102702

FINAL INTERM WORK PLAN FOR BERKS SAND PIT SITE

Longswamp Township, Pennsylvania

Contract Number 68-W8-0085
Work Assignment 85-03-3N64

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Prepared for:
U.S. Environmental Protection Agency
ARCS Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

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1. INTRODUCTION

This work plan has been developed as an Interim Work Plan to provide for the collection of additional hydrogeologic information for the pump and treatment portion of the remedial design and subsequent remedial action at the Berks Sand Pit site. Due to the complex nature of the hydrogeology at this site and limited information available in the Remedial Investigation/Feasibility Study (RI/FS), additional data is needed prior to proceeding with the design.

Since the overall scope of the design is highly dependent on this additional hydrogeologic information, a complete work plan could not be prepared at this time. This Interim Work Plan was developed to cover only the collection of additional hydrogeologic information, including installation of additional monitoring wells, groundwater sampling and analysis, aquifer testing, and surface water and sediment sampling and analysis. Once the full scope of the design can be defined, the overall work plan will be finalized.

This work plan has been developed to include all the elements necessary to proceed with the implementation of the work covered herein. Section 2 provides a general site background information by reference; Section 3 provides the scope of work as well as serving as the Field Sampling Plan. Section 4 provides site specific Quality Assurance Project Plan information and the Site Safety Plan is provided in Appendix A. This work plan was prepared in this manner to provide an expedient, cost-effective method for work approval. This will enable the additional studies to be performed in an expedited manner and provide for the timely completion of the remedial design.

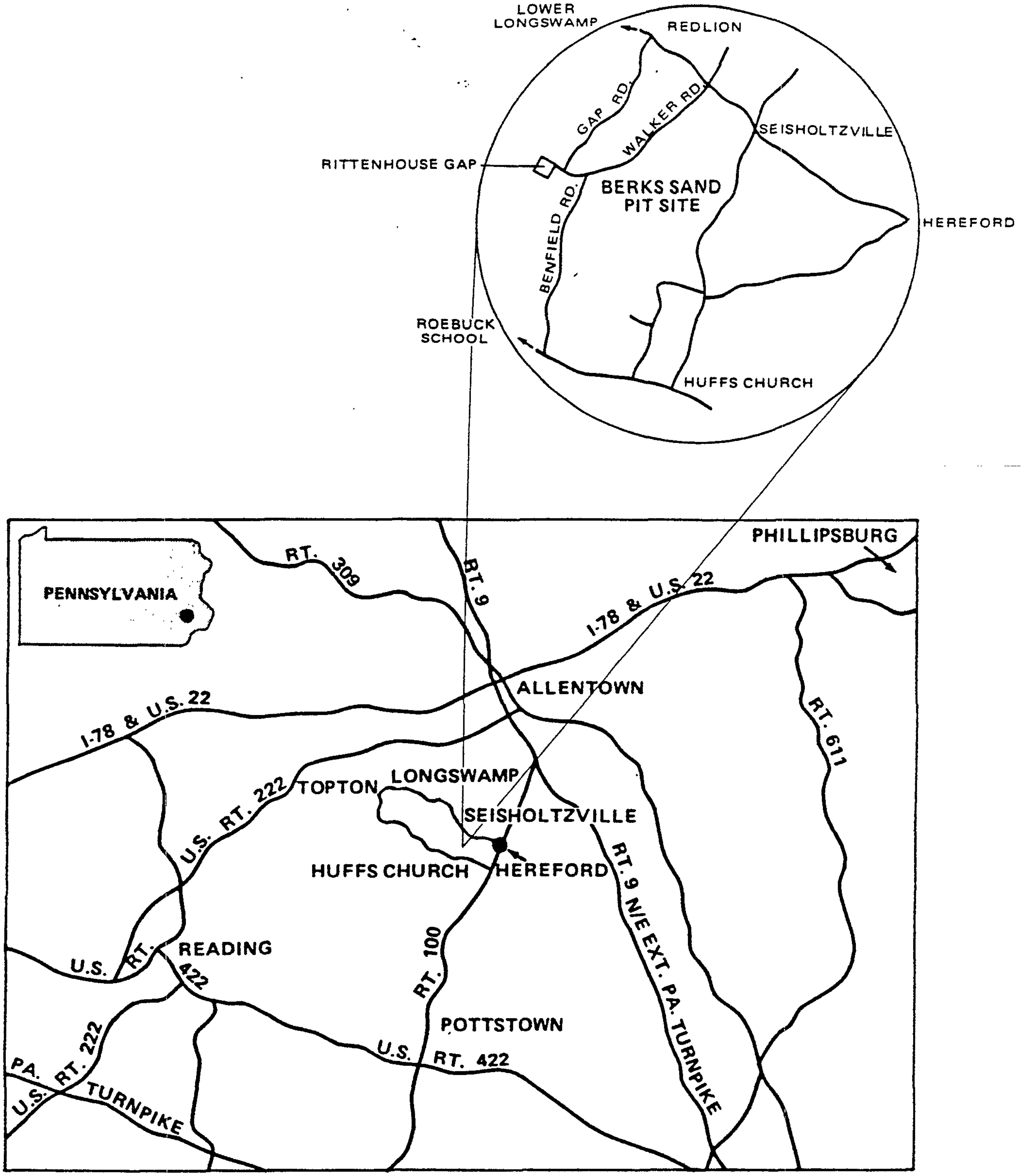

Figure 1–1 BERKS SAND PIT SITE PROJECT LOCATION MAP

2. ENVIRONMENTAL SETTING

2.1 SITE LOCATION AND DESCRIPTION

The Berks Sand Pit site is located in Berks County, Longswamp Township, Pennsylvania (see Figure 2-1). The site is approximately 15 miles northeast of Reading, near the boroughs of Huffs Church, Seisholtzville, and Mertztown. The project area is approximately 4 acres in size and contains 27 single family homes. The original sand pit itself was located on one of the residential lots (Van Elswyck residence) where a house has now been built.

The project area and the property in the immediate vicinity is zoned as R-2, which denotes a low density, residential district. Land uses near the project area are mainly agricultural and residential. Fields and orchards are located nearby in Longswamp Township as well as in the neighboring townships of Hereford and District. The tree and foliage growth in unpopulated areas is generally medium density.

2.2 GEOLOGY AND HYDROLOGY

The Berks Sand Pit is located in the Reading Prong Section of New England Physiographic Province. Bedrock within the site area, and in-general within the Reading Prong, is composed of Precambrian metamorphosed igneous, sedimentary and volcanic rocks. These rock types make up highlands in the vicinity of the site. Adjacent to the immediate site area is a valley which is part of the Valley and Ridge Physiographic Province and is composed of Cambro-Ordovician limestone and dolomite. Magnetite deposits occur throughout the Reading Prong. Magnetite-rich pegmatites were observed in three boreholes at the site.

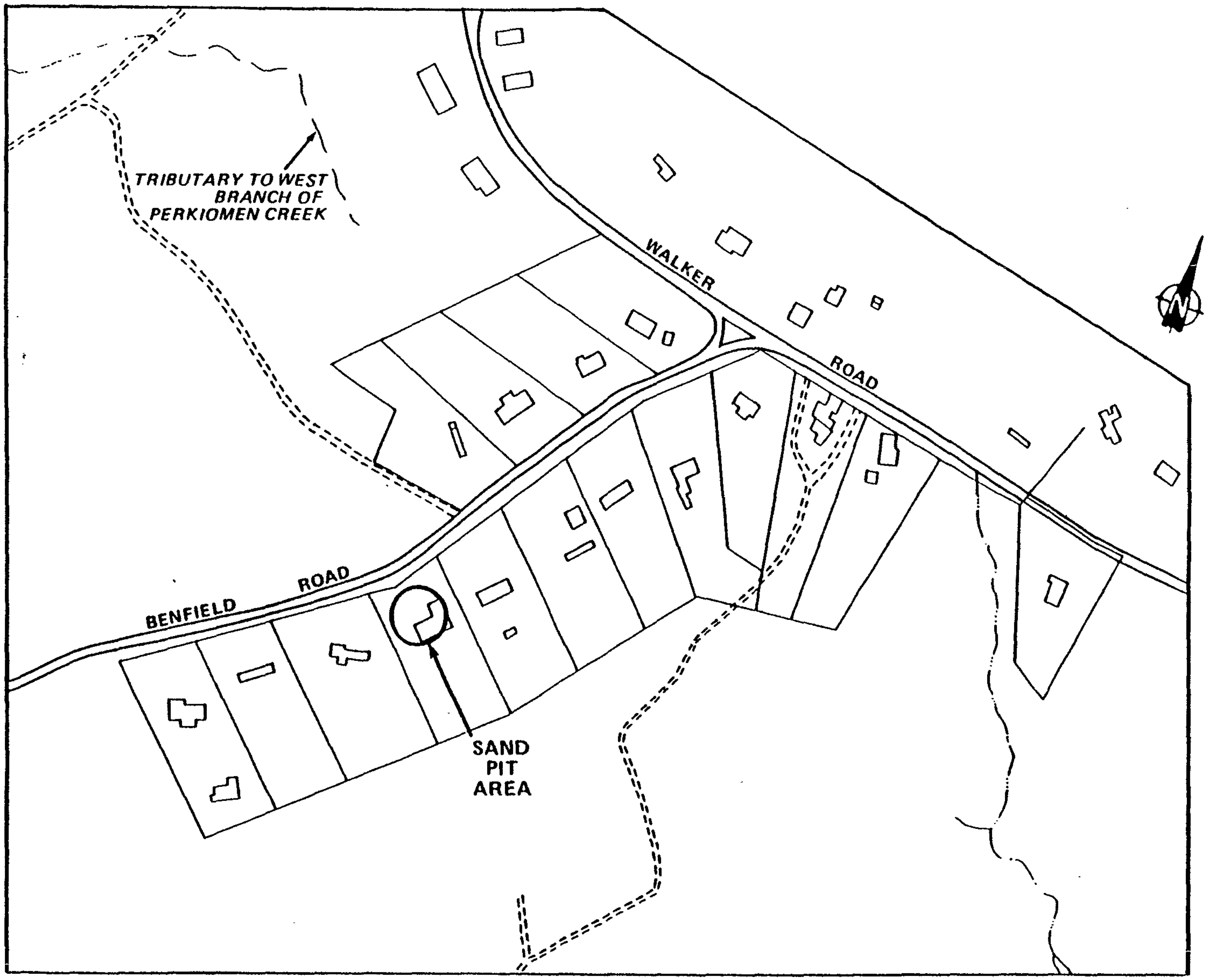

Figure 2–1 PROJECT AREA

In the vicinity of the site, saprolite soils result from the weathering of the metamorphic bedrock. These saprolites generally consist of a light brown, tan to orange clay with some silt and sand, and quartz and feldspar fragments. Increasing amounts of weathered bedrock fragments are seen with depth. Some local zones in the saprolite show evidence of foliation and relict structures. The bedrock which is principally granite gneiss is moderately to highly fractured. Many fractures encountered in the boreholes contained chlorite filling and/or hematite staining on the fracture surfaces.

Weathered bedrock is generally encountered within 30 feet of the surface and can continue to depths of 100 feet. However, there is no distinct boundary between the saprolite soils and the weathered bedrock, or between the weathered and unweathered bedrock. Rather there is gradual change from saprolite to weathered bedrock and from weathered bedrock to unweathered bedrock. The maximum depth of significant transmissive fractures is estimated to be about 250 to 300 feet (based on Monitoring Well MW-2). More data is needed to define the depth of transmissive fractures and potential contaminant movement in the groundwater.

Groundwater in the vicinity of Berks Sand Pit is encountered in the saprolitic soils, the weathered bedrock and in the fractured competent bedrock. These zones appear to be gradational rather than hydrologically distinct. In general, fractures appear to be less transmissive with depth. However, transmissive fractures which are contaminated have been observed at depths of 250 feet below surface, based on packer test data (RI Report, Baker/TSA 1988).

Groundwater in both the overburden and fractured bedrock aquifers flows from a topographic high, located southwest of the sand pit, to the east and north. A smaller volume of groundwater flow within the project area also moves in a westerly direction.

The amount of water that moves through the bedrock depends on the hydraulic gradient and hydraulic conductivity of the fractures. The direction of flow depends on both the hydraulic conductivity of the fractures and their orientation. The hydraulic conductivity of the fractures depends on such properties as width, length, interconnectedness, filling material, etc. These properties are quite variable and as a result, a highly complex flow field exists beneath the site.

2.3 NATURE AND EXTENT OF CONTAMINATION

Results of the sampling performed during the RI conducted in 1987 by Baker/TSA identified four volatile organic compounds that pose a risk to human health and/or the environment. These chemicals pose the greatest potential public health risk at the site and were chosen because they represent the chemicals which were the most toxic, mobile, and in the highest concentrations. The four contaminants that were identified as indicator parameters are:

- 1,1,1-dichloroethene (DCE);
- 1, 1-dichloroethane (DCA);
- 1,1,1-trichloroethane (TCA); and
- Tetrachloroethene (PCE).

One or more of these indicator contaminants were found in surface sediments east of the sand pit, in the groundwater beneath the project area, and in surface waters northeast of the site. The presence of volatile organic contaminants in the surface water is believed to be related to localized discharge of contaminated groundwater. Groundwater remediation should mitigate further contamination being discharged to these surface waters.

Based on data collected during the RI, the groundwater contamination beneath the project area exists as a narrow, elongated plume, extending in the west to east direction (see Figure 2-2). The plume was mapped using total concentrations of volatile organics appearing in the bedrock aquifer, which is more highly contaminated than the overburden. This data was derived from the most recent (1988) sampling data (Baker/TSA 1988). A review of historical data on contaminant concentrations dating back to 1982 shows that the plume is migrating laterally in a generally easterly direction, and is dispersing. In addition, the contamination is migrating downward into

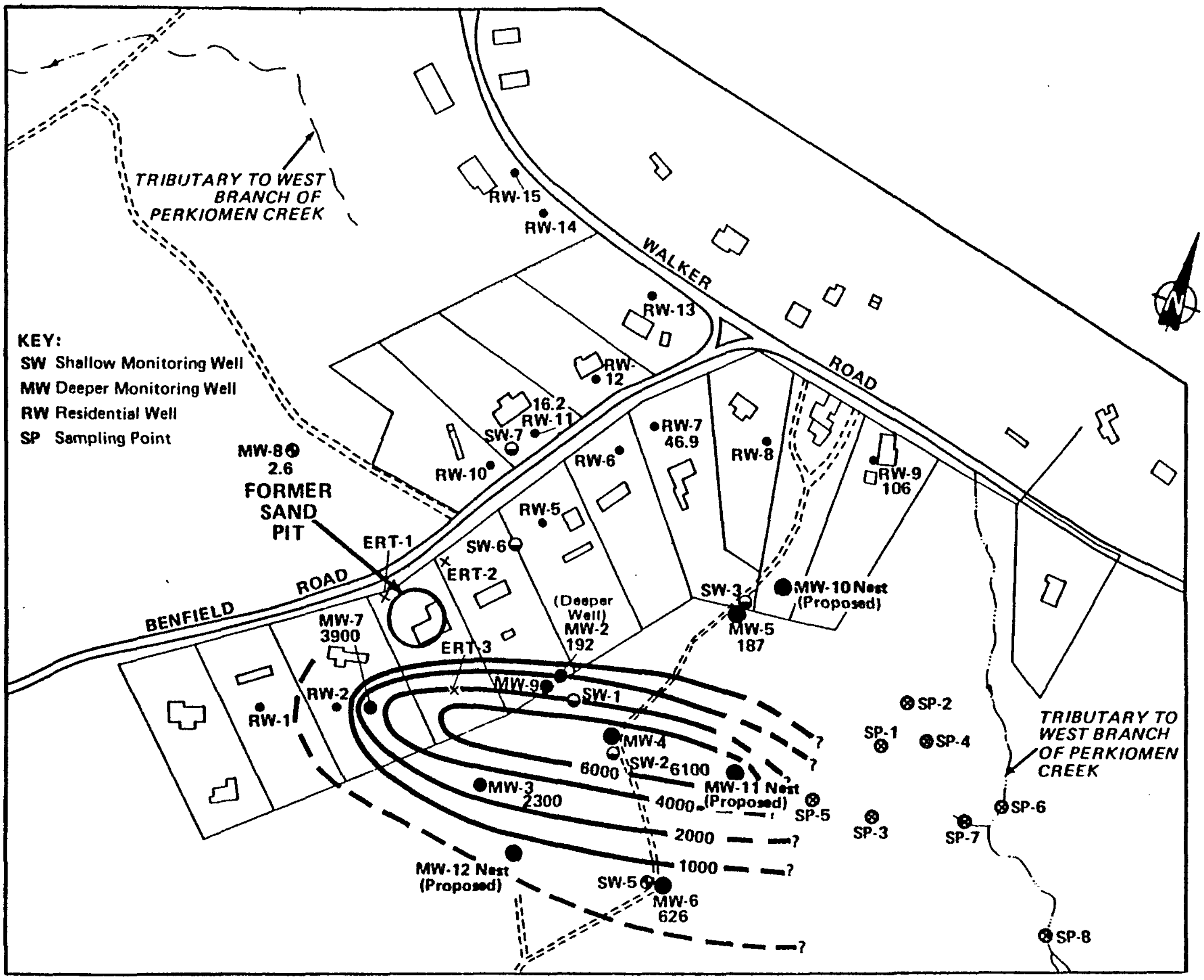

Figure 2–2 BEDROCK PLUME ORIENTATION -- CONCENTRATION OF TOTAL VOLATILE ORGANICS IN (ppb, MARCH 1988, METHOD 601)

the bedrock aquifer. Contaminant flow to the east may be controlled mainly by characteristics of the deeply weathered bedrock zone, which was observed in monitoring wells MW-4, MW-5 and MW-6 located in the eastern part of the project area (see Figure 2-2).

A more complete delineation of the extent of contamination at the site is still required. Data collected during the RI were not adequate to fully quantify the vertical extent of contamination, or the lateral extent of the groundwater plume, especially in the downgradient direction.

3. ADDITIONAL FIELD STUDIES

3.1 INVESTIGATION APPROACH

Based on a review of available site hydrogeologic and contaminant information, the following data gaps need to be filled before the final subsurface remedial design can be developed:

- The areal extent of groundwater contamination downgradient to the east of MW-4, laterally to the south of MW-6, and upgradient to the west of MW-7 has not yet been defined. Downgradient contamination is of particular concern as seep samples located several hundred feet downgradient of MW-4 showed TCA and 1,1 DCE contamination in concentrations up to the low parts per million (ppm) range.
- Vertical hydraulic gradients at the site have not been adequately determined. In addition, the full vertical extent of contamination has not been defined. The deepest packer test sample taken at 260 feet in MW-2, shows 270 ppm of DCE contamination which is above the drinking water standard (MCL) of 7 ppb.
- The degree of interconnectedness of the different aquifer media (i.e. saprolite soils, weathered and fractured bedrock and unweathered and fractured bedrock) and consequently for groundwater within these media, have not been adequately defined. While these three media have been generally identified at the site, further delineation of aquifer media and groundwater contamination within them may aid in the selection of specific pumping zones for recovery wells.
- Optimum locations and depths for recovery wells need to be selected based on additional vertical and areal plume characterization from packer production tests.

The Additional Studies Program is designed to address the previously mentioned data gaps in sufficient detail so that a cost-effective remedial design for extraction, treatment and discharge of groundwater can be developed. The objective of the work will be to site groundwater recovery wells at locations and depths which will result in the most efficient extraction of groundwater.

The flow of field work is shown on Figure 3-1. The additional studies phase will involve the following elements:

- Deep and shallow monitoring well installation to refine areal and depth-specific contamination, and to characterize shallow and deep vertical and horizontal hydraulic gradients;
- Packer production testing of deep monitoring wells (to be installed) and three existing deep monitoring wells to characterize depth specific contamination and vertical hydraulic gradients;
- Potential deepening of one of the proposed deep monitoring wells to determine the apparent base of the groundwater plume;
- Installation of intermediate wells to characterize volatile organic contamination at intermediate depths, should evidence of depth specific contamination be found during packer testing;
- Sampling of all newly installed monitoring wells, seven existing shallow monitoring wells, three ERT wells and nine existing deep monitoring wells.
- Performance of treatability tests for the carbon adsorption/air stripping treatment system. A separate work plan for these studies will be submitted as a addendum to this plan, so that the field work can proceed.
- Data validation, data evaluation and completion of a report summarizing the extent of groundwater contamination with recommendations for the next stage of work (Initial Design); and
- Meeting with EPA prior to initiating the Initial Design stage.

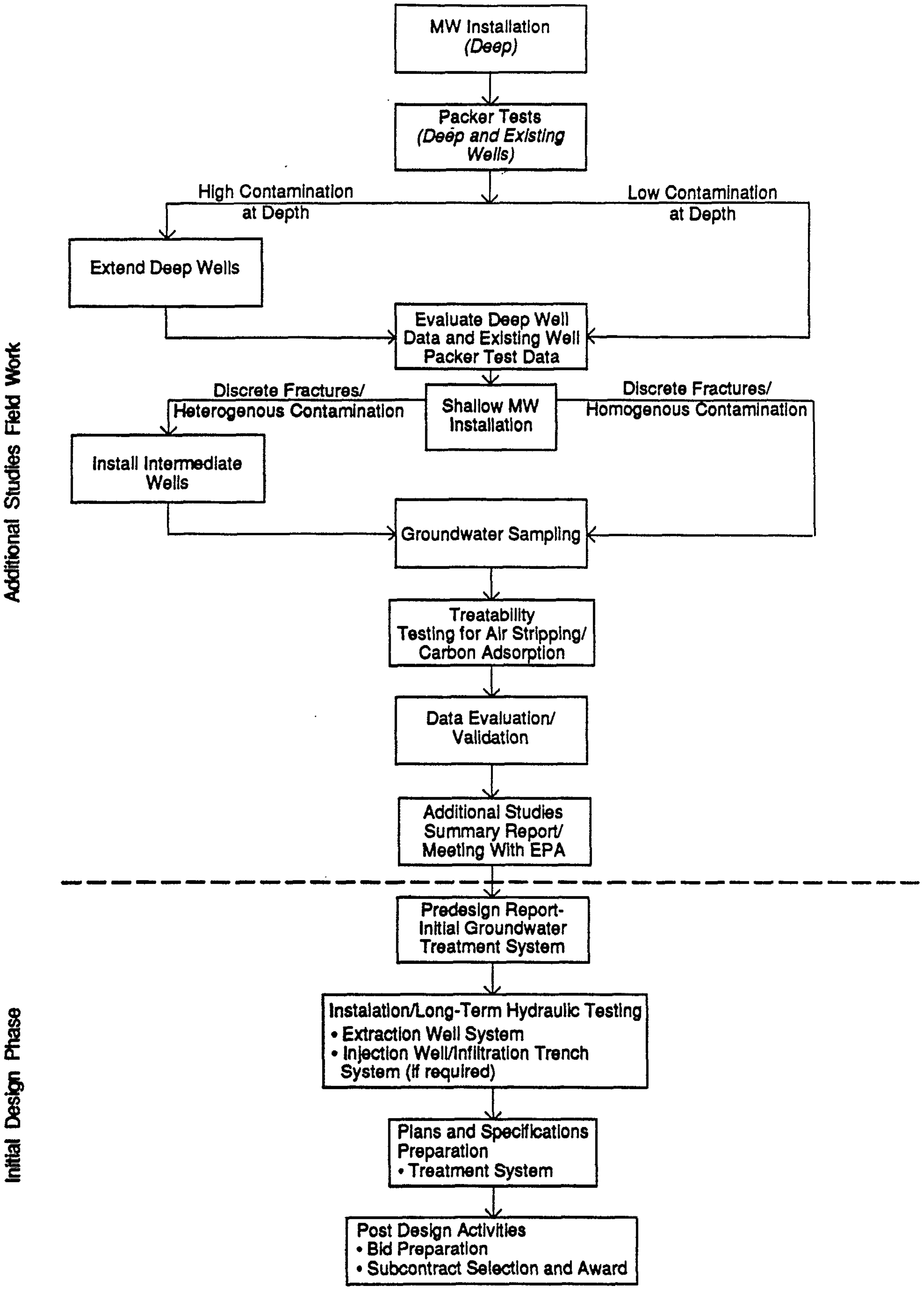

FIGURE 3-1 DIAGRAM OF ADDITIONAL STUDY /INITIAL DESIGN ACTIVITIES

Upon completion of the additional studies program, the initial design of the groundwater recovery, treatment and disposal system will be initiated. A cost proposal for the initial design phase will be submitted together with the predesign report. Costing for this work plan encompasses only the additional studies field work as described above.

Presently it is planned that field work, principally drilling, will begin during February or March of 1990. Problems with inclement weather and subfreezing temperatures will be encountered during this period. Particular attention will be given to the field and drilling crew. A heated trailer will be placed on the site and a kerosene heater (Salamander) will be maintained near the drilling rig. Water lines and pumps used during work hours will have to be evacuated during non-work hours. Any storage tanks containing water to be used during the field investigation may have to be heated periodically to prevent freezing. Road gravel may have to be placed in soft or swampy areas if rig access proves to be a problem.

3.2 MONITORING WELL INSTALLATION AND DESIGN

Six to ten additional monitoring wells will be installed on the site in nests to further define the areal and vertical extent of contamination. (See Figure 2-2). All new wells will be surveyed in.

A nest will typically consist of a shallow, intermediate and deep well. In addition, the furthest downgradient nest (MW-10S, 10I, 10D) may contain one additional well to define the base of the groundwater plume. Shallow and deep wells will be installed at each location. Intermediate wells will be installed only if there is evidence of discrete zones of contamination and of uneven distribution of contaminants with depth. Parameters that will be used to define whether heterogeneous aquifer characteristics exist include: evaluation of NX-cores from the deep wells; direct evidence of depth specific contamination from packer tests on deep wells; and variable hydraulic heads during packer tests. The decision to install an intermediate well at each location will be made in the field after installation and review of data from both the shallow and deep wells.

E & E will discuss plans for each intermediate well with EPA prior to installing the well or moving the drilling rig to a new nested well location. The depths of monitoring well types (i.e. shallow (S), intermediate (I), and deep (D)) are designed to correspond approximately to the different zones of weathering at the site. The weathering profile of layers under the site is typical of most crystalline-metamorphic bedrock terrains. In general, bedrock becomes less weathered and more competent with depth. Near-surface material is most typically unconsolidated and saprolitic in character. During the RI, unconsolidated materials were observed to range in depth from four to forty feet. Weathered bedrock was found to penetrate to depths of up to 100 feet. Beneath the weathered bedrock was non-weathered bedrock, which was observed at depths as shallow as 20 feet.

The changes from unconsolidated saprolite to weathered bedrock and to competent bedrock are gradational and somewhat irregular across the site. If a trend does exist, it is that saprolites and weathered bedrock appear to thin to the west as the topography increases in elevation and thicken to the east towards the small valley at the headwaters of Perkiomen Creek. For the most part, groundwater occurs first in weathered and competent bedrock, and to a lesser degree in the saprolite. Consequently, the additional investigation will focus on groundwater monitoring and testing of the weathered and competent bedrock zones.

Well locations were established to provide information regarding the areal and vertical extent of groundwater contamination in areas where additional plume delineation is needed. The locations of the well nests and rationale are as follows (See Figure 2-2):

- The MW-10 nest will be installed approximately 200 feet northeast of MW-5 to further characterize groundwater quality in the area of the Thomas residence, where a fracture trace analysis shows a geologic fracture which may be channeling groundwater.

- The MW-11 nest will be installed 300 feet east of MW-4 to determine groundwater quality in the area near the Perkiomen Creek seeps where high levels of TCA and 1,1 DCE have been found in seep samples.

- The MW-12 nest will be installed about 200 feet south of MW-3 to define the upgradient edge of the groundwater plume. All three locations take into consideration an EPIC fracture trace survey.

3.2.1 DEEP MONITORING WELL INSTALLATION

The three deep wells will be drilled to a depth of approximately 150-175 feet below the surface. MW-10D, which is located in an area of likely groundwater contamination, may be extended to approximately 300 feet to characterize very deep groundwater quality and hydraulic gradients. Should high levels (significantly above drinking water standards)of groundwater contamination be found at 200-300 feet, this well will be screened in a representative interval and a second deep well, 150 to 175 feet deep, will be installed in the MW-10 nest. If low levels of contamination are found in the 200-300 foot interval, the well will be backfilled with bentonite/cement grout to 150-175 feet and screened at an appropriate level. Potentially, four wells (very deep, deep, intermediate and shallow) could be installed in the MW-10 nest. This will provide a means to monitor very deep (200-300 feet), deep (150-175 feet), intermediate (80-100), and shallow (40-60 feet) contamination at the site. E & E will review all field data with EPA and seek concurrence regarding further well installation scenarios at critical points during the drilling program.

Deep monitoring well design and installation protocols, which are depicted in Figure 3-2, will be as follows:

- A 10-inch borehole will be drilled with a 6.25-inch internal diameter (ID) auger through the saprolite until the weathered bedrock zone is encountered. This depth will most likely range from 20-40 feet beneath the surface. Continuous split-spoon samples will be collected and described by an on-site geologist. Upon encountering weathered bedrock, the augers will be extracted, and six-inch ID low carbon steel casing will be installed into the borehole and extend five feet into bedrock and two feet above the surface. The steel surface casing will be pressure grouted into the borehole with a 5% bentonite/ Portland cement grout. The grout will be allowed to set for 24 hours prior to coring. Centralizers will be used at 20-30 foot intervals, beginning after the first fifty feet of casing.

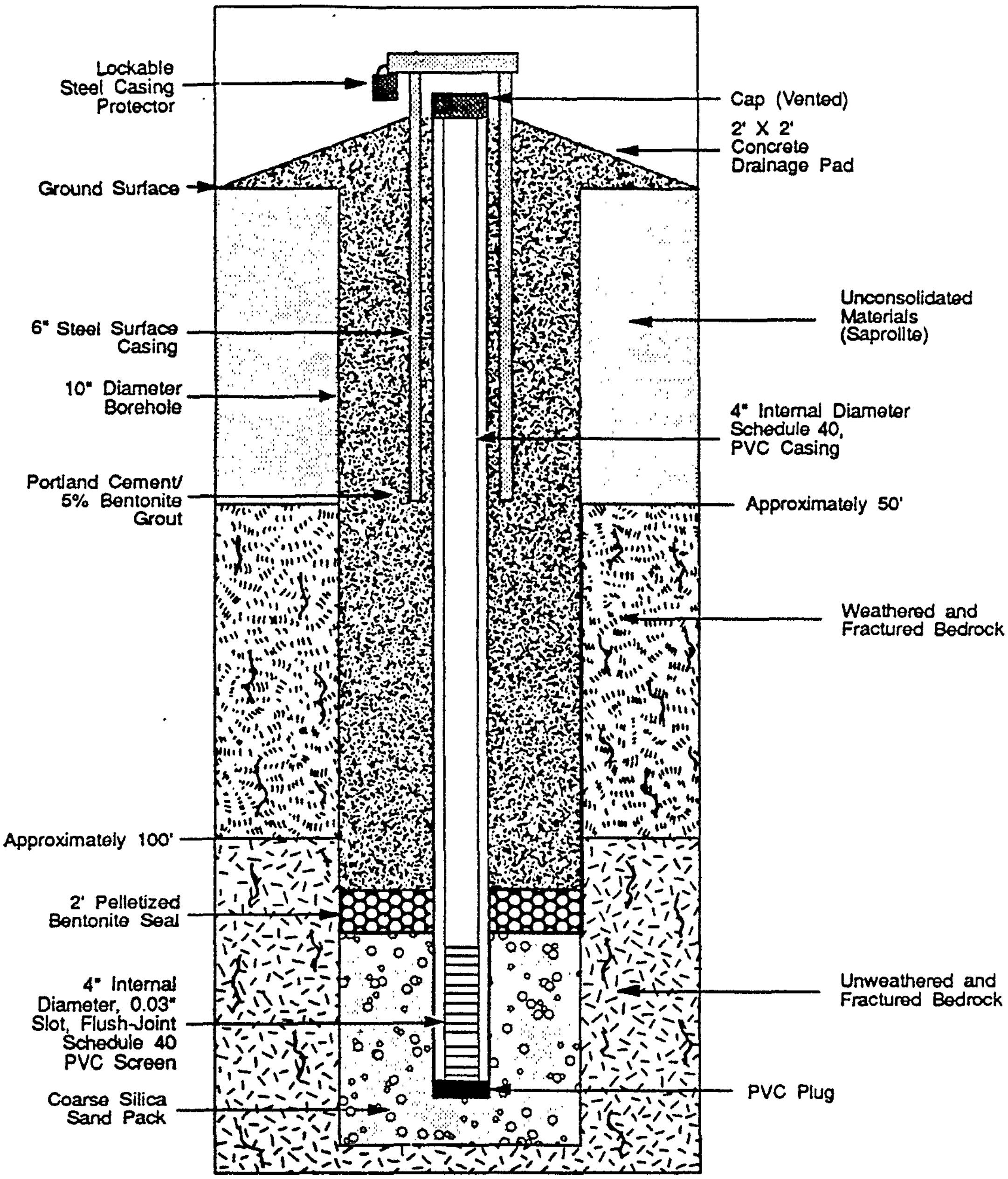

Figure 3-2
PROPOSED MONITORING WELL CONSTRUCTION FOR DEEP BEDROCK WELLS

- o Bedrock will be cored with an NX size core barrel and then reamed to 6-inch diameter by air rotary means from the top of bedrock to a depth of 50 feet. Coring and reaming will be completed over 20-30 foot intervals so that depth specific packer production tests can be completed as the hole is advanced. The cores will be described by an onsite geologist. Particular attention will be given to weathering characteristics, fracture orientation (with respect to the core), fracture widths and the presence of secondary minerals (i.e. hematite and authegenic clays) as this information may provide indirect evidence regarding groundwater transmission.

- o Packer production tests will be performed progressively over the bedrock borehole as discussed in Section 3.3. The purpose of the tests are to measure vertical hydraulic gradients and to assess groundwater quality. It is estimated that up to 10 tests per deep well will be performed. An in-field GC will be used to determine concentrations of TCA and 1,1-DCE.

- o MW-10D will be extended to a maximum depth of 300 feet if levels of TCA and/or 1,1-DCE exceed their respective drinking water standards at a depth of 120-150 feet. MW-10D may also be extended if packer tests reveal increasing levels of contamination with depth. Packer tests will be performed over the extended interval and the decision to make this a very deep monitoring well (i.e., deeper than 150 feet) will be based on their results. If this well is completed as a very deep well, an additional well (approximately 150 feet deep) may be installed in the MW-10 nest. All decisions regarding the MW-10 nest will be made with EPA concurrence.

- o Following the completion and evaluation of packer tests, a monitoring interval of no longer than 20 feet will be selected. If necessary the borehole may be backfilled with bentonite pellets to the base of the monitoring depth. Four-inch Schedule 40, flush-joint, 0.03 inch slot screen will then be installed in the monitoring interval. The balance of the borehole will then be cased with four-inch Schedule 40, flush-joint PVC riser pipe. The riser pipe will be capped and will extend 1.5 feet above grade.

- o A coarse silica sandpack will be trimmed to 1 foot above the screened interval and two feet of pelletized bentonite will be placed above the sandpack. The balance of the borehole will be cemented with a 5% bentonite/Portland cement grout.

- o The previously described six-inch low-carbon steel surface casing will extend two-feet above the surface to also serve as a locking, protective casing. A two-foot diameter sloping concrete pad will be installed at the surface and the well number will be painted on the inside of the steel cap and on the outer casing.

3.2.2 SHALLOW AND INTERMEDIATE WELL CONSTRUCTION

Shallow and intermediate wells which are depicted in Figures 3-3 and 3-4 respectively, will be installed using the same specifications as were established for the deep wells, with the following exceptions:

- Split spoon samples will not be collected in the shallow and intermediate wells as the deep well in each nest will already have been described. Shallow and intermediate wells will be cored to aid in selecting appropriate screened intervals.
- Shallow wells will be screened in weathered bedrock at depths between 40 and 60 feet. The depth of screened intervals will be selected based on the evaluation of NX-cores. In addition, the screened interval will be beneath the potentiometric surface which is expected to range from 30-40 feet across the site.
- Intermediate wells will be screened near the bottom of weathered bedrock and the top of competent bedrock which is expected to be 80-100 feet beneath the surface. The depth of the monitoring interval will be selected based on evaluation of NX-cores, depth specific contamination information and vertical hydraulic gradients from the adjacent deep well. Intermediate wells will be installed only if aquifer heterogeneity is evident following installation and data evaluation of the deep well in each respective nest.
- Deep wells will be installed prior to shallow and intermediate wells so that appropriate decisions can be made concerning shallow and intermediate well depths.
- No packer tests will be performed in shallow or intermediate wells.

3.2.3 WELL DEVELOPMENT

Following installation, wells will be allowed to stabilize a minimum of one week before development. Groundwater development will be accomplished in all wells using water surging. A surge block will be used to agitate groundwater in all wells. Groundwater withdrawal will be accomplished using a four-inch submersible pump. The pH,

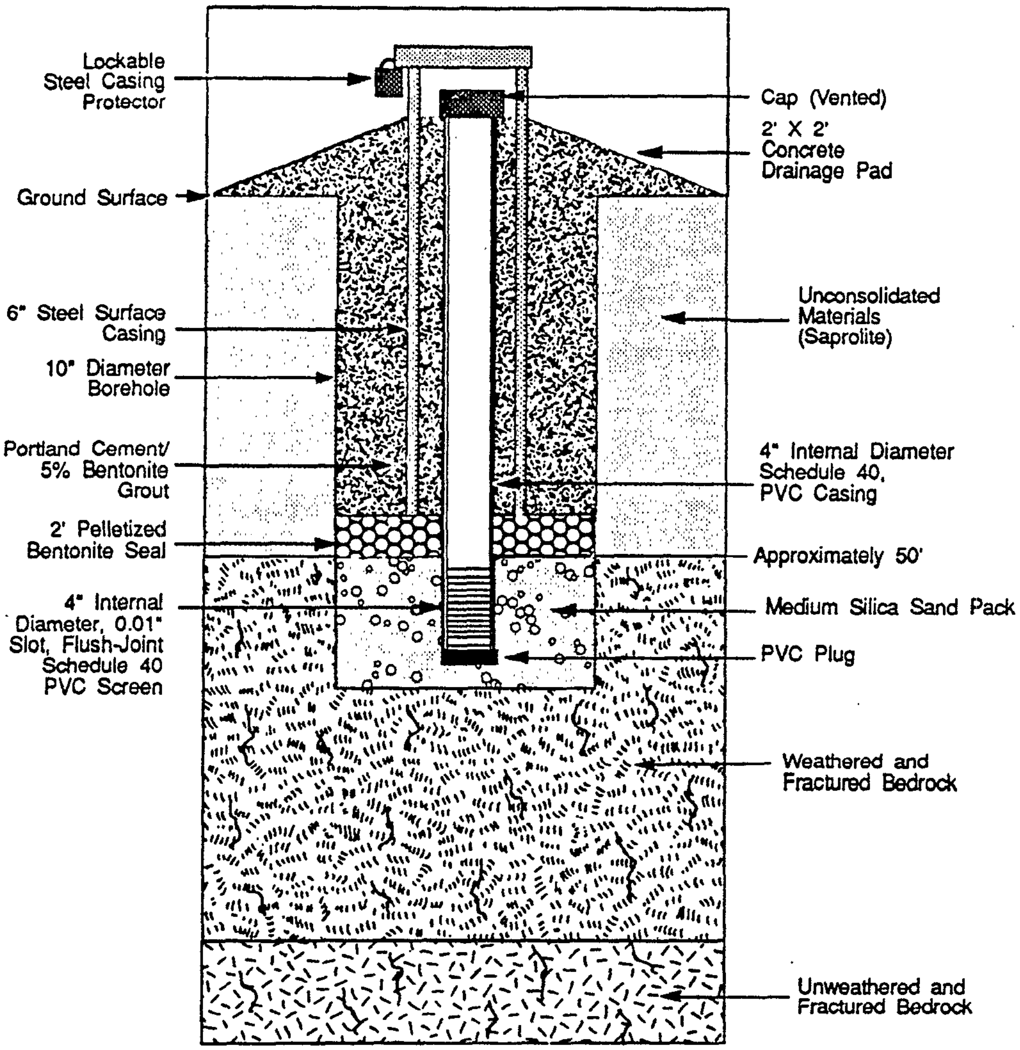

Figure 3-3
PROPOSED MONITORING WELL CONSTRUCTION FOR SHALLOW BEDROCK WELLS

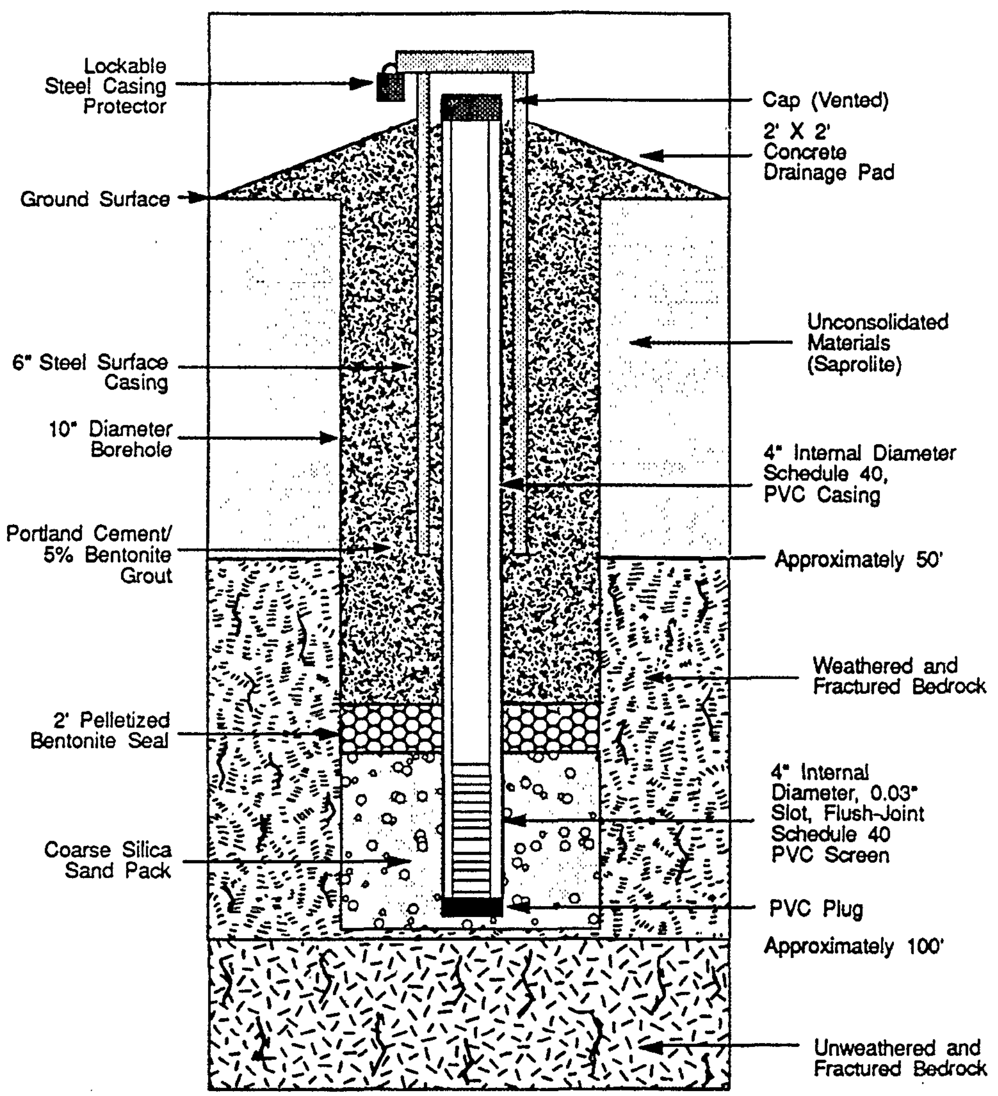

Figure 3-4
PROPOSED MONITORING WELL CONSTRUCTION FOR INTERMEDIATE BEDROCK WELLS

conductivity and turbidity will be monitored during development. Development will continue for a minimum of one-hour or until these parameters stabilize.

3.3 PACKER TESTING

Packer tests will be completed in each newly installed deep well (prior to well construction), and in the three existing monitoring wells (MW-2, MW-7 and MW-5). A dual packer assembly and a four-inch submersible pump will be used in the three existing wells. The new wells will utilize a single packer, installed at the prescribed depths as the drilling proceeds. The purpose of the tests is to investigate if depth-specific contamination exists at the site and to assess vertical hydraulic gradients. A total of five tests per well will be performed except for MW-10 which may be extended to a maximum depth of 300 feet and MW-2 which is currently 300 feet deep. A maximum of 10 tests will be performed in these wells. A total of 45 field samples and five field duplicates will be analyzed with an in-field gas chromatograph (GC). Analytical protocols for the GC are discussed in Section 4.2.

The procedure for packer tests will be as follows:

- Packer tests will be completed on each new deep well on a progressive basis while the well is being cored and reamed. Most likely, a 20-30 foot section will be cored and reamed and then packer tested. Specific test depths will be determined in the field by evaluation of cores and drilling characteristics such as water-loss and water-make. In MW's 2, 6 and 7, test depths will be selected based on evaluation of logs and borehole geophysical surveys from the RI Report.
- The test unit will consist of a 3-inch diameter (uninflated) pneumatic packer (a dual packer in the existing wells) and a 4-inch submersible pump. The unit will be lowered and set at the appropriate depth as described above.
- The pump will be engaged and water produced at a constant rate (not greater than 10 gpm) for 20 minutes prior to sampling. Water levels within the packer zone, and also above and below the packer zone, will be monitored by means of a data logger and three transducers.

- During the test, the pump rate will be no greater than 10 gpm in an attempt to withdraw groundwater from specific fractures. (This assumes some degree of fracture interconnection which could result in withdrawing groundwater from fractures that intersect with other portions of the well bore.)

- Groundwater samples from the packer tests will be analyzed with an in-field GC. Prior to sample collection, three well volumes of water (approximately 60 to 100 gallons) will be purged from the test zone. This volume should be sufficient to remove near well bore effects, and vertical mixing resulting from the drilling. The period of purging prior to sampling will range from 10 to 20 minutes, assuming an estimated yield of 5 to 10 gallons per minute.

- Water from the packer tests will then be pumped from the well head and allowed to discharge to the surface in an area away from the well, in a downgradient direction.

3.4 ENVIRONMENTAL SAMPLING

Sampling of groundwater, surface water and sediment will be performed at the site following completion of drilling and packer tests. All samples will be analyzed using EPA Method 502.2 for volatile organics. This GC method was selected because it has lower detection limits than EPA Method 624 which is a GC/MS Method. The need for MS identification is not necessary at Berks because the contaminants of concern have already been identified. Sampling and analytical protocols are discussed in Section 4.3 of the QAPP.

The number of samples to be collected for each sample media is listed in Table 3-1. Groundwater samples will be collected in all new monitoring wells, in MW's 1,2,3,4,5,6,7,8 and 9, in the three ERT wells, and in shallow wells SW-1,2,3,4,5,6, and 7 for additional plume definition. Seven seep and sediment samples will also be collected from eastern Perkiomen Creek headwaters to delineate the extent of surface water contamination. This area is suspected to be the area of discharge for the aquifer. Care will be taken to insure that the sediment samples are collected when the seeps are not frozen. In addition to the method 502.2 analysis for volatile organics, samples collected from three deep wells and three shallow will be analyzed for the following parameters, to aid in the design of the groundwater treatment system: total organic carbon (TOC); chemical oxygen demand (COD); total suspended solids

TABLE 3-1
ANALYTICAL SUMMARY

Media	Number of Samples	Number of[1] Duplicates	Number of Rinsates[2]	Number of Trips Blanks	Number of MS/MSD	Total Number of Samples	Analysis	CLP Analysis	Screening
Groundwater-Packer Testing	45	5	3	N/A	5	58	—	—	Foxboro OVA 128, GC[4], PH; Temperature; Conductivity
Groundwater-Monitoring Wells	28	3	2	3	2	38	Volatiles[5]	SAS	—
Groundwater-Monitoring Wells	6	1	—	—	—	7	TDS,TSS,TOC, COD,ALK, TAL Hardness,	SAS/RAS	—
Surface Water	7	1	1	1	1	11	Volatiles[5]	SAS	Temperature; Conductivity; H
Sediment	7	1	1	1	1	11	Volatiles[5]	SAS	

Key:
Analytical Definitions

TDS - Total Dissolved Solids
ALK - Alkalinity
TAL - 23 metals and cyanide
COD - Chemical oxygen demand
TSS - Total suspended solids
TOC - Total organic carbon
RSS - Routine analytical service
SAS - Special analytical service

1. Number of duplicates estimated at 1 per 10 samples
2. Number of rinsates and MS/MSD samples estimated at 1 per 20 samples
3. Number of trip blanks estimated at 1 per 10 samples. However, the actual number of trip blanks will depend on the number of coolers shipped per day that contain samples for organic analysis.
4. Field screening with OVA for 1,1 Dichloroethane, 1,1 Dichloroethylene, 1,1,1 Trichloroethane, and tetrachlorethylene.
5. Volatile organic analysis of new monitoring wells existing monitoring wells sediment and surface water samples will be completed using EPA Method 502.2.

RC075

(TSS); total dissolved solids (TDS); total alkalinity; hardness and primary metals. Temperature and pH will be measured in the field.

3.5 WELL RECOMPLETION

MW-2, the 300-foot deep monitoring well will be recompleted to a 4-inch diameter very deep monitoring well to provide an additional very deep monitoring point. This recompletion is possible because this well is presently a 6-inch diameter open-hole completion. The specific screen depth which is expected to range between 200-300 feet, will be selected based on the results of the packer tests. The well will be installed as per the deep well drilling protocols.

3.6 INJECTION/INFILTRATION TESTING

The preferred method for disposal of treated groundwater is via surface discharge to a stream in the project area. Evaluation of two additional potential disposal methods for extracted groundwater, i.e., via injection wells and infiltration trenches, may be required to determine their technical and economic feasibility should the surface discharge option prove to be to costly. The injection and infiltration testing would be done to assess injection/infiltration rates of water during the next phase of work, if required.

3.7 TREATABILITY STUDIES

Treatability studies will be conducted prior to design of the groundwater treatment system. The studies will be done on the air stripper with vapor phase carbon adsorption to determine stripper off-gas concentrations and carbon usage rates, thus providing data for more realistic sizing of equipment. A separate work plan for the treatability studies will be submitted as an addendum to this work plan, so that the field effort can proceed in a timely manner.

3.8 ADDITIONAL STUDIES REPORT

Upon completion of the field effort, a technical report, including one draft report, will be prepared and will delineate all findings of the additional studies task. The report will include the following items:

- A brief discussion of site background and environmental setting;
- A detailed description of the field work performed;
- A discussion of the findings and conclusions gathered from the hydrogeological, and chemical investigations performed; and
- Recommendations regarding extraction well placement, treated groundwater disposal methods, and certain design parameters for a groundwater treatment system for the next stage of work (Initial Design).

Prior to finalizing the report, the EPA Remedial Project Manager and project geologist will meet with E & E to discuss the study findings and recommendations, and to obtain concurrence on the approach for the Initial Design phase.

3.9 INITIAL DESIGN

Concurrent with the field activities, as adequate data becomes available, the initial design of the groundwater pump and treat system will be initiated. The initial design will involve one or several extraction wells, an adequate number of piezometers to monitor aquifer response, an air stripper with vapor phase carbon adsorption, and a treated groundwater discharge system. The number and construction details of the extraction wells will be determined based on hydrogeologic information gathered during the additional studies phase.

During the initial design phase, an extraction well(s) will be installed and long term (at least 72 hours) pump test will be conducted. The purpose of this task will be to determine the hydrogeologic parameters of the aquifer required to design the extraction and monitoring network. The treatment system will be designed to handle an initial capacity of contaminated groundwater, with provisions for increasing capacity and other system upgrades in the future. The preferred method of discharging treated groundwater, i.e., via surface flow to a stream downgradient from the project area, will also be designed during this phase.

E & E will prepare a predesign report which will include the design basis for the initial groundwater extraction/treatment/discharge system, and the design tasks to be completed. A cost proposal for this phase of work will also be submitted at that time.

The final design phase, potentially involving additional extraction wells and increased treatment system capability, will be developed and implemented as required, based on data gathered during operation of the initial design.

4. SITE SPECIFIC QUALITY ASSURANCE

4.1 PURPOSE

The purpose of this section is to describe the site specific quality assurance requirements for the additional studies at the Berks Sand Pit site. Described below are sampling and analytical procedures for the work covered by this Work Plan. All other aspects of quality assurance will follow the requirements as covered in Ecology and Environment's generic Quality Assurance Project Plan submitted to the Region III Central Regional Laboratory in May 1989.

The overall objective of these additional studies is to provide for a better definition of the horizontal and vertical extent of contamination and to provide various aquifer characteristics which are necessary for the design of the pump and treatment system for groundwater remediation. Table 4-1 provides a summary of the project data quality objectives.

4.2 FIELD ANALYSIS FOR VOLATILE ORGANICS

During the packer tests, samples will be obtained from discrete intervals of the water column. These samples will be screened in the field for select volatile organics by headspace analysis using a Foxboro OVA 128 GC instrument. This level II analysis will provide for relative concentrations of volatiles in groundwater. Precision and accuracy will be determined in the field through the use of blanks, duplicates, spikes, and check standards. This information will provide an overall data quality assessment. Quality control samples are summarized in Table 4.2.

The four analytes to be screened are 1,1-Dichloroethane (DCA), 1,1-Dichloroethylene (DCE), 1,1,1-Trichloroethane (TCA) and

TABLE 4-1

Sampling Activity	Data Type/ Analysis	Date Use	Selected Analytical Option	Target Detection Limit	Analytical Method	Source of Analysis	No. of Samples	Field Duplicates	Equipment Rinsate Blanks	Trip Blanks	Lab QC	Total No. of Samples
Monitoring Well Packer Pump Test	Head and Flow Meas.	1,2,3	II	—	—	Field Measurement	—	—	—	—	—	—
Groundwater Sampling- Packer Test	Volatile Organics	1,2,4	II	IDL	OVA GC	Field Analysis	45	5	3	—	5	58
Groundwater Sampling- Monitoring Well	Volatile Organics	2,3,4	V	MDL	EPA 502.2	CLP-SAS	27	3	2	3	2	37
Groundwater Sampling- Monitoring Well	TAL In- organics	2,3,4	IV	CRDL	CLP Protocol	CLP-RAS	27	3	2	3	2	37
Groundwater Sampling- Monitoring Well	Water Quality Parameters	3	V	MDL	+	CLP-SAS	6	1	—	—	—	7
Soil Boring	Permeability	3	V	MDL	SW846- 9100	CLP-SAS	2	—	—	—	—	2
Injection/ Infiltration Test (If required)	Flow and Time Measurements	3	II	—	—	Field Measurements	—	—	—	—	—	—

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TABLE 4-1 (Continued)

Key:

Analyses:

TAL Inorganics - 23 Metals and Cyanide

Data Uses:

1. Determine depth specific contamination, degree of bedrock fracture connection, selection of screen interval.
2. Extent of contamination/site characterization
3. Engineering design.
4. Plume definition

Selected analytical options:

EPA Five general levels of data quality

Target Detection Limit

CRDL - CLP Contract Required Detection Limit
IDL - Instrument Detectin Limit - as refined during method development process.
MDL - Method Detection Limit - detection limit routinely achieved by method.

Proposed Analytical Methods

EPA 601/602 Purgeable Halocarbons; Method 602 Purgeable Aromatics
OVA GC set up in field trailer to screen for 1,1 Dichloroethane, 1,1 Dichloroethylene, 1,1,1 Trichloroethane, Tetrachloroethylene.

Water quality parameters*:

- Hardness- Method 410.4
- Total dissolved solids- Method 160.1
- Total suspended solids- Method 160.2
- Total organic carbon- Method 415.1
- Chemical oxygen demand- Method 410.4
- Alkalinity- Method 310.1

*Source: "Methods For Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979

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TABLE 4-2

SUMMARY OF QUALITY CONTROL SAMPLES

QC Sample Type	Frequency
Blanks (Bottle or Equipment Rinsate)	1 per 20 Samples
Field Duplicate	1 per 10 Samples[a]
Matrix Spike	1 per 10 Samples[a]

a) or one per day, whichever is more frequent

Tetrachlorethylene (PCE). It is anticipated that detection levels for these compounds will be 10 µg/L. Actual detection limits will be determined in the field.

Sample and standard preparation and analysis procedures are adapted from E & E SOP Field Analytical Screening Project (FASP), Method 101 (See Appendix B). Water samples will be obtained using the submersible pump temporarily installed for the packer tests. For each sample, two 40 ml bottles will be filled, creating an inverse meniscus so that bubbles are not present when the bottle is capped. Samples will be forwarded to the field analyst, and screened within four hours.

A headspace will be created by using a gas-tight syringe to remove 10 ml of water from the sample bottle. The bottle will then be shaken vigorously by hand for one minute, and allowed to stand for 15 minutes, prior to analysis. Samples and standards will be exposed to the same ambient temperature throughout headspace development. After 15 minutes, 5 ml of air will be removed from the sample bottle headspace and slowly injected into the 2.5 ml sampling loop of the OVA. The contents of the sample loop will then be injected into the Foxboro "G-24" chromatographic column, through a valve-switching arrangement, at ambient temperature.

Standards will be prepared by diluting pure DCA, DCE, TCA and PCE in pesticide grade methanol. This stock solution will then be further diluted by spiking aliquots into sample bottles filled with distilled water (minus the volume of the intended spike). The working level standards created will bracket the range of sample concentrations encountered in the field, but will initially range from 10-100 µg/L. If sample concentration exceeds the range of standards prepared, a second, smaller aliquot of sample headspace will be injected.

Injection of standards in the field, both single and multi-component, will determine if the chromatographic system can resolve DCA from DCE. If it is found that these two compounds co-elute, the resultant peak will be quantitated using DCE as the standard. Results from a combined peak would be reported as a "µg/L DCE and/or DCA". A response factor will be calculated to relate peak size to analyte concentration. If sharp, narrow peaks are obtained, peak height will be used. If broad peaks are found, the area of the peak will be measured as for a triangle. After the response factor is calculated, a standard of lesser concentration will be analyzed. If the smaller concentration can be read to within 10% of the true (calculated) value, the response will be considered linear.

A check standard, prepared by spiking stock solution into distilled water, will be analyzed every 8 injections and must be within 20% of the "true" value. If the check standard is not within 20% of the true value, but is within 50% of the true value, the resultant sample concentrations will be considered to be "estimated". If the check standard concentration is not within 50% of the true value, the instrument will be recalibrated.

Blanks will be analyzed once per day, or once per 20 samples, whichever is greater. The blank will consist of the headspace over distilled water, and may be prepared as either a rinse or bottle blank. Contaminants in excess of the lowest prepared standard will be investigated prior to further sample analysis. Distilled water headspace blanks will also be analyzed following samples showing contaminants in excess of the highest prepared standards.

One in 10 samples will be collected in duplicate (two sets of two bottles) and analyzed to determine precision of the method and homogeneity of the sample. One of these bottles will also be spiked with an aliquot of stock solution. This matrix spike will assess any sample effects and, with the check standard, assess the accuracy of the method.

Non-analyte (DCA, DCE, TCA, PCE) peaks found on the chromatogram, excluding "air" or other spurious peaks, will be quantitated using the response factor for the least sensitive analyte. These results will be expressed, for example, as "unidentified compound(s), 20 µg/L (as Dichloroethane)."

4.3 SAMPLING PROTOCOLS

The following protocols will be implemented for sampling of groundwater, surface water and sediment during the field investigation.

4.3.1 GROUNDWATER SAMPLING

Groundwater sampling will take place approximately 2 weeks after the completion of well development. Sampling will proceed as follows:

- Initial water level will be measured;
- Each well will be purged of 3 to 5 times the volume of standing groundwater in the casing. The pH, conductivity, and temperature, will be measured following each well volume removed;
- Dedicated PVC bailers will be used to collect the groundwater samples;
- When transferring water from the bailer to 40 ml labeled VOA vials, care will be taken to avoid agitating the sample, since agitation promotes the loss of volatile constituents;
- Any observable physical characteristics of the groundwater (e.g., color, sheen, odor) at the time of sampling will be recorded;
- Weather conditions (e.g., air temperature, sky conditions, precipitation, recent heavy rainfalls, drought conditions) at the time of sampling will be recorded; and
- Groundwater samples will be analyzed for volatile organics using EPA Method 502.2.

4.3.2 SURFACE WATER SAMPLING

Surface water sampling will be collected by directly submerging the two prelabeled 40 ml VOA vials at the sampling location. No headspace or bubbles will be left in the vials. The pH and conductivity of the surface water will be measured at the time of the sampling. Samples will be analyzed using EPA Method 502.2. If insufficient water is available from the seep, a small hole will be dug and water allowed to collect. A sample will be taken.

4.3.3 SEDIMENT SAMPLING

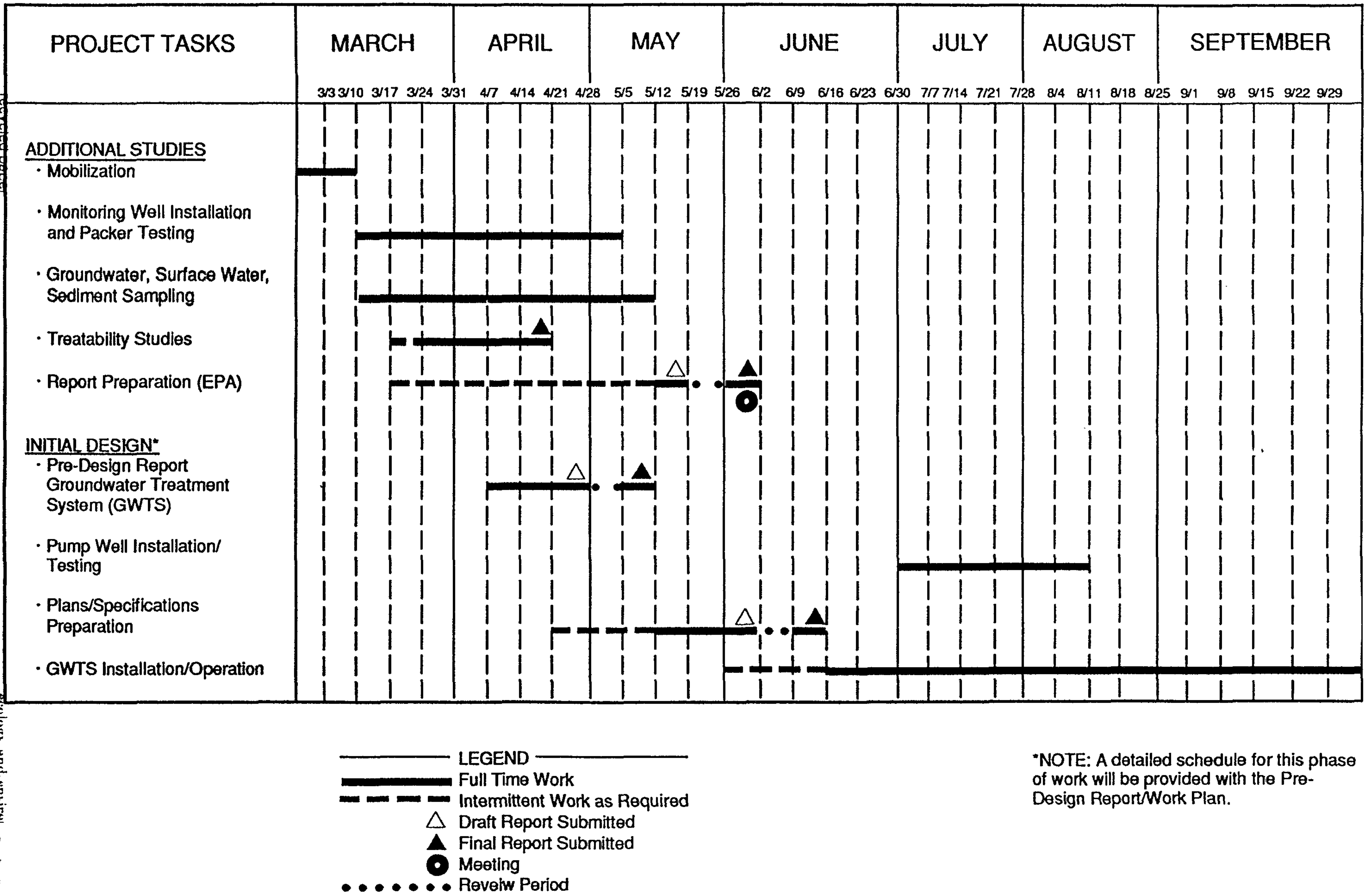
Sediment samples will be collected with dedicated stainless steel spoons and transferred directly into two prelabeled 40 ml VOA vials. Samples will be analyzed using EPA Method 502.2.

5. PROJECT COST ESTIMATE

A detailed estimate of project costs, broken down by standard tasks is provided under separate cover.

6. PROJECT SCHEDULE

A schedule for the tasks discussed in this work plan is given in Figure 6-1.



*NOTE: A detailed schedule for this phase of work will be provided with the Pre-Design Report/Work Plan.

Figure 6-1 WO[illegible]LAN SCHEDULE

APPENDIX A
HEALTH AND SAFETY PLAN

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ecology and environment, inc.

SITE SAFETY PLAN

Version 988

A. GENERAL INFORMATION

Project Title: Berks Sand Pit

Project No.: ZD-4000

TDD/Pan No.:

Project Manager: Robert Marszalkowski

Project Dir.: Joe Pearson

Location(s):

Prepared by: Martin Tatoian

Date Prepared: December 12, 1989

Approval by: Thomas Siener

Date Approved: 12-19-89

Site Safety Officer Review:

Date Reviewed:

Scope/Objective of Work: Monitoring well instalation and sampling

Proposed Date of Field Activities: FEBRUARY 1990

Background Info: Complete: ☒ Preliminary (No analytical data available) ☐

Documentation/Summary:

Overall Chemical Hazard: Serious ☐ Low ☒ Moderate ☐ Unknown ☐

Overall Physical Hazard: Serious ☐ Low ☐ Moderate ☒ Unknown ☐

B. SITE/WASTE CHARACTERISTICS

Waste Type(s):

Liquid ☐ Solid ☐ Sludge ☐ Gas/Vapor ☒

Characteristic(s):

Flammable/Ignitable ☐ Volatile ☐ Corrosive ☐ Acutely Toxic ☒

Explosive ☐ Reactive ☒ Carcinogen ☐ Radioactive* ☐

Other:

Physical Hazards:

Overhead ☐ Confined* Space ☐ Below Grade ☐ Trip/Fall ☒

Puncture ☐ Burn ☐ Cut ☐ Splash ☐

Noise ☐ Other: Posible extreme cold weather conditions

---

*Requires completion of additional form and special approval from the Corporate Health/Safety group. Contact RSC or HQ.

Site History/Description and Unusual Features (see Sampling Plan for detailed description):

Former sand and gravel pit,presently filled in.Project area is in a residential neighborhood.

Locations of Chemicals/Wastes: Contaminated groundwater, surface water and sediments. Suspected source is former sand pit.

Estimated Volume of Chemicals/Wastes: Unknown

Site Currently in Operation Yes: [ ] No: [x]

C. HAZARD EVALUATION

List Hazards by Task (i.e., drum sampling, drilling, etc.) and number them. (Task numbers are cross-referenced in Section D)

Physical Hazard Evaluation: Potential hazards include exposures to organic waste constituents, trip and fall hazards associated with drilling. Hazard Evaluation: see Table 1. Attention should be kept for freezing water around rig while drilling. Kitty litter and ice melt should be available to sprinkle on ice to avoid slipping if needed.

Task I Drilling

Chemical Hazard Evaluation:

Compound	PEL/TWA	Route of Exposure	Acute Symptoms	Odor Threshold	Odor Description
See Attachment A.					

Note: Complete and attach a Hazard Evaluation Sheet for major known contaminant.

D. SITE SAFETY WORK PLAN

Site Control: Attach map, use back of this page, or sketch of site showing hot zone, contamination reduction, zone, etc.

Perimeter identified? ☐ Site secured? ☐

Work Areas Designated? ☐ Zone(s) of Contamination Identified? ☒

Personal Protection (TLD badges required for all field personnel):

Anticipated Level of Protection (Cross-reference task numbers to Section C):

	A	B	C	D
Task 1			(x)	x
Task 2				
Task 3				
Task 4				

(Expand if necessary)

Modifications: The level of protection will be based on OVA readings in immediate work area and breathing zone. Upgrade to Level "C" will be used if readings are above background as below.

Action Levels for Excavation of Work Zone Pending Reassessment of Conditions:

- Level D: O_2 <19.5% or >25%, explosive atmosphere >10% LEL, organic vapors above background levels, particulates >_____ mg/m^3, other 0-1 ppm.
- Level C: O_2 <19.5% or >25%, explosive atmosphere >25% LEL (California-20%), unknown organic vapor (in breathing zone) >5 ppm, particulates >_____ mg/m^3, other >1 ppm - 5 ppm.
- Level B: O_2 <19.5% or >25%, explosive atmosphere >25% LEL (California-20%), unknown organic vapors (in breathing zone) >500 ppm, particulates >_____ mg/m^3, other >5 ppm - 500 ppm.
- Level A: O_2 <19.5% or >25%, explosive atmosphere >25% LEL (California-20%), unknown organic vapors >500 ppm, particulates >_____ mg/m^3, other ________.

Air Monitoring (daily calibration unless otherwise noted):

Contaminant of Interest	Type of Sample (area, personal)	Monitoring Equipment	Frequency of Sampling
Organic Vapors	Area	OVA/explosimeter	Continuous

(E pand if necessary)

Decontamination Solutions and Procedures for Equipment, Sampling Gear, etc.:

All equipment that can be decontaminated will be steam cleaned in a designated area covered with plastic. All contaminated water created by cleaning will be drummed. Non-washable items (Tyvek, gloves, booties, etc.) will be discarded in trash bags as "Hot Waste". (Precautions should be taken to avoid slipping on plastic in in decon pit when cold.)

Personnel Decon Protocol:

Soap and water wash as soon as possible following completion of field work.

Decon Solution Monitoring Procedures, if Applicable: Decon will be performed in an area upwind of exclusion zone.

Special Site Equipment, Facilities, or Procedures (Sanitary Facilities and Lighting Must Meet *29 CFR 1910.120*):

On site office trailer with power, telephone, heating.

Site Entry Procedures and Special Considerations:

Continuous monitoring will be performed during drilling operation.

Work Limitations (time of day, weather conditions, etc.) and Heat/Cold Stress Requirements:

All work will be conducted during daylight hours only. Special attention should be given if temp becomes extremely cold (<20 Degrees F). Information for hypothermia and frostbite can be noted in Addendums to SSP. Warm fluids (decaf) should be available. Heaters, if required.

General Spill Control, if applicable: N/A

Investigation-Derived Material Disposal (i.e., expendables, decon waste, cuttings):

All disposable protective clothing, decontamination-generated paper waste, and single-use equipment will be bagged, and labeled as hazardous materials, then drummed.

Protective Wear:

Tyvek, safety glasses or goggles, steel toe shoes, Scorpio or surgical gloves and hard hat. Clothing conducive to cold weather shall be available at site or worn during working hours (thermal underwear, socks, gloves, etc.)

Team Member*	Responsibility
Tom Ferraro	Team Leader
TBD	Site Safety Officer TBA

*All entries into exclusion zone require Buddy System use. All E & E field staff participate in medical monitoring program and have completed applicable training per 29 CFR 1910.120. Respiratory protection program meets requirements of 29 CFR 1910.134, and ANSI Z88.2 (1980).

E. EMERGENCY INFORMATION

(Use supplemental sheets, if necessary)

LOCAL RESOURCES

(Obtain a local telephone book from your hotel, if possible)

Ambulance Macungie 437-5252

Hospital Emergency Room ______

Poison Control Center ______

Police (include local, county sheriff, state) 911 Macungie Police 966-2222

Fire Department 911 - Same as ambulance

Airport Allentown Bethlehem Easion Airport: 100N Rt. 22E Airport

Agency Contact (EPA, State, Local USCG, etc.) ______

Local Laboratory ______

UPS/Fed. Express Allentown, Bethlehem, Easion Airport

Client/EPA Contact Chris Corbett - 215-597·6906

Site Contact Tom FERRARO / Amin AYUBCHA

SITE RESOURCES

Site Emergency Evacuation Alarm Method ______

Water Supply Source ______

Telephone Location, Number ______

Cellular Phone, if available ______

Radio ______

Other ______

EMERGENCY CONTACTS

1. Dr. Raymond Harbison (Univ. of Florida) .... (501) 221-0465 or (904) 462-3277, 3281
   Alachua, Florida (501) 370-8263 (24 hours)
2. Ecology and Environment, Inc., Safety Director
   Paul Jonmaire .... (716) 684-8060 (office)
   (716) 655-1260 (home)
3. Regional Office Contact .... 215-875-7370 (home)
   ______ (office)
4. FITOM, TATOM, or Office Manager .... ______ (home)

MEDTOX HOTLINE

1. Twenty-four hour answering service: (501) 370-8263

   What to report:

   - State: "this is an emergency."
   - Your name, region, and site.
   - Telephone number to reach you.
   - Your location.
   - Name of person injured or exposed.
   - Nature of emergency.
   - Action taken.

2. A toxicologist, (Drs. Raymond Harbison or associate) will contact you. Repeat the information given to the answering service.

3. If a toxicologist does not return your call within 15 minutes, call the following persons in order until contact is made:

   a. 24 hour hotline - (716) 684-8940
   b. Corporate Safety Director - Paul Jonmaire - home # (716) 655-1260
   c. Assistant Corp. Safety Officer - Steven Sherman - home # (716) 688-0084

EMERGENCY ROUTES

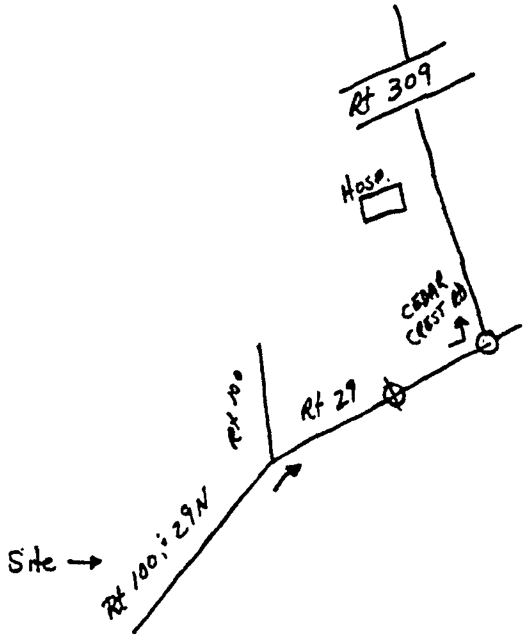
(NOTE: Field Team must Know Route(s) Prior to Start of Work)

Directions to hospital (include map) Huffs Church* Rt. 100 - 29(N) where Rt. 100 and 29 split. Take Rt. 29 2nd traffic light Cedar Crest. Turn left Lehigh Valley Hospital Center. About 2 mil. on left.

Emergency Egress Routes to Get Off-Site

\- -

*Site Walker Road turn (Rt) Main Street Turn (Rt) Seisholtsville St. Peters turn left Macungie Mt. Rd turn left Changes to Chestnut Rt. 100. turn left on 100-29 (N).



COMPOUND	PEL/TWA	ROUTE OF EXPOSURE	ACUTE SYMPTOMS	ODOR DESCRIPTION
1,1,1-Trichloroethane	350 ppm	INH/INJ/Dermal	Headaches, poor equilibrium, dermatitis, eye irritation.	Mild chloroform
1,1-Dichloroethane	100 ppm	INH/INJ	Drowsiness, CNS, IRR, eye, throat, bronch CNS.	chloroform
Dichloromethane	500 ppm	INH/Dermal	Nausea, fatigue, numb limbs, eye, skin irritation CNS.	chloroform
1,2-Dichloroethane	50 ppm	INH/Dermal	Nausea, vomiting, eye irritation, CNS	sweet chloroform
Toluene	200 ppm	INH/Dermal	Eye, nose, throat, skin irritation, fatigue, dizziness, headache, CNS.	odor like benzene
Tetrachloroethene	50 ppm	INH/Dermal	Eye, nose, throat, skin irritation, fatigue, dizziness, headache, CNS.	mild, sweet, etherish

F. EQUIPMENT CHECKLIST

PROTECTIVE GEAR

Level A	No.*	Level B	o.
SCBA		SCBA	
SPARE AIR TANKS		SPARE AIR TANKS	
ENCAPSULATING SUIT (Type ____________)		PROTECTIVE COVERALL (____________)	
SURGICAL GLOVES		RAIN SUIT	
NEOPRENE SAFETY BOOTS		BUTYL APRON	
BOOTIES		SURGICAL GLOVES	
GLOVES (Type ______________________)		GLOVES (Type ______________)	
OUTER WORK GLOVES		OUTER WORK GLOVES	
HARD HAT		NEOPRENE SAFETY BOOTS	
CASCADE SYSTEM		BOOTIES	
5-MINUTE ESCAPE COOLING VEST		HARD HAT WITH FACE SHIELD	
		CASCADE SYSTEM	
		MANIFOLD SYSTEM	
Level C		Level D	
ULTRA-TWIN RESPIRATOR	x	ULTRA-TWIN RESPIRATOR (Available)	
POWER AIR PURIFYING RESPIRATOR		CARTRIDGES (Type ______________)	
Cartridge (Type GMC-H ______________)		5-MINUTE ESCAPE MASK (Availble)	
5-MINUTE ESCAPE MASK		PROTECTIVE COVERALL (Type Tyvek ________)	
PROTECTIVE COVERALL (Type)		RAIN SUIT	
RAIN SUIT		NEOPRENE SAFETY BOOTS	
BUTYL APRON		BOOTIES	x
SURGICAL GLOVES		WORK GLOVES	x
GLOVES (Type Scorpios ________)		HARD HAT WITH FACE SHIELD	x
OUTER WORK GLOVES		SAFETY GLASSES	x
NEOPRENE SAFETY BOOTS			
HARD HAT WITH FACE SHIELD			
BOOTIES	x		
HARDHAT	x		
Safety glsses or goggles	x		
*No. dependent on task and number of			
field team members.			

INSTRUMENTATION	No.
OVA	1
THERMAL DESORBER	
O2/EXPLOSIMETER W/CAL. KIT	1
PHOTOVAC TIP	
HNu (Probe _______________)	
MAGNETOMETER	
PIPE LOCATOR	
WEATHER STATION	
DRAEGER PUMP, TUBES ____________________	
BRUNTON COMPASS	
MONITOX CYANIDE	
HEAT STRESS MONITOR	
NOISE EQUIPMENT _______________________	
PERSONAL SAMPLING PUMPS	
MINIRAM	
RADIATION EQUIPMENT	
DOCUMENTATION FORMS	
PORTABLE RATEMETER	
SCALER/RATEMETER	
NaI Probe	
ZnS Probe	
GM Pancake Probe	
GM Side Window Probe	
MICRO R METER	
ION CHAMBER	
ALERT DOSIMETER	
POCKET DOSIMETER	
TRITIUM MONITOR	
FIRST AID EQUIPMENT	
FIRST AID KIT	
OXYGEN ADMINISTRATOR	
STRETCHER	
PORTABLE EYE WASH	
BLOOD PRESSURE MONITOR	
FIRE EXTINGUISHER	

DECON EQUIPMENT	No.
WASH TUBS	
BUCKETS	
SCRUB BRUSHES	
PRESSURIZED SPRAYER	
DETERGENT (Type ___________________)	
SOLVENT (Type ________________________)	
PLASTIC SHEETING	1
TARPS AND POLES	if needed
TRASH BAGS	1
TRASH CANS	
MASKING TAPE	
DUCT TAPE	
PAPER TOWELS	1
FACE MASK	1
FACE MASK SANITIZER	
FOLDING CHAIRS	
STEP LADDERS	
DISTILLED WATER	
SAMPLING EQUIPMENT	
8 OZ. BOTTLES	
HALF-GALLON BOTTLES	
VOA BOTTLES	
STRING	
HAND BAILERS	
THIEVING RODS WITH BULBS	
SPOONS	
KNIVES	
FILTER PAPER	
PERSONAL SAMPLING PUMP SUPPLIES	
SPLIT SPOON SAMPLERS	
BRASS SLEEVES FOR SPLIT-SPOONS	
(wax and caps)	

VAN EQUIPMENT	No.
TOOL KIT	
HYDRAULIC JACK	
LUG WRENCH	
TOW CHAIN	
VAN CHECK OUT	
Gas	
Oil	
Antifreeze	
Battery	
Windshield Wash	
Tire Pressure	
MISCELLANEOUS	
PITCHER PUMP	
SURVEYOR'S TAPE	
100 FIBERGLASS TAPE	
300 NYLON ROPE	
NYLON STRING	
SURVEYING FLAGS	
FILM	
WHEEL BARROW	
BUNG WRENCH	
SOIL AUGER	
PICK	
SHOVEL	
CATALYTIC HEATER	
PROPANE GAS	
BANNER TAPE	
SURVEYING METER STICK	
CHAINING PINS & RING	
TABLES	
WEATHER RADIO	
BINOCULARS	
MAGAPHONE	

MISCELLANEOUS (Cont.)	No.
RADIATION WARNING TAPE	
RADIATION DECON SUPPLIES	
SHIPPING EQUIPMENT	
COOLERS	
PAINT CANS WITH LIDS, 3 CLIPS EACH	
VERMICULITE	
SHIPPING LABELS	
DOT LABELS: "DANGER"	
"UP"	
"INSIDE CONTAINER COMPLIES ..."	
"HAZARD GROUP"	
STRAPPING TAPE	
BOTTLE LABELS	
BAGGIES	
CUSTODY SEALS	
CHAIN-OF-CUSTODY FORMS	
FEDERAL EXPRESS FORMS	
CLEAR PACKING TAPE	

Physiological Response to Cold.

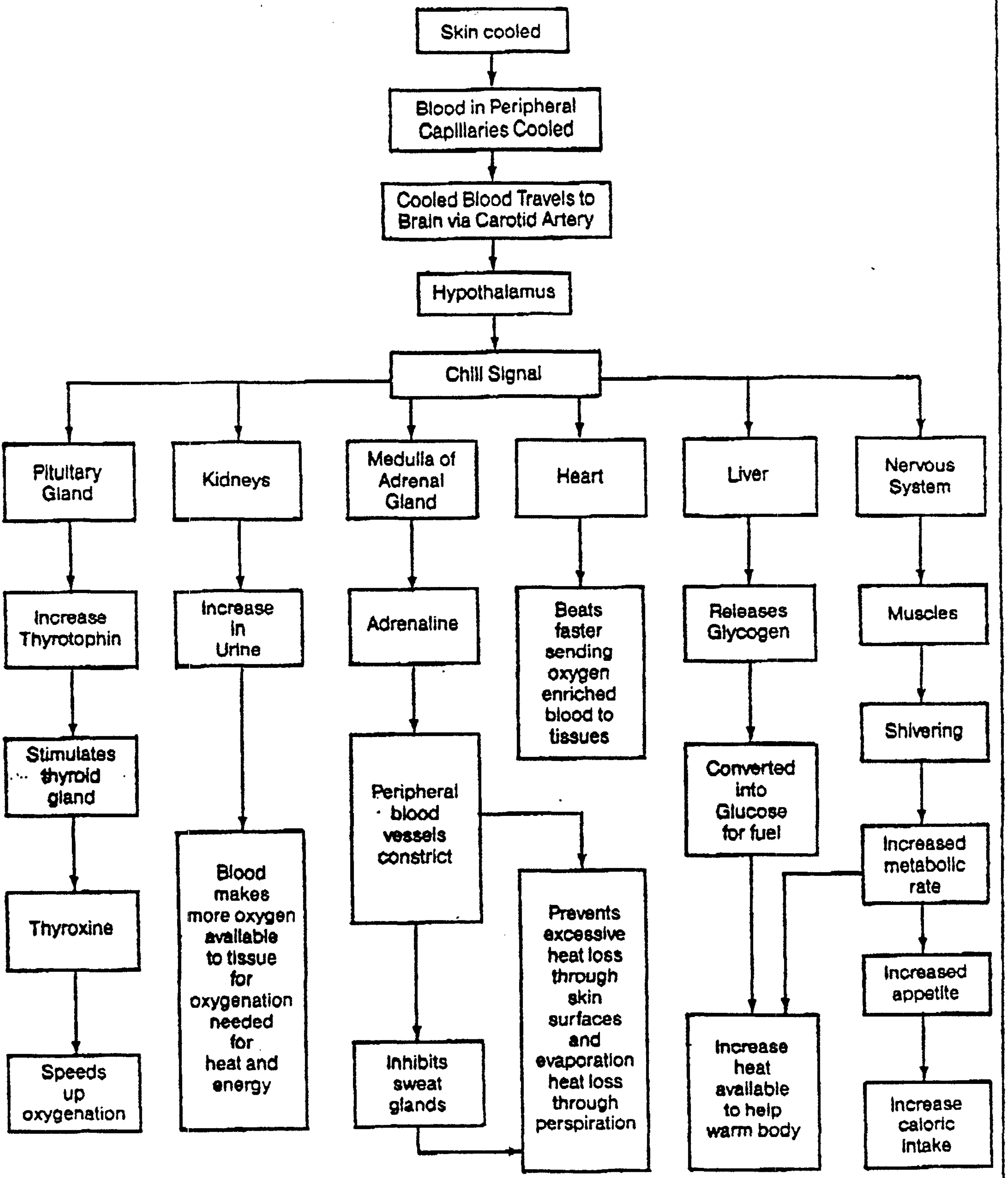


Figure 1

Hypothermia

Symptoms:

- Pain in the extremeties.
- Uncomfortable shivering and the sensation of cold.
- Reduction of body core temperature.
- Cool skin.
- Rigid muscles.
- Slowing of heart rate.
- Weakening of pulse.
- Low blood pressure.
- Irritability of heart muscle.
- Sometimes heart beating abnormally in respect to strength and rhythm.
- Slow irregular breathing.
- Memory lapses.
- Vague slow slurred speech.
- Drowsiness.
- Incoherence.
- Diminished reaction time.
- Diminished coordination.
- Diminished judgment.
- Diminished dexterity.

Possible Underlying Causes:

- Exposure to low air temperatures, high wind, inadequate clothing or water immersion.
- Underlying disease, as heart or blood vessel disease.
- Old age.
- Allergies.
- Alcoholism.
- Recent alcohol consumption.
- Smoking.
- Medications that affect the temperature-regulating mechanism.
- Exhaustion.
- Sedative drugs.
- Dehydration.

Treatment:

- Get the victim out of the win snow, or rain.
- Keep use of energy to a mi[illegible]
- Keep person awake.
- Victim should be handled on litter if movement is necessar
- Strip off all wet clothes.
- Get person into dry clothes.
- Wrap blanket around victim.
- In conscious victims, body should be packed with heat packs or wet towels no warm than 105°F, behind the neck, groin, and armpits.
- Do not rewarm extremeties a the core at the same time.
- Provide lifesaving actions as necessary—mouth-to-mouth suscitation or cardiopulmona resuscitation (CPR), if trained
- If blankets, sleeping bag, news papers, heat packs, or we[illegible] are not available rewarm victi with another body by pressing the victim's body against your on a sleeping bag.
- Give sweet warm drinks to co scious victims.
- Do not immerse victim in a warm water bath.
- Take victim to the hospital by calling an ambulance and tellir them that a cold illness emergency exists.

Frostbite

Symptoms:

- Skin changes color to white or grayish yellow, progresses to reddish violet, and ultimately turns black.
- Burn at first.
- Blisters.
- Affected part cold, numb and tingling.

Possible Underlying Causes:

- Exposure to cold.
- Lack of acclimatization.
- Age (very young or old).
- Physically disabled or mentally impaired.
- Underlying diseases, such as heart and blood vessel disease.

Treatment:

- Cover the frozen part.
- Provide extra clothing and blankets.
- Bring victim indoors as soon as possible.
- Place the frozen part in warm water at a temperature of 102° to 105° or rewarm with warm packs.
- If affected part has been thawed and refrozen, do not use water, rewarm at room temperature.
- If no water is available, wrap gently in a sheet and blanket.
- Discontinue warming the victim as soon as the affected part becomes flushed and swelling develops after thawing.
- Exercise part after rewarming but do not allow victim to walk after the affected part thaws.
- Place dry sterile gauze between affected fingers and toes, do not apply other dressings unless victim is to be transported for medical aid.
- If travel is necessary, warm fected parts with sterile or cloths during transportatic
- Elevate the frostbitten part protect them from contact bedclothes.
- Give sweet, warm fluid if v is conscious and not vomit no alcoholic or caffein bev ages.
- In absence of warm water, bitten fingers should be pl uncovered under the armp next to skin.
- If the toes or heels are affec footwear should be covere with dry socks.
- If above measures for feet a possible, place bare frostbi feet against the belly of a co panion or under clothing.
- If the cheeks are frostbitten, the affected areas with warn hands until the pain returns.
- Following rewarming, wou should be treated in open a sterile manner. Bandages hamper the circulation.
- Deep frostbite should not b thawed in the field.
- Do not rub the part with an thing (including snow and apply heat lamp or hot wat bottles, place injured part n hot stove, or break blisters.
- Obtain medical assistance a soon as possible.

Acrocyanosis

Symptoms:
- Hands and feet are cold, blue and sweaty.

Possible Underlying Causes:
- Exposure to cold.
- Inadequate clothing.
- Underlying disease such as blood vessel disease.

Treatment:
- Remove to warmer area.
- Loosen tight clothing.
- Consult physician.

Raynaud's Disease

Symptoms:
- Fingers turn white and stiff.
- Intermittent blanching and reddening of the fingers and toes.
- Affected area tingles and becomes very red or reddish purple.

Possible Underlying Causes:
- Exposure to low air temperature, high winds.
- Inadequate clothing.
- Underlying disease such as blood vessel disease.

Treatment:
- Remove to warmer area.
- Consult physician.

Chilblain

Symptoms:
- Recurrent localized itching, swelling and painful inflammation of the fingers, toes or ears.
- Severe spasms.

Possible Underlying Causes:
- Inadequate clothing.
- Exposure to cold and moisture.
- Underlying disease such as blood vessel disease.

Treatment:
- Remove to warmer area.
- Consult physician.

Symptoms:

- Edema.
- Tingling, itching.
- Severe pain.
- Blistering.

Possible Underlying Causes:

- Exposure to cold and dampness.

Treatment:

- Remove to warmer area.
- Consult physician.
- Refer to frostbite treatment

Frostnip

Symptoms:

- Skin turns white.

Possible Underlying Causes:

- Exposure to cold.

Treatment:

- Remove to warmer area.
- Refer to treatment for frostbite

TABLE 12-A. WINDCHILL INDEX

Wind speed in mph	ACTUAL THERMOMETER READING (F)									
	50	40	30	20	10	0	-10	-20	-30	-40
	EQUIVALENT TEMPERATURE (F)									
calm	50	40	30	20	10	0	-10	-20	-30	-40
5	48	37	27	16	6	-5	-15	-26	-36	-47
10	40	28	16	4	-9	-21	-33	-46	-58	-70
15	36	22	9	-5	-18	-36	-45	-58	-72	-85
20	32	18	4	-10	-25	-39	-53	-67	-82	-96
25	30	16	0	-15	-29	-44	-59	-74	-88	-104
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116
Over 40 mph (little added effect)	LITTLE DANGER (for properly clothed person)				INCREASING DANGER (Danger from freezing of exposed flesh)			GREAT DANGER		

The human body senses "cold" as a result of both the air temperature and the wind velocity. Coolin exposed flesh increases rapidly as the wind velocity goes up. Frostbite can occur at relatively mi temperatures if wind penetrates the body insulation. For example, when the actual air temperature of the wind is 40 F (4.4 C) and its velocity is 30 mph (48 km/h), the exposed skin would perceive this situation as an equivalent still air temperature of 13 F (-11 C). .

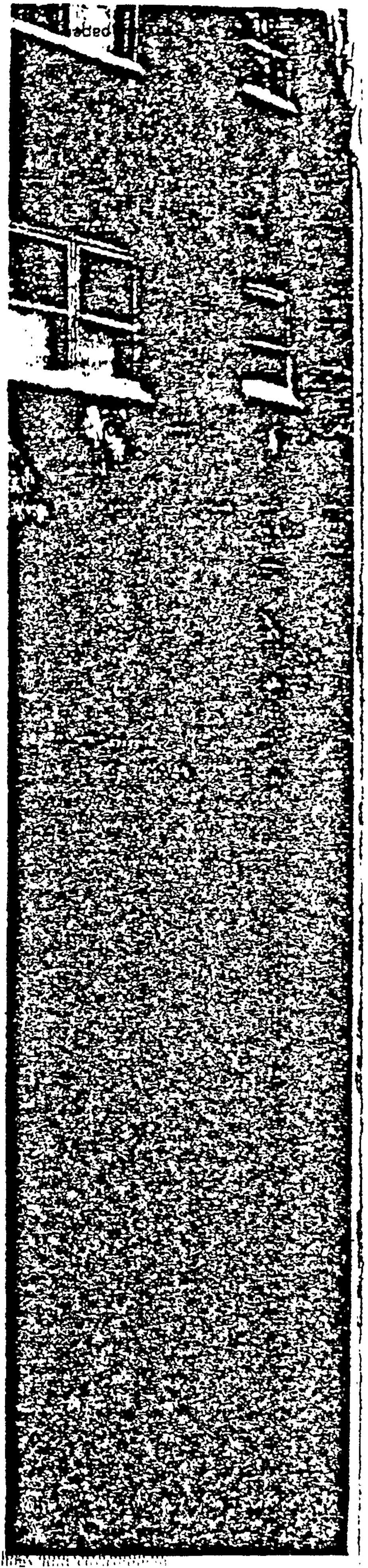
temperature much better than a single heavy outer garment worn over ordinary indoor clothing. The more air cells each of these clothing layers has, the more efficient it insulates against body heat loss (see Figure 12-2). Make sure that clothing allows some venting of perspiration. Because wet skin will freeze more rapidly than dry skin, use all feasible means to keep as dry as possible. Make full use of windbreaks and avoid exposing skin to direct effects of the wind. Problems are created by the need to wear layers of special clothing that make the wearer very clumsy in performing many routine work procedures. Increased body dimensions must also be considered if tight spaces are encountered.

If exposed skin begins to sting or tingle, rub the area to stimulate circulation. However, if the exposed area is numb, do not rub it. Especially, do not use snow; this will only make the injury more serious. Warm the affected parts in warm water (104 to 113 F or 40 to 45 C) or by other suitable means.

Thermal-type respirators are available for those bothered by breathing very cold air. At temperatures much lower than -49 F (-45 C), the lung tissue may start freezing unless the air is warmed before breathing. Time limits recommended for working in various low-temperature ranges are given in Table 12-B. Because metal will conduct heat away from the body quite rapidly, be very careful of skin contact with metal objects such as tools, and, if possible, use tools that have nonmetallic handles.

Outdoor construction workers, as well as mountaineers, hikers, and farmers are likely

DRESS UP FOR WINTER RISKS



By James Bolger

The layered look will never go out of style, at least not in some parts of the country. Not as long as the cold wind blows, snow falls and water freezes. The layered look is always in fashion in a cold spell.

Dressing in several layers of thick, loose-fitting clothing insulates the body by trapping warm, dry air. Loosely woven clothes of cotton and wool are best for trapping air and resisting dampness.

The outermost layer of clothes should be tightly woven and wind-resistant. Pound for pound, down makes the best insulating material, but it does not insulate well if it becomes wet. Wool or polypropylene jackets do better.

Mittens may seem like kid's stuff, but they make the best choice for dealing with the snow. They keep hands warmer than gloves. If you need to use your fingers outdoors, try wearing a pair of thin gloves underneath mittens.

Layering keeps feet warm, too. Start with a thin layer of cotton or polypropylene socks, to draw moisture away from feet. Top that with a pair of thick, warm socks. A pair of water-proof boots completes the layered look. Don't overdo the wool socks — wearing more than one pair can make feet fit so tightly inside of boots that warm air can't circulate.

Look for boots that give a good feel of the terrain, as well as good traction. Clearing snow and ice off steps and sidewalks will help.

The head and neck lose body heat more rapidly than other areas, and uncovered cheeks, ears and noses are prone to frostbite. A wool hat with a pull-down face mask will help keep a child's head warm. A turtleneck sweater and a scarf can help keep the neck warm.

The final part of the winter ensemble is a good pair of sunglasses. A single day spent outdoors in the combined glare of sun and snow can temporarily rob a person of as much as 50 percent of night vision. It can take as long as a week to recover fully. Wearing a good pair of sunglasses is the best way to avoid this problem.

The layered look has another advantage. An active person outdoors will work up a sweat. But sweaty, damp clothes can increase the chance of hypothermia. A person wearing several layers of warm clothes can remove a layer when perspiration begins.

Hypothermia is a dangerous drop in core body temperature. It causes rapid mental confusion, shivering, slurred speech, clumsiness and drowsiness. Often victims are too dazed to recognize their own condition.

A person suffering from hypothermia should be taken out of the cold immediately, and given dry clothes and a warm blanket. If the victim can swallow, warm drinks such as hot chocolate may help. Avoid alcoholic beverages for hypothermia victims.

Don't put the victim in a shower or bath, and don't rub the victims arms or legs. These methods will not help, and could harm, the victim.

Elderly people are at special risk for hypothermia. Family and friends must be sure to watch for the tell-tale signs. Even indoors, the elderly should dress warmly, in layers. They should also eat enough food, drink warm liquids and stay active to maintain body temperature. They can also keep warm by having plenty of blankets when they sleep.

People may say they are 'freezing' when they're just cold. When a person's skin actually freezes, it's called "frostbite." Probably every Northern and Midwestern parent has warned their children about it.

Frostbite is actually the process of tissue freezing. Faced with bitter cold, the body conserves heat by di

recting warm blood away from the arms, legs and face to supply the heart, lungs and other vital organs. If the body temperature in the extremities drops low enough, ice crystals actually form in the tissue.

Often frostbite victims feel no pain, and don't realize anything is wrong until they notice that their skin has changed color.

Superficial frostbite turns the skin white or grayish-yellow. Other symptoms include burning, tingling, aching sensations or numbness.

Deep frostbite, a more serious condition, usually attacks the hands and feet. The skin becomes white and cold, and feels solid to the touch. After the skin thaws, it may appear blue, purple or black.

Anyone suffering from frostbite should move inside and immerse the affected part into warm (102-106 F) water. If frostbite affects the face, apply warm, moist towels. Stop immersion when the affected area appears flushed — usually after about 20 minutes. One common mistake in treating frostbite is rubbing the affected area with ice and snow. *Do not rub a frostbitten area at all* — rubbing can damage sensitive tissue and cause gangrene. Don't try applying excessive heat to the area, either. Heat will damage tissue, just as cold does.

After a case of frostbite, the affected area will be more sensitive to cold, so a victim must avoid overexposure in the future. In some cases, both frostbite and hypothermia develop. Treat the hypothermia first, as it is an immediate life-threatening condition. Treat the frostbite after the core body temperature has been raised.

Even if it seems that first aid has been successful, all frostbite and hypothermia victims should see a physician.■

Ecology and Environment, Inc.
Hazard Evaluation of Chemicals
Region V - Chicago

Chemical Name 1,1-Dichloroethane Date
DOT Classification Job Number
CAS Number 75-34-3

REFERENCES CONSULTED (circle; also include MSDS if approprate.)
[✓ NIOSH/OSHA Pocket Guide] Merck Index [✓ Hazardline] [✓ Chris(vol.III)]
[✓ ACGIH TLV Booklet] Toxic & Hazardous Safety Manual [✓ SAX] [✓ Aldrich]
RTECS other: Sittig

CHEMICAL PROPERTIES:(Synonyms:1,1-Ethylidene chloride)
Chemical Formula CH_3CHCl_2 MW 99 Ionization Potential not avail
Physical State Liquid Boiling Point 135° F Freezing Point -142° F
Flash Point 17° F Flammable Limits 6-16% Vapor Pressure 182mm
Specific Gravity/Density 1.174 Odor/Odor Threshold 5ppm not reliable
Solubility-water: Insoluble Solubility-other:
Incompatabilities & Reactivity: Strong oxidizers, caustics

TOXICOLOGICAL PROPERTIES:
Exposure Limits: TLV-TWA (ACGIH) 200ppm PEL (OSHA) 100ppm
STEL 250ppm Ceiling Limits none est. IDLH 4,000ppm
Toxicity Data: (Indicate duration of study)
Human; IHL Dermal Oral
Rat/Mouse; IHL Dermal Oral LD50 725mg/kg
Aquatic: Other:
Carcinogen indef-anim mutagen N/A Reproductive Toxin exper.terat.
Route(s) of exposure - (circle all that apply): [✓ Inhalation] [✓ Ingestion]
[✓ Dermal Contact] [✓ Eye(ocular)] Dermal Absorption Other

HANDLING RECOMMENDATIONS: (personal protective measures)
Respirators: 1000 ppm- APR with chemical cartridge or SCBA;74000ppm use SCBA
Protective Clothing: Excel-viton;Good-butyl;poor-neoprene,nitrile.
Special Equipment: None

DISPOSAL,FIRE and SPILLS:(Use numbered codes;see attached sheets for explanation.)
Disposal D Fire 7 Leaks&Spills 1,3,4,6,9
Decomposition Products: CO,CO_2,hydrogen chloride & phosgene gas

FIRST AID:
ING: Give salt water, induce vomiting, medical atten. immed.
IHL: Remove to fresh air, CPR if necessary, medical attent. immed.
Eye/Skin: Irrigate/wash immediately with water.Wash skin thoroughly with with soap & water.

SYMPTOMS:
acute(immediate) exposure effects: Central nervous system depression, coughing dizziness, nausea, vomiting, drowsiness, unconsciousness.

chronic(long term) exposure effects: Liver & kidney damage,lungs & adrenal glands affected from chronic exposure. Prolonged skin contact may produce burns. Alcohol enhances systeunic toxicity.

reproductive effects: None specified for humans

Ecology and Environment, Inc.
Hazard Evaluation of Chemicals
Region V - Chicago

Chemical Name 1,2-Dichloroethane Date
DOT Classification Job Number
CAS Number 107-06-2

REFERENCES CONSULTED (circle; also include MSDS if approprate.)
[✓ NIOSH/OSHA Pocket Guide] Merck Index Hazardline [✓ Chris(vol.III)]
[✓ ACGIH TLV Booklet] Toxic & Hazardous Safety Manual [✓ SAX] [✓ Aldrich]
[✓ RTECS] other: Sittig, chemical dictionary

CHEMICAL PROPERTIES: (Synonyms: Ethylene dichloride, glycol dichloride)
Chemical Formula $ClCH_2CH_2Cl$ MW 99 Ionization Potential 11.12ev
Physical State liquid Boiling Point 183° F Freezing Point -32.3° F
Flash Point 55° F Flammable Limits 6.2-16% Vapor Pressure 62mm
Specific Gravity/Density 1.253 Odor/Odor Threshold 100ppm chloroform

Solubility-water: slightly Solubility-other:
Incompatabilities & Reactivity: Strong oxidizers, caustics, chem. active metals

TOXICOLOGICAL PROPERTIES:
Exposure Limits: TLV-TWA (ACGIH) 10ppm PEL (OSHA) 50ppm
STEL None est. Ceiling Limits 2ppm/15 min IDLH 1000ppm
Toxicity Data: (Indicate duration of study)
Human; IHL Tclo 1000ppm/1Hr Dermal Oral Ldlo 810mg/kg
Rat/Mouse; IHL Dermal Oral
Aquatic: T/M 96:1000-100ppm Other: animal positive carcinogen
Carcinogen human-sus Mutagen exper. Reproductive Toxin exp. teratogen
Route(s) of exposure - (circle all that apply): [✓ Inhalation] [✓ Ingestion]
[✓ Dermal Contact] [✓ Eye(ocular)] [✓ Dermal Absorption] Other readily skin absorb

HANDLING RECOMMENDATIONS: (personal protective measures)
Respirators: >any detectable limit-use SCBA
Protective Clothing: excel.-viton; good-butyl; poor-vinyl, nitrile, neoprene
Special Equipment: Prevent contact w/skin since readily absorbed

DISPOSAL, FIRE and SPILLS: (Use numbered codes; see attached sheets for explanation.)
Disposal D Fire 6,7 Leaks&Spills 1,3,4,6,9
Decomposition Products: CO, CO_2, hydrogen chloride & phosgene gas.

FIRST AID:
ING: Give large quantities of water, induce vomiting, med. attent.
IHL: Move to fresh air, CPR if necessary, medical attent.
Eye/Skin: Irrigate immed. w/water, at least 15 min. wash skin throughly with soap & water.

SYMPTOMS:
acute(immediate) exposure effects: Nausea, vomiting, mental confusion dizziness, headache, skin burns, dermatitis, cornea of eye damage. Acute exposure at high concentrations can result in death due to circulatory & respiratory failure.

chronic(long term) exposure effects:
Repeated long terme xposure may result in nervous system disorders, loss of appetite, stomach problems, liver and/or kidney damage. Suspect human

reproductive effects: None specified for humans.

Occupational Health Guideline for Methyl Chloroform

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CH_3CCl_3
- Synonyms: 1,1,1-trichloroethane; 1,1,1-trichloroethane, stabilized
- Appearance and odor: Colorless liquid with a mild odor, like chloroform.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for methyl chloroform is 350 parts of methyl chloroform per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1910 milligrams of methyl chloroform per cubic meter of air (mg/m^3). NIOSH has recommended that the permissible exposure limit be changed to a ceiling of 350 ppm (1910 mg/m^3) averaged over a 15-minute period. The NIOSH Criteria Document for 1,1,1-Trichloroethane should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Methyl chloroform can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

- **Effects of overexposure**

1. Short-term Exposure: Exposure to methyl chloroform vapor may cause headache, dizziness, drowsiness, unconsciousness, irregular heart beat, and death. Methyl chloroform liquid splashed in the eyes may cause irritation.

2. Long-term Exposure: Prolonged or repeated skin contact with liquid methyl chloroform may cause irritation of the skin. Reproductive abnormalities have been noted in studies of animals exposed to high concentrations of methyl chloroform.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to methyl chloroform.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to methyl chloroform at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the employee at increased risk, and to establish a baseline for future health monitoring. Examination of the skin, liver, and cardiovascular system should be stressed. The physician should be made aware of any adverse reproductive effects in workers exposed to methyl chloroform.

—Skin disease: Methyl chloroform can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Liver disease: At high concentrations, methyl chloroform causes liver changes in animals, which justifies consideration of the possible consequences before exposing persons with impaired liver function.

—Cardiovascular disease: In persons with impaired cardiovascular function, especially those with a history of cardiac arrhythmias, the inhalation of methyl chloroform might cause exacerbation of disorders of the conduction mechanism due to its sensitizing effects on the myocardium.

—Medical warning: Workers should be provided with information advising them of studies in which congenital abnormalities were found following exposure of animals to high concentrations of methyl chloro-

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 197cycled paper

form. The physician should be made aware of any reproductive abnormalities in workers.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Methyl chloroform vapor is a narcotic. Repeated exposure of animals to concentrations of 1000 to 10,000 ppm caused liver and lung changes in some species. In dogs, cardiac sensitization to epinephrine occurred at concentrations of 5000 to 10,000 ppm. A number of human fatalities related to industrial exposure in closed spaces have been reported. A 5-minute exposure to 5000 ppm can be expected to produce marked incoordination and anesthesia. Prolonged exposure at this concentration may cause coma and death. Exposure to concentrations in excess of 1000 ppm for 15 minutes, or 2000 ppm for 5 minutes, can be expected to produce a disturbance of equilibrium in the majority of adults. Above 1700 ppm, minor disturbances of equilibrium have been observed, with complaints of headache and lassitude. In controlled human exposures to 500 ppm no effects other than slight, transient eye irritation were noted; at 1000 ppm and above, mild eye irritation was experienced by all subjects, and some became dizzy. Following exposure, most of the compound is eliminated unchanged via the lungs within 48 hours. When placed into the rabbit eye, the liquid caused conjunctival irritation but no corneal damage. Dermatitis may result from repeated skin contact with the liquid.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 133.4
2. Boiling point (760 mm Hg): 74 C (165 F)
3. Specific gravity (water = 1): 1.33
4. Vapor density (air = 1 at boiling point of methyl chloroform): 4.55
5. Melting point: −38 C (−36 F)
6. Vapor pressure at 20 C (68 F): 100 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.07
8. Evaporation rate (butyl acetate = 1): 12.8

- **Reactivity**

1. Conditions contributing to instability: Heat.
2. Incompatibilities: Contact with strong caustics, strong oxidizers, and chemically active metals such as aluminum and magnesium powders, or sodium and potassium may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving methyl chloroform.
4. Special precautions: Liquid methyl chloroform will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Flash point: None in normal test method.
2. Autoignition temperature: 500 C (932 F)
3. Flammable limits in air, % by volume: (At elevated temperature and pressure) Lower: 7; Upper: 16
4. Extinguishant: Foam, dry chemical, carbon dioxide

- **Warning properties**

1. Odor Threshold: The AIHA *Hygienic Guide* states that the odor threshold of methyl chloroform may range from 20 to 100 ppm. Both May and Summer give 400 ppm as the odor threshold, however.
2. Eye Irritation Level: The *Hygienic Guide* states that "in controlled human exposures to 500 ppm no effects other than slight, transient eye irritation were noted, but at 1000 ppm and above, mild eye irritation was experienced by all subjects."
3. Evaluation of Warning Properties: Since the odor threshold of methyl chloroform is near or below the permissible exposure limit, and since eye irritation occurs at a concentration only twice the permissible exposure limit, methyl chloroform is treated as a material with adequate warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of methyl chloroform. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure methyl chloroform may be used. An analytical method for methyl chloroform is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid methyl chloroform.
- Non-impervious clothing which becomes wet with liquid methyl chloroform should be removed promptly and not reworn until the methyl chloroform is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid methyl chloroform may contact the eyes.

SANITATION

- Skin that becomes wet with liquid methyl chloroform should be promptly washed or showered to remove any methyl chloroform.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to methyl chloroform may occur and control methods which may be effective in each case:

Operation	Controls
Use as solvent in cold cleaning of metals, and plastics; in vapor degreasing; in ultrasonic cleaning; in dyeing and cleaning of fabrics and yarns	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use in organic synthesis in polymer manufacture; as primary and carrier solvent in spot cleaners, adhesives, shoe polishes, stain repellants, hair sprays, Mace, insecticides, resins, inks, lubricants, protective coatings, asphalt extraction, and waste water treatment; use in aerosol manufacture as pressure depressant	Process enclosure; local exhaust ventilation
Use as coolant and lubricant in cutting oils on metals; use during printed circuit boards production; liquid Drano production and photographic film processing	General dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If methyl chloroform gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If methyl chloroform gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If methyl chloroform soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of methyl chloroform, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- Swallowing

When methyl chloroform has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available at most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

- Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If methyl chloroform is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Methyl chloroform may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

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Occupational Health Guideline for Methylene Chloride

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: CH_2Cl_2
- Synonyms: Dichloromethane; methylene dichloride
- Appearance and odor: Colorless liquid with an odor like chloroform.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for methylene chloride is 500 parts of methylene chloride per million parts of air (ppm) averaged over an eight-hour work shift, with an acceptable ceiling level of 1000 ppm and a maximum peak concentration of 2000 ppm for 5 minutes in any two-hour period. NIOSH has recommended that the permissible exposure limit be reduced to 75 ppm averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 500 ppm averaged over a 15-minute period. NIOSH further recommends that permissible levels of methylene chloride be reduced where carbon monoxide is present. The NIOSH Criteria Document for Methylene Chloride should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Methylene chloride can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

- **Effects of overexposure**

1. Short-term Exposure: Methylene chloride is an anesthetic. Inhaling the vapor may cause mental confusion, light-headedness, nausea, vomiting, and headache. Continued exposure may cause increased light-headedness, staggering, unconsciousness, and death. High vapor concentrations may also cause irritation of the eyes and respiratory tract. Exposure to this chemical may make the symptoms of angina worse. Skin exposure to the liquid may cause irritation. If the liquid is held in contact with the skin, it may cause skin burns. Splashes of the liquid into the eyes may cause irritation.

2. Long-term Exposure: Prolonged or repeated exposure to methylene chloride may cause irritation of the skin.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to methylene chloride.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to methylene chloride at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the employee at increased risk, and to establish a baseline for future health monitoring. Examination of the skin, liver, kidneys, cardiovascular system, and blood should be stressed. Clinical impressions of the autonomic nervous system and pulmonary function should be made, with additional tests conducted where indicated.

—Skin disease: Methylene chloride can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Liver function test: Methylene chloride causes liver damage in animals and this justifies consideration before exposing persons with impaired liver function. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

—Kidney disease: Methylene chloride causes kidney damage in animals and this justifies special considera-

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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tion before exposing persons with impaired renal function.

—Cardiovascular disease: Because of reports of excessive carbon monoxide levels following exposure to methylene chloride, persons with cardiac disease may be at increased risk.

—A complete blood count: A complete blood count should be performed, including a red cell count, a white cell count, a differential count of a stained smear, as well as hemoglobin and hematocrit. Carboxyhemoglobin values should also be determined periodically, and any level above 5% should prompt an investigation of the worker and his workplace.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Methylene chloride vapor is a mild narcotic. Exposure of animals to 15,000 ppm for 7 hours was fatal. Animal experiments have shown that continuous exposure to 1,000 ppm can be lethal in 5 to 7 weeks for dogs and that fatty livers, icterus, pneumonia, and splenic atrophy developed in dogs. Cardiac arrhytmias attributed to sensitization of the myocardium have been observed following exposure to high concentrations of some chlorinated hydrocarbons, but dogs exposed to 10,000 and 20,000 ppm of methylene chloride did not show this phenomenon. In human experiments, inhalation of 500 to 1000 ppm for 1 to 2 hours resulted in lightheadedness; there was sustained elevation of carboxyhemoglobin level. High exposures have resulted in deaths in industrial situations. Lower but unknown concentrations have caused such symptoms as lightheadedness, weakness, nausea, and "drunken behavior," resulting in mistakes and accidental falls. Phosgene poisoning has been reported to occur in several cases where methylene chloride was used in the presence of an open fire. Liquid methylene chloride is irritating to the skin on repeated contact. Splashed in the eye, it is painfully irritating, but is not likely to cause serious injury.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 84.9
2. Boiling point (760 mm Hg): 39.8 C (104 F)
3. Specific gravity (water = 1): 1.3
4. Vapor density (air = 1 at boiling point of methylene chloride): 2.9
5. Melting point: −97 C (−142 F)
6. Vapor pressure at 20 C (68 F): 350 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 1.32
8. Evaporation rate (butyl acetate = 1): 27.5

- **Reactivity**

1. Conditions contributing to instability: Heat and moisture
2. Incompatibilities: Contact with strong oxidizers, strong caustics, and chemically active metals such as aluminum or magnesium powder, sodium and potassium may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene, and carbon monoxide) may be released in a fire involving methylene chloride.
4. Special precautions: Liquid methylene chloride will attack some forms of plastics, rubber, and coatings.

- Flammability

1. Flash point: None with normal test method
2. Autoignition temperature: 556 C (1033 F)
3. Flammable limits in air, % by volume: (at elevated temperatures) Lower: 12; Upper: 19
4. Extinguishant: Dry chemical, carbon dioxide, foam

- Warning properties

1. Odor Threshold: Different authors have reported varying odor thresholds for methylene chloride. Summer and May both report 150 ppm; Kirk-Othmer and Sax both report 25 to 50 ppm; Spector reports 320 ppm. Patty, however, states that since one can become adapted to the odor, it cannot be considered an adequate warning property.

2. Eye Irritation Level: Grant reports that methylene chloride "presents no particular hazard to the eyes." Kirk-Othmer, however, reports that "methylene chloride vapor is seriously damaging to the eyes." Sax agrees with Kirk-Othmer's statement.

The *Documentation of TLV's* states that irritation of the eyes has been observed in workers who had been exposed to concentrations up to 5000 ppm, but that neurasthenic disorders were found in 50% and digestive disturbances in 30% of the persons exposed.

3. Other Information: Gleason reports that methylene chloride may be "irritating to the respiratory tract and may produce pulmonary edema" but gives no quantitative information. The *Documentation of TLV's* reports that in one investigation, irritation of the respiratory passages was observed in workers who had been exposed to concentrations up to 5000 ppm.

4. Evaluation of Warning Properties: Since no detailed information is available relating the irritant effects of methylene chloride to air concentrations and since adaptation to the odor occurs, methylene chloride is treated as a material with poor warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of methylene chloride. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Peak Above Ceiling Evaluation**

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of methylene chloride. Each measurement should consist of a 30-minute sample or a series of consecutive samples totalling 30 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure methylene chloride may be used. An analytical method for methylene chloride is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid methylene chloride.
- Non-impervious clothing which becomes wet with liquid methylene chloride should be removed promptly and not reworn until the methylene chloride is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid methylene chloride may contact the eyes.

SANITATION

- Skin that becomes wet with liquid methylene chloride should be promptly washed or showered with soap or mild detergent and water to remove any methylene chloride.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to methylene chloride may occur and control methods which may be effective in each case:

Operation	Controls
Use as a solvent in paint and varnish removers; manufacture of aerosols; cold cleaning and ultrasonic cleaning; and as an extraction solvent for foods and furniture processing	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a cooling solvent in manufacture of cellulose acetate; in organic synthesis; and in plastics processing	Process enclosure; local exhaust ventilation
Use as a solvent in vapor degreasing of thermal switches and thermometers	Process enclosure; local exhaust ventilation
Use as a secondary refrigerant in air conditioning and scientific testing	General dilution ventilation; local exhaust ventilation; personal protective equipment

Operation	Controls
Use as an extraction solvent for edible fats, coca, butter, beer flavoring in hops, decaffeinated coffee, oleoresin manufacture, oils, waxes, perfumes, flavorings, and drugs	General dilution ventilation; local exhaust ventilation; personal protective equipment
Use as a solvent for paints, lacquers, varnishes, enamels, adhesives, rubber cements, manufacture of printed circuit boards, as a carrier for pharmaceutical tablet coatings, shrink-fitting of synthetic rubber covers, and dyeing of synthetic fibers	General dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If methylene chloride gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If methylene chloride gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water if the methylene chloride has not already evaporated. If methylene chloride soaks through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of methylene chloride, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When methylene chloride has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the afflicted person to vomit by having him touch the back of his throat with his finger or by giving him syrup of ipecac as directed on the package. This non-prescription drug is available most drug stores and drug counters and should be kept with emergency medical supplies in the workplace. Do not make an unconscious person vomit.

- Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND LEAK PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If methylene chloride is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

REFERENCES

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Occupational Health Guideline for Toluene

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $C_6H_5CH_3$
- Synonyms: Toluol; phenylmethane; methylbenzene
- Appearance and odor: Colorless liquid with an aromatic odor, like benzene.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for toluene is 200 parts of toluene per million parts of air (ppm) averaged over an eight-hour work shift, and during any such work shift, 300 ppm toluene may not be exceeded except that a peak of 500 ppm toluene is permitted for 10 minutes during the eight-hour work shift. NIOSH has recommended that the permissible exposure limit be reduced to 100 ppm toluene averaged over an eight-hour work shift with a ceiling level of 200 ppm averaged over a ten-minute period. The NIOSH Criteria Document for Toluene should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Toluene can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Toluene may cause irritation of the eyes, respiratory tract, and skin. It may also cause fatigue, weakness, confusion, headache, dizziness, and drowsiness. Peculiar skin sensation may be produced such as a "pins and needles feeling" or numbness. Very high concentrations may cause unconsciousness and death. The liquid splashed in the eye may cause irritation and temporary damage. Inhalation may also cause difficulty in seeing in bright light. If liquid toluene is splashed in the eyes, it will cause temporary irritation.

2. Long-term Exposure: Repeated or prolonged exposure to liquid toluene may cause drying and cracking of the skin.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to toluene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to toluene at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the central nervous system, liver and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—Urinalysis: Since proper kidney function is necessary for biologic monitoring, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment. The urine should be analyzed for hippuric acid to obtain a background level.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis. Hippuric acid level in urine may be an indicator of the level of toluene exposure.

- **Summary of toxicology**

Toluene vapor causes narcosis. Controlled exposure of human subjects to 200 ppm for 8 hours produced mild fatigue, weakness, confusion, lacrimation, and paresthesia; at 600 ppm for 8 hours there were also euphoria, headache, dizziness, dilated pupils and nausea; at 800

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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ppm for 8 hours, symptoms were more pronounced, and after-effects included nervousness, muscular fatigue, and insomnia persisting for several days. Severe but reversible liver and kidney injury occurred in a person who was a glue-sniffer for 3 years; the chief component the inhaled solvent was toluene (80% V/V); other ingredients were not listed. In workers exposed for many years to concentrations in the range of 80 to 300 ppm, there was no clinical or laboratory evidence of altered liver function. Toluene exposure does not result in the hematopoietic effects caused by benzene; the myelotoxic effects previously attributed to toluene are judged by more recent investigations to be the result of concurrent exposure to benzene present as a contaminant in the commercial toluene used. Most of the toluene absorbed from inhalation is metabolized to benzoic acid, conjugated with glycine in the liver to form hippuric acid, and excreted in the urine; the average amount of hippuric acid excreted in the urine by individuals not exposed to toluene is approximately 0.7 to 1.0 g/l of urine. The liquid splashed in the eyes of two workers caused transient corneal damage and conjunctival irritation; complete recovery occurred within 48 hours. Repeated or prolonged skin contact with liquid toluene has a defatting action, causing drying, fissuring, and dermatitis.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 92.1
2. Boiling point (760 mm Hg): 111 C (231 F)
3. Specific gravity (water = 1): 0.86
4. Vapor density (air = 1 at boiling point of toluene): 3.14
5. Melting point: −95 C (−139 F)
6. Vapor pressure at 20 C (68 F): 22 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.05
8. Evaporation rate (butyl acetate = 1): 2.24

- **Reactivity**

1. Conditions contributing to instability: Containers may burst at elevated temperatures.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon dioxide and carbon monoxide) may be released in a fire involving toluene.
4. Special precautions: Toluene will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Flash point: 4 C (40 F) (closed cup)
2. Autoignition temperature: 480 C (896 F)
3. Flammable limits in air, % by volume: Lower: 1.27; Upper: 7.1
4. Extinguishant: Carbon dioxide, dry chemical, am

- **Warning properties**

1. Odor Threshold: The American National Standards Institute (ANSI) states that "the odor of toluene is detectable by most people at concentrations in the range of 10 to 15 ppm. The odor has little value as a warning property."

Patty points out that olfactory fatigue occurs rapidly upon exposure to toluene.

2. Eye Irritation Level: Grant states that "the vapors of toluene cause noticeable sensation of irritation to human eyes at 300 to 400 ppm in air, but even at 800 ppm irritation is slight."

ANSI reports that "irritation of eyes, mucous membranes, and upper respiratory tract may occur while workers are exposed to low concentrations of toluene. There is a considerable range of variation (100 to 500 ppm) between individuals, some finding any concentration of toluene objectionable. Commercial grades of toluene vary in irritant properties."

3. Evaluation of Warning Properties: Because of its irritant effects, toluene is judged to have good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of toluene. Each measurement should consist of a ten (10) minute sample or series of consecutive samples totalling ten (10) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Peak Above Ceiling Evaluation**

Measurements to determine employee peak exposure should be taken during periods of maximum expected airborne concentration of toluene. Each measurement should consist of a 10-minute sample or a series of consecutive samples totalling 10 minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with a subsequent desorption of toluene with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure toluene may be used. An analytical method for toluene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

Methods for Set V" (order number PB 262 524).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid toluene.
- Any clothing which becomes wet with liquid toluene should be removed immediately and not reworn until the toluene is removed from the clothing.
- Clothing wet with toluene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of toluene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the toluene, the person performing the operation should be informed of toluene's hazardous properties.
- Employees should be provided with and required to use splash-proof safety goggles where liquid toluene may contact the eyes.
- Where there is any possibility that employees' eyes may be exposed to toluene, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes wet with liquid toluene should be promptly washed or showered with soap or mild detergent and water to remove any toluene.
- Employees who handle liquid toluene should wash their hands thoroughly with soap or mild detergent and water before eating or smoking.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to toluene may occur and control methods which may be effective in each case:

Operation	Controls
Use as a solvent in pharmaceutical, chemical, rubber, and plastics industries; as a thinner for paints, lacquer, coatings, and dyes; as a paint remover; insecticides	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Use as starting material and intermediate in organic chemical and chemical synthesis industries	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Use in manufacture of artificial leather; fabric and paper coatings; photogravure ink production; spray surface coating; as a diluent (cellulose ester lacquers)	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Use as constituent in formulation of automotive and aviation fuels	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- Eye Exposure

If liquid toluene gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

- Skin Exposure

If liquid toluene gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If liquid toluene soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of toluene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When toluene has been swallowed, get medical attention immediately. Do not attempt to make the exposed person vomit.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If toluene is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber. Toluene should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion. Sewers designed to preclude the formation of explosive concentrations of toluene vapors are permitted.

- Waste disposal method:

Toluene may be disposed of by atomizing in a suitable combustion chamber.

ADDITIONAL INFORMATION

To find additional information on toluene, look up toluene in the following documents:

- Medical Surveillance for Chemical Hazards
- Respiratory Protection for Chemical Hazards
- Personal Protection and Sanitation for Chemical Hazards
- NIOSH Criteria Document for Toluene (July 1973)

These documents are available through the NIOSH Division of Technical Services, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- Union Carbide Corporation, Industrial Medicine and Toxicology Department: *Toxicology Studies - Toluene*, New York, 1970.

DATE : / /
JOB NO: ______________

CHEMICAL NAME: Tetrachloroethylene
SYN : Perchloroethylene, Perk, Tetracap, PercLene
CAS NO: 127-18-4
FORMULA: $Cl_2C{-}CCl_2$
DOT CLASS: 1897

CHEMICAL PROPERTIES

Phys St: Liquid	Boil Pt: 256.00°F	Ionz Pot : 9.32ev	Fl Pt: –
Mol Wt : 165.85	Melt Pt: -8.00°F	Vap Press: 14.00 mmHg	LFL : –
Sp Gr : 1.63	Frz Pt : -8.30°F	Odr Thr : 47.00ppm	UFL : –

Odor : mildly sweet, etherish
INCOMPAT/REACT: heat, strong oxidizers, barium, lithium, beryllium, strong bases
SOLUBILITY :

TOXICOLOGICAL PROPERTIES

Exposure Limits: TLV-TWA (ACGIH): 50.00 ppm PEL (OSHA): 25.00 ppm
STEL: 200.00 ppm IDLH: 500.00 ppm
OTHER PROPERTIES : ACCEPT MAX PEAK: 300ppm for 5 min in 3 hours of any 8 hour shift
Tox Data: INHAL : -
DERMAL : -
ORAL : rat LD50: 8850 mg/kg
CARCIN : YES
MUTAGEN : –
REPRO TOX: -
AQUATIC : -
OTHER TOX: TARGET ORGANS: Liver, Kidneys, Eyes, Upper Resp Sys, CNS
ROUTES OF EXP: Ingestion, Eye(Ocular), Dermal Absorption, Skin Contact, Inhalation

PERSONAL PROTECTIVE MEASURES

RESPIRATORS : APR: dusty/windy condit or known high concent or >1 but <5ppm; SCBA: >5ppm
C[illegible]IDGE TYPE :
[illegible]CTIVE CLOTHING: Coverall: PE Tyvek Gloves: Viton
S[illegible] PRECAUTIONS :

FIRST AID

INHALATION: move to fresh air, artf resp if nec, SEEK MEDICAL ATTENTION
EYE/SKIN : flush w/water 15min, wash skin with soap/water, SEEK MEDICAL ATTENTION
INGESTION : give lg amt of salt water, induce vomiting if conscious, SEEK MEDICAL ATTENTION

SYMPTOMS

ACUTE : headache, drowsiness, dizziness, incoordination, unconscious, irritation of eyes/nose/throat, flushing of face/neck, jaundice, dark urine, narcot is high concent, cardiac
CHRONIC: skin irritation, damage to liver/kidneys, CNS, dermatitis

DISPOSAL, FIRE, SPILLS (see attached sheet)

DISPOSAL: A
FIRE: 11,13,
LEAKS & SPILLS: 1,4,6,9
DECOMPOSITION PRODUCTS: phosgene, HCl, CO, CO_2

REFERENCES CONSULTED

NIOSH/OSHA Pocket Guide, Chris(vol. III), ACGIH TLV Booklet, RTECS
OTHER REFERENCES: NIOSH guides, OSHA, Sigma-Aldrich

CHEMICAL CLASSIFICATION: Halogen Cmpds, Aliphatic & Alicyclic

LAST REVISION DATE:
05/10/89

Hazard Evaluation of Chemicals
Region V -- Chicago

DATE : / /
JOB NO: ____________

CHEMICAL NAME: Dichloroethylene, 1,1-
SYN : Vinylidene chloride, 1,1-dichloroethene
CAS NO: 75-35-4
FORMULA: $CH_2=CCl_2$
DOT CLASS: 1303/FLAM LIQ 3

CHEMICAL PROPERTIES

Phys St: Liquid
Boil Pt: 89.0°F
Ionz Pot : 10.2 ev
Fl Pt: 0°F
Mol Wt : 96.95
Melt Pt: 188.5°F
Vap Press: 3.3 mmHg
LFL : 7.3 %
Sp Gr : 1.21
Frz Pt : -188.0 °F
Odr Thr : —
UFL : 16.0 %
Odor : sweet, like chloroform or carbon tetrachloride
INCOMPAT/REACT: nitric acid, caprolactam soln, copper & aluminum, sunlight, air, heat
SOLUBILITY : insol-H_2O, sol-in organic solvents

TOXICOLOGICAL PROPERTIES

Exposure Limits: TLV-TWA (ACGIH): 5.0 ppm
STEL: 20.0 ppm
PEL (OSHA): 1.0 ppm
IDLH: —
OTHER PROPERTIES : rat 400mg/kg -- mutation
Tox Data: INHAL : -
DERMAL : -
ORAL : -
CARCIN : exper
MUTAGEN : exper
REPRO TOX: -
AQUATIC : -
OTHER TOX:
ROUTES OF EXP: Ingestion, Eye(Ocular), Skin Contact, Inhalation

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PERSONAL PROTECTIVE MEASURES

RESPIRATORS : APR: dusty/windy condit or known high concent or >1 but <5ppm; SCBA: >5ppm
CARTRIDGE TYPE : GMC-H or AP3 (RACAL)
PROTECTIVE CLOTHING: Coverall: Tyvek Gloves: PVA, Viton (PVA degrades in water)
SPEC PRECAUTIONS :

FIRST AID

INHALATION: move to fresh air, CPR if nec, SEEK MEDICAL ATTENTION
EYE/SKIN : remove contaminated clothes, flush w/lg amt of water at least 15 min, SEEK MEDICAL ATTENTION
INGESTION : give water or milk, DO NOT INDUCE VOMITING, SEEK MEDICAL ATTENTION

SYMPTOMS

ACUTE : dizziness, drunkeness, irritation to skin/eyes/mucous membranes, narcotic in high concentrations, first degree burns-

CHRONIC: lab animals developed liver and/or kidney cancer

DISPOSAL, FIRE, SPILLS (see attached sheet)

DISPOSAL: A
FIRE: 1,2,4,
LEAKS & SPILLS: -
DECOMPOSITION PRODUCTS: HCl, Phosgene

REFERENCES CONSULTED

NIOSH/OSHA Pocket Guide, Chris(vol. III), ACGIH TLV Booklet, RTECS
OTHER REFERENCES: OSHA

CHEMICAL CLASSIFICATION: Vinyl Halide

LAST REVISION DATE:
04/18/89

[illegible] Evaluation of Chemicals
Region V - Chicago

DATE : / /
JOB NO: ______________

CHEMICAL NAME: Dichloroethane, 1,1-
SYN : Ethylidene Chloride, Chlorinated hydrochloric ether, Ethylidene dichloride
CAS NO: 75-34-3
FORMULA: C2H4CL2
DOT CLASS:

CHEMICAL PROPERTIES

Phys St: Liquid	Boil Pt: 135.14°F	Ionz Pot : --	Fl Pt: 22.00°F
Mol Wt : 98.37	Melt Pt: -142.00°F	Vap Press: 182.00 mmHg	LFL : 6.00%
Sp Gr : 1.17	Frz Pt : -143.32°F	Odr Thr : 49-135.9 ppm	UFL : 16.00%
Odor : chloroform			

INCOMPAT/REACT: heat, strong oxidizers, caustics, chemically active metals (Al, Mg, Na, K)
SOLUBILITY : miscible w/common solvents; slightly soluble in H2O

TOXICOLOGICAL PROPERTIES

Exposure Limits: TLV-TWA (ACGIH): 200.00 ppm
STEL: 250.00 ppm
PEL (OSHA): 100.00 ppm
IDLH: 4000.00 ppm

OTHER PROPERTIES :
Tox Data: INHAL : -
DERMAL : -
ORAL : rat LD50: 725mg/kg
CARCIN : indet
MUTAGEN : -
REPRO TOX: exper teratogen
AQUATIC : TLm: 24hr - 100mg/l
OTHER TOX: TARGET ORGANS: Skin, Liver, Kidneys
ROUTES OF EXP: Ingestion, Eye(Ocular), Skin Contact, Inhalation

PERSONAL PROTECTIVE MEASURES

RESPIRATORS : APR: dusty/windy condit or known high concent or >1 but <5ppm; SCBA: >5ppm
CA[illegible]DGE TYPE : GMC-H or AP3 (RACAL)
PR[illegible]TIVE CLOTHING: Coverall: Tyvek Gloves: Viton
SPEC PRECAUTIONS : Narcotic in high concentrations. Fatal dose LD50 725mg/kg.

FIRST AID

INHALATION: move to fresh air, art resp if nec, SEEK MEDICAL ATTENTION
EYE/SKIN : remove contaminated clothes, flush w/water 15min, wash skin w/soap & water, SEEK MEDICAL ATTENTION
INGESTION : if conscious, induce vomiting, SEEK MEDICAL ATTENTION

SYMPTOMS

ACUTE : drowsiness, irritation of eyes,nose,throat, overexcitement,headache, intoxication, unconscious, shock, nau/vomt, disturbed vision.
CHRONIC: liver damage, dermatitis, skin burns, possible kidney disease

DISPOSAL, FIRE, SPILLS (see attached sheet)

DISPOSAL: D
FIRE: 6,7
LEAKS & SPILLS: 1,3,4,6,9
DECOMPOSITION PRODUCTS: vinyl chloride, hydrogen chloride, phosgene, carbon monoxide, carbon dioxide

REFERENCES CONSULTED

NIOSH/OSHA Pocket Guide, ACGIH TLV Booklet, RTECS
OTHER REFERENCES: Sigma-Aldrich, Handbook of Poisoning

CHEMICAL CLASSIFICATION: Halogenated Hydrocarbon, Halogen Cmpd, Aliphatic & Alicyclic

LAST REVISION DATE:
05/10/89

APPENDIX B
FIELD ANALYTICAL SCREENING PROGRAM - METHOD 101.

ecology and environment, inc.

Title: SOP-FASP Method 101-Volatile Organics in Water by Head-Space

Category: CHEM 3.7

Revised: September 1987

Approved: R. Gray R. Gray

STANDARD OPERATING PROCEDURE
FOR
FASP METHOD 101, SCREENING FOR VOLATILE ORGANICS IN WATER BY HEAD-SPACE

Revised: September 1987

Prepared by

Ecology & Environment, Inc.
195 Holtz Drive
Buffalo, New York 14225

CONTENTS

LIST OF TABLES

Title: SOP-FASP Method 101-Volatile Organics in Water by Head-Space

Category: CHEM 3.7 **Revised:** September 1987

1 INTRODUCTION

This document provides standard operating procedures to be used for Field Analytical Screening Project (FASP) Method 101, which uses gas chromatography (GC) and the head-space technique to estimate the concentrations of volatile organic compounds in water. These procedures are written specifically for the Photovac 10S50 portable gas chromatograph, but they can be used with a variety of instruments. This discussion does not cover all considerations involved in gas chromatographic screening and analysis; therefore, operators should be trained in the proper use and theory of gas chromatography.

1.1 SCOPE

This document does not list specific instrument conditions for specific compounds. Rather, it discusses procedures that must be followed for all volatile screening methods. As field experience increases, methods containing instrument conditions for specific compounds will be incorporated into the FASP methods manual after peer review by the FASP working group.

1.2 OBJECTIVES

The head-space technique is intended only for screening samples, because of several assumptions about screening for volatile compounds. For example, it is assumed that the quantity and number of compounds found in the head-space over the liquid sample directly relate to the actual concentrations of compounds in the water sample. This is often a valid assumption, especially in relatively clean or noncomplex matrices. This assumption begins to break down, however, for the complex matrices often found during environmental investigations. Examples of complex matrices are oily wastes, multiphase samples, and many samples containing high levels of one or several compounds that might prevent the usual partitioning between the liquid and gas/vapor phases in the sample bottle. Synergistic (enhancing) or antagonistic (masking) effects may either artificially increase or decrease the resulting concentrations of specific compounds in the sample.

This method should be used only to generate screening data that can be used to direct ongoing fieldwork or identify samples that need additional analysis. Such analysis should be performed using more accurate methods, such as the purge-and-trap method for volatiles analysis.

1.3 THEORY AND BACKGROUND

The Photovac 10S50 uses a Photoionization Detector (PID) to detect volatile compounds in samples. The principle of the PID is ionization of compounds by a high-energy ultraviolet (UV) light source as they enter the ionization chamber of the detector. A high-voltage potential is applied across the detector to collect the ions produced. The collision of the ions onto the charged detector creates a current that can be quantitated. In general, the PID will detect only compounds that have an ionization potential near or below the energy of the UV light source (see Table 1-1). This makes the PID very selective. A properly trained analyst can use this selectiveness to his advantage in screening for specific classes of compounds. The Photovac 10S50 uses a 10.6-eV (electronvolt) UV lamp in the PID. This energy level is well suited for detecting aromatic compounds but does not detect most aliphatic compounds. Most of the Target Compound List (TCL) volatile compounds typically investigated at hazardous waste sites are either aromatic or halogenated. The PID is thus well suited for this task.

2 EQUIPMENT

2.1 PHOTOVAC 10S50

The Photovac 10S50 gas chromatograph is a completely self-contained, portable instrument that is well suited for field operations. It has a self-contained carrier gas cylinder with a capacity sufficient for up to 8 hours of operation.

2.1.1 Power Supply

The internal battery pack can supply power for 8 hours, or the instrument can be operated using 115-volt, alternating-current power. A third source of power is the optional cigarette-lighter adapter that can be plugged into a conventional automobile cigarette lighter. The adapter is included in a separate field kit that contains equipment to support the Photovac GC in the field. In addition, the external battery can supply power for up to 16 hours.

2.1.2 Capabilities

The Photovac 10S50 GC is an ambient instrument (no heated column) and therefore can analyze samples that exist only as a gas or vapor at ambient conditions. Liquid samples must never be injected into the Photovac because of its inability to vaporize them.

2.1.3 Column Type

The 10S50 is equipped with a 10-meter, wide-bore (.53 mm) CP Sil 5CB capillary column. This polar column is well suited for the volatile compounds commonly found at hazardous waste sites. Refer to Photovac application note number 4 for an example of specific instrument conditions and compounds analyzed.

The Photovac 10S50 is a versatile instrument. For more detailed information, consult the owner's manual.

2.2 FIELD KIT

The FASP field kit contains all accessories needed to calibrate the 10S50 and analyze field samples. Standards are not included because of the variety of specific site requirements. The FASP analyst must prepare applicable standards for each specific site. General standard

Table 1-1. Density, Boiling Points, and Ionization Potential of Various Compounds

Compound	Density at 20°C (mg/uL)	Boiling Point °C	Ionization Potential (eV)
Chloromethane	.9159	-24.2	- -
Bromomethane	1.6755	3.6	10.53
Vinyl Chloride	.9106	-13.4	10.00
Chloroethane	.8978	12.3	10.97
Methylene Chloride	1.3266	40	11.35
Acetone	.7899	56.2	9.69
Carbon Disulfide	1.2632	46.2	10.13
1,1-Dichloreothene	1.218	37	- -
1,1 Dichloroethane	1.1757	57.3	11.06
Trans-1,2-Dichloroethene	1.2565	47.5	- -
Chloroform	1.4832	61.7	11.37
1,2-Dichloroethane	1.2351	83.5	11.04
2-Butanone	.8054	79.6	9.53
1,1,1-Trichloroethane	1.3390	74.1	11.25
Carbon Tetrachloride	1.5940	76.5	11.28
Vinyl Acetate	.9317	72.2	9.19
Bromodichloromethane	1.980	90	- -
1,2-Dichloropropane	1.1560	96.4	10.87
Trans-1,3-Dichloropropene	- -	- -	- -
Trichloroethene	1.4642	87	9.45
Dibromochloromethane	2.451	119	10.59

Table 1-1. Density, Boiling Points, and Ionization Potential of Various Compounds (Continued)

Compound	Density at 20°C (mg/uL)	Boiling Point °C	Ionization Potential (eV)
1,1,2-Trichloroethane	1.4397	113.8	--
Benzene	.8765	80.1	9.25
Cis-1,3-Dichloropropene	--	--	--
2-Chloroethylvinylether	--	--	--
Bromoform	2.8899	149.5	10.48
4-Methyl-2-Pentanone	.7978	116.8	--
2-Hexanone	.8113	128	--
Tetrachloroethene	1.6227	121	9.32
1,1,2,2-Techtrachloroethane	1.5953	146.2	--
Toluene	.8669	110.6	8.82
Chlorobenzene	1.1058	132	9.07
Ethylbenzene	.8670	136.2	8.76
Styrene	.9060	145.2	8.47
O-Xylene	.8802[1]	144.4	--
M-Xylene	.8642	139.1	--
P-Xylene	.8611	138.3	--

[1] Measured at 10°C.

mixes, which contain groups of compounds, can also be prepared or purchased commercially.

3 SETUP AND CALIBRATION

3.1 INSTRUMENT SETUP

The Photovac 10S50, an extremely sensitive gas chromatograph, produces reliable data in field situations despite variables such as temperature variation.

During a site investigation or other field activity where the Photovac GC is used, the instrument should be placed in an area out of direct sunlight and extreme temperature variations to minimize shifts in retention times. If possible, it should be placed in an area that provides work space, a power supply, and the most stable temperature environment. As mentioned above, the 10S50 is totally self-contained, however, as a general rule, it is always best to setup where the most support can be utilized. By minimizing temperature variations, calibration procedures can be simplified. The Photovac GC (or any other field procedure) should never be used in a motel room or other off-site location.

3.2 INSTRUMENT CALIBRATION

A standard containing each compound of interest must be injected into the 10S50 during calibration to establish a retention time and response factor for quantitation. Though the 10S50 will do single-point calibration only, the PID detector is linear over a wide concentration range. Instrument linearity can be documented by bracketing the expected sample concentration range with standards of known concentrations. The analyst should prepare a midconcentration standard as the calibration standard. After calibration, the low-concentration and high-concentration standards can be run in the same way as samples. If the instrument is linear, the low and high standards will be quantitated correctly. A correct quantitation is within 10 percent of the true value. Inaccurate quantitation can be the result of a nonlinear working range or inaccurate standards.

4 PREPARATION OF STANDARDS

For head-space screening of water samples, standards are prepared as follows. Stock standards containing the compounds of interest should be prepared before going to the field. High concentration stock standards should be prepared in analytical-grade methanol. Small amounts of the stock standard should then be used to make up working standards in water that are used to calibrate the GC in the field. Use of methanol will insure that hyrophobic organic compounds remain miscible in the water standards. This will prevent the formation of separate organic phases in the water standards that will adversely affect the desired partioning in the head-space.

Concentrations required for screening will vary from site to site. Therefore, exact procedures for standards preparation cannot be dictated. Whenever possible, prepared standards should be purchased from commercial sources. When this is not possible, standards must be prepared from "neat" (pure) primary standards. This will require formulation of applicable standards consistent with the data-quality objectives of the field activity. An example of this method is outlined in the following section.

4.1 PREPARATION OF STOCK STANDARDS

These standards are 100 milligrams per liter (mg/L) stock standards, prepared as listed here:

1. Partially fill a 100-milliliter (mL) volumetric flask with analytical grade methanol.

2. For each compound of interest, the amount of "neat" standard added is calculated by dividing the desired volume by the density of the liquid (see Table 1-1):

   Example: For 100-mg/L Benzene stock standard (density = .8765 mg/microliter (uL), the formula to follow would be

   $$\frac{\text{(Concentration of Standard)(Volume of Standard)}}{\text{Density of Standard Compound}} = \text{Amount needed}$$

   Substituting amounts into the formula, the amount needed is as follows:

   $$\frac{(100\ \text{mg/L})(0.10\ \text{L})}{0.8765\ \text{mg/uL}} = 11.4\ \text{uL}$$

3. Use the 10-uL syringe to add the required amount of standard. IMPORTANT: This is the most critical and important step in the stock standard preparation procedure.

4. After adding all compounds of interest, fill the flask to the mark with methanol and invert the flask at least 10 times to mix.

4.2 PREPARATION OF WORKING STANDARDS

To prepare a 20-ppb (parts per billion) working standard in the field from the stock standard, the following procedure is used:

1. Completely fill a 40-mL volatile organics analysis (VOA) vial (fitted with a septum cap) with distilled/deionized water. (Be sure to avoid all air bubbles in the vial.)

2. Withdraw exactly 10 mL of the water using a 10-mL syringe. Insert a separate needle through the septum to allow air to fill the head space in the vial.

3. Determine the amount of stock standard to add to the vial.

   The general formula is as follows:

   (Concentration of Stock)(Volume of Stock) = (Concentration of Standard)(Volume of Standard)

$$(100\ \text{mg/L})(\text{Volume of Stock}) = (.020\ \text{mg/L})(.03\ \text{L})$$

$$\text{Volume of Stock} = \frac{(.020\ \text{mg/L})\ (.03\ \text{L})}{100\ \text{mg/L}} = .000006\ \text{L} = 6\ \text{uL}$$

4. Using the 10-uL syringe, inject 6 uL of stock standard into the VOA vial.

5. Shake the vial vigorously for 1 minute.

6. Let the standard equilibrate for 15 minutes at ambient temperature (same as the samples).

7. The other standards are made in the same manner.

5 SAMPLE COLLECTION AND PREPARATION

5.1 SAMPLE COLLECTION

Samples collected for on-site volatiles screening should be collected by the Field Investigation Team (FIT) in the usual manner, except that an additional VOA vial fitted with a septum cap is also filled. This vial is labeled and delivered to the FASP analyst. Additional vials should also be collected for quality assurance and quality control (QA/QC) as determined in the site workplan.

5.2 SAMPLE PREPARATION

VOA samples for field screening should be prepared as follows:

1. Using the clean 10-mL syringe and vent needle, withdraw exactly 10 mL of sample from the vial.

2. (Optional) An internal standard can be injected into each sample to help compensate for shifts in retention times and reduce the number of calibration runs throughout the screening runs.

   An internal standard can be injected into each sample before screening to correct for retention time changes and resulting peak recognition errors. The internal standard should be a compound that a) is not expected to be found in the samples, b) has a retention time toward the end of the run (where the greatest shifts occur), and c) is in the middle of the expected concentration range. By including this in all the samples, the Photovac can be easily recalibrated to adjust the retention times of all the identified peaks in the sample. This procedure avoids the need to run a separate calibration run each time the ambient temperature changes. If this method is used, the working standard must also contain the internal standard as a calibration peak.

3. After removing the syringe and vent needle, shake the vial vigorously for 1 minute.

4. Let the vial equilibrate for 15 minutes at ambient temperature. This must be identical to the temperature used to equilibrate the standards.

5. The samples are ready for screening.

6 SCREENING PROCEDURE

When screening an unknown sample, the analyst should be careful not to inject high concentrations into the 10S50. This may result in instrument contamination or detector saturation. There are two ways to avoid or minimize this possibility. First, the HNu P1-101 or Photovac TIP-11 can be used to check the sample. This should be done in another partially filled larger sample bottle to compensate for the flow rates of those instruments. A second method is to inject progressively larger amounts of head space from the sample. This can begin by injecting only the amount of head space that osmotically fills the syringe needle without moving the syringe plunger. The amount injected can progress to a maximum injection volume of 2 mL of head space to obtain maximum sensitivity.

6.1 ORDER OF STANDARD AND SAMPLE INJECTIONS

1. Inject a blank head-space sample to verify a clean baseline.

2. Inject the medium-concentration calibration standard and calibrate the instrument.

3. Inject the low- and high-concentration standards to verify instrument linearity and bracket the expected sample concentration range.

4. Inject a second blank to check for carry-over. If the baseline is clean, proceed to the samples; if not, run additional blanks until the baseline is clean.

6.2 CALIBRATION RUNS

Samples should be injected in groups of 5-10 samples, and the operator should check that each peak is correctly identified. If retention times shift, the internal standard can be used to reset the peak retention times. If no internal standard is used, a calibration run must be performed after each sample that shows a retention time shift. The sample must then be run again using the corrected retention times. In between groups of samples, the calibration standard should be injected to recalculate all standard peak concentrations and retention times. The sample group size will be determined by regional requirements and site work plans. After each calibration standard, a blank must be injected to verify the clean baseline. A blank should also be injected after high-concentration samples to insure that there is no carry-over between samples.

6.3 VERIFICATION OF ANALYSIS

At the end of the day's run, the three working standards must be injected again to verify that the instrument has remained linear in the bracketed working range. All sample concentrations that fall outside this range must be reanalyzed using smaller injections to keep them in the working range. If most samples are outside the working range, the analyst may want to change instrument conditions.

6.4 RECORDKEEPING

The printout from the 10S50 is the primary record of the screening done by the analyst in the field. In addition to the information printed on the tape output, the analyst must record each sample ID number or description and the injection volume. At the end of the run, the analyst must sign each printout tape and record any other pertinent information, such as the site name.

7 CALCULATIONS

All calculations are made automatically by the 10S50 except compensation for variable injection volumes. These variations must be well documented on the printout. Consult the owner's manual for details concerning instrument calibration.

8 QUALITY ASSURANCE/QUALITY CONTROL

For a detailed discussion regarding QA/QC protocols and considerations, refer to the FASP QA/QC manual.

As a minimum, the analyst should perform duplicate analysis and spikes on 5 percent of the samples. The spikes can be made in the same manner as the working standards in the field.

Precision and accuracy data are partly a function of the sample matrix and are not available at this time.