SPOKANE COUNTY
WATER RESOURCES

Groundwater Monitoring Program

Quality Assurance Project Plan

August 2007

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A INTRODUCTION

Spokane County Water Resources staff has prepared this Quality Assurance Project Plan (QAPP) for quarterly sampling of a network of 29 monitoring wells and 17 public supply wells located within the boundary of the Spokane Valley-Rathdrum Prairie Aquifer. Data from this monitoring program are utilized to assess the current water quality of the aquifer and determine if spatial and temporal water quality trends exist. This QAPP was prepared in accordance with Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) guidelines. The purpose of the QAPP is to guide sample collection, laboratory analysis, and data review such that data generated from a sampling event is comparable to past and future sampling events and is representative of actual environmental conditions at the time of sampling.

B PROJECT MANAGEMENT

B.1 Project Organization

Spokane County Utilities Division Director	*Bruce Rawls*
Water Resources Section Manager	*Rob Lindsay*
Water Resources Section Staff:	*Reanette Boese* *Ben Brattebo* *Mike Hermanson* *Bea Lackaff* *Lauri Clift*
Analytical Laboratory:	*TestAmerica, Inc*
Laboratory Project Manager	*Randee Decker*

B.2 Problem Definition and Background

The 1979 *Spokane Aquifer Water Quality Management Plan* (WQMP) recommended establishing a regional ground water monitoring program patterned after the 16-month (May 1977 – August 1978) reconnaissance study conducted for the *Spokane Aquifer Cause and Effect Report*. In the Cause and Effect Report it was shown that the water quality of the Spokane Valley-Rathdrum Prairie (SVRP) Aquifer was being degraded by urbanization within an "Aquifer Sensitive Area." On the basis of that report an Aquifer Protection Plan, the WQMP, was developed to reduce the impacts of urbanization by implementing aquifer protection measures. The monitoring program was recommended as a tool to track the benefits derived from implementing those measures. Figure 1 outlines the Aquifer Sensitive Area defined in the WQMP and Figure 2 locates the monitoring wells used in the 1977-78 monitoring program.

In 1980 the Spokane Regional Health District (Health District) initiated the first of a series of Aquifer wide monitoring programs. This effort involved quarterly sampling of over 70 public water supply wells drawing from the Washington portion of the SVRP Aquifer. Most of the public water supply wells sampled for the Spokane County Water Quality Management Program's reconnaissance monitoring were included in the Health District monitoring. None of the monitoring wells constructed for the 1977 – 78 effort were sampled by the Health District. In November of 1995 Spokane began sampling some of the 2 inch diameter PVC cased monitoring wells installed near or up gradient of public water supply wells as part of data collection for the wellhead protection model created by CH2M Hill. The Health District continued their monitoring program until 2000 when Spokane County renewed monitoring as part of the Regional Wellhead Protection Program.

Over the years the focus of aquifer monitoring has evolved. Originally the program focused on increases in concentrations of contaminants associated with human

development in the aquifer. Nitrate and other contaminants associated with septic tank effluent such as chloride and total dissolved solids were used as indicators of human impact. All of the contaminants mentioned above increased in the aquifer as it flowed east to west beneath the Spokane Valley. Nitrate was the most critical of these because it was found at levels of public health concern. Nitrate is now one of the key analytes of the monitoring program.

As the amount of data collected from specific public supply wells increased, long term trends in contaminant concentrations in some of these wells emerged. The trends were clearest for nitrate and chloride. Chosen as indicators of on-site waste disposal and storm runoff contamination, respectively, these trends confirmed the extent of human impact.

Suitability of the aquifer as a drinking water source has also been a focus of the monitoring effort. All contaminants for which drinking water standards existed in 1977 were examined in the base line study. Many, such as the toxic metals were expected at low concentrations so were tested for in only a small percentage of the samples collected. Since the mid 1990's, when the State's Wellhead Protection Program was implemented, drinking water contaminants became a more important part of the testing package.

More recently, the seasonal low dissolved oxygen concentrations found in Lake Spokane led to establishing a Water Clean Up Plan also know as a Total Maximum Daily Load (TMDL) for point and non-point source pollution discharged to the Spokane River. Using the CE QUAL W2 river quality model the Washington Department of Ecology determined that decomposition of dead algae in the lower levels of Lake Spokane was a major source of oxygen demand. Even low phosphorus discharges to the river stimulated harmful algae growth in the lake according to model runs. Thus, control of both point and non-point sources of phosphorus became important.

B.3 Project Description

For purposes of this Quality Assurance Program Plan the project is defined as Spokane County's program to monitor groundwater from the SVRP Aquifer for establishing ambient water quality conditions. Ambient conditions can be used to describe spatial distribution of contaminants in the aquifer, long – term trends in aquifer water quality and the contaminant loading the aquifer might carry to the Spokane and Little Spokane Rivers.

The present SVRP Aquifer Monitoring Program includes 15 public water supply wells for which extensive historic data are available. Continued testing of these wells allows long-term quality trends to be evaluated. The core of the program is a suite of 28 (26 are routinely sampled) monitoring wells constructed as part of the regions Wellhead Protection Program. Some of these wells were installed up gradient of important public water supply wells and are intended to serve as early warning indicators of potential wellhead contamination. Most of these wells were constructed with screened intervals

situated to allow drawing samples from near the aquifer surface at any point in the water tables normal annual fluctuation.

B.4 Quality Objectives and Criteria

The project quality objective is to collect data that is scientifically valid, of known and documented quality and legally defensible, where appropriate. To ensure that this objective is met data will be reviewed according to Ecology's Credible Data Policy (WQP Policy 1-11).

B.4.1 Data Quality Objectives

Data Quality Objectives (DQOs) are established to ensure confidence in sample collection and analytical results facilitating appropriate detection limits.

Quality assurance objectives are established for this project to control the degree of total error in data results. These objectives are established to achieve an acceptable level of confidence in decisions made from the collected data. The established objectives include the following:

- Implement procedures for field sampling, sample custody, equipment operation and calibration, laboratory sample analysis, data reduction and data reporting that will ensure the consistency and thoroughness of data generation.

- Assess the quality of data generated to ensure that collected data are scientifically valid, of known and documented quality and legally defensible, where appropriate. This will be accomplished by establishing DQOs for parameters such as precision, accuracy, completeness, representativeness, comparability, and by testing generated data against acceptance criteria established for these parameters.

- Ensure that the quality assurance project plan and associated project plans are properly implemented.

- Daily documentation of field conditions, sampling and other activities using appropriate field reports to sufficiently recreate each sampling, analytical, testing, and monitoring event.

B.4.2 Data Quality Indicators

The basis for assessing each of these elements of data quality is discussed in the following subsections. Precision and accuracy QC limits for each analytical method and are identified in Section E1.

B.4.2.1 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. ***Analytical precision*** is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. Laboratory control sample (LCS) determine the precision of the analytical method. If the recoveries of analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch; rather the comparison is between the sample and samples analyzed in previous batches. ***Total precision*** is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results. The formula for the calculation of precision is provided in Table B.4.2-1 as RPD. For replicate analyses, the relative standard deviation (RSD) is determined. The formula for the calculation of RSD is provided in Table B.4.2-1. The required level of precision differs according to the method, and is listed in Section E.

B.4.2.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples shall also be used to provide additional information for assessing the accuracy of the analytical data being produced.

The formula for calculation of accuracy is included in Table B.4.2-1 as percent recovery (%R) from pure and sample matrices. Accuracy requirements are listed for each method in Section E.

B.4.2.3 Representativeness

Objectives for ***representativeness*** are defined for each sampling and analysis task and are a function of the investigative objectives. Representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design, with consideration of elements such as proper well locations, sampling depth, field methods, and sampling frequency. Decisions regarding these elements are documented in Section C.

B.4.2.4 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an "R" flag (see Section E for an explanation of flagging criteria). The requirement for completeness is 95 percent for aqueous samples. For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

The formula for calculation of completeness is presented below:

$$\% \text{ completeness} = \frac{\text{number of valid (i.e., non-R flagged) results}}{\text{number of possible results}}$$

B.4.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Analysis of performance evaluation (PE) samples and reports from audits shall also be used to provide additional information for assessing the comparability of analytical data produced among subcontracting laboratories. Historical comparability shall be achieved through consistent use of methods and documentation procedures throughout the project.

Table B.4.2-1 Statistical Calculations

Statistic	Symbol	Formula	Definition	Uses
Mean	$\overline{X}$	$\frac{\left(\sum_{i=1}^{n} x_i\right)}{n}$	Measure of central tendency	Used to determine average value of measurements
Standard Deviation	S	$\left(\frac{\Sigma(x_i-\overline{x})^2}{(n-1)}\right)^{1/2}$	Measure of relative scatter of the data	Used in calculating variation of measurements
Relative Standard Deviation	RSD	$(S/\overline{X}) \times 100$	Relative standard deviation, adjusts for magnitude of observations	Used to assess precision for replicate results
Percent Difference	%D	$\frac{x_1 - x_2}{x_1} \times 100$	Measure of the difference of 2 observations	Used to assess accuracy
Relative Percent Difference	RPD	$\left(\frac{(X_1 - X_2)}{(X_1 + X_2)/2}\right) \times 100$	Measure of variability that adjusts for the magnitude of observations	Used to assess total and analytical precision of duplicate measurements
Percent Recovery	%R	$\left(\frac{X_{meas}}{X_{true}}\right) \times 100$	Recovery of spiked compound in pure matrix	Used to assess accuracy
Percent Recovery	%R	$\frac{\left(\begin{array}{c}\text{value of}\\ \text{spiked}\\ \text{sample}\end{array} - \begin{array}{c}\text{value of}\\ \text{unspiked}\\ \text{sample}\end{array}\right)}{\text{Value of added spike}} \times 100$	Recovery of spiked compound in sample matrix	Used to assess matrix effects and total precision
Correlation Coefficient	r	see SW8000B section 7.5.3		Evaluation of "goodness of fit" of a regression line
Coefficient of Determination	COD	see SW8000B section 7.5.3		Evaluation of "goodness of fit" of a polynomial equation

x = Observation (concentration)
n = Number of observations

B.5 Special Training/Certifications

Samples will be submitted to a Washington Department of Ecology accredited laboratory. A current copy of the laboratory accreditation that states the expiration date and the particular analyses that the laboratory is accredited for will be kept on file.

B.6 Documentation and Records

B.6.1 Field Documentation

Permanently bound field books with waterproof paper will be used. The pages shall be numbered consecutively and shall not be removed for any reason. Entries will be made in waterproof indelible ink.

Logbooks will identify field personnel, site visitors, and document sampling conditions (e.g. the weather). Documentation in the field logbook will be of sufficient detail to explain and reconstruct field activities without relying on recollection by the field team members. Recorded data will be qualified by the calibration results for each field instrument used, the unit of each measurement, and time the data was obtained. Since the logbook is a complete documentation of field procedures, it should contain only facts and observations. Language should be objective, clear, concise, and free of personal interpretation or terminology that might be misconstrued.

No erasures will be performed. If an incorrect entry is made, the information will be crossed out with a single strike mark and the change initialed and dated by the team member making the change. Each page will be dated, legible, and contain accurate and complete documentation of field activities. Field logbooks will be identified by the project name and a project-specific number and stored in the field project files when not in use. After field activities are completed, logbooks will be stored in the permanent project file.

Spokane County staff will document groundwater-sampling activities. In addition to the field logbook, the following field forms shall be utilized for groundwater sampling and disposal activities at this site.

- Monitor Well Purging Form
- Daily Summary Field Sheets

These forms shall include the following information for groundwater sampling: (1) sample type and sampling method; (2) the identity of each sample, (3) well number and/or location; (4) volume and time of each sample collected; (5) sample description (e.g., color, odor, clarity); (6) identification of sampling devices and equipment; and (6) analytical method; (7) preservative; (8) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing); (9) water level measurement; (10) total depth of well; and (11) total volume purged.

Sufficient field records will be maintained to recreate all sampling and measurement activities and to meet all data loading requirements. The requirements listed in this section apply to all measuring and sampling activities; requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound logbook with sequentially numbered pages. In addition to the field logbook, the applicable field forms will be used to document the field and sampling activities. Any variances to this QAPP encountered in the field will be documented in the field logbook

B.6.2 Laboratory

The laboratory QA staff shall issue QA reports to the laboratory management, laboratory supervisors and task leaders. These reports shall describe the results of QC measurements, performance audits, systems audits, and confirmation sample comparisons performed for each sampling and analysis task. Quality problems associated with performance of methods, completeness of data, comparability of data (including field and confirmatory data), and data storage, shall be documented with the corrective actions that have been taken to correct the identified deficiencies.

The laboratory shall maintain electronic and hardcopy records sufficient to recreate each analytical event conducted pursuant to the SOW. The minimum records the laboratory shall keep contain the following: (1) COC forms, (2) initial and continuing calibration records, including standards preparation traceable to the original material and lot number, (3) instrument tuning records (as applicable), (3) method blank results, (4) IS results, (5) surrogate spiking records and results (as applicable), (6) spike and spike duplicate records and results, (7) laboratory records, (8) raw data, including instrument printouts, bench work sheets, and/or chromatograms with compound identification and quantitation reports, (9) corrective action reports, (10) other method and project required QC samples and results, and (11) laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples.

C DATA GENERATION AND ACQUISITION

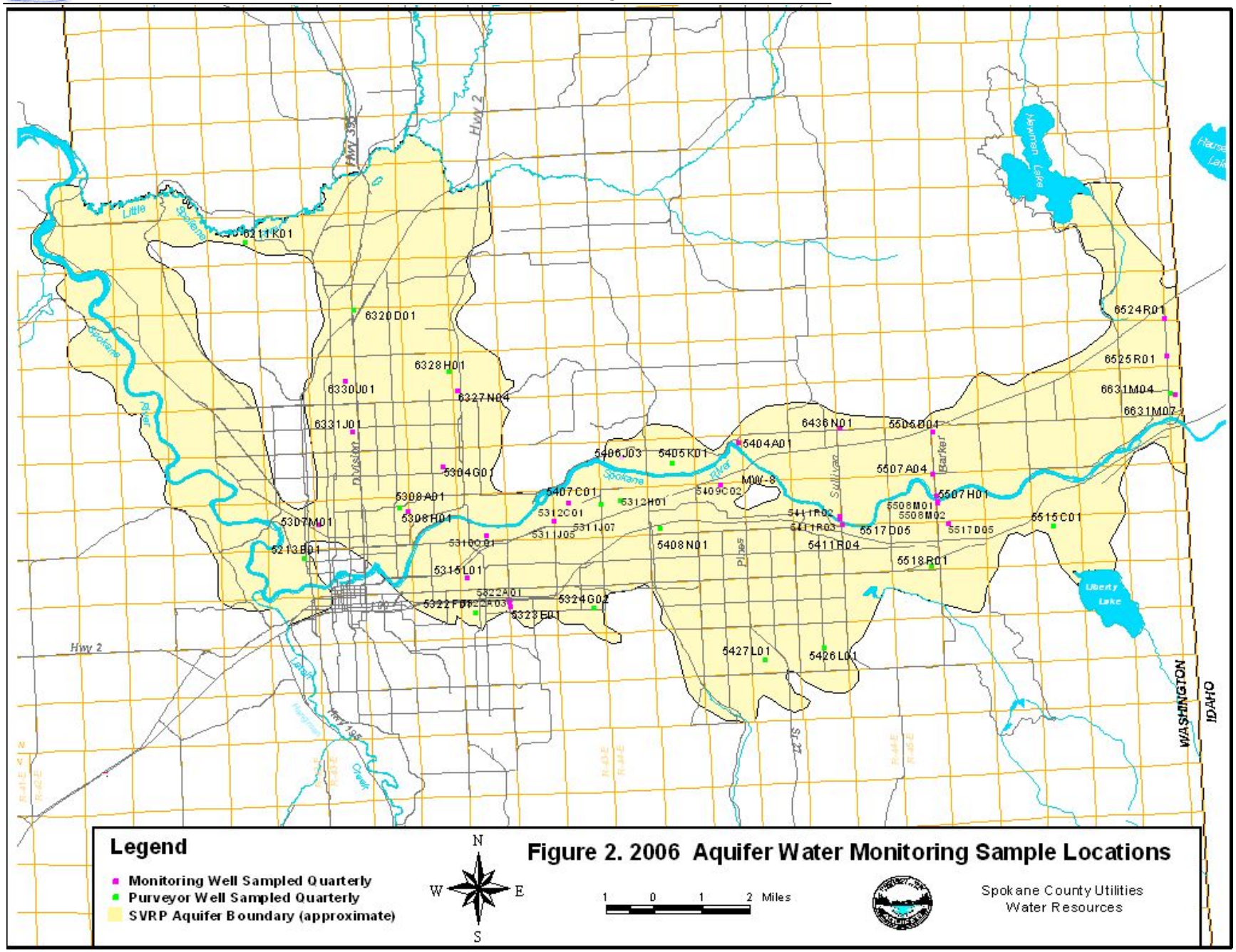
C.1 Sampling Process Design

Sampling is conducted quarterly at wells presented in tables C.1-1 and C.1-2. Well locations are shown in figure 2. Static water level, temperature, conductivity, pH, turbidity, and dissolved oxygen data is collected at each well. Samples from each well are submitted for laboratory analysis for analytes presented in table C.1-3.

Field duplicates are collected for each sample delivery group and no less than 1 for every 20 samples. A laboratory supplied field blank will be submitted with each sample delivery group. One equipment blank is collected per sampling event. The equipment blank is deionized water pumped through the sampling pump and tubing.

Table C.1-1 Monitoring Wells

WQMP Well ID	Well Name	Top of Screen	Length of Screen	Well Depth
5304G01	NE Community Center, City monitoring well	182.0	10.0	195.1
5307M01	Trinity School, Adams & Carlisle, City monitoring well	148.3	10.0	161.4
5308H01	Denver & Marietta, City monitoring well	86.0	10.0	99.0
5310Q01	monitoring well at SCC	41.0	55.0	96.0
5311J05	Hale's Ale Nested Site, east	62.8	10.0	75.9
5311J07	Hale's Ale Nested Site, mid	105.1	10.0	118.2
5312C01	Felts Field City monitoring well	68.0	10.0	78.7
5315L01	Olive & Fiske monitoring well	68.0	40.0	106.0
5322A01	Third & Havana Nested Site, east	47.1	10.0	60.2
5322A03	Third & Havana Nested Site, mid	90.0	10.0	103.1
5323E01	6th & Havana monitoring well (MW-2)	40.0	39.0	79.5
5404A01	Plantes Ferry Park monitoring well	109.5	10.0	119.5
5409C02	monitoring well Frederick & Bowdish	80.0	60.0	150.0
5411R02	Sullivan Park North, monitoring well	26.2	40.0	65.0
5411R03	Sullivan Park South, monitoring well	27.3	40.0	66.0
5411R04	Sullivan Road and Centennial Trail, monitoring well	47.8	40.0	85.0
5505D01	Trent & Barker Road, monitoring well	87.0	40.0	123.0
5507A04	Euclid & Barker monitoring well at CID5	69.5	30.0	99.5
5507H01	Barker Road north of river, monitoring well	39.5	40.0	80.0
5508M01	Barker Road Centennial Trail North, monitoring well	64.1	35.0	97.0
5508M02	Barker Road Centennial Trail South, monitoring well	63.3	35.0	96.0
5517D05	Mission & Barker monitoring well at CID 4	85.2	30.0	112.5
6327N04	Fire Station Houston & Regal, No. Spokane WD	185.9	35.0	219.0
6330J01	Holy Cross, Rhoades & Washington monitoring well	207.0	35.0	240.0
6331J01	Franklin Park, City monitoring well	208.5	10.0	221.6
6436N01	East Valley High School monitoring well	104.5	20.0	125.0
6524R01	Idaho Road 1000 ft south of Trent, monitoring well	119.5	45.0	162.5
6525R01	Idaho Road 300 ft south of pipeline, monitoring well	97.0	45.0	140.0
6631M07	Idaho Road - East Farms monitoring well at CID11	112.0	35.0	147.0


Legend
Monitoring Well Sampled Quarterly
Purveyor Well Sampled Quarterly
SVRP Aquifer Boundary (approximate)
N
W
E
S
1 0 1 2 Miles
Figure 2. 2006 Aquifer Water Monitoring Sample Locations
Spokane County Utilities
Water Resources
Hwy 2
Hwy 395
Spokane River
Little Spokane River
Newman Lake
Liberty Lake
WASHINGTON
IDAHO
6211K01
6320D01
6328H01
6330J01
6327N04
6331J01
6524R01
6525R01
6631M04
6631M07
6436N01
5505D04
5404A01
5406J03
5405K01
5304G01
5507A04
5507H01
5308A01
5308H01
5307M01
5213B01
5407C01
5312H01
5312C01
5311J07
5311J05
5310C01
5315L01
5322F01
5322A01
5322A03
5324G02
5323E01
5409C02
MW-8
5411R02
5411R03
5411R04
5508M01
5508M02
5517D05
5517D05
5408N01
5518R01
5515C01
5427L01
5426L01
Division
Sullivan
Barker
Pines
Havana
Thorpe Creek
R44E
R45E
S 25