Quality Assurance Project Plan

Assessment of Ambient Groundwater Quality Conditions in the Surficial Unconsolidated Sedimentary Aquifer of the Moxee Valley, Yakima County, Washington

By

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December 2005

Waterbody Number: WA-37-1040GW

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Approvals

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Cliff Kirchmer, Ecology Quality Assurance Coordinator, EAP	Date

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Abstract

The Moxee Valley lies adjacent to the city of Yakima, in south-central Washington and has experienced considerable population growth in recent years. Much of this growth occurred in the unincorporated portions of the valley where residents rely on individual wells and on-site septic systems to meet their potable and wastewater disposal needs. The last published evaluation of area groundwater quality was conducted by Larson (1993), who sampled 11 Moxee Valley wells during a pesticide screening survey. At that time, groundwater nitrate+nitrite (N) concentrations within the central and lower Moxee Valley averaged approximately 3.61 mg/L. This study will build on Larson's work by providing an up-to-date assessment of ambient groundwater nutrient and bacteria concentrations within the unincorporated portions of the Moxee Valley.

Background

The Environmental Assessment (EA) Program was asked to conduct a screening-level assessment of groundwater nutrient and bacteria concentrations and distribution within the Moxee Valley, which lies adjacent to the city of Yakima, in south-central Washington (Figure 1). Growth in and around the city of Yakima has accelerated in recent years and portions of the Moxee Valley are rapidly transitioning from their traditional agricultural-based uses to residential and commercial development. The cities of Yakima and Moxee are served by public water and sanitary sewers. However, much of the recent growth within the Moxee Valley has occurred in unincorporated regions of the valley where individual wells and septic systems are the primary means of water supply and domestic wastewater disposal, respectively.

Larson (1993) sampled 11 Moxee Valley wells during a pesticide screening study of the greater Yakima area. Trace amounts of the herbicides Dacthal and Atrazine were identified in water from 3 of the 11 wells sampled; however, the concentrations were well below levels of concern for drinking water. Concentrations of nitrate+nitrite (N) ranged from <0.01 to 11.9 mg/L and averaged 3.61 mg/L. One well exceeded 10 mg/L, the federal drinking water standard for nitrate (as N), while nearly half the wells had concentrations greater than 4 mg/L.

This study is being undertaken to provide an up-to-date assessment of groundwater nutrient and bacteria concentrations and distribution within the rapidly-developing, non-sewered portions of the Moxee Valley.

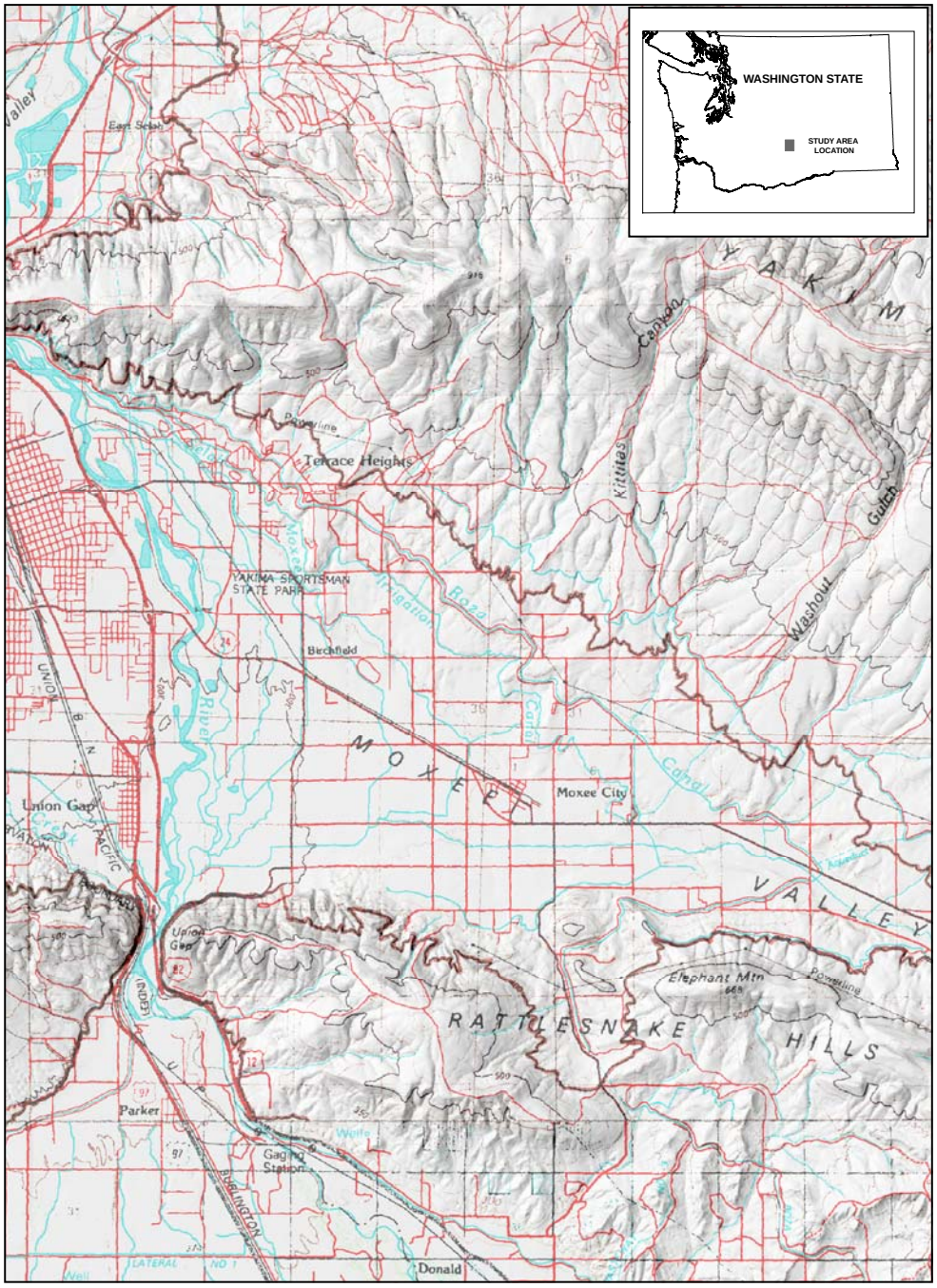

Figure 1. Study Area Location.

Project Description

The study area for this project encompasses approximately 25 square miles of the greater Moxee Valley and is loosely bounded on the west by the Yakima River and to the north and south by the lower slopes of Yakima Ridge and Rattlesnake Hills, respectively (Figure 1). The primary goal of this study is to characterize the present extent and magnitude of groundwater nutrient and bacterial concentrations within the surficial aquifer(s) of the study area.

To achieve this goal, we will sample up to 40 broadly-distributed, private domestic wells within the greater Moxee Valley. The wells will be sampled in December 2005 or January 2006 (weather permitting) and again in June 2006 for field parameters (water level, temperature, pH, DO, and conductivity) and a small suite of laboratory analyzed constituents (TPN, Nitrate+Nitrite, total and fecal coliform, chloride, TDS, iron, and manganese). This monitoring network will be used to verify past sampling results (Larson, 1993), and to determine if nitrate, bacteria, and other contaminant concentrations vary seasonally.

No attempt will be made to define the cause or origin of water quality problems that may be identified during this investigation. The study sampling and measurement efforts are intended to describe current ambient conditions and will not be knowingly biased towards specific point sources or facilities. Standard tools such as geologic or hydrogeologic maps, cross sections, data graphs, summary statistics, and comparison to promulgated standards will be employed to summarize the data collected during the project.

Organization and Schedule

Client	*Robert Raforth*, Project Client, Ecology CRO WQ Program (509) 457-7113. Responsible for project coordination with local and county government officials and other agency staff, and for reviewing drafts of the project Quality Assurance (QA) Project Plan and summary data report.
Project Lead	*Kirk Sinclair*, Ecology (360) 459-7469. Responsible for managing the project, preparing the project QA Project Plan, coordinating and completing sampling activities, analyzing project data and EIM data migration, and preparing the draft and final data reports. Serves as the principal public contact for the technical aspects of the study.
Project Assistants	*Present and Future EAP Interns.* Responsible for assisting with sampling activities.
Quality Assurance	*Bill Kammin*, Quality Assurance Officer, EA Program (360) 895-6177. Reviews QA Project Plan and all Ecology quality assurance programs. Provides technical assistance on QA/QC issues during the implementation and assessment of project.
Laboratory Services	*Pam Covey*, Manchester Environmental Laboratories (MEL) (360) 871-8827. Responsible for coordinating requests for analysis, scheduling sample processing, and providing access to project data.

Project Milestones and Responsibilities

Environmental Information System (EIM) Data Set (if applicable)	
EIM Data Engineer	Kirk Sinclair
EIM User Study ID	KSIN0002
EIM Study Name	Assessment of ambient Groundwater quality conditions in the surficial unconsolidated sedimentary aquifer of the Moxee Valley, Yakima Co. WA.
EIM Completion Due	February 2007
Final Report	
Report Author Lead	Kirk Sinclair
Schedule	
Report Supervisor Draft Due	November 2006
Report Client/Peer Draft Due	December 2006
Report External Draft Due	December 2006
Report Final Due - Original	February 2007

Quality Objectives

The measurement quality objectives (MQOs)[1] for this project are presented in Table 1. The total accuracy figures are reflective of the reported precision and bias limitations of the respective analytical methods (Ecology, 1995). Industry standard field methods will be used throughout this project to minimize measurement bias (systematic error) and to improve precision (random error). Water-level measurements will be made following guidelines outlined by Stallman (1983). Standardized well purging and sampling procedures will be used to measure field parameters (see Table 1) and to minimize potential changes to water chemistry for laboratory samples. All laboratory-bound samples will be collected, preserved, stored, and otherwise managed using accepted procedures for maintaining sample integrity prior to analysis (Ecology, 1993; USGS, 1997).

The precision and bias routinely obtained by MEL for the parameters of interest to this study will be adequate.

Table 1. Measurement Quality Objectives

Parameter	Check Standard (LCS)	Duplicate Samples	Matrix Spikes	Matrix Spike Duplicates	Lowest Concentration of Interest
	% Recovery Limits	RPD	% Recovery Limits	RPD	Units of Concentration
pH (field)[1]	± 0.2 pH units	± 0.1 pH units	NA	NA	NA
Conductivity (field)[1]	± 10 umhos/cm	± 10 %	NA	NA	25 umhos/cm @ 25 C
Temperature (field)[1]	± 0.1 C	± 5 %	NA	NA	NA
Dissolved Oxygen (field)[1]	± 0.2 mg/L	NA	NA	NA	0.2 mg/L
Laboratory analyses					
TPN, dissolved	80-120 %	± 20 %	75%-125 %	± 20 %	0.1 mg/L
Nitrate+Nitrite-N, dissolved	80-120 %	± 20 %	75%-125 %	± 20 %	0.1 mg/L
Coliform, total (MF)	NA	± 40 %	NA	NA	1 CFU
Coliform, fecal (MF)	NA	± 40 %	NA	NA	1 CFU
Chloride, dissolved	90-110 %	± 20 %	75%-125 %	± 20 %	1 mg/L
TDS	80-120 %	± 20 %	75%-125 %	± 20 %	1 mg/L
Iron, dissolved	85-115 %	± 20 %	75%-125 %	± 20 %	50 ug/L
Manganese, dissolved	85-115 %	± 20 %	75%-125 %	± 20 %	10ug/L

1 = pH, conductivity, and temperature are field measured parameters. Values are stated in terms of maximum allowable differences from the field check standards. Accuracy will be ensured by twice per day (pre and post-sampling) calibration and standard checks. Field temperatures will be verified by pre- and post-sample event instrument comparisons to a laboratory grade reference thermometer.

[1] All water quality data referenced in the final report (both new and historic) will be evaluated against the project MQOs listed in Table 1.

Sampling Design

The objectives of this study will be met through a combination of field work and in-office evaluations of historic water quality and groundwater level data. All told, approximately 40 wells will be targeted for sampling during this project. The wells will be sampled in December 2005 or January 2006 and again in June 2006 for field parameters (water level, temperature, pH, DO, and conductivity) and a small suite of laboratory-analyzed constituents (TPN, Nitrate+Nitrite, total and fecal coliform, chloride, TDS, iron, and manganese). To help define the monitoring network, a pool of candidate wells will be compiled from an initial search of area well logs and prior investigative reports (Larson, 1993). When screening wells, preference will be given to shallow wells since they are the most likely to be impacted by increased septic discharges, changing agricultural practices, or other land use activities. The following criteria will be used to screen wells for follow-up field visits and possible inclusion in the study:

1. A well drillers report (well log) must be available for the well. The report must include the following minimum information: the well site address, owner name, geologic description and well construction information, and, where possible, the well ID tag number.
2. The well should be completed within the upper most aquifer that is commonly used for domestic water supply within the area.
3. The well must be easily accessed for water level and water quality sampling.
4. The current well owner must grant access to the well.
5. The well was preferably monitored during at least one previous investigation.
6. The well should not have a water treatment device (such as a water softener or iron treatment system) or an unusually large storage tank that cannot be bypassed during purging and sampling.
7. The study wells, in total, should be distributed to provide a representative coverage of the greater Moxee Valley.

The owners of potential candidate wells will be contacted (by telephone and/or through onsite visits) to discuss their participation in the project and to confirm their well is suitable for monitoring. Wells selected for monitoring will be field located via handheld GPS units and on paper orthophotos for subsequent analysis and plotting via GIS software. The paper orthophoto locations will be used as a secondary in-office confirmation of GPS-derived well coordinates.

Measurement Procedures

This study will employ both field and laboratory based measurements. The expected detection or reporting limits for field parameters and laboratory analyses are listed in Table 2 along with the anticipated analytical method.

Table 2. Summary of Field and Laboratory Measurements, Methods, Reporting Limits, and Expected Ranges for Groundwater Samples.

Parameter	Method	Reporting Limit	Expected Range*
Field Measurements			
pH	Field Meter	+/- 0.1 SU	6.5-8.5 standard units
Conductivity	Field Meter	+/- 5%	100-700 umhos/cm @ 25 C
Temperature	Field Meter	+/- 0.2 C	8-14 C
Dissolved Oxygen	Field Meter	+/- 0.2 mg/L	Unknown
Laboratory Parameters			
TPN, dissolved	SM 4500NO3B	0.10 mg/L	Unknown
Nitrate+Nitrite-N, dissolved	SM 4500NO3I	0.01 mg/l	<0.1-12 mg/L
Coliform, total (MF)	SM 9222B	1 CFU	0-TNTC
Coliform, fecal (MF)	SM 9222D	1 CFU	Unknown
Chloride, dissolved	EPA 300.0	0.1 mg/L	3-20 mg/L
TDS	SM 2540C	10 mg/L	50-500 mg/L
Iron, dissolved	EPA 200.7	50 ug/L	<50-5000 ug/L
Manganese, dissolved	EPA 200.7	10 ug/L	<10-2000 ug/L

* Expected range determined from prior investigation by Larson, 1993.

Groundwater Levels

Groundwater levels will be measured at each of the study wells prior to purging and sampling. Water levels will be measured using a calibrated electric well probe or a steel tape (Stallman, 1983). At least two measurements will be made at each well to confirm the water level is not recovering from recent pumping or being drawn down by nearby pumping wells. The measurements will be spaced at one minute intervals and will continue until two successive measurements show a change of ±0.01 feet or less. The final value will be recorded on the field data sheet along with appropriate notations concerning recent pumping, well interference, or other factors that may have affected the measurement.

To prevent cross-contamination between wells, the well probe or steel tape will be thoroughly cleaned at each well site prior to use. The cleaning procedure will consist of a manual wipe down of the equipment with clean paper towels to remove grit or grime followed by sequential rinses of 10% bleach solution and de-ionized water. Field personnel will wear clean sampling gloves while handling measurement equipment.

Water Quality Measurements and Sampling

All wells will be purged prior to sampling. Samples will only be collected from taps or hose bibs where "raw" (un-treated) well water can be obtained. Raw tap water will be routed through a clean “Y” fitting and tubing directly to a metered-closed-atmosphere flow cell, where at three minute intervals, temperature, pH, conductivity, and dissolved oxygen will be measured and recorded. Actively used wells will be purged until field parameters are stable, while little used wells will be purged for a minimum of three casing volumes and until all field parameters are stable (Table 3).

Table 3. Well Purging Criteria.

Purge Parameter	Stabilization Criteria[(a)]
pH	±0.1 standard unit
Temperature	±0.1 ^{o}C
Conductivity	±10 µmhos/cm for values <1000 µmhos/cm ±20 µmhos/cm for values >1000 µmhos/cm
Dissolved Oxygen	±0.2 mg/L for values > 2 mg/L
Or	
All parameters	< ±10% change over 3 consecutive readings at 3 minute intervals

[(a)]Criteria as allowable variation between two consecutive measurements collected at 3-minute intervals.

Once purge parameters stabilize and have been recorded, water will be shunted to the second outlet of the “Y” fitting for sample collection. Well water, with a field-meter DO concentration less than 2.0 mg/L, will be verified using field photometric or colorimetric test kits (Table 4).

Table 4. Summary of Field Water Quality Methods.

Parameter	Measurement Method	Expected Range of Results
pH	GeoTech WTW multi-meter	5.5-8.0 SU
Temperature	GeoTech WTW multi-meter	8-15 ºC
Conductivity	GeoTech WTW multi-meter	30-1500 µmhos/cm
Dissolved Oxygen	GeoTech WTW multi-meter >2 mg/L CHEMetrics™ Indigo Carmine Photometric <2 mg/L CHEMetrics™ Rhodazine-D Photometric <0.8 mg/L CHEMetrics™ Rhodazine-D Colorimetric <0.18 mg/L	0.1-18 mg/L

Once all field tests are complete, laboratory bound water samples will be collected in pre-cleaned analyte specific sample containers supplied by MEL (Table 5). Samples for dissolved constituents will be field filtered using a new in-line 0.45 micron capsule filter. A minimum of 200 ml of well water will be purged through the filter and discarded prior to filling the first sample bottle. Sample containers will be filled in the following sequence: 1) unfiltered, unpreserved samples (TDS, total, and fecal coliform bacteria); 2) filtered, unpreserved samples (chloride); 3) filtered, preserved nutrient samples (nitrate+nitrite-N, TPN) and; 4) filtered preserved inorganic samples (iron, manganese). In the event that pre-acidified bottles are not

available from MEL, preservative acid will be added to the iron and manganese sample immediately after collection.

The filled sample bottles will be labeled and placed in portable ice filled coolers for short-term storage prior to their arrival at MEL. Since each sampling event will take several days to complete, it will be necessary to ship bacteria samples to the laboratory (via air freight or Greyhound bus) during all but the last day of sampling. The remaining samples will be delivered to the OC walk-in cooler on the final day of sampling for transport to MEL via laboratory currier.

Table 5. Container, Sample Volume, Filtration, Preservation, and Holding Time Requirements.

Analyte	Container Type	Container Volume (ml)	Filtration	Preservation	Holding Time
TPN, dissolved	w/m clear Nalgene (pre-acidified)	125[(a)]	Filter @ 0.45 micron	Adjust pH to <2 w/ H_2SO_4 and cool to <4°C	28 days
Nitrate+Nitrite-N, dissolved	w/m clear Nalgene (pre-acidified)	125[(a)]	Filter @ 0.45 micron	Adjust pH to <2 w/ H_2SO_4 and cool to <4°C	28 days
Coliform, Total	Glass bottle	500[(b)]	None	Cool to <4°C	24 hours
Coliform, Fecal	Glass bottle	500[(b)]	None	Cool to <4°C	24 hours
Chloride, dissolved	w/m poly	500	Filter @ 0.45 micron	Cool to <4°C	28 days
TDS	w/m poly	1000	None	Cool to <4°C	7 days
Iron, dissolved	HDPE	500[(c)]	Filter @ 0.45 micron	Adjust pH <2 w/ HNO_3 and cool to <4°C	6 months
Manganese, dissolved	HDPE	500[(c)]	Filter @ 0.45 micron	Adjust pH <2 w/ HNO_3 and cool to <4°C	6 months

[(a)] Water samples for TPN and Nitrate+Nitrite -N will be collected in a common 125 ml nutrients bottle.
[(b)] Water samples for total and fecal coliform will be collected in a common 500 ml bacteria bottle.
[(c)] Water samples for iron and manganese will be collected in a common 500 ml metals bottle.

Quality Control Procedures

Field

Water Level Measurements

Standard protocols for measuring groundwater levels will be followed throughout this study (Stallman, 1983). All measurement equipment (electric tape or steel tape) will be inspected prior to use to verify that it is working properly. Steel tapes will be checked for bends or twists that might result in inaccurate readings. Electric tapes will be checked to confirm they have fresh batteries and will be calibrated against a steel tape of known accuracy prior to initial use. Water levels will be measured to the nearest 0.01 foot, with at least two successive measurements being made at each well. The difference between measurements should not exceed 0.01 feet.

Accurate records of well ownership/contact information, field water level measurements, dates, times, sampling staff, well location, measuring point descriptions, and other observations will be assured through the use of standardized field forms specifically designed for this activity. All field forms will be checked by the project manager at the completion of sampling and prior to leaving the site to ensure all water-level measurements and sampling-related data were accurately recorded.

Water Quality Sampling

In addition to the general sampling procedures described above, project staff will adhere to the following protocols to maintain quality control during field sampling:

- All water-level measuring devices will be thoroughly cleaned before use to preclude contaminant introduction into wells.
- All field meters will be calibrated (if appropriate) in accordance with manufacturer's instructions at the beginning of the sampling day and again at midday. Only fresh commercially-prepared standards will be used for calibration. When field test kits are used (DO for example), a duplicate test will be conducted for every ten samples tested.
- All non-dedicated sampling equipment (Y-fittings and tubing connectors) will be cleaned between wells. Equipment decontamination will consist of an initial washing in a mild solution (0.02%) of phosphate free detergent followed by a de-ionized water rinse.
- Sampling equipment and materials will be selected based on their compatibility with the parameters of interest to prevent bias in sample results.
- Sampling teams will employ a "clean hands/dirty hands" approach to sample collection. One sampler will be responsible for filling and handling the sample bottles at each site. The designated sampler will don a pair of clean sampling gloves prior to touching and/or opening bottles, filters, tubing, and other equipment that could potentially come into contact with the sampled water.

- One equipment/filter blank will be submitted during each sample round to determine if sampling equipment or filters are biasing sample results. If bias is evident, additional steps will be taken to isolate and remove the source of error.
- Field duplicate samples will be collected at a minimum ratio of one duplicate for every ten samples and submitted to the laboratory blind.
- Chain-of-custody procedures will be followed throughout the project.
- Standardized field forms will be used to track and describe all field procedures, to record field parameters and sample identification numbers, and to describe any necessary deviations from the planned purging and sampling procedure described here.

Laboratory

MEL's routine quality control procedures (method blanks, duplicates, matrix spikes, and check standards) will be used to demonstrate laboratory precision and accuracy and that the project MQO's were met. Precision can be estimated from duplicate and check standards, duplicate sample analysis, and duplicate spiked sample analyses. Bias will be estimated from matrix spikes, matrix spike duplicates, and check standards. Recoveries from check standards provide an estimate of bias due to calibration. Mean percent recoveries of spiked sample analyses provide an estimate of bias due to interference. Results of quality control analyses will be reported in the same units as expressed for the MQOs. Laboratory staff will conduct a quality assurance review of all analytical data generated at MEL prior to releasing the data to the project lead along with a standard case narrative of laboratory QA/QC results and data qualifiers or caveats, if any.

Data Management

At the completion of each sampling event, all field and laboratory analytical data will be compiled and evaluated against the project measurement quality objectives. Data reduction, review, and reporting will follow the procedures outlined in MEL's lab users manual (MEL, 2005). Lab results will be checked for improbable or missing data. Analytical precision will be evaluated using standard statistical techniques {relative percent difference (RPD), standard deviation (s), pooled standard deviation (sp), or percent relative standard deviation (%RSD)} as appropriate. The %RSD for field and laboratory duplicates will be used to assess data quality relative to that listed in Table 1.

Data Verification and Validation

MEL staff will review all laboratory analysis for the project to verify that the methods and protocols specified in the QA Project Plan were followed; that all instrument calibrations, quality control checks, and intermediate calculations were performed appropriately; and that the final reported data are consistent, correct, and complete, with no omissions or errors (MEL, 2005). Evaluation criteria will include the acceptability of instrument calibrations, procedural blanks, spike sample analysis, precision data, laboratory control sample analysis, and the appropriateness of assigned data qualifiers, if any. MEL will prepare a written case narrative describing the results of their data review.

The project lead will review the MEL data package and case narrative to determine if the results met the MQOs for bias, precision, and accuracy for that sampling episode and to ensure that all analyses specified on the "Request for Analysis" form were performed as requested. Field duplicate and filter blank results will be evaluated and compared to the quality objectives shown in Table 1. Based on these assessments, the data will either be accepted, accepted with appropriate qualifications, or rejected.

After the laboratory and field data have been reviewed and verified by the project manager, they will be transitioned (where appropriate) to EIM for access by the project client and others. The EIM data sets (both field and laboratory results) will be independently reviewed for errors by another EA Program staff person before closing out the EIM project and setting the data validation flag to "completed." The initial data review will consist of a 10% random sampling of the project data. If any errors are discovered during the initial data review, a full independent review will be undertaken.

Data Quality Assessment and Reporting

The data collected during this project will be used to assess ambient groundwater quality conditions within the surficial unconsolidated to semi-consolidated sediments underlying the Moxee Valley. No specific decision is anticipated based on the study results. Thus, assuming the project MQOs are ultimately met, the data will be deemed acceptable for use (except as qualified during the data review and validation process).

A draft data report will be prepared and forwarded to the client within five months of receiving the final round of sample results from MEL. The report will include the following:

- Description of the project purpose, goals, and objectives.
- Map(s) of the study area and sampling sites.
- Descriptions of field and laboratory methods.
- Discussion of data quality and the significance of any problems encountered in the analyses.
- Summary tables of field and laboratory chemical data.
- Observations regarding significant or potentially significant findings.
- Recommendations based on project goals.

The final data report should be ready for publication within two months of receiving review comments on the draft data report.

Project Laboratory Costs and Timeline

Tables 6 and 7 provide a breakdown of the estimated analytical costs and the proposed timeline for this project. The reported analytical costs reflect MELs discounted price for pre-planned sample submittals.

Table 6. Estimated Analytical Cost Based on Two Samplings of 40 Wells.

Parameter	Number of Samples*	Cost per Sample	Total Cost per Parameter	Misc. Sampling Costs
TPN	90	$16	$1,440	
Nitrate + Nitrite (N)	90	$12	$1,080	Estimated
Coliform, total (mf)	90	$25	$2,250	at $200 per
Coliform, fecal (mf)	90	$21	$1,890	Sample run
Chloride	90	$12	$1,080	
TDS	90	$10	$900	
Iron (total)	90	$36	$3,240	
Manganese (total)	90	$22	$1,980	
Project Costs			$13,860	$400

* Includes four sets of field duplicate samples (10% duplicate rate) and one method/filter blank for each of the two sampling events.

Table 7. Proposed Project Timeline by Task.

Task	2005						2006												2007		
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
QAPP/Project Planning		•	•	•																	
Well Network/Sampling																					
Well inventory		•	•	•																	
Database development		•	•	•																	
Initial well selection and network design		•	•	•	•																
Well field verification			•	•	•																
Access arrangements			•	•	•																
Well sampling						•	•[2]					•									
Well owner result notification									•						•						
EIM																					
EIM Project development			•	•	•	•	•	•													
LIMS/field data migration to EIM						•	•	•	•	•	•	•	•	•	•	•					
EIM project quality assurance and closeout																•	•	•	•	•	
Data Analysis and Reporting																					
Compile, evaluate, and summarize project data						•	•	•	•	•	•	•	•	•	•						
Data quality assurance and review						•	•	•	•	•	•	•	•	•	•						
Develop figures, tables, and map templates for report										•	•	•	•	•	•						
Prepare draft report											•	•	•	•	•	•	•				
Client Review of draft report																		•			
Finalize report																			•	•	

[2] Sampling is planned for December 2005 (weather permitting) with a fall back sampling in January 2006.

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