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DRAFT WATER QUALITY MONITORING PLAN NAS FORT WORTH TX
10/1/1990
AERONAUTICS SYSTEMS HEADQUARTERS

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**NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS**

**ADMINISTRATIVE RECORD
COVER SHEET**

AR File Number 51

Air Force Plant 4

Water-Quality Monitoring Plan

DRAFT

October 1990

Prepared for
U.S. Department of the Air Force
Headquarters Aeronautics Systems Division
Wright-Patterson Air Force Base, Ohio

Submitted by Chem-Nuclear Geotech, Inc., under
DOE Contract No. DE-AC07-86ID12584 for the
U. S. Department of Energy

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WATER QUALITY MONITORING PLAN FOR AIR FORCE PLANT 41.0 BACKGROUND

Annual groundwater monitoring activities have been conducted continuously at Air Force Plant 4 (AFP 4) since 1983. Hargis + Associates, Inc., under contract to General Dynamics was responsible for groundwater monitoring until January, 1990. Chem Nuclear Geotech (formerly UNC Geotech) assumed the responsibility for continued monitoring in February, 1990. Phase 01 of Task 02 consisted of a thorough review of the Hargis + Associates, Inc. (1989b) monitoring plan and revision of the plan as required. In the process of reviewing the previous monitoring practices and results, Chem Nuclear Geotech (Geotech) found numerous problems that needed further investigation before a monitoring plan could be developed. Because of a multitude of problems with completion of the monitoring wells and records of completion, a thorough review of all monitoring wells was conducted. A description of monitoring well completions and associated problems identified for each well is presented in Appendix A. The information is summarized in Table 1. These data provide the basis for the proposed monitoring plan.

The following monitoring recommendations are the result of an extensive evaluation of previous monitoring activities at Air Force Plant 4. On the basis of this evaluation, monitoring wells were placed in the following categories:

Priority I- The minimum wells recommended for monitoring to satisfy the monitoring plan objectives. These wells were selected on the basis of location (boundary wells, wells upgradient or downgradient of hazardous waste sites, off-site wells), on the basis of recent changes in water quality, or on the basis of proximity to drinking water supply sources.

Priority II- Wells that can be used in the future to satisfy monitoring plan objectives. These wells, although not considered critical, should be added to the monitoring program as required.

Priority III- Lower priority wells that may be monitored in the future only if conditions warrant. These wells are not currently considered important for routine monitoring.

The remaining wells were not considered for continued monitoring for various reasons and many have been recommended for abandonment. Abandonment recommendations were also prioritized as follows:

Priority I- Contaminated wells that pose a serious risk to the Paluxy Aquifer or off-site receptors due to poor well design or construction.

Priority II- Contaminated wells that are poorly constructed but do not presently pose a significant risk to the Paluxy aquifer or off-site receptors.

Priority III- Poorly constructed wells that are not presently contaminated but could present a significant risk in the future due to contaminant migration.

TABLE 1. SUMMARY OF AIR FORCE PLANT 4 MONITORING WELL COMPLETIONS AND RECOMMENDATIONS

Well number	Discontinue monitoring	Monitor	Abandon	Previous monitoring frequency	Floating product present	Boundary well	Excessive filter pack	Lack of surface seal	Bentonite in screen	Screen interval too long	Uncertain completion details	In planned construction or secured area	Galvanized pipe	Filter pack extends into fill
Doak 17														
F-200	X			A	.									
F-201	X			A	X							X		
F-202	X			G	X									
F-203		III		G	X									
F-204		III		S	X									
F-205	X			S	X									
F-206	X			S	X									
F-207		I		S										
F-208		R		A										
F-209		III		G	**									
F-210	X			G	X									
F-211		II		A										
F-212	X			D										
F-213		II		S										
F-214	X			S	X									
F-215		I		A										
F-216		III		S										
F-217		III		M										
F-218		II		S										
F-219		II		S										
F-220		R		S										
F-221		II		A	X									
F-222		III		G	X									
F-223		III		G	X									
FSA3-1	X			G	X			X						
FSA3-3	X			G	X			X						
FSA3-6	X			G	X			X						
FSA3-7	X			G	X			X						
FSA3-10	X			G	X			X						
FSA3-12	X			G	X			X						
HM-2	X			D	.									
HM-5		III		D		X			X					
HM-7		III		M										
HM-9		III		D		X								
HM-10		I		G										
HM-11	X		III	A	.	X	X							X
HM-12	X		III	A	.	X	X							X
HM-13		III		A		X	X							X
HM-14	X	R		A		X	X						X	
HM-15	X			A		X	X							
HM-16		I		S		X	X					X		X
HM-17	X			A		X	X							X
HM-18	X			A		X	X							X
HM-19	X			G			X							X
HM-20	X			G			X						X	
HM-21	X		III	M		X	X						X	
HM-23	X			A		X	X						X	

TABLE 1 (cont). SUMMARY OF AIR FORCE PLANT 4 MONITORING WELL COMPLETIONS AND RECOMMENDATIONS

Well number	Discontinue monitoring	Monitor	Abandon	Previous monitoring frequency	Floating product present	Boundary well	Excessive filter pack	Lack of surface seal	Bentonite in screen	Screen interval too long	Uncertain completion details	In planned construction or secured area	Galvanized pipe	Filter pack extends into fill
HM-24	X		III	A		X	X						X	
HM-25	X		II	S	X	X	X		X					
HM-26	X		III	S		X			X					
HM-27	X		III	S		X			X					
HM-28	X		III	S			X			X				X
HM-29	X		III	S			X							
HM-30	X		III	A	.		X							
HM-31	X		III	G		X	X							
HM-33	X			D			X							
HM-36		III		A		X					X			
HM-37	X			S					X		X			
HM-38	X			S	X						X			
HM-39	X			S				X			X			
HM-40				D								X		
HM-41		III		A							X			
HM-42	X			S							X			
HM-46	X		III	S							X			
HM-47	X			S		X					X		X	
HM-48	X			A	.						X			
HM-49	X			A							X			
HM-50	X			S										
HM-51		III		S										
HM-52				A							X			
HM-53		III		G							X			
HM-56		III		S			X				X			
HM-57	X			A	.						X			
HM-59	X		III	A	.						X			
HM-60	X			S							X			
HM-62	X			S							X			
HM-63		III		G							X			
HM-64				S							X			
HM-65		III		A	.				X		X			
HM-66		III		S							X			
HM-68	X		III	A	.		X			X	X			X
HM-69	X		III	A	.		X				X			
HM-70	X		III	S			X				X			
HM-71		III		S			X				X			
HM-72			III	A	.		X				X			X
HM-76				A	.		X				X			
HM-77	X			A	.		X				X			
HM-78	X			G	X		X				X			
HM-79	X			S			X				X			
HM-82			I	S			X				X			
HM-84				A			X			X	X			
HM-86			I	S			X				X		X	
HM-87		III		S			X			X	X			
HM-88		III		S			X				X		X	
HM-89		III		S			X				X		X	

TABLE 1 (cont). SUMMARY OF AIR FORCE PLANT 4 MONITORING WELL COMPLETIONS AND RECOMMENDATIONS

Well number	Discontinue monitoring	Monitor	Abandon	Previous monitoring frequency	Floating product present	Boundary well	Excessive filter pack	Lack of surface seal	Bentonite in screen	Screen interval too long	Uncertain completion details	In planned construction or secured area	Galvanized pipe	Filter pack extends into fill
HM-90		III	III	S			X				X		X	
HM-91			I	S							X			
HM-92	X			S							X			
HM-93		I		S			X			X			X	
HM-94				S			X							
HM-95	X			S			X			X				
HM-96	X			S						X				
HM-97		III	III	S							X			
HM-98		III	III	S							X			
HM-99		I		S										
HM-101		III		D										
HM-102		III		D										
HM-103		II		S		X								
HM-104		I		A						X				
HM-106				A										
HM-108				A		X								
HM-107		R		S										
HM-108				A			X							
HM-110		II		S			X			X			X	
HM-111		III		S			X			X			X	
HM-112		III		S						X			X	
HM-113		III		S		X				X				
HM-116		I		S		X					X			
HM-117		III		S						X				
HM-118		III		S		X				X				
HM-119		I		S		X				X				
HM-120		III		S		X								
HM-121		I		S		X					X			
HM-122		I		S		X				X				
HM-123		I		S		X	X				X			
HM-124		III		S		X				X				
HM-125		I		S		X					X			
HM-126		III		S		X	X				X			
HM-127		III		S		X	X			X				
P-3				A		X							X	
P-6UN		III		S									X	
P-6US				A										
P-6M		III		S									X	
P-6J		III		S									X	
P-6M		III		S									X	
P-7U		III		S									X	
P-7M		III		S									X	
P-8UN		II		S									X	
P-8M		III		S									X	
P-8US		III		S									X	
P-8UN		I		A									X	
P-9US		I		S									X	

TABLE 1 (cont). SUMMARY OF AIR FORCE PLANT 4 MONITORING WELL COMPLETIONS AND RECOMMENDATIONS

Well number	Discontinue monitoring	Monitor	Abandon	Previous monitoring frequency	Floating product present	Boundary well	Excessive filter pack	Lack of surface seal	Bentonite		Screen interval too long	Uncertain completion details	In planned construction or secured area	Galvanized pipe	Filter pack extends into fill
									In screen	long					
P-8M		III		A									X		
P-10U		III		Q		X							X		
P-10M		III		S		X							X		
P-11U		I		Q		X							X		
P-11US				A		X							X		
P-11M		III		Q		X							X		
P-12UN		III		Q		X							X		
P-12US				A		X							X		
P-12M		I		Q		X							X		
P-13U		III		Q		X							X		
P-13US				A		X							X		
P-13M		III		Q		X							X		
P-14U		III		S			X								
P-14US		III		S											
P-15US		III		S											
P-16U		I		S											
P-18US		I		S											
P-17US		III		A											
P-18US		III		S											
P-19US		III		A											
P-20M				A											
P-21U				A											
P-22U		I		Q		X							X		
P-23M		I		Q		X							X		
P-23U		III		A		X							X		
P-24U		III		Q		X							X		
P-24M		III		Q		X							X		
P-25U		III		Q								X	X		
P-25M		III		Q								X	X		
P-28U		III		Q		X							X		
P-26M		III		Q		X							X		
A=Annually															
M=Monthly															
Q=Quarterly															
S=Semianually															
D = H+A Discontinued Routine Monitoring															
R = Will be sampled under RI/FS field investigation															
* Floating Product could be present but well design prevents detection															
** Floating Product is rare															
UNDER THE MONITORING COLUMN															
I = Highest Priority															
II = Lower Priority (II)															
III = Monitor as Necessary															
UNDER THE ABANDON COLUMN															
I = Abandon as soon as possible															
II = Eventually Abandon															
III = Possibly Abandon															

2.0 MONITORING OBJECTIVES

The objectives of the water quality monitoring program are to:

- monitor changes in water quality upgradient and downgradient of hazardous waste sites over time;
- monitor the movement of contaminant plumes;
- assess the migration of contaminants across the boundaries of the AFP 4 site;
- monitor changes in water quality of the Paluxy aquifer beneath the site;
- detect threats to water quality as early as possible so that corrective actions can be taken;
- monitor changes in water levels in wells;
- monitor changes in free-product thicknesses in selected wells known or suspected to contain free product; and
- monitor off-site water quality (White Settlement water supply wells).

3.0 MONITORING SCOPE

A total of 20 wells will be sampled quarterly in fiscal year 1991 (Figure 1 and Table 2). The sampling locations were determined by considering the magnitude of groundwater contamination at each site, the quality of individual monitoring well completions, and the reliability of previous data from each well. Depth to water and free product will be measured in wells before samples are collected. Temperature, pH, and electrical conductivity will be determined in the field prior to collecting samples for laboratory analysis. As the need arises, water levels and free-product thicknesses can be measured in wells that are not scheduled for sampling. The following sections describe the types of sampling locations selected and how each type of location will meet the specific objectives established for the monitoring program at AFP 4. For some locations, the same monitoring well will be used to satisfy more than one objective.

3.1 BOUNDARY WELLS

A total of 9 boundary wells were chosen to aid in monitoring plume migration from hazardous waste sites to the AFP 4 boundary in addition to monitoring current off-site contaminant migration. Two additional existing boundary wells (F-208 and HM-107) will be sampled during RI/FS field investigations (Geotech, 1990b). Those wells are as follows:

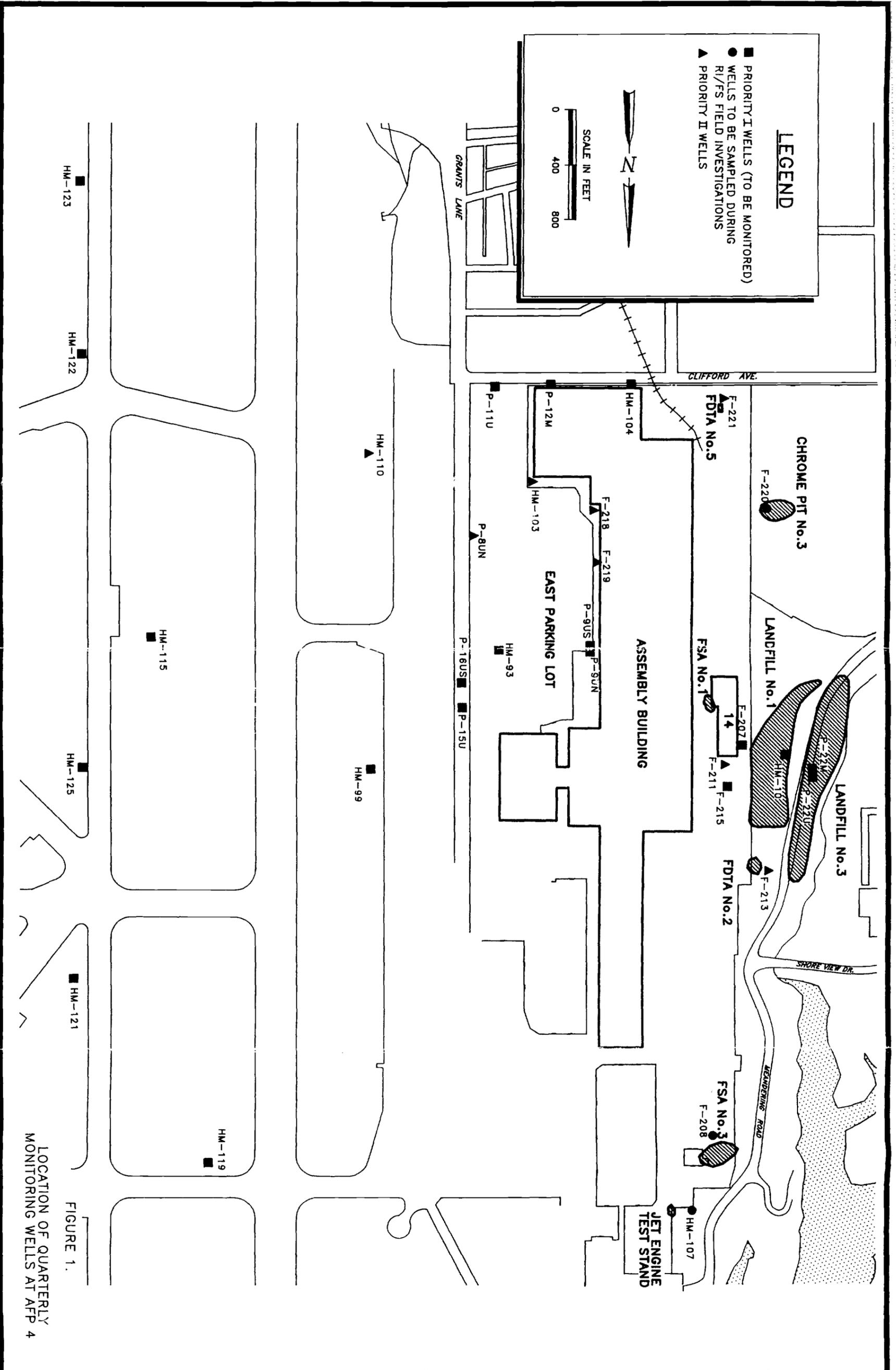


FIGURE 1.
LOCATION OF QUARTERLY MONITORING WELLS AT AFPP 4

Table 2. Minimum Recommended Monitoring Well Sampling for AFP 4

Well #	VOCs	SemiVOCs	TPH	O & G	Chromium	DGO Level
F-207	Q		Q	Q	Q	III
F-215	Q			Q	Q	III
HM-10	Q	Q				III
HM-93	Q				Q	III
HM-99	Q				Q	III
HM-104	Q		Q	Q		III
HM-115	Q		Q	Q	Q	III
HM-119	Q		Q	Q	Q	III
HM-121	Q		Q	Q	Q	III
HM-122	Q		Q	Q	Q	III
HM-123	Q		Q	Q	Q	III
HM-125	Q		Q	Q	Q	III
P-9US	Q				Q	IV
P-9UN	Q	Q				IV
P-11U	Q	Q	Q	Q		IV
P-12M	Q	Q	Q	Q		IV
P-15U	Q					IV
P-16US	Q				Q	IV
P-22U	Q					IV
P-22M	Q					IV
Field Dup	Q	*	*	*	*	
Eq Blank	Q	Q	Q	Q	Q	
Trip Blank	Q					
2 Fid Blanks	Q					
*= Duplicate all analyses for the particular well the sample is from Q= Quarterly sampling						

HM-104; see 3.2.12 Assembly Building/Parts Plant Perimeter
 HM-115; see 3.2.16 Eastern Flight Line Area
 HM-119; edge of northern TCE plume in northern Flight Line Area
 HM-121; see 3.2.16 Eastern Flight Line Area
 HM-122; see 3.2.16 Eastern Flight Line Area
 HM-123; see 3.2.16 Eastern Flight Line Area
 HM-125; see 3.2.16 Eastern Flight Line Area
 P-11U; see 3.3 Paluxy wells
 P-12M; see 3.3 Paluxy wells

3.2 HAZARDOUS WASTE SITES

All previously identified hazardous waste sites at AFP 4 were evaluated for inclusion into the monitoring program on the basis of:

- the nature and extent of contamination at each site;
- the quality of existing monitoring wells at each site;
- the availability and quality of existing data; and
- the location of the site in relation to potential environmental receptors.

An upgradient and a downgradient monitoring well were selected from hazardous waste sites where properly completed wells exist. The following section describes the rationale used in well selection. The concentrations of contaminants listed below for each well are the maximum levels detected (Hargis + Associates, 1989a).

- 3.2.1 Landfill No. 1: F-215 (upgradient, contaminated with 1500 ppb TCE, 150 ppb TCA, 240 ppb DCE, 0.3 mg/L oil and grease, and 0.14 mg/L chromium); HM-10 (downgradient, contaminated with 690 ppb TCA, 520 ppb DCE, 53 ppb TCE, and 7 ppb DCA).
- 3.2.2 Landfill No. 3: Currently, there is a lack of good monitoring wells in this area. The temporary monitoring wells installed during the RI/FS field investigations should be considered for addition to the monitoring program.
- 3.2.3 Chrome Pit No. 1: Presently, there are no monitoring wells in this area. New wells installed during RI/FS field investigations inside the Parts Plant/Assembly Building in the vicinity of Chrome Pit No. 1 should be added to the monitoring program.
- 3.2.4 Chrome Pit No. 2: There are no good monitoring wells presently in this area. New wells installed during RI/FS field investigations inside the Parts Plant/Assembly Building in the vicinity of Chrome Pit No. 2 should be added to the monitoring program.
- 3.2.5 Chrome Pit No. 3: During RI/FS field investigations, well F-220 will be sampled. It is unclear whether this well is upgradient or downgradient of Chrome Pit No. 3 because Geotech's data show that it is upgradient and Hargis + Associates' data are unclear as to whether it may be

crossgradient or downgradient. F-220 is contaminated with 220,000 ppb TCE, 300,000 ppb 1,1,1-TCA, 3,500 ppb trans-1,2-DCE, 20 mg/L oil and grease, 15 mg/L total petroleum hydrocarbons, 0.56 mg/L chromium, and 2.7 mg/L cyanide.

- 3.2.6 Die Yard Chemical Pits: Presently, there are no good monitoring wells in this area. One multiple-level monitoring well with three sampling ports will be installed during RI/FS field investigations and should be considered for inclusion in the monitoring program.
- 3.2.7 Fuel Saturation Area No. 1: F-207 is downgradient of FSA No. 1 and "upgradient" of Landfill No. 1; and contaminated with 4,200 ppb 1,1,1-TCA, 65 ppb TCE, 4,900 ppb trans-1,2-DCE, 47 ppb 1,1-DCA, 3,200 ppb 1,1-DCE, 63 ppb benzene, 0.2 mg/L oil and grease, and 0.03 mg/L chromium. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.8 Fuel Saturation Area No. 2: Presently, there are no good upgradient or downgradient monitoring wells in this area. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.9 Fuel Saturation Area No. 3: During RI/FS field investigations, well F-208 will be sampled. It is unclear whether this well is upgradient of FSA No. 3 because Geotech's data show that it is upgradient and Hargis + Associates' data show that it is crossgradient. Previous data indicates that this well is clean. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.10 Jet Engine Test Stand: During RI/FS field investigations, well HM-107 will be sampled. It is downgradient of the Jet Engine Test Stand, clean except 8 mg/L benzene and 6 mg/L carbon disulfide, and a boundary well. No upgradient wells presently exist in this area. The new conventional nested monitoring wells that will be installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.11 Wastewater Collection Basins: Presently there are no good upgradient or downgradient monitoring wells in this area. The new multiple-level monitoring well with three sampling ports that will be installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.12 Assembly Building/Parts Plant Perimeter: HM-104 is a boundary well containing 24 ppb TCE. Geotech data show that it is upgradient of AFP-4 but Hargis + Associates' data are conflicting. One Hargis + Associates map dated 7/89 shows that it is upgradient of AFP-4 and one dated 1/89 shows that it is downgradient of AFP-4.
- 3.2.13 East Parking Lot: HM-93 is upgradient of the Window Area and contains 50 ppb ethylbenzene. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.

- 3.2.14 Window Area: The Walnut aquitard that separates the Upper Zone from the underlying Paluxy (drinking water supply aquifer), is thin to absent in the Window Area. All Upper Zone wells in the Window Area are contaminated, poorly designed, pose serious risks to the Paluxy, and should be abandoned. The quality of the Paluxy will be monitored instead (see Paluxy Wells). Wells in other areas (see HM-93, East Parking Lot; and HM-99, Western Flight Line Area) will be used to monitor the upper zone upgradient and downgradient of the Window Area respectively. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.15 Western Flight Line Area: HM-99, Downgradient of the Window Area is located in the TCE plume [1,100 ppb TCE, 240 ppb trans-1,2-DCE, 6 ppb trichlorofluoromethane, 0.03 mg/L chromium] and is a good well to check for DNAPLs and LNAPLs. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.
- 3.2.16 Eastern Flight Line Area: Better definition is required for the TCE plume leaving AFP-4 and entering Carswell AFB. Wells in this area were recently installed (1989) and have not been monitored for very long. The TCE plume appears to split into two tongues after leaving the Window Area. The purpose of the monitoring program in the Flight Line Area will be to monitor the leading edges of the TCE plume. Two monitoring wells have been chosen on the edge of the southern tongue. HM-123 (3,500 ppb TCE, 840 ppb trans-DCE) is due west of the Carswell Radian wells and HM-122 (1,100 ppb TCE and 470 ppb trans-DCE) is on the lateral edge. HM-115 (380 ppb TCE and 15 ppb trans-DCE) is on the leading edge of the slower moving center. HM-121 (550 ppb TCE, 20 ppb trans-DCE, and 30 ppb methylene chloride) is on the leading edge of the northern tongue. HM-125 (2 ppb DCE, 6 ppb methylene chloride, 77 ppb TCE) is on the leading edge of the slower moving center. New wells installed during RI/FS field investigations should be added to the monitoring program in the future.

3.3 PALUXY WELLS

- P-9US: Parts Plant/Assembly Building Perimeter; 19' increase in water level last year and increase in TCE (to 7200 ppb from a previous high of 2,200 ppb); also contains trans-1,2-DCE (12 ppb), toluene (14 ppb), and chromium (0.02 mg/L).
- P-9UN: Clean except 8 ppb toluene. This well should be monitored to detect any downward migration of TCE from the upper sand (P-9US). Will have to remove submersible pump and galvanized pipe.
- P-11U: Boundary well; contains toluene (70 ppb) and methylene chloride (32 ppb). Will have to remove submersible pump and galvanized pipe.
- P-12M: Boundary well; contains toluene (44 ppb), and MEK (30 ppb). Will have to remove submersible pump and galvanized pipe.
- P-15U: Window Area; contains toluene (100 ppb), benzene (3 ppb), TCE (7 ppb), trans-1,2-DCE (3 ppb), 1,1-DCE (1 ppb), and DCA (2 ppb).
- P-16US: Window Area; contains TCE (1,500 ppb), DCE (490 ppb), toluene (14 ppb), and benzene (82 ppb).

P-22U: Landfill No. 3; contains trans-1,2-DCE (420 ppb), TCE (150 ppb), vinyl chloride (77 ppb), and toluene (15 ppb).

P-22M: Landfill No. 3; contains TCE (33 ppb), toluene (15 ppb), and trans-1,2-DCE (3 ppb).

3.4 SURFACE WATER QUALITY

Monitoring of previous creek stations will be discontinued until RI/FS sampling of surface water is completed. During RI/FS field investigations samples will be collected from around the outside of outfalls, from seeps, and from Meandering Road Creek. Some new surface water quality stations selected during the RI/FS field investigations may be added to the monitoring plan in the future.

3.5 PROPOSED ADDITIONAL WELLS (PRIORITY II)

The rationale for selecting each Priority II well is discussed below. The recommended analyses to be run on each sample are shown on Table 3.

Table 3. Recommended Priority II Monitoring Well Sampling for AFP 4

Well #	VOCs	TPH	O & G	Chromium	DGO Level
F-211	Q			Q	III
F-213	Q				III
F-218	Q			Q	III
F-219	Q			Q	III
F-221	Q	Q	Q		III
HM-103	Q		Q	Q	III
HM-110	Q	Q	Q	Q	III
P-8UN	Q		Q		IV
1-Field Dup	Q	.	.	.	
1-Eq Blank	Q	Q	Q	Q	
1-Trip Blank	Q				
1-Field Blanks	Q				
* = Duplicate all analyses for the particular well the sample is from					
Q = Quarterly sampling					

3.5.1 Upper Zone:

Landfill No. 1: F-211 (Upgradient, contaminated with 2,000 ppb TCE, 54 ppb DCE, 20 ppb TCA, 38 ppb benzene, 0.2 mg/L chromium) if a lithologic log and completion diagram cannot be found for F-215.

Fire Department Training Area No. 2: F-213 (Downgradient, clean).

Fire Department Training Area No. 5: F-221 (Upgradient, clean, boundary well that is upgradient of FDTA No. 5 and AFP-4.)

Assembly Building/Parts Plant Perimeter: F-218 (TCE plume at edge of building, also contaminated with chromium and DCE); F-219 (edge of TCE plume); HM-103 (part of TCE plume moving from southeastern portion of building to East Parking Lot; contaminated with 3,000 ppb trans-1,2-DCE, 5,600 ppb TCE, and 0.3 mg/L oil and grease). Discrepancies exist for HM-103 between the concentrations for methylene chloride reported in Table B-1 (5,400 ppb) of the Hargis + Associates Monitoring Plan (1989b) and the text of the same report and the data base (less than detection limit).

Western Flight Line Area: HM-110 (Southernmost well of TCE plume [1,400 ppb TCE and 250 ppb trans-1,2-DCE]; boundary well).

3.5.2 Paluxy Wells

P-8UN: East of East Parking Lot. There is a major discrepancy on the maximum concentration of TCE reported for this well by Hargis + Associates (1989b). Table B-1 of the Annual Hydrologic Monitoring Plan states that the maximum TCE concentration was 8,100 ppb; but the text (pg. 46) states that the maximum concentration during the same period was 140 ppb. The data base confirms the 140 ppb of the text. Similar discrepancies occur for trans-1,2-DCE concentrations (400 ppb in Table B-1 and 3 ppb in the text and data base, TCE (8,100 or 140 ppb), acetone (13 ppb), MEK (24 ppb), trans-1,2-DCE (400 ppb or not detected), and chloroform (1.4 ppb).

4.0 GROUNDWATER SAMPLING PROCEDURES

Sampling procedures will be the same as those specified in the Final RI/FS Sampling and Analysis Plan (Geotech, 1990b). These procedures are included in Appendix B of this document. Sample containers, preservation, and holding times are shown on Table 4.

Groundwater will be sampled from existing monitoring wells at AFP 4. Conductivity, temperature, and pH will be measured in the field at the time of sampling.

An interface probe will be used to measure depth to the top of any free-product layers (both DNAPLs and LNAPLs) and to the top of the water in monitoring wells. The depth to fluids will be determined with respect to the casing top and will be measured prior to purging and sampling.

Wells will be pumped before sampling for a minimum of three bore volumes where practical, to a maximum of five bore volumes. This will ensure that a representative sample is being collected. The pH, temperature, and

Table 4. Sample Containers, Preservation, Holding Times, and Analytical Procedures

Analytical Parameter	Matrix	Container Type/Size ^a	Preservation	Holding Time	Analytical Method ^b
TCL Volatile Organics	Water	Glass With Teflon tm Septa/40 mL	No Residual Chlorine, Conc. HCl to pH <2; Cool to 4°C	14 Days	EPA 8240 or 8260 of SW-846 (3rd Ed.) or EPA 624 of 40 CFR 136 or EPA 524.2
TCL Semi-Volatile Organics	Water	Glass With Teflon tm Lined Cap/4 to 6 L	No Residual Chlorine Cool to 4°C	Extr. 7 Days; Anal. 40 Days	EPA 8270 of SW-846 (3rd Ed.) or EPA 625 of 40 CFR 136
Inorganics (CrO ₄)	Water	HDPE/500 mL	Filter Through 0.45 Micron; Cool to 4 °C	28 Days	UNC Method D-3 ^c
Total Petroleum Hydrocarbons	Water	Glass With Teflon tm -Lined Cap/1 L	Cool to 4 °C Add 5 mL/L HCl	Not Specified	Analyze by UNC Method CC-1 ^d
Oil and Grease	Water	Glass With Teflon tm -Lined Cap/1 L	Cool to 4 °C Add 5 mL/L HCl	Not Specified	Analyze by EPA Method 413.2

^a Sample volumes may vary according to laboratory requirements.

^b UNC methods are described in the following: Analytical Chemistry Laboratory Administrative Plan and Quality Control Methods, Analytical Chemistry Laboratory Handbook of Analytical and Sample Preparation Methods, and Analytical Chemistry Laboratory Gamma-Ray Spectroscopy Systems Operation and Methods Manual.

^c UNC Method D-3, SOP for EPA Method 300.0

^d UNC Method CC-1, SOP for EPA Method 418.1.

conductivity of the discharge water will be monitored during pumping. The probes will be immersed in a flow-through cell soon after pumping begins to monitor the pH, temperature, and conductivity. The standard solutions for calibrating the pH meter will be brought to the temperature of the water in the flow-through bath and the meter will be standardized prior to taking the pH measurements. Electrical conductivity will be measured using a conductivity meter that has been calibrated before sampling. The conductivity probe will be placed in the flow-through bath; pH, temperature, and conductivity measurements will be recorded periodically throughout the time of pumping. The samples will be collected after the pH, temperature, and conductivity have stabilized for at least one-half a bore volume. Stabilization criteria will be +/- 0.25 pH, +/- 50 μ mhos/cm, and +/- 0.5°C.

Existing wells with dedicated triloc pumps will be purged using the existing pump. All other wells will be purged using a peristaltic suction lift-type pump. This pump will also be used to collect the inorganic samples. Organic samples will be collected using dedicated Teflon® bailers. Wells that cannot be purged using a suction lift-type pump will be purged and sampled using a submersible bladder-type pump. Two types of pumps may be used: (1) Pump A has a stainless steel housing, Viton® seals, and a Viton® bladder and (2) Pump B has a stainless steel housing, Viton® seals, and Teflon® bladder.

Chromate samples will be filtered through a 0.45-micron cellulose-acetate or nitrate membrane filter in conjunction with a flow-through filtration system. The filtration system consists of a filter holder and Teflon® support screens on the top and bottom of the filter.

Sample bottles will be filled by allowing the pump or bailer discharge to flow gently down the side of the bottle with minimal entry turbulence. The sample will then be capped and stored at 4°C. For samples requiring preservation to pH <2 (such as with HCl for VOCs) the proper amount of preservative will be added and the bottle capped. Samples collected for organics will be preserved, filled, bottled with no bubbles, and cooled to 4°C.

4.1 GROUNDWATER SAMPLING EQUIPMENT

Equipment and supplies used for groundwater sampling will include the following:

- . Masterflex Peristaltic Sampling Pump (to 20-foot sampling depth) or equivalent
- . Geofilter Peristaltic Pump (to 20-foot sampling depth) or equivalent
- . IEA Poseidon Model Gas-Operated Bladder-Type Pump (to 200-foot sampling depth) or equivalent
- . Teflon® Bailers
- . Conductivity Meter (temperature and conductivity)
- . pH Meter
- . Water-Level Indicator

- . Portable Generator
- . Filter Holder and Filters
- . Latex, Nitrile, and Silver Shield gloves
- . Sample Bottles
- . Concentrated HCl
- . Teflon® Tubing
- . Cooler With Ice (Blue Ice® or equivalent)
- . Maximum-Minimum Thermometer for Cooler
- . Chain of Sample Custody Forms (form UNC 1512)

4.2 GROUNDWATER SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

All measurement and sampling equipment that contacts groundwater will be cleaned as the equipment is removed from the well using clean rags or paper towels. Outer-surface areas will then be cleaned using soapy water, clean potable water, methanol, and deionized water.

Equipment, such as pumps and tubing that may become contaminated internally, will be cleaned by circulating soapy water (Alconox laboratory soap or equivalent) through the system. This will be accomplished by placing the pump in a bucket of soapy water, followed by a clean-water rinse through the system, and finally a deionized-water rinse. If the equipment is to be used for the collection of volatile organics, a small amount of methanol will be pumped through the system prior to the deionized-water rinse. Discharge water and solvents will be containerized and stored in steel barrels. Chemical analyses will be made of the contents of the containers. Those barrels having hazardous contents will be disposed of by the on-site group responsible for disposal of hazardous wastes. Certain fluids can be allowed to evaporate and the residue handled as routine non-hazardous waste.

4.3 SAMPLING PROCEDURES AND PROTOCOLS

The following section includes the sample identification requirements, volume requirements, preservation requirements, sample-handling, and storage requirements.

4.3.1 Sample Identification

Each sample will be assigned a unique identification number that will be easily identifiable as to the project (AFP4) and location.

4.3.2 Sample Handling, Packaging, and Shipping

All containers used will be pre-cleaned and obtained from an EPA-approved supplier for Superfund sites (e.g., I-Chem). Containers will be visually inspected for integrity and cleanliness prior to use. Suspect containers will not be used and will be labeled "Do Not Use" or will be discarded.

Sample bottles for chromate analyses will be filled to approximately 90 percent of capacity to allow for expansion of the contents. Sample bottles for organic analyses will be filled with minimum headspace. The 40-milliliter (mL) vials for volatile organic analysis will be filled with no headspace or bubbles.

Sample preservation will be performed immediately upon collection. For acidified samples, pH will be checked prior to shipment to ensure proper preservation. Ice chests will be used to cool samples during field sampling, packaging, and shipping. A refrigerator will be obtained for storing samples that will not be shipped the day of collection. This refrigerator will be kept in a locked room or at a minimum will have chain-of-custody seals placed on the door of the refrigerator to ensure sample security.

All samples will be packaged and shipped in a manner that will protect the integrity of the sample as well as protect against any detrimental effects from possible leakage. Packaging and shipping will include placing sample containers in zip-lock plastic bags, packing samples in vermiculite, and possibly placing samples in foam socks or equivalent packing material. Shipping containers will be properly labeled according to DOT guidelines.

Each shipment of samples will be accompanied by a signed Chain of Sample Custody form (see Figure 2) that specifies the analyses required for each sample and any unique handling requirements based on information obtained in the field.

5.0 WASTE MANAGEMENT

Collection and disposal of wastes associated with purging and sampling in FY 1991 will be handled according to the Chem Nuclear Geotech Waste Management Plan for RI/FS field investigations at Air Force Plant 4 (draft).

6.0 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

INTRODUCTION

The objective of field QA/QC is to provide systematic control of all phases of the various sampling processes, which includes proper sampling design, sampling procedures, accuracy, precision, comparability, and completeness.

6.1 FIELD QUALITY ASSURANCE

6.1.1 Sampling Procedures

The basic sampling procedures are described in Appendix B of this document. References to procedures approved by the U.S. Environmental Protection Agency (EPA) and/or the U.S. Department of Energy (DOE) that describe the procedures in more detail are given. Any deviation from these established procedures will be noted in the field logbooks with an explanation of the change(s) and what the resulting impact on data quality might be.

6.2 SAMPLE CONTROL

6.2.1 Sample Identity

To maintain evidence of authenticity, the samples collected must be properly identified and easily discerned from other samples. Samples collected for AFP 4 will be identified by a label attached to the sample container that will include the sample identification number, date collected, time collected, and the sampler's name.

6.2.2 Sample Custody

To maintain the integrity of the samples, it will be necessary to demonstrate that the samples were kept under custody from the time they were collected to the time they were analyzed. Chain of Sample Custody records (Figure 2) will be used to list all sample possession transfers. This document will show that the sample was in constant custody between collection and analysis.

While the sample is being shipped, the shipping container will have custody seals placed over the container opening to ensure that the integrity of the samples has not been compromised during shipment. The receiving laboratory must examine the seals on arrival and document that the seals are intact. Upon opening the container, the condition of the sample containers will also be noted (i.e., broken bottles, leaking bottles, broken seal around the lid).

6.2.3 Transportation/Shipment of Samples

All shipments will be made in compliance with DOT regulations governing shipment of hazardous materials and substances. A copy of the regulations in 49 CFR 171-179 will be made available to field personnel responsible for marking, labeling, packaging, documenting, and shipping hazardous material, substances, and waste. In addition to meeting all DOT requirements, special care will be taken to ensure the integrity of the sample through proper packaging and shipping.

To determine the proper identification of a hazardous sample, field personnel will review field measurement data and the logbooks for relevant information concerning the sample material in each container. This information will include such things as radioactivity levels, organic vapors detected, pH, explosivity determinations, or any other information useful in classifying the samples for shipment. If a sample is known or suspected to contain a specific hazardous material, the sampler will note the presence of the material on the sample label. This information is necessary for the receiving laboratory to determine proper handling of the sample prior to analysis.

6.3 DOCUMENT CONTROL

Introduction

The preparation, issue, and revision of documents that specify quality requirements or prescribe activities affecting quality will be controlled to assure that the correct documents are being used and enforced during the sampling and analysis phase of the monitoring process. The following describes the various documents that will be controlled.

6.3.1 Field Logbooks

Bound logbooks with consecutively numbered pages will be used by field personnel for each major field task performed. The field logbooks will be used to record the daily activities of the field team, record any field measurements taken, sketch maps of measurement and sample locations, and note observations that may indicate the quality of the data. Each page will be signed and dated by the person making the entries on that page and will also be signed and dated by a second person who has reviewed the entries for accuracy and clarity.

Each logbook that is issued will be signed out by the individual responsible for completion of the logbook. This record will be part of the overall Document Control Log. When the books are returned, the receiver will sign and date the return.

6.3.2 Instrument Calibration Log

An instrument calibration log will be kept for instruments requiring daily calibration or operational checks to ensure that the data being obtained are within established QA limits. Included in the logbook will be the date of calibration, the type of calibration performed, standards used, and the QA limits established for each particular instrument. The log will be signed and dated by the person performing the calibration. Instruments failing the calibration or operational checks will be adjusted or repaired (if possible) and rechecked, or will be tagged "DO NOT USE."

6.3.3 Groundwater Sample Collection Forms

A groundwater sample collection form will be completed for each sampling location (Figure 3). This form is a fairly comprehensive form that documents water quality field measurements taken at the time of sampling and purging. Information recorded includes pump type, purge volumes and rates, and type of sample bottles, preservatives, and filters used.

6.3.4 Chain-of-Custody Forms

A copy of each chain-of-custody form (see Figure 2) will be retained in a file for the project records for traceability in case of sample loss or delays during shipment. This file will be maintained in the field until completion of fieldwork and then will become part of the permanent project files after completion of the project. Copies received by the laboratory will also be maintained in a project file until completion of the analytical work and will then be transferred to the permanent project files.

6.3.5 Evidentiary File

The Project Manager, or designee, will maintain a project file that will include all pertinent information gathered in the course of fieldwork, such as permits obtained for access, correspondence relating to the project, completed forms, completed logbooks, software programs, training records, accident reports, and other records and files required for the permanent project file.

1. Date _____ Location _____ Site No. _____
2. Measure well-water depth and calculate volume.
 Depth to water _____ Depth of well _____ Well diameter _____
 Depth of water _____ Calculated water volume _____
3. Pump three to five bore volumes of water from well.
4. Pump type _____
5. Measure sample temperature: _____ °C Time _____ Instrument used _____
6. Measurement of conductivity: Time _____ Sample Conductivity _____ mmhos/cm
 Measurement conditions: In situ () Open container () Air exclusion ()
 Time of last calibration check _____
 Temperature of calibration standard _____ °C
 Conductivity reading of calibration standard _____ μmhos/cm
 Sample specific conductance at 25 °C _____ μmhos/cm
7. Measure pH: Time _____ Sample pH _____
 Measurement conditions: In situ () Open container () Air exclusion ()
 Time of last two-buffer calibration _____
 Buffer temperature at calibration _____ °C Buffers used _____
8. Measure Eh: Time _____ Sample Eh _____ mV
 Measurement conditions: In situ () Open container () Air exclusion ()
 Temperature of ZoBell solution _____ °C
 Eh of ZoBell solution _____ mV
9. Measure dissolved oxygen (DO): Time _____ Sample DO _____ mg/l
 Date and time of last zero check with NaSO₃ solution _____
 Atmospheric pressure _____ mmHg Altitude _____ ft
 Temperature of calibration chamber _____ °C
 DO saturation from table _____
 Correction factor _____ Calibration value _____
10. Measure alkalinity: Time _____ Total alkalinity _____ ppm as CaCO₃
 Hach Kit method: Titration cartridge _____
 Phenolphthalein alkalinity _____
11. Filter and collect samples:
 Number and type of filters used _____

Container Size	Container Type	No. Collected	Filtered		Preservative Used
			Yes	No	
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

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9/88

Figure 3. Groundwater Sample Collection Form

6.4 FIELD QUALITY CONTROL

Field duplicates will be collected at the rate of one per quarter. Equipment blanks will also be collected at the rate of one per quarter. One trip blank and two field blanks will be collected each quarter and analyzed for Target Compound List volatile organic compounds.

7.0 LABORATORY ANALYSES

The analytical parameters and methods are shown in Table 5. The analytical methods and procedures to be used are specified in the Final RI/FS Work Plan documents (Geotech, 1990b,c) and are only briefly summarized here. Methods used for analysis will be EPA Method 8260 for volatile organic compounds, EPA Method 8270 for semivolatile organic compounds, EPA Method 418.1 for total petroleum hydrocarbons, EPA Method 413.2 for oil and grease, and EPA Method 300.0 for hexavalent chromium.

7.1 LABORATORY PROCEDURES

Analytical Methods

All procedures will be checked for accuracy through internal laboratory quality-control checks, such as the running of blind duplicates, splits, and known standards. These checks are described in the *Quality Assurance Project Plan* (Volume III) for the PA/SI and RI/FS investigations of AFP 4 (Geotech, 1990c). The following sections briefly describe the analytical methods to be used for samples from AFP 4. Complete procedures for EPA methods are available in the appropriate EPA guidance documents. Procedures for Geotech methods are available in the *Geotech Analytical Chemistry Laboratory Handbook of Analytical and Sample Preparation Methods* and the *Geotech Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* manuals. Copies of the Standard Operating Procedures (SOPs) used by the subcontracted laboratory for AFP 4 sample analyses will be attached to this *Plan* after award of contract. The following section describes the analytical procedures to be used in the analysis of samples collected at AFP 4. Laboratory quality assurance will be according to Table 6.

7.1.1 Volatile Organic Compounds (Target Compound List)

Volatile organic analyses will be conducted by Geotech. The required analytical method will be EPA 8240 or 8260 (EPA SW-846, Third Edition).

7.1.2 Semi-Volatile Organic Compounds (Target Compound List)

Semi-volatile organic analyses will be subcontracted to a commercial laboratory. The required analytical method will be EPA 8270 (EPA, 1986).

7.1.3 Chromate (CrO₄)

Anion analyses will be performed on filtered water samples using Geotech Method D-3 (ion chromatography).

Table 5. Analytical Parameters and Methods

Acronym in text	Laboratory Parameters	Analytical Method
VOCs	<u>Target Compound List (TCL)</u> 1) Volatile Organic Compounds acetone benzene bromodichloromethane bromoform bromomethane 2-butanone carbon disulfide carbon tetrachloride chlorobenzene chloroethane chloroform chloromethane dibromochloromethane 1,1-dichloroethane 1,2-dichloroethane 1,1-dichloroethene 1,2-dichloroethene (total) 1,2-dichloropropane cis-1,3-dichloropropene trans-1,3-dichloropropene ethylbenzene 2-hexanone methylene chloride 4-methyl-2-pentanone styrene 1,1,2,2-tetrachloroethane tetrachloroethene toluene 1,1,1-trichloroethane 1,1,2-trichloroethane trichloroethene (TCE) vinyl acetate vinyl chloride xylenes (total)	EPA Method 624/8240 or 8260 ^a (GC/MS purge and trap) except as noted
Semi-VOCs	2) Semi-Volatile Organic Compounds acenaphthene acenaphthylene anthracene benzo(a)anthracene benzo(b)fluoranthene benzo(k)fluoranthene benzoic acid benzo(g,h,i,)perylene benzo(a)pyrene benzyl alcohol bromophenyl phenyl ether 4-chloroaniline	EPA Method 625/8270 (GC/MS extraction)

Table 5 (continued). Definition of Analytical Parameters

Acronym in text	Laboratory Parameters	Analytical Method
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2) Semi-Volatile Organics (con't)

bis(2-chloroethyl)ether
 bis(2-chloroethoxy)methane
 bis(2-chloroisopropyl) ether
 butyl benzyl phthalate
 4-chloro-3-methylphenol
 2-chloronaphthalene
 2-chlorophenol
 4-chlorophenyl phenyl ether
 chrysene
 dibenz(a,h)anthracene
 dibenzofuran
 1,2-dichlorobenzene
 1,3-dichlorobenzene
 1,4-dichlorobenzene
 3,3-dichlorobenzidine
 2,4-dichlorophenol
 diethylphthalate
 2,4-dimethylphenol
 dimethyl phthalate
 di-n-butyl phthalate
 di-n-octyl phthalate
 2,4-dinitrophenol
 4,6-dinitro-2-methylphenol
 2,4-dinitrotoluene
 2,6-dinitrotoluene
 bis(2-ethylhexyl)phthalate
 fluoranthene
 fluorene
 hexachlorobenzene
 hexachlorobutadiene
 hexachlorocyclopentadiene
 hexachloroethane
 indeno(1,2,3-c,d)pyrene
 isophorone
 2-methylnaphthalene
 2-methylphenol
 4-methylphenol
 naphthalene
 2-nitroaniline
 3-nitroaniline
 4-nitroaniline
 nitrobenzene
 2-nitrophenol
 4-nitrophenol
 n-nitroso-di-n-dipropylamine
 n-nitrosodiphenylamine
 pentachlorophenol
 phenanthrene
 phenol

Table 5 (continued). Definition of Analytical Parameters

Acronym in text	Laboratory Parameters	Analytical Method
	2) Semi-Volatile Organics (Con't) pyrene 1,2,4-trichlorobenzene 2,4,5-trichlorophenol 2,4,6-trichlorophenol	EPA Method 625/8270
	<u>Inorganics</u> chromate (hexavalent chromium)	EPA Method 300.0
TPH	<u>Total Petroleum Hydrocarbons</u>	EPA Method 418.1 (infrared spectroscopy)
O&G	<u>Oil and Grease in Water</u>	EPA Method 3550/413.2

^a EPA Method 8260 meets or exceeds EPA Method 8240 in precision and accuracy.

Table 6. Laboratory Quality Assurance Sample Types and Quantities

Sample Type	Analyte	Minimum Laboratory Quality Assurance			
		Checks	Duplicates	Blanks	Spikes
Groundwater	TCL Semi-Volatile Organics	5%	5%	5%	5%
	TCL Volatile Organics	5%	5%	5%	5%
	Chromium	5%	5%	N/A	5%
	Total Petroleum Hydrocarbons	N/A	5%	5%	N/A
	Oil and Grease	N/A	5%	5%	N/A

7.1.4 Total Petroleum Hydrocarbons

Total petroleum hydrocarbons will be analyzed by Geotech using Geotech Method CC-1 (infrared spectroscopy).

7.1.5 Oil and Grease

Oil and grease in water will be analyzed by Geotech using EPA Method 413.2.

7.2 LABORATORY QUALITY CONTROL

Internal Quality Control Checks

For subcontracted analyses, internal quality control will be performed according to EPA SW-846 (Third Edition). Although the laboratory selected will have a thorough internal QA/QC system that meets or exceeds the requirements set forth in EPA SW-846 (Third Edition), the following minimum requirements will be met.

- . A reagent blank will be prepared and analyzed to check for contamination caused by reagent preparation for each analytical run.
- . At least one matrix spike sample will be prepared and analyzed.
- . At least 1 duplicate sample analysis will be performed on each batch of samples of a similar matrix.
- . For analysis by gas chromatography/mass spectrometry (GC/MS), surrogate spike analyses will be run on all samples.

For Geotech laboratory analyses, the internal quality control will be as specified in EPA SW-846 (Third Edition) and the minimum requirements will be as follows:

7.2.1 Chromate

- . One sample for every batch will be analyzed in duplicate.
- . One check sample containing known amounts of each analyte will be analyzed for every batch.
- . A portion of 1 sample for every batch of samples will be spiked with known amounts of each analyte. Spike recoveries must be between 90 and 110 percent, unless the sample result is less than 10 times the reporting limit, in which case spike recoveries must be between 80 and 120 percent.

7.2.2 Volatiles

- . One sample for every batch of samples will be analyzed in duplicate.
- . One check sample containing known amounts of each analyte will be analyzed for every batch.

- . A portion of 1 sample for every batch of samples will be spiked with known amounts of each analyte. Spike recoveries for each compound are as specified in EPA Method 8240.

7.2.3 Total Petroleum Hydrocarbons

- . One sample for every batch of samples will be analyzed in duplicate. The duplicates will be within 20 percent of each other if the analyte concentration is greater than 5 times the reporting limit.

7.2.4 Oil and Grease

- . One sample for every batch of samples will be analyzed in duplicate. The duplicates will be within 20 percent of each other if the analyte concentration is greater than 5 times the reporting limit.

7.2.5 Duplicates

One duplicate sample will be collected each quarter and submitted blind to the laboratory.

7.2.6 Trip and Field Blanks

A minimum of one trip blank and two field blanks will be submitted to the laboratory for analysis of volatile organics.

7.2.7 Equipment Blanks

Equipment blanks will be collected at a rate of 1 per quarter for the purpose of evaluating equipment contamination in the field. The equipment blanks will be analyzed for all of the constituents.

8.0 DATA MANAGEMENT

Data collected from the various field measurement and field sampling activities will be in various forms. Portions of the data will be handwritten in field logbooks or on field data forms. Other data will be in laboratory analytical reports, and some data will automatically be transferred from laboratory instrumentation to a computer data base. A data-management system will be used to compile all the data onto a central data base. Files for each type of data will be created that will include data type, identification number (if applicable), location coordinates, and raw data. These files will then be edited as a QA check to ensure that the data were input correctly.

9.0 LOGISTICS AND SCHEDULE

9.1 LOGISTICS

9.1.1 Communication and Coordination

Coordination of the sampling activities with AFP 4 will be the responsibility of both the Project Manager and the Field Team Leader. The prime contact at General Dynamics is:

Luke D. Gilpin
Facility Engineer
General Dynamics
Facilities Engineering
P.O. Box 748, Ft. Worth, Texas 76101
(817) 777-8203

The Project Manager or Field Team Leader will be responsible for contacting the appropriate General Dynamics personnel prior to start of fieldwork to obtain the proper access to all areas, to arrange for escorts if required, or to arrange for facility support. He/she will also need to communicate any changes in scheduled activities while fieldwork is in progress to ensure that fieldwork is not hampered due to logistical problems.

Geotech will have a trailer and storage area available for use by the field team during sampling activities. The trailer will have a chest freezer and refrigerator for use in sample preparation/storage, telephone, and storage area for hazardous materials (such as acid used for sample preservation). To maintain a chain-of-custody, the trailer will be locked at all times when not occupied by Geotech personnel.

Sampling personnel are not to discuss or provide information on the sampling activities to the public or news media. Any communication outside the AFP 4 will be directed to the Project Manager or the appropriate Air Force (ASD) personnel.

9.1.2 Equipment, Supplies, and Transportation

All field equipment will be supplied by Geotech and their subcontractors. Sampling equipment and supplies will be shipped to the facility as needed and will be stored in the trailer or storage area. Vehicles used on the facility will be obtained from a rental agency. A refrigerator will be required for sample storage prior to shipment. A chest-type freezer will be required for freezing of Blue Ice®, or equivalent. Arrangements will be made to obtain these items locally.

Facilities or containers will be required for storage and disposal of small quantities of potentially hazardous waste generated during the sampling program. Arrangements will be made with General Dynamics for disposal of these wastes.

9.1.3 Field Personnel

Field personnel will be in the field for approximately five days each quarter. All personnel will be properly trained for the task assigned. The Project Manager will maintain documentation of personnel qualifications and training.

9.1.4 Laboratory Assignments

Personnel responsible for shipping samples will ship samples according to the required analyses to either the Geotech Analytical Chemistry Laboratory in Grand Junction, Colorado, or the subcontractor laboratory (subcontractor information will be supplied when available). The mailing address of the Geotech laboratory is:

Geotech
2597 B 3/4 Road
Grand Junction, CO 81503
Attn.: Ersel Reid

9.1.5 Sample Shipments

Due to the short holding times associated with many of the samples, shipments will be made on a daily basis, when possible or required, using an overnight or priority-mail delivery service.

9.2 SCHEDULE

Normally, the schedule for quarterly monitoring would be October, January, April, and July. Because of delays, the proposed schedule will be as follows: December 1990, March, June, and September, 1991. Each round of sampling is anticipated to be approximately 5 days in duration. Analytical results will be obtained no later than two months after sample collection.

10.0 HEALTH AND SAFETY

The *Health and Safety Plan* (Volume IV) that accompanies the final RI/FS Work Plan (Geotech, 1990d), will be enforced for field work at the AFP 4 site. The *Health and Safety Plan* is a comprehensive plan that describes the health and safety responsibilities of Geotech personnel, defines the procedures to be used, establishes protective equipment requirements, describes potential contaminants and their exposure limits, describes plans for emergency response, and provides guidance for spill cleanup and abatement.

To ensure that field personnel understand the health and safety requirements and are aware of the potential health and safety hazards for each site, the Field Manager or their designee will conduct a daily health and safety briefing.

All personnel will have received the 40-Hour Hazardous Waste Site Safety Training Course.

11.0 DELIVERABLES

A letter report will be prepared approximately two months after each round of sampling that briefly summarizes the results and significance of the findings for each round. A yearly summary of monitoring results will be prepared in a data report to be submitted no later than two months after the last round of sampling. Recommendations for FY 1992 monitoring will be included. This monitoring plan will be updated and modified as necessary.

12.0 REFERENCES

- Geotech, Inc., 1990a. *Air Force Plant 4 Preliminary Assessment/Site Inspection and Remedial Investigations/Feasibility Studies, Volume I, Final Work Plan.*
- _____, 1990b. *Air Force Plant 4 Preliminary Assessment/Site Inspection and Remedial Investigations/Feasibility Studies, Volume II, Final Sampling and Analysis Plan.*
- _____, 1990c. *Air Force Plant 4 Preliminary Assessment/Site Inspection and Remedial Investigations/Feasibility Studies, Volume III, Final Quality Assurance Project Plan.*
- _____, 1990d. *Air Force Plant 4 Preliminary Assessment/Site Inspection and Remedial Investigations/Feasibility Studies, Volume IV, Final Health and Safety Plan.*
- Hargis + Associates, 1989a. *Water Quality Data, May 1987 through January 1989. U.S. Air Force Plant No. 4, Fort Worth, Texas. April 20, 1989.*
- _____, 1989b. *Annual Hydrologic Monitoring Plan, U.S. Air Force Plant No. 4, Fort Worth, Texas. July 19, 1989.*
- U. S. Environmental Protection Agency, 1986. *Test Methods for Evaluating Solid Waste, SW-846, Third Edition, November 1986.*

DRAFT

APPENDIX A

Individual Summaries of Well Data

EVALUATION OF EXISTING WELLS AT AIR FORCE PLANT 4, FORT WORTH, TEXAS

FSA3-1 (quarterly); free product, not cemented to surface (no surface seal).
Discontinue monitoring.

FSA3-3 (quarterly); free product, not cemented to surface (no surface seal).
Discontinue monitoring.

FSA3-6 (quarterly); free product, not cemented to surface (no surface seal).
Discontinue monitoring.

FSA3-7 (quarterly); free product, not cemented to surface (no surface seal).
Discontinue monitoring.

FSA3-10 (quarterly); free product, not cemented to surface (no surface seal).
Discontinue monitoring.

FSA3-12 (quarterly); free product, not cemented to surface (no surface seal).
Discontinue monitoring.

F-200 (annually); ethyl benzene (2 ppb), toluene (20); triloc. Couldn't see floating product if present (water level fluctuates above top of screen). Well constructed monitoring well. Keep; discontinue routine monitoring.

F-201 (quarterly); floating product; in area fenced off with concertina wire; drilled in 1986. O.K. monitoring well, but is in limited access area.

Recommendation: Discontinue monitoring. Well is constructed O.K. but has floating product and is in new area that has limited access and would need special permission to enter.

F-202 (quarterly); floating product, TCE. O.K. well construction. Do not aquifer test.

Recommendation: Well is constructed O.K., but discontinue monitoring due to floating product.

F-203 (quarterly); floating product; TCE, DCE, drilled 2/25/86; CD = 31.2' (1.4' above top of Walnut); 15' screen in gravel, sand, with 3.3' sand/gravel pack. Water table is screened.

Recommendation: Keep well (good construction). Priority III for monitoring. Check for presence of floating product. Do not sample if floating product present. Good well for aquifer test (except for floating product).

F-204 (semiannually); floating product, benzene; drilled 2/25/86; good construction. Completed with 10' screen in gravel and clay. Don't aquifer test. Contamination (fuel) was already present in gravel when drilled.

Recommendation: Keep well (good construction). Check for presence of floating product. Do not sample if floating product present. Priority III for monitoring. Do not aquifer test.

F-205 (semiannually); floating product, benzene (B), toluene (T), ethylbenzene (E); drilled 1986. Well-constructed monitoring well, bottom of screen is 0.5' into Walnut. 15' screen in gravel, gravelly silt, silty sand.

Recommendation: Good monitoring well, but discontinue monitoring due to presence of floating product. Continue to record product and water levels. Good well to aquifer test (except for floating product).

F-206 (semiannually); floating product, BTE, 4" PVC, CD = 30.0' (just into shale [Goodland?]). Screened interval is 15 - 30', sand pack extends 2' above. Bentonite seal, then cemented to surface. Is a well constructed monitoring well.

Recommendation: Good monitoring well and slug-withdrawal test well (except for floating product). Discontinue monitoring on routine basis due to presence of floating product.

F-207 (semiannually); 1,1,1 trichloroethane (4,200 ppb), 1,1-DCE (3,200 ppb), 1,2-DCE (4,900), TCE (65 ppb), 1,1-DCA (47 ppb), benzene (63 ppb), oil and grease (0.2 mg/L), and chromium (0.03 mg/L). 15' screen interval and additional 1.3' sand pack in sand. Grouted from surface to 18.2'. Continue to monitor (priority I).

F-208 (annually); toluene (5 ppb); triloc. Well constructed. Keep. Will be sampled during RI/FS field investigations.

F-209 (quarterly); floating product; good well construction. Priority III for monitoring if no floating product present.

F-210 (quarterly); floating product, TCE; good well construction. Would be good well for aquifer test, except for free product.

Recommendation: Discontinue monitoring due to floating product.

F-211 (annually), E. of LF1; DCE (54 ppb), TCE (2,100), 1,1,1-TCA (20), benzene (38), Cr. Triloc. O.K. construction. Keep. Priority II for monitoring.

F-212 (annually); clean, triloc; some discrepancies between driller information and completion diagram. Keep. Discontinue monitoring.

F-213 (semiannually); DCE (2 ppb), TCE (3), toluene (11); CD = 11'. Downgradient of FDTA No. 2; 4.5' screen in Walnut (0.5'), sand and gravel (1.5'), sandy clay (2.5'). Sand pack extends additional 2.5' in sandy clay. Bentonite and cement to surface through fill. Do not aquifer test. OK well construction. Priority II for monitoring.

F-214 (semiannually); floating product, drilled in 1986.

Problem: Suspect solvents at base of drill hole, but the screened interval and end plug are slightly too high to detect sinking product. Hnu readings were very high (400 ppm) below 17.5', but bottom of screened interval is 17.5' with a 0.5' end cap.

Recommendation: Discontinue monitoring. Drill a new well nearby to capture sinking product if present.

F-215 (annually); upgradient of Landfill No. 1. General Dynamics has agreed to obtain a copy of the lithologic log and the completion diagram, neither of which appear in any previous reports. TCE (1,500 ppb), TCA (150 ppb), DCE (240), oil and grease (0.3 mg/L), chromium (0.14 mg/L). Priority I for monitoring if the well is properly completed.

F-216 (semiannually), clean?, completed in 9/86. Casing depth (CD) = 25' (just above [0.4'] Walnut), 15' screen in gravelly sand (6'), clayey silt (2'), sand (2'), and clayey silt. Gravel pack extends 1.5' above top of screen, surface seal.

Recommendation: O.K. well. Priority III for monitoring.

F-217 (monthly), triloc; contaminated with TCE (2,600 ppb), DCE (7,800 ppb), vinyl chloride (2,400 ppb), chlorobenzene (210 ppb), 1,1,1-TCA (190 ppb), benzene (56 ppb); locking cap. CD = 17.5' (0.5' into Walnut), 5' screened interval with 4.5' additional sand pack; surface seal; 4" PVC. One of the better designed monitoring wells on site.

Recommendation: Good well, priority III for monitoring.

F-218 (semiannually); DCE (370 - 700 ppb), TCE (8,400 - 11,000); chromium (0.16 mg/l), oil and grease (0.7 mg/l); drilled in 1986. Building perimeter. BTH = 36' (1.5' into Walnut), CD = 32'. Screen is 14.5' in Goodland (4'), clayey silt (1.5'), sand and gravel (0.5'), clayey silt (1.5'), sand and gravel (0.5'), and clayey silt (6.5'); sand pack extends additional 1.5'. Has bentonite (2'), then cement/bentonite grout to surface (14'). Do not aquifer test. Appears to already have had contamination from 32 - 33' (not screened) in the Goodland during drilling (Hnu 1-6 ppm). Priority II for monitoring.

F-219 (semiannually); TCE (55 ppb), drilled in 1986. CD = 34', 14.5' screened in shaley clay. Sand pack extends additional 1' down into top of Walnut and up 3' into shale (Goodland Formation). 3' bentonite seal, then cement/bentonite to surface (13.5'). Good well construction. Good well for aquifer test (already done). Priority II for monitoring.

F-220 (semiannually); TCE (220,000 ppb), 1,1,1-TCA (300,000 ppb), 1,2-DCE (3,500 ppb); oil and grease (20 mg/L), total petroleum hydrocarbons (15 mg/L), chromium (0.56 mg/L), cyanide (2.7 mg/L); 4" PVC; drilled in 1986. Well-completed monitoring well. Drilled 2.5' into Walnut, screened from Walnut through basal gravels and sand (high Hnu readings; up to 30 ppm) and into overlying clay. Sand pack extends additional 3.5' and grouted to surface. Next to new chemical processing building area, but won't be affected.

Recommendation: Good monitoring well. Will be sampled during RI/FS field investigations. Keep well. Do not aquifer test as it is completed in limestone, gravel, sand, and clay.

F-221 (annually); DCE and TCE (10 ppb); bailer. Boundary well, upgradient of AFP 4 site. Keep; good monitoring well construction. Priority II for monitoring because soil appears contaminated, but groundwater isn't; also because it's a boundary well.

F-222 (quarterly); floating product, TCE (62 ppb), benzene (680), ethylbenzene (170); boundary well. 10' screen extends from top of Walnut into sand, clay, and fill. O.K. well construction. Priority III for monitoring.

F-223 (quarterly); floating product, toluene (200 ppb), benzene (600) ethylbenzene (1,800). Good well construction. Priority III for monitoring.

HM-2 (not in H+A monitoring plan); clean. Let GD decide whether to abandon or save. Save if it is in a location which is easy to save. Otherwise, abandon. Sand/gravel pack extends from 4' to 34.6', with a screened interval from 24.6 - 34.6'. Drilled just below top of Walnut. Worthless as monitoring well. Discontinue monitoring.

HM-5 (not in H+A monitoring plan); clean; boundary well; Landfill No. 4; 4" PVC; triloc. CD = 31.8'; 10' screen in Walnut (~6.5') and gravelly clay (~3.5'). Filter pack extends additional 10.8' in gravelly clay, sand lens (1'), and sandy clay. 4' bentonite seal through sandy clay and 7' cement seal to surface through fill. Water level fluctuates entirely above top of screen. Could not find LNAPL if present. OK well. Priority III for monitoring.

HM-7 (monthly), contaminated with solvents, fuel, oil/grease; dedicated bailer. Casing depth = 14.5'. Sampled since 1982, samples gravelly sand and fill.

Problem: Sand/gravel pack does not extend above top of screen. Bentonite pellets placed 0.5' below top of screen.

Recommendation: Check for sinking/floating product. Priority III for monitoring.

HM-9 (not in H+A monitoring plan); clean; boundary well; downgradient edge of Landfill No. 4; 4" PVC; bailer. CD = 4.8'; 2' screen in Walnut (0.8') and fill (1.2'). Top of gravel pack is 0.2' below top of screen. 0.8' bentonite seal extends 0.2' into screen. Cement seal to surface (2'). Priority III for monitoring.

HM-10 (quarterly), 1,1,1-TCA (690 ppb), DCE (520 ppb), TCE (53 ppb), DCA (7 ppb), acenaphthene (52 ppb), diethyl phthalate (52 ppb), di-n-butyl phthalate (213 ppb), di-n-octyl phthalate (5 ppb); triloc, casing depth = 21.5'; 10' screened interval with 4' additional gravel pack. Sampled since 1982. Samples gravelly sand and fill. Check for sinkers and floaters and dissolved constituents.

Recommendation: Good well. Continue to monitor (priority I). Check for sinkers.

- HM-11 (annually); DCE (69 ppb), TCE (130), PCE (7). Boundary well; has hand pump. Poorly designed well. 10' screen with additional 20' filter pack through shale, limestone, clay, shaley clay, clayey shale. Discontinue monitoring. Possibly abandon (priority III) if becomes contaminated. Can't find floating product if present.
- HM-12 (annually); DCE (1 ppb), TCE (7), toluene (3). Boundary well. Triloc. Poorly constructed monitoring well. 10' screen with additional 20' of filter pack through clay, shale, and limestone. Discontinue monitoring. Could not find floating product if present. Possibly abandon (priority III) if becomes contaminated.
- HM-13 (annually); clean. Bailer. Boundary well, upgradient of AFP 4. Will be affected by widening of Clifford Ave. Needs to be flush mounted. Screened to find floating product. 10' screen with additional 14' filter pack in gravel and sand. O.K. construction due to lithology. Keep. Priority III for monitoring because it's a boundary well.
- HM-14 (annually); clean except nickel found once above detection limit; submersible pump (galvanized pipe). Boundary well. Will be affected by widening of Clifford Ave. Need to flush mount and remove galvanized pipe. Poorly designed monitoring well. 10' screen with additional 21.5' sand/gravel pack in clayey sand, silty sandy clay, silty clayey sand and sandy clay. Will be sampled during RI/FS field investigations. Discontinue monitoring after RI/FS sampling completed.
- HM-15 (annually); TCE (2,600 ppb). Bailer. Poorly designed monitoring well. 10' screen in gravel/silty sand interbeds, then additional 18' sand/gravel pack through clay. Creates vertical conduit. Discontinue monitoring. Not clear how bottom 16' of hole (below screen) was completed. Backfilled?
- HM-16 (semiannually); solvents, fuel, oil; 4" PVC, triloc; drilled in 1983. Will be affected by new chemical processing building and parking lot. CD = 47.2' (2' into Walnut) with 10' screen (8' in overlying shale), but has sand/gravel pack for 42'. Acts as conduit for downward migration of contaminants into Goodland limestone, shale, and Walnut. Very poor monitoring well construction.
- Recommendation: Abandon well (priority I) as it is poorly constructed, acts as a conduit for downward migration of contaminants through the Goodland limestone and shale into Walnut, and is in the area that will be affected by construction of the new chemical processing facility. Do not aquifer test (clay, gravel, silt, sand, limestone, shale).
- HM-17 (annually); DCE (440 ppb), TCE (8,100), triloc. Poorly designed monitoring well. 10' screen in shale with additional 20' sand/gravel pack in limestone/shale, gravel/silty sand, and fill. Discontinue routine monitoring. Consider replacing with properly constructed monitoring well. Can't detect floating product.

HM-18 (annually); Clean; triloc; poorly constructed monitoring well. 10' screen in Walnut (4') and gravel (6'), with additional 21' filter pack in gravel, sand, silty sand, sandy silt, and fill. Discontinue monitoring.

HM-19 (quarterly), solvents; triloc; 4" PVC. CD = 24'; 10' screened interval with additional 8' sand/gravel pack. Sampling from fill, sand, Goodland (2'), and 6' Walnut. Sampling interval is too long.

Recommendation: Suggest discontinue monitoring. Do not slug test.

HM-20 (quarterly); DCE (270 ppb), TCE (1,500 ppb), 1,1,1 trichloroethane (780 ppb). 10' screen and additional 27' sand/gravel pack in sand and gravel.

Problem: Bottom 1' of fill not sealed. Discontinue monitoring.

HM-21 (monthly), dedicated bailer; high solvents [trans-DCE (49,000 ppb), vinyl chloride (6,900), TCE (2,900)]; toluene (220), chlorobenzene (250), chloroform (290); oil and grease. CD = 14'; 10' screen. A poorly designed well. Screened interval is entirely in Walnut! Filter pack extends 1.2 ft. into fill, so it is not clear where contaminants are coming from (either fill or Walnut). Most likely, contaminants come from fill and can travel down the filter pack into the screened interval. Could be causing contamination of Walnut. Sampled since 1983. Possibly abandon (priority III).

HM-23 (annually); clean; submersible. Boundary well. O.K. construction, not great. 9' screen in Walnut (5') and clayey sandy gravel (4'), with additional 31' filter pack in gravel (1'), sand and gravel (16'), silty clay (14'). Discontinue monitoring.

HM-24 (annually); chloroform (49 ppb); soil had chemical odor from 12-24'; submersible, poorly constructed well. CD = TD = 42.5'. 10' screen in Walnut shale, and clayey shale; has additional 27' filter pack in shale, clay, limestone, gravel, sand, silt, and clay. Will be sampled during RI/FS field investigations. Discontinue monitoring after RI/FS sampling completed; possibly abandon (priority III); creates vertical conduit for contaminants to move into Walnut.

HM-25 (semiannually); solvents, floating product (fuel), oil and grease; drilled in 1983; boundary well; triloc, 4" PVC. TD = 42', CD = 39.3'. During drilling of this well, there were strong odors of "vinyl", "paint thinner", and "chemicals" in all materials from the surface fill through silty sandy clay, sandy clayey silt, sandy gravelly clay, and sand and gravel. The odors decreased in the Goodland limestone (24 - 32' deep). There did not appear to be a chemical odor in the underlying shale or Walnut (34 - 42'). The screened interval extends from 30' to 39.3' (Walnut, shale, Goodland limestone), but the sand pack extends to 5' depth. The well can now act as a conduit for downward migration of contaminants past the Goodland limestone into the underlying shale and Walnut Formation.

Recommendation: Although this is the only well in FDTA No. 5, it appears to have been a conduit for downward migration of contaminants into the Walnut. It is poorly completed with an excessive sand pack (34.3') through surface contaminated zones. However, it is the only monitoring well in FDTA No. 5 and it is a boundary well. Has floating product. Should be abandoned (priority II) at some point. Discontinue monitoring.

HM-26 (semiannually), boundary well; solvents [TCA (220 ppb) and others], oil and grease, hand pump, drilled in 1983. CD = 15' (7' in Walnut, rest in sand and gravel).

Problems: Top 0.3' screen is in bentonite pellets and water table fluctuates here. Would change pH and create questionable water quality. 7' of 10' screen is in Walnut.

Recommendation: Similar to HM-21. Screen is in bentonite where water table is. Questionable water quality. Discontinue monitoring because it's not clear where contamination is coming from (Walnut or sand and gravel), and assess whether well is causing contamination of Walnut. Maybe should be abandoned (priority III) and a new 9' well drilled nearby. Do not aquifer test.

HM-27 (semiannually), solvents, fuel, oil and grease; drilled in 1983. CD = 14.2'; 9' screen with 4' in Walnut and 5' in sand and gravel. Bentonite pellets extend deeper than top of screen where water table is. Drilled through zone saturated with fuel/oil at 2' to 4'. Top of sampling interval is 5'.

Recommendations: Do not aquifer test. Water quality is questionable due to bentonite in screen where water table is. Discontinue monitoring. Is a boundary well. Consider abandoning later (priority III) if there is serious problems with downward migration of contaminants into Walnut (4') along the borehole annulus.

HM-28 (semiannually); floating product, solvents, oil and grease; 4" PVC, triloc; drilled in 1983; poorly constructed monitoring well. CD = 41.3'; 10' screened interval in Walnut (5') and clay/shale (Goodland 5'); sand/gravel pack extends an additional 27' through sand, gravel, clay, silt, and into fill.

Recommendation: Discontinue monitoring due to poor completion (long sand/gravel pack), and floating product.

HM-29 (semiannually); DCE (30 ppb), TCE (2,100), 1,1,1 trichloroethane (11). Do not aquifer test. 9.3' screen in Walnut (4'), sand and gravel (5'), and 0.5' in sandy gravelly clay. Is sand/filter packed an additional 25.5' in clay, silty sand, and sandy silt. Is surface sealed through upper fill. Discontinue routine monitoring. Abandon (priority III) if water quality gets significantly worse. Creates conduit through silty clay layer for downward migration of contaminants.

HM-30 (annually); TCE (2100 ppb), toluene (2), chromium (0.03 mg/L); triloc. Can't detect floating product. 9' screen in Walnut, shale, and clay. Has

additional 38' gravel pack in clay, sand and gravel, silt, and sand. Poorly constructed monitoring well. Discontinue monitoring. Perhaps abandon (priority III) .

HM-31 (semiannually); vinyl chloride (28 ppb), DCE (1000), TCE (2,900); drilled in 1983, boundary well; CD = 40.1 ft. 9.3' screen interval in Walnut (4') and shale/limestone (5'). Excessive sand/gravel pack extends an additional 24.3' through shale, limestone, clay, clayey sand and gravel, and silty clay. Sealed through upper fill with bentonite (3') and cement (3.5'). Creates vertical pathway for downward migration of contaminants through otherwise relatively impermeable layers. Abandon (priority III) and drill new multiple-level well nearby.

HM-33 (not in H+A monitoring plan); clean; boundary well; only well in EDTA No. 3; 2" PVC; bailer. TD = 28'. CD = 26.6'; 10.6' screen in Walnut (3.6'), Goodland (3'), clay (2') and fill (2'). Uncertain whether filter pack used. Uncertain completion for additional 11' through fill. Bentonite seal (2') and cement seal to surface (3'). Do not monitor or aquifer test. Poor monitoring well design and completion records.

HM-36 (annually); trace DCE (2 ppb), TCE (2); Cr. Boundary well. Uncertain completion details. CD = 15.6'. 5' screen in Walnut (3.6') and sandy gravel (1.4'). Uncertain completion for 6' in sand, gravel, clay. Keep. Priority III for monitoring.

HM-37 (semiannually), solvents, oil and grease, 2" PVC, drilled in 1984. CD = 10.5', screened interval = 5.5' - 10.5'; (7' = Top of Walnut).

Problem: It is unclear whether there are cuttings or a sand/gravel pack around the screen (report text says filter pack, table in same report says no filter pack).

Recommendation: Discontinue monitoring due to uncertainty in whether there is a sand/gravel pack or not. Do not aquifer test because it is completed in Walnut, sandy clay, and clayey gravel. Well is potential pathway for contamination of Walnut.

HM-38 (semiannually), solvents, free product (fuel); drilled in 1984; 2" PVC. CD = 19.6', 10' screen in clayey sand and gravel, silty sand, and fill (5.5').

Problem: Unclear whether drill cuttings or sand/gravel used around screen.

Recommendation: Discontinue monitoring. Do not aquifer test or sample. Due to presence of free floating product, can't get uncontaminated water sample.

HM-39 (semiannually), solvents, oil and grease; 2" PVC, drilled in 1984. CD = 14', screen = 10' (7' in Walnut, 3' in silty clayey sand).

Problem: Unclear whether drill cuttings or sand/gravel used around screen. Bentonite in screen.

Recommendation: Discontinue monitoring.

- HM-40 (not in H+A monitoring plan); clean; located in Radar Range, SE of Landfill No. 2, south of new Chemical Processing building construction; 2" PVC; bailer. TD = 53' (4' into Walnut). Uncertain how bottom 7' of hole was completed. CD = 46'. Monitoring well screen is above the 3' basal gravel layer. 10' screen in sand (4'), sand/silt (4'), and sand (2'). Uncertain whether filter pack used. Uncertain completion for 33.5' in sand and silty/sandy clay. Bentonite seal (1') in clay; cement seal (1.5') in clay to surface. Poor monitoring well design. Do not monitor.
- HM-41 (annually); clean, TCE (12 ppb); 2" bailer. Will be affected by new chemical processing building. CD = 45.9'. 10' screen in Walnut (5'), gravel (3'), sandy silty clay (2'). Uncertain completion details for next 28' through clay, sand, silt. Flush mount if possible, drill new well if have to abandon. Priority III for monitoring.
- HM-42; (semiannually); fuel, oil and grease, Cr. Let GD decide whether to abandon or not, as above. Not clear whether it was backfilled or has sand gravel pack to 5 feet below surface. Screened interval is 36.2 - 46.2'. Drilled to just below top of Walnut. Worthless as monitoring well. Discontinue monitoring.
- HM-46 (semiannually); new chemical process building area; clean; discontinue monitoring. Much uncertainty as to screened interval and sand/gravel pack existence. The completion table shows a 1' screen but suspect it is 10'. The report table shows no pea gravel or sand used, the text says it was used for all wells covered in the report. Drilled to 43.4', just below top of Walnut; has 2" PVC. Let GD decide whether to abandon or protect during construction. Due to confusion, discontinue monitoring.
- HM-47 (semiannually); solvents (DCE, TCE); drilled 1984; 4" PVC; hand pump; poor monitor well design. 10' screen sits 8.5' above bottom of hole. Solvents will collect in that, so can't sample DNAPLs. Screened in sand and gravel but sand packed for additional 9.5' into clayey silt. No other wells in area, so keep well. Discontinue monitoring unless there is a need for data in this area.
- HM-48 (annually); DCE (1 ppb), TCE(93), chloroform (12). Submersible pump; water level fluctuates above top of screen (can't detect LNAPLs). TD = 33', CD = 27.5'. Not clear how bottom 5.5' of hole completed. Won't detect DNAPLs. 10' screen in Goodland limestone/shale. Additional 9.5' filter pack in Goodland (0.5'), clayey sand and gravel (7'), and silty sandy clay (2'). Bentonite seal and cement surface seal through sand and gravel and fill. Not great monitoring well construction; but O.K. Discontinue routine monitoring.
- HM-49 (annually); clean; DCE (10 ppb), TCE (2); triloc; Uncertain well completion (don't have data on filter pack. Report says filter packed, table says not). CD = 10.4'; 5.5' screen in Walnut (4.4'), and clay (1.1'). Bentonite and cement through clay and fill. O.K. well construction. Keep. Discontinue routine monitoring.

HM-50 (semiannually); solvents, vinyl chloride (660 ppb), DCE (2,000), TCE (170); fuel; 2" PVC, triloc, drilled in 1984; CD = 14.0', 10' screen in Walnut (7'), and fill (3'); unclear whether sand/gravel was used as filter pack. Do not aquifer test. Hargis + Associates suggested monitoring to check effectiveness of French Drains. Suggest discontinuing monitoring.

HM-51 (semiannually); DCE (120,000 ppb), methylene chloride (200,000), TCE (340,000 ppb), 1,2-DCA (40,000), toluene (58,000 ppb), chloroform (6,000 ppb); triloc, 4" PVC; drilled in 1984; suspect presence of solvent-related free product.

Recommendation: Well design is good, but a lot of data exist from this well. Priority III for monitoring because it is the only well in FDTA2.

HM-52 (annually); DCE (1 ppb), TCE (42), PCE (2), chloroform (4); triloc. TD = 26'. CD = 23.3'. Uncertain how bottom 2.7' of hole completed in Goodland limestone/shale. 10' screen in Goodland limestone/shale (5.3'), and sand and gravel (4.7'). Additional 8.3' in sand and gravel. Bentonite and cement seal through sand and fill. O.K. construction. Do not aquifer test. Keep.

HM-53 (quarterly); solvents [methylene chloride (12 ppb); TCE (800)]; fuel [toluene (24), benzene (780), ethylbenzene (56)]; hand-pump. CD = 35.4', 10' screen in Walnut (3'), Goodland (1'), sand and gravel (6'). Additional 18.9' sand/gravel pack through sand and gravel. Bentonite and cement through surface fill. Although excessive filter pack, the construction is o.k. as it goes through sand and gravel anyway. Priority III for monitoring.

HM-56 (semiannually); DCE (6 ppb), toluene (53), benzene (280), ethylbenzene (18); drilled in 1984. CD = BTH = 40'; 10' screen in Walnut (5') and Goodland (5'). Not clear whether sand/gravel pack exists from 40 - 7.5' through 22.5' additional sandy clay/clayey sand, sandy silty clay, silty clay. Appears contaminants already were at area of water table fluctuation (25 - 23.5') during drilling ("strong solvent odor" "strong fuel odor"). Well is not screened to pick up LNAPLs (top of screen is 5 - 7.5' below water table). Excessive filter pack? Priority III for monitoring.

HM-57 (annually); (East Parking Lot); bailer. Large water-level fluctuations. Related to water main leak (potable water supply or fire suppression line)? TD = CD = 39'; 10' screen in Walnut (5'), silty clay (5'). Uncertain if filter pack was used for next 23.6' (report says it was, table says it wasn't) through clay, limestone, shale. Has bentonite and cement seals through fill and part of Goodland. Water level fluctuates entirely above top of screen (can't detect LNAPLs). Keep. Discontinue routine monitoring. Poor monitoring well construction.

HM-59 (annually); (Northern E.P.L.), TCE (9 ppb), PCE (34), toluene (5); triloc; TD = 39'; CD = 38'. 10' screen in Walnut (3'), clayey shale (7'). Uncertain whether filter pack or backfill used for next 23' through shale, limestone, and clay (report says filter pack used on all wells; completion

- table in same report shows none used.) Bentonite and cement through fill. Poor monitoring well construction. Couldn't find LNAPLs because water level fluctuates entirely above screen. O.K. to aquifer text for lumped hydraulic conductivity of Goodland limestone, shale, and clay. Creates vertical conduit through lower transmissivity layers. Discontinue routine monitoring. Possibly abandon (priority III) if becomes contaminated.
- HM-60 (semiannually); TCE (850 ppb), chromium (0.01 mg/l), drilled in 1984. TD = CD = 36'; 10' screen in Walnut (4'), Goodland (2'), sand and clay (2'), clayey gravel (2'). Uncertain whether sand/gravel pack exists between bottom of the hole (BTH) and bottom of surface seal (4.5'), which is an additional (21.5'). OK construction because hole was drilled in gravels mostly. Discontinue routine monitoring.
- HM-62 (semiannually); solvents; TCE (3 ppb), toluene (1), 1,1,1 trichloroethane (10); drilled in 1984. 2" PVC, triloc. Uncertain completion details. CD = 39'. 10' screen in Walnut (6'), gravel (3'), silt/sand (1'). Uncertain sand/gravel interval (no record). Discontinue monitoring.
- HM-63 (quarterly); vinyl chloride (350 ppb), DCE (860), TCE (760), toluene (48), benzene (470), ethylbenzene (390). Monitors water quality downgradient of aboveground fuel storage tank. Uncertain completion. No details on sand/gravel pack. 10' screen in Walnut (4'), Goodland (4'), sand and gravel (2'). Completion uncertain for 23' through sand and gravel, sandy gravelly clay, and silty sand. Priority III for monitoring.
- HM-64 (semiannually); DCE (2 ppb), TCE (64), PCE (380), CD = 32'; 10' screen in Goodland (2'), gravelly sand (8'). Not clear whether sand/gravel pack was used from 4.8' to 32' (27.2' total) through clay and sand. Upper fill (0-4') had strong solvent or fuel odor. Well acts as vertical conduit to aid in transport of contaminants. Discontinue monitoring and consider abandoning (priority III).
- HM-65 (annually); PCE (2 ppb), toluene (1); triloc; strong solvent odor, greasy texture in top 3' of borehole. TD = 18'. CD = 16.1'; 10' screen in shell agglomerate (6') and Goodland limey shale, clay (4'). Bentonite in contact with top 0.4' of screen. Bentonite and cement seals through surface contamination. Water level ranges from near the top of screen to mostly above the top of screen (unlikely to find LNAPLs). Unclear how bottom 2' of hole completed (unlikely to find DNAPLs). OK to aquifer test for Goodland hydraulic conductivity. Keep well. Bentonite in screen may affect pH and water quality.
- HM-66 (semiannually); TCE (61), toluene (13); drilled in 1985. CD = 20.2'; 10' screen in Walnut (3'), Goodland (7') with additional 3.6' sand/gravel pack in Goodland. Sealed to surface. Good design. Could aquifer test for Goodland hydraulic conductivity. Priority III for monitoring.
- HM-68 (annually); southernmost well on Grants Lane; DCE (2 ppb), TCE (15), Cr? Bailer. TD = 37'; CD = 34.5'. Unclear how bottom 2.5' completed. 20' screen in shell agglomerate (3.5'), limestone (5'), clayey gravel (11.5'). Filter pack for additional 8.5' through sandy gravelly clay and sandy silty clay. Has bentonite and cement seals through fill. Poorly designed

monitoring well. Excessive screen and filter pack. Do not aquifer test. Creates vertical conduit to Walnut. Discontinue routine monitoring. Possibly abandon (priority III) in future if water quality deteriorates.

- HM-69 (annually); DCE (8 ppb), TCE (11), Cr?; triloc. TD = 38'; CD = 37'. 10' screen in limestone (5') and calcareous shale (5'). Additional 23.5' filter pack in shale (1'), Goodland shale (16'), gravel (6'), and fill (0.5'). Water level fluctuates entirely above top of screen -- couldn't find LNAPLs if present. Was aquifer tested but not a good well to test. Creates vertical conduit through mostly relatively low hydraulic conductivity layers. Bentonite and cement seals. Discontinue routine monitoring. Possibly abandon (priority III) as it may create conduit at a later time for contamination of Walnut.
- HM-70 (semiannually); solvents: DCE (14 ppb), TCE (9,900), chloroform (1); Cr; poor but O.K. monitoring well construction. CD = 46.1'; 10' screen in limestone (Walnut), clayey shale, and shaley clay (Goodland). Sand/gravel pack extends additional 30' through clay. Could be a pathway for TCE to migrate downward. Discontinue monitoring. Consider abandoning (priority III) if not too costly.
- HM-71 (semiannually); DCE (19 ppb), TCE (990), PCE (85); Walnut is at least 9.5' thick in this area. Drilled 9.5' into Walnut, but screen and filter pack start 14' above bottom of hole. Not clear whether bottom of hole was grouted because nothing is mentioned. There is a 10' screen with an additional 30' sand/gravel pack in a silty clay. Is a conduit for vertical migration. Priority III for monitoring. If water quality gets worse, well should be abandoned (priority III).
- HM-72 (annually); clean, triloc; only well in this vicinity. CD = 39.9'. 10' screen through Walnut limestone (3.9'), sandy shale (6'), and shaley clay (0.1'). Additional 23.4' of filter pack through shaley clay (3.9') and clay (19.5'). Bentonite and cement through rest of clay and fill. Water level fluctuates entirely above the screen. Couldn't find LNAPLs if present. Excessive filter pack. Creates vertical conduit through low permeability materials. Keep well, as it is only well in this area. Possibly abandon (priority III) if surface plumes move close to well.
- HM-75 (not in H+A recent monitoring program); clean; upgradient of FSA No. 2 and near south end of solvent lines; drilled 1/9/85. Poor monitoring well construction. TD = CD = 30.3'; 10' screen in Walnut (8'), Goodland (2'). Additional 15.5' filter pack through Goodland (silty clay). Bentonite and cement seal to surface. Do not monitor.
- HM-76 (annually); toluene (2 ppb); triloc TD = CD = 34.3'. 10' screen in Walnut. Additional 19.5' in Goodland (7.5') and fill (12'). Bentonite and cement seals to surface. Water level fluctuates entirely above top of screen (couldn't find LNAPLs). Not great well construction. Keep. Do not aquifer test.
- HM-77 (annually); TCE (10 ppb); triloc. TD = 35', CD = 33.8'; 10' screen in Walnut (3.8') and gravel (6.2'). Additional 17.3' filter pack in gravel (7') and silty clay (10.3'). Cement and bentonite seals to surface. Do not aquifer test. Excessive filter pack. Poorly designed monitoring

well. Water level sometimes above top of screen. Keep. Discontinue routine monitoring.

HM-78 (quarterly); floating product; construction not great. Screened interval (10'-long) is 2' in sandy clay, 4' in gravel and 4' in Walnut. Sand/gravel pack extends for an additional 14' through sandy clay into the surface silty clay. Provides a conduit for migration of contaminants.

Recommendation: Discontinue monitoring. Has floating product and was poorly constructed.

HM-79 (semiannually); DCE (1 ppb), TCE (60), PCE (12), toluene (1); MEK (20), toluene (1), trichlorofluoromethane (1). Poor monitoring well construction: CD = 40.9'; 10' screen in Walnut (4'), gravel (3'), shaley clay (3'); sand/gravel pack extends additional 25' in shaley clay and silty clay to within 6' of surface. Discontinue routine monitoring.

HM-82 (semiannually); DCE (2000 ppb), TCE (25,000), well is midway between P-14U and P-14US to the south, and P-16US to the north. Thickness of Walnut thins to the north (top surface of Walnut eroded). At P-14 wells the Walnut is 7.5 to 6.6' thick and top of the Walnut is at 593.6' and 593'. At P-16US, the Walnut is only 1.5' thick and the top of the Walnut is at 587.3'. HM-82 was drilled to within a few feet of the Walnut (596.3') and then completed with a 43.4' sand/gravel pack (in natural silty clay) to within 7' of the ground surface. This well should be abandoned (priority I) as it is contaminated with solvents (DCE and TCE) and the 43.3' sand/gravel pack acts as a conduit in the silty clay for the solvents to migrate to within a few feet of a very thin Walnut. This well poses a serious risk to the Paluxy aquifer.

HM-84 (annually); Carbon Tetrachloride (2), trans-1,2-Dichloroethylene (24), Trichloroethylene (3); well is in the Compass Rose Area. Good records of this well can not be found.

HM-86 (semiannually); DCE (38 ppb), TCE (1,000), chloroform (2); well is very close to P-14U and P-14US. Lithologic log shows borehole was drilled through Walnut, Upper Paluxy, and Paluxy Upper Sand. However, completion diagram and report (Window Area Investigation) state that total depth was 56'. It is not clear whether bottom of borehole was properly plugged and abandoned. The remainder of the borehole is poorly designed. The bottom of the well is 590.0', which is only 2' above the top of the Walnut or, according to the lithologic log, it is at the top of the Walnut!. The Walnut is only 5.5' thick here. The well has a 30' screened interval with an additional 7.5' sand pack. Above a 1' bentonite seal is 11.5' of cuttings. The surface seal only extends down 2' from the surface. This is a very poorly designed monitoring well, particularly for the Window Area. It poses a significant threat for downward migration of contaminants into the thin Walnut and the Upper Paluxy. It should be monitored (priority III) until abandoned (priority I).

HM-87 (semiannually); DCE (65 ppb), TCE (590), chloroform (1); drilled in September 1987, 4" PVC. CD = 40'; 10' screen in limestone and clayey silt. Additional 9.5' filter pack in clayey silt. 3.5' bentonite seal. Uncertain if filter or sand used for 11', and then 5' surface cement seal. O.K. construction, not great. Priority III for monitoring.

- HM-88 (semiannually); DCE (200 ppb), TCE (6,100), toluene (60), ethylbenzene (68); Cr (0.15mg/L), drilled September 1987; poor construction. Excessive filter pack through silt. CD = 45.8' (just into Walnut). 10' screen in sandy gravel (8') and gravelly silt (2'). Filter pack extends additional 19' into silt (12') and sand (5'). Bentonite seal (3.5') and cement (13.5') to surface. Priority III for monitoring because it is downgradient of underground storage tank No. 7.
- HM-89 (semiannually); DCE (830 ppb), TCE (6,200 ppb), 1,1,1 TCA (7 ppb); drilled in September 1987. 4" PVC. CD = 50'; 20' screen from Walnut (1') into gravel (13') and clay (6'). Additional 9' filter pack in clay. 3' bentonite seal and cemented 18' to surface. O.K. well construction. Priority III for monitoring.
- HM-90 (semiannually); DCE (15 ppb), toluene (1); next to P-15U, P-15US where Walnut is 2' thick (top of Walnut approximately 585.3' - 586'). Drilled 0.5' into Walnut and set bottom of filter pack 2' above top of Walnut (unclear whether they plugged the lower 2.5'). Has 8.5' screen (sandy gravel and silty clay with sand) and additional 23.5' filter pack in gravel, sand, and clay. It is unclear what was used to fill hole from 23' (top of 3' bentonite seal) to 10' (bottom of 10' cement grout). This well should be monitored (Priority III) and later abandoned if the concentrations begin to increase due to the potential for contamination of the Paluxy. If this occurs, a new well should be drilled and screened only in sandy gravel from 52 - 61' depth. If a new well is drilled, HM-90 could be abandoned (priority III).
- HM-91 (semiannually); DCE (35 ppb), TCE (1,200); uncertain completion details. Drilled to presumably within few feet of Walnut. 20' screen in gravelly sand (10') and sandy, clayey silt (10') with additional 10' filter pack in silt. Do not aquifer test. Not known what was used to fill hole from 2' (bottom of surface cement) to 27' (top of 5' bentonite). As this ?backfilled? area is all silt, a vertical conduit now exists through silt. Well should be monitored (priority III) until abandoned (priority I).
- HM-92 (semiannually); DCE (13 ppb), TCE (34), toluene (2); drilled October 4, 1987. Uncertain completion details (fill or sand/gravel pack for 12' between bentonite and cement). OK well construction. Discontinue routine monitoring.
- HM-93 (semiannually); upgradient of Window Area; toluene (2 ppb), chloroform (2), benzene (3), ethylbenzene (50); CD = BTH = 37'; 10' screen from top of Walnut, through silty clay (4') into silty sand/sandy silt (6'). Sand pack extends additional 6' in silty sand/sandy silt. 4' bentonite then cemented 17' to surface. O.K. well construction. Continue monitoring (priority I).
- HM-94 (semiannually); DCE (6,100 ppb), TCE (32,000); Walnut is 1.5' thick. Drilled through Upper Paluxy but grouted with neat cement from bottom to 0.5' above top of Walnut. Has 30' screen and additional 5' filter pack in gravel (4'), silty clay (28.5'), and sandy gravelly silt (2.5'). Creates vertical conduit in silty clay for surface contaminants to migrate within 2' of the Paluxy. Should be monitored (priority III) until abandoned

(priority I). New well could be drilled to monitor only basal gravel. Filter pack and screen are excessive.

- HM-95 (semiannually); DCE (300 ppb), TCE (6,800); drilled in October 1987. Poor construction. Excessive filter pack (22') in clay (14'). Discontinue routine monitoring.
- HM-96 (semiannually); DCE (40 ppb), TCE (1,900). Excessive screened interval (30') in Walnut (1.5'), gravel (5.5'), silty sand (7'), silty clay (8'), sandy clay (8'). Additional 2' filter pack in sandy clay. Top 22' sealed with bentonite (3') and cement (19') through sandy clay (16'), sandy gravel (2'), and clay with sand (4'). OK well construction, not great. Discontinue routine monitoring.
- HM-97 (semiannually); DCE (7 ppb), TCE (460), PCE (2); boundary well, drilled in October 1987; uncertain how bottom 30' in Paluxy abandoned. Excessive screen (20') in gravel (3'), gravelly sand (4'), clay (8'), and silty sandy clay (5'). Walnut is only 0.5' thick here. Priority III for monitoring. If water quality gets worse, it should be abandoned (priority III). Too much danger of contaminating Paluxy.
- HM-98 (semiannually); toluene (1 ppb); boundary well; drilled in March 1988. Uncertain how hole was abandoned in Paluxy and Walnut for 65.5'. O.K. construction. Priority III for monitoring. Abandon (priority III) if water quality decreases.
- HM-99 (semiannually); downgradient of Window Area; 1,2-DCE (240 ppb), TCE (1,100 ppb), trichlorofluoromethane (6 ppb), chromium (0.03 mg/L); drilled in March 1988; bentonite seal starts right at top of screen. CD - BTH - top of Walnut = 44'. 20.5' screen in sandy gravel (5.5'), sandy silt/silty sand (11.5') and clayey silt (3.5'). 3' bentonite seal and sealed with cement to surface (20.5') through silt. O.K. well construction except for bentonite in contact with top of screen. Water level fluctuates below top of screen and is not in contact with the bentonite. Do not aquifer test. Continue monitoring (Priority I). Good well for DNAPLs and LNAPLs check.
- HM-101; TCE (41 ppb); this well should be saved. It is flush mounted, with 2" PVC, and a locking meter box. It was drilled to just below top of Walnut (34'), has a 15' screened interval, has a bentonite seal 3 - 5' above the top of the screen, and is cement grouted to the surface. Is one of the better wells in this area for monitoring. Priority III for monitoring.
- HM-102; clean; not sampled, 2" PVC. Should be saved if possible. Was drilled to just below the top of the Walnut, has 30' of screen (all in shale and limestone), is screened for finding both floating and sinking product, has a bentonite seal, and is grouted to the surface. Priority III for monitoring.
- HM-103 (semiannually); 1,2-DCE (3,000 ppb), TCE (5600 ppb), and oil and grease (0.3 mg/L); discrepancies exist between the concentrations for methylene chloride reported in Hargis + Associates Monitoring Plan (1989) Table B-1 (5,400 ppb) and the text of the same report and the data base (less than detection limit). 2" PVC with locking meter box. Excellent well

construction. 10' screen in Goodland and silt. Additional 2' sand pack. Bentonite seal, then grouted to surface. Priority II for monitoring.

HM-104 (annually); TCE (24 ppb), toluene (2). Bailer; 2" PVC; locking meter box. Boundary well. TD = 39' (3' into Walnut, which all sloughed). 15' screen in sloughed Walnut (3') and Goodland shale (12'). Sand pack starts above sloughed material and extends 3.7' above top of screen and is all in Goodland shale. Hnu reading was 6.3 ppm with 0.3 background in shale at 29 ft. 2.4' bentonite pellet seal, then grouted to top with cement. Good well to aquifer test for Goodland shale hydraulic conductivity (except for sloughed Walnut in bottom 3'). Good well construction. Keep; continue to monitor (priority I).

HM-105 (annually); TCE (2 ppb), toluene (6); triloc; 2" PVC. TD = 21' (2' into Walnut). CD = 20.5'; 15' screen in Walnut (1.5'); clay (13.5'). Additional 1.5' sand pack in clay. Bentonite and grout seals to surface. Excessive screen, but O.K. construction due to lithology. Good well to aquifer test for clay hydraulic conductivity. Keep.

HM-106 (annually) -- May never have been sampled. Appears dry. Triloc. Good well completion. Keep, may want to sample if there ever is water in it.

HM-107 (semiannually); clean [8 mg/L benzene and 6 mg/L carbon disulfide], drilled 1986, 2" PVC; O.K. completion; boundary well.

Recommendation: Continue monitoring.

HM-108 (annually); toluene (6 ppb), benzene (3). Bailer, 2" PVC; locking meter box. TD = CD = 15' (Walnut). 10' screen in silt and gravel, clay, clayey sand, and gravel. Additional 1' sand pack. Bentonite and cement seals to the surface. Do not aquifer test. Keep.

HM-110 (semiannually); DCE (250 ppb), TCE (1,400); boundary well; BTH = 37"; CD = 36.5'; 10' screen in Walnut (2.5'), silty clay (1.5'), silty sand (4'), and clayey gravelly sand (2'). Additional 5' filter pack in clayey gravel sand. 3' bentonite and 18.5' cement to surface through clay, silt. O.K. well construction. Priority II for monitoring.

HM-111 (semiannually); DCE (500 ppb), TCE (1500); boundary well; 4" PVC, drilled in March 1988. CD = 49'. BTH = 53' (Walnut). 20' screen from top of Walnut in silty, sandy gravel (6'), and sandy silt (14'). Additional 7' filter pack in silt. 4' bentonite. Uncertain completion (12') in gravel (10') and silt (2') between bentonite and cement surface seal (4'). Uncertain completion for bottom 4' of hole. O.K. completion. Priority III for monitoring. Do not aquifer test.

HM-112 (semiannually); DCE (400 ppb), TCE (6,100), drilled in March 1988. BTH = 50.75' (0.25' into Walnut). CD = 50'; 30' screen in sandy gravel (5'), silty sand/sandy silt (18'), gravel (2'), gravelly silty clay (5'). 2' additional sand pack, 4' bentonite, 10' uncertain materials, 4' surface cement. Screened interval is excessive, but does monitor both gravel layers. Priority III for monitoring to keep an eye on Flight Line Area TCE plume.

- HM-113 (semiannually); DCE (200 ppb), TCE (6,500); drilled in March 1988. BTH = 49', CD = 48'; 20' screen in gravelly sand (1'), silty sand (17'), and silty clay/clayey silt (2'). 1' additional filter pack, then 5' bentonite, 18' uncertain materials, and 4' cement to surface. Top 30' is clayey silt/silty clay. Large screened interval but O.K. Priority III for monitoring.
- HM-114; (quarterly); DCE (270 ppb); TCE (2,200); Cr?; triloc; TD = 36.5', CD = 34.5'. 20' screen in gravelly sand (9.5') and sand (10.5'). Additional 1.5' filter pack in sand. 2' bentonite seal in clayey silt. Uncertain completion for 6' in clayey silt (3') and silty clay (3'); cement to surface. O.K. well construction; not great. Keep. Priority III for monitoring to assess movement of TCE plume.
- HM-115 (semiannually); DCE (15 ppb), TCE (380); triloc; drilled in January 1989. CD = 26.2'. Excessive screen (18.9'). Basically the entire well from the top of the first unit to BTH is screened. Creates vertical conduit through clay and silt to sandy gravel at bottom 4' of screen. Boundary well, continue to monitor (priority I). If water quality gets worse, abandon (priority III).
- HM-116 (semiannually); DCE (13 ppb), TCE (1,000); drilled in January 1989, boundary well; triloc, CD = BTH = 33'; 10' screen in Walnut (1'), sandy gravel (0.5'), silty sand/sandy silt (8.5'). 2' bentonite seal, then uncertain fill for 14' through limey clay (12') and limey silt (2'). 4' concrete surface seal. Not great well construction but priority III for monitoring.
- HM-117 (semiannually); DCE (15 ppb), TCE (830), PCE (9); drilled in February 1989, triloc, 4" PVC. BTH = 39.5', CD = 38.5'. Excessive screen length (20') in gravelly sand (2.5'), silty sand/sandy silt (10'), silt (2'), clayey silt (5.5'). 1' additional filter pack. Rest of borehole is silt or clay. 2' bentonite seal, then uncertain fill for 11', then 4' surface cement. Priority III for monitoring. Do not aquifer test.
- HM-118 (semiannually); DCE (4 ppb), TCE (170); triloc, 4" PVC, drilled in February 1989. Only 0.2' filter pack above screen before bentonite. Boundary well. Excessive screen (20') in sand (8.2') and silt (11.8'). Do not aquifer test. Essentially most of well screened (CD = 26.2'). Priority III for monitoring.
- HM-119 (semiannually); TCE (45 ppb); triloc; drilled in February 1989; 4" PVC; boundary well (near Lake Worth). Long screen (20') in gravel (3'), sand (12'), silty sand/sandy silt (5'). Additional 2.5' filter pack in sand, rest of borehole in silt and clay with 1.5' bentonite seal, 2' unknown materials, and 3' cement surface seal. Continue monitoring (priority I).
- HM-120 (semiannually); methylene chloride (13 ppb). Bailer; 4" PVC; drilled in February 1989. Boundary well (close to Lake Worth). BTH = 20', CD = 17.6'. 10' screen in limey clay (6'), sand/gravel (2.5'), and clayey sand (1.5'). Additional 1' filter pack. Bentonite, cement to surface. Priority III for monitoring.

HM-121 (semiannually); DCE (20 ppb), methylene chloride (30 ppb), TCE (550 ppb). Boundary well; triloc; 4" PVC; drilled in February 1987; CD - BTH = 31.5'. 20' screen in gravel (1.5'), sand (13.5'), silt (5'). Uncertain materials for 3.5' between bentonite and surface cement. Continue monitoring (priority I).

HM-122 (semiannually); DCE (470 ppb), TCE (1,100 ppb). Bailer; drilled in February 1989. Boundary well. BTH = 28.5' - bottom of filter pack. Bottom of 10' screen at 26.9' in gravel (3') and clay (7'). 1' additional filter pack. 1.1' bentonite seal. Uncertain materials from 4 - 14.9' in clay/silt. 4' cement seal to surface. Continue monitoring (priority I).

HM-123 (semiannually); DCE (840 ppb), TCE (3,500); triloc; drilled in February 1989. Boundary well. BTH = 40.5', CD = 39.5'. 20' screen in gravel (4.5'), sand (15'), and gravel (0.5'). 3' additional filter pack. Uncertain materials for 10.5' between bentonite and 4' surface cement. Continue monitoring (priority I). Good well to aquifer test for conductivity of gravel and sand.

HM-124 (semiannually); Clean? Bailer; drilled in February 1989. Boundary well. BTH = bottom of filter pack = 25'. CD = 24'. 15' screen in limestone (0.5'), limey clay (4.5'), gravel (5'), and silt (5'). Additional 1.5' filter pack. Uncertain completion for 1' between bentonite (2.5') and cement (4'). Priority III for monitoring.

HM-125 (semiannually); DCE (2 ppb), methylene chloride (6), TCE (77). Bailer; boundary well; drilled in February 1989. CD = BTH = 33'. 20' screen in clay (5'), sand (8'), clayey silt/silty clay (7'). Uncertain materials between 2' bentonite and 4' surface cement for 4.5'. Excessive screen. Continue monitoring (priority I).

HM-126 (semiannually); DCE (330 ppb), TCE (3,500), benzene (160); triloc; 4" PVC; drilled in February 1989. Boundary well. (CD = 36'). Screen (20') in sand (19'), and clayey gravelly silt (1'). 4' additional filter pack. Uncertain what materials fill borehole between 4' cement surface seal and 10' (top of 2' bentonite seal). O.K. construction. Priority III for monitoring.

HM-127 (semiannually); DCE (3 ppb), TCE (10); triloc; drilled in February 1989; boundary well. Excessive screen (20') in sand (13.5'), clayey silt/silty clay (5'), silt (1.5'). Additional 3.5' filter pack. Uncertain filter pack details and fill used from 4 - 13' in silt. Priority III for monitoring.

P-3 (annually); Boundary well; submersible. Upgradient well; has 3 monitoring zones in Paluxy. Drilled to Glen Rose Formation at 220'. Walnut from 13'-45'. Aquifer tested.

P-5M (semiannually); priority III for monitoring.

P-5UN (semiannually); priority III for monitoring.

- P-5US (annually); Bailer; cased through all but lower 3.5' of Walnut. Screened in 9' of upper sand and 1' of Walnut with additional 2.5' of sand pack in Walnut. Aquifer tested. Well frequently dry.
- P-6M (semiannually); priority III for monitoring.
- P-6U (semiannually); priority III for monitoring.
- P-7M (semiannually); priority III for monitoring.
- P-7U (semiannually); priority III for monitoring.
- P-8M (semiannually); priority III for monitoring.
- P-8UN (semiannually); TCE (8,100 ppb), DCE (400 ppb); priority II for monitoring.
- P-8US (semiannually); DCE (240 ppb), TCE (4,100 ppb); priority III for monitoring.
- P-9M (annually); toluene (5 ppb); submersible. Good monitoring well construction except for galvanized pipe. Keep. Aquifer tested. Good well for obtaining middle Paluxy hydraulic conductivity value. Priority III for monitoring because of contamination of P-9US with TCE.
- P-9UN (annually); clean, toluene (8 ppb). Submersible; cased through Walnut (27') and upper sand (9'). 5' of sandy clay in screened interval, 2' silt/sand/clay in sand packed interval and 27' sandstone in filter/screened interval. Switch to quarterly monitoring (priority I) because of contamination of P-9US with TCE.
- P-9US (semiannually); TCE (7,200 ppb), trans-1,2-DCE (12 ppb), toluene (14 ppb), and chromium (0.02 mg/L); continue to monitor but switch to quarterly monitoring (priority I) and monthly water-level measurements if possible because water level went up 19' from 1/89 to 1/90 to 10' below water levels in Upper Zone and TCE concentration increased to 7,200 ppb from a previous high of 2,200 ppb.
- P-10M (semiannually); screened 30' in middle Paluxy; sand packed additional 15' in middle Paluxy, and gravel packed in 20' of clay. Boundary well; only well west of Meandering Road Creek. Not ideal construction. Priority III for monitoring. Clean (upgradient well). Do not aquifer test.
- P-10U (quarterly); clean; screened through entire upper Paluxy; boundary well; priority III for monitoring (upgradient well).
- P-11M (quarterly); clean; galvanized pipe to submersible pump; boundary well; not ideal, but priority III for monitoring. Retrofit with non-galvanized pipe if monitored at a later date.
- P-11U (quarterly); methylene chloride (32 ppb) and toluene (70 ppb); galvanized pipe to submersible pump; boundary well; continue to monitor (priority I) but remove galvanized pipe.

- P-11US (annually); clean; bailer; boundary well; sometimes dry. Screened interval is 10.5' in Upper Sand (sand with silt, 5'), silt/sand/clay (2'), silty clay (1'), and Walnut (2.5'). Do not aquifer test.
- P-12M (semiannually); toluene (44 ppb), MEK (30 ppb); galvanized pipe to submersible pump; boundary well; continue to monitor (priority I) but remove galvanized pipe.
- P-12UN (quarterly); clean; boundary well; priority III for monitoring.
- P-12US (annually); chloroform (2 ppb); boundary well; bailer; sometimes dry. Screened interval is 7' with shale/sand (2.5'), Upper Sand sandstone (4'), and shale (0.5'); steel casing through 45' of Walnut. Do not aquifer test.
- P-13M (quarterly); clean; boundary well; large sand pack interval; priority III for monitoring.
- P-13U (quarterly); clean; boundary well; priority III for monitoring, but retrofit to remove galvanized pipe on submersible pump.
- P-13US (annually); clean (?); boundary well; bailer; frequently dry. Cased through 27' of Walnut. 10' screened interval includes clayey silt (3'), Upper Sand (6.5'), and Walnut (0.5'). Not aquifer tested, probably due to lack of water. Not good well to aquifer test. Keep.
- P-14U (quarterly); clean; very good well design. 10' screen interval. Priority III for monitoring.
- P-14US (semiannually); TCE (2,700 ppb), DCE (190 ppb); very good well design. 10' screened interval. Priority III for monitoring.
- P-15U (semiannually); trace 1,2-DCE, 1,1-DCE, DCA, and TCE; toluene (100 ppb), trace benzene (3 ppb); continue monitoring (priority I).
- P-15US (semiannually); DCE (10 ppb), TCE (22), benzene (3); Walnut is only 2' thick here, none of which is protected by steel casing. Screened interval (8') includes 2' of Walnut. Do not aquifer test. Priority III for monitoring.
- P-16US (semiannually); DCE (490 ppb), TCE (1,500), toluene (14), benzene (82). Not clear if all of Upper Sand is included. Continue monitoring (priority I).
- P-17US (annually); clean (?); bailer; frequently dry; cased through Walnut (6.3'). 10' screen in clayey sand. Good monitoring well construction. Priority III for monitoring when enough water. Good well to aquifer test although upper sandstone unit cased off.
- P-18US (semiannually); clean; bailer; cased through 9.5' of Walnut. Screened/sand packed interval (17.5') includes 3' of Walnut, 6.5' of sandstone, 6.5' of sandy clay-sandstone, and 1.5' of silty clay. Not aquifer tested. Do not aquifer test. Priority III for monitoring.

- P-19US (annually); clean; sometimes dry. Cased through Walnut; 13.7' screened/packed interval. Good well. Not aquifer tested. Priority III for monitoring when possible to collect sample.
- P-20M (annually); clean. Priority III for monitoring. Total Depth is 155'. The galvanized pipe should be changed on the submersible pump at a later date if the water quality deteriorates. The 30' screened interval is mostly in sand.
- P-21U (annually); toluene (6 ppb). This well should be saved. It is a clean well. It is an upper Paluxy well, with a 20' screen and is cased and grouted from the surface to the top of the Paluxy. Total depth is 110'. It has a locking box over the well and 3 protective posts. The galvanized pipe should be changed on the submersible pump at a later date if the water quality deteriorates.
- P-22M (quarterly); boundary well; 1,2-DCE (3 ppb), TCE (33), toluene (15); continue monitoring (priority I).
- P-22U (quarterly); vinyl chloride (77 ppb), 1,2-DCE (420), TCE (150), toluene (15); boundary well; submersible pump; continue monitoring (priority I) but remove galvanized pipe.
- P-23U (annually); toluene (3 ppb), ethyl benzene (2); boundary well; submersible; O.K. construction. Priority III for monitoring. Aquifer test.
- P-24M (quarterly); no VOCs, upgradient boundary well; priority III for monitoring.
- P-24U (quarterly); no VOCs, upgradient boundary well; priority III for monitoring.
- P-25M (quarterly); 1,1,1 trichloroethane (100 ppb); priority III for monitoring. Is in new Chemical Processing Building construction area. Keep.
- P-25U (quarterly); no VOCs (clean); in new Chemical Processing Building area; submersible pump; priority III for monitoring, but will have to remove galvanized pipe. Keep.
- P-26M (quarterly); no VOCs, submersible pump; boundary well; 70' screened interval; priority III for monitoring.
- P-26U (quarterly); no VOCs; boundary well; submersible pump; priority III for monitoring.

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B1.1 Groundwater Sampling: General Considerations

General Considerations for the Sampling of Liquids

Introduction

The importance of proper sampling techniques for liquids cannot be overemphasized. Many factors shall be considered to obtain a sample that is (1) representative of the population being sampled, (2) collected in a manner that does not compromise the sample, (3) preserved properly until it can be analyzed in the laboratory, and (4) documented so that it can be properly traced. Accurate sampling shall be responsive to all of these considerations and to other items discussed in this procedure.

1. Scope

1.1 Because the objective of most liquid sampling is to obtain a sample that is representative of the population being sampled and retains the physical and chemical properties of the population, the sampler shall make decisions concerning sample types, equipment to be used, quality control, decontamination, etc., that will greatly affect the results obtained from the sampling event. The information provided in this section will guide the sampler and provide the necessary background for the proper collection of liquid samples. The 10 items that shall be considered before collecting a sample are:

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Material Considerations	5
Equipment Selection Considerations	6
Well-Purging Strategies	7
Sample Preservation and Filtration Considerations	8
Decontamination	9
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2. Hazard Analysis

2.1 Specific hazards requiring controls are identified in the individual procedures. Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater: American Public Health Association*, Washington, D.C., 1980.

3.2 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01.2, 1984.

3.3 Korte, N. and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U. S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.4 U.S. Department of Energy, *The Environmental Survey Manual*, Appendix E, Volume 4, DOE/EH-0053, 1987.

3.5 U.S. Environmental Protection Agency, *Handbook Groundwater*, EPA/625/6-87/016, 1987.

3.6 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

3.7 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D. C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 The two general sample types are grab samples and composite samples.

4.1.1 Grab samples are the most widely used type. They provide a sample that represents the characteristics of the liquid being sampled at a particular point in space and time. Grab samples are used where:

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4.1.1.1 The flow of liquid is not continuous (e.g., batch discharges or intermittent flows.)

4.1.1.2 The characteristics of the liquid are known to be fairly constant.

4.1.1.3 The samples are to be used for parameters with characteristics that are likely to change significantly with time (e.g., dissolved gases, bacterial decay, hydrolysis reactions, oxidation/reduction reactions, etc.).

4.1.1.4 The compositing process would significantly affect the concentration of an analyte.

4.1.2 Composite samples are composed of small aliquots of constant volume collected at constant time intervals or flow increments. Composite samples are used to generate data that describe average characteristics. Composite samples are collected in several ways depending upon the particular variability being studied. The five types of composite samples are:

4.1.2.1 *Simple composite samples* consist of small aliquots of constant volume collected at constant time intervals.

4.1.2.2 *Flow-proportional composite samples* are collected by varying the time intervals with flow or by proportionally varying the volume collected with flow. Flow-proportional sampling is used where the liquid flow is highly variable.

4.1.2.3 *Sequential composite samples* require a series of individual samples collected per container, with each container representing a specific time period. This sampling technique is used where the liquid being sampled varies significantly over short periods.

4.1.2.4 *Continuous composite samples* are collected by extracting a small continuously flowing stream from the bulk source and directing it into the sample container.

4.1.2.5 *Areal composite samples* are a composite of individual grab samples collected on an areal or cross-sectional basis. Areal composite samples are generally used to collect a sample from a lake or stream.

4.1.3 Interpretation of results depends upon knowledge of groundwater flow direction and formation transmissivity, lithologies sampled, and a properly collected, preserved, and uncontaminated sample.

4.1.4 See Table 1 through Table 5 for advantages and disadvantages of different sampling devices. A description of the depth of monitoring wells and a depth to the sample interval are necessary before proper sampling strategies can be chosen.

5. Material Considerations

5.1 The quality of the analytical data can be greatly affected by interactions between the sample and the sampling device. These interactions include chemical attack, microbial colonization, sorption, and leaching effects. To ensure the integrity of the sample and maximize the analytical quality, the sampling device shall be constructed of a nonreactive material.

5.2 The following materials are generally used in construction of sampling devices and sampling containers. They are listed in order of preference (least reactive to most reactive).

5.2.1 Rigid materials.

- a. Teflon®
- b. Stainless steel.
- c. Polyvinylchloride (PVC).
- d. Low-carbon steel.
- e. Galvanized steel.
- f. Carbon steel.

5.2.2 Flexible materials.

- a. Teflon®.
- b. Polypropylene.
- c. Linear polyethylene.
- d. Flexible PVC.
- e. Viton®.
- f. Conventional polyethylene.
- g. Tygon®.
- h. Silicone/neoprene.

5.3 The choice of materials used shall be considered with respect to the parameter being sampled. The factors to be considered are:

5.3.1 *Negative contamination*—The potential for the measured analyte concentration to be artificially low because of losses due to precipitation, volatilization, or absorption.

Table 1. Grab-Type Mechanism

Advantage	Disadvantage
<p>Virtually any material can be used for construction. Device is inexpensive. No external power source is required. Mechanism can be constructed in any size and shape. Device is easy to use and easily cleaned; requires little training for operation and little maintenance.</p>	<p>Sampling is labor-intensive and time-consuming. Aeration, degassing, and turbulence occur during sampling, Sampler susceptible to exposure to any contaminants in the sample. Does not provide a continuous supply of sample.</p>

5.3.2 *Positive contamination*—the potential for the measured analyte to be artificially high because of leaching or introduction of foreign matter into the sample by particle fallout or gaseous air contaminants.

5.3.3 *Cross-contamination*—a type of contamination caused by the introduction of part of one sample into a second sample.

6. Equipment Selection Considerations

6.1 Because each sampling situation is unique, the sampler may have to modify equipment and applications to ensure that a representative sample is collected and to maintain the sample's physical and chemical integrity. No one particular device will fit every situation. The sampler shall understand the various sampling devices and their advantages and disadvantages to effectively use them to collect samples. The following items shall be considered when selecting a sampling device.

- 6.1.1 Potential impact of the device on sample integrity.
- 6.1.2 Method of sample delivery.
- 6.1.3 Flow controllability.
- 6.1.4 Depth of sampling interval.
- 6.1.5 Ease of operation, cleaning, and maintenance.
- 6.1.6 Reliability and durability.
- 6.1.7 Portability of the device.
- 6.1.8 Initial cost and operational cost.

6.2 There are basically four types of sampling devices: (1) grab mechanisms, (2) suction-lift mechanisms, (3) positive displacement mechanisms, and (4) submersible pumps. Discussion of the uses,

advantages, and disadvantages of these devices follows.

6.2.1 Grab mechanisms consist of bailers and dip-type samplers. These devices are the oldest and simplest for collection of liquid samples. They can be made of virtually any material and can be used to collect liquid samples from almost any source. Table 1 presents the advantages and disadvantages of a grab-type mechanism.

6.2.2 Suction-lift mechanisms consist of peristaltic-type pumps and centrifugal pumps that apply a vacuum, which causes the liquid to be drawn upward through a suction line. Their use is generally limited to purging wells of stagnant water and sampling for inorganic analytes. Table 2 presents the advantages and disadvantages of a suction-lift mechanism.

6.2.3 Positive-displacement mechanisms consist of gas-driven devices and gas-operated bladder pumps. These devices are generally used to sample groundwater when the liquid must be pumped to the surface. Positive-displacement devices can be constructed of a variety of materials to fit most sampling situations. Tables 3 and 4 present the advantages and disadvantages of positive-displacement mechanisms.

6.2.4 Submersible pumps are generally not used for sample collection. They are useful in purging large-volume wells of stagnant water; however, severe aeration and turbulence of the sample occur due to their method of sample delivery. Table 5 lists the advantages and disadvantages of using a submersible pump.

7. Well-Purging Strategies

7.1 To obtain a representative groundwater sample, it is necessary to remove the stagnant water from the well casing. The water within the

Table 2. Suction-Lift Mechanism

Advantage	Disadvantage
<p>Flow rates are easily adjustable. Device has no contact with the sample. Device can be used in wells of any diameter. High flow rates are obtainable for well purging. Only the tubing requires cleaning (peristaltic pumps only).</p>	<p>Use is limited to situations where the liquid level is less than 25 feet below the surface. Drop in pressure of suction-lift mechanisms causes degasing of the sample and loss of volatiles. Choice of construction material is limited. Centrifugal pumps need to be primed, resulting in possible sample contamination. Severe aeration and turbulence occur with centrifugal pump.</p>

Table 3. Gas-Driven Device

Advantage	Disadvantage
<p>Device can be used in wells of 1.5-inch inside diameter. Device inexpensive and highly portable for most sampling applications. Permanent installation is possible in boreholes without casing. Inert materials can be used for construction of device. Sample delivery rate can be controlled. Burst strength of the materials used to make device and tubing is only limiting factor in determining sampling depth.</p>	<p>Oxidation and gas-stripping of volatiles may occur if air or oxygen is used as the driving gas. Requires air compressor or large compressed-air tanks. Application of excessive air pressure can rupture the gas entry or discharge tubing. Difficult to retrieve for repair, cleaning, and maintenance when installed permanently in boreholes without casing.</p>

Table 4. Gas-Operated Bladder Pumps

Advantage	Disadvantage
<p>Pump is constructed of inert materials; most pumps are designed specifically to sample for low levels of contaminants. Driving gas does not contact the sample, thus minimizing sample aeration and gas stripping. Pump is portable, though accessory equipment may be cumbersome. Relatively high pumping rate allows well evacuation and collection of large sample volumes. Sample delivery rate can be controlled easily on some models. Most models are capable of pumping lifts in excess of 200 feet. Pump diameters are variable, depending on the application.</p>	<p>Deep sampling requires large volumes of gas and longer cycles, thus increasing operating time and expense and reducing portability. Check valves in some models are subject to failure in water with high solids content. Most available models are expensive. Minimum rate of sample discharge of some models may be higher than ideal for sampling of volatile compounds. Pump is easily disassembled for cleaning.</p>

Table 5. Submersible Pump

Advantage	Disadvantage
<p>High pumping rates are possible for well purging. Pump can be used at depths of more than 200 feet.</p>	<p>Sampler has little control of flow rates; not possible to adjust from a high rate for purging to a low rate for sampling. Severe aeration and degasing of sample occurs, thus volatilizing organics and other sensitive compounds. Pump has limited portability and requires a power source for operation. Pump is not easily disassembled for cleaning.</p>

well casing and in proximity to the well is probably not representative of the overall groundwater at the sampling site. Drilling contaminants may be near the well; and important environmental conditions, such as the oxidation/reduction potential, may differ drastically near the well from the conditions in the surrounding water-bearing formation. The recommended amount of water to be purged from the well prior to sampling varies on a case-by-case basis. The amount of water to be purged is based on the hydraulic properties of the geologic materials surrounding the well, well-construction parameters, desired pumping rates, and sampling methodology employed. There is no one single number of well volumes to be pumped that is best or fits all situations. The goal is to obtain water from the well that is representative of the groundwater, while minimizing the disturbance of the regional flow system and the collected sample.

7.2 The most common procedure is to pump or bail the well until three to five casing volumes of water have been removed. This requirement is stated in the U.S. Environmental Protection Agency (EPA) *RCRA Technical Enforcement Guidance Document* and in the EPA *Test Methods for Evaluating Solid Wastes (SW-846)*. The sampler shall use the following guidelines to determine when sufficient water has been removed from the well prior to sampling.

7.3 Guidelines for Well Purging Prior to Sampling [LQ-3(P)].

7.3.1 Purging accomplished by pumping from near the water surface within the well casing is the most reliable way to ensure removal of stagnant water within the well casing.

7.3.2 Removal of three to five casing volumes by surface pumping is sufficient to remove virtually all stagnant water within the well.

7.3.3 Monitoring pH, conductivity and temperature during purging is an indicator that when stabilized (± 10 percent), the well is providing formation water.

7.3.4 Pumping or bailing a well dry and allowing it to recover is sufficient to remove the stagnant water within the well.

7.3.5 Documentation of the purging process should be provided so that the data user can assess the quality of the data.

8. Sample Preservation and Filtration Considerations

8.1 *Sample Preservation Consideration*—Preservation of samples is necessary to stabilize specific parameters during shipment to a laboratory and while the samples are being held for analysis. Preservation is intended to (1) retard biological effects, (2) retard hydrolysis, (3) reduce sorption, and (4) reduce volatility of constituents. Preservation techniques are parameter-specific and include many different methods. Generally, the Sampling and Analysis Plan and/or the laboratory performing the analysis will determine the specific requirements. Table 6 can be used as a guide for preservation requirements, container types and sizes, and holding times; but contains only some of the more common practices.

8.2 *Sample Filtration Considerations*—Predictions of contaminant migration, whether made empirically or with a computer model, require that a distinction be made between soluble species and

Table 6. Preservation Requirements

Parameter	Container Size and Material ^a	Preservation	Holding Time	Comments
Metals	125-mL HDPE	HNO ₃ pH <2	6 months	Protect Ag from light
Anions NO ₃ and PO ₄	125-mL HDPE	Cool to 4 °C	48 hours	
Anions F, Cl, and SO ₄	125-mL HDPE	Cool to 4°C	28 days	
Cyanide	1,000-mL HDPE	NaOH pH >12	14 days	Protect from light
Sulfide	1,000-mL HDPE	2-mL 2 N zinc acetate, cool	28 days	
Total Organic Carbon	125-mL glass	H ₂ SO ₄ or HCl, pH <2, 4 °C	28 days	
Volatile Organics	2 each, 40-mL glass	Cool to 4 °C	14 days	No bubbles
Semi-Volatile Organics	2 each, 1,000-mL glass	Cool to 4 °C	14 days	Protect from light

^aHDPE = High-density polyethylene.

suspended matter. Determining the soluble species requires the samples to be filtered prior to analysis. A filter pore size of 0.45 micrometer (µm) has been accepted as the cutoff size to be used for determining dissolved versus suspended matter. Samples requiring filtration shall be filtered as soon after collection as possible, preferably at the time of collection. Many devices are available to filter the sample and include large and small disposable cartridges and large and small filter holders with replaceable filters. The device chosen will vary depending upon the amount of suspended matter in the sample, amount of sample requiring filtration, and equipment available to filter the sample. Many different types of filter media are available (including cellulose nitrate, cellulose acetate, Teflon[®], nylon, and polycarbonate) in a 0.45-µm filter size. The choice of filter media will depend on the constituents being analyzed and the amount and size of the suspended matter in the sample. The following guidelines will be helpful in the choice of sampling device and filter media.

8.2.1 The preferred device is an in-line filtration module that operates from sampling pump pressure.

8.2.2 The required filter pore size is 0.45 µm.

8.2.3 Samples containing high suspended solids or large volumes can be best filtered using a high-capacity cartridge filter.

8.2.4 Clear samples or samples requiring small volumes can be filtered using small cartridge filters or filtration devices with replaceable filter media.

8.2.5 Thoroughly clean all devices that use replaceable filters and discard the initial 50 to 100 milliliter (mL) of sample as a rinse prior to sample collection.

9. Decontamination

9.1 A major part of the work effort and cost spent during an investigation is associated with collecting and analyzing samples. To that end, effective decontamination of reusable equipment is critical to the credibility of the data generated during the investigation. No universal standards exist for equipment decontamination, but most state and federal regulatory agencies have established guidelines that should be considered when developing decontamination protocols. Therefore, the

individuals conducting the sampling shall develop protocols that will best fit the requirements of the investigation being conducted.

9.2 Decontamination consists of a physical cleaning of the equipment followed by a chemical cleaning. The process shall be designed to minimize the spread of contaminants to clean areas and to minimize the cross-contamination of sampling sites. The following general guidelines provide a basis for achieving this goal.

9.2.1 Physical decontamination methods consist of cleaning with brushes, clean rags, and high-pressure water to physically remove the contamination. This is followed by a distilled or deionized water rinse and drying with lint-free tissues.

9.2.2 Chemical decontamination methods shall depend on the nature and extent of contamination. At a minimum, chemical cleaning would consist of washing the contaminated equipment in a soap solution, rinsing with tap water, rinsing with distilled or deionized water, and air drying or wiping dry with lint-free tissues. Some situations might call for a chemical cleaning with acids such as HNO_3 or HCl , or organic solvents such as methanol, acetone, or hexane.

10. Quality-Control Considerations

10.1 The fundamental goal of field quality control is to ensure that the sampling protocol is being executed faithfully and that situations leading to error are recognized before they seriously impact the data. This goal can be achieved only through knowledge, training, experience, and continued refinement of procedures. The use of field quality-control samples such as blanks, standards, and spiked samples can account only for changes that occur after sample collection. The following guidelines are quality-control measures that are generally used by the sampler in the field.

10.1.1 *Field blanks* are used to enable quantitative correction for bias that arises due to handling, storage, transport, and laboratory procedures. They can also detect problems in inadequate field decontamination procedures or potential cross-contamination problems in field procedures or both. Field blanks consist of water that is metal-free or organic-free, or both, which contacts the sampling equipment under field conditions. Field blanks are also considered equipment blanks.

10.1.2 *Trip blanks* are used to detect any contamination or cross-contamination resulting from handling and transportation. They consist of water that is metal-free or organic-free, or both, which is placed in the sampling containers that accompany the samples to and from the field.

10.1.3 *Field duplicates* are actual samples collected in the field in duplicate and sent to the laboratory. They are used to document the precision of the sampling and analytical technique.

10.1.4 *Field spikes* are actual samples collected in the field and spiked with a known amount of analyte. They are used to determine the loss of analytes of interest during sampling and shipment. They are not generally used because they are susceptible to errors that are difficult to control in a field situation.

10.1.5 *Control samples* are samples of known analyte concentration prepared in a laboratory and then submitted with the field samples as a field sample. They are used to document the accuracy of the analytical technique.

11. Documentation

11.1 The documentation of the field activities and sample collection activities shall contain the information necessary for reconstruction of the sampling event at a later date. This documentation process consists of (1) field logbooks, (2) sample identification forms, (3) documentation of sample collection forms, (4) sample labels, and (5) chain-of-custody forms. Keep in mind that the documentation process should be able to provide answers to the questions who, why, what, when, where, and how.

11.1.1 *Field logbooks* are used to record the activities of the field team and to record information about the sampling event that is not contained on other forms. The logbook shall be bound and have consecutively numbered pages. The field team leader shall maintain the logbook. Items that would normally be recorded in the field logbook are (1) sampling team members; (2) equipment used on the sampling event; (3) source and expiration date of calibrating solutions used; (4) date, time, and sample number of samples collected; (5) weather conditions, if they are important to understanding the data; and (6) other quantitative information or measurements that are important to the data reviewer.

11.1.2 *Sample identification forms* may vary from project to project but all are designed to provide information about where the sample was collected, who collected the sample, date of collection, and comments by the sampler to document other important information.

11.1.3 *Sample labels* are necessary to prevent misidentification of the samples. Each label shall include, at a minimum, (1) sample number, (2) name of sampler, (3) date and time of collection, (4) place of collection, and (5) name and address of organization collecting the sample.

11.1.4 *Chain of custody* is an essential part of the sampling scheme to ensure the integrity of the sample from collection to data reporting. The possession and handling of the samples should be traceable from the time of collection through analysis and final disposition. This documentation is known as the chain of custody. A sample is considered to be under a person's custody if it is (1) in a person's physical possession, (2) in view of the person after taking possession, and (3) secured by that person so that no one can tamper with it or secured by that person in an area that is restricted to authorized personnel. The chain-of-custody form shall accompany the samples and each person relinquishing or receiving the samples shall sign and date the form and retain a copy for their records.

11.1.5 *Custody seals* are used to detect unauthorized tampering of samples. They shall be affixed to the shipping container in such a way that, if the shipping container is properly secured and arrives at the laboratory with the custody seals intact, the integrity of the sample can be demonstrated. Custody seals can also be placed directly over the lid of the sample container to further ensure that there has been no tampering with the sample. Custody seals may also be placed on the door of the sample storage area to document that no unauthorized entry was made while the sample was stored.

12. Shipping and Handling

12.1 The storage and transport of samples are often the most neglected elements of a sampling program. Samples shall be stored in a manner that does not compromise the sample integrity and shall be shipped to the laboratory in a timely manner to satisfy holding times. In addition, all shipments shall comply with the Department of Transportation (DOE) regulations governing shipment of

hazardous materials and substances. Coordination with the laboratory is critical to ensure that samples will arrive in a timely manner and the laboratory can meet the required holding times. This may require adjustment to sampling schedules.

12.2 The DOT regulations governing shipment of hazardous materials and substances are available in Hazardous Materials Regulations (49 CFR 171-179). The sampler should be familiar with and shall comply with these regulations. The regulations describe proper marking, labeling, packaging, documentation, and shipping procedures. Samples of a substance listed in the Hazardous Materials Table (49 CFR 172.101) shall be identified, packaged, marked, labeled, documented, and shipped according to the regulations listed for that material. However, if the composition of the sample is unknown, the shipper shall select the appropriate transportation category in accordance with 49 CFR 172.402(h). A material for which reasonable doubt exists as to its class and labeling requirements, and for which a sample must be transported for laboratory analysis, may be labeled according to the shipper's tentative class assignment based upon: (1) defining criteria (i.e., definitions of the hazard classes); (2) hazard precedence prescribed in 49 CFR 173.2; and (3) shipper's knowledge of the material.

12.3 The hazards listed in 49 CFR 173.2 fall into five classes: (1) flammable liquids, (2) radioactive materials, (3) oxidizers, (4) flammable solids, and (5) corrosives. The sampler should be familiar with the definitions of these classes to properly ship the samples.

13. Sampling Plan

13.1 A sampling plan shall be prepared after all the previous items have been properly considered. The sampling plan is the road map that should be followed during sample collection. It is a collection of separate steps arranged in a specific order that, when properly followed, results in a unique sample being obtained. It shall be flexible enough to allow for changes in data-quality objectives, information needs, and the variety of situations found at a particular site. The generalized plan presented in this section describes the steps and the goal each step is to accomplish. The steps are arranged in the order in which they should be executed, but some steps may be executed concurrently. However, some steps are not applicable to all liquid types and can

be eliminated. For example, the hydrologic-measurement and the well-purging steps are not applicable to surface or containerized liquids.

13.1.1 *Identify Sampling Site*—Consult the planning documents, maps, and other instructions to identify the sampling site. Review the documents for the specific site and determine the sampling requirements (i.e., samples to be collected, analyte requirements, required field measurements, and any personal protective equipment that might be necessary).

13.1.2 *Determine Equipment Requirements*—After reviewing the documents described in Section 13.1.1, select the appropriate equipment. The appropriate sections of this manual or other referenced documents should also be reviewed. Select equipment that has the least potential of affecting the sample and yet can provide the necessary volume required for the purging and sampling steps.

13.1.3 *Establish Documentation Requirements*—At a minimum, each sample requires a sample label and an entry in the field logbook. See the documentation section of this manual and review the planning documents for site-specific requirements.

13.1.4 *Inspect the Site*—Inspect the sampling site to identify any health and safety problems, verify the sample collection point, and identify any conditions that could affect the quality of the sample. If the site is a monitoring well, examine the condition of the surface seal and well protector to determine if there is any evidence of frost-heaving, cracks, or vandalism. Record this inspection in the field logbook.

13.1.5 *Take Appropriate Protective Measures and Conduct Area Monitoring*—Monitor the area with an organic vapor meter (OVM) and an explosivity meter to determine if special personal protective equipment will be necessary. Consult the planning documents for details of monitoring and personal protective equipment requirements. Record these monitoring results in the field logbook.

13.1.6 *Prepare the Area for Sampling*—Clear the area around the sampling point of weeds and other materials prior to beginning sampling activities. Sampling equipment shall not be placed on the ground. Place sampling equipment on a card table or drop cloth on the ground.

13.1.7 *Take Water-Level Measurements and Determine Purging Requirements*—This step is only applicable when sampling monitoring wells. Unlock the well protector, remove the cap from the well, and take OVM and water-level measurements.

13.1.8 *Calibrate Monitoring Equipment*—Calibrate or check the equipment to be used for making field measurements. Record this information in the field logbook or document the information on the sample collection form.

13.1.9 *Assemble Equipment*—Assemble the equipment to be used according to the operating manual for each piece of equipment.

13.1.10 *Purge Stagnant Water and Monitor pH, Temperature, Conductivity, and Other Parameters*—Stagnant water in the well shall be removed prior to sampling. Monitoring of pH, conductivity, and temperature is used to determine if stagnant water has been removed. These parameters should stabilize to ± 10 percent prior to sampling.

13.1.11 *Label Sample Bottles and Collect and Preserve Samples*—Label the sample bottles and collect and preserve the samples. Consult the planning documents or the appropriate sections of this manual for requirements.

13.1.12 *Record Field Measurements and Perform any Field Analysis*—Record the field monitoring parameters and conduct the field analyses at this time. Consult the planning documents for requirements at the site.

13.1.13 *Clean Equipment*—Clean and decontaminate the equipment according to the decontamination procedure in this manual. Planning documents for each site will describe site-specific decontamination procedures.

13.1.14 *Review Documents and Prepare for the Next Sample*—Review the field logbook and other records such as sample labels and field documentation forms for completeness and accuracy. Clean up the site and put away any equipment that was used for sampling. Prepare for collection of the next sample.

13.1.15 *Storage and Transport of Samples*—Place samples in secure storage and prepare the sample for transport. The samples that require storing at

4 °C shall be placed in an ice chest with ice and kept cool until shipment to the laboratory.

14. Health, Safety and Environmental Compliance Considerations

14.1 The sampling of liquids comprises numerous activities that involve the consideration of health, safety, and environmental compliance issues. Site-specific planning documents and procedures shall address these issues. Where appropriate, include these issues in procedures. However, many of these issues are site specific and should be thoroughly covered in planning documents. Health, Safety, and Environmental Compliance Specialists shall review all procedures, planning documents, and activities to verify that all items have been adequately addressed. Items

that are to be considered include, but are not limited to, the following.

- 14.1.1 Assignment of responsibilities.
- 14.1.2 Medical program requirements.
- 14.1.3 Training program requirements.
- 14.1.4 Personnel protective equipment requirements.
- 14.1.5 Personnel decontamination requirements.
- 14.1.6 Emergency procedures.
- 14.1.7 Disposal of contaminated wastes.
- 14.1.8 Compliance with environmental regulations.
- 14.1.9 Compliance with hazardous materials transportation.

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- B1.2 Measurement of Water Levels in Monitor Wells
- B1.2a Water Level Measurements Using an Electric Sounder
- B1.2b Water Level Measurements Using an Interface Probe

SITE SPECIFIC PROCEDURE CHANGE or NOTICE

PROCEDURE Measurement of Water Levels in Groundwater Monitoring Wells

PROJECT or SITE Air Force Plant 4

References to Electric Sounder

The only well sounder acceptable for use at Air Force Plant 4 will be an interface probe able to distinguish between immiscible layers of different conductivity. Ordinary electric sounders without this capability will not be used for fluid level measurements.

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Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells

Introduction

Water-level measurements shall be taken prior to any sampling or well purging. These measurements are needed to determine the casing volume of water in the well; the data are used when interpreting the monitoring results. High water levels could indicate recent recharge to the system, resulting in the dilution of the sample. Low water levels may reflect the influence of nearby production wells. Documentation of the nonpumping water levels shall also provide historical information on the hydraulic conditions at the site.

1. Scope

1.1 The water-level measurements shall be made from the top of the well casing and, for consistency, shall always be made from the same spot on the well casing. If the planning documents do not specify, and other reference points do not exist, then the measurement shall be made on the north side of the well casing.

1.2 Two methods are provided in this test method for water-level measurements. One uses an electric sounder with a conductivity cell. When the cell contacts water it completes an electrical circuit and sounds a buzzer or lights a lamp. The other method uses an interface probe. This instrument has an optical liquid sensor and a conductivity cell and can distinguish between the presence of a non-conductive layer and a conductive layer. For example, oils, fuels, and many organics are non-conductive and are immiscible in water. With this instrument the sampler can measure the thickness of a light-phase immiscible, which would float on the water surface; or a dense-phase immiscible, which would sink to the bottom of the well.

listed toxic and hazardous substance. Avoid eye and skin contact by wearing eye protection and disposable gloves. Avoid breathing vapors. Use only in a well-ventilated area. Keep away from heat, sparks, and flames.

2.2 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Standard Guide for Sampling Groundwater Monitoring Wells*, D4448-85a, 1986.

3.2 U.S. Department of Energy, *The Environmental Survey Manual*, Appendix E, Volume 4, DOE/EH-0053, 1987.

3.3 U.S. Environmental Protection Agency, *Handbook Groundwater*, EPA/625/6-87/016, 1987.

3.4 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

4. Significance and Use

4.1 Accurate measurements of water depth are necessary to calculate well-bore volumes; measurements to the nearest 0.01 foot are routine.

Method A *Water-Level Measurements Using an Electric Sounder*

5. Apparatus

5.1 Electric sounder. (There are many adequate electric sounders available. This procedure covers most models.)

Section

Method A — Water-Level Measurements Using an Electric Sounder	5-7
Method B — Water-Level Measurements Using an Interface Probe	8-10

2. Hazard Analysis

2.1 This test method uses methanol for decontaminating the apparatus. Methanol is a Department of Transportation (DOT)-regulated material; its hazard class is Flammable Liquid; and it is an Occupational and Safety Administration (OSHA)-

5.2 Kimwipe® or equivalent lint-free tissue.

5.3 Distilled or deionized water in a squeeze wash bottle.

5.5 Measuring tape with an engineering scale.

6. Procedure

6.1 The following procedure is supplemental to the instruction in the instrument-specific operating manual.

6.1.1 Check sounder to ensure that batteries are operating.

6.1.2 Clean probe with distilled or deionized water and wipe dry with a lint-free disposable tissue.

6.1.3 Slowly lower the probe into the well until the indicator sounds.

6.1.4 Raise the probe slightly until the indicator stops sounding.

6.1.5 Carefully lower the probe until the indicator sounds again and read the depth to water to the nearest 0.01 foot.

6.1.6 Repeat steps 6.4 and 6.5 until a repeatable measurement is achieved.

6.1.7 Record the depth to water to the nearest 0.01 foot.

6.1.8 Slowly withdraw the probe from the well while wiping the tape with a clean lint-free tissue moistened with distilled or deionized water.

6.1.9 Clean the probe with distilled or deionized water and wipe dry with a lint-free tissue.

7. Procedure Bias

7.1 With this method, water-level measurements shall be repeatable to ± 0.01 foot. The accuracy of the instrument shall routinely be checked against a steel tape to ensure that the cable has not stretched or twisted.

Method B Water-Level Measurements Using an Interface Probe

8. Apparatus

8.1 Soiltest Model 447-000 interface probe or equivalent.

8.2 Kimwipes® or equivalent lint-free tissue.

8.3 Deionized or distilled water in a squeeze wash bottle.

8.5 Methanol. (Department of Transportation-regulated material; its hazard class is Flammable Liquid.)

9. Procedure

9.1 The following procedure is supplemental to the instruction found in the instrument-specific operating manual.

9.1.1 Clean the probe with methanol, followed by a distilled or deionized water rinse, and wipe dry with a lint-free tissue.

9.1.2 Check the battery level and replace if low.

9.1.3 Slowly lower the probe into the well until the probe comes in contact with liquid. A steady audible alarm indicates an immiscible non-conductive liquid, while an oscillating alarm indicates a conductive liquid (water).

9.1.4 When the alarm sounds, raise the probe slightly until the alarm stops. Lower carefully until the alarm sounds again and note the depth. Repeat as necessary until a repeatable measurement of ± 0.01 foot is achieved. Record this measurement.

9.1.5 If a light-phase immiscible layer is present as indicated by a continuous audible alarm, the thickness can be measured by recording the point at which the continuous alarm begins and the point at which the oscillating alarm begins. The difference between the two measurements is the thickness of the light-phase immiscible layer.

9.1.6 If a dense-phase immiscible layer is suspected, it can be measured by slowly lowering the probe to the bottom of the well. If a dense-phase immiscible layer is present, it can be measured by recording the point at which the continuous alarm begins and the point that the probe reaches the bottom of the well.

9.1.7 Carefully withdraw the probe from the well while wiping the tape with a Kimwipe® moistened with distilled or deionized water. If the well contained any light-phase immiscible layers, the tape shall be rinsed with methanol followed by a distilled or deionized water rinse and wiped dry with a lint-free tissue as it is being removed from the well.

9.1.8 Clean the probe with methanol, followed by a distilled or deionized water rinse, and dry with a lint-free tissue.

10. Procedure Bias

10.1 When using the interface probe for liquid level measurements, readings of ± 0.01 foot can be achieved. The accuracy shall be routinely checked using a steel tape to determine if the tape has stretched or coiled.

11. Quality Assurance

57 75

11.1 The following information shall be logged when taking water-level measurements:

11.1.1 Date.

11.1.2 Well identification.

11.1.3 Depth to water.

11.1.4 Depths of light-phase and/or dense-phase immiscible liquids.

11.1.5 Name of person performing the measurement.

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B1.3 Purging Monitor Wells

B1.3a Determination of Turbidity in Waters (NTU)

SITE SPECIFIC PROCEDURE CHANGE or NOTICE

PROCEDURE Standard Practice for Purging Monitor Wells
PROJECT or SITE Air Force Plant 4

VARIANCE

The introduction section of the Standard Practice for Purging Monitor Wells states that "a general rule of thumb is to monitor purge water using an in-line flow cell for pH, conductivity, and temperature. When these parameters stabilize to +/- 10 percent for two successive well volumes, the sampler can be reasonably assured that the stagnant water has been removed from the well casing."

As per guidance from EPA Region VI, well purging criteria are revised to specify that water quality parameter measurements are to be taken after three to five well volumes have been removed at a rate of one measurement for every 1/2 well volume until the measurements stabilize or until a maximum of five bore volumes have been removed. Stabilization criteria will be:

pH	+/-	0.25
Conductivity	+/-	50 μ mhos/cm
Temperature	+/-	0.5 degrees C

If the well is pumped dry, it will be sampled 24 hours later, after recovery.

Standard Practice for Purging of Monitoring Wells

Introduction

To obtain a representative groundwater sample, the stagnant water in the well casing shall be removed. The recommended amount of purging depends on many factors such as the hydrogeological nature of the aquifer, the characteristics of the well, the type of sampling equipment to be used, and the parameters to be sampled. There is no one standard that will fit all situations. The general rule-of-thumb is to monitor the purge water using an in-line flow cell for pH, conductivity, and temperature. When these parameters stabilize to ± 10 percent for two successive well volumes, the sampler can be reasonably assured that the stagnant water has been removed from the well casing.

1. Scope

1.1 The four methods provided here are representative of those generally used to purge monitoring wells. Each method has advantages and disadvantages that must be considered. A review of the Well Purging Strategies in Section 7 of General Considerations for the Sampling of Liquids [LQ-1(G)] provides guidance for selecting the proper method.

	Section
Method A—Well Purging Using a Peristaltic-Type Pump	6-8
Method B—Well Purging Using a Bladder-Type Pump	9-11
Method C—Well Purging Using a Bailer	12-14
Method D—Well Purging Using a Submersible Pump	15-17

2. Hazard Analysis

2.1 These procedures use gasoline-powered electric generators, gasoline-powered air compressors, and battery-powered pumps and accessories. The following safety precautions shall be followed.

2.1.1 Air compressors that are belt driven shall have a belt guard in place.

2.1.2 Care shall be taken when connecting and disconnecting equipment powered by lead-acid batteries so as not to generate sparks that have the potential of creating an explosive hazard.

2.1.3 Gasoline shall be stored in Factory Mutual (FM)-approved safety cans. Safety cans shall be well secured in the vehicle during transport. Gasoline-powered equipment shall be cool before filling and care shall be taken not to spill any gasoline.

2.1.4 Air compressors shall not be operated above rated capacities and shall be configured so as not to have any dead end fittings above 20 pounds per square inch (psi). Carefully check for loose connections before operating.

2.1.5 Gasoline is a Department of Transportation (DOT)-regulated material; its hazard class is Flammable Liquid. Avoid eye and skin contact by wearing eye protection and disposable gloves. Avoid breathing vapors. Use only in a well-ventilated area and keep away from heat, sparks, and flames.

2.1.6 Gasoline-powered generators shall not be operated above their rated capacity.

2.1.7 Care shall be taken when lifting generators and air compressors. Proper lifting techniques shall be taken when lifting heavy equipment.

2.1.8 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Standard Guide for Sampling Groundwater Monitoring Wells*, D4448-85a, 1986.

3.2 U.S. Department of Energy, *The Environmental Survey Manual*, Appendix E, Volume 4, DOE/EH-0053 1987.

3.3 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

3.4 U.S. Environmental Protection Agency, *Handbook Groundwater*, EPA/625/6-87/016, 1987.

4. Significance and Use

4.1 Water may become stagnant in a well and will not reflect the local resident water's chemical and physical properties. The purging of a well can reduce this bias. Care shall be taken to allow screened intervals to come to equilibrium before sampling is performed.

5. Calculation of Volume of Standing Water in a Well

5.1 Calculations are performed for the amount of water in the well with the following formula:

$$r^2 \times \pi \times (h_1 - h_2) \times 7.48 = \text{gallons per casing volume}$$

where

- r = radius of well casing (feet) (the radius of the well is obtained from the well completion logs or can be measured with a tape measure),
- h₁ = depth of well (feet) from the top of the well casing (the depth of the well is obtained from the well completion logs), and
- h₂ = depth to water (feet) measured from the top of the well casing (the depth of water is measured using the Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Well [LQ-2(T)]).

Method A

Well Purging Using a Peristaltic-Type Pump

6. Apparatus

- 6.1 Peristaltic-type pump.
- 6.2 Silicone, C-FLEX[®], or neoprene tubing for the pump head.
- 6.3 Silicone, Teflon[®], polyethylene, or vinyl tubing for placing in the well.
- 6.4 Generator or other source of electricity.
- 6.5 Gasoline for generator. (Gasoline is a DOT-regulated material; its hazard class is Flammable Liquid.)

7. Procedure

7.1 The following procedure is supplemental to the instruction in the instrument-specific operating manual.

7.1.1 Place the suction line in the well so it is just below the liquid surface.

7.1.2 Connect the suction line to the pump.

7.1.3 Connect the pump outlet to the in-line flow cell, see Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)], or place the pump outlet hose into an open container to be used to make the field measurements.

7.1.4 Place calibrated pH, conductivity, and temperature electrodes into the in-line flow cell or the open container.

7.1.5 Initiate pumping and follow the water level down the well bore if the recovery rate of the well is below the pumping rate.

Note: Purge water may have to be contained and properly disposed. Consult the site-specific planning documents for requirements.

7.1.6 Routinely monitor and record the volumes purged and the readings for the pH, conductivity, and temperature.

7.1.7 When these readings have stabilized to ± 10 percent for two successive well volumes, sampling can begin.

7.1.8 Remove the suction line from the well, clean and decontaminate the suction line and pump tubing, as required.

8. Procedure Bias

8.1 The advantages of purging with a peristaltic pump are that (1) a peristaltic pump is relatively portable, inexpensive, and convenient; (2) it requires a minimum of down-hole equipment; and (3) it can be cleaned easily or the entire tubing can be changed between wells.

8.2 The disadvantages of purging with a peristaltic pump are that (1) purging is limited to situations where the water levels are less than about 25 feet and (2) degassing occurs whenever there is a head difference between the pump and the water level.

Method B

Well Purging Using a Bladder-Type Pump

9. Apparatus

- 9.1 Bladder-type pump.

9.2 Air compressor.

9.3 Teflon[®], polyethylene, or vinyl tubing for the air and sample line.

9.4 Gasoline for the air compressor. (Gasoline is a DOT-regulated material; its hazard class is Flammable Liquid.)

10. Procedure

The following procedure is supplemental to the instruction found in the instrument-specific operating manual.

10.1 Lower the pump gently to a position just above the screened interval.

10.2 Connect the air line to the pump controller.

10.3 Connect the pump outlet to an in-line flow cell, see Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)], or place the pump outlet hose in an open container used to make the field measurements.

10.4 Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.

10.5 Initiate pumping and routinely monitor and record the volume purged and the pH, conductivity, and temperature measurements.

Note: Purge water may have to be contained and properly disposed. Consult the site-specific planning documents for requirements.

10.6 When these readings have stabilized to ± 10 percent for two successive well volumes, sampling can begin.

10.7 Remove the pump from the well, clean and decontaminate as required.

11. Procedure Bias

11.1 The advantages of using a bladder-type pump for purging are that (1) the system is not damaged by dry pumping, (2) there is no air/water contact, and (3) the entire assembly can be made of Teflon[®] or stainless steel.

11.2 The disadvantages of using a bladder-type pump are that (1) pumping rates are relatively slow, (2) there is a high rate of air consumption during prolonged pumping, and (3) cleaning and decontamination are more difficult than with the apparatus used in methods A or C.

Method C
Well Purging Using a Bailer

12. Apparatus

12.1 Teflon[®] or stainless steel bailer.

12.2 Teflon[®] or stainless steel cable or line.

12.3 Bailer reel.

13. Procedure

13.1 Attach the bailer to the cable or line.

13.2 Lower the bailer slowly until it contacts the liquid.

13.3 Allow the bailer to sink until it is totally submerged.

13.4 Slowly raise the bailer to the surface.

13.5 Tip the bailer or use a bottom-emptying device and fill a container in which calibrated pH, conductivity, and temperature probes have been placed.

Note: Purge water may have to be contained and properly disposed. Consult the site-specific planning documents for requirements.

13.6 Routinely monitor and record the pH, conductivity, temperature, and volume purged.

13.7 When the readings have stabilized to ± 10 percent for two successive well volumes, sampling can begin.

13.8 Clean and decontaminate the bailer, as required.

14. Procedure Bias

14.1 The advantages of using bailers for well purging are that (1) bailers can be constructed of a variety of materials, (2) external power sources are not needed, (3) bailers are inexpensive, (4) bailers are easily cleaned and decontaminated, and (5) bailers can be used in wells of virtually any depth.

14.2 The disadvantages of using bailers are that (1) evacuating large amounts of stagnant water is labor intensive; (2) aeration, degassing, and turbulence will occur; (3) it is difficult to determine the depth to which the bailer has been submerged; and (4) bailer check valves may not operate properly under conditions of high suspended solids.

Method D

Well Purging Using a Submersible Pump

15. Apparatus

- 15.1 Submersible-type pump.
- 15.2 Discharge tubing of vinyl, polyethylene, polyvinyl chloride, or Teflon®.
- 15.3 Power source of generator or batteries.
- 15.4 Gasoline for generator. (Gasoline is a DOT-regulated material; its hazard class is Flammable Liquid.)

16. Procedure

The following procedure is supplemental to the instructions provided in the instrument-specific operating manual.

- 16.1 Set up the pump according to the operating manual.
- 16.2 Gently lower the pump down the well so that the pump head is submerged sufficiently and will not run dry.
Caution: Submersible pumps cannot be allowed to run dry.
- 16.3 Connect the pump outlet to an in-line flow cell, see Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)], or place the pump outlet in an open container used for the field measurements.
- 16.4 Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.
- 16.5 Initiate pumping, and monitor and record the volumes purged and the pH, conductivity, and temperature measurements.
Note: Purge water may have to be contained and properly disposed. Consult the site-specific planning documents for requirements.

16.6 When pH, conductivity, and temperature have stabilized for two successive well volumes, sampling can begin.

16.7 Remove the pump from the well; clean and decontaminate.

17. Procedure Bias

17.1 The advantages of using a submersible pump for well purging are that (1) relatively high pumping rates are possible, (2) some designs are relatively portable and easy to use, and (3) these pumps can pump from greater depths than the pumps used in methods A or B.

17.2 The disadvantages of using a submersible pump are that (1) high pumping rates and the mechanical actions cause turbulence, aeration, and degassing of the water; (2) pumps are easily damaged by dry pumping; and (3) these pumps can be difficult to clean and decontaminate.

18. Quality Assurance

18.1 All of the methods listed above require the following information to be logged for quality-assurance documentation.

- 18.1 Depth to water.
- 18.2 Depth of well.
- 18.3 Well diameter or radius.
- 18.4 Depth of water.
- 18.5 Calculated water volume.
- 18.6 Type of mechanism used to evacuate the well.
- 18.7 Date.
- 18.8 Well identification.
- 18.9 Name of person performing the purging.
- 18.10 Volume purged.
- 18.11 Conductivity, pH, and temperature measurements.

DETERMINATION OF TURBIDITY IN WATERS

1.0 INTRODUCTION

This method is applicable to drinking, surface, and saline waters in the range of turbidity from 0 to 40 nephelometric turbidity units (NTU). Higher values may be obtained with a dilution of the sample.

The method is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity of scattered light, the higher the turbidity. NTU readings are made in a nephelometer designed in accord with specifications outlined in Section 5.0 of this method.

A commercially available polymer standard is approved by the EPA for use as a calibration standard (1). This standard is identified as AMCO-AEPA-1, which is available from Amco Standard International, Inc.

2.0 INTERFERENCES

Preservation of the sample is not practical and analysis should begin as soon as possible. Refrigeration or icing to 4 °C, to minimize microbiological decomposition of solids, is recommended (2,3) if the sample cannot be analyzed immediately.

The presence of floating debris and coarse sediments which settle out rapidly will give low readings. Finely divided air bubbles will give high readings.

3.0 PRECISION AND REPORTING LIMIT

The sensitivity of the instrument should permit detection of a turbidity difference of 0.02 unit or less in waters having turbidities less than 1 unit.

4.0 REAGENTS

For turbidity-free water, pass distilled water through a 0.2 µm Gelman nuclepore filter, if such filtered water shows a lower turbidity than the distilled water.

5.0 METHODS

5.1 Instrument Conditions

- o See the Hach Instruction Manual for the Model 16800, Portolab Turbidimeter, for operating instructions (4).

o To maximize the intensity of light passing through the solution, the sample tubes must be of clear, colorless glass. They should be thoroughly cleansed, both inside and out, and discarded when they become scratched or etched. They should be provided with a protective case or be of sufficient length to prevent any handling on that part of the tube through which light will pass.

5.2 Standards

The AMCO-AEPA-1 standard as supplied requires no preparation or dilution prior to use.

5.3 Analytical Method

1. Linear calibration should be performed within six months of analysis.

- a. Empty and rinse chosen cuvette twice with approximately 5 ml of the highest NTU value in range to be calibrated.
- b. Dry exterior with lint-free paper.
- c. Fill cuvette with the highest standard for the range and insert the cuvette into the instrument well, making sure to align index marks.
- d. Adjust the 'standardize' controls so the instrument reads the known value.
- e. Empty the cuvette, rinse, and fill the same cuvette with the next lower value for that range. Clean cuvette, place in instrument, index, and read.
- f. Repeat for all standards in that range.
- g. Set up tables for standard true values versus instrument readings. Plot each range on linear paper.

2. Daily calibration should be performed whenever samples are run and include a blank.

- a. If sample and/or standard are refrigerated, allow to reach room temperature in the cuvette before taking a reading.
- b. Select a clean, scratch-free, indexed cuvette and rinse twice with 5 ml of the daily calibration standard.
- c. Fill and clean cuvette and insert it into the instrument well, making sure to align the index marks.
- d. From the linear calibration curve for the range under

standardization and the known value of the standard, determine what the reading should be. Note: Adjust the instrument to the calibration curve value, not to the value indicated on the bottle of standard.

- e. For turbidities less than 40 units, shake the sample to thoroughly disperse the solids. Wait until air bubbles disappear, then pour the sample into the turbidimeter tube.

Read the turbidity directly from the appropriate calibration curve.

- f. For turbidities exceeding 40 units, dilute the sample with one or more volumes of filtered (0.45- μ m pore size) sample until the turbidity falls below 40 units. Diluting with water may dissolve some of the turbidity (4).

6.0 CALCULATIONS

Multiply sample readings by the appropriate dilution to obtain final readings. Report results as follows:

NTU		Record to Nearest:
0.0 -	1.0	0.05
1 -	10	0.1
10 -	40	1
40 -	100	5
100 -	400	10
400 -	1000	50
>	1000	100

The data and results are then recorded on the appropriate analytical worksheet (see Introduction, Section 4.0, of this manual). The actual conditions during measurement, if different from those called for in this method, should be noted on the back of the worksheet.

7.0 NOTES

The sample size for all turbidity measurements should be 18 ml. Use the line on the sample cell as a level indicator. Variations in sample volume can affect the accuracy of the determinations.

NTU is considered comparable to the Formazin Turbidity Unit (FTU) and the Jackson Turbidity Unit (JTU).

8.0 REFERENCES

1. EPA 600/4-79-020, Method 180.1.

2. Annual Book of ASTM Standards, Part 31, 'Water,' Standard D1889-71, p. 223 (1976).
3. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p. 132, Method 214A (1975).
4. Hach Instruction Manual, Portalab Turbidimeter, Model 16800.

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B1.4 Field Measurement of pH

Standard Test Method for the Field Measurement of pH

Introduction

Perhaps no water-quality parameter is measured as frequently as pH. The pH measurement is so easily made that the attention given to it is often inadequate. An accurate pH is critical for the prediction and interpretation of the reactions and migration of dissolved species. This procedure provides a useful pH measurement under most field situations.

1. Scope

1.1 This method contains the procedures for the measurement of pH in an aqueous solution. The pH is determined using a glass hydrogen-ion electrode compared against a reference electrode of known potential by means of a pH meter.

2. Referenced Documents

2.1 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, D1293-78, 1984.

2.2 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, Washington, D.C., 1980.

2.3 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

2.4 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

3. Hazard Analysis

3.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents of a particular project.

4. Significance and Use

4.1 The pH of a solution is defined as the negative logarithm to the base 10 of the hydrogen-ion activity in moles per liter: $\text{pH} = -\log [\text{H}^+]$. Because

pH is exponentially related to concentration, great care shall be taken in making the measurement.

4.2 Natural waters usually have pH values in the range of 4 to 9. The primary control over pH in natural waters is the carbonate system, including gaseous and dissolved carbon dioxide, bicarbonate, and carbonate ions.

5. Interferences

5.1 Temperature, atmospheric contamination, and ionic strength are factors that affect pH measurements. The pH measurement is relatively free from interference from color, turbidity, colloidal matter, oxidants, or reductants.

5.1.1 *Temperature*—The temperature compensation on a pH meter only permits adjustment of the electrode slope. It does not compensate for changes in the potential of the reference electrode, the asymmetry potential of the glass electrode, or the liquid-junction potential. Nor does it compensate for changes in pH due to temperature. Thus, the temperature of the buffer and the unknown shall be recorded at the time of measurement. Ideally, their temperatures shall be within 10 °C.

5.1.2 *Atmospheric Contamination*—Atmospheric contamination can be a significant problem for groundwater samples. Dissolved oxygen and carbon dioxide can be evolved or dissolved when the sample is exposed to air, and a considerable change in pH may result. In situ measurements should be taken where possible but, for groundwater that must be pumped, the use of a flow cell gives the best results. See Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)].

5.1.3 *Ionic Strength*—Because of errors due to ionic strength (which are not worth correcting in the field), pH measurements shall be accompanied by a measurement of the specific conductance. The pH is a measurement of the hydrogen-ion activity. An ideal solution is assumed in which other ions

do not affect the hydrogen activity. This assumption deteriorates if the ionic strength is too high. Similarly, samples with low ionic strength will cause difficulties because the resistance of the sample approaches that of the glass electrode. For best results, samples with very low ionic strength should be stirred for a few seconds prior to the reading. Even then, it may require several minutes for the reading to stabilize.

5.1.4 *High Sodium and Alkalinity*—High sodium and alkalinity may also produce errors in the pH measurement. For pH 9 and a sodium concentration of 10 moles per liter, a special electrode is needed. Similarly, any pH value that is less than 1 or greater than 9 will have a greater uncertainty associated with it because the electrode response is non-Nernstian in these regions.

6. Apparatus

6.1 Numerous pH meters are available; the meter used should have a temperature compensating device, a slope adjustment, and be capable of reading pH to ± 0.01 units.

6.2 A flow cell to be used for continuous-flow measurements.

6.3 Standard pH-buffer solutions of 4.00, 7.00, and 9.00 or 10.00.

6.4 Combination pH electrode.

6.5 Temperature-measuring device capable of reading temperatures to ± 0.1 °C.

6.6 Distilled or deionized water in a squeeze wash bottle.

6.7 Kimwipes® or equivalent lint-free tissue.

6.8 Disposable beakers, test tubes, or centrifuge tubes.

7. Calibration

7.1 In each case, samplers shall follow the manufacturer's instructions for the pH meter and electrode used. Electrodes shall be kept wet when not in use. Recommended solutions for storage are the pH 4.00 or pH 7.00 buffer.

7.2 Before use, remove electrode from the storage solution, rinse with distilled water, and blot dry with a lint-free tissue.

7.3 Adjust buffer solution and electrode to ± 10 °C of the sample temperature. This can be

done by storing the buffer solutions and electrode in an ice chest or by letting sample water run over the buffer bottles and electrode until the temperatures have equilibrated.

7.4 Place the electrode in the pH 7.00 buffer, adjust the temperature compensation control to the temperature of the buffer (or use an automatic temperature compensator), and adjust the calibration control to read the pH of the buffer. The pH of the buffer is equal to 7.00 only at 25 °C; therefore, it is necessary to use the temperature-correction curve supplied by the manufacturer of the buffer.

7.5 Remove the electrode from the 7.00 buffer, rinse with distilled water, and blot dry. Place the electrode in either pH 4.00 or pH 10.00 buffer, bracketing the expected pH of the sample. Allow the reading to stabilize before making adjustments. Adjust the slope control to read the correct pH, again consulting the temperature-correction curve supplied by the manufacturer.

7.6 Rinse electrode with distilled water and blot dry. Recheck value of the pH 7.00 buffer. The value shall be within ± 0.02 pH of the correct value. If not, repeat steps 7.4, 7.5, and 7.6.

8. Procedure

8.1 The following general procedure supplements the instruction in the instrument-specific operating manual.

8.1.1 Rinse calibrated electrode (see Section 7) with distilled water, blot dry, and immerse electrode in the solution.

8.1.2 Use of a flow cell is recommended for making pH measurements; this reduces the interferences due to atmospheric contamination. If possible, in situ measurements are the best.

8.1.3 Allow the measurement to stabilize and record the reading.

8.1.4 Remove the electrode from the solution, rinse with distilled water, blot dry, and store in pH 4.00 or pH 7.00 buffer solution.

9. Quality Assurance

9.1 The following information about the field measurement of pH shall be logged for quality-assurance documentation.

9.1.1 Time of the last two-buffer calibration. The two-buffer calibration shall be performed a minimum of once each hour.

9.1.2 Buffer temperature at time of calibration.

9.1.3 Sample temperature at time of measurement.

9.1.4 Measurement conditions (i.e., in situ, open container, or air-exclusion container).

9.1.5 Source and expiration date of buffers used.

9.1.6 Instrument manufacturer and model number.

9.1.7 Name of person performing the measurement.

10. Precision and Bias

10.1 Precision of ± 0.02 pH units and an accuracy of ± 0.05 pH units can be achieved. However, ± 0.1 pH units represent the limit of accuracy under normal conditions.

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B1.5 Field Measurement of Specific Conductance

Standard Test Method for the Field Measurement of Specific Conductance

Introduction

Specific conductance is a widely used indicator of water quality. It measures the ability of water to carry an electrical current under specific conditions. This ability depends on the presence of ions, their total concentration mobility, and temperature. Specific conductance is a simple indicator of change within a system and is used as an aid in evaluating whether a sample is representative of the water in the system.

1. Scope

1.1 This procedure describes the field measurement of the specific conductance of a aqueous sample. The specific conductance is measured using a conductance meter and a platinum or stainless steel electrode.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater: American Public Health Association, Washington, D.C., 1980.*

3.2 Korte, N. and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.3 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 The specific conductance or conductivity of a sample is defined as the conductance of the sample between opposite sides of a cube, 1 centimeter (cm) in each direction. Because it is impractical to build electrodes with these characteristics, electrodes are manufactured in various forms. A

cell constant is determined by measuring a solution of known conductivity. Solutions of known conductivity are purchased or can be made from reagent-grade KCl. Samplers shall consult operating instructions for the specific instrument used for the determination of the cell constant. This conductivity is expressed in micromhos per centimeter ($\mu\text{mhos/cm}$).

5. Interferences

5.1 Temperature, ionic strength, and the determination of the cell constant are features that affect the measurement of conductivity.

5.1.1 *Temperature*—The conductivity of a solution increases with temperature at approximately 2 percent per degree C. Significant errors can result from inaccurate temperature measurements.

5.1.1.1 If the conductivity meter does not have automatic temperature correction, the sampler can use the following formula to correct the conductivity reading for temperature.

$$K = \frac{E_m}{1 + 0.0191(t - 25)}$$

where

K = corrected conductivity in $\mu\text{mhos/cm}$,

E_m = measured conductivity in $\mu\text{mhos/cm}$,
and

t = temperature in °C.

5.1.2 *Ionic Strength*—The conductivity of a solution is a function of the concentration and charge of the ions in solution and of the rate the ions move under the influence of an electrical potential. As the ionic strength increases, the rate the individual ions move decreases. Conductivity varies linearly with ionic strength for values below 1,000 $\mu\text{mhos/cm}$. As conductivity increases above 5,000 $\mu\text{mhos/cm}$, the line curves significantly; beyond 50,000

$\mu\text{mhos/cm}$, the conductivity is an unsatisfactory index of ionic concentration.

5.1.3 *Cell Constant*—The cell constant shall be checked and verified on a regular basis. A significant change in the cell constant indicates that the electrode needs cleaning or changing. Consult the instrument operating manual for procedures to check the cell constant, or see Section 7 of this procedure.

6. Apparatus

6.1 Specific conductance meter capable of measuring conductivity in the range of 0 to 100,000 $\mu\text{mhos/cm}$. This meter should also measure temperatures in the range of $-5\text{ }^{\circ}\text{C}$ to $50\text{ }^{\circ}\text{C}$.

6.2 Conductivity check solutions. Normally, 0.001 N, 0.01 N, and 0.1 N KCl solutions will cover the range of expected sample conductivity..

6.3 Distilled or deionized water in a squeeze bottle.

6.4 Disposable beakers, test tubes, or centrifuge tubes.

6.5 Kimwipes® or equivalent lint-free tissue.

7. Calibration

7.1 An actual calibration of the instrument is not performed. The cell/instrument calibration is confirmed by use of standard check solutions as described below.

7.1.1 Connect the temperature probe and conductivity cell to the instrument.

7.1.2 Rinse the temperature probe and conductivity cell with distilled water and blot dry with a lint-free tissue.

7.1.3 Place the temperature probe and conductivity cell in the 0.001 N KCl standard and allow the readings to stabilize. Record the temperature and conductivity reading in the field logbook.

7.1.4 Repeat steps 7.3 and 7.4 for the 0.01 N and the 0.1 N KCl standards.

7.1.5 Correct the readings to $25\text{ }^{\circ}\text{C}$ using the formula in Section 5.1.1.1 and compare these readings to the standard values. If these readings are within ± 10 percent of the accepted value, the cell instrument-calibration check is acceptable.

7.1.6 If the cell/instrument calibration check is unacceptable, consult the instrument operation manual for cell cleaning and instrument troubleshooting procedures.

8. Procedure

8.1 The following general procedure is supplemental to the instructions in the instrument-specific operating manual.

8.1.1 Rinse the conductivity cell and temperature probe with several volumes of sample water.

8.1.2 Immerse the probe and cell in the sample.

8.1.3 Allow the readings to stabilize and record the temperature and conductivity readings on the field log form.

8.1.4 Remove the probes from the solution, rinse with distilled water, blot dry, and store according to the manufacturer's recommended procedures.

9. Quality Assurance

9.1 The following information about the field measurement of specific conductance shall be logged for quality-assurance documentation.

9.1.1 Source and expiration date of standards.

9.1.2 Instrument manufacturer and model number.

9.1.3 Date and time of calibration check.

9.1.4 Temperature and conductivity of standards used to check calibration.

9.1.5 Sample temperature and conductivity reading.

9.1.6 Name of person performing the measurement.

10. Precision and Bias

10.1 Precision and accuracy of ± 5 percent can be achieved with this procedure at conductivity readings between 100 and 5,000 $\mu\text{mhos/cm}$. Readings between 0 and 100 $\mu\text{mhos/cm}$ and above 5,000 $\mu\text{mhos/cm}$ should provide ± 10 percent precision and accuracy. Readings above 20,000 $\mu\text{mhos/cm}$ shall not be attempted with this procedure.

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B1.6 Field Measurement of Eh

Standard Test Method for the Field Measurement of the Oxidation-Reduction Potential (Eh)

Introduction

Knowledge of a system's oxidation/reduction potential (Eh) is useful for predicting the migration or attenuation of contaminants in groundwater or surface water. The measurement, however, should be applied with caution. Only under certain conditions are Eh measurements reliable; they are primarily used as a descriptive tool.

1. Scope

1.1 This method describes the procedure for the measurement of the Eh in aqueous samples; it does not address the theoretical interpretation of the oxidation-reduction potential. This procedure has been designed for routine field measurements.

2. Hazard Analysis

2.1 This test method uses a ZoBell solution for an Eh reference. This solution contains small concentrations of potassium cyanide. Potassium cyanide is a poison and is a Department of Transportation (DOT)-regulated material; its hazard class is Poison B. Samplers shall wear eye protection and disposable gloves to avoid eye and skin contact and shall keep the solution away from strong acids that will liberate hydrogen cyanide gas, which is extremely toxic.

2.2 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, D1498-76, 1984.

3.2 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.3 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," in *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 The oxidation-reduction potential is defined as the electromotive force developed when a noble metal electrode and a reference electrode are placed in an aqueous sample. This potential, sometimes referred to as the redox potential, is related to the standard potential by the Nernst equation:

$$E_h = E^\circ + \frac{RT}{nF} \ln \frac{\text{oxidized state}}{\text{reduced state}}$$

where

E° = standard potential of the reaction,

R = gas constant,

T = absolute temperature,

F = Faraday constant, and

n = number of electrons involved in the half-cell reaction.

The potential is reported as volts (V) or millivolts (mV) relative to the standard hydrogen electrode taken as zero.

5. Interferences

5.1 Eh is sensitive to temperature change of the solution. Because the reference-electrode potential and the liquid-junction potential also vary with temperature, instrumental compensation is not possible. Reference solutions used to check the accuracy of the electrode system should be within $\pm 10^\circ\text{C}$ of the sample temperature for the readings to be valid.

5.2 Reproducible Eh measurements cannot be obtained for chemical systems that are not reversible. Samples containing dissolved oxygen above 0.01 parts per million (ppm) are essentially irreversible, and Eh measurements are not recommended. Since exposure to the atmosphere can cause rapid

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changes in dissolved oxygen, all sample measurements shall be taken in a closed, flow-through container or in situ.

5.3 Samples containing hydrogen sulfide will poison the electrode as will other ions that are stronger reducing agents than platinum.

5.4 Eh measurements are relatively free from interferences from color, turbidity, colloidal matter, and suspended matter.

6. Apparatus

6.1 Most field pH meters have the capability of measuring Eh by substitution of an appropriate set of electrodes. The meter should be capable of measuring Eh to ± 1 mV.

6.2 Combination Eh electrode.

6.3 ZoBell reference solution.

Caution: This solution is poisonous and shall be handled with care. Potassium cyanide is a DOT-regulated material; its hazard class is Poison B.

6.4 Temperature-measuring device capable of reading temperatures to ± 0.1 °C.

6.5 A flow cell. See Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)].

6.6 Distilled or deionized water in a squeeze wash bottle.

6.7 Kimwipes® or equivalent lint-free tissue.

6.8 Disposable beakers, test tubes, or centrifuge tubes.

7. Calibration

7.1 An actual calibration of the Eh electrode system is not performed. Instead, samplers shall make a performance check to determine if the electrode and meter are functioning properly. The performance check is as follows:

7.1.1 Record temperature of ZoBell solution. This solution should be within ± 10 °C of sample temperature.

7.1.2 Place electrode in the ZoBell solution and compare the reading with the theoretical value for the ZoBell solution (see Figure 1). The reading should be within ± 10 mV of the theoretical value.

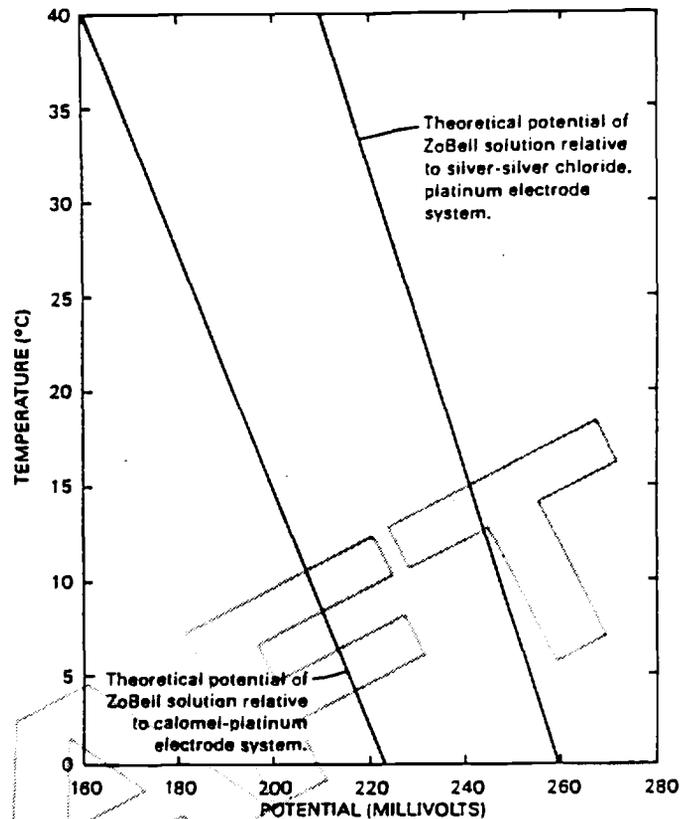


Figure 1. The Potential of ZoBell Solution Relative to Reference-Electrode Systems at Various Temperatures

7.1.3 If the reading is not within ± 10 mV, one of the following steps will usually solve the problem.

7.1.3.1 Check reference electrode filling solution; fill or replace.

7.1.3.2 Polish the platinum end of the electrode (see manufacturer's instructions).

7.1.3.3 Replace electrode.

7.1.4 Rinse electrode with distilled water, blot dry, and store according to manufacturer's suggestions.

8. Procedure

8.1 Check electrode performance according to Section 7.1.2.

8.2 Rinse electrode with distilled water and blot dry with a lint-free tissue.

8.3 Place electrode in flow-through cell and pump sample through cell for several minutes to exclude air.

8.4 Turn function switch on meter to the millivolt mode.

8.5 Allow the readings to stabilize. Stabilization should occur within 20 minutes. Turn off sample flow to prevent any streaming potential.

8.6 Record the Eh reading and temperature.

8.7 Remove the electrode from the cell, rinse with distilled water, blot dry, and store according to manufacturer's suggestion.

9. Quality Assurance

9.1 The following information about the Eh measurement shall be logged for quality-assurance documentation.

9.1.1 Temperature of sample.

9.1.2 Temperature of ZoBell solution.

9.1.3 Eh of ZoBell solution.

9.1.4 Theoretical Eh of ZoBell solution relative to the reference electrode used (Figure 1).

9.1.5 Eh of sample.

9.1.6 Theoretical Eh of ZoBell solution relative to the standard hydrogen electrode (Figure 2).

9.1.7 Name of person performing the measurement.

10. Calculation

10.1 The Eh of the sample is calculated relative to the standard hydrogen electrode as follows:

$$D = A - B + C$$

where

D = Eh of sample relative to the standard hydrogen electrode,

A = Observed Eh of sample,

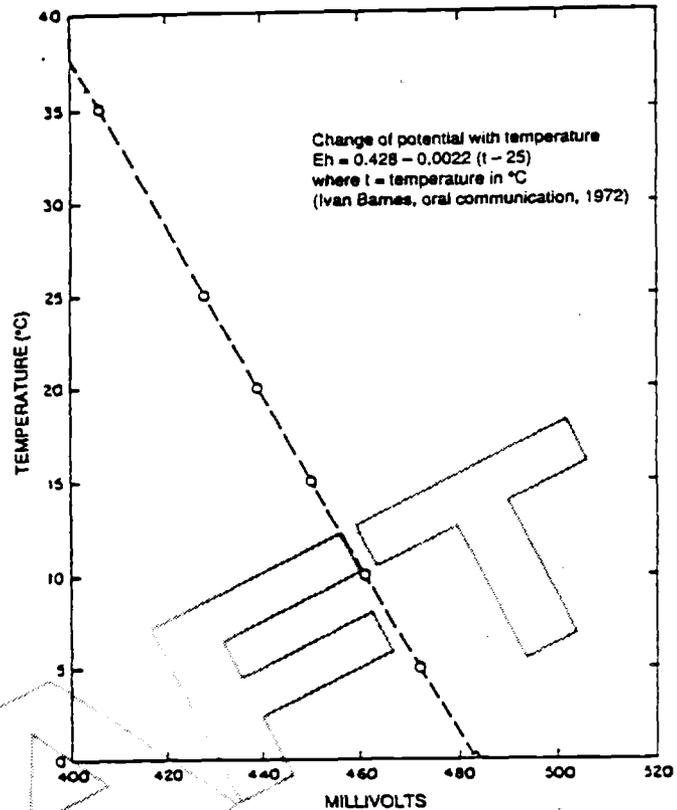


Figure 2. The Potential of ZoBell Solution, Relative to the Standard Hydrogen Electrode at Various Temperatures.

B = Observed Eh of ZoBell solution, and

C = Theoretical Eh of ZoBell solution relative to the standard hydrogen electrode.

Report D to the nearest ± 10 mV.

11. Precision and Bias

11.1 Precision and accuracy of the measurement depend largely on the condition of the electrode system and the degree to which the sample fits the interference problems mentioned in Section 5. In the absence of substances that coat or poison the electrode, the precision is ± 10 mV.

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B1.7 Field Alkalinity Measurements

Standard Test Method for the Field Measurement of Alkalinity

Introduction

The alkalinity of a water sample is a quantitative measurement of the ability of the sample to react with a strong acid to a designated pH. The alkalinity of natural waters is primarily a measure of the carbonate, bicarbonate, and hydroxide content. It is also a general indicator of groundwater quality.

1. Scope

1.1 This method describes the field measurement of alkalinity of aqueous samples. It is a measure of the aggregate property of the sample and can be interpreted in the terms of specific substances, such as carbonate and bicarbonate, only when the chemical composition of the sample is known.

1.2 The sample is titrated with a standard acid solution to a designated pH, and the end point is determined by a color change of an internal indicator.

2. Hazard Analysis

2.1 This test procedure uses sulfuric acid (H_2SO_4). Sulfuric acid is a corrosive material and is a Department of Transportation (DOT)-regulated material; its hazard class is Corrosive Liquid. Avoid contact with eyes, skin, and clothing. Adequate ventilation, eye protection, and disposable gloves are required. First aid for eye and skin contact is to immediately flush with water for 15 minutes, remove contaminated clothing, and call a physician.

2.2 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, American Water Works Association, and Water Pollution Control Federation, Washington, D.C., 1980.

3.2 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, 1984.

3.3 Korte, N. and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U. S. Department of Energy, Grand Junction Area Office, GI/TMC-07(83), 1983.

3.4 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D. C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 The alkalinity of natural water is commonly used to obtain a value for the carbonate and bicarbonate concentrations. Carbonate and bicarbonate determinations shall be made in the field at the time of sampling if the concentrations are to accurately reflect those concentrations originally present in the sample.

4.2 The following equations govern the reactions involved:

$CO_3 + H = HCO_3$ (this reaction is complete near pH 8.3),

$HCO_3 + H = H_2O + CO_2$ (this reaction is complete near pH 4.5).

The end point of pH 8.3 is determined by the color change of the phenolphthalein indicator, and the end point of the pH 4.5 is determined by the color change of the Bromocresol Green-Methyl Red indicator.

Note: If the measured pH of the sample is less than 4.5, there is no carbonate or bicarbonate alkalinity and this test method is not applicable.

5. Interferences

5.1 The measured values may include contributions from borates, phosphates, or silicates if these are present in the sample.

5.2 Natural color or the formation of precipitate while titrating the sample may mask the color change of the indicator, or waste materials may interfere chemically with the color change by destroying the indicator.

5.3 Varying results may be experienced with samples containing oxidizing or reducing substances.

6. Apparatus

6.1 Hach alkalinity test kit Model AL-DT. (This kit contains sulfuric acid which is a DOT-regulated material; its hazard class is Corrosive Liquid.)

6.2 Distilled or deionized water in a squeeze bottle.

6.3 Kimwipes® or equivalent lint-free tissue.

7. Procedure

7.1 Attach a clean, straight-stem delivery tube to a sulfuric acid titration cartridge. If the expected alkalinity is below 100 milligrams per liter (mg/L) as CaCO_3 , use a 0.16 N H_2SO_4 cartridge; if it is above 100 mg/L as CaCO_3 , use a 1.6 N H_2SO_4 cartridge; or if it is above 1,000 mg/L, use a 8.0 N H_2SO_4 cartridge. Twist the cartridge onto the titrator body.

7.2 Flush out the delivery tube by turning the small knob until a few drops of titrant are ejected from the tube. Wipe the tip and reset the counter to zero. Ensure that there are no air bubbles in the cartridge.

7.3 Take a sample by filling a clean 100-mL graduated cylinder to the 100-mL mark with water that has been filtered through a 0.45 micrometer (μm) filter. Pour the sample into a clean 250-mL Erlenmeyer flask.

7.4 Measure the pH of the sample, see Standard Test Method for the Field Measurement of pH [LQ-4(T)]. If the pH of the sample is less than 8.3, proceed to step 7.8; if the pH of the sample is greater than 8.3, proceed to step 7.5.

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

7.6 If the color turns pink, titrate with the sulfuric acid standard solution to a colorless end point. If the pink color does not develop, proceed with step 7.8.

7.7 Read and record the amount of acid used. This is the amount of carbonate alkalinity, sometimes referred to as phenolphthalein alkalinity. See Section 8 for calculations.

7.8 Add the contents of one Bromocresol Green-Methyl Red Indicator Powder Pillow to the sample and swirl to mix.

7.9 Titrate the sample with the sulfuric acid standard solution until a light pink color is obtained. Read and record the amount of acid used. This is the amount of total alkalinity. See Section 8 for calculations.

7.10 Pour the titrated sample into a properly labeled disposal container, rinse the Erlenmeyer flask and the graduated cylinder with distilled or deionized water, and place the items back in the kit.

8. Calculations

8.1 The results are reported in mg/L of CaCO_3 . The calculation depends on the normality of the sulfuric acid titration cartridge used. The calculations are performed as follows.

8.1.1 When using the 0.16 N H_2SO_4 titration cartridge, the digital readout from the titrator is multiplied by 0.1 to obtain alkalinity results in mg/L as CaCO_3 .

8.1.2 When using the 1.6 N H_2SO_4 titration cartridge, the results from the digital readout of the titrator are equivalent to mg/L as CaCO_3 .

8.1.3 When using the 8.0 N H_2SO_4 titration cartridge, the results from the digital readout of the

titrator are multiplied by 5.0 to obtain alkalinity in mg/L as CaCO₃.

9. Quality Assurance

9.1 The following information about the field measurement of alkalinity shall be logged for quality-assurance documentation.

9.1.1 Normality of the titration cartridge.

9.1.2 Phenolphthalein alkalinity.

9.1.3 Total alkalinity.

9.1.4 Name of person performing the measurement.

10. Precision and Bias

10.1 Under normal conditions, precision and accuracy of ± 15 percent can be expected from this procedure.

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B1.8 Field Measurement of Temperature

Standard Test Method for the Field Measurement of Temperature

Introduction

Temperature readings are important for numerous applications. They are used in the measurement of Eh, pH, conductivity, and dissolved oxygen; and in saturation and stability studies. It is important to know the temperature of surface waters and groundwaters for the accurate geochemical evaluation of equilibrium thermodynamics. Temperature readings of ± 1 °C are necessary for the above applications.

1. Scope

1.1 This procedure gives general guidance and recommendations that shall be considered when taking a temperature measurement. There are numerous instruments on the market that can provide adequate temperature measurements. Each instrument-operating manual shall be consulted for detailed procedures.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, American Water Works Association, and Water Pollution Control Federation, Washington, D.C., 1980.

3.2 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D. C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 Temperature is a basic physical property that is measured by the response of matter to heat. There are many devices that, once calibrated, are acceptable for taking temperature measurements.

These devices include liquid in glass (mercury in glass), thermocouples, bimetallic, and electrical-resistance thermometers. At a minimum, the device should measure temperature to ± 0.1 °C readability.

5. Interferences

5.1 The instrument-operating manual shall be consulted to identify any interferences particular to the device being used.

5.2 In general, the true sample temperature is affected by the atmospheric temperature of the surroundings and the temperature of the devices used to collect the sample.

6. Apparatus

- 6.1 Temperature-measuring device.
- 6.2 Distilled or deionized water in a squeeze wash bottle.
- 6.3 Kimwipes® or equivalent lint-free tissue.

7. Calibration

7.1 The instrument-operating manual shall be consulted for specific calibrating procedures.

8. Procedure

- 8.1 Rinse the thermometer with distilled or deionized water and blot dry.
- 8.2 Immerse the thermometer in the sample.
- 8.3 Allow the reading to stabilize and record the temperature.

9. Quality Assurance

9.1 The following information about the temperature measurement shall be logged for quality-assurance documentation.

9.1.1 Instrument used.

9.1.2 Temperature of sample.

9.1.3 Name of person performing the measurement.

10. Precision and Bias

10.1 Precision is instrument-dependent. Most measurement devices for field use are accurate to ± 0.1 °C.

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B1.9 Field Measurement of Dissolved Oxygen

SITE SPECIFIC PROCEDURE CHANGE or NOTICE

PROCEDURE Standard Test Method for the Field Measurement of Dissolved Oxygen

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8. Procedure

8.1.2 The standard test method states: "Move the probe through the water or pump through a flow cell to ensure a velocity of at least 1 foot per second past the probe." At AFP4, a YSI stirring device will be attached directly to the tip of the sampling probe that guarantees a minimum velocity of at least 1 foot per second. A separate flow cell, designed to prevent atmospheric contact with the sample stream, and incorporating the probe and stirrer will be used to take the measurements.

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Standard Test Method for the Field Measurement of Dissolved Oxygen

Introduction

Dissolved oxygen (DO) is required for the survival and growth of many aquatic organisms and the absence of dissolved oxygen may permit anaerobic decay of organic matter and the production of toxic and esthetically undesirable materials in the water. The measurement of dissolved oxygen is needed to accurately characterize the oxidation-reduction potential of a hydrologic system and can be an indicator of atmospheric contact of water before recharge to an aquifer.

1. Scope

1.1 This method contains the field procedures used to determine dissolved oxygen in aqueous samples using a polarographic technique with a membrane-covered electrode. The probe method is much more rapid and efficient than other methods, has fewer interferences, and can be used for continuous monitoring.

2. Referenced Documents

2.1 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C., 1980.

2.2 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, 1984.

2.3 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations for the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

2.4 Korte, N. and D. Ealey, *Procedures for Field Chemical Analyses for Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3. Hazard Analysis

3.1 This test method uses sodium sulfite and cobaltous chloride for the preparation of the zero-oxygen check solution. These chemicals are toxic in the concentrated form and the following precautions must be taken in the preparation of this solution. Avoid contact with the eyes and skin.

Avoid breathing suspended particles. Adequate ventilation, eye protection, and disposable gloves are required. First aid for eye contact is to flush the eyes with water for 15 minutes and contact a physician. First aid for skin contact is to wash the area thoroughly with soap and water.

3.2 Site-specific controls are available in the planning documents for a particular project.

4. Significance and Use

4.1 Oxygen-sensitive membrane electrodes are composed of two solid metal electrodes separated from the sample by an oxygen-permeable membrane. The membrane serves as a diffusion barrier against impurities. The rate of oxygen diffusion across the membrane creates a current that is directly proportional to the amount of dissolved oxygen in the sample. This current is converted to concentration units during the calibration.

5. Interferences

5.1 Membrane electrodes are sensitive to temperature variations. Most DO meters have automatic temperature compensators that correct for these variations. If not, thermal equilibrium must be established between the sample being measured and the calibrating solution.

5.2 Oxygen-permeable membranes are also permeable to other gases that can affect the measurement. Chlorine and hydrogen sulfide will eventually desensitize the probe during long-term exposures. These gases are not normally found in groundwater samples, or their concentrations are too small to cause significant problems.

5.3 Because atmospheric oxygen is rapidly absorbed by water samples, use of an air-exclusion

chamber is required if in situ measurements cannot be made.

6. Apparatus

6.1 Dissolved oxygen meter, Yellow Springs Instruments (YSI) Model 57.

6.2 Yellow Springs Instruments (YSI) 5739 dissolved-oxygen probe.

6.3 Bottle of electrolyte and extra membranes for probe.

6.4 Sodium sulfite and cobaltous chloride.

6.5 Distilled or deionized water in a squeeze wash bottle.

6.6 Kimwipes® or equivalent lint-free tissue.

6.7 Flow cell, see Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(T)].

7. Calibration

7.1 The following steps describe the calibration of the YSI Model 57 meter and the YSI 5739 probe in water-saturated air.

7.1.1 Adjust the mechanical ZERO with the instrument turned OFF.

7.1.2 Turn the control knob to the "red line" position and adjust if necessary.

7.1.3 Plug probe into instrument and wait about 15 minutes for the probe to polarize.

7.1.4 Turn the control knob to ZERO and adjust if necessary.

7.1.5 Turn the salinity knob to FRESH. A salinity correction will not be needed because the calibration is performed with distilled water.

7.1.6 Insert the probe about 4 centimeters (cm) into the open end of the bottomless plastic storage bottle containing a small sponge soaked with deionized water. Ensure that there is a tight fit between the probe and bottle and that there are no droplets of water on the probe membrane.

7.1.7 Allow at least 10 minutes for the system to reach constant temperature and 100 percent relative humidity. Be careful that this step is carried out in a constant temperature environment. Typically, bathe the bottle in a stream of the water to be tested, or at least keep the bottle in the shade during equilibration.

7.1.8 Turn the meter control knob to TEMP position and read the temperature inside the bottle to the nearest 0.5 °C.

7.1.9 Determine the DO saturation value in part per million (ppm) for that temperature from Table 1.

7.1.10 Determine the correction factor from Table 2 on the basis of either the atmospheric pressure (most accurate method) or the altitude

Table 1. Dissolved Oxygen Saturation Values at Various Temperatures

Temp (°C)	Sat. Value (ppm)						
0	14.6	12	10.8	35	8.5	36	7.0
1	14.2	13	10.6	25	8.6	37	6.8
2	13.9	14	10.4	26	8.2	38	6.7
3	13.5	15	10.2	27	8.1	39	6.6
4	13.2	16	9.9	28	7.9	40	6.5
5	12.8	17	9.7	29	7.8	41	6.4
6	12.5	18	9.5	30	7.7	42	6.3
7	12.2	19	9.3	31	7.5	43	6.2
8	11.9	20	9.2	32	7.4	44	6.1
9	11.6	21	9.0	33	7.3	45	6.0
10	11.3	22	8.8	34	7.2		
11	11.1	23	8.7	35	7.1		

above sea level. (Tables 1 and 2 are also available on the back of the YSI 57).

Table 2. Correction Factors for Dissolved Oxygen Saturation Values as Determined by Pressure or Altitude

Pressure (mm)	Altitude (ft)	Correction Factor
775	-540	1.02
760	0	1.00
745	542	0.98
730	1094	0.96
714	1688	0.94
699	2274	0.92
684	2864	0.90
669	3466	0.88
654	4082	0.86
638	4756	0.84
623	5403	0.82
608	6065	0.80
593	6744	0.78
578	7440	0.76
562	8204	0.74
547	8939	0.72
532	9694	0.70
517	10472	0.68
502	11272	0.66

7.11 Multiply the correction factor by the saturation value to obtain the calibration value.

7.12 Turn the meter control knob to the desired range and adjust the calibration knob to set the meter to the calibration value.

7.13 Perform zero oxygen check as follows. Prepare a solution containing 1 gram of sodium sulfite (Na₂SO₃) and about 1 milligram of cobaltous chloride (CoCl₂) in 1 liter of deionized water. Insert the probe into this solution and measure the dissolved oxygen. The instrument will read less than 0.2 milligram per liter (mg/L) if the probe is functioning properly.

Caution: These chemicals are toxic in the concentrated form. Avoid eye and skin contact by wearing eye protection and disposable gloves.

7.14 Leave the meter turned on during the entire day on which measurements are being taken.

Note: If the high sensitive membrane (0.0005-inch thick FEP Teflon[®]) is being used on the probe, the DO readings from the meter must all be divided by 2 to obtain the true DO value.

8. Procedure

8.1 The following steps outline the field measurement of dissolved oxygen using the YSI Model 57.

8.1.1 Remove the probe from the storage bottle and place it in the solution to be measured. An in situ measurement is preferred. If the sample is being pumped from a well, the measurement shall be made in an air-exclusion cell.

8.1.2 Move the probe through the water or pump through a flow cell to ensure a velocity of at least 1 foot per second past the probe. This prevents depletion of oxygen at the membrane-water interface.

8.1.3 Turn the meter control knob to TEMP position and record the temperature to the nearest 0.5 °C.

8.1.4 Turn the meter control knob to the proper DO scale; after the meter reading has stabilized, record DO concentration to the nearest 0.1 mg/L.

Note: If the the high-sensitive membrane (0.0005-inch thick FEP Teflon[®]) is being used, the readings need to be divided by 2 to obtain the DO concentration.

8.1.5 Remove the probe, rinse with distilled water, blot dry, and return the probe to the storage bottle.

9. Quality Assurance

9.1 The following information about the field measurement of dissolved oxygen shall be logged for quality-assurance documentation:

9.1.1 Date and time zero check was last performed.

9.1.2 Atmospheric pressure or altitude.

9.1.3 Temperature of calibration chamber.

9.1.4 DO saturation from table.

9.1.5 Correction factor used for altitude or pressure.

- 9.1.6 Calibration value.
- 9.1.7 Sample temperature.
- 9.1.8 Measured DO.
- 9.1.9 Instrument manufacturer and model number.

9.1.10 Name of person performing the measurement.

10. Precision and Bias

10.1 Under normal conditions, precision and accuracy of ± 0.5 mg/L can be expected from this procedure.

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B1.10 Field Measurements Using a Flow Cell

Standard Practice for the Use of a Flow Cell for Field Measurements

Introduction

Reliable field measurements are an essential part of a groundwater sampling program. Some properties or constituents in groundwater may change considerably within a few minutes of collection. These changes are caused by turbulence, heating or cooling, depressurization, and gas exchange with the atmosphere. Use of a closed flow-through cell will minimize these changes.

1. Scope

1.1 This procedure describes the use of a closed flow-through cell for monitoring selected chemical parameters in groundwater. The cell is used when monitoring the purging of stagnant water from monitoring wells prior to sample collection and for the measurement of pH, Eh, conductivity, temperature, and dissolved oxygen under conditions as close to in situ as practical. A flow-through cell can be purchased from various suppliers or can be constructed as described in references 3.1 and 3.2.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 Garske, E., and R. Schock, "An Inexpensive Flow-Through Cell and Measurement System for Monitoring Selected Chemical Parameters in Ground Water," *Ground Water Monitoring Review*, Summer 1986.

3.2 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.3 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," Chapter D2 in *Techniques of Water-Resources Investigations of the United States Geological Survey*, Book 1, 1976.

4. Significance and Use

4.1 Flow cells allow the sampler to obtain test results that are more representative of conditions found in the water when it resided in the ground.

That is, fewer chemical and physical changes occur if the test is made immediately through a flow cell than if the water is exposed to air and to a longer period of time before measurements are made.

5. Apparatus

5.1 Flow-through cell

5.2 Stoppers, fittings, valves, and tubing, as required.

6. Procedure

6.1 Connect the pump outlet to the inlet of the flow cell.

6.2 Insert calibrated electrodes into the flow cell.

6.3 Turn on the pump and pump the water through the flow cell and into a container where the pH buffers and other calibrating solutions are submerged to allow them to reach the sample-water temperature. Another technique to get calibrating solutions close to sample temperature is to store the solutions in an ice chest with ice. The requirement is to have the calibrating solutions within ± 10 degrees of the sample temperature.

6.4 Once temperature equilibrium has been established between the sample water, electrodes, and calibrating solutions, the electrodes shall be recalibrated.

6.5 Recheck electrode calibration as necessary during the purging of the well and just prior to sampling.

6.6 Turn off the pump, disconnect the tubing, and remove the electrodes from the flow cell.

6.7 Clean the flow cell with distilled water and prepare for sample collection.

7. Procedure Bias

7.1 The flow rate through the cell shall not be more than 1 liter per minute (L/m). If flow rates exceed 1 L/m, streaming potentials could occur. Streaming potentials are caused by the static-charge effect of water moving through small openings. These potentials can cause erroneous pH readings. If necessary, reduce the flow rate or stop pumping to take readings.

7.2 The cell assembly, electrodes, and hoses should be insulated or kept out of direct sunlight to reduce the effect of atmospheric temperature on the readings.

8. Quality Assurance

8.1 The use of a closed flow-through cell should be noted on the sample documentation form or in the field logbook.

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Bl.11a Sampling With a Peristaltic Pump
Bl.11b Sampling With a Bladder Pump
Bl.11c Sampling With a Bailer
Bl.11d Sampling With a Submersible Pump
Bl.11e Sampling With a COLIWASA Sampler
Bl.11f Sampling With a Dip Type Sampler
Bl.11g Sampling By Container Immersion
Bl.11h Sampling From Taps, Valves, or Faucets

SITE SPECIFIC PROCEDURE CHANGE or NOTICE

PROCEDURE Standard Practice for the Sampling of Liquids
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Sampling of Liquids Using Bailers - Support Line

Bailers used for monitor well sampling or purging shall be lowered and raised with a Teflon coated, stainless steel braided line. This line will be decontaminated after use at each well following the methods outlined in Section A-13. If the fluid level measurements taken prior to sampling indicate the presence of a light nonaqueous phase liquid (LNAPL), a disposable nylon line shall be used for bailing operations and disposed of upon completion of activity at each well.

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Standard Practice for the Sampling of Liquids

Introduction

The type of sampling equipment shall depend on the sample to be collected, which analytes the sample is being collected for, and the site-specific requirements such as depth to water, depth of well, etc. Because each sampling situation is unique, the equipment used and its application may have to be modified to ensure that a representative sample is collected and its physical and chemical integrity is maintained.

1. Scope

1.1 The procedures listed here are used to collect liquid samples. There are eight methods that can be used to collect liquid samples. Some sampling situations use a combination of these methods. For example, a peristaltic pump could be used to collect the inorganic samples and a bailer used to collect the organic samples. The eight methods are:

	Section
Method A—Sampling With a Peristaltic Pump	5-7
Method B—Sampling With a Bladder Pump	8-10
Method C—Sampling With a Bailor	11-13
Method D—Sampling With a Submersible Pump	14-16
Method E—Sampling With a Composite Liquid Waste Sampler (COLIWASA)	17-19
Method F—Sampling With a Dip-Type Sampler	20-22
Method G—Sampling by Container Immersion	23-25
Method H—Sampling From Taps, Valves, or Faucets	26-28

Method A
Sampling With a Peristaltic Pump

2. Hazard Analysis

2.1 These procedures use gasoline-powered electric generators, gasoline-powered air compressors, and battery-powered pumps and accessories. The following safety precautions shall be followed.

2.1.1 Air compressors that are belt-driven shall have a belt guard in place.

2.1.2 Care shall be taken when connecting and disconnecting equipment powered by lead-acid

batteries so as not to generate sparks that have the potential of creating an explosive hazard.

2.1.3 Gasoline is a Department of Transportation-regulated material; its hazard class is Flammable Liquid. Gasoline shall be stored in Factory Mutual-approved safety cans. Safety cans shall be well secured in the vehicle during transport. Gasoline-powered equipment shall be cool before filling, and care should be taken not to spill any gasoline.

2.1.4 Air compressors shall not be operated above rated capacities and shall be configured so as not to have any dead-end fittings above 20 pounds per square inch (psi).

2.1.5 Care shall be taken when lifting heavy equipment; proper lifting techniques shall be used.

2.1.6 Site-specific controls are available in the planning documents for a particular site.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Standard Guide for Sampling Groundwater Monitoring Wells*, D4448-85a, 1986.

3.2 U.S. Department of Energy, *The Environmental Survey Manual*, Appendix E, Volume 4, DOE/EH-0053, 1987.

3.3 U.S. Environmental Protection Agency, *Handbook Groundwater*, EPA/625/6-87/016, 1987.

3.4 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

3.5 U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste (SW-846)*, Volume 2, 1986.

4. Significance and Use

4.1 The usefulness and limitations for each of the first four sampling methods are listed in

General Considerations for the Sampling [LQ-1(G)], Table 1 through Table 5. COLIWASA samplers are useful to obtain representative samples of multiphase materials from drums or other containerized vessels. Limitations are their relative high costs and the difficulty of decontaminating the sampler. Dip samplers only collect grab samples with a limited vertical extent. The sampler must be aware of this limitation and also exclude surface debris or films from liquid surfaces if this is not desired. Contamination from plumbing is a primary concern when sampling taps, valves, or faucets.

5. Apparatus

- 5.1 Peristaltic-type pump.
- 5.2 Silicone, C-FLEX[®], or Norprene[®] tubing for the pump head.
- 5.3 Silicone, Teflon[®], polyethylene, or vinyl tubing for placing in the liquid to be sampled (suction line).
- 5.4 Generator or other source of electricity.

6. Procedure

- 6.1 The following procedure supplements the instruction in the instrument-specific operating manual.
 - 6.1.1 Place the suction line in the liquid to be sampled. If sampling a monitoring well, place the tubing inlet just above the screened interval.
 - 6.1.2 Connect the suction line to the pump.
 - 6.1.3 Turn on the pump and adjust the flow rate so sample turbulence is at a minimum. Allow several liters to flow and recheck stability parameters (i.e., pH, conductivity, and temperature).
 - 6.1.4 Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.
 - 6.1.5 Label, preserve, and document the samples as required.
 - 6.1.6 Remove the tubing from the liquid and clean and decontaminate as required.

7. Procedure Bias

7.1 Sampling organics using a peristaltic pump is not recommended. The suction lift action will strip volatiles and degas the sample. The silicone tubing tends to absorb some organics and slowly release them, contaminating subsequent samples.

Method B *Sampling With a Bladder Pump*

8. Apparatus

- 8.1 Bladder-type pump.
- 8.2 Air compressor.
- 8.3 Teflon[®], polyethylene, or vinyl tubing for the air and sample line.

9. Procedure

- 9.1 The following procedure is supplemental to the instruction in the instrument-specific operating manual.
 - 9.1.1 Lower the pump gently to a position just above the screened interval.
 - 9.1.2 Connect the air line to the pump controller.
 - 9.1.3 Initiate pumping and allow several liters of water to be pumped prior to sample collection (recheck stability parameters, i.e., pH, conductivity, and temperature).
 - 9.1.4 Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.
 - 9.1.5 Label, preserve, and document the samples as required.
 - 9.1.6 Remove the pump from the well, clean and decontaminate as required.

10. Procedure Bias

10.1 Bladder-type pumps constructed of stainless steel, Teflon[®], or both provide superior performance for most applications. The use of Teflon[®] sample- and air-line tubing allows the bladder

pump to be used for the collection of organics. The main disadvantage is the slow pumping rate, large consumption of compressed air, and difficulty in cleaning and decontaminating.

Method C
Sampling With a Bailer

11. Apparatus

- 11.1 Teflon[®] or stainless steel bailer.
- 11.2 Teflon[®] or stainless steel cable or line.
- 11.3 Bailer reel.

12. Procedure

- 12.1 Attach a properly cleaned bailer to the cable or line.
- 12.2 Lower the bailer slowly until it contacts the liquid.
- 12.3 Allow the bailer to sink until it reaches the screened interval of the well or the desired sampling point.
- 12.4 Slowly raise the bailer to the surface.
- 12.5 Tip the bailer or use a bottom-emptying device and fill a container to recheck the stability parameters (i.e., pH, conductivity, and temperature).
- 12.6 Repeat steps 12.2 through 12.5 as many times as necessary to fill the sample bottles.
- 12.7 Label, preserve, and document the samples as required.
- 12.8 Clean and decontaminate the bailer as required.

13. Procedure Bias

13.1 Bailers constructed of Teflon[®], stainless steel, or both provide adequate performance for most applications. Bailers expose part of the sample to the atmosphere during sample withdrawal and should not be used to collect samples where contact with the atmosphere is important (i.e., field measurement of dissolved oxygen and Eh). A bottom-emptying device is recommended for the collection of volatile organics using a bailer.

Method D
Sampling With a Submersible Pump

14. Apparatus

- 14.1 Submersible-type pump.
- 14.2 Discharge tubing of vinyl, polyethylene, or Teflon[®].
- 14.3 Power source of generator or batteries.

15. Procedure

- 15.1 The following procedure is supplemental to the instructions provided in the instrument-specific operating manual.
 - 15.1.1 Set up the pump according to the operating manual.
 - 15.1.2 Gently lower the pump to a position just above the screened interval.
 - 15.1.3 Initiate pumping and allow several tubing volumes of liquid to be pumped prior to sample collection. Recheck stability parameters, (i.e., pH, conductivity, and temperature).
 - 15.1.4 Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.
 - 15.1.5 Label, preserve, and document the samples as required.
 - 15.1.6 Remove the pump, clean and decontaminate as required.

16. Procedure Bias

16.1 Considerable sample agitation results when using a submersible pump. Submersible pumps are not recommended for the collection of dissolved gases, organics, or oxidation/reduction-sensitive samples. They also have a higher potential of sample contamination because of the construction material.

Method E
Sampling With a COLIWASA Sampler

17. Apparatus

- 17.1 COLIWASA-type sampler constructed of stainless steel, Teflon[®], polyethylene, or glass.

17.2 Teflon[®], stainless steel, or nylon suspension line.

17.3 Disposable gloves.

17.4 Kimwipes[®] or equivalent lint-free tissue.

18. Procedure

18.1 Slowly lower the sampler into the liquid to be sampled. Lower the sampler at a rate that permits the levels of liquid inside and outside the sample tube to be about the same.

18.2 When the sample interval has been reached, seat the bottom check valve.

18.3 Slowly withdraw the sampler with one hand while wiping the outside of the sampler using a disposable tissue.

18.4 Carefully discharge the sample into the sample container.

18.5 Repeat steps 18.1 through 18.4 as many times as necessary to fill all the sample bottles.

18.6 Clean and decontaminate the sampler as required.

19. Procedure Bias

19.1 The COLIWASA-type sampler is appropriate for collecting samples of containerized liquids. The material of construction should be considered for the particular type of liquid to be sampled. A COLIWASA sampler is also difficult to decontaminate adequately.

Method F

Sampling With a Dip-Type Sampler

20. Apparatus

20.1 Dip-type sampler constructed of Teflon[®], stainless steel, polypropylene, or glass.

21. Procedure

21.1 Assemble the sampler.

21.2 Slowly submerge the sampler into the liquid to be sampled causing minimal surface disturbance.

21.3 Retrieve the sampler from the liquid causing minimal surface disturbance.

21.4 Slowly empty the sampler into the sample bottle allowing the sample to flow gently down the side of the bottle.

21.5 Repeat steps 21.2 through 21.4 as many times as necessary to fill all of the sample bottles.

21.6 Clean and decontaminate the sampler as required.

22. Procedure Bias

22.1 A dip-type sampler is appropriate for surface liquids such as ponds, open tanks, pits, lagoons, and sewers. It can only be used for a grab-type sample, and its material of construction shall be compatible with the liquid to be sampled and the analytes of interest.

Method G

Sampling by Container Immersion

23. Apparatus

23.1 Sample container.

23.2 Disposable gloves.

23.3 Distilled or deionized water in a squeeze bottle.

23.4 Kimwipes[®] or equivalent lint-free tissue.

24. Procedure

24.1 After putting on the appropriate gloves, submerge the sample bottle below the liquid surface. If the liquid is flowing, point the bottle upstream.

24.2 Allow the container to fill to the desired volume.

24.3 Remove the container, cap and rinse the container's outside surface with clean water, and dry with a tissue.

24.4 Label and preserve the sample as required.

25. Procedure Bias

25.1 The container-immersion method can only be used to collect samples from shallow streams, near the shore of ponds or lakes, or from open-top containerized liquids. It can only be used for a grab-type sample and requires immersing the hands; it is not acceptable for highly polluted or hazardous liquids.

Method H
Sampling From Taps, Valves, or Faucets

26. Apparatus

26.1 Distilled or deionized water in a squeeze bottle.

26.2 Kimwipes® or equivalent lint-free tissue.

26.3 If the sample bottle cannot be placed under the tap, valve, or faucet, a hose or other device shall be attached to the outlet to allow the sample to be collected.

27. Procedure

27.1 Turn on the tap, valve, or faucet and allow sufficient liquid to flow to ensure that any rust or residue is removed from the lines and that fresh liquid is flowing.

27.2 Remove the cap from the sample container and place the container under the source.

27.3 Fill the sample bottle to the desired volume.

27.4 Repeat steps 27.2 and 27.3 as many times as necessary to fill all of the sample containers.

27.5 Shut off the tap, valve, or faucet; clean the outside of the sample container using clean water and wipe dry.

27.6 Label, preserve, and document the sample as required.

28. Procedure Bias

28.1 This procedure is used to collect grab-type samples from piped systems. Strainers, aerators, and hose attachments should be removed prior to sample collection. The material of construction for the piping system influences sample impurities and should be documented in the field logbook.

29. Quality Assurance

29.1 All of the methods listed above require the following information to be logged for quality-assurance documentation.

29.1.1 Date of sample collection.

29.1.2 Location of sample.

29.1.3 Sample number.

29.1.4 Type of sampling mechanism used.

29.1.5 Container type, size, and number of samples collected.

29.1.6 Preservatives used.

29.1.7 Signature of sampler.

B1.12 Sampling Light and Dense Nonaqueous Phase Liquids

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SAMPLING LIGHT AND DENSE NONAQUEOUS PHASE LIQUIDS

INTRODUCTION

Light nonaqueous phase liquids (LNAPLs) are relatively insoluble organic liquids that are less dense than water and spread across the water table. Dense nonaqueous phase liquids (DNAPLs) are relatively insoluble liquids that are more dense than water and tend to migrate vertically through aquifers to the top of the underlying confining layer. Wells containing light nonaqueous phase liquids will not be sampled for dissolved phases. Wells containing dense nonaqueous phase liquids will be sampled before purging the well for dissolved phase sampling. An interface probe will be lowered into the well to detect the existence and thickness of any immiscible layer(s), light and/or dense.

REFERENCE DOCUMENT

U.S. EPA, 1986, *RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD)*, OSWER-9950.1, September 1986

APPARATUS

- Photoionization detector, either an HNU, TIP II, or SIP 1000.
- Teflon bailer with bottom valve.
- Separatory funnel. (Laboratory funnel with a Teflon stopcock)
- Nylon line; disposed of after sampling.
- Waste containers.

PROCEDURE

1. Using a photoionization detector, scan the background area near the well to determine need for personnel protection. Scan inside the protective cover (flush mount lid or locking well cover) to determine if higher concentrations of organic vapors may be inside the well. Carefully remove the well riser cap and scan inside the casing to detect the presence of volatile organics. If the breathing zone has measurable volatile organic compounds, respiratory protection may be specified in Air Force Plant 4, Health and Safety Plan.
2. Lower the interface probe slowly into the well, following the procedure outlined in 6.2: Water-Level Measurements Using an Interface Probe. Note the depth to top of fluid and top of water. Continue lowering the interface probe to the bottom of the well to detect the presence of any immiscible layers below water. If a floating layer is detected disposable nylon line shall be used to lower the bailer.

3. a. To sample light nonaqueous phase liquids, lower a Teflon bailer until the bottom of the bailer is in contact with the top of the LNAPL layer. Continue to lower the bailer slowly, until the center of the bailer is centered on the water / phase interface. Smoothly raise bailer to the surface. This method will allow the collection of very thin floating layers.
- b. To sample dense nonaqueous phase liquids (after sampling any floating phase liquids), lower a Teflon bailer to the bottom of the well. Smoothly raise the bailer to the surface.
4. Carefully pour the bailer into a decontaminated separatory funnel. To sample LNAPLs use the separatory funnel to drain off the water phase and discard into a waste container. Fill sample container(s) from the separatory funnel. To sample DNAPLs use a clean separatory funnel to decant the immiscible fluid phase into the sample containers. Decant water phase into a waste container. Continue the process until adequate sample volume has been collected.

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B2.1 Photovac TIP II Photoionization Analyzer

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PHOTOVAC TIP II PHOTOIONIZATION ANALYZER

INTRODUCTION

This portable instrument is used to detect, measure, and provide a direct reading of chemicals in air that have an ionization potential of 10.2 eV or less. Most of the light permanent gases (such as air gases, hydrogen, or helium) have ionization potentials of 12 eV or more. Many organic chemicals have an ionization potential of less than 10.2 eV and can be detected by the TIP II.

The TIP II uses a small pump to continuously draw air into a small ionization chamber which is also flooded with ultraviolet light. This chamber has two electrodes; an electric voltage is applied across these electrodes and one of them is connected to a very sensitive current measuring circuit (electrometer). When ions are formed, and these will have both positive and negative charges, the negative ions will travel to the positive electrode and the positive ions will travel to the negative electrode. This will result in an electric current which is measured by the electrometer and can be used to express the "Total Ionizables Present".

The TIP II does not distinguish between different chemicals; the signal produced represents a composite of all different ionizable chemicals.

TIP II has four controls: a POWER switch, a SPAN control, a ZERO control, and a COURSE ZERO control. The Span and Zero controls are projecting knobs which can be locked into position and are provided with numerical position indicators. The Course Zero adjustment is made with a screwdriver through a hole in the front bulkhead of TIP II. A single electrical connector is located at the base of the handle and is used for battery recharging and for connection of external 12 Volt DC power. Two outputs are available at this same connector: an analog signal from the electrometer and an audio signal for connection to a headphone which is pulsed at a rate proportional to the concentration being measured.

The TIP II is powered by rechargeable Nickel Cadmium batteries. These batteries must be given proper care to insure long life performance. NiCad batteries will develop a "memory" if they are not run through complete discharge / recharge cycles on a regular basis. This means that if the TIP II is used for only one hour before recharging, the batteries will develop a "memory" for this duty cycle and will be unable to deliver adequate power for longer duty cycles. To avoid this condition, run the instrument until "LOBAT" appears on the display, then fully recharge for 16 hours as described in the TIP II manual.

WARNINGS

THIS DEVICE IS CLASSIFIED FOR USE IN CLASS 1, DIVISION 2, GROUPS A,B,C,D HAZARDOUS LOCATIONS. THIS DEVICE IS NOT INTENDED FOR CONSTANT USE WITH FLAMMABLE CONCENTRATIONS OF GASES. It complies with Underwriters Laboratories Inc. UL 1604 Standard for Electrical Equipment for use in Hazardous Locations Class 1, Division 2.

CAUTION

To reduce the risk of fire or injury to personnel, read and follow these instructions.

1. All calibration, maintenance, and servicing of this device, including battery charging, must be performed in a safe area away from hazardous locations.
2. Do not open or mutilate the battery cells. Released electrolyte is corrosive and may cause damage to the eyes or skin. It may be toxic if swallowed. Do not dispose of battery pack in a fire.

REFERENCE DOCUMENT

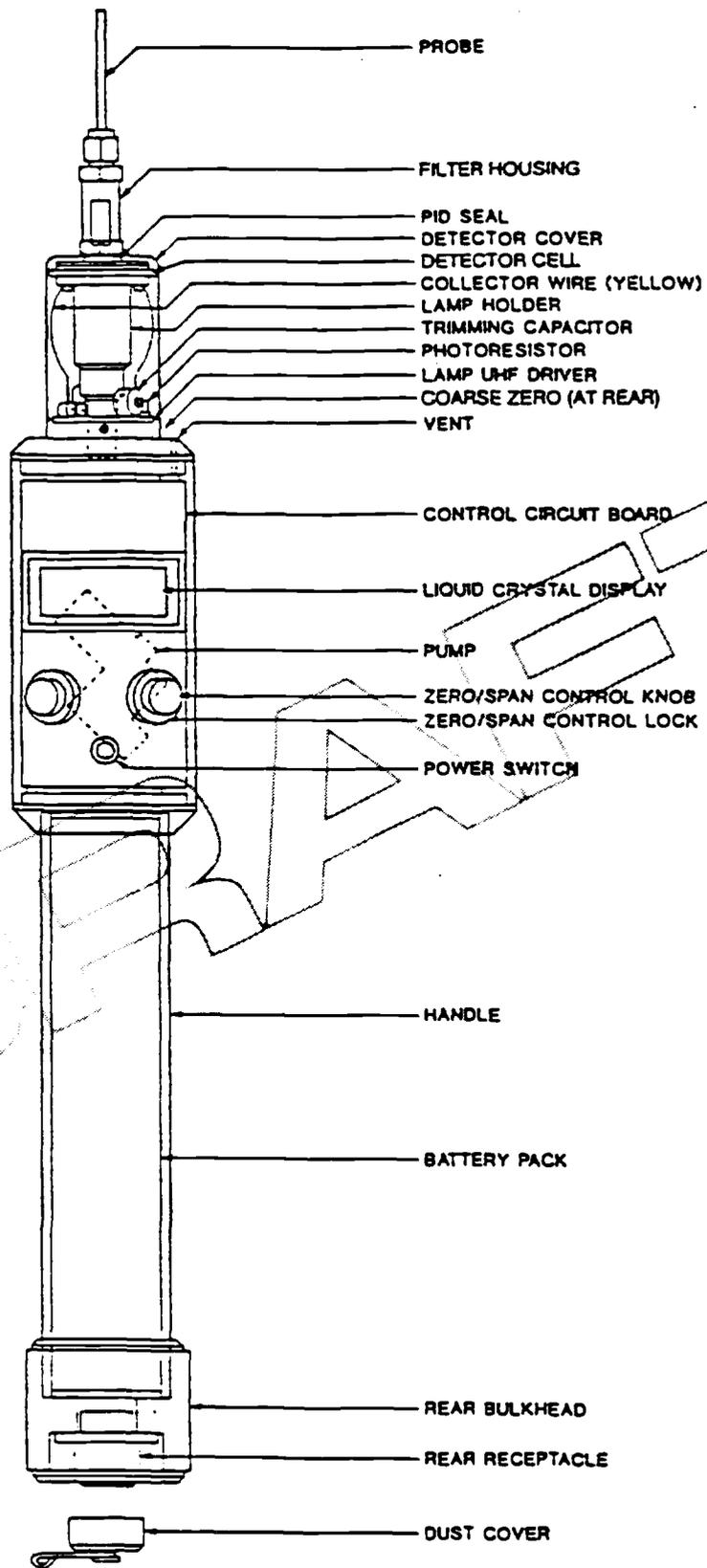
User's Manual, TIP II, Version 2.3 November 1988, Photovac Inc.

OPERATING PROCEDURES

The TIP II can be used in either a qualitative or quantitative mode. In the qualitative mode the instrument displays higher numbers as higher concentrations of ionizable gases are detected. It will not read out directly in parts per million. In quantitative mode the instrument is calibrated with a known concentration of gas and displays concentrations in parts per million. This procedure covers only the quantitative mode. See the TIP II Users Manual for a description of the qualitative mode.

SEMIQUANTITATIVE PROCEDURES TUTORIAL

1. When you press the POWER switch, the LCD of TIP II will turn on and the pump and yellow LEDs will come on briefly. Wait for them to come on continuously, indicating the ultraviolet lamp has started.
2. Turn the locking rings down to release the ZERO and SPAN controls.
3. A mid-range sensitivity (Span setting of 5) is a good place to start.
4. The cleanliness of the reference Zero air should match the application. Outdoor air away from chemical sources is usually suitable. Although background chemicals will not be canceled out as they are when TIP II is used qualitatively, the error they cause is usually insignificant. If the zero reference air contains 1 ppm equivalent of total ionizables, and TIP II is adjusted to read 100 when Span Gas is introduced, then in fact TIP II will read -1 when air with no ionizables is sampled. The error will decrease as concentration increases. If outdoor air is too heavily contaminated, bottled Zero Air should be used.
5. Turning the ZERO control clockwise will raise the LCD reading, turning it counterclockwise will lower it. Adjust the COARSE ZERO control with a small slotted screwdriver if TIP II always reads above or below zero with the ZERO control alone.
6. Hand tighten the gas bag adapter nut to TIP II inlet, and open the gas bag valve.
7. A clockwise turn of the SPAN control will raise the LCD reading, a



TIP Pictorial Diagram

counterclockwise turn will lower it.

8. Check the zero setting by sampling clean air again. Reset the ZERO control, if needed.
9. Turn the locking ring up against the SPAN control.
10. Check the SPAN setting by sampling Span Gas. Setting ZERO and SPAN controls is an iterative procedure. With experience, initial settings will be close to final settings.
11. Sample clean air while locking the ZERO control and sample Span Gas while locking the SPAN control, and hold the controls so that they don't shift when their locking rings are turned against them.
12. The LCD will now show concentrations of total ionizables in the sample in Span Gas equivalent units. Naturally, part per million readings taken with TIP II only have meaning when there is a single compound present in the sample. A mixture of two or more compounds will give a composite reading which, due to differences in response, will obviously NOT be the simple sum of the concentrations of each component. Nevertheless, there can often be a benefit to such a reading, for example, in studying the distribution of an accidental spill of gasoline. Calibration against the Span Gas gives a reasonably repeatable reference, which can then serve as a guide to the use and deployment of more sophisticated analyzers.
13. If TIP II aspirates some liquid, immediately turn to Maintenance, - If TIP II Draws in Water, and follow the instructions.
14. Switch off TIP II when finished taking readings or if the "LOBAT" sign appears at the top left of the LCD. Readings taken while "LOBAT" is on may not be reliable.

Calibrating TIP II with a known concentration of span gas provides a means of comparing readings from one day to another and compensates for film build-up on the detector lamp window.

The TIP II is calibrated at two points of concentration, 0 and 100 ppm. Its accuracy decreases when sampling concentrations away from these two points according to the following table:

Actual Concentration (ppm isobutylene)	TIP II Reading
1	1 ± 1.5
5	6 ± 2
10	12 ± 2
50	55 ± 5
100	100 ± 10
500	450 ± 10%
1000	850 ± 10%
1500	1250 ± 10%
2000	1500 ± 10%

Charge TIP II battery when "LOBAT" appears at the top left of the LCD.

NOTE: DO NOT CHARGE TIP II IN A HAZARDOUS LOCATION.

TIP II handle and the charger may be warm to the touch during charging. This is normal.

By letting TIP II fully discharge until "LOBAT" appears, then charging for 16 hours, the operating time of TIP II is maximized. Occasional overcharging for up to two days will not be detrimental to the batteries. If TIP II is consistently put on charge before "LOBAT" appears, the operating time of TIP II will be diminished.

The TIP II Charger is one of two types, either a TIP Constant Current Battery Charger, or a TIP Dual Rate Charger.

To use the Constant Current Battery Charger:

1. Switch off TIP II.
2. Remove any external devices connected to the rear receptacle, or unscrew dust cover.
3. Set selector switch on back of charger to correct AC mains voltage.
4. Connect charger plug to TIP II rear receptacle. Turn knurled collar clockwise to secure plug.
5. Plug charger into AC mains.
6. Allow TIP II to charge for 16 hours.
7. Remove charger plug from TIP II and replace dust cover.

DO NOT LEAVE TIP II ON CHARGE CONTINUOUSLY WITH THE CONSTANT CURRENT BATTERY CHARGER.

To use the Dual Rate Charger:

1. Switch off TIP II.
2. Remove any external devices connected to the rear receptacle, or unscrew dust cover.
3. Connect charger plug to TIP II rear receptacle. Turn knurled collar clockwise to secure plug.
4. Plug the charger into AC mains. The indicator light will be green.
5. Press the HIGH CHRG button. The indicator light will turn red to show the charger is charging at the high rate.
6. TIP II will be fully charged in about 15 hours. After this time, the indicator light will turn green indicating the charger has returned to its low continuous charge rate. This maintains the battery at full charge. Do not press HIGH CHRG again as this may overcharge the battery.
7. To use TIP II, remove charger plug from TIP II and replace dust cover.

The low continuous charge rate can be used to charge TIP II when it has not been fully discharged, however, it is best to fully discharge TIP II before recharging to maintain the highest battery capacity.

Procedure

If it is known that only one chemical will be present in the air being sampled the TIP II can be calibrated with a standard of that compound. Note that the presence of other gases and vapors in the sample will change the results.

1. Press POWER switch to turn on TIP II.
2. Unlock ZERO and SPAN controls by turning locking rings clockwise.
3. Set SPAN control to 5.
4. Allow TIP II to sample clean air.
5. Adjust ZERO control until LCD reads zero.
6. Connect Kevlar bag of span gas to TIP II inlet.
7. Adjust SPAN control until LCD indicates the Span Gas concentration (nominally 100 ppm isobutylene, check label on Span Gas bottle).
Disconnect gas bag.
8. Sample clean air again and readjust ZERO control if necessary.
9. Lock ZERO control by turning locking ring counterclockwise.
10. Sample Span Gas again and readjust SPAN control if necessary.
11. Lock SPAN control by turning locking ring counterclockwise. Disconnect gas bag.
12. Observe readings on LCD. Concentration of total ionizables is displayed in Span Gas equivalent units.
13. DO NOT ALLOW THE TIP II TO DRAW IN ANY LIQUIDS!
14. Press POWER switch after use to turn off TIP II.

Calibration Gas Procedure

1. Hand tighten regulator onto Span Gas tank.
2. Turn gas bag valve counterclockwise to open.
3. Hand tighten gas bag adapter nut onto regulator.
4. Turn regulator knob counterclockwise about 1/2 turn to start gas flow.
5. Fill bag until bag material just begins to stretch.
6. Turn regulator knob fully clockwise to shut off the gas flow.
7. Turn gas bag valve fully clockwise to close.
8. Remove gas bag adapter nut from regulator.
9. Remove regulator from Span Gas tank.

NOTE: Before using the gas bag for the first time, and if it has not been used for four weeks, fill and flush gas bag with span gas two times before connecting it to TIP II.

MAINTENANCE

Keeping TIP II in top operating shape means charging the battery, cleaning the ultraviolet lamp window, and replacing the dust filter. The exterior of TIP II can be wiped clean with a damp cloth and mild detergent if necessary. Keep the cloth away from the sample inlet, however, and do not attempt to clean while TIP II is connected to the mains! Organic cleaning solvents might damage the finish.

BATTERY CHARGING

Interrupting the AC power supply to the Dual Rate Charger will reset it to the low charge rate.

CLEANING THE LAMP WINDOW

As TIP II is used, a film of deposit will build up on the window of the ultraviolet lamp. The rate of film build-up depends on the chemicals and concentrations being sampled, and results from the action of ultraviolet light on the chemicals. Clean the lamp window when a span setting of 9 is insufficient to give a high enough LCD reading. Refer to TIP II Pictorial Diagram for parts location.

1. Switch off TIP II.
2. Grasp the black detector cover and unscrew it from TIP II. The detector cell, lamp holder and lamp UHF driver circuit board are now exposed. Be careful of the PID seal o-ring on top of detector cell.
3. Unplug red and yellow wires from UHF driver circuit board.
4. Grasp lamp holder so it will not rotate, and unscrew detector cell (with red and yellow wires attached) from lamp holder. Lamp will pop up.
5. Withdraw lamp from lampholder. Leave spring in lamp holder.
6. Moisten a lint-free tissue with methanol.
7. Rub lamp window with methanol-moistened tissue to remove film.
8. Dry lamp window with clean lint-free tissue.
9. Without touching window, slip lamp into lamp holder, window-end out.
10. Install detector cell onto lamp holder and tighten until just snug. Avoid cross threading.
11. Plug yellow wire onto gold pin and red wire onto tinned pin on UHF driver circuit board.
12. Install detector cover hand-tight.

When the detector cell is removed, be careful not to touch the fine wire mesh inside it. Any dirt in the detector cell may be blown out with a gentle jet of dry compressed air.

REPLACING THE DUST FILTER

TIP II is equipped with a dust filter to reduce detector contamination. As the filter becomes clogged, TIP II inlet flowrate and sensitivity will drop. If TIP II sensitivity increases by more than 10% when the filter is removed then install a new filter. Don't run TIP II without a filter for more than a minute or so.

1. Switch off TIP II.
2. Hold filter housing near detector cap with 9/16" wrench.
3. Unscrew top of housing with another 9/16" wrench. Be careful of the metal sealing washer.
4. Remove spring and filter.
5. Install new filter open end first.
6. Slip spring into top of housing and assemble housing. Tighten with two wrenches.

IF TIP II DRAWS IN WATER

Water drawn into TIP II will not cause permanent damage if the instrument is promptly disassembled and cleaned. The most important parts to clean are the lamp and the detector cell. To clean the pump, allow TIP II to run until no more water comes out of vent hole located in the front bulkhead.

1. Refer to maintenance instructions to remove detector cell and lamp.
2. Dry lamp with a clean lint-free tissue and clean the window.
3. Clean detector cell in clean water, preferably in an ultrasonic cleaner. Do not touch the fine wire mesh.
4. Dry detector cell overnight at 50 degrees C. (125° F).
5. Dry inside of lamp holder.
6. Remove filter following instructions above.
7. Dry inside of filter holder.
8. Install a new filter.
9. Assemble TIP II following instructions above.

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B2.2 HNU Photoionization Analyzer

SITE SPECIFIC PROCEDURE CHANGE or NOTICE

PROCEDURE Portable Photoionization Analyzer, Model ISPI 101 HNU

PROJECT or SITE Air Force Plant 4

CHANGE

Pressure and Humidity Calibration Corrections

Section 3 states "Connect the analyzer to the regulator and cylinder with a short piece (butt connection) of tubing". Instead of directly connecting the HNU to the regulator, the HNU will be calibrated by filling a Tedlar bag with known concentration span gas (normally 100 ppm isobutylene) and attaching the HNU to the sampling valve of the gas bag. This method permits calibration at current atmospheric pressure.

After the Tedlar bag is full, attach the tygon tubing end of the calibration gas humidifier to the bag. Use of the calibration gas humidifier while calibrating will correct for water vapor effects on the photoionization readings. Water is a strong absorber of photons in the operating region of photoionization detectors and high humidity will cause lower readings unless humidity is accounted for while calibrating. The HNU must be recalibrated using the calibration gas humidifier whenever there is a significant change in ambient humidity.

Calibration Gas Procedure.

1. Hand tighten regulator onto Span Gas tank.
2. Turn gas bag valve counterclockwise to open.
3. Hand tighten gas bag adapter nut onto regulator.
4. Turn regulator knob counterclockwise about 1/2 turn to start gas flow.
5. Fill bag until bag material just begins to stretch.
6. Turn regulator knob fully clockwise to shut off the gas flow.
7. Turn gas bag valve fully clockwise to close.
8. Remove gas bag adapter nut from regulator.
9. Remove regulator from Span Gas tank.

NOTE: Before using the gas bag for the first time, and if it has not been used for four weeks or more, fill and flush gas bag with span gas two times before connecting it to the HNU.

Ambient Humidity Calibration

1. Turn on the HNU and adjust ZERO in the STANDBY MODE.
2. Turn the range switch to 0-200.
3. Connect the tygon tubing end of the humidifier to the span gas bag.

4. Connect the fitting end (white polypropylene) of the humidifier to the 101 probe extension.

5. When the reading stabilizes (15-30 seconds), adjust the SPAN POT until the meter reads the correct value for the calibration gas used.

6. The 101 is now calibrated for direct reading on the calibration gas.

7. The calibration can be adjusted for changes in humidity by repeating the process

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PORTABLE PHOTOIONIZATION ANALYZER
MODEL ISPI 101 HNU SYSTEMS, INC.

Introduction

This portable instrument is used to detect, measure, and provide a direct reading of the concentration of a variety of trace gases in many industrial or plant atmospheres. The analyzer employs the principle of photoionization. This process involves the absorption of ultraviolet light (a photon) by a gas molecule leading to ionization:



in which

RH = trace gas

hv = Photon with an energy level equal to or greater than the ionization potential of RH

The sensor consists of a sealed ultraviolet (UV) light source that emits photons with an energy level high enough to ionize many trace species, particularly organics, but not high enough to ionize the major components of air, O₂, N₂, CO, CO₂, or H₂O.

A chamber, exposed to the light source contains a pair of electrodes: one, a bias electrode, and the second, a collector electrode. When a positive potential is applied to the bias electrode a field is created in the chamber. Ions formed by the absorption of photons are driven to the collector electrode. The current produced is then measured, and the corresponding concentration is displayed on a meter directly in parts per million (ppm).

To minimize absorption or decomposition of sample gases, a rapid flow of sample gas is maintained through the ion chamber, which is small, made of inert material and located at the sampling point.

The analyzer consists of a probe, a read-out assembly, and a battery charger. The probe contains the sensing and amplifying circuitry; the read-out assembly contains the meter, controls, power supply, and rechargeable battery. The analyzer will operate from the battery for approximately 6-10 hours.

The ISPI 101 is designed for use with interchangeable probes containing lamps of different energies. The analyzer is ready for use simply by connecting the probe to the read-out assembly, calibrating, setting the proper SPAN pot value, and then zeroing the unit.

The standard probe provided with the analyzer contains a 10.2 eV lamp. Optional probes containing lamps of 9.5 and 11.7 eV permit selective determination or exclusion of special species having IP values lower than 9.5 eV in the presence of interfering species with IP values above 9.5 eV. The probe with the 11.7 eV lamp permits measurement of species with IP values up to approximately 11.7 eV. The probes with different lamps are interchangeable in use within individual read-out assemblies for different applications. The amplifier and ion chamber in the probe are selected for the specific eV lamp. Lamps of different eV ratings cannot be interchanged between probes.

Gases with ionization potentials near to or less than that of the lamp will be

ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials higher than that of the lamp will not be detected. The ionization potential of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to about 15.6 eV and are not ionized by any of the three lamps. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, resulting in low response to the instrument. Ionization potentials for various atoms, molecules and compounds are given in Tables 8-1 through 8-13 in Section 8 of the HNU Instruction Manual.

The amount of ionization of a species of gas exposed to photons, its sensitivity, is a characteristic of that particular species. This is illustrated in Table 4-1 in the HNU Instruction Manual for a number of chemical groupings, and in Table 8-14 for a large number of individual species when exposed to photons from a 10.2 eV lamp.

The species with the higher values are more sensitive to the 10.2 eV photons than are those with lower values. Refer to Table 8-14 in the HNU Instruction Manual for further information.

WARNINGS

1. Do not look at the light source from closer than 6 inches with unprotected eyes. Observe the source only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight. The lamp cannot be observed with the probe extension attached or when the instrument is in the stand-by mode.
2. Any obstruction of the probe extension or at the sample end of the probe will seriously impair ISPI 101 operation. The fan cannot draw a sample across a pressure drop. Efforts should be made to keep dirt, dust, grease (e.g., from pipe joints) and other matter from obstructing the flow.
3. The instrument measures gases in the vicinity of the operator and a high reading when measuring toxic or explosive gases is cause for immediate action for safety.
4. Never open the valve on a gas container without a regulator attached.
5. Turn the function switch on the control panel to the OFF position before disassembly. Otherwise, high voltage of 1000 V DC will be present in the probe assembly.
6. The ISPI 101 is suitable for uses in Class I Division 1 ABCD areas except when using the charger.
7. The Read-out Unit should NEVER be opened except by a service person trained and certified by HNU Systems, Inc.
8. Do not use the instrument in the rain or other precipitation, as it will not pick up volatiles under those conditions.

Precautions and Limitations

Environmental Sensitivities

Temperature, humidity and air particulates are factors in the proper operation

of this instrument.

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Detection Range	0.1 to 2000 ppm
Minimum Detection Level	0.1 ppm
Maximum Sensitivity	0 to 20 ppm FSD at SPAN = 9.8 (full scale deflection) 0 to 2 ppm FSD at SPAN = 0.0
Repeatability	± 1% of FSD
Linear Range	0.1 to 400 ppm
Useful Range	0.1 to 2000 ppm
Response Time	Less than 3 seconds to 90% of FSD
Ambient Humidity	up to 90% RH (relative humidity)
Operating Temperature	-10 to 40° C.
Ambient (10.2 and 9.5 eV lamps)	
Operating Time on Battery (continuous use)	Approximately 6 - 10 hours: at lower temp. time is reduced due to effect of cold temp. on the battery
Recharge time from full discharge	Full recharge: 12 - 14 hours. Unit can be left on the charger and be continuously recharged whenever the unit is not in use (the analyzer will not operate while the unit is on the charger: an Intrinsically Safe feature).
Recharge current	Max. 0.4 amps at 15 V DC
Battery Charger Power	120 V AC, single phase, 50-60 Hz, 1.5 Amps 230 V AC, single phase, 50-60 Hz, .75 Amps

NOTE: The above specifications apply when the instrument is equipped with 10.2 eV Probe with SPAN set at 9.8 and measuring benzene. Values will vary for other compounds and conditions. The HNU is sensitive to interferences from the following physical/environmental conditions: overhead electrical powerlines, transmissions from some hand-held portable radios, temperature extremes, humidity, machinery emitting exhaust fumes, battery acid, and any other volatile organics that the HNU could detect. The lamp lens will need to be cleaned when working in dusty areas, or areas with heavy particulates in the air. Both the lamp lens and the ion chamber need to be cleaned when in areas of high humidity or precipitation. Water should not be sucked into the instrument.

Operating Procedures

The following procedures are to be used in operating the analyzer:

1. Unclamp the cover from the main read-out assembly.

2. Remove the inner lid from the cover by pulling out the two fasteners in order to access the charger, adapter, straps, and probe extension.
3. Connect the probe cable plug to the 12-pin keyed socket on the read-out assembly panel. Carefully match the alignment slot in the plug to the key in the connector. Screw down the probe connector until a distinct snap and lock is felt.
4. Screw the probe extension into the probe end cap. The probe may be used without the extension if desired.
5. Set the SPAN control for the probe being used (10.2, 9.5, or 11.7 eV) as specified by the initial factory calibration or by subsequent calibrations.
6. Turn the function switch to the BATT (battery check) position. The needle on the meter will go to the green zone if the battery is fully charged. If the needle is below the green arc or if the Low Battery Indicator comes on, the battery must be recharged before the analyzer is used. No measurements can be taken while charging.

NOTE: To ensure accurate readings, the ISPI 101 is designed to operate ONLY when the battery voltage is greater than 11 V DC. A low battery will cause the analyzer to shut off automatically.

7. Set the SPAN pot to the desired value based on the gas to be used.
8. Turn the function switch to STANDBY position. Turn the zero adjustment until the meter needle is at zero.
9. Turn the function switch to the appropriate operating position. Start with the 0-2000 position and then switch to the more sensitive ranges. The UV light source should be on, confirmed by removing the probe extension and briefly looking into the probe to observe a purple glow from the lamp. Do not look at the light source closer than 6 inches.
10. The analyzer is now operational.
11. Hold the probe so that the extension is at the point where the measurement is to be made. Using a fan, the instrument measures the concentration by drawing the gas in at the end of the extension, through the ionization chamber, and out the handle end of the probe.

NOTE: The fan will not operate against a pressure drop, i.e., it will not withdraw a sample from a duct with gas moving away from the probe. The ISPI 101 is designed for ambient (relatively still atmospheres) operation.

WARNING: *Stand up wind from the source whenever sampling. The instrument measures gases in the vicinity of the operator and a high reading when measuring toxic or explosive gases is cause for action for operator safety.*

12. Take the reading or readings as desired, taking into account that air currents or drafts, equipment, vehicles, or environmental interferences in the vicinity of the probe tip may cause fluctuations in readings. Change the ranges as required. Check that the probe you are using will measure the ionization potential of the chemical/source that you are sampling for.

13. Check the battery condition as required. If the Low Battery Indicator comes on, turn the analyzer off and recharge. Measurements cannot be taken while charging.
14. After completion of use, check the battery condition as described in #6.
15. Turn the function switch to the OFF position.
16. When not operating the analyzer, leave it in its assembled condition and connected to the battery charger.
17. When transporting the unit, disassemble the probe and its extension from the read-out assembly and return the equipment to its stored position.
18. In case of emergency, turn the function switch to the OFF position.

Battery Charge

Check the battery charge as described above in # 6, during each period of operation. If the battery is low, as indicated by the meter reading, it is necessary to recharge it.

To charge the battery, locate the Battery Charge Adapter Cable, (which is comprised of a 1/4-inch phone plug on one end and a mini phone jack on the other). Press the 1/4-inch phone plug onto the mating read-out assembly jack installed on top of the ISPI 101 battery charger case. Attach the charger cable with the mini-plug into the mini-jack of the battery charger adapter cable. The charger can then be plugged into a 120 VAC or 230 VAC (as specified by charger) single phase, 50-60 Hz outlet. Recharge the unit in a non-hazardous atmosphere.

The analyzer cannot be operated during this recharging period. Leave the function switch in the OFF position during charging. After the charging period, the battery charger can be detached from the analyzer and reassembled in the reverse order as described above.

Rechecking the battery's newly charged condition can be accomplished with the analyzer assembled, the probe attached and the function switch set to the BATT position. The meter should deflect to the green region.

NOTE 1: The probe assembly must be attached to the analyzer during the battery check. Without following this procedure, the instrument will not indicate the correct battery condition.

NOTE 2: The instruction on the cover of the battery charger instruct the user to "place output plug into jack on the left side of bezel." This is incorrect. The output plug should be attached to the charger adapter cable as explained above.

Calibration

The ISPI 101 Analyzer is designed for trace gas analyzer in ambient air and is calibrated at HNU with certified standards of benzene, vinyl chloride and isobutylene. Good instrumentation practice calls for calibration on the species to be measured in the concentration range to be used. This procedure assures the operator that the analyzer is operating properly and will generate reliable data.

Some general points to consider when calibrating the ISPI 101 are that the

analyzer is designed for operation at ambient conditions and therefore the gas standards used for calibration should be delivered to the analyzer at ambient temperatures and pressure and at the proper flow rates.

The instrument shall be internally calibrated with benzene on an annual basis. This shall be accomplished by the Industrial Hygienist and/or designee. Calibrations with benzene of any other toxic or hazardous gases must be done under a hood. Reference will be made to calibration checking with isobutylene. This shall also be referred to as a calibration. Isobutylene is used as a reference gas and the instrument is calibrated externally by adjusting the external span control knobs. Isobutylene is a non-toxic gas, therefore these calibrations do not have to be done under a hood.

The frequency of calibration should be dictated by the usage of the analyzer and the toxicity of the species measured. If the analyzer has been serviced or repaired, calibration should be done to verify operation and performance. When using the instrument at possible hazardous waste sites or in situations involving unknown chemicals, the instrument should be calibrated daily in a "clean" non-hazardous area.

The calibration results, along with instrument field readings must be recorded in the orange health & safety log book.

Best operation of the analyzer is accomplished by its calibration for the gas to be measured. In cases where it becomes necessary to operate with a gas for which it has not been calibrated and recalibration is not possible, correction can be made to the meter reading. One method is to multiply the meter reading by a correction factor. This equation and accompanying photoionization sensitivities can be found in section 8.4 and Table 8-14 respectively in the HNU Instruction Manual. This is to be used only when measuring a known solitary gas. It cannot be used with gas mixtures. Consult sections 8.1 and 8.3 of the HNU Instruction Manual for calibration with a special mixture or with an alternate gas.

Probe

1. Identify the lamp by the probe label. If a question exists, disassemble the probe and inspect the lamp. The energy of the lamp is etched into the glass envelope. If the lamp appears to need cleaning, see the Section titled, "*UV Lamp and Ion Chamber Cleaning*".
2. Connect the probe to the read-out assembly. A small "click" will indicate that the probe is fitted securely into the instrument.
3. The calibration cylinder should be consulted for the proper value (ppm) for the probe being calibrated. Refer to the following Section titled, "*Calibration Checking with Isobutylene*".
4. Check the Ionization Potential (IP) of the calibration gas to be used. The IP of the calibration gas must be at or below the IP of the lamp.
5. Proceed with the calibration as described below.

Calibration Checking with Isobutylene

The calibration of the analyzer can be rapidly checked by the use of an HNU

small disposable cylinder containing isobutylene and a regulator. Consult Section 3.4 of the HNU Instruction Manual for internal calibrations with benzene.

1. Battery check - with the probe attached, turn the function switch to BATT. The needle should be in the green region. If not, recharge the battery.
2. Zero set - with the probe attached, turn the function switch to STANDBY. In this position the lamp is OFF and no signal is generated. Set the zero point with the ZERO set control.
3. Connect the analyzer to the regulator and cylinder with a short piece (butt connection) of tubing. The calibration gas in the cylinder consists of a mixture of isobutylene and zero air. Isobutylene is nontoxic and safe to use in confined areas. There are no listed exposure levels at any concentration.

The regulator sets and controls the flow rate of gas at a value preset at the factory. This will be about 100 - 200 cc/min.

It is important that the tubing be clean since contaminated tubing will effect the calibration reading. Do not use the cylinder below about 30 psig as readings below that level can deviate up to 10% from the rated value. Notify the instrument technician when a cylinder is at 30 psig so additional gas cylinders can be ordered. Safely discard the disposable cylinder when empty.

4. Open the valve on the cylinder until a steady reading is obtained. This should take 30-60 seconds.
5. Turn the function switch to the range position and note the meter reading. Adjust the SPAN control setting as required to read the ppm concentration of the standard for the probe being used. The span should not have to be adjusted below 3.0. Notify the instrument technician if this is the case. This indicates that either the lamp is dirty, the lamp needs to be replaced, or the instrument needs to be calibrated internally with benzene.
6. Shut off the cylinder as soon as the reading is established.
7. Record and maintain this new SPAN setting.

Maintenance

Introduction

User maintenance of the analyzer consists of cleaning the lamp and ion chamber, and replacing the lamp or ion chamber. Other component parts or subassemblies may be serviced only by a service person trained and authorized by HNU Systems, Inc. HNU Systems has made this policy to maintain the Intrinsically Safe properties of the ISPI 101.

WARNING: Turn off the function switch on the control panel to the OFF position before probe disassembly. Otherwise, high voltage of 1000 VDC will be present in the probe assembly.

Do not look at the light source from closer than 6 inches with unprotected eyes. Observe the source only briefly. Continued

exposure to ultraviolet energy generated by the light source can be harmful to eyesight. The lamp cannot be observed with the probe extension attached.

Do not interchange lamps of different eV ratings in a probe. Amplifier and other components are selected for a specific eV lamp. A probe with the wrong lamp will not operate properly.

Cleaning Procedure for ISPI 101 Lamps and Ion Chamber

During periods of operation of the analyzer, dust or other foreign matter could be drawn into the probe, forming deposits on the surface of the UV lamp or the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting, or apparently due to moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition monthly or more often as required. Cleaning can be accomplished as follows:

Lamp Removal

1. Remove 5/32" hex screw (exhaust screw) with Allen wrench provided. Slide the innards out of the probe shell.
2. Remove the probe from the unit. Hold the probe upright, cable down. Remove the two cross-headed screws that hold the black end cap. Carefully remove the end cap. Remove the two screws holding the ion chamber on, and lift the chamber off of the probe.
3. Loosen the small set screw in the side of the lamp housing, place your hand over the end of the probe and tilt. The lamp will fall into your hand. Notice the eV number etched on the lamp.

Lamp Cleaning: 10.2 and 9.5 eV

1. Put a small drop of HNU Cleaning Compound (Part #80-PA 101534-A1) (or GLEEM™ toothpaste on the lens of the lamp (the small glass circle on the metal end).
2. Using a nonlinting tissue, rub in a circular motion until all residue is removed.
3. Rinse with hot, clean tap water, and dry with nonlinting tissue.
4. If the lens is still not clean, repeat Steps 1, 2, and 3.

Lamp Cleaning: 11.7 eV

1. Clean the lens only (the small glass circle on the metal end) with Freon™ or any chlorinated organic solvent to remove any deposits, using a non-linting tissue.
2. Do NOT use HNU Cleaning Compound, water, or any water-miscible solvent on these lamps.

1. Remove the "O" Ring from the side opposite the wire mesh and save.
2. Agitate the whole assembly in a beaker of methanol or acetone, or place the beaker and contents in an ultrasonic bath for ten minutes.
3. Remove the beaker and shake out the surplus solvent. Dry overnight at room temperature or bake for two hours in a drying oven at 100°C. Do not dry at temperatures over 100°C. Allow chamber to cool completely before reinstalling.
4. In an emergency, careful use of a hair dryer is permissible.

Reassembly

1. Hold the probe upright, cable down, and replace the lamp with the lens uppermost. Tighten the set screw in the lamp housing after insertion.
2. Replace the "O" Ring in the groove in the ion chamber (side opposite the wire mesh).
3. Place the ion chamber over the lamp with the wire mesh side on top. Make sure all the connection pins, screw holes, and the vent hole in the ion chamber are correctly aligned. (The small vent hole in the ion chamber lines up with the vent hole in the probe, which has a small black "O" Ring around it). Secure the chamber with the two screws.
4. Replace the probe cap, noting the alignment of screw holes. Replace the two screws and tighten evenly.
5. Replace the lamp housing in the probe shell, aligning the exhaust ports and the amplifier board connector. Secure with the hex exhaust screw.
6. Reattach the probe to the analyzer and check the analyzer operation.
7. If performance is still not satisfactory, replace the lamp.

The unit is now ready to be used.

Lamp Replacement

CAUTION: Do not interchange lamps of different eV ratings in a probe. Amplifier and other components are selected for a specific eV lamp. A probe with the wrong lamp will not operate properly.

To replace the lamp, disassemble the probe, remove the old lamp, install a new one of the same eV rating and reassemble. Record this on the HNU's Data Sheet which is located in the top drawer Equipment Files in Room 212.

WARNING: Turn off the function switch on the control panel to the OFF position before probe disassembly. Otherwise, high voltage of 1000 VDC will be present in the probe assembly.

If different applications for the analyzer would require lamps of different eV power, then separate probes, each with its own eV lamp must be used. A single read-out assembly will serve for any of the probes. A change in probe will require resetting of the ZERO control and the SPAN control. Calibration should be checked to verify proper operation.

Probe Assembly/Disassembly

WARNING: Turn off the function switch on the control panel to the OFF position before probe disassembly. Otherwise, high voltage of 1000 VDC will be present in the probe assembly.

Disassemble the probe by first removing the exhaust screw at the base of the probe adjacent to the handle using the 5/32" hex key (Allen wrench). Disconnect the probe cable connector at the read-out assembly. Grasp the end cap in one hand and the probe shell in the other, gently pull to separate the end cap and the lamp housing from the shell.

Hold the lamp housing with the black end cap upright. Loosen the screws on the top of the end cap, separate the end cap from the lamp housing. Remove the two screws on the ion chamber and separate the chamber from the lamp housing. To remove the lamp, locate the lamp retaining screw on the side of the lamp housing and remove.

CAUTION: Care must be taken so that the lamp does not fall out of the lamp housing when the retaining screw is removed.

Place one hand over the top of the lamp housing and tilt slightly. The light source will slide out of the housing.

Reassemble the probe by first sliding the lamp back into the lamp housing and aligning the screw hole in the lamp retaining ring with the aperture on the side of the lamp housing, then install the lamp retaining screw and tighten.

CAUTION: Overtightening this screw may break the lamp. DO NOT OVERTIGHTEN.

Place the ion chamber on top of the lamp housing, making sure that the contacts and the vent hold are properly aligned. The ion chamber fits only one way; secure it with the two screws.

If the ion chamber is to be replaced, always use one identical to the one being removed. Check the aperture (small: 3.0 mm, used with the 10.2 eV lamp; large: 6.0 mm, used with the 9.5 and 11.7 eV lamps) at the top of the ion chamber and materials of construction (gold-plated or Teflon™) to ensure proper replacement. See Parts List.

Check the ion chamber electrodes (on the side with NO mesh): the collecting electrode (a disk about 1" in diameter) must not touch the polarizing electrode (the central pin). If they do, call HNU Systems, Inc.

Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws only enough to seal the "O" Ring.

CAUTION: DO NOT OVERTIGHTEN THESE SCREWS

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Line up the pins (pogo contacts) on the base of the lamp housing with the pins inside the probe shell. Gently slide the housing assembly into the probe shell.

The end cap should meet the probe shell evenly after final assembly. If not, the ion chamber may be installed wrongly.

CAUTION: DO NOT FORCE the assembly into the shell. It fits only one way.

If the probe does not reassemble readily, remove it from the shell and check pin alignment. Check to ensure pogo contacts are not bent. Refasten the exhaust screw at the base of the probe.

Align the 12-pin probe connector to the read-out assembly and reconnect with a twisting motion until a click occurs. The lamp should light if the function switch is turned to any position except STANDBY.

Read-out Unit

WARNING: The read-out Unit should NEVER be opened except by a service person certified and authorized by **ENU Systems, Inc.** Leave the case on the Read-out Unit, which is fitted with a tamper-proof seal.

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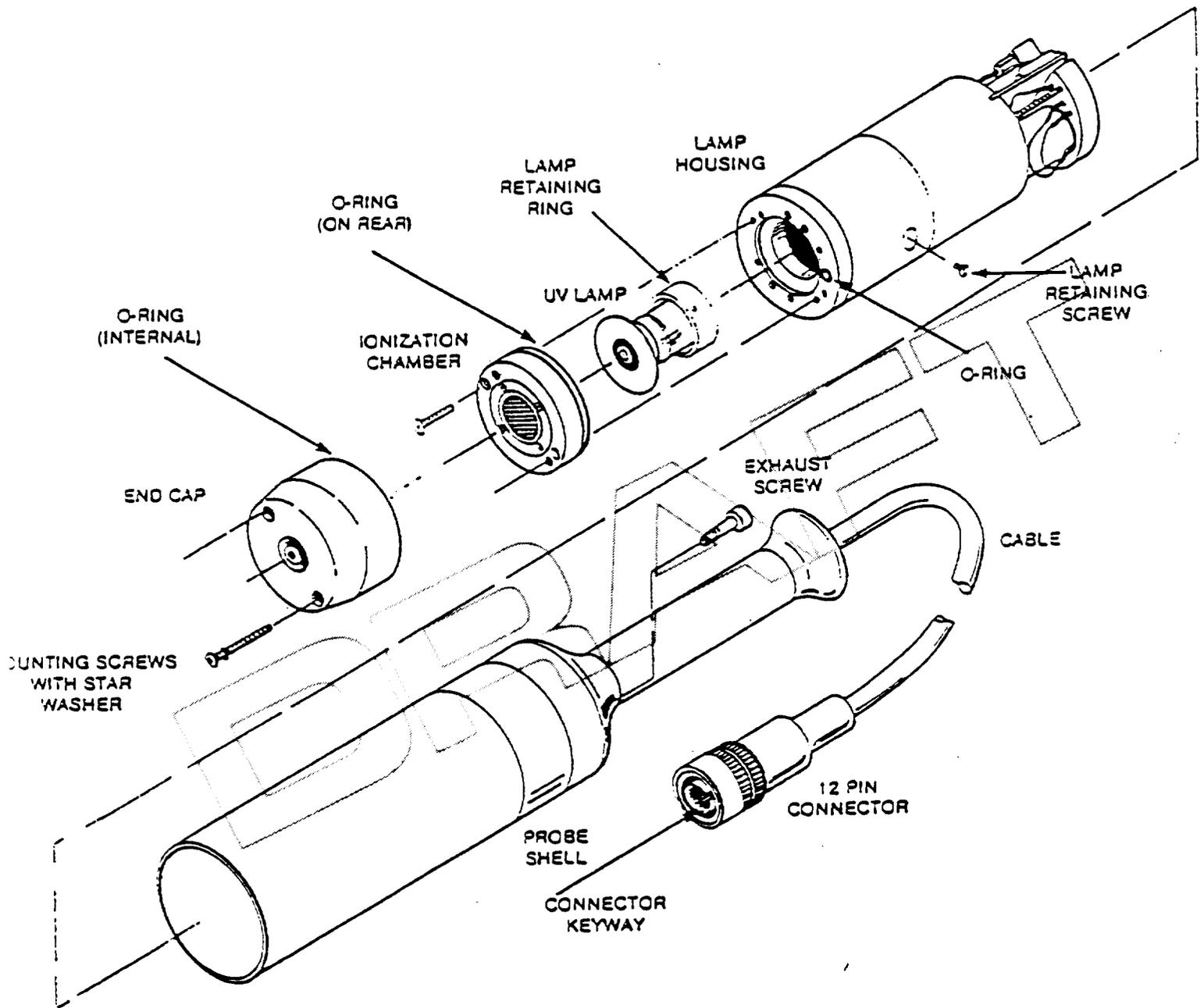


FIGURE
PROBE ASSEMBLY

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B2.3 SIP 1000 Photoionization Analyzer

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SIP 1000 ORGANIC VAPOR ANALYZER

Purpose

The SIP 1000 Organic Vapor Analyzer is for the detection of organic vapors in the work environment. The unit is to be operated only by personnel signed off by the Industrial Hygienist as qualified to operate this instrument.

Charge/Discharge Characteristics (Refer to Figures 1(a) and 1(b))

The battery is a 12-volt, 1.9 ampere-hour sealed lead-acid type that can be operated in any orientation. Since any battery loses capacity through self-discharge, it is recommended that a "top charge" be applied to any battery which has been stored prior to putting it in service. With the power and pump switches off (not depressed), connect the battery and charger as indicated on the back of the SIP 1000. Plug the battery charger into the appropriate AC power source, as indicated on the charger, and let the battery charge for 16 hours.

Connections

1. Fasten the 1/4-inch x 6-inch long probe to the probe hand grip (1/4" fitting).
2. Connect the probe hand grip to the sample inlet fitting on the back of the unit with the 1/8" coiled teflon tubing provided.
3. Turn off the hydrogen cylinder after the hydride has been charged, and unplug the quick connect by grasping the hydride container and pulling the knurled portion of the connector toward you. Unfasten the tubing from the hydrogen cylinder and connect it to the carrier inlet fitting (1/8") on the back of the SIP-1000. CAUTION: Never disconnect the tubing from the hydrogen cylinder or carrier inlet with the hydride connected as this will discharge the stored hydrogen.
4. Check the battery and charger to see that they are properly connected.
5. Connect the cable between the signal jack and any appropriate accessory recording instrument.

Operation

Turn On

Remove the reaction chamber cap, grasp the reaction module by the "O" ring and firmly pull it out of the chamber.

Electrical Shock

Depress the PWR switch and note the display will read [E E E E], indicating the program has been erased. Depress the MODE switch once. The display will read between [0 0 0 0] and [0 0 0 5] within a few seconds, indicating that the electronics are functioning properly.

FIGURE 1(a). DISCHARGE CHARACTERISTICS

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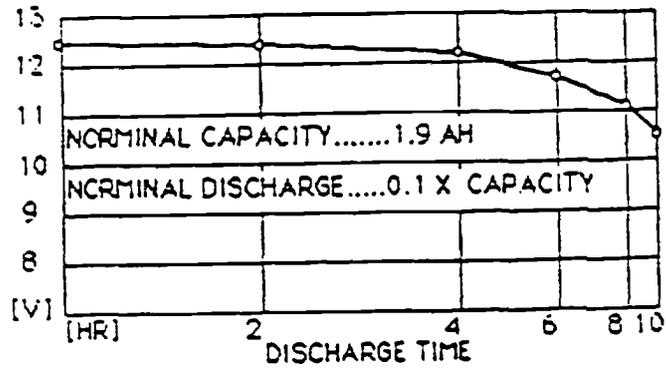
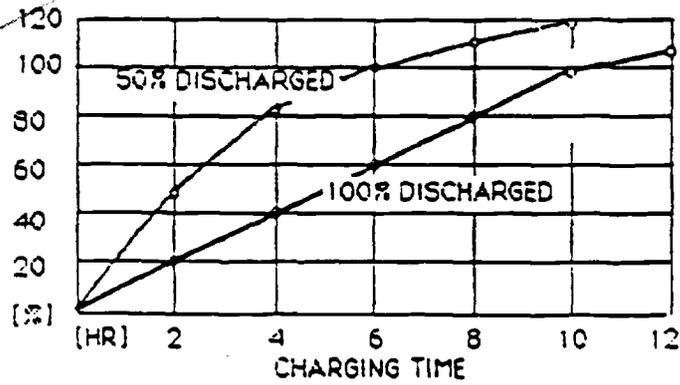


FIGURE 1(b). CHARGING CHARACTERISTICS



Pump Check

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Depress the PUMP switch, and you will hear the pump operate. Place your finger over the sample probe inlet and note the pump will "load down," indicating no major leaks in the sampling system. Turn off the POWER switch before proceeding.

Photoionization Detector (PID) Check

NOTE: Refer to the appropriate section for checking the specific detector options you have purchased. Insert the PID reaction module, (the one with the lamp window visible through the base), observe the keyway when inserting. Replace the reaction chamber cap. **CAUTION:** do not overtighten. The module is properly sealed as soon as some resistance is felt. Turn on the POWER switch, and note through the hole in the chamber cap that the ultra violet lamp is on. The display again reads [E E E E] until you depress the MODE switch once, at which time it will display background ionization counts. If the display reads [H I], wait a few minutes for the sampling system to flush and the count rate to drop. If it does not, place the sample probe in an area where it will sample uncontaminated air. The standard lamp will ionize most gases with an ionization potential at or below 10.6 electron volts. Turn off the power switch and remove the PID reaction module before proceeding to the "Flame Ionization Detector Check."

Flame Ionization Detector (FID) Check

Insert the FID reaction module, (the one with the black anodized base), again observing the keyway. Replace the cap and again do not overtighten. Plug the quick connect into the hydride container or other hydrogen source such as a compressed gas cylinder or hydrogen generator. Set the SIP 1000 regulator at 15 to 20 psi; this corresponds to a flow rate of approximately 50 cc/min. Turn on the POWER and PUMP, and wait about 30 seconds for the hydrogen to flush the column and reach the flame jet. The display will again read [E E E E]. Depress the MODE switch, and the display will read between [0 0 0 0] to [0 0 0 5]. Depress the IGNITE switch, and listen for the FID to ignite. You will hear a slight "pop," and the display will indicate background count. Reduce the pressure to between 5 and 7 psi for normal operation. **CAUTION:** Excessive hydrogen flow will cause the flame to burn too hot; this causes high background noise and may result in damage to the reaction chamber or module.

NOTE: Turn off the power and insert the reaction module you wish to calibrate before proceeding.

Thermal Conductivity Detector (TCD)

The TCD reaction module is only used in the gas chromatograph configuration and will be discussed in specific application notes.

NOTE: Turn off the POWER and insert the reaction module you wish to calibrate before proceeding.

Calibration

As with any analytical instrument, the accuracy of your results will directly relate to the calibration method, accuracy of the standards and technique. It is outside the scope of this manual to discuss the details of the many calibration methods. It is up to the user to select the method, calibration standards and technique best suited to the application. Basically, CALIBRATION is divided into two categories, ZERO and SPAN.

NOTE: Always observe the following for the most accurate results regardless of the method used:

1. Always sample the zero and span gases at ambient pressure to assure the same flow rate as the instrument normally pumps through the system, i.e., never pressurize the inlet or allow the pump to create a partial vacuum by impeding pump flow.
2. Always select the zero gas and the majority component in the span gas to be the same as the atmosphere to be sampled, i.e., use pure air as the zero gas and an air calibration mixture if you intend to look for contaminants in air. Conversely use nitrogen and nitrogen mixtures if you intend to monitor contaminants in a nitrogen atmosphere.
3. Always select a calibration mixture that is reasonably close in concentration to the average levels you would expect to find in the atmosphere to be monitored.

Zero

1. Turn the POWER and PUMP switches on and depress the MODE switch once so that you are monitoring background count. Allow the SIP 1000 to warm up for approximately 15 minutes.
2. Sample a pure gas source as described above. When the count rate has stabilized at its lowest value, depress MODE once more to zero the unit. If there is any down-scale drift, as indicated by a negative reading on the display, depress the set switch to re-zero. There is no limit on how many times you can re-zero during this process. What the unit is doing is storing the sum of both the zero and re-zero readings for subtraction from subsequent readings. This updates the "zero."

Span (Refer to Figure 2)

1. Sample an appropriate calibration standard as previously discussed and wait for the count rate to increase and stabilize.
2. Depress the MODE switch and note that the least significant digit (LSD) on the display is now blank. Enter the value of your calibration standard as follows: EXAMPLE, 14.5 ppm of Benzene, balance air.
 - a) Select 5 for LSD with the SET switch and depress MODE once to enter. The third digit is then blank.
 - b) Select 4 with the SET switch and depress MODE to enter. The second digit is then blank.

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- c) Select 1 with the SET switch and depress MODE to enter. The first digit is then blank.
 - d) Select 0 with the SET switch and depress MODE to enter. CALIBRATION IS NOW COMPLETE.

Recall (Refer to Figure 3)

After calibration has been completed, the instrument is ready to use in the monitoring mode. However, it is suggested that you recall and record the values you have entered and stored for background counts, span counts, and calibration value. You will note that the background counts stored is the sum of the counts zeroed and any rezero counts.

Recalibrate

The frequency with which you should recalibrate the SIP-1000 is a function of operator judgment and is dictated by the desired accuracy, environmental conditions and monitoring requirements. To reduce recalibration frequency, the unit has been designed to minimize long-term drift with changes in environmental conditions. Because it is many times difficult or even impossible to have the necessary equipment available for accurate on-site calibration, the following are available options:

1. An operator programmable microprocessor that stores the program for up to 10 years with the power off.
2. An electronic calibrator to dial in the values recorded as suggested previously. This device replaces the reaction module to simulate detector response and can also be used to change response factors as may be required. In addition, it is a very useful diagnostic tool.

Maintenance

General Information

The unit should be periodically cleaned to avoid the build-up of particulates, moisture, and other foreign materials that may affect operation. Dust, moisture, or other liquids allowed to accumulate in the plumbing lines, probe or detector elements could seriously damage the unit, or at a minimum, cause restriction and/or coat surfaces that would degrade accuracy. Always clean and perform routine maintenance before storage. Carefully pack the unit in the carrying case with all accessories and store in a dry, clean area. Avoid locations that may be exposed to severe environmental conditions such as the trunk of your vehicle.

FIGURE 2. PROGRAMMING

DESCRIPTION	MODE	DISPLAY	SET
PROGRAM ERASED	<input type="checkbox"/>	E E E E	<input type="checkbox"/>
BACKGROUND COUNT (SAMPLING ZERO GAS)	<input checked="" type="checkbox"/>	0 1 5 2	<input type="checkbox"/>
ZERO BACKGROUND	<input checked="" type="checkbox"/>	0 0 0 0	<input type="checkbox"/>
BACKGROUND DRIFT (IF ANY)	<input type="checkbox"/>	- 0 0 3	<input type="checkbox"/>
REZERO	<input type="checkbox"/>	0 0 0 0	<input checked="" type="checkbox"/>
SPAN COUNTS (SAMPLING CAL.GAS)	<input type="checkbox"/>	0 6 8 4	<input type="checkbox"/>
ENTER CAL. VALUE	<input checked="" type="checkbox"/>	0 0 0 .	<input type="checkbox"/>
REPEAT FOUR TIMES TO ENTER ALL DIGITS	<input checked="" type="checkbox"/>	0 0 0 . 5	<input checked="" type="checkbox"/>
	<input checked="" type="checkbox"/>	0 0 . 5	<input type="checkbox"/>
READING CAL. UNITS (PPB, PPM OR %)	<input type="checkbox"/>	1 4 . 5 0	<input type="checkbox"/>

NOTES: 1. MOMENTARILY DEPRESS

2. SELECT 0 THROUGH 9

3. DO NOT DEPRESS

4. ALTHOUGH THE FRONT PANEL READS PPM,
THE UNIT CAN BE CALIBRATED IN:
PPB, PPM OR % FROM (000.1 TO 999.9)

DESCRIPTION	MODE	DISPLAY	SET
BACKGROUND COUNT STORED	<input checked="" type="checkbox"/>	0 1 4 9	<input type="checkbox"/>
SPAN COUNTS STORED	<input checked="" type="checkbox"/>	0 6 8 4	<input type="checkbox"/>
CAL. VALUE STORED IN PPB, PPM OR %	<input checked="" type="checkbox"/>	0 1 4.5	<input type="checkbox"/>
SAMPLING MODE	<input checked="" type="checkbox"/>	2 7.3 1	<input type="checkbox"/>
RECALLS HIGHEST READING	<input type="checkbox"/>	6 8.4 2	<input checked="" type="checkbox"/>
SAMPLING MODE	<input type="checkbox"/>	5.2 0 8	<input type="checkbox"/>
BELOW THE ZERO VALUE STORED	<input type="checkbox"/>	LO	<input type="checkbox"/>
EXCEEDED THE DYNAMIC RANGE	<input type="checkbox"/>	HI	<input type="checkbox"/>
HOLD FOR 3 SEC. TO ERASE PROGRAM	<input checked="" type="checkbox"/>	---	<input type="checkbox"/>

- NOTES: 1. MOMENTARILY DEPRESS
2. (SET) RESETS WHEN HELD 3 SEC.
 (MODE) HOLD TO ERASE PROGRAM
3. DO NOT DEPRESS
4. ALTHOUGH THE FRONT PANEL READS PPM, THE UNIT CAN BE CALIBRATED IN: PPB, PPM OR % FROM (000.1 TO 999.9)

Routine Maintenance

1. CHARGING: Always "top" charge the battery and hydride when not in use and before storage.
2. CLEANING: Remove all items from the carrying case. Remove the partitions, if necessary, and wipe out the inside of the case with a damp cloth. Clean the outside with a lint roller, use a brush, soap and water, if required. Wipe down the unit and all accessories with a damp cloth. NEVER use solvents as they may damage the case, but more important, they will be detected during operation. Avoid getting any moisture in open fittings, tubing, connectors or reaction chamber. Inventory all items and repack in the carrying case.
3. PROBE FILTER: The inlet end of the probe is loosely packed with glass wool to prevent particulates from entering the system. Periodically, push it out with a fine wire from the tip end and replace.
4. INJECTION PORT: When injecting samples in the chromatograph mode, always use a syringe with a minimum needle length of 2 inches. Periodically, remove the needle guide and check the condition of the septa. Replace as required to avoid leaks.
5. REACTION MODULES: A decrease in sensitivity, excessive drift or noisy signal are indicators that the PID or FID modules require cleaning. Clean the base of the FID or window on the PID with a Q-tip soaked in Ethanol. Rinse with de-ionized water and bake at 100°C until dry.
6. LEAKS: Whenever the column is changed or fittings reconnected, there is always the possibility for leaks. To avoid leaks, NEVER overtighten fittings. To check for leaks, disconnect the column from the regulator output and plug the fitting. Connect the hydride and set the pressure regulator at 30 psi. Disconnect the hydride from the quick connect. The pressure gauge should remain at 30 psi. If not, check all fittings and injection port with a leak test soap solution. Take corrective measures and reconnect the column.

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B3.1 Decontamination Procedures

DECONTAMINATION PROCEDURESINTRODUCTION

Decontamination is essential to ensure the congruence of data from site-to-site within a study area and to provide quality control and quality assurance for the data collected. This procedure deals strictly with the decontamination of equipment. Personnel decontamination is covered in the AFP 4 *Health and Safety Plan* (Volume IV).

REFERENCE DOCUMENTS

A variety of decontamination protocols currently exist from state and federal regulatory agencies. There is no single guidance document that has been adopted by the U.S. Environmental Protection Agency (EPA) for hazardous waste site investigations. The following will be used as the basis for procedures in this appendix:

U.S. Environmental Protection Agency, 1981. *Technical Methods for Investigating Sites Containing Hazardous Substances*, Technical Monograph No. 23, June 1981.

U.S. Environmental Protection Agency, 1985. *Decontamination Techniques for Mobile Response Equipment Used at Waste Sites (state-of-the-art survey)*, EPA/600/2-85/105, August 1985.

U.S. Environmental Protection Agency, 1986. *RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD)*, OSWER-9950.1, September 1986.

SIGNIFICANCE AND USE

A major portion of the work effort in the RI/FS process during the site investigations is associated with the collection of chemical data. To that end, procedures described in this section are critical to the credibility of the chemical data collected. Decontamination procedures are directed at the highest level of data quality proposed for the AFP 4 site (Level III).

APPARATUSGeneric Use

- Photoionization detector; Either an Hnu, TIP II, or a SIP 1000. After decontamination has been completed, equipment will be scanned for residual contamination before the equipment is used again. If contamination is detected the equipment will be processed through a full decontamination cycle. All photoionization detectors will have current calibrations.

Soil Sampling Equipment (including split-barrel sampler)

- 6-mil Plastic Sheeting Ground Cover
- Stainless Steel Pans With Lids
- Wire Brush

- Scrub Brush
- Teflon Squeeze or Spray Bottles
- Aluminum Foil
- Waste-Water and Waste-Solvent Storage Containers

Drilling Equipment

- 6-mil Plastic Sheeting for Decontamination pad
- High-Pressure, Hot-Water Washer or Steam Cleaner
- Methanol and Distilled Water Sprayers

Monitoring Well Pumping and Sampling Equipment

- Stainless Steel Buckets
- Steel Barrels

Soil Gas Equipment

- Ultra Pure Zero Air
- Methanol
- Rifle cleaning wire brush

PROCEDURE

Soil Sampling Equipment

1. Set up decontamination station using plastic for ground cover. Place four stainless steel pans along the plastic with the first containing Alconox or equivalent and potable water, the second containing clean potable water, the third to be used to contain excess solvent from the solvent rinse, and the fourth to catch the waste from the deionized water rinse.
2. Remove all visible contamination with a steel brush and/or paper towel.
3. Wash equipment with scrub brushes and soapy water.
4. Rinse equipment with clean potable water.
5. Rinse equipment with laboratory-grade methanol

6. Rinse equipment with distilled or deionized water.
7. Air dry.
8. Where practical, wrap decontaminated equipment in aluminum foil and then place in a plastic bag and seal until ready for reuse.
9. Place waste wash water and solvents in appropriate containers for later disposal.

Drilling Equipment

1. Clean auger flights, bits, and any other downhole tools prior to start of drilling with a high-pressure, high-temperature cleaner using potable water, followed by a methanol rinse, then followed by a deionized water rinse.
2. Place cleaned tools on clean plastic sheeting to avoid contamination from the soil or cuttings and allow to air dry. If equipment is transported to a drilling location, it will be protected from contamination by covering with a clean plastic tarp or sheet.
3. The work area of the drill rig will also be cleaned prior to the start of work at the site.

NOTE: Sufficient auger flights and drill rods will be provided to avoid unnecessary downtime related to decontamination procedures. After the initial decontamination of all downhole drilling equipment, subsequent decontamination will be performed only as needed.

4. Collect all decontamination waste water and place in containers for later disposal based on analytical results from a sample of the waste water.

Monitoring Well Pumping and Sampling Equipment

1. As measurement and/or sampling equipment are removed from a monitoring well, after having come in contact with the water, clean outside surface first by using clean rags or paper towels.
2. Continue cleaning of outer surface by scrubbing with soapy water, followed by a clean potable water rinse, a methanol rinse, and deionized water rinse.
3. For equipment such as pumps and tubing that may become contaminated internally, clean by filling buckets with soapy water and pumping the soapy water through the system into an appropriate waste container.
4. Follow the soapy rinse with clean potable water by placing the pump in buckets of clean potable water and allowing sufficient pumping to clear the system of the soapy rinse. Containerize the water for later disposal.
5. If the system is to be used in the collection of volatile organics, pump a small amount of methanol through the system followed by a deionized or

distilled water rinse.

6. Collect rinsate from decontaminated equipment according to the schedule determined in the *Sampling and Analysis Plan* (Volume II) and send to the laboratory for analysis to help determine the effectiveness of the decontamination procedure.

Soil Gas Equipment

1. Between samples, flush stainless steel pipe, tube, and probe tips with ultra pure bottled air.
2. Before sampling, rinse expendable probe tips with methanol, rinse with distilled water and allow to air dry.
3. Sampling probes will be washed with laboratory soap, using a brush to clean the inside tube. This will be followed by a tap water rinse and a distilled water rinse. Sample probes used in areas with hydrocarbon contamination will be rinsed with methanol before the distilled water rinse and allowed to air dry for 24 hours. All sampling probes will be vented with ultra pure zero air before use.

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