2007 Annual Water Quality Monitoring Report

Spokane Valley-Rathdrum Prairie Aquifer Long Term Monitoring Program

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Introduction

The following report presents the field work, analytical results and findings from the 2007 Spokane Valley Rathdrum Prairie (SVRP) Aquifer Long Term Water Quality Monitoring Program. Spokane County Water Resources staff collected field data and groundwater samples on a quarterly basis during 2007 from 29 dedicated monitoring wells, 17 public supply wells, and 4 springs.

1.1 Background

In 1978 the Environmental Protection Agency (EPA) designated the SVRP Aquifer as a "Sole Source Aquifer" under Section 1424(e) of the Safe Drinking Water Act. From May 1977 to June 1978 the Spokane County Water Quality Management Program conducted a one year study of the aquifer to determine if surface "recharge" is occurring to carry ground surface pollutants to the aquifer, and if so, the effect of such activities. The study concluded that domestic, municipal, commercial, agricultural, and industrial activities do impact aquifer water quality.

The 1978 Spokane Aquifer Cause and Effect Report determined that on-site sewage systems contribute to water quality degradation in the SVRP aquifer. As a result the 1979 Spokane Aquifer Water Quality Management Plan included the following:

> *The recommendations for handling sanitary wastewater and mitigation of its pollution to the groundwater include the collection of all sewage from urbanized areas and treatment for discharge in such manner that the pollutants cannot enter the aquifer. Central sewer planning within the aquifer sensitive area should result in sewering of areas that have been urbanized or are to be urbanized.*

The 1983 update to the Spokane Aquifer Cause and Effect Report found that there was an increasing trend in nitrate concentrations in the aquifer confirming the need to address on-site sewage disposal.

Spokane County Utilities began implementation of the Septic Tank Elimination Program (STEP) to address concerns that onsite sewage systems contribute to water quality degradation in the aquifer. To date, a significant portion of existing septic systems have been converted to sewer and it is anticipated that STEP will be completed by 2012.

As a result of the study findings the *Spokane Aquifer Water Quality Management Plan* was developed. One recommendation of the plan was to develop and implement a long term ground water quality monitoring program to assess the effectiveness of STEP. From 1980 to 2000 the Spokane Regional Health District (SRHD) conducted the aquifer monitoring program and in 2000 the Spokane County Water Resources section of the

Division of Utilities (formerly the Spokane Water Quality Management Program) undertook the aquifer monitoring program.

The original study included 80 sample locations. Sixty locations were existing water supply wells, both water purveyor and private wells, and 20 locations were dedicated monitoring wells. From 1980 to 1996 all sampling locations were water supply wells. In 1996 dedicated monitoring wells were added to the monitoring network. In 2007 4 spring/seep sampling locations were added. Currently the monitoring network is comprised of 29 dedicated monitoring wells, 17 public supply wells and 4 spring locations. Figure 1 shows the current sampling locations.

1.2 Program Objectives

The SVRP long term monitoring program has three objectives: 1) Asses the current aquifer water quality; 2) Identify spatial and temporal water quality trends; and 3) Evaluate water quality trends that are related to the Spokane County Septic Tank Elimination Program.

2 Study Area Description and Hydrogeological Setting

2.1 Aquifer Hydrogeology

The SVRP aquifer underlies about 370 square miles of relatively flat, alluvial valley surrounded by bedrock highlands (Kahle and others, 2005). The aquifer consists primarily of coarse-grained sediments including sand, gravels, cobbles, and boulders. There is generally a greater percentage of finer material near the margins of the valley and becomes more coarse near the center throughout the Rathdrum Prairie and Spokane Valley. In the northwest portion of the aquifer, often referred to as the Hillyard Trough, the deposits are finer grained and the aquifer consists of sand with some gravel, silt, and boulders. The aquifer is highly productive aquifer. Aquifer wells yield as much as several thousand gallons per minute with relatively little drawdown. The hydraulic conductivity of the aquifer sediments is at the upper end of values measured in the natural environment (Kahle and others, 2005)

2.2 Spokane River/SVRP Aquifer Interaction

The Spokane River is the largest source of recharge to the aquifer and receives the largest amount of outflow from the aquifer. A groundwater budget for the SVRP Aquifer developed by the USGS in 2007 estimates the Spokane River discharges 718 ft^3/s to the aquifer, representing 49 percent of the total mean annual aquifer inflow of 1,417ft^3/s.

The Spokane River receives an estimated 861 ft^3/s from the aquifer representing 59 percent of the total mean annual outflow of 1,468 ft^3/s. There are two distinct river reaches where the Spokane River receives water from the aquifer: 1) Flora Road to Upriver Dam; and 2) The Spokane Gage to Nine Mile Dam. These reaches are considered gaining reaches. There are also two distinct river reaches were the Spokane River discharges to the aquifer: 1) Coeur d'Alene Lake to Flora Road; and 2) Green Street to Monroe Street. These reaches are considered losing reaches. Aquifer water quality in the immediate vicinity of the river in the losing reaches is influenced by river water quality.

2.3 Monitoring Network

The current monitoring network is spatially distributed to provide information on water quality throughout the aquifer. In addition to assessing general water quality, the monitoring network provides data for specific objectives. Four monitoring locations are at the Washington/Idaho border and provide a baseline to which water quality data from down gradient wells can be compared. At Barker Road there are four monitoring locations that provide data to evaluate the water quality in the vicinity of a losing reach of the Spokane River. At Sullivan Road there are three monitoring locations that provide data to evaluate water quality in the vicinity of a gaining reach of the Spokane River.

Samples from the dedicated monitoring wells are taken from 1 to 1.5 feet below the static water level, or water table, and therefore provide data on water quality at the surface of the aquifer. The rational for this approach is that impacts to the aquifer will occur first at the surface. There are two locations that have "nested wells" that provide data at the same location but different depths. Many of the water supply wells also withdraw water from greater depth than the dedicated monitoring wells.

In 2007 four spring locations were added to the monitoring network. Three locations will be sampled quarterly, and one location (Sullivan Springs) will be sampled when the river elevation allows sample collection. These locations provide additional water quality information on aquifer water that enters surface water bodies, both the Spokane and Little Spokane Rivers.

3 Summary of Field Activities

3.1 Monitoring Events

Sample collection, groundwater elevation measurement, and field parameter measurement was conducted quarterly during 2007. Monitoring events occurred during the first week of February, the first week of May, the first week of August, and the last week of October. A quarterly monitoring event usually occurs over the course of one week.

3.2 Field Methods

During 2007 Spokane County Water Resources staff developed a Quality Assurance Program Plan (QAPP) for the Long Term Monitoring Program. As part of this program staff implemented new monitoring procedures. As a result two different sample collection techniques were utilized during 2007.

3.2.1 First and Second Quarter Monitoring Events

Dedicated monitoring wells were sampled in the following manner. The depth to groundwater in the well was measured and recorded on field sheets. The pump intake was positioned 1 to 1.5 feet below the water table surface an adequate distance below the top of the screened interval to prevent the pump from drawing the water surface down and pumping air. In locations where the water table surface lies above the screened interval, the pump intake was positioned at the top of the screened interval. Appendix A shows the monitoring well construction details used to set the pump depth. The monitoring wells are purged of at least three well volumes and/or the field parameter specific conductance is consistent, to ensure collection of representative groundwater samples. Water supply wells used for groundwater monitoring are run a minimum of five minutes before the sample is collected to obtain a representative sample. Groundwater samples are collected from spigots on the purveyor well discharge lines as close to the pump as possible. The field parameters depth-to-water, temperature, pH, and specific conductance are recorded on field sheets. Groundwater samples are delivered to the laboratory under Chain-of-Custody procedures. Copies of the Chain-of-Custody forms are available on request.

3.2.2 Third and Fourth Quarter Monitoring Events

For the third and fourth quarter monitoring events staff utilized low flow sampling techniques. Those techniques are described in the August 2007 QAPP. Both well purging and low flow sampling are consistent with EPA and USGS groundwater monitoring guidance and yield representative results.

4 Program Results

Quarterly analytical and field results are presented in Appendix B.

4.1 Data Quality

Analytical services were provided by Test America in Spokane, WA and Test America in Bothell, WA. Analytical results were validated to ensure data quality objectives - including precision, accuracy, representativeness, and completeness - outlined in the QAPP were met. Data anomalies that have a small impact on data quality and usability are documented in Appendix C. Major data anomalies in 2007 include the following:

> *1st Quarter:* A significant matrix spike recovery (-9%) discrepancy resulted in rejection of nitrate/nitrite results for 2 samples. Orthophosphate was measured in a method blank which resulted in the rejection orthophosphate results for 11 samples.
>
> *2nd Quarter:* Orthophosphate was measured in a method blank which resulted in the rejection orthophosphate results for 2 samples.
>
> *3rd Quarter:* A significant matrix spike recovery (-9%) discrepancy resulted in rejection of zinc results for 2 samples.
>
> *4th Quarter:* No major data anomalies.

Another data quality objective of the Long Term Monitoring Program is to ensure the greatest possible degree of comparability with data from previous years. In accordance with guidelines detailed in the QAPP, the 2007 data set meets data comparability goals with one exception. Significant increases in detection limits for total phosphorus in 2007 impacted data usability of the 1st, 2nd, and 3rd quarter total phosphorus results. Total phosphorus detection limits were 0.02 mg/L for the 1st and 2nd quarter and 0.06 mg/L for the 3rd quarter. EPA method 365.2 specifies a detection limit of 0.01 mg/L for total phosphorus. A detection limit as low as 0.005 mg/L is achieved by many analytical service providers and has been achieved by Test America in the past. The Test America reported that total phosphorus detection limits were increased as the result of a regular method detection limit study. At the request of Spokane County staff 4th quarter samples for total phosphorus were sent to Test America in Bothell, WA for analysis to achieve a detection limit of 0.005 mg/L.

4.2 Aquifer Water Levels

Table 4-1 presents a comparison of static water levels measured in dedicated monitoring wells with historical averages. The majority of wells have a period of record extending back to 1999. The difference between the historical average and the value measured in 2007 was compared on an annual and quarterly basis. Historical data for the quarterly comparison was computed for the respective quarter, i.e. 1st quarter 2007 was compared to historical 1st quarter data. On an annual basis the static water levels in a majority of the wells was slightly below average. Quarterly results show that the number of wells below average and the average difference peaked in the third quarter.

Table 4-1: Static Water Level Comparison - 2007 vs. Historical Average

	annual	1st qtr	2nd qtr	3rd qtr	4th qtr
Average difference	-0.36	-0.56	0.24	-0.89	-0.25
Standard Deviation	0.88	1.02	0.85	0.71	0.44
Maximum difference	1.6	1.26	1.6	0.12	1.02
Minimum difference	-2.43	-2.43	-1.67	-2.36	-1.11
Number of wells below average	22	19	8	25	21
Number of wells above average	5	8	19	2	7

4.3 Water Quality Standards

The following section identifies analytical results that exceed either the Primary Maximum Contaminant Levels (MCL) or Secondary drinking water standards as defined by the EPA (40 CFR Chapter 1 Part 141) and State of Washington (WAC 246-290-310). In regulation these standards apply to source sampling performed by public water purveyors as prescribed in State of Washington Drinking Water regulations. These standards provide a basis for comparison for the Long Term Monitoring Program results, but exceedance of the standards is not a basis for regulatory action.

Primary MCLs are standards set for the protection of human health. During 2007 there were no exceedances of the Primary MCLs. Secondary Drinking Water Regulations (secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. The State of Washington has also identified “trigger levels” for some contaminants. Trigger levels are analyte concentrations that trigger additional sampling requirements for public water purveyors. Four analytes were found in excess of the trigger level or secondary standard during 2007: 1) Iron; 2) Arsenic; 3) Manganese; and 4) Nitrate/Nitrite.

4.3.1 Iron

Iron is not a health hazard in drinking water and therefore no iron primary MCL is established. Iron is an aesthetic contaminant and has a secondary water quality standard. Dissolved iron gives water a disagreeable taste. When the iron combines with tea, coffee and other beverages, it produces an inky, black appearance and a harsh, unacceptable taste. Vegetables cooked in water containing excessive iron turn dark and look unappealing. Concentrations of iron as low as 0.3 mg/l will leave reddish brown stains on fixtures, tableware and laundry that are very hard to remove. When these deposits break loose from water piping, rusty water will flow through the faucet.

The secondary standard (0.3 mg/l) was exceeded at 7 wells at least one time during 2007, and the trigger level (0.1 mg/l) was exceeded at 5 additional wells at least one time during 2007. Detailed information for each of the 12 wells, including a chart of historic data, summary statistics, and trend analysis, are provided in Appendix D. Well locations and 2007 results are presented in Figure 2.

4.3.2 Arsenic

Arsenic in drinking water is a health hazard. It has a primary MCL of 0.010 mg/l and a trigger level of 0.005 mg/l. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices.

The arsenic primary MCL was not exceeded at any well during 2007. The trigger level was exceeded at 6 wells at least once during 2007. Arsenic concentrations in three of the six wells have statistically significant downward trend. Detailed information for each of the 6 wells, including a chart of historic data, summary statistics, and trend analysis, are provided in Appendix E. Well locations and 2007 results are presented in Figure 3.

The average arsenic concentration at two of the six wells is below the trigger level. These wells do not have a statistically significant trend, increasing or decreasing. Four of the wells do have average arsenic concentrations that exceed the trigger level. Of these four, three have a statistically significant decreasing trend, and one has no trend.

4.3.3 Manganese

Manganese is not a health hazard in drinking water and therefore no manganese primary MCL is established. The secondary drinking water standard for manganese is 0.05 mg/l. At this level and above, water may be cloudy, form black precipitates, contribute to mineral depositing in pipes or cause difficulty in sudsing and darkening of clothing during washing.

Manganese concentrations exceeded the secondary standard in one well, (5404A01 – Plantes Ferry Park monitoring well) during 2007. This well was recently installed and has been monitored only 6 times since 2006. Iron concentrations in this well were an order of magnitude greater than all other wells sampled in 2007. This well is located on the margin of the aquifer and the well log indicates that the geology in the vicinity is quite different than all other wells in the monitoring network.

4.3.4 Nitrate

Nitrate is a health hazard in drinking water. It has a primary MCL of 10 mg/l and a trigger level of 5 mg/l. Nitrate is especially harmful to infants, who consume a large quantity of water relative to their body weight. Nitrate concentrations above the MCL can lead to methemoglobinemia, a condition that reduces the oxygen carrying capacity of blood.

Nitrate concentrations exceeded the trigger level in one well (6436N01 – East Valley High School monitoring well) during 2007. The mean nitrate concentration at this well is 6.24 mg/L , with no apparent trend, though the well has only been sampled 6 times since its installation in 2006. Detailed information for the well, including a chart of historic data, summary statistics, and trend analysis, are provided in Appendix F.

4.4 Nitrate Trend Analysis

The largest anthropogenic sources of nitrate in groundwater are septic tanks, application of nitrogen-rich fertilizers to turfgrass, and agricultural processes. To assess the effectiveness of STEP, introduced in section 1.1, a trend analysis was conducted on wells currently in the Long Term Monitoring Program. Some wells have a longer period of record than others, but taken as a whole, the analysis provides indication of overall nitrate trends.

The Mann-Kendall trend test was utilized to determine if a statistically significant trend was present at each well. The Mann-Kendall test was chosen because it does not assume a data distribution (non parametric), allows for missing data, allows for non-detect data, and is not affected by gross data errors and outliers. If a trend was detected the Sen’s slope estimation method was utilized to determine the magnitude of the trend. The Table 4-1 and Figure 5 presents the results of the trend analysis. A detailed summary of the trend test results is provided in Appendix G.

Table 4-2: Nitrate Trend Analysis Results

Station Name	Station ID	Mann-Kendall Test			Sen's Slope Estimate (mg/l)
		increasing	decreasing	no trend	
I.E. COLD STORAGE	5213B01		x		0
NE Community Center, City monitoring well	5304G01			x	0
Trinity School, Adams & Carlisle, City monitoring	5307M01		x		-0.0091
CITY of SPOKANE-Nevada	5308A02		x		0
Denver & Marietta, City monitoring well	5308H01		x		-0.0062
monitoring well at SCC	5310Q01		x		-0.0111
Hale's Ale Nested Site, east	5311J05		x		-0.0031
Hale's Ale Nested Site, mid	5311J07		x		-0.0017
Felts Field City monitoring well	5312C01			x	0
ORCHARD AVE IRRIG DIST, Site 1	5312H01	x			0.0002
Olive & Fiske monitoring well	5315L01		x		-0.0162
Third & Havana Nested Site, east	5322A01		x		-0.0146
Third & Havana Nested Site, mid	5322A03		x		-0.0203
CITY of SPOKANE-Ray	5322F01		x		0
6th & Havana monitoring well (MW-2)	5323E01		x		-0.0358
E. SPOKANE WTR DIST, Site 1	5324G01			x	0
Plantes Ferry Park monitoring well	5404A01			x	0
PASADENA PARK #2	5405K01			x	0
Orchard Ave Irrig Dist, Site 2 Buckeye & Dick	5407C01	x			0
MODERN ELECT WATER, Site 6	5408N01		x		0
monitoring well Frederick & Bowdish	5409C02			x	0
Sullivan Park North, monitoring well	5411R02		x		-0.0033
Sullivan Park South, monitoring well	5411R03		x		-0.0049
Sullivan Road and Centennial Trail, monitoring wel	5411R04			x	0
MODERN ELECT WATER, Site 11	5415E03			x	0
VERA WATER & POWER, Site 4	5426L01			x	0
Spokane Co Water Dist #3, Site 2-5, 26th & Vercler	5427L01		x		-0.0025
Trent & Barker Road, monitoring well	5505D01			x	0
Euclid & Barker monitoring well at CID5	5507A04		x		-0.0012
Barker Road north of river, monitoring well	5507H01			x	0
Barker Road Centennial Trail North, monitoring wel	5508M01			x	0
Barker Road Centennial Trail South, monitoring wel	5508M02			x	0
LIBERTY LAKE SEWER DIST, Kenney Well	5515C01		x		-0.0111
Mission & Barker monitoring well at CID 4	5517D05		x		-0.0054
CONSOLIDATED IRRIG DIST 19, Site 2A	5518R01		x		0
Spokane Fish Hatchery well	6211K01		x		-0.0043
WHITWORTH WATER DIST. #2, Well 2A	6320D01			x	0
Fire Station Houston & Regal, No. Spokane WD	6327N04		x		-0.0118
NORTH SPOKANE IRRIG. DIST. # 4, Site 4	6328H01			x	0
Holy Cross, Rhoades & Washington monitoring well	6330J01		x		-0.01
Franklin Park, City monitoring well	6331J01		x		-0.0067
East Valley High School monitoring well	6436N01			x	0
Idaho Road 1000 ft south of Trent, monitoring well	6524R01		x		-0.0098
Idaho Road 300 ft south of pipeline, monitoring we	6525R01		x		-0.0068
CONSOLIDATED IRRIG DIST 19, Site 11B	6631M04			x	0
Idaho Road - East Farms monitoring well at CID11	6631M07			x	0

The Mann-Kendall test is a presence/absence test for trend while the Sen's Slope Estimation method returns a value. In some instances the Mann-Kendall test detected a trend, but the Sen's Slope Estimation method did not return an associated slope. In these instances data was sufficient for detection of trend, but not sufficient to determine the magnitude of the trend.

Trend analysis was conducted on 46 wells. Twenty six wells show a decreasing trend in nitrate concentrations, 2 wells show an increasing trend in nitrate concentrations, and 18 show no significant trend. In general, nitrate concentrations in the aquifer show a decreasing trend. With some exceptions, the trend is more pronounced in the central portion of the aquifer. Wells showing no significant trend are generally located on the aquifer margins with the following notable exceptions.

- Wells 5508M01, 5508M02, and 5507H01, which are in close proximity to a losing reach of the Spokane River near Sullivan Park, do not show a trend. As shown in Figure 4-1 nitrate concentrations at these wells demonstrate a stronger correlation with river nitrate concentrations than nitrate concentrations throughout the aquifer.
- Well 5411R04 does not show a decreasing trend. Like the wells discussed above it is also in close proximity to the river near the Barker Road bridge. This reach, though, is considered a gaining reach and wells on the other side of the river (5411R02 and 5411R03) do show a decreasing trend. While it is a gaining reach, river and groundwater elevation data indicate that during spring high flows the reach gains from the north side and loses from the south side. As shown in Figure 4-1 nitrate concentrations decrease to concentrations found in the river only in the spring. This periodic river influence makes trend determination difficult
- Well 5415E03 is centrally located in the aquifer, though it does not show a trend. This is most likely the result of the short period of record for this well. Data for this well only exists for 2006 and 2007.
- Wells 6328H01 and 6327N04 are located near each other, though one shows a decreasing trend and one does not. This is most likely the result of the differing sampling depth. Well 6327N04 is a dedicated monitoring well and sampling occurs at the surface of the aquifer water table while well 6328H01 is a water supply well and samples are taken at greater depth. Since anthropogenic water quality impacts usually occur at the top of the water table decreasing trends are more apparent in dedicated monitoring wells.

Figure 5: River/Aquifer Nitrate Concentration Correlation