73437	362018.01133	WA	deep	28N	42E	10	04/02/92	2130	2111	19.20
9215M01	GLEASON	2457648.74636	388951.19473	WA	deep	29N	42E	15	09/11/91	2230	2198	31.90
9215M01	GLEASON	2457648.74636	388951.19473	WA	deep	29N	42E	15	10/28/91	2230	2207	22.70
9215M01	GLEASON	2457648.74636	388951.19473	WA	deep	29N	42E	15	01/28/92	2230	2209	21.40
9215M01	GLEASON	2457648.74636	388951.19473	WA	deep	29N	42E	15	04/02/92	2230	2209	20.60
9215R01	HARPER	2455842.25235	384188.61962	WA	deep	29N	42E	15	10/03/91	2160	2156	4.30
9215R01	HARPER	2455842.25235	384188.61962	WA	deep	29N	42E	15	10/28/91	2160	2156	4.30
9215R01	HARPER	2455842.25235	384188.61962	WA	deep	29N	42E	15	01/28/92	2160	2156	4.30
9215R01	HARPER	2455842.25235	384188.61962	WA	deep	29N	42E	15	04/02/92	2160	2153	6.80
9226F01	HASTINGS	2464299.92884	376305.73667	WA	shallow	29N	42E	26	09/03/91	2170	2131	39.30
9226F01	HASTINGS	2464299.92884	376305.73667	WA	shallow	29N	42E	26	10/28/91	2170	2130	39.80
9226F01	HASTINGS	2464299.92884	376305.73667	WA	shallow	29N	42E	26	01/28/92	2170	2130	39.70
9226F01	HASTINGS	2464299.92884	376305.73667	WA	shallow	29N	42E	26	04/01/92	2170	2131	39.00
8213N01	HELM	2469473.07077	358487.13668	WA	deep	28N	42E	13	06/18/91	2110	2046	63.95
8213N01	HELM	2469473.07077	358487.13668	WA	deep	28N	42E	13	11/01/91	2110	2056	53.70
8213N01	HELM	2469473.07077	358487.13668	WA	deep	28N	42E	13	01/29/92	2110	2062	47.60
8213N01	HELM	2469473.07077	358487.13668	WA	deep	28N	42E	13	04/02/92	2110	2059	51.00
8210B01	HYTEIN	2462493.43483	360539.97078	WA	deep	28N	42E	10	06/20/91	2115	2073	42.46
8210B01	HYTEIN	2462493.43483	360539.97078	WA	deep	28N	42E	10	11/01/91	2115	2059	56.00
8210B01	HYTEIN	2462493.43483	360539.97078	WA	deep	28N	42E	10	01/30/92	2115	2071	43.90
8210B01	HYTEIN	2462493.43483	360539.97078	WA	deep	28N	42E	10	04/01/92	2115	2079	35.90
8223B01	KEIFEL	2467502.35004	349783.12010	WA	deep	28N	42E	23	09/09/91	2053	2007	45.60
8223B01	KEIFEL	2467502.35004	349783.12010	WA	deep	28N	42E	23	10/28/91	2053	2011	41.80
8223B01	KEIFEL	2467502.35004	349783.12010	WA	deep	28N	42E	23	01/29/92	2053	2016	37.10
8223B01	KEIFEL	2467502.35004	349783.12010	WA	deep	28N	42E	23	04/02/92	2053	2017	36.30
8305F01	LOSHBAUGH	2481379.50855	366862.69981	WA	shallow	28N	43E	5	10/03/91	2169	2104	64.60
8305F01	LOSHBAUGH	2481379.50855	366862.69981	WA	shallow	28N	43E	5	10/29/91	2169	2104	64.50
8305F01	LOSHBAUGH	2481379.50855	366862.69981	WA	shallow	28N	43E	5	01/29/92	2169	2104	64.60
8305F01	LOSHBAUGH	2481379.50855	366862.69981	WA	shallow	28N	43E	5	04/01/92	2169	2104	65.00
8212D02	LOVE	2473168.17215	362674.91825	WA	deep	28N	42E	12	06/25/91	2147	2103	44.10
8212D02	LOVE	2473168.17215	362674.91825	WA	deep	28N	42E	12	10/29/91	2147	2103	44.00
8212D02	LOVE	2473168.17215	362674.91825	WA	deep	28N	42E	12	01/29/92	2147	2103	44.20
8212D02	LOVE	2473168.17215	362674.91825	WA	deep	28N	42E	12	04/01/92	2147	2103	44.30
8308C01	MCCANN	2483268.11593	362592.80488	WA	deep	28N	43E	8	6/14/91	2125	1976	148.94
8308C01	MCCANN	2483268.11593	362592.80488	WA	deep	28N	43E	8	10/29/91	2125	1975	149.50
8308C01	MCCANN	2483268.11593	362592.80488	WA	deep	28N	43E	8	01/27/92	2125	1976	149.40
8308C01	MCCANN	2483268.11593	362592.80488	WA	deep	28N	43E	8	04/01/92	2125	1975	149.70
8212M01	MCLEMORE	2470540.54451	363742.39198	WA	deep	28N	42E	12	06/14/91	2163	2116	47.21
8212M01	MCLEMORE	2470540.54451	363742.39198	WA	deep	28N	42E	12	11/01/91	2163	2115	48.20
8212M01	MCLEMORE	2470540.54451	363742.39198	WA	deep	28N	42E	12	01/29/92	2163	2116	47.00
8212M01	MCLEMORE	2470540.54451	363742.39198	WA	deep	28N	42E	12	04/02/92	2163	2111	51.60
9222A01	MICKAVICZ	2460686.94083	384024.39289	WA	deep	29N	42E	22	09/11/91	2203	2169	33.60
9222A01	MICKAVICZ	2460686.94083	384024.39289	WA	deep	29N	42E	22	10/28/91	2203	2173	30.40
9222A01	MICKAVICZ	2460686.94083	384024.39289	WA	deep	29N	42E	22	01/28/92	2203	2174	29.40
9222A01	MICKAVICZ	2460686.94083	384024.39289	WA	deep	29N	42E	22	04/01/92	2203	2174	29.00
9214N01	MILLER	2462000.75465	388294.28782	WA	deep	29N	42E	14	09/11/91	2250	2194	56.00
9214N01	MILLER	2462000.75465	388294.28782	WA	deep	29N	42E	14	10/28/91	2250	2194	55.50
9214N01	MILLER	2462000.75465	388294.28782	WA	deep	29N	42E	14	01/28/92	2250	2195	54.80
9214N01	MILLER	2462000.75465	388294.28782	WA	deep	29N	42E	14	04/02/92	2250	2194	55.90
8212D01	MINDEN	2473168.17215	363249.71179	WA	deep	28N	42E	12	06/14/91	2148	2104	43.61
8212D01	MINDEN	2473168.17215	363249.71179	WA	deep	28N	42E	12	10/29/91	2148	2104	44.30
8212D01	MINDEN	2473168.17215	363249.71179	WA	deep	28N	42E	12	01/29/92	2148	2104	44.00
8212D01	MINDEN	2473168.17215	363249.71179	WA	deep	28N	42E	12	04/01/92	2148	2131	17.00

Groundwater Monitoring Wells with Snapshot Data (EMCON, 1992)

WELL_ID	WELL_NAME	X_WSP_N	Y_WSP_N	STATE	AQUIFER	T	R	S	DATE	GROUND_ELEV _(USGS)	GW_ELEV _(USGS)	GW_FT_BG S
8215D01	NEFF	2462247.09474	357009.09613	WA	deep	28N	42E	15	10/03/91	2138	2065	73.40
8215D01	NEFF	2462247.09474	357009.09613	WA	deep	28N	42E	15	10/01/91	2138	2066	72.00
8215D01	NEFF	2462247.09474	357009.09613	WA	deep	28N	42E	15	01/30/92	2138	2069	69.40
8215D01	NEFF	2462247.09474	357009.09613	WA	deep	28N	42E	15	04/02/92	2138	2069	69.00
9212H01	OSTRANDER	2469390.95741	384517.07307	WA	shallow	29N	42E	13	09/11/91	2205	2171	34.20
9212H01	OSTRANDER	2469390.95741	384517.07307	WA	shallow	29N	42E	13	11/01/91	2205	2170	34.80
9212H01	OSTRANDER	2469390.95741	384517.07307	WA	shallow	29N	42E	13	01/30/92	2205	2170	35.20
9212H01	OSTRANDER	2469390.95741	384517.07307	WA	shallow	29N	42E	13	04/08/92	2205	2170	35.00
8317J01	PLUNKETT	2481133.16846	354217.24175	WA	shallow	28N	43E	17	06/18/91	1998	1913	85.46
8317J01	PLUNKETT	2481133.16846	354217.24175	WA	shallow	28N	43E	17	10/29/91	1998	1910	87.90
8317J01	PLUNKETT	2481133.16846	354217.24175	WA	shallow	28N	43E	17	01/30/92	1998	1912	86.00
8317J01	PLUNKETT	2481133.16846	354217.24175	WA	shallow	28N	43E	17	04/08/92	1998	1912	86.00
8305N01	PUTNAM	2480065.69473	367930.17354	WA	deep	28N	43E	5	06/25/91	2163	2094	68.70
8305N01	PUTNAM	2480065.69473	367930.17354	WA	deep	28N	43E	5	10/29/91	2163	2093	69.80
8305N01	PUTNAM	2480065.69473	367930.17354	WA	deep	28N	43E	5	01/27/92	2163	2094	69.00
8305N01	PUTNAM	2480065.69473	367930.17354	WA	deep	28N	43E	5	04/01/92	2163	2094	69.30
9317F01	RAMSEY	2479573.01455	387719.49427	WA	deep	29N	43E	17	09/05/91	2240	2129	111.00
9317F01	RAMSEY	2479573.01455	387719.49427	WA	deep	29N	43E	17	10/28/91	2240	2133	107.08
9317F01	RAMSEY	2479573.01455	387719.49427	WA	deep	29N	43E	17	01/28/92	2240	2133	106.80
9317F01	RAMSEY	2479573.01455	387719.49427	WA	deep	29N	43E	17	04/01/92	2240	2132	107.60
9318P01	REMINGTON	2471690.13160	388047.94772	WA	shallow	29N	43E	18	09/11/91	2220	2184	36.10
9318P01	REMINGTON	2471690.13160	388047.94772	WA	shallow	29N	43E	18	10/28/91	2220	2184	36.10
9318P01	REMINGTON	2471690.13160	388047.94772	WA	shallow	29N	43E	18	01/27/92	2220	2153	67.00
9318P01	REMINGTON	2471690.13160	388047.94772	WA	shallow	29N	43E	18	4/2/92	2220	2183	37.00
8317P01	SALTZ	2479655.12791	356844.86940	WA	shallow	28N	43E	17	06/14/91	2021	1961	59.54
8317P01	SALTZ	2479655.12791	356844.86940	WA	shallow	28N	43E	17	10/29/91	2021	1955	66.30
9317A01	SMETHERS	2481543.73528	386159.34035	WA	shallow	29N	43E	17	09/05/91	2220	2066	153.90
9317A01	SMETHERS	2481543.73528	386159.34035	WA	shallow	29N	43E	17	10/28/91	2220	2066	153.90
9317A01	SMETHERS	2481543.73528	386159.34035	WA	shallow	29N	43E	17	01/28/92	2220	2066	154.10
9317A01	SMETHERS	2481543.73528	386159.34035	WA	shallow	29N	43E	17	04/01/92	2220	2066	154.20
9214C01	STATEMA	2464710.49566	388047.94772	WA	shallow	29N	42E	14	09/11/91	2210	2171	38.70
9214C01	STATEMA	2464710.49566	388047.94772	WA	shallow	29N	42E	14	10/28/91	2210	2192	17.80
9214C01	STATEMA	2464710.49566	388047.94772	WA	shallow	29N	42E	14	01/28/92	2210	2195	14.70
9214C01	STATEMA	2464710.49566	388047.94772	WA	shallow	29N	42E	14	04/02/92	2210	2197	13.20
9234J01	STENZEL	2458387.76663	368422.85373	WA	deep	29N	42E	34	09/03/91	2162	2131	30.90
9234J01	STENZEL	2458387.76663	368422.85373	WA	deep	29N	42E	34	10/28/91	2162	2130	31.80
9234J01	STENZEL	2458387.76663	368422.85373	WA	deep	29N	42E	34	01/28/92	2162	2131	30.90
9234J01	STENZEL	2458387.76663	368422.85373	WA	deep	29N	42E	34	04/02/92	2162	2133	29.30
9223R01	TW2	2461918.64129	379836.61132	WA	shallow	29N	42E	23	10/10/91	2155	2138	16.70
9223R01	TW2	2461918.64129	379836.61132	WA	shallow	29N	42E	23	10/28/91	2155	2138	16.60
9223R01	TW2	2461918.64129	379836.61132	WA	shallow	29N	42E	23	01/28/92	2155	2138	16.60
9223R01	TW2	2461918.64129	379836.61132	WA	shallow	29N	42E	23	04/01/92	2155	2140	15.40
9332E01	VEILLETTE	2480558.37491	372939.08875	WA	deep	29N	43E	32	09/21/91	2198	2121	76.90
9332E01	VEILLETTE	2480558.37491	372939.08875	WA	deep	29N	43E	32	10/28/91	2198	2121	76.70
9332E01	VEILLETTE	2480558.37491	372939.08875	WA	deep	29N	43E	32	01/27/92	2198	2121	76.70
9332E01	VEILLETTE	2480558.37491	372939.08875	WA	deep	29N	43E	32	04/01/92	2198	2122	76.10
8224H01	WILLARD	2472429.15188	347976.62609	WA	deep	28N	42E	24	06/18/91	1988	1935	53.09
8224H01	WILLARD	2472429.15188	347976.62609	WA	deep	28N	42E	24	11/01/91	1988	1938	50.40
8224H01	WILLARD	2472429.15188	347976.62609	WA	deep	28N	42E	24	01/29/92	1988	1938	50.00
8224H01	WILLARD	2472429.15188	347976.62609	WA	deep	28N	42E	24	04/02/92	1988	1938	50.40
9330F01	WILSON	2476042.13989	376880.53022	WA	deep	29N	43E	30	09/11/91	2220	2118	101.80
9330F01	WILSON	2476042.13989	376880.53022	WA	deep	29N	43E	30	10/28/91	2220	2118	101.90
9330F01	WILSON	2476042.13989	376880.53022	WA	deep	29N	43E	30	01/29/92	2220	2118	102.30
9330F01	WILSON	2476042.13989	376880.53022	WA	deep	29N	43E	30	04/01/92	2220	2118	102.40
9223N01	WOLF	2462575.54820	382628.46570	WA	deep	29N	42E	23	6/2/91	2200	2183	16.80
9223N01	WOLF	2462575.54820	382628.46570	WA	deep	29N	42E	23	10/28/91	2200	2182	18.00
9223N01	WOLF	2462575.54820	382628.46570	WA	deep	29N	42E	23	01/28/92	2200	2182	18.30
9223N01	WOLF	2462575.54820	382628.46570	WA	deep	29N	42E	23	04/01/92	2200	2182	18.10
9215D01	WORKMAN	2459701.58046	389279.64818	WA	shallow	29N	42E	15	10/29/91	2245	2223	21.90
9215D01	WORKMAN	2459701.58046	389279.64818	WA	shallow	29N	42E	15	01/28/92	2245	2222	23.00
9215D01	WORKMAN	2459701.58046	389279.64818	WA	shallow	29N	42E	15	04/02/92	2245	2224	21.00

Groundwater Monitoring Wells with Snapshot Data (Boese and Buchanan, 1996)

WELL_ID	X_WSP_N	Y_WSP_N	GROUND_ELEV_(USGS)	GW_ELEV_(USGS)	GW_FTBS	DATE
6204N02	2456429.83279	299616.56125	1720	1549.44	170.56	Apr-Jun,1996
6211K01	2470517.86609	296434.30873	1600	1594.08	5.92	Apr-Jun,1996
6301J01	2507958.17880	302653.82128	1820	1784.00	36.00	Apr-Jun,1996
6303K02	2495124.25829	301833.57738	1860	1750.30	109.70	Apr-Jun,1996
6311B01	2501036.80323	300166.41206	1875	1750.70	124.30	Apr-Jun,1996
6312M01	2503124.73268	297700.74839	1875	1795.04	79.96	Apr-Jun,1996
6404F01	2520552.84395	304517.01911	1870	1808.70	61.30	Apr-Jun,1996
6404N01	2518989.91563	301392.94071	1865	1802.00	63.00	Apr-Jun,1996
7205C01	2450229.22059	335033.13226	2180	2172.83	7.17	Apr-Jun,1996
7212J02	2475150.77384	328099.32120	2145	2068.57	76.43	Apr-Jun,1996
7224R01	2475797.67115	315776.09373	1960	1907.12	52.88	Apr-Jun,1996
7304N01	2485664.37438	335122.98133	2010	1722.57	287.43	Apr-Jun,1996
7305C03	2479522.54809	336446.78657	2040	1825.00	215.00	Apr-Jun,1996
7312P01	2503519.30780	328556.75140	1895	1701.10	193.90	Apr-Jun,1996
7314C01	2498325.25020	326950.63047	1850	1681.60	168.40	Apr-Jun,1996
7315F02	2494007.83954	324238.08979	1847	1686.04	160.96	Apr-Jun,1996
7317E01	2482420.69521	323986.00839	1995	1962.79	32.21	Apr-Jun,1996
7319R01	2480769.25862	316043.52802	1900	1845.65	54.35	Apr-Jun,1996
7320K01	2483968.15505	317132.87063	1970	1890.29	79.71	Apr-Jun,1996
7321C02	2488667.32817	321086.82247	1680	1665.53	14.47	Apr-Jun,1996
7321C01	2488173.12652	320717.16224	1740	1665.35	74.65	Apr-Jun,1996
7324B01	2504939.75809	321483.67426	2050	2027.99	22.01	Apr-Jun,1996
7326N01	2497633.96673	311412.61495	1900	1704.10	195.90	Apr-Jun,1996
7327J01	2495354.34402	313241.07630	1825	1693.23	131.77	Apr-Jun,1996
7407P02	2509092.11698	328101.68891	2030	1987.60	42.40	Apr-Jun,1996
7420A	2516827.73229	321898.67289	2330	2313.19	16.81	Apr-Jun,1996
7427F01	2525933.87229	315757.37771	2010	1941.40	68.60	Apr-Jun,1996
7432L01	2515191.11742	309109.91359	1985	1939.20	45.80	Apr-Jun,1996
7433P01	2522004.48474	274068.17966	1840	1812.90	27.10	Apr-Jun,1996
8222Q01	2462106.98338	346859.81192	2030	1972.60	57.40	Apr-Jun,1996
8225C01	2471782.35554	345974.98021	2035	1974.80	60.20	Apr-Jun,1996
8332G01	2483937.94495	340159.85950	2055	1958.92	96.08	Apr-Jun,1996
8333E02	2485446.90342	340146.33417	1950	1892.94	57.06	Apr-Jun,1996
8335B01	2498522.96514	343292.08215	1875	1818.55	56.45	Apr-Jun,1996
8419P01	2507714.35342	348955.24227	1930	1888.18	41.82	Apr-Jun,1996
8429R01	2515434.26155	346099.97193	2330	2003.46	326.54	Apr-Jun,1996

Groundwater Monitoring Wells with Snapshot Data (CH2M Hill, 1998)

WELL_ID	X_WSP_N	Y_WSP_N	STATE	DEPTH	WL_DATE_1994	GW_ELEV_(FT_USGS)_1994	WL_DATE_1995	GW_ELEV_(FT_USGS)_1995
6306H01	2480633.55436	303449.29758	WA	136	09/13/94	1595.79	04/12/95	1597.37
6221K01	2459165.00111	285531.13365	WA	121	09/12/94	1599.72	04/11/95	1603.74
6221C05	2458422.24951	288881.21984	WA	100	09/12/94	1600.2	04/11/95	1604.04
6221D04	2456624.67884	287803.51209	WA	66	09/12/94	1600.38	04/11/95	1604.03
6227F01	2463540.48767	280265.60924	WA	126	09/13/94	1612	04/11/95	1625.77
6219A01	2449413.12751	286934.63989	WA	303	09/13/94	1615.5	04/11/95	1619.55
6234N03	2462612.85380	274358.61628	WA	71	09/16/94	1627.75	04/13/95	1632.03
5203H02	2467934.04718	271449.02318	WA	121	09/13/94	1645.43	04/13/95	1655.01
5203Q01	2464043.00333	269196.60314	WA	217	09/13/94	1645.46	04/11/95	1654.57
5203H01	2467040.02639	271904.00751	WA	124	09/15/94	1647.27	04/13/95	1647.15
5214C02	2469513.36983	261746.16664	WA	140	09/16/94	1677.77	04/13/95	1684.34
5214J01	2471742.42241	260437.40298	WA	160	09/16/94	1685.89	04/13/95	1692.82
5223B01	2470498.51932	257893.14543	WA	59	09/15/94	1687.61	04/13/95	1697.87
5213B01	2475681.88644	262521.48578	WA	208	09/14/94	1690.92	04/12/95	1700.37
6307G04	2480035.94737	299133.10287	WA	200	09/14/94	1700.56	04/12/95	1706.02
6308C02	2483172.01290	300699.81536	WA	< 100	09/13/94	1711.02		
6303N01	2492500.42008	301126.99293	WA	180	09/13/94	1742.47	04/12/95	1745.22
6318B01	2480195.91182	294049.87330	WA	282	09/13/94	1745.35	04/12/95	1748.58
5307M01	2478271.06370	266319.84038	WA	254	10/07/94	1748.1	04/11/95	1767.41
6309N01	2488446.59258	296922.28797	WA	< 175	09/13/94	1760.59	04/12/95	1761.24
6317J01	2486018.91452	292871.77569	WA	248	09/14/94	1776.27	04/12/95	1779.04
6316Q01	2490704.26483	293559.65267	WA	165	09/13/94	1787.68	04/12/95	1788.43
6319A02	2482012.94165	289743.43531	WA	228	09/14/94	1792.14	04/12/95	1796.99
6320D01	2480709.85625	289940.36253	WA	286	09/14/94	1792.58	04/12/95	1797.82
6310K01	2495380.36257	298083.63912	WA	116	09/13/94	1803.58	04/12/95	1815.58
6321J01	2490180.49499	287466.83815	WA	238	09/14/94	1815.53	04/12/95	1820.04
6330H02	2481302.37178	282901.91114	WA	310	09/15/94	1825.83	04/12/95	1837.58
6322N03	2492989.89751	285259.59546	WA	275	09/14/94	1830.63	04/12/95	1835.89
6331A02	2481870.91529	278325.18267	WA	272	09/15/94	1832.82	04/11/95	1845.98
6328M02	2487861.74711	282105.72267	WA	250	09/14/94	1836.14	04/12/95	1842.14
6330P03	2478623.67976	279486.40351	WA	234	09/15/94	1839.03	04/12/95	1845.98
6327H01	2498353.08362	281256.76151	WA	225	09/15/94	1848.6	04/12/95	1856.23
6331J01	2483412.48121	275612.36375	WA	222	09/13/94	1849.6	04/11/95	1856.72
5304B01	2490873.08798	274428.33289	WA	231	09/15/94	1851.87	04/11/95	1862.82
5304B02	2490873.08798	274428.33289	WA	216	09/15/94	1853.57	04/11/95	1862.28
5308A02	2487089.24771	268156.31067	WA	126	09/15/94	1854.37	04/11/95	1862.19
5308D01	2484242.94029	267804.76561	WA	77	09/13/94	1856.43	04/13/95	1862.88
5304G01	2492115.02195	272370.47073	WA	195	09/21/94	1857.04	04/11/95	1864.92
5308A01	2487334.24888	268152.31408	WA	124	09/15/94	1858.38	04/11/95	1866.03
5309E04	2488310.92123	267534.29739	WA	101	09/14/94	1859.57	04/11/95	1866.94
5304R01	2493520.39468	270642.18475	WA	185	09/14/94	1861.08	04/11/95	1869.21
5322F01	2495575.59669	256578.47969	WA	77	09/15/94	1863.45	04/12/95	1875.68
5316K01	2491965.57144	260684.98269	WA	65	09/15/94	1864.55	04/12/95	1871.96
5316R01	2494049.68276	260081.49448	WA	100	09/12/94	1866.13	04/12/95	1874.21
5310P02	2495260.65352	264712.27558	WA	96	09/15/94	1869.2	04/13/95	1876.85
5311E01	2499656.25387	268452.82765	WA	80	09/15/94	1870.77	04/11/95	1878.77
5311N01	2500025.81677	265454.27662	WA	70	09/13/94	1870.98	04/12/95	1878.17
5314E01	2499166.88297	262536.61178	WA	211	09/12/94	1872.05	04/11/95	1881.28
5311G01	2502193.07466	267756.50312	WA	46.7	09/14/94	1872.55	04/13/95	1881.39
5311G06	2502864.31115	268229.52820	WA		09/15/94	1872.67	04/13/95	1881.44
5322A02	2499279.66504	257859.94989	WA	79	09/16/94	1873.13	04/12/95	1881.83
5322A01	2499118.89036	257862.86808	WA	62	09/16/94	1873.15	04/12/95	1881.85
5322A03	2499217.27102	257857.61838	WA	103	09/16/94	1873.18	04/12/95	1881.87
5311H01	2502237.62669	267857.86883	WA	< 100	09/14/94	1873.65	04/12/95	1882.16
5314Q01	2502737.97330	260693.29782	WA	< 120	09/12/94	1876.8	04/11/95	1886.09
5311R01	2503428.38516	265978.98377	WA	104	09/13/94	1877.62	04/11/95	1887.12
5311J05	2504030.99681	266569.26971	WA	80	09/16/94	1878.04	04/12/95	1887.44
5312E01	2505571.04053	267292.76794	WA	103	09/14/94	1879.69	04/13/95	1888.58
5313E01	2504827.64895	261968.00430	WA	81	09/12/94	1880.67	04/11/95	1890.17
5312L03	2505699.46743	265992.68970	WA	90	09/12/94	1881.27	04/11/95	1890.87
5324G01	2508653.66880	257170.61074	WA	147	09/13/94	1882.46	04/12/95	1892.43

Groundwater Monitoring Wells with Snapshot Data (CH2MHill, 1998)

WELL_ID	X_WSP_N	Y_WSP_N	STATE	DEPTH	WL_DATE_1994	GW_ELEV_(FT_USGS)_1994	WL_DATE_1995	GW_ELEV_(FT_USGS)_1995
5312C01	2505617.57511	267908.47120	WA	80	09/14/94	1883.82	04/12/95	1892.93
5312H01	2509307.27225	268521.88185	WA	96	09/13/94	1887.35	04/11/95	1897.01
5418F01	2512052.81181	262648.24743	WA	110	09/15/94	1889.26	04/11/95	1899.1
5409E01	2520577.34695	268739.12983	WA	141	09/14/94	1890.89	04/11/95	1901.25
5406J03	2511221.50286	273621.21332	WA	180	09/13/94	1892.49	04/11/95	1902.74
5406A02	2513778.74754	274540.35514	WA	160	09/13/94	1893.58	04/11/95	1904.66
5407R01	2514579.95572	266535.29797	WA	120	09/13/94	1893.74	04/10/95	1904.04
6432Q02	2516967.82531	275735.13532	WA	139	09/13/94	1897.49	04/11/95	1907.99
5417M01	2515721.43601	261197.43489	WA	114	09/14/94	1898.6	04/11/95	1909.21
5408B01	2515993.42094	270384.35456	WA	120	09/13/94	1899.18	04/11/95	1909.15
5404K03	2523631.32026	272766.82218	WA	< 40	09/13/94	1900.16	04/11/95	1910.73
5404Q01	2525218.46922	271287.82455	WA	< 125	09/12/94	1905.31	04/11/95	1913.98
5416E01	2521032.46020	262788.89477	WA	128	09/14/94	1906.06	04/11/95	1917.16
5409Q01	2524676.54693	266989.12114	WA	< 125	09/13/94	1910.46	04/10/95	1921.64
5421N01	2521944.84287	255138.13275	WA	183	09/13/94	1910.77	04/11/95	1922.28
5428M02	2521856.67801	251513.16808	WA	160	09/13/94	1911.94	04/11/95	1923.95
5428P01	2522261.93703	250206.96353	WA	167	09/13/94	1912.75	04/11/95	1925.45
5415E01	2525578.39591	263432.86282	WA	158	09/14/94	1914.55	04/11/95	1925.49
5421J01	2525815.48972	257628.58231	WA	122	09/14/94	1915.19	04/11/95	1926.4
5428R01	2526190.79988	249977.00325	WA	132	09/14/94	1916.87		
5422R01	2531236.18900	255547.75223	WA	257	09/15/94	1919.72	04/11/95	1931.22
5426D01	2532058.79258	255259.23628	WA	170	09/15/94	1920.21	04/11/95	1931.74
5426L01	2533722.56142	252678.49808	WA	163	09/15/94	1920.97	04/11/95	1932.94
5411J01	2531155.12012	270166.53679	WA	85	09/13/94	1921.16	04/11/95	1927.8
5411N02	2531280.61897	265934.89631	WA	176	09/14/94	1922.08	04/10/95	1933.38
5423C01	2532595.78211	260022.63850	WA	97	09/15/94	1922.45	04/11/95	1933.61
5402N01	2531140.49217	271640.56403	WA	< 125	09/13/94	1923.35	04/11/95	1932.12
5423J03	2535791.65974	258049.58725	WA	210	09/15/94	1923.41	04/11/95	1935.11
5403B01	2527606.97653	275468.17453	WA	120	09/12/94	1925.09	04/11/95	1932.86
5411G01	2534246.36227	269624.48814	WA	< 125	09/13/94	1928.45	04/11/95	1938.59
5414J01	2535716.78303	263154.80312	WA	265	09/15/94	1928.5	04/11/95	1938.57
5402R01	2535120.94932	271783.41045	WA	< 125	09/13/94	1929.55	04/11/95	1940.32
5402B01	2534240.06969	275362.76908	WA	236	09/13/94	1930.05	04/11/95	1941.27
5412M01	2536057.56461	267372.04097	WA	< 150	09/12/94	1930.8	04/10/95	1942.34
5401D01	2535553.09496	275521.69608	WA	159	09/13/94	1931.83	04/11/95	1943.51
5401R01	2539719.02372	271899.34128	WA	150	09/12/94	1936.49	04/11/95	1948.51
5506D02	2540820.64639	276324.43811	WA	177	09/12/94	1938.35	04/11/95	1951.27
5517Q01	2550083.19574	261478.73562	WA	287	09/12/94	1941.62	04/10/95	1954.02
5516C01	2554976.91702	266365.20717	WA	129	09/12/94	1944.05	04/10/95	1956.42
5517D04	2547628.11055	266603.42472	WA	229	09/14/94	1944.25		
6532J02	2550990.14928	280325.51112	WA	152	09/12/94	1947.05	04/11/95	1959.84
5509B02	2554743.99944	271281.10680	WA	147	09/12/94	1947.42		
5503N01	2557969.23618	273902.99408	WA	138	09/12/94	1949.3	04/11/95	1961.78
5511M01	2564961.49279	268903.17326	WA	186	09/12/94	1949.38	04/10/95	1961.88
5515R01	2561481.49329	261938.38803	WA	155	09/12/94	1949.47	04/10/95	1970.49
5503D02	2556773.98299	277652.25056	WA	137	09/12/94	1949.52	04/12/95	1961.92
5510F01	2559487.74015	270984.36281	WA	85	09/14/94	1949.89	04/10/95	1962.34
5514F01	2564394.56736	265998.22675	WA	238	09/12/94	1950.45	04/10/95	1963.89
5511G01	2563387.21097	270009.17052	WA	< 150	09/12/94	1950.7	04/10/95	1963.68
6536N02	2566943.88164	278712.47703	WA	< 150	09/12/94	1955.85	04/11/95	1968.15
5501H03	2570332.09163	276321.76178	WA	165	09/12/94	1956.82	04/11/95	1969.42
6526H03	2566591.64835	286525.49703	WA	< 150	09/12/94	1958.42	04/11/95	1970.89
6619N01	2571755.12277	288728.03064	WA	263	09/12/94	1963.17	04/11/95	1976.04
6525J01	2571844.11757	287923.38255	WA	190	09/12/94	1964.52	04/11/95	1976.48
5311J06	2504030.99681	266569.26971	WA	98			04/12/95	-61.22
5311J07	2504030.99681	266569.26971	WA	120			04/12/95	-60.85
5313K01	2508932.98560	260933.12642	WA	125	09/16/94		04/10/95	1894.62
6331A03	2481870.91529	278325.18267	WA	272	09/15/94		04/11/95	1846.82

Groundwater Monitoring Wells with Snapshot Data (CH2MHill, 2000)

WELL_	WELL_NAME	X_WSP_N	Y_WSP_N	STATE	WL_DATE_1996	REF_ELEV_(CITY)	GW_ELEV_(CITY)	GW_ELEV_(FT_USGS)
1625H0	Yung	2577550.04563	291822.88643	ID	10/30/96	2125.07	2001.51	1984.58
0606Q0	Jacklin Seed	2581597.25116	279685.01808	ID	10/30/96	2129.34	2002.34	1985.41
1534B03	City of Post Falls #5	2596324.37145	290905.02924	ID	10/30/96	2246.12	2015.62	1998.69
1533E01	Schneidmiller(USGS)	2589533.27359	288114.64295	ID	10/30/96	2160.26	2008.13	1991.20
1531Q0	Greenacres Plant Food Ctr. #1	2581747.16034	284749.31779	ID	10/30/96	2146.97	2003.09	1986.16
1531E01	Beck, Don #1	2578062.13508	287542.40596	ID	10/30/96	2123.86	2000.87	1983.94
1530N0	POE Asphalt	2577779.88138	290138.69497	ID	10/30/96	2127.88	2001.49	1984.56
1528R03	East Greenacres ID #3C	2593100.22651	292047.68411	ID	10/30/96	2170.96	2012.21	1995.28
1528N0	East Greenacres ID #1C	2588630.21068	291112.62576	ID	10/30/96	2164.42	2009.37	1992.44
1527F01	Guy	2594766.00578	293847.00346	ID	10/30/96	2176.59	2013.49	1996.56
1522D0	East Greenacres ID #2B	2593071.16997	300770.69202	ID	10/30/96	2180.23	2015.28	1998.35
1521M0	Wolkenhaur	2588464.89855	297022.41336	ID	10/30/96	2156.39	2011.59	1994.66
1519K0	Hauser Lake Water Assoc. #1	2580072.00645	296670.45646	ID	10/30/96	2146.78	2006.61	1989.68
6631M0	Spokane County (SAJB MW#3)	2572296.74657	280712.64247	WA	10/30/96	2112.72	1994.22	1977.29
6619N0	Spokane County (208) Idaho Rd	2571755.08707	288728.01784	WA	10/30/96	2120.65	1994.23	1977.30
6536N0	Boshears	2566943.87684	278712.48672	WA	10/30/96	2086.38	1984.18	1967.25
6532J02	Schmidt	2550990.12768	280325.51452	WA	10/30/96	2115.72	1973.57	1956.64
6526H0	Pentler	2566591.62465	286525.46743	WA	10/30/96	2083.57	1987.38	1970.45
5517Q0	Spokane Gun Club	2550083.16174	261478.71272	WA	10/30/96	2062.95	1966.42	1949.49
5517D0	Spokane County (SAJB MW#1)	2547867.12523	266405.54148	WA	10/30/96	2058.29	1970.42	1953.49
5516C01	Inland Empire Paper	2554976.86802	266365.24967	WA	10/30/96	2073.36	1969.48	1952.55
5515R01	Liberty Lake Sewer District (Sprague)	2561481.48049	261938.34523	WA	10/30/96	2090.25	1977.49	1960.56
5514F01	Liberty Lake Sewer District (Schultz)	2564394.56276	265998.22595	WA	10/30/96	2160.83	1977.28	1960.35
5511M0	Kennert (North Well)	2564961.51989	268903.13936	WA	10/30/96	2127.41	1974.91	1957.98
5511G0	Bryant Motors	2563387.16787	270009.19191	WA	10/30/96	2074.00	1977.60	1960.67
5510F01	Delp	2559487.77185	270984.37631	WA	10/30/96	2040.47	1976.37	1959.44
5507A0	Spokane County (SAJB MW#2)	2546101.58964	271765.18247	WA	10/30/96	2044.08	1970.73	1953.80
5506D0	Borjessan	2540820.59859	276324.42091	WA	10/30/96	2081.61	1963.21	1946.28
5503N0	Coen	2557969.18708	273903.02817	WA	10/30/96	2065.11	1976.40	1959.47
5503D0	Otis Orchards School	2556773.99329	277652.28836	WA	10/30/96	2075.75	1976.55	1959.62
5501H0	Washington State Patrol	2570332.08893	276321.78918	WA	10/30/96	2067.92	1985.74	1968.81
5414J01	Vera Water and Power (#2 Test)	2535716.74313	263154.79092	WA	10/30/96	2061.20	1949.27	1932.34
5412M0	Central PreMix	2536057.57081	267371.99457	WA	10/30/96	2015.00	1953.48	1936.55
5401R0	Spokane Industrial Park #4	2539719.05932	271899.29508	WA	10/30/96	2034.94	1960.34	1943.41
5401D0	Trentwood ID #5	2535553.10796	275521.66738	WA	10/30/96	2068.47	1954.79	1937.86

Groundwater Monitoring Wells with Snapshot Data (USGS, 2000)

WELL_ID	X_WSP_N	Y_WSP_N	GW_ELEV _(USGS) MAR_2000	GW_ELEV _(USGS) AUG_2000
25N44E01BBCC01	2535648.50236	275495.82209	1944.45	
25N44E01CBBA01	2536796.22980	273800.94758		
25N44E01DBDD01	2539598.20111	272998.97084		
25N44E01DCDD01	2539728.44688	271606.52780	1951.63	1947.34
25N44E11DDAC01	2535731.38015	267067.88145	1940.17	1932.11
25N44E11DDAD01	2535679.20837	266919.34577	1940.31	1932.62
25N44E11DDDD01	2536064.59531	266280.25544		1931.75
25N44E12BBBD01	2536415.83680	270898.06261		
25N44E12CBCD01	2536629.86914	267782.29987	1949.25	1943.66
25N44E12CCAB01	2536958.04144	267414.40022	1947.87	1940.64
25N44E12DABB01	2540185.37425	268944.18078	1952.78	1948.30
25N44E24BDAA01	2538914.25272	259345.42927	1943.61	
25N45E01ABDD01	2570961.65537	277260.96058		1976.58
25N45E01ABDD02	2570961.65537	277260.96058		1981.91
25N45E01ABDD03	2570924.00994	277123.98337		1976.78
25N45E01ACAD01	2570770.60406	276583.24089		1976.10
25N45E01ADBB01	2571161.85401	276799.68683	1975.62	1973.83
25N45E01ADCD01	2571620.74261	275741.24292		
25N45E01BBAA01	2568347.49930	277979.89778	1976.28	1974.74
25N45E01CBBD01	2567790.58256	275005.40804		2000.02
25N45E01CBBD02	2567790.58256	275005.40804		2016.88
25N45E01CBBC01	2567461.59866	275076.94313		1988.67
25N45E02AACD01	2565023.20662	275476.27372		
25N45E02DDDD01	2567139.08600	273001.40729		
25N45E03BDAA01	2559165.36740	275618.34090		1966.84
25N45E03BDAA02	2559044.09976	275729.31815		
25N45E03CBDD01	2557960.15189	273777.73561	1964.69	
25N45E03CDDA01	2559365.23557	273075.32464		1966.94
25N45E03CDDD01	2559212.34576	272516.45908		1966.39
25N45E04BAAC02	2553516.41231	276955.50410		
25N45E05BBBC01	2545967.78324	276541.74211		1953.70
25N45E05DDBA01	2550551.69290	273190.05832	1962.61	1959.63
25N45E06BBCA01	2541147.30437	276249.66500	1955.11	1951.51
25N45E07AAAA02	2546070.66865	271813.88785		
25N45E07AAAA04	2546135.17886	271857.14387	1955.05	1951.92
25N45E07ADDD01	2546403.11765	269452.44925	1955.06	1952.64
25N45E08BDAA01	2548810.13876	270429.60463	1960.50	1957.47
25N45E08CBBC01	2546637.82024	268722.35768	1954.72	1951.21
25N45E08CBBC02	2546566.42094	268616.68962	1953.63	1950.33
25N45E09ABCD01	2554901.62445	271193.92067	1962.44	1959.00
25N45E09ADAB01	2556499.17266	270745.26966		1970.04
25N45E09ADAD01	2556848.95402	270448.12988		1967.42
25N45E10BAAA01	2559282.91420	272180.25210		1989.18
25N45E10BAAA02	2559280.42342	272282.38594		1981.18
25N45E10BAAA03	2559266.91510	272205.03931		
25N45E10BDAD01	2559461.00146	270797.50097	1957.66	1955.63
25N45E10CBDA01	2558058.82085	268790.31326		1964.82
25N45E10DBCB01	2559816.94120	268952.28283	1968.58	1966.43
25N45E11CCAA01	2563371.90218	268683.32782	1969.86	1967.09
25N45E14BACD01	2564474.85254	266096.72205	1970.30	
25N45E14CABB01	2564283.90487	264498.78872	1973.95	

Groundwater Monitoring Wells with Snapshot Data (USGS, 2000)

WELL_ID	X_WSP_N	Y_WSP_N	GW_ELEV _(USGS) MAR_2000	GW_ELEV _(USGS) AUG_2000
25N45E14CCDD01	2563802.15047	262083.24386		
25N45E15BADA01	2559529.98853	266276.07945	1963.54	
25N45E15BADC01	2559230.88870	265932.89108	1962.06	
25N45E15DDCC01	2561463.50267	261973.04317	2014.24	
25N45E16ACAB01	2555274.05481	265525.88263		
25N45E17BBAA01	2547777.78551	266549.32118		
25N45E17BBAA05	2547852.64484	266479.87100	1954.86	1951.80
25N45E17CDDD01	2549407.39019	261631.72767		
25N45E17DCCB01	2549816.75376	261790.14558	1956.96	1953.56
25N45E18DDCB01	2545735.35644	261802.80859		
25N45E23BBAA01	2563846.50796	261983.15045	1971.09	
25N46E06BBCB01	2572451.76337	277542.44526	1978.90	1977.80
25N46E06BCDD01	2573796.78628	275815.54599	1985.43	1984.98
25N46E06CBB01	2573052.58215	275055.75207		
25N46E06CCDD01	2573910.46967	273209.90486	1987.23	1987.73
25N46E07BCAC01	2573822.37270	271445.25341		
25N46E07BCAD01	2573710.72391	271158.53880	1988.05	1988.88
25N46E07BCDA01	2573952.11121	270914.79236		
25N46E07CACC01	2574094.10981	269935.72918		
26N45E24DDDA01	2571652.28290	289324.88040	1959.24	1957.50
26N45E25ABBC01	2569459.23917	288424.54562		
26N45E25BAAA01	2568966.67204	288670.61363	1981.87	
26N45E25BAAA02	2568937.66595	288709.36251		
26N45E25BCCC01	2566667.83479	286253.47579	1979.43	1977.64
26N45E25CCAC01	2567563.39616	284321.58665	1980.34	1978.83
26N45E25CCBB01	2566912.62823	284424.83492	1969.61	
26N45E25DAAB01	2571526.30032	285977.02180	1979.61	
26N45E25DAAC01	2571280.84034	285756.77458	1984.61	1983.37
26N45E25DAAC02	2571302.07023	285776.07953	1979.30	
26N45E25DDAA01	2571898.30169	284728.05989	1979.82	1979.39
26N45E26ACDD01	2565039.91124	286334.53387		
26N45E27CBAC01	2556644.11249	284965.61341		
26N45E27CBDA01	2556973.83560	284568.91359		
26N45E27CBDA02	2556988.34900	284828.90473		
26N45E32ADAA01	2550832.91682	281080.68587	1965.48	
26N45E32DBDA01	2549681.74660	279082.54362	1960.50	
26N45E32DCBC01	2548681.45154	278044.85869	1962.12	1959.05
26N45E32DCCD01	2549074.46587	277355.26070	1959.88	
26N45E33ACAB01	2554259.78853	281318.89717		
26N45E34ACDB01	2558483.88938	279704.67936	1961.90	
26N45E34ACDB02	2558455.99893	279568.20415		
26N45E35BDBD03	2563333.03437	281415.93897		
26N46E31CBBC01	2572339.79159	280867.63186	1978.15	1977.60
26N46E31DBAD03	2572240.38125	280683.78460		
50N04W05CBAA01	2616408.17981	283396.00986		
50N04W06BADA01	2612269.14005	285312.36415		
50N05W01ACBB01	2607406.28383	284288.88829	2050.46	
50N05W01CBBB01	2604667.49685	282936.52026		
50N05W04ACDA01	2592387.44926	282862.58604		
50N05W04ACB01	2590327.37537	281473.46308	2014.02	

Groundwater Monitoring Wells with Snapshot Data (USGS, 2000)

WELL_ID	X_WSP_N	Y_WSP_N	GW_ELEV _(USGS) MAR_2000	GW_ELEV _(USGS) AUG_2000
50N05W04CABD01	2590443.84420	282001.58277		
50N05W04CACC02	2590241.89609	281260.99390	1996.98	1997.48
50N05W06DCDC01	2581598.57147	279682.36884	1992.82	
50N05W07ADDD01	2583334.30443	277106.32336	1994.80	
50N05W07BCCC01	2578377.05031	276933.06837	1987.70	1987.63
50N05W07CBBD01	2578471.39955	276273.05462		
50N05W07DABC01	2582555.31043	276161.79327		2009.95
50N05W07DABC02	2582558.59791	276194.82649		
50N05W07DBBA01	2581250.98262	276557.09220	2055.83	2047.53
50N05W07DBBA02	2580124.38154	277297.29893		
50N05W07DCCB01	2580835.50759	274695.75704		
50N05W08BBBB01	2583699.54586	279524.01076		
50N05W10BAAA01	2596609.73387	279748.21635		
50N05W12BBBD02	2605300.56758	279948.25411	1999.87	
50N05W12BBAB01	2605652.96843	280145.19195		
50N05W12BBBD01	2605130.78599	280038.21356		
50N05W12BBDA01	2605762.68252	279734.41376		
50N05W12BBDA02	2605803.37477	279758.40385		
50N05W12BCAD01	2605851.55828	278668.79240	2014.60	
50N05W12BCDA01	2606065.78004	278336.39467	2067.21	
50N05W12CCCC01	2605186.91757	275453.66321		
50N06W12BDAC01	2575029.69494	277213.04980		
50N06W12CABA01	2574789.09977	276193.19071		
50N06W12CACA01	2574913.08027	275479.84644	1986.68	1986.33
50N06W12CBDB01	2574015.50017	275530.51192	1986.84	1986.56
50N06W12CCAD01	2574359.44066	274506.62985	1982.81	
50N06W12CCAD02	2574271.66956	274586.29813	1986.71	
50N06W12DBAD01	2576989.17607	275980.53154	1987.33	1986.76
50N06W12DBCD01	2576288.47155	275390.75365	1986.77	1986.65
50N06W12DCDD01	2577122.15253	274040.52890		
50N06W12DDAB01	2578001.68301	275103.01300	1987.32	1987.46
50N06W12DDCD01	2577733.77112	274238.79928	1987.51	1982.46
50N06W12DDDB02	2577987.65247	274539.88966	1987.26	1986.68
50N06W13ACDB01	2576648.90376	271891.58596		
50N06W13CAAD01	2575913.63798	270799.78255		
50N06W13CABA01	2575293.26687	271075.91871	1988.40	1989.54
51N04W20CBCD01	2614459.27144	298256.23612	2005.32	
51N05W19DBC3	2580073.96817	296669.52938		
51N05W26AAA1	2603507.77341	296026.07463		
51N05W26BBDA01	2599794.28994	295026.47928		
51N05W27DCCC01	2596314.59440	290905.75095		
51N05W28DAD1	2593095.49578	292149.47143		
51N05W31BCCB01	2577872.06259	287670.90439	1992.35	1991.90
51N06W36DAAA01	2577506.85576	286984.46853	1991.19	1991.03
51N06W36DDAA01	2577684.10159	285495.87119	1987.33	
25N44E12CCDC01	2536888.46404	266279.06598		

Groundwater Monitoring Wells with Extended Periods of Record

WELL ID	WELL NAME	DATA SOURCE	DATA TYPE	DATA RES	POR DATES	POR YRS	AQUIFER	X WSP N	Y WSP N	STATE
0507J01	USGS_15	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2582555.31043	276161.79327	ID
0507J02	USGS_15	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2582558.59791	276194.82649	ID
5202E01	CITY_WWTP	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	1/1995-1/2001	1-10	W_SVRP	2467934.04718	271449.02318	WA
5304G01	CITY_NE_COMMUNITY	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	1/1995-1/2001	1-10	W_SVRP	2492115.02191	272370.47069	WA
5307M01	CITY_TRINITY	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	3/1995-1/2001	1-10	W_SVRP	2478271.06371	266319.84041	WA
5308H01	CITY_MARIETTA	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1994-10/2000	1-10	W_SVRP	2488310.92127	267534.29735	WA
5309M04	AVISTA_MISSION	SPOKANE_CO2001	WL_HYDRO	WEEKLY	12/1998-7/1999	<1	W_SVRP	2498839.13009	269122.27885	WA
5311D03	UPRIVER_GREENHOUSE	SPOKANE_CO2001	WL_HYDRO	WEEKLY	12/1998-7/1999	<1	W_SVRP	2499183.73683	266719.12921	WA
5311E03	AVISTA_BEACON	SPOKANE_CO2001	WL_HYDRO	WEEKLY	12/1998-7/1999	<1	W_SVRP	2502956.20628	268084.58939	WA
5311H01	UPRIVER_USGS	SPOKANE_CO2001	WL_HYDRO	WEEKLY	12/1998-7/1999	<1	W_SVRP	2488927.65849	264467.70504	WA
5311J07	CITY_HALES	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1994-11/1999	1-10	W_SVRP	2504030.99680	266569.26975	WA
5312C01	CITY_FELTS_FIELD	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1994-1/2001	1-10	W_SVRP	2505617.57510	267908.47122	WA
5314E01	CITY_CENTRAL_PREMIX	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	12/1994-1/2001	1-10	W_SVRP	2499166.88296	262536.61183	WA
5322A03	CITY_THIRD_HAVANNA	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	12/1994-1/1999	1-10	W_SVRP	2499279.66501	257859.94993	WA
5411R02	SULLIVAN_N(SULLIVAN_N_1)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1998-9/2000	1-10	C_SVRP	2535679.20837	266919.34577	WA
5411R03	SULLIVAN_S(SULLIVAN_N_2)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1998-9/2000	1-10	C_SVRP	2535731.38015	267067.88145	WA
5411R04	SULLIVAN_S	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1998-9/2000	1-10	C_SVRP	2536064.59531	266280.25544	WA
5412M01	CENTRAL_PREMIX	SPOKANE_CO2001	WL_HYDRO	WEEKLY	12/1998-7/1999	<1	C_SVRP	2536629.86914	267782.29987	WA
5414J01	VERA_2	SPOKANE_CO2001	WL_HYDRO	WEEKLY	1/1967-12/2000	1-10	C_SVRP	2535716.78300	263154.80313	WA
5415J01	VERA_1	SPOKANE_CO2001	WL_HYDRO	WEEKLY	1/1967-12/2000	20-50	C_SVRP	2530783.66572	262549.97788	WA
5422H02	VERA_6	SPOKANE_CO2001	WL_HYDRO	WEEKLY	1/1967-12/2000	20-50	C_SVRP	2530890.84168	258624.70707	WA
5422R01	VERA_3	SPOKANE_CO2001	WL_HYDRO	WEEKLY	1/1967-12/2000	20-50	C_SVRP	2531236.18898	255547.75226	WA
5423C01	VERA_7	SPOKANE_CO2001	WL_HYDRO	MONTHLY	5/1967-12/2000	20-50	C_SVRP	2532595.78208	260022.63853	WA
5423J03	VERA_8	SPOKANE_CO2001	WL_HYDRO	MONTHLY	5/1987-12/2000	1-10	C_SVRP	2535791.65976	258049.58721	WA
5426D01	VERA_5	SPOKANE_CO2001	WL_HYDRO	WEEKLY	1/1967-12/2000	20-50	C_SVRP	2532058.79259	255259.23632	WA
5426L01	VERA_4	SPOKANE_CO2001	WL_HYDRO	WEEKLY	1/1967-12/2000	20-50	C_SVRP	2533722.56138	252678.49810	WA
5501B01	USGS_1	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2570961.65537	277260.96058	WA
5501B02	USGS_2	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2570961.65537	277260.96058	WA
5501B03	USGS_3	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2570924.00994	277123.98337	WA
5501G01	USGS_4	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2570770.60406	276583.24089	WA
5501M01	USGS_9	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2567790.58256	275005.40804	WA
5501M02	USGS_8	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2567790.58256	275005.40804	WA
5501M03	USGS_10	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2567461.59866	275076.94313	WA
5503F04	USGS_13	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2559165.36740	275618.34090	WA
5503P01	USGS_7	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2559365.23557	273075.32464	WA
5503P02	USGS_17	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2559212.34576	272516.45908	WA
5505D01	TRENT_BARKER	SPOKANE_CO2001	WL_HYDRO	WEEKLY	3/1999-7/1999	<1	E_SVRP	2545967.78324	276541.74211	WA
5507A04	BARKER_EUCLID(CID_BARKER_N)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	5/1999-8/2000	1-10	E_SVRP	2546135.17886	271857.14387	WA
5507H01	BARKER_N	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1998-9/2000	1-10	E_SVRP	2546403.11765	269452.44925	WA
5508M01	BARKER_CENTENNIAL_N(BARKER_S_2)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1998-9/2000	1-10	E_SVRP	2546637.82024	268722.35768	WA
5508M02	BARKER_CENTENNIAL_S(BARKER_S_1)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	11/1998-9/2000	1-10	E_SVRP	2546566.42094	268616.68962	WA
5509H01	USGS_5	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2556848.95402	270448.12988	WA
5509H02	USGS_6	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2556499.17266	270745.26966	WA
5510C01	USGS_11	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2559282.91420	272180.25210	WA
5510C02	USGS_12	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2559280.42342	272282.38594	WA
5510C03	USGS_18	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2559266.91510	272205.03931	WA
5510M01	USGS_14	SPOKANE_CO2001	WL_HYDRO	RANDOM	6/2000-3/2001	<1	E_SVRP	2558058.82085	268790.31326	WA
5516C01	INLAND_EMPIRE	SPOKANE_CO2001	WL_HYDRO	MONTHLY	7/1929-01/2001	>50	E_SVRP	2475549.45864	263131.38056	WA
5517D05	BARKER_MISSION(CID_BARKER_S)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	5/1999-9/2000	1-10	E_SVRP	2547852.64484	266479.87100	WA
6212L01	WHITWORTH_4	SPOKANE_CO2001	WL_HYDRO	RANDOM	1997-2001	1-10	N_SVRP_U	2473630.44089	296700.07176	WA
6307G01	WHITWORTH_3B	SPOKANE_CO2001	WL_HYDRO	RANDOM	1979-2001	20-50	N_SVRP_U	2480035.52107	299133.20876	WA
6308B04	ECOLOGY_DAKOTA	SPOKANE_CO2001	WL_HYDRO	DAILY	5/1998-8/1999	1-10	N_SVRP_U	2484914.30239	300581.82455	WA
6308F02	ECOLOGY_MAYFAIR	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	9/1997-9/2000	1-10	N_SVRP_L	2482486.83892	299057.26794	WA
6319A01	WHITWORTH_2A	SPOKANE_CO2001	WL_HYDRO	RANDOM	1979-2001	20-50	N_SVRP_L	2482012.57286	289743.12250	WA
6320D01	WHITWORTH_2B	SPOKANE_CO2001	WL_HYDRO	RANDOM	1979-2001	20-50	N_SVRP_L	2480709.55345	289940.10123	WA
6330F01	WHITWORTH_1	SPOKANE_CO2001	WL_HYDRO	RANDOM	1955-2001	20-50	N_SVRP_L	2479373.76912	282470.12269	WA
6331J01	CITY_FRANKLIN	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	1/1996-1/2001	1-10	W_SVRP	2483412.48151	275612.36375	WA
6525R01	IDAHO_RD_PIPELINE	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	5/1999-9/2000	<1	E_SVRP	2571898.30169	284728.05989	WA
6631M07	CID_11(IDAHO_RD)	SPOKANE_CO2001	WL_HYDRO	DAILY_AVG	5/1999-9/2000	<1	E_SVRP	2572339.79159	280867.63186	WA
7332H01	WHITWORTH_8A1	SPOKANE_CO2001	WL_HYDRO	RANDOM	1997-2000	1-10	S_LSR	2486001.30116	308535.97188	WA
7332H02	WHITWORTH_8A2	SPOKANE_CO2001	WL_HYDRO	RANDOM	1992-2001	1-10	S_LSR	2486001.30116	308535.97188	WA
7333E01	WHITWORTH_8B	SPOKANE_CO2001	WL_HYDRO	RANDOM	1988-2001	10-20	S_LSR	2487671.13266	309706.17192	WA
8316D01	ECOLOGY_CHATTEROY	SPOKANE_CO2001	WL_HYDRO	QUARTERLY	4/1978-3/2000	20-50	LSR	2484190.17458	357784.77231	WA
8323C01	SCWD3_CHATTEROY_HILLS	SPOKANE_CO2001	WL_HYDRO	RANDOM	2/1998-9/1998	<1	LSR	2497240.25134	353590.07039	WA
9233G01	ECOLOGY_DEER_PARK	SPOKANE_CO2001	WL_HYDRO	QUARTERLY	4/1978-3/2000	20-50	DP	2454676.87647	370689.61788	WA

Note: E_SVRP - Eastern portion of the Spokane Valley Rathdrum Prairie Aquifer
 C_SVRP - Central portion of the Spokane Valley Rathdrum Prairie Aquifer
 W_SVRP - Western portion of the Spokane Valley Rathdrum Prairie Aquifer
 N_SVRP_U - Northern portion of the Spokane Valley Rathdrum Prairie Aquifer, Upper Sands and Gravels
 N_SVRP_L - Northern portion of the Spokane Valley Rathdrum Prairie Aquifer, Lower Sands and Gravels
 LSR - Little Spokane Aquifer Area
 S_LSR - Southern portion of the Little Spokane Aquifer Area
 DP - Deer Park Groundwater Basin

Summary of Estimated Spokane River Gains and Losses

Spokane River Stage Measurement Station		Average River Width (ft)	Broom (1951)	Drost & Seitz (1978)	Bolke & Vaccaro (1981)		Miller (unpublished 1996)		CH2MHill (1998)			Gearhart & Buchanan (2000)
Upstream	Downstream		Gain / Loss	Gain / Loss	Leakage Coefficient (sec ⁻¹)	Gain / Loss	Gain / Loss at Low Flow	Gain / Loss at Medium Flow	Leakage Coefficient (sec ⁻¹)	Gain / Loss Fall 1994	Gain / Loss Spring 1995	Gain / Loss Dec 1998 to Jul 1999
State Line	Harvard Rd	350										
Harvard Rd	Barker Rd	300	-78	-80				5.0E-07	-45	-71	-307 to -47	
Barker Rd	Sullivan Rd	200			6.20E-07	-50	-319	2.0E-06	-91	-100	-137 to -29	
Sullivan Rd	Kaiser	150						1.0E-06	-7	-5	-28 to +126	
Kaiser	Trent Ave Brg	150	370	330	1.00E-04	240		5.0E-04	22	64	-88 to +50	
Trent Ave Brg	Plantas Ferry	200						5.0E-06	1	16		
Plantas Ferry	Argonne	250						5.0E-07	-12	-4		
Argonne	Upriver Dam	400			6.20E-07	-40	Unquantified loss	5.0E-08	-6	-4	-53 to +30	
Upriver Dam	Green St	100	566		2.00E-04	270	209	1.0E-03	149	194		
Green St	Mission St Brg	250		230				5.0E-06	-38	-32		
Mission St Brg	Sirti	300						5.0E-06	-22	-9		
Sirti	Monroe St	300			6.20E-07	-200	63	5.0E-06	-15	-1	-42	
Monroe St	Cochrane St	200	-39		1.00E-05	130	-57	5.0E-06	-42	-41		
Cochrane St	Meenach Brg	200			4.00E-06	-45		5.0E-06	-110	-80		
Meenach Brg	Albi Park	150	126	120	2.00E-06	-40		1.0E-05	50	56		
Albi Park	7 Mile	200			4.00E-06	50		1.0E-05	77	82		
7 Mile	9 Mile Falls	750	21	100	1.00E-07	-40		1.0E-05	6	9	147	
State Line to USGS at Cochrane St			819	580		350	214		-106	3		
State Line to Mission St Bridge			858	480		220	271		-64	44		
USGS at Cochrane St to 9 Mile Falls			147	220		-75			23	87		
Total (State Line to 9 Mile Falls)			966	700		275			-83	70		

Note: All values for flows, gains, and losses are in ft³/second or cfs.

Adapted from CH2MHill, 1998.

WRIA 57 extends to just downstream of the USGS Cochrane St Gage (also known as Spokane River at Spokane) Leakage Coefficient defined as the vertical hydraulic conductivity of the streambed divided by the streambed thickness

Compilation of Vertical Riverbed Hydraulic Conductivity Estimates

STUDY	Vertical Riverbed Hydraulic Conductivity (ft/sec)
Spokane Aquifer	
Drost & Seitz (1978)	1×10^{-4} to 1×10^{-3}
Bolke & Vaccaro (1981) ¹	1×10^{-7} to 2×10^{-4}
Gifford Consultants, Inc. (unpublished 1995)	1.6×10^{-4} to 4.8×10^{-2}
CH2MHill (1998) ¹	7×10^{-7} to 1×10^{-3}
Other Sand and Gravel Aquifers in the US	
Duwelius (1996)	3.4×10^{-6} to 8×10^{-4}
Yager (1993)	1.2×10^{-6} to 5.8×10^{-6}
Barker and MacNish (1976)	1.55×10^{-4} to 2.5×10^{-3}
Walton, Hills & Grunden (1967)	6.38×10^{-6}
Moore & Jenkins (1966)	2.17×10^{-5} to 2.63×10^{-5}
Weeks, Erickson & Holt (1965)	1.55×10^{-5} to 6.2×10^{-5}

Note: 1) Values given as leakage coefficients
 Adapted from Gearhart & Buchanan (2000)