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SUBSURFACE INVESTIGATION For The CONRAIL RAILYARD

ELKHART, INDIANA

NOVEMBER 10, 1989

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PREPARED BY:
GROUNDWATER TECHNOLOGY, INC.
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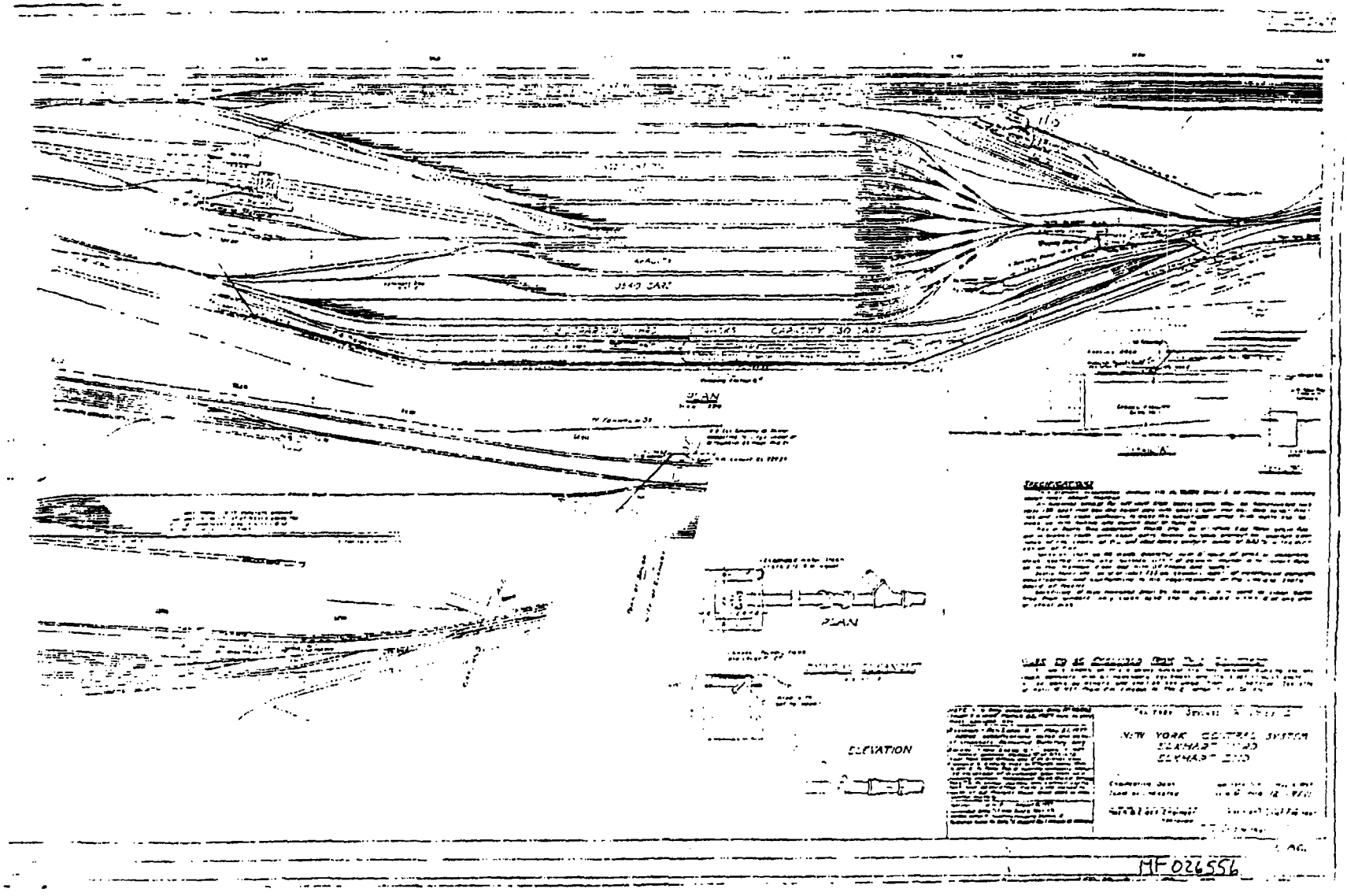

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SUBSURFACE INVESTIGATION
FOR THE
CONRAIL ELKHART RAILYARD

ELKHART, INDIANA

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SUBSURFACE INVESTIGATION
FOR THE
CONRAIL ELKHART RAILYARD

ELKHART, INDIANA

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EXECUTIVE SUMMARY

Background

Since July of 1983, local, state and federal agencies have investigated several areas in and around Elkhart, Indiana, for volatile organic chemical impacts to groundwater. The organic chemicals of concern in all cases involved chlorinated solvents - mainly trichloroethene and its breakdown products, but also chloroform, carbon tetrachloride, and perchloroethylene.

In 1986, Roy F. Weston, Inc., (a U.S. EPA contractor) conducted a city-wide groundwater investigation. The report which Weston issued following that investigation identified numerous isolated groundwater areas which had been impacted by organic chemicals.

Two of the allegedly affected areas are downgradient from the Elkhart, Indiana railyard of the Consolidated Rail Corporation ("Conrail"). The Conrail Elkhart Railyard is a rectangular parcel of land running east to west, measuring 2 miles by one-half mile, or approximately 675 acres.

Weston then performed a cursory and biased sampling investigation of the Conrail Railyard. A single soil sample taken during that limited investigation revealed a low concentration of carbon tetrachloride (0.117 ppm). Based on this single sample, the U.S. EPA proposed that the Conrail Elkhart Railyard be placed on the National Priority List (NPL), at 53 Federal Register 23986 (June 24, 1988).

For reasons unknown, the EPA has been unwilling to give anything but slight consideration to evidence that several other industries which are downgradient of the Railyard (including the so-called "Martin Drum Site"), could very possibly be the actual source of the well contamination in the City of Elkhart.

Conrail's independent review of historic and current operational information did not reveal that any significant volume of chlorinated volatile organics were ever stored, spilled, used or disposed of on the property. Nevertheless, Conrail retained an independent consultant, Groundwater Technology, Inc., to both respond to U.S. EPA's proposed NPL listing, and to design and implement an independent subsurface investigation to determine whether the Conrail Yard was a source of the downgradient contamination. The following subsurface investigation resulted from the implementation of that design.[1]

---

[1] Prior to executing the work plan designed by Groundwater Technology, Conrail submitted the plan to U.S. EPA for its comments and criticisms, if any. The EPA, however, failed to comment upon, or even to acknowledge, the plan. Conrail nevertheless directed Groundwater Technology to move forward on the plan so that the source of the contamination could be identified, consistent with the dictates of the National Contingency Plan.

Conclusions

- The purpose of this Subsurface Investigation was to obtain an independent consultant's evaluation of the allegation by U.S. EPA that Conrail's Elkhart Railyard is the major, if not the sole source of certain subsurface contamination which was discovered downgradient of the Railyard.

- The five specific compounds which EPA identified in their NPL Hazard Ranking System document to be of concern were all chlorinated compounds: trichloroethene, chloroform, carbon tetrachloride, perchloroethylene, and dichloroethane.

- The investigation set forth in this Report included the sampling of soils at 24 random locations throughout the Railyard as well as 18 "biased" locations which were identified by U.S. EPA in their reports as the most likely areas where the chlorinated compounds would be located.

- A total of 52 soil samples were analyzed from the 24 random locations. Of this total, only 3 samples, (less than 6% of the random samples), contained quantifiable amounts of the chlorinated volatile organics of concern.

- The concentrations of the chemicals of concern which were found in the three soil samples in question were in the range of 0.51 of CCl_4 to 7.5 ppm of TCE.

- A total of 36 soil samples were analyzed from the 18 "biased" locations. Of this total, none of the samples contained quantifiable amounts of the chlorinated volatile organics of concern.

- Of the 88 total soil samples analyzed, only 3 samples, or less than 4 percent, contained quantifiable amounts of the chemicals of concern.

- The investigation also included the installation and sampling of 7 randomly located groundwater monitoring wells and 3 "biased" groundwater monitoring wells. Only 2 of the groundwater well samples (one random, one biased), contained quantifiable amounts (above the detection limit of 0.2 ppb) of the chlorinated volatile organics of concern. Furthermore, the concentrations of these organics in the Railyard wells were one to two orders of magnitude <u>less</u> than the concentrations of the same organics found in downgradient domestic wells of the County Road 1 area.

- The fact that the contaminants of interest were found at only two soil locations and only two groundwater locations, coupled with the fact that even at these locations the concentration levels of the contaminants were extremely low when compared to the significant contamination found downgradient of the Railyard, strongly suggest that EPA's speculations and conclusions about Conrail's contribution to the contamination are unjustified, and that other sources downgradient of the Railyard should be carefully investigated.

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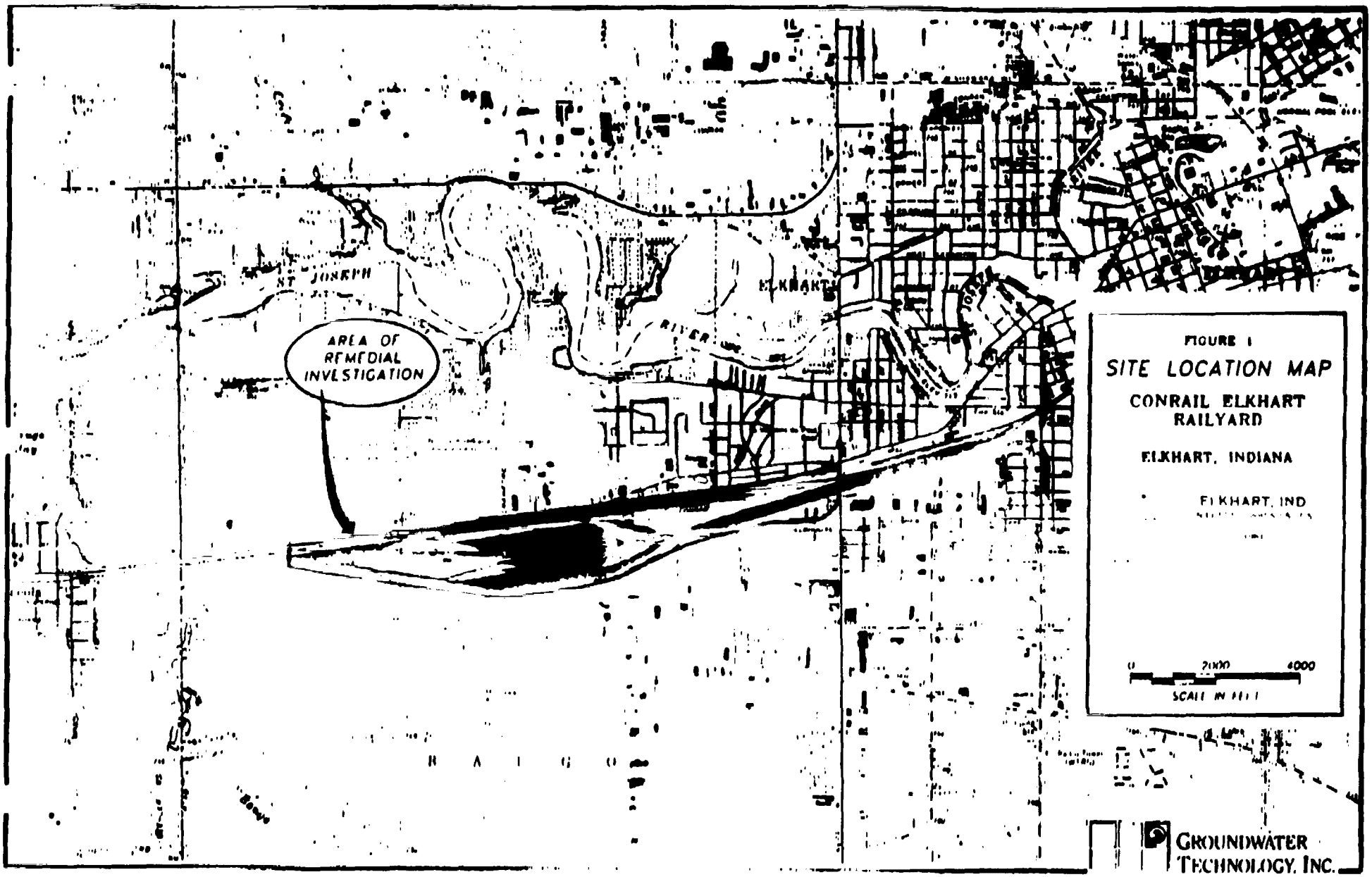
1.0 INTRODUCTION

1.1 Site Background Information

The Conrail Elkhart Railyard (Railyard) is located in the southwestern portion of Elkhart, Indiana (Figure 1). Major industrial activities in the Elkhart area include the manufacture of pharmaceuticals, furniture, recreation vehicles, mobile homes, and band instruments (Imbrigiotta, 1981). The Railyard is situated at the junction of principal Conrail routes from the East, Northeast and Mid-Atlantic states, and is considered to be Conrail's gateway yard connecting the Chicago area with the rest of the Northeast. The Railyard is a hub for the classification and distribution of rail traffic, handling freight cars to and from many points in the United States. Originally designed and built by the former New York Central Railroad in 1956, the yard became part of the Penn Central Railroad in 1968 with the merger of the Pennsylvania and New York Central, and it later became part of the Conrail system when Conrail's operations began in 1976. As a matter of law Conrail retains no liability for the activities of the New York Central or Penn Central Railroads.

In a freight classification yard, freight cars are sorted into various tracks for dispatching in trains carrying "blocks" of cars to destinations along specific railroad routes. A small hill or "hump" is used to classify the cars using gravity. Under this arrangement, trains are pushed up and over an incline, where the cars are uncoupled. Each car then rolls by gravity into its predetermined classification track, guided by automatically operated switches and braking systems to avoid excess speed. In this report, the hump and the classification yard are referred to as the "Main Clas-


ST JOSEPH
ELKHART
RIVER
AREA OF REMEDIAL INVESTIGATION
RAILROAD
FIGURE 1
SITE LOCATION MAP
CONRAIL ELKHART RAILYARD
ELKHART, INDIANA
ELKHART, IND
0
2000
4000
SCALE IN FEET
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sification Yard". Other auxiliary facilities located at the Railyard which may be referred to in this report are shown on Figure 2 and are described as follows:

West/Local Yard. A ten-track local yard is located at the west end of the north side of the main classification yard. This yard is used to preblock local freight trains in customer order, prior to departure from Elkhart.

Car Repair Yard. An eight-track car repair yard is located at the west end of the main classification yard. Each of these tracks handles specialized types of freight cars. Three tracks are covered by a roof for a distance of 300 feet for protection against inclement weather. Storeroom and shop facilities are adjacent to the repair area.

Diesel Shop. Diesel servicing facilities, located north of the hump crest, include a one-track diesel shop, two diesel servicing tracks with fuel, water, and sand, and three "ready tracks" for staging serviced locomotives. A loop track is available for turning locomotives and is referred to in this report as the **Engine Turn-Around Area.**

Hump Tower. The General Yard Office is located at the hump crest. Clerical personnel, the Hump Yardmaster, the Switchtender, the Trainmaster and the Terminal Superintendent are based in this building.

Retarder Tower Building. The Retarder Operator used to be located on the top floor of this six-story tower. Recently, a computer-operated Retarder system was installed and this function is now operated from the Hump Tower. The remainder of the building houses the electronic and power equipment necessary for the hump operation. A signal and communication maintenance shop is located on the ground floor.

North Tower and South Tower. Located at the northwest and southwest ends of the main classification yard, these towers are used by the conductors who operate the power-operated track switches in each of these areas. Crews working at these locations make up trains by moving cars from the classification yard to the departure yards.

Water Supply Tank. This tank is located due east of the Diesel Shop Area yet west of the Engine Turn-Around Track. This tower stores water pumped from the well located in a pump house approximately 120 feet east of the tower.

Designated Tank Car Assessment Area. These areas were designated, in an emergency schematic given to the City of Elkhart Fire Department by Conrail, as desired locations where cars were to be transported in the event of an emergency, in order to facilitate access by emergency personnel.

The main portion of the Conrail Elkhart Railyard which was investigated in this report is approximately 2 miles long (from east to west) and 0.5 miles wide (from north to south). The area is bounded on the north by U.S. 33; on the east by Nappannee Street (S.R. 19); on the south by the Lusher Avenue Extension (or Conrail's "South Access Road"); and, on the west by a small extension of S.R. 219. (See Figure 1).

The entire Railyard is within the St. Joseph River Basin and is located approximately one mile south of the west-flowing St. Joseph River. The Railyard is situated over outwash deposits of Pleistocene Age. These deposits are mainly valley-train materials composed of sands and gravel with some intermittent layers of silt and clay (Johnson and Keller, 1972). These valley-train deposits can vary from 50 to 200 feet in thickness (Purcell, 1983) and overlie bedrock

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composed of green and black shale called the Subury and Ellsworth Shales. The shales are Devonian and Mississipian in age and may range in thickness from 60 to 275 feet (Johnson and Keller, 1972).

Topography of the Railyard is relatively flat (with exception of the "Hump" itself) (National Geodetic Vertical Datum, NGVD). The land surface elevations range between 755 to the east and 745 to the west. Crawford Ditch flows north toward the St. Joseph River and is a man-made drainage ditch with its "headwaters" starting on the northern boundary near the center of the Conrail property. It is used as a catch basin for surface drainage water from the center portion of the railyard. Currently, there is an oil skimmer system installed by Conrail prior to the outfall from the basin into the ditch to remove any oil that may be floating on the surface water.

Based on available literature and well logs obtained from the Water Division at the Indiana Department of Natural Resources "the valley-train deposits along the St. Joseph River valley form an extensive outwash aquifer. The outwash deposits, whose average depth is 175 feet are overlain by a veneer of topsoil whose average thickness is 10 inches. Interbedded within these deposits, in much of the study area, is a layer of silt and clay whose maximum thickness is 80 feet and average thickness is 20 feet. Where present, this layer divides the outwash deposits into two aquifers and confines the deeper aquifer" (Imbrigiotta, 1981).
Existing local and on-site well and boring logs indicated the presence of a gray clay layer beneath the site at less than twenty feet below the surface. Site-specific geological data obtained during the Subsurface Investigation are described in Section 4.0 of this report.

General groundwater flow direction in both the confined and unconfined aquifers beneath the Railyard is north toward the St. Joseph River (Imbrigiotta, 1981). Site-specific groundwater flow direction; however, is discussed in Section 4.3 of this report.

1.2 Nature and Extent of Problem

Since July of 1983, several areas in Elkhart, Indiana have been under investigation by local, State, and Federal Health Agencies for the presence of volatile organic chemicals in the groundwater. The organic chemicals of concern in all cases involved chlorinated solvents - mainly, Trichloroethene (TCE) and its break-down products. However, other organic chemicals have also been detected in the area groundwater such as Chloroform, Carbon Tetrachloride (CCl_4) and Perchloroethylene (PCE).

As an immediate step to protect public health, the U.S. Environmental Protection Agency (USEPA) in cooperation with the Indiana Department of Environmental Management (IDEM) initiated a program of filter system installations with routine monitoring, bottled water and/or connection to a city water supply for residential homes that were known to be using groundwater containing organic chemicals. In conjunction with this program, the USEPA contracted Roy F. Weston, Inc. to conduct a groundwater investigation of the entire City of Elkhart, Indiana. The report produced from that investigation (Weston, September 1986) was submitted on September 16, 1986 to the USEPA. In that report, (Section 6.0), it was recommended that a comprehensive evaluation be made of the hydrogeologic conditions within each of the problem areas identified therein.

Two distinct problem areas identified in the Weston, September 1986 report were located hydraulically downgradient (north) of the Conrail Elkhart Railyard. The two areas were the County Road 1 Area - located approximately 500 feet north of the west end of the Railyard and immediately west of County Road 1; and Larue Street Well Field Area - located approximately 150 feet north of the Railyard and 1600 feet west of State Road 19 at the east end of the Railyard. Organic chemicals of major concern in those areas are Carbon Tetrachloride, its breakdown product chloroform, Trichloroethene, and various breakdown products of Trichloroethene, such as 1,1-Dichloroethene and 1,1-Dichloroethane. (See Section 3.3 for a discussion on breakdown products).

Subsequent to the September, 1986 recommendations made by Weston, the USEPA contracted Roy F. Weston, Inc. to conduct an additional investigation on the Conrail property. Two reports were completed from that investigation and submitted to USEPA in October and November of 1986 (Weston, October 1986 and Weston, November 1986, respectively).

Analytical results from only one out of 28 of the soil samples collected during the Weston Conrail property investigation showed a detectable concentration (0.117 mg/kg [ppm]) of Carbon Tetrachloride (CCl_4). Solely as a result of this one soil sample, the Conrail Elkhart Railyard was proposed to the National Priority List (NPL) in the 53 Federal Register 23986, June 24, 1988.

Conrail contacted Groundwater Technology, Inc. to respond to the proposed listing on the NPL and evaluate the database of the Weston Reports and the Hazard Ranking Scoresheet. The response and findings were submitted to USEPA on August 23,

1988. (Groundwater Technology, Inc., August 1988). A summary of the findings are as follows:

- No direct evidence exists of carbon tetrachloride discharged to groundwater from the Conrail Elkhart Railyard.

- Between the Conrail property and downgradient, contaminated residential wells to the northwest, exist other likely sources of groundwater contamination by organic solvents and carbon tetrachloride.

Subsequently, Conrail contracted Groundwater Technology, Inc. to conduct a Subsurface Investigation at the Elkhart Railyard, to take a proactive approach and to provide a statistically valid random, unbiased program for data collection and evaluation. The field work was conducted between January 30 and March 9, 1989. This report documents the rationales, methodologies, and results of that investigation. There is no historic or current data that indicates the presence of any significant volumes of Carbon Tetrachloride, Trichloroethene, or Chloroform having been stored, spilled, used or disposed of on the Conrail property.

1.3 Subsurface Investigation Summary

The objective of Groundwater Technology, Inc.'s Subsurface Investigation was to evaluate the EPA-alleged origin of various chlorinated volatile organic compounds within the soils and/or groundwater beneath the property boundaries of the Elkhart Railyard.

To achieve this objective, it was necessary to design an intensive soil and groundwater sampling program.

Soil sampling locations and monitoring well locations were selected on both a statistically valid, random and biased basis. The rationale for using both basis is described in Section 1.3.1 of this report. The analytical parameters chosen for this program were limited to five select volatile organic compounds as well as complete priority pollutant scans selected on a random basis for 30 percent of the total soil sample locations. The rationale for the selection of the specific parameters and the random scan for priority pollutants is described in Section 1.3.2 of this report.

1.3.1 Rationale For Random and Biased Soil Boring and Monitoring Well Locations

Previous investigative work conducted on the Conrail Elkhart Railyard property by USEPA's contractor's consisted solely of a biased soil sampling program. In brief, the selection of sampling locations was determined on the USEPA's perceived likelihood of those locations to have detectable chlorinated volatile organic chemicals present. While a biased sampling program will only indicate whether suspect areas indeed contain organic chemicals, it does not give a representative picture of the entire area of concern.

The rationales used in this investigation were to:

- obtain results that would be representative of the Railyard by collecting soil and groundwater samples on a random basis; and,

- evaluate the USEPA's alleged origin of chlorinated volatile organic compounds in two suspect areas (as noted in the Weston, October 1986 Report), by placing biased soil borings and monitoring wells in or near those locations.

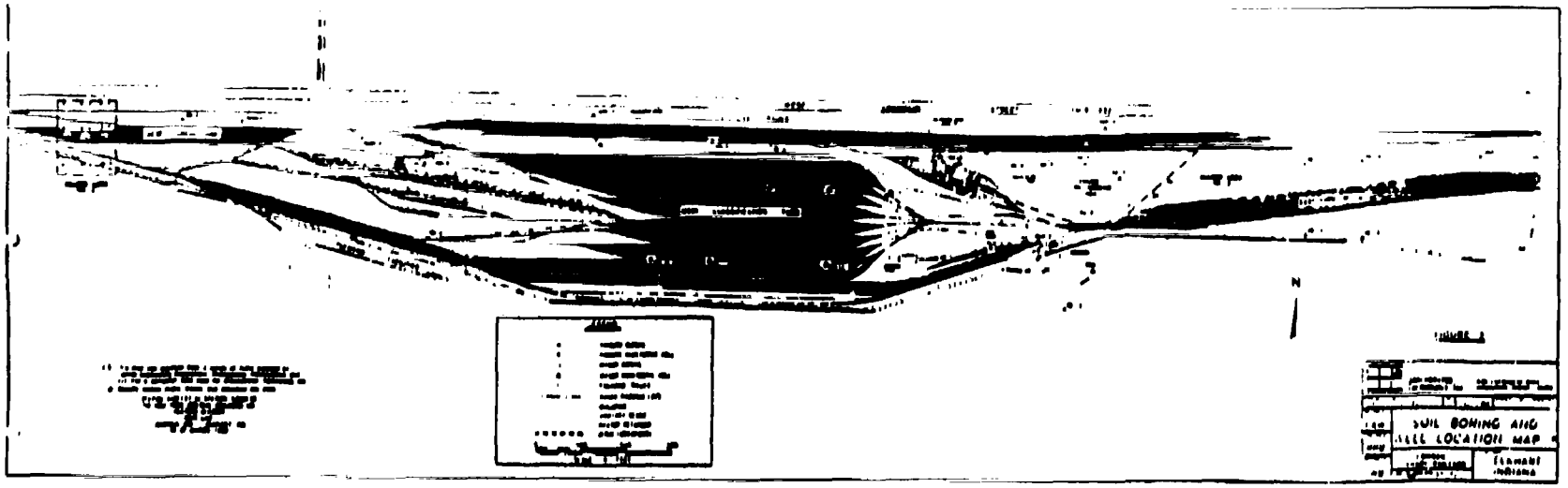
1.3.1.1 Random Locations

In order to determine random soil boring locations, a grid size was determined based on the overall size of the area of concern. As previously mentioned, the area is approximately 2 miles long and 0.5 miles wide (1 square mile is 640 acres). The Indiana Department of Environmental Management requires one soil sample for every ten acres for sites over 100 acres in size and one soil sample for every five acres for sites under 100 acres in size, for characterizing landfills (329 IAC 2-11-5(a)(1)(A)). For this study, a sample for every 8 acres was chosen, which gives a conservative total of 80 grid boxes. An 80-grid overlay (grids were 518 feet x 667 feet) was placed on top of a map of the Railyard and each grid was numbered 1 through 80. Thirty percent of the grid numbers were selected at random to determine in which grids soil samples would be collected (i.e. 24 grids). Boreholes would then be placed in the center of each selected grid and soil samples would be collected at two depths (one from the one-foot interval at the natural soil surface and one from the one-foot interval at the top of the water table). Thirty percent of the 24 borehole locations were randomly selected for completion as Random Monitoring Wells (seven random wells). Groundwater samples would then be collected after well development and stabilization.

Once plotting of the grid locations was completed on the field maps, verification was necessary for each borehole to determine whether those locations were physically possible or practical. The following criteria was used for that determination:

- Within Conrail property boundaries;
- General accessibility;
- Safety from contact with overhead and/or underground power lines; and,
- Safe distance from "live" or active tracks to ensure protection of the drilling crew during drilling.

Essentially, boreholes or monitoring wells cannot be placed in the track structure and monitoring wells can not be placed within ten feet of the center(s) of the track(s). If the locations for a random borehole/monitoring well did not comply with the safety or distance criteria mentioned above, then it was moved slightly (within several feet) one way or another so that it would comply within the criteria yet remain in the selected grid. In the case where the center of a grid point was totally off the Conrail property, another grid number was randomly selected. This situation occurred twice during the random generation process, and new locations were then selected. Locations of all soil and groundwater monitoring wells are shown on Figure 2.



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1.3.1.2 Biased Locations

Biased locations of boreholes for this investigation were selected solely on the basis of prior concern expressed by the USEPA for two specific areas.

> Biased Area 1 is located at the far west end of the West/Local Yard which is located at the far west end of the entire Railyard site (this area corresponds to "Section 6A" referred to in the Weston, October 1986 Report). USEPA's concern for this area was due to the fact that these areas were designated in an emergency schematic given to the City of Elkhart Fire Department by Conrail as desired locations where cars were to be transported in the event of an emergency, in order to facilitate access by emergency response personnel.
>
> Biased Area 2 is located in the area of the Diesel Shop and the Engine Turn-Around Tracks at the northern portion of the center of the entire railyard (this area corresponds to "Sections 3A and 2A" referred to in the Weston, October 1986 Report). USEPA's concern for this area is related to the fact that one of the soil samples collected from the Engine Turn-Around Area contained 0.117 mg/kg (ppm) of Carbon Tetrachloride.

Nine borehole locations were selected in each of the two Biased Areas.

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In Biased Area 1, a uniform grid system was used to locate each borehole in this area. The same initial grid size used for the random borehole locations (518 feet by 667 feet) was divided into nine grids that were approximately 173 feet by 222 feet in size. This nine block grid was then used as an overlay at the west end of the local yard. Boreholes were then located in the center of each grid using the same safety and distance criteria as mentioned for the random borehole locations. Soil samples were collected at the same depth intervals in each of the biased boreholes as described for the random boreholes.

In Biased Area 2, the borehole locations were not selected using a grid system as with Biased Area 1. Two different criteria were used for these borehole locations:

> Criteria 1 - Four borehole locations around the diesel shop and water tower were selected on the basis that they are in the downgradient direction of surface water or groundwater movement from the diesel shop and water tower areas.
>
> Criteria 2 - Five borehole locations in and around the Engine Turn-Around Area were selected on the basis of their close proximity to soil sample locations previously cited by the USEPA from the Weston, October 1986 Report, so that a quality check could be made of that data.

Field verification of the borehole locations was conducted in a similar manner as described for Biased Area 1 and the random locations. Soil samples were also collected in the same manner as others in this investigation.

Three biased monitoring wells were located at the Railyard in addition to the seven random monitoring wells. The intent of these biased well locations was to have at least one well located hydraulically upgradient of the entire Railyard and two located hydraulically downgradient from the Railyard at locations most likely to intercept groundwater leaving the Engine Turn-Around Area and the main classification yard. Groundwater samples were collected after well development and stabilization.

1.3.2 Rationale for Parameters Selected For Analysis

1.3.2.1 Select Volatile Organic Compound (VOC) Analytes

Five VOC analytes were selected for this Subsurface Investigation:

- Carbon Tetrachloride (CCl_4);
- Trichloroethene (TCE);
- Dichloroethane (DCA);
- Perchloroethylene (PCE); and,
- Chloroform.

The rationale for their selection is based on the USEPA allegations in the NPL Hazard Ranking System document that the Conrail Elkhart Railyard is the

major, if not the sole source of these contaminants which appear in residential drinking water wells hydraulically downgradient from the Conrail property. All soil and groundwater samples were analyzed for these five parameters. Some of the soil samples were also analyzed for Priority Pollutant parameters.

1.3.2.2 Priority Pollutant Analytes

Priority Pollutant Analytes were randomly selected for analysis in 14 (30 percent) of the total 45 boreholes. The specific Priority Pollutant analytes are shown in Table 1:

TABLE 1
List of Priority Pollutant Analytes

Analyte	Analyte
Phenol	4-Bromophenyl phenylether
Bis (2-chloroethyl) ether	Hexachlorobenzene
2-Chlorophenol	Pentachlorophenol
1,3-Dichlorobenzene	2,4-Dinitrotoluene
1,4-Dichlorobenzene	Fluorene
1,2-Dichlorobenzene	Diethylphthalate
Bis (2-chloroisopropyl) ether	4-Chlorophenyl phenyl ether
Hexachloroethane	4,6-Dinitro-2-methylphenol
N-Nitrosodipropylamine	N-Nitrosodiphenylamine
Nitrobenzene	Phenanthrene
Isophorone	Anthracene
2-Nitrophenol	Di-N-Butylphthalate
2,4-Dimethylphenol	Fluoranthene
Bis (2-chloroethoxy) methane	Benzidine
2,4-Dichlorophenol	Pyrene
1,2,4-Trichlorobenzene	Butyl Benzyl Phthalate
Naphthalene	Benzo(a)Anthracene

Hexachlorobutadiene
4-Chloro-3-methylphenol
Hexachlorocyclopentadiene
2,4,6-Trichlorophenol
2-Chloronaphthalene
Acenaphthylene
Dimethylphthalate
2,6-Dinitrotoluene
Acenaphthene
2,4-Dinitrophenol
4-Nitrophenol
Trichloroethene
Benzene
Dibromochloromethane
(+1,1,2-Trichloroethane)
(+cis-1,3,Dichloropropene)
Trichlorofluoromethane
2-Chloroethylvinylether
Bromoform
Total Xylenes
Chloroform
Toluene
Chlorobenzene
Ethylbenzene

Antimony
Arsenic
Beryllium
Cadmium
Chromium

Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc
Dieldrin

3,3'-Dichlorobenzidine
Chrysene
Bis (2-Ethylhexyl) Phthalate
Di-N-Octyl Phthalate
Benzo(b)Fluoranthene
Benzo(k)Fluoranthene
Benzo(a)Pyrene
Indeno(1,2,3,c,d)Pyrene
Dibenzo(a,h)Anthracene
Benzo(g,h,i)Perylene
Chloromethane
Bromomethane
Vinyl chloride
Chloroethane
Methylene chloride
1,1-Dichloroethene
1,1-Dichloroethane
trans-1,2-Dichloroethene
Tetrachloroethene
(+1,1,2,2-Tetrachloroethane)
Methoxychlor
1,2-Dichloroethane
1,1,1-Trichloroethane
Carbon Tetrachloride
Bromodichloromethane
1,2-Dichloropropane
trans-1,3-Dichloropropene
SS Bromochloromethane
SS 1,4-Bromofluorobenzene
Aldrin

alpha-BHC
beta-BHC
gamma-BHC
delta-BHC

4,4'-DDT
4,4'-DDE
4,4'-DDD
Endrin

Endrin Aldehyde	alpha-Endosulfan
beta-Endosulfan	Endosulfan Sulfate
Heptachlor	Heptachlor Epoxide
PCB-1242	PCB-1248
PCB-1254	PCB-1221
PCB-1232	PCB-1260
PCB-1016	

A random Priority Pollutant scan was deemed appropriate since this scan not only includes the five VOC's of concern, but also includes a scan of various breakdown products of those VOC's as well. (See Section 3.3).

1.3.3 METHODOLOGY

Prior to implementation of any field work, a Site Health and Safety Plan and a Quality Assurance and Quality Control Plan was written (Appendix A and B, respectively).

1.3.3.1 Soil Sample Descriptions

Continuous split-spoon soil samples were collected from each borehole at the Conrail Elkhart Railyard. Each borehole was made using an 8-inch outside diameter, hollow stem auger. A 2.5 foot long, split-spoon sampler was placed inside the auger and advanced into underlying material so that a relatively undisturbed view of the geologic stratigraphy could be observed and documented.

Soil descriptions were made using the criteria outlined by the U.S. Department of Agriculture, Soils Conservation Service, and color-coded using

the Munsell Color Chart. The soil boring logs are contained in Appendix C of this report.

After each split-spoon sampler was removed from the borehole and opened, soil descriptions were made taking particular care to document odor, moisture, and textural changes in the stratigraphy as well as the soil's reaction to Hydrochloric Acid (10%) when applied to a fresh exposure.

Each split-spoon sampler was thoroughly cleaned between samples with alconox soap and water obtained from a nearby water source (fire hydrant) located on the Conrail property.

All augers used at a particular borehole were thoroughly steam-cleaned between boreholes at the designated Decontamination Station. All decontamination water was collected and placed into 55-gallon drums for appropriate disposal. All soil cuttings were also placed into 55-gallon steel drums. Analysis of the drum contents will be conducted, and they will be disposed of in an appropriate manner according to State and Federal regulations.

1.3.3.2 Soil Sample Collection

The specific details of the soil and groundwater collection procedures to be followed during this Subsurface Investigation are shown in the Quality Assurance and Quality Control Plan for the On-Site Subsurface Investigation at the Conrail Elkhart Railyard, Elkhart, Indiana (Appendix B). This section of the report, however, briefly summarizes those procedures.

Two soil samples were collected from each borehole for the Subsurface Investigation: one soil sample from the 0-1 foot interval of the natural soil surface; and one soil sample from the one-foot interval at the top of the water table. The surface sample was collected to determine the presence of organic chemicals at the surface while the water table sample was collected to determine whether organic chemicals were present at depth. Surface soil samples were identified using the appropriate Random Boring Number followed by the letter "A". (Ex. RB-11A) Water table soil samples were identified in the same manner except followed by the letter "B". (Ex. RB-11B).

VOC soil samples collected at each depth were contained in two 40 ml glass vials. Each vial was filled to the top using a stainless steel spatula and efforts were made to have as little head space as possible in the top of the vial. Once filled, the glass vials were immediately labeled and sealed with a screw-cap containing a teflon-lined septum. The vials were then placed on ice until they were prepared for shipment to the analytical laboratory.

Priority Pollutant soil samples were collected at each depth in randomly selected boreholes. One, 250 ml, amber glass widemouth container and two, 40 ml glass vials were used to contain the samples. The glass vials were used for analysis of the Priority Pollutant VOC's and the amber glass container was used for the remaining analytes (PCB's, pesticides, and Base/ Neutral/ Acids).

Three "Blind Duplicate" soil samples were also collected during this investigation to verify laboratory quality control. Two were collected from the random boreholes and one was collected from a biased borehole.

1.3.3.3 Monitoring Well Installation and Development

Ten groundwater monitoring wells were installed at the Conrail Elkhart Railyard. Each monitoring well was constructed with two-inch diameter, flush-threaded, 0.010 inch slot, stainless steel screen and two-inch diameter, flush-threaded, stainless steel riser casing. The lengths of screen varied between wells due to hydrogeologic conditions. Specific details for each well are presented in Appendix C of this report. Stainless steel well construction material was selected on the basis of its inert properties when in contact with volatile organic compounds (U.S. EPA, 1986) which have been alleged to be present in the groundwater beneath the Conrail property. The annular space around each of the well screens was filled to approximately two feet above the top of the screen with Grade A (Spec. #50) silica sand obtained from Best Stone, Inc. in Chardon, Ohio. Coarse grade Wyoming Bentonite Pellets obtained from N.L. Baroid Division in Houston, Texas were used to fill the annular space above the silica sand to ensure at least a one and one half foot seal. The pelletized bentonite seal was activated by pouring at least one gallon of distilled water into the annular space. The remaining annular space was filled with a cement grout up to the

surface. Protective steel casings with locking lids and locks were placed over all the well heads and cemented in place. Conrail personnel also installed additional temporary protective wood structures around each well.

All wells were developed using an air jetting device connected to an air compressor and supplied with an in-line air filter. The discharge water was collected from the air jetting device via PVC flexible tubing and placed into the soil collection drum at each well head.

Decontamination of all well installation and development equipment was performed in the same manner as explained in part 1.3.3.1 of this Section.

1.3.3.4 Depth to Water Measurements

Water level measurements were conducted at all monitoring well locations, approximately two weeks after installation of the new wells using an electronic interface probe (0.01' resolution). The Water Level Data forms are presented in Appendix F of this report. Cleaning of the interface probe was conducted between each well location using a single rinse of alconox soap and distilled water followed by a double rinse of distilled water.

1.3.3.5 Groundwater Sample Collection

Groundwater samples were collected approximately two weeks after installation and development of the monitoring wells to allow for well stabilization.
Only select VOC's, as shown in Section 1.3.2.1, were analyzed in the groundwater samples collected from the ten wells installed on the Railyard property. Specific details of the groundwater sampling protocol are also presented in Appendix B of this report; however, this section of the report briefly describes those procedures.

A minimum of three to five well volumes were purged from each well using a teflon bailer. Once an adequate volume was purged from the well, the bottom filling teflon bailer was slowly lowered into the water and allowed to fill. The sample water was then carefully poured from the bailer into the 40 ml glass vials. No preservative was added to these samples. The vials were then labeled and capped so that no air bubbles were in the sample. Promptly after collection, all samples were placed in a cooler filled with ice and prepared for overnight shipment to Groundwater Technology Environmental Laboratory for analysis. Strict chain-of-custody procedures were followed for all samples collected and analyzed during this investigation.

Between wells, the teflon bailer was thoroughly decontaminated inside and out using a single rinse of alconox soap and distilled water, followed by a

double rinse of distilled water. Clean nitrile gloves were worn by sampling personnel at each monitoring well.

1.3.3.6 Monitoring Well Survey

All monitoring wells were surveyed into the National Geodedic Vertical Datum (NGVD). Survey elevations for various wells were based on individual benchmarks from sanitary sewer pumping stations which were located closest to those wells. The benchmark reference elevations used for the various pumping stations were obtained from a map supplied by Conrail entitled:

Sanitary Sewage Facilities - I
New York Central System
Elkhart Yard
Elkhart, Indiana
Engineering Dept. New York, N.Y. May 14, 1957
Scale: 1"=200' Issue D (Aug. 12, 1957)
#92862
Sheet 7A of 26
MF026556

All elevations noted for the wells were taken at the north side of each well casing.

1.3.3.7 Analytical Methods

The analytical methods used for the soil and groundwater samples collected during this Subsurface Investigation are as shown in Table 2:

Table 2
Analytical Methods

TYPE OF SAMPLE	TYPE OF ANALYSIS	METHOD OF ANALYSIS
Water	VOC's (5 only)	EPA 601
Soil	VOC's (5 only)	EPA 8010/ 8020/5030
Soil	Priority Pollutants:	
	Acid/Base/Neutral	EPA/8270
	Semi-Volatiles	EPA 8010/
	Volatiles	8020/5030
Soil	Pesticides/PCB's	EPA 8080

1.3.4 Coordination of Field Activities with Railyard Services and Operations

Prior to the initiation of any field work on site, all Groundwater Technology and subcontracted personnel were required to attend a Contractor Safety Training Meeting. This meeting was designed to assist contractors in understanding the operating practices of the railroad industry. All personnel working on-site also followed the safety rules set forth in the Groundwater Technology Site Health and Safety Plan for the Conrail Elkhart Railyard, Elkhart, Indiana, January 26, 1989 which is presented in Appendix A of this report.

The various sampling programs to be implemented on-site required extensive coordination efforts between Groundwater Technology and Conrail personnel prior to the actual initiation of the programs.

Coordination by Conrail personnel with Groundwater Technology and their subcontractors involved providing protection services (i.e., communications and signals) on a day-by-day basis.

2.0

2.0 SITE FEATURES INVESTIGATION

The focus of this Subsurface Investigation was solely on the Conrail Property; however, in order to generally characterize the surrounding area in conformance with the Subsurface Investigation Format, the following sections have been included in this report.

2.1 Demography

The data for this section of the report was obtained from Reference 11 - Population Statistics used for the original Hazard Ranking Score by Alan Freed of the Indiana Department of Environmental Management. In that Reference Document, Mr. Freed states that the total population for a three mile radius around the Conrail property is 55,552. The data was obtained from the Census of Population and Housing, 1980 Block statistics from Elkhart and South Bend as well as from information obtained from the Elkhart Water Works located at 130 South Main Street, Elkhart, Indiana.

2.2 Land Use

Land use in a three mile radius around the Conrail Elkhart Railyard varies from light industrial to residential and agricultural. In the August 23, 1988 response to the EPA's proposal to place the Conrail Railyard on the NPL, Groundwater Technology showed that there are at least 22 other potential sources for the area groundwater contamination. Pages from that response discussing the sources including a figure showing their location) are contained in Appendix G. One of the other potential sources is an abandoned uncontrolled hazardous waste drum dump site known as the Robert Martin Drum Site. It is located along the north side of U.S. 33 and is due east of the County Road 1 contaminated area.

Elkhart, Indiana is the location of numerous industries that manufacture recreational vehicles, mobile homes, pharmaceuticals, and metal fabrication. The majority of these industries and other light industries associated with them are located immediately adjacent to and within the three mile radius of the Conrail property. The city of Elkhart is located directly northeast of the area of concern while the remaining surrounding areas are largely suburban and/or rural communities.

2.3 Natural Resources

Natural resources of the area include mining operations for sand and gravel; groundwater; and surface waters (St. Joseph and Elkhart Rivers and Baugo Creek). Thirteen parks are located within the city limits of Elkhart - mainly near the confluence of the Elkhart and St. Joseph Rivers.

There are four well fields in Elkhart which withdraw from the groundwater and supply drinking water to the city. Individual homes outside the city limits also depend on groundwater as their water supply.

2.4 Climatology

Elkhart County has four well-defined seasons of the year due to its location in the middle latitudes and in the interior of a continent away from the moderating effects of the oceans (Kirschner, 1974).

Kirschner describes Elkhart's climate as "invigorating." The warmest month of the year is in July and generally has temperatures of 90 degrees F on an average of eight days per year. The coldest month of the year is in January and has temperatures below zero on an average of seven days per year.

Precipitation is often its greatest during the late spring and early summer months. "The winter months average a little less than two inches and the spring months, about 3.3 inches. The average yearly snowfall is 25.9 inches" (Kirschner, etal).

3.0

3.0 HAZARDOUS SUBSTANCES INVESTIGATION

3.1 Soil Sample Results

Two soil samples were collected and analyzed at each borehole drilled during this investigation. One of the samples was collected at the 0-1 foot interval of the natural soil surface, and the second sample was collected from the one-foot interval at the top of the water table.

Results of the soil analyses are shown in Table 3 and Table 4.

Discussion of the soil results have been separated into two sections: 1) Random Borehole Soil Results; and 2) Biased Area Borehole Soil Results.

3.1.1 Random Borehole Soil Results

As described in Section 1.3.1.1 of this report, the purpose of the random borehole locations was to obtain soil samples that are representative of the entire Railyard. A total of 24 random boreholes were drilled on the Conrail property. Generally, two soil samples were obtained from each borehole (24 "surface" soil samples and 24 "water table" soil samples). In the case of RMW-5 and RMW-6; however, there appeared to be a perched, water-bearing zone above the regional water table. For this reason, three soil samples were collected at each of these locations and identified as:

RMW-5A = Surface
-5B = Perched water-bearing zone
-5C = regional water table

RMW-6A = Surface
-6B = perched water-bearing zone
-6C = regional water table

Also, for Laboratory Quality Control, two "Blind Duplicate" soil samples were collected from the random borehole series.

The total number of soil analyses from randomly placed boreholes is therefore 52. Table 3 summarizes the analytical results from Random Borehole soil samples.

TABLE 3

Summary of Soils Analytical Results in Random Boreholes

Random Borehole Sample Number	Type of Analysis	VOC's of Concern (in UG/G) ppm	Other Compounds Detected
RB-1A	VOC	<.04	
RB-1B	VOC	<.04	
RB-2A	VOC	<.04	
RB-2B	VOC	<.04	
RB-3A	VOC	<.04	
RB-3B	VOC	<.04	
RB-4A	PP	<.04	PAH's
RB-4B	PP	<.04	PAH's
RB-5A	VOC	<.04	
RB-5B	VOC	<.04	
RB-6A	VOC	<.04	
RB-6B	VOC	<.04	
RB-7A	VOC	<.04	
RB-7B	VOC	<.04	
RB-8A	VOC	<.04	
RB-8B	VOC	<.04	
RB-9A	PP	<.04	MC;PAH's
RB-9B	PP	<.04	PAH's
RB-10A	PP	0.06 DCE 2.9 TCE	PAH's

TABLE 3 (continued)

Random Borehole Sample Number	Type of Analysis	VOC's of Concern (in UG/G) ppm	Other Compounds Detected
RB-10B	PP	0.18 DCE	
		7.5 TCE	PAH's
RB-11A	VOC	<.04	
RB-11B	VOC	<.04	
RB-12A	VOC	<.04	
RB-12B	VOC	0.51 CCL4	
RB-13A	VOC	<.04	
RB-13B	VOC	<.04	
RB-14A	VOC	<.04	
RB-14B	VOC	<.04	
RB-15A	PP	<.04	PAH's
RB-15B	PP	<.04	PAH's
RB-16A	VOC	<.04	
RB-16B	VOC	<.04	
RB-17A	PP	<.04	PAH's
RB-17B	PP	<.04	PAH's
RB-17D	PP	<.04	PAH's
RMW-1A	VOC	<.04	
RMW-1B	VOC	<.04	
RMW-2A	VOC	<.04	
RMW-2B	VOC	<.04	
RMW-3A	PP	<.04	PAH's
RMW-3B	PP	<.04	PAH's
RMW-4A	VOC	<.04	
RMW-4B	VOC	<.04	
RMW-5A	PP	<.04	PAH's
RMW-5B	PP	<.04	MC;PAH's
RMW-5C	PP	<.04	MC;PAH's
RMW-5D	PP	<.04	PAH's
RMW-6A	VOC	<.04	
RMW-6B	VOC	<.04	
RMW-6C	VOC	<.04	
RMW-7A	VOC	<.04	
RMW-7B	VOC	<.04	

A = Surface soil sample
B = Water table soil sample *
D = Duplicate soil sample

VOC = Five volatile organic compounds of concern
PP = 127 priority pollutants
MC = Methylene chloride
PAH = Polynuclear aromatic hydrocarbons
TCE = Trichloroethene
DCE = Trans-1,2-Dichloroethene
CCL4 = Carbon tetrachloride

* Except in RWM-5 and RWM-6:
B = perched water table sample
C = Water table sample

As shown in Table 3, only three out of 52 random soil samples contained quantifiable amounts of the volatile organic compounds of concern (RB-10A, RB-10B, and RB-12B). Three other random soil samples (RMW-5B, RMW-5C and RB-9A), indicated the presence of trace amounts of Methylene Chloride (MC)*.

Both soil samples at RB-10 (surface and water table) contained minor amounts of Trichloroethene and Trans-1,2 Dichloroethene. This random borehole was one of the boreholes selected for random analysis of Priority Pollutants. The location of RB-10 is in the southwest portion of the main classification yard where railcars are temporally staged for shipment on outbound trains. No Conrail buildings or potential surface sources of Trichloroethene are evident at this location.

Carbon Tetrachloride was found at 0.51 ppm in the water table soil sample at random borehole RB-12. This chlorinated organic was not found in the surface soil sample at this location, which indicates that the compound may already be present in the groundwater from an upgradient source. RB-12 is approximately 1550 feet due east of RB-10 and located in the southeast portion of the main classification yard. As with RB-10, there are no buildings on the Conrail property near or directly upgradient of the borehole that could be potential sources of this compound.

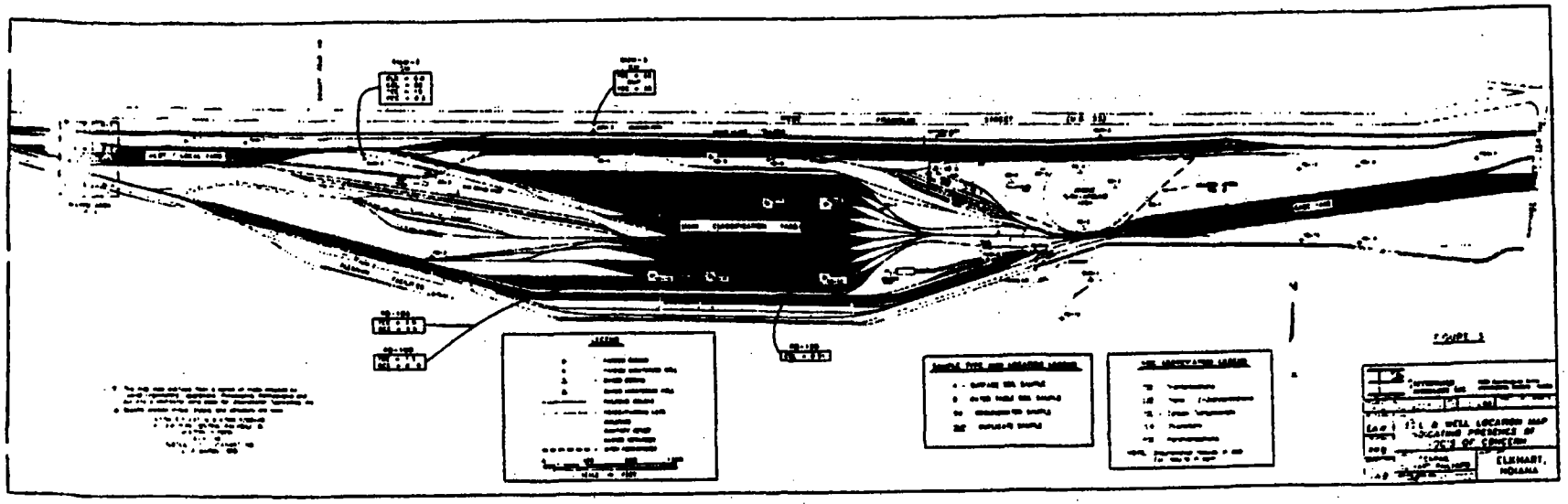
* Attributed to laboratory carry-over.

In summary, only three random soil samples out of a total of 52 random soil samples collected on the Conrail property contained quantifiable amounts of Trichloroethene and Carbon Tetrachloride (two of the chlorinated volatile organic compounds of concern to this Subsurface Investigation). Both boreholes in which the compounds were found are located near the southern boundary of the main classification yard. Figure 3 is a location map which indicates all soil sample and monitoring well samples which contained quantifiable amounts of the volatile organics of concern. Groundwater results will be discussed in Section 3.2 of this report.

3.1.2 Biased Area Borehole Soil Results

Two Biased Areas were determined for the Conrail Elkhart Railyard. Biased Area 1 is located at the far west end of the West/Local Yard and Biased Area 2 is located around the Diesel Shop and Engine Turn-Around Area near the north and central portion of the Railyard. (See Figure 2). Refer to Section 1.3.1.2 of this report for the rationale behind the selection of the Biased Areas.

Two soil samples were collected and analyzed from each biased borehole location in the same manner as described for the random borehole soil samples (i.e., one from the surface soil and one from the one foot interval at the top of the water table). Nine boreholes were made in each Biased Area, thus a total of 18 soil samples were collected.


ELKHART, INDIANA

No chlorinated volatile organics of concern to this Subsurface Investigation were found in any of the Biased Area 1 soil samples.

Samples collected from Biased Area 2 were slightly different due to geologic conditions at various borehole locations. In addition to the two routine samples collected at location B2-1, an additional sample was collected at the interval between three and four feet below the surface and labeled as B2-1 (3'-4'). The soil was discolored and exhibited a strong organic type of odor. Since this borehole location was sited as close as possible to the location at which EPA supposedly found Carbon Tetrachloride in one of its soil samples, Conrail chose to conduct a Priority Pollutant analysis on the sample. No chlorinated volatile organics were found in this sample.

Only one soil sample was collected at borehole location B2-7. During drilling, it was apparent that the location was in an area where underground diesel storage tanks had recently been removed. The excavated hole was apparently filled with ballast. When the driller determined that the augers were in native soil material, one sample was collected. The material was wet, gray clay and drilling was not continued any deeper. This sample was labeled B2-7.

No chlorinated volatile organics of concern to this Subsurface Investigation were found in any of the Biased Area 2 boreholes.

Table 4 illustrates the Biased Area 2 borehole locations which had quantifiable concentrations of Methylene Chloride and Polynuclear Aromatic Hydrocarbon (PAH) compounds which were not of concern for this investigation.

TABLE 4

Summary of Soils Analytical Results
in Biased Area 2 Boreholes
(Quantifiable Results Only)

Biased Area 2 Borehole Number	Analyte Quantified	Result (in ug/G) ppm
B2-5A (surface)	Methylene Chloride *	0.55
	Phenanthrene	2.8
	Fluoranthene	3.1
	Pyrene	6.8
	Benzo(a)Anthracene	3.6
	Chrysene	4.8
	Benzo(b)Fluoranthene	8.3
	Benzo(a)Pyrene	3.9
	Indeno(1,2,3,c,d)Pyrene	3.0
	Dibenzo(a,h)Anthracene	1.1
	Benzo(g,h,i)Perylene	2.8
B2-5B (water table)	Methylene Chloride *	0.20

TABLE 4 (continued)

Biased Area 2 Borehole Number	Analyte Quantified	Result (in ug/G) ppm
B2-9A (surface)	Methylene Chloride *	3.1
	Toluene	0.13
	Naphthalene	1.6
	Phenathrene	3.4
	Fluoranthene	2.3
	Pyrene	5.1
	Benzo(a)Anthracene	2.0
	Chrysene	4.4
	Benzo(b)Fluoranthene	9.1
	Benzo(a)Pyrene	5.0
	Indeno(1,2,3,c,d)Pyrene	2.6
	Benzo(g,h,i)Perylene	2.2
B2-9B (water table)	Naphthalene	2.2
	Acenaphthene	1.2
	Fluorene	1.6
	Phenathrene	5.5

* Attributed to laboratory carry-over

The presence of PAH compounds is not surprising in an area such as a railyard. The compounds are common constituents in petroleum products, and are not considered to be of concern during this Subsurface Investigation.

The other analytes which appear in the surface samples at B2-5 and B2-9 and the water sample at B2-9 are Polynuclear Aromatic Hydrocarbon (PAH) compounds. Due

to the concentrations found in the water table soil sample at B2-9 (near the Diesel Shop area), Conrail has initiated a separate groundwater investigation and remedial action which is presently under way. The findings and actions taken under this additional investigation will be compiled in a separate report and is not considered to be a part of this Subsurface Investigation concerning the chlorinated volatile organics.

3.2 Groundwater Sample Results

As described in Section 2.0 of this report, seven random and three biased monitoring wells were installed at the Conrail Elkhart Railyard. The purpose of these wells was to evaluate the EPA alleged origin of chlorinated volatile organics in the groundwater beneath the Conrail property.

One groundwater sample was obtained from each monitoring well. For quality control and quality assurance, the following additional samples were obtained:

- one "Blind" duplicate (labeled BMW-10-duplicate of BWM-3);
- one Rinseate Blank;
- one Trip Blank; and,
- Two Water Truck Water Analyses.

Table 5 shows the analytical results of the groundwater samples from the monitoring wells.

TABLE 5

Monitoring Well
Groundwater Results

Monitoring Well Number	VOC of Concern Quantified	Result (ug/L) ppb
RMW-1	<0.2	
RMW-2	Chloroform	6.0
	CCL4	82
	TCE	15
	PCE	0.3
RMW-3	<0.2	
RMW-4	<0.2	
RMW-5	<0.2	
RMW-6	<0.2	
RMW-7	<0.2	
BMW-1	<0.2	
BMW-2	<0.2	
BMW-3	TCE	32
BMW-10 (blind duplicate of BMW-3)	TCE	30
RINSEATE BLANK	<0.2	
TRIP BLANK	<0.2	
WATER TRUCK #1	<0.2	
WATER TRUCK #2	TCF	1.5

RMW = Random Monitoring Well
BMW = Biased Monitoring Well
CCL4 = Carbon Tetrachloride
TCE = Trichloroethene
PCE = Tetrachloroethene
TCF = Trichlorofluoromethane

3.2.1 Random Groundwater Results

There are seven random monitoring wells on the Conrail property. The only random well which showed the presence of chlorinated volatile organics was RMW-2. RMW-2 is located near the east end of the Local Yard tracks.

The concentrations of the organics shown in Table 5 are one to two orders of magnitude less than the higher concentrations of the same organics found in downgradient domestic wells of the County Road 1 area. Conrail is in the process of initiating a detailed groundwater investigation around RMW-2. The plan for the investigation and its findings will be submitted under a separate report from this document.

3.2.2 Biased Groundwater Results

There are three biased monitoring wells on the Conrail property. BMW-1 was placed so that it would be hydraulically upgradient of the Conrail property. BMW-2 and BMW-3 were placed in biased locations thought to be hydraulically downgradient of the Engine Turn-Around Area and the main classification yard, respectively.

The groundwater collected from BMW-3 (downgradient from the main classification yard) was found to contain 32 ug/l (ppb) of Trichloroethene. A blind duplicate (labeled BMW-10) was also collected from this well and the analysis of that sample confirmed the presence of Trichloroethene at 30 ug/l (ppb). No other chlorinated volatile organics were found in any of the wells. Conrail is in the process of initiating a detailed groundwater investigation around BMW-3 in the same manner as for RMW-2. The plan and findings for that investigation will be submitted within the same separate report as previously indicated for RMW-2.

3.3 Compounds of Interest and Behavior

The five VOC's of interest for this investigation, as discussed in Section 1.3.2.1 are Carbon tetrachloride, Trichloroethene, Tetrachloroethene, Chloroform, and Dichloroethane.

Carbon Tetrachloride, Trichloroethene and Tetrachloroethene are known to be ubiquitous in the environment; their presence has been detected in finished drinking water (EPA 1975a), in fresh water and rain water (Pearson and McConnell, 1975), in marine water and sediment (Pearson and McConnell, 1975; McConnell et al. 1975) and in the atmosphere (signal et al 1978; EPA 1975b; Lillian et al 1975; Lovelock et al 1973).

Users and formulations of carbon tetrachloride include: fire extinguisher manufacturing; dry cleaning operations; manufacturing of refrigerants; aerosols and propellants; manufacturing of chlorofluoromethanes; extractant; solvent; veterinary medicine; metal degreasing; fumigant; chlorinating organic compounds (Verschueren, 1983).

Users and formulations of trichloroethene include: dry cleaning operations and metal degreasing; solvents for fats, greases, waxes; solvents for greases and waxes from cotton, wool, etc., for caffeine from coffee; solvent for cellulose ester and ethers; solvent for dying; refrigerant and heat exchange liquid; organic synthesis; fumigant; anesthetic (Verschueren, 1983).

Users and formulations of tetrachloroethene include: dry cleaning operations; metal degreasing; solvents for fats, greases, waxes, rubber, gums, caffeine from coffee; remove soot from industrial boilers; manufacturing paint removers,

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printing inks; manufacturing trichloroacetic acid; vermifuge; heat transfer medium; manufacturing of fluorocarbons (Verschueren, 1983).

Users and formulations of chloroform include: manufacturing fluorocarbon refrigerants and propellants and plastics; manufacturing anesthetics and pharmaceuticals, primary source for chlorodifluoromethane; fumigant; solvent; sweetener; fire extinguisher manufacturing; electronic circuitry manufacturing; analytical chemistry; insecticide (Verschueren, 1983). Chloroform is a common degradation product of carbon tetrachloride.

Dichloroethane was analyzed for in two forms, (1,1-Dichloroethane and 1,2-Dichloroethane). 1,1-Dichloroethane is used as a chlorinated solvent intermediate; coupling agent in anti-knock gasoline; paint, varnish and finish removers; metal degreasing; organic synthesis; and ore flotation (Verschueren, 1983). It can be a degradation product of trichloroethene or 1,1,1 trichloroethane.

The users and formations of 1,2-dichloroethane include: manufacturing of vinyl chloride; manufacturing of tetraethyllead; intermediate insecticidal fumigant (peachtree borer, japanese beetle, root-knot nematodes); tobacco flavoring; constituent in paint, varnish and finish removers, metal degreaser, constituent in soaps and scouring compounds, wetting and penetrating agents; used in chemical synthesis and ore flotation. The uses of 1,2 dichloroethane include: ingredient in cosmetics (nail lacquers) and as a food additive as a result of its use in extracting spices such as annatto, paprika, and turmeric. 1,2-Dichloroethane can be a decomposition products of 1,1,1 trichloroethane. (Verschueren, 1983).

It is an "occasionally expressed, generalized perception" (Schwille-see list of references) that because the pure chlorinated solvents have a specific gravity greater than water, any mixture or solution of the same will move downward through the aquifer due to "density gradients." It has been shown by Schwille, however, that this is not the case for small concentrations dissolved in water. As an example of the lack of impact that mixtures of chlorinated solvents in groundwater have on density, the following table shows the relative increased specific gravity (with reference to water) that might be observed, based upon the dissolved concentrations in the study area of the densest of the five compounds, tetrachloroethene.

Concentration	Specific Gravity of tetrachloroethene	Specific Gravity of Solutions
0.1 ppm	1.63	1.00000063
1.0 ppm	1.63	1.0000063
10.0 ppm	1.63	1.000063

Note: Specific gravity of water is 1.0.

The resultant density or specific gravity increase of the solution over water is nominal and has little effect on downward movement of the solution. Indeed, with the five chlorinated solvents in question, their volatility more than offsets any specific gravity difference. This has been observed to keep the organic solvent in the upper 10' - 15' of the aquifer of impact. In viewing the five chlorinated solvents against other common organic chemicals for volatility (Nyer, 1985), the one with the lowest volatility, chloroform, has a Henry's coefficient of 200, equaling benzene and exceeding some other common volatile organics. The

basis of air stripping, removal of volatiles from soil and water, utilizes Henry's principal and reduced pressures to eliminate the organic from the aqueous phase.

Common low pressure zones in aquifers are discharge zones. At the Elkhart area of concern, the St. Joseph River is a groundwater discharge point, and as such, represents a low pressure point across which the volatile organic solvents in the shallow aquifer would not migrate.

These previously known facts are referenced in some detail in the text by Schwille, 1988. In this text, via laboratory experiments, Schwille proves that dissolved chlorinated mixtures tend to follow the top of the aquifer movement rather than any density gradients.

In summary, dissolved concentrations in groundwater will not sink in the aquifer, but rather follow shallow flow lines to low-pressure, groundwater discharge zones (i.e., surface streams). Therefore, one should not expect to find the chlorinated volatile organic compounds of interest at greater depths downgradient than upgradient.

4.0

0060

4.0 HYDROGEOLOGIC INVESTIGATION

4.1 Physical Soils Description

Much data was gathered related to the geologic profile of the area and unconfined water table elevations during the Subsurface Investigation at the Elkhart Railyard. Appendix C of this report contains detailed information collected from each borehole and monitoring well.

Much of the Railyard area which supports railroad tracks is covered with at least one to two feet of large, limestone aggregate (ballast). Surficial deposits of remaining areas and beneath the ballast are composed of "Made Land" as it is called by the U.S. Soils Conservation Service (Kirschner, 1974).

Visual observation and documentation of borehole information obtained during drilling confirm the presence of two to five feet of fill material over much of the north central and eastern portions of the Railyard. A hummocky terrain is visibly evident in the center and east of the Engine Turn-Around Area which is where the fill material is at its thickest. Small mounds of debris include old wooden railroad ties, gravel/materials sand piles, scrap metal and concrete materials. The fill material used for the remaining area of the Railyard was not as distinguishable due to its resemblance to the native underlying soils material. Sharp color changes and reaction to Hydrochloric Acid (HCL) are several ways of defining the fill from natural material; however, these methods are not always conclusive.

4.2 Geology

The natural soils underlying the fill ranged from coarse sand and gravel only, to a combination of fine to medium sand lenses within the sand and gravel unit, to a combination of fine to medium sand within the sand and gravel overlying a dense clay or dense, fine sand loam unit.

The top of the clay unit, when encountered, ranged in depth from six feet to twenty feet below the ground surface and occurred mainly in the center of the Railyard in the northern third of the property. The shallowest depth to the top of clay, however, occurred on the southern boundary at BMW-1. The thickness and the sloping character of the clay surface was not deemed necessary in the primary goals of this investigation; therefore, not all of the boreholes in which clay was encountered were surveyed for elevation control. The clay unit is not present at a consistent depth across the site, nor does it appear to be continuous based on drilling depths ranging between twenty to forty feet (B1-9). This clay unit also seems to have an effect on the groundwater flow direction in the sand and gravel overlying the clay. Groundwater flow direction will be discussed in Section 4.3 of this report.

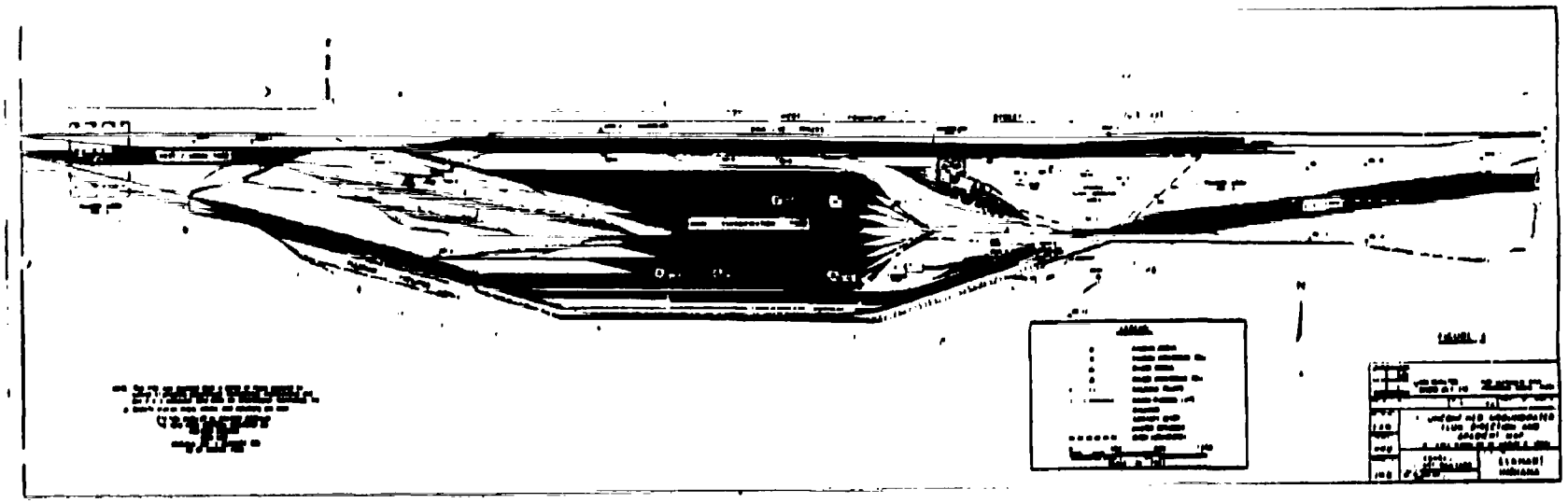
In summary, the geology beneath the Railyard is generally consistent with the statements cited in published literature for the Elkhart area. However, site-specific data reveals that the clay unit, (originally thought to be continuous across the site), may either have been "eroded" to depths not drilled to during this investigation or may be entirely absent.

4.3 Groundwater

Ten groundwater monitoring wells were installed at various locations across the Conrail Elkhart Railyard. Water level data was collected from all of the wells and a Groundwater Gradient and Flow Direction Map was constructed (Figure 4).

All the wells are screened in the aquifer material above the gray clay unit described in Section 4.2 or to a basal depth of twenty feet-whichever came first. As shown in Figure 4, a groundwater high is located in the vicinity of Biased Monitoring Well-1 (BMW-1). BMW-1 was placed in this location as a biased upgradient well. During drilling, the top of the underlying gray clay unit was only 6.5 feet below the ground surface at BMW-1 - the shallowest depth at which clay was found in any of the boreholes. Consequently, it appears that the clay unit dips generally to the north, west, and east. This apparent dip and its influence on the groundwater is reflected in the groundwater flow direction from BMW-1. A slight groundwater depression anomaly was noted in Random Monitoring Well-6 (RMW-6). The reasons for this slight depression are unknown and for purposes of a generalized groundwater flow map, this anomalous reading was not plotted.

Groundwater flow direction is generally to the north, northwest and northeast from the high at BMW-1 at a gradient of .001 foot/foot.



5.0

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APPENDIX
A

APPENDIX A

SITE HEALTH AND SAFETY PLAN

CONRAIL ELKHART RAILYARD

ELKHART, INDIANA

January, 1989

SITE SAFETY PLAN

GROUNDWATER TECHNOLOGY, INC.

Completed by:

Rita Rae Boji

Project Manager:

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INTRODUCTION

Regulatory Requirements

The Site Safety Planning process is an integral function of all treatment and disposal of hazardous wastes under CERCLA and RCRA. The risk of exposure and need for protecting employees exposed to hazardous wastes is addressed in the "Superfund Amendments and Reauthorization Act (SARA) of 1986" (FR 29261). OSHA requires that hazardous waste site personnel work in safe conditions under the Hazardous Waste Operations and Emergency Response regulations (29 CFR 1910.120). Employees performing clean-up operations under CERCLA, RCRA (corrective actions), and state and local government designated sites - generally those employees likely to have the highest exposures to hazardous substances over a longer period - would be virtually covered by all provisions of this proposal (FR 29623).

The employer's safety and health program must provide an organizational structure, a comprehensive workplan, and a site-specific safety and health plan. The plan must specifically address each work activity and operation, and the anticipated safety and health hazards associated with each operation and activity [29 CFR 1926.20(b)(1)(ii) through (b)(1)(iv)].

Groundwater Technology, Inc.'s field personnel and subcontractors are required to participate in an on-going health monitoring program. This program consists of a baseline medical exam in conjunction with annual examinations to update each employee's medical history. This allows for determination of any physical health effects possibly caused by exposure to hazardous contaminants during site work and also defines any intolerances an employee might have toward wearing any necessary personal protective equipment.

Intentions of the Site Safety Plan

Groundwater Technology, Inc.'s Site Safety Plan is designed to ensure that employees are aware of potential hazards which may be encountered during installation of monitoring wells, and other site operations at the Conrail Railyard at Elkhart, Indiana. The Plan is intended to address all concerns for health, safety, and regulatory compliance related to the services Groundwater Technology, Inc. is providing.

Groundwater Technology, Inc. recognizes that the potential exists for exposure to chemicals during the site investigation. The degree of potential exposure varies and is primarily dependent upon the type of investigation to be performed and extent of contamination in each work area.

The Site Safety Plan establishes policies and procedures to protect both workers and the public from potential hazards during routine activities and emergencies, should they occur while the project is in progress. This Plan shall be made available to all Groundwater Technology, Inc. field personnel and any subcontractors working on-site.

The Site Safety Plan will be revised and/or amended as new information is obtained.

All Groundwater Technology, Inc. field personnel and subcontractors will be required to read this Site Safety Plan and sign the Personnel Certifications and Acknowledgements to certify that they have read and understood the Plan. Only those personnel who have signed the Personnel Certifications and Acknowledgements will be permitted to enter the site and begin work. The Site Safety Officer will review this Plan with site workers during periodic safety meetings, review current site conditions, answer any questions, and discuss any short term alterations to the Plan if necessary. The Site Safety Officer or Field Team Leader will meet with field personnel at the beginning and end of each work day to review the safety procedures and precautions to be taken or that were taken that day.

EMERGENCY RESPONSE

In the event of an accident or emergency situation, immediate action must be taken by the first person to recognize the event. First aid equipment is located on site inside the Groundwater Technology, Inc. truck. Notify the Project Manager and Site Safety Officer about the situation immediately after emergency procedures are implemented.

Emergency Telephone Numbers:

Immediate Emergencies:

Local Police: (219)295-7070
State Police: 1 (800) 552-0976
Fire: (219)533-4151
Ambulance: 911

Medical:

Nearest Hospital: Elkhart General Hospital
Telephone: (219)294-2621
Address: 600 East Boulevard
Directions to: From Eastern Property Exit, North on 19 to S.R. 33, East on S.R. 33 to Bridge Street; West on Bridge Street to emergency entrance on right-hand side of street after crossing the bridge

Poison Control Center: 911

Emergency Environmental:

National Response Center: 1-800-424-8802
(U.S. EPA (24-hour Hotline))
Regional EPA Office:
Groundwater Technology, Inc.: (317) 849-0308
IDEM OSC: 1 (317) 243-5056

Encountering Emergency Situations

Personnel encountering a hazardous situation shall instruct others on site to evacuate the vicinity immediately and call the Project Manager, the Site Safety Officer, the Field Team Leader or, in their absence, the Regional Safety Director for instructions.

The site must not be re-entered until the situation has been corrected.

Procedures for Injury

1. Call for ambulance/medical assistance, if necessary. Notify the receiving hospital of the nature of physical injury or chemical overexposure.

2. Notify the Project Manager and Site Safety Officer. If the injury is minor, proceed to administer first aid and notify the Site Safety Officer.

Emergency Treatment

In all cases of chemical overexposure, follow standard procedures for poison management, first aid, and, if applicable, cardiopulmonary resuscitation. When transporting an injured person to a hospital, bring this site safety plan to assist medical personnel with diagnosis and treatment. Four different routes of exposure and their respective first aid/poison management procedures are outlined below:

1. Ingestion:

   CALL THE POISON CONTROL CENTER AT: 911 FOR INSTRUCTIONS.

   IF VOMITING IS NOT RECOMMENDED Dilute the poison by making the person drink one or two glasses of water or milk. Do not use carbonated beverages.

   IF VOMITING IS RECOMMENDED (vomiting must not be induced if the person is unconscious or having convulsions.) Give two tablespoonfuls (one ounce) of syrup of ipecac, followed by at least one cup of water. After ipecac has been administered, promptly have the person transported to the hospital. If vomiting does not occur within 20 minutes, repeat this procedure once.

2. **Inhalation**:

Move the person from the contaminated environment. Initiate CPR if necessary. Call or have someone call for medical assistance. Refer to MSDS information. If necessary, transport the victim to the nearest hospital.

3. **Skin Contact**:

Wash off skin with a large amount of water immediately. Remove any contaminated clothing and rewash skin using soap, if available. Transport person to a medical facility if necessary.

4. **Eyes**:

Hold eyelids open and rinse the eyes immediately with copious amounts of water for 15 minutes. If possible, have the person remove his/her contact lenses (if worn). Never permit the eyes to be rubbed. Transport person to a hospital.

SITE CHARACTERIZATION

A. SITE DESCRIPTION:

- Client: Conrail Elkhart Railyard
- Location of the company: Elkhart, Indiana
- Groundwater Technology, Inc. client? Yes X No____
- Contact person(s):

  Name: Rita Rae Boie/Dave Arnold Telephone: (216)-523-6743
- Topography of area surrounding the site:

  Hilly____ Flat X Hummocky____ Marshy____
- Area affected:

  Urban____ Rural____ Residential X Industrial____

  Commercial X Other____
- Types of bodies of water bordering the site, if any:

  Stream____ River X Pond____ Lake____ Bay____

  Ocean____ Other X None____

  St. Joseph River approx. 1 mile north of site
  Crawford Ditch drains the site and flows north to the St. Joseph River.
- See map in Appendix D
- Properties bordering the site:

  North:
  Description: Commercial, light industrial, and residential

  South:
  Description: Same as above with some open fields and a small airport

  East:
  Description: Commercial and residential

  West:
  Description: Mostly open fields and residential

- Additional Information: _____

B. BACKGROUND:

- History and nature of problem: The Conrail Elkhart Railroad was recently proposed to the National Priority List, based on data obtained from soil samples and groundwater collected on Conrail's property by an EPA contractor.

- Groundwater results showed less than the detection limit for the organic constituents of concern while soil samples contained only trace amounts of those organics.

- There is heavy groundwater contamination in residential and commercial drinking water downgradient of the site; however, there is no conclusive data supporting the EPA's belief that the Conrail Railyard is the source of the problem. Numerous small industries lie between the contaminated wells and the Conrail property that are known to use organic solvents in their daily activities.

C. ON-SITE WORK PLANS:

- Project objectives: To remediate soils and groundwater of contamination.

- Work tasks :

Task 1: Install and develop monitoring wells. Approximately 3 weeks.

Task 2: Well gauging. 1 day.

Task 3: Sample groundwater. 2 days.

Task 4: Sample soil during drilling.

Task 5: _____

Task 6: _____

D. OTHER HAZARDS

- Confined Space Task:

Confined space entry required?: Yes_____ No X

If yes, please specify: Shed_____ Subsurface Vault_____

Manhole_____ Residence Basement_____ Trench_____

Tank_____ Other_____

- Safety enginering controls incorporated in the design of remediation systems:

_____

_____

HAZARD EVALUATION

The potential for unknown hazards cannot be eliminated. Hazards can exist for all exposure routes such as inhalation, dermal contact, ingestion, and eye contact.

The following are potential hazards and the corresponding procedures for hazard reduction:

POTENTIAL HAZARDS	PROCEDURES FOR HAZARD REDUCTION
1. Volatilization of organic vapors during all operations can pose a potential hazard via the inhalation of vapors.	1. The ambient air within the work area and in all confined spaces must be monitored prior to entry with a photoionization detector or other organic vapor analyzer. Depending on organic vapor air concentrations, a respirator may need to be worn. See page 19 for action level and monitoring procedures. Workers should stand upwind of the source of contamination whenever possible, regardless of the air concentrations.
2. Workers may be exposed to chlorinated hydrocarbons including carbon tetrachloride, chloroform, trichloroethene, 1,2-dichloroethene, and perchloroethylene.	2. Organic vapor monitoring will be done as each new task begins and then at intervals through each work period.

POTENTIAL HAZARDS	PROCEDURES FOR HAZARD REDUCTION
3. Skin and eye contact with contaminated groundwater and/or soil may occur during well installation, well development, well gauging and soil and groundwater sampling.	3. Use of approved gloves and goggles will be required when potential skin and eye contact with contaminated substances is apparent. Gloves should be made of nitrile, polyvinyl alcohol or viton.
4. Skin and eye contact with nitric acid can occur if and when it is used to preserve groundwater samples.	4. (see 3. above)
5. Skin and eye contact with isopropyl alcohol, alconox, or other cleaning substances can occur while cleaning sampling equipment.	5. (see 3. above)
6. Ingestion of chemical contaminants can occur by accidental swallowing of contaminated soils, liquids and/or transfer of contaminated particles onto ingestable substances (such as food).	6. Eating, smoking, drinking and/or application of cosmetics is prohibited on site. This minimizes the possibility of exposure to the petrochemicals potentially encountered on site via ingestion.
7. Atmospheres that contain a level of oxygen greater than 25% pose an extreme fire hazard (the ambient oxygen level is approx. 20.5%).	7. Personnel encountering atmospheres that contain a level of oxygen greater than 25% must evacuate the site <u>immediately</u> and must notify the Fire Department (911).

POTENTIAL HAZARDS	PROCEDURES FOR HAZARD REDUCTION
8. Confined spaces may lack adequate ventilation and trap organic and/or combustible vapors. To avoid anoxia from the lack of oxygen and/or overexposure to vapors, personnel entering these spaces (if required) must follow the procedure for reducing hazards.	8. The oxygen in confined spaces must be monitored with an oxygen meter prior to entry. If oxygen monitoring indicates that the level of oxygen is less than 19.5%, personnel entering such spaces must wear air supplied respirators. The presence or absence of explosive vapors must be determined before entering any confined space. If the explosimeter readings are greater than 25% of the lower explosive limit (LEL), confined spaces must not be entered and the Fire Dept. should be notified. Note that the accuracy of explosimeters is compromised when used in atmospheres that contain less than 19.5% oxygen.
9. Physical hazards in general such as:	
a) slippery surfaces	9. a) Use of approved skid-proof boots shall be required.
b) noise	b) Approved ear plugs shall be made available for noisy work operations such as drilling.
c) confined spaces	c) Implementation of "buddy system" shall be in effect whenever a worker enters a confined space. A trained standby person shall remain outside space but within constant visual and/or auditory communication.

POTENTIAL HAZARDS	PROCEDURES FOR HAZARD REDUCTION
d) contaminated surfaces	d) Contact with contaminated surfaces, or surfaces suspected of being contaminated, should be avoided. This includes walking through, kneeling or placing equipment in puddles, mud, or discolored surfaces, or on drums and other containers.
10. Hazards associated with working in an operating railyard	a) Personnel should be knowledgeable of the Conrail safety rules and shall comply with these rules while working on-site. b) Personnel should always be alert for trains operating in either direction. c) Refer to pages 17 & 18 for specific precautions to take while working in the railyard.

Safety Rules for Operations Near Railyard Tracks

1. All work shall be done in accordance with Conrail rules.

2. All personnel shall wear hard hats, safety shoes or boots, full cover clothing, and safety vests as the minimum protection while working in the railyard.

3. Consider all tracks as operating tracks and always be on the alert for trains operating in either direction. Avoid doing work in the track area when visibility is poor.

4. Before crossing any tracks, stop and look for trains approaching in either direction. Do not cross tracks unless you have time to walk slowly, and do not take chances. Do not step on the head of the rail.

5. Do not wear loose clothing in the railyard. Loose clothing can catch on moving cars.

6. Do not step on track behind stopped rail cars, particularly those arriving at stations, due to the possibility of rail cars being reversed.

7. Do not attempt to carry heavy material across tracks without permission of proper authorities.

8. Know the procedures to follow in case of a safety situation requiring an immediate power shutdown. Also, know how to contact the Train Dispatcher.

9. Keep hands and feet clear of power switches. Do not step on switches, switch equipment, or frogs (track structure at intersection of two running rails).

10. Working Near Overhead Wires

a. All overhead wires including catenary, transmission, and signal lines in electrified zones are to be considered alive at all times.

b. Insulating covering of wire should not be depended upon for protection against shock.

c. No employee shall do any work near high voltage wires or apparatus where it is possible for any part of his body or tools and material with which he is working to come within 10 (ten) feet of such wires, unless a Conrail Overhead Maintenance employee is assigned to observe the safety of the operation. Use of metal ladders is forbidden.

d. When equipment is used in electrified territory or in the vicinity of any overhead wires, the Contractor must exercise special care to safeguard all persons in the area. Special attention must be given where the wires may be depressed. If, in the opinion of the Engineer, the required clearances cannot be maintained or any hazards are involved, a Conrail Overhead Maintenance employee must be requested.

11. Whenever the work may affect the safety of movement of trains, the method of doing such work, together with the proposed sequence of operations and time schedules for same, shall be submitted to the Conrail Engineer for approval. No work shall be started or prosecuted until such aproval has been obtained.

12. When any excavation extends below the bottom of the crossties, or where the stability of the railroad embankment and/or structure may be affected by the excavation, such excavation shall be adequately braced by the Contractor. Prior to starting any such excavation, detail drawings of the proposed bracing method shall be prepared and submitted to the Engineer for his approval.

13. The Engineer or his authorized representitive shall have complete authority in matters related to the Safety of Conrail's operations and facilities. The Conrail Flagman shall have absolute authority to direct the stoppage of trains. The GTI Project Manager/Site Safety Officer shall be responsible for insuring the safety of all his/her personnel. The GTI Project Manager/Site Safety Officer shall be equipped with air horns and flags to warn his/her personnel of the approach of trains.

Gas/Vapor Monitoring Procedures

Potential exposure to organic vapors and contaminated groundwater and soil represent the greatest potential hazard for safety and health at this site. Other site hazards may include potentially explosive and flammable atmospheres as well as the potential of oxygen-enriched or oxygen-deficient atmospheres. Ongoing air monitoring will provide data to ensure that vapor concentrations are within acceptable ranges and provide adequate selection criteria for respiratory and dermal protection. To protect against worker exposure, the following monitoring procedures will be routinely undertaken.

Prior to the initiation of activity at the site, and periodically throughout the site operations, ambient air levels for toxic vapors, potentially explosive atmospheres and oxygen deficiency will be determined utilizing a Flame Ionization Detector and a Combustible Gas/Oxygen Meter. Measurements will be taken at the start of each task and at any time during the process when it is suspected that air concentrations have changed as indicated by appropriate warning properties including odor threshold, irritation, employee stress, or as otherwise indicated.

Chlorinated hydrocarbons are potential on-site contaminants. To ensure adequate worker protection, air monitoring for organic vapors must be performed. Readings should be taken a minimum of three times a day. Organic vapor readings shall be taken at the start up of each new task of work during a work day and periodically during drilling (depending on the rate of drilling, every 15-30 minutes).

If FID readings exceed 5 ppm, a full-face respirator with organic vapor cartridges must be worn by all site workers within any area where monitoring results exceed 5 ppm. Organic vapor cartridges shall be changed once every two hours. Cartridges should be changed immediately if any odor is detected.

If FID readings exceed 200 ppm personnel shall leave site immediately and contact Site Safety Officer or Regional Safety Director for further instructions. Work can continue at an upgraded level of protection after contacting the Site Safety Officer, Regional Safety Director, or Industrial Hygienist.

Before entering a confined space or below grade vault, the following two monitoring procedures will be completed with O_2/ LEL monitoring equipment:

1) Because of the high vapor density of many organic solvents, there is a possibility that vapors in enclosed spaces will replace any oxygen that is present, even if the space is open to the air. Therefore, oxygen level monitoring will be done at the top, middle and bottom of the enclosed space to determine if there is a minimum acceptable oxygen level of 19.5% prior to entry.

2) Because combustible gas vapors can collect in enclosed spaces and in low areas, sampling shall be done to determine whether the vapor concentrations exceed 25% of the lower explosive limit. If readings exceed 25% LEL, personnel shall shut off accessible equipment, leave the site immediately, and contact the fire department.

3) Oxygen readings should always be taken first. If oxygen levels are below 19.5%, the LEL reading will not be accurate.

All monitoring equipment shall be calibrated and maintained in accordance with manufacturer's recommendation.

MSDS INFORMATION

Material Safety Data Sheets (MSDS) on all chemical substances encountered at the site shall be made available to all persons (including subcontractors) working at the site. These MSDSs shall be enclosed within this site safety plan in Appendix E.

For emergency situations not specifically addressed by this site safety plan, refer to MSDS recommendations for action information.

HEALTH HAZARDS OF SITE CONTAMINANTS

INTRODUCTION

This section describes the potential health effects that a worker may experience when exposed to the chemicals potentially present on this site. Unless stated otherwise, these health effects may be experienced only after a chronic overexposure to these chemicals. It is unlikely that a worker on this site would develop these health effects if safety procedures are followed.

TRICHLOROETHENE

Trichloroethene (TCE, trichloroethylene) is an example of a chlorinated hydrocarbon which may be found on this site. TCE is often used as a substitute for carbon tetrachloride and is an important industrial degreasing agent. It is also used as a dry cleaning agent and in decaffeinating coffee.

TCE has relatively low toxicity and is non-flammable. It is readily absorbed from the lungs and the gastro-intestinal tract; as with vinyl chloride, a large percent of TCE is exhaled via the lungs unchanged. TCE has been detected in employee urine samples several weeks after an exposure.

Prolonged skin contact can cause skin irritation as TCE defats the skin. Skin sensitization may also occur and existing eczematous conditions can be aggravated. Massive acute exposures may cause headache, nausea, dizziness, incoordination, drowsiness, and mild excitation or euphoria. The lowest concentration of TCE to produce unconsciousness in an adult human is approximately 3,000 ppm. Most of these symptoms will clear promptly when individual breathes uncontaminated air.

Workers chronically exposed to TCE have been found with central nervous system depression, intolerance to alcohol, and increased cardiac output. Again, symptoms tend to clear when exposure to TCE is ceased. Chronic exposures may also cause fatigue, headache, loss of memory, depression, cardiac anthymias, hypertension, or coma. TCE does have a potential hepato- and nephro-toxicity and has been observed to cause hepatocellular carcinoma in labortory mice.

1,2 - DICHLOROETHENE

1,2-dichloroethene (acetylene dichloride) is another chlorinated hydrocarbon used in industry as a solvent. It is also used as a low temperature extracting agent for heat-sensitive substances such as perfumes and caffeine in coffee.

Vapors of 1,2-dichloroethene may cause irritation of mucous membranes. It also has narcotic effects. Exposure to 1,2-dichloroethene may cause dizziness, drowsiness, nausea, vomiting, weakness, tremor, epigastric cramps, and unconsciousness. Reversible corneal clouding has been observed in some individuals. Exposures to 1,2-dichloroethene are hepatotoxic to small laboratory animals.

CARBON TETRACHLORIDE

Carbon tetrachloride was commonly used for dry cleaning, degreasing, cleaning electrical parts, and as a fire extinguisher. Currently, it is most often used in the production of other halocarbons and in the fumigation of grain.

Acute exposures to high concentrations of carbon tetrachloride results in central nervous system depression. Exposure to extremely high concentrations may lead to a rapid loss of consciousness. Lower concentrations may cause such central nervous system effects as dizziness, vertigo, headache, depression, mental confusion, and incoordination. Many individuals may experience gastrointestinal symptoms including nausea, vomiting, abdominal pain, and diarrhea.

Kidney and liver functional injury may occur from a single acute exposure. Chronic exposures to carbon tetrachloride at low concentrations will usually result in kidney and liver injury, with liver injury being more likely the lower the concentration. Some effects to the nervous system and in the gastrointestinal tract may also be observed after chronic exposures.

Carbon tetrachloride is a defatting substance. Contact with the skin removes the fats from the skin and causes a dry, disagreeable feeling. Prolonged contact may lead to a secondary infection. Contact with the eyes will cause irritation but does not lead to serious injury. Carbon tetrachloride is not significantly absorbed by the skin. However, considering the high potential liver toxicity, contact with the skin should be prevented.

Chronic exposures to low concentrations of carbon tetrachloride result in kidney and liver damage. Some effects to the nervous and gastrointestinal systems may also be noted, but these effects are minor compared to the liver and kidney effects.

CHLOROFORM

Chloroform was widely used as an anesthetic in the past. Although it is sometimes used as a solvent, it is now commonly used as a chemical intermediate. It also has some value as an insecticide, but its use as a fumigant is not widespread.

Chloroform is more irritating to the skin and eyes than many other chlorinated solvents. Chloroform is absorbed through the skin. Contact with the skin causes a typical "solvent defattening" of the skin, possibly resulting in secondary infection and/or peeling of the skin. When chloroform is confined to the skin, it can cause a definite burn.

Acute exposures to chloroform may result in depression of the central nervous system, liver and kidney injury, and possible cardiac sensitization.

Chronic exposures to chloroform cause kidney and liver injury. It appears to be teratogenic and highly toxic to embryos in animals.

PERCHLOROETHYLENE

Perchloroethylene is used as an industrial solvent for a number of purposes, particularly dry cleaning and degreasing. It has been used as a treatment for tapeworms in humans and animals. It also has limited use as a chemical intermediate.

Perchloroethylene vapors, which have an ether-like odor, can be irritating to the eyes and upper respiratory tract at 75 to 100 ppm. At 400 ppm, odor is strong and unpleasant and definite incoordination occurs after two hours of exposure. At 600 ppm, dizziness and loss of inhibition occurs after ten minutes of exposure.

Symptoms of subacute poisoning include headache, fatigue, nausea, vomiting, and temporary blurring of vision.

Contact of liquid perchloroethylene to the eyes may cause pain, tearing, and burning. However, permanent injury is unlikely. If skin contact with liquid perchloroethylene is frequently repeated, it will cause dermatitis by defatting the skin. Absorption through the skin is an unlikely route of exposure.

The major response to inhalation of perchloroethylene at high concentrations is central nervous system depression. There are some indications of nausea and gastrointestinal upset at high concentrations. Changes in the liver and kidney may also be seen following excessive exposure. Probably because of its low vapor pressure and toxicity, relatively few incidences of industrial problems due to perchloroethylene exposure have been reported.

CONRAIL SSP

Properties of Potential Site Contaminants

	Carbon Tetrachloride	Trichloroethene	1, 2 Dichloroethene
Physical Description:	Colorless liquid with an ether-like odor	Colorless liquid unless dyed, with a sweet odor similar to chloroform.	Colorless liquid with an ether-like, slightly acrid odor, similar to chloroform
Chemical/physical Properties:	flash pt: not combustible vapor density: (25/25) 1.589 vapor pressure: 91 mm specific gravity: 1.585 (25/4°) LEL: N/A UEL: N/A	flash pt: none boiling pt: 188°F vapor density: 58 mm vapor pressure: 57.8 mm LEL: 11% UEL: 41%	flash pt: 36-39°F boiling pt: 113-140°F vapor density: 1.253 @ 20° vapor pressure: 180-265 mm LEL: 9.7% UEL: 12.8%
Incompatabilities:	Chemically active metals such as sodium, potassium, and magnesium	Strong caustics, aluminum, chemically active metals, barium, lithium, sodium, magnesium, titanium	strong oxidizers
PEL TLV	10 ppm, 25 ppm ceiling 5 ppm (potential carcinogen)	100 ppm 25 ppm	200 ppm 200 ppm

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CONRAIL SSP

Properties of Potential Site Contaminants (cont.)

	Perchloroethylene	Chloroform
Physical Description:	Colorless liquid with an odor like ether or chloroform	Colorless liquid with a pleasant, sweet odor
Chemical/physical Properties:	flash pt: not combustible vapor density: (20/4) 1.623 vapor pressure: 14 mm specific gravity: 1.623 (20/4°) LEL: N/A UEL: N/A	flash pt: none boiling pt: 142°F vapor density: (20/20) 1.484 vapor pressure: 160 mm LEL: none UEL: none
Incompatabilities:	Strong oxidizers, chemically active metals such as barium, lithium, beryllium magnesium, titanium	Strong caustics, chemically active metals such as aluminum, magnesium powder, sodium, potassium
PEL TLV	100 ppm 50 ppm	50 ppm ceiling 10 ppm

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HEALTH AND SAFETY REQUIREMENTS

Medical Monitoring Program

All Groundwater Technology, Inc. field personnel are required to have annual medical evaluations in accordance with the company's Health and Safety Program policy. Additional re-evaluation will be considered in the event of chemical overexposure while working on the Conrail site. Chemicals suspected to be on this site are chlorinated hydrocarbons.

These potentially hazardous chemicals can affect specific organ systems producing characteristic health effects. The medical evaluation, therefore, focuses on the liver, the kidney, the nervous system, and various biochemical parameters measured in the blood and urine. Laboratory testing includes complete blood count, appropriate kidney and liver-function tests, and urinalysis. Lung function tests are performed to evaluate general lung health and the employee's physical ability to utilize respiratory protection equipment.

Work Zone Access

Entry into work site area shall be permitted only by authorized and trained work personnel. The immediate work area shall be cordoned with barricades and/or caution tape at each work site to prevent unauthorized personnel from entering the site without proper personal protective equipment. The Site Safety Officer shall be watchful to ensure that this precaution is enforced. The appropriate regulatory personnel shall be notified of all planned work operations and locations.

Personal Protective Equipment

There are four levels of personal protective equipment (PPE) as determined by federal safety regulations.

Level A

Level A is the highest level of both respiratory and dermal protection, generally requiring a supplied-air respirator and a fully-encapsulating suit.

- Supplied-air respirator approved by the Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH). Respirators may be:

  - pressure-demand, self-contained breathing apparatus (SCBA)

or

- pressure-demand, airline respirator, with escape bottle for Immediately Dangerous to Life and Health (IDLH) or potential for IDLH atmosphere.

- Fully encapsulating chemical-resistant suit
- Coveralls (optional)
- Long cotton underwear (optional)
- Gloves (inner), chemical-resistant
- Boots, chemical-resistant, steel toe and shank (Depending on suit construction, worn over or under suit boot)
- Hard hat
- Disposable gloves and boot covers (worn over fully encapsulating suit)
- Cooling unit (optional)

Level B

This level of PPE has the same respiratory protection as Level A, but a slightly lesser degree of dermal protection.

- Supplied-air respirator (MSHA/NIOSH approved)
  - pressure-demand, self-contained breathing apparatus

    or

  - pressure-demand, airline respirator, with escape bottle for IDLH or potential for IDLH atmosphere.
- Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one or two-piece chemical-splash suit; disposable chemical-resistant, one piece suits)
- Long cotton underwear (optional)
- Coveralls (optional)
- Gloves (outer), chemical-resistant

- Gloves (inner), chemical-resistant
- Boots (outer), chemical-resistant, steel toe and shank
- Disposable boot covers (outer), chemical-resistant (optional)
- Hard hat

Level C

Level C protection requires the same degree of dermal protection as Level B, with a lesser degree of respiratory protection.

- Air-purifying respirator, full-face, canister- equipped (MSHA/NIOSH approved)
- Chemical-resistant clothing (coveralls; hooded, one-piece or two-piece chemical splash suit; chemical-resistant hood and apron; disposable chemical-resistant coveralls)
- Coveralls (optional)
- Long cotton underwear (optional)
- Gloves (outer), chemical-resistant
- Gloves (inner), chemical resistant (optional)
- Boot (outer), chemical-resistant, steel toe and shank
- Disposable boot covers (outer), chemical-resistant (optional)
- Hard hat
- Escape mask (optional)

Level D

Level D basically does not require any dermal or respiratory protection other than a normal work uniform

- Coveralls
- Gloves (optional)
- Boots/shoes, leather or chemical-resistant, steel toe and shank

- Safety glasses or chemical splash goggles (optional)
- Hard hat

Site Entry/Initial Protection

During all activities performed on-site, workers shall wear a Level D suit consisting of coveralls, chemical-resistant boots and gloves, goggles, and hard hat. The recommended chemical resistant material is nitrile, polyvinyl alcohol, or viton.

All workers within the exclusion zone (see site map) will be required to wear level D protection. Level of protection should be upgraded to Level C if air monitoring readings indicate levels over 5 ppm. If respirators must be worn, Level C protection gear must be worn. However, air monitoring should be done at 15-30 minutes intervals when respirators are not worn.

During all work performed on-site, a task-by-task analysis must be performed by the Site Safety Officer in order to determine on-going and changing risks associated with the airborne toxics possibly encountered. Groundwater, air, and soils analyses will also contribute to assessment of the risks.

Once the initial site entry and air monitoring has been performed, decisions may be made as to whether upgrading, down-grading or maintaining the level of PPE is warranted. This decision will be made on a case-by-case, location-to-location basis, according to the risk of exposure due to the work task being performed.

Adjustments to Site Safety Plan

All decisions made shall be documented daily. Amendments will be made to this Site Safety Plan for any task to be performed that is not addressed in this Site Safety Plan.

Following is the set of procedures that will be followed when site conditions encountered during work operations are different than those expected and accounted for in the Site Safety Plan. Examples of situations that may occur are the need to stop on-site work due to hazardous conditions and the need to change the necessary level of protection for on-site personnel.

	STOP WORK ORDER
Site Safety Officer (SSO)	o Constantly assesses site conditions. If site conditions are perceived as a threat to the health and safety of field personnel, has the authority to immediately stop on-site work. o Notifies Regional Safety Director as soon as feasible of a 'stop work' order.
National Health and Safety Program Manager (NHSPM), and/or Industrial Hygienist (IH) with the (Regional Safety Director)	o Evaluate the conditions that prompted the stop work order. o Establish the actions necessary to take prior to starting work again. o Institute an action plan to prevent a similar situation occurring again, if possible.
	LEVEL OF PROTECTION UPGRADE
SSO	o Continually assess conditions on-site. If levels of air contaminants exceed those stated on page 19 and 20, the SSO will ensure that site personnel are wearing Level C protective gear. If they are not, the SSO will immediately clear all personnel from the area. o Stops on-site work if the necessary personal protective equipment is not available. o If necessary personal protective equipment is readily available, ensures that all field personnel don the necessary PPE immediately. o Notifies the Regional Safety Director of the Level of Protection Upgrade.

RSD	o Notifies the NHSPM and/or IH.
NHSPM/IH	o Verifies the need to upgrade the Level of Protection.
	LEVEL OF PROTECTION DOWNGRADE
SSO	o Assessment of site conditions to ensure that site conditions meet the standards stated in this Site Safety Plan on page 19 and 20. o Notifies the RSD before taking any action to downgrade.
RSD	o Consults with the NHSPM and/or IH. o Notifies the SSO of the final decision.

First Aid Equipment

Vehicles used for site work will be equipped with a first aid kit and safety equipment including:

- fire extinguisher,
- one ounce Ipecac,
- flashlight,
- water, suitable for drinking,
- portable eye wash, and
- appropriate emergency bandage material.
- thermometer with disposable covers
- ice

Site Decontamination Procedures

At each work location reusable sampling and personal protective equipment will be decontaminated prior to sampling, between each sample, and after sampling. Sampling equipment will be decontaminated by steam cleaning or washing with a mixture of alconox and water, then rinsed twice with distilled water and allowed to air dry on a clean plastic tarp. All decontamination solutions shall be disposed of at the work station where they were generated. Disposable sampling and personal protective equipment will be placed in plastic bags and temporarily stored in designated drums. These drums will be disposed of according to EPA guidelines, if necessary.

Following proper decontamination procedures (decon) is as important as donning the appropriate safety gear. If proper decon is not done, many of the protective measures taken while working on site can be for naught. So, all workers on-site must always be conscious of the different ways they can be exposed to the hazardous material.

Gloves and boots are the first items that should be deconned. A hose or shower can be used to clean all reusable equipment. Spray deconning will take place on the hypalon pad designated for this purpose.

The sequence of steps for removing and cleaning personal protective equipment follows:

- Wash gloves, boots, and outer Tyvek coveralls.
- Rinse work gloves, boots, coveralls.
- Remove tape at wrists, ankles, neck.
- Remove outer boots (if used) and outer gloves.
- Remove outer suits, avoiding any contact between the outside of the suit and the wearer's body, and package; dispose, if disposable.
- Remove facepiece of SCBA or respirator, if worn.
- Wash respirator.
- Package and/or dispose of facepiece or respirator.
- Package boots and gloves or dispose of them.
- Dispose of all contaminated items in properly labeled drums.
- If necessary, copy notes from contaminated paper onto clean paper while wearing inner gloves (surgical gloves) at decon station area.
- Remove latex gloves.
- Dispose of latex gloves and contaminated note paper.
- Wash hands and face.

Drilling Procedures

A metal detector should be used before drilling on a site to determine presence of subsurface metal tanks and/or drums. During the drilling operation, two persons (one designated as "driller" and the other as "helper") must be present at all times. The helper (whether Groundwater Technology, Inc. personnel or subcontractors) should be aware of the emergency shut-off switch. Every attempt must be made to keep unauthorized personnel from entering the work area. If this is not possible, the operation should be shut down until the area is cleared. The Site Safety Officer or the Field Team Leader has the authority and responsibility to shut down the drilling operations whenever a hazardous situation is deemed present.

The mast of the drilling rig must maintain a minimum clearance of ten feet from any overhead electrical cables. All drilling operations must cease immediately during any hazardous weather conditions.

Hard hats shall be worn at all times.

Electrical Equipment

All electrical equipment and power cables used in and around wells or structures containing petrochemical contamination must be explosion-proof and/or intrinsically-safe and equipped with a three-wire ground lead.

Fire Prevention

During equipment operation, periodic vapor concentration measurements should be taken with an explosimeter or combustimeter. If at any time the vapor concentrations exceed 25% LEL, then the Site Safety Officer or designated field worker should immediately shut down all operations.

Only approved safety cans will be used to transport and store flammable liquids.

All gasoline and diesel-driven engines requiring refueling must be shut down and allowed to cool before filling.

Smoking is not allowed during any operations within the exclusion zone.

No open flame or spark is allowed in any area containing flammable liquids.

General Health

Medicine and alcohol can increase the effects of exposure to toxic chemicals. The Site Safety Officer or Regional Safety Director should be notified of any site worker on prescription drugs with side effects that may affect judgment or coordination. Drinking and driving is prohibited at any time. Driving at excessive speeds is always prohibited.

Skin abrasions must be thoroughly protected to prevent chemicals from penetrating the abrasion.

Cold Stress Prevention

The following measures should be taken to prevent hypothermia:

1) Provide warm liquids for site workers to drink, if they will be on site for over one hour. The drinks should be decaffeinated.

2) Provide a warm sheltered area for warming, if workers will be present for over two hours.

3) Extremities, such as hands and head, should be covered.

4) Temporary windblocks may reduce the windchill factor on particularly windy days.

PROJECT PERSONNEL

Groundwater Technology, Inc. will oversee and act accordingly during all phases of the project. The following management structure will be instituted for the purpose of successfully and safely completing this project.

Project Manager

The Project Manager will be responsible for implementing the project and obtaining any necessary personnel or resources for the completion of the project. Specific duties will include:

- coordinating the activities of all subcontractors,
- selecting a Site Safety Officer and field personnel for the work to be undertaken on site,
- ensuring that the tasks assigned are being completed as planned and on schedule,
- providing authority and resources to ensure that the Site Safety Officer is able to implement and manage safety procedures,
- preparing reports and recommendations about the project to clients and affected Groundwater Technology, Inc. personnel,
- ensuring that all personnel allowed to enter the site (i.e. EPA, contractors, state officials, visitors) are made aware of the potential hazards associated with the substances known or suspected to be on site,
- ensuring that the Site Safety Officer is aware of all of the provisions of this site safety plan and is instructing all personnel on site about the safety practices and emergency procedures defined in the plan, and
- ensuring that the Site Safety Officer is making an effort to monitor site safety.

Regional Safety Director

The Regional Safety Director shall be responsible for the overall coordination and oversight of the site safety plan. Specific duties will include:

- approving the selection of the types of personal protective equipment (PPE) to be used on site for specific tasks,

- monitoring the compliance activities and documentation processes undertaken by the Site Safety Officer,

- evaluating weather and chemical hazard information and making recommendations to the Project Manager about any modifications to work plans or personal protection levels in order to maintain personnel safety,

- coordinate upgrading or downgrading PPE with Site Safety Officer, as necessary, due to changes in exposure levels, monitoring results, weather, other site conditions, and

- approving all field personnel working on site, taking into consideration their level of safety training, their physical capacity, and their eligibility to wear the protective equipment necessary for their assigned tasks (i.e.: Respirator Fit Testing Results).

Site Safety Officer

The Site Safety Officer shall be responsible for the implementation of the site safety plan on site. Specific duties will include:

- monitoring the compliance of field personnel for the routine and proper use of the PPE that has been designated for each task,

- routinely inspecting PPE and clothing to ensure that it is in good condition and is being stored and maintained properly,

- stopping work on the site or changing work assignments or procedures if any operation threatens the health and safety of workers or the public,

- monitoring personnel who enter and exit the site and controlled access points,

- reporting any signs of fatigue, work-related stress, or chemical exposures,

- dismissing field personnel from the site if their actions or negligence endangers themselves, co-workers, or the public,

- reporting any accidents or violations of the site safety plan to the Project Manager, and documenting the same for the project in the project records,

- knowing emergency procedures, evacuation routes and the telephone numbers of the ambulance, local hospital, poison control center, fire and police departments,

- ensuring that all project-related personnel have signed the personnel agreement and acknowledgments form contained in this site safety plan, and

- coordinate upgrading and downgrading PPE with the Regional Safety Director, as necessary, due to changes in exposure levels, monitoring results, weather, and other site conditions.

Field Team Leader

In the event that the Project Manager and the Site Safety Officer are not on site, the Field Team Leader will assume all responsibility for enforcing safety procedures.

Medical/Technical Advisors

Frank H. Lawrence, M.D.
ENVIROLOGIC DATA, Portland, Maine.....(207) 773-3020

Marilyn E. Grant, R.N., B.S., C.O.H.N
ENVIROLOGIC DATA, Portland, Maine.....(207) 773-3020

Lori St.Pierre, I.H.
ENVIROLOGIC DATA, Portland, Maine.....(207) 773-3020

The specific duties of the Medical/Technical Advisors include:

- providing technical input into the design of the site safety plan,

- advising field personnel on worker exposure potential along with appropriate hazard reduction methods, and

- recommending a suitable medical monitoring program for the site workers.

Other Field Personnel

All field personnel shall be responsible for acting in compliance with all safety procedures outlined in the site safety plan. Any hazardous work situations or procedures should be reported to the Site Safety Officer so that corrective steps can be taken.

APPENDIX A

Agreement and Acknowledgment Statement

Site Safety Plan Agreement

All Groundwater Technology, Inc. project personnel and subcontractor personnel are required to sign the following agreement prior to conducting work at the Conrail Railyard site.

1. I have read and fully understand the Site Safety Plan and my individual responsibilities.

2. I agree to abide by the provisions of the Site Safety Plan.

Kent Moore Name	Signature
John Mathes & Associates, Inc. Company	1/30/89 Date
Daniel Gotto Name	Signature
John Mathes & Associates, Inc. Company	1/30/89 Date
James Resler Name	Signature
John Mathes & Associates, Inc. Company	1/30/89 Date
David W. Ellis Name	Signature
John Mathes & Associates, Inc. Company	2/06/89 Date

APPENDIX A (continued)

David Julius **Name**	David D. Julius **Signature**
John Mathes & Associates, Inc. **Company**	2/13/89 **Date**
Robert Lewis **Name**	Robert Lewis **Signature**
John Mathes & Associates, Inc. **Company**	2/17/89 **Date**
Rita Rae Boje **Name**	Rita Rae Boje **Signature**
Groundwater Technology, Inc. **Company**	1/30/89 **Date**
Matthew C. Darney **Name**	Matthew C. Darney **Signature**
Groundwater Technology, Inc. **Company**	1/30/89 **Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**
Name	**Signature**
Company	**Date**

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APPENDIX B

Site Safety Plan Amendment Sheet

Project Name:_____

Project Number: _____

Location:_____

Changes in field activities or hazards:

Proposed Amendment:

Proposed by:_____ Date:_____

Approved by:_____ Date:_____

Declined by:_____ Date:_____

Amendment Number:_____

Amendment Effective Date:_____

APPENDIX C

Explanation of Hazard Evaluation Guidelines

Hazard: Airborne Contaminants

Guideline	Explanation
Threshold Limit Value Time-Weighted Average (TLV-TWA)	The time-weighted average concentration for a normal 8-hour work day and a 40-hour work week, to which nearly all workers may be repeatedly exposed without adverse effect.
Permissible Exposure Limit (PEL)	Time-weighted average concentrations similar to (and in many cases derived from) the Threshold Limit Values.
Immediately Dangerous to Life or Health (IDLH)	The maximum level from which a worker could escape without any irreversible health effects.

Hazard: Explosion

Guideline	Explanation
Lower Explosive Limit (LEL)	The minimum concentration of vapor in air below which propagation of a flame will not occur in the presence of an ignition source.
Upper Explosive Limit (UEL)	The maximum concentration of vapor in air above which propagation of a flame will not occur in the presence of an ignition source.

Hazard: Fire

Guideline	Explanation
Flash Point (flash p)	The lowest temperature at which the vapor of a combustible liquid can be made to ignite momentarily in air.

APPENDIX D

SITE MAPS

APPENDIX E

MSDSs

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MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

No. 410

CARBON TETRACHLORIDE

Revision A

Date: December 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CARBON TETRACHLORIDE
OTHER DESIGNATIONS: Tetrachlormethane, Perchlormethane, Methane Tetrachloride, CCl_4, GE Material D5850, CAS #000 056 235
MANUFACTURER: Available from several suppliers, including:
Linden Chemicals & Plastics
PO Drawer J,
Moundsville, WV 26041 Phone: (314) 843-1310

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Carbon Tetrachloride *ACGIH (1980 Intended Changes List). OSHA 8-hr TWA is 10 ppm. NIOSH has proposed a 10-hr TWA of 2 ppm. ACGIH and NIOSH recommend labeling as a suspected human carcinogen. (skin) notation indicates absorption through the skin can contribute significantly to overall exposure.	ca 100	8-hr TWA 5 ppm (skin) or 30 mg/m³* Human, oral LDlo 43 mg/kg Human, inhalation LCLo 1000 ppm TCLo 20 ppm (CNS) Hamsters and mice have developed cancer on long term feeding.

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C	76.7	Specific gravity, 25/4 C	1.585
Vapor pressure @ 20 C, mm Hg	ca 91	Melting point, deg C	-23
Vapor density (Air=1)	5.3	Volatiles, %	ca 100
Solubility in water @ 20 C, wt %	0.08	Molecular weight	153.8

Appearance & Odor: A clear, colorless liquid with a characteristic sweetish odor. Odor recognition threshold (100% of test panel): 21.4 ppm in air when prepared from CS_2; 100 ppm in air when prepared from CH_4. Odor may not be objectionable at acutely toxic levels.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER

Extinguishing Media: It is nonflammable. Use that which is appropriate for the surrounding fire. Use water spray to cool fire-exposed containers.
When involved in a fire situation, this material will emit highly toxic and irritating fumes and gases. Metals, such as aluminum and magnesium, can react violently with carbon tetrachloride when hot or burning.
Firefighters must wear self-contained breathing apparatus and full protective gear to fight fires involving this material.

SECTION V. REACTIVITY DATA

This material is stable under normal conditions of handling and use. It does not polymerize.
Thermal-oxidative decomposition will produce toxic, corrosive fumes, including phosgene and hydrogen chloride.
Violent reactions or explosions can occur with incompatible materials, such as barium, lithium, sodium, and potassium metal, powdered aluminum, magnesium, dimethylformamide (above 65 C), fluorine, etc. (See NFPA, "Manual of Hazardous Chemical Reactions".)

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No. 410

SECTION VI. HEALTH HAZARD INFORMATION

TLV 5 ppm (skin) (See Sect. II)

Carbon tetrachloride is highly toxic and irritating by inhalation and ingestion (mean lethal dose is 5-10 ml). It is toxic by skin absorption. Excessive exposure may result in CNS depression and/or gastrointestinal symptoms.* It is irritating to skin and eyes. Eye contact or systemic effects can produce visual disturbances (haze, blind spots, narrowing of visual field, etc.). Skin contacts can cause defatting & dermatitis.

Kidney & liver damage can occur from severe acute or chronic exposure. It is a suspected carcinogen in humans.

FIRST AID:

Eye Contact: Flush eyes with running water for 15 minutes, including under the eyelids. Get medical help if irritation persists or when visual disturbances occur.

Skin Contact: Remove contaminated clothing promptly. Wash exposed skin with soap and water. Get medical help for repeated or gross exposures.

Inhalation: Remove to fresh air. Restore and/or support breathing; have qualified person administer oxygen if needed. Get medical help.

Ingestion: Contact physician for gastric lavage. (If medical help and advice is not readily available, give water to drink and induce vomiting.)

*Also cardic arrhythmias.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel when large spills occur. Evacuate area. Provided maximum exhaust ventilation. Clean-up personnel must use protection against contact and inhalation (see Sect.VIII). Contain spill; pick up liquid for disposal. Small spills and residues can be absorbed on paper, vermiculite, etc. and allowed to evaporate in a hood. Prevent release of CCl_4 to surface water or sewers. Spills or discharges in 24 hours of 5000 lb or more (proposed RQ* is 1000 lb) must be reported to U.S. Government.

DISPOSAL: Consider recovery and reuse, if feasible. Scrap may be burned in approved, high temperature incinerator with scrubber or it may be disposed of as hazardous waste (EPA number U211 or F001 as a spent degreasing solvent under RCRA). Follow Federal, State and Local regulations.

*Reportable Quantity.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV. Exhaust hoods need 100 lfm min. face velocity. Ventilate sumps and low lying areas. Use air-supplied or self-contained respirators above TLV, with full face piece above 100 ppm.

PVA or neoprene gloves and protective clothing needed to prevent skin contact. Wear safety goggles and/or face shield for eye protection.

An eyewash station and chemical safety shower should be readily accessible.

Provide preplacement and twice a year medical exams. Workers with obesity, diabetes, alcoholism or pulmonary problems should have a physician's approval before working with CCl_4. Retain medical records for 30 years after termination of employment.

Provide training to those exposed to CCl_4 in the workplace. Monitor vapor levels in the workplace.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated, low fire-risk area. Protect containers against physical damage. Keep away from sources of heat, direct sunlight, and incompatible materials (see Sect. V). Prevent exposure of vapors to high temperature to prevent decomposition to toxic and corrosive gases and vapors. No smoking in areas where vapors may be present.

Prevent contact with the skin or eyes. Avoid exposure to vapors. Use good personal hygiene.

CCl_4 toxicity is markedly increased by the synergistic effects of alcohol. When possible, substitute a less hazardous solvent for CCl_4. DOT Classification - ORM-A

DATA SOURCE(S) CODE: 1-12,15,16,21-26,31,37,38,4

[illegible]

APPROVALS: MIS CRD

Industrial Hygiene and Safety 12-9-80

MEDICAL REVIEW: 16 Dec. 1980

Material Safety Data Sheet

From Genium's Reference Collection
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No. 312
TRICHLOROETHYLENE
(Revision E)

Issued: July 1979
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: TRICHLOROETHYLENE

DESCRIPTION (Origin/Uses): Prepared from *syn*-tetrachloroethane by way of eliminating HCl by boiling with lime. Used to manufacture organic chemicals, pharmaceuticals; in degreasing and dry cleaning; and as a solvent for fats, waxes, rubbers, oils, paints, varnishes, others, and cellulose esters.

OTHER DESIGNATIONS: Ethylene Trichloride; TCE; Trichloroethene; 1,1,2-Trichloroethylene; C_2HCl_3; NIOSH *RTECS* #KX4550000; CAS #0079-01-6

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640;
Telephone: (517) 636-1000; (800) 258-CHEM

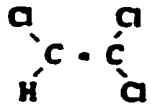
COMMENTS: Trichloroethylene is a toxic solvent and a suspected occupational carcinogen.

HMIS			
H	2	R	1
F	1	I	3
R	1	S	1
PPE*		K	0

* See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Trichloroethylene, CAS #0079-01-6; NIOSH *RTECS* #KX4550000	100	ACGIH Values 1987-88 TLV-TWA*: 50 ppm, 270 mg/m^3 TLV-STEL**: 200 ppm, 1080 mg/m^3 OSHA PEL 1986*** 8-Hr TWA: 100 ppm Ceiling: 200 ppm NIOSH REL 1986 10-Hr TWA: 25 ppm TOXICITY DATA Human, Oral, LD_{Lo}: 7 g/kg Human, Inhalation, TC_{Lo}: 6900 mg/m^3 (10 Min) Human, Inhalation, TC_{Lo}: 160 ppm/30 Min Human, Inhalation, TD_{Lo}: 812 mg/kg



- The TLV-TWA is set to control subjective complaints such as headache, fatigue, and irritability.
- ** The TLV-STEL is set to prevent incoordination and other beginning anesthetic effects from TCE. These levels should provide a wide margin of safety in preventing liver injury.
- *** The OSHA PEL is 300 ppm for 5 minutes in any 2 hours.

SECTION 3. PHYSICAL DATA

Boiling Point ... 188.6°F (87°C)
Vapor Pressure ... 58 Torr at 68°F (20°C)
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... 4.53
Evaporation Rate ... Not Listed
Specific Gravity ... 1.4649 at 68°F (20°C)
Melting Point ... -120.64°F (-84.8°C)
Molecular Weight ... 131.40 Grams/Mole

Appearance and odor: Colorless, nonflammable mobile liquid; sweetish odor like chloroform.

COMMENTS: TCE is highly soluble in lipids. A high vapor pressure at room temperature provides the potential for TCE vapors to contaminate the air.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Listed	770°F (410°C)	% by Volume	8%	10.5%

EXTINGUISHING MEDIA: TCE has no flash point in a conventional closed tester at room temperature, but it is moderately flammable at higher temperatures. Use dry chemical, carbon dioxide, alcohol foam, or other extinguishing agents suitable for the surrounding fire.

OSHA Flammability Class (29 CFR 1910.106): Not Regulated

UNUSUAL FIRE/EXPLOSION HAZARDS: During fire conditions TCE emits highly toxic and irritating fumes, including hydrochloric acid and phosgene. **SPECIAL FIRE-FIGHTING PROCEDURES:** Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode. At TCE vapor levels of 300-1000 ppm, fire fighters who lack the proper respiratory equipment may experience incoordination and impaired judgment.

DOT Flammability Class (49 CFR 173.115): Not Regulated

SECTION 5. REACTIVITY DATA

Trichloroethylene is stable. Hazardous polymerization can occur under certain circumstances (see Conditions to Avoid and Comments, below).

CHEMICAL INCOMPATIBILITIES include magnesium or aluminum powder, NaOH, KOH, or other strong alkaline materials. Reactions with alkaline materials may lead to the formation of dangerous explosive mixtures of chloroacetylenes.

CONDITIONS TO AVOID: When TCE is heated (as in the case with vapor degreasers) or exposed to sunlight, it requires extra stabilization against oxidation, degradation, and polymerization. It is slowly decomposed by light when moist.

PRODUCTS OF HAZARDOUS DECOMPOSITION include hydrochloric acid and phosgene under certain conditions at elevated temperatures.

COMMENTS: TCE is stable under normal handling and storage conditions, and hazardous polymerization is not expected to occur. However, failure of the stabilizer at elevated temperatures or other extreme conditions may allow polymerization to take place.

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SECTION 6. HEALTH HAZARD INFORMATION

Trichloroethylene is listed as a carcinogen by the NTP, IARC, and OSHA. NIOSH recommends that trichloroethylene be treated as an occupational carcinogen. IARC carcinogenic results are limited suspect, animal positive, and human inadequate. SUMMARY OF RISKS: Moderate exposures to TCE cause symptoms similar to those of alcohol inebriation. Higher concentrations cause narcotic effects. Ventricular fibrillation has been cited as the cause of death following heavy exposures. TCE-induced hepato cellular carcinomas have been detected in mice during tests conducted by the National Cancer Institute (Chem & Eng News 54 (April 5, 1976):4). Organs systems affected by overexposure to TCE are the central nervous system (euphoria, analgesia, anesthesia), degeneration of the liver and kidneys, the lungs (tachypnea), heart (arrhythmia) and skin (irritation, vesiculation, and paralysis of fingers when immersed in liquid TCE). Contact with the liquid defats the skin, causing topical dermatitis. Certain people appear to experience synergistic effects from TCE exposure concomitant with exposure to caffeine, alcohol, and other drugs. When combined with alcohol intake, toxic effects are increased and may cause a red, blotchy facial and upper body rash commonly called "degreaser's flush." Other reported symptoms of TCE exposure include abnormal fatigue, headache, irritability, gastric disturbances, and intolerance to alcohol. Toxic effects from testing of TCE on humans include hallucination, distorted perception, somnolence (general depressed activity), and jaundice. TARGET ORGANS: Respiratory system, central nervous system, heart, liver, kidneys, and skin. PRIMARY ENTRY: Ingestion, inhalation, skin contact. ACUTE EFFECTS: Headache, vertigo, visual disturbance, tremors, nausea, vomiting, dermatitis, dizziness, drowsiness, and irritation to the eyes, nose, and throat. CHRONIC EFFECTS: None Reported. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Diseases of the liver, kidneys, lungs, and central nervous system. FIRST AID: EYE CONTACT: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Do not give adrenalin to the victim. Get medical help.* INGESTION: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. A professional decision regarding whether or not to induce vomiting is required. Do not give adrenalin to the victim. Get medical help.*

*GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

COMMENTS: Workers' responses to TCE vary significantly because of many factors, including age, health status, nutrition, and intake of alcohol, caffeine, and medicines. Do not use these substances before, during, or after exposure to TCE. If a worker displays any of the symptoms of exposure to TCE, thoroughly investigate all the possible contributing factors to determine, if possible, how much the work environment levels of TCE are responsible.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Inform safety personnel of any trichloroethylene spill or leak and evacuate the area for large spills. Cleanup personnel must use respiratory and liquid contact protection. Adequate ventilation must be provided. Confine the spilled TCE to as small an area as possible. Do not allow it to run off to sewers or open waterways. Pick up spilled TCE with a vacuum cleaner or an absorbent such as vermiculite.

DISPOSAL: *Consider reclamation, recycling, or destruction rather than disposal in a landfill.*

Trichloroethylene is designated as a hazardous substance by the EPA (40 CFR 116.4).

Trichloroethylene is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U228

EPA Reportable Quantity (40 CFR 117.3): 1000 lbs (454 kgs)

Aquatic Toxicity Rating, TLm 96: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Follow the eye and face protection guidelines of 29 CFR 1910.133. GLOVES: Wear impervious gloves. RESPIRATOR: Use a NIOSH-approved respirator per the *NIOSH Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of TCE requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. WARNING: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER EQUIPMENT: Wear rubber boots, aprons, and other suitable body protection appropriate to the existing work environment. VENTILATION: Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne concentrations of TCE below the OSHA PEL standards cited in section 2. SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. OTHER SPECIAL MODIFICATIONS IN THE WORKPLACE: Because of the unresolved controversy about the carcinogenic status of TCE, all existing personal protective equipment and engineering technology should be used to prevent any possibility of worker contact with this material.

COMMENTS: Practice good personal hygiene. Keep material off of your clothes and equipment. Avoid transfer of material from hands to mouth while eating, drinking, or smoking. Adhere to the sanitation requirements of 29 CFR 1910.141 and 29 CFR 1910.142.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Prevent TCE from coming into contact with strong caustics such as NaOH; KOH; chemically active metal like Ba, Li, Na, Mg, Ti; and powdered aluminum or magnesium in acidic solutions. SPECIAL HANDLING/STORAGE: Store this material in a cool, dry, well-ventilated area. Avoid elevated temperatures because products of toxic and corrosive decomposition from TCE may form. Monitor the level of any stabilizer component that may be added to the TCE. (Consult the technical data from the supplier to determine the specifics of any added stabilizer.) If applicable, follow the supplier's recommendation concerning proper rotation of stock, shelf-life requirements, and levels of stabilizers. ENGINEERING CONTROLS IN THE WORKPLACE: Avoid collecting aluminum fines (very small particles) or chips in a TCE vapor degreaser. Monitor TCE stabilizer levels regularly. Only trained personnel should operate vapor degreasers.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: ORM-A	DOT ID No. UN1710	IMO Class: 6.1
IMO Label: St. Andrew's Cross (X)*	DOT Shipping Name: Trichloroethylene	DOT Label: None

* Harmful - Stow away from foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1-9, 12, 14, 21, 73, 87-94. PI

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Approvals JO Rechsteiner

Indust. Hygiene/Safety 11-19-87

Medical Review M. D. Halbert

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GENIUM PUBLISHING CORP.

No. 315
CHLOROFORM
(Revision D)
Issued: August 1979
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: CHLOROFORM

Description (Origin/Uses): Used as a solvent for fats, oils, rubber, alkaloids, waxes, and resins; as a cleaning agent.

Other Designations: Trichloromethane; $CHCl_3$; NIOSH *RTECS* No. FS9100000; CAS No. 0067-66-3

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS			
H	2		
F	0	R	1
R	0	I	3
PPG*		S	2
*See sect. 8		K	0

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients and Hazards	%	Exposure Limits
Chloroform, CAS No. 0067-66-3	Ca 100	**OSHA PEL** Ceiling: 50 ppm, 240 mg/m³ **ACGIH TLV, 1987-88** TLV-TWA: 10 ppm, 50 mg/m³ **NIOSH REL** Ceiling: 2 ppm, 9.78 mg/m³ **Toxicity Data*** Human, Oral, LD_{Lo}: 140 mg/kg Rat, Oral, LD_{50}: 908 mg/kg

*See NIOSH, *RTECS*, for additional toxicity data with references to mutagenic, reproductive, tumorigenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 142°F (61°C)
Melting Point: -82.3°F (-63.5°C)
Vapor Pressure: 158.4 Torr at 68°F (20°C)
Vapor Density (Air = 1): 4.13

Water Solubility (%): 0.822 ml of $CHCl_3$ per 100 ml of H_2O at 68°F (20°C)
% Volatile by Volume: 100
Molecular Weight: 119 Grams/Mole
Specific Gravity (H_2O = 1): 1.484 at 68°F (20°C)

Appearance and Odor: A heavy, colorless, clear, volatile liquid; characteristic, pleasant, ethereal, sweet odor (recognition threshold: 0.3 mg/m³); sweet taste.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
•	•		•	•

Extinguishing Media: *Chloroform does not burn. Use an agent that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Chloroform is stable if kept in closed containers and protected from air and sunlight. It does not undergo hazardous polymerization; however, even when stabilized with ethanol, this material develops acidity from prolonged exposure to air and light.

Chemical Incompatibilities: This material is incompatible with strong alkalies.

Conditions to Avoid: Avoid prolonged exposure to air and light and to strong alkalies.

Hazardous Products of Decomposition: Toxic and corrosive gases like hydrochloric acid (HCl), chlorine (Cl_2), carbon monoxide (CO), and oxides of chlorine (ClO_x) can be produced during fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Chloroform is listed as a suspected human carcinogen by ACGIH.

Summary of Risks: Exposure to this material affects the central nervous system (anesthesia); heart (arrhythmia, ventricular tachycardia, bradycardia); liver (necrosis, hepatoma); kidney (necrosis); and it is an embryonic toxin. Fatalities are associated with cardiovascular depression and ventricular fibrillation.
Medical Conditions Aggravated by Long-Term Exposure: Ailments of the heart, liver, and kidneys may be worsened by exposure to chloroform. **Target Organs:** Liver, kidneys, heart, skin, eyes. **Primary Entry:** Skin contact, inhalation.
Acute Effects: Dizziness, mental dullness, nausea, headache, fatigue, and anesthesia. **Chronic Effects:** Possible cancer.
FIRST AID
Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
Skin: Immediately wash the affected area with soap and water. **Inhalation:** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.
Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. If the exposed person is responsive, give him or her several glasses of milk or water to drink and induce vomiting. Repeat if large quantities were ingested.
Comments: Workers who are regularly exposed to chloroform require preplacement and periodic medical exams emphasizing kidney, liver, skin, and central nervous system functions. Carefully evaluate each exposure that produces a noticeable effect to determine the extent to which factors like alcohol or drugs have affected it.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel of a chloroform spill or leak. Provide ventilation. Cleanup personnel need protection against contact with and inhalation of vapor (see sect. 8). Chloroform vapor is heavier than air and will collect in low-lying areas. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U044
CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Wear a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** To prevent contact with skin, wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specific work environment. **Ventilation:** Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of chloroform below the OSHA PEL standard cited in section 2.
Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid inhalation of vapor!

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store chloroform in closed containers away from light and alkalies.

Special Handling/Storage: Protect containers from physical damage. Do not transfer chloroform through plastic or rubber hoses or pipes.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Chloroform	**DOT Label:** None	**IMO Label:** Poison
DOT Class: ORM-A	**DOT ID No.** UN1888	**IMO Class:** 6.1

References: 1, 2, 12, 73, 84-94, 100, 103.

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Material Safety Data Sheet

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No. 359
ETHYLENE DICHLORIDE
(Formerly 1,2-Dichloroethane)
(Revision C)
Issued: November 1978
Revised: August 1987

SECTION 1. PRODUCT/INGREDIENT IDENTIFICATION

CHEMICAL NAME: ETHYLENE DICHLORIDE (Changed to reflect common industrial practice)

DESCRIPTION (Dichloflint): Made from ethylene and HCl. Used as a degreaser, a scavenger in leaded gasoline, as an intermediate in the manufacture of vinyl chloride, in paint removers, in wetting and penetration agents, in ore flotation processes, as a fumigant, and as a solvent for fats, oils, waxes, and gums.

OTHER DESIGNATIONS: 1,2-Dichloroethane; *sym*-Dichloroethane; Dutch Liquid; Dutch Oil; EDC; Ethane Dichloride; Ethylene Chloride; 1,2-Ethylene Dichloride; Glycol Dichloride; $C_2H_4Cl_2$; NIOSH *RTECS* KI0525000; CAS #0107-06-2

MANUFACTURERS/SUPPLIERS: Available from several suppliers, including: Dow Chemical USA, 2020 Dow Center, Midland, MI 48640; Telephone: (517) 636-1000

COMMENTS: Ethylene dichloride is a flammable, toxic liquid.

HMIS			
H	1	R	1
F	3	I	4
R	0	S	2
PPE*		K	4

* See Sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Ethylene Dichloride, CAS #0107-06-2; NIOSH *RTECS* #KI0525000 H H Cl – C – C – Cl H H The maximum allowable peak concentration (above the ceiling level value) of ethylene dichloride is 200 ppm for 5 minutes in any 3-hour period. **COMMENTS:** Additional data concerning toxic doses and tumorigenic, reproductive, and mutagenic effects is listed (with references) in the NIOSH *RTECS* 1983-84 supplement, pages 865-66.	100	ACGIH Values 1987-88 TLV-TWA: 10 ppm, 40 mg/m^3 OSHA PEL* 1986-87 8-Hr TWA: 50 ppm; Ceiling: 100 ppm (15 Min.) NIOSH REL 1986-87 10-Hr TWA: 1 ppm Ceiling: 2 ppm (15 Min.) Toxicity Data Man, Inhalation, TC_{Lo}: 4000 ppm/1 Hr Human, Oral, TD_{Lo}: 428 mg/kg Man, Oral, TD_{Lo}: 892 mg/kg Man, Oral, LD_{Lo}: 714 mg/kg Rat, Oral, LD_{50}: 670 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point ... 182.3°F (83.5°C)
Vapor Pressure ... 87 Torr at 77°F (25°C)
Water Solubility ... Soluble in about 120 Parts Water
Vapor Density (Air = 1) ... 3.4
Evaporation Rate (n-BuAc = 1) ... Not Listed
Specific Gravity ... 1.2569 at 69°F (20°C)
Freezing Point ... -31.9°F (-35.5°C)
Molecular Weight ... 98.96 Grams/Mole

Appearance and odor: Colorless, clear liquid. Sweet, chloroform-like odor is typical of chlorinated hydrocarbons. The recognition threshold (100% of test panel) for ethylene dichloride is 40 ppm. Odor detection probably indicates an excessive exposure to vapor. High volatility and flammability, coupled with its toxicity and carcinogenic potential, make this material a major health hazard.

COMMENTS: Ethylene dichloride is miscible with alcohol, chloroform, and ether.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
See Below	775°F (413°C)	% by Volume	6.2	15.9

EXTINGUISHING MEDIA: Use chemical, carbon dioxide, alcohol foam, water spray/fog, or dry sand to fight fires involving ethylene dichloride. Direct water sprays may be ineffective extinguishing agents, but they may be successfully used to cool fire-exposed containers. Use a smothering effect to extinguish fires involving this material. **UNUSUAL FIRE/EXPLOSION HAZARDS:** Ethylene dichloride is a dangerous fire and explosion hazard when exposed to sources of ignition such as heat, open flames, sparks, etc. Its vapors are heavier than air and can flow along surfaces to distant, low-lying sources of ignition and flash back. If it is safe to do so, remove this material from the fire area. Ethylene dichloride burns with a smoky flame.
SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode.

COMMENTS: Flash Point and Method: 56°F (13°C) CC; 65°F (18°C) OC.

OSHA Flammability Class (29 CFR 1910.106): IB. DOT Flammability Class (49 CFR 173.115): Flammable Liquid

SECTION 5. REACTIVITY DATA

Ethylene dichloride is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES include strong oxidizing agents. Explosions have occurred with mixtures of this material and liquid ammonia or dimethylaminopropylamine. Finely divided aluminum or magnesium metal may be hazardous in contact with ethylene dichloride.

CONDITIONS TO AVOID: Eliminate sources of ignition such as excessive heat, open flames, or electrical sparks, particularly in low-lying areas, because the explosive, heavier-than-air vapors will concentrate there.

PRODUCTS OF HAZARDOUS DECOMPOSITION can include vinyl chloride, chloride fumes, and phosgene. Phosgene is an extremely poisonous gas. Products of thermal-oxidative degradation (i.e., fire conditions) must be treated with appropriate caution.

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SECTION 6. HEALTH HAZARD INFORMATION

Ethylene dichloride is listed as an anticipated human carcinogen by the NTP and as a probable human carcinogen (Group 2B) by the IARC. It was found to be an animal-positive carcinogen by the IARC. NCI reported positive results (mouse, rat) from its carcinogenesis bioassay. SUMMARY OF RISKS: Ethylene dichloride is considered to be one of the more toxic of the common chlorinated hydrocarbons. Deaths from accidental ingestion of this material have been reported. Inhalation of vapors usually caused these fatalities. Excessive inhalation of ethylene dichloride vapors can cause respiratory irritation, irritation, narcotic and anesthetic effects, vomiting, dizziness, depression, and diarrhea. The hepatotoxic (injurious to liver) effects of this material are significant. The systemic effects from overexposure can appear in the liver, kidneys, digestive tract, blood, lungs, adrenal glands, and the central nervous system. Tests on animals have revealed reproductive failure and fetal resorption. There may be increased risk to nursing infants of exposed mothers. TARGET ORGANS: Central nervous system, eyes, kidneys, liver, heart, adrenal glands, and skin. PRIMARY ENTRY: Inhalation, absorption through skin, oral, or eye contact. ACUTE EFFECTS: Skin contact causes irritation, defatting, and, if repeated or prolonged, burning. Eye contact causes irritation and serious injury (clouding of the cornea) if it is not removed promptly. CHRONIC EFFECTS: Injuries to the liver (hepatotoxicity) and kidneys, weight loss, low blood pressure, jaundice, oliguria (reduced excretion of urine), or anemia. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Persons taking anticoagulants could experience an increase in tendency to bleed. Persons taking insulin face an increased risk of lowered blood sugar. FIRST AID: Be prepared to restrain a hyperactive victim. EYE CONTACT: Flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Immediately flush the affected area with water. Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Get medical help.* INGESTION: Never give anything by mouth to someone who is unconscious or convulsing. Rinse victim's mouth with water. Oxygen and artificial respiration may be needed. Get medical help.* * GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Before using ethylene dichloride, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of ethylene dichloride spills or leaks and implement containment procedures. Remove and eliminate all possible sources of ignition such as heat, sparks, and open flames from the area. Cleanup personnel should use protection against inhalation of vapors and contact with liquid. Contain spills by using an absorbent material such as dry sand or vermiculite. Use nonsparking tools to mix waste material thoroughly with absorbent and place it in an appropriate container for disposal. Flush trace residues with large amounts of water. Do not flush waste to sewers or open waterways. WASTE DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Waste may be burned in an approved incinerator equipped with an afterburner and a scrubber. Follow Federal, state, and local regulations.

Ethylene dichloride is designated as a hazardous substance by the EPA (40 CFR 116.4). Ethylene dichloride is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U077

EPA Reportable Quantity (40 CFR 117.3): 5000 lbs (2270 kgs)

Aquatic Toxicity Rating, TLm 96: 1000 - 100 ppm

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety-goggles. Ethylene dichloride is particularly harmful to the eyes, and direct contact results in corneal opacity (permanent clouding of the eye). GLOVES: Wear impervious rubber gloves to prevent skin contact. RESPIRATOR: Use a NIOSH-approved respirator per the NIOSH *Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of ethylene dichloride requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. Warning: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER: Wear rubber boots, aprons, and other protective clothing suitable for use conditions to prevent skin contact. Remove contaminated clothing and launder it before wearing it again. Discard contaminated shoes. VENTILATION: Provide maximum explosion-proof local fume exhaust ventilation systems to maintain the airborne concentrations of ethylene dichloride vapors below the exposure limits cited in section 2. Install properly designed hoods that maintain a minimum face velocity of 100 lfm (linear feet per minute). SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. SPECIAL CONSIDERATIONS: Vapors are heavier than air and will collect in low-lying areas. Eliminate sources of ignition in these areas and again provide good ventilation there. COMMENTS: Practice good personal hygiene. Keep materials off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Immediately remove ethylene dichloride-saturated clothing to avoid flammability and health hazards. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store ethylene dichloride in tightly closed containers in a cool, dry, well-ventilated area away from sources of ignition. Protect containers from physical damage and from exposure to excessive heat. Avoid direct physical contact with strong acids, bases, oxidizing agents, and reducing agents. SPECIAL HANDLING/STORAGE: Use nonsparking tools. Outside or detached storage is preferred. Store and handle ethylene dichloride in accordance with the regulations concerning OSHA class IB flammable liquids. ENGINEERING CONTROLS: During transfer operations involving ethylene dichloride, the liquid and its vapors must not be exposed to nearby sources of ignition from engineering systems that are not explosion proof. Prepare emergency response procedures.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: Flammable Liquid

DOT Label: Flammable Liquid

IMO Class: 3.2

DOT Shipping Name: Ethylene Dichloride

DOT ID No. UN 1184

IMO Label: Flammable Liquid, Poison

References: 1-9, 12, 19, 21, 26, 43, 47, 73, 87-102. CK

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Approvals JO. Recasco

Indust. Hygiene/Safety DJW 11-18-87

Medical Review H. H. Smith 11-30-87

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MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

No. 313

PERCHLOROETHYLENE

Revision C

Date November 1978

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: PERCHLOROETHYLENE

OTHER DESIGNATIONS: Perchlorethylene, Tetrachloroethylene, Ethylene Tetrachloride, $Cl_2C{=}CCl_2$, GE Material D5884, CAS# 000 127 184

MANUFACTURER & TRADENAME: BLACO-PER (Baron-Blakeslee); PERCHLOR (PPG); PERK (Stauffer); PERCLENE (Diamond Shamrock)

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Perchloroethylene plus stabilizer*	ca 100	8-hr TWA 100 ppm** with 200 ppm Ceiling and 300 ppm 5 minute peak in any 3 hrs Rat, inhalation LCLo 4000 ppm/4 hrs

*Stablized material usually contains a small amount of amine and/or phenolic stabilizer. Stabilizers and levels used vary with the grade and the supplier.

**Current OSHA levels. ACGIH TLV (1978) is 100 ppm (skin). In 1976 NIOSH proposed a 10-hr TWA of 50 ppm with a 100 ppm ceiling (15 minute sample).

NIOSH (1978) has warned of possible carcogenicity based on animal tests.

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F (C)	250 (121)	Specific gravity 20/4°C	1.623
Vapor pressure at 22 C, mm Hg	15.8	Volatiles, %	ca 100
Vapor density (Air=1)	5.83	Evaporation rate (CCl_4=1)	0.27
Water solubility	Negligible	Molecular weight	165.83

Appearance & Odor: Colorless liquid with pleasant etheral odor whose recognition threshold (100% of test panel, unfatigued) is 4.68 ppm in air.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
Not Combustible	None	N/A	N/A	N/A

Extinguishing Media: Use that which is suitable for the surrounding fire. Although not combustible, perchloroethylene can be hazardous in a fire situation because of vapor generation and from thermo-oxidative degradation at high temperature to phosgene (highly toxic) and hydrogen chloride (corrosive).

Firefighters should use self-contained breathing apparatus when this material is involved in a fire situation.

SECTION V. REACTIVITY DATA

Perchloroethylene is considered a stable compound under normal storage and handling conditions. However, vapor exposure to high temperature or electric arcs may cause decomposition to hydrogen chloride and phosgene (highly toxic).

Avoid mixing with caustic soda or potash. Do not allow hydrochloric acid build-up to occur in degreasing tanks (stabilizer exhausted).

Prolonged exposure to sunlight (UV) can degrade unstabilized material.

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NO. 313

SECTION VI. HEALTH HAZARD INFORMATION

TLV 100 ppm (skin) (See Sect II)

Perchloroethylene may cause dermatitis through prolonged or repeated skin contact with liquid and irritation, lachrymation, and burning sensation of the eyes by liquid or vapor contact. Loss of coordination, narcosis, tremors, abdominal cramps, irritation of the respiratory tract, and nausea may result from inhalation of excessive airborne concentrations. (600 ppm for 10 minutes may effect the central nervous system.) Very high exposures produce unconsciousness and even death.

FIRST AID:

Eye contact: Wash eyes with copious amounts of running water to relieve irritation.

Skin contact: Remove contaminated clothes. Wash exposed skin with soap and water.

Inhalation: Remove patient to fresh air; restore breathing if necessary. Promptly contact physician. Advise doctor not to administer adrenalin.

Ingestion: If taken internally, induce vomiting. Contact physician promptly; Advise doctor not to administer adrenalin.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Supply maximum ventilation. Confine spill to small area; do not allow run off into sewer. Those involved in clean-up need protection from liquid contact and vapor inhalation. Pick up spill on absorbent solid.

DISPOSAL: Place in covered container for disposal. Chlorinated solvents in large amounts should be burned in an approved incinerator with appropriate fume scrubbing. Also, consult licensed waste disposal company in your locality and consider recovery of perchloroethylene solvent by distillation. Scrap solvent and distillation residues must be handled as toxic waste. Follow Federal, State and local regulations for waste disposal.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Airborne levels should be kept below TLV levels by use of general ventilation and local exhaust ventilation. Provide floor level ventilation to remove these vapors.

For emergency and non-routine exposure above the TLV approved full facepiece respirators should be used - cartridge and canister types up to 500 ppm, and air-supplied or self-contained types above 500 ppm.

Neoprene, Viton, PVA or PVC coated gloves should be used to prevent skin exposure. Where splashing is possible, aprons and protective clothing may be indicated. Appropriate eye and face protection should be used. Where eye contamination is possible, an eye wash fountain should be readily available.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a cool, dry, well-ventilated place in closed containers away from fire hazards. High temperature (700°C) or intense UV light can decompose perchloroethylene to toxic and corrosive materials. Smoking, open flame, welding, etc. should not be permitted in area of use or storage.

It is recommended that workers with blood pressure, heart, liver, kidney or pulmonary problems, with nervous system disorders, with excessive obesity, or with alcohol consumption problems should not work in proximity to this or other chlorinated solvents.

One study has indicated possible teratogenic effects. NIOSH has recommended that this material be handled as if it were a human carcinogen. (Current Intelligence Bulletin No. 20, 1978)

DATA SOURCE(S) CODE: 1-9, 12, 21

[illegible]

APPROVALS: MIS, CRD J. M. Nielsen

Industrial Hygiene and Safety [illegible]

Corporate Medical Staff Greg F. Martelon MD

THE ATTACHED PAGES AND MSDS SHEETS ARE INTENDED TO BE ADDED AS AN AMENDMENT TO THE SITE HEALTH AND SAFETY PLAN WRITTEN FOR THE CONRAIL ELKHART RAILYARD IN JANUARY, 1989. THIS AMENDMENT INCLUDES THE NECESSARY PROCEDURES AND ACTION LIMITS PERTAINING TO POSSIBLE EXPOSURE TO DIESEL FUEL.

GROUNDWATER TECHNOLOGY, INC.

Procedures for Injury

1. Administer first aid. Call for ambulance/medical assistance, if necessary. Notify the receiving hospital of the nature of physical injury or chemical overexposure.

2. Notify the Project Manager or Site Safety Officer (SSO).

Emergency Treatment

In all cases of chemical overexposure, follow standard procedures for poison management, first aid, and, if applicable, CPR. When transporting an injured person to a hospital, one person shall accompany the injured person to the hospital. Bring this site safety plan to assist medical personnel with diagnosis and treatment.

Four different routes of exposure and their respective first aid/poison management procedures are outlined below:

1. Ingestion

CALL THE HOSPITAL LISTED IN THE CONRAIL ELKHART RAILYARD SITE *HEALTH AND SAFETY PLAN FOR INSTRUCTIONS*.

FOR PETROLEUM-BASED COMPOUNDS IN GROUNDWATER, VOMITING IS NOT RECOMMENDED. Dilute the poison by making the person drink one or two glasses of water. Do not use carbonated beverages. Transport the victim to the hospital.

2. Inhalation

Move the person from the contaminated environment. Initiate CPR, if necessary. Call or have someone call for medical assistance. Refer to MSDS information. Transport the victim to the hospital.

3. Skin Contact

Wash off skin with a large amount of soap and water immediately. Remove any contaminated clothing and rewash skin. Transport the victim to the hospital.

4. Eyes

Hold eyelids open and rinse the eyes immediately with water for 15 minutes. Check for contact lenses and remove them if worn. Never permit the eyes to be rubbed. Transport the victim to the hospital.

Potential Hazard Situations

1. Fire:

Based on the readings of a Combustible Gas Indicator, atmospheres greater than 20% LEL will be considered explosive. If explosive atmospheres exist, work will cease and the local fire department will be notified. Efforts will be made to control all ignition sources. Spark-proof tools and explosion-proof equipment will be utilized for all remediation equipment and to the extent possible, during drilling phases.

2. Noise:

Control of noise hazards will be in accordance with 29 CFR 1910.95. Hearing protection will be worn in noise hazard areas (where normal conversation cannot be heard at a distance of 2 feet or where noise pulses over 140 decibels occur).

3. **Confined spaces:**

Confined spaces (areas with limited ingress and egress) may lack adequate ventilation and trap toxic and/or combustible vapors. To avoid anoxia from the lack of oxygen and/or overexposure to vapors, personnel entering these spaces must follow the following procedure:

a. Use the buddy system.

b. The oxygen in confined spaces must be monitored with an oxygen meter prior to entry. Because of the high vapor density of many organic solvents, there is a possibility that vapors in enclosed spaces will displace any oxygen that is present, even if the space is open to the air. Therefore, oxygen level monitoring will be done at the top and bottom of the enclosed space to determine if there is a minimum acceptable oxygen level of 19.5% prior to entry. If oxygen monitoring indicates that the level of oxygen is less than 19.5%, personnel entering such spaces must wear air supplied respirators.

c. The presence or absence of explosive vapors must be determined before entering any confined space. If the explosimeter readings are greater than 20% of the lower explosive limit (LEL), confined spaces must not be entered. Shut off accessible equipment, leave the area, and notify the fire department and the Project Manager. Note that the accuracy of combustible gas meters is compromised when used in atmospheres that contain less than 19.5% oxygen.

MONITORING REQUIREMENTS

ACTION LEVELS/LEVELS OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

INSTRUMENT	MODIFIED LEVEL D	LEVEL C	LEVEL B
LEL meter	< 100 ppm	100-750 ppm	> 750 ppm
PID (10.2 lamp)	< 100 ppm	100-750 ppm	> 750 ppm
O_2 meter	19.5 - 23%	19.5 - 23%	< 19.5%

Modified Level D: Includes neoprene gloves; skin and eye splash protection.

Level C: Includes a full-face negative pressure respirator with organic vapor cartridges and tyvek suit if splash is possible.

Level B: Includes SCBA, tyvek suite, gloves, etc.

Air monitoring should be done initially upon starting work on the site, periodically during the work day especially when moving the soil or starting a new phase of the work. If higher levels are detected to warrant Level C protection, monitoring should be conducted more frequently, every 1-2 hours.

The vapor pressure for Diesel Fuel is very low, so vapor inhalation under ambient conditions is normally not a problem. The main concern for this product involves skin and eye splash protection and combustibility.

EXXON COMPANY USA
A Division of Exxon Corporation

DATE ISSUED: 03/18/87
SUPERSEDES DATE: 07/10/86

MATERIAL SAFETY DATA SHEET

EXXON COMPANY, U.S.A. P.O. BOX 2180 HOUSTON, TX 77252-2180

A. IDENTIFICATION AND EMERGENCY INFORMATION

PRODUCT NAME
EXXON DIESEL 2

PRODUCT CODE
075700 - 00787

CHEMICAL NAME
Petroleum Distillate Fuel

CAS NUMBER
68476-34-6

PRODUCT APPEARANCE AND ODOR
Clear liquid, yellow color
Faint petroleum hydrocarbon odor

EMERGENCY TELEPHONE NUMBER
(713) 656-3424

B. COMPONENTS AND HAZARD INFORMATION

COMPONENTS	CAS NO. OF COMPONENTS	APPROXIMATE CONCENTRATION
Diesel Fuel No. 2	68476-34-6	100%

See Section E for Health and Hazard Information

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)

Health	Flammability	Reactivity	BASIS
1	2	0	Recommended by Exxon

EXPOSURE LIMIT FOR TOTAL PRODUCT
100 ppm (300 mg/m3) for an 8-hour workday

BASIS
Recommended by Exxon

C. PRIMARY ROUTES OF ENTRY AND EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT
If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician.

SKIN CONTACT
In case of skin contact, remove any contaminated clothing and wash skin thoroughly with soap and water.

INHALATION
Vapor pressure is very low. Vapor inhalation under ambient conditions is normally not a problem. If overcome by vapor from hot product, remove from exposure and call a physician immediately. If breathing is irregular or has stopped, start resuscitation, administer oxygen, if available.

INGESTION
If ingested, DO NOT induce vomiting; call a physician immediately.

*** continued ***

D. FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT (MINIMUM)
COMBUSTIBLE - Per DOT 49 CFR 173.115
60°C (140°F)
ASTM D 93, Pensky Martens Closed Cup

NOTE - Non-marine product may be 52°C (125°F) minimum flash to meet No. 2 Diesel Fuel Oil (ASTM D 975). Seasonal blends may be as low as 38°C (100°F).

AUTOIGNITION TEMPERATURE
Greater than 204°C (400°F)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - HAZARD IDENTIFICATION

Health	Flammability	Reactivity	BASIS
0	2	0	Recommended by the National Fire Protection Association

HANDLING PRECAUTIONS
Keep product away from heat, sparks, pilot lights, static electricity, and open flame.

FLAMMABLE OR EXPLOSIVE LIMITS (APPROXIMATE PERCENT BY VOLUME IN AIR)
Estimated values: Lower Flammable Limit 0.9% Upper Flammable Limit 7%

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES
Foam, water spray (fog), dry chemical, carbon dioxide and vaporizing liquid type extinguishing agents may all be suitable for extinguishing fires involving this type of product, depending on size or potential size of fire and circumstances related to the situation. Plan fire protection and response strategy through consultation with local fire protection authorities or appropriate specialists.

The following procedures for this type of product are based on the recommendations in the National Fire Protection Association's "Fire Protection Guide on Hazardous Materials", Eighth Edition (1984):

Use dry chemical, foam or carbon dioxide. Water may be ineffective, but water should be used to keep fire-exposed containers cool. If a leak or spill has ignited, use water spray to disperse the vapors and to protect men attempting to stop a leak. Water spray may be used to flush spills away from exposures. Minimize breathing gases, vapor, fumes or decomposition products. Use supplied-air breathing equipment for enclosed or confined spaces or as otherwise needed.

NOTE. The inclusion of the phrase "water may be ineffective" is to indicate that although water can be used to cool and protect exposed material, water may not extinguish the fire unless used under favorable conditions by experienced fire fighters trained in fighting all types of flammable liquid fires.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS
Fumes, smoke, carbon monoxide, aldehydes and other decomposition products, in the case of incomplete combustion.

"EMPTY" CONTAINER WARNING
"Empty" containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to clean since residue is difficult to remove. "Empty" drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All

VISCOSITY
2.7 cSt @ 40°C

G. REACTIVITY

This product is stable and will not react violently with water. Hazardous polymerization will not occur. Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite

H. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Shut off and eliminate all ignition sources. Keep people away. Recover free product. Add sand, earth or other suitable absorbent to spill area. Minimize breathing vapors. Minimize skin contact. Ventilate confined spaces. Open all windows and doors. Keep product out of sewers and watercourses by diking or impounding. Advise authorities if product has entered or may enter sewers, watercourses, or extensive land areas.
Assure conformity with applicable governmental regulations Continue to observe precautions for volatile, combustible vapors from absorbed material.

I. PROTECTION AND PRECAUTIONS

VENTILATION
Use only with ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air.

RESPIRATORY PROTECTION
Use supplied-air respiratory protection in confined or enclosed spaces, if needed.

PROTECTIVE GLOVES
Use chemical-resistant gloves, if needed, to avoid prolonged or repeated skin contact.

EYE PROTECTION
Use splash goggles or face shield when eye contact may occur.

OTHER PROTECTIVE EQUIPMENT
Use chemical-resistant apron or other impervious clothing, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact.

WORK PRACTICES / ENGINEERING CONTROLS
Keep containers and storage containers closed when not in use. Do not store near heat, sparks, flame or strong oxidants.

PERSONAL HYGIENE
Minimize breathing vapor, mist or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing; launder or dry-clean before reuse. Remove contaminated shoes and thoroughly clean before reuse; discard if oil-soaked. Cleanse skin thoroughly after contact, before breaks and meals, and at end of work period. Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water.

J. TRANSPORTATION INFORMATION

TRANSPORTATION INCIDENT INFORMATION
For further information relative to spills resulting from transportation incidents, refer to latest Department of Transportation Emergency Response Guidebook for Hazardous Materials Incidents, DOT P 5800.3.

DOT IDENTIFICATION NUMBER
NA 1993

The information and recommendations contained herein are, to the best of Exxon's knowledge and belief, accurate and reliable as of the date issued. Exxon does not warrant or guarantee their accuracy or reliability, and Exxon shall not be liable for any loss or damage arising out of the use thereof.

The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisfy itself that they are suitable and complete for its particular use.

The Hazardous Materials Identification System (HMIS) and National Fire Protection Association (NFPA) ratings have been included by Exxon Company, U.S.A. in order to provide additional health and hazard classification information. The ratings recommended are based upon the criteria supplied by the developers of these rating systems, together with Exxon's interpretation of the available data.

FOR ADDITIONAL INFORMATION ON HEALTH EFFECTS CONTACT:
DIRECTOR OF INDUSTRIAL HYGIENE
EXXON COMPANY, U.S.A.
P. O. BOX 2180 ROOM 3157
HOUSTON, TX 77252-2180
(713) 656-2443

FOR OTHER PRODUCT INFORMATION CONTACT:
MANAGER, MARKETING TECHNICAL SERVICES
EXXON COMPANY, U.S.A.
P. O. BOX 2180 ROOM 2385
HOUSTON, TX 77252-2180
(713) 656-5849

APPENDIX
B

APPENDIX A

GTEL ENVIRONMENTAL LABORATORIES, INC.
MIDWEST REGION

QA/QC PLAN

SECOND REVISION
JANUARY 1989

GROUNDWA
TECHNOLO

APPENDIX A
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3.0 PROJECT POLICY STATEMENT

3.1 Scope

This document describes the Quality Assurance/Quality Control (QA/QC) plan for analytical services performed by GTEL Environmental Laboratories, Midwest Region. The purpose of this document is to provide the objectives, chain of command, and tolerances under which the Laboratory operates. In conjunction with the Standard Operating Procedures (SOP's) and Project Management Plans, the QA/QC Plan Provides the foundation up on which is built the orderly operations and documentation of day to day work at GTEL. The approach ensures that a uniform basis is used for sample handling, methods control, instrument conditions, data generation and reporting for all samples received for analysis.

3.2 Facilities

GTEL is a subsidiary of Groundwater Technology Inc., specializing in environmental analysis of air, water, soil and hazardous waste samples.

GTEL provides a full range of environmental capabilities including Gas Chromatography, Gas Chromatography/Mass Spectrometry, Atomic Adsorption (flame, furnace, hydride), Inductively Coupled Emission Spectroscopy plus conventional wet and chemistry.

GTEL Midwest is located in Wichita, Kansas. The facility is composed of general offices and administration for GTEL Midwest and laboratory space. The laboratory is certified in numerous states as a water and hazardous waste testing laboratory.

Presently the laboratory receives 1000 samples per month and over 5000 analyses are performed. The laboratory specializes in environmental services with added expertise in RCRA, asbestos, microbiological, and food analyses. The laboratory is equipped with state-of-the-art instrumentation. The combined staff of GTEL Midwest includes 3 senior chemists and 4 chemists along with support staff. The diversity of the staff enables them to assist the environmental investigator throughout the multi-state service area.

3.3 POLICY STATEMENT

Environmental projects typically involve investigation and monitoring of environmental impacts resulting from inadvertent releases of chemical and petroleum products from storage tanks, impoundments, landfills or manufacturing processes. The projects also encompass remedial action and demonstration of improvement in time. The investigations are designed to define the areal and vertical extent of environmental impact to soil, groundwater and surface water. The vertical and horizontal extent of free-floating petroleum or chemical product lenses (if they occur) is determined through the placement of monitoring wells and subsequent liquid level and free-product monitoring. The vertical and horizontal extent of soil contamination is determined by chemical analyses of soil cores from test borings. The vertical and horizontal extent of groundwater contamination is determined and monitored through the placement of groundwater monitoring wells and the sampling of these wells for dissolved constituents.

Site specific hydrogeology is determined through a review of area and regional publications, and from analysis of geologic and hydrologic information developed during the installation and monitoring of test wells and borings. Rates and directions of contaminant movement and groundwater flow are determined from analyses of liquid level and water quality monitoring data.

Considering the high liability potential inherent in environmental projects, procedures which meet the highest standards available are selected. Analytical procedures are utilized which are appropriate for the objectives of the project. The procedures are sufficiently sensitive and precise to be of value at levels near the regulatory limits governing the situation. Table 3.1 relates the appropriate analytical methods and corresponding detection limits with applications. In general an analytical method is chosen which has a detection limit at least 3 times below the regulatory limit. The exception is the case where a regulatory agency has set the limit at the acknowledged detection limit of the approved analytical method. See Section 14 for the definition and statistical significance of the detection limit as used in this document.

Table 3.1
Detection Limit Summary
(see notes at end)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
A. Volatile organics				
(1) Purgeable aromatics -				
Benzene (PID)	EPA 602 modified	0.2 ug/L	EPA 5030/8020 modified	0.1 ug/kg
(GC/MS)	EPA 624	1.7 ug/L	EPA 5030/8240	0.5 ug/kg
Toluene	EPA 602 modified	0.5 ug/L	EPA 5030/8020 modified	0.3 ug/kg
	EPA 624	2.1 ug/L	EPA 5030/8240	0.5 ug/kg
Ethyl Benzene	EPA 602 modified	0.8 ug/L	EPA 5030/8020 modified	0.4 ug/kg
	EPA 624	4.5 ug/L	EPA 5030/8240	0.5 ug/kg
Total Xylenes	EPA 602 modified	1.7 ug/L	EPA 5030/8020 modified	0.9 ug/kg
	EPA 624	8.0 ug/L	EPA 5030/8240	0.8 ug/kg
Total VOA (sum of BTEX)	EPA 602 modified	3.2 ug/L	EPA 5030/8020 modified	1.7 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSES	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
(2) In addition to the benzene, toluene, ethyl benzene, total xylenes, and total VOA (previous page), the following parameters are provided to assist in characterization of the volatile organics typical of gasoline contamination.				
1,2 dichloroethane	EPA 601	0.1 ug/L	EPA 5030/8010	0.05 ug/kg
	EPA 624	1.6 ug/L	EPA 5030/8240	0.2 ug/kg
VOA (Volatile Organic Halocarbons): sum of total EPA 601 analytes- see pp. 7-10, this Section.	EPA 601	10 ug/L	EPA 5030/8010	3.4 ug/kg
1,2 dibromoethane (EDB)	EPA 504	0.02 ug/L	EPA 5030/8010	2.0 ug/kg
	EPA 624	7.3 ug/L	EPA 5030/8240	1.0 ug/kg
methyl tert-butylether (MTBE)	EPA 602	0.8 ug/L	EPA 5030/8020	0.08 ug/kg
	EPA 624	5.0 ug/L	EPA 5030/8240	1.0 ug/kg
lead- see p.23, this Section.				
C4-C12 aliphatics	EPA 602 modified (FID)	15 ug/L	EPA 5030/8015 modified	7.5 ug/kg
Miscellaneous Aromatics	EPA 602 modified	10 ug/L	EPA 5030/8020 modified	5.0 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSES	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
(3) Chlorinated benzenes				
Method 602 is recommended only in special circumstances for chlorinated benzenes. For these parameters, methods 601 and 624 utilize selective detection techniques less likely to be affected by petroleum hydrocarbon interferences.				
Chlorobenzene	EPA 601	0.27 ug/L	EPA 5030/8010	0.1 ug/kg
	EPA 602	0.2 ug/L	EPA 5030/8020	0.02 ug/kg
	EPA 624	3.0 ug/L	EPA 5030/8240	0.5 ug/kg
p-Dichlorobenzene	EPA 601	0.24 ug/L	EPA 5030/8010	0.1 ug/kg
	EPA 602	0.3 ug/L	EPA 5030/8020	0.03 ug/kg
	EPA 624	7.1 ug/L	EPA 5030/8240	0.5 ug/kg
m-Dichlorobenzene	EPA 601	0.41 ug/L	EPA 5030/8010	0.1 ug/kg
	EPA 602	0.4 ug/L	EPA 5030/8020	0.04 ug/kg
	EPA 624	7.1 ug/L	EPA 5030/8240	0.5 ug/kg
o-Dichlorobenzene	EPA 601	0.41 ug/L	EPA 5030/8010	0.1 ug/kg
	EPA 602	0.4 ug/L	EPA 5030/8020	0.04 ug/kg
	EPA 624	6.5 ug/L	EPA 5030/8240	0.5 ug/kg

Table 3.1
Detection Limit Summary
(Cont)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
(4) Purgeable halocarbons				
Bromodichloromethane	EPA 601	0.57 ug/L	EPA 5030/8010	0.01 ug/kg
	EPA 624	2.1 ug/L	EPA 5030/8240	0.5 ug/kg
Bromoform	EPA 601	0.20 ug/L	EPA 5030/8010	0.2 ug/kg
	EPA 624	5.7 ug/L	EPA 5030/8240	0.5 ug/kg
Bromomethane	EPA 601	1.10 ug/L	EPA 5030/8010	0.1 ug/kg
	EPA 624	1.7 ug/L	EPA 5030/8240	1.0 ug/kg
Carbon Tetrachloride	EPA 601	0.31 ug/L	EPA 5030/8010	0.01 ug/kg
	EPA 624	2.1 ug/L	EPA 5030/8240	0.5 ug/kg
Chloroethane	EPA 601	0.09 ug/L	EPA 5030/8010	0.05 ug/kg
	EPA 624	1.2 ug/L	EPA 5030/8240	1.0 ug/kg
2- Chloroethylvinyl Ether	EPA 601	0.13 ug/L	EPA 5030/8010	0.07 ug/kg
	EPA 624	2.7 ug/L	EPA 5030/8240	1.0 ug/kg
Chloroform	EPA 601	0.03 ug/L	EPA 5030/8010	0.025 ug/kg
	EPA 624	1.6 ug/L	EPA 5030/8240	0.5 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
Chloroethane	EPA 601	0.52 ug/L	EPA 5030/8010	0.04 ug/kg
	EPA 624	1.2 ug/L	EPA 5030/8240	0.5 ug/kg
Dibromochloromethane	EPA 601	0.34 ug/L	EPA 5030/8010	0.045 ug/kg
	EPA 624	3.1 ug/L	EPA 5030/8240	0.5 ug/kg
Dichlorodifluoromethane	EPA 601	0.12 ug/L	EPA 5030/8010	0.9 ug/kg
1,1-Dichloroethane	EPA 601	0.20 ug/L	EPA 5030/8010	0.035 ug/kg
	EPA 624	4.5 ug/L	EPA 5030/8240	0.45 ug/kg
1,2-Dichloroethane	EPA 601	0.25 ug/L	EPA 5030/8010	0.015 ug/kg
	EPA 624	1.6 ug/L	EPA 5030/8240	0.5 ug/kg
1,1-Dichloroethene	EPA 601	0.45 ug/L	EPA 5030/8010	0.065 ug/kg
	EPA 624	1.1 ug/L	EPA 5030/8240	0.5 ug/kg
trans 1,2-Dichloroethene	EPA 601	0.21 ug/L	EPA 5030/8010	0.05 ug/kg
	EPA 624	1.6 ug/L	EPA 5030/8240	0.5 ug/kg
1,2-dichloropropane	EPA 601	0.21 ug/L	EPA 5030/8010	0.20 ug/kg
	EPA 624	2.8 ug/L	EPA 5030/8240	0.5 ug/kg
cis-1,3-Dichloropropene	EPA 601	0.21 ug/L	EPA 5030/8010	0.17 ug/kg
	EPA 624	5.0 ug/L	EPA 5030/8240	0.5 ug/kg

Table 3.1
Detection Limit Summary
(Cont'd)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
trans-1,3-Dichloropropene	EPA 601 EPA 624	0.34 ug/L 2.4 ug/L	EPA 5030/8010 EPA 5030/8240	0.10 ug/kg 0.5 ug/kg
Methylene Chloride	EPA 601 EPA 624	0.49 ug/L 2.2 ug/L	EPA 5030/8010 EPA 5030/8240	0.125 ug/kg 0.5 ug/kg
1,1,2,2-Tetrachloroethane	EPA 601 EPA 624	0.24 ug/L 6.0 ug/L	EPA 5030/8010 EAP 5030/8240	0.015 ug/kg 0.5 ug/kg
Tetrachloroethene	EPA 601 EPA 624	0.24 ug/L 2.2 ug/L	EPA 5030/8010 EPA 5030/8240	0.015 ug/kg 0.5 ug/kg
1,1,1-Trichloroethane	EPA 601 EPA 624	0.34 ug/L 2.6 ug/L	EPA 5030/8010 EPA 5030/8240	0.015 ug/kg 0.5 ug/kg
1,1,2-Trichloroethane	EPA 601 EPA 624	0.34 ug/L 1.9 ug/L	EPA 5030/8010 EPA 5030/8240	0.01 ug/kg 0.5 ug/kg
Trichloroethene	EPA 601 EPA 624	0.56 ug/L 1.9 ug/L	EPA 5030/8010 EPA 5030/8240	0.06 ug/kg 0.5 ug/kg
Trichlorofluoromethane	EPA 601 EPA 624	0.35 ug/L 1.7 ug/L	EPA 5030/8010 EPA 5030/8240	0.1 ug/kg 0.5 ug/kg
Vinyl chloride	EPA 601 EPA 624	0.12 ug/L 1.8 ug/L	EPA 5030/8010 EPA 5030/8240	0.09 ug/kg 1.0 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSES	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
(5) Volatile organics - hazardous substance list				
Acetone	EPA 624	10 ug/L	EPA 5030/8240	1.0 ug/kg
2-butanone (MEK)	EPA 624	15 ug/L	EPA 5030/8240	1.5 ug/kg
Carbon Disulfide	EPA 624	4.5 ug/L	EPA 5030/8240	0.5 ug/kg
2-hexanone	EPA 624	4.5 ug/L	EPA 5030/8240	1.0 ug/kg
4-methyl-2-pentanone (MIBK)	EPA 624	7.3 ug/L	EPA 5030/8240	1.0 ug/kg
Styrene	EPA 624	5.0 ug/L	EPA 5030/8240	0.5 ug/kg
Vinyl acetate	EPA 624	3.6 ug/L	EPA 5030/8240	1.0 ug/kg
Xylene (see also Section 4(1))				
meta- + para-xylene	EPA 602 modified	1.1 ug/L	EPA 5030/8020	0.6 ug/kg
O & P-xylene	EPA 624	4.0 ug/L	EPA 5030/8240	0.5 ug/kg
ortho-xylene	EPA 602 modified	0.5 ug/L	EPA 5030/8240	0.3 ug/kg
M-xylene	EPA 624	4.0 ug/L	EPA 5030/8240	0.5 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
B. Semi-volatile organics - Base/Neutral/Acid Extractables				
1) Polynuclear Aromatics - The following parameters are commonly used for diesel, #2 fuel oil, JP-4, kerosene, jet fuel, and jet A fuel spills:				
a) 16 Priority Pollutants -				
EPA 610 = HPLC	EPA 625 = GC/MS			
Acenaphthene	EPA 610	0.3 ug/L	EPA 3550/8310	0.010 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.2 ug/kg
Acenaphthylene	EPA 610	1.6 ug/L	EPA 3550/8310	0.053 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Anthracene	EPA 610	0.4 ug/L	EPA 3550/8310	0.013 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Benzo (a) Anthracene	EPA 610	0.006 ug/L	EPA 3550/8310	0.001 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Benzo (a) Pyrene	EPA 610	0.000 ug/L	EPA 3550/8310	0.001 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Benzo (b) Fluoranthene	EPA 610	0.000 ug/L	EPA 3550/8310	0.001 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
Benzo (ghi) Perylene	EPA 610 EPA 625	0.016 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.001 ug/kg 0.3 ug/kg
Benzo (k) Fluoranthene	EPA 610 EPA 625	0.002 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.001 ug/kg 0.3 ug/kg
Chrysene	EPA 610 EPA 625	0.150 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.005 ug/kg 0.3 ug/kg
Dibenzo (ah) Anthracene	EPA 610 EPA 625	0.004 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.001 ug/kg 0.3 ug/kg
Fluoranthene	EPA 610 EPA 625	0.000 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.001 ug/kg 0.3 ug/kg
Fluorene	EPA 610 EPA 625	1.0 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.033 ug/kg 0.3 ug/kg
Indeno (1, 2, 3-cd) Pyrene	EPA 610 EPA 625	0.016 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.001 ug/kg 0.3 ug/kg
Naphthalene	EPA 610 EPA 625	1.0 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.033 ug/kg 0.3 ug/kg
Phenanthrene	EPA 610 EPA 625	0.200 ug/L 10 ug/L	EPA 3550/8310 EPA 3550/8270	0.007 ug/kg 0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
Pyrene	EPA 610	0.170 ug/L	EPA 3550/8310	0.006 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

b) The following non-Priority Pollutant parameters are additionally provided for fuel oil spills, etc:

1-methylnaphthalene	EPA 610	0.200 ug/L	EPA 3550/8310	0.007 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
2-methylnaphthalene	EPA 610	0.200 ug/L	EPA 3550/8310	0.007 ug/kg
	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSES	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
2) Other B/N/A compounds				
Phenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
bis(2-Chloroethyl) ether	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
2-Chlorophenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
1,3-Dichlorobenzene	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
1,4-Dichlorobenzene	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Benzyl Alcohol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
1,2-Dichlorobenzene	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
2-Methylphenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
bis (2-Chloroisopropyl) ether	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
4-Methylphenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
N-Nitroso-Di-N-propylamine	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Hexachloroethane	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Nitrobenzene	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Isophorone	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
2-Nitrophenol	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
2,4-Dimethylphenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Benzoic Acid	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
bis(2-Chloroethoxy) methane	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
2,4-Dichlorophenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
1,2,4-Trichlorobenzene	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
4-Chloroaniline	EPA 625	20 ug/L	EPA 3550/8270	0.6 mg/kg
Hexachlorobutadiene	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
4-Chloro-3-methylphenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
Hexachlorocyclopentadiene	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
2,4,6-Trichlorophenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
2,4,5-Trichlorophenol	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
2-Chloronaphthalene	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
2-Nitroaniline	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
Dimethyl phthalate	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg
3-Nitroaniline	EPA 625	10 ug/L	EPA 3550/8270	0.3 mg/kg

Table 3.1
Detection Limit Summary

(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
2,4-Dinitrophenol	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
4-Nitrophenol	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
Dibenzofuran	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
2,4-Dinitrotoluene	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
2,6-Dinitrotoluene	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
Diethylphthalate	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
4-Chlorophenyl phenyl ether	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
4-Nitroaniline	EPA 625	20 ug/L	EPA 3550/8270	0.6 ug/kg
4,6-Dinitro-2-methylphenol	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
N-Nitrosodiphenylamine	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
4-Bromophenyl phenyl ether	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
Hexachlorobenzene	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Pentachlorophenol	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
Di-n-butylphthalate	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Butyl benzyl phthalate	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
3,3-Dichlorobenzidine	EPA 625	50 ug/L	EPA 3550/8270	1.6 ug/kg
Benzo(a)anthracene	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
bis(2-ethylhexyl)phthalate	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg
Di-n-octyl phthalate	EPA 625	10 ug/L	EPA 3550/8270	0.3 ug/kg

Table 3.1
Detection Limit Summary
(Con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOIL ANALYSIS	DETECTION LIMIT
(3) Semi-volatile organics - PCBs and chlorinated pesticides				
Aldrin	EPA 608	0.004 ug/L	EPA 3550/8080	0.0003 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
alpha-BHC	EPA 608	0.003 ug/L	EPA 3550/8080	0.0002 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
beta-BHC	EPA 608	0.006 ug/L	EPA 3550/8080	0.0004 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
delta-BHC	EPA 608	0.008 ug/L	EPA 3550/8080	0.0006 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
gamma-BHC (lindane)	EPA 608	0.004 ug/L	EPA 3550/8080	0.0003 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
Chlordane (technical)	EPA 608	0.014 ug/L	EPA 3550/8080	0.001 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
4,4'-DDD	EPA 608	0.011 ug/L	EPA 3550/8080	0.001 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
4,4'-DDE	EPA 608	0.004 ug/L	EPA 3550/8080	0.0003 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
4,4'-DDT	EPA 608	0.012 ug/L	EPA 3550/8080	0.001 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Dieldrin	EPA 608	0.002 ug/L	EPA 3550/8080	0.0001 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
Endosulfan I	EPA 608	0.014 ug/L	EPA 3550/8080	0.001 ug/kg
	EPA 625	100 ug/L	3550/8270	3.2 ug/kg
Endosulfan II	EPA 608	0.004 ug/L	EPA 3550/8080	0.0003 ug/kg
	EPA 625	100 ug/L	3550/8270	3.2 ug/kg
Endosulfan Sulfate	EPA 608	0.066 ug/L	EPA 3550/8080	0.005 ug/kg
	EPA 625	100 ug/L	3550/8270	3.2 ug/kg
Endrin	EPA 608	0.006 ug/L	EPA 3550/8080	0.0004 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
Endrin Aldehyde	EPA 608	0.023 ug/L	EPA 3550/8080	0.002 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg
Heptachlor	EPA 608	0.003 ug/L	EPA 3550/8080	0.0002 ug/kg
	EPA 625	50 ug/L	3550/8270	1.6 ug/kg

Table 3.1
Detection Limit Summary
(cont'd)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Heptachlor Epoxide	EPA 608	0.003 ug/L	EPA 3550/8080	0.006 ug/kg
	EPA 625	100 ug/L		
Methoxychlor	EPA 608	0.176 ug/L	EPA 3550/8080	0.01 ug/kg
	EPA 625	100 ug/L		
Toxaphene	EPA 608	0.24 ug/L	EPA 3550/8080	0.016 ug/kg
	EPA 625	100 ug/L		
PCB-1242	EPA 608	0.065 ug/L	EPA 3550/8080	0.005 ug/kg
	EPA 625	500 ug/L	3550/8270	5 ug/kg
PCB-1016, -1221, -1232,	EPA 608	not determined	EPA 3550/8080	not determined
-1248, -1254, -1260	EPA 625	500 ug/L	3550/8270	5 ug/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
C. METALS					
All metals analyses include an acid digestion appropriate for the analyte, method and matrix. Soils are assumed to have high organic content and digestion by EPA Method 3050 is used unless otherwise specified.					
Aluminum	ICP	EPA 200.7	0.30 mg/L	EPA 6010	3.0 mg/kg
Antimony	AA Flame	EPA 204.1	0.50 mg/L	EPA 7040	50.0 mg/kg
	AA Furnace	EPA 204.2	0.005 mg/L	EPA 7041	0.5 mg/kg
	ICP	EPA 200.7	0.15 mg/L	EPA 6010	15.0 mg/kg
Arsenic	AA Furnace	EPA 206.2	0.005 mg/L	EPA 7060	0.5 mg/kg
	ICP	EPA 200.7	0.2 mg/L	N/A	20. mg/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Barium	AA Flame	EPA 200.1	0.5 mg/L	EPA 7080	50.0 mg/kg
	AA Furnace	EPA 200.2	0.005 mg/L	EPA 7081	0.5 mg/kg
	ICP	EPA 200.7	0.060 mg/L	EPA 6010	0.6 mg/kg
Beryllium	ICP	EPA 200.7	0.004 mg/L	EPA 6010	0.4 mg/kg
Cadmium	AA Flame	EPA 213.1	0.05 mg/L	EPA 7130	5.0 mg/kg
	AA Furnace	EPA 213.2	0.001 mg/L	EPA 7131	0.1 mg/kg
	ICP	EPA 200.7	0.010 mg/L	EPA 6010	1.0 mg/kg
Calcium	ICP	EPA 200.7	0.003 mg/L	EPA 6010	0.3 mg/kg
Chromium	AA Flame	EPA 218.1	0.10 mg/L	EPA 7190	10.0 mg/kg
	AA Furnace	EPA 218.2	0.005 mg/L	EPA 7191	0.5 mg/kg
	ICP	EPA 200.7	0.010 mg/L	EPA 6010	1.0 mg/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Cobalt	ICP	EPA 200.7	0.010 mg/L	EPA 6010	1.0 mg/kg
Copper	AA Flame	EPA 220.1	0.1 mg/L	EPA 7210	10.0 mg/kg
	AA Furnace	EPA 220.2	0.010 mg/L	EPA 7211	1.0 mg/kg
	ICP	EPA 200.7	0.004 mg/L	EPA 6010	0.4 mg/kg
Iron	AA Flame	EPA 236.1	0.3 mg/L	EPA 7380	30.0 mg/kg
	AA Furnace	EPA 236.2	0.010 mg/L	NA	
	ICP	EPA 200.7	0.05 mg/L	EPA 6010	5.0 mg/kg
Lead	AA Flame	EPA 239.1	0.5 mg/L	EPA 7420	50.0 mg/kg
	AA Furnace	EPA 239.2	0.005 mg/L	EPA 7421	0.5 mg/kg
	ICP	EPA 200.7	0.3 mg/L	EPA 6010	30.0 mg/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Lead in Gasoline	AA Flame	ASTM D-3237	0.005 g/gallon	--	--
Magnesium	ICP	EPA 200.7	1.0 mg/L	EPA 6010	100.0 mg/kg
Manganese	AA Flame	EPA 243.1	0.010 mg/L	EPA 7060	1.0 mg/kg
	AA Furnace	EPA 243.2	0.005 mg/L		
	ICP	EPA 200.7	0.15 mg/L	EPA 6010	15.0 mg/kg
Mercury	Cold Vapor	EPA 245.1	0.0002 mg/L	EPA 7471	0.02 mg/kg
Molybdenum	ICP	EPA 200.7	0.100 mg/L	EPA 6010	10.0 mg/kg
Nickel	AA Flame	EPA 249.1	0.3 mg/L	EPA 7520	30.0 mg/kg
	AA Furnace	EPA 249.2	0.020 mg/L	EPA 7521	2.0 mg/kg
	ICP	EPA 200.7	0.020 mg/L	EPA 6010	2.0 mg/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Potassium	AA Flame	EPA 258.1	0.050 mg/L	EPA 7610	5.0 mg/kg
	ICP	EPA 200.7	10.0 mg/L	EPA 6010	1000.0 mg/kg
Selenium	AA Hydride	EPA 270.3	.002 mg/L	EPA 7741	0.2 mg/kg
	AA Furnace	EPA 270.2	.002 mg/L	EPA 7740	0.2 mg/kg
	ICP	EPA 200.7	.24 mg/L	NA	24.0 mg/kg
Silver	AA Flame	EPA 272.1	0.15 mg/L	EPA 7760	15.0 mg/kg
	AA Furnace	EPA 272.2	0.002 mg/L	EPA 7761	0.1 mg/kg
	ICP	EPA 200.7	0.030 mg/L	EPA 6010	3.0 mg/kg
Sodium	AA Flame	EPA 273.1	0.05 mg/L	EPA 7770	50.0 mg/kg
	ICP	EPA 200.7	6.0 mg/L	EPA 6010	600.0 mg/kg

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	WATER ANALYSIS	DETECTION LIMIT	SOILS	DETECTION LIMIT
Thallium	AA Flame	EPA 279.1	1.25 ug/L	EPA 7840	120.0 ug/kg
	AA Furnace	EPA 279.2	0.001 ug/L	EPA 7841	0.1 ug/kg
	ICP	EPA 200.7	6.0 ug/L	EPA 6010	600.0 ug/kg
Vanadium	ICP	EPA 200.7	0.010 ug/L	EPA 6010	1.0 ug/kg
Zinc	AA Flame	EPA 289.1	0.05 ug/L	EPA 7950	5.0 ug/kg
	ICP	EPA 200.7	0.010 ug/L	EPA 6010	1.0 ug/kg

Table 3.1
Detection Limit Summary
(con't)

V. TOXICITY CHARACTERISTIC LEACHATE PROCEDURE OR EXTRACTION PROCEDURE TOXICITY (EP TOX).

If total contaminant in soil or solid waste as determined by above methods does not exceed specified limits in Table 3.2, then leachate procedure can be avoided. Liquids are analyzed without leachate procedure. Liquids and metal leachates are digested and analyzed by the following methods:

PARAMETER	TECHNIQUE	METHOD	DETECTION LIMIT
Arsenic	AA Furnace	EPA 7060	0.005 mg/L
Selenium	AA Furnace	EPA 7740	0.002 mg/L
Mercury	AA Cold Vapor	EPA 7470	0.0002 mg/L
Barium	ICP	EPA 3020/6010	0.5 mg/L
Cadmium	ICP	EPA 3020/6010	0.010 mg/L

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	TECHNIQUE	METHOD	DETECTION LIMIT
Chromium	ICP	EPA 3020/6010	0.01 mg/L
Lead	ICP	EPA 3020/6010	0.3 mg/L
Silver	ICP	EPA 3020/6010	0.03 mg/L

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

GROUNDWATER TECHNOLOGY, INC.
9800 Castlegate Drive, Indianapolis, IN 46256 U.S.A. (317) 849-0308

FILE COPY

QA/QC PLAN
FOR THE ON-SITE REMEDIAL INVESTIGATION
AT THE CONRAIL ELKHART RAILYARD
ELKHART, INDIANA

Rita Rae Boje
RITA RAE BOJE, C.P.G.
GTI PROJECT MANAGER AND
QUALITY ASSURANCE
OFFICER

David E. Arnold (G.G.)
DAVID E. ARNOLD
DISTRICT MANAGER

Privileged and Confidential:
Prepared in Anticipation of Litigation

Other offices: Greenville, MS; Chadds Ford, PA; Tampa, FL; North Miami Beach, FL; Mandeville, LA; Concord, CA; Farmington Hills, MI; Elgin, IL

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APPENDICES

GTEL ENVIRONMENTAL LABORATORIES, INC.
MIDWEST REGION QA/QC PLAN..... APPENDIX A

3. PROJECT DESCRIPTION

3.1 Introduction

The Conrail Elkhart Railroad was recently proposed to the National Priority List, based on data obtained from soil samples and groundwater collected on Conrail's property by an EPA contractor.

Groundwater results showed less than the detection limit for the organic constituents of concern while soil samples contained only trace amounts of those organics.

There is heavy groundwater contamination in residential and commercial drinking water downgradient of the site; however, there is no conclusive data supporting the EPA's belief that the Conrail Railyard is the source of the problem. Numerous small industries lie between the contaminated wells and the Conrail property that are known to use organic solvents in their daily activities.

The purpose of this project is to confirm or deny the presence of chlorinated organic contaminants on the Conrail Elkhart Railyard property. This will be accomplished through a random and biased soil and groundwater sampling program conducted across the site.

3.2 Site Description

The Conrail Elkhart Railyard is located at the junction of principal Conrail routes from the East, Northeast and Mid-Atlantic states, Elkhart is Conrail's gateway yard connecting the Chicago area with the rest of the Northeast. Elkhart is a hub for the classification and distribution of rail traffic, handling freight cars to and from many points in the United States.

3.2.1 History of the Conrail Elkhart Railyard

Originally designed and built by the former New York Central Railroad in 1956, the yard became part of the Penn Central Railroad in 1968, with the merger of the Pennsylvania and New York Central, and it later became part of the Conrail system when operations began in 1976.

3.2.2 Yard Operations

The function of a freight classification yard is much like the function of a post office. At a post office, mail is sorted into pigeonholes. At a railroad yard, freight cars are similarly sorted into various tracks for dispatching in trains carrying "blocks" of cars to destinations along the railroad.

A "hump" yard derives its name from the use of a small hill, or hump, to classify cars using gravity. Under this arrangement, trains are pushed up and over an incline, where the cars are uncoupled. Each car then rolls by gravity into its predetermined classification track, guided by automatically operated switches to avoid excess speed.

3.2.3 Auxiliary Facilities

Local Yard. A ten-track local yard is located at the west end of the north side of the classification yard. This yard is used to preblock local freight trains in customer order, prior to departure from Elkhart.

Car Repair Yard. An eight-track car repair yard is located at the west end of the classifications yard. Each of these tracks handles specialized types of freight cars. Three tracks are covered by a roof for a distance of 300 feet for protection against inclement weather. Storeroom and shop facilities are adjacent to the repair area.

Diesel Servicing. Diesel servicing facilities, located north of the hump crest, include a one-track diesel shop, two diesel servicing tracks with fuel, water, and sand, and three "ready tracks" for staging serviced locomotives. A loop track is available for turning locomotives.

Yard Building. The General Yard Office is located at the hump crest. Clerical personnel, the Hump Yardmaster, the Switchtender, the Trainmaster and the Terminal Superintendent are based in this building.

Retarder Tower Building. The Retarder Operator is located on the top floor of this six-story tower and the remainder of the building houses the electronic and power equipment necessary for the hump operation. A signal and communication maintenance shop is located on the ground floor.

North Tower and South Tower. Located at the northwest and southwest ends of the classification yard, these towers are used by the conductors who operate the power-operated track switches in each of these areas. Crews working at these locations make up trains by moving cars from the classification yard to the departure yards.

4. 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 Groundwater Technology, Inc.; the positions include the Principal-in-Charge, the Project and Site Manager/Project Hydrogeologist, the Quality Assurance Officer, Data Validation Chemist, the Site Health and Safety Officer, the Project Engineers, the Field Documentation Coordinator, and the Environmental Technicians. Groundwater Technology Environmental Laboratory will provide all analytical services for the analysis for the project. The Laboratory Quality Assurance Coordinator and Sample Custodian will be determined prior to the start-up of this investigation.

Principal-in-Charge

Paul Yaniga, P.G. is the Principal-in-Charge for this investigation. The Principal-in-Charge reviews all major work elements prior to submittal. The key role of the Principal-in-Charge is to provide regulatory agencies and clients with access to a Principal of Groundwater Technology, Inc. Mr. Yaniga may be reached at GTI's Chadds Ford office, 215-388-1466.

Project and Site Manager/Project Hydrogeologist

Rita Rae Boje, C.P.G. is the Project Manager for this project. The Project Manager maintains routine contact with the progress of the investigation and reviews the project schedule and all major work elements prior to submittal. She coordinates all personnel involved in completing the field investigation and report preparations considering budgetary limits. Additionally, the Project Manager is the primary contact between the client and regulatory agencies. Ms. Boje may be reached at 317-849-0308, in the Indianapolis, Indiana Office.

Project Engineer

J. W. Bloemer, P.E. is the Project Engineer for this investigation. His responsibilities include development, design, and review of engineering related tasks. The status of the engineering task will be reported to the Project Manager. Mr. Bloemer may be reached at GTI, Indianapolis, Indiana; 317-849-0308.

Quality Assurance Officer

Rita Rae Boje is also the Quality Assurance Officer for this investigation. In this capacity, she will review project plans and revision to plans to assure proper quality assurance is being maintained. It is the major responsibility of the Quality Assurance Officer to insure that all personnel have the good understanding of the Sampling and Analysis Plan, an understanding of their respective roles relative to one another, and an apprecia-

tion of the importance of the roles to the overall success of the program. Ms. Boje also checks ten percent of the field log books and sample data sheets for completeness.

Data Validation Chemist

Terry Louks is the Data Validation Chemist for this investigation. As such, he is responsible for reviewing all of the laboratory and QA/QC data, as well as the chain-of-custody records and log books, to insure that all of the analyses are being completed using approved methodologies. He will review all data processing and data processing quality control activities by performing spot checks on ten percent of the reduced and reported data. Mr. Louks may be contacted at the GTI Wichita, KA office; 1-800-633-7936.

Field Operations Manager/Site Health and Safety Officer

Rita Rae Boje is the Field Operations Manager and Site Health and Safety Officer for this project. The Field Operations Manager is immediately responsible for the field investigation. She is responsible for:

1. All daily quality assurance project activities including proper sample collection, and

2. Verifying and initialing the accuracy of field notebooks and all other field-generated documents.

She also designs the technical aspects of sampling programs, and participates in the data reduction and interpretation and the generation of reports. Ms. Boje may be contacted at GTI's Indianapolis, IN office: 317-849-0308.

Field Documentation Coordinator

Rita Rae Boje is the Field Documentation Coordinator for this project. The Field Documentation Coordinator is responsible for the day-to-day activities of the field investigation. Specifically, she is responsible for chain-of-custody records, sample labels, packaging of sample jars for shipping, daily coordination with the laboratory sample custodians and provides a final quality assurance review of all field generated documents. Ms. Boje may be reached at the GTI Indianapolis, In office: 317-849-0308.

Environmental Technicians

Matt Darney will be the Environmental Technician. Mr. Darney is a geologist. He will follow proper sample collection protocols and measurements, equipment decontamination procedures, and chain-of-custody documentation.

5. QUALITY ASSURANCE OBJECTIVES AND CRITERIA

It is expected that by the design of separate data quality requirements for field sampling and laboratory analysis, clear distinctions between 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 inherent to the overall system. The quality control samples, blanks, duplicates, specific field sampling protocol, and standard operating procedures are the measures that are taken to address the variability in the total system, not only in the laboratory.

5.1 Overall Project Objectives

The data from the this phase of the project in conjunction with the previously obtained data will be used to answer the following questions:

1. Are compounds present or absent (qualitatively)?
2. If the compounds are present, what are the types or classes that are present?
3. What quantities (concentrations) of compounds are present (quantitative)?
4. Are contaminant sources present on the Conrail Property?

To complete this investigation, the sample media to be collected are groundwater and soils to define the presence/absence of chlorinated organic contamination, on the Conrail Elkhart Railyard Property.

To achieve the overall objectives, specific data quality requirements will need to be met. The Data Quality Objectives (DQOs) outlined in section 5.2 are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process for this project. The DQOs define the uncertainty that is acceptable for individual activities or for overall sequences of processes when the individual activities cannot be isolated.

The general definitions of the data quality indicators used in the subsequent sections are defined below.

Precision

Precision is a measure of the reproductibility of measurements under a given set of conditions. For a pair of measurements, relative percent difference will be used in this project. For a series of measurements, relative standard deviation will be used. The total precision of a series of measurements can be related by the additive nature of the variances (the square of the standard deviations shown in Equation 5.1.

$$S^2_T = S^2_i + S^2_a \quad \text{(Equation 5.1)}$$

Where S = the standard deviation of a process
S^2_T = the total variance
S^2_i = the variance of the implementation (sampling) phase
S^2_a = the variance of the analytical phase

Accuracy

Accuracy is a measure of bias, or the difference between a measurement and an accepted or true value. This difference can be expressed as a percent of the true value, as is done for the parameter % Recovery. A central goal of the accuracy objective is to identify, evaluate, and limit systematic and random errors in the measurement system.

Representativeness

Representativeness expresses the degree to which data accurately and precisely represents the characteristic of an environmental condition. Multiple random measurements or samplings improves the accuracy of a determination when random errors are involved. In this way, the effects of random error are minimized. Systematic errors affect the representativeness as well and are covered by the accuracy DQOs. The precision of random samplings is the primary measure to be used to monitor the effects of the various factors, such as medium homogeneity, which affect representativeness.

Completeness

Completeness is the ratio of the amount of valid data obtained from measurement system compared to the amount expected under ideal conditions. The amount of data expected from a measurement system is by design a sufficient amount to achieve the overall project objectives. An evaluation completeness necessarily involves an evaluation of the impact of missing data on the ability of the project to achieve its goals.

Comparability

Comparability expresses the confidence with which one data set can be compared with another data set from a different phase or from a different program. Comparability involves a composite of the above parameters as well as design factors such as sampling and analytical protocols. Inter-laboratory evaluations can play a role in the evaluation of analytical comparability.

5.2 Field Investigation Data Quality Objectives

The general quality goal for the field investigation is to maximize the confidence in the data in terms of each of the data quality indicators.

Precision

The data quality objective for the field is to achieve a precision on field duplicates equal to or better than the laboratory data objectives in 5.3. Measurement of a field duplicate inevitably involves laboratory measurement precision as well and actual field precision cannot be isolated. Hence, as a result of the additive property of variance (Equation 5.1) and the above stated equality of the field and lab variability criteria, the total variability as measured by standard deviation of field replicates should be no more than 1.4 times the lab variability (Equation 5.3).

Maximum $S^2_T = 2\ S^2_L$ (Equation 5.2)

Maximum $S_T = 1.4\ S_L$ (Equation 5.3)

Where: S_T = Total variability
S_L = Standard deviation from laboratory variability

Accuracy

The objective for total accuracy is to meet the laboratory accuracy limits for the target compound list as published in the appropriate SW-846 method. Hence, the field component of accuracy will have to be negligible as compared to the laboratory component. Losses are expected to be negligible if the sampling, preservation, and handling technique outlined in Section 6 are followed. The remaining major source of bias is field contamination of samples. To assure that this factor is negligible, field blanks for groundwater samples will be monitored. The associated objective is to achieve field blanks less than the EPA Contract Laboratory Contract Required Quantification Limits for the target compound list. Monitoring field blanks will provide assurance that a very common source of bias has been avoided.

Representativeness

The field objectives for representativeness are to: a) minimize the effects of bias resulting from loss and contamination during sampling and handling; and b) to assess and minimize the affects of factors, such as medium inhomogeneity, which leads to imprecision.

A rinsate blank will be taken of sampling equipment following decontamination procedures.

The representativeness will be assured by the fulfillment of the DQOs for accuracy and precision and will be evaluated by means of the precision and duplicate samples separately procured but otherwise hypothetically identical samples.

Completeness

The field objective for completeness is 90%. Every effort will be made to obtain valid samples for every sampling point in the plan. However, due to complications in homogeneity, some difficulty is expected in generating data from samples that require all of DQOs. The overall project objective for completeness is also 90%. Due to the potential uniqueness of each sampling point, this project will require a high return of valid data to attain the project goals. Sufficient duplicates and backup samples will be taken to assure a high return of valid samples. A high return for the laboratory data is also expected.

Comparability

The field objective for comparability is to: a) provide samples collected by standardized protocols, and, b) to collect sufficient information concerning geological physical characteristics of the sampling sites to allow determination of preservation. In addition, field conditions will be considered prior to sampling to attain a high degree of data comparability. The attainment of the DQOs for accuracy and precision, representativeness, and completeness will also contribute to the comparability of the data collected.

6. SAMPLING PROCEDURES

Samples which will be collected by Groundwater Technology (GT) include groundwater samples and soil samples. Groundwater samples will be collected from seven randomly placed monitoring wells and also from three biasedly placed monitoring wells. Two soil samples will be collected from each of the 45 boreholes to be drilled on the Conrail Property. One soil sample will be collected from 0'-1' below the ground surface and one soil sample will be collected from approximately a 1' zone at the top of water table.

6.1 PRELIMINARY PREPARATIONS FOR SAMPLING

A. Lab Scheduling

All sampling events to be conducted by Groundwater Technology have been scheduled with the analyzing laboratory to ensure that the lab can accept the samples. The analyzing lab has been notified at least two weeks prior to any sampling event and informed of the approximate number of samples to be collected, the parameters to be analyzed for, and the anticipated date and time of sample arrival.

B. Item Check

The following items will be checked prior to a sampling trip:

1. Batteries of equipment to be used, to assure that they are charged.

2. Any sampling equipment scheduled for use, to be sure that the equipment is clean and in good working order.

3. Instrument calibration. Refer to Section 8.0 for calibration procedures.

4. Any back-up systems, to be sure that they are in good working order.

5. Sample bottle supply, to insure that an adequate supply of clean sample bottles is available.

6. To insure the integrity of the cleaning process and preservation methods, field blanks will be carried throughout the sampling trip and will be preserved if applicable, on site at the time the first samples are collected.

7. Field sampling kits, to insure that all items necessary to procure good, properly documented samples are present. A standard sampling kit will contain the following items:

   a. a teflon squirt bottle of 50% hydrochloric acid
   b. a supply of acetone or isopropyl alcohol and hexane
   c. alconox soap
   d. a sufficient supply of distilled water for rinsing hands and sampling equipment
   e. disposable gloves

f. paper towels
g. a waterproof pen
h. cloth labels for sample identification
i. a cooler with ice
j. chain-of-custody forms
k. site blanks
l. waste solvent disposal container
m. extra vials and narrow rang pH paper to test pH response of water.

6.2 SPECIFIC SAMPLING PROCEDURES

A. Sample Integrity

GTI takes responsibility for the integrity of all samples taken for analysis. The sampling procedures described in Section 6.4 clearly stating integrity requirements, including preservation and chain-of-custody, are assured to all client and GT offices. Any irregularities upon receipt of samples are immediately relayed to the GTI project manager. Any irregularities will be clearly stated on the QA statement with the laboratory report. GTI will not allow preserved samples to exceed the prescribed holding time.

B. Monitor Well Sampling Procedures

Prior to monitor well sampling, the volume of water in wells will be determined. Three to five times the calculated volume of a well will be purged using a teflon bailer. Wells having slow recovery periods will be bailed dry and then sampled within 24 hours. Stirring up of sediments in wells to be sampled will try

to be avoided. Once a well has been properly purged, sample collection will follow the procedure outlined in part C of this section (Section 6.2).

C. Soil Sampling

Soil samples for volatile organics analysis will be collected from the subsurface by using either a split-spoon sampler or a core-barrel sampler. Prior to the sampling trip, soil sample vials and Stainless Steel Trowels will be obtained from the analyzing laboratory. The following procedure will be adhered to when collecting soil samples for volatile organics analysis:

1. Procure a soil core from the subsurface, either using a core-barrel or split-spoon sampler.

2. Spread a piece of heavy-duty aluminum foil onto a work surface and extrude the soil sample onto the foil.

3. Slice the cylindrical soil sample lengthwise with a clean stainless-steel spatula.

4. Immediately plunge a stainless steel trowel into the mid-section of the core (into undisturbed soil) to capture a 1/2 to 1 inch long sample plug.

5. Immediately insert the soil sample plug into the vial.

6. Clean around the lip of the vial with a clean laboratory paper towel to remove soil and/or grit, then cap the vial with a teflon-lined septum cap. The teflon side must be toward the sample.

7. Collect a duplicate sample from the other half of the core directly across from the first sample.

8. Label the sample vials using cloth Groundwater Technology labels (refer to Section 6.3.A) and waterproof ink. Labels will include the following information:
   a. job name and number
   b. date and time of sample collection
   c. well number and depth of sample
   d. name of sampler
   e. type of analysis requested

9. Clean the sampling equipment. Decontamination of equipment in the field requires a detergent wash (alconox soap), a water rinse, followed by a distilled water rinse.

10. Ship the samples on ice for chemical analysis and wet weight determination via overnight mail to the laboratory.

7. Label the sample vials using cloth Groundwater Technology labels (refer to Section 6.3.A) and waterproof ink. Labels will include the following information:
   a. sample identification number
   b. job identification number
   c. date and time of sample collection
   d. type of analysis requested
   e. name of sampler

8. Check to make sure the vial caps are tight, attach the chain-of-custody tags, then place the labeled sample and duplicate on ice immediately.

9. Fill out field data sheet (refer to Section 6.5.B).

10. The samples collected should be stored together with the unopened field blanks that have accompanied the sampler since the outset of the sampling event and were preserved with the same procedure as the samples with the same stock preservative.

    The sample set and unopened blanks must be stored together, under refrigeration, in an area known to be free of contamination from solvents and other volatiles.

11. Transport the sample set, on ice, back to the office for shipment to the analyzing laboratory, maintaining custody as prescribed in section 7.1.

D. Water Sampling Procedure for Acidified VOC Samples [EPA analytical method 601, 602, or 624 (holding time - 14 days)]

1. Rinse a clean teflon bailer at least five time with sample water.

2. Slowly lower the teflon bailer into the well. Do not allow it to drop at an uncontrolled rate.

3. Collect the water sample and slowly raise the bailer from the well at a constant rate.

4. Pour the sample into the vial containing predetermined amount of HCL, if applicable. Fill the vial to overflowing, avoiding turbulence and bubbling as much as possible. Water should stand above the top of the vial (i.e. - there should be a convex meniscus above the neck of the vial).

5. Carefully but quickly slip the cap with septum onto the vial with the teflon face of the septum toward the water. Tighten the cap securely, invert the vial, and tap the vial and the cap against your hand to assure that there are no bubbles inside. If bubbles are present, open the vial, add a few more drops of sample water, and reseal. Invert the sample vial several times to mix the HCL, if applicable.

6. Collect a duplicate sample.

E. Sampling Procedure for Unacidified VOC Samples [EPA analytical method 601, 602, or 624 (holding time: 601 - 14 days; 602 and 624 - 7 days)]

The sampling procedure for collecting unacidified VOC samples is as follows:

1. Rinse a clean teflon bailer at least five times with sample water.

2. Carefully pour sample water from the teflon bailer into a 40 ml vial that has been prepared according to the procedure outlined in section 6.3.C.1 taking care to minimize turbulence, bubbling, and time of exposure to air. Fill the vial to overflowing. Water should stand above the top of the vial (i.e. - there should be a convex meniscus above the neck of the vial).

3. Carefully but quickly slip the cap with the septum onto the vial with the teflon face of the septum toward the water. Tighten the cap securely, invert the vial and the cap against your hand to assure that there are no bubbles inside. If bubbles are present, add a few more drops of sample water and reseal.

From this point, the procedure is exactly the same as that outlined in the previous section (6.2.C) from step #6 on.

E. Sampling Procedure for Semi-volatile Organics (EPA analytical method 625)

1. Well sampling for organics

Prior to sample collection, wells will be purged as outlined in Section 6.2.B of this document. Sample bottles will be prepared as outlined in Section 6.1.C.3 of this document.

a. For wells that must be sampled with a bailer, sample collection will proceed as follows:

1. Rinse a clean teflon bailer at least five times with sample water.

2. Carefully pour sample water from the bailer into a clean 1-liter glass sample bottle until full, then cap tightly.

3. Label the sample bottle with a cloth GT label (refer to Section 6.3.A) and waterproof ink. Labels will include all appropriate information.

4. Fill out chain-of-custody tag and form and securely attach it to the sample bottle.

5. Check to make sure the bottle cap is on tight, then place labeled sample bottle on ice immediately.

6. Fill out field data sheet (refer to Section 6.5.B).

7. The samples collected should be stored together with an unopened field blank that has accompanied the sampler since the outset of the sampling event. The sample set and unopened blanks must be stored together, under refrigeration.

8. Transport the sample set, on ice, back to the office for shipment to the analyzing laboratory maintaining custody as prescribed in Section 7.1.

2. Soil Sampling

Soil samples will be collected from the subsurface by using either a split-spoon sampler or a core-barrel sampler. The following procedure will be followed when collecting soil samples for non-volatile organics analysis:

a. Procure a soil core from the subsurface by using either a split-spoon or core-barrel sampler.

b. Spread a piece of heavy-duty aluminum foil onto a work surface and open the split spoons (or extrude the sample if a core-barrel used).

c. Slice the cylindrical soil sample lengthwise with a clean stainless-steel spatula.

d. Transfer the sample to a precleaned, labeled 250 ml amber glass jar fitted with a teflon liner placed next to the sample.

e. Clean off the outside of the jar, then wrap the jar to prevent breakage while in transport.

f. Fill out chain-of-custody form (see Section 7.1), and place the sample on ice.

g. Ship the samples to the analyzing laboratory.

6.3 LABELING, PRESERVATION METHODS, AND HOLDING TIMES

A. Labeling

Labels will be applied to sample vials at the time of sample collection. The standard sample label used by Groundwater Technology is a white cloth label, shown below. Information will be written on labels with a black waterproof ball-point pen, and will include the sample ID number, the job ID number the date and time, the type of analysis requested, and the sampler's name. Labels will be positioned on sample vials so that they are easily seen and so that they do not come off if the vials are wet for a prolonged period of time.

B. Preservation Methods

1. Water sample preservation

Water samples to be analyzed for volatile organics that need preservation will be preserved by acidifying samples with a sufficient amount of 50% hydrochloric acid to lower sample pH to less than 2. All VOC samples will be maintained on ice or refrigerated at 4 degrees C until they are analyzed.

2. Soil sample preservation

Soil sample preservation will be provided by immediately placing the soil-containing vials on ice to cool the samples to 4 degrees C.

C. Holding Times

The holding times for volatile organics are 7 days if samples are not acidified and 14 days if they are acidified. Semi-volatile organics samples must be extracted within 7 days and completely analyzed within 40 days of extraction. After samples have been collected, sample sets will be sent to the lab as quickly as possible (via overnight mail) in sealed coolers packed with fresh ice.

6.4 MEASUREMENT OF VARIOUS FIELD PARAMETERS

pH will be measured using a properly calibrated pH meter (see Section 8 for calibration procedures). Hydrocarbon vapor levels will be measured using either an Organic Vapor Analyzer (OVA) or a HNU model 101 photoionization analyzer (see Section 8 for calibration procedures). Liquid levels will be measured using an Oil Recovery Systems interface probe. All field values will be recorded on appropriate field sheets.

6.5 FIELD DOCUMENTS AND RECORDS

A. Field Notebooks

All field measurements will be recorded in bound field notebooks (Lietz brand transit field book no. 8152-00 or equivalent). All pertinent calibration data for each day's work will be entered into the field notebook. All samples will be assigned field numbers which will be recorded in the field notebook as well as on sample vial labels and on field data sheets.

B. Field Data Sheets

Field data sheets will be filled out for each sample collected. The sheets will be filled out with a black waterproof pen. Information to be recorded on field sheets include:

1. date(s)
2. time(s)

3. location
4. project number
5. type of sample
6. sample ID number
7. source of sample
8. pertinent well data
9. materials encountered by the sample
10. pumping method (for well samples)
11. field parameters measured
12. preservation method
13. name of sampler

Other information that will be noted includes unusual odor or color, unusual foaming or reactions, etc. Field sample numbers will be assigned at the time of sample collection and will be recorded on field sheets, in field notebooks, on chain-of-custody forms, and on sample labels. If errors are made on field data sheets, corrections will be made by drawing a single line through the errors and entering the correct information. Such corrections will be initialed and dated. Under no circumstances will error be crossed out so that the information is not legible.

6.6 MEASURES TO AVOID CROSS-CONTAMINATION OF SAMPLES

A. Well Sampling

Measures taken to avoid cross-contamination in well water samples will include the following:

1. Upon arrival at a site, teflon bailer to be used to collect water samples will be rinsed thoroughly and scrubbed with alconox soap and thoroughly rinsed with tap water, followed by a thorough rinse with distilled water.

2. If water quality data are available for a site, the least contaminated well will be sampled first, the second cleanest well will be sampled second, and so on, until the last well is sampled, which will be the most contaminated well. If no water quality data are available, the well suspected to be the cleanest will be sampled first, and wells suspected to be the most contaminated will be sampled last.

3. The sampler's hands will be protected from contact with the sample water using nitrile gloves. Between the collection of each sample the teflon bailer will be scrubbed with alconox soap, followed by a thorough rinsing with distilled water. Other items that come in contact with well casing or well water (such as tape measures) will be rinsed with alconox soap followed by a distilled water rinse.

4. If any equipment comes in contact with any hydrocarbons such as oily soil, oily clothes, tar, etc., that equipment be thoroughly cleaned by alconox soap scrubbing, and a thorough rinse with distilled water. Any sampling equipment which has come into contact with liquid hydrocarbons (free product) will be regarded with suspicion. Such equipment will have tubing and cables replaced and all accessible parts will be washed as above. Visible deposits, if necessary, will be removed with hexane, followed by a rinse and washing as listed above.

5. Upon completion of a round of sampling for a site, sampling equipment will be scrubbed with alconox soap and rinsed thoroughly with distilled water.

B. Soil Sampling

To avoid cross-contamination during soil sampling, soil that is actually collected as a sample will not have come into contact with the walls of the split-spoon or with the sampler's hands. Stainless steel trowels will be used to gather soil samples. The split-spoon used to core the soil will be rinsed with alconox soap and water and rinsed with distilled water between each sample.

7. SAMPLE CUSTODY

7.1 CHAIN-OF-CUSTODY

The Conrail samples analyzed by the Groundwater Technology Lab are of an evidentiary nature. The possession of these samples must be traceable from the time samples are collected in the field until the analysis is completed and the data are entered as evidence. In such cases, the tracing of the samples from the field through the laboratory is accomplished by "chain-of-custody" procedures.

A. A chain-of-custody label will be completed for each sample bottle. The labels will be filled out using black waterproof ink and will contain all pertinent field information. The labels will be attached to sample bottles in such a way that they cannot be physically separated from the container. All sample numbers will be documented in bound field notebooks.

B. A chain-of-custody record (Figure 7.1) will be completed for each set of samples. The sampler will sign the first "Relinquished By" line at the bottom of the chain-of-custody record, and will indicate the date and time of the custody transfer. Samples will not leave custody of the field investigator until relinquished to another party. Custody is defined as:

1. In the actual physical possession of field personnel.

2. In the field personnel's view after being in physical possession.

3. In a locked area after being in physical possession.

4. In a designated, locked storage area.

Transfer of samples to the analyzing laboratory will be done by use of common carrier. Samples and sample containers will be secured in such a way that no containers can be opened in transit. The person to whom custody is being transferred will sign on the first "Received By" line of the chain-of-custody record, indicating that custody is being accepted by the carrier for all the samples listed on the sheet. For subsequent transfers of custody, the succeeding relinquish and receipt lines will be used.

Upon arrival at the laboratory, the sample custodian at the lab is responsible for maintaining possession of the chain-of-custody samples and for maintaining all records documenting that possession. Upon receipt of samples, the sample custodian signs the shipping report accompanying each sample and records the date and time. All of the logging procedures are performed for each sample by the custodian. The samples are then secured under lock and key in refrigerated storage.

After each extraction or analysis of a sample fraction, the accession log for that sample is signed by the analyst indicating the date and time of completion. By signing the accession log,

the individual affirms that he was completely responsible for the sample fraction during the period of time it was not in the possession of the custodian.

8. CALIBRATION PROCEDURES AND FREQUENCY

8.1 FIELD MEASUREMENTS

Field instruments that require periodic calibration include pH meters and vapor level meters.

A. pH meter - the pH meter will be calibrated in the field at the beginning of the sampling event and after every third measurement. Fisher brand certified buffer solutions of pH 7 and of either pH 4 or pH 10 (depending on the expected sample pH) will be used for calibration. The calibration procedure will be as follows:

1. Insert the pH electrode into the pH 7 buffer solution and adjust the calibration knob on the pH meter until the meter gives a steady reading of pH 7.

2. Turn the meter off and remove the electrode.

3. Rinse the electrode with distilled water and dab it dry with a soft paper towel or tissue.

4. Insert the electrode into a ph (or pH 10) buffer solution and adjust the slop control on the pH meter until the meter reading equals the pH of the buffer solution.

5. Turn the meter off and remove the electrode.

6. Rinse and dry the electrode as in step #4 above.

7. Repeat the procedure from step #2 on until the meter readings equal the pH of the buffer solutions with no adjustments. At this point the meter is properly calibrated and ready to measure pH of a sample.

B. Vapor level meter - the HNU model 101 photoionization analyzer will be calibrated according to the procedure outlined on pages 19-21 in the instrument instruction manual, which is included in Appendix A. Calibration gas will be obtained from HNU Systems. The instrument will be calibrated one day prior to each scheduled use.

8.2 LABORATORY MEASUREMENTS

GT Laboratory will analyze water and soil samples for volatile organics by gas chromatography and by gas chromatography/mass spectrometry. The calibration frequency required by these methods is daily with freshly made aqueous standards. Spiked reference samples are introduced into the analytical system to determine recovery and to validate calibrations.

9. ANALYTICAL PROCEDURES

9.1 FIELD DATA

Parameters measured in the field and the equipment used to measure them are as follows:

Parameter	Equipment	Owner
pH	pH meter	GT
Vapor levels	HNU model 101 Photoionization analyzer or Organic Vapor Analyzer (OVA)	GT
Liquid level elevations	Oil Recovery Systems Interface Probe	GT

The procedures for measuring each of the above field parameters are given in the instruction manuals for each piece of equipment. Measurement of these parameters will be in accordance with the operating procedures outlined in the instruction manuals. The above list of equipment is not an endorsement of the manufacturers or products. GT reserves the right to replace any of the equipment with an equivalent piece of equipment.

10. LABORATORY ANALYSES

The QA/QC plan for the laboratory analytical procedures are given in Appendix A.

11. INTERNAL QUALITY CONTROL CHECKS

The internal quality control checks to be routinely implemented by GTEL include the following:

A. Replicates - a minimum of 10% of all samples will be duplicated in the lab. Duplicate data will be used to determine analytical precision. The EPA Contract Lab Program criteria under which the GTEL GC/MS lab operates specifies a minimum of 5% duplicates.

B. Spikes - spiked samples will be prepared in the lab and will be analyzed with the samples at a rate of 10% of all samples and at least one spiked sample per sample set. EPA Method 624 and EPA Contract Lab Program criteria under which the GTEL GC/MS lab operates specify a minimum of 5% spikes, spiked sample per sample set

C. Blanks - blanks will be analyzed at a minimum of one daily.

D. Quality control standards - quality control standards traceable to the U.S. EPA or generated from concentrates prepared separately from concentration standards will be included at a rate dependent on sample matrix and lab performance. EPA traceable standards will be run at least quarterly.

E. Quality control charts - quality control charts will be prepared for precision and accuracy by GTEL and will be submitted with each set of analytical data. Charts prepared in the industrial method for relative range (I) will be accepted.

Table 3.1
Detection Limit Summary
(con't)

PARAMETER	WATER ANALYSIS	DETECTION LIMIT
IV. Specific Conductance	EPA 120.1	1 mmhos/cm
V. Chloride	EPA 325.3	0.1 mg/L
VI. Total dissolved solids	EPA 160.1	10 mg/L
VII. Temperature	EPA 170.1	0.1 °C

1. See Section 9 for method descriptions, modifications, and references, and Section 14 for the definition of detection limit.

2. Modifications under Methods 602 and 8020 for all of these parameters enhance the ability to reject interferences. Such modifications are allowed under the method and are fully documented as required.

3. Detection limit of EPA 624 can be decreased by a factor of 5 by operating under EPA Method 524.1 which uses a larger sample volume.

4. Detection limits in soil are based on following sample sizes: volatile organics - 10 grams; extractable organics - 30 grams; metals -1 gram.

5. Detection limits for extractables in water are based on 1 liter sample volume.

Table 3.2

Regulatory Limits

Toxicity Characteristic Leachate Procedure

For solids, if the total concentration does not exceed the following limits (left hand column), then the extraction procedure can be avoided. For liquid and TCLP extracts, the regulatory limit is listed in the right hand column.

Metals	Total Limit (mg/kg)	Liquid/Leachate Limit (mg/L)
Arsenic	100	5
Barium	10,000	100
Cadmium	20	1
Chromium	100	5
Lead	100	5
Mercury	4	0.2
Selenium	80	4
Silver	100	5

4.0 ORGANIZATION AND RESPONSIBILITY

4.1 Overview

GTEL is divided into three sections: Organic Chemistry, GC/MS, and Inorganic Chemistry. Each laboratory is managed by an experienced Section Manager. The staff of GTEL consists of individuals skilled in environmental chemistry and engineering. The broad experience of the GTEL staff provides exceptional support for the client in the areas of sampling, troubleshooting, analytical schemes and protocols, and project quality assurance.

GTEL does not provide sampling services. For quality assurance purposes GTEL provides sampling containers and sampling SOPs (see Section 6).

4.2 Roles and Responsibilities

Each person involved in the generation of data is implicitly a part of the QA/QC program. The following certain individuals have specifically delegated QA/QC responsibilities.

A. Quality Assurance Officer

All QA/QC management responsibilities for GTEL shall be directed by the Director of Quality Assurance. The independence and objectivity of the QA/QC Program depends on the QA Director's being independent of the data generation process.

The QA Director has primary responsibility for all

laboratory QA/QC activities. The QA Director reports directly to the Corporate Laboratory Services Manager. His/her responsibilities include the development, evaluation, and documentation of QA/QC policy and procedures appropriate for the GTEL projects.

The QA Director performs the day to day auditing of laboratory activities to assure that the QA/QC plan is being implemented. The QA Director has the authority to perform laboratory audits without notice, submit control samples, and request access to data files and other information for satisfying the goals of an independant audit.

The QA Director periodically reports on the progress and deficiencies of the laboratory QA/QC program, identifies specific needs (e.g., methods development and problem areas), and recommends specific courses of action for strengthening the program.

B. Project Manager

The GTEL Project Manager is responsible for managing and implementing the technical and administrative requirements of the project. He/she must assure and document the quality of each task output, i.e., the data and conclusions. The Project Manager collaborates with the GTEL QA/QC organization to formulate and fulfill a suitable QA/QC project plan for each task under his/her purview in

conformity with the quality assurance requirements of the client.

The Project Manager has overall responsibilities for designating the level of quality control necessary for the intended use of the data and for formulating the QA/QC project plans and activities. He/she will also enlist and encourage the cooperation of all GTEL personnel in the QA/QC project plan and program.

C. Laboratory Director

The GTEL Laboratory Director has overall responsibility for all laboratory activities, including QA/QC. The success of the QA/QC program ultimately depends on the Director's full support of QA/QC management. The Director will enlist and encourage the cooperation of all GTEL personnel in the program.

D. Section Managers

The GTEL Section Manager has responsibility for carrying out the daily QC activities and providing the technical expertise and guidance to maintain a smooth flow of work while complying with the requirements of the QA/QC plan.

4.3 Organizational Structure

Organization of GTEL is shown on the organization chart,

Figure 4.1 There are in general four layers of management: senior management; independent quality control with direct reporting to management; group supervisors; and support service management.

A. Senior Management

Scott C. Hines	General Manager, Lab Services
Gary Phillips	Lab Operations Manager
Larry Jackson	Technical Director
Terry R. Loucks	Director GTEL Midwest
Eileen Foley	Asst. Lab Operations Manager

B. Quality Assurance

Michael D. Webb	Director of QA/QC

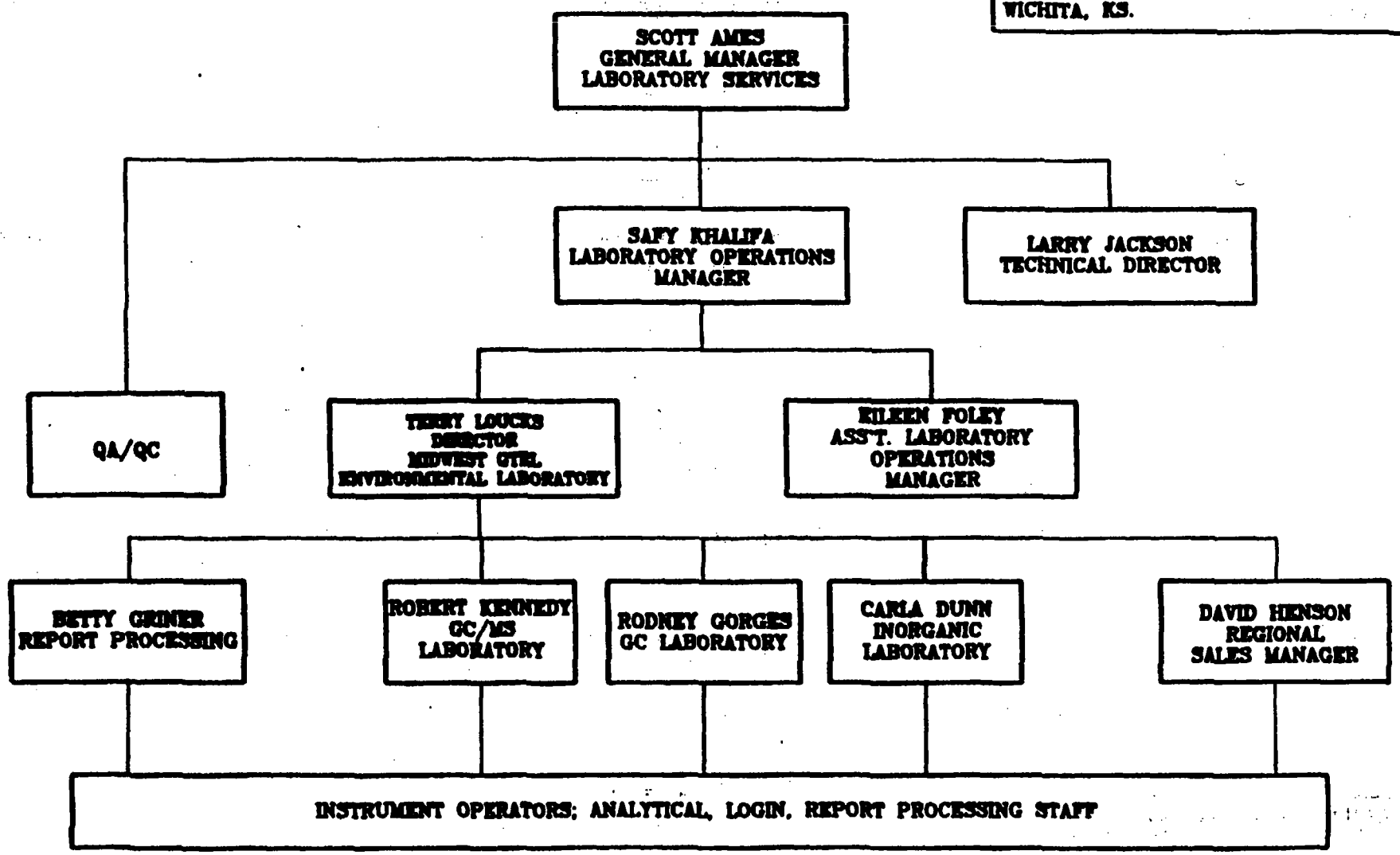
C. Department Management

Robert Kennedy	GC/MS Laboratory
Rodney Borges	GC Laboratory
Carla Dunn	Inorganic Laboratory

D. Support Services Managers

David Henson	Regional Sales Manager
Gerry LeBlanc	Controller
Betty Griner	Report Processing

GTEL ENVIRONMENTAL LABORATORIES
ORGANIZATIONAL CHART
WICHITA, KS.



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

1. Groundwater Technology Evironmental Laboratory (GTEL) quality assurance objectives for precision, accuracy, completeness, representativeness, and comparability are as follows:

A. Precision: The laboratory objective for precision is to equal or exceed the precision demonstrated for these analytical methods on similar samples and to exceed precision data for these analyses published by the U.S. EPA. See Table 5.1. Precision is documented on the basis of replicate analyses.

B. Accuracy: The laboratory objective for accuracy is to equal or exceed the accuracy demonstrated for these analytical methods on similar samples and to exceed recovery data published by the U.S. EPA. See Table 5.1. Accuracy is documented on the basis of recovery of spiked reference materials introduced into the analytical system.

C. Completeness: The completeness objective of an analysis is to provide sufficient information to allow the data user to assess the quality of the results. The overall project

completeness objective is documented by the ratio of the number of acceptable data points compared to the total number of measurements attempted.

D. Representativeness: The representativeness of the data from the sampling sites depends on the sampling procedures. The laboratory expects to be able to assist the customer with enacting proper sampling methods. The representativeness of the analytical data is a function of the procedures used in processing the samples. The objective for representativeness is to provide data which is representative of the sampled medium. The representativeness can be documented by the difference between separately procured, but otherwise identical samples or sample aliquots.

E. Comparability: The objectives for comparability are: to demonstrate traceability of standards to NBS or EPA sources; to use standard methodology; to participate in interlaboratory studies to document laboratory performance; and to report results consistently in conventional units of measure (see Table 5.2). Comparability of analytical results with those from other laboratories will be enhanced by these processes. See Table 5.3 for recent performance data.

Table 5.1 summarizes the precision, accuracy, and completeness objectives for the measurement parameters typically measured by GTEL. The values listed in Table 5.1 are based on EPA requirements published in the Federal Register (October 26, 1984), the EPA requirements in the Contract Laboratory Program, or if available statistical limits for GTEL performance (when an improvement over the EPA criteria).

The GTEL quality control program consists of appropriately placed blanks, duplicates, spikes, and QC check samples according to the method criteria (refer to Section 11).

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
1. VOLATILE ORGANICS - PRIORITY POLLUTANTS					
BENZENE	71-43-2	EPA 602	39-150	23.9	90%
		EPA 624	76-127	7.8	90%
BROMODICHLORO-		EPA 601	42-172	24.7	90%
METHANE	75-27-4	EPA 624	35-155	18.9	90%
BROMOFORM	75-25-2	EPA 601	13-159	35.0	90%
		EPA 624	45-169	18.2	90%
BROMOMETHANE	74-83-9	EPA 601	10-144	42.8	90%
		EPA 624	45-169	58.0	90%
CARBON		EPA 601	43-143	22.1	90%
TETRACHLORIDE	56-23-5	EPA 624	70-140	11.3	90%
CHLOROBENZENE		EPA 601	38-150	24.5	90%
	108-90-7	EPA 602	55-135	16.8	90%
		EPA 624	75-130	9.2	90%
CHLOROETHANE	75-00-3	EPA 601	46-137	20.5	90%
		EPA 624	14-230	30.5	90%
2-CHLOROETHYL-		EPA 601	14-186	35.0	90%
VINYL ETHER	110-75-8	EPA 624	10-300	84.0	90%
CHLOROFORM	67-66-3	EPA 601	49-133	18.9	90%
		EPA 624	51-138	18.2	90%
CHLOROMETHANE	74-87-3	EPA 601	10-193	60.4	90%
		EPA 624	10-270	58.4	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
DIBROMOCHLORO-		EPA 601	24-191	31.8	90%
METHANE	124-48-1	EPA 624	53-149	17.5	90%
1,2 - DICHLORO -		EPA 601	18-200	43.2	90%
BENZENE	95-50-1	EPA 602	37-154	24.8	90%
		EPA 624	18-190	28.8	90%
1,3 - DICHLORO -		EPA 601	7-187	34.0	90%
BENZENE	541-73-1	EPA 624	56-141	19.4	90%
		EPA 602	59-156	17.2	90%
1,4 - DICHLORO	106-46-7	EPA 601	42-143	22.2	90%
BENZENE		EPA 602	42-143	22.2	90%
		EPA 624	18-190	28.8	90%
DICHLORODIFLUOROMETHANE	75-71-8	EPA 601	40-160	25.0	90%
1,1 - DICHLORO-		EPA 601	47-132	19.3	90%
ETHANE	75-34-3	EPA 624	59-155	16.4	90%
1,2 - DICHLORO-		EPA 601	17-147	19.8	90%
ETHANE	107-06-2	EPA 624	49-155	28.6	90%
1,1 - DICHLORO		EPA 601	28-167	26.9	90%
ETHENE	75-35-4	EPA 624	61-145	9.9	90%
TRANS - 1,2		EPA 601	36-156	24.6	90%
DICHLOROETHANE	56-60-5	EPA 624	54-156	18.2	90%
1,2 - DICHLORO -		EPA 601	44-150	23.8	90%
PROPANE	78-87-5	EPA 624	40-210	45.0	90%
CIS-1,3, DICHLORO		EPA 601	22-178	32.8	90%
PROPANE	10061-01-5	EPA 624	18-225	52.8	90%
TRANS-1,3 -DICHLORO-		EPA 601	22-178	32.00	90%
PROPANE	10061-02-6	EPA 624	17-183	34.00	90%
ETHYL BENZENE	100-41-4	EPA 602	32-160	27.2	90%
		EPA 624	37-162	24.3	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
METHYLENE		EPA 601	25-162	29.3	90%
CHLORIDE	75-09-2	EPA 624	20-180	36.5	90%
1,1,2,2-TETRACHLORO		EPA 601	8-184	37.5	90%
ETHANE	79-34-5	EPA 624	46-157	20.4	90%
TETRACHLORO-		EPA 601	25-162	29.8	90%
ETHENE	127-18-4	EPA 624	64-148	15.6	90%
TOLUENE	108-88-3	EPA 602	46-148	21.6	90%
		EPA 624	76-125	9.2	90%
1,1,1- TRICHLORO-		EPA 601	41-138	24.7	90%
ETHANE	71-55-6	EPA 624	52-162	20.6	90%
1,1,2,- TRICHLORO-		EPA 601	39-136	22.9	90%
ETHANE	79-00-5	EPA 624	52-150	18.0	90%
TRICHLORO-		EPA 601	35-146	24.7	90%
ETHENE	79-01-6	EPA 624	71-120	9.9	90%
TRICLOROFLUORO-		EPA 601	21-156	31.1	90%
METHANE	75-69-4	EPA 624	17-181	33.6	90%
VINYL CHLORIDE	75-01-4	EPA 601	28-163	29.1	90%
		EPA 624	10-200	65.0	90%
II. VOLATILE ORGANICS - HSL AND MISCELLANEOUS					
ACETONE	67-64-1	EPA 624	20-180	25	90%
1,2- DIBROMO-					
ETHANE	106-93-4	EPA 504.1	40-160	20	90%
2-BUTANONE	78-93-3	EPA 624	20-180	25	90%
CARBON					
DISULFIDE	75-15-0	EPA 624	20-180	25	90%

TABLE 5.1
CTTL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
HEXANE	110-54-3	EPA 602 (FID)	20-200	20.0	90%
2-HEXANONE	591-78-6	EPA 624	20-100	25.0	90%
4-METHYL-2-PENTANONE	108-10-1	EPA 624	20-100	25.0	90%
METHYL TERT-BUTYL ETHER	1634-04-4	EPA 602	40-160	20.0	
		EPA 624	30-170	20.0	90%
STYRENE	100-42-5	EPA 624	40-160	20.0	90%
VINYL ACETATE	108-05-4	EPA 624	10-190	30.0	90%
M-XYLENE	108-38-3	EPA 602	51-145	13.0	90%
		EPA 624	40-160	20.0	90%
O-XYLENE	95-47-6	EPA 602	37-154	19.0	90%
		EPA 624	35-165	20.0	90%
		EPA 624	35-165	20.0	90%
P-XYLENE	106-42-3	EPA 602	36-163	22.0	90%
		EPA 624	35-165	20.0	90%

III. SEMI-VOLATILE ORGANICS - BASE/NEUTRAL EXTRACTABLE PRIORITY POLLUTANTS

ACENAPHTHENE	83-32-9	EPA 610	10-124	55.5	90%
		EPA 625	46-118	21.92	90%
ACENAPHTHYLENE	208-96-8	EPA 610	10-139	42.8	90%
		EPA 625	33-145	25.4	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
ANTHRACENE	120-12-07	EPA 610	10-126	41.7	90%
		EPA 625	27-133	26.2	90%
BENZO(a)		EPA 610	12-135	34.3	90%
ANTHRACENE	56-55-3	EPA 625	33-143	25.3	90%
BENZO(b)		EPA 610	6-150	38.0	90%
FLUORANTHENE	205-99-2	EPA 625	24-159	30.1	90%
BENZO(k)		EPA 610	10-159	69.3	90%
FLUORANTHENE	207-08-9	EPA 625	11-162	35.5	90%
BENZO(ghi)		EPA 610	10-116	68.1	90%
PERYLENE	191-24-2	EPA 625	10-219	56.6	90%
BENZO(a)		EPA 610	10-120	52.8	
PYRENE	50-32-8	EPA 625	17-163	33.5	90%
BENZYL BUTYL					
PHTHALATE	85-68-1	EPA 625	10-152	54.4	90%
BIS(2-CHLOROETHOXY)					
METHANE	111-91-1	EPA 625	33-184	27.9	90%
BIS(2-CHLOROETHYL)					
ETHER	111-44-4	EPA 625	12-158	35.1	90%
BIS(2-CHLOROISOPROPYL)					
ETHER	108-60-1	EPA 625	36-166	26.8	90%
BIS(2-ETHYLHEXYL)					
PHTHALATE	117-81-7	EPA 625	8-158	36.8	90%
4-BROMOPHENYL					
PHENYL ETHER	101-55-33	EPA 625	53-127	16.7	90%
2-CHLORO-		EPA 610	9-148	37.8	90%
NAPHTHALENE	91-58-7	EPA 625	60-118	13.4	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	EPA 625	25-158	29.5	90%
CHRYSENE	218-01-9	EPA 610	10-189	63.1	90%
		EPA 625	17-168	32.9	90%
DIBENZO(ah)	-	EPA 610	10-110	45.8	90%
ANTHRACENE	53-70-3	EPA 625	10-227	50.3	90%
DI-N-BUTYL PHTHALATE	84-74-2	EPA 625	1-118	40.8	90%
1,2-DICHLORO-		EPA 612	9-160	41.1	90%
BENZENE	95-50-1	EPA 625	32-129	24.5	90%
1,3-DICHLORO-		EPA 612	10-150	40.0	90%
BENZENE	541-73-1	EPA 625	10-172	41.1	90%
1,4-DICHLORO-		EPA 612	13-137	19.0	90%
BENZENE	106-46-7	EPA 625	36-97	19.8	90%
3,3'-DICHLORO-					
BENZIDINE	91-94-1	EPA 625	10-262	50.1	90%
DIETHYL PHTHALATE	84-66-2	EPA 625	10-114	52.5	90%
DIMETHYL PHTHALATE	131-11-3	EPA 625	10-112	100.6	90%
2,4-DINITRO TOLUENE	121-14-2	EPA 625	24-96	26.8	90%
2,6-DINITRO TOLUENE	606-20-2	EPA 625	50-158	19.3	90%

TABLE 5.1
GTKL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
DI-N-OCTYL PHTHALATE	117-84-0	EPA 625	4-146	38.6	90%
FLUORANTHENE	206-44-0	EPA 610	14-123	32.4	90%
		EPA 625	26-137	27.3	90%
FLUORENE	86-73-7	EPA 610	10-142	68.0	90%
		EPA 625	59-121	13.7	90%
HEXACHLORO		EPA 612	15-159	36.0	90%
BENZENE	118-74-1	EPA 625	10-152	42.3	90%
HEXACHLORO BUTADIENE	87-68-3	EPA 625	24-116	26.7	90%
HEXACLORO		EPA 612	8-139	36.0	90%
ETHANE	67-72-1	EPA 625	40-113	18.1	90%
INDENO(1,2,3-cd)		EPA 610	10-116	42.2	90%
PYRENE	193-39-5	EPA 625	10-171	50.6	90%
ISOPHORONE	78-59-1	EPA 625	21-196	33.2	90%
1-METHYL-		EPA 610	10-122	41.0	90%
NAPHTHALENE	90-12-0	EPA 625		30.0	90%
2-METHYL-		EPA 610	10-122	41.0	90%
NAPHTHALENE	91-57-6	EPA 625		30.0	90%
NAPHTHALENE	91-20-3	EPA 610	10-122	42.3	90%
		EPA 625	21-133	29.1	90%
NITROBENZENE	98-95-3	EPA 625	35-180	27.2	90%
N-NITROSODI-n- PROPYLAMINE	621-64-7	EPA 625	41-116	26.9	90%
PHENAN-		EPA 610	10-155	46.7	90%
THRENE	85-01-8	EPA 625	54-120	15.3	90%
PYRENE	129-00-0	EPA 610	10-140	42.0	90%
		EPA 625	26-127	21.9	90%
1,2,4, -TRICHLORO-	8001-35-2	EPA 612	5-149	39.0	90%
BENZENE	120-82-1	EPA 625	39-98	19.8	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
PESTICIDE/PCB PRIORITY POLLUTANTS					
ALDRIN	309-00-2	EPA 608	42-122	15.6	90%
a-BHC	319-84-6	EPA 608	37-134	23.0	90%
b-BHC	319-85-7	EPA 608	17-147	33.0	90%
d-BHC	319-86-8	EPA 608	19-140	26.0	90%
g-BHC	58-89-9	EPA 608	32-127	18.8	90%
CHLORDANE	57-74-9	EPA 608	45-119	18.4	90%
4,4'-DDD	72-54-8	EPA 608	31-141	25.4	90%
4,4'-DDE	72-55-9	EPA 608	30-145	23.4	90%
4,4'-DDT	50-29-3	EPA 608	25-160	19.1	90%
DIELDRIN	60-57-1	EPA 608	36-146	12.7	90%
ENDOSULFAN I	959-98-8	EPA 608	45-153	22.0	90%
ENDOSULFAN II	33212-65-9	EPA 608	18-200	44.9	90%
ENDOSULFAN SULFATE	1031-07-8	EPA 608	26-134	28.1	90%
ENDRIN	72-20-8	EPA 608	30-147	16.8	90%
ENDRIN ALDEHYDE	7421-93-4	EPA 608	20-200	24	90%
HEPTACHLOR	76-44-8	EPA 608	34-111	14.1	90%
HEPTACHLOR EPOXIDE	1024-57-3	EPA 608	37-142	20.7	90%
TOXAPHENE	8001-35-2	EPA 608	41-126	19.5	90%

TABLE 5.1
GTRL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
PCB 1016	12674-11-2	EPA 608	50-114	16.1	90%
PCB 1221	1104-28-2	EPA 608	15-178	33.7	90%
PCB 1232	11141-16-5	EPA 608	18-215	37.3	90%
PCB 1242	53469-21-9	EPA 608	39-150	24.2	90%
PCB 1248	12672-29-6	EPA 608	38-158	24.3	90%
PCB 1254	11097-69-1	EPA 608	29-131	26.8	90%
PCB 1260	11096-82-5	EPA 608	8-127	25.8	90%
IV. SEMI VOLATILE - ACID EXTRACTABLE PRIORITY POLLUTANTS					
4-CHLORO-3 METHYLPHENOL	59-50-7	EPA 625	23-97	29.7	90%
2-CHLOROPHENOL	95-57-8	EPA 625	27-123	28.3	90%
2,4-DICHLORO PHENOL	120-83-2	EPA 625	39-135	22.5	90%
2,4-DIMETHYL PHENOL	105-67-9	EPA 625	32-119	23.7	90%
2,4-DINITRO PHENOL	51-28-5	EPA 625	10-191	83.8	90%
2-METHYL-4,6-DINITOROPHENOL	534-52-1	EPA 625	29-182	56.4	90%
2-NITROPHENOL	88-75-5	EPA 625	10-132	29.5	90%
4-NITROPHENOL	100-02-7	EPA 625	10-80	35.2	90%
PENTACHLORO-PHENOL	87-86-5	EPA 625	9-103	35.2	90%
2,4,6-TRICHLORO PHENOL	88-06-2	EPA 625	37-144	24.8	90%
PHENOL	108-95-2	EPA 625	12-89	29.7	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

ELEMENT	METHOD	METHOD REFERENCE	ACCURACY	PRECISION	COMPLETENESS
V. METALS					
ALUMINUM	ICP	EPA 200.7	75-125	14	90%
ANTIMONY	AA FLAME	EPA 204.1	85-115	14	90%
	AA FURNACE	EPA 204.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
ARSENIC	AA FURNACE	EPA 206.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
	AA HYDRIDE	EPA 206.3	85-115	14	90%
BARIUM	AA FLAME	EPA 208.1	85-115	14	90%
	AA FURNACE	EPA 208.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
BERYLLIUM	ICP	EPA 200.7	75-125	14	90%
CADMIUM	AA FLAME	EPA 213.2	85-115	14	90%
	AA FURNACE	EPA 213.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
CALCIUM	ICP	EPA 200.7	75-125	14	90%
CHROMIUM	AA FLAME	EPA 218.1	85-115	14	90%
	AA FURNACE	EPA 218.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
COBALT	ICP	EPA 200.7	75-125	14	90%
COPPER	FLAME	EPA 220.1	85-115	14	90%
	FURNACE	EPA 220.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

ELEMENT	METHOD	METHOD REFERENCE	ACCURACY	PRECISION	COMPLETENESS
IRON	AA FLAME	EPA 236.2	85-115	14	90%
	AA FURNACE	EPA 236.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
LEAD	AA FLAME	EPA 239.2	85-115	14	90%
	AA FURNACE	EPA 239.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
LEAD IN GASOLINE	AA FLAME	ASTM D-3237	85-115	14	90%
MAGNESIUM	ICP	EPA 200.7	75-125	14	90%
MANGANESE	AA FLAME	EPA 243.1	85-115	14	90%
	AA FURNACE	EPA 243.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
MERCURY	COLD VAPOR	EPA 245.1	75-125	14	90%
MOLYBDENUM	ICP	EPA 200.7	75-125	14	90%
NICKEL	AA FLAME	EPA 249.1	85-115	14	90%
	AA FURNACE	EPA 249.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
POTASSIUM	AA FLAME	EPA 258.1	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
SELENIUM	AA FURNACE	EPA 270.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
	AA HYDRIDE	EPA 270.3	85-115	14	90%
SILVER	AA FLAME	EPA 272.1	85-115	14	90%
	AA FURNACE	EPA 272.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR WATER ANALYSIS

ELEMENT	METHOD	METHOD REFERENCE	ACCURACY	PRECISION	COMPLETENESS
SILVER	AA FLAME	EPA 273.1	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
THALLIUM	AA FLAME	EPA 279.1	85-115	14	90%
	AA FURNACE	EPA 279.2	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%
TIN	ICP	EPA 200.7	75-125	14	90%
VANADIUM	ICP	EPA 200.7	75-125	14	90%
ZINC	AA FLAME	EPA 289.1	85-115	14	90%
	ICP	EPA 200.7	75-125	14	90%

MEASUREMENT PARAMETER	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
VI. INORGANICS/PHYSICAL/INFRARED				
CHLORIDE	EPA 325.3	90-110	10	90%
CONDUCTIVITY - LAB	EPA 120.1	90-110	10	90%
-FIELD	MANUFACTURER	90-110	10	90%
PH - LAB	EPA 150.1	.01 PH UNIT	10	90%
- FIELD	MANUFACTURER	.1PH UNIT	10	90%
TEMPERATURE - LAB	EPA 170.1	.1 DEGREE	10	90%
- FIELD		.1 DEGREE	10	90%
TOTAL DISSOLVED SOLIDS	EPA 160.1	80-120	10	90%
OIL AND GREASE (GRAVIMETRIC)	EPA 413.1	60-80 (1)	10	90%
OIL AND GREASE (INFRARED)	EPA 413.2	60-140 (1)	15	90%
PETROLEUM HYDROCARBONS (INFRARED)	EPA 418.1	60-140 (1)	15	90%

(1) THESE ACCURACY LIMITS ARE FOR A FUEL OIL #2 SPIKE

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
I. VOLATILE ORGANICS - PRIORITY POLLUTANTS					
BENZENE	71-43-2	EPA 5030/8020	29-155	28.3	90%
		EPA 5030/8240	76-127	14.9	90%
BROMODICHLORO-		EPA 5030/8010	32-182	24.7	90%
METHANE	75-27-4	EPA 5030/8240	25-145	18.9	90%
BROMOFORM	75-25-2	EPA 5030/8010	10-169	35.0	90%
		EPA 5030/8240	35-179	18.2	90%
BROMOMETHANE	74-83-9	EPA 5030/8010	10-154	42.8	90%
		EPA 5030/8240	35-179	58.0	90%
CARBON		EPA 5030/8010	33-153	22.1	90%
TETRACHLORIDE	56-23-5	EPA 5030/8240	60-150	11.3	90%
CHLOROBENZENE		EPA 5030/8010	28-160	24.5	90%
	108-90-7	EPA 5030/8020	45-145	16.8	90%
		EPA 5030/8240	65-140	14.9	90%
CHLOROETHANE	75-00-3	EPA 5030/8010	36-147	20.5	90%
		EPA 5030/8240	10-230	30.5	90%
2-CHLOROETHYL-		EPA 5030/8010	10-196	35.0	90%
VINYL ETHER	110-75-8	EPA 5030/8240	10-300	84.0	90%
CHLOROFORM	67-66-3	EPA 5030/8010	39-143	18.9	90%
		EPA 5030/8240	41-138	18.2	90%
CHLOROMETHANE	74-87-3	EPA 5030/8010	10-200	60.4	90%
		EPA 5030/8240	10-270	58.4	90%
		EPA 5030/8240	10-200	35	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
DIBROMOCHLORO-		EPA 5030/8010	14-200	31.0	90%
METHANE	124-48-1	EPA 5030/8240	43-150	17.5	90%
1,2 - DICHLORO -		EPA 5030/8010	18-200	43.2	90%
BENZENE	95-50-1	EPA 5030/8020	27-144	24.0	90%
		EPA 5030/8240	18-200	28.0	90%
1,3 - DICHLORO -		EPA 5030/8010	7-197	36.0	90%
BENZENE	541-73-1	EPA 5030/8020	40-151	18.4	90%
		EPA 5030/8240	45-146	17.2	90%
1,4 - DICHLORO	106-46-7	EPA 5030/8010	32-153	22.2	90%
BENZENE		EPA 5030/8020	32-153	22.2	90%
		EPA 5030/8240	18-190	24.0	90%
DICHLORODIFLUOROMETHANE	75-71-8	EPA 5030/8010	30-170	30.0	90%
1,1 - DICHLORO-		EPA 5030/8010	37-142	19.3	90%
ETHANE	75-34-3	EPA 5030/8240	49-146	16.4	90%
1,2 - DICHLORO-		EPA 5030/8010	18-157	19.0	90%
ETHANE	107-06-2	EPA 5030/8240	39-145	20.6	90%
1,1 - DICHLORO		EPA 5030/8010	18-177	25.9	90%
ETHENE	75-35-4	EPA 5030/8240	51-155	15.6	90%
TRANS - 1,2		EPA 5030/8010	28-146	24.6	90%
DICHLOROETHANE	56-60-5	EPA 5030/8240	44-146	19.2	90%
1,2 - DICHLORO -		EPA 5030/8010	34-148	23.0	90%
PROPANE	78-87-5	EPA 5030/8240	30-210	45.0	90%
CIS-1,3, DICHLORO		EPA 5030/8010	12-188	32.0	90%
PROPANE	10061-01-5	EPA 5030/8240	18-225	53.0	90%
TRANS-1,3 -DICHLORO-		EPA 5030/8010	12-168	37.0	90%
PROPANE	10061-02-6	EPA 5030/8240	18-143	30.0	90%
ETHYL BENZENE	100-41-4	EPA 5030/8020	22-170	30.0	90%
		EPA 5030/8240	37-172	29.0	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
METHYLENE		EPA 5030/8010	15-172	29.3	90%
CLORIDE	75-09-2	EPA 5030/8240	10-190	36.5	90%
1,1,2,2-TETRACHLORO		EPA 5030/8010	0-194	37.5	90%
ETHANE	79-34-5	EPA 5030/8240	36-167	20.4	90%
TETRACHLORO-		EPA 5030/8010	15-172	29.8	90%
ETHENE	127-18-4	EPA 5030/8240	54-158	15.6	90%
TOLUENE	108-88-3	EPA 5030/8020	36-158	30	90%
		EPA 5030/8240	66-135	14.9	90%
1,1,1- TRICHLORO-		EPA 5030/8010	31-148	24.7	90%
ETHANE	71-55-6	EPA 5030/8240	42-172	20.6	90%
1,1,2,- TRICHLORO-		EPA 5030/8010	29-146	22.9	90%
ETHANE	79-00-5	EPA 5030/8240	42-160	18.0	90%
TRICHLORO-		EPA 5030/8010	25-156	24.7	90%
ETHENE	79-01-6	EPA 5030/8240	61-130	17.0	90%
TRICLOROFLUORO-		EPA 5030/8010	11-166	31.1	90%
METHANE	75-69-4	EPA 5030/8240	10-191	33.6	90%
VINYL CHLORIDE	75-01-4	EPA 5030/8010	18-173	29.1	90%
		EPA 5030/8240	10-200	65.0	90%
II. VOLATILE ORGANICS - HSL AND MISCELLANEOUS					
ACETONE	67-64-1	EPA 5030/8240	10-190	30	90%
1,2- DIBROMO-	106-93-4 (ECD)	EPA 5030/8010	30-170	25	90%
ETHANE					
2-BUTANONE	78-93-3	EPA 5030/8240	10-190	30	90%
CARBON					
DISULFIDE	75-15-0	EPA 5030/8240	10-190	30	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
HEXANE	110-54-3 (FID)	EPA 5030/8020	30-170	25.0	90%
2-HEXANONE	591-78-6	EPA 5030/8240	10-190	30.0	90%
4-METHYL-2-PENTANONE	108-10-1	EPA 3550/8270	10-190	30.0	90%
METHYL TERT-BUTYL ETHER	1634-04-4	EPA 5030/8020	30-170	25.0	
		EPA 5030/8240	20-160	25.0	90%
STYRENE	100-42-5	EPA 5030/8240	30-170	25.0	90%
VINYL ACETATE	108-05-4	EPA 5030/8240	10-190	30.0	90%
M-XYLENE		EPA 5030/8020	41-155	30.0	90%
		EPA 5030/8240	30-170	25.0	90%
O-XYLENE	95-47-6	EPA 5030/8020	27-164	30.0	90%
		EPA 5030/8240	25-175	25.0	90%
		EPA 5030/8240	25-175	25.0	90%
P-XYLENE	106-42-3	EPA 5030/8020	28-173	30.0	90%
		EPA 5030/8240	25-175	25.0	90%
III. SEMI-VOLATILE ORGANICS - BASE NEUTRAL EXTRACTABLE PRIORITY POLLUTANTS					
ACENAPHTHENE	83-32-9	EPA 3550/8310	10-134	55.5	90%
		EPA 3550/8270	36-128	13.4	90%
ACENAPHTHYLENE	208-96-8	EPA 3550/8310	10-149	42.8	90%
		EPA 3550/8270	23-155	25.4	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
ANTHRACENE	120-12-07	EPA 3550/8310	10-136	41.7	90%
		EPA 3550/8270	17-143	26.2	90%
BENZO(a)		EPA 3550/8310	10-145	34.3	90%
ANTHRACENE	56-55-3	EPA 3550/8270	23-123	25.3	90%
BENZO(b)		EPA 3550/8310	6-150	38.0	90%
FLUORANTHENE	205-99-2	EPA 3550/8270	14-169	38.1	90%
BENZO(k)		EPA 3550/8310	10-169	69.3	90%
FLUORANTHENE	207-08-9	EPA 3550/8270	10-172	35.5	90%
BENZO(ghi)		EPA 3550/8310	10-126	60.1	90%
PERYLENE	191-24-2	EPA 3550/8270	10-219	50.6	90%
BENZO(a)		EPA 3550/8310	10-138	52.8	
PYRENE	50-32-8	EPA 3550/8270	10-173	33.5	90%
BENZYL BUTYL					
PHTHALATE	85-68-1	EPA 3550/8270	10-162	54.4	90%
BIS(2-CHLOROETHOXY)					
METHANE	111-91-1	EPA 3550/8270	23-194	27.9	90%
BIS(2-CHLOROETHYL)					
ETHER	111-44-4	EPA 3550/8270	10-168	35.1	90%
BIS(2-CHLOROISOPROPYL)					
ETHER	108-60-1	EPA 3550/8270	26-176	26.0	90%
BIS(2-ETHYLHEXYL)					
PHTHALATE	117-81-7	EPA 3550/8270	8-168	36.8	90%
4-BROMOPHENYL					
PHENYL ETHER	101-55-3	EPA 3550/8270	43-137	16.7	90%
2-CHLORO-		EPA 3550/8310	9-158	42	90%
NAPHTHALENE	91-58-7	EPA 3550/8270	50-128	13.4	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	EPA 3550/8270	15-160	28.5	90%
CHRYSENE	218-01-9	EPA 3550/8310	10-200	63.1	90%
		EPA 3550/8270	10-178	32.9	90%
DIBENZO(ah)		EPA 3550/8310	10-120	45.8	90%
ANTHRACENE	53-70-3	EPA 3550/8270	10-227	59.3	90%
DI-N-BUTYL PHTHALATE	84-74-2	EPA 3550/8270	1-120	40.0	90%
1,2-DICHLORO-		EPA 3550/8120	9-170	41.1	90%
BENZENE	95-50-1	EPA 3550/8270	22-139	28.5	90%
1,3-DICHLORO-		EPA 3550/8120	10-160	54	90%
BENZENE	541-73-1	EPA 3550/8270	10-182	41.1	90%
1,4 - DICHLORO-		EPA 3550/8120	10-147	19	90%
BENZENE	106-46-7	EPA 3550/8270	26-197	19.1	90%
3,3-DICHLORO BENZIDINE	91-94-1	EPA 3550/8270	10-262	50.1	90%
DIETHYL PHTHALATE	84-66-2	EPA 3550/8270	10-124	52.5	90%
DIMETHYL PHTHALATE	131-11-3	EPA 3550/8270	10-122	100.6	90%
2,4-DINITRO TOLUENE	121-14-2	EPA 3550/8270	14-196	33.2	90%
2,6-DINITRO TOLUENE	606-20-2	EPA 3550/8270	40-168	19.3	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
DI-N-OCTYL PHTHALATE	117-84-0	EPA 3550/8270	4-156	38.6	90%
FLUORANTHENE	206-44-0	EPA 3550/8310	10-133	32.4	90%
		EPA 3550/8270	16-147	27.3	90%
FLUORENE	86-73-7	EPA 3550/8310	10-152	61.0	90%
		EPA 3550/8270	49-131	13.7	90%
HEXACHLORO BENZENE	118-74-1	EPA 3550/8120	10-169	41.0	90%
		EPA 3550/8270	10-162	42.3	90%
HEXACHLORO BUTADIENE	87-68-3	EPA 3550/8270	14-126	26.7	90%
HEXACLORO ETHANE	67-72-1	EPA 3550/8120	8-149	41.0	90%
		EPA 3550/8270	30-123	18.1	90%
INDENO(1,2,3-cd) PYRENE	193-39-5	EPA 3550/8310	10-126	42.2	90%
		EPA 3550/8270	10-181	50.6	90%
ISOPHORONE	78-59-1	EPA 3550/8270	11-200	33.2	90%
1-METHYL-NAPHTHALENE	90-12-0	EPA 3550/8310	10-132	46.0	90%
		EPA 3550/8270		35.0	90%
2-METHYL-NAPHTHALENE	91-57-6	EPA 3550/8310	10-132	46.0	90%
		EPA 3550/8270		35.0	90%
NAPHTHALENE	91-20-3	EPA 3550/8310	10-132	42.3	90%
		EPA 3550/8270	11-143	29.1	90%
NITROBENZENE	98-95-3	EPA 3550/8270	25-190	27.2	90%
N-NITROSODI-n PROPYLAMINE	621-64-7	EPA 3550/8270	31-126	26.9	90%
PHENAN-THRENE	85-01-8	EPA 3550/8310	10-165	46.7	90%
		EPA 3550/8270	44-130	15.3	90%
PYRENE	129-00-0	EPA 3550/8310	10-150	42.0	90%
		EPA 3550/8270	16-137	25.5	90%
1,2,4, -TRICHLORO-	8001-35-2	EPA 3550/8310	5-159	44.0	90%
BENZENE	120-82-1	EPA 3550/8270	29-108	16.3	90%

TABLE 5.1
CTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

MEASUREMENT PARAMETER	CAS #	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
PCB 1016	12674-11-2	EPA 3550/8080	60-126	18.1	90%
PCB 1221	1104-28-2	EPA 3550/8080	10-186	33.7	90%
PCB 1232	11141-16-5	EPA 3550/8080	10-215	37.3	90%
PCB 1242	53469-21-9	EPA 3550/8080	29-180	24.2	90%
PCB 1248	12672-29-6	EPA 3550/8080	20-180	24.3	90%
PCB 1254	11097-69-1	EPA 3550/8080	10-141	20.8	90%
PCB 1260	11096-82-5	EPA 3550/8080	6-137	25.8	90%
IV. SEMI-VOLATILE ORGANICS - ACID EXTRACTABLE PRIORITY POLLUTANTS					
4-CHLORO-3-METHYLPHENOL	59-50-7	EPA 3550/8270	13-107	23.3	90%
2-CHLOROPHENOL	95-57-8	EPA 3550/8270	17-133	35.4	90%
2,4-DICHLORO PHENOL	120-83-2	EPA 3550/8270	29-145	22.5	90%
2,4-DIMETHYL PHENOL	105-67-9	EPA 3550/8270	22-129	23.7	90%
2,4-DINITRO PHENOL	51-28-5	EPA 3550/8270	10-200	83.8	90%
2-METHYL-4,6-DINITROPHENOL	534-52-1	EPA 3550/8270	18-192	56.4	90%
2-NITROPHENOL	88-75-5	EPA 3550/8270	10-142	29.5	90%
4-NITROPHENOL	100-02-7	EPA 3550/8270	1-90	35.4	90%
PENTACHLORO-PHENOL	87-86-5	EPA 3550/8270	9-113	33.2	90%
2,4,6-TRICHLORO PHENOL	88-06-2	EPA 3550/8270	37-144	24.8	90%
PHENOL	108-95-2	EPA 3550/8270	5-112	24.8	90%

TABLE 5.1
GYEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

ELEMENT	METHOD	METHOD REFERENCE	ACCURACY	PRECISION	COMPLETENESS
V. METALS					
ALUMINUM	ICP	EPA 6010	75-125	14	90%
ANTIMONY	AA FLAME	EPA 7040	85-115	14	90%
	AA FURNACE	EPA 7041	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
ARSENIC	AA FURNACE	EPA 7060	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
	AA HYDRIDE	EPA 7061	85-115	14	90%
BARIUM	AA FLAME	EPA 7080	85-115	14	90%
	AA FURNACE	EPA 7081	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
BERYLLIUM	ICP	EPA 6010	75-125	14	90%
CADMIUM	AA FLAME	EPA 7130	85-115	14	90%
	AA FURNACE	EPA 7131	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
CALCIUM	ICP	EPA 6010	75-125	14	90%
CHROMIUM	AA FLAME	EPA 7190	85-115	14	90%
	AA FURNACE	EPA 7191	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
COBALT	ICP	EPA 6010	75-125	14	90%
COPPER	AA FLAME	EPA 7210	85-115	14	90%
	AA FURNACE	EPA 7211	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%

TABLE 5.1
CTEL OBJECTIVES AND 100 ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

ELEMENT	METHOD	METHOD REFERENCE	ACCURACY	PRECISION	COMPLETENESS
IRON	AA FLAME	EPA 7380	85-115	14	90%
	AA FURNACE		85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
LEAD	AA FLAME	EPA 7420	85-115	14	90%
	AA FURNACE	EPA 7421	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
MAGNESIUM	ICP	EPA 6010	75-125	14	90%
MANGANESE	AA FLAME	EPA 7460	85-115	14	90%
	AA FURNACE		85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
MERCURY	COLD VAPOR	EPA 7471	75-125	14	90%
MOLYBDENUM	ICP	EPA 6010	75-125	14	90%
NICKEL	AA FLAME	EPA 7520	85-115	14	90%
	AA FURNACE	EPA 7521	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
POTASSIUM	AA FLAME	EPA 6010	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
SELENIUM	AA HYDRIDE	EPA 7741	85-115	14	90%
	AA FURNACE	EPA 7740	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
SILVER	AA FLAME	EPA 7760	85-115	14	90%
	AA FURNACE	EPA 7761	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%

TABLE 5.1
GTEL OBJECTIVES AND FOR ACCURACY, PRECISION
AND COMPLETENESS FOR SOIL ANALYSIS

ELEMENT	METHOD	METHOD REFERENCE	ACCURACY	PRECISION	COMPLETENESS
SODIUM	AA FLAME		85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
THALLIUM	AA FLAME	EPA 7840	85-115	14	90%
	AA FURNACE	EPA 7841	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%
TIN	ICP	EPA 6010	75-125	14	90%
VANADIUM	ICP	EPA 6010	75-125	14	90%
ZINC	AA FLAME	EPA 7950	85-115	14	90%
	ICP	EPA 6010	75-125	14	90%

MEASUREMENT PARAMETER	METHOD	METHOD REFERENCE	ACCURACY % RECOVERY	PRECISION % REL STD DEV	COMPLETENESS
VI. PHYSICAL/INFRARED					
OIL AND GREASE	(GRAVIMETIC)	SM 503A AND D	30-80 (1)	15	90%
OIL AND GREASE	(SOXHLET/INFRARED)	SM 503B AND D	20-100 (1)	20	90%
PETROLEUM HYDROCARBONS	(SOXHLET/INFRARED)	SM 503D AND E	20-100 (1)	20	90%

SM = STANDARD METHOD (SEE SECTION 8)
(1) = THESE ACCURACY UNITS ARE FOR FUEL OIL #2 SPIKE

GTEL participates in several performance testing programs to provide an unbiased measure of the laboratory capability and to maintain appropriate certification eligibility. GTEL is a New Hampshire Certified Laboratory covered by the program for which the Laboratory has achieved consistently acceptable results in the EPA performance testing programs.

The objectives listed in Table 5.1 will routinely be compared to results obtained from specific analytical procedures (addressed in Section 9) to assess the precision and accuracy of data and to determine if corrective action is required.

PERFORMANCE EVALUATION REPORT DATE: 11/17/8

WATER POLLUTION STUDY NUMBER #P019

LABORATORY: KS017

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
MINERALS IN MILLIGRAMS PER LITER: (EXCEPT AS NOTED)						
PH-UNITS	3	3.94	4.00	3.93- 4.09	3.95- 4.07	CHECK FOR EP
	4	9.07	9.19	8.86- 9.60	8.93- 9.33	ACCEPTABL
SPEC. COND.	1	659	659	592.- 732.	610.- 714.	ACCEPTABL
(UMHOS/CM AT 25 C)	2	277	272	245.- 302.	252.- 295.	ACCEPTABL
TDS AT 180 C	1	362	399	325.- 492.	344.- 462.	ACCEPTABL
	2	139	158	95.9- 217.	111.- 202.	ACCEPTABL
TOTAL HARDNESS	1	162	159.5	151.- 174.	154.- 172.	ACCEPTABL
(AS CACO3)	2	68.6	73.5	65.1- 82.9	67.3- 80.7	ACCEPTABL
CALCIUM	1	63.9	63.0	54.7- 74.0	57.1- 71.6	ACCEPTABL
	2	1.09	0.905	.700- 1.78	.835- 1.65	ACCEPTABL
MAGNESIUM	1	0.54	0.520	.424- .635	.451- .608	ACCEPTABL
	2	16.0	17.3	14.3- 19.8	15.4- 19.2	ACCEPTABL
SODIUM	1	52.0	52.6	46.0- 58.4	47.5- 56.8	ACCEPTABL
	2	14.1	13.7	10.3- 16.2	11.4- 15.6	ACCEPTABL
POTASSIUM	1	17.4	19.0	14.9- 21.0	15.6- 20.2	ACCEPTABL
	2	10.0	10.0	8.29- 11.5	8.68- 11.1	ACCEPTABL
TOTAL ALKALINITY	1	56.5	55.0	49.0- 60.4	50.4- 59.0	ACCEPTABL
(AS CACO3)	2	7.89	7.49	4.71- 11.6	5.57- 10.8	ACCEPTABL
CHLORIDE	1	113	113	106.- 128.	108.- 125.	ACCEPTABL
	2	51.0	52.1	47.1- 57.1	48.3- 55.9	ACCEPTABL
FLUORIDE	1	1.85	2.01	1.74- 2.23	1.80- 2.17	ACCEPTABL
	2	0.24	0.247	.155- .337	.172- .314	ACCEPTABL
SULFATE	1	76.2	74.0	60.7- 85.5	63.8- 82.4	ACCEPTABL
	2	33.0	33.0	24.5- 39.4	26.3- 37.5	ACCEPTABL

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT DATE: 11/17.

WATER POLLUTION STUDY NUMBER WP019

LABORATORY: KS017

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
NUTRIENTS IN MILLIGRAMS PER LITER:						
AMMONIA-NITROGEN	1	0.74	0.500	.538- 1.09	.605- 1.03	ACCEPTABL
	2	2.89	3.00	2.33- 3.58	2.48- 3.43	ACCEPTABL
NITRATE-NITROGEN	1	0.50	0.500	.383- .614	.411- .536	ACCEPTABL
	2	2.00	2.00	1.59- 2.39	1.63- 2.28	ACCEPTABL
ORTHOPHOSPHATE	1	0.078	0.090	.0454- .109	.0529- .100	ACCEPT
	2	0.799	0.800	.682- .934	.709- .877	ACCEPT
KJELDAHL-NITROGEN	3	0.54	0.500	.0635- 1.02	.179- .903	ACCEPTABL
	4	4.72	4.00	2.79- 5.16	3.07- 4.97	ACCEPTABL
TOTAL PHOSPHORUS	3	0.331	0.300	.226- .394	.246- .373	ACCEPT
	4	2.10	2.00	1.63- 2.63	1.73- 2.34	ACCEPTA
DEMANDS IN MILLIGRAMS PER LITER:						
COD	1	151	150	119.- 155.	124.- 152.	ACCEPTABL
	2	296	275	213.- 337.	225.- 295.	ACCEPTABL
5-DAY BOD	1	88.3	97.9	61.6- 134.	70.5- 125.	ACCEPTABL
	2	156	175	108.- 242.	125.- 225.	ACCEPTABL
PCB'S IN MICROGRAMS PER LITER:						
PCB-AROCLOR 1016/1242	1	4.89	4.57	2.01- 6.61	2.60- 6.02	ACCEPTABL
PCB-AROCLOR 1262	2	1.99	1.96	1.19- 2.25	1.32- 2.11	ACCEPTABL

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT DATE: 11/17/

WATER POLLUTION STUDY NUMBER WP019

ABORATORY: KS017

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
PESTICIDES IN MICROGRAMS PER LITER:						
LDRIN	1	0.826	0.351	.225- 1.16	.344- 1.04	ACCEPTABL
	2	0.362	0.334	.0833- .460	.131- .412	ACCEPTABL
IELDRIN	1	0.898	0.829	.453- 1.12	.539- 1.03	ACCEPTABL
	2	0.310	0.290	.134- .405	.166- .370	ACCEPTABL
DD	1	0.404	0.390	.135- .565	.189- .511	ACCEPTABL
	2	1.031	0.975	.419- 1.31	.533- 1.20	ACCEPTABL
DE	1	0.764	0.676	.285- .920	.365- .840	ACCEPTABL
	2	0.192	0.169	.0926- .255	.113- .234	ACCEPTABL
	1	0.327	0.297	.0879- .477	.137- .428	ACCEPTABL
	2	0.755	0.742	.330- 1.07	.424- .973	ACCEPTABL
HEPTACHLOR	1	0.576	0.540	.203- .745	.272- .676	ACCEPTABL
	2	0.169	0.166	.0595- .239	.0824- .215	ACCEPTABL
HEPTACHLOR EPOXIDE	1	0.106	0.105	.0550- .144	.0664- .132	ACCEPTABL
	2	0.477	0.456	.262- .693	.305- .560	ACCEPTABL
HLORDANE	3	7.97	7.73	3.56- 9.39	4.31- 8.45	ACCEPTABL
	4	0.712	0.620	.240- .919	.327- .833	ACCEPTABL
VOLATILE HALOCARBONS IN MICROGRAMS PER LITER:						
,2 DICHLOROETHANE	1	58.9	54.8	37.3- 72.9	41.9- 68.3	ACCEPTABL
	2	2.67	3.65	.594- 7.74	1.60- 6.93	ACCEPTABL
HLOROFORM	1	92.9	92.9	52.8- 129.	62.6- 120.	ACCEPTABL
	2	12.5	14.7	8.21- 21.7	9.93- 20.0	ACCEPTABL
1,1,1 TRICHLOROETHANE	1	35.5	32.6	18.4- 52.7	22.9- 43.3	ACCEPTABL
	2	8.78	9.38	4.84- 15.5	6.20- 14.1	ACCEPTABL

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT DATE: 11/17/

WATER POLLUTION STUDY NUMBER WPG19

LABORATORY: KS017

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
VOLATILE HALOCARBONS IN MICROGRAMS PER LITER:						
TRICHLOROETHENE	1	46.4	48.2	30.3- 67.4	35.0- 62.8	ACCEPTABL
	2	2.31	2.41	1.02- 3.74	1.37- 3.39	ACCEPTABL
CARBONTETRACHLORIDE	1	30.7	27.2	16.7- 39.7	19.5- 35.9	ACCEPTABL
	2	7.32	6.81	3.31- 11.0	4.29- 9.99	ACCEPTABL
TETRACHLOROETHENE	1	27.4	23.9	15.7- 42.0	19.0- 38.0	ACCEPT
	2	5.06	5.34	1.65- 9.04	2.59- 8.11	ACCEPTABL
BROMODICHLOROMETHANE	1	34.1	32.2	24.5- 45.4	27.1- 42.7	ACCEPTABL
	2	7.24	7.24	4.11- 11.5	5.05- 10.5	ACCEPTABL
DIBROMOCHLOROMETHANE	1	70.2	67.7	37.7- 108.	46.6- 98.7	ACCEPT
	2	3.70	2.26	.643- 4.15	1.09- 3.70	ACCEPTA
BROMOFORM	1	30.5	32.9	21.9- 49.9	25.2- 45.3	ACCEPTABL
	2	4.64	4.93	2.23- 7.22	2.87- 6.58	ACCEPTABL
METHYLENE CHLORIDE	1	47.2	42.6	25.8- 67.3	31.1- 62.0	ACCEPTABL
	2	1.68	2.13	D.L.- 5.51	.003- 6.79	ACCEPTABL
CHLOROBENZENE	1	30.4	30.9	19.7- 43.9	21.9- 40.9	ACCEPTABL
	2	3.82	3.85	1.68- 6.07	2.07- 5.43	ACCE
VOLATILE AROMATICS IN MICROGRAMS PER LITER:						
BENZENE	1	9.35	9.69	6.29- 14.0	7.29- 13.0	ACCEPTABL
	2	42.7	42.9	29.4- 57.7	33.0- 54.0	ACCEPTABL
ETHYLBENZENE	1	7.73	8.47	4.52- 11.6	5.46- 10.7	ACCEPTABL
	2	23.9	26.1	16.3- 35.5	18.8- 33.1	ACCEPTABL
TOLUENE	1	5.56	5.95	3.24- 8.90	3.97- 8.07	ACCEPTAB
	2	28.0	29.7	20.8- 39.4	23.2- 37.0	ACCEPTAB

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY

D.L. STANDS FOR DETECTION LIMIT

12.0 PERFORMANCE AND SYSTEM AUDITS

12.1 Performance Audits

Laboratory QC audits are to be carried out by the Laboratory Quality Assurance staff semi-annually for each method. Blind audit samples will be utilized. Results of blind audit sample analyses will be reviewed by the Quality Assurance Officer and will be reported as part of the Quality Assurance Reports to Management.

In addition to blind audit samples, the laboratory will be involved in performance audits conducted semi-annually by the EPA in which EPA perfqrmance evaluation samples will be analyzed. Additional performance audits are conducted as part of the New York State Laboratory Approval Program.

12.2 System Audits

The Quality Assurance Officer will conduct a systems audit of field quality control procedures and of laboratory quality control procedures shortly after these systems are operational for a project at the client's request.

12.3 On Site Inspections

GTEL is open to inspection by state agencies in order to document compliance with the various certification programs in which the Laboratory participates. GTEL is also open to system audits carried out by the Florida DER and other regulatory agencies.

TABLE 11-2

SURROGATE SPIKE RECOVERY LIMITS (1)

FRACTION	SURROGATE COMPOUND	WATER	LOW/MEDIUM SOIL
VOA	Toluene-d[8]	88-110	81-117
VOA	4-Bromofluorobenze	86-115	74-121
VOA	1,2-Dichloroethane-d[4]	76-114	70-121
BN	Nitrobenze-d[5]	35-114	23-120
BN	2-Fluorobiphenyl	43-116	30-115
BN	p-Terphenyl-d[14]	33-141	18-137
ACID	Phenol-d[5]	10-94	24-113
ACID	2-Fluorophenol	21-100	25-121
ACID	2,4,6-Tribromophenol	10-123	19-122
PCB	Dibutylchlorendate	48-136	20-150

PCB Surrogate Recoveries are for advisory purposes only and should not be used to determine if the sample should be reanalyzed. Once 20 samples of a given matrix are evaluated, statistical control should be developed as described in Section 14. The surrogate limits for other parameters should also be updated when 50 samples of a given matrix have been evaluated, or sooner as needed.

TABLE 11-1

SPIKE RECOVERIES

FRACTION	MATRIX SPIKE COMPOUND	WATER	LOW/MEDIUM SOIL
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	38-107
BN	Acenapthene	46-118	31-137
BN	2,4-Dinitrotoluene	24-96	28- 89
BN	Pyrene	26-127	35-142
BN	N-nitroso-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
METALS	all pre-digest spikes	75-125	75-125
METALS	matrix spikes	85-115	85-115
OTHER	all inorganic spikes	75-125	75-125

I) ICP Interference Check Samples (ICS) - an interference check sample containing high levels of iron, aluminum, calcium and magnesium must be run with every batch of soil samples analyzed by ICP.

E) Quality Control Standards - Quality control standards (often referred to as spiked reference materials or SPRM's) traceable to the U.S. EPA or generated from concentrates prepared separately from calibration standards, will be included at a rate dependent on sample matrix and lab performance with matrix spikes. The minimum is one QC standard to validate the initial calibration. For metals analysis after every twenty (20) samples, a QC or mid-range calibration standard will be analyzed to continuously verify that the calibration is within 10% of the initial calibration. For organic analyses after every 12 hours of operation, a QC or mid-range standard will be analyzed to verify that the Calibration Check Compounds are within 25% of the initial calibration curve for volatiles analysis (30% for semi-volatiles analysis). Additionally, for organics the system response for System Performance Check Compounds must be verified to be above the minimum levels as described in the method SOP.

EPA or NBS traceable standards will be run at least quarterly. The acceptability limits will be 90 - 110% for metals, except mercury for which the limits are 80-120%. For other inorganic or organic analyses, the limits will be 80-120% or as specified by the US EPA.

F) GC/MS Tune - Once every 24 hours the GC/MS tune must be verified as per the EPA Method. This tune is followed by the calibration verification, a method blank, and the internal standard response and retention time check below before resuming sample analysis.

G) GC/MS Internal Standard Response and Retention Times - immediately after calibration verification the internal standard response must be verified to be within 50% to 200% of the response for the previous verification, and the internal standard retention times must be within 30 seconds of the previous verification run.

H) Metals Laboratory Control Sample (LCS) - A QC sample taken through the entire prep must be run in each batch and achieve recovery of 80-120% for all metal analyses of soils, TCLP, leachatesand RCRA waters. The mercury analysis calibration verification QC sample is equivalent to the LCS and hence a separate LCS is not required.

11.1.2 Duplicates

Blind field duplicates (as opposed to duplicate containers full of sample intended as backup) are sequential or collocated grab samples to monitor field precision (actually entire measurement system precision as described in Section 5). One duplicate will be taken and submitted per twenty (20) samples, or one (1) per area matrix type, as described in Section 5, whichever is greater.

11.2 Laboratory Quality Control

The internal quality control checks to be routinely implemented by the lab include the following:

A) Replicates - A minimum of 10% of all samples will be duplicated in the lab. The GC/MS analysis this is carried out with a sample duplicate (MSD) at a rate of 5% of all samples.

B) Spikes - Spiked samples will be prepared in the lab and will be analyzed with the samples at a rate of 10%. For the GC/MS analysis spiked samples, (MS) are performed at a rate of 5% as specified in the method. GC/MS matrix spikes recovery limits are listed in Table 11-1.

C) Surrogate spikes - surrogate compound spikes are plac into all samples for organic analysis prior sample pre The control limits for GC/MS analysis are outlined in Table 11-2.

D) Blanks - Blanks will be analyzed at a minimum of one daily. These blanks are referred to as method blanks.

The acceptability limits for method blanks is to be below the contract required quantification limits or less than 1/10 of the lowest sample in the batch. Up to five times the method detection limit will be allowed for methylene chloride, toluene, acetone, 2-butanone, and phthalates if such level is above the contract required quantification limit.

If the Field Blank shows evidence of contamination above the detection limit for any species for any parameter class analyzed then the Trip Blanks for that parameter class must be analyzed.

3) All Trip Blanks must be analyzed for any parameter classes and all species within those classes for which-specified Field Blank analyses were found to be contaminated above detection limit.

5. Blanks for Soil Samples

To effectively address quality control during the collection of soil samples, Blank Samples, in water matrix, must be composed and analyzed. Trip (travel) Blanks for soil and water samples may be counted together at the minimum rate of 5% per parameter group. For example, for 25 groundwater and 15 soil samples (a total of 40 samples for one parameter group) 2 Trip blanks must be submitted for analyses. However, Equipment Blanks must be collected specificially for soil samples (as described earlier) to address contamination due to improper equipment cleaning while retrieving soil samples. Thus in the above example, one Equipment Blank must be submitted for 15 soil samples collected in addition to 2 Equipment Blanks for 25 groundwater samples. Field Blanks need not be composed for soil samples.

6. Matrix or Site Control Blanks

For each significant geological or geographical feature identifiable amount sampling sites a representative uncontaminated sample, such as an upstream surface water sample or an upgradient soil sample from a similar strata, will be sought. This sample will provide perspective to the site conditions found and demonstrate the ability to the entire measurement system to generate a clean sample given the techniques and ambient conditions. The sample is taken as a collocated duplicate because it is often depended upon to provide perspective to site conditions and to site remediation goals.

Travel Blanks are prepared by adding analyte-free water to the appropriate sample container. Preservatives or additives are added if required for that parameter group. Travel Blanks are then sealed and stored in the ice chest where real samples will be stored and transported. Travel Blanks are to originate at the facility providing the analyte-free water for the Equipment and Field Blanks.

4. Hierarchial Analyses of Blanks

The following hierarchy must be adhered to in order to effectively address quality control in the field. In order to minimize financial expenses and alleviate time involved with the analyses of the blank samples.

All Blanks collected in the field will be analyzed in the following order meeting the prescribed conditions:

1) All Equipment Blanks collected will be analyzed for all parameter classes specific to the project. This includes all individual compounds, species or elements specified for the sampling project.

   If the equipment blank for any given parameter class shows no contamination for the species of interest (below established detection limit), no Field or Trip Blanks need be analyzed.

   If no Equipment Blank has been prepared (no field cleaning), proceed to step 2 below.

2) All Field Blanks must be analyzed for any parameter class and for all designated species within that class for which the Equipment Blank shows contamination above the established detection limit. For that case where no Equipment Blank was prepared, all Field blanks must be analyzed for all parameter classes and all compounds, species or elements specified for the project.

   If the Field Blank shows no contamination above the detection limit for any species or any analyzed parameter class, then no Trip Blanks need be analyzed.

1. Equipment (Rinseate) Blank

The Equipment (Rinseate) Blank is designed to address cross contamination in the field between sample sources due to deficient field cleaning procedures. This Blank also addresses field preservation procedures, environmental site interference, integrity of the blank water for field cleaning and those concerns singularly addressed by the travel blank.

An Equipment Blank will be prepared for each parameter group sampled where a particular piece of sampling equipment was employed for sample collection and subsequently decontaminated in the field or use in additional sampling. The equipment blank will be composed for the parameter group, an analyte-free water rinse from the equipment (bailer, pump tubing, spoon, auger, corer, etc.) after execution of the last step of the proper field decontamination protocol. Preservatives or additives must be added to the equipment blank where appropriate for the parameter group.

2. Field Blank

Field Blanks are used to evaluate the sample container filling procedure, the effects of environmental contaminants at the site, purity of preservatives of additives and those concerns uniquely addressed by the travel blank.

Field Blanks are prepared on-site, by filling sample containers (appropriate for the parameter group) using analyte-free water. Preservatives or additives are added if necessary, and the Blank sample container is then sealed. The Field Blanks is then grouped transported and stored with the real samples collected for the same parameter group.

3. Travel (Trip) Blanks

The Travel Blank is designed to address interferences derived from improper sample container cleaning preparation, contaminated source blank water, sample cross contamination during storage/transport, and extraneous environmental conditions affecting the sampling event to and from the site, including delivery to the analyzing laboratory.

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 Field Quality Control Checks

The field quality control checks monitor the data quality as it is affected by field procedures and conditions to the degree feasible as discussed in Section 5. The degree of effort (number of check samples per total samples taken) is stated in this section for each category. The acceptability criteria were outlined in Section 5.6. All field quality control samples are submitted blind to the laboratory.

11.1.1. Blanks

Blank samples are introduced into the total measurement system as a means of control and evaluation of the level of contamination and variability of results as contributed by potential artifacts and interferences arising at any point in the measurement process. For the field sample collection activity, the various types of blank samples, Equipment, Field and Travel blanks as defined below, are designed to measure 1) the integrity of sample container and sample equipment cleaning, 2) the actual sample collection process, 3) purity of sample preservative or additive reagent, 4) the influence of site environmental conditions (contamination), 5) cross contamination of samples and 6) indeterminate artifacts introduced during the transport of samples, sample and shipping containers sample preservatives, cleaning agents and sampling equipment. Equipment, Field and Travel blanks are required at a minimum rate of 5% per parameter group per site per day. These blanks must be composed of analyte-free (blank/source) water. All blanks should be composed of the sample source of analyte-free water.

A <u>parameter class</u> is here defined as group of analytes for which sample container type, sample container preparative cleaning and sample preservation technique are identical. For example, EPA Methods 601 & 602 Purgeable compounds (typically analyzed for Leaking Underground Storage Tank site) is considered one parameter group provided 602 compounds are not preserved. Note that sufficient blank samples must be available for all analyses by <u>all</u> analytical methods specified for the site. In case of analyses for purgeable compounds, air headspace has been introduced the blank sample cannot be used for further determinations. This may require the collection of additional purgeables blank samples for any remaining purgeables analyses.

All final customer report folders will be filed in a secure area in the laboratory documentation office. Quality control sample reports are maintained in a separate file. All data, chromatograms, calculations, and reports will be stored for a minimum of five years.

Reference

Dixon, W.J., Processing Data for Outliers, Biometrics, Vol. 9, No.1, March 1953, pp. 74-89. (see Appendix E)^R

(b) site ID number,

(c) sample ID number,

(d) date sampled,

(e) date analyzed.

(f) parameters measured,

(g) units in which each parameter is reported,

(h) analytical methods used,

(i) detection limits,

(j) certification statement by the person responsible for validation of the data concerning sample integrity and QA acceptance, and

(k) date of extraction, if applicable.

Analytical data will be generated from direct-reading instruments, reporting integrators or data mangement computer software. The automated outputs will include indentifications of compounds, concentrations, and retention times. Outputs will be in graphic form (chromatograms), spectra, recorder charts, and in printed tabular form. The outputs will be in a standard format specified for each analysis and monitored for consistency. For direct reading instruments without hardcopy output, the analyst will be required to record all results into a bound lab notebook.

Other auxiliary data produced for internal records, which will not normally be reported to customers as part of the analytical data, will include the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standard records, maintenance records, calibration records, and associated quality control records. These sources will be available, however, for inspection during audits to determine the validity of data.

obtained, then sampling error will be dismissed as a possible cause of the outlier.

(d) Analyst(s) - The analyst(s) will be asked to examine his notes and calculations and, if possible, to rerun the sample for the specific parameter in question. The sample will be rerun even if the holding time has been exceeded, but the rerun value will be used for purposes of comparison only.

10.3.2 Treatment of Outliers

Rejection of any suspect data or outliers will only be done by the Project Manager. The data will be rejected as an unacceptable outlier by the Project Manager if:

(a) A problem with equipment or an incorrect procedure during the sampling stage is identified.

(b) The rerun by the analyst generates a value that significantly differs from the value being examined.

10.4 Data Flow

An overall view of data flow from the point of raw data collection through storage of validated data is shown in Figure 10.1.

10.5 Reporting and Report Storage

A typical standard data report form is included in Appendix B. Standard lab reports will contain as a minimum, the following information:

(a) laboratory ID number,

10.3.1 Identification of Outliers

Procedures for the identification of outliers will be followed at both the analytical stage and at the ensuing data reduction stage.

Outliers in laboratory data can arise from errors in analysis or from site-specific conditions that are out of control of the laboratory. Errors in the laboratory are most often detected in the data review and validation process. In the event that quality control processes, which directly affect only 20 percent of the samples, detect an outlier, the statistical approach of Dixon, 1953 (see Appendix E), will be used to eliminate outliers.

It is necessary to eliminate outliers from QC data because of the skewing effect which can destroy the effectiveness of the QC data.

Outliers will be identified at the data reduction stage by the Project Manager, Project Hydrogeologist, or Project Geologist. When any particular value is suspected to be an outlier, the following steps will be taken:

(a) Other data from the same sample will be checked to see if they are also anomalous.

(b) The Project Manager will interrogate any individuals involved in generating the anomalous value. This will include questioning the field crew and the analyst(s).

(c) Field crew - If samplers demonstrate standard competency in the sampling procedure used at the time the sample with the anomalous value was

10.3 Identification and Treatment of Outliers

Outliers are unusually large or unusually small values in a population of observations. Outliers may be the result of a variety of circumstances, including any of the following:

(a) errors in recording of data,
(b) calculation errors,
(c) analytical errors,
(d) inaccurate reading of meters,
(e) faulty or defective instruments,
(f) actual values due to comparatively unique conditions,
(g) sample identification incorrectly transcribed in the field or lab,
(h) sampling artifact, or
(i) sample integrity problem.

Assurance. The laboratory section manager will be responsible for the final review of all data and for the proofing of reports prior to submittal of the reports to the client.

Final client reports will be typed from the in-process report forms approved by the supervisor after the review of all supporting data. The in-process forms along with all hardcopy data output and other case records will be stored together in a single secure location indexed by project number for at least five years.

10.2 Field and Laboratory Validation

10.2.1 Field Validation

The field Quality Assurance Officer should proof ten percent of the entries in the bound field notebook for completeness and correctness.

10.2.2 Laboratory Validation

A complete record of each sample's history will be available for documenting its progress from the time of sample collection to arrival at the laboratory and through the laboratory from sample receipt to reporting. Data validation will include the use of dated entries, signed by analysts and supervisors, on worksheets and log books used for all samples, the use of sample tracking and numbering systems to logically follow the progress of samples through the laboratory, and the use of quality control criteria to reject or accept specific data (see Section 11).

10.2.3 Project Data Validation

Upon receipt of the hardcopy analytical results, the Project Manager will review the data. In particular, the results of the field duplicates and blanks will be evaluated at this time along with comparisons using previous and field screening data.

volume recorded in the analysis logbook. The resulting run factor and how it is derived will be transcribed onto the in-process data form to assist in the validation process.

For spectrophotometric and atomic absorption analyses the raw data output will be in absorbance units or proportional units, such as peak height. This output will be recorded in hardcopy with sample ID, date, dilutions, and should be signed and dated. Subsequent data reduction will involve the use of a fully-documented calibration curve, as indicated in the specific method SOP.

For soil analyses, the separate determination of the dry weight of the soil sample will be necessary. The worksheet for this process is in Appendix H.

For analysis projects for which a QA deliverables package (includes a blank summary) is being prepared , the data will not be blank-corrected and will be flagged if blanks do not meet acceptability criteria. Additionally, any result that is less than ten times the value of the blank will be considered suspect. Routine analyses will be blank corrected.

Chemists and technicians will be responsible for the measurement/analysis of any specific parameter, and for any calculations associated with the determination of parameter concentrations. All calculations shall be listed in the referenced method SOP. The chemists and their supervisors will be responsible for reviewing all results and applying calculation checks on a minimum of 10 percent of the results on each report. These individuals will be responsible for determining whether or not the results are acceptable, though the ultimate authority to determine acceptability will be with the Director of Quality

TABLE 10.1

DATA REPORTING CONVENTIONS

NAME ANALYSIS	UNITS	DECIMAL ACCURACY
Volatile Organics by GC/MS		
Soil (low level technique)	ug/l	1.0
Soil (med/high technique)	mg/kg(dry)	0.1
Water	ug/l	1.0
Semi-Volatile Organics by GC/MS		
Soil	ug/kg (dry)	1.0
Water	ug/l	1.0
Pesticides/PCBs by GC		
Soil	ug/kg (dry)	1.0
Water	ug/l	0.1
Metals - in water		
by ICP	mg/l	0.01
Furnace AA	ug/l	0.1
Metals - in soil		
by ICP	mg/kg (dry)	10
Furnace AA	mg/kg (dry)	0.01
Temperature	oC	0.1
pH	pH Units	0.1
Specific Conductance	umhos/cm	0.1

10.1.2 Laboratory Data Collection and Reduction

The data reduction scheme used in the lab for each of the measurement parameters, including the formulas used for calculating concentrations for both water and soils, will be that stated in the standard operating procedure for the analytical method used. The "method reference" column of Table 5.1 lists the analytical methods for each measurement parameter. All analyses will utilize a bound notebook into which will be recorded the following items, at a minimum:

(a) analyst,
(b) date,
(c) sample number (lab #), and
(d) analysis set-up conditions, e.g., dilutions, autosampler position number, or other instrument specifics not covered by an SOP.

For instrumental analysis, this analysis notebook will be instrument-specific and referred to as an instrument log. For other types of analyses, this analysis logbook will also contain all raw data collected by the analyst.

The volatile organics analysis involves electronic data handling, resulting in values bearing the conventional units (Table 10-1), already corrected for dilutions. The analyst will need to round the answers appropriately and sometimes sum columns of data. The in-process data report forms onto which data are to be transcribed are shown in Appendix H. For extractable organics, sample volume, and amount of injection enter into the calculation. In this case the electronic data handling system will report in-solution concentration, and the analyst will apply the corresponding correction using the sample volume recorded on the extractions lab bench sheet (Appendix H), and the injection

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data validation practices will be followed to insure that new data is not altered and that an audit trail is developed for data that will be reduced. Data validation practices occur in the field and laboratory.

10.1 Data Reduction

10.1.1 Field Data Collection and Reduction

Field personnel will log all field measurements, observations, and field instrument calibrations in bound, waterproof field notebooks. Notebook entries will be dated, legible, and contain accurate and inclusive documentation of an individual's project activities. Because the logbook will be used to write reports, it will contain only facts and observations. Language will be objective, factual, and free of personal feelings or other terminology that may prove inappropriate. Each individual making an entry into the field notebook will date and sign their entry.

Calculations for the reduction of field data are as follows:

1. Temperature - no calculations are required
2. Conductivity - no calculations are required if sample temperature is 25 C. The correction factor is 2% of the conductivity for every degree Celsius from 25 degrees C.

Examples: If sample temp = 27 degrees C and measured conductance reading = 100 micromhos, then corrected conductivity = 104 micromhos.

If sample temp = 23 degrees C and measured conductance reading = 100 micromhos, then corrected conductivity = 96 micromhos.

3. pH - no calculations are required as the instrument used compensates for temperature

Column A:

DB-5 (bonded phase phenyl/methyl silicon), 1 um thickness on 0.53 mm id x 30 m fused silica capillary, 8 cc/min. helium carrier (J & W Scientific, Rancho Cordova, CA 95670).

Column B:

DB-wax (bonded phase carbowax) 1 um thickness on 0.53 mm id x 30 m fused silcia capillary, 8 cc/min helium carrier (J & W Scientific, Rancho Cordova, CA 95670).

Temperature Program

40 deg C for 8 minutes, 7 deg/min to 60 deg C, hold 4 minutes, 10 deg/min to 150 deg C, hold 5 minutes. Columns are baked out at 200 deg for 20 minutes at least once per day.

Because of the sophistication of this particular chromatographic approach the GTEL modified Method 602 reports benzene, toluene, ethylbenzene, total xylenes, and if requested aliphatic hydrocarbons and miscellaneous aromatics. The flame ionization detector and the chromatographic fractionation of aliphatic gasoline hydrocarbons away from other compound types on the polar column combine to form a reliable method for quantitating this group. Hexane is used as the calibration standard. The mulitiude of volatile aromatics common in gasoline contaminated water (alkyl benzenes eluting after o-xylene) is summed up from the photoionization response using o-xylene as a calibration standard to generate the value for the group called miscellaneous aromatics.

The FID second column confirmation can be used by analysts to assure the compound quantitiations and identities are correct on the primary column. Additionally, methyl tert-butlyl ether can be evaluated on the photoionization channel, however, GC/MS confirmation must be used to positively identify this compound. It coelutes with commonly occuring aliphatics.

of detectors and columns have been used to enhance the qualitative confirmation power of the methodology. Certain modifications such as these are allowed as long as method performance can be shown to meet the standards of the original. These performance data are availbable from GTEL upon request. Appendix A contains the letter of approval from EPA Region 1.

The following method description documents the particular modifications of Method 602 utilized by GTEL. The purge and trap carrier flow leads to a tee in the chromotograph oven to which is connected a pair of fused silica columns providing simultaneous dual column separations. A photoionization detector is used with a moderately polar column (column A) for the primary quantitation. The chromatography of this column is similar to the packed column recommedation for the primary separation in Method 602. It does not suffer from the coelution of chlorobenzene with m-xylene, but does not separate m, and p-xylene.

The confirmation column (column B) leads to a flame ionization detector. This is a very polar column which partitions C4 to C10 aliphatic hydrocarbons, common interferences with aromatics when flame ionization is used for detection of gasoline hydrocarbons, away from the aromatics of interest. This column also provides separation of all three xylenes.

9.0 ANALYTICAL PROCEDURES

9.1 LABORATORY ANALYSES

The methods indicated in Tables 3.1 and 5.1 are derived from the following referenced manuals:

A. Organics in water EPA 601, 602, 608, 610, 624 and 625, "Methods for Organic chemical Analysis of Municipal and Industrial Wastewater", EPA 600/4-82-057, July 1982.

B. Metals in water, inorganic parameters, oil and grease, and petroleum hydrocarbons "Methods for Chemical Analysis of Water and Waste", EPA 600/4-79-020, March 1979.

C. Metals in soils and mobility extracts; organics in soil and hazardous material characterization,, "Methods for Evaluating Solid Waste", EPA SW-846, 3rd edition, November 1986.

The method descriptions are included here by reference to above manuals. The exception is EPA 602. The enormous number of organic compounds found in contaminated groundwater particularly with the presence of petroleum products, greatly increases the probability of misidentifications and baseline disruptions with the GC methods. Hence GTEL has made use of widebore capillary columns (WCOT) with unique liquid phases to improve separations of analytes away from interferences. Additionally, combinations

8.8.2 Field pH

The pH meters will be calibrated according to the manufacturer's instructions with two standard buffer solutions (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 manufactorer's bottle label. The temperature (measured as below) at which the sample pH was measured wil then be used to compensate for temperature on the meter.

8.8.3 Field Temperature

Temperature measurement will be performed using field thermometers (Thomas Science No. 9329A10) calibrated at 10 degrees and 45 degrees C to an NBS specification thermometer (Fisher No. 15-043A). This correction factor will be clearly marked on each thermometer, and the corrected data recorded as the raw reasurement in degrees C. This level of accuracy is sufficient for the temperature measurements required.

8.8.4 Field Specific Conductance

Specific conductance meter calibration will be checked using a 0.01N KCl solution (1413.0 umho measured conductance) prepared fresh. A temperature compensated reading may be obtained by taking a conductivity reading using this solution applied in the following formula:

Km = 1413umhos (+/-2% for each degree C away from 25)

where Km = measured conductance.

To obtain a value for specific conductance in the field, the cell constant determined in the laboratory should be applied using the following formula:

$$Ks = \frac{C \times Km}{1 + .02(T-25 \text{ degrees C})}$$

where Ks = specific conductance,
C = cell constant,
Km = measured conductivity,
T = temperature of the solution.

The cell constant must be determined for the field instrument once annually.

8.7.1 Thermometers

Thermometers shall be calibrated against an NBS certified thermometer once per year.

8.8 Field Calibration Procedures

8.8.1 General Procedures

In addition to the laboratory analysis conducted during the course of this investigation, field measurements will be taken during groundwater, surface water, and soil sampling. The pH, specific conductance, and temperature will be measured in water samples.

Field calibration procedures will, at a minimum, include the following:

1. All instruments will be calibrated as specified and documented as follows:

a. Each insturment/meter shall have a dedicated log book to record all calibrations, maintenance/repair work, and usage, in a standard format including the information below.

b. Entries to the insturment log books shall be made at least daily whenever the insturment is in use.

c. Calibration records shall include:
-calibrator's name
-standard(s) used
-date/time of calibration
-corrective actions taken
-instrument name/model
-temperature/barometric pressure/humidity conditions (if known)
-results of calibration (raw data and summary)

d. All standards used shall be checked monthly to determine stability and operating condition, and a record log kept of these inspections.

e. All personnel performing instrument calibrations shall be trained in its operation and calibrating procedures.

8.5.9 Conductivity Meter

Conductivity meters equipped with conductivity cells having platinum electrodes shall be checked annually over the range of interest using at least five concentrations of a standard potassium chloride solution. Conductivity meter is to be checked daily with 0.01M KCl.

8.5.10 Specific Ion Meter

The Specific Ion Meter is calibrated with two calibration standards over a narrow range of concentrations spanning sample concentrations. The slope of the response should be compared to the range of expected values published by the manufacturer of the particular probe in use as a factor in acceptance of the calibration. The acceptance limits for the calibration verification QC is +\- 20%.

8.6 Continuing Calibration Verification

The frequency of Continuing Calibration Verification is summarized in Table 8.1. The acceptance limits for verification are the same as for the Initial Calibration Verification specified in the calibration procedures for each category above.

For the organic methods, when the matrix spikes are in control, continuing calibration verification is reduced to a minimum of one per day. The sum of the number of matrix spikes generating acceptable data and the number of calibration verification QC's will amount to a frequency exceeding those in Table 8.1.

8.7 Periodic Calibration

The frequency of calibration for general use equipment is summarized in Table 8.1. The specific requirements of each type are summarized below.

8.7.1 Balances

Analytical balances shall be calibrated with two Class S certified weights once per month.

8.5.3 GC/ECD (PCB/Pesticides)

The gas chromatograph (GC) with electron capture detector (ECD) will be calibrated with three calibration standards and a blank. On a daily basis, calibration verification will be carried out with a single QC sample and blank with acceptance limits of 85% to 115%.

8.5.4 HPLC (Polynuclear Aromatics)

The HPLC will be calibrated with three calibration standards and a blank. On a daily basis, calibration verification will be carried out with a single QC sample and blank with acceptance criteria of 80%-120%.

8.5.5 Atomic Absorption/Inductively Coupled Plasma (Metals)

The AA and ICP Spectrometers will be calibrated as per manufacturers specifications with a minimum of two calibration standards and one blank. Calibration verification acceptance criteria are 90%-110%, except for mercury for which it is 80%-120%.

8.5.6 Infrared (Petroleum Hydrocarbons)

A minimum of three calibration standards, made freshly daily from stock solutions of the standard reference oil, plus a freon reagent blank are used to carry out calibration. Acceptance of the curve is based on the general criteria above in Section 8.4.

8.5.7 UV-Visible Spectrophotometer (Wet Chemistry Methods)

For initial calibration, standard curves consisting at a minimum of one reagent blank and five standards shall be prepared with each analysis. Continuing calibration will be carried out daily with a single mid-range standard and blank. The absorbance or transmittance reading for each prepared standard shall be based upon the average of three replicate readings of each standard. Calibration verification has acceptance limits of 80-120%.

8.5.8 pH Meter

The pH meter will be calibrated with a pH 7 buffer and checked at pH 4 and 10 on a daily basis.

8.5.2.5 Continuing Calibration (GC/MS)

A calibration standard containing all volatile or semivolatile HSL compounds as well as all required surrogates should be performed each 24 hours during analysis. Compare the RF data from the standards each 24 hours with the average RF from the initial calibration for a specific instrument as shown below for the CCC's. A system performance check with the SPCC's must also be made each 24 hours. If the minimum response factors are not met, the system should be evaluated and corrective action should be taken before sample analysis begins.

If SPCC criteria are met, a check of consistency with initial calibration response factors is made for the Calibration Check Compounds (CCC). This is done by calculating the per cent difference of the response factors as follows:

$$\% \text{ Difference} = \frac{RF(IC) - RF(CC)}{RF\ (IC)} \times 100$$

where: RF(IC) = mean response factor for initial calibration.
RF(CC) = response factor for continuing calibration verification.

The acceptability limit of the per cent difference is 25%. If this criterion is not met for any one CCC, corrective action must be taken. If no source for the problem can be identified, a new five point initial calibration must be initiated.

8.5.2.6 Internal Standard Response And Retention Time Monitoring

The internal standard responses and retention times in the calibration check standard must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 30 sec from the last check calibration (12 hr.), the chromatographic system must be inspected for malfunctions and corrections must be made, as required. If the EICP area for any of the internal calibration standards changes by a factor of two (-50% to +100%) from the last daily calibration check, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate.

TABLE 8.6

CALIBRATION CHECK COMPOUNDS

BASE/NEUTRAL FRACTION	ACID FRACTION
acenaphthene	4-chloro-3-methylphenol
1,4-dichlorobenzene	2,4-dichlorophenol
hexachlorobutadiene	2-nitrophenol
N-Nitroso-di-n-phenylamine	phenol
di-n-octylphthalate	pentachlorophenol
fluoranthene	2,4,6-trichlorophenol
benxo(a)pyrene	

VOLATILE FRACTION

1,1-dicloroethene
chloroform
1,2-dicloropropane
toluene
ethylbenzene
vinyl chloride

TABLE 8.5

SEMIVOLATILE INTERNAL STANDARDS WITH CORRESPONDING
HSL ANALYTES ASSIGNED FOR QUANTIFICATION

PHENANTHRENE-d 10	CHRYSENE-d 12	PERYLENE-d 12
4,6-Dinitro-2-methylphenol	Benzidine	Di-n-octyl Phthalate
n-Nitrosodiphenylamine	Pyrene	Benzo (b) fluoranthene
1,2-Diphenylhydrazine	Butylbenzyl Phthalate	Benzo (k) fluoranthene
4-Bromophenyl Phenyl Ether	3,3'-Dichlorobenzidine	Benzo (a) pyrene
Hexachlorobenzene	Benzo (a)-anthracene	Indeno (1,2,3-cd) pyrene
Pentachlorophenol	bis (2-ethylhexyl) Phthalate	Dibenz (a,h) anthracene
Phenanthrene	Chrysene	Benzo (g,h,i) perylene
Anthracene	Terphenyl-d (surr) 14	
Fluoranthene		

TABLE 8.5

SEMIVOLATILE INTERNAL STANDARDS WITH CORRESPONDING
HSL ANALYTES ASSIGNED FOR QUANTIFICATION

1,4-DICHLOROBENZENE-d 4	NAPTHALENE-d 8	ACENAPTHENE-d 10
N-Nitrosodimethylamine	Nitrobenzene	Hexachlorocyclopentadine
Phenol	Isophorone	2,4,6-Trichlorophenol
Aniline	2-Nitrophenol	2,4,5-Trichlorophenol
bis (2-chloroethyl) ether	2,4-Dimethylphenol	2-Chloronapthalene
1,1-Dichlorobenzene	bis (2-chloro-ethoxy)methane	Dimethyl Phthalate
1,4-Dichlorobenzene	2,4-Dichlorophenol	Acenaphthylene
Benzyl Alcohol	1,2,4-Trichlorobenzene	3-Nitroaniline
1,2-Dichlorobenzene	Naphthalene	Acenapthene
2-Methylphenol	4-Chloroaniline	2,4-Dinitrophenol
bis (2-Chloroisopropyl) ether	Hexchlorobutadiene	4-Nitrophenol
4-Methylphenol	4-Chloro-1-methyl phenol	Dibenzofuran
N-nitroso-Di-n-propylamine	2-Methylnapthalene	2,4-Dinitrotoluene
Hexachlorothane	Nitrobenzene-d (surr) 5	2,6-Dinitrotoluene
2-Fluorophenol		Diethyl Phthalate
Phenol-d 6		4-Chlorophenyl ether
		Fluorene
		4-Nitroaniline
		2-Fluorobiphenyl (surr)
		2,4,6-Tribromo Phenol (surr)

Initial calibration of semivolatile compounds is recommended at 20, 50, 80, 120, and 160 total nanograms. Ten compounds: benzoic aicd, 2,4-dinitrophenol, 2,4,5-triclorophenl, 2-nitroamiline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, 4,6-dinitro-2-methylphenol, pentachorophenol, and benzidine use a four-point initial calibration at 50, 80, 120, and 160 total nanograms because detection at less than 50 ng per injection is difficult. Semivolatile internal standards with corresponding HSL analytes are listed in Table 8.5.

8.5.2.3 System Performance Check Compound Response

A system performance check should be performed so that minimum average response factors are met before the calibration curve is used.

For volatiles, the five System Performance Check Compounds (SPCCs) are: chloromethane, 1,1-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and chlorobenzene. The minimum acceptable average response factor (RF) for these compounds is 0.3 (0.25 for bromoform). These compounds typically have RF's of 0.4 to 0.6.

For semivolatiles, the SPCC's are: n-nitroso-di-n-propylamine, hexachlorocyclopentadience, 2,4-dinitrophenol, 4-nitrophenol, and benzidine. The minimum acceptable average RF for these compounds is 0.05. These compounds (SPCC's) typically have very low RF's ().1 to 0.2).

8.5.2.4 Initial Calibration Response Factor Variation with Concentration

Six calibration check compounds (CCC) shown in Table 8.6 are established for volatiles analysis. The relative standard deviation (RSD) of the response factors across the working range of the calibration cannot exceed 30% for an acceptable calibration. Once the calibration is accepted, the mean response factor is used for quantitations.

Likewise, thirteen Calibration Check compounds are established for semivolatile analysis(Table 8.6). The RSD for the response factors for each HSL should be less than 30%. However, the RSD MUST be less than 30% for the Calibration Check Compounds.

TABLE 8.4

VOLATILE INTERNAL STANDARDS WITH CORRESPONDING
RSL ANALYTES ASSIGNED FOR QUANTIFICATION

DICHLORODIFLUOROMETHANE	1,4-DIFLUOROBENZENE	CHLOROBENZENE-d5
Chloromethane	2-Butanone	2-Hexanone
Bromomethane	1,1,1-Trichloroethane	4-Methyl-2-Pentanone
Vinyl Chloride	Carbon Tetrachloride	Tetrachloroethene
Chloroethane	Vinyl Acetate	1,1,2,2-Tetrachloroethane
Methylene Chloride	Bromodichloromethane	Toluene
Acetone	1,2-Dichloropropane	Chlorobenzene
Carbon Disulfide	trans-1,3-Dichloropropene	Ethylbenzene
1,1-Dichloroethene	Trichloroethene	Styrene
1,1-Dichloroethane	Dibromochloromethane	Total Xylenes
trans-1,2-Dichloroethene	1,1,2-Trichloroethane	Bromofluorobenzene
Chloroform	Benzene	(surr)
1,2-Dichloroethane	cis-1,3-Dichloropropene	Toluene-d8 (surr)
1,2-Dichloroethane-d4	1-Chloroethyl Vinyl Ether	
(surr)	Bromoform	

TABLE 8.3

BFB KEY IONS AND ABUNDANCE CRITERIA

MASS	ION ABUNDANCE CRITERIA
50	15.0 TO 40.0 percent of the base peak
75	30.0 to 60.0 percent of the base peak
95	Base peak, 100 percent relative abundance
96	5.0 to 9.0 percent of the base peak
173	Less than 1.00 percent of the base peak
174	Greater than 50.0 percent of the base peak
175	5.0 to 9.0 percent of mass 174
176	Greater than 95.0 percent but less than 101.0 percent of mass 174
177	5.0 to 9.0 percent of mass 176

NOTE:
Whenever the laboratory takes corrective action which may change or affect the tuning criteria for DFTPP or BFB (e.g. ion source cleaning or repair, etc.), the unit must be verified prior to initiating sample analysis.

DFTPP and BFB criteria must be met before any samples, sample extracts, blanks, or standards are analyzed.

BFB(p-bromofluorobenzene): Each GC/MS system used for the analysis of volatile HSL compounds must be tuned to meet the abundance criteria listed in Table 8.3 for a 50 ng injection of BFB. The criteria should be demonstrated daily. Documentation of the calibration should be provided in the form of a bar graph plot and as a mass listing.

8.5.2.2 Internal Standard Calibration

The calibration for volatile and semivolatile organics by GC/MS must meet the following criteria which are unique to this category. Documentation and acceptance of the daily GC/MS mass calibration and abundance pattern (tune) must be maintained as a chronological working record in the laboratory in conjnction with the instrument notebook in a manner similar to other calibration data described in Section 8.2.

Internal standard calibration technique must be utilized as detailed below. The calibration curves are developed and accepted as indicated in Section 8.4 using a minimum of 5 standards and a blank. For GC/MS analysis, typical linear ranges are 0 to 400 ng for base neutrals, 0 to 1,000 ng for phenols, and 0 to 1,000 ng for volatiles.

USEPA criteria specify both the concentration levels for initial calibration and have also specified the specific internal standard to be used on a compound-by-compound basis for quantification. Calculate the response factor (RF) for each compound at each concentration level using the following equation:

$$RF = \frac{Ax}{Ais} \times \frac{Cis}{Cx}$$

where: Ax = area the characteristic ion for the compound to be measured.
Ais = area of the characteristic ion for the specific internal standards.
Cis = concentration of the internal standard.
Cx = concentration of the compound to be measured.

Initial calibration of volatile HSL compounds is recomended at 20, 50, 100, 150, and 200 ug/L. If a sample analyte saturates at the 200 ug/L concentration level, it must be documented. Volatile internal standards with corresponding HSL analytes are listed in Table 8.4.

TABLE 8.2

DFTPP KEY IONS AND ION ABUNDANCE CRITERIA

MASS	ION ABUNDANCE CRITERIA
51	30.0 - 60.0 percent of mass 198
68	Less than 2.0 percent of mass 69
70	Less than 2.0 percent of mass 69
127	40.0 - 60.0 percent of mass 198
197	Less than 1.0 percent of mass 198
198	Base peak, 100 percent relative abundance
199	5.0 - 9.0 percent of mass 198
275	10.0 - 30.0 percent of mass 198
365	Greater than 1.00 percent of mass 198
441	Present but less than mass 443
442	Greater than 40 percent of mass 198
443	17.0 - 23.0 percent of mass 442

a) Linearity through the origin can be justified if the RSD of the response factors does not exceed 10%.
b) One calibration standard must be near the detection limit. This is not performed when sngle calibration standard is used.
c) The exceptional blank criteria noted above apply primarily to this category.
d) The limits of acceptance for the calibration verification QC are +/- 20% (i.e. 80 - 120% Recovery).

The analysis of volatiles in solids (soil, sludge, and solid waste) involves calibration standards prepared exactly as for the water analysis. The standards are not carried through the extra sample extraction process involved with solids. The method blank includes the extraction solvent. The limits of acceptance for the calibration verification QC are +\- 15%.

8.5.2 GC/MS Calibration Procedures

The calibration of the GC/MS for volatile and semivolatile organic Hazardous Substance List (HSL) compounds in water and soil/sediment must meet the following criteria.

8.5.2.1 Tuning and GC/MS Mass Calibration

Prior to initiating Initial Calibration or Continuing Calibration data collection, it is necessary to establish that a given GC/MS meets the standard mass spectral abundance criteria. This is accomplished through the analysis o decafluorotriphenylphosphine (DFTPP) for base/neutral and acid (BNA) compounds or p-bromofluorobenzene (BFB) for volatile compounds. The ion abundance criteria for each calibration compound should be met before any samples, blanks, or standards can be analyzed.

DFTPP (decafluorotriphenylphosphine
for the analysis of semivolatile or pes
be tuned to meet the abundance criteria
for a 50 nanogram (ng) injection of DFT
separately, and the criteria must
Documentation of the calibration must be
bar graph plot and as a mass listing.

8.4.6 Initial Calibration Verification

Once the calibration curve is established as per the above criteria the blank bias and midrange accuracy must be verified.

8.4.6.1 Acceptance of the Method or Reagent Blank

Acceptance of blanks is determined by method and contract requirements and by the concentration range of samples analyzed. The method blank shall be below a contract required quantification limit, less than 1/10 of the lowest sample in the batch, or less than 1/10 a regulatory limit to which the data is to be compared. Up to five times the method detection limit will be allowed for methylene chloride, toluene, acetone, 2-butanone, and phthalates.

This assumes that the detection limit is significantly below any regulatory limit to which the data is to be compared. For benzene and EDB in water, and other analytes for which regulatory limits are extremely close to the detection limit, the blank must be less than the detection limit.

8.4.6.2 Accuracy Verification

The acceptance of the calibration for midrange accuracy is based on limits set in each method for the results of the calibration verification QC. Guidelines are included below in the calibration procedures for each category of analysis.

8.5 Laboratory Operational Calibration Procedures

8.5.1 Gas Chromatography - GC/PID/FID, GC/ELCD, GC/ECD (for EDB)

The methods covered by this document for volatile organics in water including the microextraction technique for EDB involve carrying the calibration standards through the sample prep and extraction procedure. The calibration curves are developed and accepted as indicated above using a minimum of 3 standards and a blank. Method 602 is calibrated with a minimum of one standard and one blank. The following additional criteria are unique to this category:

8.4.3 Consistency of Response

The consistency of the response with previous performance is evaluated by reviewing the chronological record of response factors required by Section 8.2.1. Some methods and/or manufacturer's calibration procedures provide an acceptable range of response factors. The mean response over time +/- two standard deviations can also be used as a guideline for performance.

8.4.4 Sensitivity

The detection limit is dependent on the signal to noise ratio. For routine analyses a minimum limit on the response factor established in calibration should be implemented such that a response for a concentration near the detection limit overcomes the background noise by at least a factor of three.

Some methods also specify minimum limits on the response factor for key analytes for which degradation of response is indicative of the need for maintenance. An example is the System Performance Check Compounds (SPCC's) specified for GC/MS below.

8.4.5 Blank Bias

The calibration curve should pass through the data point for the blank. For regression fit of a curve to the data the y-intercept should not be significantly different from the blank response. The y-axis is instrument response. If the analytical system is expected to have zero response for the blank, then the blank response, and hence the curve, should perform accordingly. If there is a significant blank bias. the analyst must be assured that the bias affects all samples as well as standards before accepting the curve.

When the linear-through-the-origin assumption is justified and utilized, any blank bias in an analytical system will become apparent in the calibration verification step. Initial Calibration Verification must always include the analysis of a reagent or method blank. Acceptability of a blank is discussed in Section 8.4.6.1.

In order to describe and evaluate the response characteristics the calibration data can be plotted or described mathematically as response as a function of concentration. The key characteristics to be evaluated for the sake of acceptance of the curve are as follows:

a) the degree of variation of the response factor with concentration (i.e. curvature). The response factor is expressed in units of response per unit of concentration, b) the working range of the curve
c) the consistency of the response factor with past experience,
d) the sensitivity as it relates to detection limit and system performance,
e) the blank bias,
f) the Initial Calibration Verification.

The following subheadings address each of the above.

8.4.1 Response Factor Variation with Concentration

Linearity of response can be assumed if the variation of the response factor over the range of interest is not significant. A minimum of three calibration points are necessary to verify linearity. The special case of linearity through the origin justifies the convenient use of a single response factor across the entire working range of the calibration. Some methods specify criteria for verifying this assumption. If linearity through the origin is not verified then the actual response curve must be utilized.

8.4.2 Working Range of the Curve

The range of concentrations chosen for calibration should be appropriate for the samples to be analyzed. Samples more concentrated than the highest standard used should be diluted to give a response within the working range of the curve. When samples are diluted, the detection limit is increased proportionally and should be so noted with the analytical results.

Caution must be taken when samples are analyzed which give a response below the lowest standard. See blank bias below.

FIGURE 8.1

NOTICE OF EQUIPMENT CALIBRATION FAILURE

EQUIPMENT NUMBER_____

EQUIPMENT NAME_____

REASON FOR FAILURE TO PASS CALIBRATION_____

_____

_____

WAS EQUIPMENT REPAIRED OR REPLACED?_____

_____

IF REPAIRED, WAS THE CORRECTIVE ACTION ADEQUATE?_____

_____

_____

_____

_____

SIGNED_____

Note: If this form is not used, enter the above information in the instrument notebook.

8.2.3 Calibration Failure

Failure to meet calibration requirements shall be documented as described above. Additionally, notification of a supervisor of the failure and corrective action is required. An example notification format is shown in Figure 8.1. This permanent record of corrective action shall be stored with the chronological calibration records or in the notebook. as described in Section 8.2.1.

8.3 Calibration Reference Materials

Calibration reference materials for organic analysis shall be a minimum of 97% purity. Reference materials used to generate quality control samples (used to verify calibration) shall be from a source independent of the calibration standards, or if not available from a reliable independent source shall be from stock standards prepared separately from calibration standards.

Calibration standards for metals are to be prepared fresh daily with dilutions of commercially available 1000 ppm stock solutions (Fisher Scientific or equivalent) . Standards from a source independent from the calibration standards shall be used for initial calibration verification.

All other analyses will follow the criteria for organics unless sample matrix or specific calibration procedures require otherwise.

8.4 Generation and Acceptance of a Standard Curve

The standard curve is generated by the analysis of a reagent or method blank and a series of standard solutions over a concentration range appropriate for the samples to be analyzed and recording the instrument response. Some methods carry the standard solutions and the blank (i.e. method blank) through the entire sample preparation process. Others use simple dilutions of standard solutions. The number of calibration standards required is specific to the method and is indicated below with the individual procedure types.

8.1 Calibration Frequency

Operational and periodic calibration frequency is outlined in Table 8.1. Calibration for organics analysis should occur whenever calibration verification acceptance limits are exceeded. or the method is deemed out of control and repairs are needed. Many other analyses depend on daily calibration. Periodic calibration frequency is set by Good Laboratory Practice and laboratory certification requirements.

8.2 Calibration Records

8.2.1 Operational Calibration

A bound notebook shall be kept for every instrument covered by this plan . Each of the following shall be assembled chronologically by instrument and stored together as a laboratory working record or entered in its entirety into the instrument notebook:

a) calibration data
b) calibration verification data
c) method blank data

The record, whether as a separate file or an entry in the notebook, must include response factor information if available from the calibration process as required in the analytical method. In all cases, for each event a notebook entry must be made containing the analyst's comments concerning the factors leading to the acceptance of a calibration curve or calibration verification. In the event of a failure to accept. the corrective action must be referenced.

As a convenience a copy of the calibration data above (a, b and c) may be placed into the data file for each sample affected by the calibration.

8.2.2 Periodic Calibration

Periodic calibration results including discussion of any adjustments made shall be maintained in a bound notebook for each piece of equipment.

TABLE 8.1
CALIBRATION FREQUENCY

INSTRUMENT DESCRIPTION (ANALYTE TYPE)	INITIAL CALIBRATION (IC)	CALIBRATION CHECK QC (CCQC)	CONTINUING CALIBRATION VERIFICATION (CCV)
GC/PID, FID, GC/ELCD, GC/ECD (VOL., EDB)	after repair, column change, or failure of ICV/CCQC	following a full calibration	10%
GC/MS (VOL.,SEMIVOL.)	after repair, column change, or failure of ICV/CCQC	NA	24 hr.
GC/ECD (PCB/TEST.)	after repair, column change, or failure of ICV/CCQC	daily	24 hr.
HPLC (PAH)	after repair, column change, or failure of ICV/CCQC	daily	5%
AA- FLAME/ FURNACE, ICP (METALS)	daily	daily	5%
INFRARED (PETROLEUM HYDROCARBONS)	daily	daily	5%
UV- VIS. SPECTROMETER (WET CHEM)	after repair, reagent preparation, failure of ICV/CCQC	daily	5%
pH METER	daily	--	--
CONDUCTIVITY METER	annually	daily	--
SPECIFIC ION METER	daily	daily	5%
BALANCE	annually	monthly	--
THERMOMETER	annually	--	--

8.0 Calibration Procedures and Frequency

This section prescribes the criteria by which GTEL provides calibration for various classes of measurement systems. Tolerances to be maintained in calibration are specific to analytical methods developed for particular regulatory purposes. Specific procedures for individual instruments and analytical methods should be documented in instrument manuals and SOP's and are not delineated in this document.

Two types of calibration are discussed, operational and periodic. Operational calibration is carried out routinely as part of instrument usage. The operational calibration program involves Initial Calibration, Calibration Check QC (often referred to as Initial Calibration Verification), and Continuing Calibration Verification. Periodic Calibration is a distinct process carried out for general purpose equipment, such as analytical balances.

Initial Calibration involves the establishment of the response characteristics of a measurement system and the verification that certain tolerances for this response, such as minimum response factors, linearity, and negligible blank bias are met. Also, a working range of the calibration curve is established by the range of concentrations of the calibration standards used and subsequent samples with responses outside of this range must be diluted to give a response within the working range.

Calibration Check QC involves establishing the accuracy of the calibration, preferably in reference to an external source such as NBS or EPA. If the verification QC sample is not traceable to these sources, it should be prepared from a stock solution independent of the calibration solutions.

Continuing Calibration Verification involves periodically checking the instrument response against established criteria to verify that the initial calibration is still valid. Continuing Calibration Verification is referred to as Continuing Calibration in GC/MS analysis.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

60 WESTVIEW STREET, LEXINGTON, MASSACHUSETTS 02173

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Section No.:	1
Revision No.:	0
Date:	10/23/97
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August 6, 1987

Michael Webb
GT Environmental Laboratories
4 Mill Street
Greenville, New Hampshire 03048

Dear Mr. Webb:

GT Environmental Laboratories request (February 12, 1987) for Limited National Pollution Discharge Elimination System (NPDES) Approval to use a wide bore capillary column in place of a packed column for Method 602 has been granted.

The Approval is limited to your clients which reside in Region One (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont). For those clients which reside outside Region One, you must request approval from the appropriate EPA Regions.

If you have any questions concerning the Approval, please call Charles Porfert at (617)-861-6700.

Sincerely,

Edward Conley, Director
Environmental Services Division

cc: W. Walsh, EPA
A. DePalma, EPA
E. Thompson, CT Dept. Health
R. French, ME Dept. Human Services
Dr. J. O'Brien, MA DEQE
C. Dyer, NH DES
Dr. R. Lundgren, RI Dept. Health
B. Clarkson, VT DEC

1967 to 1972

Bruce Smith Drug Store, Prairie Village, Kansas, as a clerk and eventually as Manager of the Camera Department with 3-4 workers under my supervision.

EDUCATION:

B.A. in Chemistry in 1978 from the University of Kansas, Lawrence, Kansas.

PERSONAL:

Born 8-30-51, height 6', weight 170 lbs. married, with 2 children. Hobbies: spelunking, canoeing, camping, hunting, and photography. Active in church.

Health: excellent

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WORK EXPERIENCE

May 1988 to Present:

GTEL Environmental Laboratories, Inc., Wichita, Kansas, as an organic GC chemist. I perform EPA, ASTM, and assorted other analyses on environmental samples. Supervisor: Terry Loucks

March 1982 to April 1988:

Vulcan Materials Co., Wichita, Kansas, as Project Chemist in the Control Laboratory. Special analyses of acids, caustics, chlorinated hydrocarbons for process plants, and environmental analyses for disposal plant. Analyses were performed on the following instruments: FID, ECD, TCD, PID, and Hall detector gas chromatographs; AA spectrophotometer with Zeeman graphite furnace; and UV/VIS and IR spectrophotometers. I worked with H.P., Varian, and Perkin-Elmer equipment. I was a volunteer worker for the company credit union as an officer of the credit committee. Supervisor: Jim Cotton.

August 1978 to March 1982:

Cook Paint and Varnish Co., No. Kansas City, Missouri, as a Research Chemist in the Polyester Research Department. Formulation and testing of polyester gel coats, laminating resins, and casting resins. Production support and customer technical service. I originated, developed, and put into production various products new to the industry, e.g. EMI reflecting gel coats, clear casting resins, cultured onyx, and surf board resins. Supervisor: Mike Weber.

1972 through 1974

National Photo Co., Kansas City, Missouri, as Assistant Plant Manager. I had 12-15 people working under my supervision. My superiors were the Plant Manager, Mr. Farrel and the owner, Bob Weaver. National Photo does photo finishing for the public. I was offered the position of Plant Manager, but opted to go to college to earn a chemistry degree.

WORK EXPERIENCE

July 1987 - Present:	Mid West Analytical Laboratories Wichita, Kansas Measure Oil and Grease, Total Suspended Solids, and Fluorides in samples. Prepare samples for PCB analysis, BNA analysis, herbicide analysis, and pesticide analysis. Collect various samples for analysis.

The following employment paid for about 20% of my college expenses:

June 1986 - Jan. 1987:	Cook for Sunset Restaurant in El Dorado, Kansas
Sept. 1985 - May 1986:	Dishwasher for Dormitory Food Service at Kansas State University in Manhattan, Kansas
May 1985 - Aug. 1985:	Farmhand for McCollum Brothers' Farm in Fall River, Kansas
Sept. 1983 - May 1984:	Laboratory Assistant for BCCC in El Dorado, Kansas Prepared labs for the chemistry classes. Managed the division of work for myself and two other assistants. Cleaned, organized, and inventoried the laboratory.
Sept. 1983 - May 1984:	Resident Assistant for BCCC Dormitory in El Dorado, Kansas

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EDUCATION

B.S. in Chemistry with a minor in Mathematics and a minor in Spanish from Wichita State University. graduated May 1987
A.A. from Butler County Community College for Pre-chemical Engineering: received May 1984 Total current GPA = 3.45

Major Course Work:

Calculus 1,2, & 3
Differential Equations
Elementary Statistics
Chemistry 1 & 2 with Labs
Organic Chemistry 1 & 2 with Labs
Analytical Chemistry with Lab
Instrumental Analysis with Lab
Inorganic and Advanced Inorganic Chemistry
Research under Jack McCormick

Related Course Work:

Technical Writing
Biochemistry with Lab
Ecology and Man
Sociology
Psychology

HONORS AND ACTIVITIES

Cross Country/Track Scholarship from BCCC: 1982-1984
Academic Scholarship from BCCC: 1982-1984
Dean's Award from Kansas State: May 1982
Kansas Scholarship: 1982-1983, 1984-1985, 1986-1987
Teeter-Zeebold Math-Science Award from BCCC: May 1984
Mitchell Scholarship: 1984-1985
President of Church Youth Group 1984, Secretary of same: 1986-1987

REFERENCES

Wilfred Pettus: Professor of Chemistry
Butler County Community College
Box 888, El Dorado, Kansas 67042
Telephone: (316) 321-5083

Amos Marsh: Professor of Physics
Butler County Community College
Box 888, El Dorado, Kansas 67042
Telephone: (316) 321-5083

Jack McCormick: Head of the Chemistry Department
Wichita State University
326 McKinley, Box 51
Wichita, Kansas 67208
Telephone: (316) 689-3120

EMPLOYMENT EXPERIENCE - continued

Teacher. Maize Unified School District #266, January 1985 to January 1986. Instructed various classes at the high school level in the math and science fields, including Pre-Algebra, Algebra I, Science Topics, Vocational Math, and Chemistry. (Supervisor: Principal, James Baker)

Anesthesia Maintenance Aide II, St. Francis Regional Medical Center, December 1980 to December 1984. Responsible for the daily care and maintenance of twenty-five anesthesia machines in the surgery department. Also responsible for the daily restocking of anesthesia medications and supplies in twenty operating rooms.

Office Aide. Kansas Newman College, September 1979 to May 1983. Responsibilities included all general office work including typing, filing, record-keeping, phone answering, and student updating. Entrusted with much confidential information, such as special scholarship recipients and student grades.

Stackhand Operator. The Alfalfa Farm, Lakin, Kansas, Three summers from 1977 to 1979.

REFERENCES

Dr. Jesse Moore
Chairman, Chemistry Department
Kansas Newman College
3100 McCormick Avenue
Wichita, KS 67213
Phone 942-4291

Mrs. Mary Therese Landreth
Chairperson, Education Department
Kansas Newman College
3100 McCormick Avenue
Wichita, KS 67213
Phone 942-4291

Mr. Neil Miller
Former Coordinator of Science Education of Wichita Schools
5745 N. Tyler Road
Wichita, KS 67205
Phone 721-3462

AWARDS AND ACHIEVEMENTS

Pizza Hut Scholarship--Awarded to one academically successful incoming high school student.

Outstanding Freshman Chemistry Student Award--Awarded to one student each year.

Dean's Honor List--GPA of 3.5 or better--Achieved nine out of nine full-time semesters.

Outstanding Academic Achievement Award--GPA of 3.85 or better-Achieved five out of five years.

Elected Senator for the Public Relations Committee of Kansas Newman's Student Government. Duties included participation in all weekly meetings and advertisement and promotion of all scholastic, cultural, and social events. Also responsible for keeping in touch with the student body and working well with others.

EMPLOYMENT EXPERIENCE

Chemist, Mid West Analytical Laboratory, February 1986 to present.

Responsible for the bulk of the physical testing, inorganic chemistry, petroleum testing, organic preparation, and non-routine one-time tests that enter the laboratory.

Routinely perform the following EPA and/or ASTM methods: Specific Conductance, pH, Residue (filterable, non-filterable, total, and volatile), Alkalinity, Chloride, Cyanide, Fluoride, Nitrogen (Ammonia, Total Kjeldahl, Nitrate), Dissolved Oxygen, Total Phosphorus, Sulfate, Sulfide, Biochemical and Chemical Oxygen Demands, Oil and Grease, Phenols, and Total Organic Halogens.

Also do preparatory work for analysis of Pesticides, Herbicides, PCB, and BNA. Have a basic familiarity with the final analysis and calculation of pesticides, herbicides, and PCB.

Also do metals digestions prior to AA analysis, and have a basic understanding of the operation of the AA.

Familiar with AOAC methods of meat analysis, including fat, moisture, ash, and protein content.

Routinely perform standard plate counts and total coliform bacteria analyses.

Familiar with ASTM and UOP methods of petroleum testing, including fuel distillation, bomb calorimetry (also bomb methods for chloride and sulfate), and physical testing.

RODNEY J. GORGES
2328 Crawford
Wichita, KS 67217
(316) 943-7042

PROFESSIONAL OBJECTIVE

Seeking a challenging entry-level position in a scientific lab with opportunity for future advancement. Am interested in working in a professional atmosphere in which my education, background, and skills can best be utilized.

EDUCATION

Kansas Newman College, Wichita, Kansas (1979 - 1984)

Bachelor of Science Chemistry
Bachelor of Science Mathematics
Bachelor of Science Education

GPA -- 3.834

Special Courses:
General Chemistry I & II
Organic Chemistry I & II
Analytical Chemistry
Physics I & II
Physical Chemistry I & II & Lab
Chemistry Seminar

Others:
Calculus I, II, & III
Advanced Calculus
Geometry
Probability and Statistics
Differential Equations
Mathematical Statistics
Abstract Algebra
Linear Algebra
BASIC Programming
FORTRAN Programming
Numerical Analysis
Microbiology
Philosophy
Ethics

Andale High School, Andale, Kansas (1976 - 1979)

FRED A. RIFFEL, JR.

PUBLICATION

Rounds, H. D. and Riffel, F. A. (1974). Life-and death-promoting factors from the subesophageal ganglion of the American Cockroach. J. Insect Physiol.

MILITARY SERVICE

None

ACTIVITIES

Interested in music, enjoy water skiing and tennis when time permits. Active in high school athletics. Elected Vice President of senior class.

REFERENCES

Will be furnished upon request.

FRED A. RIFFEL, JR.
1821 S. BLECKLEY
WICHITA, KS 67218
1-316-683-2460

EDUCATION

1970-74 Degree of Master of Sciences in Biology, June 1974
Concentrated on physiology. Expenses partially paid by the Department of Biology through a Graduate Assistantship Program. Wichita State University

1964-69 B.A. Degree in Biology, June 1969. Majored in microbiology with a minor in chemistry and anthropology. Expenses financed through full-time and part-time employment. Wichita State University

WORK EXPERIENCE

Department of Biology
Wichita State University

1978-87 Assistant Instructor of Physiology
duties include teaching Human Physiology lecture and labs, teaching Applied Physiology lecture and labs for physical therapists, teaching basic biology labs. Responsible for general budget and ordering of media and equipment for physiology courses listed above.

1973-77 Assistant Instructor of Microbiology
Duties included teaching microbiology lectures and labs. Was responsible for maintaining and testing all cultures for teaching purposes. Did all cultural freeze drying for the department. Was responsible for general budget and microbiology, departmental inventory or equipment and overseeing of microscope repair and utilization of service contracts. Did limited maintenance on various pieces of equipment.

1972-73 Lecturer
Purpose of teaching microbiology lab courses while completing M.S. Degree.

1970-72 Graduate Teaching Assistant
Taught botany and general biology lab courses.

Gibson Wholesale, Inc.

1964-70 Full-time and part-time employment
Duties included order filling, shipping and receiving, sales.

CARLA K. DUNN
7677 E. 21st Street, #905
Wichita, Kansas 67206
(316) 686-9423

CAREER OBJECTIVE: A position in chemistry utilizing laboratory and research skills and interests.

EDUCATION:

B.S. in Biochemistry, December, 1985
Wichita State University, Wichita, Kansas

Major GPA = 3.12
Overall GPA = 3.25

EMPLOYMENT:

September 1985 - December 1985
Wichita State University
Wichita, Kansas
<u>Chemistry Laboratory Teaching Assistant</u>

January 1985 - December 1985
Wichita State University
Wichita, Kansas
<u>Research Assistant for Dr. Bill Groutas in Organic Synthesis</u>

January 1986 - Present
Mid West Analytical Laboratories
902 West Second Street
Wichita, Kansas
(316) 262-4407

<u>Atomic Absorption Spectroscopy</u>
Instrumentation: Perkin-Elmer 5000 with HGA500 furnace and AS-40 autosampler. Familiar with preparation and analysis of EPA200 and EPA7000 metal series for RCRA, wastewater, and groundwater evaluation.

<u>Inorganic Analyses</u>
Familiar with EPA or Standard Methods for analysis of pH, TDS, TSS, Total Hardness, Sulfate, Biochemical Oxygen Demand, Oil and Grease, Total Cyanide, Ammonia-N, Nitrate-N, Total Phenols, and Sulfide.

HONORS AND ACTIVITIES:

Dean's Honor Roll in Fairmount College of Liberal Arts and Sciences - Spring 1983, Fall 1983, Fall 1984, Fall 1985

Charles and Nina Kirby Jones Scholarship in Biochemistry - Fall 1984, Spring 1985

REFERENCES: Available upon request.

WORK EXPERIENCE IN CHEMISTRY

My work experience in analytical chemistry, though limited to my employment at Mid West and GTEL, has included nearly the complete gamut of environmental analytical techniques.

I have had routine working experience with standard wet chemical, titrimetric, gravimetric, specific ion electrode, spectrophotometric and calorimetric analyses for inorganic and organic parameters including alkalinity, acidity, ammonia, biochemical oxygen demand, chemical oxygen demand, bromide, chloride, conductivity, cyanide, dissolved oxygen, fluoride, hardness, nitrate, oil and grease, phenols (4 AAP), phosphate, residues, silica, sulfate, sulfide, surfactants (MBAS), and total petroleum hydrocarbons (IR).

My routine working experience with instrumental techniques includes atomic absorption/emission spectroscopy, both flame and furnace (IL 951 and 955); gas chromatography using a variety of detectors including TCD (Fischer 1200), FID (HP 5730A), ECD, HECD, PID, and NPD (Tracor 540, 570, 700A, 703, 7032); gas chromatography - mass spectrometry (Finningan Incos 50); and infrared spectroscopy (Perkin Elmer 1600 FTIR and Infracord dispersive IR). I have taken manufacturers training classes for both Instrumentation Laboratories AA and Finnigan MAT GC-MS (Operators and Data System). Over the years, I've developed considerable trouble shooting and problem solving skills with the AA, GC, GC-MS, and IR instruments as well as skill in interpretation of analytical results.

My experience with EPA, APHA, NIOSH, AOAC, UOP and ASTM methodologies covers a wide range of environmental and industrial analyses in a variety of matrices (groundwater, wastewater, soil, air, oils and sludges) and products (foods, pesticides, paints, composites, alloy polymers, petroleum, fuels, and natural gas). I have work experience with many of the methods in the EPA 100, 200, 300, 400, 600, 3000, 7000, and 8000 series and considerable experience with metals, pesticides, PCBs, volatile halocarbons/ aromatics and BNA semivolatiles in particular.

In my work with industrial clients, I've frequently served as consultant to compliment our analytical services. My knowledge of chemical processes and regulatory requirements (RCRA, TSCA, NPDES, NIOSH, OSHA, etc.) has often magnified the value of our analytical data to our customers.

In my capacity as senior chemist, I've developed a laboratory standard operating procedures manual, implemented a lab QA/QC program, and obtained initial certification (through performance evaluation analyses) for our lab with state (KDH&E) and federal (EPA Region 7) agencies for most of the parameters we are currently certified to perform. My current position also involves limited supervision of four chemists, primarily in a training and problem solving role.

ROBERT K. KENNEDY
1629 W. 13th Street
Wichita, KS 67203
262-5629

ACADEMIC HISTORY:

1973 - 1974	Macalester College, St. Paul, MN
1979 - 1983	Wichita State University

COLLEGE DEGREE:

Bachelor of Arts	Wichita State University 1983
Major:	Chemistry (ACS Accredited) GPA: 3.8

ACADEMIC HONORS:

B.A. Magna Cum Laude
American Institute of Chemists
Student Research and Recognition Foundation
Award as outstanding senior chemistry major at WSU in 1983

RECENT EMPLOYMENT HISTORY:

1979 - 1983	Research Assistant to Dr. Paul Tasch
1982 - 1983	Assistant Radiation Safety Officer at WSU
1983 - 1987	Senior Chemist at Mid West Analytical Laboratories, Inc.
1987 - Present	Senior Chemist and GC/MS Section Manager at GTEL Environmental Laboratories, Inc., Midwest Region

REFERENCES:

Dr. Paul Tasch, Professor Emeritus, WSU
1346 N. Parkwood Lane, Wichita, KS

David Daniels, Territory Manager, Groundwater Technology, Inc., 902 W. Second St., Wichita, KS

Terry Loucks, Lab Director, GTEL Environmental Laboratories, Inc., 902 W. Second Street, Wichita, KS

Sampling and Analysis - Mr. Webb provides technical assistance to field engineers and geologists concerning sampling protocols and analytical method selection based on site specific conditions for hazardous site evaluations. He has participated in the design, installation, and evaluation of sampling and treatment equipment, primarily in the areas of air stripping, bioreactors, stimulation of in situ microorganisms, and subsurface vapor remediation.

Employment Chronology

Sept. 1987 - to date	GTEL Environmental Laboratories, Director of QA
Sept. 1982 - to date	GTEL Environmental Laboratories, Technical Director
1980 - 1982	Emtek, Inc., Field Chemist
1974 - 1979	Kapiolani and Maui Community Colleges, Lecturer, Chemistry and Environmental Chemistry
1973 - 1974	University of Hawaii, Honolulu, Research Assistant

Professional and Honorary Associations

American Chemical Society
American Society for Quality Control

Publications and Presentations

Webb, M., M. Duffy, E.S. Atwood, J.M. Driscoll. Determination of Aromatic Hydrocarbons in Gasoline Contaminated Water Samples Using Purge-and-trap Capillary GC with PID and FID. Paper No. 373, Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, March 1987.

Driscoll, J.M., M. Duffy, S. Pappas, M. Webb. Analysis of Purgeable Organics in Water by Capillary GC/PID-ELCD. Journal of Chromatographic Science, Vol. 25, August 1987.

GTEL ENVIRONMENTAL LABORATORIES, INC

MICHAEL D. WEBB
Director of Quality Assurance
GTEL Environmental Laboratories
Milford, New Hampshire 03055

Academic Training

B.A. Chemistry, University of California
M.S. Chemistry, University of Hawaii

Summary of Relevant Management Experience

Quality Assurance and Control - Mr. Webb is responsible for the design and monitoring of all quality control procedures for the GTEL Northeast Regional Laboratory. As a senior member of management he makes recommendations to corporate management concerning QA issues affecting sampling and consulting services as well as laboratory services. He serves as QA coordinator for projects accepted by GTEL. As Technical Director of GTEL Environmental Laboratories (GTEL) Mr. Webb has led the implementation of numerous environmental analytical techniques through the equipment aquisition, validation, and analyst training stages. Both as Technical Director and as Director of Quality Assurance, management responsibilities have included coordination of analyses of performance evaluation samples for state and federal programs.

Summary of Relevant Technical Experience

Technical Support to Regulatory Development - Mr. Webb has provided technical advice to the San Francisco Regional Water Quality District and the State of Florida Department of Environmental Regulation concerning proposed regulation of volatile aromatics and total hydrocarbons based on gas chromatographic analyses utilizing PID and FID detection.

Methodology Development and Evaluation - Mr. Webb has led the development and evaluation of a capillary column and twin detector variation of a standard EPA method for evaluation of volatile aromatics in water and waste presented to and approved by EPA Region 1 as an Alternative Procedure. As QA Director of GTEL he passes judgement on all method validations and analyst start-up accuracy and precision tests.

Manual Preparation and Revision - Mr. Webb is the primary author of the GTEL QA/QC Manual and the Groundwater Technology, Inc. QA/QC Plan for Investigation and Monitoring of Contamination of Soil and Groundwater. He additionally authors or reviews all GTEL method and procedural SOPs.

GTEL ENVIRONMENTAL LABORATORIES, INC

CAREER ACHIEVEMENTS:

1978 Directed the City of Wichita Municipal Laboratory to become the first certified municipal laboratory in the State of Kansas.

1979 Made a presentation to the American Water Works Association, Kansas Section, meeting. The presentation was on automated controls for a water treatment plant control room.

1980 Developed and implemented the Extra Strength Charge program for the City of Wichita.

1981 Made a presentation to the Kansas Section Water Pollution Control Federation meeting. This presentation was entitled "BOD The Control Parameter."

1982 Implemented and administered the Pretreatment Program for the City of Wichita. This involved establishing a sample monitor scheme for the 55 industries involved and scheduling the compliance monitoring schedule.

1981-84 Served three years on the Public Affairs Committee for the Kansas Section AWWA. This committee was selected to monitor any water legislation by the State of Kansas.

1985 Co-founder of Kansas Laboratory Education Association (KLEA). This organization is a state-wide organization that holds an annual conference to help educate and inform fellow laboratories of changes that are occurring. KLEA also sends out a newsletter once a quarter. Past President of KLEA.

Affiliations: American Chemical Society, American Water Works Association, KAWSA Water Pollution Control Federation, Kansas Laboratory Education Association.

TERRY R. LOUCKS
512 Redbarn
Wichita, KS 67212

EDUCATION: B.A. in chemistry with emphasis in Analytical Chemistry, Emporia State University
M.S. in Analytical Chemistry

1978 - Attended Perkin-Elmer's school for Atomic Absorption Spectroscopy

1979 - Attended EPA Region #7 course on Evaluation of Priority Pollutants by GC/MS

1980 - Attended AWWA Course: "Safety of Hazardous Materials"

1983 - Technicon Course - Advanced training in auto-analyzers analysis and maintenance of equipment.

1987 - NIOSH Course 582 - Sampling and Evaluating Airborne Asbestos Dust in Air.

EXPERIENCE:
1-74 to 3-75 - Research and Development Chemist, Penn State Chemical Company.

Responsible for custom development of solvents for a particular client's application.

4-75 to 3-77 - Analytical Chemist, Wichita Water Department

Responsible for trace metal analysis, organic analysis, and water treatment development.

3-77 to 4-86 - Laboratory Director, Wichita Water Department Laboratory

Responsible for providing administrative and technical direction working in the laboratory. The position plans, directs, and supervises the laboratory and treatment plant control room.

5-86 to 10-87 - Laboratory Director, Mid West Analytical Laboratories

10-87 to Present - Laboratory Director, GTEL Environmental Laboratories, Inc., Midwest Region

Responsible for administrative and technical direction in the operation of the laboratory. Also responsible for performing analytical analysis for organic compounds utilizing EPA Methods 601-602 and 603.

* Design of 700 gpm packed tower air stripper for removal of trace volatile organics from a Massachusetts Community water supply. Responsibilities include design of all structural and process aspects required to meet performance criteria.

* Assessment of factors leading to microbiological fouling of packed tower air strippers at spill sites. Responsibilities include definition of precursors, review of applicable treatment techniques and development of a suitable treatment technology.

AFFILIATIONS AND PUBLICATIONS

Ames, S.C. et al, 1985, Subsurface Hydrocarbon Vapors: Low Level Sampling and Analytical Techniques Applicable to Their Identification and Mitigation.

Proceedings of the Fifth National Symposium and Exposition on Aquifer Restoration and Groundwater Monitoring, NWWA May 1985.

National Well Water Association, Technical Division

Massachusetts Superfund Advisory Subcommittee

American Water Works Association

GTEL ENVIRONMENTAL LABORATORIES INC

Scott C. Ames
Laboratory Services Manager
GT Environmental Laboratories
Northeast Region, Greenville, N.H.
Western Region, Concord, CA.

EDUCATION

B.S., (Magna Cum Laude) Keene State College, 1978

EXPERIENCE

Mr. Ames is Laboratory Services Manager of the GT Environmental Laboratories Northeast Region located in Greenville, N.H. and Western Region located in Concord, CA. His responsibilities include overall management and administration for both groups, as well as serving as a senior staff engineer.

Mr. Ames joined ORS/Groundwater Technology in 1979, and has been one of the key professionals involved in development of the company. His accomplishments have included:

* Establishment of the Groundwater Technology Analytical Laboratories.
* Establishment of the Groundwater Technology Chemical Engineering Group.
* Product development for water treatment and soil degassing.
* Technique development for subsurface vapor plume mapping, vapor phase pump tests and control of plume migration.
* Analytical technique development for analysis for air contaminants by Tenax GC.
* Design of a hazardous vapor venting system for a six story 160,000 square foot office building in Montreal. Responsibilities included specification of all system components, design and layout of sub-slab plenums, architectural modifications to support structure, and supervision of start up.

GTEL ENVIRONMENTAL LABORATORIES INC.

17.0 RESUMES OF KEY INDIVIDUALS

adjustments, such as GC/MS tunes and ICP interference checks, including acceptability criteria;

3. Copies of sample queues, sample prep worksheets with example calculations, and other worksheets carrying important sample data and calculations, including calibration and QC sample dilution schemes utilized;

4. Copies of all instument hardcopy output, such as chromatograms and printer output.

5. For GC/MS, copies of mass spectra labelled and approved by qualified person.

16.2 Quality Assurance Reports to Management

Weekly, the Director of QA/QC reports to the corporate manager. All corrective actions implemented by the Laboratory Director will be documented and followed to completion. ' Results of the QC processes and auditing processes are evaluated against the quality assurance objectives of the laboratory.

16.3 Quarterly QA Reports

Certain projects under regulatory review will require quarterly summaries of QA conformance and corrective action. For such projects, sufficient information for such a report is contained in the Blue or Red Level packages requested by the client prior to analysis of each sample set. Any further information needed will be provided by the Director of Quality Assurance upon request.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1 Blue and Red Level QA Deliverable Packages (see Appendix C for further detail):

A. Blue Level

If a QA report is requested, at a minimum, GTEL will submit the following items along with the data reports:

1. Precision and accuracy quality control results and acceptance limits (If the matrix spike is not in the sample set it will be from a reasonably equivalent matrix on the same instrument and in the same control period);

2. Results of the reagent blank for the analyses run in the control period on all analysis dates for the sample set;

3. Surrogate recoveries and acceptance limits if applicable;

4. A QA conformance summary certifying that the analyses met the established objectives for the above, or explains the non-conformance and corrective action.

   The conformance summary will also contain an itemization of conformance with completeness criteria (all missing data will be explained), and with method calibration and sample integrity requirements.

5. A clear definition, including CAS# for all analytes, of all procedures or terminology which might be unique to the laboratory or sample set.

B. Red Level

Red Level QA Deliverables Packages are full documentation packages that contain, in addition to the Blue Level Deliverables above, the following:

1. Results summaries of initial calibration, continuing calibration,and calibration verification QC samples or standards, including acceptability criteria;

2. Results summaries of necessary instrument setup

contaminated, the GTEL Quality Assurance Coordinator will inform the client Quality Assurance Officer, who in turn will initiate corrective action at the project level.

If a laboratory systems audit reveals a procedural problem, the GTEL lab manager will initiate corrective action. Any data generated during the time procedural problems existed will be closely scrutinized for acceptability. The client Quality Assurance Officer and Project Manager will jointly decide whether or not such data will be used.

2. When warning limits or control limits are exceeded (as with outliers) corrective action will be as follows:

Warning limit exceeded - when this occurs, the procedure will be examined to determine where the problem may lie. Analysis will continue with increased frequency of replicate and spiked samples until results fall within warning limits.

Control limit exceeded - when this occurs analysis will be stopped. The problem will be identified and corrected, and samples will be rerun.

B. Corrective Action at the Project Level

The Client Quality Assurance Officer will review the data sets and quality control data if submitted by the laboratory. If any data fail to meet the precision, accuracy, and completeness criteria listed in Table 5.1, the lab manager will be notified and will be required to make any necessary systematic changes and then reanalyze the samples in question.

If the samples in question cannot be reanalyzed for some reason, then the client Quality Assurance Officer, the client Project Manager, and the GTEL Project Manager will jointly decide whether or not the suspect data will be used.

B. Corrective Action Necessitated by Evaluations and/or Audits

If GTEL generates "not acceptable" results on performance evaluation samples, the lab manager will be required to determine the source of the error. If blank samples are shown to be

FIGURE 15.1
GROUNDWATER TECHNOLOGY INC.
CORRECTIVE ACTION DECISION MATRIX

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Revision No. 0
Date 10/23/87
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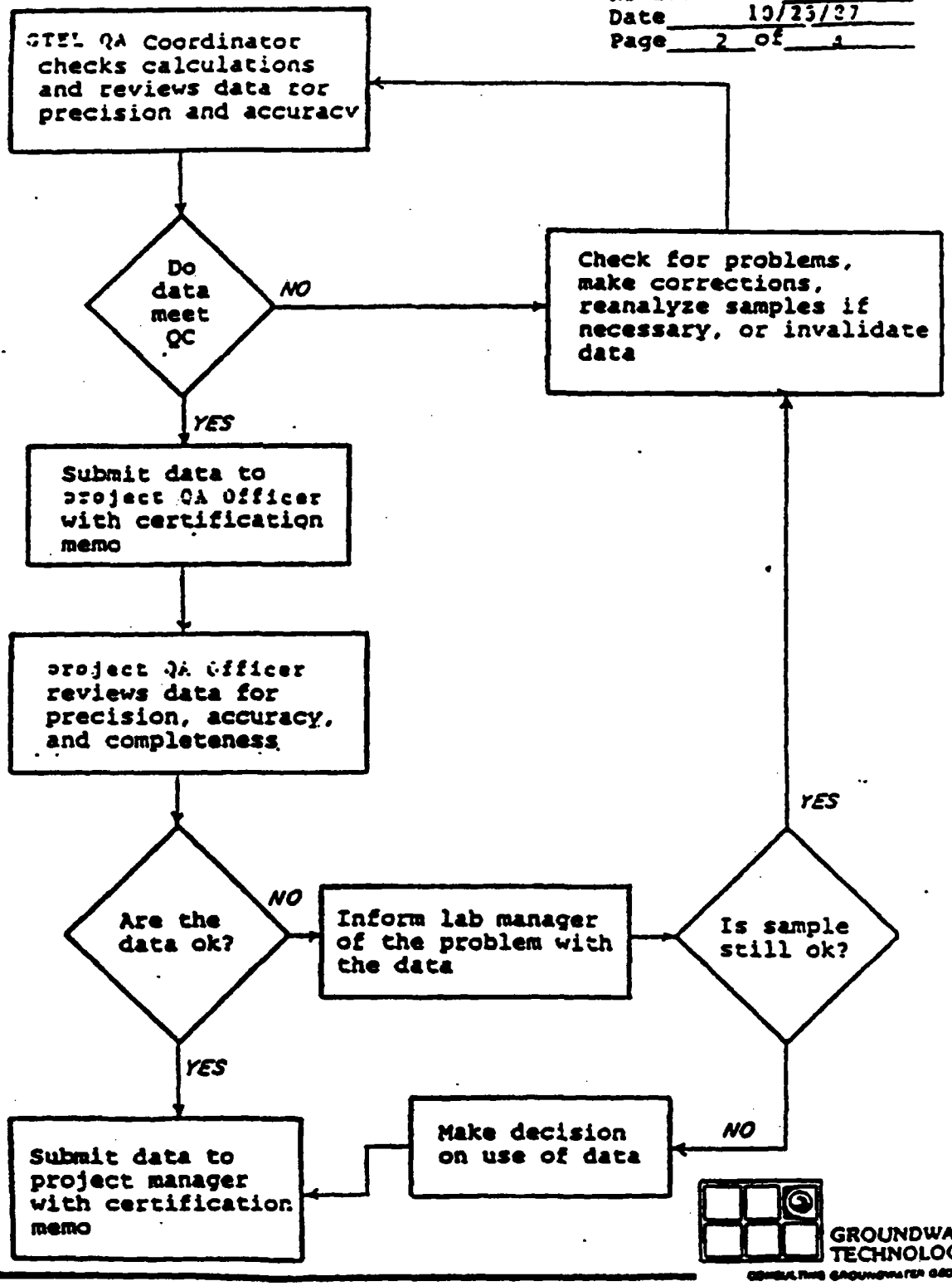

GROUNDWATER TECHNOLOGY
CONSULTING GROUNDWATER GEOLOGISTS

15.0 CORRECTIVE ACTION

Corrective action will be taken when any one of the following occurs:

A. Precision and/or accuracy fall outside the acceptable limits listed in Table 5.1.
B. The slope of the calibration differs significantly from that normally experienced.
C. Blank values are not acceptable.
D. Performance evaluation sample results are "not acceptable" or "check for error".
E. A systems audit reveals a procedural problem.
F. A regulatory agency, such as the Florida Department of Environmental Regulation should deem corrective action necessary.

Figure 15.1 shows the GTI decision matrix for initiating corrective action.

15.1 CORRECTIVE ACTION

A. Corrective Action of the Analytical Level

1. The GTEL Quality Assurance Coordinator will review each set of data to determine precision, accuracy, and blank values, and will check anomalous or suspect values which may indicate systematic problems. If systematic problems are identified, the lab manager will correct them. Any set of samples which fail to meet pre-defined limits for precision and accuracy (Table 5.1) will be reanalyzed. If holding times for the reanalyzed samples have been exceeded, the analytical results will be submitted with a clear indication on the cover memo that holding times were exceeded prior to analysis.

instances where the method explicitly states a control limit the referenced control limit will be used unless a statistical evaluation indicates that laboratory performance is significantly better than the referenced limit.

Statistical control is also dependent on the following trends of greater than 7 results:

a) ascending

b) descending

c) one side of mean (central) line

As a minimum, GTEL maintains control charts for matrix spikes for accuracy and either duplicate matrix spikes or duplicate samples for precision. Additionally for some methods GTEL maintains charts for the slope of the calibration line, calibration verification QC samples (analogous to the slope of the calibration), or for surrogate spike results.

14.4 DEFINITION OF DETECTION LIMIT

For methods operating under this document the Method Detection Limit (MDL) will be defined according to Appendix A, EPA 600/4-82-057, "The minimum concentration that can be measured and reported with 99% confidence that the value is above zero." The procedure for its determination is in Appendix F. It is approximately 3 times the standard deviation of a set of seven replicates at a concentration very near (within 5 times) the detection limit.

The MDL defines a limit above which false positives are very unlikely. However, the relative precision at this limit is expected to be very large and quantitation is not reliable. For methods operating under this document quantitation is considered reliable at 10 standard deviations above background, i.e. at about 3 times the MDL. Data above this level can be reliably compared to regulatory limits.

14.5 METHOD CONTROL

Method control is based on a statistical evaluation of quality control results and is usually displayed as a quality control chart. The control limit for a method under statistical control is +/- three standard deviations from the mean. A warning limit is set at +/- two standard deviations. In the case of precision control charts the control limit and warning limit are 3.27 and 2.51 times the mean RPD, respectively. In certain

Reference materials are essential to the evaluation of accuracy. Stock solutions for accuracy spikes shall be traceable to a source independent from the calibration solutions. Quality Control Standards (used for calibration verification) will if possible likewise be traceable to a source independent from the calibration solutions. In such cases QC Standards will be acceptible to use for accuracy assessments in addition to matrix spikes. When using commercial sources for solutions the QA Department will verify that the materials are from an independent source.

14.3 COMPLETENESS

Completeness is evaluated by dividing the total number of verifiable data points by the maximum number of data points possible and expressing the ratio as a percent.

$$C\ (\%) = \frac{D}{P \times n} \times 100 \qquad \text{(equation 14.5)}$$

where: D = number of verifiable quantitations (not suspect due to QC or sample integrity shortcomings)

P = number of analytical parameters per sample requested for analysis

n = number of samples requested for analysis

RSD is related to RPD by the relationship in Equation 14.3.

% rel. std. dev. = 0.707 RPD Equation 14.3

As the relative percent difference (RPD) generally has a dependency on concentration it may be necessary to apply these statistics over a limited range of concentrations.

The day-to-day acceptability of the analytical precision will be based on the QC charts with the control limit at the 99% confidence level (3.27 times the mean RPD as discussed in Section 14.5).

14.2 ACCURACY

Bias (accuracy) will be based on the average % recoveries of spiked samples (Equation 14.4).

$$\%R = \frac{SSR - SR}{SA} \times 100 \qquad \text{Equation 14.4}$$

where: %R = % Recovery
SSR = spiked sample result
SR = sample result
SA = amount of spike

The accuracy interval reported to management will be expressed as follows: accuracy interval = mean recovery +/- 2 std. dev. Day-to-day acceptability of accuracy will be based on the QC charts with the control limits at the 99% confidence level (see Section 14.5).

14.0 SPECIFIC ROUTINE PROCEDURES TO BE USED TO ASSESS DATA PRECISION, ACCURACY, COMPLETENESS, DETECTION LIMIT, AND METHOD CONTROL

14.1 PRECISION

When more than two measurements are to be evaluated, such as for a series of daily reference samples, the standard deviation is derived from equation 14.1:

$$S = \left(\left[\sum_{i=1}^{n} (Xi - \bar{X})^2 / (n-1) \right] \right)^{1/2} \qquad \text{Equation 14.1}$$

where:
- S = standard deviation
- Xi = each observed value
- $\bar{X}$ = the arithmetic mean of all observed values
- n = total number of values

The precision of laboratory test results will be expressed as the percent relative standard deviation (RSD) or relative percent difference (RPD). The % relative standard deviation (RSD) is obtained by dividing the S by $\bar{X}$, expressing the ratio as a percent. RPD is derived from the absolute difference between duplicate analyses divided by the mean value of the duplicates (Equation 14.2).

Equation 14.2

$$RPD = \frac{|D1 - D2|}{(D1 + D2)/2} \times 100$$

where D1 and D2 are the two replicate values

The following maintenance supplies are kept on hand for regular and emergency maintenance:

1. septa
2. purge-and-trap sparger
3. purge-and-trap traps
4. tubing and fittings
5. thermal conductivity leak detector
6. chart paper
7. column ferrules
8. u.v. lamp for PID detector
9. syringes for spiking
10. mass spectrometer source filaments
11. jet separator
12. pump oil
13. analytical columns (all analyses)
14. flow meter bubble solution
15. extra flow meter

13.2 Graphite Furnace Atomic Absorption

Daily Maintenance:

1. Clean furnace windows with alcohol and lense paper.
2. Clean contact rings with alcohol and cotton swabs.
3. Change graphite tube.
4. Check DI water quality.

13.3 Flame Atomic Absorption

Daily Maintenance:

1. Inspect burner head and observe flame symmetry.
2. Check gas supplies.
3. Check DI water quality

13.4 Inductively Coupled Plasma Emission

Daily Maintenance:

1. Clean chimney.
2. Clean nebulizer.
3. Change autosampler pump tubing and reset flow.
4. Check DI water quality

Weekly maintenance (twice)

1. Sedium Bullet text.
2. Xtrium bullet test.

Bi-weekly maintenance:

1. Background emission correction (BEC calibration)

13.5 Infrared

Daily maintenance:

1. Clean windows with freon and lens paper.
2. Check sensitivity and adjust gain, if necessary.
3. Run spectrum of polystyrene.

13.0 PREVENTATIVE MAINTENANCE

13.1 Gas Chromatograph and Gas Chromatograph/Mass Spectrometer (GC and GC/MS)

1. Maintenance log is kept for each instrument
2. GC septa are changed daily
3. Detectors are cleaned on a schedule recommended by the manufacturer or more frequently as needed: FID monthly, PID monthly, MS quarterly.
4. Laboratory is vacuumed weekly
5. Instrument electronics are visually inspected and cleaned quarterly.
6. Room temperature and humidity are maintained according to manufacturer's specifications.
7. Refrigerator temperatures are logged daily:
8. Raw data is archived electronically if possible at least until report is accepted by the client or the GT office QA officer.
9. Hoods are cleaned and checked quarterly to assure minimum laboratory contamination and maximum safety conditions.
10. Broken glassware are sent for repair bimonthly.
11. GC columns and PAT traps are numbered and logged and are baked out daily. Changes and monthly flow checks are logged.
12. Teflon tips are replaced biweekly.
13. Temperature measurement devices are checked against NBS traceable standards semi-annually.
14. Analytical balances are under service contract and are maintained semiannually.
15. PAT devices are pressure tested monthly and whenever glassware is changed.
16. Electronic flow meters are calibrated monthly.

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In NH (800) 922-3422

Report No.
Submitted to:

Groundwater Technology

Sample Identification:
This reports the analysis of water samples # , for BTEX/Total Voc by PID , taken by , at site#

Method:
The analytical procedure used follows the EPA protocol 602, using purge/trap extraction and analysis by gas chromatography-PID. The parameter "Total VOC" is the sum of all components detectable by photoionization.

The method detection limit for aromatic parameters is 0.5 ppb. (ug/L).

Sampling and sample handling and preservation are specified by this laboratory to be as per EPA Method 602. Any irregularities are referenced as notes to the analytical report.

Results:
Results are reported in ppb (ug/L).

Prepared by:
Bob Edwards Analyst
GC Manager

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HYDROCARBONS IN WATER ug/L (ppb)
REPORT NO.

Sample I.D.	DATE SAMPLED	DATE RUN	BENZENE	TOLUENE	ETHYL BENZENE	TOTAL XYLENES	TOTAL BTEX

*NOTES:

ND = NONE DETECTED

TOTAL BTEX = THE SUM OF BENZENE, TOLUENE, ETHYL BENZENE, AND XYLENES, ROUNDED TO TWO SIGNIFICANT FIGURES.

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HYDROCARBONS IN WATER ug/l
REPORT NO.

SAMPLE NO.	I.D.	TOTAL VOC (PID)

*NOTES
TOTAL = THE SUM OF THE TOTAL BTEX AND THE ABOVE PARAMETERS.

ND = NONE DETECTED

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Groundwater Technology

Report Date
Project #
Site Location
Sampling Date

The enclosed data reports the analysis of water samples for purgeable halocarbons. The analytical method used conforms to the EPA 601 protocol, and uses purge and trap gas chromatography with Hall Electrolytic Conductivity Detection. GTEL employs a quality assurance program to ensure the accuracy and validity of all analytical results.

Bob Edwards

GC Lab Manager

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In NH (800) 922-3422

Purgeable Halocarbons

Sample I.D.

Report No.

Date Run

Compound	Analytical Result, ug/L	Method Detection Limit ug/L
Methylene Chloride	ND	0.25
1,1-Dichloroethylene	ND	0.13
1,1-Dichloroethane	ND	0.07
trans-1,2-Dichoroethylene	ND	0.10
Chloroform	ND	0.05
1,2-Dichloroethane	ND	0.03
1,1,1-Trichloroethane	ND	0.03
Carbon Tetrachloride	ND	0.12
Bromodichloromethane	ND	0.10
1,2-Dichloropropane	ND	0.04
Bromomethane	ND	1.18
Chloroethane	ND	0.52
Dichlorodifluoromethane	ND	1.81
trans-1,3-Dichloropropene	ND	0.34
Trichloroethylene	ND	0.12
1,1,2-Trichloroethane	ND	0.02
Dibromochloromethane	ND	0.09
cis-1,3-Dichloropropene	ND	0.20
2-Chloroethylvinylether	ND	0.13
Bromoform	ND	0.20
1,1,2,2-Tetrachloroethane	ND	0.03
Tetrachloroethylene	ND	0.03
Chlorobenzene	ND	0.25
Vinyl Chloride	ND	0.18
1,2-Dichlorobenzene	ND	0.15
1,3-Dichlorobenzene	ND	0.32
1,4-Dichlorobenzene	ND	0.24
Chloromethane	ND	0.52
Trichlorofluoromethane	ND	---

NOTES:
ND = NONE DETECTED

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In NH (800) 922-3422

Report No.
Submitted to:

Groundwater Technology

Sample Identification:
The attached report covers water samples # taken by using 40mL septum-capped glass vials at site #

Method:
Analysis was performed for purgeable aromatic priority pollutants and xylenes by purge and trap gas chromatography with photoionization and flame ionization detection as per a modified EPA Method 602. Quantification was performed on a very polar column which fractionates aliphatics (up to C12) away from volatile aromatics. Chromatographic conditions are referenced in GTL Method Code 110. Hexane and orthoxylene are used as calibration standards, for the aliphatic hydrocarbons and miscellaneous aromatics, respectively.

Samples diluted in order to maintain the calibrated range are so indicated by a footnote giving the factor by which the MDL is raised.

Minimum Detection Limit (MDL) at 5 times background is 0.5 ppb for all parameters. The level for reliable quanititation for the summed groups such as aliphatics is 20 ppb. Sampling and sample handling and preservation are specified by this laboratory to be as per EPA Method 602. Any irregularities are referenced as notes to the analytical report.

Results:
Results are reported in ppb (ug/L).

Certification Status:
Category - purgeable organics
Certifying Agency - Florida Department of Health and Rehabilitative Services
I.D. Number: T87103

Prepared by:
Bob Edwards Analysts
GC Manager

0338

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In NH (800) 822-3422

HYDROCARBONS IN WATER ug/L (ppb)
REPORT NO.

Sample I.D.	DATE SAMPLED	DATE RUN	BENZENE	TOLUENE	ETHYL BENZENE	TOTAL XYLENES	TOTAL BTEX

*NOTES:

ND = NONE DETECTED

TOTAL BTEX = THE SUM OF BENZENE, TOLUENE, ETHYL BENZENE, AND XYLENES, ROUNDED TO TWO SIGNIFICANT FIGURES.

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HYDROCARBONS IN WATER ug/L (ppb)
REPORT NO.

SAMPLE NO.	I.D.	C4-C12 ALIPHATIC HYDROCARBONS	MISC AROMATICS C8-C12	TOTAL

NOTES:

TOTAL = THE SUM OF THE TOTAL BTEX AND THE ABOVE PARAMETERS.

ND = NONE DETECTED

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In NH (800) 922-3422

Laboratory Test Results

0/00/00
Report No. 00-000-00
Submitted to:

John Doe
Groundwater Technology
000 Street
Someplace, ZX. 00000

Sample Identification:

The attached report covers 00 water samples #00000-00000, collected in acid washed containers by J. Smith. The samples were collected on 00/00/00 from site 00-000, town,State.

Analysts:

Method:

Sample digestion performed on 0/00/87. Samples were analyzed by EPA Method xxx.x Atomic Absorption, Furnace Method.

Results:

Results are reported in ug/L (ppb).

Certification:

These results have been reviewed for correctness and completeness.

Prepared by:

(name)
(title)

Respectfully submitted,

Frank I. Saksa
Metals Laboratory Manager

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Priority Pollutant
Metals in Soil

Report No.00-0000-00

Sample No.	ID	Concentration (mg/Kg)					
		Pb	Ni	Ba	Tl	Cu	Ag
00000	MW-1	< 0.5	7.0	98	< 50	4.7	< 4
00000	MW-2	< 0.5	8.8	120	< 50	5.8	< 4
00000	MW-3	< 0.5	11.2	180	< 50	6.0	< 4
00000	MW-4	< 0.5	12.4	110	< 50	8.6	< 4

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EP TOXICITY
Report No. 00-0000-00

Sample No.	I.D.	Metal Concentration (ug/L)								Comment
		As	Ba	Cd	Cr	Pb	Hg	Se	Ag	
00000	Tap									

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Laboratory Test Results

Report No.
Submitted to:

Groundwater Technology

Sample Identification:
The attached report covers water samples # taken by on using 40 ml septum-capped glass vials at site and acidified to pH 2.

Method:
Analysis was performed for volatile organics by purge and trap gas chromatography with a mass spectrometer detector as per EPA Method 624. Detection limits are listed on the report. Samples diluted in order to maintain the calibrated range are so indicated by a footnote giving the factor by which the MDL is raised.

Sampling and sample handling and preservation are specified by this laboratory to be as per EPA Method 624.

Results:
Results are reported in ppb (ug/l).

Certification Status:
Category - volatile organics
Certifying Agency - Massachusetts Department of Public Health

Prepared by:

Dave Reese
GC/MS Manager
DRR/ch

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In NH (800) 922-3422

REPORT NO.
VOLATILE ORGANICS ANALYSIS

Sample No.	00000	00000	00000	00000
ID	00000	00000	0000	0000
Date Sampled	0000000	0000000	0000000	0000000
Date Analyzed	0000000	0000000	0000000	0000000

PARAMETER	CONCENTRATION ug/l				D.L.
Chloromethane	ND	ND	ND	ND	5.0
Bromomethane	ND	ND	ND	ND	1.7
Vinyl Chloride	ND	ND	ND	ND	1.8
Chloroethane	ND	ND	ND	ND	1.2
Methylene Chloride	ND	ND	ND	ND	2.2
Trichlorofluoromethane	ND	ND	ND	ND	0.7
1,1-Dichloroethene	ND	ND	ND	ND	1.1
1,1-Dichloroethane	ND	ND	ND	ND	4.5
trans-1,2-Dichloroethene	ND	ND	ND	ND	1.6
Chloroform	ND	ND	ND	ND	1.6
1,2-Dichloroethane	ND	ND	ND	ND	1.6
1,1,1-Trichloroethane	ND	ND	ND	ND	2.6
Carbon tetrachloride	ND	ND	ND	ND	2.1
Bromodichloromethane	ND	ND	ND	ND	2.1
1,2-Dichloropropane	ND	ND	ND	ND	2.8
cis-1,3-Dichloropropene	ND	ND	ND	ND	5.0
Trichloroethene	ND	ND	ND	ND	1.9
Benzene	ND	ND	ND	ND	1.7
Dibromochloromethane	ND	ND	ND	ND	3.1
trans-1,3-Dichloropropene	ND	ND	ND	ND	2.4
1,1,2-Trichloroethane	ND	ND	ND	ND	1.9
Ethylene Dibromide	ND	ND	ND	ND	7.3
2-Chloroethylvinylether	ND	ND	ND	ND	2.7
Bromoform	ND	ND	ND	ND	5.7
Tetrachloroethene	ND	ND	ND	ND	2.2
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	6.0
Toluene	ND	ND	ND	ND	2.1
Chlorobenzene	ND	ND	ND	ND	3.0
Ethylbenzene	ND	ND	ND	ND	4.5
M-xylene	ND	ND	ND	ND	4.0
O & P xylene	ND	ND	ND	ND	4.0
M-Dichlorobenzene	ND	ND	ND	ND	6.5
O & P Dichlorobenzene	ND	ND	ND	ND	7.1

GT Environmental Laboratories
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NOTES:

ND = NOT DETECTED
BDL = BELOW DETECTION LIMIT
D.L. = DETECTION LIMIT

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Laboratory Test Results

Report No.
Submitted to:
Groundwater Technology

Sample Identification:
The attached report covers water samples # taken by on using 1 liter TFE lined cap bottles at site #

Method:
Analysis was performed for semi-volatile organics gas chromatography with a mass spectrometer detector as per EPA Method 625. Detection limits are listed on the report. Samples diluted in order to maintain the calibrated range are so indicated by a footnote giving the factor by which the MDL is raised.

Sampling and sample handling and preservation are specified by this laboratory to be as per EPA Method 625.

Results:
Results are reported in ppb (ug/l).

Prepared by:

Dave Reese
GC/MS Manager
DRR/ch

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In NH (800) 922-3422

Report No.

SEMI-VOLATILE ORGANICS ANALYSIS

Sample No.
ID
Date Sampled
Date Extracted

PARAMETER	CONCENTRATION ug/l	D.L.	PARAMETER	CONCENTRATION ug/l	D.L.
Phenol	ND	10	Acenaphthene	ND	10
Bis(2-Chloroethyl)Ether	ND	10	2,4-Dinitrophenol	ND	50
2-Chlorophenol	ND	10	4-Nitrophenol	ND	50
1,3-Dichlorobenzene	ND	10	Dibenzofuran	ND	10
1,4-Dichlorobenzene	ND	10	2,4-Dinitrotoluene	ND	10
Benzyl Alcohol	ND	10	2,6-Dinitrotoluene	ND	10
1,2-Dichlorobenzene	ND	10	Diethylphthalate	ND	10
2-Methylphenol	ND	10	4-Chlorophenyl-phenylether	ND	10
Bis(2-Chloroisopropyl)Ether	ND	10	Fluorene	ND	10
4-Methylphenol	ND	10	4-Nitroaniline	ND	50
N-Nitroso-Di-n-Propylamine	ND	10	4,6-Dinitro-2-Methylphenol	ND	50
Hexachloroethane	ND	10	N-Nitrosodiphenylamine(1)	ND	10
Nitrobenzene	ND	10	4-Bromophenyl-phenylether	ND	10
Isophorone	ND	10	Hexachlorobenzene	ND	10
2-Nitrophenol	ND	10	Pentachlorophenol	ND	50
2,4-Dimethylphenol	ND	10	Phenanthrene	ND	10
Benzoic Acid	ND	50	Anthracene	ND	10
Bis(2-Chloroethoxy)Methane	ND	10	Di-n-Butylphthalate	ND	10
2,4-Dichlorophenol	ND	10	Fluoranthene	ND	10
1,2,4-Trichlorobenzene	ND	10	Pyrene	ND	10
Naphthalene	ND	10	Butylbenzylphthalate	ND	10
4-Chloroaniline	ND	10	3,3'-Dichlorobenzidine	ND	20
Hexachlorobutadiene	ND	10	Benzo(a)Anthracene	ND	10
4-Chloro-3-Methylphenol	ND	10	Bis(2-Ethylhexyl)Phthalate	ND	10
2-Methylnaphthalene	ND	10	Chrysene	ND	10
Hexachlorocyclopentadiene	ND	10	Di-n-Octyl Phthalate	ND	10
2,4,6-Trichlorophenol	ND	10	Benzo(b)Fluoranthene	ND	10
2,4,5-Trichlorophenol	ND	50	Benzo(k)Fluoranthene	ND	10
2-Chloronaphthalene	ND	10	Benzo(a)Pyrene	ND	10
2-Nitroaniline	ND	50	Indeno(1,2,3-cd)Pyrene	ND	10
Dimethyl Phthalate	ND	10	Dibenz(a,h)Anthracene	ND	10
Acenaphthylene	ND	10	Benzo(a,h,i)Perylene	ND	10
3-Nitroaniline	ND	50			

(1) Cannot be separated from diphenylamine

Project Specific QA
Blue Level

* suitable for general regulatory review
* basically equivalent to New Jersey Tier 2
* recommended for all Florida jobs
* recommended for all Shell projects

Laboratory QA Deliverables

* this deliverables format costs 20% per sample above the analysis standard price from GTEL, Eastern Region, for 7 or more samples in the sample set. For 6 or fewer samples, this QA report costs 40% more per sample.

1) results of analysis for method blanks associated with the sample set (sample data will be reported uncorrected for blank)
2) surrogate recovery results and acceptability limits for all samples, blanks, and spikes
3) matrix spike recovery results to demonstrate accuracy. Method specified acceptability limits must be included (any statistical control limits reported must exceed the method specified ones.
4) duplicate analysis results to demonstrate precision. Acceptability limits must be included.
5) all compounds reported will be associated with an NPDES number or CAS number.
6) a nonconformance summary covering calibration, quality control,& sample integrity will be included
7) a copy of the chain of custody

Project Management Specifics

1) Field blanks and trip blanks are relatively costly in small data sets. Unless otherwise specified in a particular QA plan, use of a single combined blank per sampling day is acceptable for small sets.
2) Field duplicates to be analysed to check sampling variability and representativeness are also relatively costly in small data sets. Plan these into only a representative number of sampling events over the course of a project to cut costs. For larger data sets, 10% field duplicates is the accepted practice.
3) The matrix spikes generated for a blue level QA deliverables package are relatively costly in small data sets (40% more). Under some circumstances it will be acceptable to plan these into a representative number of sampling events to cut costs. However the QA report from the lab showing that it was in control for accuracy and precision in reasonably similar matices during the same control period as the sample set in question (along with the other Blue Level deliverables) will still carry a surcharge, though at a substantially lower level than 40%.

Project Specific QA

Red Level

* acceptable for litigation
* basically equivalent to New Jersey Tier 1
* basically equuivalent to New Jersey ECRA deliverables criteria
* basically equivalent to EPA Superfund Contract Lab (CLP) deliverables package

Laboratory QA Deliverables

* The price of this deliverables format will be quoted on a project basis by GTEL

1) includes all basic and Blue Level criteria

2) full documentation of calibration validation for the data set (summary of criteria plus chromatograms)

3) full documentation of matrix spikes and duplicate analysis (summary of criteria plus chromatograms)

4) full documentation of GC/MS tuning process

5) all chromatograms, mass spectra (labelled and approved by qualified person), sample prep. work sheets with examples of calculations

6) copies of all appropriate certifications

Project Management Specifics

1) Laboratory QA reporting at this level is paticularly expensive for small data sets but is justifiable for these projects

2) For some projects, 10% field duplicates are required to be analysed.

3) Recommended for a certain percentage of all data submitted on major projects. This will generally be a requirement for projects directed by the New Jersey DEP, Div. of Waste Management.

General Quality Assurance Criteria for All Projects

1) sampling and safety SOPs will be followed
2) samplers will take part in a periodic training program
3) field procedures and data reduction procedures will be auditted periodically
4) all laboratories, including subcontractors and local labs used (henceforth referred to simply as "labs"), will be auditted at least once per year covering the analyses involved
5) sample integrity, preservation, and holding time criteria will be met (labs will validate)
6) analytical methods will be appropriate for the project objectives
7) detection limits will be appropriate for the project objectives (labs will validate at least once every 6 months by the EPA MDL method and list on all reports)
8) labs will maintain method-specified calibrations, blanks, surrogate spikes, matrix spikes, and reference material quality control procedures. Additionally precision will be evaluated by the analysis of duplicates at the same rate as matrix spikes (5 - 10%)
9) labs will make use of sufficiently experienced personnel as required by the EPA methods and applicable certifications
10) labs and project office will maintain a documented corrective action process to eliminate outliers and indefensible data
11) field duplicates, trip blanks, and field blanks will be analysed as necessary during the project to check sampling variability and artifacts
12) all lab reports shall include:
    lab name, contact person, agency certification status, project name or ID (client's name not mentioned without written approval), sample ID (field), sample ID (lab), sample location (city,state), type of sample (water,etc.), type of sampling container, preservation technique, date of sampling, sampler's name, date of extraction, date of analysis, and date of any other critical procedure, methodology reference (including any modifications and validation), laboratory method SOP number reference, detection limits, units as specified by project plan, definition of convention used to designate values at or below detection limit, defintion of convention used to designate target compounds in the blank.
13) all chromatographic analyses will include a qualitative confirmation of representative samples by a second column, second detector, or GC/MS analysis and be stated on report
14) all metals analyses will be analyzed by the method of standard additions as necessary
15) all pesticide analyses will utilize a surrogate compound (e.g. dibutylchlorendate)

APPENDIX E

OUTLIER TEST

An extreme observation (outlier) is a datum that appears to be different from the main data pattern.

The principal safeguards against obtaining or using an outlier are vigilance during all operations and visual inspection of data before performing statistical analyses.

If a datum falls above or below the control limits of either the X or R control chart, the value shall be investigated. Sometimes the investigation will reveal a recording or computational mistake that can be revised to obtain the correct value. If an error is found but the correct value cannot be determined, the erroneous value shall not be used in statistical calculations. When errors are found, either correctable or uncorrectable, all analytical results for that lot must be inspected to ensure that erroneous results are not reported. If an uncorrectable error affected results of environmental samples, the lot shall be judged as out of control, and analyses must be repeated.

If no assignable cause for the outlier can be found, the datum shall be statistically tested using tables of the probability that an outlier would be observed if the data were normal and conformed to the assumed model. Dixon's Test expresses the gap between an outlier and the nearest value as a fraction of the range between the smallest and largest value. A datum so determined to be an outlier will be removed from the data set before statistical calculations. Likewise, data sets of environmental measurements which can be assumed to be normally distributed can be evaluated for outlier with this test.

Table K-1. Critical Values for Dixon's Outlier Test

Number of Measurements (N)	Criterion (r)	Critical Value of r (1% Risk)	(5% Risk)
3		0.988	0.941
4		0.889	0.765
5	10	0.780	0.642
6		0.698	0.560
7		0.637	0.507
8		0.683	0.554
9	11	0.643	0.512
10		0.615	0.477
11		0.679	0.576
12	21	0.642	0.546
13		0.615	0.521
14		0.641	0.546
15		0.616	0.525
16		0.595	0.507
17		0.577	0.490
18		0.561	0.475
19		0.547	0.462
20	22	0.535	0.450
21		0.524	
22		0.516	
23		0.505	
24		0.497	
25		0.489	

APPENDIX F

DEFINITION AND PROCEDURE FOR THE DETERMINATION OF THE METHOD DETECTION LIMIT

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and determined from analysis of a sample in a given matrix containing analyte.

Scope and Application

This procedure is designed for applicability to a wide variety of sample types ranging from reagent (blank) water containing analyte to wastewater containing analyte. The MDL for an analytical procedure may vary as a function of sample type. The procedure requires a complete, specific and well defined analytical method. It is essential that all sample processing steps of the method be included in the determination of the MDL.

The MDL obtained by this procedure is used to judge the significance of a single measurement of a future sample.

The MDL procedure was designed for applicability to a broad variety of physical and chemical methods. To accomplish this, the procedure was made device or instrument independent.

Procedure:

1. Make an estimate of the detection limit using one of the following:

   a. The concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5. If the criteria for qualitative identification of the analyte is based upon pattern recognition techniques, the least abundant signal necessary to achieve identification must be considered in making the estimate.

   b. The concentration value that corresponds to three times the standard deviation of replicate instrumental measurements for the analyte in reagent water.

   c. The concentration value that corresponds to the region of the standard curve where there is a significant change in sensitivity at low analyte concentrations i.e. a break in the slope of the standard curve.

   d. The concentration value that corresponds to known instrumental limitations.

   It is recognized that the experience of the analyst is important to this process. However, the analyst must include the above considerations in the estimate of the detection limit.

2. Prepare reagent (blank) water that is as free of analyte as possible. Reagent or interference free water is defined as a water sample in which analyte and interferent concentrations are not detected at the method detection limit of each analyte of interest. Interferences are defined as systematic errors in the measured analytical signal of an established procedure caused by the presence of interfering species (interferent). The interferent concentration is presupposed to be normally distributed in representative samples of a given matrix.

3. a. If the MDL is to be determined in reagent water (blank). prepare a laboratory standard (analyte in reagent water) at a concentration which is at least equal to or in the same concentration range as the estimated MDL (Recommend between 1 and 5 times the estimated MDL). Proceed to Step 4.

   b. If the MDL is to be determined in another sample matrix. analyze the sample. If the measured level of the analyte is

in the recommended range of one to five times the estimated MDL, proceed to step 4.

If the measured concentration of analyte is less than the estimated MDL add a known amount of analyte to bring the concentration of analyte to between one and five times the MDL.

If the measured level of analyte is greater than five times the estimated MDL, there are two options:

1. Obtain another sample of lower level of analyte in same matrix if possible.

2. The sample may be used as is for determining the MDL if the analyte level does not exceed 10 times the MDL of the analyte in reagent water. The variance of the analytical method changes as the analyte concentration increases from the MDL, hence the MDL determined under these circumstances may not truly reflect method variance at lower analyte concentrations.

4. Take a minimum of seven aliquots of the sample to be used to calculate the MDL and process each through the entire analytical method. Make all computations according to the defined method with final results in the method reporting units. If blank measurements are required to calculate the measured level of analyte, obtain separate blank measurements for each sample aliquot analyzed. The average blank measurement is subtracted from the respective sample measurements.

5. Calculate the standard deviation(s) of the replicates.

6. Calculate the MDL as follows using t from the table below:

$$MDL = T \times S$$

Table of Students' t values at the 99 Percent Confidence Level

Number of Replicates	Degrees of Freedom (n-1)	t(n-1, 1-a = .99)
7	6	3.143
8	7	2.998
9	8	2.896
10	9	2.821

REFERENCE: "Appendix A, Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", EPA 600/4-82-057, July 1982.

FN: 32.SOP

MAJOR EQUIPMENT LIST

I. Gas Chromatography/Mass Spectrometry (GC/MS) Group.

QTY	INSTRUMENT	REGION*
9	GC/MS instruments including:	
	Extrel ELQ-400 GC/MS Systems	NE, W.
	Finnigan-MAT 1020 GC/MS System	NE
	Finnigan-Incos 50 GC/MS System	MW
	Hewlett Packard 5970 GC/MSD Systems	W
2	GC/MS Data System, Digital Elect. Corp.	NE, W.
1	Data General E6267-A, Computer System	MW
1	O.I. Corporation Purge/Trap Autosampler	W
2	Tekmar LSC-2 Purge/Trap Autosampler	NE, W

II. Chromatography Group.

QTY	INSTRUMENT	REGION*
24	Hewlett-Packard, Varian, Perkin Elmer, Tracor Gas Chromatographs equipped with:	NE, MW, W
	Electron Capture Detectors	
	Flame Ionization Detectors	
	Nitrogen-Phosphorous Detectors	
	Coulson Detectors	
	Hall Detectors	
	Flame Photometric Detector	
	Photo ionization Detectors	
	Thermal Conductivity Detectors	
3	High-Pressure Liquid Chromatographs	NE, W
1	Spectra-Physics ChromStation-2 Data System	NE
3	Nelson Analytical Data Systems	W
1	Varian DS654 Data System	W
10	O.I. Corporation Purge/Trap Autosamplers	NE, W
14	Tekmar LSC-2 Purge/Trap	NE, W, MW
2	Varian 8035 Autosampler	W
1	Perkin Elmer ISS100 Autosampler	W

III. Inorganics Group.

QTY	INSTRUMENT	REGION*
2	Inductively Coupled Plasma Spectrometers	NE, W
5	Atomic Absorption Spectrometers	MW, NE, W
4	Infrared Spectrometers	MW, NE, W
2	Ion Chromatographs	NE, W
1	Mitsubishi Organic Halogen TOX-10 Analyzer	W
1	Dohrmann Carbon Analyzer	W
4	pH Meters	NE, MW, W
1	Dionex Automated Sampler	W
1	Milton Roy Spectronic 501 Ultraviolet/ visible spectrometer	W

IV. Laboratory Information Management Systems (LIMS).

QTY	INSTRUMENT	REGION*
1	Perkin Elmer LIMS Mainframe	NE
1	Radian Sample and Analysis Management System	W

---

*REGION KEY

MW = Midwestern (Wichita, Kansas)
NE = Northeastern (Milford, New Hampshire)
W = Western (Concord and Torrance, California)

Job #:_____ Job Name:_____ Prepped By:_____ Date:_____

Sample #	A/B	Field ID	Weight of Dish	Dish + Wet	Dish + Dry	Vial ID	Weight of Vial	Vial + Wet	Volume of MeOH

METHOD: GC-
Soil Prep WS

Document No: QA/QC
Section No: H
Revision No: 0
Date: 7/12/88
Page 1 of 11

Soil Sample Analytical Results

Project #:_____ Project Name:_____ Date:_____

Sample #	ID#	Benzene	Toluene	Ethyl Benzene	Xylenes	Total BTEX	Aliphatics	Aromatics	Total HC's	Sample Dry Wt.
(A/B)										
MeOH Blank Values										
Blank Correc Smpl Values										
Sample Result ug/L										

Document No.: QA/QC
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METHOD: GC-
Soil Worksheet

GAS CHROMATOGRAPHIC ANALYSIS - GASOLINE HYDROCARBON/602 IN WATER

Project #:_____ Analyst:_____

Sample ID	Run #/Instr.	Anal. Date	TCE Surrogate	Benzene	Tol.	Ethyl Benzene	Total Xyl.	Total BTEX	Aliph.	Arom.	Total Hyd.	OTHER

Document No.: QA/QC
Section No.: H
Revision No.: 0
Date: 7/12/88
Page 3 of 11

METHOD: GC-
Water Sample US

Environmental Laboratories
A division of Groundwater Technology, Inc.

PROJECT NAME: _____
PROJECT NUMBER: _____
DATE: _____
ANALYST: _____
ANALYSIS: _____
WASTEWATER: _____
SOIL: _____

SURROGATE STD: _____
SURROGATE AMT: _____
SPIKE MATRIX: _____
SPIKE AMT:

SAMPLE NUMBER	FIELD ID#	SAMLPE VOLUME /WEIGHT	INT. PH.	BASE ADJ. PH.	SOLVENT VOLUME (BASE)	ACID ADJ. PH.	SOLVENT VOLUME (ACID)	FINAL CONC. VOL.	COMMENTS

Document No.: QA/QC
Section No.: H
Revision No.: 0
Date: 7/12/88
Page: 4 of 11

METHOD: 625

Extracting Solvent (Lot#): _____

0363

Environmental Laboratories

PROJECT NAME:
PROJECT NUMBER:
DATE:
ANALYST:
ANALYSIS :
WASTEWATER:
SOIL:

SURROGATE STD:
SURROGATE AMT:
SPIKE MATRIX:
SPIKE AMT:

Sample Number	Field ID#	Sample Vol./Wt.	Volume of Solvent Used	Final Conc. Volume	Volume After Clean-Up	Dilution Factor of C/Up			COMMENTS:

Extracting Solvent (Lot#):
Exchange Solvent (Lot#):

METHOD: 610
608 + Herbicides

Document No.: QA/QC
Section No.: H
Revision No.: 0
Date: 7/12/88
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0364

METHOD: EDB

GTEL
ENVIRONMENTAL LABORATORIES, INC.
Northeast Region
Meadowbrook Industrial Park
Milford, NH 03055
(603) 672-4835
(603) 673-8105 (FAX)

EPA METHOD 504
SAMPLE PREPARATION WORKSHEET

Date _____

Analyst _____

(Location _____) Job # ____-____-_____-____

Sample # _____

Vial+Sample _____ g

-Empty Vial _____ g

= Sample _____ g

Place Label Here

Sample # _____

Vial+Sample _____ g

-Empty Vial _____ g

= Sample _____ g

Place Label Here

Sample # _____

Vial+Sample _____ g

-Empty Vial _____ g

= Sample _____ g

Place Label Here

Sample # _____

Vial+Sample _____ g

-Empty Vial _____ g

= Sample _____ g

Place Label Here

Sample # _____

Vial+Sample _____ g

-Empty Vial _____ g

= Sample _____ g

Place Label Here

Environmental Laboratories
A division of Groundwater Technology, Inc.

PROJECT NAME:
PROJECT NUMBER:
DATE:
ANALYST:
ANALYSIS :

		Sample Number							
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								
PH / TIME	Volume of acid added								

METHOD: EPTOX

Document No.: QA/QC
Section No.: H
Revision No.: 0
Date: 7/12/88
Page 7 of 11

0366

METHOD: Metals- Water

WATER SAMPLE PREPARATION SHEET

Job No. 50-4277-4 date 6/7/87 notebook# page#

Site TEXACO ST. AUGUSTINE Analyst J.B.

Sample ID No.	M1 tare beaker	M2 Dish + @100ml	M2-M1 water mass	V1 vol H2O sample	Vf volume factor	DF dilution factor
50582-1	111.08	163.82	52.74	52.84548	0.946154	1
50582-2	111.54	161.54	50	50.1	0.996003	1
1330	105.75	157.83	52.08	52.18416	0.958145	1
1331	106.68	158.34	51.66	51.76332	0.965934	1

Document No.:	QA/QC
Section No.:	H
Revision No.:	0
Date:	7/12/88
Page	9 of 11

METHOD: Metals-Soils, p.1

soil sample calculation sheet

date 1/30/87

Site 61-8631-3 Analyst J.B.

Sample ID No.	M1 tare Al dish	M2 Dish + wet soil	M3 Dish + dry soil	M3-M1 Mass dry soil	fraction soil	M4 tare beaker
38188	0.97	3.1	2.96	1.99	0.934272	29.92
38189	0.97	2.53	3.17	2.2	1.410256	
38190	0.98	2.77	2.93	1.95	1.089385	
38191	0.98	4.08	3.03	2.05	0.661290	
38192	0.97	3.57	3.62	2.65	1.019230	
38193	0.96	3.35	3.13	2.17	0.907949	
38194	0.97	2.85	2.82	1.85	0.984042	
38188-1	0.97	3.32	2.96	1.99	0.846808	29.99
1005	0.97	3.32	2.96	1.99	0.846808	29.18
38189-3	0.97	3.74	3.17	2.2	0.794223	29.1
38189-4	0.97	3.74	3.17	2.2	0.794223	30.41
38190-5	0.96	3.31	2.93	1.97	0.838297	29.19
1006	0.96	3.31	2.93	1.97	0.838297	29.43
38191-7	0.97	3.62	3.03	2.06	0.777358	29.54
38191-8	0.97	3.62	3.03	2.06	0.777358	29.36
38192-9	0.97	4.15	3.62	2.65	0.833333	30.06
1008	0.97	4.15	3.62	2.65	0.833333	28.86
38193-11	0.98	3.63	3.13	2.15	0.811320	28.77
38193-12	0.98	3.63	3.13	2.15	0.811320	29.55
1007	0.98	3.5	2.82	1.84	0.730158	29.33
38194-14	0.98	3.5	2.82	1.84	0.730158	28.99

METHOD: Metals-
Soils, p.2

M5 beaker + soil	M6 mass wet soil	MASS DRY SOIL
1.1	-28.82	-26.9257

32.65	2.66
30.55	1.37
32.03	2.93
33.25	2.84
32.15	2.96
32.77	3.34
32.1	2.56
31.38	2.02
31.73	1.67
31.18	2.32
30.88	2.11
31.9	2.35
31.15	1.82
31.41	2.42
39.67	10.09
38.16	8.47

METHOD: Oil & Grease

OIL AND GREASE

GRAVIMETRIC ANALYSIS

Job No.: _____

Job Name: _____

Analyst: _____

SAMPLE #				
MASS OF EMPTY FLASK				
CONSTANT MASS OF FLASK				
FLASK + RESIDUE				
CONSTANT MASS OF FLASK				
MASS OF EMPTY FLASK				
RESIDUE + FLASK				
MASS OF RESIDUE				
SAMPLE VOLUME				
CONC				

APPENDIX C

APPENDIX C

SOIL BORING AND GROUNDWATER MONITORING WELL
CONSTRUCTION LOGS

GROUNDWATER
TECHNOLOGY, INC

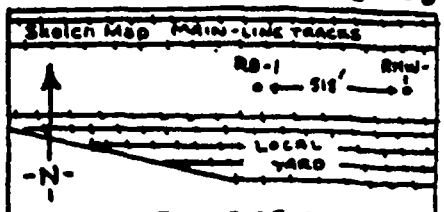
GROUNDWATER TECHNOLOGY

Random
Boring Number RB-1

Drilling Log

Project Conrail II Owner Conrail
Location Elkhart, IN Project Number 402-142-9207
Date Drilled 2/13/89 Total Depth of Hole 20.0' Diameter 8"
T.O.C Elevation N/A Water Level, Initial 10.0' 24-hrs. N/R
Screen: Dia. N/A Length N/A Slot Size N/A
Casing: Dia. N/A Length N/A Type N/A
Drilling Company J. Mathes & Assoc Drilling Method Hollow Stem Auger
Driller Jim Resler Log by Rita Boje

Sketch Map MAIN-LINE TRACKS



LOCATED AT THE WEST END ON THE NORTH SIDE OF THE LOCAL YARD

Notes started: 1530
ended : 1630

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No	S-1*		Black (10YR2/1), med.-crs. SAND AND GRAVEL mixed with coal fragments, poorly sorted, moist.
2–5					Yellowish Brown (10YR5/6), med.-fine SAND with trace gravel, fairly well sorted, moist.
6–10					Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL with some clay, poorly sorted, moist.
10			S-2*		
11–20		Yes	S-3		Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL, no clay present, poorly sorted, wet throughout.
20					End of Boring at 20.0'.
21–26					* Submitted for VOC analysis

02100144

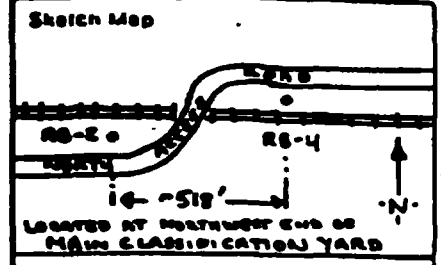
GROUNDWATER TECHNOLOGY

Random
Boring Number RB-2

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/16/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C Elevation: N/A Water Level Initial: 12.0' 24 Hrs: N/A
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J. Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Jim Resler Log By: Rita Boje

Sketch Map



Notes: started: 1400
ended : 1510

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–20	N/A	No	S-1*		Dark Brown (10YR3/3), gradually changing to Yellowish Brown (10YR5/4), SAND AND GRAVEL, well sorted down to 12.0' then poorly sorted thereafter, diesel odor from 2.0' down 14.0', moist down to 12.0', wet thereafter. A fine, well sorted, sand stringer was present at 15.0'-15.25'. Color changed at 3.0' to Grayish Brown (10YR5/2) and Dark Gray (10YR1/1) at 12.0'.
			S-2 Composite		
			S-3 Composite		
10–20		Yes	S-4*		
			S-5		
20					End of Boring at 20.0'.
21–26					* Submitted for VOC analysis

02100144

GROUNDWATER TECHNOLOGY

Random

Boring Number RB-3

Drilling Log

Project: Conrail II — Owner: Conrail

Location: Elkhart, IN — Project Number: 402-142-9207

Date Drilled: 2/16/89 — Total Depth of Hole: 20.0' — Diameter: 8"

T.O.C Elevation: N/A — Water Level, Initial: 12.0' — 24-hrs: N/R

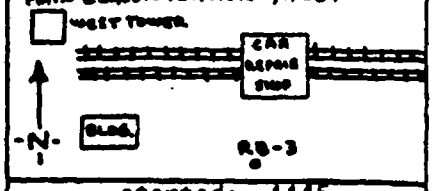
Screen: Dia. N/A — Length: N/A — Slot Size: N/A

Casing: Dia. N/A — Length: N/A — Type: N/A

Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger

Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started: 1145
ended : 1245

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–6	N/A	No	S-1*		Dark Brown (10YR3/3) gradually changing to Yellowish Brown (10YR5/6), med.-crs. SAND with some gravel, fairly well to poorly sorted, moist.
7–12		Yes (slight Yes (strong			Brownish Yellow (10YR6/6), crs. SAND AND GRAVEL with gravel content decreasing downward, poorly sorted, damp to moist.
13–19			S-2* S-3		Brown (10YR5/3), med. SAND, trace silt and gravel, fairly well sorted with gravel content increasing near the base, wet at 12.0'.
20–26					End of Boring at 20.0'. * Submitted for VOC analysis

02100144

0375

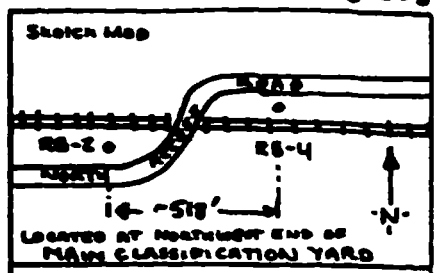
GROUNDWATER TECHNOLOGY

Random
Boring Number RB-4

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/13/89 — Total Depth of Hole: 20.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level Initial: 6.0' — 24 hrs.: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J. Mathes & Assoc. — Drilling Method: Hollow Stem Auger
Driller: Jim Besler — Log by: Rita Baje

Sketch Map



Notes: started: 1325
ended : 1500

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No	S-1*		Dark Brown (10YR3/3), SAND mixed with gravel aggregate, moist.
2–3					Yellowish Brown (10YR5/6), fine-med. SAND, well sorted gradually changing to poorly sorted from 3.5' to 4.0', moist.
4–5		Yes			Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL, poorly sorted, moist down to 6.0', wet thereafter.
6			S-2*		
7–8					
9–15					Yellowish Brown (10YR5/6), fine SAND gradually becoming coarse SAND at 13.0', well to poorly sorted, wet throughout.
16–17			S-3		
18–19					
20					End of Boring at 20.0'.
21–26					* Submitted for Priority Pollutant Analysis

02100144

GROUNDWATER TECHNOLOGY

Drilling Log

Random Boring Number RB-5

Project: Conrail II — Owner: Conrail

Location: Elkhart, IN — Project Number: 402-142-9207

Date Drilled: 2/13/89 — Total Depth of Hole: 8.0' — Diameter: 8"

T.O.C Elevation: N/A — Water Level, Initial: 4.0' — 24-hrs.: N/R

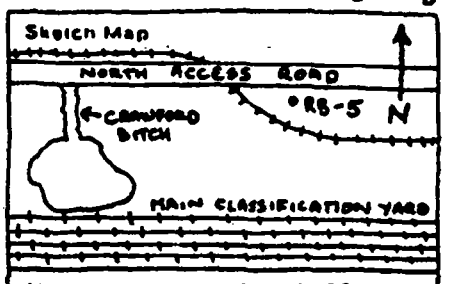
Screen: Dia. N/A — Length: N/A — Slot Size: N/A

Casing: Dia. N/A — Length: N/A — Type: N/A

Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger

Driller: Jim Resler — Log by: Rita Boie

Sketch Map



Notes: started: 1120
ended : 1205

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
	N/A	N/R			Black-stained gravel (not sampled)
1		No	S-1*		Dark Yellowish Brown (10YR3/4), med. SAND mixed with gravel from above with gradual color change to Yellowish Brown (10YR5/6) near base, well sorted.
2					
3					
4			S-2*		Dark Yellowish Brown (10YR4/6), SAND at top 3 inches than abrupt color change to Yellowish Brown (10YR5/6) med. SAND, poorly to moderately well sorted, moist down to 4.0', wet, thereafter.
5					
6		Yes			
7			S-3		Gray (10YR6/1), CLAY, wet.
8					End of Boring at 8.0'.
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					* Submitted for VOC analysis.
21					
22					
23					
24					
25					
26					

02100144

GROUNDWATER TECHNOLOGY

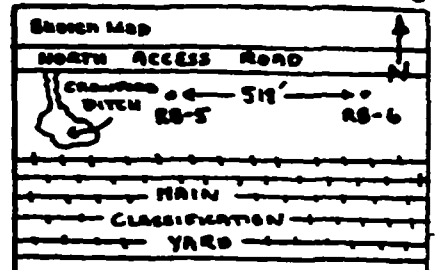
Random

Boring Number RB-6

Drilling Log

Project: Conrail II
Owner: Conrail
Location: Elkhart, IN
Project Number: 402-142-9207
Date Drilled: 2/13/89
Total Depth of Hole: 20.0'
Diameter: 8"
T.O.C Elevation: N/A
Water Level Initial: 6.0'
24 hrs.: N/R
Screen: Dia. N/A
Length: N/A
Slot Size: N/A
Casing: Dia. N/A
Length: N/A
Type: N/A
Drilling Company: J. Mathes & Assoc.
Drilling Method: Hollow Stem Auger
Driller: Jim Resler
Log by: Rita Boje

Sketch Map



Notes: started: 0900
ended : 1055

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structure)
1	N/A	No	S-1*		Dark Brown (10YR3/3) fine SAND mixed with gravel aggregate, moist.
2					Brownish Yellow (10YR6/6) fine SAND, well sorted, moist.
3			S-2		Brown (10YR5/3) to Grayish Brown (10YR5/2), med.-fine SAND with some gravel, well sorted, black stained material present from 3.0'-4.0', moist.
4					
5					Grayish Brown (10YR5/2) to Gray (10YR5/1), med.-crs. SAND, fairly well sorted, trace gravel, moist down to 6.0', wet thereafter.
6			S-3*		
7					
8					
9					Dark Gray (10YR4/1), fine-med. SAND, well sorted, wet.
10		Yes			
11					
12					
13					
14					
15					
16					
17					
18			S-4		Dark Gray (10YR4/1), crs. SAND AND GRAVEL, poorly sorted, slight sewage odor noted, wet.
19					
20					End of Boring at 20.0'.
21					
22					
23					
24					
25					* Submitted for VOC analysis
26					

02100144

GROUNDWATER TECHNOLOGY

Random Boring Number RB-7

Drilling Log

Project: Conrail II Owner: Conrail

Location: Elkhart, IN Project Number: 402-142-9207

Date Drilled: 1-30-89 Total Depth of Hole: 16.5' Diameter: 8"

T.O.C Elevation: N/A Water Level, Initial: 8.0' 24-Hrs: N/R

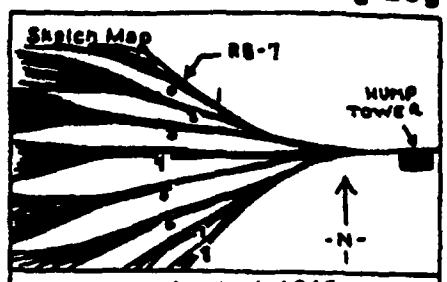
Screen: Dia: N/A Length: N/A Slot Size: N/A

Casing: Dia: N/A Length: N/A Type: N/A

Drilling Company: J. Mathes & Assoc Drilling Method: Hollow Stem Auger

Driller: Jim Resler Log by: Rita Boje

Sketch Map



Notes: started 1345
ended 1650

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No			Dark Yellowish Brown, (10YR4/6) med.-crs. SAND, slight oil staining at surface, few pebbles, moist.
2		Slight			
3		No			Gray, (7.5YR6/1), med.-crs. SAND at 2.25' texture changed to a clayey sand, very stiff, trace iron staining, moist.
4			S-1*		
5					
6		Yes			Gray, (7.5YR6/1), med.-fine SAND, well sorted, trace gravel layer from 6.5' to 8.5', slight diesel odor, wet at 8.0'.
7					
8			S-2*		
9					
10					
11					
12					Gray, (10YR6/1), crs. SAND AND GRAVEL, well sorted, oily sheen on cuttings coming out of the hole, wet.
13					
14					
15					
16			S-3		
17					Gray, (10YR6/1), silty CLAY, wet.
18					End of Boring at 16.5'
19					
20					
21					
22					
23					
24					
25					* Submitted for VOC analysis
26					

02100144

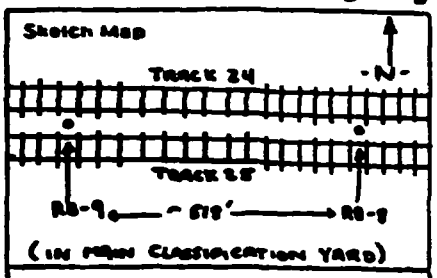
GROUNDWATER TECHNOLOGY

Drilling Log

Random Boring Number RB-8

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 1/31/89 — Total Depth of Hole: 12.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level Initial: 8.0' — 24 Hrs.: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J. Mathes & Assoc. — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started 1355
ended 1455

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate)
2–6		No	S-1*		Strong Brown, (7.5YR5/6) med.-fine SAND with some ballast from above, black staining on the ballast, well sorted sand, with trace of fine gravel from 4.0'-6.0' and color change to light Yellowish Brown (10YR6/4) at 6.0'.
6			S-2		
7–8		Yes			
8–11			S-3*		Light Yellowish Brown (10YR6/4) crs. SAND AND GRAVEL. dark staining from 9.5' to 10.0', poorly sorted, wet.
11			S-4		
12					Gray (10YR6/1) CLAY, wet.
13–26					End of boring at 12.0'.

* Submitted for VOC analysis

02100144

0380

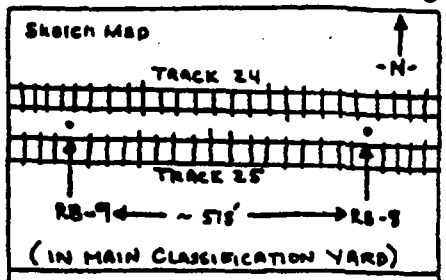
GROUNDWATER TECHNOLOGY

Drilling Log

Random Boring Number RB-9

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 1/31/89 — Total Depth of Hole: 18.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level, Initial: 5.0' — 24-hrs.: N/R
Screen: Dia. N/A — Length N/A — Slot Size N/A
Casing: Dia. N/A — Length N/A — Type N/A
Drilling Company: J. Mathes & Assoc. — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log By: Rita Boje

Sketch Map



Notes: started 1020
ended 1215

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate)
2–6		No	S-1*, S-2*		Yellowish Brown, (10YR5/4), med.-fine SAND with some ballast from above and trace fine gravel, appeared stained with black material, fairy well sorted, texture gradually gets coarser at 4.0'-6.0', moist from 2.0'-5.0', wet at 5.0'.
6–10					Black to Very Dark Brown, (10YR2/1-2/2) med.-crs. SAND, trace fine gravel, poorly sorted, wet color changes to Yellowish Brown, (10YR5/6) at 9.0'.
10–17		Yes	S-3		Yellowish Brown (10YR5/6) crs. SAND AND GRAVEL, poorly sorted, poor recovery, wet.
17–18			S-4		Grayish Brown, (10YR5/2) CLAY, very stiff, wet.
18–26					End of boring at 18.0'.

* Submitted for Priority Pollutants and metals analysis.

02100144

0381

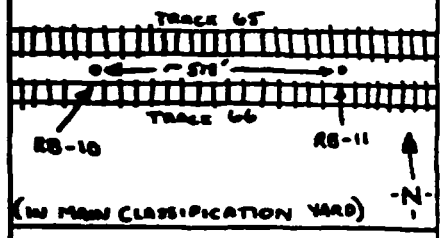
GROUNDWATER TECHNOLOGY

Drilling Log

Random Boring Number RB-10

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/01/89 — Total Depth of Hole: 26.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level Initial: 4.0' — 24 hrs: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started 1520
ended 1750

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate with dark staining on it).
2–3		No	S-1*		Yellowish Brown, (10YR5/4) crs. SAND AND GRAVEL, poorly sorted, moist.
4–5			S-2*		Light Yellowish Brown, (10YR6/4) crs. SAND, trace gravel, somewhat poorly sorted, wet at 4.0'.
6–8		Yes			Yellowish Brown, (10YR5/4) crs. SAND AND GRAVEL, poorly sorted with trace of Strong Brown (7.5YR5/6) clay nodules present, wet.
9–12			S-3		Yellowish Brown, (10YR5/4) crs. SAND, poorly sorted, grading to a fine sand at 11.0' which is well sorted and wet.
13–25					Yellowish Brown (10YR5/4) crs. SAND AND GRAVEL, poorly sorted, wet.
26					End of boring at 26.0'.

02100144 *Submitted for Priority Pollutants and Metals analysis.

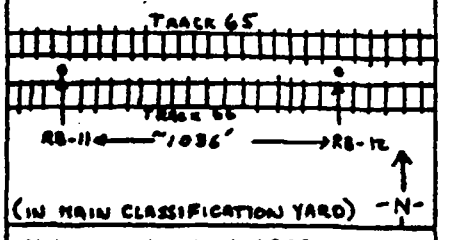
GROUNDWATER TECHNOLOGY

Random Boring Number RB-11

Drilling Log

Project Conrail II Owner Conrail
Location Elkhart, IN Project Number 402-142-9207
Date Drilled 2/01/89 Total Depth of Hole 26.0' Diameter 8"
T.O.C Elevation N/A Water Level, Initial 6'7" 24-hrs N/R
Screen: Dia. N/A Length N/A Slot Size N/A
Casing: Dia. N/A Length N/A Type N/A
Drilling Company J. Mathes & Assoc. Drilling Method Hollow Stem Auger
Driller Jim Resler Log by Rita Boje

Sketch Map



Notes started 1240
ended 1505

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate).
2–6		No → Yes	S-1*		Yellowish Brown (10YR5/8) med.-fine SAND with trace gravel, some ballast from above with black staining near the top, well sorted, color changes to Brownish Yellow (10YR6/6) at 4.0', moist down to 6.58', then wet.
7			S-2*		
8–21			S-3		Yellowish Brown (10YR5/6) crs. SAND AND GRAVEL, poorly sorted, color changes to Brown (10YR5/3) at 12.0', wet.
22–26					Gray (10YR6/1), fine SAND, with trace gravel, densely packed, well sorted, wet.
26					End of boring at 26.0'.

02100144

* Submitted for VOC analysis

0383

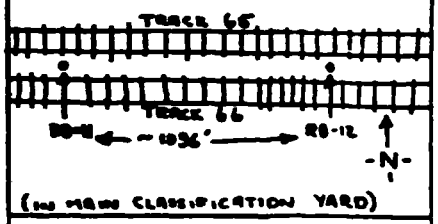
GROUNDWATER TECHNOLOGY

Random Boring Number RB-12

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/01/89 — Total Depth of Hole: 20.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level Initial: 7.0' — 24 hrs.: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J.Mathes & Assoc. — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started 0805
ended 1000

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
	N/A	N/R			BALLAST (large limestone aggregate).
1–6		No	S-1*		Yellowish Brown (1-YR5/6), med.-fine SAND, some ballast from above well to very well sorted, moist.
6–7			▽		Gray (10YR6/1), med.-crs. SAND with some gravel, poorly sorted, wet at 7.0', poor recovery.
8–10		Yes	S-2*		Dark Yellowish Brown (10YR4/4), crs. GRAVEL with some sand, poorly sorted, grading to Yellowish Brown (10YR5/4) med.-crs. SAND with some gravel, poorly sorted, wet.
11–13			S-3		Yellowish Brown (10YR5/4), med. to crs. SAND, well sorted, gravel seam from 10.5' to 11.0', wet.
14–15					Brown (10YR5/3), med.-fine SAND with a silt seam from 14.5' to 15.0', well sorted, wet.
16–18			S-4, S-5		Brown (10YR5/3), fine sand LOAM, with trace of fine gravel, stiff, slight unidentifiable odor at 16.0', wet.
20–26					End of boring at 20.0'.

* Submitted for VOC analysis.

02100144

0384

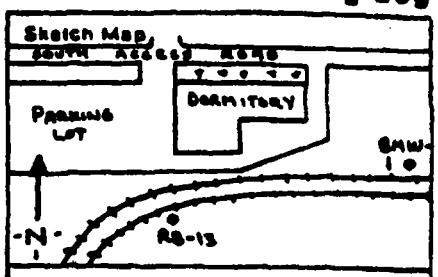
GROUNDWATER TECHNOLOGY

Random

Boring Number RB-13

Drilling Log

Project Conrail II Owner Conrail
Location Elkhart, IN Project Number 402-142-9207
Date Drilled 2/18/89 Total Depth of Hole 20.0' Diameter 8"
T.O.C Elevation N/A Water Level, Initial 4.0' 24-hrs. N/R
Screen: Dia. N/A Length N/A Slot Size N/A
Casing: Dia. N/A Length N/A Type N/A
Drilling Company J.Mathes & Assoc Drilling Method Hollow Stem Auger
Driller Bob Lewis Log by Rita Boje



Notes started: 1150
ended : 1400

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate)
2		No	S-1*		Pale Brown (10YR6/3) changing to Brown (10YR5/3), med.-fine SAND, trace of fine gravel from 4.0'-6.0', some iron staining from 2.0'-4.0', well sorted, moist down to 4.0', wet thereafter. Color changes to Dark Gray (5Y4/1) at 16.0'.
3			▽		
4			S-2*		
5					
6					
7					
8					
9		Yes			
10		No			
11					
12		Yes			
13					
14					
15					
16					
17					
18					
19					
20			S-3		Gray (10YR5/1), loamy, crs. SAND, trace gravel, poorly sorted, wet.
21					End of Boring at 20.0'.
22					
23					* Submitted for VOC analysis
24					
25					
26					

02100144

GROUNDWATER TECHNOLOGY

Drilling Log

Random Boring Number RB-14

Project: Conrail II — Owner: Conrail

Location: Elkhart, IN — Project Number: 402-142-9207

Date Drilled: 2/3/89 — Total Depth of Hole: 20.0' — Diameter: 8"

T.O.C Elevation: N/A — Water Level Initial: 6.0' — 24 hrs: N/R

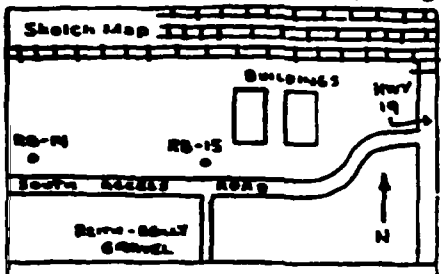
Screen: Dia. N/A — Length: N/A — Slot Size: N/A

Casing: Dia. N/A — Length: N/A — Type: N/A

Drilling Company: J. Mathes & Assoc — Drilling Method: Hollow Stem Auger

Driller: Jim Resler — Log By: Rita Boje

Sketch Map



Notes: started: 1040
ended : 1230

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1		No	S-1*		Dark Brown (10YR3/3), sandy LOAM with organic material, poorly sorted, frozen-moist.
2		Yes (slight)			
3					Brownish Yellow (10YR6/6) fine SAND, trace fine gravel, well sorted, coarse sand and gravel seams from 9.0'-9.5'; 15.5'-16.0'; and 17.5'-18.5', moist down to 6.0', wet thereafter.
4					
5					
6			S-2*		
7		Yes (strong)			
8					
9					
10					
11					
12					
13					
14					
15			S-3		
16					
17					
18					
19					
20					
21					End of Boring at 20.0'.
22					
23					
24					
25					* Submitted for VOC Analysis
26					

02100144

0386

GROUNDWATER TECHNOLOGY

Random Boring Number RB-15

Drilling Log

Project: Conrail II — Owner: Conrail

Location: Elkhart, IN — Project Number: 402-142-9207

Date Drilled: 2/6/89 — Total Depth of Hole: 20.0' — Diameter: 8"

T.O.C Elevation: N/A — Water Level, Initial: 10.0' — 24 hrs: N/R

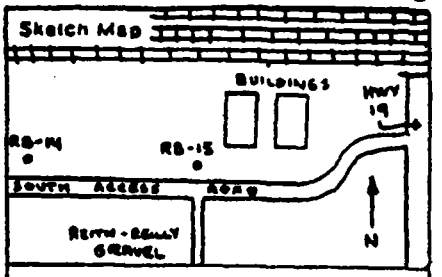
Screen: Dia. N/A — Length: N/A — Slot Size: N/A

Casing: Dia. N/A — Length: N/A — Type: N/A

Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger

Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started: 1500
ended : 1630

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–3		No	S-1*		Dark Brown (10YR3/3) grading to Yellowish Brown (10YR5/8), med. SAND, well sorted, with trace organic material and gravel, moist.
3–10		Yes			Pale Brown (10YR6/3), med.-fine SAND with some gravel seams in it that are well to poorly sorted, a 4-inch clayey gravel was at 4.0'-4.33', the lower portion, well sorted and moist.
10–12		No	S-2*		Yellowish Brown (10YR5/6), loamy SAND, densely packed from 10.0'-10.5', abrupt change to crs. SAND AND GRAVEL from 10.5'-11.0' then abrupt change to a fine SAND, well sorted, wet at 10.0'.
12–20		Yes			Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL, poorly sorted, and wet throughout.
20–26					End of Boring at 20.0'.

* Submitted for Priority Pollutant Analysis.

02100144

0387

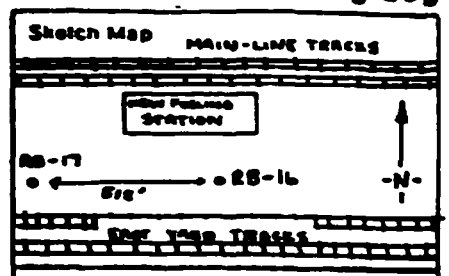
GROUNDWATER TECHNOLOGY

Random Boring Number RB-16

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/19/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C Elevation: N/A Water Level Initial: 14.0' 24-hrs: N/A
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log by: Rita Boje

Sketch Map



Notes: started: 1640
ended : 1800

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–4	N/A	No	S-1*		Dark Brown (10YR4/3), SAND AND FILL MATERIAL, wood chips, trace gravel, plant roots, poorly sorted, moist.
5–9					Dark Yellowish Brown (10YR4/6) gradually changing to Yellowish Brown (10YR5/6), fine SAND, some iron staining, well sorted, moist.
10–13		Yes			Brownish Yellow (10YR6/6), SAND AND GRAVEL, iron staining from 10.0'-12.0', poorly sorted, moist.
14–18			S-2*		Yellowish Brown (10YR5/6), med.-crs. SAND, trace gravel from 14.0'-16.0', fine SAND from 16.0'-18.0', fairly well sorted, wet throughout.
19–20			S-3		Yellowish Brown (10YR5/6), SAND AND GRAVEL, poorly sorted, wet.
21–26					End of Boring at 20.0'.

* Submitted for VOC analysis

02100144

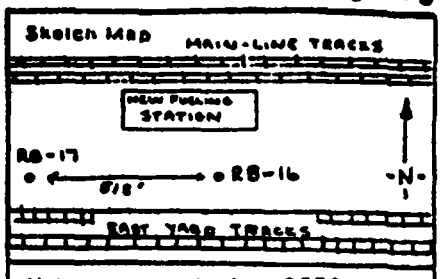
GROUNDWATER TECHNOLOGY

Random
Boring Number RB-17

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/20/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C Elevation: N/A Water Level, Initial: 15.0' 24-hrs: N/R
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log by: Rita Boje

Sketch Map



Notes: started: 0850
ended : 1045

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–6	N/A	N/R			Black (10YR2/1), SAND AND FILL MATERIAL, wood chips, and gravel.
6–7		No	S-1*		
7–14					Olive Brown (2.5Y4/4) changing sharply to Yellowish Brown (10YR5/6) at 8.0', fine-med. SAND, grading to crs. SAND at 17.5', trace gravel between 8.0'-10.0', iron staining from 12.0'-14.0', fairly well sorted, moist down to 15.0', wet therafter.
14–15		Yes			
15–16			S-2*		
16–18					
18–19			S-3		
20–26					End of Boring at 20.0'.

* Submitted for Priority Pollutant analysis

02100144

0389

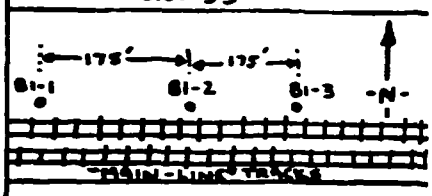
GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-1

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/14/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C Elevation: N/A Water Level Initial: 12.0' 24 hrs.: N/R
Screen Dia.: N/A Length: N/A Slot Size: N/A
Casing Dia.: N/A Length: N/A Type: N/A
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Jim Resler Log by: Rita Baje

Sketch Map — Located North of the West End of Local Yard



Notes: started: 1245
ended : 1445

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
0–1	N/A	Yes			Black cinders and fine sand
1–20			S-1*, S-2*		Yellowish Brown (10YR5/4) changing gradually to Brown (10YR5/3), med.-fine SAND, with trace med.-fine gravel, trace iron staining at 2.0'-4.0', trace clay at 4.0'-5.0', a stringer of black coal/cinders at 3.5'-3.66', well sorted throughout, moist down to 12.0', wet thereafter.
2–4		No			
4–20		Yes			
16–20					Brown (10YR5/3), crs. SAND, trace gravel, poorly sorted, wet.
20–26					End of Boring at 20.0'.

* Submitted for VOC analysis

02100144

0390

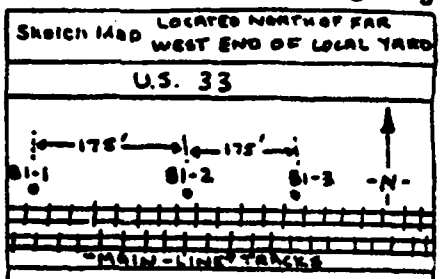
GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-2

Drilling Log

Project Conrail II Owner Conrail
Location Elkhart, IN Project Number 402-142-9207
Date Drilled 2/14/89 Total Depth of Hole 20.0' Diameter 8"
T.O.C Elevation N/A Water Level, Initial 10.0' 24-hrs N/R
Screen: Dia. N/A Length N/A Slot Size N/A
Casing: Dia. N/A Length N/A Type N/A
Drilling Company J.Mathes & Assoc. Drilling Method Hollow Stem Auger
Driller Jim Besler Log by Rita Boje

Sketch Map — LOCATED NORTH OF FAR WEST END OF LOCAL YARD



Notes: started: 1500
ended : 1635

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No			FILL material, black cinders and sand and gravel, moist.
2		Yes			
3		No to slight	S-1*		Dark Brown (10YR3/3), SAND AND GRAVEL, poorly sorted, moist.
4		No			Yellowish Brown (10YR5/8), clayey SAND AND GRAVEL, poorly sorted, moist.
5					
6		Yes			Light Yellowish Brown (10YR6/4), SAND AND GRAVEL, some limestone aggregate present between 6.0'-8.0', very poorly sorted, damp to moist.
7					
8					
9					
10			S-2*		Brown (10YR5/3), fine-med. SAND, trace gravel, with a gravel seam from 12.5' to 13.0', well sorted, wet after 10.0'.
11					
12					
13					
14					
15					
16					
17					
18					
19			S-3		
20					End of Boring at 20.0'.
21					
22					
23					
24					* Submitted for VOC analysis
25					
26					

02100144

0391

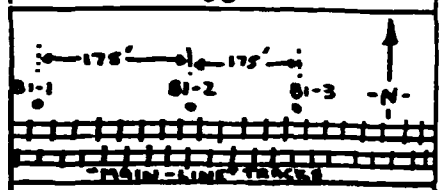
GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-3

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/15/89 Total Depth of Hole: 21.0' Diameter: 8"
T.O.C Elevation: N/A Water Level Initial: 11.5' 24 hrs: N/R
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J.Mathes & Assoc Drilling Method: Hollow Stem Auger
Driller: Jim Resler Log by: Rita Baje

Sketch Map: Located North of the West End of Local Yard
U.S. 33



Notes: started: 0845
ended : 1030

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–3	N/A	Yes (slight); Yes (strong)	S-1*		FILL MATERIAL, black sand, cinders and coarse sand and gravel, poorly sorted, moist.
4–21		No; Yes; No Recovery; No	S-2*		Yellowish Brown (10YR5/4) to Brownish Yellow (10YR6/6), fine to crs. SAND, well sorted gradually changing to poorly sorted at 11.0', trace fine gravel throughout with some limestone aggregate from 5.0'-7.0', moist down to 11.5', wet thereafter.
21–26					End of Boring at 21.0'.

* Submitted for VOC analysis

02100144

0392

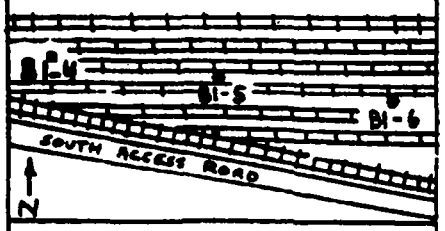
GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-4

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/7/89 — Total Depth of Hole: 20.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level, Initial: 8.0' — 24-hrs: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje

Sketch Map: WEST END / LOCAL YARD



Notes: started: 1210
ended : 1335

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate)
2–6		No	S-1*		Black (10YR2/1), fine SAND and ballast mixed together from 2.0'-3.0', poorly sorted with an abrupt change to Yellowish Brown (10YR5/6), fine to med. SAND at 3.0', well sorted but changing to poorly sorted with trace of gravel and clay at 5.75', moist throughout.
6–8			S-2		Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL, poorly sorted with a Brown (10YR5/3) gravelly clay seam from 6.0' to 6.5', moist.
8–9			S-3*		
9–10					Yellowish Brown (10YR5/6), med.-fine SAND with some gravel, well to poorly sorted, poor recovery, wet at 8.0'.
10–20		Yes			Pale Brown (10YR6/3), crs. SAND, with trace of fine gravel, moderately well sorted, color changing to Brown (10YR5/3) at 12.0', sand becomes coarser at 18.0'-20.0' and poorly sorted, wet throughout.
20–26					End of Boring at 20.0'

* Submitted for Priority Pollutant Analysis

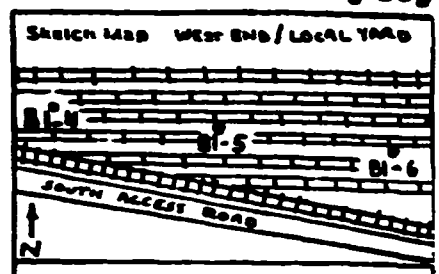
02100144

GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-5

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/7/89 — Total Depth of Hole: 20.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level Initial: 10.0' — 24 hrs: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje



Notes: started: 1440
ended : 1645

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate)
2–10		No	S-1*, S-2		Dark Yellowish Brown (10YR3/4), med. SAND mixed with ballast from 2.0'-2.5' then abrupt change to Yellowish Brown (10Yr5/6), med. SAND, well sorted with trace gravel, color changes to Light Yellowish Brown (10YR6/4) at 8.0', moist throughout.
10–14			Void, S-3*		Brown (10YR5/3), med. SAND, with trace gravel, poorly sorted, wet at 10.0' - poor recovery from 10.0'-13.0'. NOTE: when the split-spoon was placed inside the auger at 10.0', it readily dropped to 13.0' as if a void in the subsurface was present. No sample was obtained.
15–20		Yes			Brown (10YR5/3), fine SAND, no gravel, well sorted from 15.0'-18.0' then gradually changing to a coarse sand and gravel, poorly sorted, wet throughout.
20–26					End of Boring at 20.0'.

* Submitted for VOC Analysis

02100144

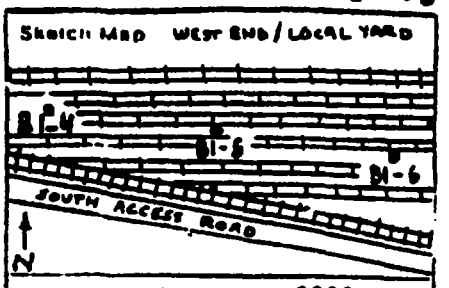
039

GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-6

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/8/89 — Total Depth of Hole: — Diameter: 8"
T.O.C Elevation: N/A — Water Level, Initial: 10.0' — 24-hrs.: N/R
Screen: Dia.: N/A — Length: N/A — Slot Size: N/A
Casing: Dia.: N/A — Length: N/A — Type: N/A
Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje



Notes: started: 0830
ended : 1235

Depth (Feet)	Well Construction		Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate)
2–3		No	S-1*		Dark grayish Brown (10YR4/2), med.SAND mixed with Ballast from above from 2.0'-3.0', then abrupt color change to Yellowish Brown (10YR5/6), at 4.0', relatively well sorted, trace gravel, frozen to moist.
4–5					
6–7					Brown (10YR4/3), med. SAND AND GRAVEL with a clayey seam from 6.0'-6.5', poorly sorted, very moist.
8–9					
10			S-2*		Yellowish Brown (10YR5/6), med. SAND with some gravel, well to poorly sorted, moist down to 10.0', wet, thereafter.
11–12					
13		Yes			
14–15					
16–17					
18–19			S-3		
20					Gray (10YR6/1), CLAY, wet.
21–22					End of Boring at 20.0'.
23–24					
25–26					* Submitted for Priority Pollutant Analysis

02100144

GROUNDWATER TECHNOLOGY

Biased Area 1:

Boring Number B1-7

Drilling Log

Project: Conrail II — Owner: Conrail

Location: Elkhart, IN — Project Number: 402-142-9207

Date Drilled: 2/2/89 — Total Depth of Hole: 20.0' — Diameter: 8"

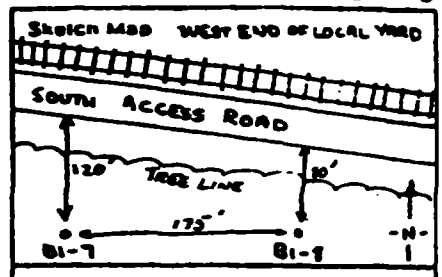
T.O.C Elevation: N/A — Water Level Interval: 8.0' — 24 hrs: N/R

Screen: Dia. N/A — Length: N/A — Slot Size: N/A

Casing: Dia. N/A — Length: N/A — Type: N/A

Drilling Company: J. Mathes & Assoc. — Drilling Method: Hollow Stem Auger

Driller: Jim Resler — Log by: Rita Boje



Notes: started 0930
ended 1155

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No	S-1*		Dark Yellowish Brown (10YR3/4), loamy SAND, with leaves, twigs and plant roots present, moist.
2		Yes			Yellowish Brown (10YR5/8), med.-crs. SAND, poorly sorted, trace gravel, moist.
3					
4					
5					Yellowish Brown (10YR5/4) med.-crs. SAND AND GRAVEL, poorly sorted, gradually getting coarser downward, bands of iron staining from 4.0'-6.0' and at 11.66', trace of organic black sand between 8.0'-10.0', moist down to 8.0', wet thereafter.
6					
7					
8			S-2*		
9					
10					
11					
12			S-3		
13					
14					
15					
16					
17					
18					
19					
20					
21					End of boring at 20.0'.
22					
23					
24					
25					* Submitted for VOC analysis.
26					

02100144

GROUNDWATER TECHNOLOGY

Biased Area 1:

Boring Number B1-8

Drilling Log

Project Conrail II Owner Conrail

Location Elkhart, IN Project Number 402-142-9207

Date Drilled 2/2/89 Total Depth of Hole 20.0' Diameter 8"

T.O.C Elevation N/A Water Level, Initial 8.5' 24-hrs. N/R

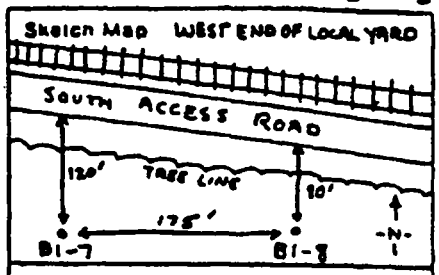
Screen: Dia. N/A Length N/A Slot Size N/A

Casing: Dia. N/A Length N/A Type N/A

Drilling Company J. Mathes & Assoc. Drilling Method Hollow Stem Auger

Driller Jim Resler Log by Rita Boje

Sketch Map



Notes started 1300
ended 1530

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No	S-1*		Dark Yellowish Brown (10YR3/4) loamy SAND with twigs, leaves, plant roots, moist.
2					Yellowish Brown (10YR5/6) fine SAND with some gravel, well sorted, moist.
3					
4		Yes			
5					
6					
7					Dark Yellowish Brown (10YR4/6) crs. SAND AND GRAVEL, poorly sorted, with a Light Yellowish Brown (10YR6/4) fine-crs. sand, poorly sorted from 6.0'-8.0'. Moist down to 8.5', wet thereafter. Small lenses of fine, well sorted sand between 17.5' to 20.0'.
8					
9			S-2*		
10					
11					
12					
13					
14					
15					
16					
17					
18					
19			S-3		
20					
21					End of boring at 20.0'.
22					
23					
24					
25					* Submitted for VOC analysis
26					

02100144

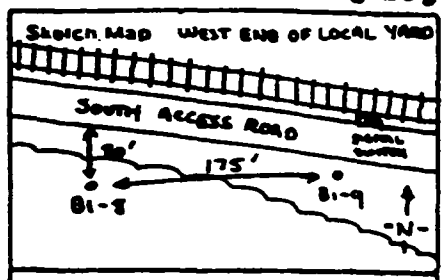
0397

GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-9

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/2-3/89 Total Depth of Hole: 40.0' Diameter: 8"
T.O.C Elevation: N/A Water Level Initial: 8.5' 24 hrs: N/R
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Jim Resler Log by: Rita Boje



Notes: started 1555/0813
ended 1810/0925

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No	S-1*		Dark Yellowish Brown (10YR4/4), loamy SAND with trace gravel and organic material, moist.
2					Yellowish Brown (10YR5/6) fine SAND, trace gravel, poorly sorted, moist.
3		Yes			
4					
5					
6					
7					Brownish Yellow (10YR6/6), crs. SAND AND GRAVEL, poorly sorted, with a med.-crs. sand seam, fairly well sorted from 13.0'-14.0', and a sandy loam from 19.75'-20.0', damp to moist down to 8.5', wet thereafter.
8			S-2*		
9			S-3d*		
10					
11					
12					
13					
14					
15					
16					
17					
18					
19			S-4		
20					
21					Not sampled.
22					
23					
24		Yes			Brownish Yellow (10YR6/6), crs. SAND with gravel, fairly well sorted, wet.
25					
26					

02100144

GROUNDWATER TECHNOLOGY

Biased Area 1:
Boring Number B1-9

Drilling Log

Project Conrail II Owner Conrail
Location Elkhart, IN Project Number 402-142-9207
Date Drilled 2/2-3/89 Total Depth of Hole 40.0' Diameter 8"
T.O.C Elevation N/A Water Level, Initial 8.5' 24-hrs. N/R
Screen: Dia. N/A Length N/A Slot Size N/A
Casing: Dia. N/A Length N/A Type N/A
Drilling Company J.Mathes & Assoc Drilling Method Hollow Stem Auger
Driller Jim Resler Log by Rita Boje

Sketch Map

See Previous Page

Notes started 1555/0815
ended 1810/0925

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
28	N/A				Not sampled.
29		Yes			Brownish Yellow (10YR6/6), crs. SAND, with gravel, fairly well sorted, wet.
30					
31					
32					Not sampled.
33					
34		Yes			Brownish Yellow (10YR6/6), crs. SAND, with gravel, fairly well sorted, wet.
35					
36					
37					Not sampled.
38					
39		Yes			Brownish Yellow (10YR6/6), crs. SAND, with gravel, fairly well sorted, wet.
40					
					End of boring at 40.0'.
					* Submitted for Priority Pollutants and Metals analysis. S-3d was taken as a duplicate sample.

02100144

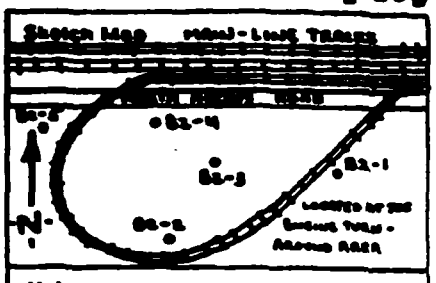
GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number 82-1

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/20/89 Total Depth of Hole: 21.0' Diameter: 8"
T.O.C Elevation: N/A Water Level Initial: 9.0' 24-hrs.: N/A
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J. Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log by: Rita Boje

Sketch Map



Notes: started: 1055
ended : 1210

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–2	N/A	N/R	S-1*		Black (10YR2/1), LOAMY SAND mixed with gravel, wood chips, plant roots, hit an old RR tie from 0.5'-1.0' (drilled thru it), poorly sorted, moist.
3–5		NO	S-2**		Yellowish Brown (10YR5/6), med. SAND grading to a firm SANDY LOAM, strong creosote odor, black staining throughout, fairly well sorted, moist.
6–8					Dark Brown (10YR3/3), CLAYEY SAND AND GRAVEL, slight creosote odor present, poorly sorted, moist.
9–14		Yes	S-3*		Grayish Brown (2.5Y5/2), fine-crs. SAND, trace gravel from 7.0'-8.5', well to poorly sorted, moist down to 9.0', wet thereafter.
15–16			S-4		Gray (10YR5/1), crs. SAND AND GRAVEL, large clay chunk at 15.58', poorly sorted, wet.
17–19					Gray (10YR5/1), fine SAND, well sorted, wet.
20–21			S-5		Gray (10YR5/1), CLAY, wet.
22–26					End of Boring at 21.0'.

* Submitted for VOC analysis
** Submitted for Priority Pollutant analysis

02100144

0400

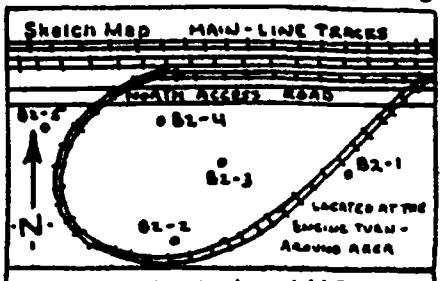
GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-2

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/20/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C Elevation: N/A Water Level, Initial: 6.0' 24-hrs: N/R
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log by: Rita Boje

Sketch Map



Notes: started: 1410
ended : 1550

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate).
2–6		No	S-1*		Dark Brown (10YR3/3), med.-fine SAND, gradually getting coarser at 6.0', trace of fine gravel from 6.0'-8.0', fairly well sorted, moist down to 6.0', wet thereafter.
5–6		Yes			
6			S-2		
7–11					
11–14					Yellowish Brown (10YR5/4), CLAYEY SAND AND GRAVEL, poorly sorted, wet.
14–15					Gray (10YR5/1), fine SAND with gradual change to a SANDY LOAM, well sorted, wet.
16–19			S-3		Gray (10YR5/1), SANDY LOAM, well sorted, compact, with some clay present, wet.
20					End of Boring at 20.0'.
21–26					* Submitted for VOC analysis

02100144

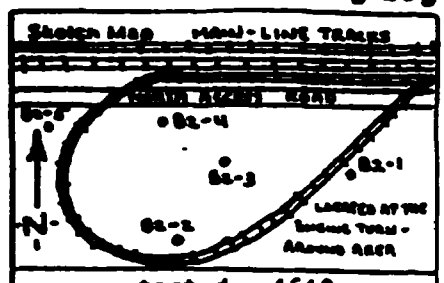
0401

GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-3

Drilling Log

Project	Conrail II	Owner	Conrail
Location	Elkhart, IN	Project Number	402-142-9207
Date Drilled	2/20/89	Total Depth of Hole	17.0'
Diameter	8"		
T.O.C Elevation	N/A	Water Level Initial	9.0'
24 hrs	N/R		
Screen: Dia.	N/A	Length	N/A
Slot Size	N/A		
Casing: Dia.	N/A	Length	N/A
Type	N/A		
Drilling Company	J.Mathes & Assoc.	Drilling Method	Hollow Stem Auger
Driller	Bob Lewis	Log by	Rita Boje



Notes: started: 1610
ended : 1735

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R	S-1*		Brown (10YR5/3), med. SAND, mixed with gravel and cinders, poorly sorted, moist.
2–4					Split spoon hit an old buried RR tie, augered this segment to move the tie-no sample collected.
5–6		No			Light Brownish Gray (10YR6/2) gradually changing to Yellowish Brown (10YR5/4), crs. SAND with fine SAND layers at 5.0'-7.0' and 13.0'-16.5', trace gravel between 9.0'-11.0', well to poorly sorted, moist down to 9.0', wet thereafter.
7–15		Yes	S-2*		
16			S-3		
17					Gray (10YR5/1), CLAY, wet.
18–26					End of Boring at 17.0'.

* Submitted for VOC analysis

02100144

0402

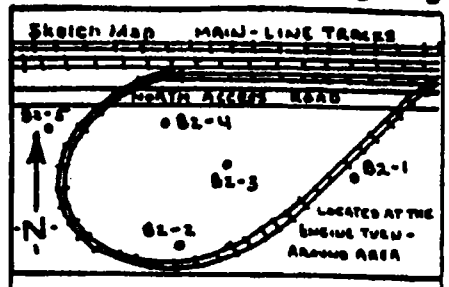
GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-4

Drilling Log

Project: Conrail II Owner: Conrail
Location: Elkhart, IN Project Number: 402-142-9207
Date Drilled: 2/21/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C Elevation: N/A Water Level, Initial: 7.0' 24-hrs: N/R
Screen: Dia. N/A Length: N/A Slot Size: N/A
Casing: Dia. N/A Length: N/A Type: N/A
Drilling Company: J. Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log by: Rita Boje

Sketch Map



Notes: started: 0845
ended : 1040

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–20	N/A	No	S-1*		Black (10YR2/1), gradually changing to Dark Yellowish Brown (10YR4/4), med. SAND, some gravel, well sorted, moist.
7–20		Yes	S-2*		Yellowish Brown (10YR5/6) to Brownish Yellow (10YR6/6), fine-med. SAND, trace gravel from 4.0'-6.0', well sorted, moist down to 7.0', wet thereafter.
20–26					End of Boring at 20.0'.

* Submitted for VOC analysis

02100144

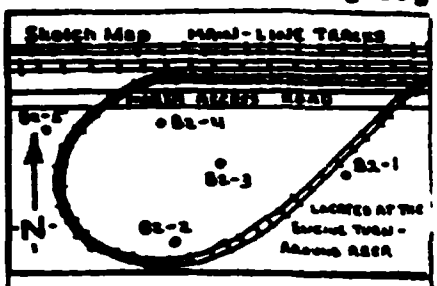
0403

GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-5

Drilling Log

Project	Conrail II	Owner	Conrail
Location	Elkhart, IN	Project Number	402-142-9207
Date Drilled	2/21/89	Total Depth of Hole	20.0'
Diameter	8"		
T.O.C Elevation	N/A	Water Level Initial	8.0'
24 hrs	N/R		
Screen: Dia.	N/A	Length	N/A
Slot Size	N/A		
Casing: Dia.	N/A	Length	N/A
Type	N/A		
Drilling Company	J. Mathes & Assoc.	Drilling Method	Hollow Stem Auger
Driller	Bob Lewis	Log by	Rita Boje



Notes: started: 1100
ended : 1210

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classdication (Color, Texture, Structures)
1–7	N/A	No	S-1*		Dark Brown (10YR5/3) gradually changing to Grayish Brown (10YR5/2), med.-crs. SAND, trace gravel between 0.0'-2.0' and 12.0'-14.0', moist down to 8.0', wet thereafter.
8–9		Yes	S-2*		
10–13					
14–17					Gray (10YR5/1), fine SANDY LOAM, well sorted, wet.
18–20			S-3		Gray (10YR5/1), SAND AND GRAVEL, poorly sorted, wet.
21–26					End of Boring at 20.0'.

* Submitted for Priority Pollutant analysis

02100144

0404

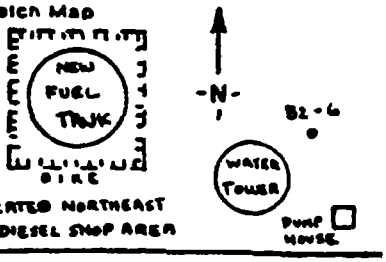
GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-6

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/17/89 — Total Depth of Hole: 14.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level, Initial: 6.0' — 24-hrs: N/A
Screen: Dia. N/A — Length N/A — Slot Size N/A
Casing: Dia. N/A — Length N/A — Type N/A
Drilling Company: J.Mathes & Assoc — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started: 1640
ended : 1730

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	No	S-1*		Black (10YR2/1), fine SAND AND GRAVEL, well sorted, moist.
2–5					Yellowish Brown (10YR5/6) gradually changing to Brown (10YR5/3), med.-fine SAND, well sorted, trace gravel from 6.0'-8.0', color changes to Gray (10YR5/1) between 6.0'-8.0', moist down to 6.0', wet thereafter.
6–7			S-2*		
8–12					
13		Yes	S-3		
14					Gray (10YR6/1), CLAY, wet.
15–26					End of Boring at 14.0'.

* Submitted for VOC analysis

02100144

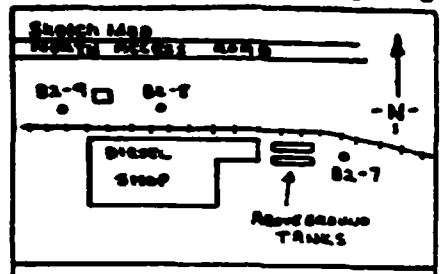
0405

GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-7

Drilling Log

Project: Conrail II
Owner: Conrail
Location: Elkhart, IN
Project Number: 402-142-9207
Date Drilled: 2/17/89
Total Depth of Hole: 21.0'
Diameter: 8"
T.O.C Elevation: N/A
Water Level Initial: ?
24 hrs: N/R
Screen: Dia. N/A
Length: N/A
Slot Size: N/A
Casing: Dia. N/A
Length: N/A
Type: N/A
Drilling Company: J.Mathes & Assoc
Drilling Method: Hollow Stem Auger
Driller: Jim Resler
Log by: Rita Boje



Notes: started: 1540
ended : 1630

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1–19	N/A	N/R			BALLAST (large limestone aggregate mixed with Black sand. Borehole appears to be located in an old tank excavation. No natural material was encountered until 19.0').
19–20		Yes	S-1*		Gray (10YR6/1), CLAY with diesel odor, wet.
21–26					End of Boring at 21.0'.

* Submitted for VOC analysis

02100144

0406

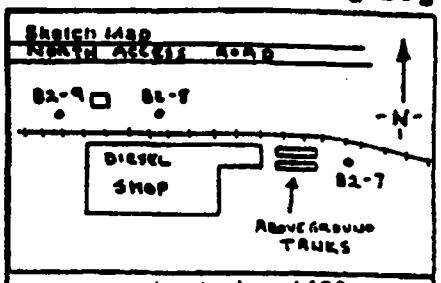
GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-8

Drilling Log

Project Conrail II Owner Conrail
Location Elkhart, IN Project Number 402-142-9207
Date Drilled 2/17/89 Total Depth of Hole 16.0' Diameter 8"
T.O.C Elevation N/A Water Level, Initial 10.0' 24-hrs N/R
Screen: Dia. N/A Length N/A Slot Size N/A
Casing: Dia. N/A Length N/A Type N/A
Drilling Company J Mathes & Assoc. Drilling Method Hollow Stem Auger
Driller Jim Besler Log by Rita Boie

Sketch Map



Notes started: 1430
ended : 1530

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (limestone gravel for parking area)
2–3		No	S-1*		Black (10YR2/1), SAND AND GRAVEL, poorly sorted, moist.
4–7			S-2 Composite down to 12'		Olive Yellow (2.5Y6/6) gradually changing to Light Brownish Gray (2.5Y6/2), fine SAND to 10.0', crs. SAND thereafter, well sorted, strong diesel odor to 8.0', wet with diesel fuel from 8.0'-10.0', wet with diesel fuel and water thereafter.
8–12			S-3*		
13–14					
15–16		Yes	S-4		Gray (10YR5/1), CLAY, wet.
17–26					End of Boring at 16.0'.

* Submitted for VOC analysis

02100144

0407

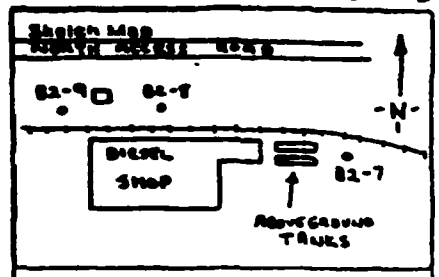
GROUNDWATER TECHNOLOGY

Biased Area 2:
Boring Number B2-9

Drilling Log

Project: Conrail II — Owner: Conrail
Location: Elkhart, IN — Project Number: 402-142-9207
Date Drilled: 2/17/89 — Total Depth of Hole: 16.0' — Diameter: 8"
T.O.C Elevation: N/A — Water Level Initial: 12.0' — 24 hrs: N/R
Screen: Dia. N/A — Length: N/A — Slot Size: N/A
Casing: Dia. N/A — Length: N/A — Type: N/A
Drilling Company: J. Mathes & Assoc — Drilling Method: Hollow Stem Auger
Driller: Jim Resler — Log by: Rita Boje

Sketch Map



Notes: started: 1150
ended : 1300

Depth (Feet)	Well Construction	HCL RX?	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
1	N/A	N/R			BALLAST (large limestone aggregate mixed with fill sand).
2–10		No	S-1*		Black (10YR2/1) gradually changing to Yellowish Brown (10YR5/6), fine SAND, color changing sharply at 7.0' to Dark Gray (10YR4/1), well sorted, strong diesel odor throughout, moist.
7–9			S-2 Composite		
10–12		Yes	S-3*		Dark Gray (10YR4/1), crs. SAND AND GRAVEL, poorly sorted, wet with diesel fuel from 10.0'-12.0', wet with diesel fuel and water from 12.0' downward.
14					Dark Gray (10YR4/1), fine SAND, well sorted, wet with diesel and water.
15–16			S-4		Gray (10YR5/1), CLAY, wet.
17–26					End of Boring at 16.0'.

* Submitted for Priority Pollutant analysis

02100144

0408

GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM WELL NUMBER: RMW-1

PROJECT: Conrail II OWNER: Conrail

LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207

Date Drilled: 2/13/89 Total Depth of Hole: 20.0' Diameter: 8"

T.O.C. Elev.: 737.98 Water Level, Initial: 10.0' 24-Hours: 12.75'

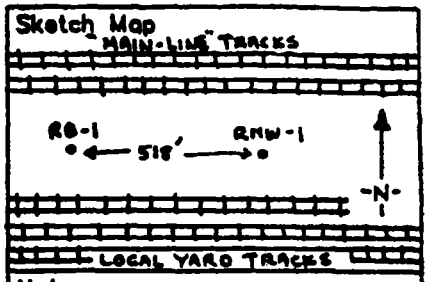
Screen: Dia.: 2" Length: 10.0' Slot Size: 0.010"

Casing: Dia.: 2" Length: 10.92' Type: SS

Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger

Driller: Jim Resler Log By: Rita Boje

Sketch Map



Notes
started: 2/13/89 1700
ended : 2/14/89 1000

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect Cover			Ground Elevation: 736.58
1, 2		Cement Grout	S-1*		FILL MATERIAL, sand, gravel and cinders, poorly sorted, and moist. No reaction to HCL.
3, 4			S-2		Dark Brown (10YR3/3), med. SAND changing color to Yellowish Brown (10YR5/6) at 3.5', fairly well sorted, moist. No reaction to HCL.
5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15		Bentonite Pellets; Silica Sand	S-3*		Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL with some clay mixed in it from 5.0'-6.0', and a med. sand seam at 9.75' to 10.0', very poorly sorted, moist down to 10.0', wet thereafter. No reaction to HCL down to 6.0', strong reaction after 6.0'.
16, 17, 18, 19, 20					Yellowish Brown (10YR5/6), fine-med. SAND, well sorted, wet. Strong reaction to HCL.
					End of Boring at 20.0'.
					* Submitted for VOC analysis

Detailed by EAW

0409

GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM WELL NUMBER: RMW-2

PROJECT: Conrail II — OWNER: Conrail

LOCATION: Elkhart, IN — PROJECT NO.: 402-142-9207

Date Drilled: 2/16/89 — Total Depth of Hole: 20.0' — Diameter: 8"

T.O.C. Elev.: 740.80 — Water Level, Initial: 12.0' — 24-Hours: 13.68'

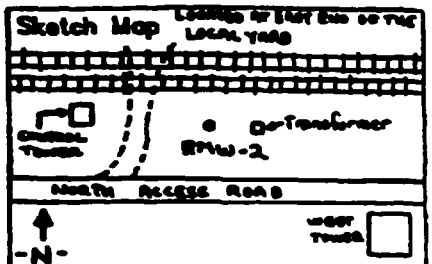
Screen: Dia.: 2" — Length: 10.0' — Slot Size: 0.010"

Casing: Dia.: 2" — Length: 10.39' — Type: SS

Drilling Company: J.Mathes & Assoc. — Drilling Method: Hollow Stem Auger

Driller: Jim Resler — Log By: Rita Boje

Sketch Map



Notes: started: 0906; ended: 1133

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect. Cover			Ground Elevation: 739.25
1, 2, 3, 4, 5, 6, 7, 8		Cement Grout; Bentonite Pellets	S-1*		Yellowish Brown (10YR5/6) to Brownish Yellow (10YR6/6), med.-fine SAND, fairly well sorted, moist. No reaction to HCL.
9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19		Silica Sand; Natural Sand and Gravel	S-2* ; S-3		Yellowish Brown (10YR5/6), SAND AND GRAVEL, poorly sorted, moist down to 12.0', wet thereafter. Strong reaction to HCL below 9.5'.
20					End of Boring at 20.0'. * Submitted for VOC analysis

Detailed by EAW

0410

GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM WELL NUMBER: RMW-3

JECT: Conrail II OWNER: Conrail

LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207

Date Drilled: 2/16/89 Total Depth of Hole: 20.0' Diameter: 8"

T.O.C. Elev.: 741.59 Water Level, Initial: 11.5' 24-Hours: 13.05'

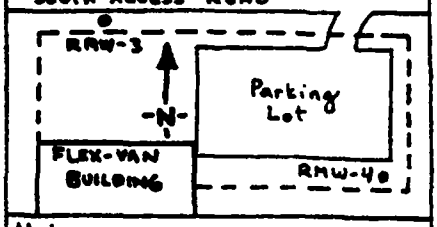
Screen: Dia.: 2" Length: 10.0' Slot Size: 0.010"

Casing: Dia.: 2" Length: 9.67' Type: SS

Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger

Driller: Jim Resler Log By: Rita Boje

Sketch Map



Notes started: 1520
ended : 1715

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect. Cover			Ground Elevation: 739.86
0–20		Cement Grout; Bentonite Pellets; Silica Sand; Natural Sand and Gravel	S-1*; S-2*; S-3		Dark Yellowish Brown (10YR4/6) gradually changing to Yellowish Brown (10YR5/6), fine-med. SAND, trace gravel, well sorted to 6.0', poorly sorted thereafter, moist down to 11.5' and wet thereafter. No reaction to HCL between 0-3.5' and 4.0'-5.5'. Slight reaction to HCL between 3.5'-4.0' and 5.5'-10.0'. Strong reaction to HCL after 10.0'.
15–20					Yellowish Brown (10YR5/6), drs. SAND AND GRAVEL, poorly sorted, wet. Strong reaction to HCL.
20					End of Boring 20.0'.

* Submitted for VOC analysis

Detailed by EAW

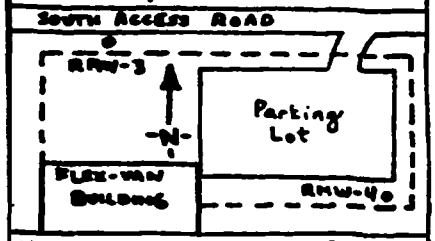
GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM
WELL NUMBER: RMW-4

PROJECT: Conrail II OWNER: Conrail
LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207
Date Drilled: 2/16/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C. Elev.: 744.67 Water Level, Initial: 14.0' 24-Hours: 14.40'
Screen: Dia.: 2" Length: 10.0' Slot Size: 0.010"
Casing: Dia.: 2" Length: 12.73' Type: SS
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Jim Resler Log By: Rita Boje

Sketch Map



Notes started: 1735
ended : 1830

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect Cover			Ground Elevation: 742.66
0–1			S-1*		Dark Yellowish Brown (10YR4/4) changing to Yellowish Brown (10YR5/4), fine SAND, well sorted, moist. No reaction to HCL.
1–20		Cement Grout; Bentonite Pellets; Silica Sand	S-2*		Yellowish Brown (10YR5/6), crs. SAND AND GRAVEL, some clay present between 6.0'-8.0' and 12.0'-14.0', iron staining from 14.0'-16.0', poorly sorted throughout, moist down to 14.0', wet thereafter. No reaction to HCL down to 7.0'. Slight reaction to HCL between 7.0'-9.0'. Strong reaction to HCL after 9.0'.
20					End of Boring at 20.0'.

* Submitted for VOC analysis

Detailed by EAW

0412

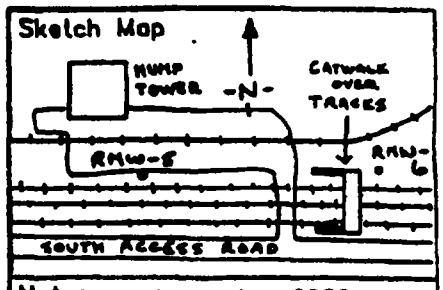
GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM
WELL NUMBER: RMW-5

PROJECT: Conrail II OWNER: Conrail
LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207
Date Drilled: 2/19/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C. Elev.: 745.16 Water Level, Initial: 4.5' 24-Hours: 9.31'
Screen: Dia.: 2" Length: 15.0' Slot Size: 0.010"
Casing: Dia.: 2" Length: 6.07' Type: SS
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log By: Rita Boje

Sketch Map



Notes started: 0930
ended : 1115

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect. Cover			Ground Elevation: 743.07
0, 1		Bentonite Pellets			BALLAST (large limestone aggregate)
3, 4, 5			S-1*, S-2*		Yellowish Brown (10YR5/3) changing to Dark Gray (10YR4/1) at 3.5', med. SAND, trace gravel, well to poorly sorted, moist down to 4.5', wet between 4.5'-6.0'. No reaction to HCL.
6, 7					Black (10YR2/1), loamy SAND, appears to be like an old top soil layer, fairly well sorted, wet. No reaction to HCL.
8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18		Silica Sand; Natural Sand	S-3*, S-4		Dark Gray (10YR4/1), med.-crs. SAND, trace of fine gravel between 8.0'-10.0' and 14.0'-16.0' and a fine loamy sand seam from 7.0'-7.25', well sorted, moist down to 10.0', wet thereafter. No reaction to HCL down to 12.0', strong reaction to HCL after 12.0'.
20					End of Boring at 20.0'.

* Submitted for Priority Pollutant analysis

Detailed by EAW

0413

GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM WELL NUMBER: RMW-6

PROJECT: Conrail II OWNER: Conrail

LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207

Date Drilled: 2/18/89 Total Depth of Hole: 20.0' Diameter: 8"

T.O.C. Elev.: 746.12 Water Level, Initial: 5.0' 24-Hours: 12.67

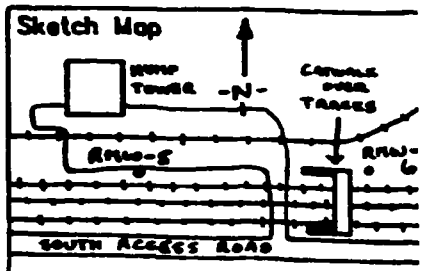
Screen: Dia.: 2" Length: 15.0' Slot Size: 0.010"

Casing: Dia.: 2" Length: 5.98' Type: SS

Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger

Driller: Jim Resler Log By: Rita Boje

Sketch Map



Notes started: 1540
ended : 1800

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect Cover			Ground Elevation: 744.02
1					BALLAST (large limestone aggregate)
2, 3, 4, 5, 6		Bentonite Pellets	S-1*, S-2*		Yellowish Brown (10YR5/4) gradually changing to Dark Grayish Brown (2.5Y5/2), fine-med. SAND, trace gravel, well sorted, moist down to 5.0', wet from 5.0'-6.0'. Strong reaction to HCL.
7, 8, 9		Silica Sand			Dark Grayish Brown (2.5Y4/2), fine SAND, very compacted, trace fine gravel, some clay near base, wet to very moist. Strong reaction to HCL between 6.0'-7.0'. No reaction to HCL between 7.0'-8.0'.
10, 11, 12, 13, 14, 15, 16, 17, 18, 19		Natural Sand	S-3*		Grayish Brown (2.5Y5/2), med.-fine SAND, well sorted, moist from 8.0'-11.0', wet thereafter. Color changed to Light Brownish Gray (10YR6/2) at 12.0'-20.0'. No reaction to HCL between 8.0'-12.0'. Strong reaction to HCL after 12.0'.
20					End of Boring at 20.0'.

* Submitted for VOC analysis.

Detailed by EAW

6 0414

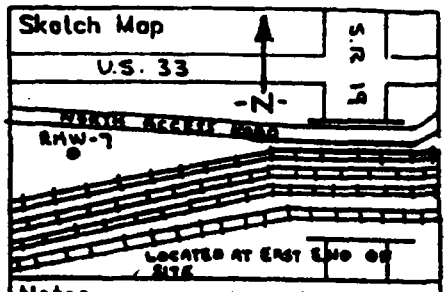
GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

RANDOM
WELL NUMBER: RMW-7

OJECT: Conrail II OWNER: Conrail
LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207
Date Drilled: 2/19/89 Total Depth of Hole: 26.0' Diameter: 8"
T.O.C. Elev.: 754.74 Water Level, Initial: 20.0' 24-Hours: 21.75
Screen: Dia.: 2" Length: 10.0' Slot Size: 0.010"
Casing: Dia.: 2" Length: 16.85' Type: SS
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log By: Rita Boje

Sketch Map



Notes started: 1215
ended : 1345

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect. Cover			Ground Elevation: 753.14
1, 2, 3, 4, 5, 6, 7		Cement Grout	S-1*		Brown (10YR4/3) gradually changing to Yellowish Brown (10YR5/6), med.-crs. SAND, trace gravel, some iron staining and black mottling, fairly well to poorly sorted, moist to damp. No reaction to HCL.
8, 9, 10					Yellowish Brown (10YR5/6), CLAYEY SAND AND GRAVEL, poorly sorted, moist. No reaction to HCL.
11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22		Bentonite Pellets; Silica Sand	S-2*		Yellowish Brown (10YR5/6), SAND AND GRAVEL, no clay present, some iron staining, poorly sorted, moist down to 20.0', wet thereafter. No reaction to HCL down to 12.75', strong reaction to HCL thereafter.

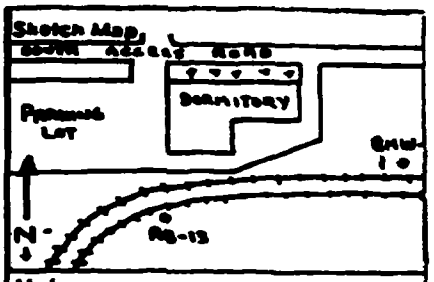
Detailed by EAW

GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

BIASED
WELL NUMBER: BMW-1

PROJECT: Conrail II OWNER: Conrail
LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207
Date Drilled: 2/18/89 Total Depth of Hole: 8.0' Diameter: 8"
T.O.C. Elev.: 741.62 Water Level, Initial: 4.0' 24-Hours: 5.39'
Screen: Dia.: 2" Length: 5.0' Slot Size: 0.010"
Casing: Dia.: 2" Length: 5.9' Type: SS
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Jim Resler Log By: Rita Boje



Notes started: 0950
ended : 1050

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect Cover			Ground Elevation: 739.54
1			S-1*		Black (10YR2/1), loamy SAND with plant roots, fairly well sorted, moist. No reaction to HCL.
2, 3		Bentonite Pellets			Dark Grayish Brown (10YR4/2), SANDY CLAY LOAM, poorly sorted, moist. No reaction to HCL.
4, 5			S-2*		Grayish Brown (2.5Y5/2), crs. SAND, trace silt and some gravel, poorly sorted, moist down to 4.0', wet thereafter. No reaction to HCL.
6, 7, 8		Silica Sand	S-3		Gray (10YR5/1), CLAY, wet. No reaction to HCL down to 6.0'. Strong reaction to HCL after 6.0'.
9					End of Boring at 9.0'.
10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20					* Submitted for VOC analysis

Detailed by EAW

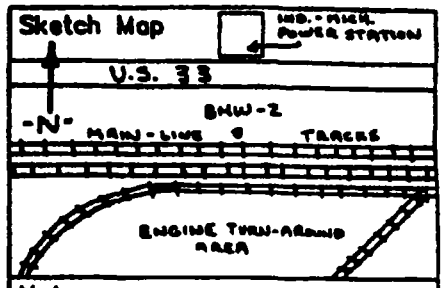
GROUNDWATER TECHNOLOGY, INC.

DRILLING LOG

BIASED
WELL NUMBER: BMW-2

F. JECT: Conrail II OWNER: Conrail
LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207
Date Drilled: 2/21/89 Total Depth of Hole: 20.0' Diameter: 8"
T.O.C. Elev.: 746.21 Water Level, Initial: 10.0' 24-Hours: 11.54
Screen: Dia.: 2" Length: 10.0' Slot Size: 0.010"
Casing: Dia.: 2" Length: 8.61' Type: SS
Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger
Driller: Bob Lewis Log By: Rita Boje

Sketch Map



Notes started: 1530
ended : 1715

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1, 0		Protect. Cover			Ground Elevation: 744.72
1		Cement Grout			BALLAST (large limestone aggregate)
2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18		Bentonite Pellets; Silica Sand	S-1*; S-2*		Dark Brown (10YR3/3) gradually changing to Yellowish Brown (10YR5/6), med.-crs. SAND, some gravel and cinders from 2.0'-2.5', some iron staining from 2.0'-8.0', trace gravel from 4.0'-6.0', small band of coal and pebbles at 13.75', poorly sorted from 2.0'-6.0', well sorted thereafter, moist down to 10.0', wet thereafter, no reaction to HCL down to 11.75', strong reaction thereafter.
19			S-3		Gray (10YR5/1), CLAY, wet, strong reaction to HCL.
20					End of Boring at 20.0'.

* Submitted for VOC analysis

Detailed by EAW

0417

GROUNDWATER TECHNOLOGY, INC.

BIASED

DRILLING LOG

WELL NUMBER: BMW-3

PROJECT: Conrail II OWNER: Conrail

LOCATION: Elkhart, IN PROJECT NO.: 402-142-9207

Date Drilled: 2/15/89 Total Depth of Hole: 20.0' Diameter: 8"

T.O.C. Elev.: 738.48 Water Level, Initial: 6.5' 24-Hours: 9.71'

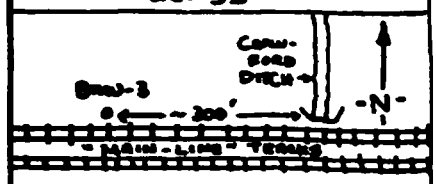
Screen: Dia.: 2" Length: 10.0' Slot Size: 0.010"

Casing: Dia.: 2" Length: 6.22' Type: SS

Drilling Company: J.Mathes & Assoc. Drilling Method: Hollow Stem Auger

Driller: Jim Resler Log By: Rita Boje

Sketch Map



Notes started: 1115
ended : 1515

Depth in Feet	Well Construction	Notes	Sample Number	Graphic Log	Description/Soil Classification (Color, Texture, Structures)
2, 1		Protect. Cover			Ground Elevation: 737.08
0, 1		Cement Grout			FILL MATERIAL, black cinders, sand and gravel, poorly sorted, moist. No reaction to HCL.
2, 3, 4, 5, 6, 7		Bentonite Pellets	S-1*, S-2*		Dark Brown (10YR4/3), to Black (10YR2/1), med.-crs. SAND mixed with some cinders from above from 2.5'-4.0', gradually changing from poorly sorted to well sorted at 5.5', color changes to Grayish Brown (10YR5/2) at 6.0', moist down to 6.5', wet thereafter. No reaction to HCL.
8, 9, 10, 11, 12, 13, 14		Silica Sand			Gray (10YR5/1), crs. SAND AND GRAVEL, poorly sorted, with Olive Brown (2.5Y4/4), mottling between 13.0' and 14.0', wet throughout. Strong reaction to HCL below 8.0'.
15, 16, 17		Allowed natural sand to fill this void			Gray (10YR5/1), fine SAND, well sorted, wet. Strong reaction to HCL.
18, 19			S-3		Gray (10YR5/1), CLAY, wet. Strong reaction to HCL.
20					End of Boring at 20.0'.

* Submitted for Priority Pollutant Analysis.

Detailed by EAW

APPENDIX D