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SAMPLING AND ANALYSIS PLAN
FOR
REDMOND – BEAR CREEK VALLEY GROUNDWATER MANAGEMENT AREA

Prepared for:

King County Department of Natural Resources
Seattle, Washington

Submitted by:

Golder Associates Inc.
Redmond, Washington

April 17, 2001

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1. INTRODUCTION

1.1 Project Description

Between 1989 and 1996, the Seattle - King County Dept. of Public Health, under Washington Dept. of Ecology guidance (according to WAC 173-100), developed Ground Water Management Plans (GWMPs) for five Ground Water Management Areas (GWMAs) in King County, including the Redmond - Bear Creek Valley (RBCV) GWMA (Figure 1). Each GWMP included proposals for data collection and management, with the purpose of monitoring both the groundwater quality and quantity.

Water quality in the RBCV GWMA is generally excellent. The emphasis of the GWMP is therefore to protect existing water quality. The GWMP proposed sixteen goals to address groundwater quality and quantity, including hazardous materials management, infrastructure (e.g. sewage treatment and underground storage tanks), pesticides, and sand and gravel mining (Redmond - Bear Creek Valley Ground Water Advisory Committee, 1999).

The study served by this SAP is intended to provide an overall description of groundwater conditions in the RBCV GWMA and, in combination with sampling in the other GWMAs, throughout King County as a whole. Under this plan, sampling will be conducted at wells previously sampled during development of the RBCV GWMP. Comparison of water quality results from the current study to previous sampling events will permit evaluation of long term changes in water quality. To this end the selection of wells, sampling techniques, and analytical methods for this present study have been made as compatible as possible with the previous GWMP sampling. Variability among replicate samples for a given parameter during the original GWMP sampling should provide an indication of the significance of any observed changes during the present sampling rounds. Water levels recorded at the time of the present rounds of sampling will be compared to earlier measurements to evaluate changes in groundwater quantity.

1.2 Purpose

This Sampling and Analysis Plan (SAP) has been developed to guide the initial groundwater sampling in the RBCV GWMA. Initial efforts under this SAP will begin in 2001. Following receipt and interpretation of the results of this effort, the data collection program will be revised in conjunction with the RBCV Ground Water Management Committee, according to the new information available or new areas of concern identified. This SAP will be revised to cover subsequent sampling efforts.

1.3 Study Area Description

The RBCV GWMA is an area approximately 44 square miles in size, located in north central King County approximately 20 miles northeast of Seattle. It is bounded on the west by the Sammamish River and on the north by the Snohomish-King County line. The eastern boundary follows the topographic divide between the Bear Creek and Snoqualmie River valleys. The area is bounded on the south by Lake Sammamish and by the boundary of the water supply service area of the NE Sammamish Water and Sewer District. The Bear Creek Valley bisects the study area north to south, and the Evans Creek Valley bisects the southern tip east to west. (Redmond - Bear Creek Valley Ground Water Advisory Committee, 1999).

1.4 Sampling Plan Objectives

Data collected under this SAP is intended for use by both the public (including Management Committees) and technical people to assess groundwater quality and develop future sampling needs. This data will also be used for Environmental Benchmarks under the Growth Management Act. This SAP outlines field procedures and quality control procedures that will be followed to ensure a complete and an accurate data set. Although groundwater will be analyzed for drinking water parameters, analysis need not be by drinking water methods or be performed by a lab certified to perform drinking water analyses. Drinking Water Analysis Reporting Forms also do not need to be used. However, method detection limits (MDLs) below maximum contaminant levels (MCLs) will be attained.

1.5 Sampling Locations and Frequency

Approximately thirty-five wells in the RBCV GWMA will be sampled. The locations of these wells are shown in Figure 2. Groundwater sampling under this Plan will be conducted semi-annually. The first round of sampling will be conducted in April or May 2001. Another round of sampling will be conducted in the fall 2001.

1.6 Project Organization and Responsibilities

Activities outlined in this SAP will be conducted by personnel from both King County Department of Natural Resources (KCDNR) and Golder Associates (Golder). Ken Johnson (KCDNR) and Bob Anderson (Golder) will assume the roles of Project Managers in their respective organizations. Contact information is provided below:

Ken Johnson
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Water and Land Resources Division
Regional Water Resources Services Unit
201 S. Jackson St. (King Street Center), Suite 600
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(206) 296-8323

Bob Anderson
Golder Associates
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Redmond, WA 98052-3333
(425) 883-0777

1.6.1 King County DNR Responsibilities

Chris Hughes will be in charge of the groundwater sampling program under the direction of Ken Johnson. Prior to sampling, King County personnel will arrange site access with all landowners and for the provision of sample bottles and coolers from the King County Environmental Laboratory (KCEL). KCDNR personnel will conduct all groundwater sampling, transmit samples to KCEL and process and manage water quality results.

1.6.2 Golder Associates Responsibilities

Golder is responsible for preparation of this sampling and analysis plan (SAP). Golder personnel will provide groundwater sampling assistance upon request.

2. DATA QUALITY OBJECTIVES

2.1 Overview

As stated previously, the goal of groundwater sampling under this SAP is to evaluate groundwater quality and quantity in the RBCV GWMA, with a primary focus on the identification of widespread water quality problems at a regional scale. Wells were selected to be representative of major geologic units and to provide good geographic coverage. The quality of groundwater in this set of wells should provide an overall assessment of regional groundwater conditions in the GWMA.

2.2 Target Analytes

Samples will be analyzed for the constituents listed in Table 1. Field parameters (pH, conductivity, dissolved oxygen, turbidity, and temperature) will be monitored at all wells.

3. SAMPLING AND ANALYSIS PROCEDURES

3.1 Field Data Collection

3.1.1 Water Supply Well Sample Collection from Hose Bibs

The wells chosen for this study are primarily domestic or public supply wells. Figure 3 illustrates a typical configuration of a water supply well house. Because well configurations will vary from site to site, guidelines will be provided for the point in the distribution system where samples should be collected and the volume of water that should be purged prior to sample collection. At each site, professional judgement will be exercised in implementing these guidelines. To ensure comparability of the data between sample rounds, well-specific sampling protocols will be documented.

The goal of groundwater sampling is to collect a sample that is representative of subsurface conditions. For domestic and public water supply wells, water samples should therefore be collected from a hose bib in the well distribution system as close to the wellhead as possible. Three well volumes should be purged prior to sample collection. For some wells, purging three full well volumes may not be possible due to slow pumping rates. In these cases, a minimum of one well volume will be purged and then samples will be collected once field parameters (pH, conductivity, temperature, dissolved oxygen and turbidity) have stabilized. If feasible, samples should be collected upstream of any holding tank (e.g., cistern, water heater, pressure tank). If samples are collected downstream of a holding tank, the full volume of the holding tank should be purged prior to sample collection. In systems where this would amount to large volumes of water, samplers should consult the Project Manager prior to purging. Samples should be collected ahead of any water treatment such as chlorination, fluoridation, or softening. Sampling procedures specific to springs or holding tanks are outlined in Section 3.1.2.

A photograph (or sketch) will be taken to document each systems configuration. At each well, a well sampling field form (Attachment A) will be completed. Prior to sampling, the water level will be recorded, provided the well head is accessible. Well details and purge volumes will be recorded on the well sampling form. At each well, field parameters (pH, conductivity, dissolved oxygen, turbidity, and temperature) will be recorded during purging. Purge water will be directed away from the well house using a garden hose. Field parameter samples will be collected at the end of this hose. Laboratory parameter samples will be collected as soon as field parameters have stabilized and turbidity is less than 5 NTU, as outlined in Golder Technical Procedure TP 1.2-20. Whenever possible, laboratory parameter samples will be collected directly from the hose bib. A complete set of field parameters will also be measured on a sample collected directly from the hose bib (as opposed to at the end of the garden hose) to ensure transmission through the garden hose has not affected field parameters.

In the event that laboratory samples cannot be collected directly from the hose bib (e.g., high pressure, potential flooding of the well house or insufficient access), a length of pre-cleaned, lab-grade PVC tubing will be connected to the hose bib using a hose clamp. A separate set of tubing will be required for each well site. In addition, both an autoclaved and an acid-rinsed length of tubing will be required for each well. The autoclaved tubing will be used to collect the bacteriology and conventional chemistry samples. The acid-rinsed tubing will be used to collect the trace metals sample. All cleaning and decontamination of tubing will occur at KCEL. No decontamination of tubing will occur in the field.

Sample collection will be conducted in accordance with Golder Technical procedure TP 1.2-20, "*Collection of Groundwater Quality Samples*." This procedure describes sample purging, sample collection, and measurements to ensure representative groundwater samples are obtained using bailers, a variety of portable pumps or with dedicated pumps.

Table 2 provides sample volumes, preservation and holding times for groundwater samples to be collected at each well. One inch of headspace will be left in all bottles, if possible. If a bottle is overfilled, excess water will not be decanted from the bottle. The metals collection bottle will be rinsed three times with sample water prior to filling. Samples for all other parameters will be collected directly into the appropriate sample bottles. Samples collected for bacteriology must not contact any surface that is not sterile prior to transfer to the bacteriology bottles.

Because of the low detection limits required for the metals tests, precautions will be taken during sampling to minimize contamination. Sample containers for metals samples will be sealed in zip-lock bags before and after sample collection. Sample collection personnel will wear clean, powder free vinyl gloves while handling the zip-lock bags and the sample containers. Gloves will be changed frequently. The field blank, a sample bottle containing reagent water from the lab, will be handled in the same manner as the samples. This includes removing the bottle from the zip-lock bag, opening the bottle, exposing the blank water to the ambient conditions at a typical sampling site for the duration of sample collection, and returning the bottle to the zip-lock bag.

All samples will be placed in the appropriate sample containers and labeled. Golder Chain of Custody procedure TP-1.2-23 will be followed during storage and shipment of all samples for analysis. Samples will be shipped or dropped off at the laboratory for analysis at the end of each day. Short holding times for nitrate, nitrite, and coliform necessitate this. At the request of KCEL, sample collection will not be conducted on Fridays. This will ensure that all analyses are conducted within the appropriate holding times.

Field analysis of total nitrate, iron, and manganese will be conducted with HACH kits at the discretion of the Project Manager. HACH kits allow rapid and easy determination of nitrate, iron and manganese concentrations using colorimetric methods. The method detection limits of these analyses are 1 mg/L (nitrate), 0.1 mg/L (iron), and 0.02 mg/L (manganese). Concentrations are determined by comparison of the color of a groundwater solution following treatment with reagents to a color chart. These analyses are therefore appropriate as "screening" tools. The precision and accuracy of these results are considered secondary to laboratory determined values.

Field-tests to evaluate biological activity (BART tests) may also be employed at the direction of the Project Manager. BART tests provide an easy way to detect specific bacterial groups and algae in water. Bacteria may impart offensive taste and odor in potable water or result in plugging of wells. The following types of bacteria can be evaluated using BART tests: iron-related, nitrifying, sulfate reducing, slime-forming, and total aerobic. Personnel are referred to the BART manual for specific instructions regarding each test.

3.1.2 Sample Collection from Holding Tanks

Several of the sampling sites require collection from a tank or reservoir (i.e., springs or wells without access to the water prior to treatment). When sampling directly from a holding tank or other reservoir, the sampler shall wear new disposable gloves that must be changed between sampling sites. A sterilized bailer will be used to collect the bacteriology and conventional samples. A separate, acid-washed bailer will be used to collect the metals samples. All samples

collected with the bailers will be transferred directly into the correct lab containers. If the holding tank is part of a potable water system, extreme care must be taken to prevent contamination of the water source with the sampling equipment. Separate bailers will be available for each reservoir and therefore no field decontamination will be required. Bailers will be provided by KCEL.

3.1.3 Sample Designation

Each sample will be clearly labeled with a unique identification number, which will also be used on the Chain of Custody, and field logbooks for identification and tracking and for use in the database that will be developed. The sample identification code format will consist of a unique number and increment sequentially for each new sample. The following information will be collected on the sample integrity sheets or a field book for entry into the database to further describe samples:

1. Sample Location (including LIMS Locator and GIS Coordinates);
2. Filtered/Unfiltered: Filtered = F; Unfiltered = U;
3. Filter Size;
4. QC Type: (Blank = Bk, Duplicate = Dp);
5. Date: Mo/Da/Yr;
6. Time: Hour and Minutes HH:MM; and
7. Sampler's initials.

3.1.4 Equipment

During all sampling activities, disposable equipment will be used whenever possible. All non-dedicated sampling equipment (in contact with sample) shall be laboratory cleaned prior to each sampling event to prevent cross-contamination between samples and to ensure accurate representation of analytes of interest in each sample. No field cleaning procedures shall be performed for any bacteriology sampling; all sample containers and sampling equipment shall be sterilized and transported to the field under conditions to preserve its sterility. No field cleaning procedures shall be performed for metals sampling. Sampling equipment for metals samples will be prepared at the lab prior to each sampling event and transported to the field in plastic bags to preserve cleanliness. The analytical laboratory as part of their agreement shall provide all sample containers, container preparation services, preservatives, gloves, and field blanks.

Non-dedicated pumps and tubing used to purge two-inch monitoring wells will be decontaminated by KCEL between wells following procedures outlined in Technical Procedure TP 1.2-20.

Field meters (pH, dissolved oxygen, conductivity, temperature, and turbidity) will be thoroughly rinsed with distilled or deionized water before and after each reading. Personnel performing decontamination of field testing equipment shall wear gloves, eye protection, and such other safety equipment as needed. Equipment decontamination procedures are described in Golder Technical Procedure TP 1.2-20.

3.2 Laboratory Analysis

Groundwater samples will be submitted to KCEL for analysis. KCEL will arrange for subcontracting the analysis of Total Organic Halides, Silica and Fluoride.

3.2.1 Analytes and Method Detection Limits

Table 1 lists the parameters to be analyzed at each well. Groundwater will be analyzed for drinking water parameters using method detection limits (MDLs) below the maximum contaminant levels (MCLs). Table 3 lists the MDL that will be achieved for each parameter based on the chosen analytical method. This table also provides Washington State Drinking Water Limits and Groundwater Limits for comparison. Except for total mercury, which will be determined by cold vapor atomic absorption spectroscopy, all metals testing will be conducted by ICP-OES and ICP-MS. Based upon expected sample values, total calcium, magnesium, sodium, potassium and iron will be reported by ICP-OES and total arsenic, barium, cadmium, chromium, copper, lead, manganese, selenium, silver and zinc by ICP-MS.

3.2.2 Follow-up Sampling

In the instances where analytical results suggest that resampling of the potable water is indicated, the Laboratory Project Manager will contact the Project Manager to provide verbal notification of the results. Resampling may be necessary for any parameters that exceed primary (health based) drinking water standards. If resampling is ordered, the samples will be collected from the appropriate potable tap, using appropriate sampling containers and technique. The sample should be delivered to the lab clearly labeled as a follow-up POTABLE water for the appropriate analysis. Samples labeled as Potable Water, when bacteriological analysis is indicated, will receive confirmation for Fecal Coliform as part of the Total Coliform analysis under Drinking Water criteria.

The follow-up potable sample will be collected at a point in the distribution system following treatment (e.g., chlorination or filtration). When selecting the faucet from which to take the sample, it is important to be aware that samples taken from an individual's tap may be affected by conditions which exist on the premises and may not accurately reflect the condition of the distribution system. The Washington Department of Health (DOH) (1995) provides following list of less desirable sites with respect to bacteriological sampling:

- Outdoor garden hoses because of probable surface contamination;
- Faucets in a shallow sink or near or below grade. The faucet should not allow hot and cold water to be controlled by the same valve. Water passing through the "hot" water side usually does not represent the water in the distribution system;
- Swing spouts can allow bacteria to grow where the faucet pivots;
- Leaky faucets or faucets that allow water to seep around the valve stem may introduce contamination to the sample;
- Threaded taps can allow bacteria to grow in the tread grooves; and,
- Faucets supplying dishwater in places such as cafes, janitorial sinks, or other sites with higher than usual possibility for bacterial contamination.

Prior to sample collection from a cold water tap, all devices should be removed from the tap including screens and aerators. The water should be allowed to run several minutes before

collecting the sample. For bacteriological sampling, it is essential that headspace be left at the top of the bottle. Samples should be transported to the lab the same day.

If follow-up samples test positive for Coliform or indicate an exceedance of a primary drinking water standard, the Lab Manager will provide verbal notification of the results to the Project Manager as soon as possible. The Project Manager will then take action with respect to notification of the appropriate parties (well owner). The well owner will be responsible for notification of the Health Department, if appropriate (if the well is a public water system). Public Health of Seattle & King County will be provided with all the data on a timely basis after it is compiled and checked. The data are provided for a general understanding of conditions in the area aquifers, and will not be used for compliance purposes.

4. QUALITY ASSURANCE/QUALITY CONTROL

4.1 Field Equipment Calibration and Maintenance

Calibration of all measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be controlled as required by Golder procedure QP-11.1, "Calibration and Maintenance of Measuring and Test Equipment." Lease equipment shall require certifications or other documentation demonstrating acceptable calibration status for the entire period of use for this project. Field calibration requirements shall be in compliance with the technical procedure describing the instruments use and/or with the manufacturer's instructions issued with the equipment.

4.2 Field Measurement QC

To assess the precision of field measurements, duplicate measurements will be obtained at a frequency of 1 in 10 measurements or 1 set per day, whichever is greater. Duplicate measurements should be made using a fresh portion of sample relative to the original measurement and after rinsing the meter using the same procedures used between wells. The duplicate field measurement is recorded only after all acceptance criteria applied to the original measurement have been met (see 3.1.1 and 3.1.3). A copy of the field results for pH, conductivity and turbidity will be left with the laboratory at sample delivery.

Field measurement duplicates must meet or exceed the following criteria or corrective actions must be taken before any additional sampling is conducted.

- +/- 0.1 unit for pH;
- +/- 0.5 ^{o}C for temperature;
- +/- 10% for conductivity and dissolved oxygen; and,
- +/- 10% for turbidity and turbidity less than 5 NTU.

4.3 Field Replicates and Blanks

To assess the precision of field sampling procedures and the variability of the sample source, field replicates will be collected at a frequency of 1 in 10 samples or 1 per day, whichever is greater. Each field replicate is to be collected after performing the decontamination and purging routines used for normal sample collection. One field blank, provided by KCEL, will also be collected each day for metals analysis. The information obtained by collecting field replicates and blanks will be taken into account by the data user when making decisions based on data generated under this QA plan.

The field replicate (for lab analysis) should be collected immediately after collecting an acceptable field measurement duplicate, therefore field parameters (pH, conductivity, turbidity, dissolved oxygen and temperature) will have been measured to ensure that they are still stable and turbidity is less than 5 NTU. If field parameters are no longer stable (stability as defined in TP 1.2-20), the well will continue to be purged until parameters re-stabilize. Upon stabilization, the replicate sample will be collected.

4.4 Laboratory QA/QC

4.4.1 Precision

Laboratory precision will be assessed using laboratory duplicates. When either the original or lab duplicate results exceed the RDL (reporting detection limit) the RPD (relative percent difference) should be less than 25% or the current lab acceptance limit, whichever is lower. For microbiology measurements, the RPD should meet the method requirements. No acceptance criteria are presented when either the original or duplicate results are below the RDL, but above the MDL, as these RPD are provided for informational purposes only.

4.4.2 Accuracy

For this project, laboratory control samples, or blank spikes, whichever are available, will be used to assess method accuracy. Results should be within 20% of the true value or within the criteria provided by the supplier of the control sample.

Accuracy will also be assessed by the evaluation of method blank data. Analytical results for method blanks should be less than the MDL (method detection limit). Note that some common organics laboratory contaminants may exceed the reported MDL. Sample results that are less than 10 times the concentration detected in the method blank will be qualified with a “B” flag to indicate the sample results may be biased.

The use of matrix spike recovery data will provide additional information regarding method performance on actual samples. The laboratory will use professional judgment regarding assessment of data quality and any subsequent action taken as a result of matrix spike recoveries.

4.4.3 Representativeness

Representative samples will be obtained through the following practices:

- The use of generally accepted sampling procedures will allow for the collection of representative samples; and,
- Subsampling within KCEL will be conducted according to lab standard operating procedures. These procedures are designed to obtain representative subsamples.

4.4.4 Comparability

Data comparability will be obtained through the use of standard sampling procedures and trained personnel as described in this plan, and through standard analytical methods used by the laboratory. Additionally, adherence to the procedures and QC approach contained in this QA Plan will provide for comparable data throughout the duration of this project. Any deviations in sampling or analysis must be evaluated for comparability prior to implementation.

4.4.5 Completeness

Completeness will be evaluated by the following criteria:

- The number of usable data points compared to the projected data points as detailed in this plan;
- Compliance with the data quality criteria as presented in this section; and,
- Compliance with required holding times.

The goal for the above criteria is to obtain 100% data completeness. However, where data are not complete, decisions regarding resampling and/or reanalysis will be made by a collaborative process involving both data users and data generators. These decisions will take into account the project data quality objectives as presented above.

5. DATA MANAGEMENT AND REPORTING

5.1 Field Reports

Personnel will record daily sampling activities in a field book or field reporting form. A well sampling form (Attachment A) will be completed at each site. At least one photograph (or sketch) will be taken to document each well.

5.2 Laboratory Reports

Data reduction, review, and reporting will be performed under KCEL's standard operating procedures. Data will be provided to data recipients within 30 days of receipt of the last sample for a sampling event. Data will be reported in the standard laboratory reporting format. This includes an analytical result, MDL (method detection limit), and RDL (reporting detection limit).

All analytical data packages submitted by the analytical laboratory shall include the following:

- Copy of all chain-of-custody documentation, including identification of field sampling personnel, shipping personnel (or organization);
- Analytical results for each sample containing the reduced results for all analytes/constituents requested in the chain of custody, request for analysis or purchase order; and,
- Sample results will be available through LIMS or in an electronic version (Excel) of the hardcopy report (Comprehensive Report). QC summaries are available in hardcopy form only.

5.3 Database Management

Prior to entry into the database, all analytical data will be validated. The Project Manager will dictate the level of data validation. Procedures outlined in USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, 1994) may be used as a reference during data validation.

Each sampling event for a specific well will be assigned a unique numerical identifier for use in the database. Water quality data will be entered into EQUIS or Access.

5.4 Annual Water Quality Report

At the completion of one year of sampling (two rounds), water quality data will be summarized in an annual report. This report will include:

- Tabulation of all water quality data;
- Identification of exceedences to drinking water and groundwater standards;
- Water quality trend analysis;
- Graphical representation of water quality types (stiff or piper diagrams); and
- Mapping of water quality data to show geographical distributions.

This report should also include an evaluation of the QA/QC protocols. This evaluation may include evaluation of field replicates and field blanks. Charge balances may also be performed on individual water analyses as a tool in assessing analytical accuracy.

6. REFERENCES

EPA, 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA-540/R-54-013.

Redmond-Bear Creek Valley Ground Water Advisory Committee, 1999. Redmond-Bear Creek Valley Ground Water Management Plan Supplement 1 – Area Characterization, Final.

Washington State Department of Health, 1995. Preparation of a Coliform Monitoring Plan (Group A Systems with less than 100 Service Connections).

TABLES

Analyte List for Groundwater Sampling

Total Metals
Arsenic
Cadmium
Lead
Selenium
Barium
Calcium
Chromium
Copper
Iron
Magnesium
Manganese
Potassium
Silver
Sodium
Zinc
Mercury
Cyanide
Total Phosphorus
Conventionals
Total Dissolved Solids
Total Alkalinity
Chloride
Nitrate + Nitrite
Sulfate
Subcontracted Analyses
Silica
Fluoride
Special Study/Requested
Microbiology
Total Coliform
Fecal Coliform
Special Study/Requested
Organic-Chlorinated Herbicides
2,4,5-T
2,4,5-TP (Silvex)
2,4-D
2,4-DB
Dalapon
Dicamba
Dichloroprop
Dinoseb
MCPA
MCPP

Special Study/Requested
Organic-BNA
1,2,4-Trichlorobenzene
1,2-Dichlorobenzene
1,2-Diphenylhydrazine
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
3,3'-Dichlorobenzidine
3-Methylphenol
3-Nitroaniline
4,6-Dinitro-O-Cresol
4-Bromophenyl Phenyl Ether
4-Chloro-3-Methylphenol
4-Chloroaniline
4-Chlorophenyl Phenyl Ether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
Acenaphthene
Acenaphthylene
Aniline
Anthracene
Atrazine
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene

BNA list continued
Benzoic Acid
Benzyl Alcohol
Benzyl Butyl Phthalate
Bis(2-Chloroethoxy)Methane
Bis(2-Chloroethyl)Ether
Bis(2-Chloroisopropyl)Ether
Bis(2-Ethylhexyl)Phthalate
Caffeine
Carbazole
Chrysene
Coprostanol
Diazinon
Dibenzo(a,h)anthracene
Dibenzofuran
Diethyl Phthalate
Dimethyl Phthalate
Di-N-Butyl Phthalate
Di-N-Octyl Phthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-Cd)Pyrene
Isophorone
Naphthalene
Nitrobenzene
N-Nitrosodimethylamine
N-Nitrosodi-N-Propylamine
N-Nitrosodiphenylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
Pyridine
Simazine

Special Study/Requested
Organic-VOA
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichloroethylene
1,1-Dichloroethane
1,1-Dichloroethylene
1,2-Dichloroethane
1,2-Dichloropropane
2-Butanone (MEK)
2-Hexanone
4-Methyl-2-Pentanone (MIBK
Acetone
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon Disulfide
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
Cis-1,3-Dichloropropene
Ethylbenzene
Methylene Chloride
Styrene
Tetrachloroethylene
Toluene
Total Xylenes
Trans-1,2-Dichloroethylene
Trans-1,3-Dichloropropene
Trichlorofluoromethane
Vinyl Acetate
Vinyl Chloride

Sample Volumes, Preservation, and Holding Times

Conventionals				
TDS	KCEL	1 L polyethylene	Cool 4°C +/- 2	7 days
Alkalinity (total)	KCEL	500 mL polyethylene	as above	14 days
Chloride, Sulfate	KCEL	250 mL polyethylene	as above	28 days
Nitrate, Nitrite	KCEL	125 mL polyethylene	as above	48 hours
Subcontracted Analyses				
Fluoride, Silica	AmTest	250 mL polyethylene	Cool 4oC +/- 2	28 days
Analyte:				
Microbiology				
Total and Fecal Coliform	KCEL	500 mL HDPE, sterile, leave one inch of headspace	Cool 4oC +/- 2	30 hours
Organics				
Volatile Organic Acids (VOA)	KCEL	40mL glass (4)	Cool 4oC +/- 2	14 days before extraction
Chlorinated Herbicides	KCEL	1L Amber glass (1)	Cool 4oC +/- 2	14 days before extraction
Base Neutral Acids (BNA)	KCEL	1L Amber glass (3)	Cool 4oC +/- 2	14 days before extraction

KCEL - King County Environmental Laboratory.
AmTest - AmTest Laboratories, Inc.

Analyte Analytical Techniques and Method Detection Limits

Parameter	Method	Analytical Technique	MDL (mg/L)	Method	Analytical Technique	MDL (mg/L)	WAC 246-290-310 Drinking Water Standards (mg/L)	WAC 173-200-050 Ground Water Quality Criteria (mg/L)
Total Metals								
Arsenic	EPA 200.8	ICP-MS	0.0005	EPA 200.7	ICP-OES	0.05	0.05	0.05
Cadmium	EPA 200.8	ICP-MS	0.0001	EPA 200.7	ICP-OES	0.003	0.005	0.01
Lead	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.03	0.015[a]	0.05
Selenium	EPA 200.8	ICP-MS	0.0015	EPA 200.7	ICP-OES	0.05	0.05	0.01
Barium	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.001	2.0	1.0
Calcium	EPA 200.8	ICP-MS	0.02	EPA 200.7	ICP-OES	0.05	-	-
Chromium	EPA 200.8	ICP-MS	0.0004	EPA 200.7	ICP-OES	0.005	0.1	0.05
Copper	EPA 200.8	ICP-MS	0.0004	EPA 200.7	ICP-OES	0.004	1.3[a]	1.0
Iron	N/A	N/A	N/A	EPA 200.7	ICP-OES	0.05	0.3 (S)	0.3
Magnesium	EPA 200.8	ICP-MS	0.02	EPA 200.7	ICP-OES	0.03	-	-
Manganese	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.002	0.05 (S)	0.05
Potassium	N/A	N/A	NA/	EPA 200.7	ICP-OES	2	-	-
Silver	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.004	0.1 (S)	0.05
Sodium	N/A	N/A	N/A	EPA 200.7	ICP-OES	0.5	20[b]	-
Zinc	EPA 200.8	ICP-MS	0.0005	EPA 200.7	ICP-OES	0.005	5.0 (S)	5.0
Mercury	EPA 245.2	CVAA	0.0002				0.002	0.002
Cyanide	EPA 335.2 ?	?	?				0.2	0.2
Total Phosphorus	SW 9010 ?	?	?				-	-
Conventionals								
Total Dissolved Solids	SM 2540-C	Gravimetric	5				500	500
Total Alkalinity	SM2320-B	Titrimetric	0.2				-	-
Chloride	SM 4110B	IC	0.05				250 (S)	250
Nitrate + Nitrite	SM 4500	Colorimetric	0.02				10 as N	10 as N
Sulfate	SM 4110B	IC	0.1				250	250
Subcontracted Analyses								
Silica	SM 4500-SI-E	Colorimetric	0.04				-	-
Fluoride	EPA 340.2	Alpchem Autoanalyzer	0.1				2.0 (S)	4
Special Study/Requested								
Microbiology								
Total Coliform	SM9222-B	Membrane Filtration	1 CFU per100mL					
Fecal Coliform	SM9222-D	Membrane Filtration	1 CFU per100mL					
Organic								
VOA	EPA 624	GC/MS	varies per analyte				varies per analyte	varies per analyte
Chlorinated Herbicides	SM 8151	GCMS MODIFIED	varies per analyte				varies per analyte	varies per analyte
BNA	SM 3520C/8270C	GC/MS	varies per analyte				varies per analyte	varies per analyte

[a] Action Level (S) Secondary MCL

[b] Recommended Level '-' parameter not regulated.

FIGURES

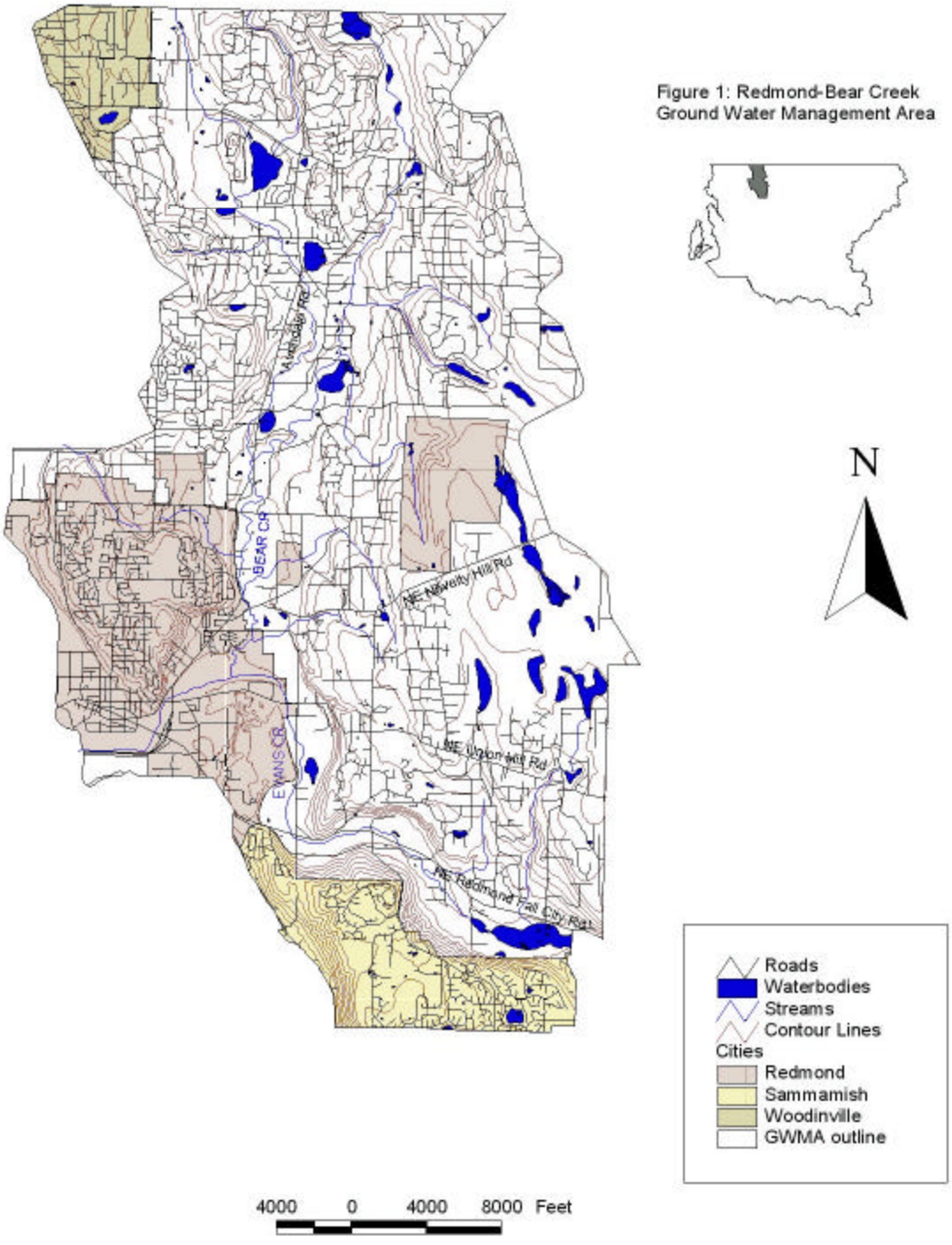


Figure 1: Redmond-Bear Creek
Ground Water Management Area
N
BEAR CR
EVANS CR
NE Novelty Hill Rd
NE Union Hill Rd
NE Redmond Fall City Rd
Roads
Waterbodies
Streams
Contour Lines
Cities
Redmond
Sammamish
Woodinville
GWMA outline
4000 0 4000 8000 Feet

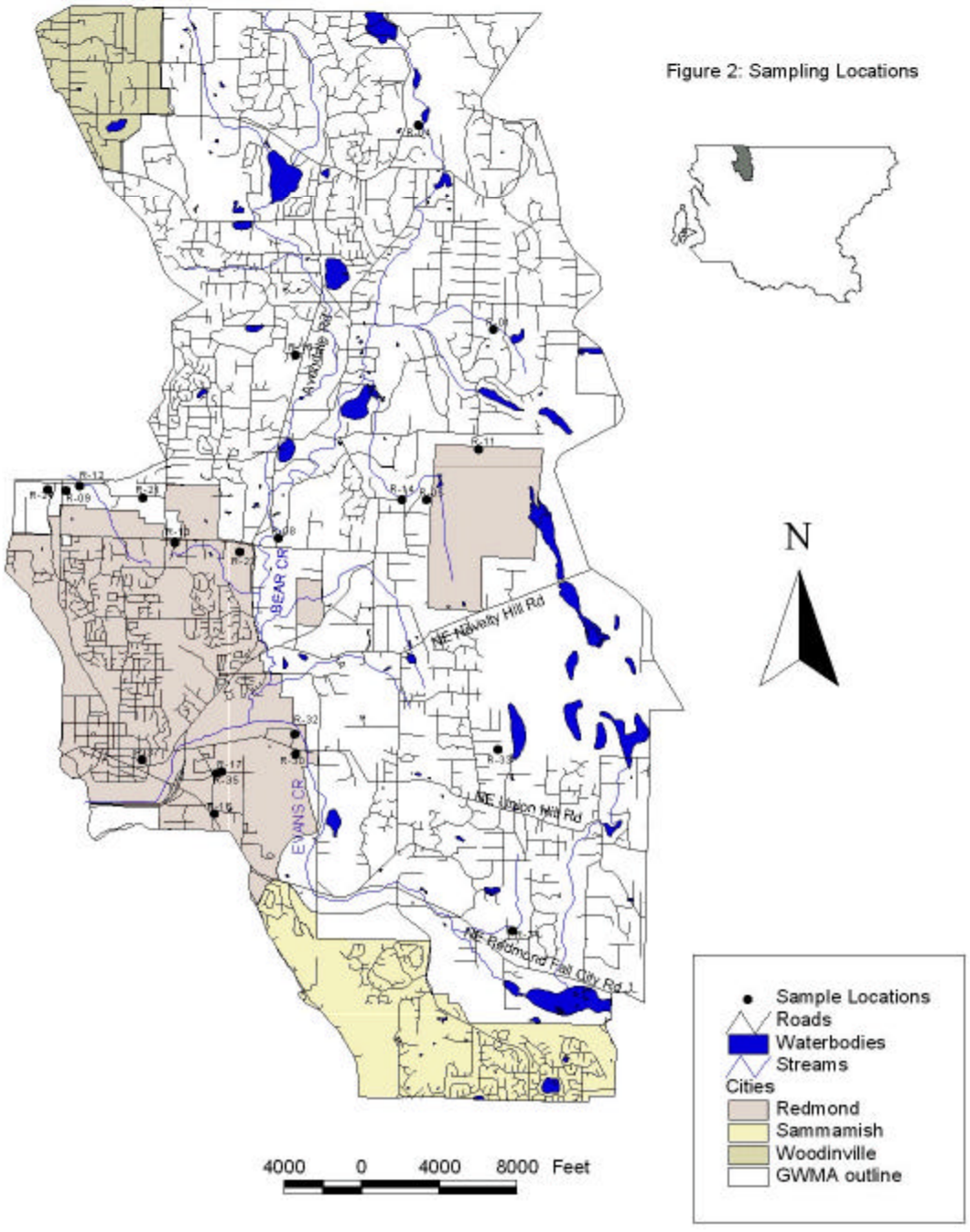
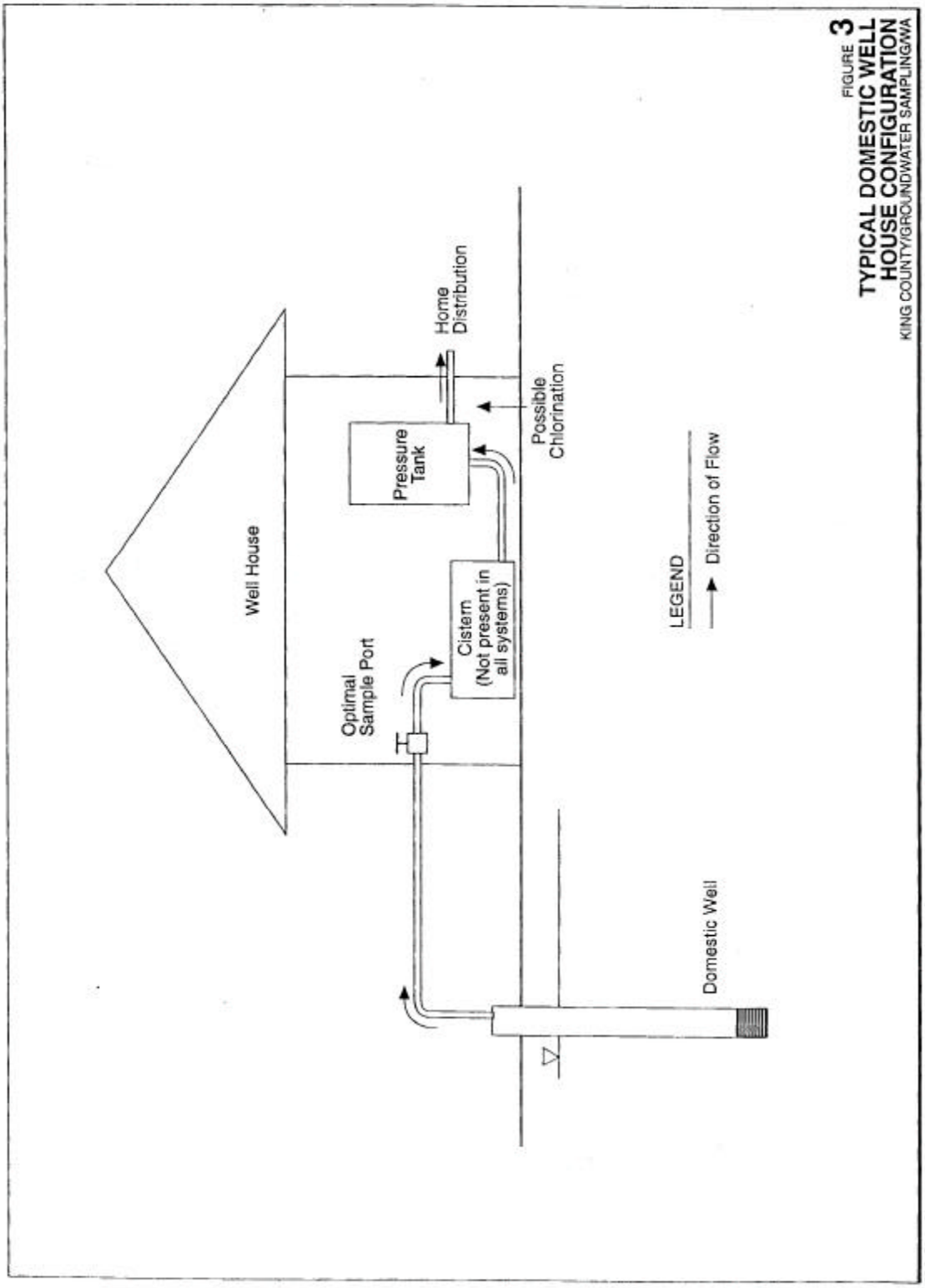


Figure 2: Sampling Locations
N
BEAR CR
EVANS CR
NE Novelty Hill Rd
NE Union Hill Rd
NE Redmond Fall City Rd
4000 0 4000 8000 Feet
Sample Locations
Roads
Waterbodies
Streams
Cities
Redmond
Sammamish
Woodinville
GWMA outline


Well House
Home Distribution
Possible Chlorination
Pressure Tank
Cistern (Not present in all systems)
Optimal Sample Port
Domestic Well
LEGEND
Direction of Flow
FIGURE 3
TYPICAL DOMESTIC WELL HOUSE CONFIGURATION
KING COUNTY/GROUNDWATER SAMPLING/WA
Golder Associates
PROJECT NO. 003-1071.100 DRAWING NO. 10941 DATE: 12/1/2000 DRAWN BY: EA

ATTACHMENT A

WELL SAMPLING FIELD FORM

Project:	Well Identification:
Site:	Sampling Method:
Job Number:	Purge Method:

Well Specifications	**System Configuration**
Hole Diameter d_h =	
Well Casing	
Inside Diam d_wID =	
Water Level H =	
Depth of Well TD =	
Purge Volume Calculations	
Well Volume (ft^3)= $V_c = \pi(d_w ID/2)^2(TD-H)$=	
Vt = Vc * 7.482 gal/ft^3 or Vt = (TD-H) * wcgf	
Minimum Purge Volume (gallons)=	
Vp = Vt x 3 =	
Holding Tank Volume =	

Date	Time Begin	Time Finish	Water Purged (gal)	Cumulative Water Purged (gal)	Cumulative Water Purged Well Vol	Water Characteristics pH	Conductivity (µ mhos/cm)	Turbidity (NTU)	DO (mgdo/L)	Temperature (° Celsius)	Comments

Sampling Date:	
Sample Number:	
Analyses to be Performed:	
No. and Type of Sample Containers/Preserve:	
Chain of Custody Seal Number:	
Analytical Laboratory:	
Date Shipped:	
Carrier:	

well casing diameter to gallons per foot of head: wcgf =

8 " = 2.637 6" = 1.468 4" = 0.653 3" = 0.367 2" = 0.163

TECHNICAL PROCEDURES

TP 1.2-20	**Collection of Groundwater Quality Samples**
TP-1.2-23	**Chain of Custody Procedure**
QP-11.1	**Calibration and Maintenance of Measuring and Test Equipment**

Note: Printed copies of the Technical Procedures section are available by request. Please contact:

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