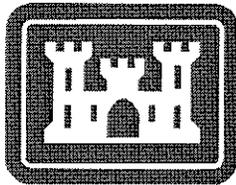


**Final
Work Plan /
Sampling and Analysis Plan
for
Long Term Monitoring
at
Former Schilling Air Force Base
Salina, Kansas**

July 25, 2006

Prepared for



**U.S. Army Corps of Engineers
Kansas City District**

Prepared by



&



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LIST OF ACRONYMS AND ABBREVIATIONS

1		
2		
3		
4	AML	Analytical Management Laboratories, Inc.
5	AOI	Area of Interest
6		
7	BMcD	Burns & McDonnell Engineering Company, Inc.
8		
9	°C	degrees Celsius
10	CENWK	Kansas City District (USACE)
11	cm	centimeter
12	COC	Chain of Custody
13		
14	DO	dissolved oxygen
15	DQCR	Daily Quality Control Report
16		
17	ESI	Expanded Site Investigation
18		
19	FS	Feasibility Study
20	FSM	Field Site Manager
21	ft	feet
22		
23	ICBM	Intercontinental Ballistic Missile
24	ID	inside diameter
25	IDW	investigation-derived waste
26		
27	KDHE	Kansas Department of Health and Environment
28		
29	LDPE	low-density polyethylene
30	LTM	long term monitoring
31		
32	mg/L	milligrams per liter
33	mL	milliliter
34	mL/min	milliliters per minute
35	mV	millivolts
36	MPS	multiprobe system
37	MS	matrix spike
38	MSD	matrix spike duplicate
39	MSL	mean sea level
40		
41	NA	natural attenuation
42	NAVD	North American Vertical Datum
43	NTU	Nephelometric Turbidity Unit
44		
45	ORP	oxidation-reduction potential
46	OU	Operational Unit
47		
48	PDB	passive diffusion bag
49	POC	Point of Contact
50	PVC	polyvinyl chloride

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

1		
2		
3	QA	quality assurance
4	QAPP	Quality Assurance Project Plan
5	QC	quality control
6		
7	RI	Remedial Investigation
8		
9	SAA	Salina Airport Authority
10	SAFB	Schilling Air Force Base
11	SAP	Sampling and Analysis Plan
12	SI	Site Investigation
13	SOP	Standard Operating Procedure
14	SSHS	Site Safety and Health Supervisor
15		
16	TCE	trichloroethene
17	TOC	total organic carbon
18		
19	umhos	micro-mhos
20	USACE	United States Army Corps of Engineers
21	USEPA	United States Environmental Protection Agency
22	UTM	Universal Transverse Mercator
23		
24	VOA	volatile organic analyte
25	VOC	volatile organic compound
26		
27	WP	Work Plan
28		
29		
30		*****

1.0 INTRODUCTION

1.1 PURPOSE

This *Draft Work Plan / Sampling and Analysis Plan* (WP/SAP) provides a description of procedures for executing long-term monitoring (LTM) of groundwater at the former Schilling Air Force Base (SAFB) Site, located at Salina, Kansas.

ECC has a contract with the United States Army Corps of Engineers (USACE) – Kansas City District (CENWK) to provide LTM services at the former SAFB Site. ECC has subcontracted Burns & McDonnell Engineering Company, Inc. (BMcD) to prepare work plan documents; execute the fieldwork for this project; and provide daily quality control reports (DQCRs) and monthly reports. The USACE-CENWK will be responsible for contracting analytical services, data validation, and data analysis and reporting. USACE-CENWK has prepared the Quality Assurance Project Plan (QAPP) for this effort (USACE-CENWK, 2006).

This WP/SAP will only provide background and field procedures to support the LTM of groundwater at the SAFB Site. Additional remedial investigation (RI) activities are planned at both Operational Unit (OU)-1 and OU-2; however, these are outside the scope of this LTM. Additional monitoring wells will be installed as part of these RI activities. The monitoring well network will undergo periodic re-evaluation, which could result in either the addition or deletion of wells from the network. Analytes may also be adjusted, following the review of data by USACE-CENWK. See Section 1.5.3 below for additional information on modifications to this WP/SAP.

1.2 SITE HISTORY

The Smoky Hill Army Air Base was built in 1942. The name of the base was changed to the Smoky Hill Air Force Base in 1946 and to SAFB in 1957. In 1942, the base encompassed 365 acres and housed 5,000 military personnel. By 1967, the base had expanded to 4,000 acres.

In 1942, the base served as headquarters for the newly created Army Air Corps Unit, 20th Bomber Command, and became the first operational training base for B-29 bombers. The base remained a bomber base for five years after World War II ended and was deactivated in 1949.

In 1951, the base was reopened for the Korean War. Upon reactivation, several improvements to the facility were made, including a 25-mile long jet fuel pipeline that terminated at a bulk fuel tank farm on the base. Additional improvements were made after the Strategic Air Command took over operational control of the base. These included construction of a training building, a boiler facility, a gas distribution

1 system, and a bulk oil storage system. The base was designated a permanent Air Force installation in July
2 1953. B-47 bombers were operated from the facility.

3 In 1960, the bombardment wing was transferred to Forbes Air Force Base at Topeka. A squadron of
4 Atlas F intercontinental ballistic missiles (ICBMs) and Nike surface-to-air missiles was deployed to
5 twelve sites around SAFB and attached to SAFB for support. New facilities were constructed for storage
6 and repair of both conventional and nuclear munitions and nuclear warhead maintenance. The SAFB was
7 also upgraded to receive B-52 bombers and KC-135 tankers.

8 The closure of SAFB was announced in 1964 and in 1966 the property was transferred to the Salina
9 Airport Authority (SAA). SAA has since used much of the property in operating the airfield, renamed the
10 Salina Municipal Airport. The remainder of the former SAFB is currently used for light-to-heavy
11 industrial, aviation, and educational purposes. Many of these entities either lease property from SAA or
12 have purchased their properties outright. Major landowners at the SAFB include the Kansas Board of
13 Regents, the Salina Area Vocational Technical School, Kansas National Guard, and the Occupational
14 Center of Central Kansas. Local industries include Tony's Pizza, Schwan's Sales Enterprises, Raytheon
15 (Beechcraft), Flower Aviation, and Moore's Midway Aviation.

16 More detailed information on the history of the Schilling Site can be found in the *Final Remedial*
17 *Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas* (USACE-
18 CENWK, 2005).

19 **1.3 INVESTIGATION HISTORY**

20 The USACE – CENWK, the United States Environmental Protection Agency (USEPA) Region VII, and
21 the Kansas Department of Health and Environment (KDHE) have conducted several environmental
22 investigations at the former SAFB. In 1993, CENWK tasked RUST Environmental and Infrastructure to
23 conduct a Site Investigation (SI) in order to locate potential contamination in Areas of Suspected
24 Contamination. CENWK personnel conducted an SI in 1996 to investigate newly identified Areas of
25 Interest (AOIs) and to obtain additional information on selected areas identified by the RUST SI. If areas
26 identified by the CENWK SI required additional investigation, they were included in the RI performed by
27 BMcD. In 2000, the USEPA conducted an Expanded Site Investigation (ESI) that focused on ground
28 water and potential sources of contamination. Three phases of a Supplemental RI were conducted by
29 CENWK and URS Group in 1999, 2003, and 2004. The Supplemental RI was conducted to acquire data
30 to address issues remaining from previous investigations. The indoor air at the Kansas State University
31 Salina School of Technology has been the subject of two investigations. USEPA and KDHE sampled

1 indoor air to determine if contaminants in the soil were migrating into the buildings by way of vapor
2 intrusion.

3 The primary contaminants at the former SAFB Site are trichloroethene (TCE) and its associated
4 degradation products.

5 More detailed information on the investigation history of the Schilling Site can be found in the *Remedial*
6 *Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas* (USACE-
7 CENWK, 2005).

8 **1.4 SITE SETTING**

9 The former SAFB is located to the southwest of the city of Salina, Kansas, and is shown in Figure 1-1.
10 The Site is within the alluvial plain of the Smoky Hill River within the Smoky Hills Physiographic
11 Province. The former SAFB is located in a transitional environment between the residual uplands to the
12 west and the alluvial valley floodplain to the east.

13 The site geology at the former SAFB consists of alluvial deposits sitting on top of weathered shale
14 belonging to the Wellington Formation (Permian). Alluvium is located in the eastern and northern areas
15 of the SAFB and thickens to the east, towards the Smoky Hill River. The alluvium consists of variable
16 thicknesses of clay, silt, sand, and gravel. Alluvium thickness ranges from zero in the west and southwest
17 to more than 70 feet (ft) in the north and northeast portions.

18 The former SAFB is located within a complex hydrogeologic regime, being located in a transition area
19 between residual uplands developed on bedrock, and alluvial valley and terrace deposits. The principal
20 aquifer at the site is the Smoky Hill River Valley alluvium. This aquifer provides water for public-supply
21 in the Salina area. Groundwater is encountered at shallow depths (less than 20 ft) in the alluvium.
22 Recharge occurs via subsurface inflow from upstream alluvium and via infiltration of precipitation in the
23 local area. Groundwater flow within the alluvium is generally to the east. The shale bedrock generally
24 yields too little water and/or is too highly mineralized for most uses.

25 More detailed information on the site geology and hydrogeology can be found in the *Remedial*
26 *Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas* (USACE-
27 CENWK, 2005).

1.5 RATIONALE AND SCOPE OF WORK

1.5.1 Rationale

Over the course of previous environmental investigations at the SAFB Site, nearly 100 monitoring wells have been installed within the three OUs. There has not been a regular program of groundwater monitoring at these locations. The primary objective of this LTM program is to provide a continuous, synoptic data set for selected monitoring wells within the established network.

The project design for this LTM effort was developed by staff at the USACE-CENWK. The following key decisions were made with regard to project design:

- 79 of the existing monitoring wells were selected for sampling. Based on historical information, it was determined that these would provide good coverage across the three OUs. Additional monitoring wells will be installed in the future as part of planned remedial investigations at OU-1 and OU-2.
- Sampling would be restricted to volatile organic compounds (VOCs). This was based on previous sampling results that indicate that VOCs are the only significant contaminants of concern in groundwater.
- PDB samplers were selected for use. This method for sampling VOCs has been widely tested at numerous sites. It has been demonstrated that PDB samplers will provide reliable, accurate concentration data on VOCs, with significant cost savings compared to conventional sampling methods.
- A subset of 16 monitoring wells was selected for natural attenuation (NA) indicator parameter sampling. Data collected from these wells will assist in an evaluation of the fate of chlorinated solvent compounds in groundwater. These monitoring wells were selected based on their location relative to known VOC plumes.
- The decision was made to sample these monitoring wells quarterly the first year in order to evaluate potential seasonal variations in concentrations. Sampling will continue for an additional four years on a semi-annual basis, in order to provide the data necessary for trend analysis.

1.5.2 Scope of Work

Field activities associated with this LTM project will include the following:

- Water level and total depth measurements

- 1 • Groundwater sampling at selected monitoring wells using low-flow purging procedures with
- 2 a bladder pump
- 3 • Groundwater sampling at monitoring wells using PDB samplers
- 4 • Surveying of selected monitoring wells
- 5 • Management of investigation-derived waste (IDW)

6
7 All monitoring wells will be sampled quarterly for the first year and then semi-annually for the next four
8 years, for a total of twelve sampling events. The monitoring wells will be sampled for VOCs using PDB
9 samplers. In addition, 16 selected wells will also be sampled during each event for NA indicator
10 parameters, to include methane, ethane, and ethene, chloride, nitrate, nitrite, sulfate, sulfide, total iron,
11 total organic carbon (TOC), alkalinity, ferrous iron, dissolved oxygen (DO), oxidation/reduction potential
12 (ORP), pH, and temperature. Samples will also be collected from these 16 monitoring wells for the
13 evaluation of VOCs. The NA sampling will be conducted using low-flow pumps following the removal
14 of the PDB samplers and recovery of the wells. The collection of this data will allow for an evaluation of
15 natural attenuation as part of the Feasibility Study (FS) phase of the RI/FS at OU-1 and OU-2. In
16 addition, the VOC results from these 16 monitoring wells will be compared to PDB sampler results from
17 these wells to ensure that there is a good correlation between results from the two methods.

18 The first quarterly sampling event will be unique, in that, in most cases, either two or three PDB samples
19 will be placed in each monitoring well. This will be done in order to determine, based on contaminant
20 concentrations, the optimal vertical location in each well for placing a single PDB sampler. Only one
21 PDB sampler will be placed in each monitoring well during subsequent events.

22 The monitoring well network consists of 79 wells within the three OUs (Figure 1-1). These include a mix
23 of both flush mount and stick-up well completions. Only one of the 16 monitoring wells identified for the
24 collection of NA indicator parameters has a dedicated bladder pump. The remaining 15 wells will be
25 sampled using non-dedicated equipment.

26 **1.5.3 Work Plan Modifications**

27 It is anticipated that additional monitoring wells will be installed as part of planned future investigations
28 at the former SAFB Site. This will result in changes to this WP/SAP, which could include either the
29 addition or deletion of monitoring wells, or a modification to the analytes being collected. The USACE-
30 CENWK will continue to re-evaluate the data collected and will propose modifications to the sampling
31 network in order to optimize the quality of data being collected. At a minimum, newly installed
32 monitoring wells will be incorporated into the LTM program within six months of installation, depended

1 on the availability of funding. The incorporation of new wells in the WP/SAP will result in the
2 requirement to issue changes to all tables, the figure, and some of the text. Modifications to the analytes
3 collected will require changes to Tables 3-2, 3-3, and 3-4, and some text.

4 * * * * *

1 **2.0 PROJECT ORGANIZATION AND REPORTING**

2 **2.1 PROJECT ORGANIZATION**

3 This section describes key project organizations and personnel. Figure 2-1 provides an organization chart
4 showing key personnel and lines of authority.

5 **2.1.1 United States Army Corps of Engineers**

6 Ms. Robyn Kiefer is the CENWK Project Manager for this project and will serve as the primary point of
7 contact for all questions of a technical nature. Ms. Kiefer can be contacted at 816-389-3615.

8 **2.1.2 ECC**

9 ECC has overall responsibility for the project to the USACE-CENWK, and will act as the program
10 administrator and provide independent quality control (QC) of all submittals. Mr. Bradden Bigelow is the
11 ECC Program Manager and Mr. Jon Vail is the ECC Project Manager. Mr. Bigelow and Mr. Vail can
12 both be reached at (303) 298-7607. However, the BMcD field team will coordinate all field activities
13 with the BMcD project manager.

14 **2.1.3 Burns & McDonnell Engineering Company, Inc.**

15 Mr. Tracy Cooley will serve as the BMcD Project Manager. Mr. Cooley will be responsible for complete
16 coordination of the work, including adequate internal controls and review procedures to eliminate
17 conflicts, errors, and to verify technical accuracy. In addition, Mr. Cooley is responsible for overseeing
18 activities involving sampling and performance of audits. Mr. Cooley can be contacted at 816-822-3369.

19 A BMcD Field Site Manager (FSM) and the Site Safety and Health Supervisor (SSHS) will be designated
20 for each sampling event. The FSM/SSHS will supervise the field activities relevant to this project and
21 will have direct responsibility for site-specific activities and decisions regarding the immediate safety of
22 investigation personnel. The FSM/SSHS will report to the BMcD Project Manager and the BMcD Safety
23 and Health Officer.

24 Mr. Eric Wenger, Industrial Hygienist, will serve as the BMcD Safety and Health Officer for this project
25 and will have ultimate responsibility for the health and safety of field personnel. Mr. Wenger can be
26 contacted at 816-822-3894.

1 **2.1.4 Contract Laboratory**

2 Analytical Management Laboratories, Inc (AML) is the contract laboratory for the analysis of
3 groundwater samples from the Site. AML is under contract to the USACE-CENWK. The AML address
4 is listed below.

5 Analytical Management Laboratories, Inc (AML)
6 15130 South Keeler
7 Olathe, KS 66062
8 (913) 829-0101
9 Point of Contact (POC): Dr. Viswanathan

10
11 **2.1.5 Quality Assurance Laboratory**

12 The ECB Laboratory is the designated quality assurance (QA) laboratory for groundwater samples
13 collected from the former Schilling AFB Site. The ECB Laboratory address is listed below:

14 Sample Custodian
15 ECB Laboratory
16 420 S. 18th Street
17 Omaha, NE 68102
18 (402) 444-4313

19
20 **2.2 PROJECT REPORTING**

21 Required reports for this project will include daily DQCRs and monthly reports.

22 **2.2.1 Daily Quality Control Reports**

23 The FSM will be responsible for ensuring that the former Schilling AFB Site sampling team record daily
24 activities on the standard DQCR form. A DQCR, Chain of Custody (COC), Field Sampling Form, and
25 Calibration Form will be completed daily and submitted in draft form to the BMcD project manager no
26 later than 0800 on the day following the fieldwork. The BMcD project manager will review the
27 document, then forward it on to ECC and the CENWK technical manager for review. The reports will be
28 reviewed by ECC and CENWK. Comments will be provided as appropriate to the BMcD Project
29 Manager within 24 hours of submittal or the next business day. BMcD will correct the reports in
30 accordance with the comments. A copy of the DQCR is included in Appendix B of this WP/SAP

31 **2.2.2 Monthly Progress Reports**

32 BMcD will submit a progress report each month to the CENWK Project Manager. These progress reports
33 will be submitted by the 15th of each month and will include the following information:

- 34 • Progress made during the reporting period

3.0 FIELD ACTIVITIES

3.1 FIELD ACTIVITIES OVERVIEW

The following field activities will be conducted at the Former SAFB Site:

- Water level and total depth measurements
- Groundwater sampling using PDB samplers
- Groundwater sampling for NA indicator parameters using low-flow purging procedures with a bladder pump
- Surveying of selected monitoring wells
- Management of IDW

As stated previously in Section 1.0, multiple PDB samplers (two or three) will be placed in most of the 79 monitoring wells to be sampled during the first quarterly sampling event only. All 79 wells will have at least one PDB sampler installed. Table 3-1 provides information on the number of PDB samplers and the depths at which the PDB samplers will be placed in each of the 79 monitoring wells. Following placement of the PDB samplers, a minimum of three weeks (21 days) will be allowed for equilibration before collecting groundwater samples.

The PDB samplers will be removed and sampled from all 79 monitoring wells. In 16 of the 79 monitoring wells, NA indicator parameters will also be collected and analyzed. These 16 monitoring wells were selected by CENWK personnel. Prior to low-flow purging and sample collection for NA indicator parameters in these 16 wells, the PDB samplers will be removed and sampled, and these will have a minimum of 24 hours to re-equilibrate. Following removal of all the PDB samplers, the field crew will perform NA indicator parameter sampling on the 16 selected monitoring wells using bladder pumps. Table 3-2 provides the analytical sampling requirements for the first quarterly sampling event only.

Following an evaluation by the USACE-CENWK of the analytical data for the first quarterly sampling event, an optimal depth will be determined for the placement of only one PDB sampler in each monitoring well for subsequent sampling activities. A revised Table 3-1 will be issued with this information, which will replace the Table 3-1 included in this document. Otherwise, the sampling procedures will be identical to those performed during the first quarterly event, including the NA parameter sampling. Table 3-3 provides the analytical sampling requirements for the sampling events subsequent to the first quarterly event (events 2 through 12).

1 Table 3-4 provides information on analytical methods, holding times, preservatives and sample containers
2 for all parameters.

3 **3.2 WATER LEVEL MEASUREMENTS**

4 Prior to each sampling event, water level and total depth measurements will be collected from all 79
5 monitoring wells at OU1, OU2, and OU3. All water level measurements will be performed with an
6 electronic water level meter and will be to the nearest 0.01 of a foot. Total depth measurements will be
7 taken to the nearest 0.1 foot. Table 3-5 provides a list of all monitoring wells and their top of casing
8 elevations. This table can also be used to record water level data as it is collected in the field.

9 During water level measurements, the field team should note any problems related to the well
10 construction. These should be logged so that they can be brought to the attention of the CENWK project
11 manager.

12 **3.3 PASSIVE DIFFUSION SAMPLER PROCEDURES**

13 **3.3.1 Introduction**

14 The process of PDB sampling is based on the phenomena of diffusion, the tendency of chemicals to
15 equally distribute themselves within unconfined conditions. Because chemical concentration gradients
16 are inherently unstable and under the influence of random motion, chemicals naturally disperse to form a
17 uniform concentration. Because there are more solute molecules moving in areas of higher concentration,
18 it is more likely that a molecule will wander out of the area than it is for one to wander in, so chemicals
19 distribute themselves until equal concentration is achieved through out the available space.

20 Diffusion is achieved through selective permeation; a barrier is established through which some
21 chemicals can pass and others cannot. Thus the equalization of some compounds is allowed while other
22 compounds are excluded. In PDB sampling, low-density polyethylene (LDPE) is used which allows the
23 migration of small molecules while stopping larger ones. The smaller molecular compounds of interest in
24 this case are volatile organic compounds (VOCs; also known as volatile organic analytes [VOAs]).
25 Currently, only VOC samples can be collected with PDB samplers. Diffusion limitations and sample
26 volume requirements limit the utility of this technique at this time.

27 **3.3.2 Obtaining and Placing Passive Diffusion Bags**

28 PDB samplers specifically designed for the collection of VOC samples, and associated hanging lines
29 (leaders), weights and mesh bags are commercially available. The typical PDB is flat, 24" long and 1.5"

1 wide giving a volume of approximately 270 milliliters (mL), sufficient to fill six 40 mL VOA vials.
2 These bags can be obtained either pre-filled or empty. For this project, pre-filled bags will be used
3 PDB samplers (one, two or three) will be placed in the monitoring wells at depths specified in Table 3-1
4 for the first sampling event in order to sample a vertical profile. Additional bags will be placed where
5 required for the collection of QA/QC and matrix spike (MS)/matrix spike duplicate (MSD) samples.

6 **3.3.3 Initial Placement of Leader and Weight**

- 7 1. Leaders, weights and mesh bags should be ordered from the supplier of the PDB samplers to
8 ensure they are inert and do not leach analytes. Leaders should be ordered an extra ten ft long to
9 allow extra length for adjustment and securing
- 10 2. If the screened interval is known, leaders should be premeasured, installed and insertion depth
11 marked. The following conditions of bag placement should be met in the following order:
 - 12 i) Bags should be placed so they are completely inside the screened interval
 - 13 ii) At least two ft of water column should be present above the bag to inhibit loss of analytes by off
14 gassing.
 - 15 iii) The weight should be at least a foot off of the bottom of the well to reduce the possibility of
16 stirring up sediment when placing or retrieving the bag
- 17 3. Measure water level to ensure that PDB sampler(s) will be at least two ft below surface of the
18 water.
- 19 4. Attach the mesh bag to the leader, if no attachment point is available thread a zip tie through
20 several loops of the mesh and secure it to provide an attachment loop.
- 21 5. Leaders should be threaded through the vent hole in well cap and secured with a cable stay. Extra
22 leader should be cut off and discarded.

23 **3.3.4 Insertion of Bags**

24 Bags are placed in the wells inside a protective mesh bag and suspended from weighted stainless steel
25 wire leaders. The procedure for installing pre-filled PDB samplers is given below. Nitrile gloves should
26 be worn while handling the leader, mesh bags and PDB samplers.

- 1 1. Remove mesh bag from leader by disconnecting the lanyard and cutting zip tie securing the
2 bottom of the bag to the leader. Coil the leader and weight and secure, place in trash bag or
3 Ziploc® bag to protect from contamination. If the well cap is attached to the leader it should be
4 left outside the bag to protect the leader from surface contamination.
- 5 2. Secure the PDB sampler to the mesh using a zip tie, with the cap of the bag protruding from the
6 mesh. Place the zip tie in the joint between the cap and the bag, do not put the zip tie through the
7 loop created by the flip top lid and its seat, this may cause the lid to open allowing contamination
8 of the bag or loss of the bag. Tying the bottom of the mesh bag closed by weaving a zip tie
9 through the mesh is recommended.
- 10 3. Reattach the mesh bag to the lanyard using the looped zip tie at the top. If an attachment to the
11 PDB sampler is provided, secure it with the lanyard as well. Secure the mesh bag to the leader
12 near the bottom of the bag using a zip tie.
- 13 4. Lower the leader with the bag into the well and secure the well cover.

14 3.3.5 Recovery of Bags and Collection of Samples

15 Once equilibrium has been established (at least three weeks) a sample can be collected. To
16 collect samples use the following steps:

- 17 1. Determine depth to water prior to removing the PDB samplers.
- 18 2. Open the well and draw up the leader until the PDB sampler is withdrawn from the well. If two
19 or three bags are present suspend these additional bags in the well by placing the cap back on the
20 well to secure the leader until the first bag is sampled.
- 21 3. Remove mesh bag from leader by disconnecting the lanyard and cutting zip tie securing the
22 bottom of the bag to the leader. Coil the leader and weight and secure, place in trash bag or
23 Ziploc® bag to protect from contamination. If the well cap is attached to the leader it should be
24 left outside the bag to protect the leader from surface contamination.
- 25 4. Hold the PDB sampler in the mesh bag by the cap and gently tap the bag to dislodge any air
26 bubbles that may be clinging to the sides of the bag.
- 27 5. Sampling is a two man job. One person should hold the bag and the other the vials. Full PDB
28 samplers are difficult to handle, leaving them in the mesh bag while sampling adds rigidity and

1 aids in control. Use a discharge straw to decant water from the PDB sampler to the vials. Fill
2 each vial cap to provide enough water for “rounding off” the sample in order to fill each vial
3 without any bubbles. There should be enough water to get six vials, but with spillage and
4 “rounding off”, five is the practical maximum.

5 6. Once all the samples have been taken, discard the rest of the water in the bag in accordance with
6 the IDW plan.

7 7. Remove the PDB sampler from the mesh bag and discard it.

8 8. Label, pack and ship samples.

9 **3.3.6 Quality Control**

10 QC samples will be collected during PDB sampling efforts. Trip blanks, duplicates and MS/MSD
11 samples will be taken as directed in the QAPP, and as indicated on Tables 3-2 and 3-3. QA/QC and
12 MS/MSD samples will be collected from a second PDB sampler, which will be hung immediately below
13 the PDB sampler from which the primary samples will be collected.

14 A method blank will be collected from an unused PDB sampler at the time these are being placed into the
15 monitoring wells. This will involve removing water from an unused PDB sampler and sending it to the
16 analytical laboratory for analysis of VOCs.

17 All coolers containing VOC samples will contain a trip blank, which will be analyzed by the laboratory
18 for VOCs. Temperature blanks will also be placed in each cooler.

19 **3.3.7 Required Equipment and Supplies**

20 Initial placement of leader and weight:

- 21 • Gloves
- 22 • Field notebook
- 23 • Tape measure
- 24 • Water level meter
- 25 • Tools (screwdriver, knife, wire cutters)
- 26 • Leaders, lanyards, weights, mesh bags
- 27 • Cable stays
- 28 • Zip ties

Field Activities

1 Insertion of bags:

- 2 • Gloves
- 3 • Field notebook
- 4 • Laboratory grade deionized water
- 5 • PDBs (pre-filled)
- 6 • Knife/wire cutters
- 7 • Zip ties
- 8 • Ziploc® bags

9

10 Reagent Blanks sampling supplies:

- 11 • Gloves
- 12 • Field notebook
- 13 • Sample bottles
- 14 • Sample labels
- 15 • Chain of custody form
- 16 • Cooler
- 17 • Double bagged ice
- 18 • Strapping tape
- 19 • Shipping form

20

21 Recovery of bags and taking of samples:

- 22 • Gloves
- 23 • Field notebook
- 24 • Sample bottles
- 25 • Sample labels
- 26 • Ziploc® bags
- 27 • Zip ties
- 28 • Knife/wire cutters
- 29 • 5 gallon bucket with lid (for IDW)
- 30 • Chain of custody forms

- 1 • Coolers
- 2 • Double bagged ice
- 3 • Strapping tape
- 4 • Shipping forms
- 5

6 **3.4 LOW-FLOW PURGING PROCEDURES**

7 The USACE-CENWK has adapted a revised Standard Operating Procedure (SOP) for groundwater low-
8 flow purging (USACE-CENWK, 2002). This document is included in this WP/SAP as Appendix A.

9 This revised purging method is a low-flow, low-stress method, which should result in the collection of a
10 representative sample from the aquifer. This method can be used with either dedicated or non-dedicated
11 bladder pumps.

12 The collection of groundwater samples from monitoring wells using this method will be accomplished in
13 four general steps:

- 14 1. Determine the sustainable purge flow rate for the well
- 15 2. Obtain a stabilized water level in the well
- 16 3. Obtain stabilized water quality parameters
- 17 4. Collect groundwater samples
- 18

19 Stabilization parameters will be collected with the use of a multiprobe meter and a flow-through cell.
20 This will facilitate the collection of temperature, pH, specific conductance, ORP, and DO data from each
21 monitoring well sampled with a bladder pump. Turbidity will also be measured. Following parameter
22 stabilization, ferrous iron will be determined by use of a Hach colorimeter and alkalinity will be
23 determined using a Hach digital titrator (Appendix B contains Hach-supplied procedures for these field
24 tests). During purging and sampling of each well, field parameters and water elevations will be recorded
25 every five minutes on the field groundwater sampling report along with the date, time and other pertinent
26 sampling information. All data will be recorded on both the field groundwater sampling report (Appendix
27 C) and in the field logbook.

28 In order to compare analytical results between the PDB samplers and the low-flow purging results, it will
29 be important to ensure that the bladder pump intake is located at the correct depth within the monitoring
30 well screen. For the first quarterly sampling event, the bladder pump intake will be located at the same
31 depth as was the PDB sampler. This will be done in all 16 monitoring wells designated for sampling by

1 low-flow purging procedures. In those monitoring wells with either two or three PDB samplers, the
2 bladder pump intake will be positioned at the same depth as the deepest of the multiple PDB samplers.
3 These depths are presented on Table 3-1. For all sampling events subsequent to the first quarterly event,
4 only one PDB sampler will be deployed in each monitoring well. In these cases, the bladder pump intake
5 will be positioned at the same depth within the screen as the single PDB sampler.

6 Monitoring wells will be purged using the low-flow methodology described below in Sections 3.4.1 and
7 3.4.2. Once field parameters stabilize over at least three consecutive readings while a stabilized water
8 elevation is maintained, the final set of field parameters are recorded, a sample is collected for field
9 ferrous iron determination, the flow-through cell is disconnected and samples for the lab are collected at a
10 pump rate at or below the rate where water elevation stability was obtained. The pump rate will be
11 reduced to 100 milliliters per minute (mL/min) when collecting samples for VOC analysis. A final water
12 level after completion of sampling will also be recorded on the log sheet.

13 Groundwater sampling reports are included in Appendix D for 12 of the 16 monitoring wells which will
14 be sampled by bladder pump. These will assist the field crew in predicting how the monitoring wells will
15 respond to pumping and provide information on anticipated stabilization parameter values.

16 **3.4.1 Procedures for Sustainable Recovery Wells**

17 In these procedures, a “sustainable recovery” well is defined as a well in which stabilized water level can
18 be obtained during pumping at any given, constant flow rate at an elevation above the pump intake such
19 that there is sufficient volume for all required samples (including any extra volume required for QA/QC
20 purposes), plus two sampling system volumes. A sampling system volume is the sum of the volume of
21 the pump bladder, the volume of the discharge tubing, and the volume of the flow-through cell.

22 “Excessive drawdown” is defined as drawdown at any given, constant flow rate such that a stabilized
23 water level can not be obtained at an elevation above the pump intake such that there is sufficient volume
24 for all required samples, plus two sampling system volumes.

25 **“Standard” Sustainable Recovery Wells**

26 In this procedure, a “standard” sustainable recovery well is defined as a well in which a stabilized water
27 level can be obtained during pumping at any given, constant flow rate at an elevation above the pump
28 intake such that there is sufficient volume for all required samples, plus two sampling system volumes, at
29 a pumping rate equal to or greater than 100 mL/min. The procedures for “standard” sustainable recovery
30 wells are as follows:

- 1 1. Obtain well casing and borehole diameters and filter pack percent porosity from well construction
2 records, if available (may be needed for calculations if the well is determined to be a low-
3 recovery well).

- 4 2. If using a non-dedicated bladder pump, the following steps apply:
 - 5 • Measure the water level from the top of the casing to the nearest 0.01 foot.
 - 6 • Determine the depth at which the non-dedicated bladder pump intake should be placed.
7 Measure the length of the pump from intake to the tubing attachment. Measure the length of
8 tubing needed to set the pump at the desired depth within the screened interval
 - 9 • Slowly lower the pump into the well casing to the desired depth in the screened interval,
10 taking care not to encounter the bottom of the well and cause unnecessary agitation of
11 sediment. Affix the pump in this position by securing the tubing at the top of the well casing.
12 Record the depth of the pump intake from the top of the casing.
 - 13

- 14 3. If using a dedicated bladder pump, the following steps apply:
 - 15 • Obtain the well depth and the depth of the pump intake from well construction records (if
16 available).
 - 17 • Measure the depth to water from the top of the casing to the nearest 0.01 foot.
 - 18

- 19 4. Determine the saturated casing volume and saturated borehole volume (saturated casing volume +
20 saturated filter pack volume) (this may be needed for calculations if the well is determined to be a
21 low-recovery well).

- 22 5. Determine the saturated casing volume above the pump intake (this may be needed for
23 calculations if the well is determined to be a low-recovery well).

- 24 6. Determine the sampling system volume (volume capacity of pump, tubing, and flow-through cell)
25 (this may be needed for calculations if the well is determined to be a low-recovery well).

- 26 7. Determine the volume necessary to collect all required samples, including QA/QC samples (this
27 may be needed for calculations if the well is determined to be a low-recovery well).

- 28 8. If the sustainable flow rate is not known for the well, begin purging at 100 mL/min. For wells
29 with historical sustainable flow rate data, use the historical rate

- 1 9. Ensure that no air bubbles are in the pump tubing
- 2 10. Measure and record the water level and an initial set of water quality indicator parameter
3 measurements.
- 4 11. Determine the initial purge flow rate from the well.
- 5 12. Determine whether the initial purge flow rate causes excessive water level drawdown in the well.
6 Measure and record the water level and water quality indicator parameters at 500 mL or five
7 minute intervals. The water level will be considered stable if water level readings do not decrease
8 over three successive measurements (it is acceptable for the water level to remain unchanged or
9 to increase) and if the volume of water in the casing above the pump intake is equal to or greater
10 than the volume needed for all required samples plus two sampling system volumes.
- 11 13. If the initial purge rate of 100 mL/min does not cause excessive drawdown and is an appropriate
12 rate for project analytes and purposes, document that sustainable recovery has been achieved at
13 this rate and go to step #17 below and obtain stabilized indicator parameter readings.
- 14 14. If the initial purge rate of 100 mL/min does not cause excessive drawdown and a higher rate is
15 desirable for project-specific reasons, adjust the flow rate and determine whether sustainable
16 recovery can be obtained using the higher flow rate. Record each adjustment made to the
17 pumping rate, the water level, and the indicator parameter readings measured immediately after
18 each adjustment. The water level and water quality parameters should be measured and recorded
19 approximately every five minutes. When sustainable recovery has been documented at the higher
20 flow rate, go to step #17 below and obtain stabilized indicator parameter readings.
- 21 15. If the initial purge rate of 100 mL/min causes excessive drawdown and the well is less than 25 to
22 30 ft deep, the procedure may be repeated with a "mini" bladder pump to determine whether
23 sustainable recovery can be obtained at flow rates less than 100 mL/min (see "alternate"
24 sustainable recovery well procedures below).
- 25 16. If the initial purge rate of 100 mL/min causes excessive drawdown and alternative equipment
26 with flow rates less than 100 mL/min cannot be used, go to the low-recovery procedure (see
27 Section 3.4.2).
- 28 17. Once a stabilized water level has been obtained, the field indicator parameters will be monitored
29 for stabilization. If the flow rate is equal to or greater than 100 mL/min, measure and record the

1 water quality indicator parameters at five minute intervals. If the flow rate is less than 100
2 mL/min, measure and record the water quality indicator parameters at time intervals of 500 mL
3 divided by the purge rate. Field indicator parameter measurements will be considered stable
4 when three consecutive measurements within the following ranges are obtained:

- 5 • Turbidity: < 50 Nephelometric Turbidity Units (NTUs)
- 6 • DO: ± 0.1 milligram per liter (mg/L) for DO values less than 1 mg/L, or $\pm 10\%$ for DO values
7 greater than 1 mg/L
- 8 • Eh (ORP): ± 10 millivolts (mV)
- 9 • Specific Conductance: $\pm 1\%$ of full-scale reading (instrument repeatability) or default ± 20
10 micro-mhos per centimeter (umhos/cm)
- 11 • pH: ± 0.1 unit
- 12 • Temperature: ± 0.5 degrees Celsius ($^{\circ}\text{C}$)

14 18. Once stabilized field indicator parameter measurements have been obtained, samples may be
15 collected.

16 19. If the other parameters stabilize, but turbidity readings less than 50 NTU cannot be attained, the
17 BMcD project manager will be contacted. The BMcD project manager will then make a
18 recommendation to the USACE-CENWK project manager on how to proceed.

19 **“Alternate” Sustainable Recovery Wells**

20 An “alternate” sustainable recovery well is defined as a well in which a stabilized water level can be
21 obtained during pumping at any given, constant flow rate at an elevation above the pump intake such that
22 there is sufficient volume for all required samples, plus two sampling system volumes, at a pumping rate
23 less than 100 mL/min using alternate equipment capable of a lower flow rate (e.g., “mini” bladder pump).

24 The procedures for “alternate” sustainable recovery wells are as follows:

- 25 1. If a purge rate of 100 mL/min causes excessive drawdown and the well is less than 25 to 30 ft
26 deep, the standard sustainable recovery procedure may be repeated using a “mini” bladder pump
27 to determine whether sustainable recovery can be obtained at flow rates less than 100 mL/min
- 28 2. If stabilized water level can be obtained at a pumping rate less than 100 mL/min using alternative
29 equipment, go to step #17 above and obtain stabilized indicator parameter readings. Note for

1 flow rates of less than 100 mL/min, parameter measurement interval is determined by 500 mL
2 divided by the purge rate.

3 **3.4.2 “Low-Recovery” Wells**

4 A “low-recovery” well is defined as a well in which a stabilized water level cannot be obtained at an
5 elevation above the pump intake such that there is sufficient volume for all required samples, plus two
6 sampling system volumes, regardless of pumping rate or equipment type. If a purge rate of 100 mL/min
7 causes excessive drawdown and/or alternate equipment with flow rates less than 100 mL/min cannot be
8 used, then the following procedure will be used:

9 1. The following information will be needed:

- 10 • Obtain well casing and borehole diameters, and filter pack percent porosity, from well
11 construction records.
- 12 • Determine saturated casing volume and saturated borehole volume (casing volume +
13 saturated filter pack volume)
- 14 • Determine the saturated casing volume above the pump intake
- 15 • Determine the sampling system volume (volume capacity of pump, tubing and flow-through
16 cell)
- 17 • Determine the volume necessary to collect all required samples, including QA/QC samples

18
19 2. Determine whether the saturated casing volume above the pump intake is sufficient for at least
20 two sampling system volumes plus required samples.

21 3. If the casing volume above the pump intake is sufficient for at least two sampling system volumes
22 plus required samples, purge slowly at a constant flow rate; measure and record water level and
23 field indicator parameters every 500 mL until two (or available) system volumes have been
24 removed; collect samples; and document conditions and procedures. Note that the water level
25 will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.

26 4. If the casing volume above the pump intake is not sufficient for at least two sampling system
27 volumes plus required samples, but is sufficient for at least one sampling system volumes plus
28 required samples, purge slowly at a constant flow rate; measure and record water level and field
29 indicator parameters every 500 mL until one (or available) system volumes have been removed;
30 collect samples; and document conditions and procedures. Note that the water level will not be
31 stable (i.e., drawdown will occur) and indicator parameters may not be stable.

- 1 5. If the casing volume above the pump intake is sufficient for all required samples only, determine
2 whether it is acceptable to collect samples without purging. If this is acceptable for project
3 purposes, collect samples at a constant flow rate without purging, and document conditions and
4 procedures.
- 5 6. If the casing volume above the pump intake is not sufficient for all required samples, then the
6 BMcD project manager will be contacted to determine whether samples can be prioritized and it
7 is acceptable to collect priority samples without purging. If this is acceptable for project
8 purposes, collect the priority samples at a constant flow rate without purging, and document
9 conditions and procedures.
- 10 7. If the casing volume above the pump intake is not sufficient for all required samples, samples can
11 not be prioritized, and/or it is not acceptable for project purposes to collect samples without
12 purging, do not sample, document conditions, and contact the BMcD project manager.

13 3.4.3 Required Instruments

14 The following instruments will be used to collect field parameters when conducting low-flow purging and
15 sampling:

- 16 • YSI 556 Multiprobe System (MPS) with flow-through cell (DO, ORP, pH, conductivity, and
17 temperature)
- 18 • Hach 2100P Portable Turbidity Meter (turbidity)

20 3.4.4 Instrument Calibration Procedures

21 The YSI 556MPS will be calibrated at the beginning of each day using calibration solutions provided by
22 the meter's manufacturer (see Appendix B for YSI-supplied calibration instructions). In addition, ORP
23 will be checked for accuracy using standard redox solution (200-275 mV at 25 °C). Calibration checks
24 will be performed at midday and at the end of the day, recalibrating as necessary during the midday
25 check. Calibration checks and recalibration will also be performed any time the readings appear to be
26 abnormal.

27 The DO will be checked before and after sampling each well. An accuracy check will be performed on
28 the ferrous iron colorimeter once per day. The manual will be consulted if the reading is not within ± 0.25
29 mg/L of the standard solution

1 The Hach 2100P turbidity meter will be checked against a set of standards. This instrument is factory
2 calibrated and the calibration can not be adjusted in the field. In the event the instrument fails to conform,
3 the BMcD project manager will be contacted for guidance.

4 All calibrations and calibration checks will be recorded in the field logbook and on the Daily Calibration
5 Log (Appendix C). Extreme cold or hot weather is known to affect meters. In these instances, calibration
6 of the meter will be checked more frequently. Equipment technical manuals will be available in the field
7 for all field measurement instruments. Field personnel should consult the manual for additional technical
8 details.

9 In the event any instrument fails to conform to required calibration checks, and if the field team can not
10 solve the problem, the BMcD project manager will be contacted for guidance.

11 **3.4.5 Equipment Decontamination Procedures**

12 All sampling and investigation equipment will be decontaminated prior to beginning investigation
13 activities, between borings, between locations, and upon completion of investigation activities.

14 Typical decontamination equipment includes the following items:

- 15 • Deionized water
- 16 • Non-chlorinated potable water
- 17 • Isopropanol, pesticide-grade
- 18 • Wash bottles
- 19 • Buckets
- 20 • Scrub brushes
- 21 • Non-phosphate laboratory grade detergent (e.g. Liquinox®)
- 22 • Plastic sheeting
- 23 • Garbage bags

25 **Decontamination of Non-Dedicated Bladder Pumps**

26 Decontamination of non-dedicated bladder pumps will be conducted using the following procedures:

- 1 1. Leave or attach approximately four feet of air supply and water discharge tubing to the pump.
- 2 Place the pump inside a 5-foot section of 2-inch inside diameter (ID) polyvinylchloride (PVC)
- 3 pipe that has one end capped.
- 4 2. Attach the air supply tube to the controller, which is attached to the compressed air source, and
- 5 direct the discharge tube back into the pipe to recirculate the wash water. Fill the PVC pipe with
- 6 deionized water, adding approximately one-half teaspoon of non-phosphate laboratory-grade
- 7 detergent (e.g. Liquinox®).
- 8 3. Turn on the pump and circulate the wash water for approximately one minute.
- 9 4. Direct the discharge into a bucket and pump all detergent water from the PVC pipe.
- 10 5. Pump three to five liters of deionized water through the pump, adding water to the pipe as
- 11 needed, to rinse the detergent from the pump.
- 12 6. Retain decontamination fluids for disposal as described in Section 4.0.

13 **Decontamination of Other Sample-Contacting Equipment**

14 Non-disposable and other non-dedicated equipment which contact the sample will be decontaminated
15 prior to the collection of each sample. This equipment includes, but is not limited to, flow-through cell,
16 water level indicators, and other sampling equipment.

17 Sampling equipment will be decontaminated according to the following procedure:

- 18 1. Fill a nonmetallic wash tub or bucket to a depth of about 6 inches with deionized water. Mix a
- 19 detergent solution in the tub. The solution will consist of approximately 1 tablespoon of non-
- 20 phosphate laboratory-grade detergent (e.g. Liquinox®) per gallon of water.
- 21 2. Scrub all sampling equipment with a stiff-bristled brush and detergent solution.
- 22 3. Transfer the equipment to another wash tub partially filled with deionized water and rinse.
- 23 4. Rinse the sampling equipment with fresh deionized water.
- 24 5. If sampling for organics, rinse the equipment with pesticide-grade isopropanol.
- 25 6. Place the equipment on clean plastic and allow it to air dry.

1 7. Store the equipment covered with plastic or aluminum foil upon the completion of
2 decontamination

3 8 Retain decontamination fluids for disposal as described in Section 4.0

4 The multiparameter meter used for the collection of groundwater parameter data will be decontaminated
5 by spraying the meter's probes with a deionized water spray. The meter's probes will be placed in the
6 receptacle provided, but not before the receptacle itself is decontaminated with a deionized water spray.
7 The meter probes will be removed during decontamination of the flow-through cell.

8 Equipment will not be allowed to be stored next to fuel sources at any time. The bed of a pick-up truck or
9 a panel truck used to transport equipment will be decontaminated and then plastic sheeting will be placed
10 in the bed. Upon completion of work, materials used to construct the decontamination area will be placed
11 in large trash bags and disposed of in a sanitary landfill. Other materials will be disposed of in
12 accordance with Section 4.0.

13 **3.4.6 Quality Control**

14 QC samples will be collected when conducting low-flow purging and sampling for the NA indicator
15 parameters. Trip blanks, duplicates and MS/MSD samples will be taken as directed in the QAPP, and as
16 indicated on Tables 3-2 and 3-3.

17 Equipment blanks will be collected when using the non-dedicated bladder pump. Two equipment blanks
18 will be collected; the first after the initial decontamination of the pump, but before the first well is purged
19 and sampled. A second equipment blank will also be collected, at a time chosen by the field site manager.
20 These equipment blanks will be sent to the laboratory and analyzed for the entire suite of analytes which
21 will be collected from these 16 monitoring wells, including VOCs.

22 All coolers containing VOC samples will contain a trip blank, which will be analyzed by the laboratory
23 for VOCs. All coolers containing methane, ethane, and ethene samples will contain a separate trip blank,
24 which will be analyzed for these three compounds. Temperature blanks will also be placed in each
25 cooler.

26 **3.5 CHAIN OF CUSTODY AND DOCUMENTATION**

27 **3.5.1 Sample Chain of Custody**

28 At all times sample custody must be maintained by the field team. In the field, sample custody is
29 maintained when one or more of the following criteria are met: 1) The samples are in the possession of

1 the sampling team; 2) the samples are in the view of the sampling team; or 3) the samples are stored in a
2 designated secure area.

3 **3.5.2 Chain of Custody Form**

4 The COC form acts as a transmittal form for the analytical samples as sample possession passes from the
5 sampling team to the analytical laboratory (Appendix C) It is the documentation that ensures that sample
6 custody is maintained It also provides the laboratory with critical information regarding the samples
7 delivered. The information contained on the chain of custody will include: project name, project number,
8 matrix of sample, sample designation, date and time of sample collection, sample type, container type and
9 volume, EPA analytical method and remarks. A completely filled out COC will be affixed to the inside
10 of each cooler's lid sent into the analytical laboratory.

11 **3.5.3 Sample Identification Nomenclature**

12 All groundwater sample numbers will consist of the Sample Point and Sample Designator, with
13 appropriate modifiers:

- 14 • Sample Point – This will be the monitoring well ID (for example, 03W11)
- 15 • Sample Designator – This will consist of the letters 'GW', followed by an alphanumeric

16 The numeric will indicate the sampling round for the calendar year (01, 02, 03, 04). For the first
17 sampling round only, the letters A, B, or C will be added as required after the round number to indicate
18 whether the sample is from the shallow, intermediate or deep PDB sampler. The letter 'N' will be added
19 after the round number to indicate that the sample is a NA sample.

20 In addition, the following conventions will be used for QA/QC and MS/MSD samples:

- 21 • QC (Field Dupe) – the letters 'DUP' will be added after the sample designator
- 22 • QA – the letters 'QA' will be added after the sampling designator
- 23 • MS/MSD – the letters MS or MSD will be added at the end of the sampling designator as
24 required

25 The following is an example of sample nomenclature for the first event The complete sample
26 designation for the lower of the two PDB samplers at MW 02W07 would be: 02W07-GW01B. If a
27 duplicate was taken from this bag, the sample designation will be 02W07-GW11BDUP. If an MS/MSD
28 was taken at this location, the sample designation would be 02W07-GW11BMS or 02W07-GW11BMSD.
29 When the NA sampling is performed at this well, the sample designation would be 02W07-GW01N.

1 For the second and successive rounds, the A, B, or C will be dropped from the sample designator, since
2 there will only be a single PDB sampler placed in each well. Using the above example well again and
3 assuming it is round 2, one would have the following sample numbers.

4 The complete sample designation for the PDB sample would be: 02W07-GW02. If a duplicate was taken
5 from this bag, the sample designation will be 02W07-GW02DUP. If an MS/MSD was taken at this
6 location, the sample designation would be either 02W07-GW02MS or 02W07-GW02MSD. When the NA
7 sampling is performed at this well, the sample designation would be 02W07-GW02N (the 'N' will be
8 retained on 2nd round and successive events to differentiate the NA sampling at those wells). A QA
9 sample collected during the NA sampling would have a sample designation of 02W07-GW02NQA.

10 **3.5.4 Field Logbook**

11 Bound field logbooks will be used for the maintenance of field records. A logbook will be dedicated
12 specifically to this project. The BMcD field personnel's name, project name, and project number will be
13 entered on the inside of the front cover of the logbook. All entries will be dated and the time of entry
14 recorded. At the end of each day's activity, or at the entry of a particular event, the investigator may draw
15 a diagonal line at the conclusion of the entry and initial indicating the conclusion of the entry of the day's
16 activity. All aspects of sample collection and handling as well as visual observations, will be documented
17 in the field logbooks. Documentation will be recorded in pre-numbered bound notebooks using indelible
18 ink pens in sufficient detail so that decision logic may be traced back once reviewed. Documentation will
19 include but not be limited to:

- 20 • Project name
- 21 • Sampling location
- 22 • Date and times
- 23 • Sampling personnel present (identify responsibilities, if applicable)
- 24 • Level of personal protection equipment worn
- 25 • Weather or any environmental condition which may affect the samples
- 26 • Equipment utilized
- 27 • Calibration data for field screening instruments
- 28 • Deviations from the approved WP/SAP
- 29 • Notating of the system for identifying and tracking all samples taken to their associated QC
30 samples
- 31 • Visitors to the site

- 1 • Investigation name, initials, and date on each page
- 2 • Lining out of any remaining blank portions or pages with a signature and date
- 3 • Sampling procedures

4 All entries in field logbooks will be legibly recorded with black ink, and contain accurate and inclusive
5 documentation of an individual's project activities. Since field records are the basis for written reports,
6 language will be objective, factual, and free of personal feelings or other terminology, which might prove
7 inappropriate. Once completed, these field logbooks become accountable documents and are maintained
8 as part of the permanent project files. All data recorded on the field groundwater sampling reports
9 (Appendix C) will be duplicated in the logbook.

10 **3.5.5 Field Forms**

11 On a daily basis, and as appropriate, various field forms will be filled out to document aspects of the
12 fieldwork to be performed. Forms include: the DQCR, field groundwater sampling reports, sample
13 labels and chain of custody. The DQCR will be filled out on a daily basis to document the work
14 performed, problems encountered and their resolution. A field groundwater sampling report will be filled
15 out to document purging procedures for monitoring wells to be sampled with a bladder pump.
16 Information provided should include the various groundwater parameters, water levels, the discharge rate
17 of the pump and time of day in military time. A COC form will be filled out and enclosed in all sample-
18 laden coolers. Copies of all field forms to be used for the former Schilling AFB Site are located in
19 Appendix C of this WP/SAP. Analytical sample labels will be completely filled out so that sample
20 identity can be ascertained. The unique sample number will correspond to the monitoring well sampled.
21 Ancillary information contained on the label will include analyte, USEPA Method, date and time of
22 sampling, sampler's identity, project name and project number.

23 **3.6 SAMPLE HANDLING AND SHIPMENT**

24 Once collected, the sample vials will immediately be placed in iced coolers. The ice will be double
25 bagged in Ziploc® baggies. The coolers will maintain a temperature of 4° C. The samplers will refrain
26 from keeping the cooler's lid open to ensure a low temperature is maintained inside the cooler. Once
27 sampling is completed for the day, the sampling team will prepare the samples for shipment. The
28 packaging requirements are as follows:

- 29 • Verify that the sample container is adequately identified with a properly filled out label with date,
30 time, sampling locations, etc

- 1 • Cover the label with clear tape or otherwise secure the label to the bottle. As these are VOA
2 samples, ensure that the tape does not cover the cap.
- 3 • Each VOC sample is represented by three VOA vials with the three vials placed in one Ziploc®
4 bag. If a trip blank is submitted, it will be placed in its own separate bag and represented by three
5 VOA vials. The sample set will also include a temperature blank provided by the laboratory. As
6 much air as possible should be squeezed from the baggie before sealing
- 7 • A cooler of an appropriate size to hold the samples will be used as a shipping container. In
8 preparation for shipping samples, the drain plug (if present) should be taped shut from the
9 outside.
- 10 • Place approximately three inches of inert packing material, i e., styrofoam or an environmentally
11 friendly packing material in the bottom of the cooler.
- 12 • Place sample containers upright in the lined cooler in such a way that they do not touch and will
13 not touch during shipment. Cardboard separators may be placed between the bottles at the
14 discretion of the shipper.
- 15 • Place additional inert packing material in the cooler to further cover the sample bottles. Ice in
16 double bags, sufficient to maintain a temperature of 4°C will be placed in the cooler such that it
17 surrounds the sample bottles. The cooler will then be filled with inert packing material and the
18 lid taped shut.
- 19 • The original COC form will be placed in a plastic bag and affixed to the inside of the cooler lid.
- 20 • Close cooler and tape shut with strapping tape (filament-type).
- 21 • Affix a minimum of two signed custody seals on opposite sides of the cooler's lid.
- 22 • A Federal Express air-bill will be completely filled out for both laboratories. Field samples will
23 be shipped to AML. QA samples will be sent to the ECB Laboratory. Laboratory shipping
24 addresses are provided in Section 2.1
- 25 • The cooler(s) will be delivered directly to a Federal Express agent or to an authorized agent for
26 shipment. The full service Fedex office in Salina, Kansas is located at 3450 Centennial Road. It

1 accepts express shipments until 6:00 p m. For additional questions regarding shipping, contact
2 Fedex at 1-800-463-3339.

3 **3.7 SURVEYING**

4 Six monitoring wells located in the southern part of OU2 will be surveyed for both vertical and horizontal
5 control. These six wells are WSMW-1, -2, -3, -4, -5 and -6 (Figure 1). Surveying will be performed by a
6 licensed Kansas land surveyor. The sample locations will be surveyed horizontally to the nearest 0.1 foot
7 and tied into the Universal Transverse Mercator (UTM). The ground surface elevation of the sample
8 locations will be measured to the nearest 0.1 foot relative to mean sea level (MSL) and reported using
9 North American Vertical Datum 88 (NAVD 88). For all monitoring wells, the reference notch in the top
10 of the riser pipe and the monitoring well monument in the concrete base will be surveyed to the nearest
11 0.01 foot relative to MSL and reported using NAVD 88.

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4.0 INVESTIGATION-DERIVED WASTE

4.1 LIQUID INVESTIGATION-DERIVED WASTE

Liquid IDW generated during groundwater sampling will include purge water from monitoring wells and water generated during the decontamination of sampling equipment. BMcD will be responsible for containerizing, sampling, and disposing of all liquid IDW generated during LTM sampling activities. This liquid IDW will consist of both purge water generated during well sampling and water from the decontamination of equipment. Liquid IDW will be containerized in drums, which will be staged at a pre-arranged location. Samples of the liquid IDW will be collected and sent to the contract laboratory for analysis of VOCs. Based on the analytical results, the liquid IDW will be discharged to the local municipal wastewater system or will be disposed of as hazardous waste. This will be coordinated through the USACE project manager.

4.2 SOLID INVESTIGATION-DERIVED WASTE

Solid IDW will include items such as used PDB samplers, latex gloves, tubing, and other investigation-generated material. This material will be bagged and disposed of as a municipal waste in accordance with applicable regulations.

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5.0 REFERENCES

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Interstate Technology & Regulatory Council (ITRC), 2004, *Technical and Regulatory Guidance for Using Polyethylene Diffusion Bag Samplers to Monitor Volatile Organic Compounds in Groundwater*, ITRC Diffusion Sampler Team

United States Army Corps of Engineers – Kansas City District (USACE-CENWK), 2002, *Standard Operating Procedures for Groundwater Low-Flow Purging and Sampling, Version 1.3*.

USACE-CENWK, 2005, *Final Remedial Investigation for Operable Unit One at the Former Schilling Air Force Base, Salina, Kansas*.

USACE-CENWK, 2006, *Quality Assurance Project Plan for the Former Schilling Air Force Base Long Term Monitoring*

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Tables

Table 3-1
PDB Sampler Placement for 1st Quarterly Sampling Event
Former Schilling AFB LTM
 Salina, Kansas

	Well ID	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	NA Well	PDB #1 (ft btoc)	PDB #2 (ft btoc)	PDB #3 (ft btoc)	Comments
1	00M01	21.71	31.71	NO	24	29	NA	
2	00M03	28.25	38.25	NO	31	36	NA	
3	00M05	24.35	29.35	NO	27	NA	NA	
4	00M07	8.36	13.36	NO	11	NA	NA	
5	00M10	11.54	21.54	NO	14	19	NA	
6	01M15	21.59	30.59	NO	24	29	NA	
7	01M16	17.48	26.48	NO	19	24	NA	
8	01M17	17.28	26.28	NO	19	24	NA	
9	01M18	14.24	23.69	NO	16	22	NA	
10	02M45	14.59	24.59	NO	17	22	NA	
11	02M46	15.59	25.59	NO	18	23	NA	
12	02W05	9.22	19.22	NO	12	17	NA	
13	02W06	7.81	17.81	NO	10	15	NA	
14	02W07	8.36	18.86	YES	11	16	NA	
15	02W08	8.9	18.9	NO	11	16	NA	
16	03M40	11.85	16.85	NO	14	NA	NA	
17	03M41	9.53	14.53	NO	12	NA	NA	
18	03M42	8.36	13.36	YES	11	NA	NA	
19	03M43	13.47	23.47	YES	16	21	NA	Water level may preclude placement of PDB #1
20	03M52	14.67	19.67	NO	17	NA	NA	
21	03M53	28.95	38.95	NO	31	36	NA	
22	03W09	9.28	19.08	YES	12	17	NA	
23	03W10	7.49	17.49	NO	10	15	NA	
24	03W11	12.96	27.96	YES	15	20	25	Water level may preclude placement of PDB #1
25	03W12	10.68	25.68	NO	13	18	23	Water level may preclude placement of PDB #1
26	06M30	4.05	9.05	NO	7	NA	NA	
27	06M31	17.47	22.47	NO	20	NA	NA	
28	07M01	48.22	57.97	NO	50	56	NA	
29	10M09	14.48	24.48	NO	17	22	NA	
30	10M10	10.28	20.28	NO	13	18	NA	
31	10M11	18.22	28.22	NO	21	26	NA	
32	10M12	17.02	26.02	NO	19	24	NA	

Table 3-1
PDB Sampler Placement for 1st Quarterly Sampling Event
Former Schilling AFB LTM
 Salina, Kansas

	Well ID	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	NA Well	PDB #1 (ft btoc)	PDB #2 (ft btoc)	PDB #3 (ft btoc)	Comments
33	22M12	14.12	18.62	NO	16	NA	NA	
34	31M09	16.78	21.28	NO	19	NA	NA	
35	99M02	10.03	15.03	NO	13	NA	NA	
36	99M03	10.29	20.29	NO	13	18	NA	
37	99M04	9.69	14.69	NO	12	NA	NA	
38	99M07	12.75	22.75	NO	15	20	NA	
39	99M08	8.63	13.63	NO	11	NA	NA	
40	99M09	11.6	21.6	NO	14	19	NA	
41	99M10	7.62	17.62	NO	10	15	NA	
42	99M11	14.76	24.76	YES	17	22	NA	Water level may preclude placement of PDB #1
43	99M12	10.68	20.68	NO	13	18	NA	
44	99M13	19.92	29.92	YES	22	27	NA	
45	99M14	9.59	19.59	NO	12	17	NA	
46	99M15	8.59	18.59	NO	11	16	NA	
47	99M17	13.14	23.14	NO	16	21	NA	
48	99M18	13.02	23.02	NO	16	21	NA	
49	99M19	12.79	22.79	YES	15	20	NA	
50	99M20	13.1	23.1	NO	16	21	NA	
51	99M21	13.4	23.4	YES	16	21	NA	
52	99M22	18.64	28.64	NO	21	26	NA	
53	99M23	18.52	28.52	NO	21	26	NA	
54	99M24	19.72	29.72	YES	22	27	NA	
55	99M25	13	23	NO	16	21	NA	
56	99M26	16.09	26.09	YES	19	24	NA	
57	99M28	24.2	34.2	YES	27	32	NA	
58	99M29	17.34	27.34	NO	20	25	NA	
59	99M30	19.02	29.02	NO	22	27	NA	
60	99M31	12.7	17.7	NO	15	NA	NA	
61	99M32	11.29	16.29	YES	14	NA	NA	
62	99M33	15.72	20.72	NO	18	NA	NA	
63	99M34	14.58	19.58	YES	17	NA	NA	

Table 3-1
PDB Sampler Placement for 1st Quarterly Sampling Event
Former Schilling AFB LTM
 Salina, Kansas

	Well ID	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	NA Well	PDB #1 (ft btoc)	PDB #2 (ft btoc)	PDB #3 (ft btoc)	Comments
64	99M35	18.28	28.28	NO	21	26	NA	
65	99M37	20.25	30.25	NO	23	28	NA	
66	99M38	13.9	23.9	NO	16	21	NA	
67	99M39	32.5	42.5	YES	35	40	NA	
68	99M40	62.9	77.4	NO	65	70	75	
69	SAW02	9.8	24.8	NO	12	17	22	
70	SAW04	7.27	22.27	YES	10	15	20	Water level may preclude placement of PDB #1
71	SAW05	7.42	22.42	NO	10	15	20	Water level may preclude placement of PDB #1
72	SAW07	9.27	24.27	NO	12	17	22	Water level may preclude placement of PDB #1
73	SAW08	9.39	24.39	NO	12	17	22	Water level may preclude placement of PDB #1
74	WSMW01	14	24	NO	17	22	NA	
75	WSMW02	10	20	NO	13	18	NA	
76	WSMW03	15	30	NO	18	23	27	
77	WSMW04	12	32	NO	15	22	29	
78	WSMW05	12	27	NO	15	20	24	
79	WSMW06	17.5	32.5	NO	21	25	30	

Notes:

- PDB sampler placement depths are for the 1st quarterly sampling event only. All subsequent events will have only one PDB sampler placed. A revised Table 3-1 will be issued for these events.
 - The 14 monitoring wells indicated in bold will also be sampled for NA parameters, to include dissolved oxygen, oxidation/reduction potential, pH, temperature, nitrate, ferrous iron, sulfate, sulfide, methane, chloride, and chlorinated VOCs.
- btoc - below top of casing
 ft - feet
 NA - not applicable or natural attenuation
 PDB - passive diffusion bag (sampler)

Table 3-2
Analytical Sampling Requirements - 1st Sampling Event
Former Schilling AFB LTM
Salina, Kansas

No.	Well ID	Groundwater Level	Laboratory Analyses										QA/QC Samples			Field Parameters				
			Volatile Organic Compounds (Note 1)	Volatile Organic Compounds (Note 2)	Nitrate (Note 2)	Nitrite (Note 2)	Sulfate (Note 2)	Sulfide (Note 2)	Total Iron (Note 2)	TOC (Note 2)	Methane, Ethane, Ethene (Note 2)	Chloride (Note 2)	QA Sample	QC Field Duplicate	MS/MSD	Dissolved Oxygen (Note 3)	ORP (Note 3)	Alkalinity (Note 3)	Iron (II) (Note 3)	Temperature, pH, Turbidity & Conductivity (Note 3)
1	00M01	1	2												1/1					
2	00M03	1	2																	
3	00M05	1	1																	
4	00M07	1	1												1/1					
5	00M10	1	2																	
6	01M15	1	2												1/1					
7	01M16	1	2																	
8	01M17	1	2												1/1					
9	01M18	1	2																	
10	02M45	1	2										1	1						
11	02M46	1	2																	
12	02W05	1	2										1	1						
13	02W06	1	2																	
14	02W07	1	2	1	1	1	1	1	1	1	1				1	1	1	1	1	1
15	02W08	1	2										1	1						
16	03M40	1	1												1/1					
17	03M41	1	1																	
18	03M42	1	1	1	1	1	1	1	1	1	1			1/1	1	1	1	1	1	1
19	03M43	1	2	1	1	1	1	1	1	1	1				1	1	1	1	1	1
20	03M52	1	1												1/1					
21	03M53	1	2																	
22	03W09	1	2	1	1	1	1	1	1	1	1				1	1	1	1	1	1
23	03W10	1	2																	
24	03W11	1	3	1	1	1	1	1	1	1	1			1/1	1	1	1	1	1	1
25	03W12	1	3																	
26	06M30	1	1												1/1					
27	06M31	1	1												1/1					
28	07M01	1	2																	
29	10M09	1	2												1/1					
30	10M10	1	2												1/1					
31	10M11	1	2												1/1					
32	10M12	1	2																	
33	22M12	1	1										1	1						
34	31M09	1	1												1/1					
35	99M02	1	1																	
36	99M03	1	2																	
37	99M04	1	1										1	1						
38	99M07	1	2										1	1						
39	99M08	1	1																	
40	99M09	1	2										1	1						
41	99M10	1	2																	
42	99M11	1	2	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1
43	99M12	1	2																	
44	99M13	1	2	1	1	1	1	1	1	1	1				1	1	1	1	1	1
45	99M14	1	2																	
46	99M15	1	2																	
47	99M17	1	2										1	1						
48	99M18	1	2																	
49	99M19	1	2	1	1	1	1	1	1	1	1				1	1	1	1	1	1
50	99M20	1	2										1	1						
51	99M21	1	2	1	1	1	1	1	1	1	1				1	1	1	1	1	1
52	99M22	1	2										1	1						

Table 3-2
Analytical Sampling Requirements - 1st Sampling Event
Former Schilling AFB LTM
Salina, Kansas

No.	Well ID	Groundwater Level	Laboratory Analyses										QA/QC Samples			Field Parameters				
			Volatile Organic Compounds (Note 1)	Volatile Organic Compounds (Note 2)	Nitrate (Note 2)	Nitrite (Note 2)	Sulfate (Note 2)	Sulfide (Note 2)	Total Iron (Note 2)	TOC (Note 2)	Methane, Ethane, Ethene (Note 2)	Chloride (Note 2)	QA Sample	QC Field Duplicate	MS/MSD	Dissolved Oxygen (Note 3)	ORP (Note 3)	Alkalinity (Note 3)	Iron (II) (Note 3)	Temperature, pH, Turbidity & Conductivity (Note 3)
53	99M23	1	2										1	1						
54	99M24	1	2	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	
55	99M25	1	2																	
56	99M26	1	2	1	1	1	1	1	1	1	1	1				1	1	1	1	
57	99M28	1	2	1	1	1	1	1	1	1	1	1				1	1	1	1	
58	99M29	1	2										1	1						
59	99M30	1	2																	
60	99M31	1	1										1	1						
61	99M32	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	
62	99M33	1	1																	
63	99M34	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1	
64	99M35	1	2																	
65	99M37	1	2										1	1						
66	99M38	1	2										1	1						
67	99M39	1	2	1	1	1	1	1	1	1	1	1				1	1	1	1	
68	99M40	1	3												1/1					
69	SAW02	1	3																	
70	SAW04	1	3	1	1	1	1	1	1	1	1	1				1	1	1	1	
71	SAW05	1	3												1/1					
72	SAW07	1	3																	
73	SAW08	1	3										1	1						
74	WSMW01	1	2																	
75	WSMW02	1	2																	
76	WSMW03	1	3												1/1					
77	WSMW04	1	3																	
78	WSMW05	1	3												1/1					
79	WSMW06	1	3																	
	Total Wells	79	153	16	16	16	16	16	16	16	16	16				16	16	16	16	
	Trip Blank		10	4							4									
	PDB Blank		1																	
	Equipment Blank			2	2	2	2	2	2	2	2	2								
	QA/QC		16	2	2	2	2	2	2	2	2	2	18	18						
	MS/MSD		16/16	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2		18/18						
	Totals	79	212	28	24	24	24	24	24	24	28	24	18	18	18/18	16	16	16	16	

Notes:

- 1 These VOC samples will be collected with PDB samplers. Either 1, 2, or 3 samplers will be deployed in the monitoring well (see Table 3-1 for specific info on PDB sampler depth placement).
- 2 These analytes will be collected from the designated wells using a bladder pump and low-flow purging methodology. Analysis will be conducted at the off-site analytical laboratory.
- 3 These parameters will be collected from the designated wells in the field during low-flow purging using either a flow-through cell and multiprobe or using field test kits.
- 4 QA/QC and MS/MSD samples will be collected at a frequency of 10% each.
- 5 Shaded QA/QC and MS/MSD samples represent those to be collected from monitoring wells sampled using low-flow purging methodology (2 X QA/QC each and 2 X MS/MSD each).
- 6 The selected locations for the collection of QA/QC and MS/MSD samples are tentative and could require adjustment based on actual field conditions.

Table 3-3
Analytical Sampling Requirements - Events 2 through 12
Former Schilling AFB LTM
Salina, Kansas

No.	Well ID	Groundwater Level	Laboratory Analyses										QA/QC Samples			Field Parameters				
			Volatile Organic Compounds (Note 1)	Volatile Organic Compounds (Note 2)	Nitrate (Note 2)	Nitrite (Note 2)	Sulfate (Note 2)	Sulfide (Note 2)	Total Iron (Note 2)	TOC (Note 2)	Methane, Ethane, Ethene (Note 2)	Chloride (Note 2)	QA Sample	QC Field Duplicate	MS/MSD	Dissolved Oxygen (Note 3)	ORP (Note 3)	Alkalinity (Note 3)	Iron (II) (Note 3)	Temperature, pH, Turbidity & Conductivity (Note 3)
1	00M01	1	1																	
2	00M03	1	1																	
3	00M05	1	1																	
4	00M07	1	1																	
5	00M10	1	1																	
6	01M15	1	1											1/1						
7	01M16	1	1																	
8	01M17	1	1																	
9	01M18	1	1																	
10	02M45	1	1									1	1							
11	02M46	1	1																	
12	02V05	1	1																	
13	02V06	1	1																	
14	02V07	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1
15	02V08	1	1									1	1							
16	03M40	1	1											1/1						
17	03M41	1	1																	
18	03M42	1	1	1	1	1	1	1	1	1	1			1/1	1	1	1	1	1	1
19	03M43	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1
20	03M52	1	1											1/1						
21	03M53	1	1																	
22	03V09	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1
23	03V10	1	1																	
24	03V11	1	1	1	1	1	1	1	1	1	1			1/1	1	1	1	1	1	1
25	03V12	1	1																	
26	06M30	1	1																	
27	06M31	1	1											1/1						
28	07M01	1	1																	
29	10M09	1	1																	
30	10M10	1	1																	
31	10M11	1	1											1/1						
32	10M12	1	1																	
33	22M12	1	1									1	1							
34	31M09	1	1											1/1						
35	99M02	1	1																	
36	99M03	1	1																	
37	99M04	1	1																	
38	99M07	1	1									1	1							
39	99M08	1	1																	
40	99M09	1	1																	
41	99M10	1	1																	
42	99M11	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
43	99M12	1	1																	
44	99M13	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1
45	99M14	1	1																	
46	99M15	1	1																	
47	99M17	1	1									1	1							
48	99M18	1	1																	
49	99M19	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1
50	99M20	1	1																	
51	99M21	1	1	1	1	1	1	1	1	1	1				1	1	1	1	1	1
52	99M22	1	1									1	1							

Table 3-3
Analytical Sampling Requirements - Events 2 through 12
Former Schilling AFB LTM
Salina, Kansas

No.	Well ID	Groundwater Level	Laboratory Analyses										QA/QC Samples			Field Parameters				
			Volatile Organic Compounds (Note 1)	Volatile Organic Compounds (Note 2)	Nitrate (Note 2)	Nitrite (Note 2)	Sulfate (Note 2)	Sulfide (Note 2)	Total Iron (Note 2)	TOC (Note 2)	Methane, Ethane, Ethene (Note 2)	Chloride (Note 2)	QA Sample	QC Field Duplicate	MS/MSD	Dissolved Oxygen (Note 3)	ORP (Note 3)	Alkalinity (Note 3)	Iron (II) (Note 3)	Temperature, pH, Turbidity & Conductivity (Note 3)
53	99M23	1	1																	
54	99M24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
55	99M25	1	1																	
56	99M26	1	1	1	1	1	1	1	1	1	1	1								
57	99M28	1	1	1	1	1	1	1	1	1	1	1								
58	99M29	1	1										1	1						
59	99M30	1	1																	
60	99M31	1	1																	
61	99M32	1	1	1	1	1	1	1	1	1	1	1								
62	99M33	1	1																	
63	99M34	1	1	1	1	1	1	1	1	1	1	1								
64	99M35	1	1																	
65	99M37	1	1										1	1						
66	99M38	1	1																	
67	99M39	1	1	1	1	1	1	1	1	1	1	1								
68	99M40	1	1																	
69	SAW02	1	1																	
70	SAW04	1	1	1	1	1	1	1	1	1	1	1								
71	SAW05	1	1																	
72	SAW07	1	1																	
73	SAW08	1	1																	
74	WSMW01	1	1																	
75	WSMW02	1	1																	
76	WSMW03	1	1																	
77	WSMW04	1	1																	
78	WSMW05	1	1																	
79	WSMW06	1	1																	
	Total Wells	79	79	16	16	16	16	16	16	16	16	16				16	16	16	16	16
	Trip Blank		5	4							4									
	PDB Blank		1																	
	Equipment Blank			2	2	2	2	2	2	2	2	2								
	QA/QC		8	2	2	2	2	2	2	2	2	2	10	10						
	MS/MSD		8/8	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2			10/10					
	Totals	79	109	28	24	24	24	24	24	24	28	24	10	10	10/10	16	16	16	16	16

Notes:

1. These VOC samples will be collected with PDB samplers (see Table 3-1 for specific info on PDB sampler depth placement)
2. These analytes will be collected from the designated wells using a bladder pump and low-flow purging methodology. Analysis will be conducted at the off-site analytical laboratory.
3. These parameters will be collected from the designated wells in the field during low-flow purging using either a flow-through cell and multiprobe or using field test kits.
4. QA/QC and MS/MSD samples will be collected at a frequency of 10% each.
5. Shaded QA/QC and MS/MSD samples represent those to be collected from monitoring wells sampled using low-flow purging methodology (2 X QA/QC each and 2 X MS/MSD each).
6. The selected locations for the collection of QA/QC and MS/MSD samples are tentative and could require adjustment based on actual field conditions.

Table 3-4
Analytical Methods, Preservatives, Holding Times, and Sample Containers
Former Schilling AFB LTM
 Salina, Kansas

Matrix	Parameter	Analytical Method ¹	Sample Containers	Sample Preservation	Holding Times
Water	VOCs	5030B/8260B	3 X 40 mL glass vials Teflon-lined septa caps	HCl to pH<2 Cool to 4°C	Analyzed--14 days
	NA Indicator Parameters Methane, Ethane, and Ethene	RSK-175	3 X 40 mL glass vials Teflon-lined septa caps	HCl to pH<2 Cool to 4°C	Analyzed--14 days
	Chloride	300.1	125 mL HDPE	None	Analyzed--28 days
	Nitrate	300.1	250 mL HDPE	Cool to 4°C	Analyzed--48 hours
	Nitrite	300.1	250 mL HDPE	Cool to 4°C	Analyzed--48 hours
	Sulfate	300.1	125 mL HDPE	Cool to 4°C	Analyzed--28 days
	Sulfide	9030B/9034	500 mL HDPE	Cool to 4°C, 4 ml zinc acetate NaOH to pH > 9	Analyzed--7 days
	Total Iron	3010A/6010B	500 mL HDPE	HNO ₃ to pH <2; Cool to 4°C	Analyzed--6 months
	Total Organic Carbon	415.1/9060	100 mL HDPE	H ₂ SO ₄ to pH <2; Cool to 4°C	Analyzed--28 days
	Alkalinity	Hach Digital Titration Method	Not Applicable	None	Field Analysis
	Ferrous Iron	Hach Colorimetric Method	Not Applicable	None	Field Analysis
	Conductivity	Field Probe w/ Direct Reading	Not Applicable	None	Field Analysis
	Dissolved Oxygen	Field Probe w/ Direct Reading	Not Applicable	None	Field Analysis
	Oxidation/Reduction Potential	Field Probe w/ Direct Reading	Not Applicable	None	Field Analysis
	pH	Field Probe w/ Direct Reading	Not Applicable	None	Field Analysis
	Temperature	Field Probe w/ Direct Reading	Not Applicable	None	Field Analysis
	Turbidity	Direct Reading	Not Applicable	None	Field Analysis

Notes:

Where two numbers are cited, the first is the preparation method and the second is the analytical method. Methods are described in Section 6 of the QAPP (USACE-CENWK, 2006).

inc = Sample preparation included in analytical method

L = Liter

mL = Milliliter

HDPE = High-Density Polyethylene Bottles

VOCs = Volatile Organic Compounds

°C = Degrees Celsius

Table 3-5
Water Level Elevations
Former Schilling AFB LTM
Salina, Kansas

	Well ID	Top of Casing Elevation (ft msl)	Depth to Water (ft TOC)	Total Depth (ft TOC)	Water Level Elevation (ft msl)
1	00M01	1258.20			
2	00M03	1247.30			
3	00M05	1305.74			
4	00M07	1283.01			
5	00M10	1288.74			
6	01M15	1280.12			
7	01M16	1271.94			
8	01M17	1271.90			
9	01M18	1280.08			
10	02M45	1241.93			
11	02M46	1241.63			
12	02W05	1241.48			
13	02W06	1241.11			
14	02W07	1241.17			
15	02W08	1242.46			
16	03M40	1272.99			
17	03M41	1264.41			
18	03M42	1260.76			
19	03M43	1272.26			
20	03M52	1268.87			
21	03M53	1276.44			
22	03W09	1273.80			
23	03W10	1264.32			
24	03W11	1279.59			
25	03W12	1281.26			
26	06M30	1255.79			
27	06M31	1266.54			
28	07M01	1274.14			
29	10M09	1249.29			
30	10M10	1246.58			
31	10M11	1244.87			
32	10M12	1245.55			
33	22M12	1246.77			
34	31M09	1262.90			
35	99M02	1256.52			
36	99M03	1251.44			
37	99M04	1254.36			
38	99M07	1250.33			
39	99M08	1252.29			
40	99M09	1253.23			
41	99M10	1248.68			
42	99M11	1247.93			
43	99M12	1248.29			
44	99M13	1243.51			
45	99M14	1245.78			
46	99M15	1245.74			

Table 3-5
Water Level Elevations
Former Schilling AFB LTM
Salina, Kansas

	Well ID	Top of Casing Elevation (ft msl)	Depth to Water (ft TOC)	Total Depth (ft TOC)	Water Level Elevation (ft msl)
47	99M17	1242.62			
48	99M18	1242.39			
49	99M19	1240.61			
50	99M20	1240.08			
51	99M21	1244.31			
52	99M22	1241.10			
53	99M23	1240.52			
54	99M24	1240.75			
55	99M25	1237.19			
56	99M26	1239.56			
57	99M28	1239.86			
58	99M29	1241.26			
59	99M30	1242.58			
60	99M31	1254.01			
61	99M32	1254.77			
62	99M33	1254.94			
63	99M34	1248.18			
64	99M35	1254.60			
65	99M37	1247.22			
66	99M38	1243.70			
67	99M39	1244.91			
68	99M40	1243.08			
69	SAW02	1247.43			
70	SAW04	1244.76			
71	SAW05	1246.80			
72	SAW07	1245.90			
73	SAW08	1246.62			
74	WSMW01	TBS			
75	WSMW02	TBS			
76	WSMW03	TBS			
77	WSMW04	TBS			
78	WSMW05	TBS			
79	WSMW06	TBS			

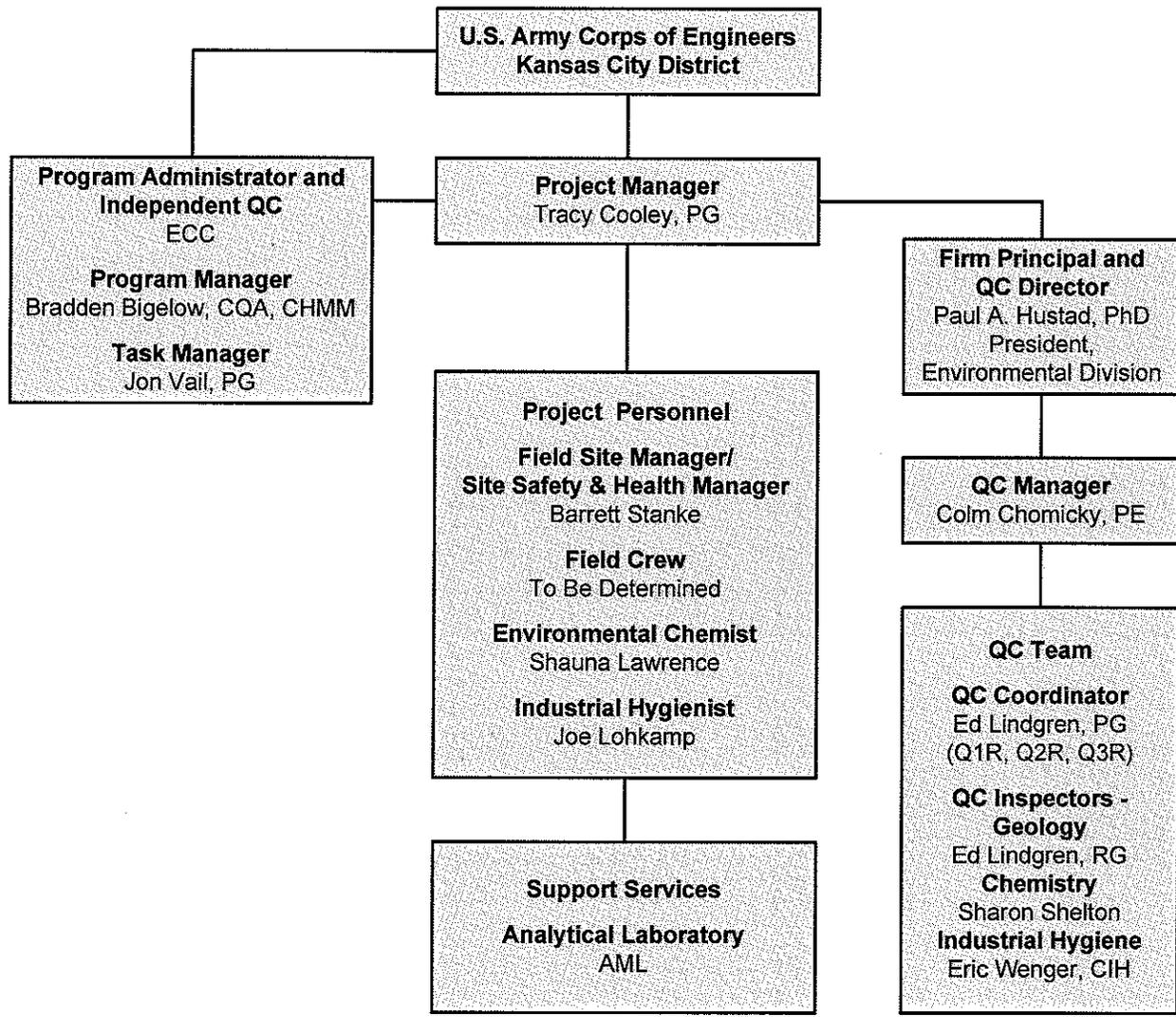
Notes:

msl - mean sea level

TBS - to be surveyed (these wells be will surveyed as part of the first quarterly event)

TOC - top of casing (TOC will be reference point for depth to water and total depth measurements)

Figures



Notes:
BMcD will inform USACE of the members
of the Field Crew when selected.



Figure 2-1
Organization Chart
Former SAFB LTM
Salina, Kansas

Appendix A

SOP for Low-Flow Purging

Standard Operating Procedure for Groundwater Low-Flow Purging

1 Purpose

The purpose of this standard operating procedure (SOP) is to provide a standardized set of procedures, decisions, and criteria for low-flow groundwater purging and sampling. This SOP will be reviewed on an annual basis by the appropriate technical disciplines and updated as appropriate. Reviews without revision will be indicated by changing the date in the header. Reviews with revision will be indicated by changing the version in the header and providing the date of the version.

2 Technical Background

The objective of groundwater sampling is to produce reproducible, representative, verifiable, legally defensible groundwater chemical data. Monitoring wells are purged prior to sampling because it is generally accepted that water in the well casing is not representative of formation water in the aquifer (Puls and Barcelona, 1996). Water may be chemically nonrepresentative for any or all of the following reasons (Puls and Barcelona, 1996):

- concentration gradients for dissolved oxygen (DO) and other gases with depth from the air-water interface
- concentration gradient for volatile organic compounds (VOC) with elevation from the screened interval
- leaching from and/or sorption to the casing or filter pack
- chemical changes due to reaction with clay seals and/or backfill
- surface infiltration

2.1 Historical Overview

Although it has long been agreed that subsurface disturbance and sample handling must be minimized in order to prevent sample alteration and obtain representative samples, there has been considerable disagreement as to the extent or significance of particular disturbances and the magnitude of the resultant physical and chemical changes (Puls and Powell, 1992a). Controversies regarding well purging concern the manner in which the well is purged and the required duration (Giddings, 1983; Gibs and Imbrigiotta, 1990; Puls and Powell, 1992a).

Historical well purging has included a number of common practices which may have significant negative impact on sample quality and/or have been found to be lacking in technical justification. Many of these practices are considered “industry standard” and are still used. Some have been recommended in older but still widely-used guidance documents (e.g., US EPA, 1986, 1991). These include:

- removing large or arbitrary amounts of water (e.g., 3-5 “well volumes” – may be either casing or borehole) during purging
- purging at rates in excess of natural flow through the well screen using a high-speed submersible pump or bailer
- water level drawdown is not controlled during purging
- no specific placement of the pump in the well (i.e., pump intake may be in the cased interval rather than in the screened interval)

- using different devices for purging and sampling (e.g., purging with a high-speed pump and then sampling with a bailer)
- monitoring only 3 water quality parameters
- purging “low-recharge” wells dry and sampling as soon as sufficient water volume re-enters the well

Purging a large or arbitrary number of “well volumes” (either casing or borehole) increases the pumping radius of influence within the aquifer and averages a large volume of water in the sample (Puls and Paul, 1995). Since many contaminant plumes are thin or narrow, this mixing of chemically-distinct waters can result in dilution and misleading data concerning contaminant presence and concentration gradients (Puls and Paul, 1995). High-volume purging is also time-consuming, costly, and generates unnecessarily large volumes of contaminated water which must be managed as investigation-derived waste (Puls and Barcelona, 1996; Puls and Powell, 1992a).

In order to minimize the field time and cost of standardized “well volume” purging, a high-speed pump and fast flow rates would typically be used (Puls and Paul, 1995). However, purging at rates in excess of site hydrogeologic conditions causes excessive drawdown in the well, which pulls stagnant water into the screened interval, mixes chemically-distinct waters, and causes aeration, turbulence, and redevelopment of the well (Giddings, 1983; Gilham, et al., 1983; Puls and Powell, 1992a). The resulting artificially-induced chemical and physical changes in the groundwater include changes in redox, pH, carbonate equilibria, metal speciation, chemical precipitation, erroneously high turbidity and total metals, suspension of particles that may not be mobile in the aquifer and which may have adsorbed contaminants, order-of-magnitude errors in dissolved chemical data, and the potential for damage to the filter pack of the monitoring well (Barcelona and Helfrich, 1986; Barcelona et al., 1994; Gibs and Imbrigiotta, 1990; Gibs et al., 1993; Giddings, 1983; Gilham, et al., 1983; Kaminski, 2002; Martin-Hayden et al., 1991; McCarthy and Zachara, 1989; Powell and Puls, 1993; Puls and Barcelona, 1996; Puls and Powell, 1992a,b; Puls et al., 1992; Reilly and Gibs, 1993; Robbins and Martin-Hayden, 1991; Robin and Gilham, 1987; Schmidt, 1982; Strausberg, 1983; Wilson and Rouse, 1983).

In addition to the adverse consequences of uncontrolled drawdown and high pumping rates, historical “well volume” purging typically had no requirement for pump intake placement within the well. The high-speed submersible pump would often be placed near the top of the water column (Puls and Paul, 1995), a placement that has been shown to actually increase the volume required to access formation water to values much greater than the conventional 3-5 “well volumes” (Robin and Gilham, 1987).

Various workers (e.g., Kearl et al., 1992; Powell and Puls, 1993; Robin and Gilham, 1987) have determined that groundwater flow through the screened interval of a well is laminar, with little interaction or mixing with chemically-different water in the overlying well casing unless disturbed (e.g., by insertion of sampling equipment or pumping at high rates), and therefore is representative of formation water in the surrounding aquifer. By placing the pump within the screened interval and pumping at a rate low enough to minimize or eliminate drawdown, many adverse effects on sample quality would be mitigated. Studies using a downhole camera during purging and sampling indicate that emplacement of the sampling device causes significant disturbance at the sampling point (Kearl et al., 1992; Powell and Puls, 1993). Use of different devices for purging and sampling should therefore be avoided.

Although monitoring field water quality indicator parameters for stabilization to determine when formation water is being accessed (“equilibrated”) has generally been conducted prior to groundwater sampling, historically, only three parameters (pH, temperature, and specific conductance) were usually measured. Work by various investigators beginning in the 1980s indicates that pH, temperature, and

specific conductance tend to stabilize quickly and that these parameters are insensitive in distinguishing between formation water and stagnant water (Humenick et al., 1980; Pionke and Urban, 1987; Powell and Puls, 1993; Puls and Barcelona, 1996; Puls and Powell, 1992b; Puls et al., 1991, 1992). In the early 1990s, Puls et al. (1991, 1992) determined that oxidation-reduction potential (ORP), dissolved oxygen (DO), turbidity, and contaminant concentrations are the most sensitive indicators of equilibrated conditions.

Using the volume of the sampling system (bladder pump, tubing, and flow-through cell) as a means for comparison, the earliest that a well could show stabilization of indicator parameters would be after two “system volumes” had been removed (Barcelona et al., 1994; Puls and Paul, 1995). At flow rates of 0.2 – 0.5 L/min, Puls and Paul (1995) found that the indicator parameters equilibrated at 0.7 “well volumes” (4 L) for a dedicated sampling system and 1.8 “well volumes” (10 L) for a portable system. They also determined that after removing 3 sampling system volumes at a constant flow rate and stabilized water level, the water quality parameters were within 20% of the final equilibrated values.

Dewatering a well considered to be “low-recharge” is another common, historical practice that has a number of adverse hydrogeological and hydrochemical consequences. When a well is evacuated, water drains from the well filter pack, the filter pack pore spaces fill with air, which remains even after water re-enters the well, the trapped air upsets the natural gas equilibria and alters fO₂-pH conditions, and samples are not representative (Kaminski, 2002).

2.2 Low-flow Method

“Low-flow” (also called “low stress”) purging and sampling addresses the various problems associated with historical well purging practices. “Low-flow” refers to the velocity at which water enters the pump intake and which is imparted to the formation water in the immediate vicinity of the well screen, not to the flow rate of water discharged at the surface (Puls and Barcelona, 1996; Puls and Paul, 1995). Low-flow purging is typically conducted at flow rates on the order of 100 – 500 mL/min (Puls and Barcelona, 1996). It should be noted that 1 L/min is the upper limit for low-flow purge rate, regardless of the transmissivity of the formation, since higher flow rates will exceed the laminar flow regime and induce turbulent flow (Puls and Barcelona, 1996).

One of the major objectives of low-flow purging is to minimize stress by pumping at a rate that does not exceed natural flow rate of groundwater within the aquifer. Water level drawdown is considered the best indicator of the stress imparted by a given flow rate in a particular hydrogeological situation (Puls and Barcelona, 1996; Puls and Paul, 1995), and is monitored frequently.

Other characteristics of the “low-flow” method include:

- Use of a variable-speed pump capable of low flow rates (100 mL/min or less is recommended for sensitive analytes such as VOC and redox-sensitive species).
- Using the same pump for both purging and sampling to minimize disturbance caused by insertion and withdrawal of sampling devices (Kearl et al., 1992).
- Isolation of water from the screened interval of the well from overlying stagnant casing water by placing the pump intake within the screened interval.
- Pumping at a rate that does not exceed natural flow rate of groundwater within the aquifer.
- Monitoring water level drawdown during purging to determine the amount of stress on the aquifer.

- Monitoring six water quality indicator parameters (dissolved oxygen (DO), turbidity, Eh (ORP), specific conductance, pH, and temperature) during purging to determine when formation water is being accessed and samples can be collected.

In addition to minimizing physical disturbance and chemical changes, low-flow purging also typically minimizes the amount of investigation-derived waste (IDW) generated during the sampling event.

3 Procedure Overview

The collection of groundwater samples from monitoring wells using the low-flow method will be accomplished in four general steps:

- Determine the sustainable purge flow rate for the well;
- Obtain stabilized water level in the well;
- Obtain stabilized water quality indicator parameters;
- Collect groundwater samples.

In order to avoid cross-contamination, monitoring wells will be purged and sampled in order so that the well having the lowest suspected contamination is sampled first, and the well having the highest suspected contamination is sampled last. (Note: It is important to “flush” the pumping system with groundwater to remove residues from the last operation, regardless of whether the pump is dedicated or portable)

3.1 Stabilization Criteria

3.1.1 Water Level

Water level will be measured to the nearest 0.01 ft using an electronic water level indicator. Water level will be considered stable when 3 successive readings at 5-min. intervals show no change. Note: for purposes of this SOP, either stable (no change) or rising water level will be considered acceptable.

3.1.2 Water Quality Indicator Parameters

The six field indicator parameters to be monitored are: dissolved oxygen (DO), turbidity, Eh (ORP), specific conductance, pH, and temperature. Of these, DO, ORP, specific conductance, pH, and temperature are moderately to extremely sensitive to contact with atmospheric oxygen, and will be measured in-line using a flow-through cell and multimeter. Turbidity may be measured separately on a discrete sample. Indicator parameters will be monitored continuously during purging and values recorded approximately every 3-5 minutes.

3.1.2.1 DO, ORP, specific conductance, pH, and temperature

Stabilization is mathematically defined as an asymptote (i.e., the slope of a plotted curve for each parameter is no longer changing). The operational criteria for DO, ORP, specific conductance, pH, and temperature are 3 successive readings at 5-min. intervals (for flow rate equal to or greater than 100 mL/min) within the following ranges:

- DO: ± 0.1 mg/L for DO values less than 1 mg/L, *or* $\pm 10\%$ for DO values greater than 1 mg/L.
- Eh (ORP): ± 10 mV
- specific conductance: $\pm 1\%$ of full-scale reading (instrument repeatability) *or* default ± 20 μ mhos/cm
- pH: ± 0.1 unit
- temperature: ± 0.5 °C

3.1.2.2 Turbidity

Turbidity is considered stabilized if values are less than 50 NTU for 3 successive readings at 5-min. intervals (assuming a 100 mL/min flow rate). If the other parameters stabilize, but turbidity remains >50 NTU, the field personnel should continue purging at the determined sustainable flow rate to see whether the turbidity decreases with additional pumping. If turbidity does not decrease, the designated point-of-contact for the Project Delivery Team (PDT) should be notified.

3.2 Recommended Equipment

In addition to field equipment specified in the project Field Sampling Plan (FSP), the following equipment should be available:

- variable-speed bladder pump or submersible pump capable of low flow rates (i.e., 100 mL/min or less)
- contingency low-flow sampling device (e.g., peristaltic pump)
- project- or analyte-specific tubing (e.g., Teflon or Teflon-lined)
- Flow-through cell no larger than 500 mL (smaller is preferable) equipped at a minimum with probes for DO, ORP, pH, conductivity, temperature
- Above probes must be calibratable by field personnel
- Instrument for measurement of turbidity. Must be able to calibrate
- Stopwatch
- 500-mL graduated cylinder
- Three or more 5-gallon buckets
- Pre-printed field forms for recording readings
- Water level measuring device
- Graph paper or field computer - for plotting readings vs. time if desired)

Backup equipment should be available as necessary

4 Procedures for Sustainable Recovery Wells

In these procedures, a “sustainable recovery” well is defined as a well in which stabilized water level can be obtained during pumping at any given, constant flow rate at an elevation above the pump intake such that there is sufficient volume for all required samples (including any extra volume required for quality assurance/quality control (QA/QC) purposes) plus two sampling system volumes (see sec. 4.1, no. 9).

“Excessive drawdown” is defined as drawdown at any given, constant flow rate such that a stabilized water level can not be obtained at an elevation above the pump intake such that there is sufficient volume for all required samples plus two sampling system volumes.

4.1 “Standard” Sustainable Recovery Wells

In this procedure, a “standard” sustainable recovery well is defined as a well in which stabilized water level can be obtained as described in sec. 4 at a pumping rate equal to or greater than 100 mL/min.

Note: The project Field Sampling Plan should be consulted for site-specific field preparatory activities which may take place at a given well prior to purging.

1. Obtain well casing and borehole diameters and filter pack percent porosity from well construction records (may be needed for calculations if the well is determined to be a low-recovery well).
2. Calibrate the electronic water quality multi-meter equipment (e.g., Horiba U22 or equivalent) as per manufacturer's instructions and record calibration data in the field logbook or on a field data form.
3. Check the function of the electronic water level meter as per the manufacturer's instructions.
4. Assemble equipment at the well and perform field preparatory activities as described in the project-specific Field Sampling Plan.
5. If using a portable pump, the following steps are applicable:
 - Measure well depth. Using the electronic water level meter, measure and document the depth of the well (to the nearest 0.01 ft) from the reference mark on the top of the inner well casing.
 - Measure water level. Using the electronic water level meter, measure and document the water level to the nearest 0.01 ft. from the reference mark on the top of the inner well casing.
 - Assemble the pump and sampling line components, taking care not to contact any of the components with potentially-contaminated media, and ensure that the discharge line is affixed such that initial discharge is captured in either a graduated 5-gallon bucket or a purge water collection/disposal drum.
 - Determine the depth of portable pump intake. Measure length of pump from intake to tubing and cable attachment. Measure length of tubing and cable needed to set pump at desired depth within the screened interval.
 - Slowly lower the pump into the well casing to the desired depth in the screened interval, taking care not to encounter the bottom of the well and cause unnecessary agitation of sediment. Affix the pump in this position by fastening the supporting cable. Record depth of pump intake from the reference mark on the top of the inner well casing.
6. If using a dedicated pump, the following steps are applicable:
 - Obtain well depth and depth of pump intake from well construction records.
 - Measure water level with pump in place. Using the electronic water level meter, measure and document the depth to water (to the nearest 0.01 ft) from the reference mark on the top of the inner well casing.
7. Determine saturated casing volume and saturated borehole volume (saturated casing volume + saturated filter pack volume) (may be needed for calculations if the well is determined to be a low-recovery well).
8. Determine the saturated casing volume above the pump intake (may be needed for calculations if the well is determined to be a low-recovery well).

9. Determine sampling system volume (volume capacity of pump, tubing, and flow-through cell) (may be needed for calculations if the well is determined to be a low-recovery well).
10. Determine volume necessary to collect all required samples, including QA/QC samples (may be needed for calculations if the well is determined to be a low-recovery well).
11. Connect the flow-through cell and multi-meter to the pump tubing.
12. If the sustainable flow rate is not known for the well, begin purging at 100 mL/min. For wells with historical sustainable flow rate data, use the historical rate.
13. Ensure that no air bubbles are entrained in the pump tubing. Raise the level of the flow-through cell above the well such that water must pump upward through the intake tubing of the cell. This will purge any bubbles through the tubing. After the cell fills with water, it may be lowered.
14. Measure and record the water level and an initial set of water quality indicator parameter measurements.
15. Determine the initial purge flow rate from the well. Using a graduated cylinder, bucket, or other suitable container of known volume and a stopwatch, time the rate of filling.
16. Determine whether the initial purge flow rate causes excessive water level drawdown in the well. Measure and record the water level and water quality indicator parameters at 500 mL or 5- min. intervals. The water level will be considered stable if water level readings do not decrease over 3 successive measurements (it is acceptable for the water level to remain unchanged or to increase) and if the volume of water in the casing above the pump intake is equal to or greater than the volume needed for all required samples plus 2 sampling system volumes.
17. If the initial purge rate of 100 mL/min does not cause excessive drawdown and is an appropriate rate for project analytes and purposes, document that sustainable recovery has been achieved at this rate and go to no. 21 and obtain stabilized indicator parameter readings.
18. If the initial purge rate of 100 mL/min does not cause excessive drawdown and a higher rate is desirable for project-specific reasons, adjust the flow rate and determine whether sustainable recovery can be obtained using the higher flow rate. Record each adjustment made to the pumping rate, the water level, and the multi-meter readings measured immediately after each adjustment. The water level and water quality parameters should be measured and recorded approximately every five minutes. When sustainable recovery has been documented at the higher flow rate, go to no. 21 and obtain stabilized indicator parameter readings.

Note: Assuming a highly transmissive formation, 1 L/min is the *maximum* purge rate that will preserve laminar flow in the screened interval.
19. If the initial purge rate of 100 mL/min causes excessive drawdown and the well is less than 25 – 30 ft. deep, the procedure may be repeated using a peristaltic pump to determine whether sustainable recovery can be obtained at flow rates less than 100 mL/min (“alternative” sustainable recovery well – sec. 4.2).
20. If the initial purge rate of 100 mL/min causes excessive drawdown and alternative equipment with flow rates less than 100 mL/min cannot be used, go to the low-recharge procedure (sec. 4.3).
21. Once a stabilized water level has been obtained, the field indicator parameters will be monitored for stabilization. If the flow rate is equal to or greater than 100mL/min, measure and record the water quality indicator parameters at 5- min. intervals. If the flow rate is less than 100mL/min, measure and record the water quality indicator parameters at time intervals of 500 mL ÷ purge rate. Field indicator parameter measurements will be

considered stable when 3 consecutive measurements within the following ranges are obtained:

- turbidity: < 50 NTU
- DO: ± 0.1 mg/L for DO values less than 1 mg/L, *or* $\pm 10\%$ for DO values greater than 1 mg/L
- Eh (ORP): ± 10 mV
- specific conductance: $\pm 1\%$ of full-scale reading (instrument repeatability) *or* default ± 20 μ mhos/cm
- pH: ± 0.1 unit
- temperature: ± 0.5 °C

22. Once stabilized field indicator parameter measurements have been obtained, samples may be collected.
23. If the other parameters stabilize, but turbidity < 50 NTU cannot be attained, the designated point-of-contact for the Project Delivery Team (PDT) should be notified.

4.2 “Alternative” Sustainable Recovery Wells

An “alternative” sustainable recovery well is defined as a well in which stabilized water level can be obtained as described in sec. 4 at a pumping rate less than 100 mL/min. using alternative equipment capable of lower flow rates (e.g., peristaltic pump, “mini” bladder pump).

1. If a purge rate of 100 mL/min causes excessive drawdown and the well is less than 25 – 30 ft deep, the standard sustainable recovery procedure may be repeated using a peristaltic pump to determine whether sustainable recovery can be obtained at flow rates less than 100 mL/min.
2. If stabilized water level can be obtained at a pumping rate less than 100 mL/min. using alternative equipment, go to sec. 4.1 no. 21 and obtain stabilized indicator parameter readings. Note that for flow rates of less than 100 mL/min, parameter measurement interval is determined by $500 \text{ mL} \div \text{purge rate}$.

4.3 “Low-Recovery” Wells

A “low-recovery” well is defined as a well in which stabilized water level cannot be obtained as described in sec. 4, regardless of pumping rate or equipment type.

1. If a purge rate of 100 mL/min causes excessive drawdown and/or alternative equipment with flow rates less than 100 mL/min cannot be used, the following procedure should be used.
2. The following information (see sec. 4.1, steps 1, 7, 8, 9) will be needed:
 - Obtain well casing and borehole diameters and filter pack percent porosity from well construction records
 - Determine saturated casing volume and saturated borehole volume (casing volume + saturated filter pack volume)
 - Determine saturated casing volume above the pump intake.
 - Determine sampling system volume (volume capacity of pump, tubing, and flow-through cell).
 - Determine volume necessary to collect all required samples, including QA/QC samples.

3. Determine whether the saturated casing volume above the pump intake is sufficient for at least 2 sampling system volumes plus required samples.
4. If the casing volume above the pump intake is sufficient for at least 2 sampling system volumes plus required samples, purge slowly at a constant flow rate; measure and record water level and field indicator parameters every 500 mL until 2 (or available) system volumes have been removed; collect samples; document conditions and procedures. (Note: water level will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.)
5. If the casing volume above the pump intake is not sufficient for at least 2 sampling system volumes plus required samples, but is sufficient for at least 1 sampling system volumes plus required samples, purge slowly at a constant flow rate; measure and record water level and field indicator parameters every 500 mL until 1 (or available) system volumes have been removed; collect samples; document conditions and procedures. (Note: water level will not be stable (i.e., drawdown will occur) and indicator parameters may not be stable.)
6. If the casing volume above the pump intake is sufficient for all required samples only, determine whether it is acceptable to collect samples without purging. If this is acceptable for project purposes, collect samples at a constant flow rate without purging, document conditions and procedures.
7. If the casing volume above the pump intake is not sufficient for all required samples, determine whether samples can be prioritized and it is acceptable to collect priority samples without purging. If this is acceptable for project purposes, collect the priority samples at a constant flow rate without purging, document conditions and procedures.
8. If the casing volume above the pump intake is not sufficient for all required samples, samples can not be prioritized, and/or it is not acceptable for project purposes to collect samples without purging, do not sample, document conditions
9. If the well cannot be sampled using the low-recharge procedure:
 - Determine whether diffusion samplers or other “passive” methods are acceptable for project purposes and can be used.
 - Determine whether the well can be removed from the monitoring network

5 Decision Trees

- I. Wells with historical purge rate data:
- A. Does historical purging data indicate a consistent, sustainable recovery well (i.e., stabilized water level can always be achieved) using either standard or alternative equipment?
- If yes, use historical sustainable flow rate and equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples.
- B. Does historical purging data indicate a well with inconsistent recovery across sampling events?
- 1 Determine whether sustainable flow rate can be achieved during this sampling episode using standard or alternative equipment
- If yes, use sustainable rate and appropriate equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples.
 - If no, use low recharge procedure.
- II. Wells without historical purge rate data but with information from well development or redevelopment:
- A. Does well development or redevelopment record indicate a sustainable recovery well using either standard or alternative equipment?
- If yes, determine sustainable flow rate and use sustainable rate procedure and appropriate equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples.
 - If no, use low recharge procedure.
- III. Wells without either historical purge rate or well development or redevelopment data:
- A. Determine whether sustainable flow rate can be achieved during this sampling episode using standard or alternative equipment
- If yes, use sustainable rate and appropriate equipment; obtain stabilized water level; obtain stabilized indicator parameters; collect samples
 - If no, use low recharge procedure.

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Appendix B

Hach and YSI Technical Guidance



YSI Environmental

Model 556

Quick-Start Guide

This Quick-Start Guide is meant to serve as a quick reference in operating the YSI Model 556. It is not intended to replace the information found in the Operations Manual. For your convenience, included in parenthesis for each section, are the section numbers from the full-length manual where additional information may be found.

INSTALLING THE DO MEMBRANE (3.4)

Note: The DO sensor is shipped with a dry shipping membrane to protect the electrode. **A new membrane cap must be installed before the first use.**

- 1 Prepare the O₂ probe solution according to the instructions on the bottle. After mixing, allow the solution to sit for 1 hour. This will help prevent air bubbles from later developing under the membrane.
- 2 Unscrew and remove the probe sensor guard.
- 3 Unscrew, remove, and discard the old membrane cap.
- 4 Thoroughly rinse the sensor tip with distilled or deionized water.
- 5 Fill a new membrane cap with O₂ probe solution. Be very careful not to touch the membrane surface.
- 6 Thread the membrane cap onto the sensor, moderately tight. A small amount of electrolyte should overflow.
- 7 Screw the probe sensor guard on moderately tight.

MENU FUNCTIONS (2.9 – 2.11)

The Model 556 is set up with a menu-based interface. To navigate through the menus, use the up and down arrow keys to highlight a desired menu option, then press the **Enter** key to open the menu feature. Press the **Esc** key to return to a previous screen. The 556 will automatically power on to the Run screen. Press the **Esc** key to display the main menu screen.

SETTING THE DATE AND TIME (10.2)

- 1 Select **System Setup** from the main menu and then select **Date & Time**.
- 2 Highlight **Date** and press **Enter**.
- 3 Use the keypad to enter the correct date and press **Enter**.
- 4 Highlight **Time** and press **Enter**.
- 5 Use the keypad to enter the correct military time and press **Enter**.
- 6 Press **Esc** several times to return to the main menu.

SETTING UP SENSORS & REPORTING PARAMETERS (4 - 5)

Although a sensor may be installed on the probe of the 556, it must be enabled in the Sensor menu for it to operate. Once a sensor is enabled, the parameters and units to display for that sensor must then be selected in the Report menu.

- 1 From the main menu, select **Sensor**.
- 2 Sensors which are enabled will appear with a black dot. If a sensor is disabled, it will appear with an empty circle. Use the arrow keys to highlight the sensor you want to change. Press the **Enter** key to enable or disable it.
- 3 When Dissolved Oxygen is selected, a submenu will appear with a selection of membranes. Each membrane type is also identified by the color of the membrane cap. Highlight the desired membrane choice and press **Enter** to activate the selection. Press **Esc** to return to the Sensor menu.
- 4 Once changes to the Sensor menu have been completed, press **Esc** to return to the main menu.
- 5 Select the **Report** menu option.
- 6 Parameters which are enabled will appear with a black dot. If a parameter is disabled, it will appear with an empty circle. Use the arrow keys to highlight the parameter you want to change. Press the **Enter** key to enable or disable it.
- 7 For some parameters, a new submenu will appear to allow a selection of units for the parameter. Make a selection from the submenu and then press **Esc** to return to the Report menu.
- 8 Once all changes are complete, press **Esc** to return to the main menu.

BAROMETER CALIBRATION (10.9 – 10.10)

Note: The following information is only for 556 Instruments equipped with the optional internal barometer.

- 1 Determine your local barometric pressure (BP) in mmHg from a mercury barometer, an independent laboratory or from a local weather service. If the BP reading has been corrected to sea level, use the following equation to determine the true BP in mmHg for your altitude:

$$\text{True BP} = (\text{Corrected BP}) - \{2.5 * (\text{Local Altitude}/100)\}$$

- 2 Select **System Setup** from the main menu and then select **Calibrate Barometer**.
- 3 Use the keypad to input the known barometric pressure as determined in steps 1 and 2. Press **Enter** to confirm the value.
- 4 Press **Esc** to return to the main menu.

CONDUCTIVITY, pH, ORP CALIBRATION (6)

- 1 From the main menu, select **Calibrate**.
- 2 Place the correct amount of calibration standard into a clean, dry or pre-rinsed calibration cup.
- 3 Immerse the probe into the solution, making sure the sensor to be calibrated is adequately covered
- 4 Allow at least one minute for temperature to stabilize
- 5 Select the sensor to be calibrated. For conductivity, a second menu will offer the option of calibrating in **specific conductance, conductivity, or salinity**. Calibration of any one option automatically calibrates the other two. For pH, a second menu will appear offering the choice of a 1-, 2-, or 3-point calibration.
- 6 Enter the value of the standard being used. (For pH, always calibrate in the 7 buffer first.) Be certain that the units are correct and press **Enter**. The current values of all enabled sensors will appear.
- 7 Observe the readings and when they show no significant change for approximately 30 seconds, press **Enter**. The screen will indicate if the calibration has been accepted
- 8 Press **Enter** again to return to the Calibrate screen, or, for pH, to continue with the second point of the calibration.

DO CALIBRATION (6)

The Model 556 offers two options for calibration of dissolved oxygen. The first is an air calibration method in % saturation. The second is calibrating in mg/L to a solution with a known DO concentration (usually determined by a Winkler Titration). Calibration of either option (% or mg/L) will automatically calibrate the other. The procedure outlined here is the % saturation calibration, the easier of the two methods to perform.

- 1 Place approximately 3 mm (1/8 inch) of water in the bottom of the transport/calibration cup. Screw the transport/calibration cup onto the probe, engaging only 1 or 2 threads to ensure venting to the atmosphere.
Note: Make sure the DO and temperature sensors are not immersed in the water.
- 2 Turn the instrument on to the Run mode and wait 10 minutes for the DO sensor to stabilize
- 3 From the main menu, select **Calibrate**, then **Dissolved Oxygen**, then **DO %**.
- 4 Use the keypad to enter the current local barometric pressure and press **Enter**. The current values of all enabled sensors will appear.
- 5 Observe the readings and when they show no significant change for approximately 30 seconds, press **Enter**. The screen will indicate if the calibration has been accepted
- 6 Press **Enter** again to return to the DO Calibration screen.

TAKING MEASUREMENTS AND STORING DATA (7 - 9)

1. Power the instrument on, or select **Run** from the Main Menu.
2. Insert the probe into the sample to be measured. Continuously stir, or move the probe, through the sample until the readings on the screen stabilize.
3. Use the arrow keys to highlight **Log one sample**, or select **Start logging** to record a series of data. Press **Enter**. The Enter Information screen should appear.
4. Use the keypad to enter a filename for the measurement. If no file name is entered, the instrument will assign a default of NONAME. Press **Enter**.
5. If you would like to enter an optional site description, highlight that field and use the keypad to enter the information. Press **Enter**.
6. Highlight **OK** and press **Enter**. If logging one sample, the instrument will confirm the data point was successfully logged.
7. If a series of points is being logged, the Start logging entry in the run screen will change to Stop logging. At the end of the logging interval, press **Enter** to stop logging.

UPLOADING DATA TO A PC (8.4)

1. Make sure EcoWatch for Windows is installed on the PC.
2. Disconnect the probe assembly from the 556 instrument and use the 655173 PC interface cable to connect the meter to the serial port of the PC.
3. Open EcoWatch for Windows on the PC.
4. Click on the sonde/probe icon in the upper toolbar. 
5. Set the com port number to match the serial port the 556 is connected to and choose OK. A terminal window should appear with a flashing cursor.
6. Power on the 556. From the Main menu select **File**, then **Upload to PC**.
7. From the File List, highlight the file you wish to transfer and press **Enter**. The file transfer should begin with a progress shown on both the 556 and PC.
Note: The file will automatically upload to C:\ECOWIN\DATA.
8. After the file transfer is complete, close the terminal window in EcoWatch.
9. Press **Esc** on the 556 until you have returned to the main menu.

CONTACT INFORMATION

Contact YSI Environmental if you need assistance or have questions regarding any YSI Environmental Product. Business hours are Monday through Friday, 8AM to 5PM ET.

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Revision A • July 2003

Method 8203

Phenolphthalein and Total using Sulfuric Acid Method

Digital Titrator

(10 to 4000 mg/L as CaCO₃)

Scope and Application: For water, wastewater, and seawater



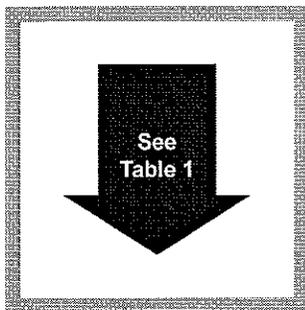
Tips and Techniques

- For added convenience when stirring, use the TitraStir® apparatus (Cat. No. 19400-00, -10).
- Four drops of Phenolphthalein Indicator Solution (Cat. No. 162-32) may be substituted for the Phenolphthalein Indicator Powder Pillow.
- Four drops of Bromcresol Green-Methyl Red Indicator Solution (Cat. No. 23292-32) may be substituted for the Bromcresol Green-Methyl Red Indicator Powder Pillow.
- $\text{meq/L Alkalinity} = \text{mg/L as CaCO}_3 \div 50$

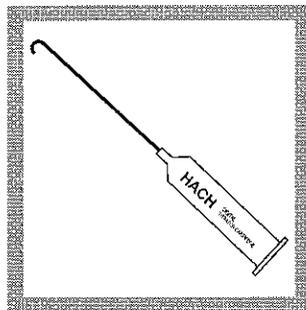


Digital Titrator

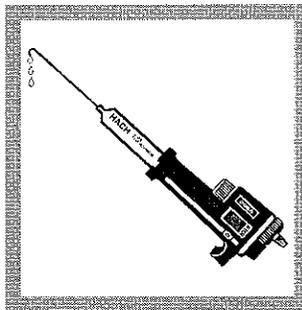
Method 8203



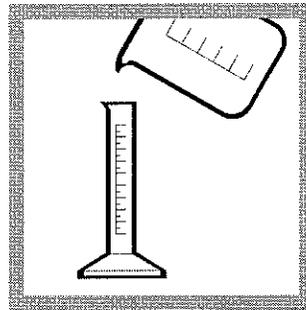
1. Select the sample volume and Sulfuric Acid (H₂SO₄) Titration Cartridge that correspond to the expected alkalinity concentration as mg/L calcium carbonate (CaCO₃) from *Table 1*



2. Insert a clean delivery tube into the titration cartridge. Attach the cartridge to the titrator body.

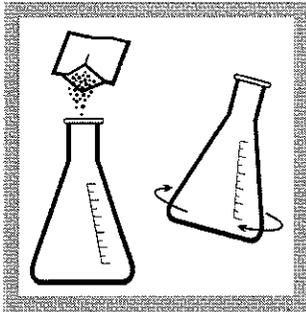


3. Turn the delivery knob to eject a few drops of titrant. Reset the counter to zero and wipe the tip.

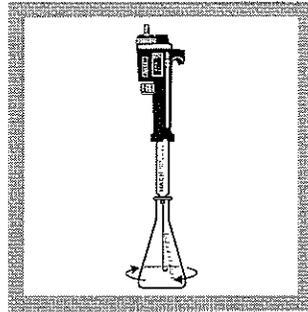


4. Use a graduated cylinder or pipet to measure the sample volume from *Table 1*. Transfer the sample into a clean, 250-mL Erlenmeyer flask. Dilute to the 100-mL mark with deionized water, if necessary.

Alkalinity

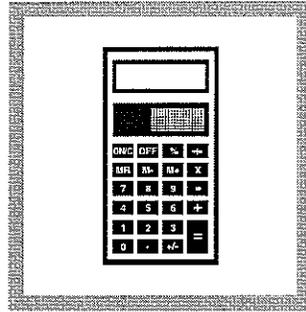


5. Add the contents of one Phenolphthalein Indicator Powder Pillow and swirl to mix

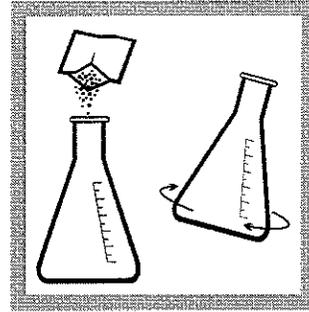


6. If the solution turns pink, titrate to a colorless end point. Place the delivery tube tip into the solution and swirl the flask while titrating with sulfuric acid. Record the number of digits required

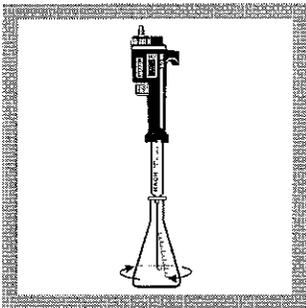
If the solution is colorless before titrating with Sulfuric acid, the Phenolphthalein (P) alkalinity is zero. Proceed to step 8.



7. Calculate:
 Digits Required X
 Digit Multiplier =
 mg/L as CaCO₃ P Alkalinity

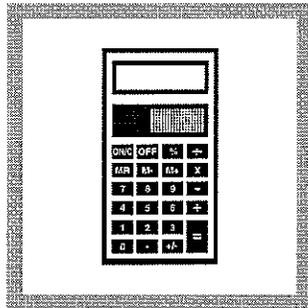


8. Add the contents of one Bromcresol Green-Methyl Red Indicator Powder Pillow to the flask. Swirl to mix.



9. Continue the titration with sulfuric acid to a light pink (pH 4.5) color as required by sample composition. Record the number of digits required.

Note: A pH meter may be used to titrate to a specific pH as required by sample composition. See Table 2



10. Calculate:
 Digits Required X
 Digit Multiplier =
 mg/L as CaCO₃ Total (T or M)
 Alkalinity

Carbonate, bicarbonate, and hydroxide concentrations may be expressed individually using the relationships shown in Table 3

Table 1

Alkalinity

Range (mg/L as CaCO ₃)	Sample Volume (mL)	Titration Cartridge (N H ₂ SO ₄)	Catalog Number	Digit Multiplier
10-40	100	0.1600	14388-01	0.1
40-160	25	0.1600	14388-01	0.4
100-400	100	1.600	14389-01	1.0
200-800	50	1.600	14389-01	2.0
500-2000	20	1.600	14389-01	5.0
1000-4000	10	1.600	14389-01	10.0

Table 2 End Point pH

Sample Composition	End Point	Phenolphthalein Alkalinity
Alkalinity about 30 mg/L	pH 4.9	pH 8.3
Alkalinity about 150 mg/L	pH 4.6	pH 8.3
Alkalinity about 500 mg/L	pH 4.3	pH 8.3
Silicates or phosphates present	pH 4.5	pH 8.3
Industrial wastes or complex system	pH 4.5	pH 8.3
Routine or Automated Analyses	pH 4.5	pH 8.3

Sampling and Storage

Collect samples in clean plastic or glass bottles. Fill completely and cap tightly. Avoid excessive agitation or prolonged exposure to air. Samples should be analyzed as soon as possible after collection but can be stored at least 24 hours by cooling to 4 °C (39 °F) or below. Warm to room temperature before analyzing.

Alkalinity Relationship Table

Total alkalinity primarily includes hydroxide, carbonate and bicarbonate alkalinities. The concentration of these alkalinities in a sample may be determined when the phenolphthalein and total alkalinities are known (see Table 3).

Table 3 Alkalinity Relationship

Row	Result of Titration	Hydroxide Alkalinity Equals	Carbonate Alkalinity Equals	Bicarbonate Alkalinity Equals
1	Phenolphthalein Alkalinity = 0	0	0	Total Alkalinity
2	Phenolphthalein Alkalinity equal to Total Alkalinity	Total Alkalinity	0	0
3	Phenolphthalein Alkalinity less than one-half of Total Alkalinity	0	Phenolphthalein Alkalinity times 2	Total Alkalinity minus two times Phenolphthalein Alkalinity
4	Phenolphthalein Alkalinity equal to one-half of Total Alkalinity	0	Total Alkalinity	0
5	Phenolphthalein Alkalinity greater than one-half of Total Alkalinity	2 times Phenolphthalein Alkalinity minus Total Alkalinity	2 times the difference between Total and Phenolphthalein Alkalinity	0

Alkalinity

To use the table follow these steps:

- a. Does the phenolphthalein alkalinity equal zero? If yes, use Row 1
- b. Does the phenolphthalein alkalinity equal total alkalinity? If yes, use Row 2
- c. Divide the total alkalinity by 2 to give one-half the total alkalinity
- d. Select Row 3, 4, or 5 based on comparing the result of step c (one-half total alkalinity) with the total alkalinity.
- e. Perform the required calculations in the appropriate row, if any
- f. Check your results. The sum of the three alkalinity types will equal the phenolphthalein alkalinity

For example:

A sample has 170 mg/L as CaCO₃ phenolphthalein alkalinity and 250 mg/L as CaCO₃ total alkalinity. What is the concentration of hydroxide, carbonate and bicarbonate alkalinities?

The phenolphthalein alkalinity does not equal 0 (it is 170 mg/L), see step a

The phenolphthalein alkalinity does not equal total alkalinity (170 mg/L vs. 250 mg/L), see step b

One-half of the total alkalinity (250 mg/L) equals 125 mg/L. Because the phenolphthalein alkalinity (170 mg/L) is greater than one-half the total alkalinity (125 mg/L), select Row 5.

The hydroxide alkalinity is equal to:

$$2 \times 170 = 340$$

$$340 - 250 = 90 \text{ mg/L hydroxide alkalinity}$$

The carbonate alkalinity is equal to:

$$250 - 170 = 80$$

$$80 \times 2 = 160 \text{ mg/L carbonate alkalinity}$$

The bicarbonate alkalinity equals 0 mg/L.

Check: (See step f)

$$90 \text{ mg/L hydroxide alkalinity} + 160 \text{ mg/L carbonate alkalinity} + 0 \text{ mg/L bicarbonate alkalinity} = 250 \text{ mg/L}$$

The above answer is correct; the sum of each type equals the total alkalinity.

Accuracy Check

End Point Confirmation

A solution of one pH 8.3 Buffer Powder Pillow (Cat No. 898-68) and one Phenolphthalein Powder Pillow in 50 mL of deionized water is recommended as a comparison for determining the proper end point color

A solution of one Bromocresol Green-Methyl Red Powder Pillow and one pH 4.5 Buffer Powder Pillow (895-68) in 50 mL of deionized water is recommended as a comparison for judging the pH 4.5 end point color

Standard Additions Method (Sample Spike)

This accuracy check should be performed when interferences are suspected or to verify analytical technique.

1. Snap the neck off an Alkalinity Voluette® Ampule Standard, 0.500 N.
2. Use a TenSette Pipet (Cat. No. 19700-01) to add 0.1 mL of standard to the sample titrated in steps 6 or 9. Resume titration back to the same end point. Record the number of digits needed.
3. Repeat, using two more additions of 0.1 mL. Titrate to the end point after each addition.
4. Each 0.1 mL addition of standard should require 25 additional digits of 1.600 N titrant or 250 digits of 0.1600 N titrant. If these uniform increases do not occur, refer to *Section 3.4 Method Performance* to determine the cause.

Interferences

Highly colored or turbid samples may mask the color change at the end point. Use a pH meter (Cat. No. 51700-10) for these samples, titrating to a pH 8.3 for phenolphthalein alkalinity and the appropriate pH (see *Table 2*) for total alkalinity.

Chlorine at levels above 3.5 mg/L may cause a yellow-brown color upon the addition of the Bromocresol Green-Methyl Red Powder Pillow. Add one drop of 0.1 N Sodium Thiosulfate (Cat. No. 323-32) to eliminate this interference.

Summary of Method

The sample is titrated with sulfuric acid to a colorimetric end point corresponding to a specific pH. Phenolphthalein alkalinity is determined by titration to a pH of 8.3, as evidenced by the color change of phenolphthalein indicator, and indicates the total hydroxide and one half the carbonate present. M (methyl orange) or T (total) alkalinity is determined by titration to a pH between 3.7 and 5.1, and includes all carbonate, bicarbonate and hydroxide. Alternatively, total alkalinity end points may be determined by using a pH meter and titrating to the specific pH required for the sample composition.

Alkalinity

Required Reagents

Description	Unit	Cat. No
Alkalinity Reagent Set (about 100 tests) (varies with sample characteristics)		22719-00
Includes:		
Bromcresol Green-Methyl Red Powder Pillows	100/pkg	943-99
Phenolphthalein Powder Pillows	100/pkg	942-99
Sulfuric Acid Titration Cartridge, 1 600 N	each	14389-01
Sulfuric Acid Titration Cartridge, 0 1600 N	each	14388-01
Water, demineralized	4 L	272-56

Required Apparatus

Select one or more based on sample concentration

Cylinder, graduated, 10-mL	each	508-38
Cylinder, graduated, 25-mL	each	508-40
Cylinder, graduated, 50-mL	each	508-41
Cylinder, graduated, 100-mL	each	508-42
Digital Titrator	each	16900-01
Flask, Erlenmeyer, 250-mL	each	505-46

Required Standards

Alkalinity Standard Solution, Voluette® Ampule 0 500 N Na ₂ CO ₃ , 10-mL	16/pkg	14278-10
Buffer Powder Pillows, pH 4.5	25/pkg	895-68
Buffer Powder Pillows, pH 8.3	25/pkg	898-68



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HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932



Method 8146

1, 10 Phenanthroline Method*

Powder Pillows or AccuVac® Ampuls

(0.02 to 3.00 mg/L)

Scope and Application: For water, wastewater, and seawater

* Adapted from *Standard Methods for the Examination of Water and Wastewater*, 15th ed 201 (1980)



Tips and Techniques

- Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric iron, which is not determined.
- For more accurate results, determine a reagent blank value for each new lot of reagent. Follow the procedure using deionized water in place of the sample. Subtract the reagent blank value from the final results or perform a reagent blank adjust. See the instrument manual for more information on *Running a Reagent Blank*.
- If ferrous iron is present, an orange color will form after adding the reagent.

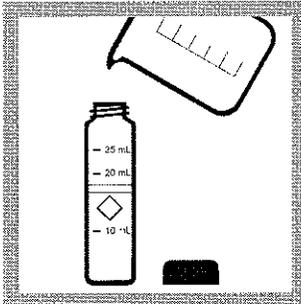


Powder Pillows

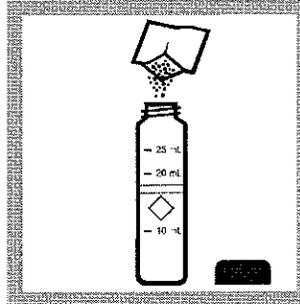
Method 8146



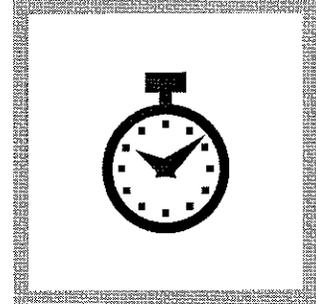
1. Touch **Hach Programs**
Select program
255 Iron, Ferrous
Touch **Start**



2. Fill a clean, round sample cell with 25 mL of sample.

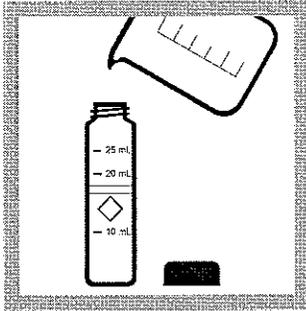


3. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample) Swirl to mix.

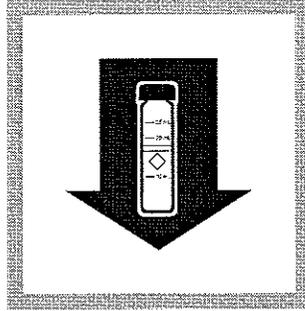


4. Touch the timer icon
Touch **OK**
A three-minute reaction period will begin

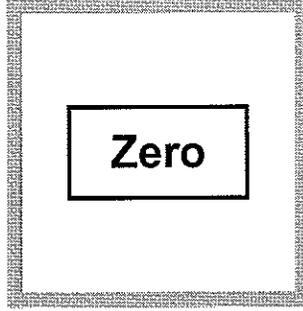
Iron, Ferrous



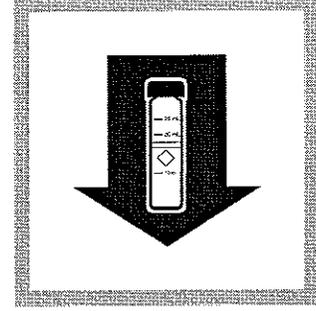
5. Fill a second round sample cell with 25 mL of sample (the blank).



6. When the timer beeps, place the blank into the cell holder



7. Touch **Zero**
The display will show:
0.00 mg/L Fe²⁺

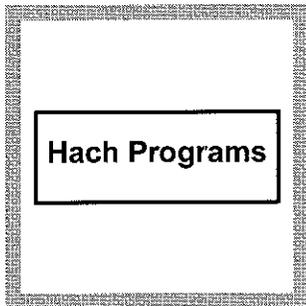


8. Place the prepared sample into the cell holder.
Results will appear in mg/L Fe²⁺

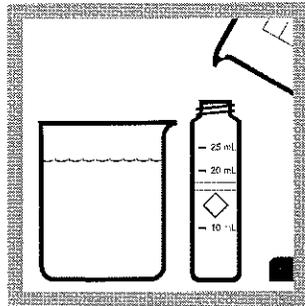


AccuVac Ampul

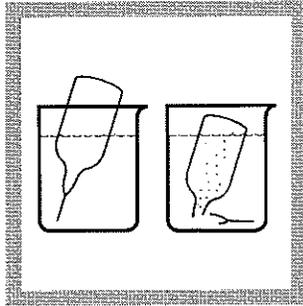
Method 8146



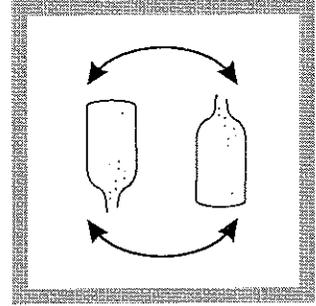
1. Touch
Hach Programs.
Select program
257 Iron, Ferrous AV
Touch **Start**



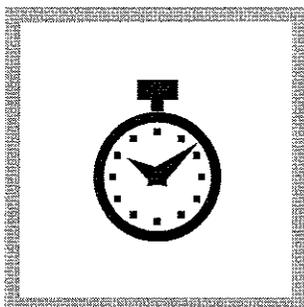
2. Fill a sample cell with 25 mL of sample (the blank) Collect at least 40 mL of sample in a 50-mL beaker



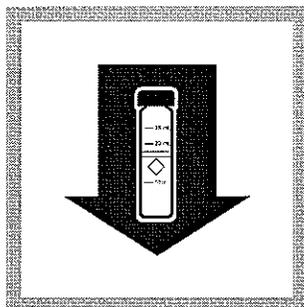
3. Fill a Ferrous Iron AccuVac® Ampul with sample. Keep the tip immersed while the ampule fills completely.



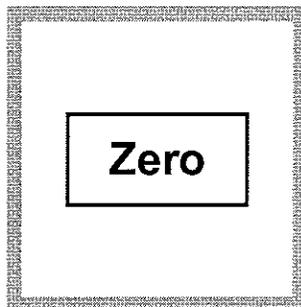
4. Quickly invert the ampule several times to mix. Wipe off any liquid or fingerprints.



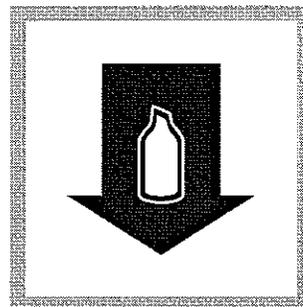
5. Touch the timer icon. Touch **OK**. A three-minute reaction period will begin.



6. When the timer beeps, place the blank into the cell holder.



7. Touch **Zero**. The display will show:
0.00 mg/L Fe²⁺



8. Place the AccuVac Ampul into the cell holder. Results will appear in mg/L Fe²⁺.

Sample Collection, Storage and Preservation

Collect samples in plastic or glass bottles. Analyze samples as soon as possible after collection.

Accuracy Check

Standard Solution Method

1. Prepare a ferrous iron stock solution (100-mg/L Fe²⁺) by dissolving 0.7022 grams of Ferrous Ammonium Sulfate, hexahydrate, in deionized water. Dilute to one liter in a Class A volumetric flask. In a 100-mL Class A volumetric flask, dilute 1.00 mL of this solution to 100 mL with deionized water to make a 1.0-mg/L standard solution. Prepare this solution immediately before use. Perform the iron procedure as described above.
2. To adjust the calibration curve using the reading obtained with the 1.0-mg/L Fe²⁺ Standard Solution, touch **Options** on the current program menu. Touch **Standard Adjust**.
3. Touch **On**. Touch **Adjust** to accept the displayed concentration. If an alternate concentration is used, touch the number in the box to enter the actual concentration, then touch **OK**. Touch **Adjust**.

See Section 3.2.4 *Adjusting the Standard Curve* on page 49 for more information.

Method Performance

Precision
Standard: 1.000 mg/L Fe

Program	95% Confidence Limits of Distribution
255	0.989–1.011 mg/L Fe
257	0.977–1.023 mg/L Fe

See Section 3.4.3 *Precision* on page 53 for more information, or if the standard concentration did not fall within the specified range.

Iron, Ferrous

Sensitivity

Program	Portion of Range	ABS	Concentration
255	Entire range	0.010	mg/L Fe
257	Entire range	0.010	0.023 mg/L Fe

See Section 3.4.5 Sensitivity on page 54 for more information.

Summary of Method

The 1,10 phenanthroline indicator in the Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not react. The ferric iron (Fe³⁺) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test. Test results are measured at 510 nm.

Required Reagents

Description	Quantity Required per test	Unit	Cat. No.
Ferrous Iron Reagent AccuVac® Ampuls	1 ampul	25/pkg	25140-25
<i>or</i>			
Ferrous Iron Reagent Powder Pillows	1 pillow	100/pkg	1037-69

Required Apparatus

Beaker, 50-mL	1	each	500-41H
Sample Cells, 10-20-25 mL, w/cap	2	6/pkg	24019-06

Required Standards

Ferrous Ammonium Sulfate, hexahydrate, ACS	113 g		11256-14
Water, deionized	4 liters		272-56



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 Telephone: (970) 669-3050
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Appendix C Field Forms

DAILY QUALITY CONTROL REPORT

Site: _____
 Project No: _____
 Date: _____
 Crew No: _____
 Crew Mem: _____

Weather (circle)

Bright Sun	Clear	Overcast	Rain	T-storm	Snow
Temp: to 32	32-50	50-70	70-85	85+	
Wind: Still	Gusty	Moder.	High	Direction: _____	
Humidity: Dry	Moder.	Humid			

Subcontractors and Equipment on Site: _____

Health and Safety Levels: (circle)

D	Mod. D.	C	B	A
---	---------	---	---	---

Summary of Health and Safety Activities: _____

Instrument Used: (circle)

PID	Fe	pH	Cond.	Temp.	Turbidity	DO	ORP

Calibrated: (check)

For actual calibration results, see field calibration forms

Summary of Work Performed: _____

All Samples Were Collected According to Procedures Outlined in the Work Plan?

Yes _____ No _____

Problems Encountered/Corrective Action Taken: _____

Time Project Manager Contacted: _____

Tomorrow's Expectations: _____

Name: _____ Signature: _____

Appendix D
2004 Water Collection Field Sheets

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
 10975 El Monte, Suite 100
 Overland Park, Kansas 66211
 (967) 344-1000

Project: Former Schilling Air Force Base						Personnel: <u>T. Smith, D. Bronson</u> <u>M. Phoenix</u> M. Orr Sample Time: <u>1615</u>
Sample No.: 99M13-W0504 Sample Media: Groundwater Sample Date: <u>4/29/04</u>	Weather	Clear	P. Cldy	<input checked="" type="radio"/> Cldy	Fog	
	Temp <u>75</u> °F	Wind	<input checked="" type="radio"/> Calm	Mod	High	
	Precipitation <u>NO</u>	Rain	Light	Mod	Hvy	
	Snow	Light	Mod	Hvy		

Purging Information

Date: <u>4/29/04</u>	Time Started: <u>1520</u>	Time Completed: <u>1615</u>
Method: Fultz Pump		Casing Diameter: 2"
Construction Well Depth (BTOC): 30.32'		Initial Water Level (BTOC): <u>5.12</u>
Mid Screen Depth (BTOC): 24.92' Screen length: 10'		Depth Sounding (BTOC):
Boring Dia. (ft.): 0.67 Top of Filter: (BTOC): 17.72'		Volume of Sample: <u>0.36</u> Liters
Purge Rate: <u>0.13</u> Liters per Minute		VAI: [(ID - 17.72) x 3.882] + [(17.72 - WL) x 0.644] = <u>36.06</u> Liters
Actual Purge Volume [<u>45</u> x <u>0.13</u>] = _____ Liters (Minutes) x (pump rate)		

Water Quality Parameters During Purging

Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (± 0.1)	Temp. (°C) (± 0.5°C)	Conductivity (µmhos/cm) (± 1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (± 10% if > 1, or 0.1 if < 1)	ORP (mV) (± 10mV)	Water Level (BTOC)	Purge Rate (L/M)
20	2.60	7.01	14.68	1430	44.3	1.45	79.8	5.30	0.13
25	3.20	7.00	14.54	1417	31.0	1.05	77.1	5.30	0.13
30	3.85	7.00	14.52	1404	23.0	0.85	77.6	5.30	0.13
35	4.40	6.99	14.52	1400	16.0	0.75	72.8	5.30	0.13
40	4.95	6.99	14.54	1397	12.0	0.71	71.1	5.30	0.13
45	5.50	6.99	14.56	1398	9.1	0.65	69.2	5.30	0.13

Sampling Information

Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory
OC	99M13-W0504-OC	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML
OA	99M13-W0504-OA	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	CEWES

Field Parameter Information

Date	4/29/04	Time	1615	Dissolved Oxygen:	0.65 mg/l
Temperature	14.56 °C	Turbidity	9.1 NTU	Conductivity	1398 mmhos/cm
pH buffer (before)	6.99	ORP	69.2 mV	Odor (circle one)	(None) Weak Strong
pH (Sample)	6.99	Appearance (circle one)	(Clear) Sl. Cloudy Cloudy		
pH buffer (after)	6.99				

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
10975 El Monte, Suite 100
Overland Park, Kansas 66211
(979) 344-1000

Project: Former Schilling Air Force Base						Personnel: T. Smith, <u>D. Bronson</u> <u>M. Phoenix</u> , M. Orr Sample Time: <u>1445</u>
Sample No.: 99M26-W0504	Weather	Clear	P. Cldy	Cldy	Fog	
Sample Media: Groundwater	Temp <u>70</u> F	Wind	<u>Calms</u>	Mod	High	
Sample Date: <u>4/29/04</u>	Precipitation	Rain	Light	Mod	Hvy	
	<u>NO</u>	Snow	Light	Mod	Hvy	

Purging Information

Date: <u>4/29/04</u>	Time Started: <u>1340</u>	Time Completed: <u>1445</u>
Method: Fultz Pump <u>BLADDER PUMP</u>	Casing Diameter: <u>2"</u>	
Construction Well Depth (BTOC): <u>26.09'</u>	Initial Water Level (BTOC): <u>9.72</u>	
Mid Screen Depth (BTOC): <u>21.09'</u> Screen length: <u>10'</u>	Depth Sounding (BTOC): <u>BLADDER PUMP</u>	
Boring Dia. (ft.): <u>0.67</u> Top of Filter: (BTOC): <u>12.69'</u>	Volume of Sample: <u>0.36</u> Liters	
Purge Rate: <u>0.15</u> Liters per Minute	VAI: [(ID - 12.69) x 3.882] + [(12.69 - WL) x 0.644] = <u>34.51</u> Liters	
Actual Purge Volume [<u>55</u> x <u>0.15</u>] = <u>7.85</u> Liters (Minutes) x (pump rate)		
VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level		

Water Quality Parameters During Purging

Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if >1, or 0.1 if <1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
35	5.25	7.00	15.08	1376	21.6	1.00	114.5	9.93	0.15
40	5.90	7.00	15.06	1378	14.7	0.76	110.2	9.93	0.15
45	6.55	7.00	15.12	1381	14.9	0.68	105.2	9.93	0.15
50	7.20	7.00	15.04	1378	11.9	0.62	101.7	9.95	0.15
55	7.85	7.00	15.02	1375	9.47	0.61	98.9	9.93	0.15

Sampling Information

Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory
QC	99M26-W0504-QC	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML
QA	99M26-W0504-OA	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	CEWES

Field Parameter Information

Date	<u>4/29/04</u>	Time	<u>1455</u>	Dissolved Oxygen:	<u>0.61</u> mg/l
Temperature	<u>15.02</u> °C	Turbidity	<u>9.47</u> NTU	Conductivity	<u>1375</u> mmhos/cm
pH buffer (before)	<u>7.00</u>	ORP	<u>98.9</u> mV	Appearance (circle one)	<u>Clear</u> Sl. Cloudy Cloudy
pH (Sample)	<u>7.00</u>	Odor (circle one)	<u>None</u> Weak Strong		
pH buffer (after)	<u>7.00</u>				

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
10975 El Monte, Suite 100
Overland Park, Kansas 66211
(977) 344-1000

Project: Former Schilling Air Force Base						Personnel: T. Smith, <u>D. Bronson</u> , <u>M. Phoenix</u> , M. Orr					
Sample No.: 99M24-W0504						Weather		Clear	P. Cldy	<u>Cldy</u>	Fog
Sample Media: Groundwater						Temp		Wind	<u>Calm</u>	Mod	High
Sample Date: <u>4/29/04</u>						Precipitation		Rain	Light	Mod	Hvy
						<u>NO</u>		Snow	Light	Mod	Hvy

Purging Information		
Date: <u>4/29/04</u>	Time Started: <u>0900</u>	Time Completed: <u>1040</u>
Method: Bladder Pump		Casing Diameter: 2"
Construction Well Depth (BTOC): 29.72'		Initial Water Level (BTOC): <u>8.11</u>
Mid Screen Depth (BTOC): 24.72' Screen length: 10'		Depth Sounding (BTOC):
Boring Dia. (ft.): 0.67 Top of Filter: (BTOC): 16.72'		Volume of Sample: <u>0.36</u> Liters
Purge Rate: 0.09 <u>0.15</u> Liters per Minute		VAI: [(ID - 16.72) x 3.882] + [(16.72 - WL) x 0.644] = <u>36.60</u> Liters
Actual Purge Volume [<u>86</u> x <u>0.15</u>] = <u>8.53</u> Liters		VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level
(Minutes) x (pump rate)		

Water Quality Parameters During Purging									
Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if > 1, or 0.1 if < 1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
10	0.90	6.55	14.24	1240		1.24	175.2	8.17	0.09
40	2.80	6.73	14.15	1268	75	0.62	162.8	8.17	0.07
48	3.28	6.76	14.22	1274	75	0.56	157.8	8.17	0.06
56	4.03	6.79	14.30	1279	50	0.49	152.8	8.20	0.15
61	4.78	6.80	14.32	1283	75	0.42	148.2	8.20	0.15
66	5.53	6.81	14.39	1287	120	0.39	143.2	8.20	0.15
71	6.28	6.82	14.41	1292	140	0.34	139.1	8.20	0.15
76	7.03	6.82	14.48	1294	150	0.36	134.7	8.20	0.15
81	7.78	6.82	14.50	1295	145	0.37	131.3	8.20	0.15
86	8.53	6.83	14.52	1297	137	0.39	129.1	8.20	0.15
TURBIDITY COULD NOT BE REACHED AT A <50 NTU LEVEL THE WATER WAS OPAQUE IN COLOR.									

Sampling Information				
Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information						
Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory
OC	99M24-W0504-OC	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML
OA	99M24-W0504-OA	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	CEWES

Field Parameter Information			
Date	<u>4/28/04</u>	Time	<u>1040</u>
Temperature	<u>14.52</u> °C	Dissolved Oxygen:	<u>0.39</u> mg/l
pH buffer (before)	<u>6.83</u>	Turbidity	<u>137</u> NTU
pH (Sample)	<u>6.83</u>	Conductivity	<u>1297</u> mmhos/cm
pH buffer (after)	<u>6.83</u>	ORP	<u>129.1</u> mV
Appearance (circle one)	Clear Sl. Cloudy <u>Cloudy</u>	Odor (circle one)	<u>None</u> Weak Strong

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
 10975 El Monte, Suite 100
 Overland Park, Kansas 66211
 (984) 344-1000

Project: Former Schilling Air Force Base						Personnel: T. Smith, D. Bronson, M. Phoenix, M. Orr Sample Time: 1400
Sample No.: 99M32-W0504	Weather: Clear	P. Clty: Calm	Clty: Mod	Fog: High		
Sample Media: Groundwater	Temp: 80°F	Wind:				
Sample Date: 5/14/04	Precipitation: NO	Rain: Light	Mod:	Hvy:		

Purging Information

Date: 5/14/04	Time Started: 1320	Time Completed: 1400
Method: FULTZ PUMP BLADDER PUMP	Casing Diameter: 2"	
Construction Well Depth (BTOC): 16.29'	Initial Water Level (BTOC): 11.32	
Mid Screen Depth (BTOC): 13.79' Screen length: 5'	Depth Sounding (BTOC): —	
Boring Dia. (ft.): 0.67 Top of Filter (BTOC): 9.29'	Volume of Sample: 0.12 Liters	
Purge Rate: 0.10 Liters per Minute	VAI: [(ID - 9.29) x 3.882] + [(9.29 - WL) x 0.644] = 16.16 Liters	
Actual Purge Volume [25 x 0.10] = 2.50 Liters VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level (Minutes) x (pump rate)		

Water Quality Parameters During Purging

Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if >1, or 0.1 if <1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
10	1.0	7.15	16.58	835	3.44	3.25	-12.3	11.49	0.10
15	1.5	7.06	16.56	845	1.91	1.71	-53.0	11.53	0.10
20	2.0	7.03	16.70	854	2.83	1.68	-60.0	11.53	0.10
25	2.5	7.04	16.99	861	3.19	1.61	-63.7	11.53	0.10

Sampling Information

Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory
QC	99M32-W0504-QC	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML
QA	99M32-W0504-QA	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	CEWES
DID NOT DO AT THE REQUEST OF NARON STEIGELWALT						

Field Parameter Information

Date: 5/14/04	Time: 1400	Dissolved Oxygen: 1.61 mg/l
Temperature: 16.99 °C		Turbidity: 3.19 NTU
pH buffer (before): 7.00		Conductivity: 861 mmhos/cm
pH (Sample): 7.04		ORP: -63.7 mV
pH buffer (after): —		Odor (circle one): None Weak Strong
Appearance (circle one): Clear Sl. Cloudy Cloudy		

WATER SAMPLE COLLECTION FIELD SHEET

11.32

URS Corporation
10975 El Monte, Suite 100
Overland Park, Kansas 66211
(986) 344-1000

Project: Former Schilling Air Force Base						Personnel: T. Smith, B. Bronson	
Sample No.: 99M34-W0504 Sample Media: Groundwater Sample Date: 5/14/04	Weather	Clear	P. Cldy	Cldy	Fog	Sample Time: 1215	
	Temp 70°F	Wind	Calm	Mod	High		
	Precipitation	Rain	Light	Mod	Hvy		
		No	Snow	Light	Mod	Hvy	

Purging Information (Low Recovery)		
Date: 5/14/04	Time Started: 1105	Time Completed: 1215
Method: Bladder Pump	Casing Diameter: 2"	
Construction Well Depth (BTOC): 19.58'	Initial Water Level (BTOC): 10.43'	
Mid Screen Depth (BTOC): 17.08' Screen length: 5'	Depth Sounding (BTOC): —	
Boring Dia. (ft.): 0.67 Top of Filter: (BTOC): 11.58'	Volume of Sample: 0.36 Liters	
Purge Rate: 0.10 Liters per Minute	VAI: [(ID - 11.58) x 3.882] + [(11.58 - WL) x 0.644] = 22.09 Liters	
Actual Purge Volume [55 x 0.10] = 5.5 Liters VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level (Minutes) x (pump rate)		

Water Quality Parameters During Purging									
Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if >1, or 0.1 if <1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
25	1.25	7.17	17.53	1101	3.21	3.48	103.8	12.0	0.05
35	1.75	7.16	17.89	1115	4.30	3.13	102.2	12.42	0.05
<p>* W.L. IS DRIPPING WITH A 0.05 L/M RATE. USING THE HISTORICAL INFORMATION FOR THE WELL, THE LOW RECOVERY METHOD IS STARTED WITH A 0.1 L/M RATE. W.L. HAS GONE FROM 10.43' TO 12.42' IN 35 MINUTES.</p>									
40	2.25	7.14	17.10	1095	3.37	2.80	101.9	13.35	0.10
45	2.75	7.13	17.19	1097	2.57	2.55	98.7	13.85	0.10
50	3.25	7.13	17.85	1098	3.12	2.15	94.2	14.20	0.10
55	3.75	7.12	17.95	1123	2.14	2.46	90.5	14.80	0.10

Sampling Information				
Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information						
Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory
MS	99M34-W0504-MS	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML
MSD	99M34-W0504-MSD	3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

Field Parameter Information			
Date 5/14/04	Time 1115	Dissolved Oxygen: 3.46 mg/l	Turbidity: 2.14 NTU
Temperature 17.95 °C		Conductivity 1123 mmhos/cm	ORP 90.5 mV
pH buffer (before) 7.00		Odor (circle one) None	Weak Strong
pH (Sample) 7.12			
pH buffer (after) —			
Appearance (circle one) Clear	Sl. Cloudy Cloudy		

2135

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
 10975 El Monte, Suite 100
 Overland Park, Kansas 66211
 (1008) 344-1000

Project: Former Schilling Air Force Base						Personnel: T. Smith, <u>D. Bronson</u>	
Sample No.: SA W04-W0504	Weather: <u>Clear</u>	Wind: <u>Caler</u>	P. Clidy: <u>Mod</u>	Clidy: <u>Mod</u>	Fog: <u>High</u>	M. Phoenix, M. Orr	
Sample Media: Groundwater	Temp: <u>80</u> °F	Rain: <u>No</u>	Light: <u>Mod</u>	Mod: <u>Mod</u>	Hvy: <u>Hvy</u>	Sample Time: <u>1500</u>	
Sample Date: <u>5/14/04</u>	Precipitation: <u>No</u>	Snow: <u>Light</u>	Light: <u>Mod</u>	Mod: <u>Mod</u>	Hvy: <u>Hvy</u>		

Purging Information

Date: <u>5/14/04</u>	Time Started: <u>1420</u>	Time Completed: _____
Method: Bladder Pump	Casing Diameter: <u>2"</u>	
Construction Well Depth (BTOC): <u>NA'</u>	Initial Water Level (BTOC): <u>9.62</u>	
Mid Screen Depth (BTOC): <u>NA'</u> Screen length: <u>NA'</u>	Depth Sounding (BTOC): _____	
Boring Dia. (ft.): <u>NA</u> Top of Filter: (BTOC): <u>NA'</u>	Volume of Sample: <u>0.12</u> Liters	
Purge Rate: <u>0.15</u> Liters per Minute	VAI: [(ID - _____) x _____] + [(_____ - WL) x 0.644] = _____ Liters	
Actual Purge Volume [<u>25</u> x <u>0.15</u>] = <u>3.35</u> Liters	VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level	
(Minutes) x (pump rate)	NA = Not Available	

Water Quality Parameters During Purging

Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if >1, or 0.1 if <1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
<u>10</u>	<u>1.50</u>	<u>7.03</u>	<u>14.84</u>	<u>725</u>	<u>9.98</u>	<u>2.50</u>	<u>33.7</u>	<u>9.73</u>	<u>0.15</u>
<u>15</u>	<u>2.15</u>	<u>6.92</u>	<u>15.09</u>	<u>713</u>	<u>6.42</u>	<u>1.55</u>	<u>7.7</u>	<u>9.74</u>	<u>0.15</u>
<u>20</u>	<u>2.70</u>	<u>6.86</u>	<u>15.00</u>	<u>698</u>	<u>5.76</u>	<u>1.49</u>	<u>-0.1</u>	<u>9.74</u>	<u>0.15</u>
<u>25</u>	<u>3.35</u>	<u>6.87</u>	<u>15.01</u>	<u>692</u>	<u>4.90</u>	<u>1.46</u>	<u>-2.0</u>	<u>9.74</u>	<u>0.15</u>

Sampling Information

Sample Container	Preservative	Analysis Required	Method	Laboratory
<u>3 x 40 mL Vials</u>	<u>4°C, HCl</u>	<u>VOCs</u>	<u>8260B</u>	<u>AML</u>

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory

Field Parameter Information

Date: <u>5/14/04</u>	Time: <u>1500</u>	Dissolved Oxygen: <u>1.46</u> mg/l
Temperature: <u>15.00</u> °C		Turbidity: <u>4.90</u> NTU
pH buffer (before): <u>7.00</u>		Conductivity: <u>692</u> mmhos/cm
pH (Sample): <u>6.87</u>		ORP: <u>-2.0</u> mV
pH buffer (after): _____		Odor (circle one): <u>None</u> , Weak Strong
Appearance (circle one): <u>Clear</u> , Sl. Cloudy Cloudy		

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
10975 El Monte, Suite 100
Overland Park, Kansas 66211
(965) 344-1000

Project: Former Schilling Air Force Base						Personnel: <u>T. Smith, D. Bronson,</u> <u>M. Phoenix, M. Orr</u> Sample Time: <u>1015</u>
Sample No.: 99M11-W0504 Sample Media: Groundwater Sample Date: <u>05/01/04</u>	Weather	Clear	<input checked="" type="radio"/> F. Cldy	Cldy	Fog	
	Temp <u>53</u> °F	Wind	<input checked="" type="radio"/> Calm	Mod	High	
	Precipitation	Rain	Light	Mod	Hvy	
		Snow	Light	Mod	Hvy	

Purging Information

Date: <u>05/01/04</u>	Time Started: <u>0930</u>	Time Completed: <u>1015</u>
Method: <u>Fultz Pump</u>	Casing Diameter: <u>2"</u>	
Construction Well Depth (BTOC): <u>25.16'</u>	Initial Water Level (BTOC): <u>7.50</u>	
Mid Screen Depth (BTOC): <u>19.76'</u> Screen length: <u>10'</u>	Depth Sounding (BTOC): <u>25.20</u>	
Boring Dia. (ft.): <u>0.67</u> Top of Filter: (BTOC): <u>11.66'</u>	Volume of Sample: <u>0.42</u> Liters	
Purge Rate: _____ Liters per Minute	VAI: $[(ID - 11.66) \times 3.882] + [(11.66 - WL) \times 0.644] =$ _____ Liters	
Actual Purge Volume [_____ x _____] = _____ Liters (Minutes) x (pump rate) VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level		

Water Quality Parameters During Purging

Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if >1, or 0.1 if <1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
5	1.25	7.15	14.23	1.153	23	2.73	171.4	10.68	0.25
10	2.5	7.13	14.31	1.154	20	2.57	166.9	12.18	0.25
15	3.75	7.13	14.37	1.156	24	2.58	164.3	14.19	0.1
20	4.25	7.14	14.62	1.162	18	2.32	163.5	14.31	0.1
25	4.75	7.16	15.02	1.173	19	2.29	164.2	14.39	0.1
30	5.25	7.15	15.17	1.176	17	2.24	165.4	14.78	0.1
Switch to low recovery sampler after 30 minute readings									
5.75	5.75	7.15	15.43	1.184	24	2.15	165.9	15.12	—
6.25	6.25	7.15	15.55	1.186	21	2.05	166.0	15.22	—
6.75	6.75	7.16	15.61	1.187	22	2.01	164.2	15.28	—
7.25	7.25	7.14	15.71	1.190	20	1.88	164.3	15.35	—

Sampling Information

Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory

Field Parameter Information

Date: <u>05/01/04</u>	Time: <u>1015</u>	Dissolved Oxygen: <u>1.80</u> mg/l
Temperature: <u>15.71</u> °C		Turbidity: <u>20</u> NTU
pH buffer (before): _____		Conductivity: <u>1180</u> µmhos/cm
pH (Sample): <u>7.14</u>		ORP: <u>164.3</u> mV
pH buffer (after): _____		Odor (circle one): <input checked="" type="radio"/> None <input type="radio"/> Weak <input type="radio"/> Strong
Appearance (circle one): <input checked="" type="radio"/> Clear <input type="radio"/> Sl. Cloudy <input type="radio"/> Cloudy		

WATER SAMPLE COLLECTION FIELD SHEET

URS Corporation
 10975 El Monte, Suite 100
 Overland Park, Kansas 66211
 (927) 344-1000

Project: Former Schilling Air Force Base						Personnel: T. Smith, D. Bronson, M. Phoenix, M. Orr Sample Time: 850
Sample No.: 02W07-W0504	Weather	<input checked="" type="radio"/> Clear	P. Cldy	<input type="radio"/> Cldy	<input type="radio"/> Fog	
Sample Media: Groundwater	Temp 50 °F	<input type="radio"/> Wind	<input checked="" type="radio"/> Calm	<input type="radio"/> Mod	<input type="radio"/> High	
Sample Date: 5/13/04	Precipitation	<input type="radio"/> Rain	<input type="radio"/> Light	<input type="radio"/> Mod	<input type="radio"/> Hvy	
		<input type="radio"/> Snow	<input type="radio"/> Light	<input type="radio"/> Mod	<input type="radio"/> Hvy	

Purging Information

Date: 5/13/04	Time Started: 815	Time Completed: 850
Method: F4/T2	Casing Diameter: 2"	
Construction Well Depth (BTOC): 19.06'	Initial Water Level (BTOC): 10.92	
Mid Screen Depth (BTOC): 13.61' Screen length: 10.5'	Depth Sounding (BTOC): AA2	
Boring Dia. (ft.): 0.67 Top of Filter: (BTOC): 7.36'	Volume of Sample: .120 Liters	
Purge Rate: .13 Liters per Minute	VAI: [(ID - 7.36) x 3.882] + [(7.36 - WL) x 0.644] = _____ Liters	
Actual Purge Volume [$\frac{4035 \times .13}{(Minutes) \times (pump\ rate)}$] = 4.55 Liters VAI = Vol. Above Intake, ID = Intake Depth, WL = Water Level		

Water Quality Parameters During Purging

Elapsed Time Since Purging Began (Minutes)	Cumulative Volume Purged (Liters)	pH (±0.1)	Temp. (°C) (±0.5°C)	Conductivity (µmhos/cm) (±1% or 20 µmhos/cm)	Turbidity (NTUs) (<50 NTU)	DO (mg/L) (±10% if >1, or 0.1 if <1)	ORP (mV) (±10mV)	Water Level (BTOC)	Purge Rate (L/M)
10	1.3	6.85	11.67	849	10.36	2.74	216.0	11.03	.13
15	1.95	6.89	12.06	855	6.77	2.51	211.4	11.06	.13
20	2.6	6.94	12.36	861	4.88	2.48	206.3	11.04	.13
25	3.25	6.94	12.23	857	4.10	2.54	203.9	11.06	.13
30	3.9	6.95	12.32	857	3.63	2.39	202.0	11.04	.13
35	4.55	6.96	12.37	857	3.44	2.50	200.4	11.04	.13

Sampling Information

Sample Container	Preservative	Analysis Required	Method	Laboratory
3 x 40 mL Vials	4°C, HCl	VOCs	8260B	AML

QA/QC Information

Type	Sample Number	Container	Preservative	Analysis Required	Method	Laboratory

Field Parameter Information

Date 5/13/04	Time 850	Dissolved Oxygen: 2.5 mg/l
Temperature 12.37 °C		Turbidity 3.44 NTU
pH buffer (before) 7.0		Conductivity 857 mmhos/cm
pH (Sample) 6.96		ORP 200.4 mV
pH buffer (after) NA		Odor (circle one) <input checked="" type="radio"/> None <input type="radio"/> Weak <input type="radio"/> Strong
Appearance (circle one) <input checked="" type="radio"/> Clear <input type="radio"/> Sl. Cloudy <input type="radio"/> Cloudy		