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WORK PLAN FOR REMEDIAL INVESTIGATIONS/ FEASIBILITY STUDIES AT THE FORMER WITCO CORPORATION SITE 900 WILMINGTON ROAD NEW CASTLE, DELAWARE

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TASK 1

DESCRIPTION OF CURRENT SITUATION

Introduction

In this document, existing data and conditions at the site are summarized; Work Plan is developed in response to these data; and analysis of data obtained in the Work Plan is described. Information is also provided on possible remedial technologies and their evaluation. To facilitate regulatory review, the format of this report follows the EPA guidance document for CERCLA/SARA Remedial Investigation/Feasibility Study development.

1.A Site Background

During the summer of 1977, Tris(beta chloropropyl)-phosphate (Tris) leaked from a drum in a drum storage area at Witco Chemical Company's New Castle facility onto the adjacent New Castle Board of Water and Light Commission (NCBW&L) property. The spill was first detected by a NCBW&L employee who noticed an area of dead grass along the Witco/NCBW&L property boundary. This area was adjacent to a drum storage area. An investigation was performed by Witco which revealed the presence of Tris in the soils under the dead grass. Shortly after the spill (1977-1978), approximately 50,000 gallons of ground water potentially contaminated with Tris were pumped from the NCBW&L gallery into the adjacent wetlands under the direction of DNREC. In January 1978 the U.S. Environmental Protection Agency (EPA) conducted an investigation which revealed the presence of Tris in the ground water at 3 ppb or less.

To date, a total of five field investigations and two summary reports have been completed for the Witco property and adjacent NCBW&L property. They were:

1. "A Chemical Intrusion Study of Shallow Aquifer Water Sources at New Castle Water Filtration Plant on Wilmington Avenue", July 1979, by Duffield Associates, Inc. and Betz, Converse, Murdoch, Inc.

2. "Groundwater Evaluation Phase III - Chemical Intrusion Investigation", September 1980, by Duffield Associates, Inc.

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3. "Groundwater Well Sampling at Witco - Inofoam Division, Wilmington, Delaware", January 18, 1983, by Princeton Aqua Science.

4. "Soil and Groundwater Sampling at Witco - Inofoam Division, Wilmington, Delaware", June 1983, by Princeton Aqua Science.

5. "Hydrogeologic Evaluation of the Witco Chemical Company New Castle Water Works Matter at New Castle, Delaware", November 1983, by Environmental Resources Management, Inc.

6. "New Castle Spill, Technical Review of Documents, Final Report", February 1986, by Planning Research Corporation (PRC) for U.S. EPA.

7. "A Preliminary Assessment of Chicago Bridge and Iron, EPA No. DE-38, Emergency and Remedial Response Information System, July 1984, by DNREC, Solidwaste Branch.

The Chicago Bridge & Iron property is located approximately 1000 feet east of the Witco Corporation site. From 1958 to the early 1960s, CBI discharged 5 to 6 percent sulfuric acid and 1.5 percent phosphoric acid into a pit on their plant property. In 1959, the New Castle's water supply was found to have a decreased pH and elevated levels of iron and manganese. When the source of this degradation in water quality was attributed to CBI, the firm began discharging the dilute acids to four foundation pits instead of the original disposal pit. In 1976, such discharge ceased, and acidic wastes were instead sent off-site for disposal. Based on an October 1981 Preliminary Assessment of the CBI site by EPA and a February 1982 DNREC inspection, no further action at the site was deemed necessary. In 1983, CBI was granted small quantity generator status. Wastes shipped off site included methylene chloride, waste oil, and x-ray fixer solution. A July 1984 preliminary assessment of the CBI site by DNREC recommended that a "very low priority" site inspection, consisting of soil sampling for metals, sulfate, and total phosphorus, be conducted to determine any migration of contamination from the former acid disposal areas.

1.A.1 Location

The former Witco and NCDW&L properties are located approximately one-half mile west of the Delaware River and within the city limits of the Town of New Castle, Delaware (Figure 1-1). Both properties are accessible by Wilmington Avenue (Route 9) as shown

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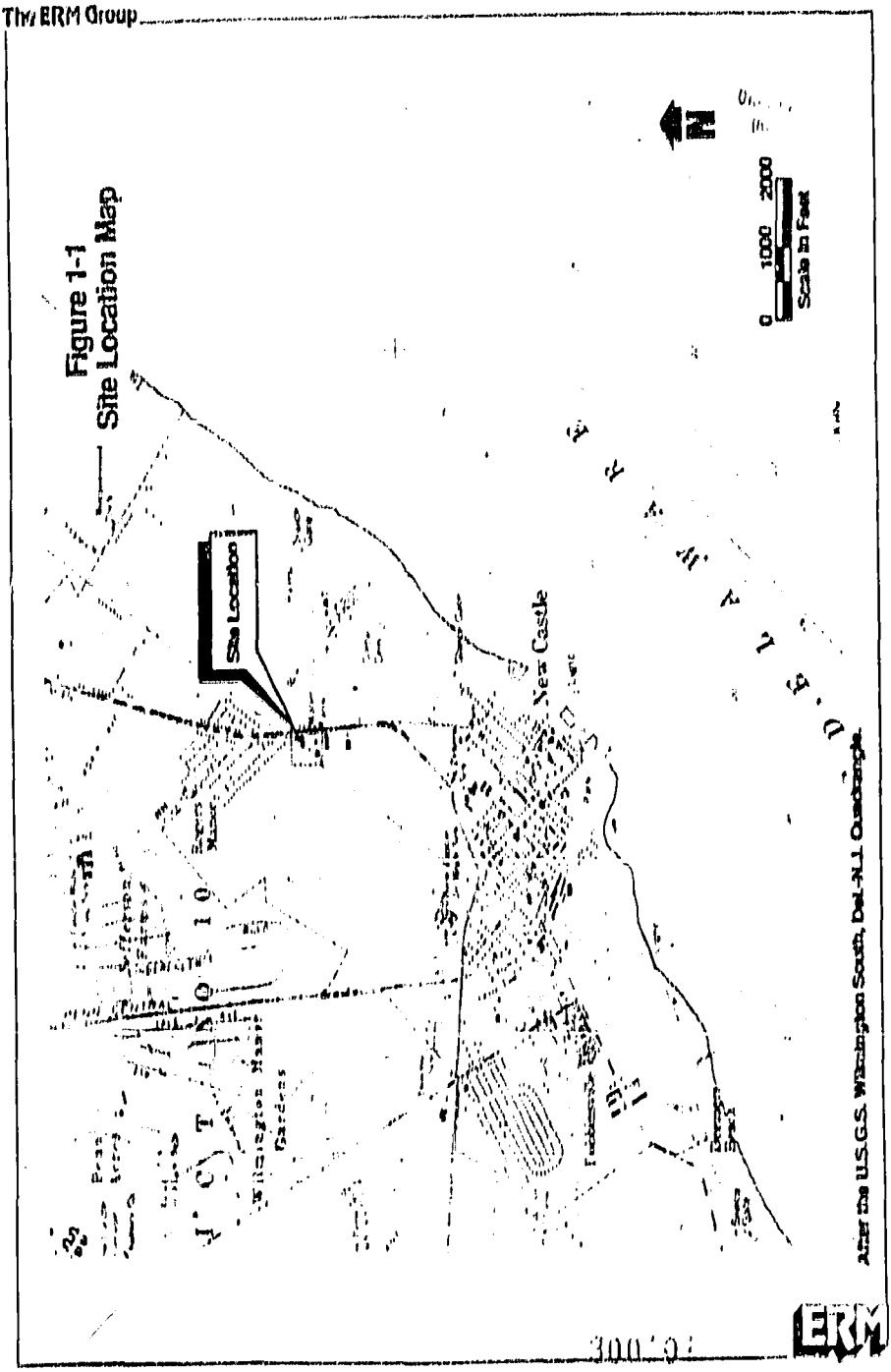

Figure 1-1
Site Location Map

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on Figure 1-2. The original area of investigation for EPA and its subsequent contractors, which encompassed the entire former Witco and NCBW&L properties, is delineated in Figure 1-2.

1.A.2 Physiography

Both the Witco Chemical and NCBW&L properties are relatively flat-lying. According to the USGS Wilmington South, Delaware-New Jersey 7-1/2 minute topographic map, the property lies in the Delaware River floodplain at an elevation ranging from zero to ten feet above mean sea level.

Surface drainage from the site is generally in a west-northwest direction, towards the right-of-way for a set of Conrail tracks. The Conrail tracks are built on a marsh which extends west and south of the tracks and drains to the south.

1.A.3 Hydrogeology

Ground water at the site occurs in two major flow systems: the water table aquifer at the surface and a second, deeper aquifer which underlies a clay confining unit. The NCBW&L has a deep production well (Well No. 11) which is screened in the deep aquifer. Existing data demonstrate that hydraulic connection between the two flow systems is prohibited by the clay confining layer (see Section 1.B.5). Flow in the water table aquifer is principally lateral, but the direction of flow is still in question.

Figure 1-3 shows a stratigraphic section constructed from a correlation of drilling logs for two on-site wells. At the site, the water table aquifer is the Columbia Aquifer. It is exposed at the surface, is 25 to 40 feet thick, and is composed of sand and gravel. An average hydraulic conductivity for the Columbia Aquifer of mid-Delaware has been estimated by Johnston (1973) to be 75 feet per day. The underlying confining unit is composed of 80 to 90 feet of clay to sandy clay. The vertical hydraulic conductivity of the confining layer has been calculated (Martin, 1984) to be 10^{-5} feet per day (2.12×10^{-7} cm/sec) in the New Castle area. Recent pump test data, discussed in Section 1.B.5, demonstrate that the deeper aquifer (the Upper Potomac Aquifer), in the region of the site is confined by the separating clay. Beneath the site, the Upper Potomac Aquifer is believed to be as thick as 140 feet. An approximate hydraulic conductivity for the Upper Potomac Aquifer has been estimated to be 25 feet per day (Martin, 1984).

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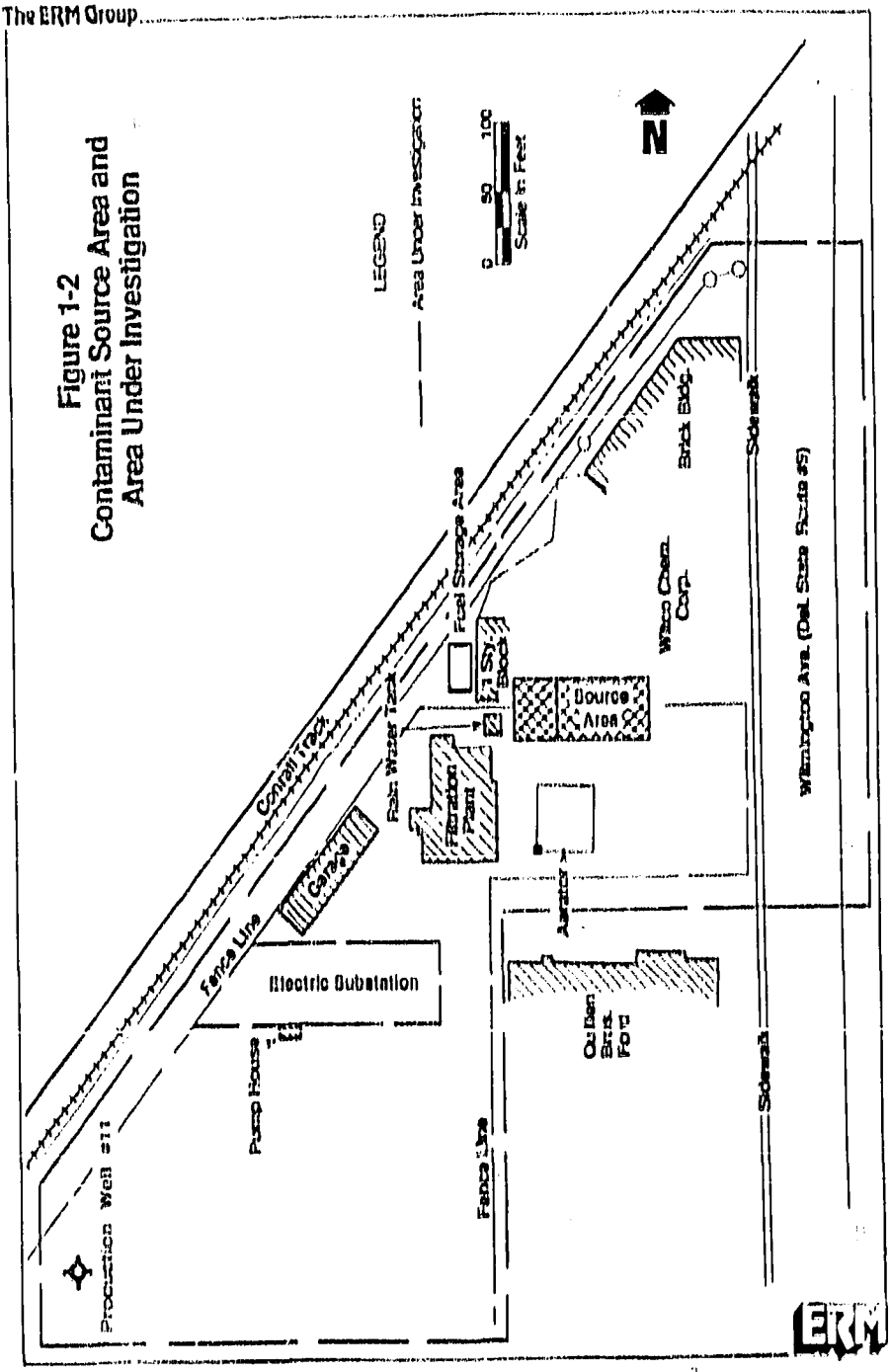

Figure 1-2
Contaminant Source Area and
Area Under Investigation

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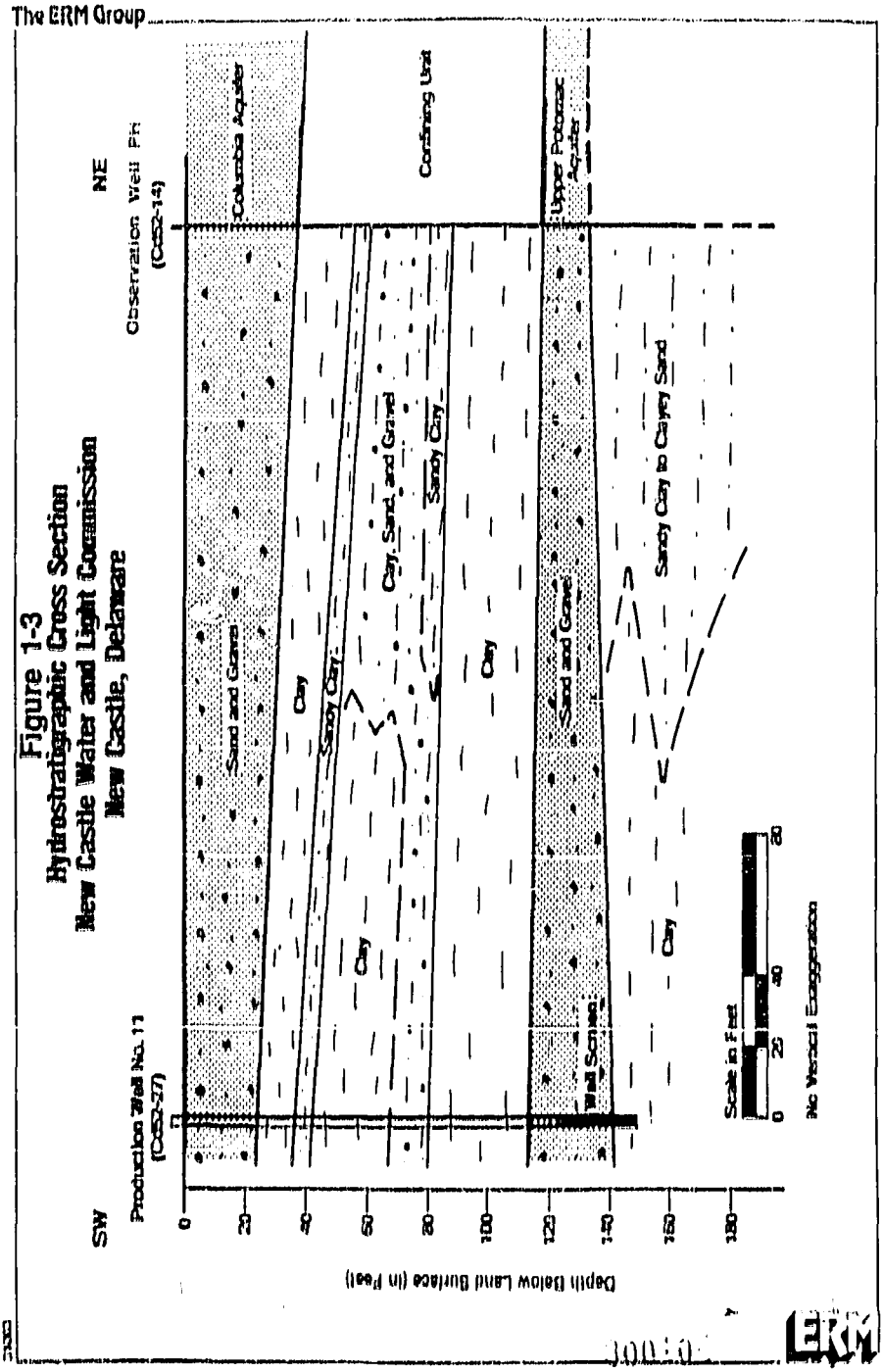

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1.A.4 Geology

Stratigraphically, the Columbia Aquifer represents the Pleistocene Age Columbia Formation. The Columbia is underlain by Potomac Formation sediments of Lower Cretaceous Age; therefore, the Columbia unconformably overlies the Potomac. The Upper Potomac Aquifer at the site represents the Upper Sandy Zone of the Potomac Formation, as identified by Sandstrom and Pickett (1967). The upper sandy zone is measured from the bottom of the clay underlying the Columbia Aquifer down to the top of the next clay layer. In turn, middle and lower sandy zones, also separated by clay layers, are present in the site area. The base of the Potomac Formation is identified as the contact between the lower sandy zone and underlying crystalline bedrock (Figure 1-3). The approximate thickness of each unit in the site area is listed below:

- Columbia Formation	25 to 40 feet
- Separating Clay	80 to 90 feet
- Upper Sandy Zone Potomac Formation	40 to 140 feet
- Remaining Potomac Formation (separating clay, middle and lower sandy zones)	160 to 260 feet

1.A.5 Vegetation

Most of the Witco property has either a building or concrete at the surface. The NCDWQ property has several areas of grass and the marsh to the west contains reeds and grass.

1.B Nature and Extent of Problem

As stated in Section 1.A, the initial response action to the spill was taken by the EPA in an investigation conducted in January of 1978. Subsequent site studies, listed in Section 1.A, have spanned the time frame between 1980 and 1986, when the final report of a technical review was submitted by PRC to the EPA.

The sampling dates, list of parameters analyzed, and consultants collecting samples have varied. For this reason, A comprehensive summary of all sampling events has been prepared. Tables have been generated which provide the historic monitoring record for each specific constituent. These tables are included in the following discussion and in Appendix C.

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A synopsis of report findings is presented below. The principal compound of concern at this site appears to be tris (beta-chloropropyl) phosphate (Tris). Other compounds (including those whose source does not appear to be Witco) are discussed below. Boring locations referred to in the text are shown in Figure 1-4; observation wells are depicted in Figure 1-5.

1.B.1 Tris (beta-chloropropyl) phosphate

The occurrence of Tris in ground water is concentrated in the shallow water table aquifer, where it ranges from less than a hundred to thousands of ppb beneath both the former Witco property and the directly adjacent NCBW&L property to the south. Historic water quality results for Tris at the site are presented in Table 1-1. Samples have also been taken from NCBW&L deep production Well PW-11. As stated in Section 1.A, Tris was initially detected in 1978 in a sample from the production well at a trace concentration of 0.03 ppb. Subsequent samples between 1978 and 1983, however, did not detect Tris. Soil samples collected in the vicinity of the Tris spill at depths from 0 to 12 feet showed Tris concentrations of less than 50 ppb to over 200,000 ppb (Figures 1-6 through 1-9).

1.B.2 Other Constituents Present in Soils

The soils associated with the former Witco site have been sampled three times since 1979. The samplings included seven borings at a 2 foot depth and 17 borings from zero to 12 feet. Soil samples were analyzed for priority pollutants (with the exception of those listed in Section 1.B.4) as well as other compounds thought likely to be on site (e.g. Tris). Compounds detected in the soils are discussed as follows.

Polychlorinated biphenyls (PCBs) were detected in only one location, Boring No. 5 along the Conrail right-of-way, at 2 feet at a concentration of 3500 ppb. As indicated in Table 1-2, PCBs were not detected at any other boring location on the site up to a depth of 12 feet. Potential sources of PCBs may be the electric substation less than 100 feet from Boring No. 5 or Conrail train transformers.

Tetrachloroethylene (PCE) was detected at a single location, Boring C11, west of Quillen Brothers Ford at a depth of over 10 feet, at 10.4 ppb. Three samples at shallower depths at the same location showed no evidence of PCE. As indicated in Table 1-3,

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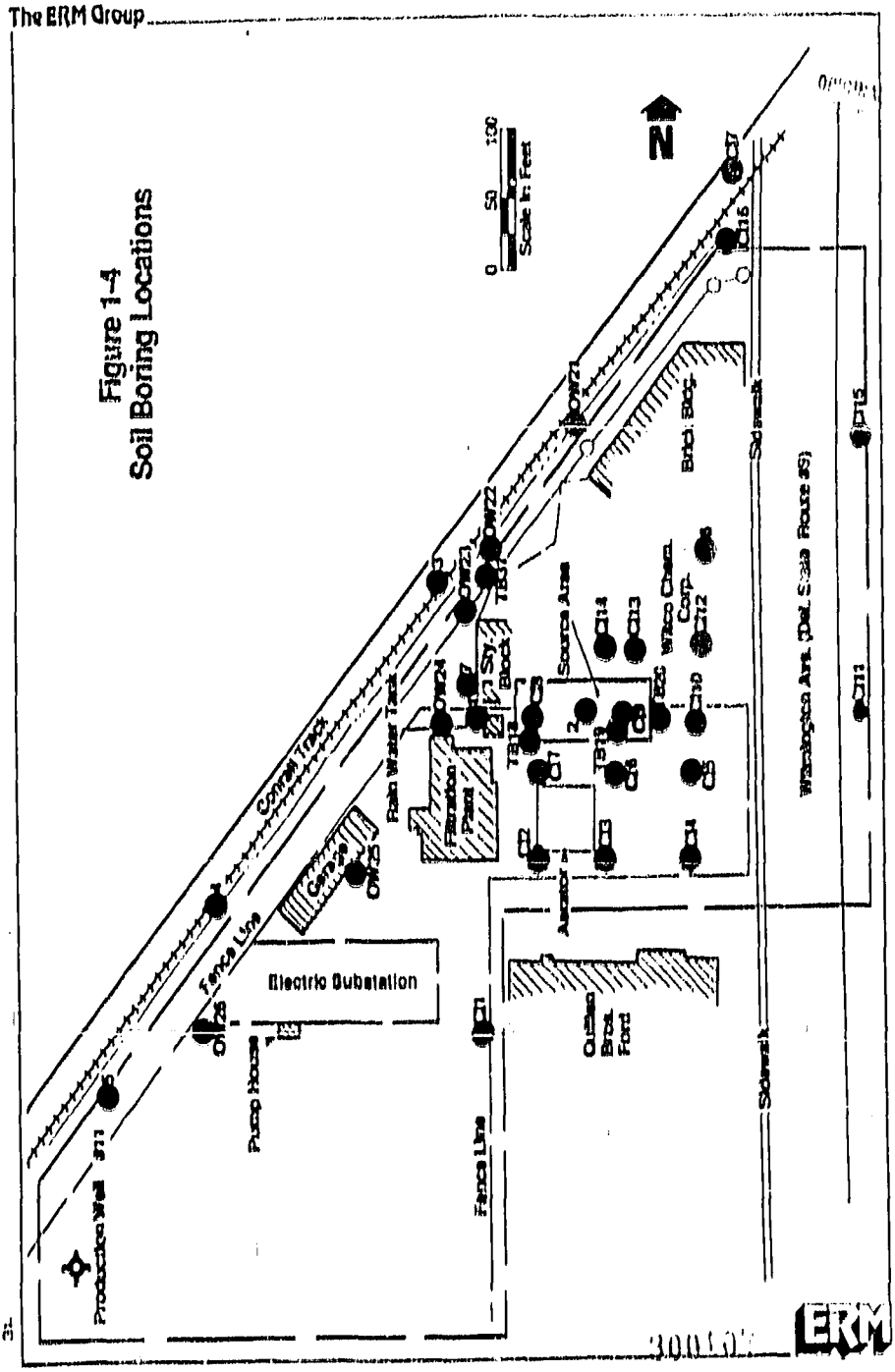

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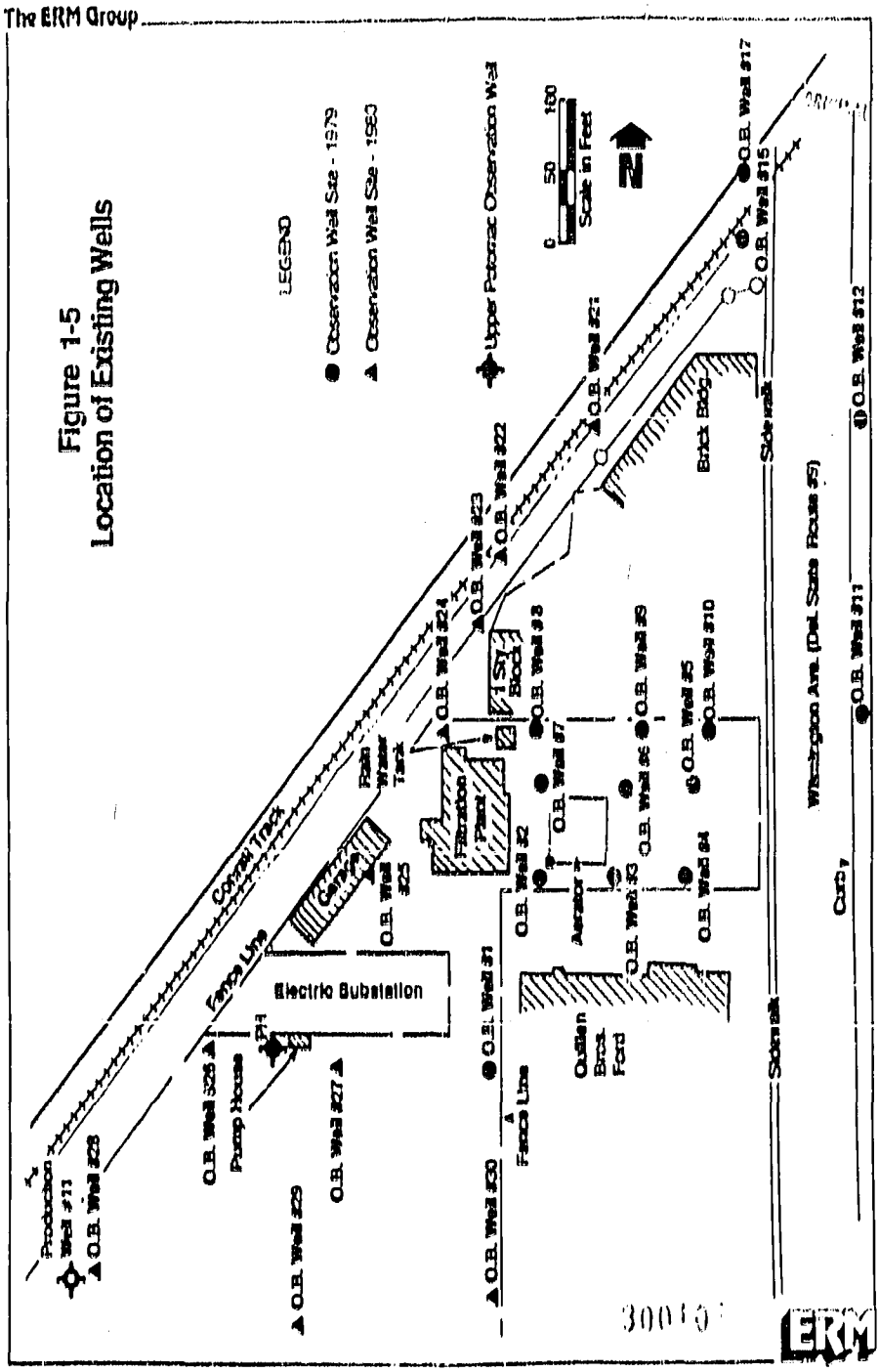

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TABLE 1-1

GROUND WATER QUALITY DATA
Nitro Chemical Company

Tris-B-chloropropyl Phosphate
(all values in ppb)

Date Sampled, Sampler[a]	Observation Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Production Well 11
1/30/79 EPA	2.8																								0.03
8/29/79 EPA	25.6	25.6	43								<1.5														
2/5/80 BCM																									<7
2/19/80 BCM	<7	<7	32	<7	289	1210	3140	1750	71	<7	702	<7	15	232											<7
3/24/80 BCM																									<9
4/1/80 BCM																									<9
6/29,7/11/80 BCM															760	72.2	1200	144	72	102	14.6	9.6	[illegible]	<1.7	
1/18/83 PAS	<10	<10	<10	<10	<10	<10	<10	1070	946	228	<10		<10		10100	370	435	376							<10
1/18/83 Dougherty								1000																	
5/19-20/83 PAS								1980					24		6900		1890	400				44	<20	<20	<20
5/19-20/83 E & E								ND	ND				ND		ND		ND	ND				ND	ND	ND	ND

ND = not detected

[a] EPA = Environmental Protection Agency
BCM = BMC, Inc. (Duffield Associates)
PAS = Princeton AquaScience
E&E = Ecology and Environment
Dougherty = Ralph Dougherty

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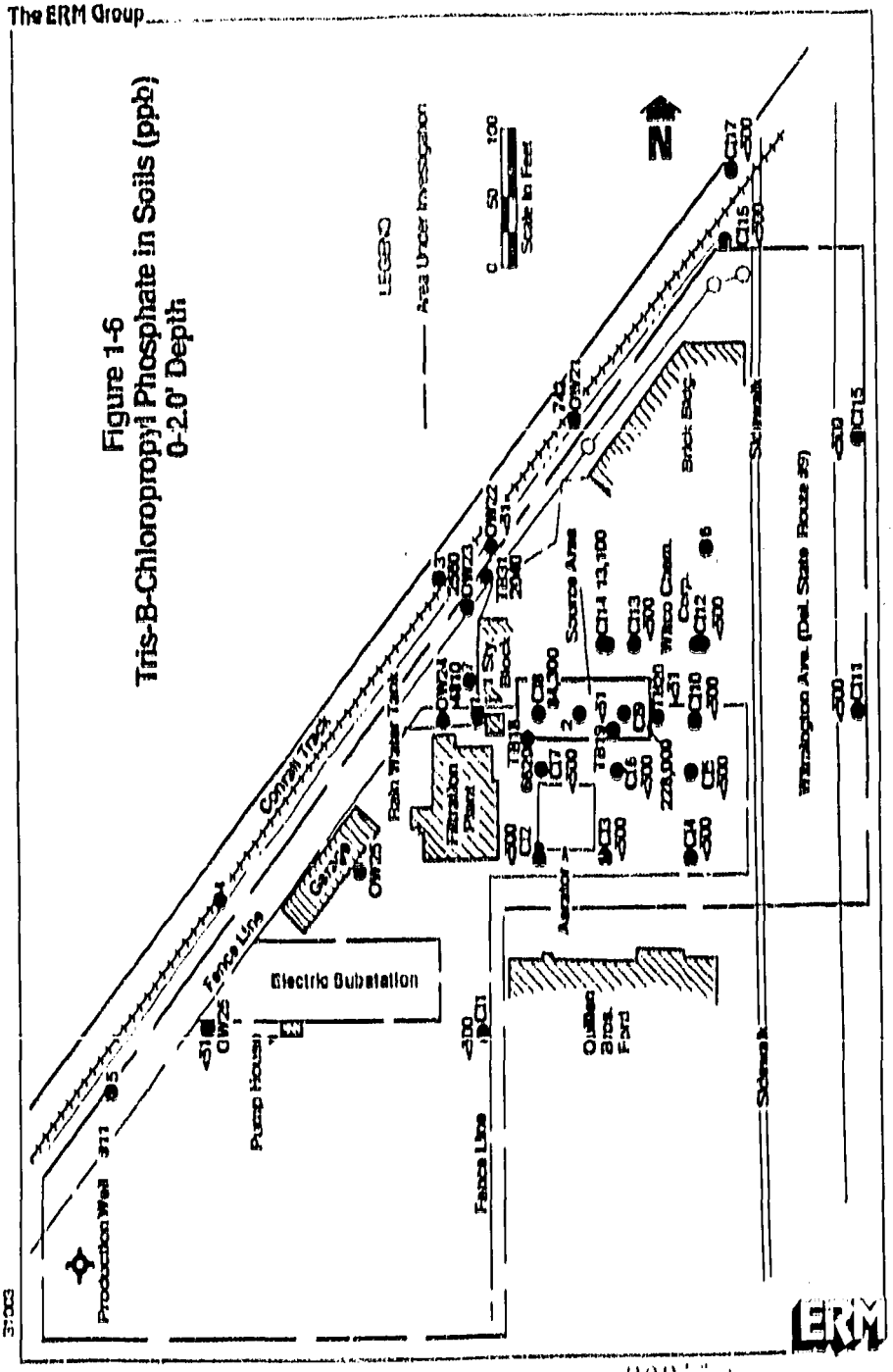

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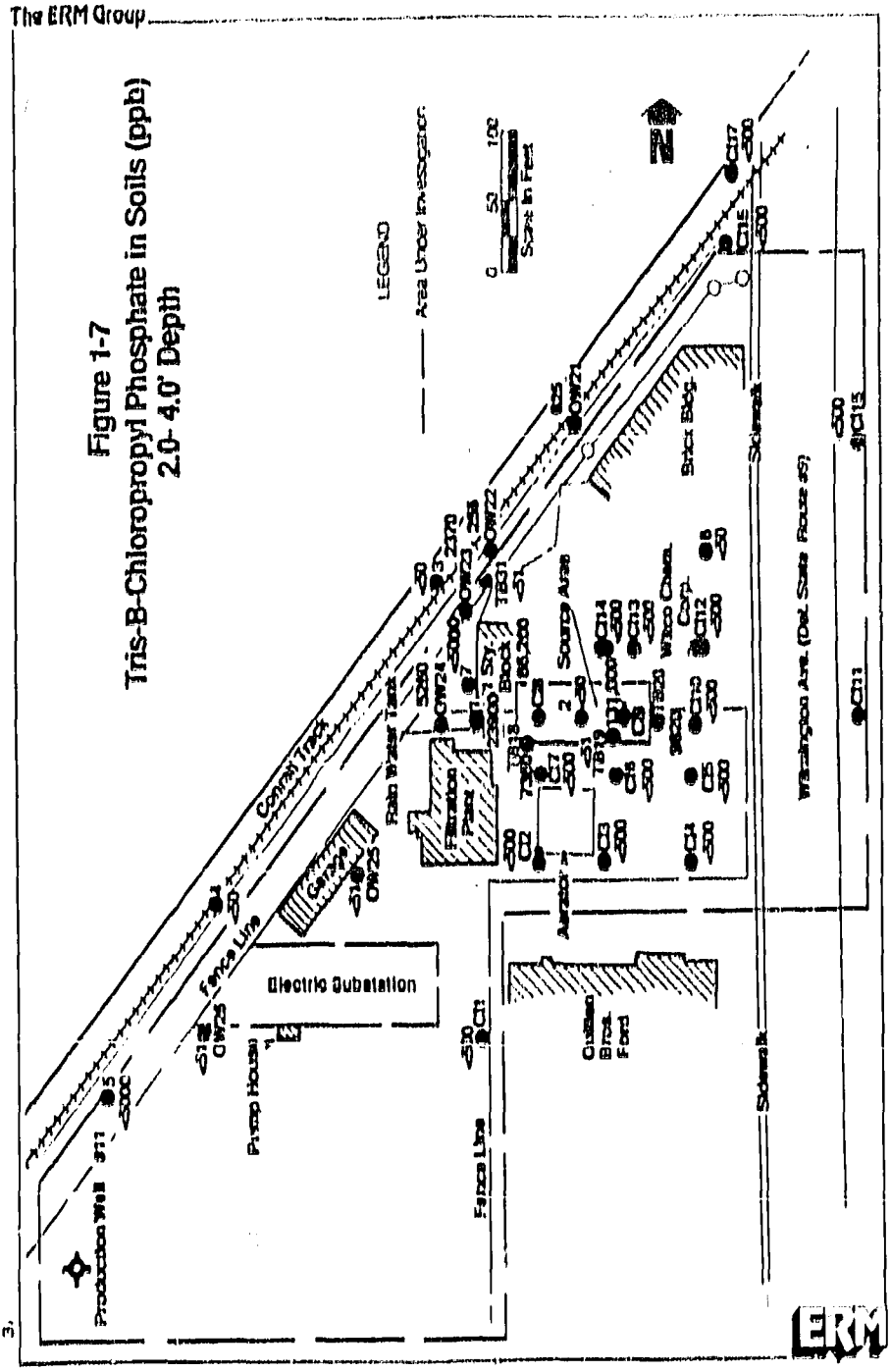

Figure 1-7
Tris-B-Chloropropyl Phosphate in Soils (ppb)
2.0- 4.0' Depth

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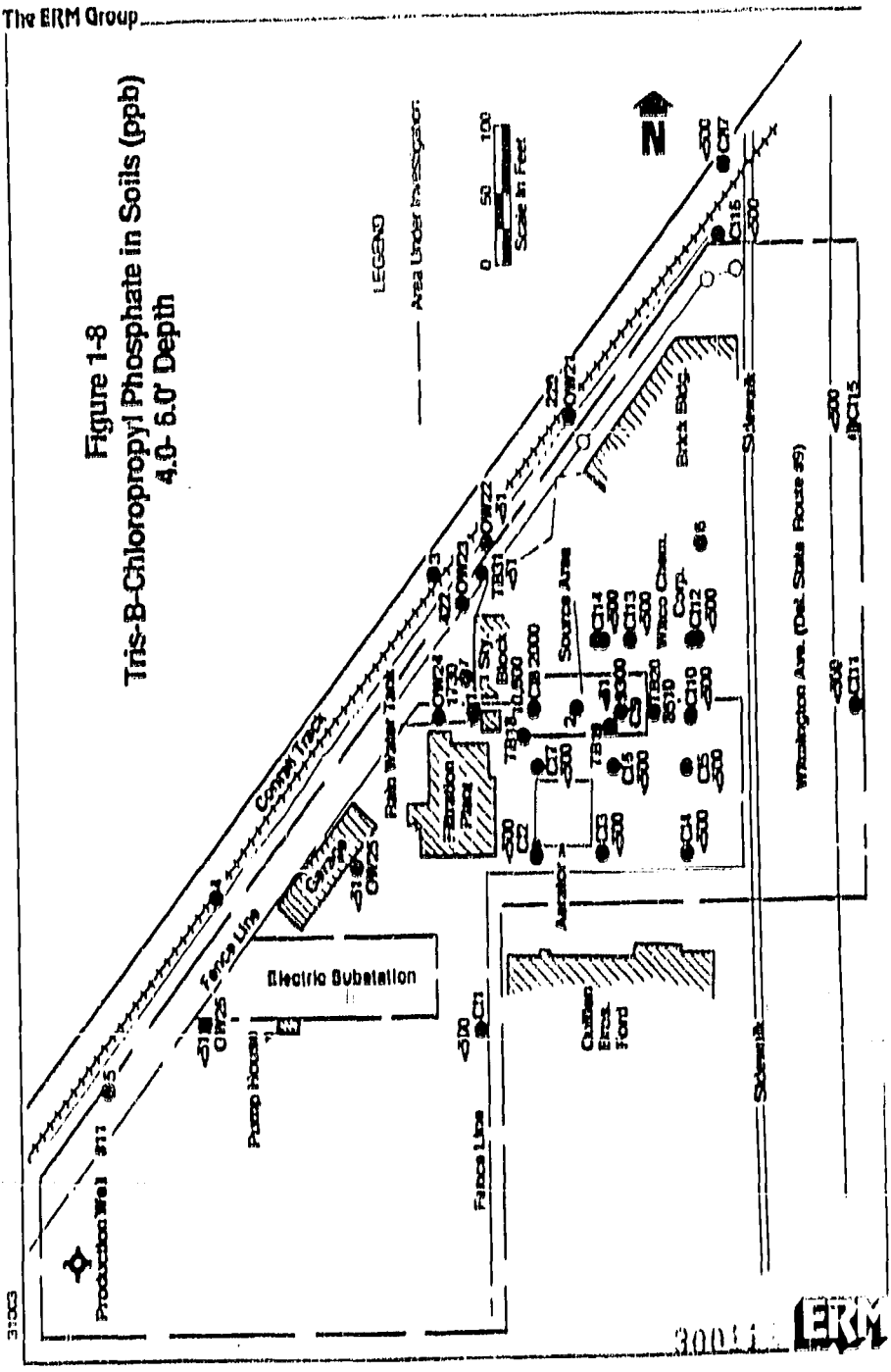

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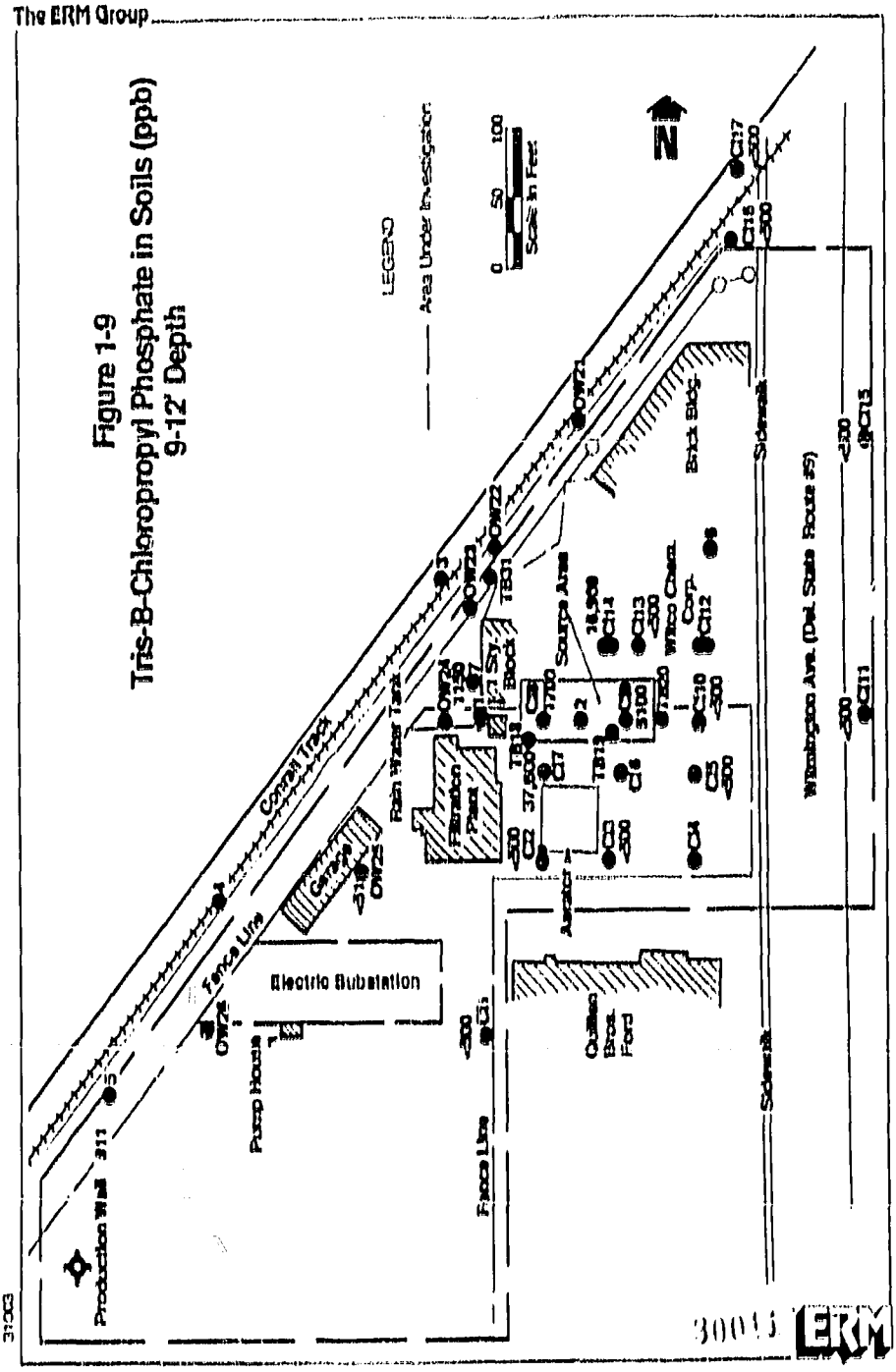

Figure 1-9
Tris-B-Chloropropyl Phosphate in Soils (ppb)
9-12' Depth

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TABLE 1-2

Soils Concentration Data
Vitro Chemical Company

Polychlorinated Biphenyls
(all values in ppb)

Depth feet	Boring Location 1	2	3	4	5	6	7	G 1	G 2	G 3	G 4	G 5	G 6	G 7	G 8	G 9	G 10	G 11	G 12	G 13	G 14	G 15	G 16	G 17
0.5								a	a	a	a	a	a	a	a	a	a	a			a	a	a	
0.75																				a	a			
2.0	<3000	<3000	<3000	<3000	3500	<3000	<3000	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
2.5								a	a	a	a	a	a	a	a	a	a		a	a	a	a	a	
5.46																					a			
6.0								a			a	a	a	a	a	a	a	a	a	a		a		a
10.5								a																
11.75									a	a	a	a						a				a		a
12														a	a	a	a			a	a		a	

Samples at boring locations 1-7 taken by PHE, 5/29/81.
Samples at boring locations G1 - G17 taken by BCM, 7/2-11/79.

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TABLE 1-3

SOILS CONCENTRATION DATA
Witco Chemical Company

Tetrachloroethylene
(all values in ppb)

Boring Location

Depth, ft	CI 1	CI 2	CI 3	CI 4	CI 5	CI 6	CI 7	CI 8	CI 9	CI 10	CI 11	CI 12	CI 13	CI 14	CI 15	CI 16	CI 17
0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1
0.75													<0.1	<0.1			
2.0																	<0.1
2.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	
3.ab														<0.1			
3.75		<0.1	<0.1	<0.1												<0.1	
6	<0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1		<0.1
10.5	10.4																
11.75		<0.1	<0.1	<0.1	<0.1						<0.1				<0.1		<0.1
12							<0.1	<0.1	<0.1	<0.1			<0.1	<0.1		<0.1	

Boring Location

Depth, ft	1	2	3	4	5	6	7
2.0	<20	<20	<20	<20	<20	<20	<20

Samples at boring locations 1-7 taken by PAS, 5/20/83.
Samples at boring locations CI1 - CI17 taken by BCM, 7/2-11/79.

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PCE was not detected at any other boring location on the site up to a depth of 12 feet. Thus, the distribution of PCE indicates an off-site source.

Trichloroethylene (TCE) was found at trace amounts only at depths over 10 feet in Borings C11, C17, C18, C19, and C114. The concentrations ranged from a high of 10.4 ppb at Boring C11 west of Quillen Brothers Ford, decreasing in a northward direction across the site to a value of 1.4 ppb at Boring C114. Samples at shallower depths at the same locations showed no evidence of TCE. As indicated in Table 1-4, TCE was not detected at any other boring location on the site at depths up to 12 feet. The detection depth and the decreasing concentrations across the site indicate a probable off-site source for TCE.

Chloroform was detected only at Boring No. 1 between the filtration plant and the one story block building on the Witco property at a trace concentration of 40 ppb at a depth of 2 feet. As noted in Table 1-5, chloroform was not detected at any of six other borings sampled on site. The potential sources for chloroform, a general solvent, could be the garage or filtration plant on the NCBW&L property and the block building or the spill source area on the former Witco property.

The base neutral compounds anthracene, naphthalene, benzo(a)-anthracene, pyrene and fluoranthene are common constituents of creosote, a wood preservative, or asphalt paving, roofing, or waterproofing. These compounds were detected at Boring Nos. 1 through 4 and 6. As noted in Table 1-5, concentrations of these constituents ranged between 100 and 2800 ppb at a depth of 2 feet. Concentrations found in Boring Nos. 3 and 4 along the Conrail tracks suggest creosote from the railroad ties as being the potential source for these constituents. The presence of these base neutrals in Boring Nos. 1, 2, and 6 may be representative of coal tar derivatives from asphalt construction products.

Di(n)butyl phthalate was found in Boring Nos. 2 and 4 at a depth of 2 feet, at concentrations of 490 ppb and 845 ppb, respectively (see Table 1-5). This constituent, a plasticizer, was not found in any other boring locations on site. Certain phthalate compounds frequently occur due to laboratory cross-contamination, where plastic laboratory equipment is in widespread use. Examination of laboratory QA/QC for these samples (not available) might indicate cross-contamination (particularly in laboratory blanks). Otherwise, its presence in Boring No. 2 might indicate that the spill source area is a potential source. The di(n)butyl phthalate was detected in Boring No. 4 along the Conrail tracks but not at Boring No. 1 between the tracks and the source area. This suggests a potential off-site source, possibly railroad rolling stock.

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TABLE 1-4

SOILS CONCENTRATION DATA
Witco Chemical Company

Trichloroethylene
(all values in ppb)

Boring Location

Depth ft.	CI 1	CI 2	CI 3	CI 4	CI 5	CI 6	CI 7	CI 8	CI 9	CI 10	CI 11	CI 12	CI 13	CI 14	CI 15	CI 16	CI 17
0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1
0.75													<0.1	<0.1			
2.0												<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				<0.1			
5.4b																<0.1	
5.75		<0.1	<0.1	<0.1											<0.1		<0.1
8	<0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
10.5	10.4										<0.1				<0.1		<0.1
11.75		<0.1	<0.1	<0.1	<0.1								<0.1	1.4		<0.1	
12							2.9	0.3	2.9	<0.1							

Boring Location

Depth ft.	1	2	3	4	5	6	7
2.0	<20	<20	<20	<20	<20	<20	<20

Samples at boring locations CI1 - CI17 taken by BCM, 7/2-11/79.
Samples at boring locations 1-7 taken by PAS, 5/20/83.

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TABLE 1-5

SOILS CONCENTRATION DATA
Witco Chemical Company

Other Constituents
(all values in ppb)

	1	2	3	4	5	6	7
chloroform	40	<20	<20	<20	<20	<20	<20
anthracene	130	<50	2000	160	<5000	600	<5000
naphthalene	140	<50	630	180	<5000	900	<5000
benzo(a)anthracene	<50	111	<50	470	<5000	<50	<5000
di(n)butyl phthalate	<50	490	<50	845	<5000	<50	<5000
pyrene	<50	100	<50	600	<5000	760	<5000
fluoranthene	<50	<50	<50	100	<5000	<50	<5000
toluene	<20	<20	<20	<20	43	<20	56

All Samples taken at 2' depth by PAG, 5/20/83.

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Toluene was detected in trace amounts, (approximately 50 ppb), only in Boring Nos. 5 and 7 (see Table 1-5). The potential source for toluene in Boring No. 7 may be the above-ground fuel tanks west of the one story block building. However, none of the other compounds associated with fuel, such as benzene or xylene, were detected. No assignable source or trend was observed for toluene in Boring 5; however, the boring is located along the railroad right-of-way, which could be the source area.

1.B.3 Other Constituents Monitored in Ground Water

The ground water associated with the former Witco site has been sampled a total of twelve times since 1978. The samplings included a series of 24 monitoring wells screened in the shallow water table aquifer and deep production well No. 11, screened in the upper sandy unit of the Potomac Formation.

1.B.3.1 Shallow Aquifer Samples

The shallow ground water has been sampled for priority pollutant volatile organic (VOCs), base neutral (BNs), and acid extractable (AEs) compounds, with the exception of acrolein, acrylonitrile, and tetrachlorodibenzo-p-dioxins.

Many of the constituents analyzed for in the various samplings were below detection limits. These constituents are listed in Appendix C. Other constituents, which were found to be present in the shallow aquifer, fall into three classes as discussed in the remainder of this section. It is noted at this point that there are three major potential sources of contamination adjacent to the site, as well as the Witco spill source area. These include the Conrail tracks and right-of-way west of the site, a limited area of fuel storage in above-ground tanks behind the one-story block building on the western perimeter of the former Witco property, and Quillen Brothers Ford south and east of the site. A fourth possible source is the former steel manufacturing plant, Chicago Bridge and Iron, east of the site across State Route No. 9.

Over the period of historic monitoring, some constituents were found in monitoring wells which were located in both the spill source area and along the railroad right-of-way. There are two potential scenarios for the contamination found in these wells. One interpretation is that the drainage from the spill source area moves west into low-lying areas along the Conrail track, and then moves north along with surface water drainage. This surface water then seeps into the water table, causing the presence of

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the constituent in the monitoring wells. The second interpretation is that constituents associated with the railroad right-of-way have seeped into the ground along the low-lying drainage area east of the right-of-way, and have migrated east in the ground water to the monitoring wells located in the spill source area.

For some constituents, the range in concentration is from less than detectable to approximately 50 ppb. Given the small distances between the spill source area, fuel storage tanks, and railroad right-of-way, and the limited range of constituent concentrations, it may not be possible to identify the source of constituents through ground water monitoring wells. An alternative approach would be to clearly determine which constituents could potentially be derived from each source. Some constituents, however, may be potentially available from more than one source. This general discussion has been provided as a basis for the discussion of individual constituents that follows. Well locations referenced in the discussion are found on Figure 1-5.

Constituents other than TrIs that have been detected in the shallow aquifer samples fall into three classes as follows:

1. Constituents which were found at detectable concentrations in the early part of the sampling record but were found at only trace levels (5 ppb) or below the detection limit at subsequent samplings.

2. Constituents which were detected, but have a limited sampling record of 1 or 2 samplings.

3. Constituents which have been detected over multiple samplings at concentrations above trace or detection limits.

Several constituents were detected during the initial sampling events, but were not found above trace levels or above detection limits in subsequent monitoring events. These constituents include ethylbenzene, methylene chloride, tetrachloroethylene, and toluene. Tables 1-6 through 1-9 list the historic concentrations for these constituents over the period of sampling. Ethylbenzene is a solvent and diluent which is sometimes used in an intermediate step of styrene production. Since an initial sampling in January of 1981, ethylbenzene has not been found above detection limits with the exception of one sample taken from Well No. 22 (16 ppb) along the Conrail right-of-way in June 1984. At this location, in the drainage area adjacent to the railroad right-of-way, potential sources of ethylbenzene include upgradient drainage sources such as the spill area, electric substation, filtration plant, garage, and fuel storage area as well as the right-of-way.

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TABLE 1-4

GROUND WATER QUALITY DATA
Witco Chemical Company

Ethylbenzene
(all values in ppb)

Date Sampled, Sampler[a]	Monitoring Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Production Well 11
1/19/83 PAS	12.6	<3	12.6	11	11.5	9.3	11.4	57.2	13.2	10.2	<3		<3		<3	62.0	54.5	29.3							<3
5/19-20/83 PAS								<5					<1		<1		5	<1				<1	<1	<1	<1
5/19-20/83 E & E								ND	ND				ND		ND		ND	ND				ND	ND	ND	ND
5/17/84 ERM	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				<1	<10								<1	
6/21/84 EPA								<1	<1	ND						16									
12/18/84 ERM								<1																	

a PAS - Princeton AquaScience
E&E - Ecology and Environment
ERM - Environmental Resources Management
EPA - Environmental Protection Agency

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TABLE 1-7

GROUND WATER QUALITY DATA
Vitro Chemical Company

Methylene Chloride
(all values in ppb)

Date Sampled, Sampler[a]	Monitoring Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Product Line Well 11
1/18/83 PAS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1		252	<1	164	51.0							<1
1/18/83 Dougherty								50																	
5/19-20/83 PAS								221					<1		183		44	<1				<1	370	160	<1
5/19-20/83 E & E								ND	ND				ND		ND		ND	ND				ND	ND	ND	ND
5/17/84 ERM	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				4	7									
6/21/84 EPA								ND	ND	ND						11									
12/18/84 ERM								1-2																	

[a] PAS - Princeton AquaScience
E&E - Ecology and Environment
ERM - Environmental Resources Management
EPA - Environmental Protection Agency
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TABLE 1-8

GROUND WATER QUALITY DATA
Ritter Chemical Company

Tetrachloroethylene
(all values in ppb)

Date Sampled / Sampler[a]	Observation Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Production Well 11
1/30/78 EPA	8.3																								<0.2
2/5/80 BCM																									41.1
2/19/80 BCM	<0.1	<0.1	<0.1	0.2	0.4	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1											41.1
3/26/80 BCM																									<0.1
6/1/80 BCM																									<1
6/26,7/11/80 BCM															1.2	<0.1	1.4	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	
1/18/83 PAS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		1.4		<1	<1	<1	<1							<1
5/19-20/83 PAS								<5					2		10		<1	6				<1	<1	<1	<1
5/19-20/83 E & E								ND	ND				0.5		7.7		ND	5.7				ND	ND	ND	ND
5/17/84 EDM	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				<1	<1								<1	
6/21/84 EPA		ND			ND	ND	ND	ND	<1	ND					1.6	ND									
12/12/84 EDM								<1																	

[a] PAS - Priority AquaScience
E&E - Ecology and Environment
EDM - Environmental Resources Management
EPA - Environmental Protection Agency
BCM - BMC, Inc. (Duffield Associates)

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TABLE I-9

GROUND WATER QUALITY DATA
Wirco Chemical Company

Toluene
(all values in ppb)

Date Sampled / Sampler[a]	Monitoring Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Production Well 11
1/18/83 PAS	9	<3	12.5	6.5	7.5	3.0	6.4	16.3	8	<3	<3		5.2		8.3	50.4	11.9	8.0							<3
1/18/83 Dougherty								20																	
5/19-20/83 PAS								<5					<1		<1		<1	<1				2	<1	<1	<1
5/19-20/83 E & E								ND	ND				ND		0.6		ND	ND				ND	ND	ND	ND
5/17/84 ERM	<1	<1	<1	1	<1	3	1	7	<1	<1	1				<1	<10								<1	
6/21/84 EPA								<1	<1	2.5						1.3									
12/18/84 ERM								<1																	

[a] PAS - Princeton AquaScience
E&E - Ecology and Environment
ERM - Environmental Resources Management
EPA - Environmental Protection Agency
Dougherty - Ralph Dougherty

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The same statement made for ethylbenzene can be applied to the potential source of methylene chloride. In recent samplings, methylene chloride has only been detected in excess of 5 ppb at Well No. 22 (11 ppb) and has not been found above 5 ppb in any of the wells associated with the Trin spill source area. Methylene chloride is a common solvent and a notorious cross-contaminant of laboratory samples analyzed using GC techniques.

Tetrachloroethylene, another common solvent used in dry cleaning, pharmaceutical, and degreasing operations, has been detected above 5 ppb at Monitoring Well Nos. 21 and 24, (maximum concentrations of 10 and 6 ppb, respectively). Well No. 24 is located in the path of surface drainage moving from the spill source area to the Conrail right-of-way and in proximity to the fuel storage area. Well No. 21 is located north of Well No. 24 in the downgradient direction of the drainage moving north along the right-of-way.

After the initial sampling for toluene in January of 1983, the levels of toluene fell to trace or below detection limit concentrations.

Constituents that were detected but have a sampling record that is limited to one or two monitoring events are summarized in Table 1-10. Acetone was detected for Monitoring Well No. 8 adjacent to the spill area in 1983 at 700 ppb. Among its other uses this compound is used to clean sampling equipment, and a quality control error is possible. None of the other eight wells sampled, including those immediately adjacent to the spill area, had detectable acetone levels. 2-hexanone and 4-methyl-2-pentanone were detected in only one of nine monitoring wells sampled, Well No. 30, which is 400 feet south of the spill area and adjacent to the fenceline between the NCRW&L property and Quillen Brothers Ford. Acetone, 4-methyl-2-pentanone, and 2-hexanone are all solvents used as wood preservatives or lacquers.

Dichlorodifluoromethane and dichlorofluoromethane were analyzed for two samplings in 1983. Neither compound was detected in the initial sampling. Dichlorodifluoromethane was detected in the second sampling at Monitoring Well No. 8 (5 ppb) in the spill source area, and at Well Nos. 21 (36 ppb) and 23 (15 ppb), which are located along the railroad right-of-way. A subsequent sampling was conducted by the U.S. EPA, which analyzed for dichlorofluoromethane for the June 1984 sampling. The method used for the analysis yields only an estimated concentration. Only observation well No. 22, along the railroad right-of-way indicated a significant level of the constituent, estimated at 95 ppb. These chlorofluoromethanes are primarily used as refrigerants or aerosol propellants.

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TABLE 1-10

GROUND WATER QUALITY DATA
Witco Chemical Company

Other Constituents
(all values in ppb)

Parameter	Date Sampled, Sampler*	Observation Well 1	2	3	4	5	6	7	8	9	10	11	16	17	21	22	23	26	28	29	30	Production well 1A
Acetone	5/19-20/83 E & E								100	ND			ND		ND		ND	ND	ND	ND	ND	
2-hexanone	5/19-20/83 E & E								ND	ND			ND		ND		ND	ND	ND	ND	23	
4-methyl-2-pentanone	5/19-20/83 E & E								ND	ND			ND		ND		ND	ND	ND	ND	12	
Dichlorodifluoromethane	1/18/83 PAS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1				<1
	5/19-20/83 PAS								5				<1		36		15	<1	<1	<1	<1	<1
Total xylenes	7/15/83 PAS	19.0	<1	29.9	22.6	<1	14.0	26.2	26.5	18.6	16.0	<1	<1		<1	150	218	21.0				<1
Ortho, meta-xylene	6/21/84 EPA								ND	ND	ND					63**						
Para-xylene	6/21/84 EPA								ND	ND	ND		ND			23**	ND	ND				
Alkyl substituted benzene	5/19-20/83 PAS								26				<20		<20		42	<20	<20	<20	<20	<20
Dichlorofluoromethane	5/19-20/83 E & E								ND	ND					ND		ND	ND				ND
	6/21/84 EPA		2*			ND	ND	3*	3*	4*	ND				ND	99**						
Pentachlorophenol	1/18/83 PAS	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10	33.2	<10	<10				<10

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TABLE 1-10 (continued)

GROUND WATER QUALITY DATA
Bitco Chemical Company

Other Constituents
(all values in ppb)

Parameter	Date Sampled, Sampler*	Observation Well 1	2	3	4	5	6	7	8	9	10	11	16	17	21	22	23	24	28	29	30	Production Well 11
Pentachlorophenol	5/19-20/83 E & E								ND	ND			ND		ND		ND	ND	ND	ND	ND	ND
2-methyl-4,6-dinitrophenol	1/18/83 PAS	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10	16.5	<10	<10				<10
Bis(2-ethylhexyl) phthalate	1/18/83 PAS	<10	<10	<10	<10	<10	<10	<10	<10	14	<10	<10	<10		<10	120	298	<10				<10
	5/19-20/83 PAS								<20				<20		42		<20	<20	<20	<20	<20	276
	5/19-20/83 E & E								ND	ND			ND		ND		ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	1/18/83 PAS	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10	<10	34	<10				<10
	5/19-20/83 PAS								<20				<20		<20		<20	<20	<20	<20	<20	<20
	5/19-20/83 E & E								ND	ND			ND		ND		ND	ND	ND	ND	ND	ND
Dimethyl disulfide	1/19/83 Dougherty								120													
Hexamethyl disiloxane/ trimethyl silanol	1/19/83 Dougherty								6000													

* estimated values

* PAS - Princeton AquaScience
E&E - Ecology and Environment
EPA - Environmental Protection Agency
Dougherty - Ralph Dougherty

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A total xylene analysis conducted on samples taken in July 1983 revealed detectable xylene for many of the monitoring wells. Concentrations in wells located between the fence north of Quillen Brothers Ford and the source area ranged from 14 to 26.5 ppb. Well Nos. 22, 23, and 24 are positioned along the railroad right-of-way in proximity to the fuel storage tanks. The range in concentration for these wells was 21 to 210 ppb, with no apparent trend over well locations. The components of total xylene (ortho-, meta-, and para-xylene) were monitored for by EPA in June 1984. The method of analysis gave estimated detectable concentrations of each component for the sample from Well No. 22. All of the other six wells sampled had no detectable concentrations.

Alkyl substituted benzenes (ASBs) were only analyzed for one monitoring event in May 1983. ASBs were detected in samples from Well No. 8 and 23 at 26 and 42 ppb, respectively. The well locations correspond to the spill source and fuel storage areas.

The historic analyses for pentachlorophenol, a wood preservative, and 2-methyl-4,6-dinitrophenol, a herbicide, indicated that all but Observation Well No. 22 had less than detectable levels of the compounds. It is plausible that these compounds would be found in samples from Well No. 22, located along the railroad right-of-way, since these two compounds could find application there.

Bis(2-ethylhexyl) phthalate has been detected at Monitoring Well No. 9 in the spill source area and in Well Nos. 21, 22, and 23 along the railroad right-of-way. The highest concentrations of the phthalate are found for observation wells 22 and 23, 120 and 290 ppb, respectively. The compound was detected at a relatively low concentration in the spill area (14 ppb) and at much higher concentrations along the railroad right-of-way. Butyl benzyl phthalate was detected in only one of the monitoring wells sampled, Well No. 23, at 34 ppb for the January 1983 sampling. A second sampling round, conducted four months later, indicated that there was no detectable concentration of this phthalate in any of the monitoring wells. As previously discussed, phthalate compounds are frequently laboratory cross-contaminants. Dr. Ralph Dougherty of Florida State University was contracted by legal counsel for the NCDW&L to obtain and analyze samples from monitoring Well No. 8. Dougherty's data indicate relatively high concentrations for select constituents, including trichlorofluoromethane (34000 ppb), hexamethyl disiloxane trimethylsilanol (6000 ppb), and dimethyl disulfide (120 ppb). Hexamethyl disiloxane, trimethyl silanol, and dimethyl disulfide are

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not priority pollutant compounds and are not on the Target Compound List. Trichlorofluoromethane is discussed in the following paragraph.

Two constituents other than Trin have been monitored and consistently detected at greater than trace amounts over the sampling record. These compounds are trichlorofluoromethane and trichloroethylene (Tables 1-11 and 1-12). Trichlorofluoromethane, a refrigerant and aerosol propellant, was analyzed in three samplings between 1983 and 1984. This compound has been detected at concentrations ranging from less than detectable to 356 parts ppb in Monitoring Wells 8, 9, 16, 21, 23, and 24. (As previously noted, the Dougherty result of 34,000 ppb for Well No. 8 is considered suspect). A subsequent sampling conducted in 1984 indicated that four additional wells, Nos. 2, 6, 7, and 22 also yielded samples with trichlorofluoromethane. These latter analyses, however, may not be representative because the analytical method used by the EPA yielded an estimated value of the constituent. Monitoring Well No. 8, in the Trin spill source area, had the highest concentration of trichlorofluoromethane at 356 ppb. The second highest concentration (256 ppb) was found at Observation Well No. 21 along the railroad right-of-way. The analytical work for all sampling in 1983 for trichlorofluoromethane is suspect since the two pairs of split samples taken yielded widely varied results.

Trichloroethylene has been analyzed in twelve samplings conducted between 1978 and 1984. In the early samplings the compound was detected in twelve of the observation wells, ranging from less than 1 to 75 ppb. In a later sampling, June 1984, the range in concentration had decreased, ranging from less than detectable to 20 ppb. Only three of the 13 wells sampled then yielded samples with greater than trace amounts (5 ppb) of trichloroethylene. These included Well Nos. 3, 21 and 22. Monitoring Well No. 3 is located along the north fenceline between Quillen Brothers Ford and the NCDW&L property, whereas Well Nos. 21 and 22 are located along the railroad right-of-way. Trichloroethylene is a constituent found in solvents that could have been associated with Quillen Brothers Ford or Conrail. The former Witco property is less suspect as a source because there was no significant TCE found in the ground water in the spill source area.

1.B.3.2 Water Quality for Production Well No. 11

The NCDW&L deep Production Well (PW No. 11) has been sampled nine times since 1978 for priority pollutant organic constituents. Many of the constituents have been consistently reported as

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TAB -11

GROUND WATER QUALITY DATA
Mitco Chemical Company

Trichlorofluoromethane
(all values in ppb)

Date Sampled, Sampler[a]	Monitoring Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Production Well 11
1/18/83 PAS	<1	<1			<1	<1	<1	<1	<1	<1			<1		<1	<1	<1	<1							<1
1/18/83 Dougherty								34000																	
5/19-20/83 PAS								356					<1		256		156	<1				<1	<1	<1	<1
5/19-20/83 E & E								ND	12				3.3		ND		ND	5.5				ND	ND	ND	ND
6/21/84 EPA		1*			ND	2*	13*	300*	ND	ND					53*	160*									

* estimated value

a PAS = Princeton AquaScience
E&E = Ecology and Environment
EPA = Environmental Protection Agency
Dougherty = Ralph Dougherty

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GROUND WATER QUALITY DATA
Mitco Chemical Company

Trichloroethylene
(all values in ppb)

Date Sampled, Sampler[a]	Monitoring Well 1	2	3	4	5	6	7	8	9	10	11	15	16	17	21	22	23	24	25	26	27	28	29	30	Production Well 11
1/30/78 EPA	4.5																								0.7
2/5/80 BCM																									13.6
2/19/80 BCM	17.0	<0.1	<0.1	<0.1	0.6	5.6	10	<0.1	11.4	<0.1	<0.1	<0.1	<0.1	<0.1											13.6
3/24/80 BCM																									<0.1
4/1/80 BCM																									<0.1
6/25,7/11/80 BCM															11.5	5.8	68.0	5.6	<0.1	3.2	0.6	<0.1	<0.1	74.7	
1/18/83 PAS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1		6.8	1.8	3.5	<1							<1
5/19-20/83 PAS								<5					9		6		11	<1				<1	<1	4	<1
5/19-20/83 E & E								ND	1.6				1.5		4.9		15	1.2				ND	ND	3.4	0.6
5/17/84 ERM	<1	<1	5	<1	<1	<1	<1	<1	<1	<1	<1				11	5								2	
6/21/84 EPA	ND	1.6	5.9	ND	ND	ND	ND	ND	1.0	<1					20	6.7								1.5	ND
12/18/84 ERM								<1																	
4/1-4/86 NCWLC																									0.1

a PAS = Princeton AquaScience
E&E = Ecology and Environment
ERM = Environmental Resources Management
EPA = Environmental Protection Agency
BCM = BMC, Inc. (Duffield Associates)
NCWLC = New Castle Water and Light Commission

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non-detectable or less than detectable (Appendix C). Constituents detected for one or more monitoring events are listed in Table 1-13. The most pervasive contaminant in the upper aquifer, Tri, was reported only once out of seven analyses, at a trace concentration (0.03 ppb) in 1980. This low a reported value is suspect, as all other detection limits reported by the various laboratories have been 7 ppb or greater.

Tetrachloroethylene (PCE) and trichloroethylene (TCE) were detected by BCM in February, 1980 at concentrations of 41.1 and 13.6 ppb, respectively. Neither compound, however, has been detected above 1 ppb in seven subsequent samplings.

Bis(2-ethylhexyl) phthalate has been monitored in three samplings of PW No. 11. It was not detected in January, 1983, but was reported at 274 ppb in one of two different contractor samples in May, 1983. The second of these contractors reported non-detectable, indicating a probable laboratory cross-contamination problem as the source of the 274 ppb report. Many shallow aquifer monitoring wells were also sampled during these three sampling events. These analyses indicate non-detectable phthalate concentrations for many of the monitoring wells in the shallow aquifer. Four of the monitoring wells had reported concentrations (ranging from 14 to 298 ppb) of the compound for at least one sampling. It is unlikely that the single elevated value of bis(2-ethyl hexyl) phthalate from PW No. 11 is the result of leakage from the shallow aquifer for several reasons. The single reported concentration for PW No. 11, 274 ppb, is comparable to the highest concentration reported in the shallow monitoring wells (298 ppb). This means that there could have been no dilution, absorption, or compound degradation as the phthalate passed through the upper aquifer, 80 to 90 feet of clay unit, and into the Upper Potomac Aquifer. The total absence of these mechanisms for reduction in concentration is not conceivable. Furthermore, the specific gravity of bis(2-ethylhexyl) phthalate is 0.99. Therefore, the compound is not heavier than water and would not have a tendency to sink. Thus, laboratory cross-contamination is considered the source of the reported 274 ppb at Production Well 11. Based on this analysis and the lack of any other detectable compounds above trace levels, it is concluded that the ground water produced from Production Well No. 11 is of good quality and has not been adversely impacted by contamination from the upper aquifer. This conclusion is consistent with the lack of aquifer interconnection discussed in Section 1.8.5.

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TABLE 1-13

Historic Water Quality Data for
Constituents Detected at Production Well No. 11
(all values in ppb)

Date Sampled	Sampler[a]	Constituents: Tetrachloroethylene	Trichloroethylene	Tris-(B-Chloropropyl) Phosphate	Bis(2-ethyl hexyl) Phthalate
1/30/79	EPA	<0.2	0.7	0.03	—
2/19/80	BCM	41.1	13.6	<7	—
3/24/80	BCM	<0.1	<0.1	<5	—
4/1/80	BCM	<1	<0.1	<5	—
1/15/83	PAS	<1	<1	<10	<15
5/19-20/83	PAS	<1	<1	<20	274
5/19-20/83	E & E	ND	0.6	ND	ND
6/21/84	EPA	—	ND	—	—
4/1-4/26	NCWLC	ND	-1	—	—

Production Well No. 11 has been sampled and analyzed for Priority Pollutant organic parameters during various samplings; nondetected parameters and sampling dates are reported in tables in Appendix A.

ND = Not detected, detection limit not reported
"—" = not analyzed for

[a] EPA = Environmental Protection Agency
BCM = BCM, Inc. (Duffield Associates)
PAS = Princeton AquaScience
E&E = Ecology and Environment
NCWLC = New Castle Water and Light Commission

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1.B.4 Priority Pollutant Compounds not Analyzed for in Soils and Ground Water

The 18 non-PCB pesticide priority pollutants were not analyzed for in soils. Although analyzed for in ground water samples, none of these 18 compounds were found. The 11 acid extractable priority pollutants also were not analyzed for in soils. Only two compounds of this class (4,6-dinitro-o-cresol at 16.5 ppb at Observation Well 22, and pentachlorophenol at 33.2 ppb at Observation Well 22) were analyzed for and detected in ground water samples. One volatile (cis-1,3-dichloropropylene) was not tested for in soils and was not found in ground water. Acrolein, acrylonitrile, and tetrachlorodibenzo-p-dioxins were not tested for in soils or ground water, and no metals or cyanide monitoring was performed on either soil or ground water samples.

1.B.5 The Issue of Aquifer Interconnection

The "Technical Review of Documents, Final Report", prepared for the US EPA by Planning Research Corporation, February 3, 1986, reports a lack of sufficient information to assess the hydraulic connection, or lack thereof, between the shallow Columbia Aquifer and the deeper Potomac Aquifer. However, sufficient information is available which demonstrates a lack of aquifer interconnection between the shallow and deep systems at the site. The lack of aquifer interconnection is demonstrated by three different types of data, including:

- regional and site-specific cross sections,
- pump test data,
- water quality data.

1.B.5.1 Cross-Sections

Cross sections in the region of the former Witco site have been recently developed by the Delaware Geological Survey. These cross-sections are presented in the Hydraulic Map Series No. 3, Geohydrology of the Wilmington Area. Sheet 1 of the map series provides lines of cross-section surrounding the site in map view and the associated cross-sections in vertical view. The stratigraphic column represented at each test boring or well used in constructing the cross-sections was examined. This exercise demonstrated that every well or test boring encountered the characteristic stiff clay which separates the Columbia Aquifer from the Upper Potomac Aquifer. The clay thicknesses for these borings are plotted in Figure 1-10. No attempt has been made to

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construct isopach contours in that the thickness of the clay is highly variable, yet at every location the clay was present. The thickness of the clay ranged from 12 to 90 feet. In some cases, the clay unit occurs with interbedded sandy beds; however, at each location the characteristic stiff clay was present in the clay unit.

In addition, a cross-section was constructed from drillers' logs kept during on-site drilling. One log (Cd52-27) is from a test boring for Production Well No. 11. The other is for an observation well installed 245 feet northeast of the production well (Cd52-14). These logs were used to generate the cross-section shown in Figure 1-1. As illustrated by the cross-section, the two drill logs show a good correlation illustrating the "layer-cake" geology present at the site. The Columbia Aquifer ranges in thickness from approximately 25 feet at Production Well No. 11 to approximately 35 feet at the observation well. The clay unit that underlies the Columbia Aquifer is predominantly composed of a stiff, high-percentage clay with minor amounts of sandy clay, and sand and gravel. This confining unit was found to be approximately 90 feet thick in the vicinity of Production Well No. 11 and approximately 80 feet thick at the observation well. The upper sandy unit of the Potomac Aquifer or Upper Potomac Aquifer is encountered by both test borings. The zone of production underlying the site was found to be approximately 27 feet thick at the production well and 15 feet thick at the observation well. A clay unit forms the base of this deeper aquifer at the site. This unit was indicated to be a stiff high-percentage clay in the test boring for the production well and a sandy clay to clayey sand in the vicinity of the observation well. This cross-section clearly indicates that the separating clay that is ubiquitous in the region surrounding the site is also present within the site boundaries.

1.B.5.2 Pump Test

The NCBW&L conducted a series of four 48-hour pump tests in April and early May of 1986 in order to reinstate Production Well No. 11 as a source of potable water. A comprehensive monitoring program was conducted during the last of the four tests in order to examine the issue of aquifer interconnection. Water levels in the deep observation well (Cd-52-14), referred to as Well PH, and in eight shallow aquifer monitoring wells during the test were monitored. The test was conducted between April 29 and May 1, 1986. Water level hydrographs were plotted for each well monitored and are shown in Figure 1-11. The fluctuation in the tide in the Delaware River, east of the site, during the pump test, was estimated from published tidal tables and is found as

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Figure 1-11
Water Level Hydrographs
Pump Test of Well No. 11
New Castle Water and Light Commission
April 29, 1986 to May 1, 1986

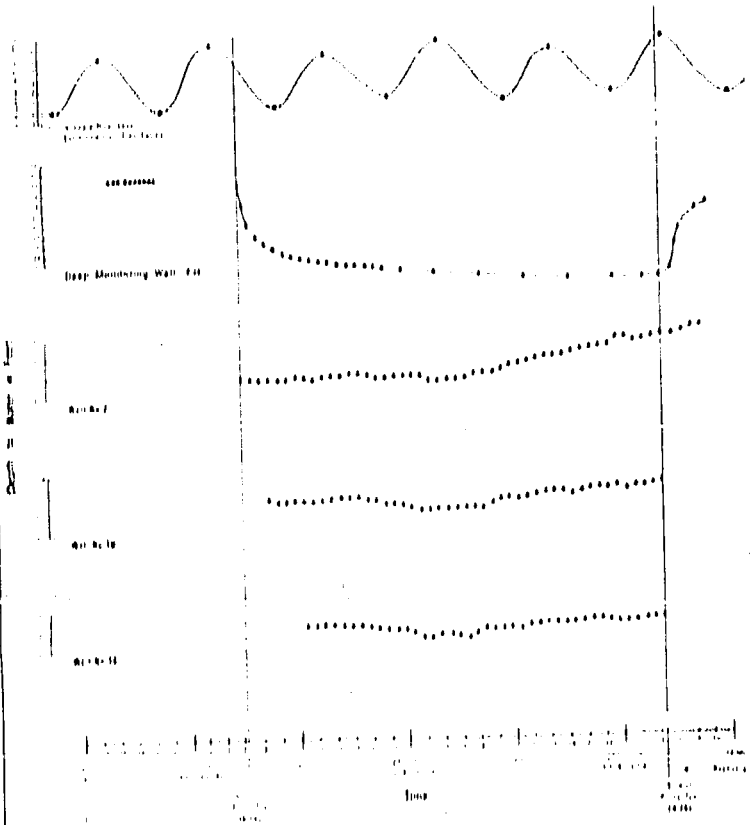

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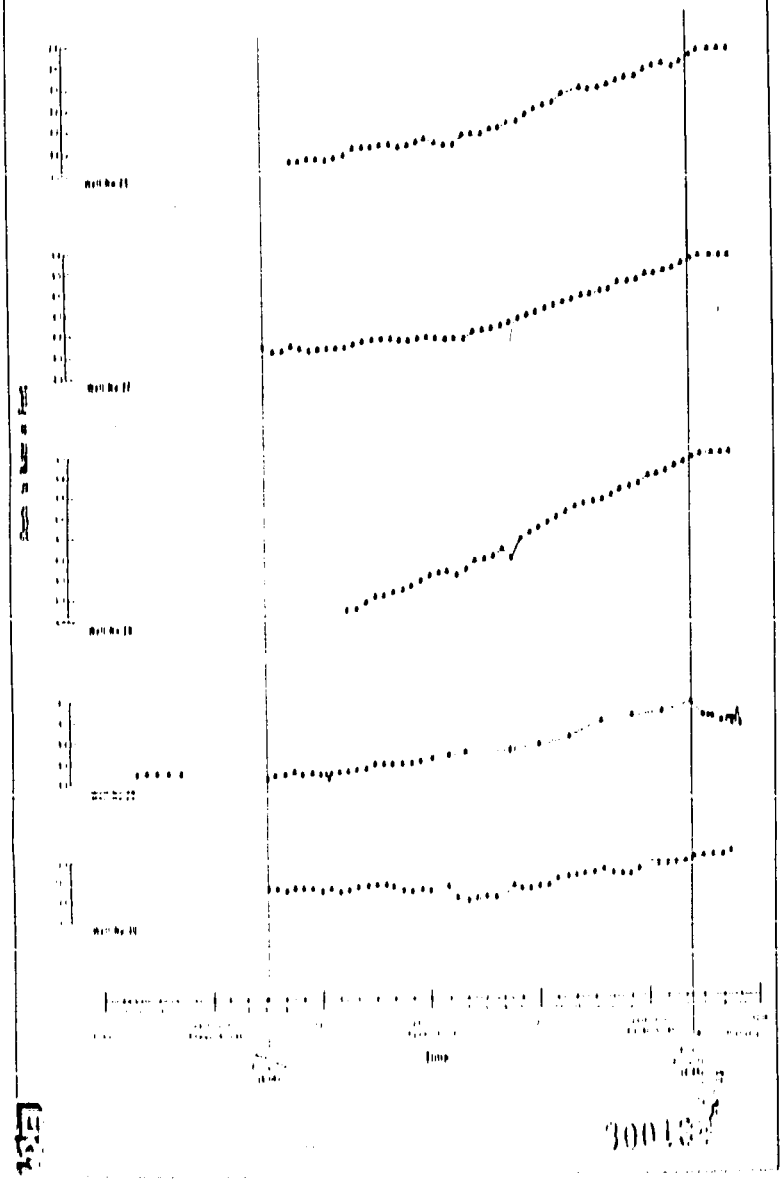
Figure 1-11 Continued
Water Level Hydrographs
Pump Test of Well No. 11
New Castle Water and Light Commission
April 20, 1980 to May 1, 1980



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the top hydrograph in Figure 1-11. This illustration is provided to show that the fluctuating tidal levels had no observed effect on water levels measured in the monitoring wells.

The water levels in the shallow aquifer monitoring wells would have indicated the presence of aquifer interconnection if a decline in water levels could be observed as the piezometric surface in the deep aquifer was lowered. As illustrated by Figure 1-11, none of the shallow aquifer monitoring wells experienced a decrease in water level; in fact, many of the observation wells experienced an increase in water level over the pump test. The water level increased because the discharge from the production well was directed towards a storm sewer just north of the filtration plant. This storm sewer was clogged, and a large volume of water ponded on the ground in the area between the electric substation and the production well (see Figure 1-2). This water recharged the shallow aquifer, causing the water levels to rise. It should be noted, however, that the greatest decrease in water level in the deep aquifer monitoring well PH was observed in the first 12 hours of the pump test. Many of the observation wells had not begun to respond to the recharge of the shallow aquifer at this point in time. For example, Sheet 2 of Figure 1-11 shows the hydrograph for observation well no. 27, which is in close proximity to Well PH. Although the drawdown in Well PH was sixteen feet, the water level in well No. 27 showed a variable, minimal fluctuation over a range of one-tenth of a foot in this 12-hour period. Therefore, no evidence of aquifer interconnection was indicated by water levels in the shallow aquifer.

Observation well PH was located approximately 245 feet northeast of the pumping well. This well showed a total drawdown of approximately 20 feet over the duration of the pump test. The time/drawdown data for well PH were analyzed using the Standard Theis curve matching technique. Figure 1-12 illustrates the match between the log/log drawdown versus time curve for Well PH and the Theis-type curve. This type of comparison would indicate recharge from leakage through the clay unit if the observed data fall below the Theis-type curve. As shown on Figure 1-12, the observed data coincide almost precisely with the Theis-type curve. This match indicates a confined system in which no significant recharge is received from leakage from an overlying aquifer. Induced leakage from pumping would have occurred if there had been a gap in the separating clay in the vicinity of the site or if the permeability of the clay was large enough to allow the vertical migration between the aquifers.

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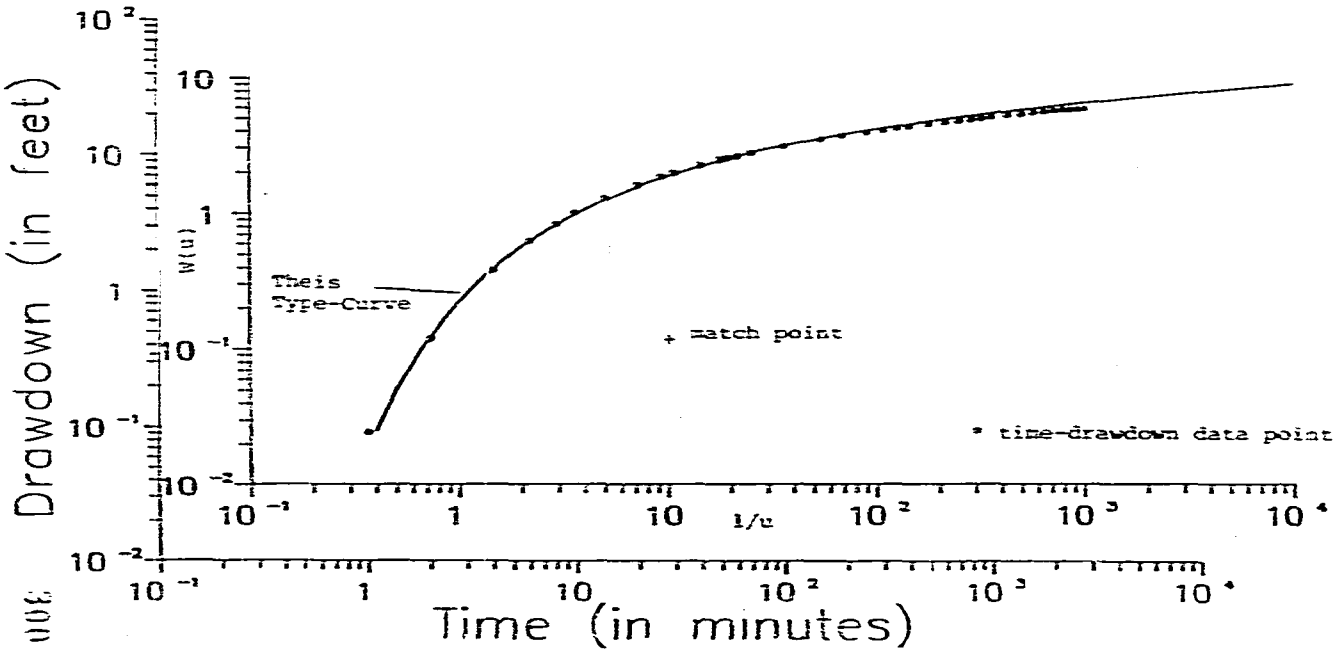
Figure 1-12

Time—Drawdown Plot for Obs. Well PH, Pump Test on Well No. 11



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The pump test data were used to derive transmissivity and storage coefficient values for the deep aquifer. Calculation of the hydrogeologic parameters was performed as follows.

Discharge rate (Q, in gallons/minute) = 200
Distance from pumping well to observation well (r, in feet) = 245

Match Point:

drawdown (s, in feet) = .37 W(u) = .10
time (t, in minutes) = 25 1/u = 10

$$\text{Transmissivity (T, gallons/day/foot)} = \frac{114.6\ QW(u)}{s}$$

= 6194 g/d/ft

$$\text{Storage Coefficient (S, dimensionless)} = \frac{Tt}{2693(1/u)r^2}$$

= .00011

The calculated transmissivity value is representative of values derived from other pump tests in the region. The value for the storage coefficient (.00011) is sufficiently low to indicate that the aquifer in the site area is confined as opposed to semi-confined (Freeze and Cherry, 1979, p.60).

1.B.5.3 Water Quality Data

The third line of evidence for the lack of aquifer interconnection is the historic water quality monitoring data for Production Well No. 11. As discussed in Section 1.B.3.2, the production well has consistently yielded samples of generally high quality and lacking detectable TCE. At the same time, the shallow aquifer overlying the deeper aquifer has been contaminated with TCE, and potentially other compounds, since 1978 or before. Therefore, no aquifer interconnection is indicated by the ground water quality data.

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1.C Site Visits

Witco representatives have been to the site on several different occasions in 1983, 1986, and 1987. During these visits, personnel became familiar with both the Witco and NCDW&L properties as well as the area immediately surrounding the site.

1.D Definition of Study Boundaries

Based on review of the ground water and soil data in Section 1B, the areal boundaries for this remedial investigation are defined as shown in Figure 2-1. These boundaries are subject to change as new data become available. The boundaries include the Witco property, the source area, and the NCDW&L property running east and west of the filtration plant, which, based on existing data, is a potential migration site from such property and source area.

1.E Site Map

A detailed site map will be prepared when the locations for proposed new monitoring wells are surveyed. The site topographic map will have a scale of one inch equals fifty feet and a contour interval of one foot.

1.F Site Office

At present, there are no plans to provide a field office-type facility. All operations will be performed from vehicles assigned to participating staff. An equipped van will serve as the field office on a daily basis. If additional equipment is needed, it can quickly be brought to the site.

1.G Contractor Procurement

Witco or its representative, will be responsible for the procurement of subcontractors necessary to provide the services required for the remedial investigation and feasibility study.

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TASK 2

WORK PLAN

2.A Technical Approach

2.A.1 Introduction

In accordance with guidance of the Delaware DNREC, this RI/FS study is focused to consider pathways which include ground water, soil, and surface water and sediment associated with adjacent wetland areas. Existing data gaps which remain for the soils include:

1. Horizontal and vertical extent of the Target Compound List (TCL) volatile and semi-volatile compounds.

2. Sources of the TCL compounds detected in site soils.

Existing data gaps which remain for ground water include:

1. Direction of ground water flow in the shallow aquifer and the change in this direction in response to tidal fluctuations.

2. Horizontal and vertical extent of TCL volatile and semi-volatile compounds and Tris (B-chloropropyl) phosphate in the shallow aquifer.

3. Sources of the TCL compounds detected in the shallow aquifer.

Related to the second item under ground water is the potential for heavier than water constituents to sink to the bottom of the aquifer and accumulate on top of the clay unit.

Given the previous discharge of ground water to the adjacent wetlands, this area is being investigated to establish the presence of absence of the indicator constituent, Tris.

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2.A.2 Purpose

The RI/FS program will be designed to fill the data gaps and to collect information in order to develop Remedial Alternatives and the Endangerment Assessment (EA). A discussion on how the data gaps will be filled and the type of information that will be collected is provided below.

2.A.3 Basic Approach

The following is a step-by-step outline of the work to be conducted at the site. Each step is described fully in the following subsections:

1. Prepare a site map.

2. Obtain further information on past industrial operations and ground water discharge to adjacent wetlands.

3. Inventory existing wells to determine their condition, obtain water levels, perform a tidal effect study, and determine the direction of ground water flow.

4. Conduct a site wells investigation for TCL volatile and semi-volatile compounds and Trin.

5. Install monitoring wells in select test borings at the top of the clay unit.

6. Determine the Columbia Aquifer hydraulic conductivity by conducting a pump test at a proposed Columbia Aquifer pumping well.

7. Collect ground water samples for water quality determination and water treatment feasibility.

8. Collect and analyze sediment and surface water samples from the adjacent wetlands to evaluate impact of site on that area.

Discussion concerning the evaluation of data collected during the remedial investigation is provided in Task 4. Draft and final report preparation is discussed under Task 6.

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2.A.4 Description of Work

2.A.4.1 Site Map

A base map will be constructed using aerial photography and a site survey conducted by professional surveyors. The survey will include the elevation and location of the existing and new wells, once installed. The surveyors will produce a map of the site with topography at one-foot contour intervals and and a scale of one inch equals fifty feet (1" = 50'). This map will include the locations of all wells and buildings, surface drainage, roadways, and the Conrail tracks.

2.A.4.2 Inventory of Past Industrial Operations

As part of the Remedial Investigation, a listing of former site owners/operators and the manufacturing operations carried out on site will be compiled and incorporated into the site background. In addition, a summary of Witco manufacturing processes and process chemicals will be provided. Data for this task will be obtained from interviews with Witco personnel, plant records, and, if necessary, from state and county tax records, deeds, and previous site owners/operators.

2.A.4.3 Evaluation of Ground Water Discharge to Adjacent Wetlands

According to DNREC officials, approximately 50,000 gallons of ground water was pumped by NCDW&L from their gallery into the adjacent marsh in 1977 to 1978 under DNREC direction. As part of the Remedial Investigation, available information on this action will be compiled and incorporated into the site background. Data and information will be obtained from NCDW&L, Witco, and DNREC records, and, if necessary, interviews with NCDW&L, Witco, and DNREC personnel.

2.A.4.4 Well Inventory and Water Level Measurements

The well inventory will assess the present condition of the old wells. The inventory will determine if any wells have been destroyed or buried, the surface condition, and depth to bottom. Water levels in selected wells will be monitored on a continuous basis for a period of 24 hours using Hermit® field data loggers. This monitoring will be conducted to establish the effect of tidal fluctuations on the direction and gradient of ground water flow. A river monitoring point will also be used to aid in evaluating potential reversals in gradient at the site during a tidal cycle. Also, during the collection of ground water

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measurements, all existing wells will be checked for phased product/ground water liquid separation.

2.A.4.5 Soil Sampling

As discussed in Section 1 B., certain priority pollutant organic compounds have never been analyzed for in the site soils. In addition, none of the sampling programs have been specifically designed to indicate the potential for off-site sources of contamination.

Although many parameters have been analyzed for in the past, the list of parameters and depths of samples have not been consistent. Additionally, there is an indication that the constituents in site soils have degraded over time. For these reasons, the following parameters will be analyzed for in soil samples in accordance with the QAPP:

Tris
TCL Volatile Compounds
TCL Semi-Volatile Compounds

Many of the compounds which were previously analyzed for will be also analyzed for in this soil sampling program. Redeterminations for certain organic constituents will provide a current analysis which could potentially be used to develop rates of natural degradation when considering remedial action alternatives.

The first step in the soil sampling program will be to advance eight test borings for soil sampling. The proposed locations for the borings are shown in Figure 2-1 and have been selected based on a review of the existing data and location of potential on-and off-site sources. Each test boring will be advanced to the top of the water table using hollow stem augers and continuous split spoon sampling. An oversized spoon will be used in order to collect a sufficient amount of sample for analysis. All split spoon samples will be logged by an experienced hydrogeologist who will observe all site work. All sampling equipment and appropriate drilling equipment will be decontaminated prior to sampling and/or between test borings according to the Quality Assurance Project Plan (QAPP).

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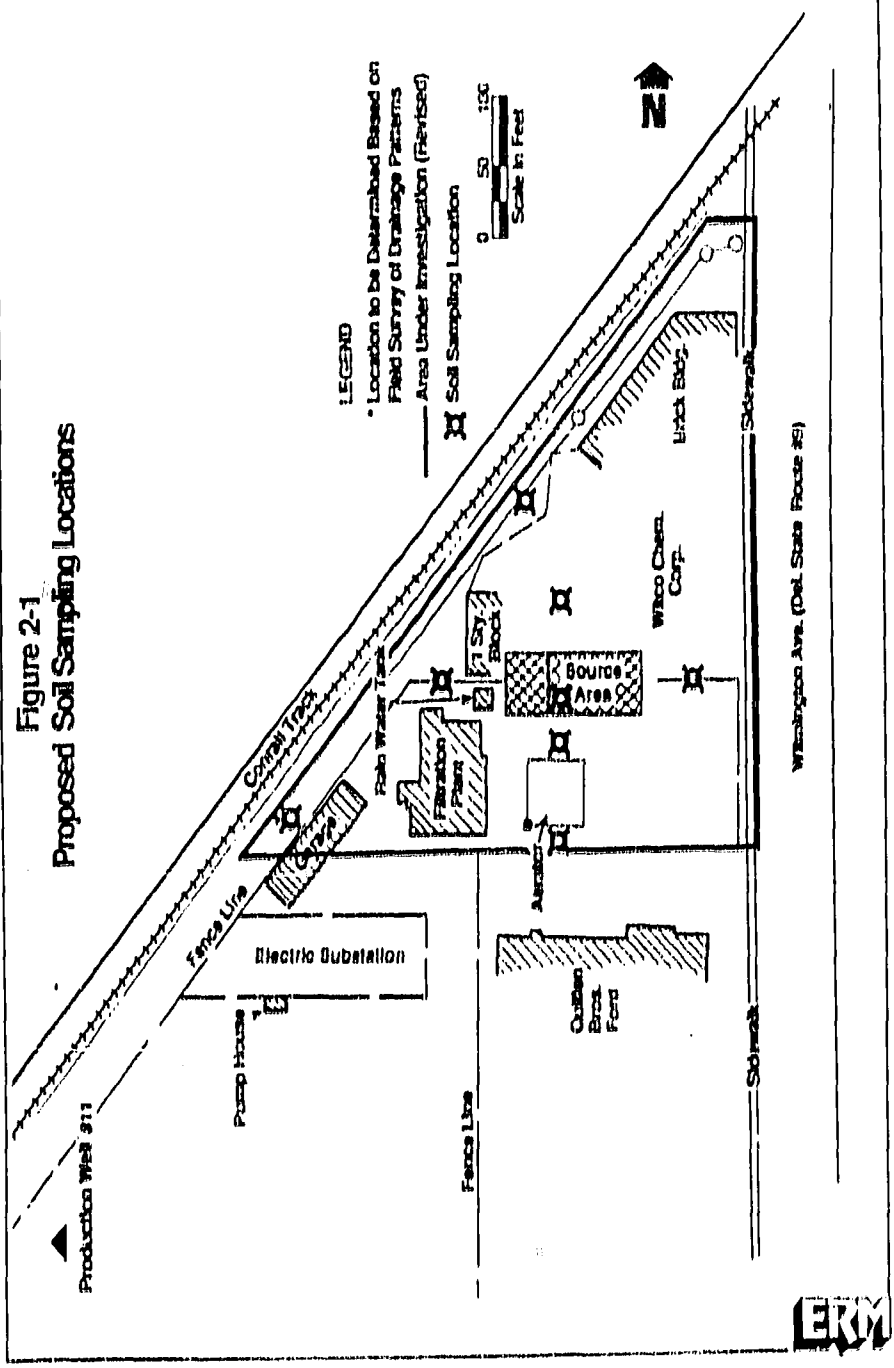

Figure 2-1
Proposed Soil Sampling Locations

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Samples obtained from the test borings will be handled in the following manner:

1. Each 2 foot interval will be composited.

2. Each composite sample will be split into two aliquots. One aliquot (portion A) will be placed (using a stainless steel spatula) in a laboratory supplied glass bottle with Teflon®-lined enclosure and handled as described in Section 4.7.3 of the QAPP. Sufficient soil from the second aliquot (portion B) will be placed to fill one eight of a wide mouth liter container for headspace measurement. Immediately after the soil is placed into the container, the mouth of the jar will be lined with aluminum foil and the enclosure securely replaced.

3. Prior to taking a headspace VOC measurement, the measurement vessel containing the sample will be placed in a room at a constant temperature for a duration of 1 hour. At the completion of the hour, the maximum headspace reading will be recorded using an Organic Vapor Analyzer (OVA). A three-eighths (3/8) inch hole drilled through the center of the plastic cap will allow the puncture of the aluminum seal with the probe of the OVA to measure total VOC content. The headspace measurements and visual observation will be used to select samples for laboratory analysis from each boring.

4. Based on Step 2, select sample splits will be sent for analysis of Trix, TCL volatile and semi-volatile compounds, and the next 40 highest GC/MS peaks in accordance with CLP protocols. The laboratory VOC determination is considered qualitative due to the volatilization of sample constituents during sample handling and storage. Therefore, the laboratory VOC analysis can be used to indicate the presence of VOCs in each sample. A semi-quantitative determination of total VOCs will be made from the headspace analyses (Step 3), using sample weight, headspace volume, and the OVM reading.

2.A.4.6 Ground Water Monitoring

The results of the water table and tidal study will be used to select locations for the installation of monitoring wells. The locations of these wells will be determined in a meeting with Witco, Witco representatives, and the DNREC.

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Monitoring wells will be nested with existing wells to:

- establish vertical flow components in the Columbia Aquifer

- to test for contaminant stratification, sinking, and migration on top of the clay unit.

Where appropriate, new wells will be installed in selected soil test borings. These borings will be extended from the water table to the top of the clay unit using the hollow stem auger method. Split-spoon samples will be collected at five-foot intervals below the water table or at materials changes. The deeper samples will be used to complete the geologic well logs for the extended borings. In cases where new test borings are required for monitoring well construction, split spoon samples will be taken at five-foot intervals for the entire length of each boring. All spoon samples will be subjected to the same headspace analysis as the composite soil samples discussed in 2.A.4.5. The headspace readings may aid in determining the preferred direction of contaminant movement in the subsurface. The borings for monitoring wells will be drilled five feet into the clay unit. A Shelby tube sample of the clay will be taken at the bottom of each test boring and sent to a soils testing laboratory for vertical permeability testing. This testing will be used to determine the permeability of the clay.

Monitoring well construction details are shown in Figure 2-2. The five-foot clay interval from the bottom of the test hole will be backfilled with bentonite pellets. Each well will then be constructed of two-inch I.D. Schedule 40 PVC well riser and five feet of .020-inch machine-slotted screen directly above the clay unit. All joints will be threaded and flush. The screened interval will be sand packed to two feet above the top of the screen. Two feet of bentonite pellets will be placed on top of the sand pack to establish the base of the seal for the remaining annulus. The annulus will be filled with a 10 percent bentonite-cement grout to isolate the well screen.

The wells will be developed by surging with compressed air and/or pumping from a centrifugal pump. The ground water pumped during well development will be properly disposed. All wells will be finished with six-inch I.D. steel risers and locking caps.

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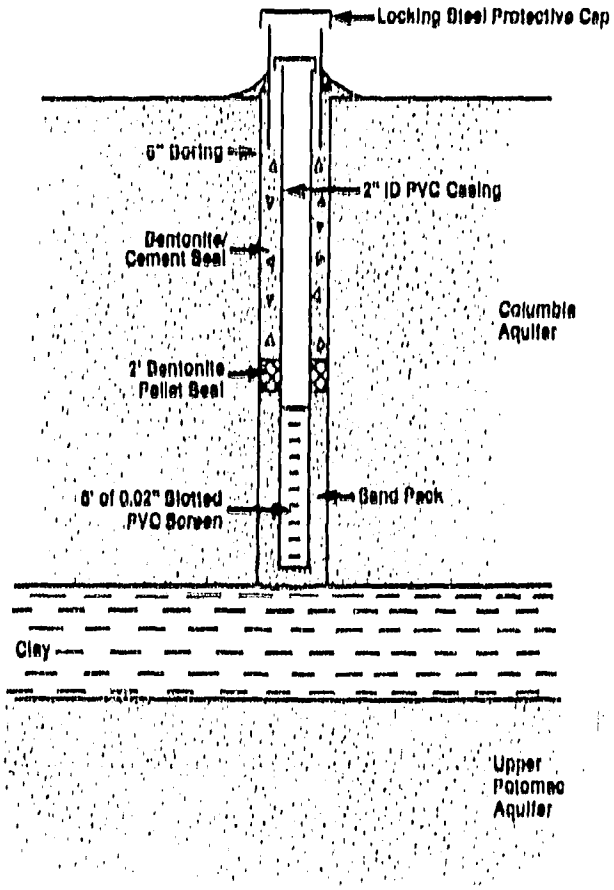
Figure 2-2
Monitoring Well Construction Schematic



Not To Scale

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An additional well, to be used as a pumping well, will be located in the center of the spill/source area. This well will be constructed of six-inch I.D. Schedule 40 PVC well riser and twenty feet of .020-inch machine-slotted screen in order to achieve nearly full penetration of the saturated thickness of the Columbia Aquifer. All joints will be threaded and flush. The screened interval will be sand packed to two feet above the top of screen. Two feet of bentonite pellets will be placed on top of the sand pack to establish the base of the seal on the remaining annulus. The annulus will be filled with a 10 percent bentonite-cement grout to isolate the well screen. The pumping well will be developed using a submersible pump. The ground water pumped during well development will be pumped to a tank truck and manifested to an appropriate disposal facility. The well will be finished with a ten-inch I.D. steel riser and locking cap. Figure 2-3 shows the proposed design for the pumping well.

2.A.4.7 Pump Testing

A 24-hour pump test will be conducted using the new Columbia Aquifer pumping well described in 2.A.4.6. Water level drawdowns will be measured in selected monitoring wells and water samples will be collected at 1 hour and 23 hours into the test. These samples will be analyzed for the same list of compounds described in 2.A.4.8. Sample analyses will be used to evaluate treatment alternatives under the ground water recovery scenario as a remedial action alternative. The results of the pump test will be analyzed to determine the transmissivity (T) and specific yield of the Columbia Aquifer at the site. These parameter values will be used to evaluate pumping schemes for ground water recovery alternatives. In addition, the T value will be used to derive a hydraulic conductivity value (K) for the aquifer, by knowing the saturated thickness (b). The K value will then be used to determine the ground water velocity, given measured water table gradients (i) and an assumed porosity (n) derived from the hydrogeologic literature.

2.A.4.8 Water Quality Sampling

To define the extent of contamination in the Columbia Aquifer, one complete round of ground water samples will be collected from selected existing monitoring wells found to be functional and from the new monitoring wells. All ground water samples will be analyzed for the following parameters in accordance with the QAPP:

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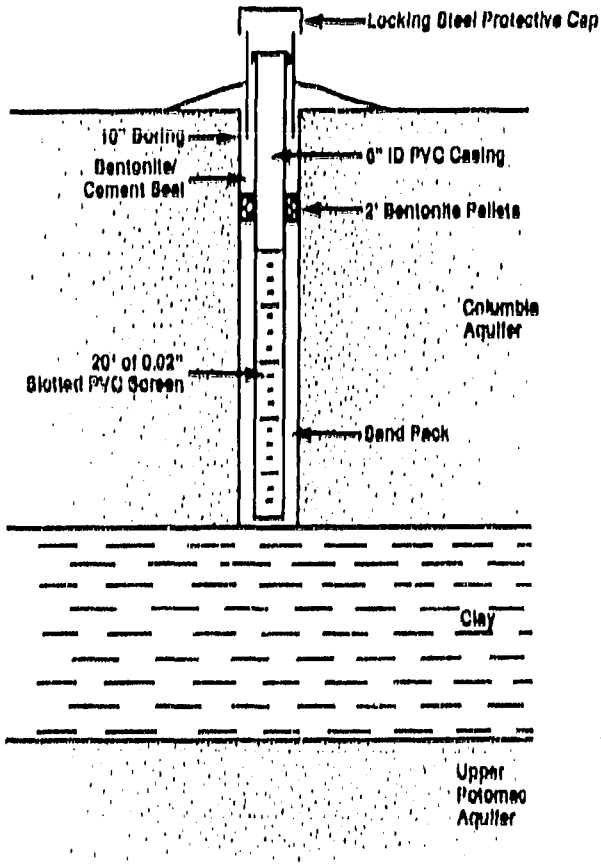
Figure 2-3
Test Well Construction Schematic



Not To Scale

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Tris
TCL Volatile Compounds
TCL Semi-Volatile Compounds
Total Organic Carbon (TOC)
Chemical Oxygen Demand (COD)
pH
Iron
Manganese

The latter 5 compounds will aid in the evaluation of remedial alternatives. Samples will be collected according to the sampling plan procedures described in QAPP.

2.A.4.9 Wetlands Sampling

Based on a field reconnaissance of the site on July 2, 1987 by USEPA, DNREC and Witco representatives, it was agreed that six (6) stations would be sampled. Water and sediment would be collected from those stations with surface water. If no water is present at a station, the station will only be sampled for sediments.

The approximate station locations are shown in Figure 2-4. The station locations follow the anticipated direction of surface water flow from the Witco Site toward the straight ditch.

A sample will be collected from the ponded water area in the ditch between the culvert under the railroad and the transmission line right-of-way, paralleling the railroad on the north side.

Two samples will be collected from the general flow path in the wetlands located to the west of the transmission line right-of-way. The samples will be collected at approximately one-third and two-thirds the distance from the vicinity of the ponded water area to the first tributary upstream of the railroad bridge.

Samples will be collected at the head of the first tributary which potentially receives the surface flow across the wetland area.

Two samples will be collected from the straight ditch. One sample will be collected immediately upstream of the confluence of the first tributary. A second sample will be collected in the vicinity of the next upstream tributary.

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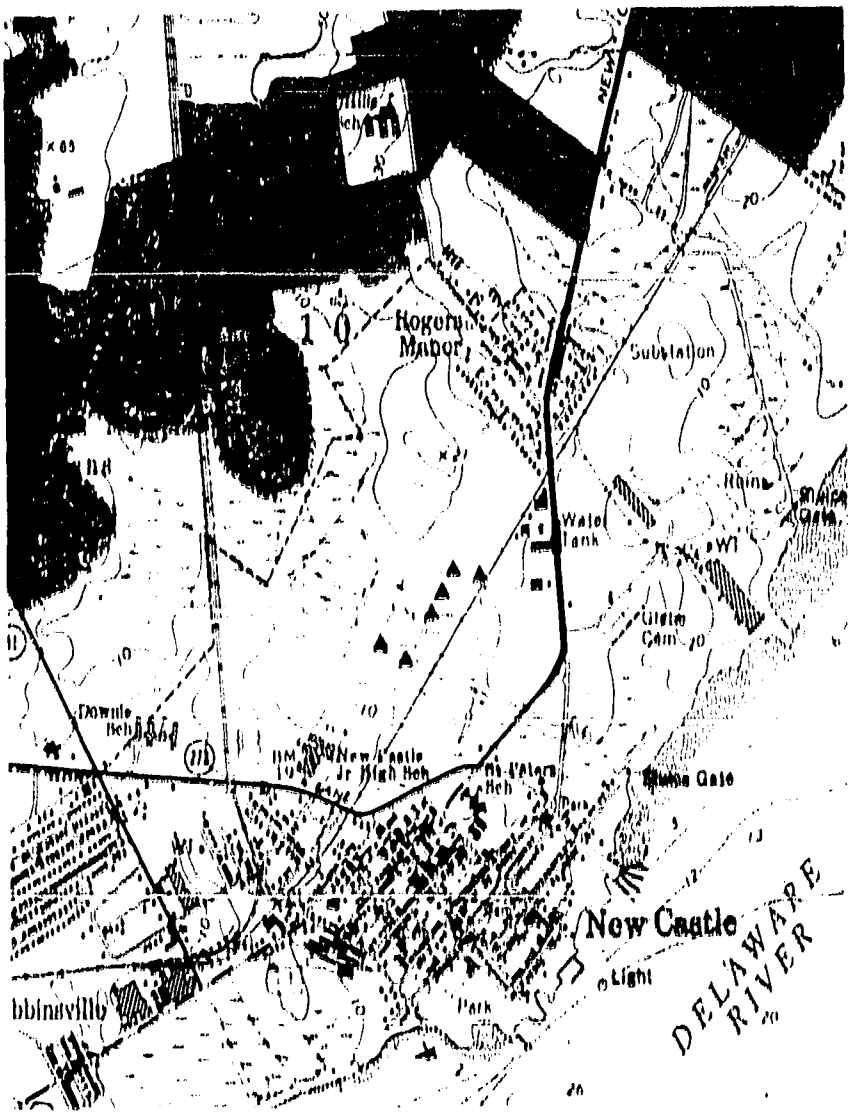
Figure 2-4
Approximate Locations of Sediment and Water Sample Locations



Source: USGS 7.5 Min. Topographic Quadrangle; Wilmington South, DE

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The sample station locations are intended to assess the potential distribution of Tris in the drainage swale and wetlands as well as in the receiving water in the blind cut and straight ditch. Sample collection will follow protocols presented in the QAPP.

The following parameters will be analyzed for:

Water Samples

Tris (beta-chloropropyl) phosphate
pH
Conductivity

Sediment Samples

Tris (beta-chloropropyl) phosphate
Percent Moisture
Grain Size Distribution
Total Organic Carbon
pH

For these samples, pH and conductivity will be field measured.

2.9 Schedule

The Witco representative is prepared to commence work on this proposed RI/FS study within ten days of the approval of the technical approach by DNREC. The project will take approximately 40 weeks from DNREC approval to submittal of the final report. The proposed schedule is illustrated in Figure 2-5. Considering the scope of the project, this schedule represents the narrowest time frame in which the work could be accomplished. Several types of problems could result in justifiable delays with the potential to impact the schedule. These potential problems include:

- Field delays during drilling and well installation due to weather, unexpected conditions, or mechanical problems.
- Laboratory turnaround time
- Extended preliminary final report review time

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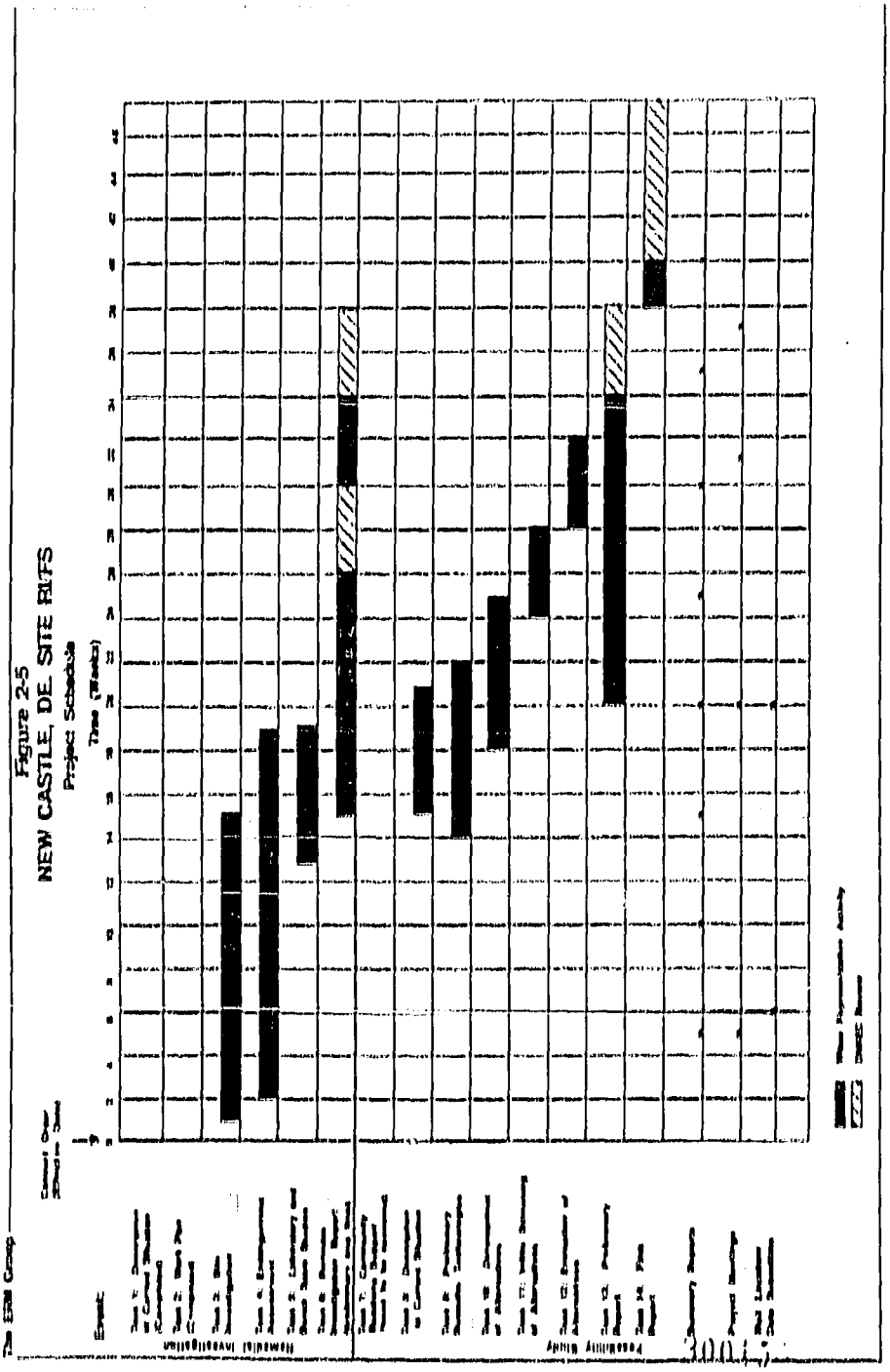

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2.C Sampling Plan

The objective of the sampling plan is to define the horizontal and vertical extent of TRIs and TCL volatile and semi-volatile compounds in soils and ground water and the potential distribution of TRIs in the surface water and sediments in the wetlands adjacent to the site. Select wells found to be functional during the inventory and newly installed monitoring wells will be sampled during one round of sampling. Following the sampling procedure, which is consistent with EPA protocol, all wells will be purged of three well volumes prior to sampling. Purged water will be pumped to a tank truck and manifested to an appropriate waste disposal site. Purging for 2-inch wells will be performed using an ISCO 2600 non-contact, diaphragm-type well sampler or a PVC bailer. Purging of larger diameter wells will be performed using a submersible pump. After the water levels recover, PVC bailers will be used to collect the ground water samples for analysis. All samples will be submitted to a CLP-certified-laboratory. Soil sampling procedures are described n Section 2.A.4.5. Procedures for sampling of surface water and sediments in the wetlands are described in Section 2.A.4.9. The QAPP for analytical data and standard sampling procedures to be employed at the site are provided and described in Appendix A.

2.D Health and Safety

Health and safety procedures for the study are presented as Appendix B.

2.E Data Management

Data management considerations for the proposed RI/FS study are included in the QAPP, Appendix A.

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TASK 3

SITE INVESTIGATION

The investigation discussed in Task 2 has been designed to characterize the site and its actual or potential hazard to public health and the environment for soil and ground water contamination and determine the potential distribution of TCIs in the surface water and sediments in the adjacent wetlands. The investigations will be designed to provide data of adequate technical content to support, if necessary, the development and evaluation of remedial alternatives during the feasibility study. Investigation activities will focus on problem definition and data to support the screening of remedial technologies, alternative development and screening, and detailed evaluation of alternatives.

The site investigation activities will follow the plans set forth in Task 2. All sample analyses will be conducted at laboratories following procedures set forth in the appropriate work plan. Strict chain-of-custody procedures will be followed and the location of all samples will be shown on the site map (and grid system) established under Tasks 1 and 2.

3.A Waste Characterization

The constituents of concern present in the soils, the Columbia Aquifer and the wetland, have been defined in Section 1.B. An appropriate proposed list of compounds to be analyzed has been prepared. These compounds are discussed in Sections 2.A.4.5, 2.A.4.8, and 2.A.4.9

3.B Soils and Hydrogeologic Investigation

An investigation program designed to determine the presence, preferred migration path, and potential extent of chemical constituents in soils and ground water will be conducted (see Task 2). The program is based on a survey of the previous studies listed in Task 1. The program in Task 2 is designed to establish the horizontal and vertical distribution of chemical constituents in soils and ground water. A predictive analysis of the long-term disposition (i.e., distribution and dispersion with time) of chemical constituents will be made, assuming no remedial action at the site.

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3.C Wetlands Investigation

As a result of the previous discharge of ground water by the NCDW&L to the wetlands under DNREC direction, an investigation program to establish the presence or absence of the indicator compound, Trin, in wetlands adjacent to the site will be conducted (see Task 2). This program is based on the NOAA requirement to evaluate the impact of the site on any natural resources in close proximity to the site. The program is designed to sample surface waters and sediments along the potential discharge flow path to determine if Trin is present and if concentrations significantly exceed background levels.

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TASK 4

SITE INVESTIGATION ANALYSIS

4.A Scope of Task

A thorough analysis and summary of data obtained during the site investigation will be prepared to ensure that the investigation data are sufficient in quality (i.e., quality assurance/quality control procedures listed in Appendix A have been followed) and quantity to determine the necessity for any further investigations. The summary will include definition of the occurrence and extent of the chemical constituents listed in Sections 2.A.4.5, 2.A.4.8, and 2.A.4.9 that are in soils, ground water and the adjacent wetlands at the site; the number, locations, and types of nearby populations and activities; and the pathways that may result in an actual or potential threat to public health or the environment.

4.B Endangerment Assessment

The purpose of the endangerment assessment is to characterize risks to human health and the environment under present conditions as well as those associated with remedial alternatives. To evaluate current conditions and the effects of remedial alternatives, the following subtasks will be carried out:

- Subtask 1: Identification of Indicator Chemicals

  In this task, contaminants will be evaluated to determine their relative propensity for hazard based on the ranking system described in EPA's Superfund Public Health Assessment Manual (ICF, 1985).

- Subtask 2: Identification of Exposure Scenarios

  Given the existing knowledge of the extent of contamination in the shallow aquifer, ingestion of contaminated ground water will be considered. As additional field data are obtained from the site, additional exposure scenarios will be considered.

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- Subtask 3: Evaluation of Transport Mechanisms

  In this subtask, the transport of contaminants to various exposure points will be evaluated. The fate and transport of the contaminants in the soils, the Columbia Aquifer, and the wetlands will be eva[illegible]ted using an appropriate fate model as necessary.

- Subtask 4: Risk Characterization

  In this subtask, the levels of risk associated with exposures and intakes to concentrations released from the site will be determined. The acceptability of current concentrations at exposure points will be determined by comparison of constituent with appropriate or acceptable and relevant environmental standards. At the present time, EPA considers Maximum Contaminant Levels (MCL's) for drinking water, national ambient air quality standards (NAAQS), and federally-approved state water quality standards to be the only potentially applicable or relevant and appropriate ambient concentration requirements. At the conclusion of this subtask, a risk characterization report will be prepared which will contain summaries of the findings of subtasks 1 through 4.

- Subtask 5: Assessment of Remedial Alternatives

  Remedial alternatives will be compared in terms of their effects on lowering risk to affected populations, if any. Acceptable alternatives from an environmental perspective are those which pose substantially lower risk and attain or exceed environmental standards. The endangerment assessment analysis will be included in the final RI report.

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TASK 5

LABORATORY AND BENCH-SCALE STUDIES

Consideration will be given to the necessity to conduct laboratory and/or bench-scale studies to determine the applicability of remedial technologies to site conditions and specific contaminants that might be present in the ground water. If such a program is recommended, plans will be developed and submitted to the DNREC for review and approval. Such plans will include:

- consideration of analysis of the technologies based on literature review, vendor contracts, and past experience to determine the testing requirements;
- development of a testing plan identifying the type(s) and goal(s) of the study(ies), the level of effort needed, and data management and interpretation guidelines;
- evaluation of the testing results to assess the technologies with respect to the goals identified in the test plan; and
- plans to scale up those technologies selected based on testing results. Results, both positive and negative, will be summarized in a report of the testing program.

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TASK 6

REPORTS

6.A Program Reporting Requirements

6.A.1 Monthly Summary Reports

Monthly summary reports will be prepared to describe the technical progress of the project. These reports will discuss the following items:

1. Identification of site and activity
2. Status of work at the site and progress to date
3. Summaries of data collected
4. Percentage of expenditure and/or percentage completion per Task
5. Difficulties encountered during the reporting period
6. Actions being taken to rectify problems
7. Activities planned for the next month
8. Changes in personnel
9. Explanation of any significant variation from the forecasted target
10. A projection to completion listing target and actual completion dates for each element of activity, including project completion, and an explanation of any deviation from the milestones in the work plan.

6.B Remedial Investigation Report

The preliminary and final reports will be prepared and submitted to DNREC for review. This report will include the results of Tasks 1 through 5. The report text will address constituents

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present in site soils, sediments, surface water, or ground water. An evaluation of the site hydrogeology and pathways of contaminant migration will also be provided.

The report figures will include water table maps, cross sections, a top of clay contour map, and test boring logs. Tabulated data will include:

- Well specifications for previous and existing monitoring and production wells
- Analytical data for soil, sediments, surface water, and ground water samples; and,
- Water level data

6.C Final Report

A final RI report will be submitted to DNREC based on revision of the preliminary final report as mutually agreed upon by Witco and DNREC.

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TASK 7

COMMUNITY RELATIONS SUPPORT

Witco, Witco representatives and DNREC will assess the necessity for establishing a formal community relations program after the results of the remedial investigation and feasibility study have been presented to the DNREC in the form of the preliminary final report.

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TASK 8

DESCRIPTION OF CURRENT SITUATION

The remedial action feasibility study will include a description of the current site situation in order to evaluate the extent of the problem and the remedial action alternatives. Much of the information has already been described in this proposal under Task 1. This previously derived information and new information generated during the remedial investigation will be incorporated into the RI/FS final report.

If, during the course of the remedial investigation, any changes to the original project scope as described under Task 2 are required, these changes will be discussed and justified to DNREC based on observations made during the remedial investigation to date.

Included in the description of the current situation will be a statement of purpose for the remedial response, if such remedial action is required. This statement will be based on the results of the remedial investigation. The statement of purpose will identify the actual or potential exposures from ground water and other routes, if applicable, that are addressed by the recommended remedial alternatives.

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TASK 9

PRELIMINARY REMEDIAL TECHNOLOGIES

9.A Scope of Task

Based on the current site conditions and the statement of purpose for remedial action response, a master list of potentially feasible technologies will be developed. The remedial alternatives will address source remediation, ground water treatment, or a combination of alternatives.

1. Ground water treatment alternatives to be considered will consist of, but may not be limited to:

   a. Air stripping
   b. Carbon adsorption
   c. Chemical oxidation
   d. Discharge to POTW
   e. Combinations of the above
   f. No treatment/continued monitoring
   g. No action

2. Source control alternatives to be considered consist of, but may not be limited to:

   a. Complete soil removal
   b. Extraction
   c. Immobilization
   d. Isolation
   e. Combinations of the above
   f. No action

Evaluation parameters will be based on literature values, past experience, and bench-scale treatability tests for carbon adsorption (isotherms only) and chemical oxidation, if appropriate.

The technologies will include consideration of both on-site and off-site remedies, depending on site problems. The master list will be screened based on site conditions, waste characteristics, and technical requirements, to eliminate or modify those technologies that may prove extremely difficult to implement, will require unreasonable time periods or will rely on insufficiently developed technology.

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9.B Preliminary Review of Treatability of Targeted Contaminants

A review of the existing data regarding two of the more prevalent compounds tris (beta-chloropropyl)phosphate and bis (2-ethyl hexyl) phthalate, is presented below.

9.B.1 Tris (Beta-Chloropropyl) Phosphate

The molecular weight of tris (beta-chloropropyl) phosphate is approximately 327 grams per gram mole. It has been found in concentrations in ground water samples between non-detectable and 10,100 ppb at this location. Due to its high molecular weight, this compound appears to have a low volatility which would not lend itself toward air stripping. It can be hydrolyzed into chloropropanol (perhaps by using enzymes) and phosphoric acid. Chemical oxidation with $KMnO_4$ or hydrogen peroxide is possible if there is a way to concentrate the compound prior to oxidation. Biological treatment is also a possibility if sufficient detention time and suitably acclimated microorganisms are available.

9.B.2 Bis (2-Ethyl Hexyl) Phthalate

The molecular weight of bis (2-ethyl hexyl) phthalate is approximately 390 grams per gram mole. It has been found in ground water samples at concentrations of non-detectable to 298 ppb in ground water samples from this location. This compound is characterized in the literature as having a high boiling point and low volatility. Its low volatility implies that it is not a suitable candidate for air stripping. Its structure indicates that it should be biologically degradable. One reference[1] indicated that 91 percent was degraded within 38 hours of activated sludge treatment. The detention time may be reduced for a specialized microorganism culture and adequate aeration.

9.B.3 Other Compounds

Several other compounds discussed in Section 1.B are volatile in nature and have been detected at concentrations greater than 10 ppb. These compounds include ethylbenzene, toluene, trichlorofluoromethane, TCE, PCE, xylenes, and methylene chloride and should be amenable to air stripping.

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1 Fate of Pollutants in the Air and Water Environments, Part 2. Chemical and Biological Fate of Pollutants in the Environment. Vol. 8, 1977. p. 287.

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TASK 10

DEVELOPMENT OF ALTERNATIVES

Based on the results of the remedial investigation and consideration of preliminary remedial technologies (Task 9), remedial action alternatives will be developed on the basis of objectives established for the response.

10.A Establishment of Remedial Response Objectives

Site-specific objectives for the remedial response will be established in the report of the feasibility study. These objectives will be based on public health and environmental concerns defined in the endangerment assessment, the description of the current situation (from Tasks 1 and 8), and information gathered during the remedial investigation. Objectives for source control measures will be developed to prevent or significantly minimize migration of harmful chemical constituents into the Columbia Formation water table aquifer. Objectives for management of migration measures will prevent or minimize impacts of the chemical constituents that have migrated in the water table aquifer.

10.B Identification of Remedial Alternatives

Alternatives will be developed to incorporate remedial technologies (from Task 9), response objectives, and other appropriate considerations into a comprehensive site-specific approach. Alternatives developed will include consideration of the following:

- Alternatives which attain applicable and/or relevant public health or environmental standards
- Alternatives which exceed applicable and/or relevant public health or environmental standards
- Alternatives which do not attain applicable and/or relevant public health or environmental standards but which will reduce the likelihood of present or future threat from the site-derived contaminants. This will include an alternative which closely approaches the level of protection provided by the applicable or relevant standards

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- No action

There may be overlap among the alternatives developed. Furthermore, alternatives outside of these categories may also be developed. Documentation of the rationale for excluding any technologies identified in Task 9 will be provided.

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TASK 11

INITIAL SCREENING OF ALTERNATIVES

Initially, the alternatives developed in Task 10 will be screened to eliminate those that are clearly infeasible or inappropriate. The screening will be a two step process, with an initial screening based on environmental and public health criteria and technical feasibility, followed by a cost screening.

11.A Environmental Protection

Only those alternatives that satisfy the response objectives and that will contribute substantially to the protection of public health, welfare, or the environment will be considered further. Alternatives posing significant adverse environmental effects will be excluded. Source control alternatives will achieve adequate control of source materials. Management of migration alternatives will minimize or mitigate any potential threat to public health or the environment.

11.B Technical Feasibility

Technologies that may prove extremely difficult to implement, will not achieve the remedial objectives in a reasonable time period, or will rely upon unproven technology will be modified or eliminated.

11.C Cost

Present worth costs will be developed for remedial alternatives passing the initial environmental public health screening. The costs will include the implementation and operation and maintenance (O&M) costs for the alternatives. The present worth costs will be developed for comparative purposes only; their accuracy will not be suitable for planning capital budgets.

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TASK 12

EVALUATION OF THE ALTERNATIVES

The cost-effectiveness of alternative remedies that pass through the initial screening in Task 11 will be evaluated. Alternative evaluation will be preceded by detailed development of the remaining alternatives.

12.A Technical Analysis

The technical analysis will, as a minimum:

12.A.1 Describe appropriate treatment, storage, and disposal alternatives.

12.A.2 Discuss how each alternative does (or does not) comply with specific requirements of other environmental programs. When an alternative does not comply, the discussion will include how the alternative prevents or minimizes the migration of chemical constituents and the associated public health or environmental impacts. Special design needs that could be implemented to achieve compliance will be described.

12.A.3 Provide an outline of the operation, maintenance, and monitoring requirements of the remedy.

12.A.4 Identify and review potential off-site disposal facilities to ensure compliance with applicable RCRA and other EPA environmental program requirements applicable to disposal facilities, both current and proposed. Potential disposal facilities will be evaluated to determine whether off-site management of site chemical constituents could result in a potential for a future release from the disposal facilities.

12.A.5 Identify temporary storage requirements and off-site disposal needs and provide transportation plans.

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12.A.6 Describe whether the alternative results in permanent treatment or destruction of the chemical constituents and, if not, the potential for future release to the environment.

12.A.7 Outline safety requirements for remedial implementation (including both on-site and off-site health and safety considerations).

12.A.8 Describe how the alternative could be segmented into areas to allow implementation in differing phases.

12.A.9 Describe special engineering requirements of the remedy or site preparation considerations.

12.B Environmental Analysis

An environmental assessment for each alternative evaluated in Task 12 will be performed. The environmental assessment will focus on the site problems addressed by each alternative. The environmental assessment for each alternative will include, at a minimum, an evaluation of beneficial effects of the response, adverse effects of the response, and an analysis of measures to mitigate adverse effects. The no-action alternative will be fully evaluated to describe the current site situation and anticipated environmental conditions if no actions are taken. The no-action alternative will serve as the baseline for the analysis.

12.C Public Health Analysis

Each alternative will be assessed in terms of the extent to which it mitigates long-term exposure and protects public health both during and after completion of the remedial action. The assessment will describe the levels and characterizations of chemical constituents on site, potential exposure routes, and potentially affected populations. The effect of "no action" will be described in terms of short-term effects, long-term exposure to any residual contamination, and resulting public health impacts. Each remedial alternative will be evaluated to determine the level of exposure and the reduction over time. The relative reduction in public health impacts for each alternative will be compared to the no-action level. For management of migration measures, the relative reduction in impact will be determined by comparing residual levels of each alternative with existing criteria,

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standards, or guidelines acceptable to EPA. For source control measures or when criteria, standards, or guidelines are not available, the comparison will be based on the relative effectiveness of technologies. The no-action alternative will serve as the baseline for the analysis.

12.D Institutional Analysis

Each alternative will be evaluated based on relevant institutional needs. Specifically, regulatory requirements, permits, community relations, and participating agency coordination will be assessed.

12.E Cost Analysis

The cost of feasible remedial action alternatives (and for each phase or segment of the alternative) will be evaluated. The cost will be presented as a present worth cost and will include the total cost of implementing the alternative and the annual operating and maintenance costs. Both monetary costs and associated non-monetary costs will be included. A distribution of cost over time will be provided.

12.F Evaluation of Cost-Effective Alternative

Alternatives will be compared using technical, environmental, and economic criteria. At a minimum, the following areas will be used to compare alternatives.

12.F.1 Present Worth of Total Costs

The net present value of capital and operating and maintenance costs will be presented.

12.F.2 Health Information

For the remedial action alternatives, a quantitative statement including an estimated range of maximum individual risks will be provided. Where quantification is not possible, a qualitative analysis will be provided. For the no-action alternative or management of migration measures, a quantitative risk assessment including a range estimate of maximum individual risks will be provided.

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12.F.3 Environmental Effects

The most important effects or impacts will be summarized. Reference will be made to supplemental information arrayed in a separate table, if necessary.

12.F.4 Technical Aspects of the Remedial Alternatives

The technical aspects of each remedial alternative relative to the others will be clearly delineated. Such information will be based on the professional opinion of Witco's representative regarding the site and the technologies comprising the remedial alternative.

12.F.5 Information on the Extent to which Remedial Alternatives Meet the Technical Requirements and Environmental Standard of Applicable Environmental Regulations

This information will be arrayed so that differences in how remedial alternatives satisfy such standards are readily apparent. The general types of standards that may be applicable at the site include:

a. RCRA design and operating standards
b. Drinking water standards and criteria

12.F.6 Information on Community Effects

Information will be provided to address the extent to which implementation of a remedial alternative disrupts the community, i.e., traffic, temporary health risks, and relocation.

12.F.7 Other Factors

This category of information will include such things as institutional factors that may inhibit implementing a remedial alternative and any other site-specific factors as identified in the course of the detailed analysis that may influence which alternative is eventually selected.

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TASK 13

PRELIMINARY FINAL REPORT

The preliminary final report for the Feasibility Study (FS) will present the results of Tanks 8 through 12. Copies of the preliminary final report will be submitted for review and comment to DNREC. Revisions to the preliminary final report will be implemented as mutually agreed upon by Witco and DNREC.

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TASK 14

FINAL REPORT

The final reports will be submitted to DNREC. The reports will include the results of Tasks 1 through 5 and 8 through 12 and any supplemental information or revisions generated and mutually agreed upon by Witco and DNREC as discussed in Tasks 6 and 13.

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APPENDIX

APPENDIX

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Date of QAPP Revision (No.)
July 17, 1987 (0)
February 1, 1988 (1)
March 23, 1988 (2)

QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR THE REMEDIAL INVESTIGATION AT THE FORMER WITCO CORPORATION SITE

New Castle, Delaware

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APPENDIX

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SECTION 1

INTRODUCTION

1.1 Background

During the summer of 1977, Tris(beta-chloropropyl)-phosphate (Tris) leaked from a drum in a drum storage area at Witco Corporation's New Castle facility onto the adjacent New Castle Water and Light Commission (NCWLC) property. The spill was first detected by a NCWLC employee who noticed an area of dead grass along the Witco/NCWLC property boundary. This area was adjacent to a drum storage area. An investigation was performed by Witco which revealed the presence of Tris in the soils under the dead grass. The U.S. Environmental Protection Agency (EPA) conducted an investigation in January 1978 which revealed the presence of Tris in the ground water at 3 ppb or less.

To date, a total of four field investigations and two summary reports have been completed for the Witco property, the adjacent NCWLC property, and the nearby Chicago Bridge & Iron property. They were:

1. "A Chemical Intrusion Study of Shallow Aquifer Water Sources at New Castle Water Filtration Plant on Wilmington Avenue", July 1979, by Duffield Associates, Inc. and Betz, Converse, Murdoch, Inc.

2. "Groundwater Evaluation Phase III - Chemical Intrusion Investigation", September 1980, by Duffield Associates, Inc.

3. "Groundwater Well Sampling at Witco - Isofoam Division, Wilmington, Delaware", January 10, 1983, by Princeton Aqua Science.

4. "Soil and Groundwater Sampling at Witco - Isofoam Division, Wilmington, Delaware", June 1983, by Princeton Aqua Science.

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5. "Hydrogeologic Evaluation of the Witco Chemical Company New Castle Water Works Matter at New Castle, Delaware", November 1983, by Environmental Resources Management, Inc.

6. "New Castle Spill, Technical Review of Documents, Final Reports", February 1986, by Planning Research Corporation (PRC) for U.S. EPA.

7. "A Preliminary Assessment of Chicago Bridge and Iron", EPA No. DE-18, Emergency and Remedial Response Information System, July 1984. (Chicago Bridge & Iron report ERRIS).

For a comprehensive description of the current situation at the former Witco Corporation site, refer to Task 1 of the Work Plan.

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SECTION 2

PROJECT ORGANIZATION AND RESPONSIBILITY

While all personnel involved in an investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specifically delegated responsibilities. Within ERM these are the Project Manager, the Quality Assurance Manager, the RI Task Manager, the FS Task Manager, the Quality Assurance Officer, the Field Operations Manager/Project Geologist, and the Project Technicians. Cambridge Analytical, Inc., of Cambridge, Massachusetts, will provide all analytical services for this investigation. Specific laboratory personnel with quality assurance/quality control responsibilities include the Laboratory Quality Assurance Officer and Laboratory Sample Custodian. Figure 2-1 presents a project organization flow chart.

2.1 Project Manager

Mr. Richard T. Wardrop is Project Manager for the Witco Corporation RI/FS. The Project Manager maintains routine contact with the investigation's progress, regularly reviews the project schedule, and reviews all major work elements prior to submittal. The Project Manager oversees all scheduling and budgeting, and serves as the prime contact with local, state, and federal agencies.

2.2 Quality Assurance Manager

ERM's Mr. David R. Blye serves as Quality Assurance Manager on all projects requiring the collection of data, and as such is not directly involved in the routine performance of technical aspects of the investigations.

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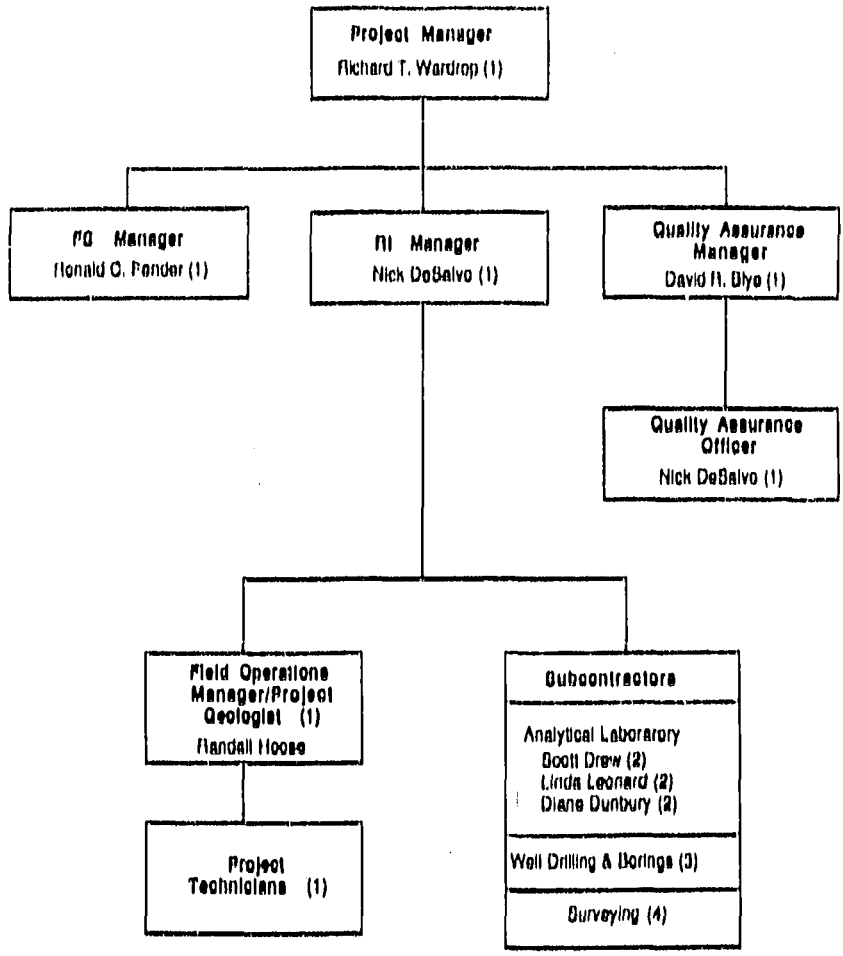
Figure 2-1

Project Organization Chart



(1) Environmental Resources Management, Inc.
855 Springdale Drive, Exton, PA 19341
(215) 524-3500

(2) Cambridge Analytical
1106 Commonwealth Ave., Boston, Mass. 02215
(617) 232-2207

(3) Walton Corporation
P.O. 1097, Newark, DE 19715
(302) 737-6460

(4) Vandemark & Lynch
P.O. Box 2047, Wilmington, DE 19899
(302) 764-7635

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It is the Quality Assurance Manager's responsibility to develop, evaluate and to document the Quality Assurance Project Plan and procedures appropriate to the investigation. All laboratory audits will be conducted by the Quality Assurance Manager. Additionally, it is the Quality Assurance Manager's responsibility to review all project plans and revisions to the plans to assure proper quality assurance is maintained. Frequent and regular meetings will take place between the Quality Assurance Manager and the Quality Assurance Officer to review all quality assurance activities. The Quality Assurance Manager is also responsible for all data processing activities, data processing quality control, and data quality review.

2.3 RI Manager

Mr. Nick DeSalvo will serve as RI Manager for this investigation, with the responsibilities of implementing the Work Plan and overseeing the day-to-day activities of all work to be conducted including that of subcontractor personnel.

2.4 FS Manager

Mr. Ronald Fender will serve as the FS Manager with the responsibility of preparing the FS Work Plan, budgeting and scheduling the FS, and implementing the FS Work Plan. Further clarification on the FS Manager's responsibilities and other FS personnel for the Witco Corporation's RI/FS will be included in the FS Work Plan.

2.5 Quality Assurance Officer

Mr. Nick DeSalvo will also serve as the Project Quality Assurance Officer. The Field Quality Assurance Officer has primary responsibility for overall project quality assurance. The Quality Assurance Officer is responsible for field audits, field quality assurance, and all other non-analytical data quality review. It is a major responsibility of the Quality Assurance Officer to insure that all personnel have a good understanding of the project quality assurance plan, an understanding of their respective roles relative to one another, and an appreciation of the importance of the roles to the overall success of the program.

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2.6 Field Operations Manager/Project Geologist

It is ERM's policy that a Field Operations Manager/Project Geologist be assigned to large-scale projects where the Task Manager cannot be present for all on-site activities. Mr. Randall Moore is the Field Operations Manager/Project Geologist for the RI. The Field Operations Manager/Project Geologist reports directly to the RI Task Manager and is immediately responsible for the day-to-day activities of all ERM field personnel. Further responsibilities include the verification for accuracy of field notebooks, driller's logs, chain-of-custody records, sample labels, and all other field-related documentation.

2.7 Project Technicians

Ground water, soil, and air sampling tasks required by this investigation will be conducted by experienced environmental technicians. Their responsibilities will include the documentation of the proper sample collection protocols, sample collection and field measurements, equipment decontamination, and chain-of-custody documentation.

2.8 Cambridge Analytical's Quality Assurance Officer

The volume of analytical work for a project of this size necessitates the subcontract analytical laboratory specify a Quality Assurance Officer whose duties are specific to the project. Ms. Linda Leonard will serve as Cambridge Analytical's Quality Assurance Officer with the responsibility for maintenance of all laboratory quality assurance activities in association with the project.

2.9 Laboratory Sample Custodian

Ms. Diane Dunbury will serve as project Laboratory Sample Custodian for Cambridge Analytical. The Sample Custodian's responsibilities include insuring proper sample entry and sample handling procedures by laboratory personnel.

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SECTION 3

QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, AND COMPLETENESS

3.1 Overall Project Objectives

Data Quality Objectives (DQO) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process. DQO define the total uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both sampling error and analytical error. Ideally, the prospect of zero uncertainty is the intent; however, the variables associated with the process (field and laboratory) inherently contribute to the uncertainty of the data. It is the overall objective to keep the total uncertainty within an acceptable risk that will not hinder the intended use of the data. In order to achieve this objective, specific data quality requirements such as detection limits, criteria for accuracy and precisions, sample representativeness, data comparability and data completeness will be specified. The overall objectives and requirements will be established such that there is a high degree of confidence in the data measurements. The data collected during the course of the investigation will be used to answer the following questions:

1. Are contaminants present or absent? (qualitatively)

2. If contaminants are present, what are the types or classes are present?

3. What quantities (concentrations) of contaminants are present (quantitative)?

4. What are the pathways for contaminant release?

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5. What are the boundaries of contaminant sources and pathways?

6. What are the environmental/public health factors?

7. What are the contaminant characteristics with respect to migration?

The media that will be sampled to answer these questions will be ground water, surface water, soils and sediments. The specific analytical parameters for the samples collected during the investigation are specified in Task 2 of the Work Plan.

As stated earlier, the indicators that will be used to specify data quality requirements and to evaluate the analytical system performance are precision, accuracy, representativeness, completeness and comparability (PARCC). Table 3-1 presents definitions for these indicators.

3.2 Field Investigation Quality Objectives

The objectives with respect to the field investigation are to maximize the confidence in the data in terms of PARCC.

In terms of precision and accuracy, Section 9 presents the frequency with which field duplicates and field blanks will be collected such that the specific degree of precision and accuracy can be calculated. The data quality objective for field duplicates is to achieve precision equal to or greater than laboratory duplicate precision requirements established in the EPA's Contract Laboratory Program (CLP) Information For Bid (IFB) (organic and inorganic).

Acceptable sample precision can be attained by careful sample homogenizing when appropriate. Precision will be calculated as relative percent difference (RPD) if there are only two (2) analytical points and relative standard deviation (RSD) if there are more than two (2) analytical points. The submission of field blanks will provide a check with respect to accuracy. Although accuracy is best assessed by evaluating the results of blanks, blanks do not monitor analyte losses. The submission of blanks

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TABLE 3-1

DEFINITIONS OF DATA QUALITY INDICATORS

- Precision - a measure of the reproducibility of measurements under a given set of conditions.

- Accuracy - a measure of the bias that exists in a measurement system.

- Representativeness - the degree to which sample data accurately and precisely represent selected characteristics.

- Completeness - a measure of the amount of the valid data obtained from the measurement system compared to the amount that was expected under "normal" conditions.

- Comparability - express the confidence with which one data set can be compared with another.

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will, however, monitor errors associated with the sampling process, field contamination, preservation, handling, and laboratory contaminants. The data quality objective for field blanks is to meet or exceed those criteria established in the EPA's CLP IFB (organic and inorganic). In the event that the blanks are contaminated and/or poor precision is obtained the associated data will be qualified as described in Section 12.3. Through the submission of field QC samples the distinction can be made between laboratory problems, sampling technique, and sample matrix variability.

Precision and accuracy for the field pH and conductivity are dependent on the type and condition of the instrument used and the care used in the standardization and operation. The precision and accuracy objectives for the instrumentation used are as follows:

- pH precision will be ±0.3 pH standard units and an accuracy of ±0.3 pH standard units.

- Conductivity precision will be ±3 umhos/cm on the 500 umhos/cm range, ±25 umhos/cm on the 5,000 umhos/cm range, and ±250 umhos/cm on the 50,000 umhos/cm range. Accuracy for the conductivity measurements are a function of the conductivity reading for the probe and instrument combined and is given in Figure 2, page A2-7 of Attachment 3 of this QAPP.

To assure samples representativeness all sample collection will be performed in strict accordance the U.S. EPA-recommended procedures for the collection, and preservation, and holding times specified in EPA 600/4-79-020 (Methods for Chemical Analysis of Water and Wastes) the Federal Register, 26 October 1984, and the specific CLP IFB which Cambridge Analytical is operating under.

The data quality objective for the completeness of data with respect to the sampling (field investigation) is 100%. Although this goal appears rather ambitious, it can be attained. Through the phased sampling approach the critical data points will be identified. Every effort will be made to obtain valid data for all sampling points particularly those classified as critical points. Critical sampling points are those which will be used to directly answer questions posed in the design of overall project

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objectives (Section 3.1). Those sampling points identified as critical will necessarily be selected as QC samples (duplicate and matrix spikes) at the frequency specified in Section 9.

In order to establish a degree of comparability such that observations and conclusions can be directly compared with all historical data, ERM will use standardized methods of field analysis, sample collection, holding times and preservation. In addition, field conditions will be considered prior to sampling in order to attain a high degree of data comparability.

3.3 Laboratory Quality Objectives

The laboratory will demonstrate analytical precision and accuracy, by the analysis of laboratory duplicates and matrix spike duplicates. Precision will also be demonstrated (as well as instrument stability) by comparison of response factors for calibration standards. Laboratory accuracy will be demonstrated by the addition of surrogate and matrix spikes compounds/constituents. Accuracy will be presented as percent recovery. Precision will be presented as RPD, RSD, or PD whichever is applicable to the specific type of QC samples. Laboratory blanks will also demonstrate accuracy with respect to the analyses. The frequency of laboratories duplicates, matrix spikes and laboratory blanks are specified in Section 9. As considerable reference is made to Attachment 1 in the remainder of this QAPP, it is suggested it be reviewed at this time. Cambridge Analytical data quality objectives are detailed in Attachment 1 to this QAPP.

The analysis laboratory will be expected to process (purge, extract or digest) an aliquot of sample such that the analytical results will provide a high degree of representation with respect to each sampling point. In addition the analysis laboratory will be expected to document all analytical problems encountered during the course of the investigation. This will enable ERM to achieve a 100% completeness goal. Further, the laboratory will be required to provide all data packages in full CLP deliverables as to assure that analytical methods, parameters, and reporting units are comparable with other existing data.

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3.4 Criteria Objectives

The quantitative objectives (criteria) that ERM will require for both field and laboratory accuracy and precision are summarized in Table 3-2.

The laboratory will be expected (as an ideal objective) to report the method detection limits (MDL) for all samples in the appropriate statistical reporting units for all analyses as stated in the most current IFB used by the analysis laboratory. However, it should be noted that actual detection limits are sample specific and depend on variables such as dilution factors, sample matrices and the specific analyte. The handling of data reported at or near the MDL will be done cautiously since the stated data quality objectives for accuracy and precision may not "translate" well in these cases.

3.5 Data Management Objectives

It is a data management objective that all aspects of the investigation from sample design, collection, shipment, analysis, use/decisions, etc. be performed in conjunction with rigorous QA/QC documentation. The specific details of this documentation can be found throughout this document and the associated work plan.

It is expected that by the design of separate data quality requirements for field sampling and laboratory analysis, clear distinctions can be made such that any problems found in the system can be isolated with respect to the cause. Conversely, the data quality requirements are also designed to provide an indication of the variability inherit to the overall system.

Through sampling, analysis, data assessment (data review), data qualification, and feedback, the overall data management objective is to provide a complete data base with a high degree of confidence that will thoroughly characterize the study area.

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TABLE 3-2

CRITERIA OBJECTIVES

	Aqueous	Solid/Other
Precision Objectives		
Aqueous Duplicate/Replicates (Blind or labeled)		
VOA	within 20% RPD	within 30% RPD
BNA	within 25% RPD	within 40% RPD
Tris	within 25% RPD	within 50% RPD
Inorganics (Fe, Mn)	within 20% RPD	
Additional Parameters (TOC and COD)	within 20% RPD	within 50% RPD
Laboratory Duplicates (Unspiked)		
VOA	within 20% RPD	within 30% RPD
BNA	within 25% RPD	within 40% RPD
Tris	within 25% RPD	within 50% RPD
Inorganics	within 20% RPD	
TOC and COD	within 20% RPD	within 50% RPD
Laboratory Duplicate (MSD)		
VOA	As specified in current IFB	
BNA	As specified in current IFB	
Accuracy Objectives		
Field or trip blanks		
VOA	Less than the detection limit	
BNA	Less than the detection limit	
Tris	Less than the detection limit	
Inorganics	Less than the detection limit	
TOC and COD	Less than the detection limit	
Laboratory Blanks		
VOA	As specified in current IFB	
BNA	As specified in current IFB	
Tris	Less than the detection limit	
Inorganics	As specified in current SOW	
TOC and COD	Less than the detection limit	
Matrix spikes/surrogate spikes (All fractions)	As specified in current IFB/SOW	

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SECTION 4

SAMPLING PROCEDURES

The generalized sampling procedures used by ERM are presented as Attachment 2, "Standard Operating Procedures for the Collection of Environmental Samples". These procedures have been standardized to allow applicability to a wide type of environmental investigations. Procedures associated with the soil sampling, surface water/sediment sampling, and ground water sampling at the former Witco Corporation site will be conducted according to Attachment 2, with site-specific procedures noted as below.

The numbers of samples, locations, and justifications for each sample media to be collected are presented in Task 2 of the Work Plan. Please refer to the Work Plan for this information.

4.1 Subsurface Soil Sampling

The Work Plan addresses collection of soil samples from test borings and well borings.

4.1.1 Split Spoon Soil Sampling

Split spoon soil samples will be collected as per ASTM D-1586, with modifications allowing the use of oversized spoons to obtain sufficient sample. Each split spoon samples will be divided into two aliquots. One aliquot will be placed (using a stainless steel spatula) in laboratory supplied glass bottles with a Teflon®-lined enclosure and handled as described in Section 4.7.3 of this QAPP. Sufficient soil from the second aliquot will be placed to fill one eighth of a wide mouth liter container for headspace measurement. Immediately after the soil is placed into the container, the mouth of the jar will be lined with aluminum foil and the enclosure securely replaced.

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Prior to taking a headspace VOC measurement, the measurement vessel containing the sample will be placed in a room a constant temperature for a duration of 1 hour. At the completion of the hour, the maximum headspace reading will be recorded using a Foxboro, Century OVA 128. A three-eighths (3/8) inch hole drilled through the center of the plastic cap will allow the puncture of the aluminum seal with the probe of the OVA to measure total VOC content. The headspace measurements and visual observation will be used to select samples for laboratory analysis from each boring.

4.2 Surface Water and Sediment Sampling

4.2.1 Surface Water Sampling

Surface water sampling will proceed from the farthest "downstream" location and proceed to upstream locations to minimize potential cross-contamination from suspended material in the stream from sampling activities. Dependent upon depth and surface water velocity, samples will be either collected directly into the appropriate sample containers at a point upstream of the samplers position or through the use of a long-handled polyethylene grab sampler from the bank of the stream.

Surface water velocity and flow characteristics will be noted at each sampling location. Stream velocity will be measured using a Mead® Pigmy MP-302 open channel velocity meter. Flow will be determined based on the estimated cross-section area at the sampling station.

4.2.2 Sediment Sampling

At each surface water sampling location a sediment sample will also be collected. If present, a composite of the equal volumes of fine sediments (surface) from two points in the vicinity of the surface water location will be homogenized on an enamel pan with a stainless steel spatula and an appropriately sized volume transferred to the sample containers.

Sediments will be collected with a stainless steel trowel and dewatered as much as possible prior to placement into the sample containers.

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4.3 Ground Water Sampling Procedures

In addition to the information presented in Section 3.1 of Attachment 2, site-specific protocols for the Witco Corporation RI/FS are presented in this section.

4.3.1 Preparation for Sampling

Preparation for sampling includes the acquisition of all necessary monitoring equipment and site-specific information to perform the required monitoring. The results of the water table and tidal study described in Task 2 of the Work Plan will be used to select locations for the installation of monitoring wells. In addition, various testing (i.e., pump tests) will be conducted at several wells to determine the hydrogeological characteristics of the discrete water bearing zones. Prior to initiating any sampling activities, a complete round of depth to water levels will be measured to the nearest one hundredth of a foot.

Monitoring wells are to be evacuated and sampled proceeding from the suspected least to most contaminated well to minimize potential cross-contamination. The sampling order of the wells from least to most contaminated will be based on ground water flow directions, well location with respect to the suspected source areas, historical data, and field OVA readings on soil samples and of the well head during drilling. Total well depths necessary to calculate the required purge volumes will be tabulated in Table 4-1 after the completion of the installations.

4.3.2 Well Evacuation

Monitoring wells will be evacuated of three volumes of water standing in the well casing or until the well goes dry prior to sample acquisition. The volume of water to be purged for each well will be calculated as described in Section 3.1.1.2 of Attachment 2.

A stainless steel body, ISCO Model 2600 non-contact, diaphragm-type well sampler with polyethylene tubing will be used to evacuate all of the monitoring wells proposed to be sampled in the Work Plan. Pump placement depth will be dependent on well yields. Diaphragm pump flow rates are typically low ($\leq$ 1.5 gpm), necessitating placement of the pump intake at the top of the water column in high yielding wells. Low well yields require

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TABLE 4-1

WELL DEPTH FOR
THE FORMER WITCO CORPORATION SITE

Well No.	Total Depth (feet)

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pump placement to be at the bottom of the well. Proper pump placement will insure complete and proper evacuation. Upon completion of the required purge volume, the pumping system will be removed from the well. Wells that are inaccessible with the pump system will be hand bailed using a PVC bailer.

ERM's newly installed 6" diameter pumping well will be purged using a stainless steel Grundfos® submersible pump fitted with stainless steel discharge tubing. A check valve placed immediately above the pump prevents purge water in the tubing from re-entering the well when the pump is turned off. Pump placement depth is again dependent on well yields (see above paragraph).

4.3.3 Sample Acquisition

Sample acquisition will be as described in Section 3.1.1.3 of Attachment 2. Dedicated one and one-quarter (1-1/4) inch, bottom-loading PVC bailers will be used to collect grab, ground water samples for transfer into the proper sample containers. Monofilament polypropylene will be used to raise and lower the bailer. It is anticipated that well yields will be relatively high at the site, however, if well yields are low, the samples will be collected as the well recovers and provides a sufficient volume for sample collection.

4.4 Decontamination and Post-Sampling Procedures

4.4.1 Drilling Equipment Decontamination

Drilling equipment will be decontaminated prior to initial use, between boring locations, and at the completion of drilling activities. Items necessary to decontaminate include:

- back of the drilling rig
- auger flights
- down-hole equipment
- well casing and the screen

A manual scrubbing to remove foreign material followed by a thorough steam cleaning will be used for decontamination of the above items. Drilling equipment, well screen, and well casing will be stored in a contaminant free location above ground on wooden supports after decontamination, and covered with plastic until use.

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4.4.2 Sampling Equipment Decontamination

All non-disposable equipment (bailers, split spoon samplers, hand trowels, etc.) will be decontaminated according to the procedures in Section 4.1 of Attachment 2. Each dedicated bailer will be individually wrapped in plastic trash bags and sealed following decontamination, and stored on-site at a contaminant free location or at ERM's warehouse for future use. The ISCO diaphragm pump will be decontaminated with clean tap water and distilled water as described on page 4-2, Section 4.1 of Attachment 2.

The submersible pump system used for the 6" well will be decontaminated by flushing with approximately 50 gallons of clean tap water. The outside of the pump and discharge tubing will be thoroughly rinsed with distilled water using a hand-held pressure sprayer.

4.4.3 Sample Preparation and Preservation

Ground water samples collected for metals (iron and manganese) analysis will be field filtered through a 0.45 um pore size filter prior to preservation to allow determination of dissolved metals. The filtering system used will be as described in Section 4.2 of the SOP.

Immediately after collection, samples will be transferred to properly labeled (see Section 5 of this QAPP) sample containers with all necessary preservatives added. Table 4-2 lists the proper container material, volume requirement, and preservation needed for the RI analyses. Samples requiring refrigeration for preservation will be immediately transferred to coolers packed with ice or ice packs. Proper chain-of-custody documentation will be maintained as discussed in Section 5 of this QAPP.

Field measurements for pH, specific conductance, and temperature will be obtained on ground water samples immediately following sample collection. A grab sample collected in a beaker will be used to obtain measurements. Surface water samples will be measured in situ. A one to four (1:4) sediment to distilled water slurry will be used to measure sediment pH in a Whirlipak® bag.

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TABLE 4-2

SAMPLE CONTAINERS AND PRESERVATION REQUIREMENTS
FOR ANALYSES IN CONJUNCTION WITH
THE FORMER WITCO CORPORATION SITE

Analysis	Sample Container	Preservation
WATER:		
TCL Volatiles	2-40 ml vials with Teflon® screw cap septa	HCl to pH≤2, Cool to 4°C
TCL Semivolatiles	2 amber glass liters	Cool to 4°C
Trip	1 amber glass liter	Cool to 4°C
Dissolved Metals	1 plastic liter	Field filter (ground water only) with 0.45 filter followed by HNO_3 to pH ≤ 2
COD, TOC	1 glass liter	Cool, 4°C, H_2SO_4 to pH <2
SOIL/SEDIMENT SAMPLES:		
TCL Volatiles	1 glass 4 oz. wide-mouth with Teflon® lined cap	Cool to 4°C
TCL Semivolatiles Analysis	1 glass 32 oz. wide-mouth with Teflon® lined cap	Cool to 4°C
Trip	1 glass 32 oz. wide-mouth with Teflon® lined cap	Cool to 4°C
COD, TOC	1 glass 32 oz. wide-mouth with Teflon® lined cap	Cool to 4°C
Grain Size	1 glass 32 oz. wide-mouth with Teflon® lined cap	None

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The ERM Group

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SECTION 5

SAMPLE CUSTODY

The primary objectives of sample custody procedures are to create accurate written records which can be used to trace the possession and handling of all samples from the moment of their collection, through analysis, until their final disposition. Sample custody for samples collected during this investigation will be maintained by the Field Operations Manager (FOM) or the field personnel collecting the samples. The FOM or field personnel are responsible for documenting each sample transfer and maintaining custody of all samples until they are shipped to the laboratory.

All necessary sample bottles will be shipped to ERM by Cambridge Analytical and received by the FOM or field personnel. All necessary chemical preservatives will be added to the bottle by ERM immediately upon bottle receipt. Sample bottles needed for a specific sampling task will then be relinquished by the FOM to the sampling team after the FOM has verified the integrity of the bottles and assured that the proper bottles have been assigned to the task to be conducted.

A self-adhesive sample label (Figure 5-1) will be affixed to each container before sample collection to minimize label loss during handling of the container. At a minimum, the sample label will contain:

- Client - Job Name (Witco Corporation)
- ERM Traffic Report Number
- Sample identification - place of sampling
- Date and time collected
- Sampler's initials
- Testing required
- Preservatives added

Immediately after sample collection, each sample bottle will be sealed in an individual plastic bag. Samples will then be placed

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FIGURE 5-1

Cambridge Analytical Associates
1106 Commonwealth Ave., Boston, MA 02215
(617) 232-2207

CHEMICAL ANALYSES:

SAMPLE DATA:

Client _____
Project/Site _____
Date/Time _____
Sample ID _____
Location _____
Collector _____

PRESERVATIVES:

____ None
____ HNO_3
____ H_2SO_4
____ ZnAc/NaOH
____ NaOH
____ Sterile
____ MeOH
____ $MeCl_2$
____ Other (specify)

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immediately into an insulated cooler for shipment to the laboratory. ERM field Chain-of-Custody records (Figure 5-2) and an ERM Traffic Report (Figure 5-3), completed at the time of sample collection will accompany the samples inside the cooler for shipment to the laboratory. The samples will be properly relinquished on the field Chain-of-Custody record by the sampling team. These record forms will be sealed in a ziplock plastic bag to protect them against moisture. Each cooler will contain sufficient ice and/or ice packs to insure that proper temperature is maintained, and will be packed in a manner to prevent damage to sample containers. The FOM will then initial and custody seal (Figure 5-4) each sample cooler. All coolers will be shipped by an overnight courier according to current US DOT regulations. Prior to releasing the coolers, the FOM will require the courier to sign an ERM Cooler Transfer Acknowledgment (Figure 5-5). Upon receiving the samples, the laboratory Sample Custodian will inspect the condition of the samples, compare the information on the sample labels against the field Chain-of-Custody record and Traffic Reports, assign a Cambridge Analytical control number, and log the control number into the computer sample inventory system. A detailed description of this log-in procedure is given in Attachment 1, Section 7.0.

The preparation of all sample bottles (cleaning technique, preservative added, etc.) will be documented. When samples requiring preservation by either acid or base are received at the laboratory, the pH will be measured and documented. The Laboratory Sample Custodian will then store the sample in a secure sample storage cooler maintained at 4°C and maintain custody until assigned to an analyst for analysis.

The Laboratory Sample Custodian will note any damaged sample containers or discrepancies between the sample label and information on the field Chain-of-Custody record when logging the sample and will note any discrepancies in Section 11 of the ERM Traffic Report. This information will also be communicated to the FOM or field personnel so proper action can be taken. The Chain-of-Custody form will be signed by both the relinquishing and receiving parties each time the sample changes hands, and the reason for transfer indicated.

An internal Chain-of-Custody form will be used by Cambridge Analytical to document sample possession from laboratory Sample Custodian to Analysts and final disposition (Attachment 1,

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FIGURE 5-2

EPA CHAIN OF CUSTODY RECORD

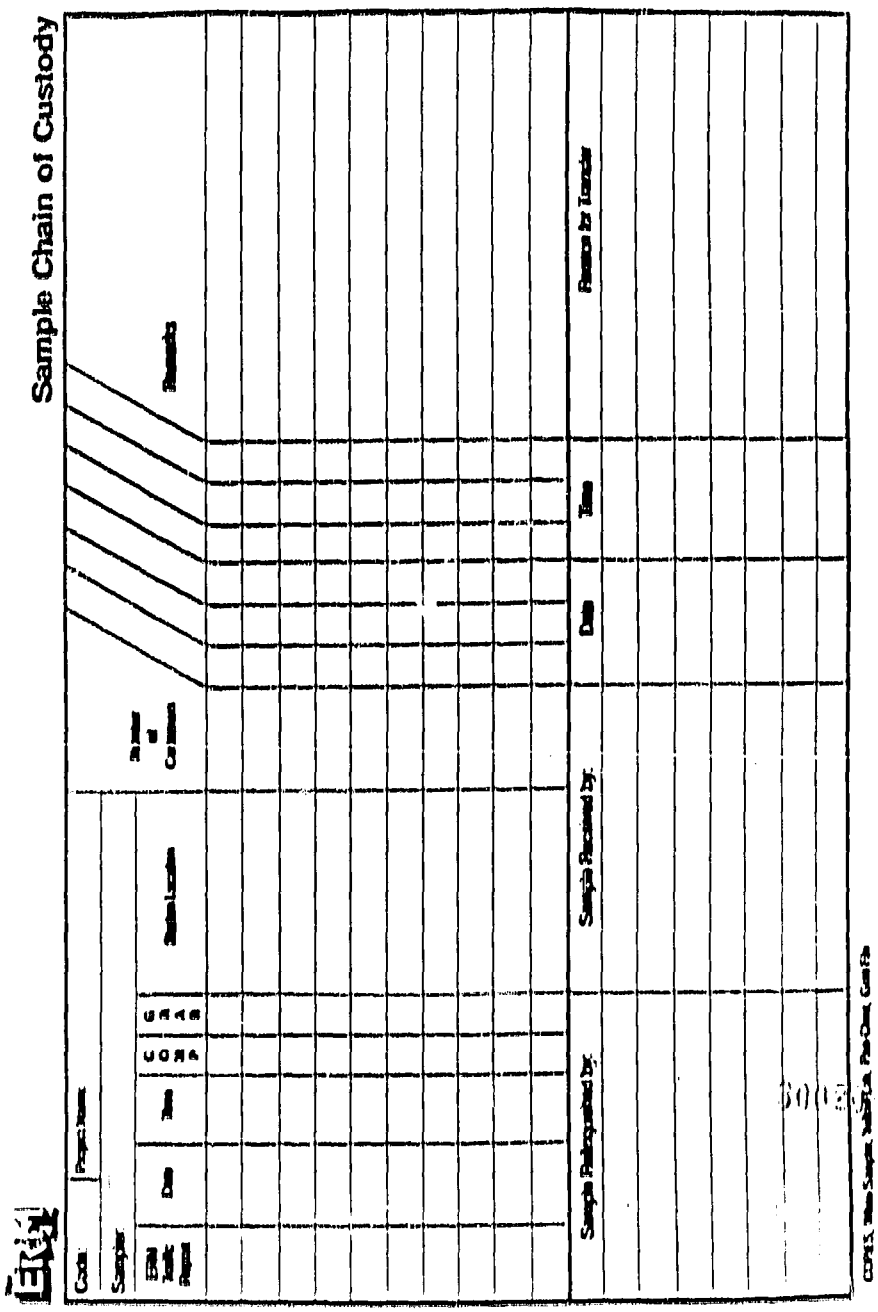

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FIGURE 5-3
ERM TRAFFIC REPORT FORM

ERM

Traffic Report

I Project W.O. #	II Sample Concentration	№ 1003
Project Name/Location	☐ Low Concentration	
	☐ Medium Concentration	I Ship to:
	III Sample Matrix	
V Sampling Personnel Contact	☐ Liquid	
Sampler / Project Manager	☐ Solid	
Phone #	☐ Other _____	Attn:

VI Shipping Information	VII Specify Number of Containers, Approximate Volume and the Type of Analyses Requested		
(Name of Carrier)			
(Date Shipped)	ANALYSES/METHOD REQUESTED	# OF BOTTLES	TOTAL VOLUME
(Airbill Number)			
IV Sample Location			
Date:			
Time:			

VI Sample Description	VIII Special Handling (e.g. Safety Procedures/Hazardous)
☐ Surface Water ☐ Soil	
☐ Ground Water ☐ Solid	
☐ Leachate Other _____	Additional comments:
☐ Sediment	

XI Condition of Samples Received (to be completed by Laboratory Log-In.)	
☐ Samples received intact	
☐ Samples at 4 degrees (C)	Log-In Person's Signature
☐ Samples not leaking	
☐ Container numbers match as specified in Item 7	
☐ Container tags match Chain of Custody	
☐ Cooler received with Custody Seals intact	

Copies: White - Sampler, Yellow - Lab, Pink - Client, Gold - File

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FIGURE 5-4
ERM CUSTODY SEAL

ERM	OFFICIAL CUSTODY SEAL	Name _____ Date _____

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FIGURE 5-5

ERM COOLER TRANSFER ACKNOWLEDGEMENT

Section: 5.0
Revision No.: 0
Date: 17 July 1987
Page: 7 of 8

ERM COOLER TRANSFER ACKNOWLEDGEMENT

DATE / TIME	CLIENT / PROJECT / CLIENT NUMBER	NUMBER OF COOLERS	ERM RELEASE (SIGNATURE)	RECEIVED BY (SIGNATURE)	DATE / TIME

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Section 7.0). All Chain-of-Custody information will be supplied with the data packages for inclusion in the document control file.

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SECTION 6

CALIBRATION PROCEDURES AND FREQUENCY

6.1 Laboratory Calibration

Laboratory calibration and frequency for the required methods specified for this study are presented in Attachment 1, Section 8.0.

6.2 Field Calibration

In addition to the laboratory analyses conducted during the course of this investigation, field measurements of pH, specific conductance, and temperature will be taken for all surface and ground water samples. An OVA meter will be used to measure total volatile organics in air or soil headspace.

The frequency of field calibration procedures will, at a minimum, include the following:

- The pH and specific conductance meters will be calibrated a minimum of once daily and documented in the calibrator's field book. Calibration will be checked as necessary to insure proper measurements are taken.

- pH meters will be calibrated using specific techniques according to the manufacturer's instructions given in Attachment 3 and two standard buffer solutions (either 4, 7, or 10) obtained from chemical supply houses. The pH values of these buffers will be compensated for temperature according to the values supplied on the manufacturer's bottle label. The temperature (measured as below) at which the sample pH was measured will then be used to compensate for temperature on the meter.

- Temperature measurements will be performed using field thermometers (Thomas Science No. 9329A10).

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- Specific conductance meters will be calibrated using a 1413.0 umho (KCl) solution prepared by ERM according to Standard Methods for the Analysis of Water and Wastewater, 16th Edition, 1985, Method 205, 3b, page 79. The conductivity probe cell constant will be calculated according to the formula:

$$K = \frac{1413.0 \left(\frac{1}{C}\right)}{1 + 0.02\,(T - 25°C)}$$

Where:

K = probe cell constant (unitless)
C = measured conductance value of standard
T = temperature (°C) of standard

Table 6-1 will be used to correct for the standard solutions' conductivity value if it is not at 25°C.

Using the cell constant calculated above and the following formula, field specific conductance measurements will be corrected to 25°C.

$$S = \frac{K \cdot C}{(1 + 0.02\,(T - 25))}$$

Where:

S = specific conductance at 25°C (umhos/cm)
K = calculated cell constant
C = field specific conductance (umhos/cm)
T = temperature (°C) of sample at which conductance was measured

- The Foxboro Century OVA 128 will be calibrated to a methane in air standard (87 ppm) once a week to insure total volatile organic readings are accurate. The methane in air standard is manufactured by Liquid Carbonic and marked with its concentration. The standard

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is run directly into the intake of the pickup probe and the gain adjustment of the OVA 128 is then used to calibrate the reading to 87 ppm. Any OVA, total volatile organic readings will to reported as "X ppm as methane".

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TABLE 6-1

CONDUCTIVITY TEMPERATURE CORRECTIONS
FOR 1,413 UMHOS/CM CONDUCTIVITY STANDARD

Temperature, °C	umhos/cm
15	1,141.5
16	1,167.5
17	1,193.6
18	1,219.9
19	1,246.4
20	1,273.0
21	1,299.7
22	1,326.6
23	1,353.6
24	1,380.0
25	1,400.1
26	1,436.5
27	1,463.2
28	1,490.9
29	1,510.7
30	1,546.7

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SECTION 7

ANALYTICAL PROCEDURES

All analytical procedures to be used are officially approved EPA procedures. The appropriate references are given in Attachment 1, Section 9.0.

The analytical methods which are to be used for the analysis of the sample media collected at the former Witco Corporation Site will be in accordance with Contract Laboratory Program (CLP) IFB for Organics and the Statement of Work (SOW) for Inorganics. The specific version will be the current awarded contract Cambridge Analytical is operating under. As stated by the laboratory, these methods are applicable to aqueous, solids, soils and leachate samples. A complete list of the organic and inorganic compounds/constituents and the applicable detection limits that will be required for all samples collected for the subject investigation is presented on Table 7-1.

The methods to be used for TRH, COD, pH, specific conductance, and TOC by Cambridge Analytical are presented on Table 7-2. The characterization of grain size will be performed by Hatuchen Analytical, Hatuchen, New Jersey. The vertical permeability testing will be performed by Woodward Clyde, Plymouth Meeting, Pennsylvania. The method to be used for these additional parameters are also presented on Table 7-2.

Holding times that are required to be met are presented on Table 7-3.

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TABLE 7-1

ORGANIC COMPOUNDS FOR ANALYSIS AND QUANTITATION LIMITS

Volatiles	CAS Number	Detection Limits[a] Low Water[a] ug/l	Low Soil/Sediment[b] ug/kg
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	10	10
7. Carbon Disulfide	75-15-0	5	5
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-35-3	5	5
10. trans-1,2-Dichloroethene	156-60-5	5	5
11. Chloroform	67-66-3	5	5
12. 1,2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	10	10
14. 1,1,1-Trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Vinyl Acetate	108-05-4	10	10
17. Bromodichloromethane	75-27-4	5	5
18. 1,1,2,2-Tetrachloroethane	79-34-5	5	5
19. 1,2-Dichloropropane	78-87-5	5	5
20. trans-1,3-Dichloropropene	10061-02-6	5	5
21. Trichloroethene	79-01-6	5	5
22. Dibromochloromethane	124-48-1	5	5
23. 1,1,2-Trichloroethane	79-00-5	5	5
24. Benzene	71-43-2	5	5
25. cis-1,3-Dichloropropene	10061-01-5	5	5

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TABLE 7-1
(Continued)

Volatiles	CAS Number	Detection Limits[a] Low Water[a] ug/L	Low Soil/Sediment[b] ug/kg
26. 2-Chloroethyl Vinyl Ether	110-75-8	10	10
27. Bromoform	75-25-2	5	5
28. 2-Hexanone	591-78-6	10	10
29. 4-Methyl-2-pentanone	108-10-1	10	10
30. Tetrachloroethene	127-18-4	5	5
31. Toluene	108-88-3	5	5
32. Chlorobenzene	108-90-7	5	5
33. Ethyl Benzene	100-41-4	5	5
34. Styrene	100-42-5	5	5
35. Total Xylenes	100-42-5	5	5

[a]Medium Water Contract Required Detection Limits (CRDL) for Volatile TCL Compounds are 100 times the individual Low Water CRDL.

[b]Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Volatile TCL Compounds are 100 times the individual Low Soil/Sediment CRDL.

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TABLE 7-1
(Continued)

Semi-Volatiles	CAS Number	Detection Limits* Low Water[a] ug/l	Detection Limits* Low Soil/Sediment[a] ug/kg
36. Phenol	108-95-2	10	330
37. bis(2-Chloroethyl)ether	111-44-4	10	330
38. 2-Chlorophenol	95-57-8	10	330
39. 1,3-Dichlorobenzene	541-73-1	10	330
40. 1,4-Dichlorobenzene	106-46-7	10	330
41. Benzyl Alcohol	100-51-6	10	330
42. 1,2-Dichlorobenzene	95-50-1	10	330
43. 2-Methylphenol	95-48-7	10	330
44. bis(2-Chloroisopropyl) ether	39638-32-9	10	330
45. 4-Methylphenol	106-44-5	10	330
46. N-Nitroso-Dipropylamine	621-64-7	10	330
47. Hexachloroethane	67-72-1	10	330
48. Nitrobenzene	98-95-3	10	330
49. Isophorone	78-59-1	10	330
50. 2-Nitrophenol	88-75-5	10	330
51. 2,4-Dimethylphenol	105-67-9	10	330
52. Benzoic Acid	65-85-0	50	1600
53. bis(2-Chloroethoxy) methane	111-91-1	10	330
54. 2,4-Dichlorophenol	120-83-2	10	330
55. 1,2,4-Trichlorobenzene	120-82-1	10	330
56. Naphthalene	91-20-3	10	330
57. 4-Chloroaniline	106-47-8	10	330
58. Hexachlorobutadiene	87-68-3	10	330
59. 4-Chloro-3-methylphenol	59-50-7	10	330
60. 2-Methylnapthalene	91-57-6	10	330
61. Hexachlorocyclopentadiene	77-47-4	10	330
62. 2,4,6-Trichlorophenol	88-06-2	10	330
63. 2,4,5-Trichlorophenol	95-95-4	50	1600

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TABLE 7-1
(Continued)

Semi-Volatiles	CAS Number	Detection Limits[a] Low Water[a] ug/l	Detection Limits[a] Low Soil/Sediment[a] ug/kg
64. 2-Chloronaphthalene	91-58-7	10	330
65. 2-Nitroaniline	88-74-4	50	1600
66. Dimethyl Phthalate	131-11-3	10	330
67. Acenaphthylene	208-96-8	10	330
68. 3-Nitroaniline	99-09-2	50	1600
69. Acenaphthene	83-32-9	10	330
70. 2,4-Dinitrophenol	51-28-5	50	1600
71. 4-Nitrophenol	100-02-7	50	1600
72. Dibenzofuran	132-64-9	10	330
73. 2,4-Dinitrotoluene	121-14-2	10	330
74. 2,6-Dinitrotoluene	606-20-2	10	330
75. Diethylphthalate	84-66-2	10	330
76. 4-Chlorophenyl Phenyl ether	7005-72-3	10	330
77. Fluorene	86-73-7	10	330
78. 4-Nitroaniline	100-01-6	50	1600
79. 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
80. N-nitrosodiphenylamine	86-30-6	10	330
81. 4-Bromophenyl Phenyl ether	101-55-3	10	330
82. Hexachlorobenzene	118-74-1	10	330
83. Pentachlorophenol	87-86-5	50	1600
84. Phenanthrene	85-01-8	10	330
85. Anthracene	120-12-7	10	330
86. Di-n-butylphthalate	84-74-2	10	330
87. Fluoranthene	206-44-0	10	330
88. Pyrene	129-00-0	10	330
89. Butyl Benzyl Phthalate	85-68-7	10	330
90. 3,3'-Dichlorobenzidine	91-94-1	20	660
91. Benzo(a)anthracene	56-55-3	10	330
92. bis(2-ethylhexyl)phthalate	117-81-7	10	330

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TABLE 7-1
(Continued)

Semi-Volatiles	CAS Number	Detection Limits[a] Low Water[b] ug/L	Detection Limits[a] Low Soil/Sediment[b] ug/kg
93. Chrysene	218-01-9	10	330
94. Di-n-octyl Phthalate	117-84-0	10	330
95. Benzo(b)fluoranthene	205-99-2	10	330
96. Benzo(k)fluoranthene	207-08-9	10	330
97. Benzo(a)pyrene	50-32-8	10	330
98. Indeno(1,2,3-cd)pyrene	193-39-5	10	330
99. Dibenz (a,h)anthracene	53-70-3	10	330
100. Benzo(g,h,i)perylene	191-24-2	10	330

[a]Medium Water Contract Required Detection Limits (CRDL) for Semi-Volatile TCL Compounds are 100 times the individual Low Water CRDL.

[b]Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Semi-Volatile TCL Compounds are 60 times the individual Low Soil/Sediment CRDL.

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TABLE 7-1
(Continued)

Compounds	CAS Number	Detection Limits* Low Water ug/l	Detection Limits* Low Soil/Sediment ug/kg
101. tris (B-chloropropyl) phosphate (Fyrol PCF®)	13674-84-5	10**	330**

aka: tris(tris-1-chloromethyl phosphate)

*Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment on dry weight basis, as required by the contract, will be higher.

**Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

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TABLE 7-1
(Continued)

Element	Detection Limits Low Water (ug/L)
Iron	100
Manganese	15

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TABLE 7-1
(Continued)

Parameter	Detection Limits Low Water (mg/L)
Chemical Oxygen Demand (COD)	5.0
Total Organic Carbon (TOC)	0.1

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TABLE 7-2

ANALYTICAL METHODOLOGY REFERENCED
FOR ADDITIONAL PARAMETERS

Additional Constituents/ Parameters	Method Reference	Method Description
Tris	Method 8270 (1)	Solvent extraction, gas chromatography/mass spectrometry
pH	Method 150.1 (2)	Electrometric
Specific Conductance	Method 120.1 (2)	Potentiometric
TOC	Method 415.2 (2)	Persulfate oxidation, UV promoted
COD	Method 410.1 (2)	Titrimetric
Molids	Method 335.2 (2)	Weighted difference
Vertical Permeability	Method EM 1110-2-1906 (3)	Physical testing
Grain Size	ASTM D112-77	Physical testing

(1) U.S. EPA. 1982. Test Methods for Evaluating Solid Wastes, SW-846, U.S. EPA, Washington, D.C. 3rd Edition.

(2) U.S. EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020 (Revised, March 1983). EPA/EMSL, Cincinnati, Ohio.

(3) Department of the Army, 1970. Laboratory Soils Testing. Engineering and Design. EM/1110-2-1906.

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TABLE 7-3

RECOMMENDED HOLDING TIMES FOR ANALYSES TO BE CONDUCTED ON SAMPLES FOR THE FORMER WITCO CORPORATION SITE

Parameter	Holding Times[1]
Total Metals	6 mon (28 days for Hg)
TOC, COD	28 days
Semi-Volatiles	7 days until extraction; Analysis 40 days after extraction.
Tris	7 days until extraction; Analysis 40 days after extraction.
Volatile Organics	14 days for water; 10 days for soil[2]
Field pH and Conductivity	Measured immediately after sample collection

[1] From date of collection according to 40 CFR, Part 136, Friday, October 26, 1984.
[2] According to the current organic SOW for the CLP. This will be from date of collection.

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SECTION 0

DATA REPORTING, VALIDATION, AND REDUCTION

Data validation practices will be followed to insure that raw data are not altered and that an audit trail is developed for those data which require reduction. All the field data, such as those generated during field measurements, observations and field instrument calibrations, will be entered directly into a bound field notebook. Each project team member will be responsible for proofing all data transfers made, and ERM's Quality Assurance Officer will proof at least ten percent of all data transfers.

Cambridge Analytical group leaders will check and validate all data generated by their group as specified in Attachment 1, Section 10.0.

Upon receipt of the sample data packages, the laboratory data will again be quantitatively and qualitatively validated by ERM's Quality Assurance Manager. Data validation is discussed in detail in Section 12.

It is anticipated that ERM's data reduction for this investigation will be minimal and will consist primarily of tabulating analytical results from Cambridge Analytical's Form I (Analytical Reports) onto summary tables through the use of computerized spreadsheet software. All reduced data will be assigned document control identification numbers and placed in the central file maintained by the Project Manager.

All analytical data obtained during the course of the investigation for ground waters and surface waters will be reported as ug/l. Laboratory data for soil analyses will be reported as ug/kg (organics) on a dry weight basis. Data packages associated with the analyses of samples collected during the RI will be prepared utilizing full CLP deliverables. The required deliverables are stated in Section D of the IFB and SOW currently in use by Cambridge Analytical.

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ERM will require a rigorous data control program that will insure that all documents for the investigations are accounted for when they are completed. Accountable documents include items such as log books, field data records, correspondence, chain-of-custody records, analytical reports, data packages, photographs, computer disks, and reports. The Project Manager is responsible for maintaining a central file in which all accountable documents will be inventoried.

To maintain control in the transfer of data, all copies of raw data from the field notebooks, and the data as received from the laboratory, will be entered into a data file and assigned an appropriate document control identification number. The data file will serve as the ultimate archive for all information and data generated during this investigation.

The documentation of sample collection will include the use of bound field log books in which all information on sample collection will be entered in indelible ink. Appropriate information will be entered to reconstruct the sampling event, including: site name (top of each page), sample identification, brief description of sample, date and time of collection, sampling methodology, field measurements and observations, and sampler's initials (bottom of each page, and dated). An example of a field log is presented in Figure 8-1.

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① Wilco Corporation

5-8-87

Personnel Present:

Weather Description:

Field Tases, Observations, Notes on Samples Collected:

Location of Sample
Depth to water
Depth to bottom
Purge Volume
Purge Method
Physical Observations (ie odor, Sheen)
Field Measurements of Specific Conductance
Sample Collection Equipment
Type of Collection, EPA IRF

Equipment Calibration

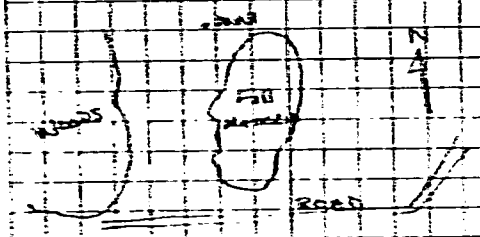
Decontamination Methods Used:

D.R. Blye
5/8/87

② Wilco Corporation

5-8-87

Relevant Sketch:
(or attach location map)



DR Blye
5/8/87

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SECTION 9

INTERNAL QUALITY CONTROL CHECKS

9.1 Laboratory Internal Quality Control Checks

Cambridge Analytical's Internal Quality Control Checks are presented in Attachment 1, Section 11.0. These will be a continuation of ERM's Field Internal Quality Control Checks presented below.

9.2 Field Internal Quality Control Checks

Field Internal Quality Control Checks will be utilized during this investigation through the use of the following:

- Field (Travel) Blanks - These blanks consist of ultrapure, deionized water contained in each sample container with any preservatives required for that analysis. ERM produces ultrapure deionized water by use of a Hydro® Model 20C2-44PE Ultrapure Water System. These blanks will accompany the samplers during the sampling process and will serve as QC check on container cleanliness, external contamination, and the analytical method. Travel (field) blanks will be submitted once per day per analytical fraction for ground water and surface water samples. A travel blank will be submitted daily for soil/sediment samples which will be analyzed for organics only. These blanks are comprised of sodium sulfate (Na_2SO_4) and microcrystalline cellulose.

- Duplicate Samples - Duplicate samples will be collected to allow determination of analytical precision. One duplicate sample in every twenty (20) ground water and surface water samples will be collected, and one in every twenty (20) soil or sediment samples will be collected and submitted for analysis. These samples may be run as matrix spike duplicates (see below).

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- Matrix Spike Sample - A matrix spike sample will also be submitted as a further QC check. These will be collected at the same frequency as stated above for the duplicate samples. These will allow accuracy to be determined by the recovery rates of compounds (the matrix spike and/or surrogate spike compounds defined in the analytical methods). The purpose of these laboratory spikes is to monitor any possible matrix effects specific to samples collected from the subject site. The addition of known concentrations of compounds/constituents into the sample also monitors extraction/digestion efficiency.

Summarizing the above discussion, every twentieth sample or five percent, whichever is more frequent, will be analyzed in duplicate (or matrix spike duplicate) and run as a matrix spike sample.

Duplicate/replicate and matrix spike sample aliquots will be acquired for ground and surface water samples by collecting sequential grab samples after collecting of the initial sample aliquot. Therefore, the specific sample location which will be used for matrix spikes and duplicates/replicates will be chosen by the Quality Assurance Officer. Soil/sediment duplicate and matrix spike samples will be collected by splitting the sample between the sample container, duplicate container, and matrix spike container. Homogenizing is discouraged prior to splitting to avoid the loss of volatile organic compounds. If insufficient soil/sediment sample is present at a particular location to collect the three sample volumes, a single sample bottle will be split at the laboratory for duplicate and matrix spike analysis.

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SECTION 10

PERFORMANCE AND SYSTEM AUDITS

10.1 On-Site Audit

An on-site system audit will be performed during major field activities to review all field-related quality assurance activities. The system audit will be conducted by ERM's Quality Assurance Officer. Figure 10-1 presents ERM's Quality Assurance Audit forms.

Specific elements of the on-site audit include the verification of:

- Completeness and accuracy of sample Chain-of-Custody forms, including documentation of times, dates, transaction descriptions, and signatures.
- Completeness and accuracy of sample identification labels, including notation of time, date, location, type of sample, person collecting sample, preservation method used, and type of testing required.
- Completeness and accuracy of field notebooks, including documentation of times, dates, drillers' names, sampling method used, sampling locations, number of samples taken, name of person collecting samples, types of samples, results of field measurements, soil logs, and any problems encountered during sampling.
- Adherence to health and safety guidelines outlined in the Site Health and Safety Plan including wearing of proper protective clothing.
- Adherence to decontamination procedures outlined in Section 4 of this QAPP, including proper decontamination of pumps and pump tubing, bailers, and sampling equipment.

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FIGURE 10-1
ERM QUALITY ASSURANCE AUDIT

PROJECT _____ W.O.# _____

DATE _____ AUDIT CONDUCTED FROM ___ HR. TO ___ HR.

AUDITOR(S): _____

_____

ON-SITE SAMPLING PERSONNEL: _____

_____

Audit Conducted on the Following:

_____ Soil Sampling
_____ Surface Water/Sediment
_____ Ground Water
_____ Decontamination
_____ Health & Safety

Sample Collection:

Do sampling locations agree with those specified in the Work Plan? _____

Is the sampling locating either documented sufficiently or marked to allow it to be found/sampled again in the future? _____

Are sampling times, ERM Traffic Report Numbers and sample description noted? _____

Is sampling proceeding from the suspected least contaminated area to the most contaminated area? _____

Have sample bottles been labeled properly? _____

Have proper containers and preservatives been used? _____

Are proper sample volumes procured? _____

Are samples being refrigerated/iced immediately after collection? _____

Does a travel blank exist for each matrix present? _____

Does the potential for sample cross-contamination exist based on procedures observed? _____

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FIGURE 10-1
(Continued)

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Soil Sampling (Check if not applicable _____):
Type: _____ Hand _____ Auger or Rig

Are samples being collected at proper depths? _____

Are samples being screened with an OVA (if specified in Work Plan and applicable)? _____

Is a description of soils/materials being logged? _____

(Have soils been homogenized where applicable (specified by the Sampling Plan)? _____

Surface Water/Sediment Sampling (Check if not applicable _____):

Have stream flow and velocity parameters been noted? _____
Estimated _____ or Measured _____

Has sampling proceeded from downstream to upstream locations? _____

Has the sampler acquired the water sample upstream of his position to minimize suspended sediment from entering the sample? _____

Have water samples been collected in the mixing zone, not stagnant areas? _____

Have sediments been characterized as to type and size distribution? _____

Has the proper sediment fraction (fine, depth) been sampled for the analyses of interest? _____

Are the selected locations effectively monitoring effects of the potential source? _____

Ground Water Sampling (Check if not applicable _____):

Have the well specifications been noted properly (i.e., Total Depth, Casing diameter, Depth-to-water to the nearest one-hundredth of a foot, etc.)? _____

Has the purge volume been calculated properly? _____

What evacuation method has been used?
_____ Bailer _____ Submersible _____ Bladder Pump
_____ Other (_____)

If metals are being analyzed, have the samples been field filtered? _____

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Are field pH, conductivity, and temperature being measured? _____ Is there documentation of calibrating the instruments? _____

Has well yield been properly evaluated to determine when sample aquisition should take place (i.e., well goes dry and needs to recover). _____

Is bailer line and bailer dedicated to each well and line disposed of after use? _____
Bailer type _____ Line type _____

Have appropriate measures been taken to dispose of contaminated purge water, pump lines, bailers, etc? _____

For Domestic Wells - Has as much information on the well and distribution system been obtained, i.e., depth, casing type, diameter, treatment present, etc.? _____

Has the sample been collected prior to treatment and as close to the well head as possible? _____

Has the domestic well been purged sufficiently to reach temperature stabilization? _____

Have the weather conditions been recorded? _____

Decontamination:

Has sampling equipment been decontaminated properly for the given analytes? _____

Have the proper decontamination solutions been used? _____

For large equipment (backhoes, drill rigs), has decontamination taken place in an appropriate area? _____

Has decontaminated water/solution been collected for proper disposal? _____ Where disposed? _____

Safety:

Is the proper level of protective clothing being worn for the tasks? _____ Level A __ B __ C __ D __

Is the site Health and Safety Plan present with proper emergency contacts included? _____

Is monitoring equipment present? _____ OVA _____
H_2, O_2 meter _____ Explosimeter _____ Other _____

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Is the vehicle equipped with a First Aid Kit? _____

Is contaminated protective clothing being disposed of properly? _____

Are personnel aware of the contaminants present at the site? _____

General:

Are employees conducting the investigation in a professional manner? _____

Are the objectives of the sampling activities understood by the field personnel? _____

Are weather conditions affecting sample quality? _____

Audit Summary and Comments:

_____

Signed by: _____ Print: _____

_____ _____

_____ _____

Date: _____

DB/gl

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- Adherence to sample collection, preparation, preservation, and storage procedures.

10.2 Laboratory Audit

10.2.1 Internal Laboratory Audits

Cambridge Analytical performs regular systems and performance audits, and these are described in Attachment 1, Section 12. ERM's Quality Assurance Manager will also conduct a system audit of the laboratory once during the project to insure that proper quality assurance measures are being incorporated into the sample handling and analysis. Table 10-1 lists the checklist that will be used for the system audit.

10.2.2 ERM's Performance Audit of Cambridge Analytical

As Cambridge Analytical participates in EPA's Contract Laboratory Program (CLP) for both organic and inorganic analyses, a performance audit sample will not be submitted for analysis. The most recent CLP Performance Evaluation samples analyzed during the investigation will be requested and reviewed to evaluate laboratory accuracy.

Results of both the field and laboratory audit will be submitted to ERM's Project Manager for review and incorporation into the status reports prepared by ERM for the Wilco Corporation. Results of these audits will be forwarded to the EPA Project Officer for review.

The acceptance criteria for the field and laboratory audit will be based upon the adherence to the elements defined in this QAPP for field sampling and laboratory analysis. Outliers found that deviate from this QAPP will immediately necessitate defining the outlier to the individual and initiating corrective action. If the results of the audit necessitate further action, the Project Manager will be notified of such and will be apprized of any action taken.

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TABLE 10-1

ERM'S SYSTEM AUDIT CHECKLIST FOR CAMBRIDGE ANALYTICAL

I. Chain-of-Custody

- Log-In Procedures Evaluated
- Sample Custodian is Assigned and Oversees Sample Transfers
- Sample Routing and Pickup is Documented and Accounted For
- Separate Area for Sample Storage and Maintained in Locked Storage

II. Sample Preparation

- Correct Sample Preparation Procedures are Followed
- Areas Designated for Sample Preparation (Organic and Inorganic)
- Holding Times Maintained

III. QA/QC Procedures

- Procedures are Being Followed According to Methods Specified
- Data Validation and Reduction Processes Reviewed by Group Leaders
- Proper Documentation of QA Procedures
- Internal QC Maintained
- Data Transfers and Reporting Checked by Group Leaders
- Awareness of Personnel of QA Requirements

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TABLE 10-1
(Continued)

IV. Equipment Maintenance

- Maintenance Logs are Up-to-Date
- Instrumentation is in Repair
- Reasonable Spare Parts are on Hand

V. Miscellaneous

- Overall Housekeeping in Order
- Certifications Up-to-Date

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SECTION 11

PREVENTIVE MAINTENANCE

11.1 Laboratory Maintenance

A typical standard operating procedure for maintenance, including specific routine and preventive procedures, and maintenance logs for the gas chromatograph/mass spectrometer is given in Attachment 1, Section 13.0.

11.2 Field Maintenance

ERM's field equipment is maintained through the use of a tracking system incorporating the tagging of each equipment item. This tag identifies its most recent maintenance, battery charge, and condition. When damaged or equipment in need of repair is returned to the equipment warehouse, it is appropriately flagged for the required maintenance to be performed. This process assures only operable and maintained equipment enters the field. Routine daily maintenance procedures conducted in the field will include:

- Removal of surface dirt and debris from exposed surfaces of the sampling equipment and measurement systems.
- Cleansing of filters in the organic vapor analyzer.
- Storage of equipment away from the elements.
- Daily inspections of sampling equipment and measurement systems for possible problems (e.g., cracked or clogged lines or tubing or weak batteries).
- Check instrument calibrations as described in Section 6.2 of this QAAP.

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- Charging any battery packs for equipment when not in use.

Spare and replacement parts stored in the field to minimize downtime include:

- Appropriately sized batteries
- Locks
- Extra sample containers and preservatives
- Bailer line
- Additional bailers
- OVA igniters and filters
- OVA H_2 gas, battery charger, and support equipment
- Spare filters for filtration apparatus.
- Extra pH probes, conductivity probes, samples coolers, packing material, and sample location stakes.
- Additional supply of health and safety equipment i.e., respirator cartridges, boots, gloves, tyvek, etc.
- Additional equipment as necessary for the field tasks.

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SECTION 12

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 Overall Project Assessment

Overall data quality will be assessed by a thorough understanding of the data quality objectives which are stated during the design phase of the investigation. By maintaining thorough documentation of all decisions made during each phase of sampling, performing field and laboratory audits, thoroughly reviewing (validating) the analytical data as it is generated by the laboratory, and providing appropriate feedback as problems arise in the field or at the laboratory, ERM will closely monitor data accuracy, precision and completeness.

12.2 Field Quality Assessment

To assure that all field data are collected accurately and correctly, specific written instructions will be issued to all personnel involved in field data acquisition by the Project Manager. The Quality Assurance Officer will perform field audit(s) during the investigation to document that the appropriate procedures are being followed with respect to sample (and blank) collection. These audits will include a thorough review of the field books used by the Project personnel to insure that all tasks were performed as specified in the instructions. The field audits will necessarily enable the data quality to be assessed with regard to the field operations.

The evaluation (data review) of field blanks, and other field QC samples will provide definitive indications of the data quality. If a problem that can be isolated arises, corrective actions can be instituted for future field efforts.

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12.3 Laboratory Data Quality Assessment

Specific measures that will be taken by Cambridge Analytical to assess data quality are presented in Attachment 1, Section 14.0

12.4 ERM's Laboratory Data Assessment

12.4.1 ERM Data Validation

All analytical data generated during the investigation will undergo a rigorous ERM data review. This review will be performed in accordance with the "Functional Guidelines for the Evaluation of Organic (and Inorganic) Analysis".

A preliminary review will be performed to verify all necessary paperwork (chain-of-custodies, traffic reports, analytical reports, laboratory personnel signatures) and deliverables (as stated in the current IFB (organics) and SOW (inorganics) are present.

A detailed quality assurance review will be performed by the ERM Quality Assurance Manager (or a staff reviewer) to verify the qualitative and quantitative reliability of the data as it is presented. This review will include a detailed review and interpretation of all data generated by Cambridge Analytical. The primary tools used by experienced data review chemists include: guidance documents, established (contractual) criteria, and professional judgement. Table 12-4 presents the items examined during the quality assurance review.

Based upon the review of the analytical data, a quality assurance report will be prepared which will state in a technical yet "user friendly" fashion the qualitative and quantitative reliability of the analytical data. The report will consist of a general introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to best be utilized. Based upon the quality assurance review, qualifier codes will be placed next to specific sample results on the sample data table. These qualifier codes will serve as an indication of the qualitative and quantitative reliability.

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TABLE 12-4

ITEMS REVIEWED DURING THE ERM DATA VALIDATION

Areas Examined	Applicability (organic, inorganic, both)
ERM and Laboratory Chain of Custodies (Traffic Reports, Field Notes, Etc) Laboratory Narrative and QC Summaries	Both
Holding Times	Both
Extraction/Digestion Logs	Both
Blanks - field and laboratory (accuracy)	Both
Instrument Tune	Organic
Standards	Both
Linearity	Both
Sensitivity/Stability	Both
Selectivity/Specificity	Both
EPA Criteria (SPCC & LCS)	Both
Variability of Technique (internal standards)	Organic
Analyte Breakdown	Organic
Analytical Sequence	Organic
ICP Interference	Inorganic
Control Standards	Inorganic
Samples	
Detection Limits	Both
Instrument Printouts	Both
ICP data	Inorganic
AA data	Inorganic
GC data	Organic
GC/MS data	Organic
Autoanalyzer data	Inorganic
Qualitative Identification	Both
Mass spectra	
Tentatively identified compounds	

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TABLE 12-4
(Continued)

Quantitative Reliability	Both
Calculations/Equations	Both
Matrix spikes (accuracy)	Both
Bias	
Matrix spike duplicates	Organic
Bias	
Accuracy & Precision	
Surrogate Spikes	Organic
Bias	
Duplicates (field and laboratory)	Both
Precision	
Representativeness	

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During the course of the data review, an organic and inorganic support documentation package is prepared which will provide the backup information that will accompany all qualifying statements presented in the quality assurance review.

Once the review has been completed, the Quality Assurance Manager will then submit these data to the Project Manager. The approved data tables and quality assurance reviews will be signed and dated by the Quality Assurance Manager.

12.5 Data Management Quality Assessment

As the analytical data generated from the subject investigation are validated, qualified and submitted to the Project Manager, the quality of the data will be assessed from an overall management perspective by direct comparison of analytical results obtained from previous samplings. Information that can be obtained include comparison of results obtained from samples taken within the same general vicinity, which can aid in the identification of missing data points. By examination of the data at the "back-end" of the process, the data quality can be assessed with respect to representativeness, precision, compatibility and completeness.

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SECTION 13

CORRECTIVE ACTION

13.1 Cambridge Analytical's Corrective Action

Correction actions for Cambridge Analytical are presented in Attachment I, Section 15. Cambridge Analytical will provide documentation as to what, if any, corrective actions were initiated concerning this study and report them to ERM's Quality Assurance Manager.

13.2 ERM's Corrective Action

Field quality assurance activities will be reported topically to ERM's Project Manager. Problems encountered during the study affecting quality assurance will be reported on a Corrective Action Form as presented in Figure 13-1. The Project Manager will be responsible for initiating the corrective actions and for insuring that the actions are taken in a timely manner, and that the desired results are produced. The Project Manager will report to the Quality Assurance Manager and Quantity Assurance Officer on all necessary corrective actions taken, the outcome of these actions, and their affect on data produced. All corrective action taken will be reported to the Witco Corporation.

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FIGURE 11-1
ERM'S CORRECTIVE ACTION FORM

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Corrective Action Form

Date: _____

Job Name: _____

Initiator's Name and Title: _____

Problem Description: _____

Reported To: _____

Corrective Action: _____

Reviewed and Implemented By: _____

cc: Project Manager - _____
QA Manager - _____
QA Officer - _____

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SECTION 14

QUALITY ASSURANCE REPORTS TO MANAGEMENT

Every sixty (60) days after project initiation the Project Manager, in conjunction with the Quality Assurance Manager and Officer, will submit in the RI progress report, summaries of all applicable quality assurance activities. These summaries shall contain at least the following types of information:

- The status and coverage of various laboratory and field quality assurance project activities.
- Data quality assurance reviews including assessment of: accuracy, precision, completeness, representativeness, and comparability.
- Significant quality assurance problems discovered, corrective actions taken, progress and improvements, plans, and recommendations for further implementation or updating of the Investigative QAPP.
- Any significant field observations noted in the field notebook during the sampling procedure.
- A summarization of the results of performance and system audits, if conducted. All performance audit reports will also be transmitted to the EPA Project Officer.

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ATTACHMENT A

CAMBRIDGE ANALYTICAL QUALITY ASSURANCE PLAN
FOR THE FORMER WITCO CHEMICAL
COMPANY SITE

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Environmental Resources Management
855 Springdale Drive
Exton, Pennsylvania 19341

Quality Assurance Project Plan

for the

Remedial Investigation/Feasibility Study
Witco Corporation

Prepared By:

Cambridge Analytical Associates, Inc.
1106 Commonwealth Avenue
Boston, Massachusetts 02215

MARCH 23, 1988

Approved: _____ CAA Project Manager Date: 03/24/88

Approved: _____ CAA QA Officer Date: 3/28/88

Approved: _____ ERM Project Manager Date: 3/30/88

Approved: _____ ERM QA Officer Date: 3/30/88

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3. PROJECT DESCRIPTION

3.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is submitted by Cambridge Analytical Associates, Inc. (CAA) in response to a request by Environmental Resources Management, Inc. (ERM). This is a QAPP for laboratory services provided in support of a Remedial Investigation/Feasibility Study for Witco Corporation. The laboratory will use U.S. EPA Contract Laboratory Program (CLP) protocols.

These services will consist of preparation and analysis of multi-media multi-concentration samples for metals, extractable and volatile organics, pesticides, and conventional pollutants as specified in the EPA CLP protocol. The protocol used in the laboratory will be the revision currently required of CAA by EPA at the time of receipt of the sample.

Table 1.1 provides a listing of the analytical parameters of interest and the detection limits required by the organic and inorganic Statement of Work (SOW) 705.

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Table 3.1 SOW 785 Contract Required Detection Limits (CRDL) - Volatiles

Volatiles	CAS Number	Detection Limits[a] Low Water[a] ug/L	Low Soil/Sediment[b] ug/Kg
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	10	10
7. Carbon Disulfide	75-15-0	5	5
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-35-3	5	5
10. trans-1,2-Dichloroethene	156-60-5	5	5
11. Chloroform	67-66-3	5	5
12. 1,2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	10	10
14. 1,1,1-Trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Vinyl Acetate	108-05-4	10	10
17. Bromodichloromethane	75-27-4	5	5
18. 1,1,2,2-Tetrachloroethane	79-34-5	5	5
19. 1,2-Dichloropropane	78-87-5	5	5
20. trans-1,3-Dichloropropene	10061-02-6	5	5
21. Trichloroethene	79-01-6	5	5
22. Dibromochloromethane	124-48-1	5	5
23. 1,1,2-Trichloroethane	79-00-5	5	5
24. Benzene	71-43-2	5	5
25. cis-1,3-Dichloropropene	10061-01-5	5	5

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Table 3.1 SOW 785 Contract Required Detection Limits (CRDL) - Volatiles (cont.)

Volatiles	CAS Number	Detection Limits[a] Low Water[a] ug/L	Low Soil/Sediment[b] ug/Kg
26. 2-Chloroethyl Vinyl Ether	110-75-8	10	10
27. Bromoform	75-25-2	5	5
28. 2-Hexanone	591-78-6	10	10
29. 4-Methyl-2-pentanone	108-10-1	10	10
30. Tetrachloroethene	127-18-4	5	5
31. Toluene	108-88-3	5	5
32. Chlorobenzene	108-90-7	5	5
33. Ethyl Benzene	100-41-4	5	5
34. Styrene	100-42-5	5	5
35. Total Xylenes	100-42-5	5	5

[a]Medium Water Contract Required Detection Limits (CRDL) for Volatile HSL Compounds are 100 times the individual Low Water CRDL.

[b]Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Volatile HSL Compounds are 100 times the individual Low Soil/Sediment CRDL.

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Table 3.1 SOW 785 Contract Required Detection Limits (CRDL) - Semi-Volatiles

Semi-Volatiles	CAS Number	Detection Limits[1] Low Water[2] ug/L	Low Soil/Sediment[3] ug/Kg
36. Phenol	108-95-2	10	330
37. bis(2-Chloroethyl) ether	111-44-4	10	330
38. 2-Chlorophenol	95-57-8	10	330
39. 1,3-Dichlorobenzene	541-73-1	10	330
40. 1,4-Dichlorobenzene	106-46-7	10	330
41. Benzyl Alcohol	100-51-6	10	330
42. 1,2-Dichlorobenzene	95-50-1	10	330
43. 2-Methylphenol	95-48-7	10	330
44. bis(2-Chloroisopropyl) ether	39638-32-9	10	330
45. 4-Methylphenol	106-44-5	10	330
46. N-Nitroso-Dipropylamine	621-64-7	10	330
47. Hexachloroethane	67-72-1	10	330
48. Nitrobenzene	98-95-3	10	330
49. Isophorone	78-59-1	10	330
50. 2-Nitrophenol	88-75-5	10	330
51. 2,4-Dimethylphenol	105-67-9	10	330
52. Benzoic Acid	65-85-0	50	1600
53. bis(2-Chloroethoxy) methane	111-91-1	10	330
54. 2,4-Dichlorophenol	120-83-2	10	330
55. 1,2,4-Trichlorobenzene	120-82-1	10	330
56. Naphthalene	91-20-3	10	330
57. 4-Chloroaniline	106-47-8	10	330
58. Hexachlorobutadiene	87-68-3	10	330
59. 4-Chloro-3-methylphenol	59-50-7	10	330
60. 2-Methylnaphthalene	91-57-6	10	330
61. Hexachlorocyclopentadiene	77-47-4	10	330
62. 2,4,6-Trichlorophenol	88-06-2	10	330
63. 2,4,5-Trichlorophenol	95-95-4	50	1600

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Table 3.1 SOW 705 Contract Required Detection Limits (CRDL) - Semi-Volatiles (Cont.)

Semi-Volatiles	CAS Number	Detection Limits* Low Water[a] ug/L	Low Soil/Sediment[b] ug/Kg
64. 2-Chloronaphthalene	91-58-7	10	330
65. 2-Nitroaniline	88-74-4	50	1600
66. Dimethyl Phthalate	131-11-3	10	330
67. Acenaphthylene	208-96-8	10	330
68. 3-Nitroaniline	99-09-2	50	1600
69. Acenaphthene	83-32-9	10	330
70. 2,4-Dinitrophenol	51-28-5	50	1600
71. 4-Nitrophenol	100-02-7	50	1600
72. Dibenzofuran	132-64-9	10	330
73. 2,4-Dinitrotoluene	121-14-2	10	330
74. 2,6-Dinitrotoluene	606-20-2	10	330
75. Diethylphthalate	84-66-2	10	330
76. 4-Chlorophenyl Phenyl ether	7005-72-3	10	330
77. Fluorene	86-73-7	10	330
78. 4-nitroaniline	100-01-6	50	1600
79. 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
80. N-nitrosodiphenylamine	86-30-6	10	330
81. 4-Bromophenyl Phenyl ether	101-55-3	10	330
82. Hexachlorobenzene	118-74-1	10	330
83. Pentachlorophenol	87-86-5	50	1600
84. Phenanthrene	85-01-8	10	330
85. Anthracene	120-12-7	10	330
86. Di-n-butylphthalate	84-74-2	10	330
87. Fluoranthene	206-44-0	10	330
88. Pyrene	129-00-0	10	330
89. Butyl Benzyl Phthalate	85-68-7	10	330
90. 3,3'-Dichlorobenzidine	91-94-1	20	660
91. Benzo(a)anthracene	56-55-3	10	330
92. bis(2-ethylhexyl)phthalate	117-81-7	10	330
93. Chrysene	218-01-9	10	330
94. Di-n-octyl Phthalate	117-84-0	10	330
95. Benzo(b)fluoranthene	205-99-2	10	330
96. Benzo(k)fluoranthene	207-08-9	10	330
97. Benzo(a)pyrene	50-32-8	10	330

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Table 3.1 SOW 705 Contract Required Detection Limits (CRDL) - Semi-Volatiles - (Cont.)

Semi-Volatiles		CAS Number	Detection Limits[a] Low Water[a] ug/L	Low Soil/Sediment[b] ug/Kg
98.	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
99.	Dibenz(a,h)anthracene	53-70-3	10	330
100.	Benzo(g,h,i)perylene	191-24-2	10	330

[a] Medium Water Contract Required Detection Limits (CRDL) for Semi-Volatile HSL Compounds are 100 times the individual Low Water CRDL.

[b] Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Semi-Volatile HSL Compounds are 60 times the individual Low Soil/Sediment CRDL.

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Table 3.1 Detection Limits - Other Organic Compounds

Compound	CAS Number	Detection Limits* Low Water ug/L	Low Soil/Sediment ug/Kg
101. Tris (B-chloropropyl) phosphate (Fyrol PCF)	6145-73-9	10.0**	330**

*Detection limits listed for soil/sediment are based on wet weight. The detection limits are calculated by the laboratory for soil/sediment on dry weight basis, as required by the contract, will be higher.

**Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

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Table 3.1 SOW 785 Contract Required Detection Limits (CRDL) - Metals

Element	Detection Limits Low Water (ug/L)
Iron	100
Manganese	15

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Table 3.1 (cont'd) Detection Limits -
Conventional Pollutants

Parameter	Detection Limits Low Water mg/l
Chemical Oxygen Demand (COD)	5.0
Total Organic Carbon (TOC)	0.1

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4. PROJECT ORGANIZATION AND RESPONSIBILITIES

4.1 Description of Responsibilities

The responsibilities for the individuals associated with this Quality Assurance/Quality Control (QA/QC) program are described and illustrated in Figure 4.1:

- The Quality Assurance Officer is responsible for reviewing and advising on all aspects of QA/QC. The duties and responsibilities of the QA Officer are to:

  1. assist the project/task manager in specifying QA/QC procedures to be used during the project;
  2. execute quality control procedures and techniques to assure that the laboratory achieves established standards of quality;
  3. evaluate data quality and maintain records on related QC charts and other pertinent information;
  4. monitor laboratory activities to determine conformance with authorized quality assurance policy, and to implement appropriate steps to ensure adherence to quality assurance programs;
  5. coordinate internal audits with the Project Manager;
  6. review performance evaluation results;
  7. administer intralaboratory and interlaboratory QA efforts; and
  8. prepare quality assurance reports to management.

- The project manager has overall responsibility for management of the analytical tasks of the project. The duties and responsibilities of the project manager are to:

  1. administer and supervise all requirements of the analytical tasks to ensure meeting project objectives within budget and on schedule;
  2. direct formulation of the work plan and initiate work plan revisions in accordance with the project officer's directions;

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3. work with task managers in planning and conducting project progress meetings;

4. review work plans, progress reports, analytical reports, project reports, and financial reports prior to issue; and

5. take part in corrective actions.

o The task managers have the day-to-day responsibilities for the analytical tasks of the project. Their areas of responsibilities are to:

1. organize the personnel, equipment, and materials in a manner required to meet the objectives of the analytical tasks of the project;

2. implement analytical procedures for use in data evaluation;

3. provide technical directions in conduct of laboratory analyses, and resolve day-to-day problems;

4. direct the task activities and monitor performance of task members to ensure that they are adhering to high technical standards and to the budget and task schedules;

5. review analytical data for validity and clarity ; and

6. maintain contact with the project manager in areas of technical concern, and advise him of progress, needs, and potential problems of the various tasks.

o The project analysts are responsible for each task identified in the scope of work. They are responsible for performing the laboratory technical activities within their tasks. In execution of their duties, the analysts are expected to:

1. assist in planning for each phase of their tasks and in defining objectives and activities;

2. respond to work plan revisions related to their tasks;

3. advise the task manager of progress, needs, and potential problems of their tasks;

4. train and qualify alternate analysts in specified laboratory QC and analytical procedures;

5. verify that laboratory QC and analytical procedures are being followed as specified;

6. review sample QC data at least daily. This will include examination of raw data such as chromatograms (and

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checking of calculations for a minimum of 10% for the samples analyzed) as well as an inspection of reduced data, calibration curves, and laboratory notebooks; and

7. Inform task managers if the daily review indicates a decline in data quality and implement corrective actions.

- o Sample Coordinator - The sample coordinator acts as sample custodian for the laboratory. The duties and responsibilities of the sample coordinator are to:

  1. Sign for the incoming field samples and verify the data entered on the chain-of-custody forms;

  2. Enter sample information into computerized Sample and Analysis Management System (SAM) for tracking & reporting;

  3. Generate computerized sample tracking and laboratory data entry forms;

  4. Transfer samples and tracking forms to laboratory project analysts.

- o Document Control/Data Managers - The document control/data managers are responsible for maintaining the case document files. The duties and responsibilities of the document control/data managers are to:

  1. Verify that laboratory QC and analytical procedures are being followed as specified by the EPA CLP Statement of Work;

  2. Review sample/project QC data for validity;

  3. Compile sample and QC data into a data package to be sent to the client;

  4. Maintain the case file with all appropriate forms, such as chain-of-custody, sample tags, work orders, worksheets, raw data and the data package until data can purged to the client.

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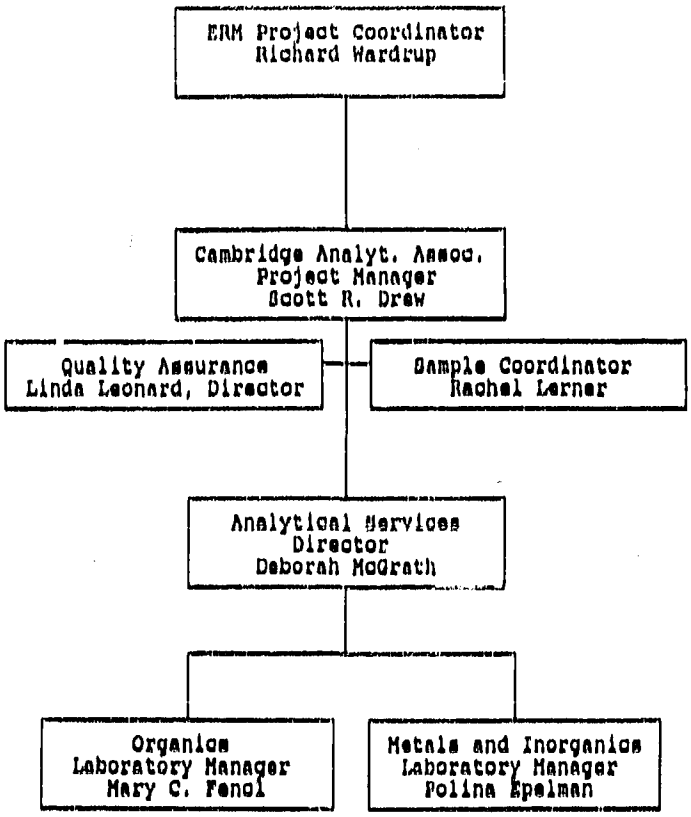
Figure 4.1 Project Organization



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5. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS REPRESENTATIVENESS, AND COMPARABILITY

The analytical quality assurance objectives for this project are to provide analytical data of known quality and to be able to defend the quality of that data. Data quality is assessed for precision, accuracy, completeness, representativeness, and comparability. The analytical protocols to be used for the analyses contain detailed descriptions of the quality control measures to be employed. The analysis of replicate and spiked samples will provide precision and accuracy data for assessing the validity of analytical results. Analytical precision and accuracy goals for the parameters of interest are provided in Table 5.1.

5.1 Level of QA Efforts

Every attempt will be made to have all data generated be valid data. The precision of laboratory analysis will be evaluated using sample duplicates. Analytical accuracy will be monitored using recovery of analytes from surrogate spikes, matrix spikes, EPA reference check standards and Performance Evaluation (PE) samples. These quality control measures and their control limits, are summarized in Table 5.2. These QA efforts will assist in determining the reliability of the analytical data.

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5.2 Accuracy and Precision

Accuracy is a measure of the degree of agreement between an analyzed value and the true or accepted reference value where it is known. Accuracy is usually expressed as percent recovery. Precision is a measure of the mutual agreement among individual measurements of the same parameter under similar conditions, usually expressed as standard deviation. The QA objectives for accuracy and precision are shown in Table 5.1. The objectives will be used to monitor data acceptability.

5.3 Completeness

Completeness is a measure of the amount of valid data obtained from the analytical measurement system, expressed as a percentage of the number of valid measurements that should have been or were planned to be collected. CAA will make every attempt to generate valid data from all samples received. However, realistically, some samples may be lost in laboratory accidents or some results may be deemed questionable based on internal QC procedures. Due to the variable nature of the completeness value, the objective will be to have data completeness for all samples received for analysis as high as possible to meet completeness objectives as described by the client.

5.4 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the sample. Sampling will be performed by the client or their contractors. Sample handling protocols (e.g., storage, preservation and transportation) have been developed to preserve the representativeness of the collected samples. Proper documentation will establish that protocols have been followed and sample identification and integrity assured.

5.5 Comparability

Comparability is a QA objective wherein all sample data is comparable

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with other representative measurements made by CAA or another organization. CAA will achieve comparability by operating within the instrument linear range and by strict adherence to analytical protocols. The use of published analytical methods, standard reporting units and thorough documentation will ensure meeting this objective.

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TABLE 5.1 ESTIMATES OF ANALYTICAL PRECISION ACCURACY AND COMPLETENESS

ANALYSIS	MATRIX	PRECISION (Relative % Difference)	ACCURACY (% Recovery)	COMPLETENESS
Volatile Organics	Aqueous	≤20%	75-125%	95
	Soil/Sediment	≤20%	60-120%	95
Semi-Volatile Organics	Aqueous	≤20%	50-130%	95
	Soil/Sediment	≤20%	50-130%	95
Tris	Aqueous	≤50%	30-150%	95
	Soil/Sediment	≤50%	30-150%	95
Metals	Aqueous	≤20%	80-120%	95
Conventional Pollutants	Aqueous	≤20%	80-120%	95

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TABLE 5.2 Quality Control Measures - Organics*

CONTRACT REQUIRED SURROGATE SPIKE RECOVERY LIMITS

Fraction	Surrogate Compound	Low/Medium Water	Low/Medium Soil/Sediment
VOA	Toluene-d_8	88-110	81-117
VOA	4-Bromofluorobenzene	86-115	74-121
VOA	1,2-Dichloroethane-d_4	76-114	70-121
BNA	Nitrobenzene-d_5	35-114	23-120
BNA	2-Fluorobiphenyl	43-116	30-115
BNA	p-Terphenyl-d_{14}	33-141	18-137
BNA	Phenol-d_5	10-94	24-113
BNA	2-Fluorophenol	21-100	25-121
BNA	2,4,6-Tribromophenol	10-123	19-122

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Table 5.2 MATRIX SPIKE RECOVERY LIMITS[a]

Fraction	Matrix Spike Compound	Water[b]	Soil/Sediment[b]
VOA	1,1-Dichloroethene	61-145	59-172
VOA	Trichloroethene	71-120	62-137
VOA	Chlorobenzene	75-130	60-133
VOA	Toluene	76-125	59-139
VOA	Benzene	76-127	66-142
BN	1,2,4-Trichlorobenzene	39-98	39-107
BN	Acenaphthene	46-118	31-137
BN	2,4-Dinitrotoluene	24-96	28-89
BN	Pyrene	26-127	35-142
BN	N-Nitro-Di-n-Propylamine	41-116	41-126
BN	1,4-Dichlorobenzene	36-97	28-104
Acid	Pentachlorophenol	9-103	17-109
Acid	Phenol	12-89	26-90
Acid	2-Chlorophenol	27-123	25-102
Acid	4-Chloro-3-Methylphenol	23-97	26-103
Acid	4-Nitrophenol	10-80	11-114

[a]U.S. EPA CLP Quality Control Measures and Control Limits as taken from Statement of Work, 7/85.

[b]These limits are for advisory purposes only. They are not to be used to determine if a sample should be reanalyzed. When sufficient multi-lab data are available, standard limits will be calculated.

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TABLE 5.2 Quality Control Measures - Inorganic*

INITIAL AND CONTINUING CALIBRATION VERIFICATION

Analytical Method	Inorganic Species	% of True Value (EPA Set) Low Limit	High Limit
ICP/AA	Metals	90	110
Other	TOC, COD	85	115

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Table 5.2 Digestion Spike Recovery

Compound	Control Limit %R
Metals	75-125[a]
Conventional Pollutants	75-125

[a]Quality Control Measures and Control Limits as taken from U.S. EPA CLP Statement of Work, 7/85.

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6. SAMPLING PROCEDURES

CAA does not expect to perform sampling. If sample collection should be required, quality control procedures will be provided as a revision to this QA plan.

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7. SAMPLE CUSTODY

7.1 Chain-of-Custody Procedures

The purpose of the chain-of-custody procedure is to document in a legally defensible manner, the transfer of custody for each sample from collection through analysis to analytical data reports. The sample custody procedures to be used conform to the guidelines of the U.S. EPA Contract Laboratory Program, and are performed under the supervision of the sample coordinator and the document control/data manager. The sample coordinator will have primary responsibility for ensuring chain-of-custody procedures are followed and all documentation is properly executed.

When samples arrive at CAA, the sample coordinator documents the condition of the locked or sealed shipping box on the custody form. She then checks the sample label information (Figure 7.1) against the custody record, and traffic report forms and notes the conditions of the samples and verifies proper container and preservative procedures as noted in Table 7.1. Samples are then logged in by assigning laboratory identification numbers in serialized ascending sequence. The sample log-in record will include the sample number, date of receipt, condition of sample when received, the assigned laboratory number, sample preparation, sample distribution and other pertinent information. A sample distribution sheet will be generated. Samples will then be secured in a refrigerator maintained at approximately 4°C prior to preparation and analysis. Analysts will sign for the receipt of all samples to be processed and maintain the samples in their possession or in view at all times when the samples are outside of the storage area. At all times when custody is transferred, both the issuing and receiving parties will verify that information in the sample label is properly recorded.

7.2 Laboratory Document Control

The goal of the Document Control Program is to assure that all documents for a group of samples will be accounted for when the project is completed.

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All observations and results recorded by CAA, are entered into pre-printed data sheets or into permanent laboratory logbooks. Data recorded are referenced with the project number, date and analyst's signature at the top of the page. All pertinent data are maintained in the project file.

All documentation in logbooks and other documents are entered in ink. If an error is made in a logbook assigned to one individual, that person will make corrections simply by crossing a line through the error crossing a line through the error then initially and dating it. The correct information is then entered. Changes made subsequently are dated and initialed. Corrections made to other data records or logbooks are made by crossing a single line through the error, entering the correct information and initialing and dating the correction.

Before releasing analytical results, the laboratory assembles and cross checks the information of custody records, lab bench sheets, analyst and instrument logs and other relevant data to ensure that data pertaining to each particular sample is consistent throughout the record.

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Cambridge Analytical Associates
1106 Commonwealth Ave., Boston, MA 02215
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CHEMICAL ANALYSES:

SAMPLE DATA:
Client _____
Project/Site _____
Date/Time _____
Sample ID _____
Location _____
Collector _____

PRESERVATIVE:
____ None ____ Sterile
____ HNO_3 ____ MeOH
____ H_2SO_4 ____ $MeCl_2$
____ ZnAc/NaOH ____ Other
____ NaOH (specify)

Figure 7.1
Sample Bottle Label

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Table 7.1 Recommendations for Sampling and Preservation of Samples[1]

Parameter	Minimum Volume Required (ml)	Container[2]	Preservation[3]	Holding[4] Time
Total Metals	600	P	HNO_3 to pH <2	6 mon.
TOC, COD	1000	P,G	Cool, 4°C, H_2SO_4 to pH <2	28 days
Extractables	1000	G, Teflon	Cool, 4°C	7 days until extraction. Analysis 40 days after extraction.
Trin	1000	G, Teflon	Cool, 4°C	7 days until extraction. Analysis 40 days after extraction.
Volatile Organics	2 x 40 ml	G, Teflon lined septum	HCl to pH≤2 Cool, 4°C	14 days for water; 10 days for soil.

NOTES

[1]More specific instruction are contained in each method.

[2]Plastic (P) or Glass (G) for metals, polyethylene with a polypropylene cap (no liner) is preferred.

[3]Sample Preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, samples may be preserved by maintaining at 4°C until compositing and sample splitting are complete.

[4]Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held from date of collection before analysis and still be considered valid.

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0. CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration procedures and frequency for the instrumentation which will be used in the determination of the parameters of interest. All materials used for instrument calibration, internal standards and surrogate standards will be of the highest purity available and will be obtained through the U.S. Environmental Protection Agency Pesticide and Industrial Chemicals Repository or a suitable commercial source. The calibration procedures presented here are those routinely used in the laboratory.

0.1 Gas Chromatography/Mass Spectrometer

0.1.1 Calibration Standards

1. Prepare stock solutions using materials available from the EPA Reference Standards Repository.

2. Prepare working standards by dilution of the stock standards.

3. Verify the working standards by analysis of a calibration check standard prepared using either EPA QC concentrates or other independent standard.

0.1.2 Calibration Procedure

1. At the beginning of each day that analyses are performed using Method 624/0240, the GC/MS system must be checked to verify that acceptable performance criteria are obtained for bromofluorobenzene (BFB). The performance test must be passed before analyzing any samples, blanks or standards.

2. On each day that Method 625/0270 analyses are performed, the GC/MS system must be checked to see if acceptable performance criteria are achieved for DFTPP. The performance criteria must be achieved before any samples, blanks or standards are analyzed.

3. Prior to the analysis of samples and after tuning criteria have been met, analyze a quality control check standard prepared using an EPA quality control concentrate. If the precision and accuracy data do not meet the criteria stated in the analytical method, the source of the problem must be located and the problem corrected before sample analysis can proceed. Calibration must be verified every twelve hours.

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4. Record all values for the initial and subsequent calibration verifications.

8.2 Gas Chromatography

8.2.1 Calibration Standards

1. Prepare stock solutions using materials available from the EPA Reference Standards Repository.

2. Prepare working standards by dilution of the stock standards.

3. Verify the working standards by analysis of a calibration check standard prepared using either EPA QC concentrates or other independent standard.

8.2.2 Calibration Procedure

1. At the beginning of each day, calibrate the instrument using a minimum of three standards each of a different concentration. Using peak height or area response versus standard concentration, calculate the linearity of the instrument where the percent standard deviation is less than or equal to ten percent for each compound on the primary column.

2. Calculate the average response factor for each compound. The maximum percent relative standard deviation permitted for the primary column is 15% and 20% for the confirming column. The calibration curve must be checked on each working day.

3. Analyze a quality control check standard prepared using an EPA quality control concentrate. If the precision and accuracy fail to meet the criteria stated in the analytical method, the source of the problem must be located and the problem corrected before sample analysis can proceed.

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4. Record all values for the initial and subsequent calibration verifications.

8.3 Inductively Coupled Argon Plasma Emission Spectrometer

8.3.1 Calibration Standards

1. Prepare calibration standards by dilution of the stock standard.

2. The calibration standards are prepared using the same type of acid or combination of acids as the sample will have after preparation.

8.3.2 Calibration Procedure

1. At the beginning of each day, calibrate the instrument using a blank and a standard.

2. After the system is calibrated, verify and document the initial calibration for each element of interest using an EPA Quality Control concentrate. If an EPA certified solution is not available an independent standard at a concentration other than that used for calibration but within the linear range can be used.

3. If the reported values for the calibration check sample exceed the control limits, the analysis is terminated and the problem corrected. Then return to Step 1.

4. To assure calibration accuracy throughout each analysis run, the calibration check standard must be analyzed at a frequency of 10% or every 2 hours during an analysis run, whichever is

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more frequent. The calibration check sample is also analyzed after the last analytical sample. If the calibration check sample is outside the control limits, the analysis must be terminated and the instrument recalibrated. All samples analyzed since the last time the calibration check was in control must be reanalyzed.

5. Record all values for the initial and subsequent calibration verifications.

8.4 Atomic Absorption Spectrophotometer

8.4.1 Calibration Standards

1. Prepare calibration standards by dilution of the stock standard.

2. The calibration standards are prepared using the same type of acid or combination of acids as the sample will have after preparation.

8.4.2 Calibration Procedure

1. At the beginning of each day, calibrate the instrument beginning with the blank and three standards of differing concentration, working toward the highest concentration standard.

2. After the system is calibrated, verify and document the initial calibration for each element of interest using an EPA Quality Control concentrate. If an EPA certified solution is not available, an independent standard at a concentration other than that used for calibration but within the calibration range can be used.

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3. If the reported values for the calibration check sample exceed the control limits, the analysis is terminated and the problem corrected.

4. To assure calibration accuracy throughout each analysis run, the calibration check standard must be analyzed at a frequency of 10% or every 2 hours during an analysis run, whichever is more frequent. The calibration check sample is also analyzed after the last analytical sample. If the calibration check sample is outside the control limits, the analysis must be terminated and the instrument recalibrated. All samples analyzed since the last time the calibration check was in control must be reanalyzed.

5. Record all values for the initial and subsequent calibration verifications.

8.5 Technician Autoanalyzer II

8.5.1 Calibration Standards

1. Prepare the calibration standards by dilution of the stock standard at the time of analysis. Calibrate the instrument using a blank and a minimum of three standards.

2. Prepare the standards in the same manner as samples using the same combination of reagents at the same concentration as that which the sample will have after preparation.

8.5.2 Calibration Procedure

1. At the beginning of each day, calibrate the instrument beginning with the blank and 3 standards of differing concentration, working toward the highest concentration

If the page filmed on this frame is not as readable or legible as this label, it is due to substandard color or condition of the original page.

2. After the system is calibrated, verify and document the initial calibration using an EPA Quality control concentrate. If an EPA certified solution is not available an independent standard at a concentration other than that used for calibration but within the calibration range can be used.

3. If the reported values for the calibration check sample exceed the control limits, the analysis is terminated and the problem corrected.

4. To assure calibration accuracy throughout each analysis run, the calibration check must be analyzed at a frequency of 10% or every 2 hours during an analysis run, whichever is more frequent. The calibration check sample is also analyzed after the last analytical sample. If the calibration check sample is outside the control limits, the analysis must be terminated and the instrument recalibrated. All samples analyzed since the last time the calibration check was in control must be reanalyzed.

8.6 Dohrmann DC80 TOC Analyzer

8.6.1 Calibration Standards

1. Prepare the calibration standards by dilution of the stock standard at time of analysis. Calibrate the instrument using a standard at 10,400, or 2000 ppm as appropriate for operating range.

2. Prepare the standards in the same manner as samples using the same combination of reagents at the same concentration as that which the sample will have after preparation.

300.3

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8.6.2 Calibration Procedure

1. At the beginning of each day, calibrate the instrument in accordance with the manufacturers' instructions.

2. After the system is calibrated, verify and document the initial calibration using an EPA Quality Control concentrate. If an EPA certified solution is not available an independent standard at a concentration other than that used for calibration but within the calibration range can be used.

3. If the reported values for the calibration check sample exceed the control limits, the analysis is terminated and the problem corrected.

4. To assure calibration accuracy throughout each analysis run, the calibration check must be analyzed at a frequency of 10% or every 2 hours during an analysis run, whichever is more frequent. The calibration check sample is also analyzed after the last analytical sample. If the calibration check sample is outside the control limits, the analysis must be terminated and the instrument recalibrated. All samples analyzed since the last time the calibration check was in control must be reanalyzed.

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9. ANALYTICAL PROCEDURES

The analytical procedures to be used in this project are contained in the EPA Organic Statement of Work (SOW) 7/85 and the Inorganic SOW 7/85, except where noted. These methods are summarized in Table 9.1 for organic parameters and Table 9.2 for inorganic parameters.

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Table 9.1 Summary of Organic Analytical Methods

Constituent	Method Reference	Method Description
Volatile Organic Compounds	US EPA, 1985 (1)	Purge and trap, gas chromatography/mass spectrometry
Semivolatile Organics-Acid/Base/Neutral Extractables	US EPA, 1985 (1)	Solvent extraction, gas chromatography/mass spectrometry
Tris	US EPA, 1985 (1)	Solvent extraction, gas chromatography/electron capture detection

(1) U.S. EPA. 1985. US EPA Contract Laboratory Program Statement of Work for Organics Analysis - Multi-Media, Multi-Concentration. Revised 7/85. U.S. EPA, Washington, D.C.

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Table 9.2. Summary of Inorganic Analytical Methods

Constituent	Method Reference	Method Description
Sample Preparation	Furnace Digestion (2) ICP/Flame AA Digestion Procedure Sediments, Sludges and Soils Digestion Procedure	Acid-digestion
Metals-Aqueous/Solids	As specified below	
Iron	US EPA 1985 (2)	Inductively Coupled Argon Plasma Emission Spectroscopy (ICP)
Manganese	U.S. EPA 1985 (2)	ICP

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Table 9.2 (Cont'd) Summary of Inorganic Analytical Methods

Constituent	Method Reference	Method Description
COD	Method 410.1 (1)	Titrimetric
TOC	Method 415.2 (1)	Persulfate oxidation, UV Promoted
%Percent Solids	US EPA 1985 (2)	Weight difference

(1) U.S. EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020 (Revised, March 1983). EPA/EMSL, Cincinnati, Ohio.
(2) U.S. EPA. 1985. Inorganic Analysis Multi-media Multi-concentration. SOW 785 (Based on: Caucus Inorganic Protocol)

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10. DATA REDUCTION, VALIDATION, AND REPORTING

10.1 Data Reduction

Analysis results will be reduced to the concentration units specified in the analytical procedures using the equations provided in the analytical procedure. All calculations will be independently checked by senior laboratory staff.

10.2 Data Validation

Data validation is the process by which analytical data are filtered and accepted or rejected based on a set of criteria. CAA personnel use the following criteria in the validation of laboratory data:

- o use of published or approved analytical procedures
- o use of properly operating and calibrated instrumentation
- o precision and accuracy achieved comparable to that achieved in similar analytical programs
- o completeness of data set.

Records of all data will be maintained, even those judged to be "outlying" values. Outliers will be identified using Dixon's test[1,1] for extreme observations or the one-tailed t-test for difference. The persons validating the data will have sufficient knowledge of the technical work to identify questionable values. All analyses requiring CLP protocols will be validated in accordance with the requirements of those protocols.

10.3 Data Reporting

Figure 10-1 depicts the analytical data reduction, validation and reporting process. Key personnel who will handle data gathering and evaluation are shown in the Project Organization Chart (Figure 4-1).

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To report the data, forms from both the organic and inorganic SOW 785 protocols are used. The data packages are compiled and each page is serially numbered. Each data package includes:

- o sample results
- o QC results
- o initial and continuing calibration results
- o blank results
- o laboratory duplicate results
- o matrix and surrogate spike %recoveries
- o detection limit information
- o holding time information
- o all raw data generated for the project
- o traffic reports

All raw data generated by Cambridge Analytical Associates will be stored in a secure facility for a six year period. At the end of this six year period EEM will be notified to determine if disposal of raw data can occur at that time.

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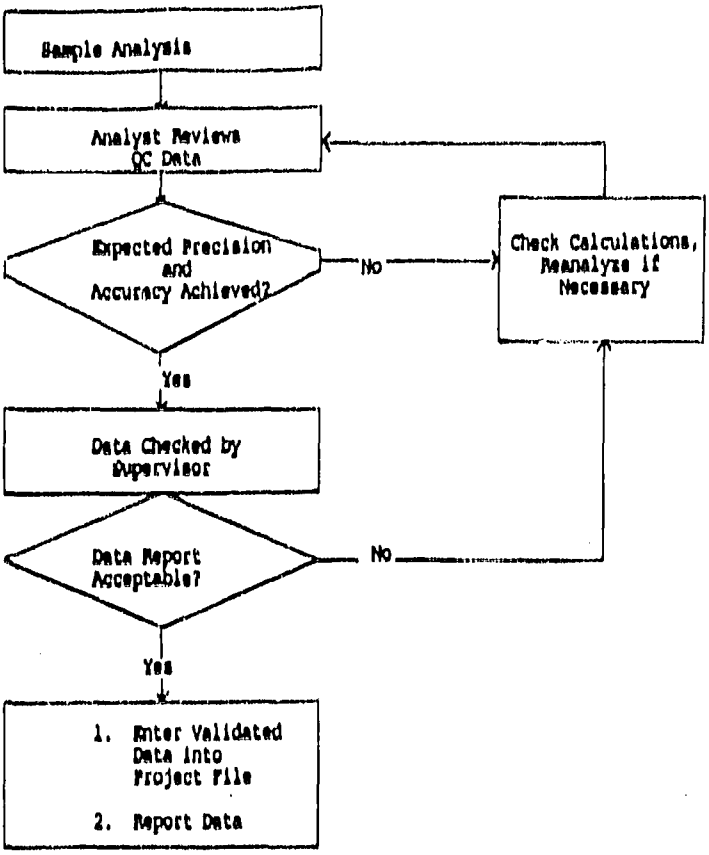

Figure 10-1. CAA Analytical Data Reporting Scheme

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Sample Number

Organics Analysis Data Sheet
(Page 1)

Laboratory Name _____ Case No _____

Lab Sample ID No _____ QC Report No _____

Sample Matrix _____ Contract No _____

Date Release Authorized By _____ Date Sample Received _____

Volatile Compounds

Concentration Low Medium (Circle One)

Date Extracted/Prepared _____

Date Analyzed _____

Conc/Dil Factor _____ pH _____

Percent Moisture (Not Decanted) _____

CAS Number		ug/l or ug/kg (Circle One)
74-87-3	Chloromethane	
74-83-9	Bromomethane	
75-01-4	Vinyl Chloride	
75-00-3	Chloroethane	
75-09-2	Methylene Chloride	
67-64-1	Acetone	
75-15-0	Carbon Disulfide	
75-35-4	1,1-Dichloroethene	
75-34-3	1,1-Dichloroethane	
156-60-5	Trans-1,2-Dichloroethene	
67-66-3	Chloroform	
107-06-2	1,2-Dichloroethane	
78-93-3	2-Butanone	
71-55-6	1,1,1-Trichloroethane	
56-23-5	Carbon Tetrachloride	
108-05-4	Vinyl Acetate	
75-27-4	Bromodichloromethane	

CAS Number		ug/l or ug/kg (Circle One)
78-87-5	1,2-Dichloropropane	
10061-01-5	Trans-1,3-Dichloropropene	
79-01-6	Trichloroethene	
124-48-1	Dibromochloromethane	
79-00-5	1,1,2-Trichloroethane	
71-43-2	Benzene	
10061-02-6	Cis-1,3-Dichloropropene	
110-75-8	2-Chloroethyl vinyl ether	
75-25-2	Bromoform	
591-78-6	2-Hexanone / Pentanone	
108-10-1	4-Methyl-2-Pentanone	
127-18-4	Tetrachloroethene	
79-34-5	1,1,2,2-Tetrachloroethane	
108-88-3	Toluene	
108-90-7	Chlorobenzene	
100-41-4	Ethylbenzene	
100-42-5	Styrene	
	Total Xylenes	

Data Reporting Qualifiers

For reporting results to EPA, the following results qualifiers are used. Laboratories may be reporting analytical results on a standard form. The definitions of each flag should be included.

Value: If the result is a value greater than or equal to the detection limit report the value.

U: Indicates compounds were analyzed for but not detected. Report the sample quantitation limit for the sample with a U (10U) based on the reporting quantitation limit. Blanks do not substitute for the reporting quantitation limit. The laboratory should use the (percentage) and volumes to find the reporting limit. The Agency's CLP quantitation limits represent the lowest for the sample.

J: Indicates an estimated value. This flag is used if: "GC/MS QC criteria are met, but the value is below the lowest calibration standard (10 ug/l or 10 ug/kg, respectively) or if the value is greater than the lowest calibration standard but the quality control criteria are not met.

E: This flag applies to organic compounds whose concentration exceeds the calibration range of the GC/MS instrument. Dilute the sample and reanalyze to get a value within the calibration range.

B: This flag is used when the analyte is found in the blank as well as the sample. It indicates possible/probable blank contamination and warns the data user to take extra care in the data interpretation.

Other: Other qualifiers may be used to describe data that have been rejected or qualified for other reasons. Define these qualifiers in the data summary report.

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Figure 10.2 Organic Form 1 (Page 1)

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Sample Number

Laboratory Name _____

Case No _____

Organics Analysis Data Sheet
(Page 2)

Semivolatile Compounds

Concentration Low Medium (Circle One)

Date Extracted/Prepared _____

Date Analyzed _____

Conc/Dil Factor _____

Percent Moisture (Decanted) _____

GPC Cleanup ☐Yes ☐No

Separatory Funnel Extraction ☐Yes

Continuous Liquid - Liquid Extraction ☐Yes

CAS Number		ug/l or ug/kg (Circle One)
108-95-2	Phenol	
111-44-4	bis(2-Chloroethyl)Ether	
95-57-8	2-Chlorophenol	
541-73-1	1,3-Dichlorobenzene	
106-46-7	1,4-Dichlorobenzene	
100-51-6	Benzyl Alcohol	
95-50-1	1,2-Dichlorobenzene	
95-48-7	2-Methylphenol	
108-60-1	bis(2-Chloroisopropyl)Ether	
106-44-5	4-Methylphenol	
621-64-7	N-Nitroso-Di-n-Propylamine	
67-72-1	Hexachloroethane	
98-95-3	Nitrobenzene	
78-59-1	Isophorone	
88-75-5	2-Nitrophenol	
105-67-9	2,4-Dimethylphenol	
65-85-0	Benzoic Acid	
111-91-1	bis(2-Chloroethoxy)Methane	
120-83-2	2,4-Dichlorophenol	
120-82-1	1,2,4-Trichlorobenzene	
91-20-3	Naphthalene	
106-47-8	4-Chloroaniline	
87-68-3	Hexachlorobutadiene	
59-50-7	4-Chloro-3-Methylphenol	
91-57-6	2-Methylnaphthalene	
77-47-4	Hexachlorocyclopentadiene	
88-06-2	2,4,6-Trichlorophenol	
95-95-4	2,4,5-Trichlorophenol	
91-58-7	2-Chloronaphthalene	
88-74-4	2-Nitroaniline	
131-11-3	Dimethyl Phthalate	
208-96-8	Acenaphthylene	
99-09-2	3-Nitroaniline	

CAS Number		ug/l or ug/kg (Circle One)
83-32-9	Acenaphthene	
51-28-5	2,4-Dinitrophenol	
100-02-7	4-Nitrophenol	
132-64-9	Dibenzofuran	
121-14-2	2,4-Dinitrotoluene	
606-20-2	2,6-Dinitrotoluene	
84-66-2	Diethylphthalate	
7005-72-3	4-Chlorophenyl-phenylether	
86-73-7	Fluorene	
100-01-6	4-Nitroaniline	
534-52-1	4,6-Dinitro-2-Methylphenol	
86-30-6	N-Nitrosodiphenylamine(1)	
101-55-3	4-Bromophenyl-phenylether	
118-74-1	Hexachlorobenzene	
87-86-5	Pentachlorophenol	
85-01-8	Phenanthrene	
120-12-7	Anthracene	
84-74-2	Di-n-Butylphthalate	
206-44-0	Fluoranthene	
129-00-0	Pyrene	
85-68-7	Butylbenzylphthalate	
91-94-1	3,3'-Dichlorobenzidine	
56-55-3	Benzo(a)Anthracene	
117-81-7	bis(2-Ethylhexyl)Phthalate	
218-01-9	Chrysene	
117-84-0	Di-n-Octyl Phthalate	
205-99-2	Benzo(b)Fluoranthene	
207-08-9	Benzo(k)Fluoranthene	
50-32-8	Benzo(a)Pyrene	
193-39-5	Indeno(1,2,3-cd)Pyrene	
53-70-3	Dibenzo(a,h)Anthracene	
191-24-2	Benzo(g,h,i)Perylene	

(1) Cannot be separated from Diphenylamine

Form 1

7/85

300292

Figure 10.2 Organic Form 1 (Page 2)

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Sample Number

Laboratory Name _____

Case No _____

Organics Analysis Data Sheet
(Page 3)

Pesticide/PCBs

Concentration Low Medium (Circle One)

Date Extracted/Prepared _____

Date Analyzed _____

Cont/Dil Factor _____

Percent Moisture (decanted) _____

GPC Cleanup ☐Yes ☐No

Separatory Funnel Extraction ☐Yes

Continuous Liquid - Liquid Extraction ☐Yes

CAS Number		ug/l or ug/Kg (Circle One)
319-84-6	Alpha BHC	
319-85-7	Beta BHC	
319-86-8	Delta BHC	
58-89-9	Gamma BHC (Lindane)	
76-44-8	Heptachlor	
309-00-2	Aldrin	
1024-57-3	Heptachlor Epoxide	
959-98-8	Endosulfan I	
60-57-1	Dieldrin	
72-55-9	4,4'-DDE	
72-20-8	Endrin	
33213-65-9	Endosulfan II	
72-54-8	4,4'-DDD	
1031-07-8	Endosulfan Sulfate	
50-29-3	4,4'-DDT	
72-43-5	Methoxychlor	
53494-70-5	Endrin Ketone	
57-74-9	Chlordane	
8001-35-2	Toxaphene	
11096-82-5	Aroclor 1016	
11104-28-2	Aroclor 1221	
11141-16-5	Aroclor 1232	
53469-21-9	Aroclor 1242	
12672-29-6	Aroclor 1248	
11097-69-1	Aroclor 1254	
11096-82-5	Aroclor 1260	

V_t = Volume of extract injected (ul)

V_s = Volume of water extracted (ml)

W_s = Weight of sample extracted (g)

V_t = Volume of total extract (ul)

V_s _____ or W_s _____ V_t _____ V_t _____

Form I

Figure 10.2 Organic Form 1 (Page 3)

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Laboratory Name _____

Case No _____

Sample Number

Organics Analysis Data Sheet
(Page 4)

Tentatively Identified Compounds

CAS Number	Compound Name	Fraction	RT or Scan Number	Estimated Concentration (ug/l or ug/kg)
1.				
2				
3.				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
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26				
27				
28				
29				
30				

Form 1 Part B 7 85

Figure 10.2 Organic Form 1 (Page 4)

300599

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Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.

Date _____

INORGANIC ANALYSIS DATA SHEET

CASE NO. _____

LAB NAME _____

SOW NO. _____

QC REPORT NO. _____

LAB SAMPLE ID. NO. _____

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil _____ Sludge _____ Other _____

ug/L or ug/kg dry weight (Circle One)

1. Aluminum _____
2. Antimony _____
3. Arsenic _____
4. Barium _____
5. Beryllium _____
6. Cadmium _____
7. Calcium _____
8. Chromium _____
9. Cobalt _____
10. Copper _____
11. Iron _____
12. Lead _____
13. Magnesium _____
14. Manganese _____
15. Mercury _____
16. Nickel _____
17. Potassium _____
18. Selenium _____
19. Silver _____
20. Sodium _____
21. Thallium _____
22. Vanadium _____
23. Zinc _____

Cyanide _____

Percent Solids (%) _____

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explained and contained on Cover Page, however.

Comments: _____

Lab Manager _____

B - 8

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Figure 10.3 Inorganic Form I

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11. INTERNAL QUALITY CONTROL CHECK

Quality control is the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process. Quality control checks are the application of CAA's Quality Control program for laboratory analysis in order to ensure the generation of valid analytical results on project samples. These checks are performed by project participants throughout the program under the guidance of the QA Manager. They are to be performed as per CLP SOW 7/03 and CLP limits are to be adhered to.

CAA makes use of a number of different types of QC samples to document the validity of the generated data. The following types of QC samples are used routinely:

1. Blank Samples - Blanks are used to assess contamination introduced in transit, storage or in the laboratory.

   a. Laboratory Method Blanks - These samples are prepared in the laboratory, and analyzed in order to assess possible laboratory contamination.

   c. Laboratory Holding Blank - These blanks are placed in cold storage with the volatile organics samples during the holding time to assess contamination which may be introduced in storage.

   d. Calibration Blanks - For all analyses, these blanks are used in instrument calibration and contain all the reagents used in

300590

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preparing instrument calibration standards except the parameters of interest.

2. Initial and Continuing Calibration Verification - Verification samples are analyzed during analysis runs to assure calibration accuracy for each analyte.

3. Surrogate Spikes - For organic analyses, all samples are spiked with surrogate compounds prior to sample preparation in order to assess the behavior of actual components in individual samples during the entire preparative and analysis scheme.

4. Matrix Spikes/Analytical Spikes - For all analyses at frequencies particular to each method, samples are spiked with spiking solutions in order to evaluate any matrix effect of the samples on the analytical method.

5. Duplicate Samples - For all analyses, a second aliquot of a sample carried through all sample preparation and analysis procedures to verify the precision of the analytical method. At least one sample in each analysis batch of 20 or fewer samples is analyzed in duplicate.

6. Laboratory Control Samples - For inorganic analyses, at least one sample in each preparation batch of 20 or fewer samples is prepared and analyzed for each analyte of interest, in order to verify the preparation and analytical methods.

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The duplicate and spiked samples or reference materials may also be submitted as "blind" QC samples, those which are not recognizable to the analyst. Blind QC samples are prepared by the QA Department and inserted into the sample flow at the time samples are logged in.

Reagents used in the laboratory are normally of analytical reagent grade or higher purity. Each lot of acid or solvent received is checked for acceptability prior to lab use. All reagents are labeled with the date received and date opened. The quality of the laboratory deionized water is continuously monitored through the use of an in-line conductivity meter.

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12. SYSTEM AND PERFORMANCE AUDITS

12.1 System Audits

A system audit is an evaluation of the various components of a laboratory's measurement system to assess proper selection and use. This audit will consist of an on-site review of a laboratory's quality assurance systems and physical facilities for sampling, calibration and measurements. System audits are performed on a regular basis by the U.S. EPA as well as various state agencies. CAA will cooperate on all on-site external systems audits performed by Florida DER. The audit may include several or all of the components listed below:

- o Personnel, facilities and equipment
- o Chain-of-custody procedures
- o Instrument calibration and maintenance
- o Standards preparation and verification
- o Analytical procedures
- o Quality control procedures
- o Data handling procedures
- o Documentation control procedures

A copy of these audits will be submitted to the EPA Project Officer.

12.2 Performance Audits

Performance audits provide a systematic check of laboratory operations and measurement systems by comparing independently obtained data with routinely obtained data. CAA routinely participates in laboratory performance evaluations for the U.S. EPA as part of the Water Supply (WS) and Water Pollution (WP) programs. The laboratory also undergoes periodic audits by EPA as required by the Contract Laboratory Program which supports Superfund investigations and activities. In addition, CAA participates in numerous on-going state performance evaluations. The reports from these audits will be made available to the EPA Project Officer.

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13. PREVENTIVE MAINTENANCE

CAA follows a well-defined program to prevent the failure of laboratory equipment or instrumentation during use. This preventive maintenance and careful calibration help to assure accurate measurements from laboratory instruments. CAA also avoids any time delays during analyses due to unscheduled downtime by maintaining more than one instrument of each type in full working order.

Preventive maintenance procedures such as lubrication, source cleaning, detector cleaning and the frequency of such maintenance are performed according to the procedures delineated in the manufacturer's instrument manual. Chromatographic carrier gas purification traps, injector liners, and injector septa are cleaned or replaced on a regular basis. Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance must be performed when the instrument begins to degrade as evidenced by the degradation of peak resolution, shift in calibration curves, decreased sensitivity, or failure to meet one or another of the quality control criteria. The preventive maintenance performed on the major instrumentation which will be used is summarized in Table 13-1.

Instrument logbooks are maintained in the laboratories at all times. They contain records of usage, calibration, maintenance and repairs. Adequate supplies of spare parts such as GC columns, syringes, septa, injection port liners, and electronic parts are maintained in the laboratories so that they are available when needed.

300303

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Table 13.1 Maintenance Procedures and Schedule For Major Instrumentation

Instrument	Maintenance Procedure/Schedule	Spare Parts
Gas Chromatography/ Mass Spectrometry	1. Replace pump oils as needed 2. Change septa as needed 3. Change gas line dryers as needed 4. Replace electron multiplier as needed	1. Syringes 2. Septa 3. Various electronic components and 4. Plumbing supplies - tube fittings
Gas Chromatograph	1. Change septa as needed 2. Change gas line dryers as needed 3. Leak check when installing new analytical column 4. Periodically check inlet system for residue buildup	1. Syringes 2. Septa 3. Various electronic 4. Plumbing supplies - tube fittings
Inductively Coupled Argo Plasma Spectrometer	1. Clean torch assembly and mixing chamber when discolored or after 8 hours of running high dissolved solids samples.	1. Spare torch and 2. Spare coil
Purge and Trap Sample Concentrator	1. Replace trap as needed 2. Decontaminate system as required by blank analysis 3. Leak check system	1. Spare traps 2. Various electronic components and circuit boards 3. Plumbing supplies - tube supplies
Graphite Furnace Atomic Absorption Spectrophotometer	1. Change graphite contact rings as necessary 2. Change D_2 background correction lamp as necessary 3. Clean quartz windows as necessary	1. Contact rings 2. D_2 arc lamp
Spectroproducts Hg Analyzer	1. Clean tubing and quartz cell as necessary 2. Clean aspirator as necessary	1. Quartz cells 2. Aspirator
Technicon Autoanlyzer II	1. Inspect pump tubes after each 8-hr run; replace if discolored or distorted	1. Pump tubes, glass coil, flow cells
pH Meter	1. After use in solutions containing free oil and water, wash the electrode in soap and water and rinse thoroughly with water. Immerse the lower third of the electrode in 1+9 HCl for 10 minutes to remove any film formed. Rinse thoroughly with water. 2. Keep electrode properly filled with appropriate filling solution.	1. Filling solution
Total Organic Carbon Analyzer	1. Replace tubing as needed. 2. Replace injection septum after every 100 injections or when leakage is apparent. 3. Prepare fresh reagent daily. 4. Check scrubber daily, repack tube when tin is one-half consumed.	1. Tubing 2. Septa 3. 20 mesh granular ti

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14. SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

14.1 Precision

Precision is a measure of the degree of agreement between repeated measurements of the same parameter under prescribed, similar conditions. analytical precision will be monitored using results from duplicate analyses. The program analytical precision goals, expressed as relative percent difference (RPD), are presented in Table 1 in Section 5. The RPD is expressed as follows:

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \times 100$$

where RPD = Relative Percent Difference

D_1 = First Duplicate Value (percent recovery)

D_2 = Second Duplicate Value (percent recovery)

Percent relative standard deviation (%RSD) is used when calculating the precision of the calibration curve for GC/MS. The %RSD is expressed as follows:

$$\%RSD = \frac{SD}{\bar{X}} \times 100$$

Where %RSD = percent relative standard deviation

SD = standard deviation

$\bar{X}$ = mean of the initial calibration factors

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14.2 Accuracy

Accuracy is the degree of agreement between the true value of the parameter being measured and the observations made according to the test method. Accuracy will be evaluated by comparing the recovery of the parameters of interest against the goals established in Section 5 through the use of EPA Quality Control Samples or NBS Standard Reference Materials. The recovery of a compound will be defined as:

$$\text{Percent Recovery} = \frac{Q_d}{Q_a} \times 100\%$$

where Q_d = observed value; determined as per Methods indicated in Section 9, Analytical Procedures.

Q_a = true value

Accuracy criteria for this project are included in Table 5.1.

14.3 Completeness

Completeness is a measure of the amount of valid data obtained from the analytical measurement system. It is defined as the total amount of acceptable data divided by the total number of samples received multiplied by 100. The QA objective for this study is to obtain acceptable data for all of the samples received. The procedures in Section 10 of this QA Plan for validating data will be used to determine which data are acceptable. Completeness also implies the ability of the final report to answer the client's questions. CAA's scientists and engineers will be available to interpret the analytical reports and consult with the client to recommend future courses of action.

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$$C = 100 \frac{V}{T}$$

Where:

C = Percent completeness

V = Number of measurements judged valid

T = Total number of measurements

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15. CORRECTIVE ACTION

An important part of any quality assurance program is a well-defined effective policy for correcting quality problems. CAA maintains a closed-loop corrective action system which operates under the direction of the QA Director. While the entire quality assurance program is designed to avoid problems, it also serves to identify and correct those that may exist. Usually these quality problems fall into two categories, immediate corrective action or long-term corrective action.

Specific quality control procedures are designed to help analysts detect the need for corrective action. Often an analyst's experience will be most valuable in identifying suspicious data or malfunctioning equipment; immediate corrective action may then be taken. The actions should be noted in laboratory notebooks but no other formal documentation is required unless further corrective action is necessary.

The need for long-term action may be identified by standard QC procedures, control charts, performance or system audits. Any quality problem which cannot be solved by immediate corrective action falls into this long-term category. CAA uses a system to insure that the condition is reported to a person who is part of the closed-loop action and follow up plan.

The essential steps in the closed-loop corrective action system are:

a. The problem will be identified.

b. Responsibility for investigating the problem will be assigned.

c. The cause of the problem will be investigated and determined.

d. A corrective action to eliminate the problem will be determined.

e. Responsibility for implementing the corrective action will be assigned and accepted.

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f. The effectiveness of the corrective action will be established and the corrective action implemented.

g. The fact that the corrective action has eliminated the problem will be verified.

h. The complete process of establishing and implementing corrective action will be documented. The Corrective Action Request Form (Figure 15.1) serves to summarize all such documentation.

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Corrective Action Request Form No._____

Originator_____ Date_____

Person responsible for replying_____ Laboratory_____

Nature of Problem:

_____

_____

_____

Cause of Problem:

_____

_____

_____

Corrective Action Planned:

_____

_____

_____

Temporary action

Permanent action

Acceptance of Corrective Action

Approved By:_____

Record Distribution

Original: QC Coordinator
2nd copy: Originator
3rd copy: CAA file

Figure 15-1

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16. QUALITY ASSURANCE REPORT TO MANAGEMENT

In order to provide information to CAA's project manager on the performance of the quality assurance program for this project, the laboratory quality assurance coordinator will meet with the project manager, and task managers on a periodic basis to review quality control data summary documentation, and other pertinent information.

On a quarterly basis the Quality Assurance Director prepares reports to CAA's corporate management summarizing the performance of measurement systems and data quality. These reports will include:

- results of interlaboratory precision and accuracy studies;
- results of performance evaluation studies for ongoing or new contracts;
- summary results of blind internal QC test samples;
- an assessment of measurement data accuracy, precision and completeness;
- significant quality assurance problems and recommended solutions.

The results of the performance audits, data audits and corrective actions for this project will be forwarded to the EPA Project Officer.

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ATTACHMENT 2

STANDARD OPERATING PROCEDURES
FOR THE COLLECTION OF
ENVIRONMENTAL SAMPLES

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STANDARD OPERATING PROCEDURES FOR THE COLLECTION OF ENVIRONMENTAL SAMPLES

March 1986

Prepared By:

Environmental Resources Management, Inc.
999 West Chester Pike
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Revised: _____

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SECTION 1

INTRODUCTION

This document is Environmental Resources Management, Inc.'s (ERM) Standard Operating Procedures (SOPs) for the Collection of Environmental Samples, and includes procedures for collecting ground water, surface water, soil, sediment samples, and air samples. This document is intended to be an integral part of ERM's Quality Assurance/Quality Control project plans which also includes the following support documents: (1) the Site-Specific Project Work Plan, (2) Subcontract Laboratory Quality Control Plan, (3) Subcontract Laboratory Operations Manual, and (4) the Project Health and Safety Plan.

As much as possible, the procedures in this document have been standardized to make them applicable to all types of environmental investigations. It must be recognized, however, that under certain site specific conditions, all of the procedures discussed herein may not be appropriate. In such cases, it will be necessary to adapt the procedures given to the specific conditions of the investigation. To guarantee the timeliness of ERM's Standard Oerating Procedures, every six months this document will be reviewed and updated as necessary. Dates of review will be listed on the front cover and amendment on each individual page. All ERM employees are invited to comment on these Standard Operating Procedures and to submit their comments in writing to the company Quality Assurance Coordinator.

This document is divided into four major sections: (1) preparation of a project sampling plan; (2) procedures for the collection of environmental samples; (3) post-sampling procedures; and (4) sample packaging, shipping, chain-of-custody.

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SECTION 2

PREPARATION OF A PROJECT SAMPLING PLAN

Prior to the collection of environmental samples, it is necessary to prepare a project sampling plan which is site-specific. This will require determination of the following: (1) the objectives of the sampling program, (2) the media to be sampled, (3) the sampling locations, and (4) the analyses to be conducted. Predetermination of these items will result in the design and performance of a cost-effective and technically feasible sampling plan.

The three basic objectives of a sampling plan are the following: (1) determine the presence or absence of contamination, (2) determine the extent and magnitude of contamination, and (3) determine the contaminant pathways which may exist at a site. Each of these will greatly affect the sampling plan as each will subsequently affect the determination of the media to be sampled, the sampling locations, and the analyses to be conducted.

The second step in developing a sampling plan is the determination of the media to be sampled at a particular site. This may include the collection of surface and ground water samples, stream sediment samples, leachate springs or seeps, soil or rock samples, or air samples. Again, the materials to be sampled will be greatly affected by the objectives of the sampling.

The third step is to determine the sampling locations. In addition, it is necessary that the justifications for the selection of the sampling locations be detailed along with the intended use of the data.

The fourth step is to determine exactly what analysis will be conducted. The constituents analyzed are usually selected for several reasons. These are: (1) required by regulations; (2) considered to be toxic and present at the site or there is an indication of their presence at the site; (3) indicators of contamination which may not be toxic; and (4) site-specific constituents or those constituents known to be present at the site whether toxic or non-toxic.

All of the above factors will be dependent upon the work to be conducted at the site, whether it be a site investigation, feasibility study, and/or remedial design. In order to make informed decisions as to the above considerations, it is mandatory that all available background data on the site be collected

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and reviewed. Using this information, a detailed site-specific sampling plan for the investigation can be proposed. The plan must include a checklist of all equipment which will be needed during the sampling and a detailed discussion of all procedures to be used. As stated previously, the following sections will detail ERM's Standard Operating Procedures for the collection of environmental samples. These are to be used where applicable in the development and performance of the sampling plan.

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SECTION 3

PROCEDURES FOR THE COLLECTION OF ENVIRONMENTAL SAMPLES

The following discussion of sampling procedures for the collection of environmental samples is divided into five sections. These sections include procedures for the collection of (1) ground water, (2) surface water, (3) sediment, (4) soil samples, and (5) air samples.

3.1 Ground Water Sampling

There are two types of wells from which ground water samples may be obtained; monitoring wells or residential wells and municipal wells. Sampling from each of these will require the collection of different types of presampling information and sampling equipment, as well as different sampling procedures. Since sampling from monitoring wells is by far the most complex, it will be addressed first. The sampling of monitoring wells is further divided into three subsections: (1) preparation for sampling, (2) well evacuation, and (3) sample collection.

3.1.1 Monitoring Wells

3.1.1.1 Preparation for Sampling

Prior to going to a site, it is important to know the specifics of well construction, including: inside diameter of the well casing, total depth of the well, depth to the screened portion of the well, screen length, and the material used in the construction of the well and well screen. The diameter of the well casing is most important as it will directly affect the equipment and procedures to be used during well evacuation and sampling. The majority of the wells used only for monitoring have two-inch inside diameter casings, however, some older wells may have inside diameters of less than two inches. In many cases where ground water recovery may be a viable option for remediation of a contamination problem, wells with either four-, six-, or eight-inch inside diameter casings may have been installed. It is also important to know the accessibility of the wells. This may affect the selection of the sampling equipment to be used or, at a minimum, the procedure for getting the equipment to the well location. Prior to sampling, locate all the wells on a site map

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and determine the order in which each well will be sampled. If the water quality information is available, the order of well samples should be from least contaminated to most contaminated. Direction of anticipated or known ground water flow can be used to determine sampling order where no chemical data are available. Wells upgradient of the source area should be sampled first, then proceed from wells farthest downgradient and work towards the source area.

The following is a list of equipment which may be needed when evacuating and sampling monitoring wells:

- Material for sample preparation (see Section 4.2).
- Reagents for sample preservation (see Section 4.3).
- Appropriate sample containers (see Section 4.4).
- Meters, probes, and standards for field measurements (see Section 4.5).
- Appropriate field and transportation blanks. The type and number of blanks should be established with the laboratory conducting the analysis.
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Keys. Many monitoring wells will have locking caps and keys will be necessary to gain access. In addition, some sites may be secured or may have a guard on duty, in which case keys and/or permission may be necessary.
- Tools to assist in well access. These may include screw drivers, hammers, chisels, pipe wrenches, or possibly a propane torch. All or any of these may be necessary for removing steel security caps on wells which have not been recently opened.
- Tape measure graduated in tenths and hundredths of feet. A tape measure may be useful for measuring the diameter of the well casing and the elevation of the well casing above ground level.
- Electronic water level indicator/graduated depth sounder. These may be necessary for determining the static water level and the total depth of the well if it is unknown.

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- Pocket calculator. This may be used for determining the volume of water within the well which, in turn, will be used for calculating the volume of water to be evacuated.

- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and observations on the environmental conditions at the time of sampling.

- Well evacuation equipment. In general a pump will be used to purge or evacuate stagnant water in the well prior to obtaining the sample (per Section 3.1.1.2). The size and capacity of the pump to be used will depend upon the inside diameter of the well casing, the depth to water, total depth of the well, well yield, and the volume of water to be removed. In some cases it may be necessary to use a bailer for well evacuation. ERM recommends that the following equipment be used for well evacuation when applicable.

  - For two-inch diameter wells where the depth to water is greater than 25 feet; an Isco Model No. 2600 diaphragm-type pump should be used for well evacuation.

  - For any well with an inside diameter of 2 inches or greater and where the water level in the well will remain above 25 feet; a self-priming centrifugal pump should be used. A gate value may be necessary to adjust the pumping rate so that the level of water in the well can be maintained above 25 feet. The ease of decontamination for this equipment makes it the first choice for evacuation.

  - A small-diameter bailer may be used to evacuate two-inch wells with a low volume of water needed to be purged from the well.

  - For large-diameter wells (4 inches or greater) where the depth to water is below 25 feet, a large-diameter, impellor-type, submersible pump will be required for evacuation. Great caution

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must be taken when using this pump as it can be very difficult to decontaminate compared to the other pumps used for evacuation.

- A dry inert gas or compressed air regulator. This is needed to activate the Isco 2600 pump. Nitrogen gas is recommended. Argon gas or compressed air can be used as an alternative.

- Bottom loading PVC, stainless steel, or Teflon bailer. The bailer will be used to obtain the ground water sample after the well has been evacuated. The choice of the material in bailer construction will depend on the site-specific characteristics.

- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the ground water or contaminated materials (see Section 5.1).

- Buckets, scrub brushes, and sponges will be needed during cleaning of all contaminated material (see Section 4.1).

- Buckets and/or graduated plastic pails. These will be used for measuring the flow rate and volume of water evacuated from the well prior to sampling and also for containment of potentially contaminated water until it can be properly disposed of if required by the investigation. A low-flow, totalizing meter can be used where necessary.

- Camera/film. These may be required for documenting sampling procedures and well locations.

After assembling all of the required sampling equipment, be sure that it is in working order, and has been decontaminated.

3.1.1.2 Well Evacuation

Prior to evacuating the well, it will be necessary to determine the volume of water being held in the well casing. The calculation of the well volume should be conducted as follows:

1. Measure well casing inside diameter.

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2. Determine the static water level. This should be measured to the nearest one-hundredth of a foot below the measuring point elevation. The top of the well casing should be used as the measuring point and marked to standardize its location. (Note: The water indicator must be cleaned before use in each well.)

3. Determine the total depth of the well from the measuring point.

4. Calculate the number of linear feet of static water (total depth of the well minus the static water level).

5. Calculate the static volume in gallons ($\pi r^2 h \times 7.48$ gal/ft^3).

   where:

   π = 3.14
   r = radius of well in feet
   h = number of linear feet of static water

It is ERM's policy that three well volumes be removed prior to sample collection. In most cases, removal of three well volumes should insure the collection of a representative sample not influenced by stagnant water remaining in the well casing, and yet not result in overpumping of the well. The latter can result in pulling diluted or more concentrated ground water from another area within the aquifer. If the well goes dry, during evacuation allow it to recover and re-evacuate until at least one and one-half (1-1/2) volumes are purged.

Before evacuating the well, the depth at which to place the pump in the well must be determined. In high-yielding wells the pump should be placed near the top of the water column rather than in the screened area. This forces water to move up the well casing to the pump; otherwise, water may be removed from the formation only and water standing in the well above the screen may not be evacuated. This will not occur though if the pumping rate is high enough to cause significant well drawdown. Most diaphragm-type pumps for small-diameter wells are not capable of flows greater than one and one-half (1-1/2) gallons per minute. Therefore, this problem is greater in high-yielding, small-diameter wells. If well yield is low to moderate, the pumps should be placed at the bottom of the screened interval. The flow rate of the pumps may be measured using a graduated plastic bucket, or a totalizing flow meter in the case of submersible pumps.

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The sample must not be obtained from the pump or bailer used to purge the well. Furthermore, any hose coming in contact with the ground water must be decontaminated before use in the next well to avoid the possibility of cross-contamination. Cross-contamination can be avoided if the rope and the hose used during well evacuation is dedicated to each particular well and decontaminated between each use in that particular well. If this is not feasible, the rope and hose should be decontaminated between use in each well at the site.

3.1.1.3 Sample Acquisition

The following procedure is recommended for obtaining ground water samples from monitoring wells:

- If a pump has been used to purge the well, the hose, rope, and pump must be removed from the well and decontaminated and/or stored in an appropriately labeled container if each is to be dedicated to the particular well. The pump used for evacuation must be dismantled and cleaned, if necessary.

- If a bailer has been used to purge the well, a previously cleaned second bailer must be used to obtain the sample.

- The bailer used for collecting the sample should be lowered into the well, retrieved, and emptied to insure that the bailer is only in contact with water in the well.

- When collecting the ground water needed for filling the sample bottles, the bailer should be gently lowered sufficiently into the water column to collect or sample unaffected by equilibration with the atmosphere (approximately ten feet, if possible), jerked gently to insure the ball valve is closed, and retrieved at a steady rate to the surface.

- When transferring the water from the bailer to the sample containers, care must be taken to avoid agitation to the sample which will promote the loss of volatile constituents, and promote chemical oxidation.

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- If a bailer is not dedicated to a specific well, it must be cleaned between wells. Procedures for cleaning of equipment are given in Section 4.1. Again, all equipment and materials coming into contact with the inside casing of the wells or the ground water must be cleaned.

The geochemistry of ground water is such that exposure of ground water samples to atmospheric conditions can result in substantial loss of sample integrity. Therefore, it is necessary that immediately after collection, the samples are prepared, preserved, and stored in such a manner as to prevent any changes in sample chemistry. Refer to subsequent sections of this document for the procedures for sample preparation, preservation, storage, and in situ measurements.

3.1.2 Residential and Municipal Wells

Some precautions must be taken when collecting ground water samples from residential and municipal wells. Proper scheduling of sampling periods for residential and municipal wells is important. It is important that a municipal well be sampled while it is in a pumping cycle; thus insuring that you are taking a sample from water that has not been held stagnant in the well casing. Residential wells are continuously pumped, with the usage rate varying over the course of the day (heavy in the early morning hours for showers, etc.; moderate during the day; and heavy again at evening during cooking, dishwashing, and shower usage). This continuous usage creates an established homogeneity in the water entering the residential well. Therefore, the largest factor affecting sample integrity is the residence time water has spent in the pressure tank (holding tank). Also, when sampling a group of residential wells in a particular area, be sure to sample them over a relatively short period of time. When collecting more than one round of samples, make the sampling periods consistent with respect to the time of day the samples are taken.

When sampling residential and municipal wells, site accessibility is normally not a problem, since a limited amount of equipment is required. However, accessibility of the well can cause major problems. Before attempting to sample a residential well, determine if the well is physically accessible for sampling. For municipal wells, check to see if a spigot or valve is available from which a sample can be taken. Be sure that the sampling port or spigot is positioned as close to the well head as possible and prior to any type of treatment process, such as a water softener or carbon filtration unit. Residential wells generally have a spigot located at the base of the pressure tank. This is usually

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the closest tap to the actual well head. When collecting raw samples from the tap off the pressure tank, a cold water faucet should be turned on and run a minimum of five minutes and/or until temperature stabilization (two readings plus/minus ten percent). pH and/or conductivity may also be used to indicate fresh water is entering the pressure tank. After stabilization has been achieved, continue to run the cold water faucet and collect samples from the tap off the pressure tank. This will insure collection of a representative sample.

Contact the owner's or operator's of the wells to determine what tools, valves, hoses, etc., will be needed. Wrenches may be needed for opening and closing faucets or spigots. Often spigots on municipal wells may be too large, resulting in a high-volume flow which will make sampling difficult. In this case, it will be necessary to reduce the flow by using appropriate fittings. Obtain information from the operator on the size of the fittings required and on accessibility of the sampling spigot. It may be convenient to attach a section of hose to the line, especially under very cramped quarters.

Generally, all the equipment listed in the previous section on ground water sampling for monitoring wells should be used during the sampling of residential and municipal wells with the exception of the pumps and the bailer. Since municipal wells are high-volume water producers, there is no necessity for evacuating the well. However, the lines between the well and the spigot must be cleared. For most residential and municipal wells, the samples can be collected either directly into the sample bottles or, in cases where sample filtration is needed, samples can be placed directly into the filtration apparatus.

When collecting samples after residential or municipal systems with activated carbon treatment, a post-treatment tap simply needs to be cleared of stagnant water. Sample collection can then proceed, usually directly into the sample container. As with the ground water samples collected from monitoring wells, it will be necessary to prepare and preserve the samples prior to storage. Refer to the later sections of this document for the procedures for sample preparation, sample preservation, and sample storage in Sections 4.2, 4.3, and 4.4, respectively.

3.2 Surface Water Sampling

Surface water sampling may include the sampling of streams, rivers, ponds, or lakes. Prior to sampling, the surface water drainage in and around the area to be studied should be characterized using all available background information, including

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topographic maps and aerial photographs. As with all sampling procedures, an initial survey of the site should be conducted to verify sampling locations. This site survey will help to identify any special equipment, personnel safety requirements, or procedures which might be necessitated by terrain or other factors specific to the site. Needed background information includes: the depth of the surface water body, flow rate, and overall position of the sampling point and/or stream or tributary in the stream basin. Also, it is recommended that stream characteristics, such as stagnation zones or mixing zones which might affect the distribution or volatilization of constituents in the water, be noted.

The equipment needed for most surface water sampling is minimal. In fact, in many instances, the sample container will serve as the sampling device. The following is a recommended list of surface water sampling equipment and accessories:

- Materials for sample preparation (see Section 4.2).
- Reagents for sample preservation (see Section 4.3).
- Appropriate sample containers (see Section 4.4).
- Meters, probes, and standards for in situ measurements (see Section 4.5).
- Appropriate field and transportation blanks. The type and number of blanks should be established with the laboratory conducting the analysis.
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Flow and velocity estimation devices.
- Sampling devices. These may include anything from use of the sample containers to use of a telescoping aluminum pole with an attached clamp and beaker known as a grab sampler. These can be bought from laboratory supply houses. Otherwise, a Kemmerer sampler can be used to collect samples from a particular depth in the water column. Due to problems which may result from the inaccessible nature of many surface sampling locations, it may be appropriate to use a boat to sample surface waters.

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- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the sample (see Section 4.1).

- Buckets, plastic wash basins, scrub brushes, and sponges. These will be used for cleaning contaminated equipment and materials.

- Camera/film. For use in documenting sampling procedure and sample location.

Most surface water samples are taken as grab samples. Typically, surface water sampling involves immersing the sample container into the body of water. The following suggestions are made to help insure that the samples obtained are representative of the body of water being sampled:

- Generally, the most representative samples of streams or rivers are obtained at mid-channel, at one-half of the stream depth in a well mixed stream.

- Stagnated areas in streams or rivers might contain zones of contaminant concentration, depending upon the physical/chemical properties of the contaminants and the position of these stagnated waters relative to the source of contamination.

- When sampling a stream, proceed from downstream to upstream stations to avoid releasing contaminants into the water from bottom sediments.

- Though the containers used to obtain the samples are previously cleaned in the laboratory, it is recommended that the sample container be rinsed at least once, preferably three times, with the water to be sampled before the sample is taken.

- Sampling must begin at the suspected zones of lowest contamination and proceed towards to the zones of highest contamination.

- When sampling a pond or other large standing body of water, the surface area may be divided into grids. A series of samples may be taken from each grid and combined into one sample (a composite) or separate samples may be obtained from several grid locations at random. This will improve the representativeness of the sample and/or samples.

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- A discrete composite sampler may be used to collect a composite sample at a specific location over time or proportional to flow.

- Care should be taken to avoid excessive agitation of the water which can result in the loss of volatile constituents.

- Do not take a surface water sample at the surface/water interface unless sampling specifically for a known constituent which is immiscible with water (i.e., such as oil which floats on top of water). Instead, the sample container should be inverted, lowered to one-half the water depth, and held at about a 45° angle with the mouth of the bottle facing upstream.

Generally, surface water samples are more stable than ground water samples because these waters tend to be in equilibrium with atmospheric conditions. Therefore, samples from these streams will not undergo significant changes in water chemistry upon extraction from their environment. However, it is best not to assume that the surface water samples can be left unattended after collection. Hence, it is necessary to prepare, preserve, and store the samples appropriately as described in Sections 4.2, 4.3, and 4.4 of this document. Also, it is important that all the in-situ measurements described in Section 4.5 of this document be performed immediately after sample collection.

3.3 Sediment Sampling

The collection of sediment samples from ponds, lagoons, or streams is normally not a difficult task unless sampling is being conducted at great depth, in which case a boat and specialized equipment would be necessary. Caution must be taken to obtain samples which will be representative of the contaminants of interest versus the sediment materials present. For example, it is unlikely that absorbed organic constituents will be found in high concentrations in coarse-sized materials. However, the finer materials which are most likely to absorb organic contaminants from stream waters may not be located within the immediate flow areas of the stream transporting the contaminants, rather they would be located in less turbulent areas.

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A review of site background information may give an indication of the type of constituents present in the sediments and the type of sediments to be collected. It is important to consider the following:

- Constituents which may have affinities for particular sediment types.

- Hydrogeological information which may help establish a relationship between the contaminant source and the contaminants in the sediment.

- The pH of the surface water over the sediments. Unusual pH conditions may influence contaminant precipitation.

- Several sediment samples should be obtained from the area nearest the suspected contaminant point source. These samples should also be collected from various types of materials near the source (i.e., coarse gravels versus fine clays) to determine the relationship of the contaminants to the sediment material.

- Samples should be collected progressing from downstream to upstream to prevent the release of potentially contaminated sediments from one sampling station to another further downstream.

When developing a sampling plan for the collection of sediments from small streams or surface drainageways, it is important to address possible effects of runoff which may have occurred many years prior to the time of sampling. Consequently, it is often insufficient to test only the surface sediments because erosion and deposition of additional stream bed sediments in the intervening years could have formed a cover of uncontaminated surface sediments over potentially contaminated sediments. Therefore, the following procedures are recommended for the collection of samples from small streams:

- Assess which side of the stream received contaminated sediments from overland flow and collect samples on that side of the stream from mid-stream to the stream bank.

- Using a shovel, core or bucket sampler, collect a surface grab or composite sample of the top six inches of sediment.

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- At these same locations, collect another grab or composite sample at an approximate depth of six to twelve inches.

- The number of samples collected at each location should be proportionate to the stream width (i.e., three samples from a six-foot wide stream should sufficiently characterize sediment quality).

Comparatively, when sampling from large rivers, ponds or lakes, it may be necessary to lay out a visual or surveyed grid, if possible, and composite samples or collect grab samples from either random or regular locations within the grid.

After determining the relationship between the contaminant constituents and the sediments, a sampling plan can be prepared. The following is a list of recommended sediment sampling equipment:

- Materials for sample preparation (see Section 4.2).

- Appropriate sample containers (see Section 4.4).

- Chain-of-custody labels, tags, and record forms (see Section 5.2).

- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and observations on the environmental conditions at the time of sampling.

- Sampling devices. Sample devices may range from the sample container and a trowel, to more elaborate power-driven devices. See the discussion below on sediment sampling techniques.

- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the sediment and the sampling devices (see Section 4.1).

- Buckets, wash basins, scrub brushes, and sponges. These will be used for cleaning of all contaminated materials.

- Camera/film. For use in documenting sampling procedures and sample locations.

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Very simple techniques can usually be employed in collecting sediment samples. Below are some suggested techniques for sediment sampling:

- As previously mentioned, in small, low-flowing streams or near the shore of a pond or lake, the sample container, a shovel, or hand-operated bucket auger may be used to scrape up sediments. The sediment must be dewatered as much as possible so as not to reflect soluble concentrations in the water.

- To obtain sediments from larger streams or further from the shore of a pond or lake, a beaker attached to a telescoping aluminum pole by means of a clamp may be used to dredge sediments.

- To obtain sediments from rivers or in deeper lakes and ponds, a spring-loaded sediment dredge (Eckman dredge) or benthic sampler may be used. Several types of sediment core samples exist for specialized sampling of sediments.

Lastly, all the equipment used should be decontaminated between the sampling stations using the procedures described in the following section.

3.4 Soil Sampling

There are two types of soil samples: surface (consisting of the top two feet) and subsurface (below two feet). In most cases, both types will be collected as grab samples. Although, in some cases composite sampling may be useful for obtaining data about contamination over a wide area. This provides a rough estimate of the overall extent and magnitude of contamination, while reducing the analytical costs. However, when composite sampling, it is important that extreme care be taken in documenting the location and depth of the composites.

3.4.1 Surface Soil

Listed below are three possible scenarios for the collection of surface soil samples over a large area:

- the total area may be divided by a grid system to identify specific sampling locations;

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- If the area is large and if complete characterization is required, a random sampling approach may be used to reduce the number of samples. In this instance, the area is laid out in a grid and sample locations determined randomly; and

- an extremely large study area can also be divided by grids with soil samples being composited from several locations within the grid.

The list of equipment necessary for the collection of surface soil samples may be minimal, depending upon the analytical parameters to be determined. As previously discussed in Section 2 of this document, the sampling devices may be constructed of either PVC, linear polyethylene, Teflon, or stainless steel, depending upon the parameters of interest. The following is a list of equipment necessary for the collection of surface soil samples:

- Materials for sample preparation (see Section 4.1).

- Appropriate sample containers (see Section 4.4).

- Chain-of-custody labels, tags, and record forms (see Section 5.2).

- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and information on environmental conditions at the time of sampling.

- Sampling devices. Generally, these include a scoop or hand trowel constructed of appropriate material. However, in some cases, shovels, picks, hoes, and/or hand augers may be necessary.

- Decontamination solutions/water. These will be used for decontaminating equipment (see Section 4.1).

- Buckets, plastic wash basins, scrub brushes, and sponges. These will be used in the cleaning of contaminated equipment.

- Camera/film. For use in documenting sampling procedures and sample location.

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Grab samples of surface soils are collected by placing the scooped or troweled sample into an appropriately sized bottle. However, composite soil sampling requires considerably more caution. Depending upon the number of samples to be collected and the area to be covered, the soil samples from various areas should be placed into an appropriately constructed pan, thoroughly mixed, and an appropriately sized aliquot taken. It is important that the volume of soil from each location be as identical as possible. When possible, it is recommended that composite soil sampling only be conducted when the soils are relatively dry. Wet soils are very difficult to work with thus making the collection of a representative composite sample difficult. Since it is necessary to split the samples and expose them to the atmosphere prior to storage, it is impossible to collect representative composite soil sample for volatile constituents.

3.4.2 Subsurface Soil

Subsurface soils can be collected either as grab or composite samples. The same precautions for composite sampling of surface soils apply to the compositing of subsurface soils. Although this document does not generally discuss safety factors involved in the collection of samples, it is important at this point to note that the collection of subsurface soil samples can constitute a substantial safety hazard. The most important safety factor involved is the avoidance of buried containers or pockets of highly contaminated material. A thorough background information search should be completed before obtaining subsurface samples. At a minimum, a metal detector survey should also be performed at sites where buried materials are suspected.

Generally, the problems encountered in the collection of subsurface soil samples are similar to those encountered in the collection of surface soil samples. Additionally, subsurface sampling must also address the depths from which the samples will be obtained. The overall approach is similar to that discussed previously for surface sampling, considering the aspects of grid systems and random versus specific sampling locations. The depths at which samples are to be taken will depend upon the suspected contaminants, their general mobilities, and the method by which they have entered the subsurface environment. Generally, subsurface samples can be obtained by three methods: shallow subsurface sampling by hand-operated equipment and deep subsurface samples by use of a drilling rig or a backhoe.

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The following is a list of recommended equipment for sampling subsurface soils:

- Materials for sample preparation (see Section 4.2).
- Appropriate sample containers (see Section 4.4).
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and observations on the environmental conditions at the time of sampling and the location.
- Sampling devices (depending upon the sampling methods described in the following paragraph).
- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the soils and the inside of the casing or auger flights (see Section 4.1).
- Buckets, wash basins, scrub brushes, and sponges. These will be used for equipment decontamination.
- Steam cleaner. A steam cleaner should be used when attempting to decontaminate large pieces of equipment such as auger flights.
- Camera/film. These are for use in documenting sampling procedures and sample locations.

Depending upon the depth and type of samples to be collected, a variety of methods are available for sampling subsurface soils. These include:

- A shovel which may be used to depths of several inches or several feet, depending on soil types.
- A slotted sampling trier which is limited to about two and one-half (2-1/2) to three feet.
- A hand auger may be used to collect subsurface samples at depths up to four to five feet; however, it mixes and thus destroys the cohesive structure and stratigraphic character of the soil preventing detailed soil description.

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- A hand-driven split-spoon sampler provides a means to obtain somewhat undisturbed core samples. The depth will again be limited by the soil type.

- Drill rig-operated sampling devices. These may be placed into two categories: (1) solid stem augers and (2) hollow stem augers. With solid stem augers, materials are mixed as brought to the surface, making representative samples from discreet depths impossible to obtain. With hollow stem augers, either a split-spoon or Shelby tube can be used for sample collection.

- Soil samples may be collected from a backhoe trench. It is emphasized that at no time should the sampler enter the backhoe trench. A contaminated air supply or possible caving makes this a dangerous situation. To collect samples from the pit, a long-handled bucket auger or the backhoe bucket may be used to collect the soil from the desired depth interval.

Lastly, proper decontamination procedures, discussed in Section 4.1, should be used in cleaning all the soil sampling equipment. Sample preservation for soils is not as imperative although volatile organic soils should be kept cool, and ERM recommends refrigeration of all soil samples.

3.5 Air Sampling

Air sampling of a hazardous waste site is useful in assessing potential adverse health effects caused by the inhalation of organics or inorganic constituents. Organic compounds volatizing into the air from surface streams, lagoons, open drums, or contaminated soils, as well as inorganic particulates, such as asbestos or lead, may be collected in sampling bags or tubes and analyzed to determine the specific constituents and their respective concentrations.

As previously discussed with the other types of environmental sampling, an initial survey of the site is necessary to provide background information needed for the design of an effective air sampling program. This background information includes: identification of personnel safety requirements, the locations of potential contaminant source areas, location of a background sampling station, and prevailing upwind and downwind directions. Also, if the types of constituents that are being monitored are known, then the sampling program should be designed to better

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detect these constituents. For example, heavy organic compounds will migrate along the ground surface and should be sampled at ground level.

The equipment needed for air sampling is minimal. Sampling for organic constituents will only be addressed in this section. Sampling air for organic vapor is performed by drawing air into a sample collection bag using an Analytical Instrument Development, Inc. Portable Organic Vapor Meter (OVM). Two design features of the Model 500 make this type of sample collection the preferred method. The first is that the detection system used in the Model 500 is the Photoionization Detector which is a non-destructive detector, making it possible to run the sample through the detector into the sample bag without changing the character of the sample. This makes it possible for the collection of the exact sample which may cause a high reading on the meter. The feature of the Model 500 that allows this sample collection is a positive displacement pumping system used to draw the sample into the Model 500. It is then a very simple procedure to attach the sample bag to the exit of this pump and trap the sample after it has passed through the detector.

Besides the OVM, the other necessary equipment needed for air sampling is as follows:

- Sample Collection Bag. The material and size of the sample bag is dependent upon the constituents which are to be analyzed. A one-liter size is an acceptable sample volume for most analysis. When analyzing for organic compounds, absorption of the organic molecules onto the surface of the bag becomes a serious problem. It is suggested that the bags be constructed or at least lined with Teflon or polyethylene to minimize the amount of absorption.

- Intake Collection Tube. This may be constructed of a relatively inert material, such as Tygon, which can be disposed of after the collection of each sample.

- Chain-of-custody labels, tags, and record forms (see Section 5.2).

- Log book and indelible ink marker. This is for recording information pertinent to the sampling.

- Camera/film. For use in documenting sampling procedures and sample locations.

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The actual collection of the sample is a relatively easy operation. The bag is attached to the OVM using the intake tubing. The OVM is switched on and air is pumped through the OVM, out the exit port, and into the sample bag until the bag is stiff but not bursting. The OVM Model 500 pumps at a rate of 500 ml per minute which will fill a one-liter bag in approximately two minutes. During filling, the OVM readings should be recorded for comparison to the final analysis. After the bag is filled, the valve on the bag is closed, and the bag is detached from the intake tubing.

It should be noted that air samples cannot be collected as composite samples since the bag may not be sealed and opened again before analysis. Also, analysis of the constituents in the bag should be conducted as soon as possible to prevent possible absorption of organics onto the surface of the bag. Background information on site conditions can be obtained by collecting an upwind sample at the site. During the sampling period, recording of the general weather conditions such as wind directions, wind speed, temperature, humidity, and degree of cloud cover may prove useful in the assessment of the results. Because high humidity and/or dampness interfere with the OVM intake system, air samples may not be collected during precipitation events.

Other than sample labeling, logging, and chain-of-custody, there is very little preparation needed for air samples. Organic samples should be kept cool (about 4°C) as prescribed in Section 4.3 of this document. The intake tubing should be discarded after each sample is collected. Most collection bags are reusable and should be properly purged according to the specifications of each individual manufacturer.

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SECTION 4

POST-SAMPLING PROCEDURES

Post sampling procedures include: (1) equipment decontamination, (2) sample preparation, (3) sample preservation, and (4) sample storage. Additionally, in many cases, in-field measurements of certain parameters may be required.

4.1 Equipment Decontamination

All non-disposable equipment used for the collection, preparation, preservation, and storage of the environmental samples must be cleaned prior to their use and after each subsequent use. Unless the equipment and materials being used are disposable or of sufficient number so as not to be reused during any one sampling period, decontamination will have to be conducted in the field. Field decontamination can be a tedious and expensive chore, as it can require taking into the field a sizable amount of equipment and reagents. If possible, attempts should be made to minimize field decontamination.

The materials needed for decontamination are dependent upon the equipment to be cleaned. The following is a very generalized list of equipment to be used during decontamination:

- Cleaning solutions. These will be dependent upon the items to be cleaned and the parameters which are being analyzed.

- Water. In some cases, tap water may be adequate for initial or intermediate rinses. The final rinses, however, must be with deionized/distilled water.

- Storage vessels. These will be used to transport large volumes of deionized/distilled water to the site. It is recommended that fifteen-gallon plastic carboys with a spigot positioned near the bottom of the tank be used.

- Buckets and wash basins. For use in the washing and rinsing of equipment.

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- A drying rack. All materials and equipment must be dried prior to additional use. Paper towels or Chemwipes should not be used for drying surfaces of equipment which come into contact with the samples.

- Paper towels and Chemwipes. For use in cleaning all outside surfaces or surfaces that do not come into contact with the sample.

Basically, there are two types of recommended field cleaning procedures. When collecting samples for inorganic constituents, the following procedures are recommended:

- Wash with a non-phosphate detergent (or steam clean).

- Rinse with tap water.

- Wash or rinse through the use of a squirt bottle with a dilute nitric acid. A one to five percent nitric acid solution is adequate.

- Rinse three times with deionized/distilled water.

When sampling for organic parameters, the following cleaning sequence is recommended:

- Wash with a non-phosphate detergent (or steam clean.
- Rinse with tap water.
- Rinse with reagent-grade acetone.
- Triple rinse with deionized water.

If analyses are to be conducted for ammonia or nitrogen compounds, it is necessary that a one to five percent solution of hydrochloric acid be used in place of the nitric acid bath. If it is found that persistent stains or water marks are present, it may be desirable to use a chromic acid solution as a further cleaning procedure. However, both hydrochloric acid and chromic acid are extremely corrosive and, if possible, their use should be avoided while in the field.

Larger pieces of equipment may require specialized decontamination procedures. The small-diameter bladder-type pump can be decontaminated with the use of two specially-designed decontamination tanks. These tanks can be constructed of a three-foot section of four-inch I.D. PVC pipe with an end cap placed on one end. The pump is set inside one tank along with three to five gallons of clean tap water. By pumping the clean tap water from

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the tanks, both the outside and inside of the pump can be decontaminated. After the tap water wash, the pump should be appropriately cleaned as per the above procedures using deionized water and the second tank.

The tubing used for a centrifugal pump can be decontaminated by pumping tap and then distilled water through the tubing. The outside of the tubing can be decontaminated by use of a pressure sprayer. To avoid cross-contamination, it is recommended that the PVC tubing be dedicated to each well and cleaned between uses.

Larger diameter submersible pumps are difficult to decontaminate and for this reason should be used only where absolutely necessary. These pumps have high flow rates and large volumes of clean water are needed to decontamiante the inside of the tubing. In most cases, the cost of the tubing for these pumps is prohibitive to dedication of tubing to each well. A pressure sprayer can be used to effectively decontaminate the outside of the pump and tubing. At sites where a clean tap water source is available, the submersible pump should also be decontaminated by pumping 75 to 100 gallons through it and the discharge tubing. A 45-gallon polyethylene drum has been dedicated for this use.

4.2 Sample Preparation

Immediately before sample collection, each sample bottle should have a label attached which includes the following information: sample identification, date, time, sampler's name, analysis requested, and the site name.

Whether or not a sample is to be prepared prior to preservation and storage depends upon the analyses to be conducted and the type of sample collected. If dissolved metal concentrations are desired, then the sample must be filtered in the field immediately after collection. Field filtration of surface water samples is not as critical as filtration of ground water samples. Surface water samples generally exist in equilibrium with atmospheric conditions and, as such, will not undergo rapid change after collection. However, ground waters tend to be more reducing and, precipitation will occur if the sample is not filtered immediately after withdrawal.

It is recommended that all surface and ground water samples be filtered using a Sartorious", or Nalgene" filtration apparatus or a Millipore" pressure filter, depending on the quantity and turbidity of the samples (Figures 1, 2, and 3). The Sartorius" and Nalgene" apparatus is inert with respect to metals and also

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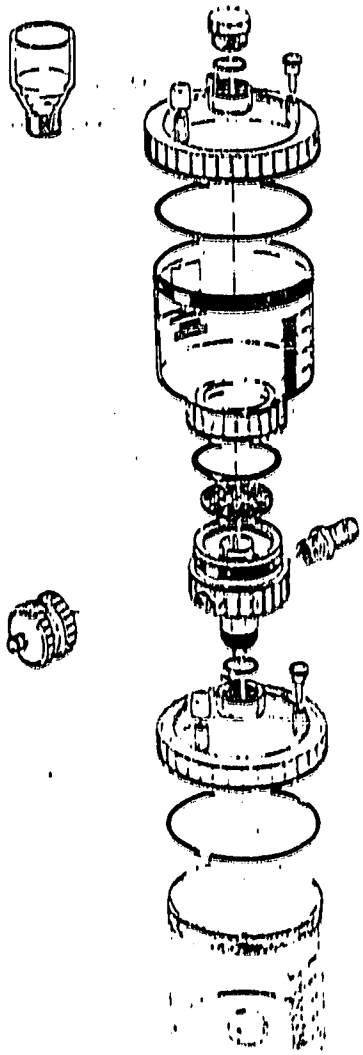
Figure 1
Sartorious Filtration Apparatus



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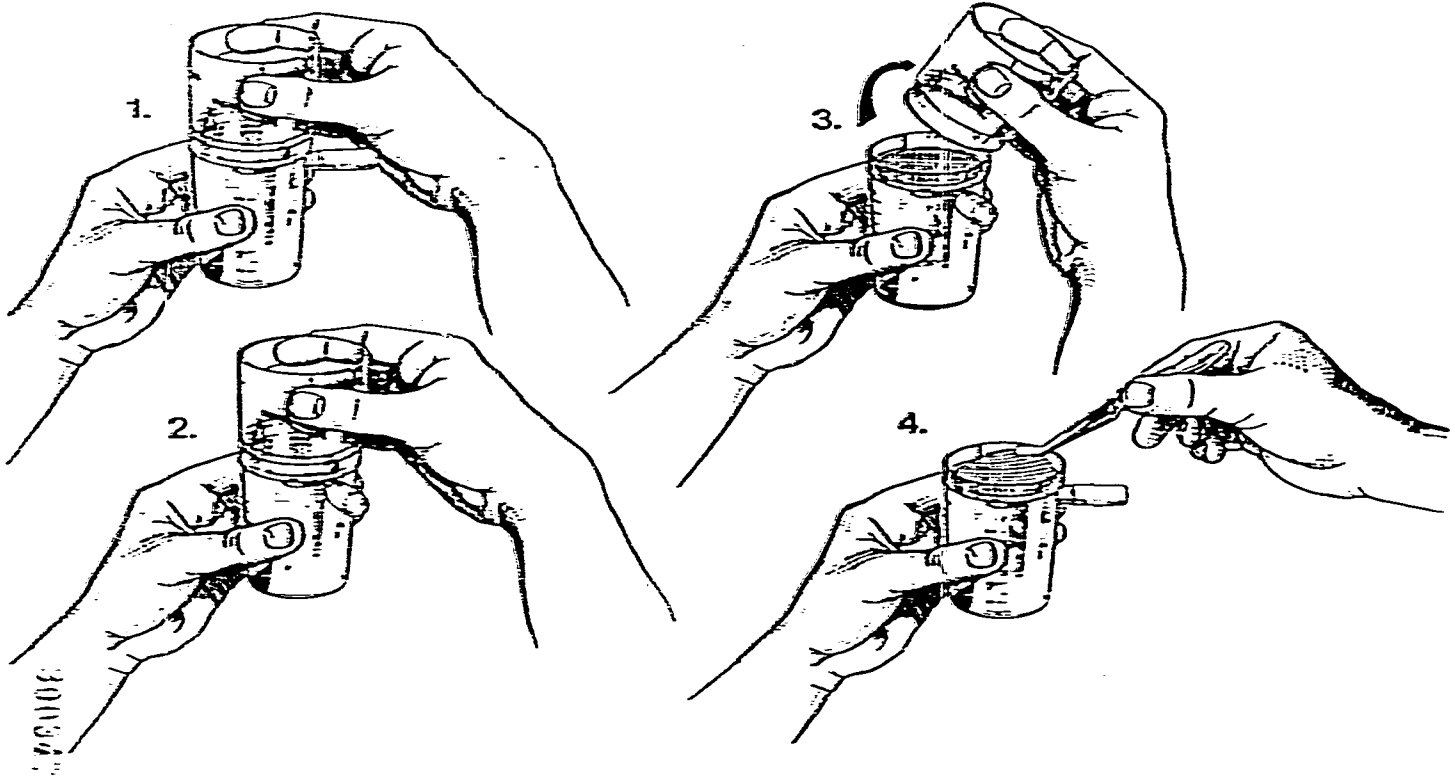

Figure 2 - Nalgene Disposable Filter Unit

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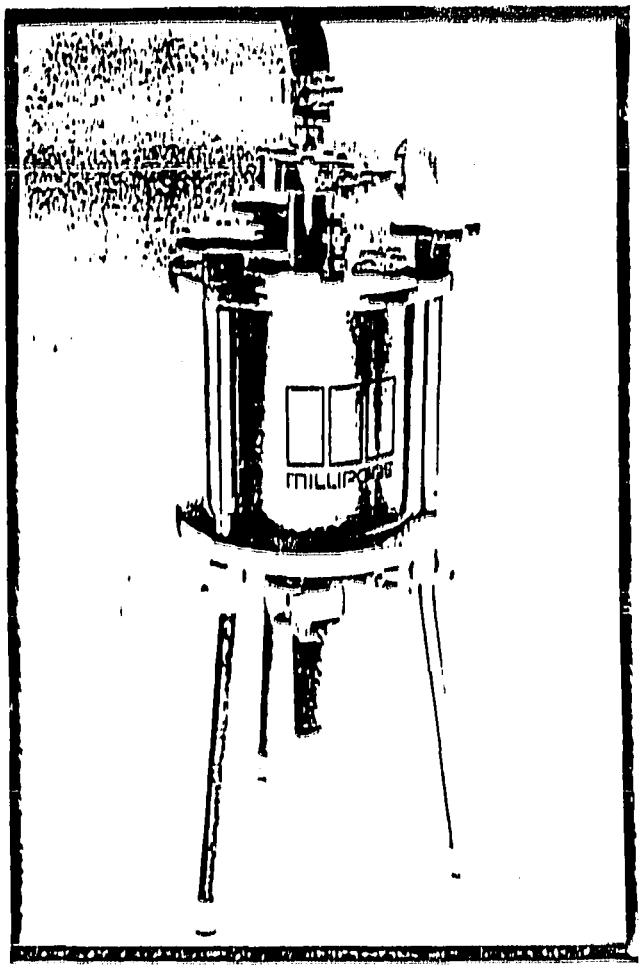
Figure 3 - Millipore Pressure Filter

MILLIPORE®

HAZARDOUS WASTE FILTRATION SYSTEM



INSTALLATION, OPERATION AND MAINTENANCE MANUAL
OM100

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in a closed system which will prevent oxidation of the sample. A .45-micron pore sized membrane should be used for sample filtration. The sample may be pumped through the filter using a standard laboratory vacuum pump or a Nalgene hand vacuum pump. The Millipore" pressure filter can be used where large volumes of sample need to be filtered, or the sample is extremely turbid. This pressure filter allows for rapid filtration and is constructed of all stainless steel and Teflon" materials. A N_2 gas sample is needed to operate it. Samples being collected for organic contaminants need not be field filtered.

In general, soil and sediment samples are not prepared in the field. However, in cases where composite samples are being collected, it may sometimes be desirable to combine and split the samples in the field. In these cases, it will be necessary to sieve the samples to remove large, non-representative fractions and then to split the same using a soil sample splitter. This procedure, however, will be extremely difficult if the soils and sediments are damp or wet. In this case, it will be necessary to return the individual aliquots to the laboratory for preparation. As stated previously, samples collected for volatile constituents cannot be composited.

4.3 Sample Preservation

It is impossible to completely stabilize every constituent within a sample. At best, preservation techniques can only retard the chemical and biological changes that continue after the sample is removed from its environment. If the sample environment is significantly different from atmospheric conditions, the sample may undergo changes which will render it non-representative of its original environment. Methods of preservation are relatively limited and are intended to retard biological action, hydrolysis of chemical compounds and complexes, and volatility. Generally, preservation methods are limited to pH control, chemical addition, refrigeration, and freezing. Table 1 gives recommended volume sizes, container types, preservatives, and holding times for a variety of standard water quality parameters. Please be aware that preservative techniques are continuously changing, and these should be routinely checked.

Sample preservation should be performed in the field immediately after sample collection and preparation. In many cases where pH control or additions of reagents are required, separate bottles and preservatives may be supplied by the laboratory. In other cases, the preservatives may be placed directly in the sample bottle prior to collection.

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Table 1
Recommendation For Sampling And Preservation Of Samples According To Measurement

Measurement	Vol. Req. (ml)	Container[1]	Preservative	Holding Time[1]
100 Physical Properties				
Color	50	P,G	Cool, 4°C	24 Hrs.
Conductance	100	P,G	Cool, 4°C	24 Hrs.[m]
Hardness	100	P,G	Cool, 4°C HNO_3 to pH < 2	6 Mos.[m]
Odor	200	G only	Cool, 4°C	24 Hrs.
pH	25	P,G	Det. on site	6 Hrs.
Residue				
Filterable	100	P,G	Cool, 4°C	7 Days
Non-Filterable	100	P,G	Cool, 4°C	7 Days
Total	100	P,G	Cool, 4°C	7 Days
Volatile	100	P,G	Cool, 4°C	7 Days
Settleable Matter	1000	P,G	None Req.	24 Hrs.
Temperature	1000	P,G	Det. on site	No Holding
Turbidity	100	P,G	Cool, 4°C	7 Days
200 Metals				
Dissolved	200	P,G	Filter on site HNO_3 to pH < 2	6 Mos.[m]
Suspended	200		Filter on site	6 Mos.
Total	100	P,G	HNO_3 to pH < 2	6 Mos.[m]

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Table 1 (Cont)

Measurement	Vol. Req. (ml)	Container[1]	Preservative	Holding Time[1]
Mercury				
Dissolved	100	P,G	Filter on site HNO_3 to pH < 2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P,G	HNO_3 to pH < 2	38 Days (Glass) 13 Days (Hard Plastic)
300 Inorganics, Non-Metallics				
Acidity	100	P,G	None Req	24 Hrs.
Alkalinity	100	P,G	Cool, 4°C	24 Hrs.
Bromide	100	P,G	Cool, 4°C	24 Hrs.
Chloride	50	P,G	None Req.	7 Days
Chlorine	200	P,G	Det. on site	No Holding
Cyanides	500	P,G	Cool, 4°C NaOH to pH 12	24 Hrs.
Fluoride	300	P,G	None Req.	7 Days
Iodide	100	P,G	Cool, 4°C	24 Hrs.
Nitrogen				
Ammonia	400.	P,G	Cool,4°C H_2SO_4 to pH < 2	24 Hrs.
Kjeldahl, Total	500	P,G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.[10]
Nitrate plus Nitrite	100	P,G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.[10]
Nitrate	100	P,G	Cool, 4°C	24 Hrs.
Nitrite	50	P,G	Cool, 4°C	48 Hrs.

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Table 1 (Cont)

Measurement	Vol. Req. (ml)	Container[1]	Preservative	Holding Time[1]
Dissolved Oxygen				
Probe	300	G only	Det. on site	No Holding
Winkler	300	G only	Fix on site	4-8 Hours
Phosphorus*				
Ortho-phosphate, Dissolved	50	P,G	Filter on site Cool, 4°C	24 Hrs.
Hydrolyzable	50	P,G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.[19]
Total	50	P,G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.[19]
Total, Dissolved	50	P,G	Filter on site Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.[19]
Silica	50	P only	Cool, 4°C	7 Days
Sulfate	50	P,G	Cool, 4°C	7 Days
Sulfide	500	P,G	2 ml zinc acetate	24 Hrs.
Sulfite	50	P,G	Det. on site	No Holding
400 Organics				
BOD	1000	P,G	Cool, 4°C	24 Hrs.
COD	50	P,G	H_2SO_4 to pH < 2	7 Days[19]
Oil & Grease	1000	G only	Cool, 4°C H_2SO_4 or HCl to pH < 2	24 Hrs.
Organic carbon	25	P,G	Cool, 4°C H_2SO_4 or HCl to pH < 2	24 Hrs.
Phenolics	500	G only	Cool, 4°C H_3PO_4 to pH < 4 1.0 g $CuSO_4$/l	24 Hrs.
MBAS	250	P,G	Cool, 4°C	24 Hrs.

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Table 1 (Cont)

Measurement	Vol. Req. (ml)	Container[1]	Preservative	Holding Time[1]
NTA	50	P,G	Cool, 4°C	24 Hrs.

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-82 (1976) Method D-3370.

2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.

3. It should be pointed out that holding times listed above are recommended for properly preserved samples based on currently available data. It is recognized that for some sample types, extension of these times may be possible while for other types, these times may be too long. Where shipping regulations prevent the use of the proper preservation technique or the holding time is exceeded, such as the case of a 24-hour composite, the final reported data for these samples should indicate the specific variance.

4. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and results reported at 25°C.

5. Where HNO_3 cannot be used because of shipping restrictions, the sample may be initially preserved by icing and immediately shipped to the laboratory. Upon receipt in the laboratory, the sample must be acidified to a pH < 2 with HNO_3 (normally 3 ml 1:1 HNO_3/liter is sufficient). At the time of analysis, the sample container should be thoroughly rinsed with 1:1 HNO_3 and the washings added to the sample (volume correction may be required).

6. Data obtained from National Enforcement Investigations Center-Denver, Colorado, support a four-week holding time for this parameter in Sewerage Systems. (51C 4952).

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4.4 Sample Storage

The ideal sample bottle must be constructed of a non-reactive material. In general, there are three types of material from which sample bottles are made. These are: plastic, glass, and Teflon. In general, samples collected for metals and general water quality parameters are stored in plastic bottles. Samples collected for organic analysis are routinely placed in glass bottles of various types and sizes, depending upon the particular analysis to be conducted. Table 1 gives a list of recommended sample containers and their volumes. In most cases, bottles will be supplied by the laboratory conducting the analysis.

4.5 In-Field Measurements

As discussed previously, determination of sample pH, Ec, Eh, and temperature on ground and surface waters require in field measurements taken immediately after sample collection. Although in-field measurements are more critical for ground water samples than samples from aerated surface waters, it is recommended that measurements be taken as soon as the sample is removed from its in-situ environment. When possible, measurements may be made directly in the well to avoid the loss of sample integrity.

An alternative method for in-situ measurements is through the use of a "closed cell". This is particularly applicable to ground water measurements where pumped water can be used to fill up a closed container in which measurement probes have been previously installed (closed cell). After removing all head space from the closed cell, the cell is closed to atmospheric conditions through the use of two stop cocks. This allows measurements on ground water samples to be made as close to its original, reducing environment as it were in the formation, and eliminates error due to atmospheric oxidation of the sample.

Prior to conducting the in-field measurement, the samplers or field team must review the operating manuals for the equipment to be employed and guarantee that all of the instruments and probes are properly standardized. All measurements should then be conducted according to the procedures outlined in the appropriate operating manuals.

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SECTION 5

SAMPLE PACKAGING, SHIPPING, AND CHAIN-OF-CUSTODY PROCEDURES

Once the samples have been collected, prepared, preserved, and appropriately stored, they must be packaged for shipment and/or delivery to the laboratory. In addition, from the time of sample collection until the analyses have been completed, chain-of-custody procedures must be followed to insure the proper handling and possession of the samples. This section outlines procedures for the packing and shipping of environmental samples, and general chain-of-custody procedures.

5.1 Packaging and Shipping Procedures for Environmental Samples

All individual sample containers must be placed in a strong outside shipping container. It is recommended that for this purpose a metal or styrofoam insulated cooler be used. The following is an outline of the procedures to be followed:

- Using fiberglass tape, secure the drain plug at the bottom of the cooler to insure that water from sample container breakage or ice melting does not leak from the outside container.
- Line the bottom of the cooler with a layer of absorbent material such as vermiculite.
- Place all sample containers in the cooler. Check screw caps for tightness and mark sample volume level on the outside of large containers.
- For large glass containers, packing peanuts may be used to keep containers in place and to prevent breakage.
- Small containers such as forty-milliliter vials may be placed in small plastic sandwich bags. When shipping these with large containers, steps should be taken to prevent shifting of the larger containers which might break the smaller ones.

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- Cushioning material is not necessary when shipping only plastic sample containers. However, some absorbent should be included in case of breakage or leaks.

- Ice sealed in plastic bags or cool paks should be placed in the cooler when samples must be kept at 4°C.

- Documents accompanying the samples should be sealed in a ziplock plastic bag attached to the inside of the cooler lid.

- The lid of the cooler must be closed and fastened.

- Fiberglass tape should be used to seal the space between the lid and the cooler. The tape should be wrapped around the cooler several times to insure that the lid does not open if the latch becomes unfastened.

- The following information must be attached to the outside of the cooler: name and address of receiving laboratory with return address, arrows indicating "This End Up" on all four sides, and "This End Up" label on the top of the lid.

- Additional labels such as "Liquid in Glass" are optional. If the bottles have been carefully packaged, additional warnings should not be needed.

- If the cooler is not equipped with a padlock, a custody seal should be affixed and signed across the lid of the cooler.

Samples packaged in this way may be shipped by commercial air. Personnel should be prepared to open and reseal the cooler for inspection if it is required. Be aware that some commercial carriers have limits as to the number of pounds per item that can be shipped.

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5.2 Chain-of-Custody Procedures

As in any other activity that may be used to support litigation, ERM must be able to provide the chain-of-possession and custody of any samples which are offered to evidence or which form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever samples are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate written record which can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence.

A sample is defined as being in someone's custody if:

- it is in one's actual possession, or
- it is in one's view, after being in one's physical possession, or
- it is in one's physical possession and then stored in a secure facility or location so that no one can tamper with it, or
- it is kept in a secured area, restricted to authorized personnel only.

The number of persons involved in collecting and handling samples should be kept to a minimum. Detailed field records should be kept in a bound log book and should contain the following information:

- Unique sample identification or log number
- Date and time
- Source of sample (including name, location, and sample type)
- Preservative used
- Analysis required
- Name of collector(s)
- Pertinent field data (pH, DO, residual chlorine, specific conductance, temperature, redox potential, etc.)
- Serial numbers on seals and transportation cases

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To help eliminate possible problems in the chain-of-custody protocol, one person will be appointed Field Custodian for each investigation. For investigations where large sampling teams are used, all samples are to be turned over to the Field Custodian by the team members who collected the samples. The Field Custodian will then document each transaction and the sample will remain in his/her custody until it is shipped to the laboratory.

Each sample must be labeled using waterproof ink and sealed immediately after it is collected. Labels should be filled out before collection to minimize handling of the sample container.

Labels and tags must be firmly affixed to the sample containers. Be sure that the container is dry enough for a gummed label to be securely attached. Tags attached by string are acceptable when gummed labels are not applicable.

The sample container should then be placed in a transportation case, along with the chain-of-custody record form, pertinent field record, and analysis request form as needed. The transportation case should be sealed or locked. However, on those occasions when the use of a chest is inconvenient, the collector should seal the cap of the individual sample container with tape in a way that tampering would be easy to detect.

When samples are composited over a time period, unsealed samples can be transferred from one field crew to the next. The transferring crew lists the samples and a member of the receiving crew signs the list. The receiving crew either transfers the samples to another crew or delivers them to the laboratory.

When transferring the samples, the transferee must sign and record the date and time on the chain-of-custody record (Figure 2). Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record form. To minimize custody records, the number of custodians in the chain-of-possession should be minimized.

The Field Custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record.

All packages sent to the laboratory should be accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms should be retained by the originating office (either carbon or photo copy). Mailed packages can be registered with

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The ERM

Sample Chain of Custody

Code: | Project Name:

Sampler:

ERM Traffic Report	Date	Time	COMP	GRAB	Station Location	Number of Containers							Remarks

Sample Relinquished by:	Sample Received by:	Date	Time	Reason for Transfer

COPIES: 1 Sampler, Yellow-Lab, Pink-Client, Gold-File

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return receipt requested. For packages sent by common carrier, receipts should be retained as part of the permanent chain-of-custody documentation.

Writing chain-of-custody procedures, as well as the various promulgated laboratory analytical procedures, facilitates the admission of evidence under Rule 803(6) of the Federal Rules of Evidence (P.L. 93-595). Under this statute, written records of regularly conducted business activities may be introduced into evidence as an exception to the "hearsay rule" without the testimony of the person(s) who made the record. Although it is preferable, it is not always possible for the individuals who collected, kept, and analyzed samples to testify in court. In addition, if the opposing party does not intend to contest the integrity of the sample or testing evidence, admission under Rule 803(6) can save a great deal of trial time. For these reasons, it is important to standardize the procedures followed in collection and analysis of evidentiary samples.

In criminal cases, however, records and reports of matters observed by police officers and other law enforcement personnel are not included under the business record exceptions to the "hearsay rule" according to Rule 803(8), P.L. 93-595. It is arguable that those portions of the compliance inspection report dealing with matters other than sampling and analysis results come within this exception. For this reason, in criminal cases, records and reports of response team members may not be admissible. The evidence may still have to be presented in the form of oral testimony by the person(s) who made the record or report, even though the materials come within the definition of business records.

In a criminal case, the defense counsel may be able to obtain copies of reports prepared by a witness, even if the witness does not refer to the records while testifying. If obtained, the records may be used in cross-examination.

Records are not automatically admitted in either of these actions. The business records section authorizes admission "unless the source of information or the method of circumstance of preparation indicates lack of trustworthiness". The caveat under the public records reads "unless the sources of information or other circumstances indicate lack of trustworthiness".

Thus, whether or not the team members anticipate that various records will be introduced as evidence, they should make certain that all reports are as accurate and objective as possible.

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ATTACHMENT 3

INSTRUCTION MANUALS FOR pH
AND CONDUCTIVITY METERS

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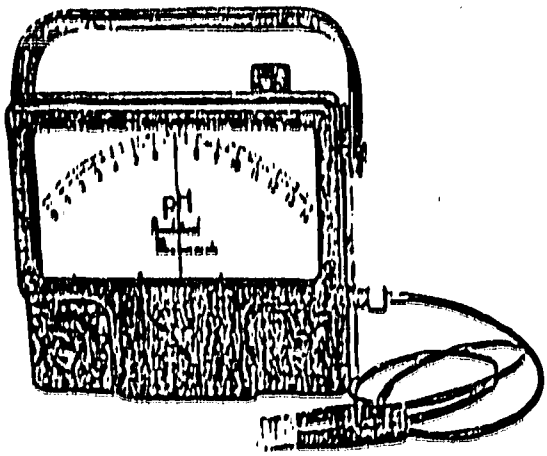
ANALYTICAL

BIG SCALE pH Meter

Model 707-B



Operating Instructions

Analytical Measurements

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ANALYTICAL BIG SCALE pH METER, MODEL 707-B

Operating Instructions

Set "Selector" Switch to "O" position. Rotate "Calibrate" knob clockwise and counterclockwise and observe pointer movement. Pointer should move freely up and down scale as knob is rotated. Then set pointer to 7 pH with "Calibrate" knob.

Remove sample cup from Probe and rinse Probe in distilled or deionized water. (If neither is available then rinse with tap water.)

Immerse Probe Unit in a beaker of 7 pH buffer solution. Turn Selector Switch to pH. Rotate Calibrate knob until pointer reads 7 pH.

Rinse Probe Unit under tap water or in a vessel of clean water, and immerse into a beaker of 4 pH buffer solution. The meter should now read 4 pH.

Rinse Probe Unit and instrument is now ready to test required samples.

Turn Selector Switch to O position and note reading. This is important. (If Calibrate knob is inadvertently rotated during later testing, it would not be necessary to go through Steps 3 and 4 again.) Reset pointer by means of Calibrate knob to value noted above with Selector Switch in O position.

Turn Selector Switch to pH. Set Temperature dial to temperature of sample under test.

When finished with samples, rinse Probe, replace sample cup and fill sample cup with water to keep bulb moist.

Turn Selector Switch to "Off".

To replace battery, remove back of meter (4 corner screws). Remove old battery, snap on new battery, place in clip and replace back. Use a standard 9 volt Transistor Radio battery available locally.

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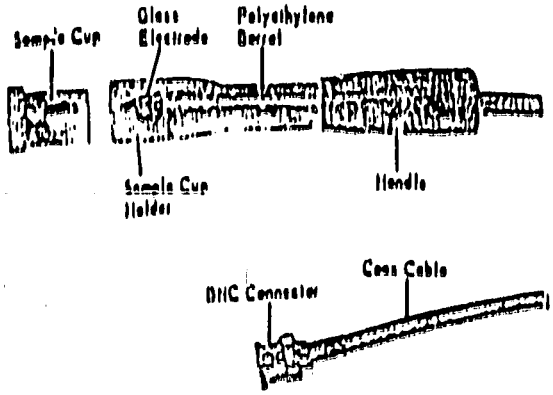
ANALYTICAL pH PROBE UNIT

This Probe Unit is of a new type requiring no refilling with KCl solution. This is accomplished with gel filling and a ceramic junction. The Probe Unit must be immersed above the top of the cup holder in order to make connection with the ceramic junction in the body of the electrode.



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ORIGINAL
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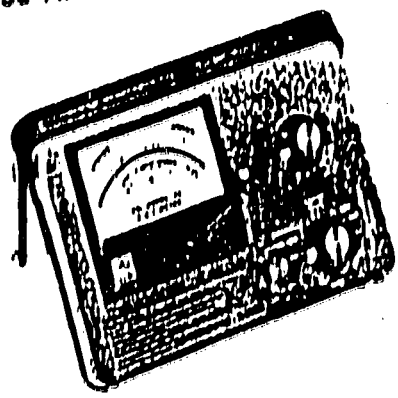
INSTRUCTIONS FOR YSI MODEL 33 AND 33M S·C·T METERS



Scientific Division
Yellow Springs Instrument Co., Inc.
Yellow Springs, Ohio 45387 • Phone 513-767-7241

PRICE INCLUDING HANDLING $5.00

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GENERAL DESCRIPTION

The YSI Model 33 and 33M S-C-T Meters are portable, battery powered, microprocessor instruments designed to accurately measure salinity, conductivity and temperature. They use a probe consisting of a rugged, glass conductivity cell and a precision YSI thermistor temperature sensor combined in a single unit.

Conductivity with the Model 33 is expressed in microsiemens/centimeter (µmhos/cm), with the 33M, it's millisiemens/meter (mS/m). These are measurements of the electrical conductance the sample would show if measured between opposite faces of a 1cm cube. (Conversion information: 1 µmho/cm = 0.1 mS/m.) Salinity is the number of grams of salt/kilogram of sample (ppt = grams per thousand). This measurement assumes the sample contains no "non-ionized" salt water (oil, sugar). The sample temperature is measured in degrees Celsius.

Salinity measurements are mathematically temperature compensated by direct dial Conductivity measurements are not temperature compensated. However, a temperature function is provided on the instrument for use with calculation of corrections. Also, when just temperature and conductivity are known it is possible to calculate salinity, and when only temperature and salinity are known it is possible to calculate conductivity.

SPECIFICATIONS

Model 33 Conductivity

Ranges	0-500, 0-5,000, 0-50,000 µmhos/cm with YSI 3300 Series Probes. (Note: The "µmho" designations on the meter are abbreviated from the "µmho/cm".)
Accuracy	±2.5% max. error at 500, 5,000 and 50,000 plus probe ±3.0% max. error at 250, 2,500 and 25,000 plus probe See Error Section

Resolution	2.5 µmhos/cm on 500 µmho/cm range 25 µmhos/cm on 5,000 µmho/cm range 250 µmhos/cm on 50,000 µmho/cm range
Temperature Compensation	None

Model 33M Conductivity

Ranges	0-50, 0-500, 0-5,000 mS/m with YSI 3300 Series Probes
Accuracy	±2.5% max. error at 50, 500 and 5,000 plus probe ±3.0% max. error at 25, 250 and 2,500 plus probe See Error Section
Resolution	0.25 mS/m on 50 mS/m range 2.5 mS/m on 500 mS/m range 25.0 mS/m on 5,000 mS/m range
Temperature Compensation	None

Salinity

Range	0-40 ‰ in temperature range of -2 to +45°C
Accuracy	Above 4°C, ±0.9 ‰ at 40 ‰ and ±0.7 ‰ at 20 ‰ plus conductivity probe Below 4°C, ±1.1 ‰ at 40 ‰ and ±0.9 ‰ at 20 ‰ plus conductivity probe See Error Section
Resolution	0.2 ‰ on 0-40 ‰ range
Temperature Compensation	Manual by direct dial from -2 to +45°C

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Temperature	
Range	-2 to +50°C
Accuracy	±0.1°C at -2°C, ±0.6°C at 45°C plus probe See Error Section
Readability	±0.15°C at -2°C to ±0.37°C at 45°C
Power Supply	Two D size alkaline batteries. Eveready E95 or equivalent, provide approximately 200 hrs. of operation
Probe	YSI 3300 Series Conductivity/Temperature Probe Nominal Probe Constant: K = 5/cm
Accuracy	±2% of reading for conductivity and salinity Error of ±0.1°C at 0°C and ±0.3°C at 40°C
Instrument Ambient Range	Satisfactory operation -5 to +45°C. A maximum error of ±0.1% of the reading per °C change in instrument temperature can occur. This error is negligible if the instrument is compensated to reading for each reading

OPERATION PROCEDURE

1. Setup
   (a) Adjust meter zero (if necessary) by turning the balance screw on the meter face so that the meter needle coincides with the zero on the conductivity scale
   (b) Calibrate the meter by turning the MODE control to REDUNE and adjusting the REDUNE control so the meter

needle lines up with the indicator on the meter face. If this cannot be accomplished replace the batteries
   (c) Plug the probe into the probe jack on the side of the meter case
   (d) Put the probe in the solution to be measured (See Probe Use)
2. Temperature
   Set the MODE control to TEMPERATURE. Read the temperature on the bottom scale of the meter in degrees Celsius. Allow time for the probe temperature to come to equilibrium with that of the water before reading
3. Salinity
   (a) Transfer the temperature reading from Step 2 to the °C scale on the instrument
   (b) Switch the MODE control to the SALINITY position and read salinity on the red 0-40 ‰ meter range
   (c) Depress the CELL TEST button. The meter reading should fall less than 2% if greater the probe is fouled and the measurement is in error. Clean the probe and re-measure
4. Conductivity on Model 33 (Model 33M data are in parentheses)
   (a) Switch the MODE control to the X100 scale. If the reading is below 50 on the 0-500 range (5.0 on the 0-50 range) switch to the X10 scale. If the reading is still below 50 (5.0) switch to the X1 scale. Read the meter scale and multiply the reading appropriately. The answer is expressed in µmhos/cm (mS/m). Measurements are not temperature compensated

Example:	Meter Reading	24.7 (24.7)
	Scale	X10
	Answer	247.0 µmhos/cm (24.7.0 mS/m)

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(b) When measuring on the X100 and X10 scales, depress the CELL TEST button. The meter reading should fall less than 2% of greater, the probe is faulty and the measurement is in error. Clean the probe and re-measure.

NOTE: The CELL TEST does not function on the X1 scale.

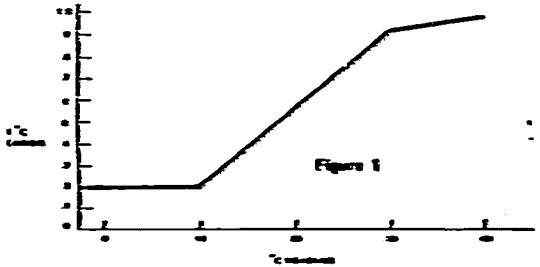
E. Error

The maximum error in a reading can be calculated by using the graphs in the following sections.

(1) Temperature

The temperature scale is designed to give the minimum salinity error when the temperature readings are used to compensate salinity measurements.

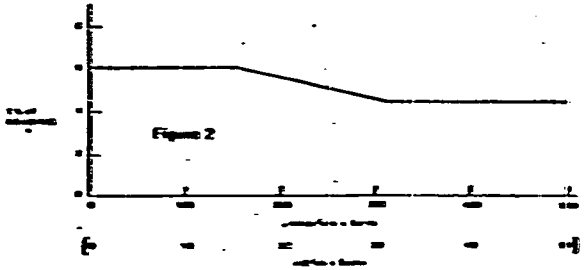
Figure 1 shows total error for probe and instrument versus °C meter reading.



Example: Meter Reading 15°C
Total Error 0.4°C
Accuracy 15°C ± 0.4°C for probe and instrument combined

(2) Conductivity on Model 33 (Model 336 data are in parentheses.)

Figure 2 shows the worst case conductivity error as a function of the conductivity reading for the probe and instrument combined.



Example: Meter Reading 360 µmhos/cm (36 mS/m)
Scale X10
% Reading Error ± 4.5%
Accuracy 360 ± 16.2 µmhos/cm
(36.0 ± 1.62 mS/m)
for probe and instrument

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(3) Salinity

The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both. The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale error.

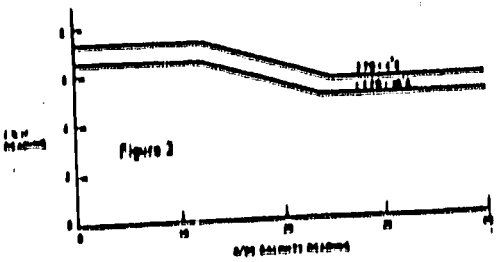

Figure 3

Example: Meter Reading 10.0/00, @ 10°C

% of Reading Error, 0.5%

ACCURACY 10 ‰ ± 0.05 ‰ for all errors, combined worst case.

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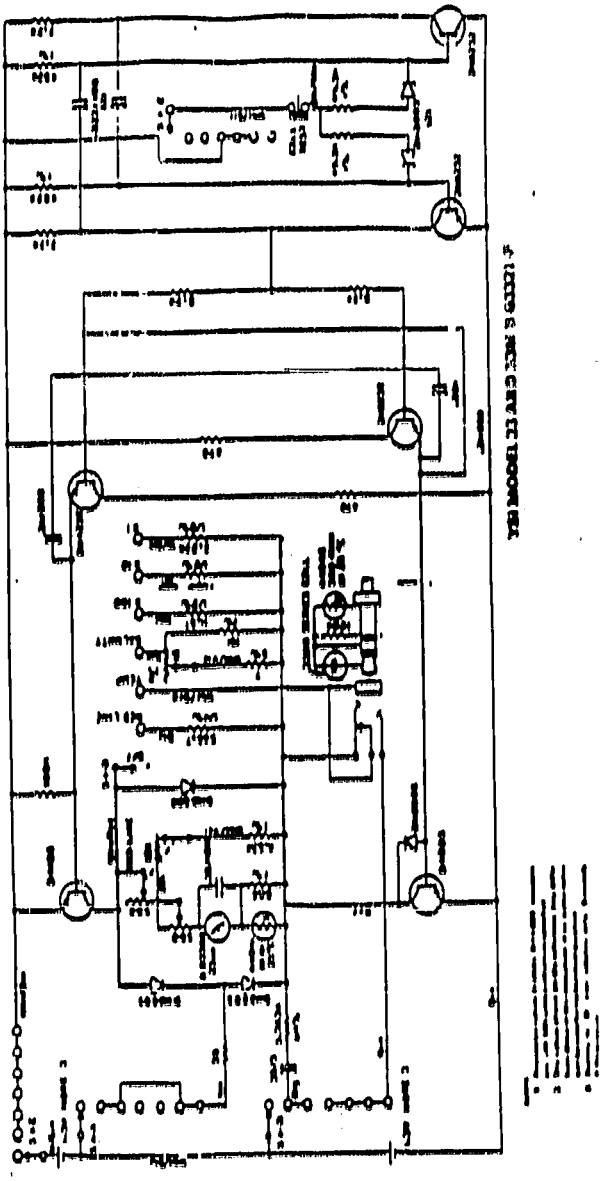

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CIRCUIT DESCRIPTION, MAINTENANCE AND CALIBRATION

1. Description

The circuit is composed of two parts, a multivibrator and switching transistors. The multivibrator produces a square waveform voltage. The square wave is applied to two switching transistors. They alternately apply two batteries of opposite polarity to the probe thus preventing AC power which minimizes polarization effects. The meter is in series with one battery and measures the current from it. The current from the battery is proportional to the conductance of the cell. Salinity is measured in a special range conductivity circuit which includes a user-adjusted temperature compensator. In the temperature, reading and X1 positions the multivibrator operates at 100 Hz. In the salinity X100 and X10 positions the multivibrator operates at 800 Hz and in these ranges pushing the CELL TEST button drops the frequency to 100 Hz allowing the operator to judge the degree of probe polarization.

2. Maintenance

The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent, will provide 200 hrs of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the reading adjustment cannot be accomplished.

Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the six screws from the rear plate. The battery holders are color coded. The Positive (+ button) end must go on red.

3. Calibration of Model 33 (Model 33M data are in parentheses.)

It is possible for the temperature knob to become loose or drop from its normal position. In an emergency the dial can be re-positioned. It must be emphasized that this is an emergency procedure only, and that the instrument should be returned to the factory for proper recalibration at the earliest opportunity.

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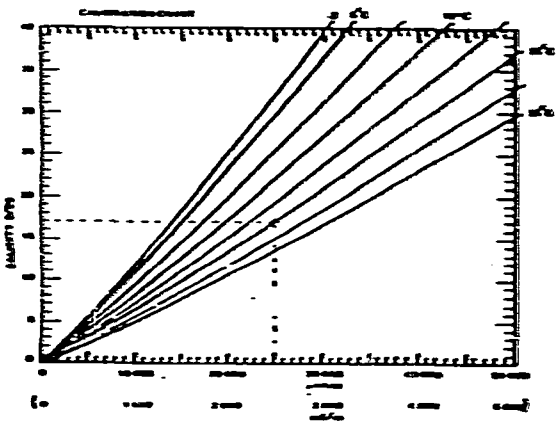
(c) Read the temperature and conductivity of the solution. Determine the salinity of the solution by running a line vertically on the graph from this conductivity value until it intersects the appropriate °C line (temperature as reported for temperature between the green °C lines). From that intersection extend a



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line horizontally to the edge of the graph. This determines the salinity for that sample.

Example: 25 000 µmhos/cm and 20°C gives a salinity of 17

Example: 2 500 mS/m and 20°C gives a salinity of 17.0

(d) Remove the °C knob, switch to SALINITY and turn the control shaft until the meter needle indicates the salinity value determined in Step (c). In the example given, the value is 17

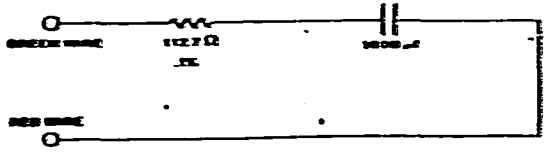
(e) Switch to TEMPERATURE (Note: This temperature reading must be the same as Step (a). If not, begin again at Step (a).) Place the knob on the control shaft (without turning the control shaft) with the knob pointer at the same temperature as the meter reading and tighten both set screws securely.

At instrument appropriately recalibrate using the following procedure or return the instrument to factory for service.

(a) Set the instrument for a salinity measurement as normal.

(b) Substitute a 1000 µf capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the pick connections inside the instrument.



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(c) Turn the temperature dial until the meter needle indicates

Now match the temperature knob with the meter at 25°C. This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

PROBE

1. Description of TSI 3300 Series Conductivity/Temperature Probe

The TSI 3300 Series Conductivity Probes are designed for field use, embodying construction and design for rugged, accurate service.

Each probe features a built-in cell constant of 5.0 (500 Ω/MΩ) ±2%, a precision TSI thermistor temperature sensor of ±0.1°C accuracy at 0°C and ±0.3°C at 40°C and a low capacitance cable assembly terminating in a three-channel 0.25" dia. phono type connector.

The 3310 has a 10 ft. cable and the 3311 is a 50 ft. version. Other lengths are available on special order.

The probe has a rigid PVC body, platinumized pure nickel electrodes, and a durable cable providing resistance to a wide range of water-borne substances.

2. Maintenance

(a) Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, salt and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as: Dow Chemical "Bathroom Cleaner", Hawaiian Industries "Ruby Tile, Porcelain and Chrome Cleaner", Johnson Wax "Energy Instant Cleaner" or Lysol Brand "Basin Tub Tile Cleaner".

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HCl can be used.

Always wash the probe after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, re-platinumizing is required.

(b) Re-Platinumizing

Equipment Required —

(1) TSI (3140) Platinumizing Solution, 2 fl. oz. (2% platinum chloride dissolved in 0.025% lead acetate solution)

(2) TSI Model 33 or 3360 S.C.T. Meter

(3) 50 ml glass beaker or equivalent bottle

(4) Distilled water

Procedure —

(1) Clean the probe as in Section (a) — either method.

(2) Place the cell in the beaker and add sufficient TSI (3140) solution to cover the electrodes. Do not cover the top of the probe.

(3) Plug the probe into the Model 33 or 3360 switch to the X100 scale to platinize the electrode. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below.

Meter Reading		Time
µmhos/cm	mS/m	(minutes)
30 000	3 000	5
25 000	2 500	6
20 000	2 000	8
15 000	1 500	11
10 000	1 000	16

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(4) After the elapsed time remove the probe and rinse in fresh water.

(5) Return the solution to its container. 2 oz. of solution should be sufficient for 50 measurements.

(c) Storage

It is best to store conductivity cells in deionized water. Cells stored in water require less frequent photocoulometer. Any cell that has been stored dry should be soaked in deionized water for 24 hours before use.

3. Probe Use

(a) Dimensions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic non-conductive objects. Metallic objects such as pens or weights should be kept at least 6 inches from the probe.

(b) Weights are attached to the cable of the TSI 3110 and 3111 Probes. The TSI 3127 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, we suggest limiting the total weight to two pounds (8 pairs). For weights in excess of two pounds, use an independent suspension cable. In other case, weights must be kept at least 6 inches away from the probe.

(c) Gently agitate by moving and lowering the probe several times. Giving a measurement minimum flow of specimen water through the probe and improves the time response of the temperature sensor.

4. Cell Calibration & Standard Solutions

The TSI 3300 Series Cells are calibrated to absolute accuracy of ±1.5% based on a standard solution. Since the literature on conductivity does not indicate a consistently accepted standard solution, we have chosen the 0.01 demal KCl solution method as determined by Jones and Bradshaw in 1933 as our standard. Recent textbooks, as well as the ASTM standards, concur with this choice.

The solution is prepared by dissolving 0.745 grams of pure dry KCl with distilled water and the solution is 1 kilogram. The table below shows the values of conductivity this solution would have if the distilled water were non-conductive. However since even high purity distilled water is slightly conductive, the measured conductivity will be higher by an amount equal to the water's conductivity.

Temperature °C	Conductivity µmhos/cm	Conductivity mS/m
15	1141.5	114.2
16	1162.5	116.8
17	1183.6	118.4
18	1215.8	122.0
19	1246.4	124.6
20	1273.0	127.3
21	1299.7	130.0
22	1326.6	132.7
23	1353.6	135.4
24	1380.6	138.1
25	1408.1	140.8
26	1436.5	143.7
27	1463.2	146.3
28	1490.9	149.1
29	1518.7	151.9
30	1546.7	154.7

The operator may use the standard solution and the table to check accuracy of a cell's constant or to determine an unknown constant. The formula is shown below.

$$K = \frac{R\,KC_1 + C_2}{10^6} \quad \text{or} \quad \frac{R\,KS_1 + S_2}{10^6}$$

where K = Cell constant

R = Measured resistance in Ω

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C_t = Conductivity in µmhos/cm

C_r = Conductivity in µmhos/cm of the distilled water used to make solution

S_t = Conductivity in mS/m

S_r = Conductivity in mS/m of the distilled water used to make the solution

R, C_t and C_r or S_t and S_r must either be determined at the same temperature or corrected to the same temperature to make this relationship valid.

Note: For further information on conductivity and the above standard information, refer to ASTM Standards, Part 23 — Standard Methods of Test for Electrical Conductivity, in Water and Industrial Waste Water — ASTM Designation D1125 64

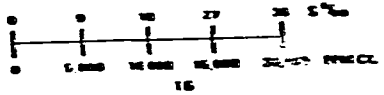
TSI MODEL 33 AND 33M USED WITH TSI 51A, 54 and 57 OXYGEN METERS

If the salinity measurement is to be used for salinity correction on the 51A, the reading should be converted to Chlorinity. The formula is:

$$\text{PPM Chlorinity} = \frac{\text{Salinity } ‰ - 0.03}{1.8} \times 10^6$$

For these instruments the 0.03 can be neglected so the equation simplifies to

$$\text{PPM Cl} = \frac{SS - \text{[illegible]} \times 10^6}{1.8}$$



For salinity corrections when using the Model 57 use the salinity reading direct from the Model 33 or 33M. No conversion is necessary.

Model 33 and 33M salinity readings taken in conjunction with Model 54 dissolved oxygen readings can be used to correct the Model 54 for salinity and to make point measurement salinity corrections to the salinity oxygen data. Correction tables are available from the factory.

WARRANTY

All TSI products carry a one-year warranty on workmanship and parts, exclusive of batteries. Damage through accident, misuse or tampering will be repaired at a nominal charge.

If you are experiencing difficulty with any TSI product, it may be returned to an authorized TSI dealer for repair even if the warranty has expired. If you need factory assistance for any reason, contact:

Service Department
Yellow Springs Instrument Co., Inc.
P.O. Box 279
Yellow Springs, Ohio U.S.A.
Phone: (513) 767-7241

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APPENDIX D

HEALTH AND SAFETY PLAN

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RECOMMENDED HEALTH AND SAFETY PLAN
FOR THE FORMER WITCO SITE RI/FS
NEW CASTLE, DELAWARE

July 1987

(Consulting Firm) H&S Coordinator

Plan Adopted By:
(Witco Corporation
Designated Representative)

(Consulting Firm)
Designated Representative

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EXECUTIVE SUMMARY

The following Health and Safety Plan has been developed for the former Witco Site RI/FS in New Castle, Delaware by (consulting firm). The intent of this plan is to recommend appropriate Health and Safety procedures to be followed by site personnel during the field operations of this Project. Consulting assistance to the Witco Corporation Site Representative in implementing, as a minimum, protocols established herein throughout those applicable activities associated with the Witco Site Investigation will be provided by the RI/FS consultant.

The Witco Corporation Site Representative may adopt the health and safety policies and procedures set forth in this Plan; however, (the consultant) assumes no liability regarding its implementation unless specifically agreed upon in writing by a Principal of (consulting firm). This plan has been developed on the basis of the information found through previous investigations undertaken at the Witco Site.

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SECTION 1

INTRODUCTION

This Health and Safety Plan has been developed for the Witco Site Remedial Investigation/Feasibility Study in New Castle, Delaware. This plan will serve to provide recommended health and safety procedures for those employees who may be exposed to any hazardous materials and conditions that may be present during the investigation. The procedures set forth in this plan are designed to reduce the risk of exposure to chemical substances and physical or other hazards which may be present in the soil, water and air associated with the Witco Site. The procedures set forth herein are developed in accordance with the provisions of 29 CFR 1910:120 (Interim Final OSHA Rule). (Consulting firm) shall be responsible solely for compliance with the provisions of the present Health and Safety Plan by its' employees unless otherwise specified and agreed to in writing by a Principal of (consulting firm).

A detailed site history can be found in the Work Plan developed for the Witco Site RI/FS. The Work Plan also discusses the planned site activities and standard operating procedures.

1.1 Risk Assessment - Potential Chemical Exposure

Key compounds associated with the Witco Site investigation have been identified and are listed in Table 1-1 along with a concise summary of the hazards involved with exposure to each component. The compounds listed in Table 1-1 have persistently been identified throughout previous investigations.

Other constituents have been identified in the information found in available reports, however, these compounds were not consistently identified throughout previous site investigations. Additionally, these compounds have, for the most part been present in trace concentrations, and as such do not create a significant health threat to site employees. The level of personal protection has been established on a conservative basis to allow for the potential presence of these components. Table 1-2 lists the potential compounds and corresponding exposure limits.

Toxicological studies of the compounds listed in Table 1-1 indicate that exposure to Trichloroethylene poses the most significant health threat of the three (3) compounds identified.

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Tris(beta-chloropropyl) phosphate (Fyrol®-PCF) has been determined to be a non-mutagenic and non-carcinogenic compound with no known adverse acute exposure effects.

Trichlorofluoromethane is a highly volatile compound and is not expected to be present in concentrations that will induce the irritant effects noted in Table 1-1.

Trichloroethylene has been identified as a possible carcinogen and is known to have several adverse effects resulting from acute exposures. The American Conference of Governmental Industrial Hygienists has established a TLV-TWA of 50 ppm for this compound upon which recommendations within this plan are based.

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TABLE 1-1

IDENTIFICATION AND ASSESSMENT OF PERSISTENT COMPOUNDS
AT THE FORMER WITCO CORPORATION SITE

COMPOUND	PEL, TLV	ODOR THRESHOLD	ROUTE OF EXPOSURE	SYMPTOMS OF ACUTE EXPOSURE
Tris(beta-chloropropyl) phosphate	None established	Odorless liquid	Inhalation; direct contact	None identified
Trichlorofluoromethane	100 ppm	135-209 ppm	Inhalation; ingestion; direct contact	(1)
Trichloroethene	50 ppm	21.4-400 ppm	Inhalation; ingestion; direct contact	(1), (2) (3), (4) (5)

(1) Eye, Nose, Throat, Skin Irritation
(2) Headache, Fatigue, Nausea
(3) Lightheaded, Some Nausea, Dull Visual and Audio Response
(4) Central Nervous System Disorder, Convulsions, Sweating
(5) Possible Carcinogen
(6) Inadequate Evidence of Carcinogenicity

PEL - Permissible Exposure Limit (OSHA - US or California)
TLV - Threshold Limit Value (ACGIH)
NOTE: Lowest established value is listed.

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TABLE 1-2

POTENTIAL COMPONENTS - WITCO SITE

Compound	TLV or PEL
Polychlorinated Biphenyl (54% Cl)	0.5 mg/m^3
Tetrachloroethene	50 ppm
Chloroform	10 ppm
Ethyl Benzene	100 ppm
Methylene Chloride	100 ppm
Napthalene	10 ppm
Anthracene	0.2 mg/m^3
Toluene	100 ppm
Xylene	100 ppm
Dichlorodifluoromethane	10 ppm
Pentachlorophenol	0.5 mg/m^3 (skin)

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1.1 Risk Assessment - Physical and Other Hazards

The Witco Site RI/FS poses several physical hazards to those workers directly involved with the site activities. Implementation of feasible engineering controls and safe work practices will greatly reduce the threat of physical injury due to the inherent hazards present at the site.

Physical hazards associated with the site include the presence of heavy machinery, underground utilities, and heat stress. Such inherent hazards pose the threat of illness and injury to site personnel and must be considered in the Health and Safety Plan.

1.2 Applicable Regulations

Federal and state agencies have established standards and guidelines addressing worker protection and safe work practices.

These regulations may or will impact the manner in which the Witco RI/FS is conducted. Table 1-3 summarizes key regulations that must be considered and/or followed during the Witco Site Investigation.

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TABLE 1-3

APPLICABLE STANDARDS

AGENCY	STANDARD REFERENCE	SUBJECT OF REGULATION
U.S. Dept. of OSHA	1910.20	Recordkeeping
U.S. Dept. of OSHA	1910.134	Respiratory Protection
U.S. Dept. of OSHA	1910.151	Medical Facilities
U.S. Dept. of OSHA	1910.120	Worker Protection at Hazardous Waste Sites
U.S. Dept. of OSHA	1926	Construction Activities

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SECTION 2

PROJECT ORGANIZATION AND RESPONSIBILITIES

The following responsibilities and authorities have been or will be assigned to designated personnel for the duration of the Witco Site RI/FS.

2.1 Designated Representative and Project Manager

Person duly appointed by (consulting firm) to act in a supervisory capacity over all its' employees and activities with respect to its' contractual obligations to Witco Corporation Site Representatives during the Witco Site Investigation. The (consulting firm) Site Manager for this investigation is responsible for assuring that the Health and Safety responsibilities are carried out in conjunction with this site investigation.

2.2 Site Manager

Person duly appointed by the (consulting firm) and under the supervision of the Project Manager to conduct field and related activities specific to the Witco Site Investigation. The Site Manager for this Project is responsible for carrying out (consulting firm) Health and Safety responsibilities on the site as designated by contractual agreements between (consulting firm) and the Witco Corporation Site Representative.

2.3 Witco Site Designated Representative and Witco RI/FS Project Manager

Person duly appointed to monitor all services performed by (consulting firm) or its designated subcontractor.

2.4 Site Safety Officer

Person duly appointed by a Designated Representative and having:

- responsibility for the field implementation, evaluation, and any necessary field modifications of the designated Health and Safety Plan;

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- responsibility for maintaining adequate supplies of all personal protective equipment as well as calibration and maintenance of all monitoring instruments.

- authority to suspend work during the Witco Site Investigation due to any ineffectiveness of this Health and Safety Plan.

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SECTION 3

MEDICAL MONITORING AND PERSONNEL TRAINING REQUIREMENTS

3.0 Medical Monitoring

The U.S. Department of OSHA has established requirements for a medical surveillance program designed to monitor and reduce health risks for employees potentially exposed to hazardous materials. This program has been designed to provide baseline medical data for each employee involved in hazardous waste operations including field activities and to determine his/her ability to wear personal protective equipment, such as chemical resistant clothing and respirators. The medical examinations must be administered on a pre-employment and annual basis and as warranted by symptoms of exposure or specialized activities. These examinations shall be provided by employers without cost or loss of pay to the employee.

All site personnel involved with the Witco Site RI/FS activities may be required to have participated in a medical monitoring program meeting specifications of 29 CFR parts 1910.120 , due to the potential presence of chemical compounds associated with the Witco Site and anticipated activities. The examining physician is required to make a report to the employer of any medical condition which could place such employees at increased risk of wearing a respirator or other personal protection equipment. Each employer engaged in site work shall assume the responsibility of maintaining site personnel medical records as regulated by 29 CFR 1910.20 where applicable.

A medical program is required for all those employees who wear or may wear respiratory protection as regulated by 29 CFR 1910.134. This program must determine an individual's ability to wear respiratory protection while performing designated duties.

3.1 Personnel Training

Site personnel associated with those field activities in which the potential for exposure to hazardous substances exists may be required to participate in a health and safety training program that complies with the U.S. Department of OSHA interim final regulation, 29 CFR 1910.120. This program must instruct employees on general health and safety principles and procedures, proper operation of monitoring instruments, and use of personal protective equipment.

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In addition, site employees must undergo site-specific training prior to the start-up of any given project or task. As activities change at a particular site, related training must be provided as necessary. The site-specific training must address potential hazards and associated risks, site operating procedures and safe working practices, decontamination procedures, emergency response and site control methods to be employed. A Site-Specific Health and Safety Plan such as this must be developed and provided to all personnel involved in pertinent field activities.

Additional, specialized training must also be provided as dictated by the nature of site activities. Specialized training must be provided for activities such as confined space entry, excavations and handling of unidentified substances. Employees involved in these types of activities shall be given off-site instruction regarding the potential hazards involved with site activities and the appropriate health and safety procedures to be followed.

These training requirements may apply to the Witco Site Investigation based on the scheduled site activities and the potential compounds present. All site personnel involved shall have received the required basic training discussed above where applicable. Exhibit 3-1 will be used by (consulting firm) to document its' Subcontractor site personnel as having met the training requirements specified in 29 CFR 1910.120. The Appropriate Health and Safety Plan shall be distributed to all site personnel and discussed prior to the start of field activities. Specialty training shall be provided as determined by task and responsibility. All training of personnel will be conducted under direct supervision of a trained Health and Safety officer.

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EXHIBIT 3-1

SUBCONTRACTOR OCCUPATIONAL SAFETY AND HEALTH CERTIFICATION

PROJECT: _____

CONTRACTOR: _____

1. Contractor certifies that the following personnel to be employed on the Witco Site have met the following requirements of the OSHA Hazardous Waste Operations Standard (29 CFR 1910.120) and other applicable OSHA standards.

Contractor Personnel	Training	Respirator Certification	Medical Examination

2. Contractor certifies that it has received a copy of the Site Safety and Health Plan and will ensure that its employees are informed and will comply with its requirements.

3. Contractor further certifies that it has read and understands and will comply with all provisions of its contractual agreement with (consulting firm) and Witco Corporation Site Representatives.

Signed _____ Date _____

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SECTION 4

SITE MONITORING AND PERSONAL PROTECTIVE EQUIPMENT

4.1 Site Monitoring

Field activities taking place during the Witco RI/FS may create potentially hazardous conditions, such as the release of hazardous substances into the breathing space. These substances may be in the form of mists, vapors, dusts, or fumes that can enter the body through ingestion, inhalation, absorption and direct contact. Other parameters that may be evaluated include explosivity, atmospheric oxygen content, toxic gas concentrations and radioactivity. Monitoring site conditions and parameters ensures appropriate personal protective measures are employed during site activities.

The following describes the monitoring parameters to be evaluated during the Witco Site Investigation. Recommended instruments to be used are also provided in the discussion. All instruments to be used during site activities must meet the established requirements set forth by OSHA, MSHA, NIOSH and state agencies where applicable. Action levels based on monitoring results are discussed in the following section.

Organic Vapor Concentrations - will be monitored routinely in the breathing space with an organic vapor meter. Organic vapor concentrations may be used as action level criteria for upgrading or downgrading protective equipment and implementing additional precautions or procedures. A backup organic vapor meter should be present throughout site activities in the event of an instrument malfunction.

Explosivity - will be monitored periodically during site activity. Measurements obtained from this instrument will be used as action level criteria for institution of additional precautions, site evacuation and protective equipment selection. An instrument capable of indicating the percentage of the lower explosive limit for substances present at the site should be utilized. Again, a backup or secondary meter is recommended during site activities.

Toxic Gas - will be monitored only during confined space activities or as warranted by information obtained

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during the site investigation. The monitoring instrument should indicate the presence of hydrogen sulfide in parts per million and signal an alarm at concentrations of 5 ppm or greater.

Radioactivity - based on available information, it is not necessary to monitor for radioactivity during project activities.

All site monitoring will be conducted by or under the supervision of the Site Safety Officer. All readings obtained will be recorded in a dedicated site notebook by the Site Operations Manager and/or Consultant. The Site Safety Officer will maintain all monitoring instruments throughout the site investigation to ensure their reliability and proper operation.

4.2 Action Levels

The following action levels have been established for activity cessation, site evacuation, emergency response, and the upgrade or downgrade in the level of personal protective equipment. Level D personal protective equipment as described in this Plan will be permitted for those activities and operations that do not pose a potential threat of exposure to toxic or hazardous substances and where concentrations of organic vapors do not exceed 25 ppm in the breathing space. This level of protection has been established based on one-half the Threshold Limit Value of Trichloroethene (TLV = 50 ppm).

Organic Vapors

Half face respirators with Level C protection as described in this plan will be used where organic vapors persist between 25-250 ppm in the breathing space. A full face respirator with the prescribed Level C ensemble will be worn where organic vapors persist between 250-900 ppm in the breathing space. Site personnel shall don self-contained breathing apparatus should organic vapor concentrations reach or exceed 900 ppm in the breathing space. The established action level is based on one-half the Threshold Limit Value of 50 ppm for Trichloroethene and a protection factor of 10 and 50 for half face and full-face respirators, respectively.

Explosivity

All site activity will cease whenever the lower explosive limit reaches or exceeds 20%. The site will then be evacuated of all personnel as quickly as

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possible. Fire officials will be informed of the situation so that effective measures can be taken to eliminate the risk of explosion. A lower explosive limit in the range of 10-20% will require the use of intrinsically safe instruments and equipment for all activity. Employees must use extreme caution under these conditions to avoid actions that may provide a source of ignition.

Toxic Gas

All site activity will cease where hydrogen sulfide concentrations reach or exceed 5 ppm. Site personnel will don self-contained breathing apparatus in order to continue activities where H_2S levels persist at or above 5 ppm.

4.3 Personal Protective Equipment

Personal protective equipment requirements must be established for the Witco Site RI/FS based on the assessment of potential hazards identified in preceding reports and site characterization (engineering controls shall also be implemented whenever possible to enhance worker protection throughout the investigation). All applicable state and federal regulations will be adhered to during the site operations regarding worker safety, engineering controls, and work practices.

The Site Safety Officer will determine whether or not a level of protection can be upgraded or downgraded. Changes in level of protection will be recorded in the dedicated site logbook along with an explanation as to why changes were made. Level D protection may be used for those activities that do not pose a potential threat of exposure to toxic or hazardous substances. Level C protection will be required as determined by action levels stated in the preceding section.

Level B Protection

a. Pressure demand cascade air system or other suitable self-contained, pressure demand breathing apparatus.

b. Chemical-resistant clothing such as Poly-coated Tyvek® or Saranex®. Suits will be one piece with booties and elastic wrist bands.

c. Outer nitrile and inner latex surgical gloves (both chemical resistant).

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d. Leather boots with rubber overboots.

e. Chemical-resistant tape over protective clothing as necessary.

f. Options as required:

1. Coveralls
2. Disposable outer boots
3. Face shield
4. Escape mask as appropriate
5. Hard hat
6. Ear protection

Level C Protection

a. Full-face/half-face air purifying respirator equipped with appropriate organic vapor canisters or cartridges must be worn (all personnel requiring respiratory protection are fit tested with the respirator to be used in the field). Dust pre-filters will be available and utilized as warranted by site conditions.

b. Chemical-resistant clothing such as Poly-coated Tyvek® or Saranex®. Suits will be one piece with booties and elastic wrist bands.

c. Outer nitrile gloves and inner latex surgical gloves.

d. Leather boots with rubber overboots.

e. Options as required:

1. Coveralls
2. Disposable outer boots
3. Escape mask
4. Hard hat
5. Face shield
6. Ear protection
7. Safety glasses
8. Chemical-resistant tape

Level D Protection

a. Coveralls or long sleeve shirts and long pants.

b. Outer nitrile gloves at a minimum. Inner latex surgical gloves are recommended where pratical.

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c. Leather boots with rubber overboots.

d. Options as required

1. Disposable outer boots
2. Hard hat
3. Safety glasses
4. Ear protection

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SECTION 5

DECONTAMINATION

5.0 General

Personnel involved with the Witco Site activities may be exposed to compounds in a number of ways, despite the most stringent protective procedures. Site personnel may come in contact with vapors, gases, mists, or particulates in the air, or may come in contact with site media while performing site duties. Use of monitoring instruments and site equipment can also result in exposure to hazardous substances.

In general, decontamination involves scrubbing with an Alconox/water solution followed by clean water rinses. All disposable items shall be disposed of in a dry container. Certain parts of contaminated respirators, such as harness assemblies and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. In addition to being decontaminated, all respirators, non-disposable protective clothing, and other personal articles must be sanitized before they can be used again if they become soiled from exhalation, body oils, and perspiration. The manufacturer's instructions should be followed in sanitizing the respirator masks. The Site Safety Officer will be responsible for the proper maintenance, decontamination, and sanitizing of all respirator equipment.

The decontamination zone layout and procedures should match the prescribed levels of personal protection. A detailed discussion for the establishment of the decontamination zone and the procedures required for the various levels of personnel protection follows:

> Exclusion Zone (EZ). The site of activity, it is considered to be potentially contaminated. Appropriate personal protective equipment must be worn while in this zone. This zone is normally separated from the contaminant reduction zone by a 'hotline' or barrier to prevent personnel from entering the exclusion zone boundary without protective equipment. The exclusion zone will extend to an area that exhibits background levels of monitoring parameters. At a minimum, this zone will radiate to a distance of 20 feet from the point of operations.

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Contaminant Reduction Zone (CRZ). It is within this zone that the decontamination process is under way. Personnel and their equipment must be adequately decontaminated before leaving this zone for the support zone.

Support Zone (SZ). The support zone is considered to be uncontaminated; as such, protective clothing and equipment are not required but should be available for use in emergencies. All equipment and materials are stored and maintained within this zone. Protective clothing is put on in the support zone before entering the contaminant reduction zone.

The nature of the Witco Site activities is such that the establishment of a decontamination line may not be practical for all site employees and activities. The following procedures have been established to provide site personnel with minimum guidelines for proper decontamination. These minimum procedures must be followed by personnel leaving the point of operations designated as the exclusion zone. The decontamination process shall take place at a reasonable distance away from any area of potential contamination.

5.2 Minimum Decontamination Procedure

Personnel leaving the point of operations should wash outer gloves and boots whenever possible. At a minimum, the outer boots shall be removed first and stored in an appropriate area or properly disposed of. Outer boots must be properly washed where gross contamination is evident. Personnel shall then remove and dispose of the Tyvek coveralls. Personnel should remove the Tyvek coveralls so that inner clothing does not come in contact with any contaminated surfaces. After Tyvek removal, personnel shall remove and discard outer nitrile gloves. Personnel shall then remove the respirator, where applicable. Respirators shall be disinfected between use with towelettes or other sanitizing methods. A wash station, at a minimum, will be present so that site personnel can thoroughly wash hands and face after leaving the point of operations. A portable shower unit may be necessary depending on prevalent site conditions or particular activities.

Portable wash stations shall be utilized for easy and efficient access. The wash station shall consist of a potable water supply, hand soap and clean towels. Portable sprayer units filled with Alconox solution and potable water should also be available to wash and rinse off grossly contaminated boots, gloves and equipment. The Site Safety Officer will monitor decontamination procedures to ensure their effectiveness.

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Modifications of the decontamination procedure may be necessary as determined by the Site Safety Officer's observations.

5.3 Standard Decontamination Procedure

The following is a typical decontamination procedure for Level B Personal Protective Equipment. Site personnel should employ the appropriate steps based on the level of protection employed whenever possible.

Level B - Personal Protection Decontamination Procedure

Step 1 -- Segregated Equipment Drop

Deposit equipment (tools, sampling devices, notes, monitoring instruments, radios, etc.) used on the site onto plastic drop cloths.

Step 2 -- Boot Covers and Glove Wash

Outer boot covers and outer gloves should be scrubbed with a decontamination solution of detergent and water.

Step 3 -- Rinse Off Boot Covers and Gloves

Decontamination solution should be rinsed off boot covers and gloves using generous amounts of water. Repeat as many times as necessary.

Step 4 -- Tape Removal

Remove tape from around boots and gloves and place into container with plastic liner.

Step 5 -- Boot Cover Removal

Remove disposable boot covers and place into container with plastic liner.

Step 6 -- Outer Glove Removal

Remove outer gloves and deposit in container with plastic liner.

Step 7 -- Suit/Safety Boot Wash

Completely wash splash suit, SCBA, gloves, and safety boots. Care should be exercised that no water is allowed into the SCBA regulator. It is suggested that the SCBA regulator be wrapped in plastic.

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Step 8 -- Suit/Safety Boot Rinse

Thoroughly rinse off all decontamination solution from protective clothing.

Step 9 -- Tank Changes/Canister Changes

This is the last step in the decontamination procedure for those workers wishing to change air tanks and return to the exclusion zone. The worker's air tank or canister is exchanged, new outer glove and boot covers are donned, and joints taped.

Step 10 -- Removal of Safety Boots

Remove safety boots and deposit in container with a plastic liner.

Step 11 -- SCBA Backpack Removal

Without removing face piece, the SCBA backpack should be removed and placed on a table. The face piece should then be disconnected from the remaining SCBA unit and then proceed to the next station.

Step 12 -- Splash Suit Removal

With care, remove splash suit. The exterior of the splash suit should not come in contact with any inner layers of clothing.

Step 13 -- Inner Glove Wash

The inner gloves should be washed with a mild decontamination solution (detergent/water).

Step 14 -- Inner Glove Rinse

Generously rinse inner gloves with water.

Step 15 -- Face Piece Removal

Without touching face with gloves, remove face piece. Face piece should be deposited into a container which has a plastic liner.

Step 16 -- Inner Glove Removal

Remove inner glove and deposit in container with plastic liner.

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Step 17 -- Field Wash

Wash hands and face thoroughly. If highly toxic, skin-corrosive, or skin-absorbent materials are known or suspected to be present, a shower should be taken.

Level C and Level D Personal Protection Decontamination Procedure

This decontamination procedure for Level C and Level D personal protection will employ applicable steps detailed in the Level B decontamination process.

5.3 Sampling Equipment and Sample Container Decontamination

All non-disposable sampling equipment will be decontaminated with an Alconox/water solution followed by a clean water rinse. As an added precaution against cross-contamination, all non-disposable sampling equipment will be rinsed with distilled water. All disposable sampling equipment will be properly disposed of in dry containers.

Before leaving the site, all sample containers will be thoroughly decontaminated using an Alconox/water solution followed by a clean water rinse. The decontamination procedure should include a complete scrubbing of the container's surface to remove possible contamination. Care must be exercised to prevent damage to sample container identification labels.

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SECTION 6

SITE CONTROL AND COMMUNICATIONS

6.0 Site Access

Access to the Witco Site activities must be limited to authorized personnel. Such personnel include (consulting firm) employees, designated equipment operators, and designated Witco Corporation representatives. However, access into the established exclusion zone will be limited to those personnel wearing appropriate personal protective equipment. The exclusion zone will be cordoned off with flagging tape or other suitable indicators designating the exclusion zone boundary. The zone will also be monitored by the Site Safety Officer to ensure personnel do not enter without proper personal protection.

Sign-in procedures may be implemented to ensure that authorized personnel only will participate in the investigatory activities. The Site Operations Manager will coordinate this effort and maintain the generated documentation accordingly.

6.1 Site Control

The Witco Site is secured by fencing, however, the site is not routinely patrolled by police or any independent security department. Thus, certain procedures must be followed to ensure suitable site control and limitation of access so that those persons who may be unaware of site conditions are not exposed to inherent hazards.

Well caps will be secured by suitable locking devices to prevent unauthorized access. All heavy machinery and equipment shall be locked or chained each evening upon completion of daily activities. All potentially contaminated media, such as purged ground water, cuttings, and soils, will be covered with plastic prior to leaving the site each day.

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SECTION 7

EMERGENCY RESPONSE

7.0 Emergency Response

In the event of an emergency, site personnel shall signal distress with three blasts from an appropriate horn (car horn, air horn, etc.). All appropriate authorities will then be immediately notified of the nature and extent of the emergency. Medical personnel will be informed of site hazards and activities prior to project initiation so that emergency situations can be handled most efficiently. Table 7-1 provides a list of important telephone numbers for use in necessary situations.

7.1 Responsibilities

The Site Safety Officer will be responsible for responding to all emergencies. The Site Safety Officer will:

1. Notify appropriate individuals, authorities and/or health care facilities of the activities and hazards of the investigation. Table 7-1 will be posted within the field office or any other visible location.

2. Ensure that the following safety equipment is available at the site: eyewash station, first aid supplies, and fire extinguishers.

3. Have working knowledge of all safety equipment available at the site.

4. Ensure that a map which details the most direct route to the nearest hospital shall be prominently posted with the emergency telephone numbers.

7.2 Accidents and Injuries

In the event of a safety or health emergency at the site, appropriate emergency measures must immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The Site Safety Officer will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in First-Aid should be present during

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site activities to provide appropriate treatment of injuries or illnesses incurred during operations.

7.3 Site Communications

Two-way radios may be used during the Witco Site RI/FS activities to facilitate field communications. Hand signals may also be utilized where radios are impractical or unsafe. If possible, mobile phones should be present during site activities for emergency response and office communications. Public telephones will be located prior to the start-up of activities as back up to the mobile phones or as the primary off-site communication network.

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TABLE 7-1

TELEPHONE NUMBER LIST

Affiliation (Name)	Telephone Number
(Consulting Firm) Designated Representative and Project Manager	
(Consulting Firm) Site Manager	
Witco Designated Representative and Project Manager	
(Consulting Firm) Site Safety Officer	
(Consulting Firm) Health and Safety Coordinator	

Emergency

Police	- New Castle City Department	- (302) 322-9800
Fire	- Goodwill	- 911
Ambulance	- Goodwill	- 911

Hospital
Address: - Christiana Hospital
4755 Ogletown/Stanton Road
Newark, Delaware 19718

(302) 733-1000

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SECTION 8

SPECIAL PRECAUTIONS AND PROCEDURES

8.0 Potential Risks

The Witco Site RI/FS poses potential exposure risks to both chemical and physical hazards. The chemical risks have been explained in detail in the previous sections. The potential for chemical exposure to hazardous substances is significantly reduced through the use of personal protective clothing, engineering controls and implementation of safe work practices.

Other potential hazards that are associated with the site activities include injury from heavy equipment, heat stress, construction refuse, and underground utilities. Precautionary measures have been established to reduce these risks to a minimum during site activities.

8.1 Heat Stress

The timing of this project is such that heat stress may pose a threat to the safety of site personnel. Work/Rest regimens will be employed as necessary so that personnel do not suffer adverse effects from heat stress. Special clothing and an appropriate diet and fluid intake will be recommended to all site personnel to further reduce heat stress hazards.

8.2 Heavy Machinery/Equipment

All site employees must remain aware of those site activities that involve the use of heavy equipment and machinery. Respiratory protection and protective eyewear may be worn frequently during site activities. This protective equipment significantly reduces peripheral vision of the wearer. Therefore, it is essential that all employees at the site exercise extreme caution during operation of equipment and machinery to avoid physically injury to themselves or others.

8.3 Construction Materials and Site Refuse

All construction materials and site refuse should be contained in appropriate areas or facilities. Site personnel should make certain that nails, lumber, cement etc. are not scattered

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throughout the area of activity and that all trash and scrap materials are immediately and properly disposed of.

8.4 Underground Utilities

Underground utilities such as electrical lines, gas lines, industrial sewers etc. must be identified and located prior to start-up of any activity involving subsurface operations. Such activities include soil borings and well installation.

8.5 Confined Space Entry

Site personnel must obtain prior written permission from a trained health and safety officer in order to enter any confined or semi-confined space. Confined or semi-confined space entry requires, at a minimum, continuous monitoring for organic vapors, toxic gas, atmospheric oxygen, and explosive conditions. Monitoring results will indicate whether the area can be entered safely, and if so, will determine the level of personal protection necessary for confined space activities. Five minute escape masks at a minimum must be readily available to all employees entering the confined or semi-confined space. Other precautions include the use of lifeline and life harness as determined by site conditions and activities.

8.6 Additional Safety Practices

The following are important safety precautions which will be enforced during this investigation:

1. Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases that probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated.

2. Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking, or any other activity.

3. Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

4. No excessive facial hair which interferes with the effectiveness of a respirator will be permitted on personnel required to wear respiratory protection equipment. The respirator must seal against the face

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so that the wearer receives air only through the air purifying cartridges attached to the respirator. Fit testing shall be performed prior to respirator use to ensure a proper seal is obtained by the wearer.

5. Contact with potentially contaminated surfaces should be avoided whenever possible. One should not walk through puddles, mud, or other discolored surfaces; kneel on ground; lean, sit or place equipment on drums, containers, vehicles, or the ground.

6. Medicine and alcohol can potentiate the effect from exposure to certain compounds. Prescribed drugs and alcoholic beverages should not be consumed by personnel involved in the project.

7. Personnel and equipment in the work areas should be minimized, consistent with effective site operations.

8. Work areas for various operational activities should be established.

9. Procedures for leaving the work area must be planned and implemented prior to going to the site. Work areas and decontamination procedures must be established on the basis of prevailing site conditions.

10. Respirators will be issued for the exclusive use of one worker and will be cleaned and disinfected after each use.

11. Safety gloves and boots shall be taped to the disposable, chemical-protective suits as necessary.

12. All unsafe equipment left unattended will be identified by a "DANGER, DO NOT OPERATE" tag.

13. Noise mufflers or ear plugs may be required for all site personnel working around heavy equipment. This requirement will be at the discretion of the Site Safety Officer. Disposable, form-fitting plugs are preferred.

14. Cartridges for air-purifying respirators in use will be changed daily at a minimum.

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APPENDIX C

SOIL CONCENTRATION AND GROUND WATER
QUALITY DATA -
TRACE OR NON-DETECTABLE CONSTITUENTS

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Soil Concentration Data

Nitco Chemical Company
Other Constituents not detected or present at <10 ppb
(all values in ppb)

Parameter	Detection Limit	Date Sampled, Sampler	Boring Locations
Alkyl substituted benzenes	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Propyl benzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Trimethylxylenol	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
1,2,3-Trichloropropane	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Benzene	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Bis(chloromethyl)ether	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Bromoform	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Carbon tetrachloride	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Chlorobenzene	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Chlorodibromomethane	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Chloroethane	20	5/19-20/83, PAS	1,2,3,4,5,6,7
2-Chloroethylvinyl ether	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Dichlorobromomethane	20	5/19-20/83, PAS	1,2,3,4,5,6,7
Dichlorodifluoromethane	20	5/19-20/83, PAS	1,2,3,4,5,6,7
1,1-Dichloroethane	20	5/19-20/83, PAS	1,3,3,4,5,6,7
1,2-Dichloroethane	20	5/19-20/83, PAS	1,2,3,4,5,6,7
1,1-Dichloroethylene	20	5/19-20/83, PAS	1,2,3,4,5,6,7
1,2-Dichloropropane	20	5/19-20/83, PAS	1,2,3,4,5,6,7

[a] Detection limit = 5000 ppb

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Soil Concentration Data

Nitco Chemical Company
Other Constituents not detected or present at <10 ppb
(all values in ppb)

Parameter	Detection Limit	Date Sampled, Sampler	Boring Locations
1,2-Dichloropropylene	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Ethylbenzene	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Methyl bromide	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Methyl chloride	20	9/19-20/83, PAS	1,2,3,4,5,6,7
1,1,2,2-Tetrachloroethane	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Tetrachloroethylene	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Trans 1,2-Dichloroethylene	20	9/19-20/83, PAS	1,2,3, ,5,6,7
1,1,1-Trichloroethane	20	9/19-20/83, PAS	1,2,3,4,5,6,7
1,1,2-Trichloroethane	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Trichloroethylene	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Trichlorofluoromethane	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Vinyl Chloride	20	9/19-20/83, PAS	1,2,3,4,5,6,7
Acenaphthene	50	9/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Acenaphthylene	50	9/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Benzo(b)fluoranthene	50	9/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Benzo(k)fluoranthene	50	9/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Benzo(a)pyrene	50	9/19-20/83, PAS	1,2,3,4,5[a],6,7[a]

[a] Detection limit = 5000 ppb

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Soil Concentration Data

Witco Chemical Company
Other Constituents not detected or present at <10 ppb
(all values in ppb)

Parameter	Detection Limit	Date Sampled, Sampler	Boring Locations
Benzo(g,h,i)perylene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Benzidine	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Bis(2-chloroethyl)ether	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Bis(2-chloroethoxy)methane	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Bis(2-ethylhexyl)phthalate	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Bis(2-chloroisopropyl)ether	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
4-Bromophenyl phenyl ether	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Butyl benzyl phthalate	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
2-Chloronaphthalene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
4-Chlorophenyl phenyl ether	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Chrysene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Dibenzo(a,h)anthracene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
1,2-Dichlorobenzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
1,3-Dichlorobenzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
1,4-Dichlorobenzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
3,3'-Dichlorobenzidene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Diethylphthalate	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Dimethylphthalate	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
2,4-Dinitrotoluene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
2,6-Dinitrotoluene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]

[a] Detection limit = 5000 ppb

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Soil Concentration Data

Nitco Chemical Company

Other Constituents not detected or present at <10 ppb

(all values in ppb)

Parameter	Detection Limit	Date Sampled, Sampler	Boring Locations
Di-n-octylphthalate	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
1,2-Diphenylhydrazine	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Fluorene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Hexachlorobenzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Hexachlorobutadiene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Hexachlorocyclopentadiene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Hexachloroethane	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Indeno(1,2,3-c,d)pyrene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Isophorone	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
Nitrobenzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
N-Nitrosodimethylamine	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
N-Nitrosodi-n-propylamine	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
N-Nitrosodiphenylamine	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]

[a] Detection limit = 5000 ppb

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Soil Concentration Data

Nitco Chemical Company
Other Constituents not detected or present at <10 ppb
(all values in ppb)

Parameter	Detection Limit	Date Sampled, Sampler	During Locations
Phenanthrene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
2,3,7,8-tetrachloro-dibenzo-p-dioxin	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]
1,2,4-trichlorobenzene	50	5/19-20/83, PAS	1,2,3,4,5[a],6,7[a]

[a] Detection limit = 5000 ppb

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Ground Water Quality Data

Hilton Chemical Company
Compounds Not Detected or Present at <10 ppb

Pesticide Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Aldrin	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
BHC-alpha	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
BHC-beta	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
BHC-gamma	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
BHC-delta	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Chlordane	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
op'-DDD	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
pp'-DDE	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
op'-DDT	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Dieldrin	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Endosulfan-alpha	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Endosulfan-beta	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11

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Ground Water Quality Data

Witco Chemical Company
Compounds Not Detected or Present At <10 ppb

Pesticide Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Endosulfan Sulfate	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Endrin	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Endrin Aldehyde	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Heptachlor	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Heptachlor Epoxide	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Toxaphene	5	1/10/83, PAS	1-11,16,21,22,23 24,PW11

300452

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Ground Water Quality Data

Nitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Acid Extractable Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
4-Chloro-3-Methylphenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
2-Chlorophenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
2,4-Dichlorophenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
2,4-Dimethylphenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
2,4-Dinitrophenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
2-Nitrophenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
4-Nitrophenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Phenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
2,4,6-Trichlorophenol	10	1/10/83, PAS	1-11,16,21,22,23 24,PW11
Base Neutral Extractable Organic Compounds			
Acenaphthene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Acenaphthylene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

30043

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Ground Water Quality Data

Mitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Anthracene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Benzo(a)anthracene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Benzo(b)fluoranthene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Benzo(k)fluoranthene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Benzo(a)pyrene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Benzo(g,h,i)perylene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Benzidine	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

30041

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Ground Water Quality Data

Witco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Bis(2-chloroethyl)ether	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Bis(2-chloroethoxy)methane	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Bis(2-chloroisopropyl)ether	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
4-Bromophenyl phenyl ether	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
2-Chloronaphthalene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
4-Chlorophenyl Phenyl Ether	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Chrysene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

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Ground Water Quality Data

Mitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	Detection Limit, ppb	Date Sampled, Sampler	Well:
Dibenzo(a,h)anthracene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Di n butylphthalate	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
1,2-Dichlorobenzene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
1,3-Dichlorobenzene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
1,4-Dichlorobenzene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
3,3'-Dichlorobenzidene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Diethyl Phthalate	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

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Ground Water Quality Data

Witco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Dimethyl Phthalate	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
2,4-Dinitrotoluene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
2,6-Dinitrotoluene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Di-n-octylphthalate	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
1,2-Diphenylhydrazine	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Fluoranthene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

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Ground Water Quality Data

Witco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	*Detection* Limit, ppb	Date Sampled, Sampler	Wells
Fluorene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Hexachlorobenzene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Hexachlorobutadiene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Hexachloroethane	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Hexachlorocyclopentadiene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Indeno(1,2,3-c,d)pyrene	10	1/10/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

300423

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Ground Water Quality Data

Mitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Isophorone	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29, 30,PW11
Naphthalene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29, 30,PW11
Nitrobenzene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29, 30,PW11
N-Nitrosodimethylamine	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29, 30,PW11
N-Nitrosodi-n-propylamine	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29, 30,PW11
N-Nitrosodiphenylamine	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	5/19-20/83, PAS	16,21,23,24, 28,29, 30,PW11

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Ground Water Quality Data

Nitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Base Neutral Extractable Organic Compounds	Detection Limit, ppb	Date Sampled, Sampler	Wells
Phenanthrene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
Pyrene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
2,3,7,8-tetrachloro-dibenzo-p-dioxin	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11
1,2,4-trichlorobenzene	10	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	20	9/19-20/83, PAS	16,21,23,24, 28,29,30,PW11

30042

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Ground Water Quality Data

Wilco Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
cis-1,2-Dichloroethylene	Unknown	9/19-20/83, Ecology and Environment	8,9,16,21,23,24, 28,29,30,PW11
	Unknown	6/21/84, EPA	1-10,21,22,30,PW11
Carbon disulfide	Unknown	6/21/84, EPA	1,3,4,8,9,10,22, 30,PW11
Chloromethane	Unknown	6/21/84, EPA	1,3,4,30,PW11
1,1 Dichloroethylene	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	Unknown	9/19-20/83, Ecology and Environment	8,9,16,21,23,24, 28,29,30,PW11
	1	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	1	9/11/84, EIM	1-7,8[b],9-11,21,22[b],30
	1	6/21/84, EPA	8,9,10,22
	30	12/10/84, EIM	8
trans-1,2-dichloroethylene	1	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	Unknown	9/19-20/83, Ecology and Environment	8,9,16,21,23,24, 28,29,30,PW11
	1	9/11/84, EIM	1-11,21,22[b],30
	Unknown	6/21/84, EPA	8,9,10,22
	1	12/10/84, EIM	8

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Ground Water Quality Data

Nitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
Dimethyl cyclopentane	Unknown	6/21/84, EPA	8,9,10,22
Dimethyl cyclohexane	Unknown	6/21/84, EPA	8,9,10,22
Methyl cyclohexane	Unknown	6/21/84, EPA	8,9,10,22
Benzene	5	1/10/83, PAS	1-11,16,21,22,23,24,PW11
	1	5/19-20/83, PAS	8[a],16,21,23,24,28,29,30,PW11
	1	5/17/84, EHM	1-11,21,22[d],30
	1	12/10/84, EHM	8
Chlorobenzene	1	1/10/83, PAS	1-11,16,21,22,23,24,PW11
	1	5/19-20/83, PAS	8[a],16,21,23,24,28,29,30,PW11
	Unknown	5/19-20/83, Ecology and Environment	8,9,16,21,23,24,28,29,30,PW11
	1	5/17/84, EHM	1-11,21,22,30
	1	12/10/84, EHM	8
Chloromethane	1	1/10/83, PAS	1-11,16,21,22,23,24,PW11
	1	5/19-20/83, PAS	8[a],16,21,23,24,28,29,30,PW11
	5	5/17/84, EHM	1-11,21,22,30
	5	12/10/84, EHM	8
	0.1[b]	4/1-4/86, HCHLC	PW11

300420

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Ground Water Quality Data

Witco Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
Bromomethane	1	1/81/83, PAS	1-11,16,21,22,23, 24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	5	9/11/84, EHM	1-11,21,22,30
	5	12/10/84, EHM	8
2-Chloroethylvinyl ether	1	1/10/83, PAS	1-11,16,21,22,23, 2[illegible],PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	1	9/11/84, EHM	1-11,21,22,30
	10	12/10/84, EHM	8
Vinyl chloride	1	1/10/83, PAS	1-[illegible],16,21,22,23, 2[illegible],PW11
	1	[illegible]/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	Unknown	9/19-20/83 Ecology and Environment	8,9,16,21,23,24 28,29,30,PW11
	1	9/11/84, EHM	1-11,21,22,30
	1	12/10/84, EHM	8
Chloroethane	1	1/10/83, PAS	1-11,16,21,22,23 24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	1	9/11/84, EHM	1-11,21,22,30
	1	12/10/84, EHM	8

300129

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Ground Water Quality Data

Nitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Found	Detection Limit, ppb	Date Sampled, Sampler	Wells
1,1 Dichloroethane	1	1/18/83, PAS	1-11,16,21,22,23 24,PW11
	1	9/19-20/83, PAS	8[a], 16,21,23,24, 28,29,30,PW11
	1	5/11/84, EIM	1-11,21,22[b],30
	1	12/18/84, EIM	8
Chloroform	1	1/18/83, PAS	1-11,16,21,22,23 24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	Unknown	9/19-20/83 Ecology and Environment	8,9,16,21,23,24, 28,29,30,PW11
	1	5/11/84, EIM	1-11,21,22[b],30
	1	12/18/84, EIM	8
1,2, Dichloroethane	1	1/18/83, PAS	1-11,16,21,22,23 24, PW11
	1	9/19-20/83, PAS	8[a], 16,21,23,24, 28,29,30,PW11
	1	5/11/84, EIM	1-11,21,22[b],30
	1	12/18/84, EIM	8

50042

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Ground Water Quality Data

Nitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
1,1,1, trichloroethane	1	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	1	5/19-20/83, PAS	8[a], 16,21,23,24, 28,29,30,PW11
	Unknown	5/19-20/83, Ecology and Environment	8,9,16,21,23,24, 28,29,30,PW11
	1	5/17/84, EHM	1-11,21,22[d],30
	1	12/18/84, EHM	8
Carbon tetrachloride	1	1/18/83, PAS	1-11,16,21,22, 23,24,PW11
	1	5/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	Unknown	5/19-20/83, Ecology and Environment	8,9,16,21,23,24, 28,29,30
	1	5/17/84, EHM	1-11,21,22[d],30
	1	12/18/84, EHM	8
Dichlorobromomethane	1	1/18/83, PAS	1-11,16,21,22, 23,24,PW11
	1	5/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	1	5/17/84, EHM	1-11,21,22[d],30
	1	12/18/84, EHM	8
O-xylene	Unknown	8/21/84 EPA	8,9,21,28,29,PW11

30142

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Ground Water Quality Data

Niton Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
1,2 Dichloropropane	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	1	9/11/84, EHM	1-11,21,22[d],30
	1	12/10/84, EHM	8
Trans-1,3 dichloropropene	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/11/84, EHM	1-11,21,22[d],30
	1	12/10/84, EHM	8
Dibromochloromethane	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	1	9/11/84, EHM	1-11,21,22,30
	1	12/10/84, EHM	8
1,1,2 Trichloroethane	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	1	9/11/84, EHM	1-11,21,22,30
	1	12/10/84, EHM	8

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Ground Water Quality Data

Mitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
cis-1,3-Dichloropropene	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/11/84, EHM	1-11,21,22,30
	1	12/10/84, EHM	8
Bromoform	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	2	9/11/84, EHM	1-11,21,22,30
	2	12/10/84, EHM	8
1,1,2,2-Tetrachloroethane	1	1/10/83, PAS	1-11,16,21,22, 23,24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
	Unknown	9/19-20/83 Ecology and Environment	8,9,16,21,23,24, 28,29,30,PW11
	2	9/11/84, EHM	1-11,21,22,30
	2	12/10/84, EHM	8
Propyl benzene	20	9/19-20/83 PAS	8,16,21,23,24, 28,29,30,PW11
Trimethyl xylenol	20	9/19-20/83, PAS	8,16,21,23,24, 28,29,30,PW11

300453

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Ground Water Quality Data

Vitco Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection Limit, ppb	Date Sampled, Sampler	Wells
1,2,3 Trichloropropane	1	9/19-20/83, PAS	8,16,21,23,24, 28,29,30,PW11
Bis(2-chloromethyl)ether	1	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
1,2 Dichloropropylene	1	1/18/83, PAS	1-11,16,21,22,23, 24,PW11
	1	9/19-20/83, PAS	8[a],16,21,23,24, 28,29,30,PW11
Styrene	Unknown	9/19-20/83, Ecology and Environment	8,9,16,21,23,24 28,29,30,PW11
Polychlorinated biphenyls	0.29	1/30/78, EPA	1, PW11
	Unknown	8/28/78, EPA	1,2,3,11
	0.17[a]	2/5/80, BCH	PW11
	0.11[a]	2/19/80, BCH	1-11,15,16,17,PW11
	0.050[a]	3/24/80, BCH	PW11
	0.019[a]	4/1/80, BCH	PW11

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Ground Water Quality Data

Nitro Chemical Company
Compounds Not Detected or Present at <10 ppb

Compound	Detection limit, ppb	Date Sampled, Sampler	Wells
Polychlorinated biphenyls	0.02	6/26,7/11/80, BCM	21[b], 22[b], 23, 24, 25, 26, 27, 28, 29
	5	1/10/85, PAS	1-11, 16, 21, 22, 23, 24, Pell
	10	5/13-20/85, PAS	5, 16, 21, 23, 24, 28, 29, 30, Pell
	Unknown	5/13-20/85, Ecology and Environment	5, 9, 14, 21, 23, 24, 28, 29, 30, Pell

[a] Detection limit = 5 ppb
[b] Detection limit = 50 ppb
[c] Detection limit = 0.014 ppb
[d] Detection limit = 10 ppb
[e] Detection limit = 20 ppb

[f] Detected at all wells sampled, highest value found

Sampler abbreviations:

PAS = Princeton Aquasciences
EPA = Environmental Protection Agency
BCM = BCM, Inc. (Duffield Associates)
NCWLC = New Castle Water and Light Commission

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