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Interim Remedial Measures Evaluation Work Plan For Linden Road Landfill Flint Township, Michigan

July 1990

WESTON℠
MANAGERS DESIGNERS/CONSULTANTS

INTERIM REMEDIAL MEASURES EVALUATION WORK PLAN FOR
LINDEN ROAD LANDFILL
FLINT, MICHIGAN

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SECTION 1

INTRODUCTION

The Linden Road Landfill (LRLF) site, located in Flint Township, Michigan, is owned by General Motors (GM)-AC Rochester Division. The LRLF site was utilized by GM during various periods until 1969, for disposal of general refuse from the GM-Chevrolet-Flint manufacturing complex located approximately four miles west of the site.

A Phase I Environmental Assessment of the LRLF site, dated February 1990 conducted by Roy F. Weston, Inc. (WESTON) summarized site characteristics, historical land uses, and previous studies and investigations at the LRLF site. The assessment identified several potential environmental issues at the site surface including the presence of various debris, stained soils, a small oil disposal area, numerous drums and drum carcasses, isolated areas of dried sludge-like material, and scrap metal piles. The chemical characteristics of these materials are presently unknown. Additionally, the assessment identified a need for further investigation and characterization at the LRLF site in order to provide data which will support further site characterization and facilitate the evaluation of potential interim and/or final remedial measures.

GM will implement two (2) integrated work plans; a Site Investigation Work Plan and an Interim Remedial Measures Evaluation (IRME) Work Plan to effectively and accurately accomplish the investigation, characterization, and remedial evaluation tasks at the LRLF site in Flint Township, Michigan.

This document defines the planned activities associated with conducting an Interim Remedial Measures Evaluation.

Purpose and Objectives of Work Plan

This work plan presents the technical approach and associated scope of work for the following activities at the LRLF site:

- Performing a surface waste characterization and volume determination of surficial material at several areas of the site.
- Performing some preliminary site preparations and obtaining technical data and additional site information which integrates and supports the site investigation plan activities.
- Preparing a report to establish a record of the findings and activities associated with Work Plan implementation.

Several important objectives are intended to be accomplished through the preparation and implementation of this Work Plan. These objectives include:

- Conducting a limited interim remedial measures evaluation (IRME) program to determine the potential for direct exposure and/or migration of waste material and debris present at the surface of the LRLF property.
- Obtaining additional site information and data beneficial to conducting the Site Investigation Work Plan.

This Work Plan is presented in four (4) sections with three appendices. Section 2 presents a more detailed site description and background to the project. Section 3 provides detailed discussion of the technical approach and scope of the specific work plan tasks. Section 4 outlines GM's anticipated schedule for Work Plan implementation. Three appendices to this work plan include: Appendix A - Quality Assurance/Quality Control Plan; Appendix B - Sampling and Analysis Plan; and, Appendix C - Site Health and Safety Plan.

SECTION 2

SITE DESCRIPTION

2.1 LOCATION

The LRLF is a 40-acre parcel in Flint Township, Genesee County, Michigan (Figure 2-1). Specifically, it is located in Section 17 of Township 7 North and Range 6 East, and is approximately 1.5 miles west of the city of Flint, Michigan. LRLF is bounded by Linden Road on the east. The northern boundary of LRLF lies approximately one-quarter mile south of Calkins Road while the southern boundary lies about one half mile north of West Court Street. The west boundary of the site lies approximately 1/4 mile east of Dye Road.

Land use of properties adjoining the site includes agricultural, residential and commercial, and is characteristic of a developing suburban community adjacent to a large metropolitan area. The population of Genesee County is 450,000 according to the 1980 Census, which ranked the county as the fourth most populous county in the State of Michigan. Single family residences are located to the south of the site and west of Dye Road. The land to the east of the LRLF site is presently farmed. An office complex abuts LRLF to the north. Private property, currently referred to as the "Dye Road Dump", lies immediately west of the site between LRLF and Dye Road. The Dye Road Dump site is also on the Michigan Act 307 Priority List.

Most of the area surrounding the LRLF site is zoned R-1B, which is designated for single family dwelling. This zoning designation includes publicly-owned-and-operated parks, playfields, playgrounds and other recreational facilities, public or parochial non-profit schools, and residences.

2.2 SITE PHYSIOGRAPHIC SETTING AND DESCRIPTION

Flint is located in the eastern portion of the Lower Peninsula of the State of Michigan. Physiographically, this places LRLF in the Eastern Lake Section of the Central Lowlands Province, Interior Plains Division. The topography generally consists of mature, dissected and glaciated cuestas and lowlands with associated moraines, lakes, and lacustrine plains.

The glacial origin of the topography is expressed in the surface soils of Flint Township as lake beds of sand, ground moraines (till plains), and outwash and glacial channels. According to U.S. Department of Agriculture (USDA) Soil Conservation Service General Soil Map for Genesee County (1972), the LRLF is in the Celina-Conover-Miami soil association. These soils are level to sloping, poorly to well drained loams that overlie a clay loam subsoil. The

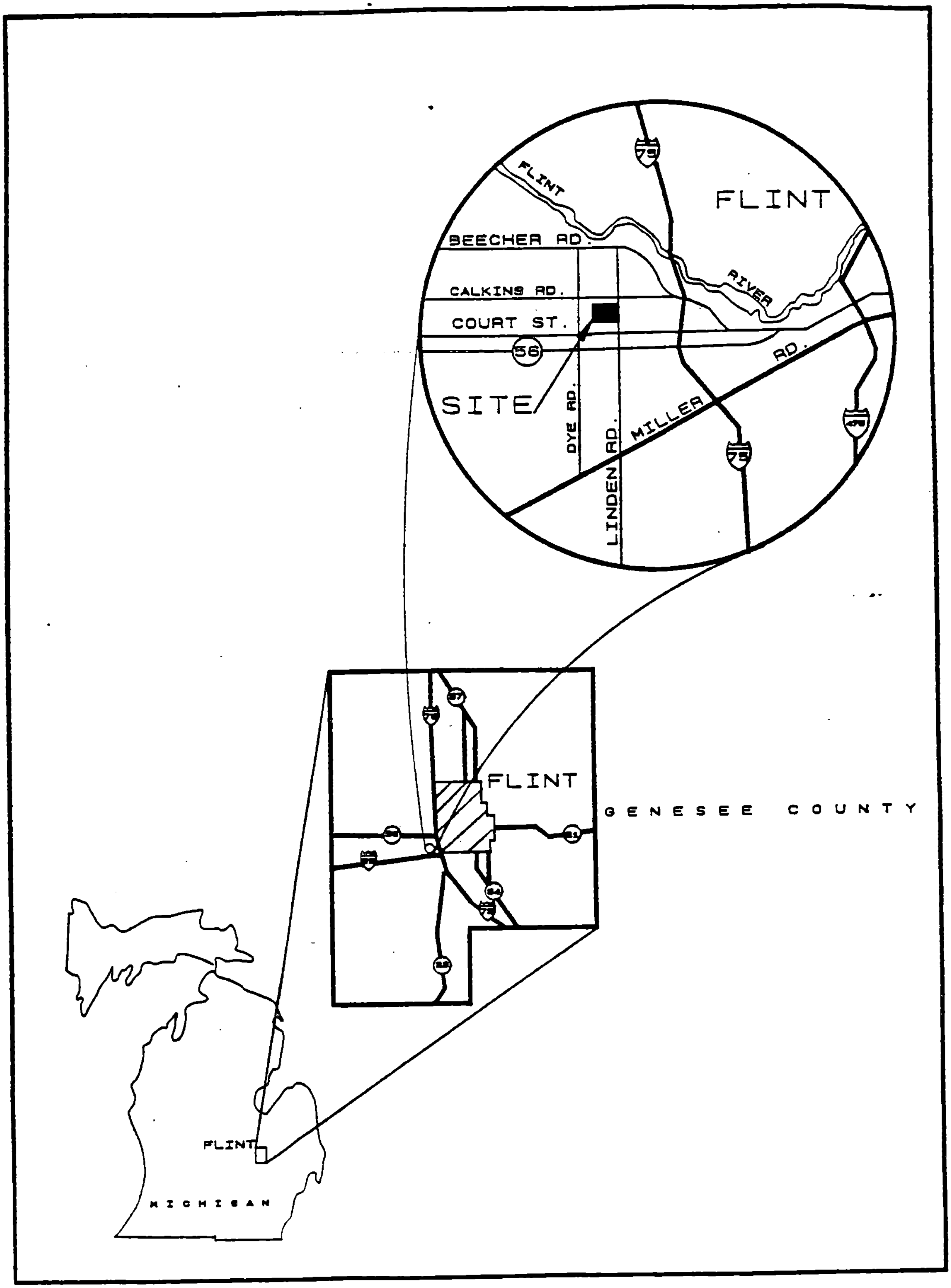


FIGURE 2-1
SITE LOCATION MAP
LINDEN ROAD LANDFILL SITE

LRLF site is outlined as a gravel pit in the annotated aerial photographs of the USDA Soil Survey for Genesee County with elevations ranging from 740 to 760 feet above mean sea level (MSL).

2.3 GEOLOGIC AND HYDROGEOLOGIC SETTING

2.3.1 Geologic Setting

Glacial till deposits in Genesee County are approximately 100 to 200 feet thick in the eastern section and 50 to 100 feet in the western section. Well logs of the area around LRLF indicate that the glacial drift ranges in thickness from 62 to 145 feet. The drift, according to the well logs, is predominantly clay/till with isolated lenses of sand and/or gravel. Some of these lenses provide limited water resources for domestic wells.

Stratigraphically, the area is part of the Michigan Basin, which is a relatively shallow, intracratonic structure which includes all of the Lower Peninsula, part of the Upper Peninsula, and parts of Wisconsin, Illinois, Indiana, Ohio, and Ontario. The topography of the bedrock surface in Genesee County ranges from 650 to 700 feet above MSL.

The predominant underlying bedrock in Genesee County is the Saginaw Formation. The Saginaw Formation is Lower Pennsylvanian in age and has a maximum thickness of 765 feet as reported from well logs collected in the Michigan Basin (MDNR, 1978). In Genesee County the Saginaw Formation is thickest (100 to 200 feet) in the northwestern part of the County. The formation thins and finally pinches out in the east and southeastern parts of the County. The Saginaw Formation is generally composed of interbedded sandstones, shales, limestone, and coal. The sandstone beds vary considerably in thickness and thin or pinch out in relatively short distances. Studies of the Saginaw Formation have shown several cycles of deposition, which indicate a previous, fluctuating marine environment with many changes in sea level.

Underlying the Saginaw are the Michigan Formation of Upper Mississippian and the Marshall Sandstone of Lower Mississippian age. The Michigan Formation is the underlying bedrock in eastern Genesee County in areas where the Saginaw Formation has thinned out. The Michigan Formation is composed of beds of anhydride and gypsum, gray to dark gray and greenish-gray shale, limestone, dolomite, and sandstone. A sand unit of the Michigan Formation, called the Michigan "Stray Sandstone" is reported to be a potential source for large quantities of natural gas. The Michigan Formation is approximately 50 to 200 feet thick in Genesee County. The Marshall Sandstone underlies the Michigan Formation and consists of sandstone and siltstone with some zones exhibiting red coloration. The Michigan Formation thins out south of Genesee County and is replaced by Marshall Sandstone underlying the glacial drift. The Marshall Sandstone is a major water-bearing unit (MDNR, 1978).

2.3.2 Hydrogeologic Setting

2.3.2.1 Precipitation and Surface Water

Climatologically, Flint Township is in the temperate zone of the United States and as such experiences four seasons of weather. The central portion of the state receives on average about 35 inches of rain a year. With a mean evaporation rate of about 30 inches per year, the area has a precipitation surplus of about 5 inches which will either infiltrate into the ground to replenish the groundwater or be transported by the natural drainage system as surface water.

The surface water in Genesee County drains to the Flint River as part of the Flint River Drainage Basin. This drainage basin encompasses most of Genesee and Lapeer Counties and parts of Saginaw and Oakland Counties. The Flint River flows to the northwest into the Saginaw River which drains into Saginaw Bay of Lake Huron. The regional drainage from areas surrounding LRLF flows to the northeast into an unnamed creek just to the north of the property. The creek flows to the northwest into the Flint River.

2.3.2.2 Groundwater

According to MDNR records, in 1980 there were a total of 13,187 water wells in Genesee County. Of these, 1,075 wells were in the Flint township. A small portion of the domestic wells tapped discontinuous sand and gravel beds within the glacial drift. The larger portion of the wells tapped bedrock formations, typically the Marshall Sandstone.

Genesee County is located on the border of usable groundwater from Mississippian formations (Marshall Sandstone) and the Pennsylvanian (Saginaw) Formations. At the western edge of Genesee County, well sampling efforts have documented that the total dissolved solid (TDS) levels in these formations are as high as 100,000 mg/l. The glacial drift also has been shown to have elevated levels of TDS. The brine content of these formations diminishes to the east, away from the center of the Michigan Basin. The regional groundwater flow in the Saginaw Formation and Mississippian formations is to the northwest.

Limited water level data obtained from shallow observation wells installed at the LRLF by Keck Consulting Services, Inc., did not adequately define the groundwater flow at the site. Based upon local topography, the local groundwater flow in the glacial drift may be toward the Flint River in the north-northeast direction.

According to the Keck, Inc. study, the predominant material encountered in the glacial overburden (up to a depth of approximately 88 feet) was clay/till. The depth to the uppermost perched water table is 15 to 20 feet below the surface. The Keck, Inc. study did not indicate the presence of any significant confining clay layers within the glacial overburden. However, depending on the nature of the clay/till overburden, the entire overburden may act as a protective unit for any aquifer(s) underlying the water table aquifer. As mentioned earlier, it is known that many wells in the surrounding area tap the bedrock aquifers underlying the glacial overburden at depths ranging from approximately 60 to 90 feet below the surface.

2.4 SITE HISTORY

Based on current knowledge, LRLF has had three periods of land use during this century. It was first used as a gravel excavation. GM purchased the property in 1931 and used it as a landfill. Since landfilling activities had ceased in 1969, it has been a vacant property.

According to previous reports, the site had been mined for sand and gravel prior to the 1930s. The gravel excavation occupied about one-third of the present site by area, and was reportedly excavated to a depth of approximately 40 feet. However, the extent of the gravel excavation is uncertain. WESTON's review of an aerial photograph of the site taken in 1941 did not indicate any evidence of large excavations or even traces of a filled excavation. For an undetermined number of years preceding 1931, a rubbish incinerator occupied the site. The Chevrolet Division of GM purchased the 40-acre property from a residential owner in 1931.

The GM-Chevrolet Division used the site as a general refuse landfill from about 1931 until about 1969. The refuse reportedly consisted of construction debris, plaster, buffing and grinding wheels, buffing and grinding refuse, and metallic chips, and, potentially other process wastes.

After landfilling operations ceased in 1969, several organizations, including the Genesee County Parks and Recreation Commission and The Nature Conservatory, expressed interest in acquiring the property. However, the transactions were never completed. A security fence around the site was constructed by GM in July 1980. A more detailed account of the site history is presented in WESTON's Phase I Environmental Assessment of Linden Road Landfill.

2.5 PHASE I INVESTIGATION

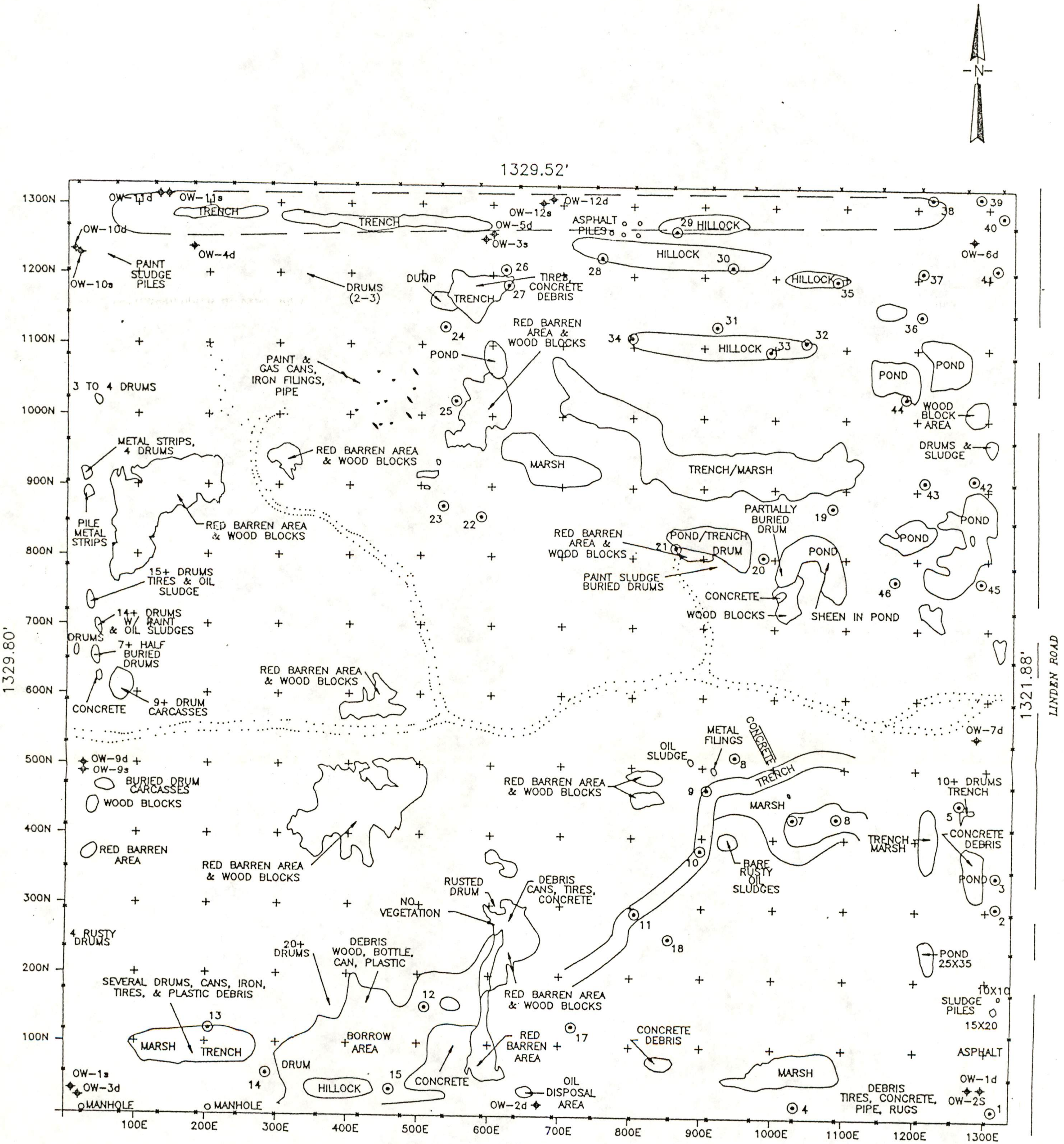
A Phase I Environmental Assessment of LRLF site was completed for GM AC Rochester Division in February 1990. During this investigation the following tasks were performed: a file review, a site inspection, a historical aerial photograph review, and an aerial survey. As part of the Phase I investigation, a detailed topographic map (1" = 50') was prepared. The findings of this investigation are documented in the Phase I Environmental Assessment report.

The LRLF site, as observed during WESTON's inspections and from historical aerial photographs, shows signs of extensive modification from fill operations. The topography of the site generally parallels the surrounding area which slopes downward gently to the north and east. Within the landfill boundaries the topography is varied with numerous hillocks, trenches and ponded areas. The Site Features Map (Figure 2-2) shows major surficial features currently present at the site, including those observation wells installed during previous investigations at the site. Also displayed are the locations of test pit excavations that were part of a previous investigation.

There are currently at least five large observable east-west oriented trenches at LRLF. Two of these trenches are located close to the northern boundary of the site, one in the northeastern section and two within the southern half of the site. There are several marshy areas and ponds associated with these trenches. Also shown in Figure 2-2 is the approximate boundary of a large trench, as seen in an aerial photograph of LRLF taken in 1957.

Several areas devoid of vegetation, characterized by red surfacial soils (referred to as Red Barren Areas) of various extents, are located throughout LRLF. The northeast quadrant of the site is characterized by the presence of a large number of hillocks. A small oil disposal area exists in the south-central section of the site.

A review of the aerial photographs of the site taken between 1941 and 1987 indicated that LRLF was extensively landfilled over the entire property, and no area was untouched by past operations; however, the nature and type of fill is uncertain. A detailed description of the historical aerial photographs review is also presented in the Phase I report.



LEGEND

⊙ GILBERT/COMMWEALTH ASSOC., INC. TEST PIT LOCATIONS

✦OW- EXISTING OBSERVATION WELL (CONSTRUCTED BY KECK, INC.)

– – – – – APPROXIMATE BOUNDARY OF LARGE TRENCH AS SEEN IN 6-12-1957 AERIAL PHOTOGRAPH

\+ GRID LOCATION (SOIL GAS SURVEY LOCATION)

–x–x– FENCE LINE

: : : : : ACCESS ROAD

0' 100'
SCALE

FIGURE 2-2

SITE FEATURES MAP

SECTION 3

WORK PLAN

3.1 OVERVIEW AND SUMMARY OF WORK

This work plan outlines waste characterization and interim remedial measures evaluation activities which are comprised of the following tasks, presented within their anticipated work sequence, and summarized as follows:

Task 1 - Waste Characterization

This task includes conducting a surface waste characterization and volume estimation at several areas of the site where waste materials have been identified at the surface of the LRLF. Waste sampling and analysis will be conducted in accordance with the Sampling and Analysis Plan presented in Appendix B. Surface waste volume determinations will be made, by waste type, from field measurements.

Task 2 - Assessment of Waste Characterization Data

This task will entail a detailed review of laboratory analytical reports and field investigative findings from the Task 1 waste characterization activities. Findings from this assessment will be utilized to confirm, further define, or determine the need for interim remedial measures (Task 3). Completed waste characterization data and data evaluation will be presented to MDNR in the form of an Addendum to this Work Plan, prior to the implementation of any interim remedial measures activities, if required, as outlined in Task 3. In addition, the waste characterization data, waste volume determinations, and field reconnaissance notes will be beneficial to additional, planned investigation activities set forth in the Site Investigation Work Plan.

The following tasks, if deemed necessary, would be addressed in the subsequent Work Plan Addendum, as referenced above.

Task 3 - Potential Scope of Interim Remedial Measures (IRM) Program

Task 3a - Mobilization and Site Preparations

This task may involve, depending on Task 2 findings, performing mobilization of facilities, equipment, and personnel. Conducting initial site preparations including preliminary access road construction, limited clearing of brush and trees for access, establishing a utility source for temporary on-site facilities, and establishing survey control lines and a grid system within the site boundaries.

Task 3b - Surface Waste and Debris Removal and Disposal

Based upon review and assessment of waste characterization data obtained from Tasks 1 and 2, a limited removal and disposal of surface waste material may be conducted. If this task is implemented, it will consist of removal, transportation, and off-site disposal of materials present at the oil disposal area and drums containing various wastes and residues. All transportation and disposal activities under this task will be conducted in accordance with applicable State and Federal regulations.

Task 3c - Surface Waste Consolidation, Containment, and Staging

This task is planned in the event that waste characterization data identifies the presence of waste materials requiring special handling, treatment, or disposal due to their chemical composition. Under this task, such materials will be identified, consolidated as appropriate, recontainerized, staged, and stored securely on-site for subsequent management during the remedial measures phase of the site work, if required.

Task 3d - Surface Waste Consolidation and On-Site Management

In the event this task of the IRM is implemented, certain non-hazardous and inert surface wastes and debris, including empty and crushed drums, scrap metals, wood and plastic debris, may be consolidated and managed on-site by incorporation into the preliminary and final grading and backfilling plans for the site. A determination will be made during the waste characterization task as to which surface materials may be suitable for on-site management.

Task 3e - Preliminary Surface Grading and Backfilling

If this task of the IRM is deemed necessary, it is anticipated to involve surface grading, backfilling, and restoration of areas of the site disturbed by waste and debris removal conducted under Tasks 3b, 3c, and 3d. This task may also include backfilling, regrading and stabilizing certain slopes, depressions and exposed areas of refuse and debris to promote drainage, minimize potential for erosion, and in general, improve the appearance of the site. This work activity will be conducted in a manner which recognizes that additional investigative activities will be conducted as the final remedial measures for the site are developed.

Task 4 - Final Report on Interim Remedial Measures

A final report will be prepared to document relevant findings and work activities associated with the waste characterization and IRM activities at the LRLF site. This final report will be presented to MDNR and will be utilized in combination with site investigation data in evaluating the final remedial design plans for the site.

3.2 DETAILED WORK PLAN APPROACH

3.2.1 Waste Characterization

A waste characterization program will be conducted on specific surface materials identified at the LRLF. This surface waste characterization will involve a physical and chemical characterization conducted for the purpose of determining suitable handling and disposal requirements for the subject materials. All waste characterization activities will be conducted in compliance with state and Federal solid and hazardous waste characterization regulations. Specifically, the following surface areas and potential waste materials will be characterized under this task:

- Sludge and bottom soils associated with the small oil disposal area along the south boundary of the LRLF.
- Areas of surface soil discoloration (red barren areas) including the wood blocks located at various areas within the site boundary.
- Various drums containing waste and drums with distinguishable contents located in various areas of the site.

Additional surface materials determined to be present at the site may be incorporated into this characterization plan as more detailed field information is obtained during ongoing site reconnaissance.

A grid coordinate system will be established on the site for horizontal ground control. This grid system will be set, by survey methods, at 100-foot intervals and will be identified with numeric identifying system. This grid system shall be set from perpendicular baselines set along the north and east property lines. Grid points shall be set by establishing perpendicular survey lines from each baseline and measuring-100-foot distances by transit stadia interval or field chain methods. All sample points and field references will be made with respect to this grid system.

Sampling and analysis of these materials will be conducted in accordance with the sampling protocols and analytical methods detailed in Appendix A - Quality Assurance - Quality Control Plan and Appendix B-Sampling and Analysis Plan. Physical characterization of the surface wastes will be conducted by field assessment and photographic documentation during sampling of the specific materials.

Volume determinations of the various materials will be made during the waste characterization phase via field surface area and depth measurements, including:

- A volume determination of solids, semi-solids, and liquids at the oil disposal area.
- A volume estimation of solids and potentially contaminated soils present within the red barren areas.
- An estimate of the number of drums present and containerized waste volume at the surface of the LRLF categorized by integrity of the container, distinguishable material content, labeling and/or similar identifying system.
- An estimate of the volume of wood blocks present at the site.
- A volume estimate of the amount of recoverable scrap metal present at the site.

These volume determinations will be utilized in combination with laboratory analytical data, and physical characterization in evaluating and finalizing waste handling and disposal methods of the IRME.

3.2.2 Assessment of Waste Characterization Data

Following implementation of the Sampling and Analysis Plan (Appendix B) and the associated field reconnaissance during sampling, an assessment will be conducted to confirm and refine the approach to those tasks associated with the IRME program. This assessment will include a detailed review of each waste type for chemical composition, physical characteristics, and waste volume as determined by field documentation and laboratory analytical reports. Conclusions drawn from this data assessment will be utilized in evaluating the work scope, level of effort, and timing of the appropriate planned IRM activities, if any. Consideration will be given to the potential efficiency and effectiveness gained by performing IRM removal activities after the site investigation and evaluation of final remedial measures is completed. In addition, an evaluation will be made as to the most efficient removal, transportation, and disposal methods of the surface materials, if any.

Following completion of this assessment, a brief addendum to this Work Plan will be prepared which confirms, refines, or modifies, as necessary, the work tasks of the IRM based on the information obtained from the waste characterization task. This addendum submittal to MDNR will summarize all waste analysis data and waste volume determinations, and will identify contracted removal, transportation, and disposal facilities. The final schedule for any IRM work will also be presented within this addendum. This

Work Plan addendum will be prepared for review and acceptance by the MDNR prior to the initiation of IRM activities.

3.2.3 Final Report

A final report will be prepared to document the Interim Remedial Measures Evaluation Work Plan implementation and to serve as a reference for subsequent investigations at the LRLF. This final report will be completed for MDNR submittal and will contain the following:

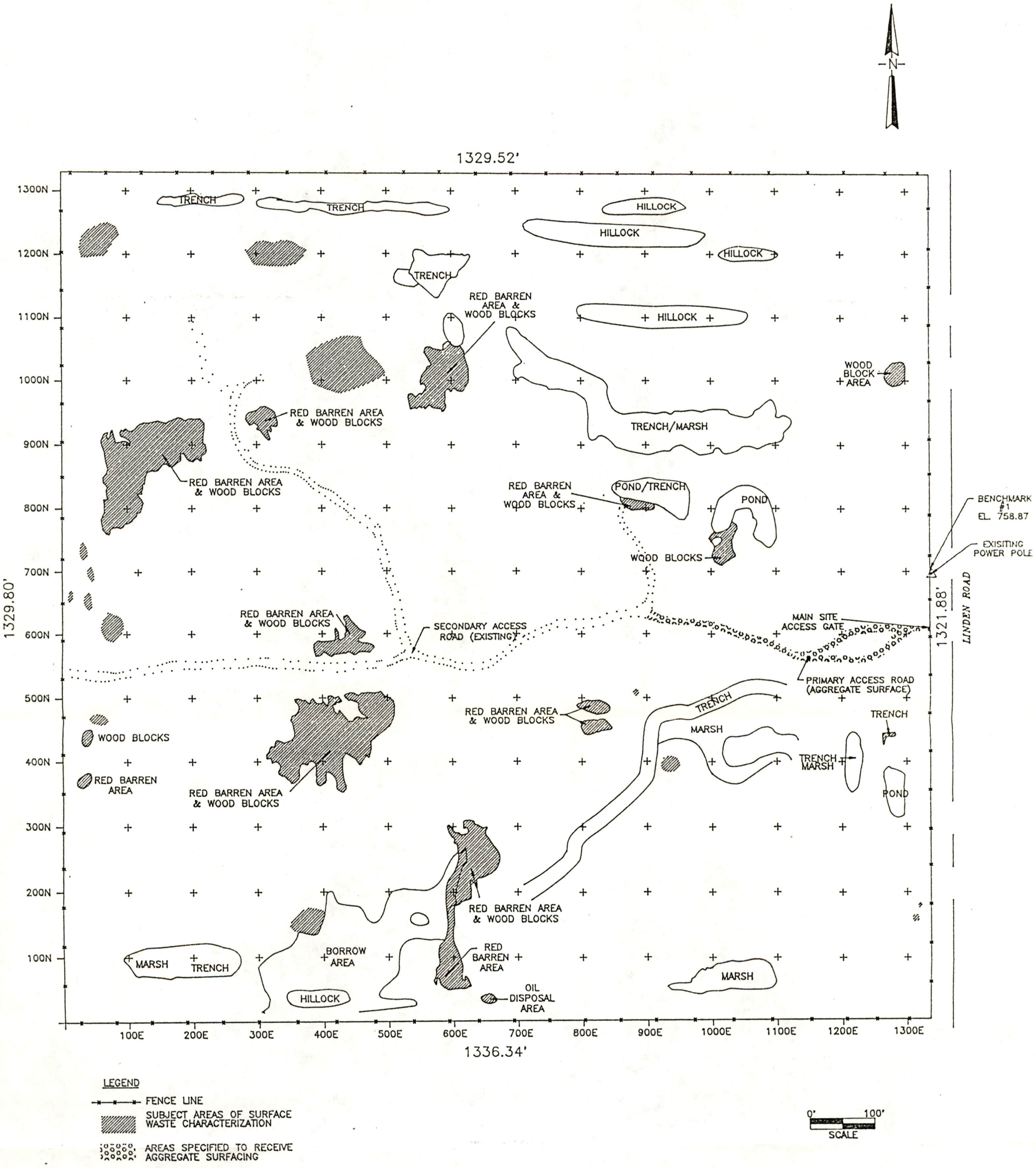
- A complete summary of waste characterization data including laboratory analytical reports, field records, and waste volume determinations.
- A summary of IRME activities including survey drawings, notations of site modifications, waste removal locations and waste volumes.

This final report will be completed following the completion of field and laboratory activities, as outlined in Section 4 - Site Investigation Schedule.

SECTION 4

INTERIM REMEDIAL MEASURES EVALUATION SCHEDULE

Figure 4-1 presents an overview of the anticipated sequence of tasks, duration, and overall schedule for the implementation of both the Interim Remedial Measures Evaluation Work Plan and the Site Investigation Work Plan. This schedule considers that an addendum to the Work Plan will be prepared following the waste characterization task and a refined schedule for field IRM activities if necessary, will be presented with this addendum submittal. Unanticipated site conditions, extreme weather, and other similar factors may impact this planned schedule.



NOTE: 1. ADDITIONAL SELECT CLEARING AT SURFACE WASTE AREAS TO BE DETERMINED IN FIELD.
2. ADDITIONAL INTERNAL SECONDARY ACCESS ROAD CONSTRUCTION TO BE DETERMINED IN FIELD AT TIME OF WASTE REMOVAL ACTIVITY.

FIGURE 3-1

SITE LAYOUT AND PREPARATIONS FOR IRME

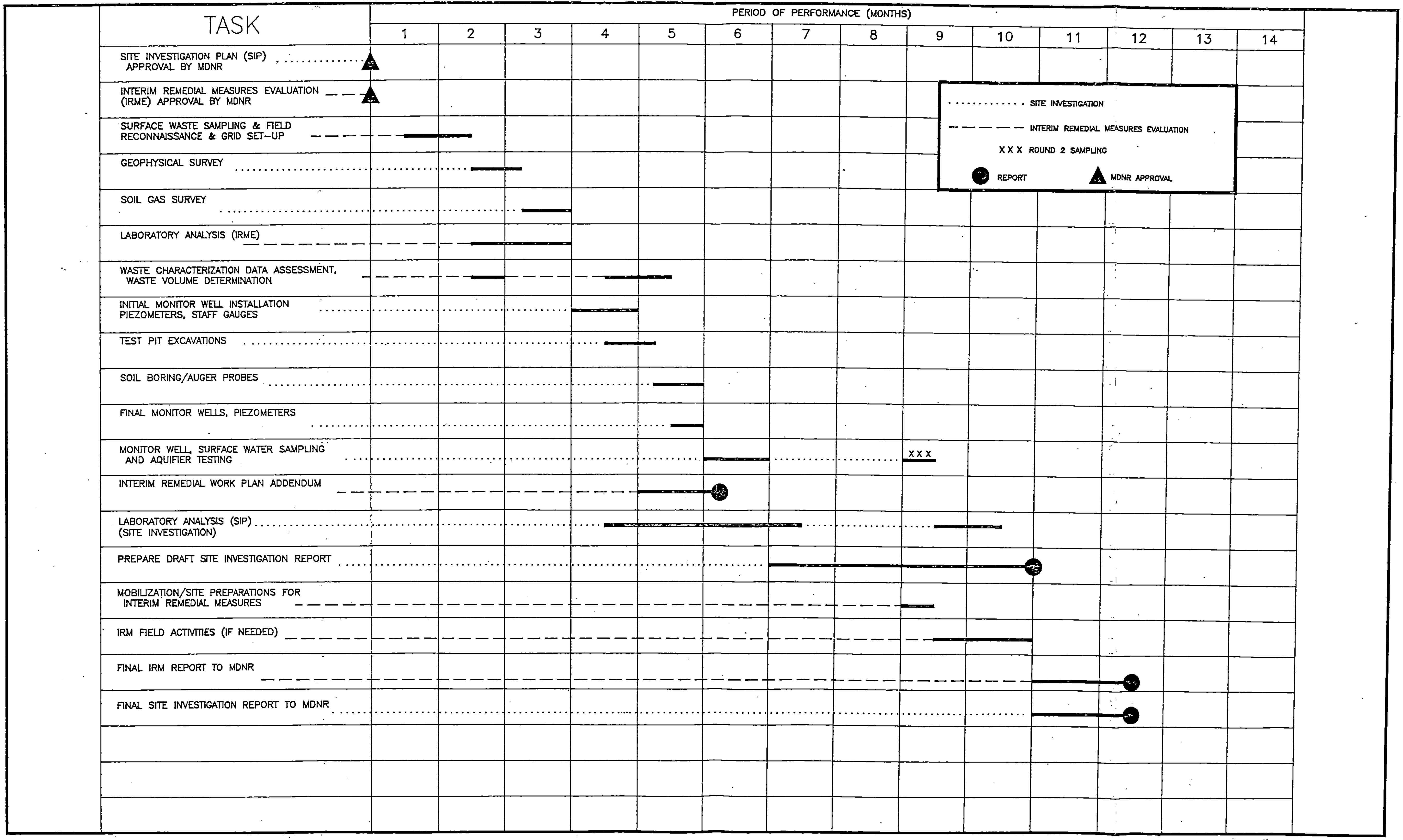


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FIGURE 4-1
SITE INVESTIGATION SCHEDULE

APPENDIX A

QUALITY ASSURANCE-QUALITY CONTROL PLAN
LINDEN ROAD LANDFILL SITE
FLINT TOWNSHIP, MICHIGAN

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APPENDIX A

LIST OF TABLES

1.0 INTRODUCTION

This Appendix presents the Quality Assurance/Quality Control (QA/QC) plan for the Interim Remedial Measures Evaluation (IRME) activities proposed for the Linden Road Landfill site, Flint Township, Michigan. The objectives for data measurements and the implementation of the QA/QC plan are described in the following sections.

2.0 OBJECTIVES FOR MEASUREMENT DATA

The purpose and objective of the Quality Assurance Project Plan (QAPP) is to establish standard procedures such that the integrity, accuracy, precision, completeness, and representativeness of samples are maintained. The level of QA/QC effort will be defined in regards to all aspects of sampling, field testing, sample preparation and shipment, chain-of-custody, laboratory testing and equipment calibration, internal QA and corrective actions.

2.1 Level of Quality Assurance/Quality Control Effort

To assess the quality of analytical data from the field sampling, specific QA/QC additional field samples will be prepared and/or collected. These samples include field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, field blanks, and trip blanks. The field duplicate samples will be analyzed to check for sampling reproducibility. Field blank analyses will check for procedural contamination that may cause sample contamination by assessing if adequate field sampling equipment decontamination procedures were performed. The trip blanks will be used to assess contamination due to VOC migration during sample storage and shipment, thereby determining if outside contamination sources have affected the samples. MS/MSD analyses will be performed on select investigative field samples to assess the laboratory method precision for each matrix. This data will provide percent recovery for certain analytical parameters and provides information about the effect of the sample matrix on the analytical methodology.

The frequency of the field duplicates to be collected will be 10 percent, or 1 duplicate for every 10 investigative samples submitted. Field blanks will be prepared for every 10 investigative water samples submitted for analysis of the same parameters as the investigative samples. One MS/MSD sample will be prepared for every 20 investigative samples submitted to the laboratory for Target Compound List (TCL) VOCs, BNAs, pesticides and PCB analyses. Three times the volume of one sample will be collected for MS/MSD analysis. There will be approximately 5 trip blanks analyzed for VOCs. This is an estimated amount since these QA/QC samples are only submitted with shipments containing samples scoped for VOC analysis. Specifically, one VOA trip blank consisting of Ultra Pure or Milipore water poured into two 40-ml vials will be included with each shipment of aqueous VOA samples.

Each trip blank will be placed in the VOA sample cooler with the other field samples and shipped to the laboratory for analysis. The procedures and methodology used in collection of these QA samples are further discussed in the Sampling and Analysis Plan (Appendix B).

2.2 Field Measurements

During the field investigation, field data will be collected concurrent with daily sample collection activities, along with other field activities. These activities include, but are not limited to, the following:

- Time and weather condition documentation.
- Sample location, depths, and description.
- Installation of grid coordinate system.
- Qualitative screening using photoionization detector (PID) or flame ionization detector (FID).

The primary QA objective for conducting these various tasks are to obtain reproducible measurements to a degree of accuracy consistent with the intended use of the measurements. Measurements involving instrumentation will include proper operation and calibration. The Sampling and Analysis Plan in Appendix B further describes the procedures and methodology for the majority of the tasks listed above.

3.0 IMPLEMENTATION

3.1 Field Chain-of-Custody Procedures

The procedures used during the chain-of-custody process are used to document the sampling history, from time of collection to its analysis at the laboratory. The sample is considered in custody if it is in the employee's physical possession, in view, secured for prevention of tampering and/or secured in an authorized (restricted) area by the employee. The typical procedures involved in sample handling at the LRLF site will include the following:

- The sampler will be responsible for proper care and handling of the samples until they are relinquished. A minimum number of people will be involved in the sample handling process.
- Samples will be properly marked for identification purposes. Labels will be completed with information such as sample number, location, time collected, sampler initials, analysis required, etc. A water-proof pen will be used in marking the sample labels. Labels will also

be covered with clear, water resistant tape for adequate protection against moisture damage.

- Samples will be placed into appropriate shipment containers and a chain-of-custody form will be completed by the sampler for each shipment cooler. The form provides a record of sample collection, transfer between personnel, sample shipment and receipt by the laboratory. When samples are transferred over to another person, the date, time and signature of the persons relinquishing and receiving will be documented on the form.

The field procedures used in sample collection, proper containers, preservatives, sample packing and shipment are further discussed under the Sampling and Analysis Plan in Appendix B.

3.2 Laboratory Chain-of-Custody Procedures

The laboratory will be responsible for the integrity and security of the samples upon their receipt. The person receiving the samples at the laboratory will record on the chain-of-custody form that they were received from the sample shipper. The following procedures will be performed at the laboratory upon sample receipt.

- Samples will be logged in and laboratory identification numbers assigned to each sample.

- The chain-of-custody forms and samples will be checked to assure proper information has been provided for the laboratory.

- Samples will be secured and placed into appropriate refrigerators or walk-in coolers within the laboratory.

- Internal chain-of-custody will be maintained for sample handling during the analytical process.

- Documentation of analytical procedures will be performed on the samples.

- Remaining sample material (after analysis) will be kept in original containers and placed into areas at appropriate temperatures for storage/preservation.

- The samples will be held by the laboratory until all analytical results have been reported and accepted. They will be held at the laboratory for one year, unless otherwise requested.

- The samples will be disposed of using proper disposal procedures. Appropriate sample custody protocol will be used when transferring or disposal of the sample from the laboratory.

3.3 Decontamination Program

To provide accurate and reliable analytical data, a strict decontamination program will be implemented during field sampling. The typical procedures involved in decontaminating sampling devices would include the following steps:

- Scrub sampling equipment with a nonphosphatic detergent (e.g., Alconox) solution using soft-bristle brushes.
- Rinse equipment with potable water.
- Rinse equipment with a isopropanol by spraying until dripping.
- Allow equipment to air dry.
- Rinse equipment with deionized water (laboratory grade).
- Wrap sampling equipment in polypropylene sheeting or aluminum foil until its next use.

Heavy equipment used during field sampling (e.g., drill rig, trackhoe) will be decontaminated between sample locations with pressurized steam cleaners. The decontamination process for heavy equipment, tools, and sampling devices and equipment will be performed in one designated area for the entire field program. The selected area will typically be located outside the anticipated impacted areas within the property. The drippings from decontamination of sampling equipment (during solvent rinse and subsequent water rinse) will be retained and disposed of in an appropriate manner. Heavy equipment (trackhoe, drill rig) wash-down water will be discharged to the ground surface.

Personal decontamination procedures will be performed near the heavy equipment decon area. Protective clothing will be placed in appropriate containers and properly managed. A more thorough discussion of personal decon, equipment decon, and personal protection is covered in Sections 5.0 and 9.0 of the Health and Safety Plan (Appendix C).

3.4 Calibration Procedures and Frequency

The field instruments, such as a flame ionization detector (FID) or photoionization detector (PID), will be calibrated each day. Calibration gases will be used in accordance with the manufacturer's recommendations. The calibration events will be recorded in appropriate field log books.

The pH and conductivity meters will be calibrated each day prior to collection of groundwater samples. The pH meter will be calibrated with a minimum of two buffer solutions. The pH meter will be adjusted accordingly to match the buffer pH values. The conductivity meter would be checked with a manufacturer recommended reference solution to determine the accuracy of the conductivity meter. The conductivity readings should be within 5 percent of the reference solution.

3.5 Analytical Procedures

All samples collected for analysis will be analyzed by a laboratory utilizing U.S. EPA-approved methodologies. The analytical parameters, listed in Tables 3-1 and 3-2, are those on the current U.S. EPA target list for investigating potentially contaminated sites.

The soil samples analyzed for Target Compound List (TCL) volatile organic compounds will be tested utilizing the gas chromatography/mass spectrometer (GC/MS), where temperature controls separate the organic compounds (Method 8240). The compounds are detected by a photoionization detector (electron capture) unit. Water samples analyzed for TCL volatile organic compounds will be tested using the purge and trap method.

Soil and water samples will also be analyzed for TCL semivolatile organic compounds, also known as base neutral/acid extractables (BNAs). The sample is extracted using a solvent solution, then the sample extract is subjected to GC/MS analysis. The method for performing the analyses will be Method 8270, consistent with the EPA-approved laboratory procedures.

The polychlorinated biphenyls (PCBs) will be analyzed in the soil medium using gas chromatograph/electron capture detection (GC/ECD) (Method 8080).

Select soil samples analyzed for Target Analyte List (TAL) metals will be tested using Inductively Coupled Plasma (ICP) or atomic absorption (AA) spectrometry procedures (Method 6000-7000 series). Method 9010 will be used for cyanide analysis.

Analytical data qualifiers, if appropriate, will be addressed in case narratives. The data reduction, validation, and reporting procedures for the analytical services will be performed in accordance with U.S. EPA established protocols. All analytical reports will include complete documentation of QA/QC data, such as original chain-of-custody forms, precision and accuracy data. The data review services would also be performed by the contractor, and findings will be documented as part of the final investigation report.

TABLE 3-1

TARGET COMPOUND LIST (TCL)

	VOLATILES	CAS NUMBER	DETECTION LIMITS[(1)][(2)] Low Water (ug/l)	Low Soil Sediment (ug/kg)
1	Chloromethane	74-87-3	10	10
2	Bromomethane	74-83-9	10	10
3	Vinyl Chloride	75-01-4	10	10
4	Chloroethane	75-00-3	10	10
5	Methylene Chloride	75-09-2	5	5
6	Acetone	67-64-1	10	10
7	Carbon Disulfide	75-15-1	5	5
8	1,1-Dichloroethene	75-35-4	5	5
9	1,1-Dichloroethane	75-35-3	5	5
10	1,2-Dichloroethene (total)	540-59-0	5	5
11	Chloroform	67-66-3	5	5
12	1,1-Dichloroethane	107-06-2	5	5
13	2-Butanone	78-93-3	10	10
14	1,1,1-Trichloroethane (total)	71-55-6	5	5
15	Carbon Tetrachloride	56-23-5	5	5
16	Vinyl Acetate	108-05-4	10	10
17	Bromodichloromethane	75-27-4	5	5
18	1,1,2,2-Tetrachloroethane	10061-02-6	5	5
19	1,2-Dichloropropane	78-87-5	5	5
20	trans-1,3-Dichloropropene	10060-02-6	5	5
21	Trichloroethene	79-01-6	5	5
22	Dibromochloromethane	124-48-1	5	5
23	1,1,2-Trichloroethane	79-00-5	5	5
24	Benzene	71-43-2	5	5
25	bis-1,3-Dichloropropene	10060-01-5	5	5
26	Bromoform	75-25-2	5	5
27	2-Hexanone	591-78-6	10	10
28	4-Methyl-2-pentanone	108-10-1	10	10
29	Tetrachloroethene	127-18-4	5	5
30	Toluene	108-88-3	5	5
31	Chlorobenzene	108-90-7	5	5
32	Ethyl Benzene	100-41-4	5	5
33	Styrene	100-42-5	5	5
34	Xylenes (total)	1330-20-7	5	5

TABLE 3-1 (Cont.)

TARGET COMPOUND LIST (TCL)

	SEMIVOLATILES	CAS NUMBER	Low Water (ug/l)	Low Soil Sediment (ug/kg)
35	Phenol	108-95-2	10	330
36	bis(2-Chloroethyl)ether	111-44-4	10	330
37	2-Chlorophenol	95-57-8	10	330
38	1,3-Dichlorobenzene	541-73-1	10	330
39	1,4-Dichlorobenzene	106-46-7	10	330
40	Benzyl Alcohol	100-51-6	10	330
41	1,2-Dichlorobenzene	95-50-1	10	330
42	2-Methylphenol	95-48-7	10	330
43	bis(2-Chloroisopropyl)ether	108-60-1	10	330
44	4-Methylphenol	106-44-5	10	330
45	N-Nitroso-Dipropylamine	621-64-7	10	330
46	Hexachloroethane	67-72-1	10	330
47	Nitrobenzene	98-95-3	10	330
48	Isophorone	78-59-1	10	330
49	2-Nitrophenol	88-75-5	10	330
50	2,4-Dimethylphenol	105-67-9	10	330
51	Benzoic Acid	65-85-0	50	1600
52	bis(2-Chloroethoxy)methane	111-91-1	10	330
53	2,4-Dichlorophenol	120-83-2	10	330
54	1,2,4-Trichlorobenzene	120-82-1	10	330
55	Naphthalene	91-20-3	10	330
56	4-Chloroaniline	106-47-8	10	330
57	Hexachlorobutadiene	87-68-3	10	330
58	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59	2-Methylnapththalene	91-57-6	10	330
60	Hexachlorocyclopentadiene	77-47-4	10	300
61	2,4,6-Trichlorophenol	88-06-2	10	330
62	2,4,5-Trichlorophenol	95-95-4	50	1600
63	2-Chloronapthalene	91-58-7	10	330
64	2-Nitroaniline	88-74-4	50	1600

TABLE 3-1 (Cont.)

TARGET COMPOUND LIST (TCL)

	SEMIVOLATILES	CAS NUMBER	Low Water (ug/l)	Low Soil Sediment (ug/kg)
65	Dimethyl Phthalate	131-11-3	10	330
66	Acenaphthylene	208-96-8	10	330
67	3-Nitroaniline	99-09-2	50	1600
68	Acenaphthene	83-32-9	10	330
69	2,4-Dinitrophenol	51-28-5	50	1600
70	4-Nitrophenol	100-02-7	50	1600
71	Dibenzofuran	132-64-9	10	330
72	2,4-Dinitrotoluene	121-14-2	10	330
73	2,6-Dinitrotoluene	606-20-2	10	330
74	Diethylphthalate	84-66-2	10	330
75	4-Chlorophenyl Phenyl ether	7005-72-3	10	330
76	Fluorene	86-73-7	10	330
77	4-Nitroaniline	100-01-6	50	1600
78	4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79	N-nitrosodiphenylamine	86-30-6	10	330
80	4-Bromophenyl Phenyl ether	101-55-3	10	330
81	Hexachlorobenzene	118-74-1	10	330
82	Pentachlorophenol	87-86-5	50	1600
83	Phenanthrene	85-01-8	10	330
84	Anthracene	120-12-7	10	330
85	Di-n-butylphthalate	84-74-2	10	330
86	Fluoranthene	206-44-0	10	330
87	Pyrene	129-00-0	10	330
88	Butyl Benzyl Phthalate	85-68-7	10	330
89	3,3'-Dichlorobenzidine	91-94-1	20	660
90	Benzo(a)anthracene	56-55-3	10	330
91	bis(2-ethylhexy)phthalate	117-81-7	10	330
92	Chrysene	218-01-9	10	330
93	Di-n-octyl Phthalate	117-84-0	10	330
94	Benzo(b)fluoranthene	205-99-2	10	330
95	Benzo(k)fluoranthene	207-08-9	10	330
96	Benzo(a)pyrene	50-32-8	10	330
97	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98	Dibenz(a,h)anthracene	53-70-3	10	330
99	Benzo(g,h,i)perylene	191-24-2	10	330

TABLE 3-1 (Cont.)

TARGET COMPOUND LIST (TCL)

	PESTICIDES & PCBs	CAS NUMBER	Low Water (ug/l)	Low Soil Sediment (ug/kg)
100	Alpha-BHC	319-84-6	0.05	8.0
101	Beta-BHC	319-85-7	0.05	8.0
102	Delta-BHC	319-86-8	0.05	8.0
103	gamma-BHC	58-89-9	0.05	8.0
104	Heptachlor	76-44-8	0.05	8.0
105	Aldrin	309-00-02	0.05	8.0
106	Helptachlor epoxide	1024-57-3	0.05	8.0
107	Endosulfan I	959-98-8	0.05	8.0
108	Dieldrin	60-57-1	0.10	16
109	4,41 - DDE	72-55-9	0.10	16
110	Endrin	72-20-8	0.10	16
111	Endosulfan II	33213-65-9	0.10	16
112	4,41 - DDD	72-54-8	0.10	16
113	Endosulfansulfate	1031-07-8	0.10	16
114	4,41 - DDT	50-29-3	0.10	16
115	Methoxychlor	72-43-5	0.05	80
116	Endrin ketone	53494-70-5	0.10	16
117	alpha-chlordane	5103-71-9	0.05	80
118	gamma-chlordane	5103-74-2	0.05	80
119	Toxaphene	8001-35-2	1.0	160
120	Aroclor - 1016	12674-11-2	0.05	80
121	Aroclor - 1221	11104-28-2	0.05	80
122	Aroclor - 1232	11141-16-5	0.05	80
123	Aroclor - 1242	53469-21-9	0.05	80
124	Aroclor - 1248	12672-29-6	0.05	80
125	Aroclor - 1254	11097-69-1	1.0	160
126	Aroclor - 1260	11096-82-5	1.0	160

(1) Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment on dry weight basis will be higher.

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

TABLE 3-2

TARGET ANALYTE LIST (TAL)

Element	Detection Limit[1] (ug/l)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	5
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

(1) The detection limits for samples may be considerably higher depending on the sample matrix.

3.6 Data Reduction, Validation and Reporting

The validation process will include additional data reduction, following verification of the laboratory reduction results and confirmation of compliance with QA/QC requirements. This process would evaluate the quality and consistency of the analytical data.

3.7 Internal Quality Control Procedures

The internal quality control procedures for the analyses performed by the laboratory will be in accordance with EPA-approved quality assurance guidelines. The specifications for the guidelines would include the type of audits required such as surrogate spikes, reference samples, controls, and blanks. The audit frequency, compounds to be used for surrogate spikes, and quality control acceptance criteria for the audits are also covered in the guidelines.

The field measurements will be quality-controlled by use of multiple readings and proper instrument calibration. The quality control of field sampling is accomplished by collection of additional samples (i.e., field duplicates, blanks, etc.) as discussed earlier in Section 1.1.1.

3.8 Corrective Action Procedures

If the quality control audit indicates suspect analytical data or procedures, corrective action will be required. The corrective action may include re-analysis of the sample (if holding times permit), resampling and analysis, evaluation of the sampling procedure or accepting the data and acknowledgement of its level of uncertainty.

3.9 Quality Assurance Report

Although separate QA reports are not yet scoped for the project, a QA/QC section may be provided in the final report for the investigation study. This section would summarize the quality of the data collected, results of audits, and any significant QA problems encountered, along with the recommended solutions. Reports and/or memoranda will be included as part of the quality assurance record for documentation of data assessment activity.

3.10 Field Audits

The field manager will be responsible for assuring the project execution to be in compliance with the project plans. The field audits would cover proper investigative procedures (e.g., drilling techniques, well construction, sample collection, chain-of-custody, sample shipment, etc.). Any variances from the project plans would be documented, along with corrective actions. Documentation would be placed on a QA program field audit plans would be documented, along with corrective actions. Documentation would be placed on a QA program field audit checklist.

APPENDIX B

SAMPLING AND ANALYSIS PLAN
INTERIM REMEDIAL MEASURES EVALUATION
LINDEN ROAD LANDFILL SITE
FLINT TOWNSHIP, MICHIGAN

APPENDIX B

SAMPLING AND ANALYSIS PLAN

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APPENDIX B

SAMPLING AND ANALYSIS PLAN

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) outlines the waste sampling and laboratory analytical procedures to be utilized during the waste characterization (Task 1) of the Interim Remedial Measures Evaluation program at the Linden Road Landfill (LRLF).

The SAP provides details of planned sample locations, materials to be sampled, laboratory analytical parameters, field and laboratory documentation procedures, and other relevant activities during surface waste characterization. Sampling activities related to subsurface materials at LRLF are described in Appendix B of the Site Investigation Work Plan.

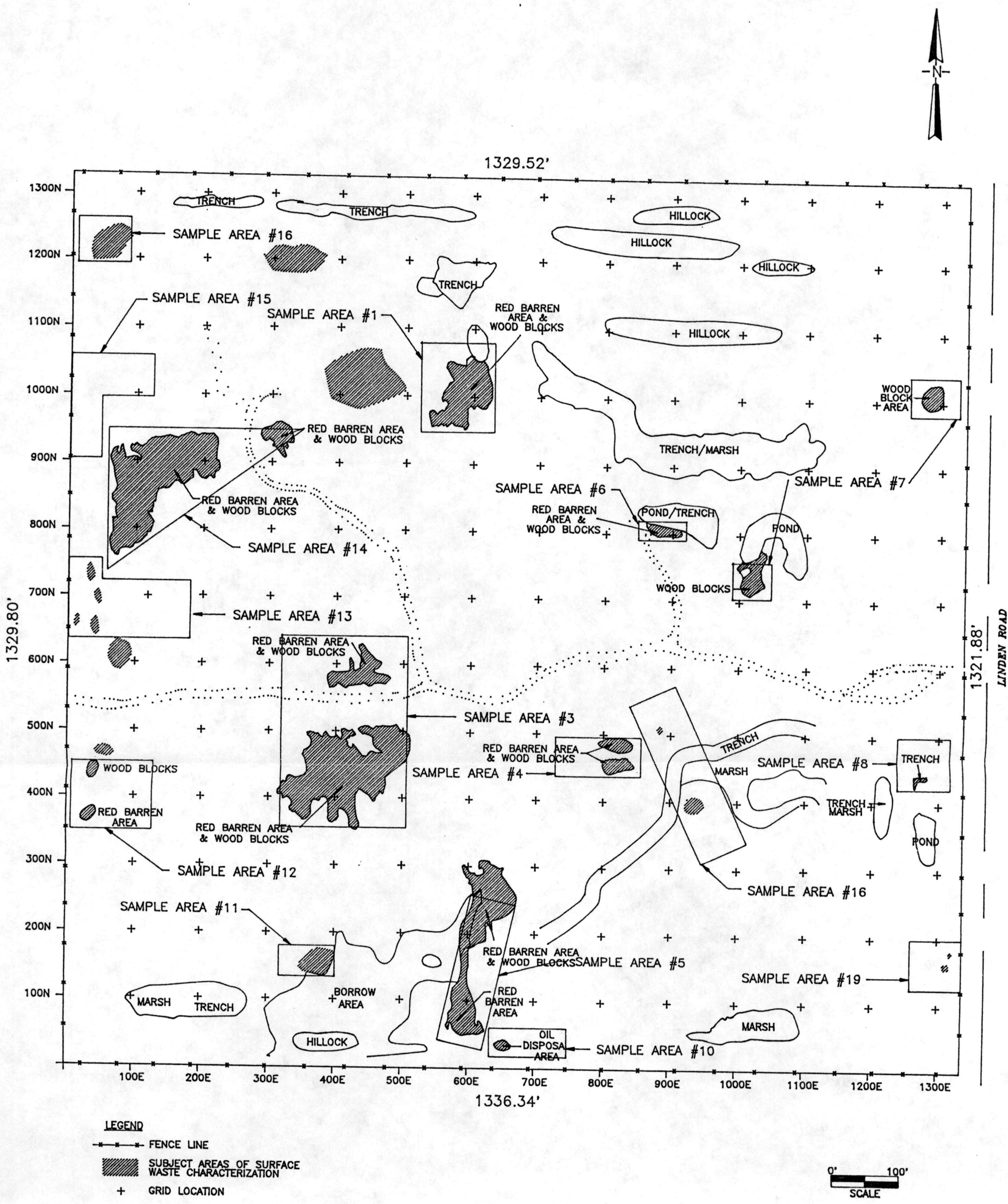
The current SAP has been prepared for MDNR review and approval or acceptance and to serve as a guideline for field personnel during implementation of sampling activities. The objective of the sampling and analytical program outlined herein is to characterize specific surface wastes and debris identified at the LRLF site. This analytical characterization will provide a basis for identifying the necessary waste removal and disposal methods and to support additional investigations at the site, if necessary.

2.0 SAMPLING LOCATIONS AND METHODOLOGIES

2.1 SAMPLING LOCATIONS

Figure 2-1 depicts the planned surface waste sampling locations within the LRLF site. Table 2-1 presents a summary of the estimated sample locations, sample composites by area. These sampling locations have been selected to be representative of the waste materials being considered to be removed and disposed during the IRME, as discussed in the accompanying Work Plan. The sample areas have been grouped to include the following:

- Several areas of surface soil discoloration (red barren areas) identified at the site.
- Several areas containing wood block flooring.
- The oil disposal area located near the southern boundary of the site.
- Drum groupings with distinguishable waste and/or residue contents.
- Identifiable areas of surface process sludges.



NOTE: REFERENCE WORK PLAN TABLE 2-1 FOR NUMBER OF SAMPLES AND COMPOSITING PLAN.

FIGURE 2-1
SAMPLING LOCATION MAP

TABLE 2-1

SUMMARY OF SAMPLE LOCATIONS, SAMPLE COMPOSITE AND SAMPLE GROUPING FOR WASTE CHARACTERIZATION

Sample Area	Waste Type(s)	Estimated No. of Sample Locations	Resulting Composite Samples for Analysis
1	Red Barren Area Soils	5	1
	Wood Blocks	2	0
2	Red Barren Area Soils	8	0
	Wood Blocks	4	1
3	Red Barren Area Soils	12	1
	Wood Blocks	4	1
4	Red Barren Area Soils	6	1
	Wood Blocks	2	0
5	Red Barren Area Soils	6	0
	Wood Blocks	2	0
6	Red Barren Area Soils	4	1 (+D)
	Wood Blocks	2	0
7	Wood Blocks	2	1 (+D)
8	Drums	4	2
9	Surface Sludges	6	2
10	Oil Disposal Sludge	2	1 (+D)
	Oil Disposal Area Sidewall Soil	2	1
11	Drums	4	2
12	Red Barren Area Soils	3	1
	Wood Blocks	2	1
13	Drums	8	4 (+D)
14	Drums	2	2
15	Surface Sludges	8	2
16	Surface Sludges	6	2

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* A single sample will be collected from each location.

** Discrete samples collected for VOC analysis. The number of discrete samples collected for VOC analysis in each sample area will not exceed the number of composite samples collected from that particular area.

*** Samples from more than one Red Barren Area may be combined to generate composite samples.

(+D) A duplicate sample.

All field sampling locations will be identified by placement of a survey stake with a unique identifying number. These staked sampling locations will then be located with respect to a surveyed site horizontal grid system which will be established at the site.

It is anticipated that a four to six-person sampling crew will be necessary to implement this sampling plan at the 16 delineated locations at the site (see Figure 2-1). Level C personal protective equipment is anticipated for this sampling activity, as outlined in the Appendix C Health and Safety Plan. Based upon results of real-time air monitoring this level of protection may be modified in accordance with such provisions of the safety plan.

2.2 SAMPLING METHODS

The following sampling methods are specified for each of the subject site areas.

2.2.1 Red Barren Areas Sampling

The red barren areas will be sampled utilizing surface and shallow depth soil sampling techniques. A hand shovel, or post hole digger will be utilized to retrieve samples of the affected soils and solids to a maximum depth of 12-inches at the locations shown on Figure 2-1. Discreet samples collected from several locations within a single barren area will be composited to a single sample. This sample will be representative of the designated red barren area. The estimated number of sample locations and the number of resulting composite samples are shown in Table 2-1. A total of 44 soil samples will be collected from the subject areas and will be composited into 4 samples as indicated in Table 2-1. In the event that positive results are obtained from these composite samples, individual samples that comprised the composite will be analyzed to appropriately define the chemical characteristics of the red barren areas.

2.2.2 Wood Blocks Sampling

Wood block samples will be collected from each representative area of the site where appreciable quantities of wood blocks have been identified (see Figure 2-1). An estimated 20 wood block samples will be collected from 8 areas as indicated in Table 2-1 and Figure 2-1. A total of 4 composite wood block samples will be prepared for analysis. In the event that positive results are obtained from a composited sample, the individual samples that comprised the composited sample will also be tested for that parameter. Pending the results of this analysis, additional samples may be analyzed to appropriately define the chemical character of the wood blocks.

2.2.3 Oil Disposal Area Sampling

Oil Disposal Area sampling will be comprised of sampling the sludges and semi-solids within the pit and the sidewall soils present immediately beneath the sludge layer. Sludges and semi-solids will be sampled utilizing a coliwasa or bucket sampler capable of obtaining a composite sample representative of the entire depth of the sludge layer at each location. The two (2) sample composites will be combined to represent a single composite of the oil disposal area sludge (Table 2-1).

Sidewall soil samples will be collected at two locations within the oil disposal area and composited as a single sample to characterize soils just beneath adjacent to the sludge/soil interface.

2.2.4 Sampling/Analysis of Drums

Drums present at the surface (Sample Area Nos. 8, 11, 13, and 14) of the site have been divided into distinct groupings based upon their physical location within the LRLF site (Figure 2-1).

Drum contents will be sampled at each of the drum grouping areas of the site at a frequency of 2 representative drum content samples for each group of 10 drums. Determinations will be made at the time of sampling whether to increase the frequency of drum sampling to a greater frequency, as necessary, if drums with varying and readily distinguishable contents are discovered.

The unknown waste from the drum groupings shall receive compatibility screening for purposes of separating them into the following potential classifications:

- Organics.
- Organic peroxides.
- Inorganic acids.
- Inorganic neutrals and bases.
- Oxidizers.
- Inorganic peroxides.
- PCB-containing material.
- Inorganic cyanides.
- Organic chlorides.

The following procedures typically are utilized to determine the compatibility of waste in drums. Each sample will be tested for both solubility and reactivity simultaneously. With the addition of water to a sample aliquot, any reactivity will be noted immediately. If the sample remains stable, its solubility and/or density with respect to the water will be noted. A second aliquot of the sample will be tested in a similar manner using hexane instead of water. Again, the solubility and/or density will be noted visually. Aqueous samples will be checked for pH using a pH meter. Following the reactivity and solubility testing, the sample will be tested for the presence of peroxide and oxidizers in general. The peroxide test will be performed using an indicating test strip and the oxidizer test will be performed using an iodine/starch test. Following these tests, the sample shall be analyzed for cyanides using a chloramine-T/Pyridinebarbituric acid spot test. If the sample is positive, it will be confirmed by use of a cyanide ion selective electrode.

The final testing will consist of a gas chromatographic analysis for both chlorinated solvents and PCBs. These tests will be conducted on a composited group containing 10 samples. If positive results are obtained from the bulked sample, the individual samples that comprised the composited sample will be tested.

The above testing shall be conducted by an analytical laboratory, or a mobile on-site laboratory, if practical. This waste characterization and compatibility screening will then be utilized during subsequent evaluations to determine appropriate management methods for these materials. All sampling and analysis will be conducted in accordance with the Quality Control Procedures outlined in Appendix A.

Drums containing liquids will be sampled with a Coliwasa to the full depth of the liquid layer. Solids and residues in drums will be sampled by hand trowel or similar device. Attention will be given by the sampler(s) to ensure that the entire depth of solids is represented. Any significant layering of drum contents will be denoted.

2.2.5 Surface Sludges

Miscellaneous areas where sludge-like materials are present at the surface of the LRLF site will be sampled in a manner similar as that described for the red barren areas (Section 2.2.1). Samples will be collected utilizing hand shovels or post-hole digger advanced the full depth of the sludge materials. For large surface areas of sludge, additional sample locations will be utilized to form a single representative composite of the sludge surface area.

3.0 ANALYTICAL PROTOCOLS

The Sampling and Analysis Plan of the waste characterization phase of the Interim Remedial Measures Evaluation has been developed for the purpose of determining suitable means for handling and final disposal of various surface specified materials identified herein. Therefore, each of the investigative samples specified in Section 2 of this SAP will be analyzed for standard disposal parameters established to determine hazardous or non-hazardous nature of the materials. These analytical parameters, listed for each waste type are presented on Table 3-1.

TABLE 3-1

LABORATORY ANALYTICAL PARAMETERS
BY WASTE TYPE
LINDEN ROAD LANDFILL
FLINT TOWNSHIP, MI

Parameter	Red Barren Areas (4 Samples)	Wood Blocks (4 Samples)	Oil Disposal Area Sludge and Soil (2 Samples)	Drum Contents (12 to 15 Samples)	Surface Sludges (6 Samples)
Volatile Organics, (TCLP)	X	X	X	X[1]	X[1]
Semi-Volatile Organics, (TCLP)	X	X	X	X[1]	
RCRA Metals, (TCLP)	X		X	X[1]	X[1]
Corrosivity	X		X		X[1]
Ignitability	X		X		X[1]
Reactivity					
Cyanides	X		X		X[1]
Sulfides	X		X		X[1]
Pesticides/PCBs	X	X	X	X[1]	X[1]
Paint Filter Test					
<u>Compatability Screening</u>					
H_2O				X	X
Hexane				X	X
pH				X	X
Peroxides				X	X
Oxidizers				X	X
Halogens				X	X

TCLP Toxic Characteristic Leachate Procedure

[1] Analysis pertains to waste composites resulting from compatability screening only.

Laboratory analytical methods will be conducted in accordance with standards and procedures established by U.S. EPA Manual SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition and the procedures outlined in Appendix I of 40 CFR, Part 268.

In addition, all sampling and analytical activities will be conducted in accordance with the Quality Assurance/Quality Control (QA/QC) procedures outlined in Appendix A.

4.0 SAMPLE HANDLING AND DOCUMENTATION

4.1 SAMPLE CONTAINERS AND PRESERVATIONS

Sample containers will be provided by an approved laboratory. Containers and sample handling protocols will be specific to the analysis and volume requirements of the sample matrix. Table 4-1 summarizes the correct container type, and volume, holding times, and required preservatives.

4.2 SAMPLE NUMBERING SYSTEM AND FIELD LOGS

Each waste characterization sample and QA/QC sample will be given unique sample identification numbers. The sample numbers will be maintained in a field chain-of-custody logbook by the sampling team. Each sample will be identified by a project sample number, consisting of specific components. These components will include:

- A two character project identifier; the identifier for this site will be LR for Linden Road Landfill.
- Sample location code - A four to six character designation that specifies the unique horizontal location of the sample or sample composite area, as outlined in Figure 2-1 sample location designations.

Sampling activities and associated field reconnaissance will be recorded in a field sampling logbook. At a minimum, the following information will be noted:

- Condition of drum (or sampled area).
- Sample location stake or drum identifying number.
- Date and time of sampling.
- Visual character of sampled area.
- Measured area and depth of sampled waste type (for volume determination).
- Physical consistency of sampled material.

TABLE 4-1

SAMPLE QUANTITIES, CONTAINERS AND HANDLING REQUIREMENTS

Analysis	Bottles and Jars	Preservation	Holding Time	Volume of Sample
Volatiles, TCLP and Totals	Two 4-oz. volatile	Iced to 4°C	14 days	Fill completely-no headspace
Semi-Volatiles, TCLP and Totals Pesticides/PCBs	one 8-oz. wide mouth glass jar	Iced to 4°C	7 days until extraction; 40 days after extraction	Fill 3/4 full
RCRA Classification - Corrosivity (pH) - Ignitability (flashpoint) - Metals, TCLP - Reactivity (cyanides/sulfides)	Two 8-oz. wide mouth jars	Iced to 4°C	6 months	Fill 3/4 full
Compatability Screens	One 8-oz. wide mouth jar	Iced to 4°C	6 months	Fill 3/4 full

- Other items pertinent to developing final handling, removal, and disposal of the surface wastes.

4.3 SAMPLE PACKAGING AND SHIPMENT

Sample packaging and shipping procedures are based on U.S. EPA specifications and state and federal Department of Transportation (DOT) regulations. The procedures will vary according to sample concentrations, type of potential contaminant hazards and matrix. The procedures have been established to provide adequate protection of samples and to minimize the potential right to the public. Investigative samples will typically be sent within 48 hours of their field collection. The sample container exteriors will be thoroughly cleaned and properly sealed in preparation of shipment.

4.4 CHAIN-OF-CUSTODY RECORDS

Chain-of-custody documentation will be completed for each sample as outlined in Sections 3.1 and 3.2 of the Appendix A Quality Assurance - Quality Control Plan.

APPENDIX C

SITE HEALTH AND SAFETY PLAN
LINDEN ROAD LANDFILL SITE
FLINT TOWNSHIP, MICHIGAN

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1.0 INTRODUCTION

This section of the Site Health and Safety Plan (SHSP) document defines general applicability and general responsibilities with respect to compliance with Health and Safety programs at the Linden Road Landfill site (Figure 1-1).

1.1 SCOPE AND APPLICABILITY OF THE SITE HEALTH AND SAFETY PLAN

The purpose of this Site Health and Safety Plan is to define the requirements and designate protocols to be followed at the LRLF site during investigation and remediation activities. Applicability extends to all Government employees, contractors, subcontractors, and visitors.

Relevant sections of this plan must be reviewed and an agreement to comply with the requirements must be signed by all personnel prior to entering the Exclusion Zone or Contamination Reduction Zone.

During development of this plan consideration was given to current safety standards as defined by OSHA/NIOSH, health effects data and standards for known contaminants, and by also consulting procedures designed to account for the potential for exposure to unknown substances. Specifically, the following reference sources have been consulted:

__X__ OSHA 29 CFR 1910.120 and 40 CFR

__X__ NIOSH Pocket Guide to Chemical Hazards

__X__ (ACGIH) Threshold Limit Values

1.2 VISITORS

All visitors to the LRLF site who wish to enter the Contamination Reduction Zone or Exclusion Zone will be required to read and verify compliance with the provisions of this SHSP. In addition, visitors will be expected to comply with relevant OSHA requirements such as medical monitoring (Sec. 6.0), training (Sec. 4.0), and respiratory protection (Sec. 5.0). Visitors will also be expected to provide their own protective equipment which complies with OSHA requirements.

In the event that a visitor does not adhere to the provisions of the SHSP, he/she will be requested to leave the work area. All non-conformance incidents will be recorded in the Site Health and Safety log.

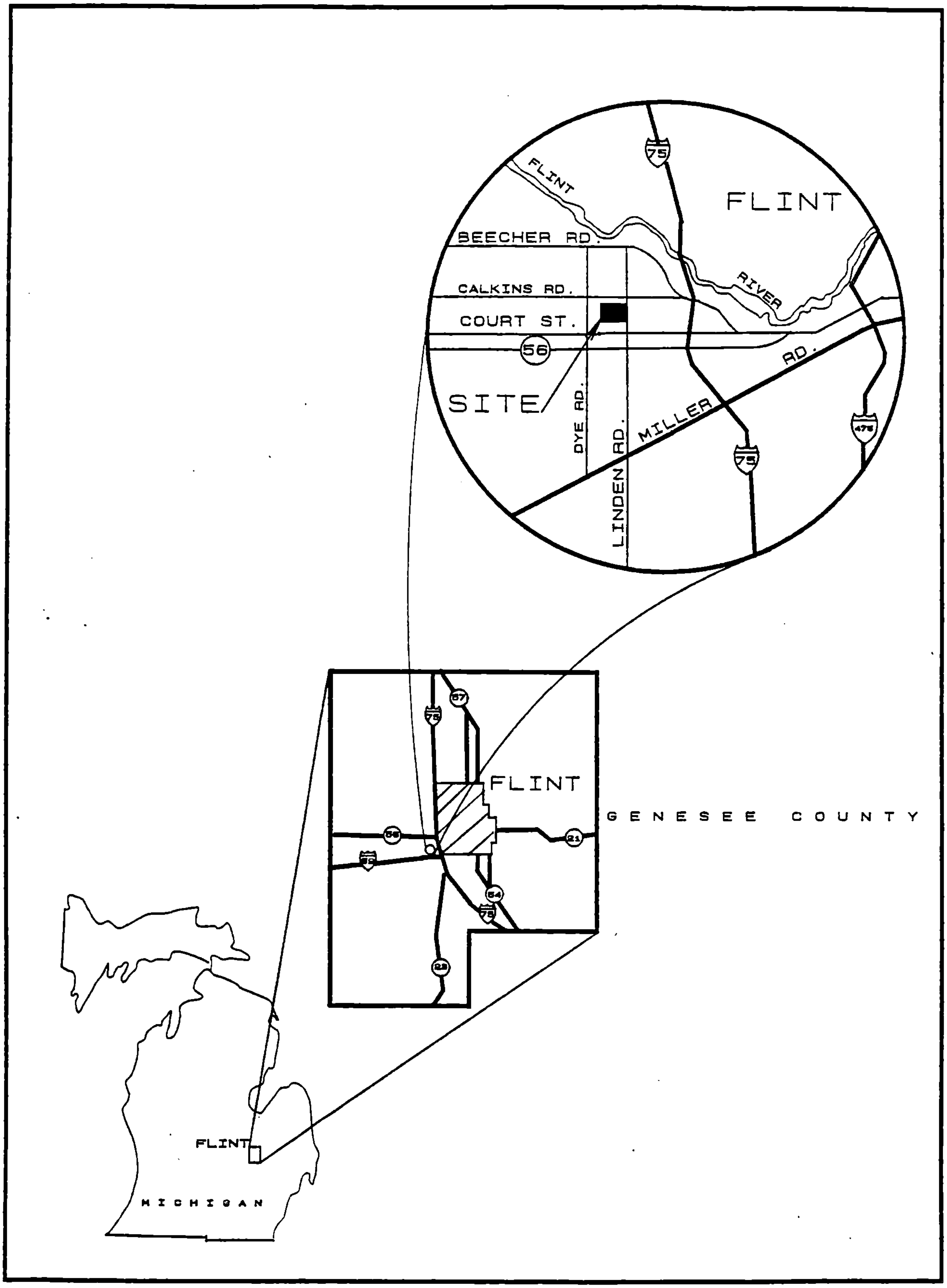


FIGURE 1-1
SITE LOCATION MAP
LINDEN ROAD LANDFILL

2.0 KEY PERSONNEL/IDENTIFICATION OF HEALTH AND SAFETY PERSONNEL

2.1 KEY PERSONNEL

To be assigned.

2.2 SITE SPECIFIC HEALTH AND SAFETY PERSONNEL

The Site Health and Safety Coordinator (SHSC) has total responsibility for ensuring that the provisions of this SHSP are adequate and implemented in the field. Changing field conditions may require decisions to be made concerning adequate protection programs. Therefore, it is vital that personnel assigned as SHSC be experienced and meet the additional training requirements specified by OSHA in 29 CFR 1910.120.

3.0 TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS

3.1 HISTORICAL OVERVIEW OF SITE

This SHSP defines the hazards associated with the LRLF site, and the program to protect personnel from those hazards as identified in previous site work or background information. For a thorough overview of historical information concerning the site see the following documents:

- Phase I Environmental Assessment of Linden Road Landfill, Flint Township, Michigan, February 1990.
- Final Report Phase I Hydrogeological Investigation Linden Road Landfill, Section 17, Flint Township Genesee County, Michigan, 8 January 1980.
- Chevrolet Motor Division Phase II Hydrogeological Investigation Linden Road Landfill - Section 17 Flint Township, Genessee County, Michigan, 18 November 1980.

Linden Road Landfill is a 40-acre parcel in Flint Township, Genesee County, Michigan. It is located on Linden Road one-quarter mile south of Calkins Road and one-half mile north of West Court Street. The surrounding area is either farmland or single family residences with some commercial establishments at nearby major intersections. The topography of the area is generally flat with some gently sloping hills typical of glacial plains.

According to historical information, the site had originally been mined for gravel prior to the 1930s, and reportedly was excavated to a depth of approximately 40 feet. For an undetermined number of years preceding 1931, a rubbish incinerator occupied the site. The Chevrolet Division of GM purchased the 40-acre property in 1931. The GM-Chevrolet Division used the site as a general refuse landfill from 1931 until about 1969. The refuse reportedly consisted of construction debris, plaster, buffing and grinding wheels, buffing and grinding refuse, metallic chips, and potentially other process wastes.

3.2 TASK BY TASK RISK ANALYSIS

The evaluation of hazards is based upon the knowledge of site background presented in Section 3.1, and anticipated risks posed by the specific operation. There is no evidence suggesting the presence of Radioactive Materials at this site; however, activities will be surveyed with radiological monitoring equipment in compliance with 29 CFR 1910.120.

The following subsections describe each task/operation in terms of the specific hazards associated with it. Also identified are the protective measures to be implemented during completion of those operations.

Tables 3-1 and 3-2 provide a summary of hazards and protective measures planned for each task at the LRLF site.

3.2.1 Surface Waste Sampling

This task will be performed during the Interim Remedial Measures Evaluation Phase, and will consist of collecting and compositing samples from several areas containing discolored soils and wood blocks, an oil disposal area, surficial drum sludges and other miscellaneous surface waste materials. Prior to and during sampling, air monitoring will be performed using an HNu (or OVA), a CGI and a radiation meter. Sampling activities will be conducted in level C protective equipment which may be modified to level D based on actual conditions at the respective locations.

3.2.2 Surface Waste and Debris Removal and Disposal

This task is anticipated to consist of removal, transportation, and off-site disposal of the materials present at the oil disposal area, the drums containing various wastes and residues, and the fragmented, empty and crushed drums, the miscellaneous surface debris and scrap metals, wood, and plastics. The waste residue, and debris removal will be performed using Level B protection, with a downgrade contingency to Level C or Level D. Storage and transportation activities will be performed in Level D. All removal and sampling will be performed under the direction of the field team leader. Air monitoring will be performed using a CGI, HNu (or OVA) and Radiation survey meter during these activities on the excavated areas and breathing zones. Air monitoring results will be documented in the field. Any changes in levels of protection will be based on these results in consultation with the SHSC.

3.2.3 Surface Waste Consolidation, Containment, and Staging

This task is planned in the event that waste characterization data determines the presence of waste materials requiring special handling, treatment, or disposal due to their chemical composition. Under this task, such materials will be identified, consolidated as appropriate, recontainerized if necessary, staged and stored securely on-site for subsequent management during the final remedial measures phase of the site work. All consolidation, containment, and staging will be done in Level D protection with upgrade to Level C or B contingency. The field team leader will implement HNu or OVA monitoring during these activities on the excavated areas and breathing zones and will be responsible for logging the monitoring results and for consulting with the SHSC

TABLE 3-1

TASK ANALYSIS
CHEMICAL HAZARDS OF CONCERN
Linden Road Landfill

Property/Task	Contaminants of Concern	PEL/TLV/IDLH (ppm)	Maximum Concentration On-Site (ppm)/Matrix	Route of Exposure	Monitoring Device
A. All intrusive tasks (test pits, soil borings, and Groundwater Sampling Pond Surface Water	Lead	$0.05^b/0.15^b$/NA	NA	Inh/Ing	NA
	Mercury	$0.1^b/0.05^b/28^b$	NA	Inh/Ing	NA
	Chromium	$1^b/0.5^b/500^b$	NA	Inh/Ing	NA
	Barium	$0.5^b/0.5^b/250^b$	NA	Inh/Ing	NA
	Cadmium	$0.2^b/0.05^b$/Ca*	NA	Inh/Ing	NA
	PCB		NA	Inh/Ing	NA
	Methane	350^b/500/10,000	NA	Inh	OVA
	Arsenic	10ug/m^3/Ca*	NA	Inh/Ing	NA
	Nickel	1 mg/m^3/Ca*	NA	Inh/Ing	NA
	Zinc	5 mg/m^3	NA	Inh/Ing	NA
	Phenols	20^b/5/250	NA	Inh/Con	NA
	Petroleum Products	350^b/500/10,000	NA	Inh/Ing	HNu/OVA
	Trans-1,2-dichloroethene	790^b/200/4,000	NA	Inh/Ing	HNu/OVA
	Trichloroethene	100/50/Ca*	NA	Inh/Ing	HNu/OVA
	Methylene Chloride	500/100/Ca*	NA	Inh/Ing	HNu/OVA
	N-nitrosodiphenylamine	Ca*	NA	Inh/Ing	HNu/OVA
B. Sampling Equipment Decontamination	Isopropanol	400/400/12,000	NA	Inh/Con	HNu/OVA

* - Human carcinogen, no IDLH listed.
** - Potential carcinogen, no IDLH listed.
b - Units are mg/m^3.

TABLE 3-2

TASK ANALYSIS
PHYSICAL HAZARDS OF CONCERN
Linden Road Landfill

Property/Task	Hazard	Description	Prevention/Monitoring Technique
A. Test Pits Surface Waste and Debris Consolidation, Containment, Staging, Removal, and Disposal	Backhoe or Truck	Pinch points on backhoe, equipment and tools	Team excavating with hard hats, safety boots, and other safety equipment.
	Slip/Trip/Fall	Ice, mud or wet pavement	Keep work area clear of ice, mud, and debris.
	Cold Stress	Field work during winter	Protective, layered clothing and periodic indoor rest.
	Heat Stress	Field work during summer	Plenty of fluid intake at periodic cool down breaks.
	Utilities	Excavation near overhead or underground utilities	Locate all utility locations before excavating.
	Noise	Excessive noise at backhoe during excavation activities	Hearing protection and/or limit time at drill rig during loud work activities.
	Excavation	Fall into pit	Keep 3 feet from edge of pit.
B. Drilling and Sampling of Soil Borings (includes well installation)	Drill Rig	Pinch points on drill rig, equipment and tools.	Team drilling with hard hats, safety boots, and other safety equipment.
	Slip/Trip/Fall	Ice, mud or wet pavement	Keep work area clear of ice, muud, and debris.
	Cold Stress	Field work during winter	Protective, layered clothing and periodic indoor rest.
	Heat Stress	Field work during summer	Plenty of fluid intake at periodic cool down breaks.
	Utilities	Drilling near overhead or underground utilities.	Locate all utility locations before drilling.
	Noise	Excessive noise at rig during drilling activities	Hearing protection and/or limit time at drill rig during loud work activities.
C. Groundwater Sampling Geophysical and Soil Gas Survey	Slip/Trip/Fall	Ice, mud or wet pavement	Keep work area clear of ice, mud, and debris.
	Cold Stress	Field work during winter	Protective, layered clothing and periodic indoor rest.

TABLE 3-2 (Cont.)

TASK ANALYSIS
PHYSICAL HAZARDS OF CONCERN
Linden Road Landfill

Property/Task	Hazard	Description	Prevention/Monitoring Technique
	Heat Stress	Field work during summer	Plenty of fluid intake at periodic cool down breaks.
D. Surface Water Sampling	Slip/Trip/Fall	Slippery pond banks	Extreme caution when collecting water samples.
	Cold stress	Field work during winter	Protective, layered clothing and periodic indoor rest.
	Heat stress	Field work during summer	Plenty of fluid intake at periodic cool down breaks.

before determining any changes in levels of protection.

3.2.4 Geophysical Surveys

All geophysical surveys will be conducted in Level D as no intrusive activity is involved in this survey. Two technicians will perform the geophysical survey. No HNu or OVA monitoring will be done during the survey. The potential chemical and physical risks are presented in Tables 3-1 and 3-2.

3.2.5 Soil Gas Surveys

Soil gas sampling will be performed at a maximum of 250 locations throughout LRLF. These probes will be set as described in the Sampling and Analysis Plan. The probes will be installed and sampled by a geologist and field technician in Level D protection with a Level C contingency. The geologist will perform CGI, HNu (or OVA), and radiation monitoring and will be responsible for logging the monitoring results and for consulting with the SHSC before determining any changes in levels of protection.

If significant readings are recorded by the HNu, samples may be collected at selected points using Tedlar bags. The Tedlar bags will be shipped to the laboratory for VOC analysis. Such quantitative analysis may guide in planning safety measures during subsequent intrusive activities planned at the site.

3.2.6 Test Pit Excavations

A maximum of 25 test pits will be excavated to depths (up to 15 feet) within LRLF. Samples will be collected from the soils excavated from the pits. No personnel will enter the excavated pits. All sampling will be done from soils excavated from the pits. The test pits will be excavated using a trackhoe with an operator in the cab, and a helper assisting in directions. A geologist and field technician will provide supervision and oversight, and will document all observations and sampling activities. Because there is some uncertainty of the exact of the chemical hazards, the test pits will be excavated in Level B, with a contingency to downgrade to Level C protection. The geologist will perform CGI, HNu (or OVA), and radiation monitoring at all test pits and breathing zones during excavations will be responsible for logging the monitoring results and for consulting with the SHSC before determining any changes in levels of protection.

3.2.7 Monitor Well and Piezometer Drilling/Split-Spoon Sampling

A maximum of 10 monitoring wells and two piezometers will be installed at various locations around and within LRLF. Split-spoon sampling will be conducted during monitoring well drilling. One or two drill rigs, either an all-terrain vehicle (ATV) or truck-mounted rig, will be used to install the wells and piezometers. Each drilling team will consist of two subcontractor drilling personnel, one geologist who will provide supervision and oversight, and if necessary, a field technician who will assist in all drilling and sampling activities. All drilling activities will be performed using a Level D protection with a Level C contingency. The geologist will perform CGI, HNu (or OVA), and radiation monitoring at all boreholes and breathing zones during drilling and will be responsible for logging the monitoring results and for consulting with the SHSC before determining any changes in levels of protection. The potential chemical and physical risks are presented in Tables 3-1 and 3-2.

3.2.8 Soil Boring and Auger Probe Drilling and Sampling

A maximum of 6 soil borings and 20 auger probes, to varying depths, will be drilled within LRLF. Split-spoon samples will be collected at various depths during the drilling of the soil borings. The subcontractor drilling team and the geologist will perform the same tasks as described for the monitoring well drilling (Subsection 3.2.6), including the same protocols for protection levels and air monitoring. The potential chemical and physical risks by task are presented in Tables 3-1 and 3-2.

3.2.9 Groundwater Sampling

Subsequent to well installation and well development, groundwater samples will be collected from each well. Two field personnel will perform the sampling. HNu or OVA monitoring at the well head and breathing zone will be performed prior to any sampling collection and the results will be documented. Detailed sampling procedures are presented in the Sampling and Analysis Plan. Level D protection will be utilized, unless HNu or OVA monitoring determines that an upgrade to Level C is warranted. The potential chemical and physical risks are presented in Tables 3-1 and 3-2.

3.2.10 Surface Water Sampling

Surface water samples will be collected from five ponds within LRLF. The surface water samples will be collected from the banks of the ponds. Sampling details are presented in the Sampling and Analysis Plan. The potential chemical and physical hazards are presented in Tables 3-1 and 3-2.

4.0 PERSONNEL TRAINING REQUIREMENTS

Consistent with OSHA's 29 CFR 1910.120 regulations covering Hazardous Waste Operations and Emergency Response, all site personnel and visitors to the decontamination and exclusion zone will be trained in accordance with the standard's requirements. At a minimum, all personnel will be trained to recognize the hazards on-site, the provisions of this SHSP, emergency procedures and the responsible personnel on-site.

4.1 PRE-ASSIGNMENT AND ANNUAL REFRESHER TRAINING

Prior to arrival on-site, each employer will be responsible for certifying that his/her employees meet the requirements of a 40 hour preassignment training. Topics included in that training should cover generalities behind hazard recognition, respiratory protective equipment use, and site operations. Each WESTON and subcontractor employee will provide a document certifying dates of 40 hours training attendance and latest annual refresher before the commencement of site work.

4.2 SITE SUPERVISORS TRAINING

Consistent with OSHA 29 CFR 1910.120 paragraph e8, individuals designated as site supervisors require an additional 8 hours of training. The specific training requirements for supervisors include principles of supervision, and elements of Health and Safety decision-making.

The following individuals are identified as site supervisors:

Name	Title/Responsibility
To be assigned.	

4.3 TRAINING AND BRIEFING TOPICS

The following items will be covered at the site specific training meeting, daily or periodically. All on-site training meetings and safety briefings held at the LRLF site will be documented in the field log book.

Site Specific Training Meeting	Daily	Periodically	
X		X	Site characterization and analysis, Sec. 3.0; 29 CFR 1910.120 i.

Site Specific Training Meeting	Daily	Periodically	
X		X	Physical hazards, Table 3-2
X		X	Chemical hazards, Table 3-1
X		X	Site control, Sec. 8.0; 29 CFR 1910.120 d.
X		X	Training requirements Sec. 4.0; 29 CFR 1910.120 e.
X		X	Medical surveillance Sec. 6.0; 29 CFR 1910.120 f.
X		X	Engineering controls and work practices, Sec. 8.5; 29 CFR 1910.120 g.
X		X	Forklift
X		X	Backhoe
X		X	Equipment
X		X	Tools
X		X	Overhead and underground utilities
X		X	Pressurized air cylinders
X		X	Personnel protective equipment, Sec. 5.0; 29 CFR 1910.120 g; 29 CFR 1910.134.
X		X	Level B
X		X	Level C
X		X	Level D
X		X	Respiratory protection Sec. 5.8; 29 CFR 1910.120g; Z88.2-1980.

Site Specific Training Meeting	Daily	Period-ically	
X		X	Monitoring, Sec. 7.0; 29 CFR 1910.120 h.
X		X	Decontamination, Sec. 9.0; 29 CFR 1910.120 k.
X		X	Emergency response, Sec. 10.0; 29 CFR 1910.120 l.
X		X	Elements of an emergency response, Sec. 10.0; 29 CFR 1910.120 l.
X	X		Procedures for handling site emergency incidents, Sec. 10.0; 29 CFR 1910.120 l.
X		X	Off-site emergency response, 29 CFR 1910.120 l.
X		X	Handling drums and containers, 29 CFR 1910.120 j.
X		X	Opening drums and containers. Electrical material handling equipment.
X		X	Radioactive waste.
X		X	Shock sensitive waste.
X		X	Laboratory waste packs.
X		X	Sampling drums and containers.
X		X	Shipping and tansport, 49 CFR 172.101.
			Tank and vault procedures.
X		X	Illumination, 29 CFR 1910.120 m.
X		X	Sanitation, 29 CFR 1910. 120n.

5.0 PERSONAL PROTECTIVE EQUIPMENT TO BE USED

This section describes the general requirements of the EPA designated Levels of Protection (A-D), and the specific levels of protection required for each task at the LRLF site. It is assumed for purposes of the LRLF project that no Level A protection will be required, but if a change in site conditions warrants this level of protection, on-site work will cease until the scope of work is re-assessed.

5.1 LEVELS OF PROTECTION

Personnel wear protective equipment when response activities involve known or suspected atmospheric contamination, when vapors, gases, or particulates may be generated by site activities, or when direct contact with skin-affecting substances may occur. Full facepiece respirators protect lungs, gastrointestinal tract, and eyes against airborne toxicants. Chemical-resistant clothing protects the skin from contact with skin-destructive and absorbable chemicals.

The specific levels of protection and necessary components for each have been divided into four categories according to the degrees of protection afforded:

Level A:	Should be worn when the highest level of respiratory, skin, and eye protection is needed.
Level B:	Should be worn when the highest level of respiratory protection is needed, but a lesser level of skin protection. Level B is the primary level of choice when encountering unknown environments.
Level C:	Should be worn when the criteria for using air-purifying respirators are met, and a lesser level of skin protection is needed.
Level D:	Should be worn only as a work uniform and not on any site with respiratory or skin hazards. It provides minimal protection against chemical hazards.

Modifications of these levels are permitted, and routinely employed during site work activities to maximize efficiency. For example, Level C respiratory protection and Level D skin protection may be required for a given task. Likewise the type of chemical protective ensemble (i.e., material, format) will depend upon contaminants, degrees of contact, etc. The Level of Protection selected is based upon the following:

- Type and measured concentration of the chemical substance in the ambient atmosphere and its toxicity.
- Potential for exposure to substances in air, splashes of liquids, or other direct contact with material due to work being done.
- Knowledge of chemicals disposed along with properties such as toxicity, route of exposure, etc.

IN SITUATIONS WHERE THE TYPE OF CHEMICAL, CONCENTRATION, AND POSSIBILITIES OF CONTACT ARE NOT KNOWN, THE APPROPRIATE LEVEL OF PROTECTION WILL BE SELECTED BASED ON PROFESSIONAL EXPERIENCE AND JUDGMENT UNTIL THE HAZARDS CAN BE BETTER IDENTIFIED.

5.2 LEVEL A PERSONNEL PROTECTIVE EQUIPMENT:

- Supplied-air respirator approved by the Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH). Respirators may be positive pressure-demand, self-contained breathing apparatus (SCBA), or positive pressure-demand, airline respirator (with escape bottle for Immediately Dangerous to Life and Health (IDLH) or potential for IDLH atmosphere)
- Fully encapsulating chemical-resistant suit
- Coveralls
    - Long cotton underwear
    - Gloves (inner), chemical-resistant
- Boots, chemical-resistant, steel toe and hank (depending on suit construction, worn over or under suit boot)
- Hard hat (under suit)

- Disposable gloves and boot covers (worn over fully encapsulating suit)

- Cooling unit

  - 2-way radio communications (intrinsically safe)

5.3 LEVEL B PERSONNEL PROTECTIVE EQUIPMENT:

- Supplied-air respirator (MSHA/NIOSH approved). Respirators may be positive pressure-demand, self-contained breathing apparatus (SCBA), or positive pressure-demand, airline respirator (with escape bottle for IDLH or potential for IDLH atmosphere)

- Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one or two-piece chemical-splash suit; disposable chemical-resistant, one-piece suits)

- Long cotton underwear

- Coveralls

- Gloves (outer), chemical-resistant

- Gloves (inner), chemical-resistant

- Boots (outer), chemical-resistant, steel toe and shank

- Boot covers (outer), chemical-resistant (disposable)

- Hard hat (face shield)

- 2-way radio communications (intrinsically safe)

5.4 LEVEL C PERSONNEL PROTECTIVE EQUIPMENT:

- Air-purifying respirator, full-face, cartridge-equipped (MSHA/NIOSH approved)

- Chemical-resistant clothing (coveralls; hooded, one-piece or two-piece chemical splash suit; chemical-resistant hood and apron; disposable chemical-resistant coveralls)

- Coveralls
- Long cotton underwear
- Gloves (outer), chemical-resistant
- Gloves (inner), chemical-resistant
- Boots (outer), chemical-resistant, steel toe and shank
- Boot covers (outer), chemical-resistant (disposable)
- Hard hat (face shield)
- Escape mask
- 2-way radio communications (intrinsically safe)

5.5 LEVEL D PERSONNEL PROTECTIVE EQUIPMENT:

- Coveralls
- Gloves
- Boots/shoes, leather or chemical-resistant, steel toe and shank
- Safety glasses
- Hard hat

5.6 REASSESSMENT OF PROTECTION PROGRAM

The Level of Protection provided by PPE selection will be upgraded or downgraded based upon a change in site conditions or findings of investigations.

When a significant change occurs, the hazards will be reassessed. Some indicators of the need for reassessment are:

- Commencement of a new work phase, such as the start of drum sampling or work that begins on a different portion of the site.
- Change in job tasks during a work phase.
- Change of wind direction/season/weather.

- Contaminants other than those previously identified are being handled.

- Change in ambient levels of contaminants.

- Change in work scope which effects the degrees of contact with contaminants.

5.7 SPECIFIC LEVELS OF PROTECTION PLANNED FOR THE LRLF SITE

The following levels of protection will be utilized during activities at the LRLF site (this includes the contingency level of protection):

/__/ Level A: /__/ modified
/X_/ Level B: /__/ modified
/X_/ Level C: /__/ modified
/X_/ Level D: /__/ modified

Table 5-1 presents the activity with the level of protection planned and special comments/additions to the personal protective ensemble.

Table 5-2 lists the specific components of each Level of Protection planned for activities at the LRLF site.

5.8 CLEANING, INSPECTION AND STORAGE OF PPE

All PPE used in the field should be stored in a clean, secure area. Coveralls, Tyveks and gloves should remain in their packaging material until their use. After use, coveralls should be stored in an area away from the unused PPE, and all disposable PPE shall be contained in a waste container.

5.8.1 Cleaning and Disinfecting Air Purifying Respirators (APR)

APRs in routine use should be cleaned and disinfected at least daily. Where respirators are used only occasionally, or when they are in storage, the cleaning interval is weekly or monthly, as appropriate.

5.8.1.1 Daily Cleaning Routine

The steps to be followed for cleaning and disinfecting daily are as follows:

- Respirator Disassembly. Respirators are taken to a clean location where the filters, cartridges or

TABLE 5-1

LEVELS OF PROTECTION PLANNED FOR ACTIVITIES AT THE LRLF SITE

Task/Property	Level of Protection	Comments/Additions
1. Surface Waste Sampling	C	Contingency Level D
2. Surface waste and debris removal and disposal	B	Contingency Level C or D
3. Surface waste consolidation, containment, and staging	D	Contingency Level C or B
4. Geophysical surveys	D	
5. Soil gas survey	D	Contingency Level C
6. Test pit excavations	B	Contingency Level C or D
7. Monitor well/piezometer	D	Contingency Level C
8. Soil boring and auger probe drilling and sampling	D	Contingency Level C
9. Groundwater sampling	D	Contingency Level C
10. Pond surface water and sediment sampling	D	Contingency Level C

TABLE 5-2

SPECIFIC COMPONENTS OF LEVELS OF PROTECTION PLANNED FOR THE LINDEN ROAD LANDFILL

/__/ Level A
Tasks:

/X/ Level B
Tasks:

All tasks at the Linden Road Landfill site required at Level B protection

o Surface waste and debris removal and disposal
o Test pit excavations

Protective Equipment:

o MSA Ultrlight self-contained breathing apparatus (SCBA)
o Saranex coveralls
o Long cotton underwear
o Cotton and surgical inner gloves
o Silver Shield or Nitrile outer gloves
o Work gloves
o Steel toe boots
o Nitrile pull-over boots
o Hard hat

/X/ Level C
Tasks:

1. All Level D tasks at the Linden Road Landfill site requiring a Level C contingency as determined by HNu or OVA monitoring.

Protective Equipment:

o Full-face APR w/ GMC-H cartridges
o Saranex coveralls
o Long cotton underwear
o Cotton and surgical inner gloves
o Silver Shield or Nitrile outer gloves
o Work gloves
o Steel toe boots
o Nitrile pull-over boots
o Hard hat

/X/ Level D
Tasks:

The following tasks at the Linden Road Landfill site:

o Surface waste consolidation, containment, and staging
o Geophysical surveys
o Soil gas survey
o Groundwater sampling at all well locations
o Pond surface water and sediment sampling
o Monitor well and soil boring drilling and sampling

Protective Equipment:

o Coveralls
o Work gloves
o Steel toe boots
o Hard hat

canisters are removed, damaged to prevent accidental reuse, and discarded. For thorough cleaning, the inhalation and exhalation valves, speaking diaphragm, and any hoses are removed.

- Cleaning. In most instances, the cleaning and disinfecting solution provided by the manufacturer is used, and is dissolved in warm water in an appropriate tub. Using gloves, the respirator is placed in the tub and swirled for a few moments. A soft brush may be used to facilitate cleaning.

- At a minimum, the mask should be wiped with disinfectant wipes (benzoalkaloid or isopropyl alcohol), and allowed to air dry in a clean area.

- Rinsing. The cleaned and disinfected respirators are rinsed thoroughly in water to remove all traces of detergent and disinfectant. This is very important for preventing dermatitis.

- Drying. The respirators may be allowed to dry in room air on a clean surface. They may also be hung upside down like drying clothes, but care must be taken not to damage or distort the facepieces.

- Reassembly and Inspection. The clean, dry respirator facepieces should be resembled and inspected in an area separate from the disassembly area to avoid contamination. Special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve, and can cause valve leakage or sticking.

5.8.2 <u>APR Inspection and Checkout</u>

1. Visually inspect the entire unit for any obvious damages, defects, or deteriorated rubber.

2. Make sure that the facepiece harness is not damaged. The serrated portion of the harness can fragment which will prevent proper face seal adjustment.

3. Inspect lens for damage and proper seal in facepiece.

4. Exhalation Valve - pull off plastic cover and check valve

for debris or for tears in the neoprene valve (which could cause leakage).

5. Inhalation Valves (two) - screw off cartridges/ canisters and visually inspect neoprene valves for tears. Make sure that the inhalation valves and cartridge receptacle gaskets are in place.

6. Make sure a protective cover lens is attached to the lens.

7. Make sure the speaking diaphragm retainer ring is hand tight.

8. Make sure that you have the correct cartridge.

9. Don and perform negative pressure test.

5.8.3 Storage of Air Purifying Respirators

OSHA requires that respirators be stored to protect against:

- Dust
- Sunlight
- Heat
- Extreme cold
- Excessive moisture
- Damaging chemicals
- Mechanical damage

Damage and contamination of respirators may take place if they are stored in dirty or questionable areas.

5.8.4 Cleaning and Disinfecting Self-Contained Breathing Apparatus (SCBA)

Cleaning procedures for Self-Contained Breathing Apparatus (SCBA) facepieces are identical to those for Ultratwin APRs. The backpiece is cleaned with cleaning solution and a brush. Following cleaning, the facepiece is combined with the regulator and an operational check performed.

5.8.5 SCBA Inspection & Checkout

Monthly Inspection:

1. Check cylinder label for current hydrostatic test date.
2. Inspect cylinder for large dents or gouges.
3. Inspect cylinder gauge for damage.

4. Complete routine inspection.
5. Fill out the appropriate records with results and recommendations.

Routine Inspection: Perform immediately prior to donning or after cleaning.

1. Before proceeding, check that the:

   - High-pressure hose connector is tight on cylinder fitting.
   - By-pass valve is closed.
   - Mainline valve is closed.
   - Regulator outlet is not covered or obstructed.

2. Backpack and harness assembly:

   - Visually inspect straps for wear, damage, and completeness.
   - Check wear and function of belt.
   - Check backplate and cylinder holder for damage.

3. Cylinder and high pressure hose assembly:

   - Check cylinder to assure that it is firmly attached to backplate.
   - Open cylinder valve; listen or feel for leakage around packing and hose connection.
   - Check high pressure hose for damage or leaks.

4. Regulator:

   - Cover regulator outlet with palm of hand.
   - Open mainline valve.
   - Note stoppage of air flow after positive pressure builds.
   - Close mainline valve.
   - Remove hand from regulator outlet.
   - Open by-pass valve slowly to assure proper function.
   - Close by-pass valve.
   - Open mainline valve.
   - Note pressure reading on regulator gauge.
   - Close cylinder valve while keeping hand over regulator outlet.
   - Slowly remove hand from outlet and allow air to flow.
   - Note pressure when low-pressure warning alarm sounds; it should be between 550-650 psi.

- Remove hand from regulator outlet.
- Close mainline valve.
- Check regulator for leaks by blowing air into regulator for 5-10 seconds. Draw air from outlet for 5-10 seconds. If a positive pressure or vacuum cannot be maintained there is a leak. DO NOT USE SCBA.

5. Facepiece and corrugated breathing hose:

   - Inspect hand harness and facepiece for damage, serrations, and deteriorated rubber.
   - Inspect lens for damage and proper seal in facepiece. Inspect exhalation valve for damage and dirt build-up.
   - Stretch breathing hose and carefully inspect for holes and deterioration.
   - Inspect connector for damage and presence of washer.
   - Perform negative pressure test with facepiece donned.

6. Storage:

   - Refill cylinder to 2216 psi.
   - Close cylinder valve.
   - Tightly connect high pressure hose to cylinder.
   - Bleed pressure from high pressure hose by opening mainline valve.
   - Close by-pass valve.
   - Close mainline valve.
   - Fully extend all straps.
   - Store facepiece in a clean plastic bag for protection.

6.0 MEDICAL SURVEILLANCE REQUIREMENTS

Medical monitoring programs are designed to track the physical condition of employees on a regular basis as well as survey pre-employment or baseline conditions prior to potential exposures. The medical surveillance program is a part of the Contractor's Health and Safety program.

6.1 BASELINE OR PRE-ASSIGNMENT MONITORING

Prior to being assigned to a hazardous or a potentially hazardous activity involving exposure to toxic materials, each employee will receive a pre-assignment or baseline physical. The content of the physical is to be determined by a medical consultant. As suggested by NIOSH/OSHA/USCG/EPA's "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities", the minimum medical monitoring requirements for work at the LRLF site are as follows:

- Complete medical and work histories.
- Physical examination.
- Pulmonary function tests (FVC and FEV1).
- Chest X-ray.
- EKG.
- Eye examination and visual acuity.
- Audiometry.
- Urinalysis.
- Blood chemistry, including hematology, serum analyses, and heavy metals toxicology.

The pre-assignment physical will categorize employees as fit-for-duty and able to wear respiratory protection.

6.2 PERIODIC MONITORING

In addition to a baseline physical, all employees require an updated physical within the last 12 months. Again, WESTON's medical consultant will prescribe an adequate medical which fulfills OSHA 29 CFR 1910.120 requirements.

All personnel working in contaminated or potentially contaminated areas at the LRLF site will verify currency (within 12 months) with respect to medical monitoring and respirator fit test.

6.3 SITE SPECIFIC MEDICAL MONITORING

For activities at the LRLF site, no specific tests will be required prior to individuals entering the Exclusion Zone or Contamination Reduction Zone.

6.4 EXPOSURE/INJURY MEDICAL SUPPORT

This plan requires a number of forms of exposure/injury/ medical support, including:

- Requiring that at least one person on-site must be currently certified in First Aid and CPR. See Contingency Plans for action to be taken relative to an injury or exposure.
- Identifying a local medical emergency facility capable of treating the types of injuries or exposures which could occur on this site. See Section 10.6 for identification.
- Having on retainer a medical emergency consultant who is on call 24 hours a day, seven days a week to provide advice on chemical exposure emergencies. Such services may be accessed by any employee for assistance or direction of medical treatment simply by calling the Emergency Agency Contact Number.
- All Emergency Agency Contact Telephone numbers will be prominently displayed on-site (near every telephone if available) along with the identification of the Local Medical Emergency Facility with a map and directions on how to get there. If telephones are not available on-site, every site person will be shown the location of the Emergency Numbers and information.
- During the process of reviewing all Health and Safety Plans, a review of chemical, biological, and physical hazards present is made. Where additional testing is indicated by references or knowledge of toxicology, the Medical Consultant is contacted for appropriate action.
- In the case of the LRLF site, there is no anticipated need for additional testing.
- All incidents involving injury, exposure, or the potential for either will be reported to the Site

Health and Safety coordinator , verbally, as soon as possible, but no later than 24 hours after the incident. Corrective action to remedy unsafe conditions or activities will begin immediately.

7.0 FREQUENCY AND TYPES OF AIR MONITORING/PERSONNEL SAMPLING

This section explains the general concepts of an air monitoring program and specifies the surveillance activities that will take place during project completion at the LRLF site.

The purpose of air monitoring is to identify and quantify airborne contaminants in order to verify and determine the level of worker protection needed. Initial screening for identification is often qualitative, i.e., the contaminant, or the class to which it belongs, is demonstrated to be present but the determination of its concentration (quantification) must await subsequent testing. Two principal approaches are available for identifying and/or quantifying airborne contaminants:

- o The on-site use of direct-reading instruments.
- o Laboratory analysis of air samples obtained by gas sampling bag, collection media (i.e., filter, sorbent), and/or wet-contaminant collection methods.

7.1 DIRECT-READING MONITORING INSTRUMENTS

Unlike air sampling devices, which are used to collect samples for subsequent analysis in a laboratory, direct-reading instruments provide information at the time of sampling, enabling rapid decision-making. Data obtained from the real-time monitors are used to assure proper selection of personnel protection equipment, engineering controls, and work practices. Overall, the instruments provide the user the capability to determine if site personnel are being exposed to concentrations which exceed exposure limits or action levels for specific hazardous materials.

Of significant importance, especially during initial entries, is the potential for Immediately Dangerous to Life and Health (IDLH) conditions or oxygen deficient (less than 16% oxygen) atmospheres. Real-time monitors can be useful in identifying any IDLH conditions, toxic levels of airborne contaminants, flammable atmospheres, or radioactive hazards. Periodic monitoring of conditions is critical especially if exposures have increased since initial monitoring or if new site activities have begun.

Table 7-1, excerpted from "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," provide

TABLE 7-1

DIRECT-READING INSTRUMENTS FOR GENERAL SURVEY

Instrument	Hazard Monitored	Application	Detection Method	General Care and Maintenance	Typical Operating Times
Combustible Gas Indicator (CGI) (see Appendix B)	Combustible gases and vapors.	Measures the concentration of a combustible gas or vapor.	A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured.	Recharge or replace battery.	Can be used for the combustible gas or vapor.
Flame Ionization Detector (FID) with Gas Chromatography Option. Example: Foxboro OVA	Many organic gases and vapors.	In survey mode, detects the total concentrations of many organic gases and vapors. In gas chromatography (GC) mode identifies and measures specific compounds. In survey mode, all the organic compounds are ionized and detected at the same time. In GC mode, volatile species are separated.	Gases are ionized in a flame. a current is produced in proportion to the number of carbon atoms present.	Recharge or replace battery. Monitor fuel and/or combustion air supply gauges. Perform routine maintenance as described in the manual.	8 hours; 3 hours with strip chart recorder.
Radiation Survey Instrument (see Appendix C)	Alpha, Beta Gamma Radiation depending upon probe used	Environmental radiation monitor	Ionization detector	Check for leaks. Must be calibrated annually at a specialized facililty.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.
Portable Infrared (IR) Spectrophotometer	Many gases and vapors.	Measures concentration of many gases and vapors in air. Designed to quantify one- or two-component mixtures.	Passes different frequencies of IR through the sample. The frequencies absorbed are specific for each compound.	As specified by manufacturer.	

TABLE 7-1 (Continued)

DIRECT-READING INSTRUMENTS FOR GENERAL SURVEY

Instrument	Hazard Monitored	Application	Detection Method	General Care and Maintenance	Typical Operating Times
Ultraviolet (UV) Photoionization Detector (PID) Example: HNu (see Appendix A)	Many organic and some inorganic gases and vapors.	Detects total concentrations of many organic and inorganic gases and vapors. Some identification of compounds is possible if more than one probe is used.	Ionizes molecules using UV radiation; produces current proportional to the number of ions.	Recharge or replace battery. Regularly clean and and maintain the instrument and accessories.	10 hours; 5 hours with strip chart recorder.
Direct-reading Colorimetric Indicator Tube	Specific gases and vapors.	Measures concentrations of specific gases and vapors.	The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compounds compounds concentrations.	Does not use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate prior to use to maintain shelf life of about 2 years. Check expiration date of tubes. Calibrate pump volume at least quarterly. Avoid rough handling which may cause channeling.	

TABLE 7-1 (Continued)

DIRECT-READING INSTRUMENTS FOR GENERAL SURVEY

Instrument	Hazard Monitored	Application	Detection Method	General Care and Maintenance	Typical Operating Times
Oxygen Meter	Oxygen (O_2)	Measures the percentage of of O_2 in the air.	Uses the electrochemical sensor to measure the partial pressure of O_2 in the air and converts that reading to O_2 concentration.	Replace detector cell according to manufacturer's recommendations. Rechare or replace batteries prior to expiration interval. If the ambient air is more than 0.5% CO_2, replace detector cell frequently.	8 to 12 hours.
Real Time Aerosol Monitor Example: Mini-Ram (see Appendix D)	Particulates	Measures total particulates in the air.	Uses an internal light source. The particles diffract the light beam and the amount of diffraction is then converted into concentration (mg/m^3).	Recharge batteries. Replace dissicant when necessary.	8 to 12 hours
Monotox	Gases and vapors	Measures specific gases and vapors.	Electrichemical sensor relatively specific for the chemical species in question.	Moisten sponge before use, check the function switch, change the battery when needed.	

See Attachments A, B, C, and D for operation, calibration, and maintenance procedures.

an overview of available monitoring instrumentation and their specific operating parameters. The checklist in Section 7.3.1 lists the instruments that will be used at the LRLF site.

7.2 PERSONAL SAMPLING

After site mitigation activities have commenced, the selective monitoring of high-risk workers, i.e., those who are closest to the source of contaminant generation, is essential. Personal monitoring samples should be collected in the breathing zone and, if workers are wearing respiratory protective equipment, outside the facepiece.

Those employees working closest with the source have the highest likelihood of being exposed to concentrations which exceed established exposure limits. Representative sampling approaches emphasizing worst case conditions, those employees with the greatest risk of exposure, should be performed. The sampling strategy may change if the operation or tasks change on-site or if exposures are potentially increased.

7.3 SPECIFIC CONTAMINANTS TO BE MONITORED AT THE LRLF SITE

The following checklist provides a summary of the contaminants to be monitored for and frequency/schedule of monitoring. An air sampling strategy is also defined in the checklist. All monitoring results will be documented in the field log book and/or on field data forms. (See Attachments for specific users manuals and calibration procedures for the instruments to be used for air monitoring.)

7.3.1 Site Air Monitoring and Sampling Program

A. Air Monitoring Instruments

__X__ 1. Real-time PID (HNu) and/or FID monitors (Foxboro OVA).
__X__ 2. Real-time aerosol monitors (for particulates).
__X__ 3. Explosimeters (for explosive environments).
__X__ 4. Oxygen monitors (for oxygen levels).
__X__ 5. Other: Radiation Meter

B. Air Monitoring Frequency

_____ 1. Four times daily - twice in morning and twice in afternoon.

____ 2. Twice daily - once in morning and once in afternoon.
X 3. Continuous
____ 4. Other:

C. Monitoring Locations

X 1. Upwind and downwind of site activities.
____ 2. Near residents, etc.
X 3. Key site activity locations:
    X decon area
    X staging area
    X excavation area
    ____ field lab area
    ____ storage tanks
    ____ lagoons
____ 4. Fixed stations.
X 5. Other: At sampling locations (boreholes, surface soils, oil disposal area, etc.) and breathing zones.

D. Action Levels

X 1. Explosive atmosphere:

Action Level	Action
10% LEL	Continue investigation.
10%-25% LEL	Continue on-site monitoring with extreme caution as higher levels are encountered.
>25% LEL	Explosion hazard. Withdraw from area immediately.

X 2. Oxygen:

Action Level	Action
<19.5%	Monitor wearing self-contained breathing apparatus. NOTE: Combustible gas readings are not valid in atmospheres with <19.5% oxygen.

19.5%-25%	Continue investigation with caution. Deviation from normal level may be due to presence of other substances.
>25%	Fire hazard potential. Discontinue investigation. Consult a fire safety specialist.

__X__ 3. Radiation:

Action Level	Action
≤ 2 mrem/hr	Radiation above background levels (normally 0.01-0.02 mrem/hr)[g] signifies the possible presence of radiation sources. Continue investigation with caution. Perform thorough monitoring. Consult with a health physicist.
> 2 mrem/hr	Potential radiation hazard. Evacuate site. Continue investigation only upon the advice of a health physicist.

__X__ 4. Organic gases and vapors:

* Action Level	Action
Depends on chemical	Consult standard reference chemical manuals for air concentration/ toxicity data. Action level depends on PEL/REL/TLV. See Table 3.1.

__X__ 5. Inorganic gases and vapors:

Action Level	Action
Depends on chemical	Consult standard reference manuals for air concentration/toxicity data. Action levels depend on PEL/REL/TLV. See Table 3.1.

* Action level is 1/2 the current TLV. However, due to the possible unknown nature and quantity of different organic compounds anticipated to be present on-site, WESTON will adopt the U.S. EPA action guidelines for hazardous waste sites. These action guidelines are: Level D, background; Level C, 0 to 5 units above background in breathing zone; Level B, over 5 units above background in breathing zone.

E. Reporting Format

__X_ 1. Field notebook.
__X_ 2. Field data sheets.
__X_ 3. Air monitoring log.
____ 4. Trip report.
____ 5. Other:

7.3.2 Site Ambient Air Sampling

The following is a list of criteria that will determine the necessity for air monitoring.

A. Sampling Criteria

_NA_1. Meteorological conditions:

- ____ a. dry weather for ____ days.
- ____ b. ambient temperature above ___.
- ____ c. winds sufficient to cause erosion.

_NA_ 2. Health and safety observations:

- __NA a. vapors levels two-three times above background.
  1. Breathing zone
  2. Soil/air interface
  3. Container opening
  4. Other:
- __NA b. particulate levels two-three times above background.
  1. Breathing zone
  2. Soil/air interface
  3. Container opening
  4. Other:

NA 3. Site specific activities:

____ a. major spills.
____ b. change in site activities.
____ c. site activity increase airborne contaminants possibilities.

B. Sample Location

NA 1. Ambient background:

____ a. one station.
____ b. two stations.

NA 2. Fixed on-site locations:

____ a. 1-4 stations.
____ b. 4-8 stations.
____ c. 8-12 stations.
____ d. other:

NA 3. Fixed off-site locations:

____ a. 1-2 stations.
____ b. 2-4 stations.
____ c. other:

NA 4. Mobile off-site locations:

____ a. 1-2 stations.
____ b. other:

NA 5. Mobile on-site locations:

____ a. 1-2 stations.
____ b. 2-4 stations.
____ c. other:

NA 6. Background Stations

____ a. 1-2 stations.
____ b. 2-4 stations.
____ c. other:

C. Sampling Procedures

		Media	Analytical Method
NA	1.	150 mg carbon tubes 200 cc/min.; 500 cc/min.; 1000 cc/min*.	
_____	a.	aromatic hydrocarbons	_____ NIOSH 1501
_____	b.	halogenated hydrocarbons	_____ NIOSH 1003
_____	c.	hydrocarbons	_____ NIOSH 1500
_____	d.	duplicate	_____
_____	e.	other:	_____
NA	2.	600 mg carbon tubes	
_____	a.	aromatic hydrocarbons	_____
_____	b.	halogenated hydrocarbons	_____
_____	c.	hydrocarbons	_____
_____	d.	duplicate	_____
_____	e.	other:	_____
NA	3.	Small silica gel 75/150 mg	
_____	a.	washed	_____
_____	b.	unwashed	_____
NA	4.	2 stage silica gel 500 cc/m; 1000 cc/m;	
_____	a.	washed	_____
_____	b.	unwashed	_____
_____	c.	inorganic acids	___ NIOSH 7903
_____	d.	aromatic amines	___ NIOSH 2002
_____	e.	other	_____
NA	5.	3 stage silica gel 200 cc/m; 500 cc/m	
_____	a.	aliphatic amines	_____ NIOSH 221
_____	b.	other	_____
NA	6.	150 mg florisil 200 cc/m; 500 cc/m; 1000 cc/m	
_____	a.	PCBs	_____ NIOSH 253
_____	b.	chlorinated hydrocarbons	_____
_____	c.	other	_____

NA 7. PUF samples 1 L/m; 2 L/m

_____ a. prefilter ______________
_____ b. pesticides ____ Lewis & MacLeod
_____ c. semivolatiles ____ Lewis & MacLeod

* Three values indicate minimal, optimal and maximum flow rate. Consult analytical methodology.

NA 8. Tenax/CMS: 200 cc/m; 50 cc/m; 100 cc/m

_____ a. VOCs ___________EPA TO1
_____ b. other ______________

NA 9. 37 mm .8u MCEF filters: 1 L-2 L/m/10-15/

_____ a. elements _____ NIOSH 7300
_____ b. other ______________

NA 10. 25 mm .8u MCEF Filters: 2 L/m; 2.5 L/m; 10 L/m

_____ a. asbestos ______ NI7402 EPA FR October 30,

_____ b. other ______________

NA 11. 37 mm .45u MCEF Filters: 2 L/m; 2.5 L/m

_____ a. PCB particulates _____ NIOSH 5121
_____ b. other ______________

NA 12. 37 mm PTFE filters: 1 L/m; 2 L/m

_____ a. PAHs/PNAs _____ NIOSH 5506/5516

_____ b. other ______________

NA 13. 37 mm glass fiber filter

_____ a. particulate pesticide _______NIOSH/Macleod
_____ b. other ______________
NA 14. Impinger setups

- Impingers are generally compound specific, therefore, methodologies should be sought as required for sampling.

8.0 SITE CONTROL MEASURES

The following section defines measures and procedures for maintaining site control. Site control is an essential component in the implementation of the site health and safety program.

8.1 BUDDY SYSTEM

During all Level B and Level C activities or when conditions present a risk to personnel, the implementation of a buddy system is mandatory. A buddy system requires at least two people who work as a team; each looking out for each other. For example, Level B operations require three people, one or two people in Level B protection, and one person as a safety watch.

8.2 SITE COMMUNICATIONS PLAN

Successful communications between field teams and contact with personnel in the support zone is essential. The following communications systems will be available during activities at the LRLF site.

_X_ Radios: Two way (intrinsically safe)

_X_ Compressed air horn

___ Megaphone

_X_ Whistle

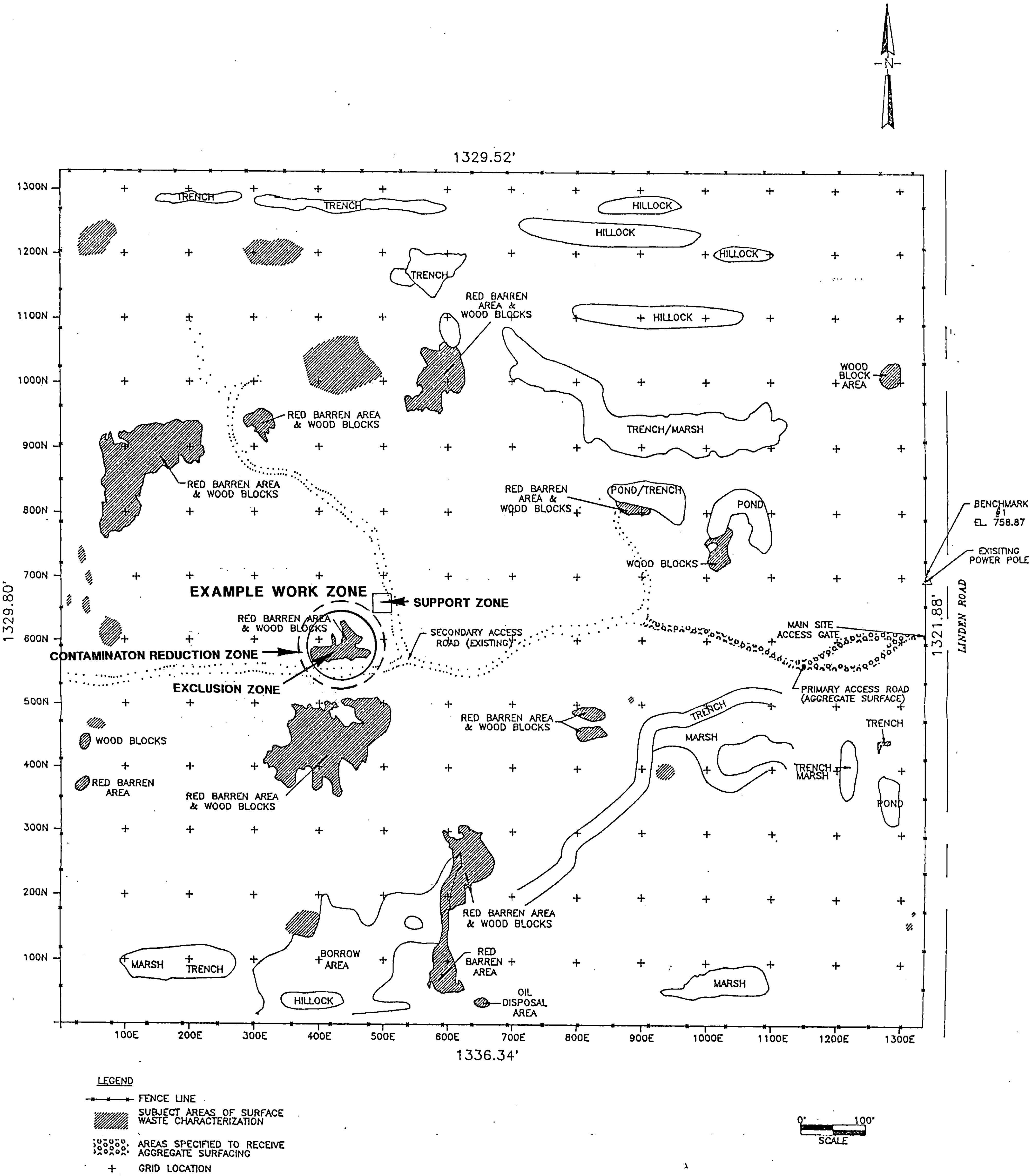
_X_ Hand signals: Standard hand signals will be utilized in order to communicate at and around the drill rig and during excavation activities.

8.3 WORK ZONE DEFINITION

The three general work zones to be established at the LRLF site are the Exclusion Zone, Contamination Reduction Zone, and Support Zone. Figure 8-1 provides a site map of the LRLF site with the work zones designated on it.

8.3.1 The Exclusion Zone

The Exclusion Zone is defined as the area where contamination is either known or likely to be present, or because of activity, will provide a potential to cause harm to personnel.



NOTE: 1. ADDITIONAL SELECT CLEARING AT SURFACE WASTE AREAS TO BE DETERMINED IN FIELD.
2. ADDITIONAL INTERNAL SECONDARY ACCESS ROAD CONSTRUCTION TO BE DETERMINED IN FIELD AT TIME OF WASTE REMOVAL ACTIVITY.

FIGURE 8-1
WORK ZONES OF LRLF SITE

Entry into the Exclusion Zone requires the use of personnel protective equipment.

8.3.2 The Contamination Reduction Zone

The Contamination Reduction Zone is the area where personnel conduct personal and equipment decontamination. It is essentially a buffer zone between contaminated areas and clean areas. The Contamination Reduction Zone should always be placed upwind of the Exclusion Zone to prevent the migration of blowing dust or contamination into the Reduction or Support Zones. Activities to be conducted in this zone will require personal protection as defined in the decontamination plan.

8.3.3 The Support Zone

The Support Zone is situated in clean areas where the chance to encounter hazardous materials or conditions is minimal. Personal protective equipment is therefore not required. The Support Zone should also be placed upwind of both the Exclusion and Contamination Reduction Zones.

8.4 NEAREST MEDICAL ASSISTANCE

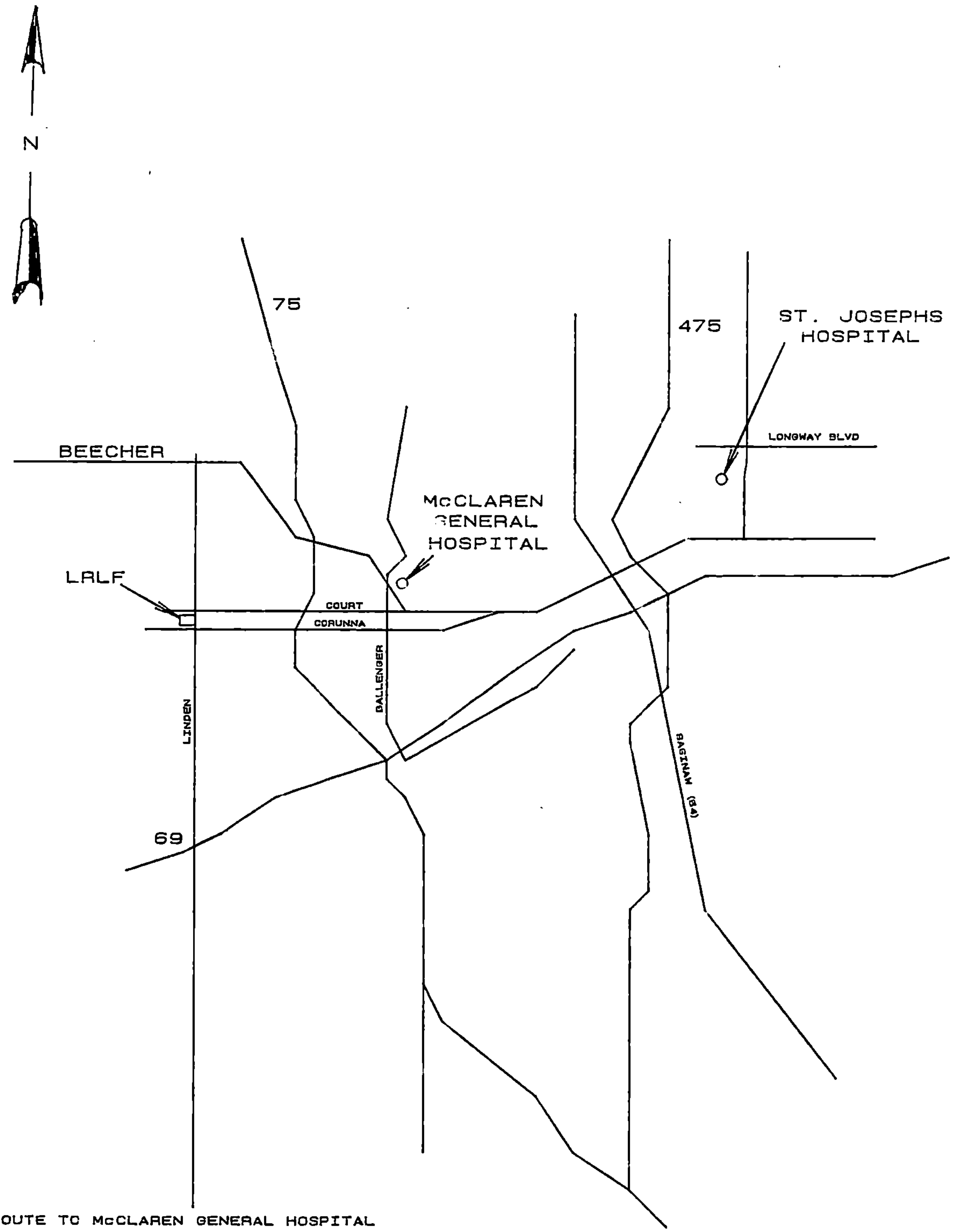
Figure 8-2 provides a map of the route to the nearest medical assistance.

The following individuals have current certification in CPR and/ or first aid:

TO BE ASSIGNED

8.5 SAFE WORK PRACTICES

Table 8-1 provides a list of standing orders for the LRLF site.



ROUTE TO McCLAREN GENERAL HOSPITAL
NORTH ON LINDEN ROAD
EAST ON COURT
NORTH ON BALLENGER

HOSPITAL AT G-1080 N. BALLENGER
313/762-2000

FIGURE 8-2
ROUTE TO HOSPITAL FROM LRLF

TABLE 8-1

STANDING ORDERS FOR THE LRLF SITE

- No smoking, eating, or drinking on-site.
- No horseplay.
- No matches or lighters, except in designated areas.
- Check-in on entrance to the site.
- Check-out on exit from the site.
- Implement the communications system.
- Line of sight must be in position.
- Wear the appropriate level of protection as defined in the SHSP.

9.0 DECONTAMINATION PLAN

Table 5-1 lists the tasks and specific levels of protection required for each. Consistent with the levels of protection required, Figures 9-1 through 9-3 provide a step by step representation of the personnel decontamination process for Levels B through D.

9.1 LEVELS OF DECONTAMINATION PROTECTION REQUIRED FOR PERSONNEL

The levels of protection required for personnel assisting with decontamination will be [__ Level B, __ Level C, _X_ Level D].

9.2 EQUIPMENT DECONTAMINATION

Sampling equipment will be decontaminated in accordance with procedures as defined in the Quality Assurance Project Plan.

9.3 DISPOSITION OF DECONTAMINATION WASTES

When decontamination is necessary, all used personnel protective equipment and decon rinse liquids will be drummed and will be stored adjacent to the decontamination area. The contents of these drums will be disposed of appropriately.

FIGURE 9-1

LEVEL B DECONTAMINATION

Step 1 Segregated equipment drop

Step 2 Boot cover and glove wash

Step 3 Boot cover and glove rinse

Step 4 Tape removal

Step 5 Boot cover removal

Step 6 Outer glove removal

- - - - - - - - - - - - - - HOT LINE - - - - - - - - - - - - -

Step 7 Suit/safety boot wash

Step 8 Suite/SCBA/boot/glove rinse

Step 9 Outer safety boot removal

Step 10 SCBA backpack removal

Step 11 Splash suit removal

Step 12 Inner glove wash

Step 13 Inner glove rinse

Step 14 Face piece removal

Step 15 Inner glove removal

Step 16 Inner clothing removal

- - - - - - - - CRZ/Support Zone Boundary/ - - - - - - - -

Step 17 Field wash

Step 18 Redress

FIGURE 9-2

LEVEL C DECONTAMINATION

Step 1 Segregated equipment drop

Step 2 Boot cover and glove wash

Step 3 Boot cover and glove rinse

Step 4 Tape removal

Step 5 Boot cover removal

Step 6 Outer glove removal

- - - - - - - - - - - - - - - - - - - HOT LINE - - - - - - - - - - - - - - - - -

Step 7 Suit/safety boot wash

Step 8 Suit/safety boot rinse

Step 9 Outer safety boot removal

Step 10 Splash suit removal

Step 11 Inner glove wash

Step 12 Inner glove rinse

Step 13 Face piece removal

Step 14 Inner glove removal

Step 15 Inner clothing removal

- - - - - - - - - - - - - CRZ/Support Zone Boundary/- - - - - - - - - -

Step 16 Field wash

Step 17 Redress

FIGURE 9-3

LEVEL D DECONTAMINATION

Step 1 Segregated equipment drop

Step 2 Boot cover and glove wash

Step 3 Boot cover and glove rinse

Step 4 Boot cover removal

Step 5 Outer glove removal

- - - - - - - - - - - - HOT LINE - - - - - - - - - - - - - - - -

Step 6 Suit/safety boot wash

Step 7 Suit/safety boot rinse

Step 8 Inner glove wash

Step 9 Inner glove rinse

Step 10 Inner glove removal

- - - - - - - - - - - CRZ/Support Zone Boundary/- - - - - - - -

Step 11 Field wash

Step 12 Redress

10.0 EMERGENCY RESPONSE/CONTINGENCY PLAN

This section describes contingencies and emergency planning procedures to be implemented at the LRLF site.

10.1 PRE-EMERGENCY PLANNING

During the site briefings held periodically/daily, all employees will be trained in and reminded of provisions of the emergency response plan, communication systems, and evacuation routes (see Section 4.3).

The plan will be reviewed and revised if necessary, on a weekly basis by the SHSC in order to ensure that it is adequate and up-to-date with prevailing site conditions.

10.2 LINES OF AUTHORITY

As the prime contractor of the project, (Contractor to be assigned) has primary responsibility for responding to and correcting emergency situations. This includes taking appropriate measure to ensure the safety of site personnel and the public. Possible emergency actions may involve evacuation of personnel from the site area, and evacuation of adjacent residents. The SHSC is additionally responsible for ensuring that corrective measures have been implemented, appropriate authorities notified, and followup reports completed.

The individual contractor organizations are responsible for assisting the SHSC in his/her mission within the parameters of their scope of work.

10.3 EMERGENCY RECOGNITION/PREVENTION

Table 3-1 and 3-2 provide a listing of chemical and physical hazards on-site. Additional hazards as a direct result of site activities are listed in Table 10-1, along with prevention and control techniques/mechanisms.

10.4 EVACUATION ROUTES/PROCEDURES

In the event of an emergency which necessitates an evacuation of the site, a compressed air horn will be sounded three times in succession.

Personnel will be expected to proceed to the closest exit in pairs if possible, and mobilize to the muster area associated with the evacuation route. Personnel will remain at that area until another "Re-Entry" alarm is sounded or the SHSC provides

TABLE 10-1

EMERGENCY RECOGNITION/CONTROL MEASURES

Hazard	Specific Condition/ Location	Prevention/Control
Fire/Explosion	Drill rig/backhoe malfunction	Fire extinguisher at rig
		Daily fire Inspections
Air and/or Other Gaseous Release	Boreholes on-site	Appropriate Monitoring
		Evacuation Routes
Combustible Gas	Boreholes on-site	Monitor with CGI
		>25% LEL in Hole, inert with dry ice
		>50% LEL in Hole, STOP
		>25% LEL Ambient STOP
Fuel Spill	Fuel Tank(s) (if present)	Dike around tank(s) (if required)

further instructions.

Figure 10-1 provides a map depicting evacuation routes for the site and immediate area. Also indicated are locations of emergency equipment in muster areas and designated safe distances in the event of a major incident. This information will be conveyed to all site personnel prior to the start of work.

10.5 EMERGENCY EQUIPMENT/FACILITIES

Figure 10-1 provides a map of the site and identifies the location of the following emergency equipment:

X First Aid Kit
X Fire Extinguisher
___ Stretcher

___ Public Telephone
___ Site Telephone

X Mobile Telephone

___ Sorbent Material
___ Spill Kits

X Emergency SCBAs Stations

___ Other

X Eye Wash
___ Emergency Shower

X Two-way Radio
X Off-site Telephone

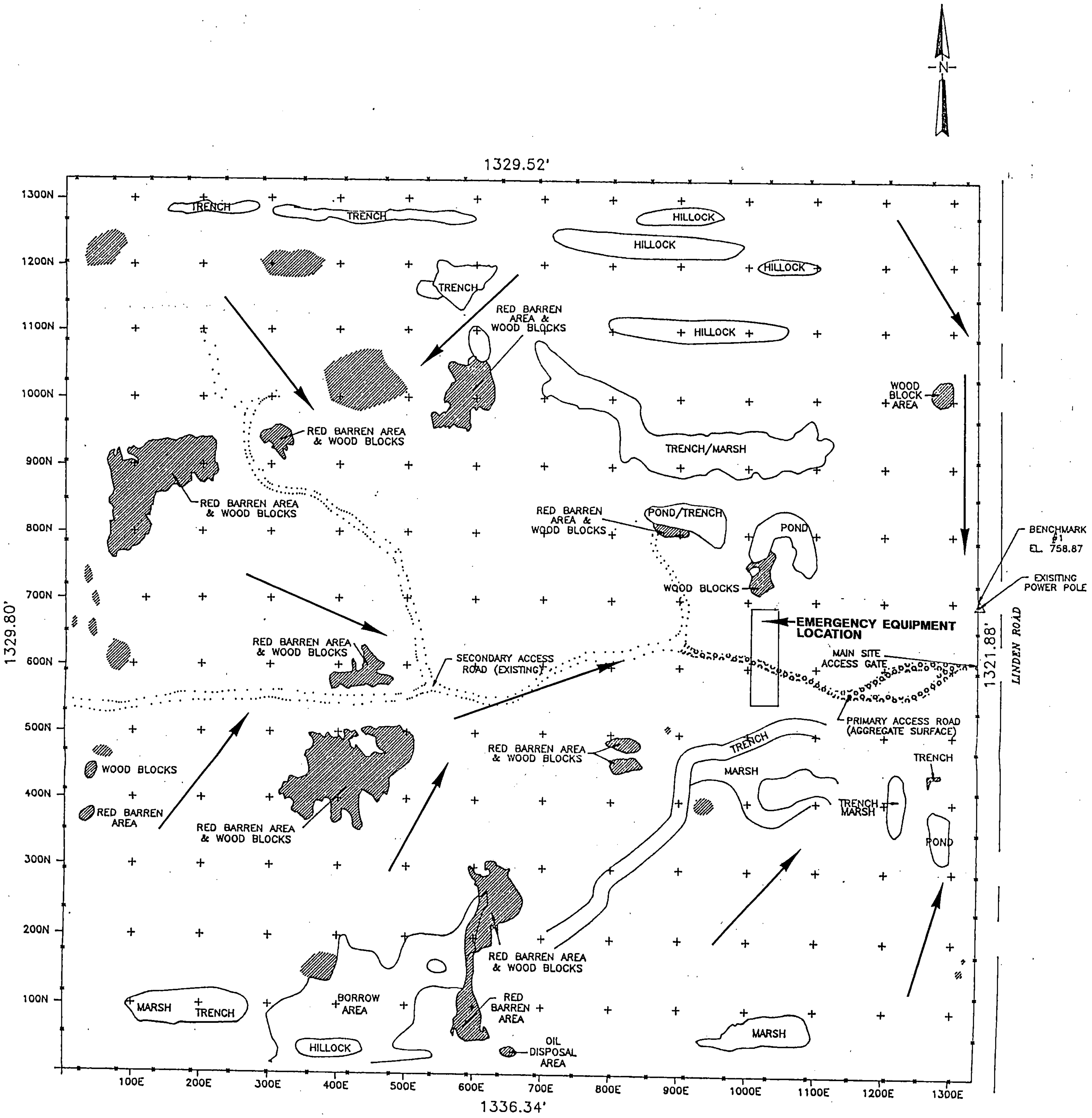
___ Drums
___ Berm Material

___ Air Monitoring

10.6 EMERGENCY CONTACT/NOTIFICATION SYSTEM

The following list provides names and telephone numbers for emergency contact personnel.

Organization	Contact	Telephone
Ambulance:	Flint Fire Dept.	(313) 232-2222
Police:	Dispatcher	(313) 732-9911
Fire:	Dispatcher	(313) 232-2222
Hospital #1:	St. Jos. Hosp. 302 Kensington Rd. Flint, MI	(313) 762-8710 (313) 762-8000



LEGEND

—×—×— FENCE LINE

▨ SUBJECT AREAS OF SURFACE WASTE CHARACTERIZATION

ഃ AREAS SPECIFIED TO RECEIVE AGGREGATE SURFACING

\+ GRID LOCATION

← EVACUATION ROUTE

0' 100'
SCALE

EMERGENCY EQUIPMENT LOCATION CONTAINS:
EMERGENCY SHOWER
FIRE EXTINGUISHER
FIRST AID KIT
TELEPHONE
HEALTH AND SAFETY PLAN
EYE WASH

NOTE:
1. ADDITIONAL SELECT CLEARING AT SURFACE WASTE AREAS TO BE DETERMINED IN FIELD.
2. ADDITIONAL INTERNAL SECONDARY ACCESS ROAD CONSTRUCTION TO BE DETERMINED IN FIELD AT TIME OF WASTE REMOVAL ACTIVITY.

FIGURE 10-1
EVACUATION ROUTES AND EMERGENCY EQUIPMENT LOCATIONS

Hospital #2:	McLaren General G-1080 N. Ballenger Highway Flint, MI	(313) 762-2000
Poison Control Ctr.:		(800) 632-2727
National Response Center		800-424-8802
Center for Disease Control		404-488-4100
Chemtrec		800-424-9555

10.7 MEDICAL EMERGENCIES

Any person who becomes ill or injured in the exclusion zone must be decontaminated to the maximum extent possible before they are transported from the site. If the injury or illness is minor, full decontamination should be completed and first aid administered prior to transport. If the patient's condition is serious, at least partial decontamination should be completed (i.e., complete disrobing of the victim and redressing in clean coveralls or wrapping in a blanket.) First aid should be administered while awaiting an ambulance or paramedics. All injuries and illnesses must immediately be reported to the SHSC.

Any person being transported to a clinic or hospital for treatment should take with them information on the chemical(s) they have been exposed to at the site. This information is included in Table 3-1.

Any vehicle used to transport contaminated personnel, will be treated and cleaned as necessary.

10.8 FIRE OR EXPLOSION

In the event of a fire or explosion, the local fire department will be summoned immediately. Upon their arrival, the SHSC or designated alternate will advise the fire commander of the location, nature, and identification of any potential hazardous materials on-site.

If it is safe to do so, site personnel may:

- o Use portable fire extinguishers available on-site to control or extinguish and incipient stage fire.
- o Remove or isolate flammable or other hazardous materials which may contribute to the fire.

10.9 SPILL OR LEAKS

In the event of a spill or a leak, site personnel will:

- o Inform their supervisor immediately;
- o Locate the source of the spillage and stop the flow if it can be done safely; and,
- o Begin containment and recovery of the spilled materials.

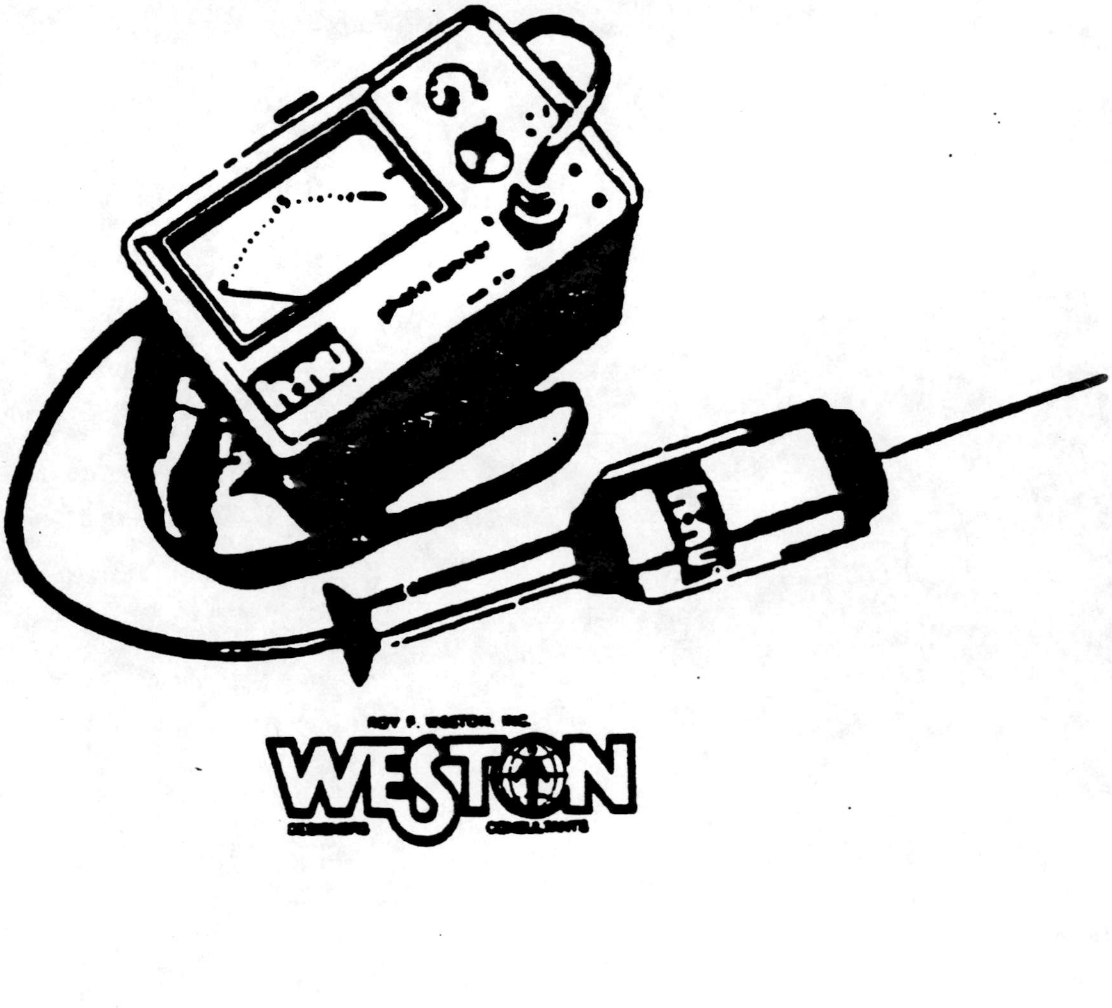
Appropriate spill response gear and materials will be maintained on-site or where easily accessible and maintained in readiness.

Note: If mutliple or large capacity fuel tanks will be utilized at this site, a spillt plan may be required.

ATTACHMENT A

HNu OPERATION, MAINTENANCE, AND CALIBRATION PROCEDURES

FIELD MANUAL FOR THE OPERATION, CALIBRATION AND TROUBLESHOOTING OF THE HNU PHOTOIONIZER



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WESTON
DESIGNERS CONSULTANTS

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A.) INTRODUCTION TO THE HNU

The HNU is a portable trace gas analyzer that can be used to measure a wide variety of organic vapors including chlorinated hydrocarbons, heterocyclics and aromatics, aldehydes and ketones, as well as several inorganic gases including hydrogen sulfide and ammonia.

The HNU photoionizer employs the principal of photoionization for detection. Photoionization is initiated by the absorption of a photon of ultraviolet radiation energetic enough to ionize a molecule and produce an instrument response only if the ionization potential (IP) is equal to or slightly less than the ionizing energy supplied by the instrument's UV lamp (9.5 eV, 10.2 eV, 11.7 eV). Species that have a very high IP will display a poor instrument response or none at all. Employing the 11.7 eV lamp will ensure the total range of detectable species, but there will still be a number of undetectable sample components, such as cyanide or methane. So, whenever possible, it is recommended that the 11.7 eV probe be used in cases involving unknown species.

The 11.7 eV lamp is identified by the inscription "11.7 ev" near the lamp number on the glass envelope. A comparison of response to selected species of compounds utilizing the 9.5 eV, 10.2 eV and 11.7 eV lamps are listed in Table 1. The relative sensitivity of the 11.7 eV lamp is about one-tenth that of the 10.2 eV. The 11.7 eV lamp provides a more universal response than the 10.2 lamp which makes the 11.7 eV lamp more practical to our type of needs at Weston.

CAUTION: The HNU instrument is not intrinsically safe. Its use in a probable explosive environment should be attempted after the area in question has been metered by a explosimeter and deemed safe for the HNU instrument operation.

TABLE 1

SELECTED LIST OF SPECIES DETECTED

Class species	Photoionization Response 9.5eV lamp	 10.2 eV lamp	 11.7 eV lamp
Paraffins and unsaturated hydrocarbons			
methane	NR	NR	NR
ethylene	NR	L	H
acetylene	NR	NR	H
1-butene	H	H	H
hexane	Nr	L	H
Chlorinated hydrocarbons			
methyl chloride	NR	NR	H
carbon tetrachloride	NR	NR	H
chloroform	NR	NR	H
dichloroethane	NR	NR	H
vinylidene chloride	L	H	H
trichloroethylene	H	H	H
Heterocyclics & aromatics			
phenol	H	H	H
pyridine	H	H	H
benzene	H	H	H
toluene	H	H	H
xylene	H	H	H
styrene	H	H	H
aniline	H	H	H
chlorobenzene	H	H	H
nitrobenzene	NR	L	H
Nitrogen compounds			
formamide	NR	H	H
ammonia	NR	L	H

TABLE 1 (Continued)

Class species	Photoionization Response 9.5eV lamp	 10.2 eV lamp	 11.7 eV lamp
Nitrogen compounds (Continued)			
hydrazine	H	H	H
methyl amine	H	H	H
acetonitrile	NR	NR	NR
acrylonitrile	NR	NR	H

NR = No response.
H = High response.
L = Low response.

B.) OPERATION

1.) Before attaching the probe, check the function switch on the control panel to make sure it is in the "OFF" position. Figure 1.

2.) Carefully match the alignment key in the probe connector to the 12 pin connector on the control panel, and then twist the probe connector until a distinct snap and lock is felt.

3.) Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale plate.

If the needle is in the lower portion of the arc, recharge before use. If the LED comes on, recharge before use. (See Section D. Recharging the HNU.)

4.) Turn the function switch to "On." In this position, the UV light source should be on. If looking into the end of the probe reveals a purple glow, the UV light source is working.

5.) Set the span to the desired gain.

6.) Zero the instrument by turning the function switch to the stand-by position and rotate the zero potentiometer knob. Clockwise produces an up-scale deflection and counterclockwise yields a downscale deflection:

NOTE: If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. (Stand- by position)

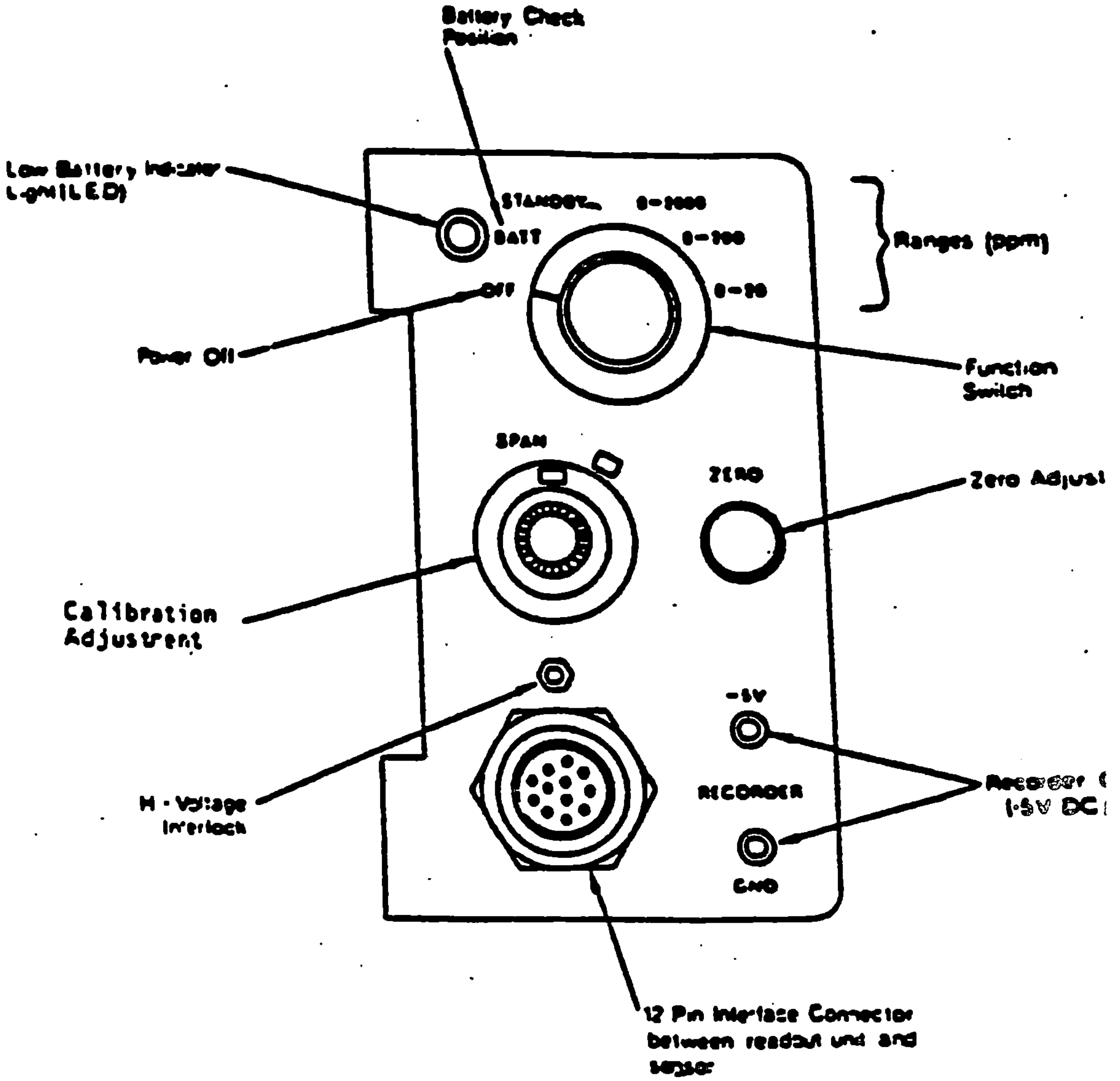

FIGURE 1
Control Panel Functions

The instrument is supplied calibrated to read directly in ppm (0-20, 0-200, 0-2000) of benzene with the span position set at 9.8. For additional sensitivity, the span poteniometer is turned counterclockwise (smaller numbers) to increase the gain. Changing the gain changes instrument sensitivity and specificity (if changed from 9.8, it will no longer be direct reading for benzene). By changing the span setting from 10.0 to 1.0, the sensitivity is increased approximately ten-fold. The 0-20, 0-200 and 0-2000 scales become 0-2, 0-20 and 0-200, respectively.

The span control can be utilized to calibrate nearly any compound, measured by photoionization, to be direct reading on the 0-20 ppm range. For example, gain settings of 4.5 or 8.9, respectively, will provide direct reading capability (0-20, 0-200 ppm) for vinyl chloride and trichloroethylene, respectively. Table 2 is a listing of approximate gain setting values for some common compounds. Note that these settings are approximate until the meter is calibrated against the specific compound.

TABLE 2

RELATIVE PHOTOIONIZATION SENSITIVITES FOR VARIOUS GASES

Grouping	Span/Gain Setting	Examples
Aromatic	9.8	Benzene, Toluene, Styrene
Aliphatic Amine	9.8	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	5-7	MEK, MIBK, Acetone, Cyclohexene
Unsaturated	3-5	Acrolein, Propylene, Cyclohexene, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C_5-C_7)	1-3	Pentane, Heptane
Ammonia	0.3	--
Paraffin (C_1 - C_4)	0	Ethane, Propane, Butane

7.) The instrument is now ready for calibration or measurement by switching the function switch to the proper measurement range, i.e., 0-20, 0-200, or 0-2000.

C.) CALIBRATION

The recommended and most accurate procedure for calibration of the HNU instrument is utilizing a pressurized gas cylinder containing a known ppm value at a specified span setting attached to a designated probe. The following procedure refers to Figure 2.

1.) Follow steps 1-7 in OPERATION section (above).

2.) Attach the tygon tubing to the 8" extension probe of the photoionization probe.

3.) Crack the valve of the pressurized cylinder until a slight flow of gas is being released from the cylinder.

The instrument should read ±10% of the gas value; if not, one of two things can be done:

a. Change span to get the gas value. NOTE: If span is changed more than ±10%, proceed to b.

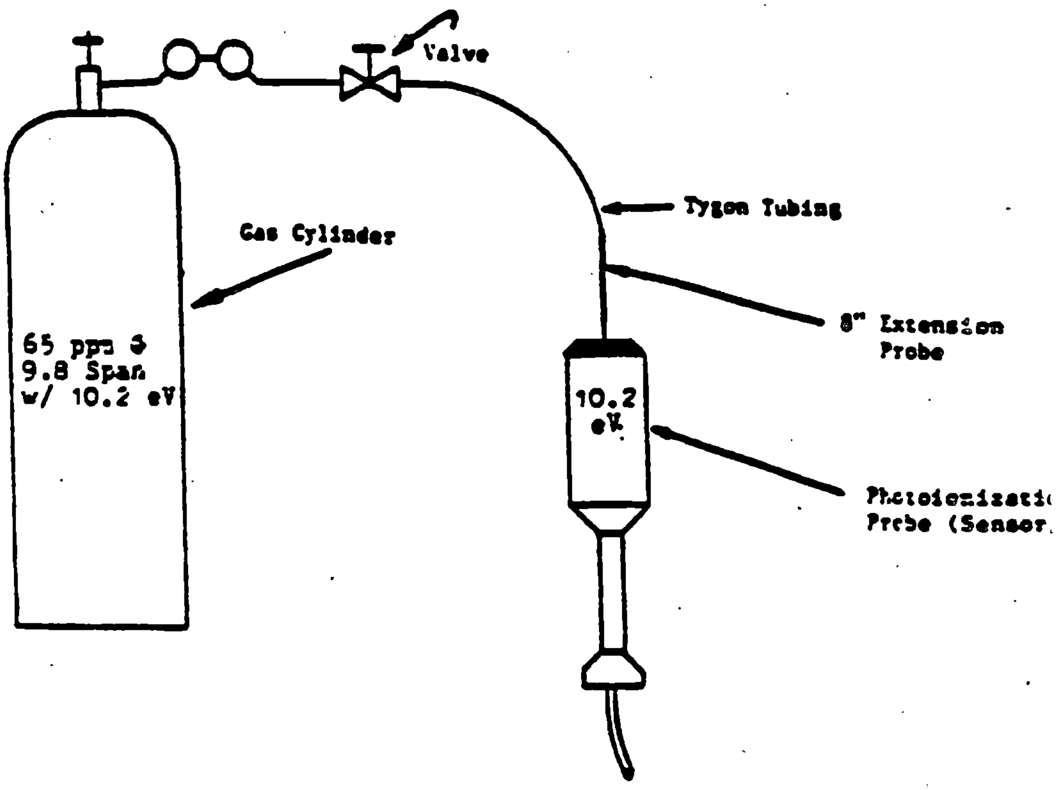

FIGURE 2
Recommended Calibration Procedure

b. Clean lamp and IP chamber. A dirty lamp will yield low readings, and a dirty chamber will yield high readings.

NOTE: If the instrument span setting is changed, the instrument should be turned back to the stand-by position and rezeroed, if necessary.

If using the 11.7 eV probe and the gas calibration cylinder showing a ppm value of 9.8 span with 10.2 eV probe, all steps above will be necessary. The final span setting using the 11.7 eV probe should be approximately the same value as indicated for the specific probe in Appendix 2.

The HNU instrument is now ready for field measurements.

D.) RECHARGING THE HNU

To ensure no damage to the HNU instrument and to extend the life of the battery, the following steps should be followed when recharging the HNU.

1.) Place the miniphone plug into the jack on the left side of the read-out unit.

2.) Plug the charger into a 120 vac outlet.

3.) Let stand overnight or for at least 14 hours.

NOTE: Overcharging is not a major problem with the HNU as it has a built-in solid-state battery protection circuit; also, when the battery voltage drops below approximately 11 volts, this circuit will automatically turn off power to the instrument. This prevents deep discharging of the battery.

It is, however, recommended that if the battery check shows ample power available, not to charge the unit.

4.) When disconnecting the charger, remove the charger from the 120 vac before removing the miniphone plug.

The instrument can be operated during the recharging cycle. This will only lengthen the time required to completely recharge the instrument battery.

E.) FALSE READINGS

Incorrect values may be detected by the HNU, outside of mechanical failures within the unit. Some of the field situations which may be encountered are as follows:

1.) High wind
2.) High humidity (>95%)
3.) Probe too far from source
4.) High electrical areas
5.) Temperatures above 105°F or below 32°F.

High wind and high humidity are two variables beyond control of the instrument operator. The probe being too far from the source is self-explanatory for correction. When working around high electrical areas, the following steps may be utilized to obtain relevant measurements.

1.) Zero the instrument in an electrically quiet area in the stand-by position.

2.) Move the instrument to the area in question. If AC pick-up is going to be a problem, the meter (in the stand-by position) will indicate the magnitude of error.

3.) Subtract this difference, Step 2, from the indicated value to obtain the actual value.

The HNU should not be used in temperatures greater than 105°F. In temperatures less than 32°F, the unit should function properly as long as the probe extention and probe inlet are wiped dry after use. The probe extension should be wiped dry because when moving the unit from a warm area to a cold area and back to a warm area again, condensation will develop inside the extension probe causing erratic values. If moisture enters into the lamp area of the probe, the following steps should be taken to free the unit of moisture or dust particles. Figure 3.

1.) Turn the function switch to the off position.

2.) Disconnect the probe from read-out unit.

3.) Remove the exhaust screw found near the base of the probe.

4.) Grasp the end cap in one hand and the probe shell in the other; gently pull to separate the end cap and lamp housing from shell.

5.) Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing.

6.) Turn the end cap over into your hand and tap on the top of it; the ion chamber should fall out into your hand.

7.) Place one hand over the top of the lamp housing and tilt slightly, the light source will slide out into your hand.

8.) Wipe dry all parts with a soft dry cloth, except for lamp and lamp window.

CAUTION: If the window in lamp of the 11.7 eV lamp is dirty and needs to be cleaned, do not clean with water or any organic solvent miscible with water such as acetone or methanol. The window should be cleaned with a soft tissue dipped in an organic (nonwater miscible) solvent or freon. The cleaning compound for the 10.2 eV lamp should not be used under any circumstances on the 11.7 eV lamp.

F.) TROUBLESHOOTING

Some of the basic problems which may occur and probable causes and solutions are as follows:

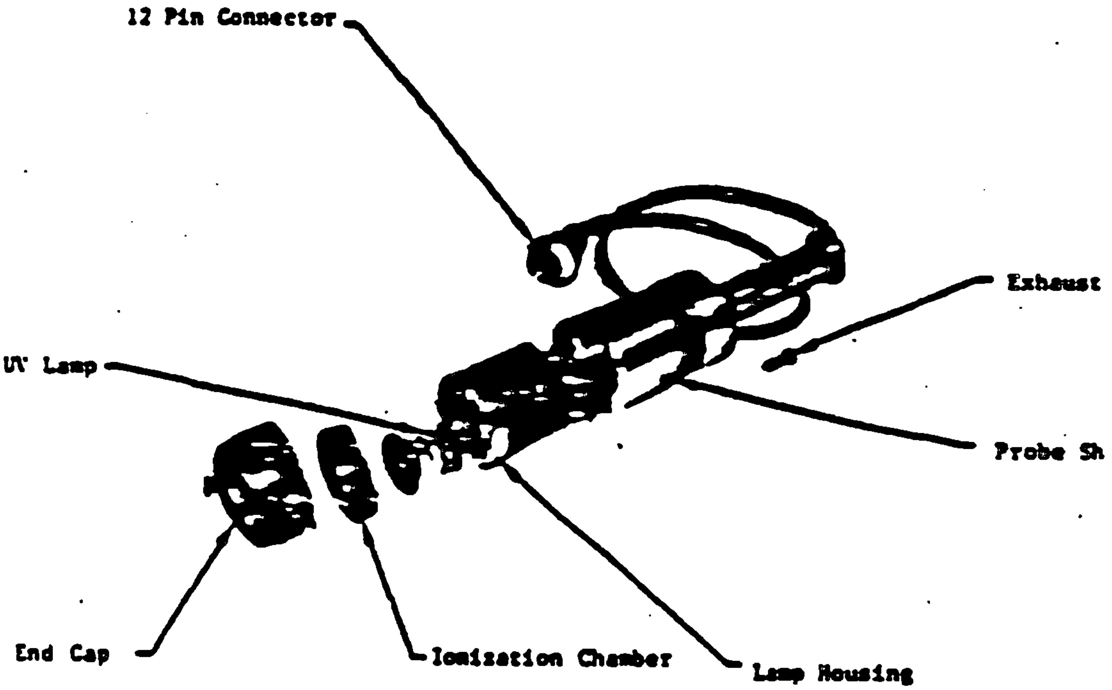

FIGURE 3
Component Parts of Probe

1. No meter response in any switch position (including BATT CHK)

    A. Broken meter movement

        (1) Tip instrument rapidly from side to side. Meter needle should move freely and return to zero.

    B. Electrical connection to meter is broken

    C. Battery is completely dead

        (1) Disconnect battery and check voltage with a volt-ohm meter.

    D. Check 2 amp fuse

    E. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others

    A. Power supply defective

        (1) Check power supply voltages. If any voltage is out of specification, consult the factory.

B. Input transistor or amplifier has failed

   (1) Rotate zero control; meter should deflect up/down as control is turned.

   (2) Open probe. Both transistors should be fully seated in sockets.

C. Input signal connection broken in probe or read-out

   (1) Check input connector on printed circuit board. Should be firmly pressed down.

   (2) Check components on back side of printed circuit board. All connections should be solid, and no wires should touch any other object.

   (3) Check all wires in read-out for solid connections.

3. Instrument responds correctly in BATT CHK, and STBY, but not in measure mode.

A. Check to see that light source is on.

   (1) Check high voltage power supply.

   (2) Open end of probe; remove lamp and check high voltage on lamp contact ring.

   (3) If high voltage is present at all above points, light source has most likely failed. Consult the factory.

4. Instrument responds correctly in all positions but signal is lower than expected.

   A. Check span setting for correct value.

   B. Clean window of light source.

   C. Check power supply 180 V output.

   D. Check for proper fan operation. Check fan voltage.

   E. Rotate span setting. Response should change if span pot is working properly.

5. Instrument responds in all switch positions, but is noisy (erratic meter movement).

   A. Open circuit in feedback circuit. Consult the factory.

   B. Open circuit in cable shield or probe shield. Consult the factory.

6. Instrument response is slow and/or irreproducible.

   A. Fan operating improperly. Check fan voltage.

   B. Check calibration and operation. See Sections B and C.

7. Low battery indicator.

   A. Indicator comes on if battery charge is low.

   B. Indicator also comes on if ionization voltage is too high.

ATTACHMENT B

OVA OPERATION, MAINTENANCE, AND CALIBRATION PROCEDURES

USER'S MANUAL TO THE PORTABLE ORGANIC VAPOR ANALYZER

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A. INTRODUCTION TO THE OVA

The Organic Vapor Analyzer (OVA) measures trace quantities of organic compounds in the air by using ionization as the detection method. The ionization is caused by a hydrogen flame within the flame ionization detector. As the compound is ionized, the ions pass through two charged plates whereby the conductivity is measured and this current is then displayed on an external meter.

The OVA can operate in two modes:

1. Survey Mode

A sample of ambient air is routed through the OVA into the detector, allowing all organic species to be ionized and detected at the same time. The OVA analyzes total organic vapor concentrations on a continuous sampling basis and reports the results on the basis of sensitivity of the instrument to various compounds as compared to the calibration gas methane. When the OVA is calibrated to methane, the instrument is sensitive to .1 ppm.

2. Gas Chromatography Mode

When there is a mixture of organic vapors present or when qualitative and quantitative identification of a compound is necessary, then the OVA can be operated in the GC mode. the

OVA can analyze air samples in the GC mode through general survey, syringe injection, or through the use of collector tubes.

The components to be separated are carried through a column packed with an inert solid. The different components of the sample migrate through the column at different rates (retention times) and can be identified by comparing their retention time to a known standard.

The OVA is more sensitive to hydrocarbons than to any other class of organics. Compounds containing oxygen, such as alcohols, ethers, aldehydes, phenols and esters, give a lower response than that observed for hydrocarbons. Also, compounds containing nitrogen and halogenated compounds show a lower relative response as compared with hydrocarbons. The OVA gives the lowest response for materials containing no hydrocarbon and it is also limited in detecting compounds with high molecular weight. Listed below is a table indicating the relative response of compounds as compared to the calibration gas methane.

Compound	Relative Response
Methane	100
Ethane	90
Propane	64
n-Butane	61
n-Pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Acetone	100
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
Methanol	15
Ethanol	25
Isopropyl alcohol	65
Carbon tetrachloride	10
Chloroform	70
Trichloroethylene	72
Vinyl chloride	35

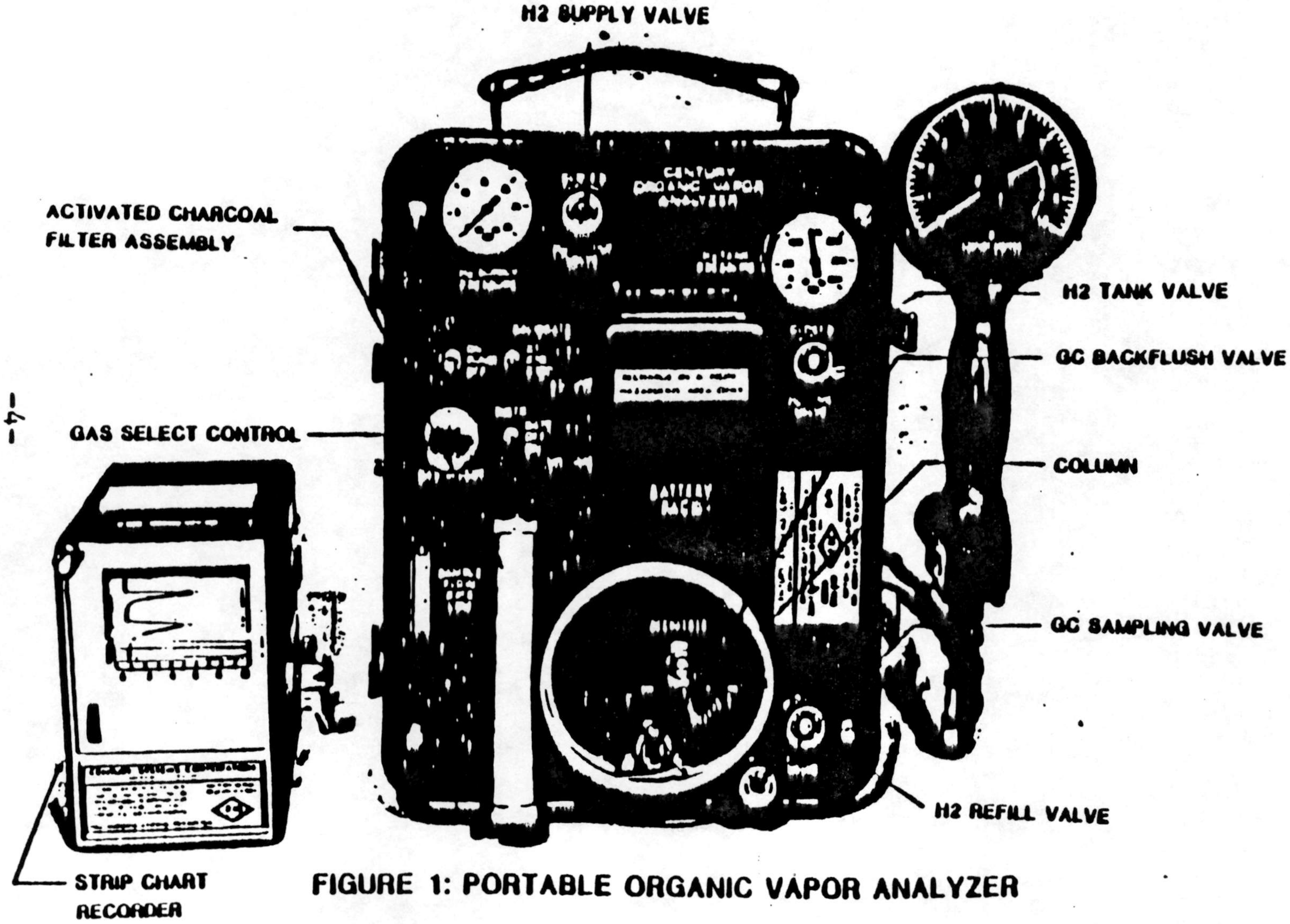

FIGURE 1: PORTABLE ORGANIC VAPOR ANALYZER

B. OPERATION OF THE OVA

Turn On Procedure

1. Move INSTR switch to ON and allow five minutes for warm up. See Figure 1 for illustration of instrument panel.

2. To set the audible alarm to a predetermined level, turn the PUMP switch to ON and adjust the meter pointer to the desired alarm level by using the CALIBRATE ADJUST (zero) knob. Turn the Alarm Level Adjust knob on the back of the Readout Assembly until the audible alarm just comes on. Adjust the speaker volume with the VOLUME knob. The instrument is then preset to activate the alarm when the level exceeds that of the setting.

3. Move the CALIBRATE switch to X10 and adjust the meter reading to zero with the CALIBRATE ADJUST knob.

4. Confirm the PUMP switch is on and observe the SAMPLE FLOW RATE indicator. Indication should be approximately 2 units.

5. Open the H_2 TANK VALVE and the H_2 SUPPLY VALVE one turn each and observe the reading on the H_2 TANK PRESSURE indicator.

Approximately 150 psi is needed for each hour of operation.

6. Open the H_2 supply valve one-half to one turn and observe the reading on the H_2 supply indicator. The pressure should be around 10 psi when operating.

   <u>CAUTION</u>: Do not leave the H_2 SUPPLY VALVE open when the pump is not running as this will allow hydrogen to accumulate in the detector chamber.

7. Confirm that the meter is still reading zero (re-adjust if required).

8. Depress igniter button. There will be a slight "pop" as the hydrogen ignites and the meter pointer will move upscale. Immediately after ignition, release the igniter button. Do not depress igniter button for more than 6 seconds at a time. If the burner does not ignite, let the instrument run for several minutes and try again. After ignition, the meter pointer will indicate the background concentration. Use the CALIBRATE ADJUST knob to zero meter again and null the background reading.

9. Move the instrument to an area where you think the cleanest air to be surveyed is present. Move the CALIBRATE switch to X1 and adjust the meter to read 1 ppm with the CALIBRATE ADJUST knob. This permits minor downward fluctuations in the normal background level without dropping below zero, which would actuate the flame-out alarm. It is important, therefore, to remember that 1 ppm must be subtracted from all readings, e.g., a reading of 1.8 ppm would actually be 0.8 ppm.

10. If the alarm level is to be set above the normal background detection level, turn the Alarm Level Adjust knob on the back of the Readout Assembly until it activates slightly above background. The instrument is now ready for use.

Operation Procedures for Survey Mode

When using the OVA in the Survey Mode, ensure that the SAMPLE INJECT VALVE is in the FULL OUT position and that the BACKFLUSH VALVE is in either FULL IN or FULL OUT position.

1. Set the CALIBRATE switch to the desired range. Using one hand operation, survey the areas of interest while observing the meter and/or listening for the audible alarm. For broad surveys

outdoors, the pickup fixture should be positioned several feet above ground level. When making a quantitative reading or pinpointing a contaminant, the pickup fixture should be positioned at the point of interest.

2. When organic vapors are detected, the meter pointer will move upscale and the audible alarm will sound when the preset point is exceeded. The frequency of the audible alarm will increase as the detection level increases.

3. If the flame-out alarm is actuated, confirm that the pump is running; then, press the igniter button. Under normal conditions, flame-out results from sampling a gas mixture that is above the lower explosive level which causes the H_2 flame to extinguish. If this is the case, reignition is all that is required.

   Another possible cause for flame-out would be restriction of the sample flow line which would not allow sufficient air into the chamber to support combustion of the H_2 flame. The usual cause for such restriction would be a clogged particle filter or other restriction in the line.

> Remember that the chamber exhaust port is on the bottom and blocking it with the hand will cause fluctuations and/or flame-out.

Operating Procedures for GC Mode

To use the OVA in the GC (Gas Chromatograph) mode, place the Sample Inject Valve in the "in" position and turn on the unit as described in this section. Place the BACKFLUSH VALVE in the IN position and leave the hydrogen fuel and pump on for three to four minutes before attempting ignition to allow the hydrogen to purge the column.

A strip chart recorder, called a chromatogram, is usually used to record the output concentration from the OVA as a function of time. Figure 1 shows the GC option and strip chart recorder. The following procedures are for operation of the chromatograph:

> Turn on the recorder and push the Sample Inject valve in with a fast, positive motion. This starts the GC analysis which is automatic until the unit is backflushed. To inject a sample, use an air-tight syringe to draw a predetermined amount of the sample gas into the syringe. Insert the syringe into the column

and inject the sample. Occasionally, the flame in the Flame Ionization Detector (FID) may go out, which would be indicated by a sharp and continued drop of the concentration level. If this occurs, simply re-ignite the flame and continue the analysis. A negative peak typically occurs shortly after sample injection and should not be confused as flame-out. The negative air peak and various positive compound peaks will be indicated on the OVA read-out meter and the strip chart recorder, which represents the chromatogram of the analysis.

After the analyses are complete, rapidly move the Backflush Valve to the out position. Leave the instrument in this position until the backflush peak printed on the recorder returns to baseline; then, return the backflush valve to the "in" position. The OVA is now ready for injection of another sample into the GC system.

Shut-Down Procedures

1. Close H_2 supply valve. Do not tighten the valves down too hard because the Teflon seats are very fragile.

2. Close H_2 tank valve and H_2 Supply valve.

3. Move INSTR switch to OFF.

4. Wait 5 seconds and move PUMP switch to OFF.

C. REFUELING THE OVA

The instrument should be completely shut down during hydrogen tank refilling operations. The tank should be refilled in a ventilated area. There should be no flame or other potential ignition source in the area.

If you are filling the instrument for the first time, or if the filling hose has been allowed to fill with air, THE FILLING HOSE SHOULD BE PURGED WITH N_2 OR H_2 PRIOR TO FILLING THE INSTRUMENT TANK. This purging is not required for subsequent fillings.

- To connect the supply tank to the instrument, first attach the filling hose assembly to the supply tank if it is not left on the tank between fillings. Ensure that the FILL/BLEED valve on the instrument end of the hose is in the OFF position. Connect the hose to the refill connection on the Side Pack Assembly.

BEFORE FILLING THE HYDROGEN TANK, BE SURE TO HAVE THE H_2 TANK VALVE AND H_2 SUPPLY VALVE CLOSED ON THE INSTRUMENT TO PREVENT DAMAGE TO THE PRESSURE REGULATORS.

- Open the hydrogen supply bottle valve slightly. Open the REFILL VALVE and the H_2 TANK VALVE on the instrument panel and turn the FILL/BLEED valve on the filling hose assembly to FILL. The pressure on the instrument tank will now be indicated on the H_2 TANK PRESSURE indicator.
- After the instrument tank is filled, shut off the REFILL VALVE on the panel, the FILL/BLEED valve on the filling hose assembly and the hydrogen supply bottle valve.
- Bleed the filling hose to atmospheric pressure by turning the FILL/BLEED valve on the filling hose assembly to the BLEED position. After the hose is bled to atmospheric pressure, turn the FILL/BLEED valve to the FILL position to allow the hydrogen that is trapped in the connection fittings to go into the hose

assembly. Then, bleed the hose again.

- Turn the FILL/BLEED valve to OFF to keep the hydrogen at one atmosphere in the hose so that at the time of the next filling, there will be no air trapped in the filling line. If possible, leave the filling hose assembly attached to the supply tank.

- Close the H_2 TANK VALVE.

- With the H_2 TANK VALVE and the H_2 SUPPLY VALVE closed, a small amount of H_2 at high pressure will be present in the regulators and plumbing. As a leak check, observe the H_2 TANK PRESSURE indicator while the remainder of the system is shut down. If the pressure indicator decreases rapidly (greater than 350 PSIG/ hr), there is a significant leak in the H_2 supply system.

D. RECHARGING THE OVA

Never charge the OVA in a hazardous area or environment. Approximately one hour of charging time is required for each hour of operation, although an overnight charge is recommended. The charger can be left on indefinitely without damaging the batteries.

Recharging the Batteries

1. Plug charger BNC connector into connector on battery cover and insert AC plug into 115V AC wall outlet.

2. Switch on the battery charger switch. The light above the switch should illuminate.

3. Battery charge condition is indicated by the meter on the front panel of the charger. During charging, the meter will deflect to the right and when the battery is fully charged, the pointer will be in line with the "charged" marker above the scale.

4. When the battery is charged, switch off battery charger and unplug it from the Side Pack assembly.

If the battery has been allowed to completely discharge, the above procedures may not be sufficient to recharge the battery. When this happens, the following steps should be taken:

1. Remove the battery from the instrument case.

2. Connect the battery to any variable DC power supply.

3. Apply 50 volts at 1/2 amp maximum.

4. As soon as the meter on the power supply shows that the battery is drawing current, reduce the voltage on the power supply at a slow rate until the meter reads approximately 15 volts. The time required to reach the 15 volt reading will depend on the degree of discharge.

5. Repeat steps 3 and 4 to continue charging.

E. CALIBRATION OF THE OVA

The OVA is capable of detecting nearly all organic compounds. The instrument is factory-calibrated to a methane in air standard, but it can be easily calibrated to any of a variety of compounds for precise analyses.

A GAS SELECT control on the instrument panel is used to set the electronic gain to a particular organic compound. Internal electronic adjustments are provided to calibrate and align the electronic circuits (Figure 2). There are four adjustments on the electronics board, but one adjustment potentiometer, R-38, is used to set the power supply

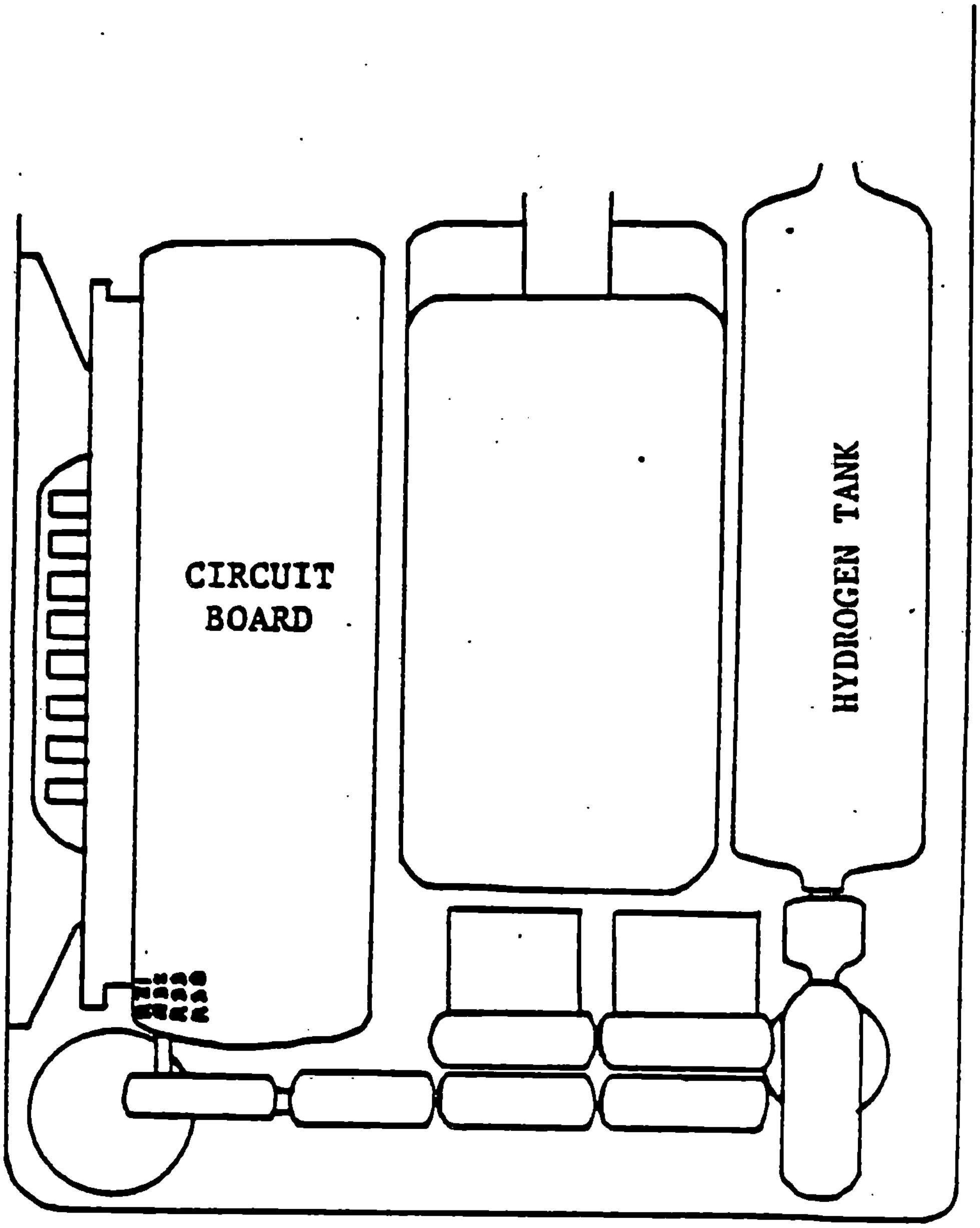

FIGURE 4. LOCATION OF ELECTRONIC ADJUSTMENTS.

voltage and has a one-time factory adjustment. The other three adjustments, R-31, R-32, and R-33, are used for setting the electronic amplifier gain for each of the three calibration ranges. The instrument must be removed from its case to access these adjustments.

To calibrate the OVA to methane, follow the procedures for Gain Adjustment and Bias Adjustment.

Gain Adjustment

1. Turn on instrument as described in Section B. Set CALIBRATE switch to X10 and GAS SELECT control to 300.

2. Use the CALIBRATE ADJUST knob to adjust the meter reading to zero.

3. Introduce a methane sample of a known concentration (near 100 ppm and adjust trimpot R-32 on the circuit board so that the meter reads the concentration as equivalent to that of the known sample. This sets the instrument gain for methane with the gain adjustment on the panel (GAS SELECT knob) set at a reference of 300.

4. Turn off the H_2 SUPPLY VALVE to put out the flame.

Bias Adjustment

5. Leave the CALIBRATE switch on X10 position and use the CALIBRATE ADJUST knob to adjust the meter reading to 4 ppm.

6. Turn the CALIBRATE switch to X1. Using trimpot R-31 on the circuit board, adjust the meter reading to 4 ppm.

7. Set the CALIBRATE switch to X10 again and use the CALIBRATE ADJUST knob to set meter reading to 40 ppm.

8. Move the CALIBRATE switch to X100 position and use trimpot R-33 on the circuit board to adjust meter to 40 ppm.

9. Set the CALIBRATE switch to X10 position and use the CALIBRATE ADJUST knob to adjust meter to zero.

The unit is now balanced from range to range, calibrated to methane, and ready for use.

Calibration to Various Organic Vapors

Primary calibration of the OVA is accomplished by using a known mixture of a specific organic vapor compound.

To calibrate for a specific gas, turn the instrument on as described in Section B, and use the following procedures:

1. Zero out the ambient background reading.

2. Draw a sample of the calibration gas into the instrument. Calibration gases of known concentrations can be obtained from local laboratories or prepared by injecting a known concentration of compound into a known volume of air.

3. Use the GAS SELECT knob to adjust the meter to correspond to the known concentration of the calibration gas mixture.

4. Read and record the setting on the digidial. This is the setting for that particular organic vapor compound.

The instrument is now calibrated for the specific gas mixture. This can be repeated for a large variety of compounds. When a particular compound is to be read, turn the GAS SELECT control to the setting that was recorded for that compound. Calibration on any one range automatically calibrates the other two ranges.

Relative response data can be used to estimate concentrations of various vapors. With the instrument calibrated to methane, obtain the concentration reading for a calibration sample of the test vapor. The relative response, in percent, for that test vapor would then be:

concentration read/concentration of calibrated sample X100.

F. APPLICATIONS

Sample Screening

Priority Pollutant Analyses at hazardous waste sites can run $1,500 a sample. To initially screen samples before analysis to determine if any contaminant is found can be a very cost-effective method. In order to do this, duplicate samples should be collected in 40 ml VOA jars with Teflon-lined caps. Be sure to leave head space in each of the sample jars, for it is actually the head space that you will be analyzing.

Standards can be purchased or prepared specifically for the concentration and identity of the compound or compounds in question. The standard is injected with a gas-tight syringe as described in Part B and retention time and peak height are measured from the standard. Be sure to purge the gas-tight syringe before injecting a sample to prevent cross-contamination.

A known volume (100-1,000 ul) of head space is then injected into the column. Retention times and peak heights for the sample are then compared back to the standard to verify if the compound exists, and, if so, an approximate concentration can be determined. If the sample indicates a positive presence for a specific compound, then the duplicate sample could be sent to an analytical laboratory for quantitation.

General Surveying

The OVA instrument is a very good general survey instrument and is usually used in conjunction with the photo-ionization detector (PID) to verify accuracy of the general readings. The instrument can be used to detect methane whereby the PID is not sensitive to methane. Also, vapor levels can be accessed to diagnose hazards that exist on site and to determine proper levels of personnel protection.

Fugitive Air Emissions

Monitoring of fugitive air emissions at hazardous waste sites can be accomplished by placing one OVA upwind and one downwind of a site.

The instruments are placed in general survey modes and hooked to a strip chart recorder to monitor daily vapor emissions. If properly charged and filled with hydrogen, the instruments will operate on a 8-10 hour basis unattended.

G. TROUBLESHOOTING THE OVA

Table G-1 presents a summary of recommended field troubleshooting procedures when using the instrument in the survey mode. If necessary, the instrument can be easily removed from the case by unlocking the four one-quarter turn fasteners on the panel face and removing the refill cap and exhaust port. The battery pack is removed by taking out the four screws on the panel and disconnecting the power connector at the battery pack.

Table G-2 presents recommended field troubleshooting procedures which are peculiar to the GC system. These are in addition to what is presented in Table G-1.

TABLE VI

TROUBLESHOOTING IN SURVEY MODE

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
1. Low sample flow rate on flow indicator. Nominally 2 units on flow gauge. (See also 6 below.)	a) Check primary filter in sidepack and particle filters in the pickup assembly.	Replace or clean filter if clogged. The filter is located behind the sample inlet connector on the Side Pack Assembly and is removed by using a thin wall socket to unscrew the Fitting Assembly. The filter cup, "O" ring, and loading spring will come out and the filter cup can then be cleaned by blowing it out or washing it in a solvent. If a solvent is used, al solvent should be removed by blowing out or heating the filter. Reassemble in reverse order.
	b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove Readout Assembly, remove primary filter, etc.	Investigate the assembly containing this restriction determine cause of blockage. Clean or replace as required.
	c) If the restriction is in the Side Pack Assembly, further isolate by disconnecting the sample flow tubing at various points, i.e., pump output, chamber input, etc. Note: The inherent restrictions due to length of sample line, flame arrestors, etc., must be taken into account when troubleshooting.	If restriction is in the detector chamber, remove and clean or replace porous metal flame arrestors. If pump is found to be the problem, remove and clean or replace.
2. H2 flame will not light. (See also 6 below).	a) Check sample flow rate (see 1 above).	If sample flow rate is low, follow procedure 1 above.
	b) Check igniter by removing the chamber exhaust port and observing the flow when the IGNITE Button is depressed.	If igniter does not light up, replace the plug. If igniter still does not light, check the battery and wiring.
	c) Check for rated H2 Supply Pressure. (Listed on calibration plate on pump bracket.)	If low, remove battery pack and adjust to proper level by turning the allen wrench adjustment on the low pressure regulator cap.
	d) Check H2 flow rate by observing the PSI decrease in pressure on the H2 Tank Pressure gauge. The flow rate should be about 130 PSI decrease in pressure per hour. (Approximately 12 cc/min. at detector.) On instruments with GC Option, disconnect column and measure H2 flow rate with a bubble meter.	The usual cause for H2 flow restriction is blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the H2 Supply Pressure by one-half or one PSI. If flow rate cannot be compensated for, replace capillary tubing.

TABLE G1 (Continued)

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
	e) Check all H2 plumbing joints for leaks using soap bubble solution. Also, shut off all valves and note pressure decay on H2 tank gauge. It should be less than 350 PSIG per hour.	Repair leaking joint.
	f) Check to see if H2 supply system is frozen up by taking unit into a warm area.	If there is moisture in the H2 supply system and the unit must be operated in subfreezing temperatures, purge the H2 system with dry H2 and ensure the H2 gas used is dry.
	g) Remove exhaust port and check for contamination.	If the chamber is dirty, clean with ethyl alcohol and dry by running pump for approximately 15 minutes. If H2 fuel jet is misaligned, ensure the porous metal flame arrestor is properly seated.
	h) Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.	Adjust by screwing Mixer/Burner Assembly in or out. This spacing problem should only occur after reassembling a Mixer/Burner Assembly to a Preamp Assembly.
3. H2 flame lights but will not stay lighted	a) Follow procedures 2(a), (c), (d), (e), (g), and (h) above. Also refer to 5 below.	
4. Flame-out alarm will not go on when H2 flame is out.	a) Check instrument calibration setting and GAS SELECT control setting. Refer to Section B-Turn On Procedure.	Readjust as required to proper setting. Note that on linear OVAs the flame-out alarm is actuated when the meter reading goes below zero. On logarithmic OVAs, the alarm is actuated when the signal level goes below 1 ppm methane or equivalent.

ATTACHMENT C

EXPLOSIMETER OPERATION, MAINTENANCE, AND CALIBRATION PROCEDURES

MSA

Combustible Gas and Oxygen Alarm

part no.
449900

model 260

instruction manual

IMPORTANT WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR INSTALLING, USING, OR SERVICING THE PRODUCT. Like any piece of complex equipment, the Combustible Gas and Oxygen Alarm, Model 260 will perform as designed only if it is installed, used and serviced in accordance with the manufacturer's instructions. OTHERWISE IT COULD FAIL TO PERFORM AS DESIGNED AND PERSONS WHO RELY ON THIS PRODUCT FOR THEIR SAFETY COULD SUSTAIN SEVERE BODILY INJURY OR DEATH.

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not installed, used and serviced in accordance with the instructions in this manual. Please protect yourself and your employees by following them. We encourage our customers to write or call for a demonstration of this equipment prior to use or for any additional information relative to use or repairs.

Manufactured by
MINE SAFETY APPLIANCES COMPANY
PITTSBURGH, PENNSYLVANIA, U.S.A. 15230

CONTENTS

FIGURES

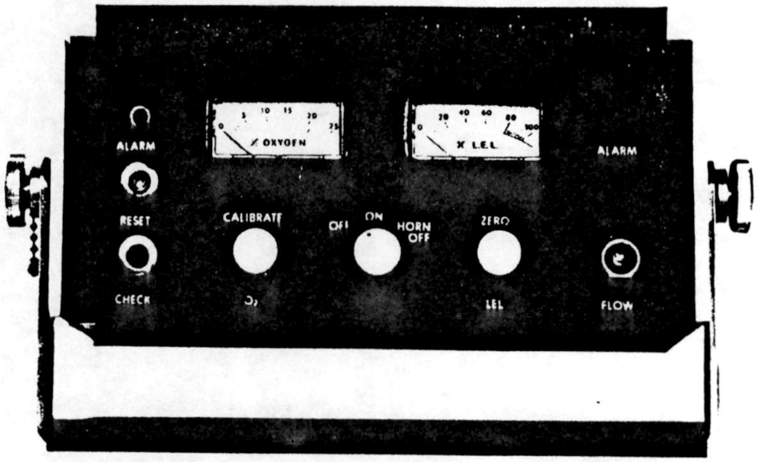

FIGURE 1 — MSA MODEL 260 CONTROL PANEL

I. CAUTIONS AND LIMITATIONS

Prior to testing potentially dangerous atmospheres with the MSA® Model 260 Combustible Gas and Oxygen Alarm the user should be familiar with the first five sections of this instruction manual.

Cautions and limitations associated with the use of the Model 260 are as follows:

1. **The Model 260 is designed to measure combustible gas or vapor content in air. It will not indicate the combustible gas content in an inert gas background, furnace stack or in a reducing atmosphere. Further, this instrument should not be used where the oxygen concentration exceeds that of fresh air (oxygen enriched atmospheres).**
2. **Proper readings are obtained only when the battery has a sufficient level of charge.**
   a. **The battery charge level should be checked occasionally throughout a testing period.**
   b. **Upon receiving a new Model 260, it is recommended that the battery be charged for at least 16 hours.**
   c. **As a regular monthly maintenance item for optimum battery service, the Model 260 should be run for 8 to 10 hours and then fully charged for 24 to 36 hours.**
   d. **After each day of use or if the indicator has not been used for more than 7 days, the battery should be charged for a minimum of 16 hours.**
   e. **Do not operate Model 260 while it is charging.**
   f. **Recharging must be done in a non-hazardous location, known to be free of combustible gases or vapors.**

3. Certain materials such as silicone, silicates and organic lead compounds tend to poison the pelement catalyst thereby giving erroneously low readings. Calibration checks should be made frequently if such materials are suspected to be present in the tested atmosphere. (See Section III for more detail.)

4. The combustible gas indicator detects only combustible gases and vapors in air. It will not indicate the presence of combustible airborne mists or dusts such as lubricating oils, coal dust, or grain dust.

5. Pressurized or low pressure samples will give erroneous oxygen percent readings. For atmospheric sampling at higher or lower altitudes the instrument oxygen meter should be calibrated at the elevation where sampling is to take place.

6. Acid gases, such as carbon dioxide will shorten the service life of the oxygen sensor.

7. The oxygen sensor is packaged separately in an inert atmosphere. It must be installed before the Model 260 can be used.

8. When sampling with accessory sampling lines, a 50 foot sample line will increase the initial response time of the Model 260 to approximately 30 seconds and the final response to approximately 3 minutes. Two 50 foot lines connected in series will increase the response times to 60 seconds and 6 minutes respectively. Lines over 100 feet in length are not recommended.

INITIAL INSTALLATION INSTRUCTIONS FOR OXYGEN SENSOR

The oxygen sensor used in the Model 260 to measure the oxygen concentration is now packaged separately. The oxygen sensor must be installed in the Model 260 prior to placing the instrument into service. Once installed, it should be left in place until end of its useful life, normally one year.

To install the sensor:

1. Remove the carrying handle by loosening both knurled screws and spreading the handle beyond the collars. Lift it from the shafts of the screws.
2. Remove the left side of the case by removing the four mounting screws. Slowly draw the side away from the case as far as the connecting wires will permit. (Hold the case lid to prevent its falling from the case).
3. Slide the top panel approximately three inches from the remainder of the case.
4. Open the protective bag containing the oxygen sensor and install the "O" ring provided onto the threaded end of the sensor.
5. Screw the sensor into the manifold by hand, firmly, so as to compress the "O" ring and prevent sample flow leakage.
6. Push the connectors onto the two terminals at the top of the sensor — the gray wire to the positive terminal and the yellow wire to the negative.

7. Reassemble the case by sliding the top panel back into position.
8. Place the case side in position and install the lid hinge pins into each side.
9. Install the mounting screws. Note: insert all four screws loosely before tightening any one of them.
10. Reattach the handle.
11. See the instruction manual pages for leak testing the sample flow system and adjusting the oxygen calibration.

II. INSTRUMENT DESCRIPTION

The MSA Model 260 Combustible Gas and Oxygen Alarm is a hand-carried, battery-operated instrument (See Figures 1 and 2). It has been designed to sample atmospheres for combustible gases or vapors and oxygen content and warn the user when pre-determined concentrations of either are reached.

Major features of the Model 260 are ease of operation and reliability. Integrated circuit electronics and rugged components have been used to provide a tough, compact instrument.

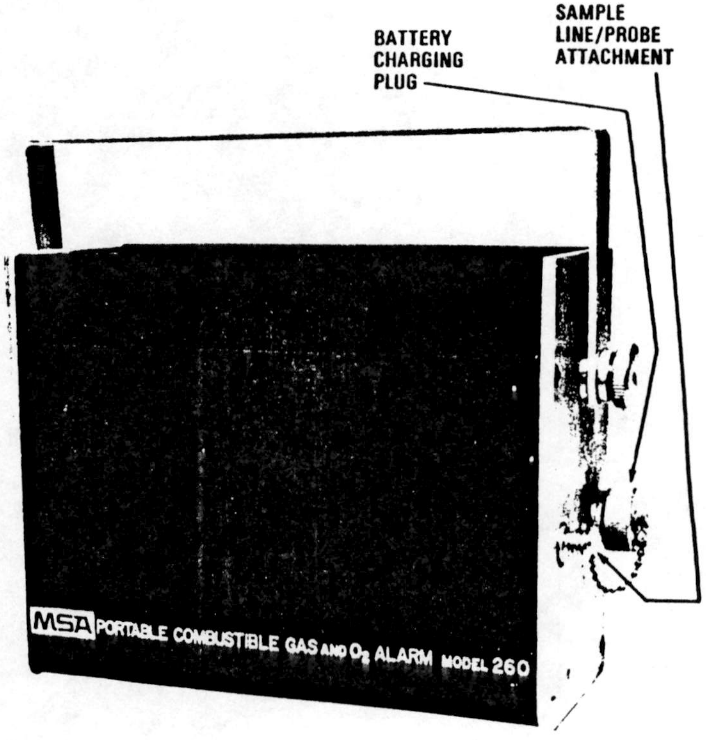

FIGURE 2 —
SAMPLE LINE/PROBE AND BATTERY CHARGING CABLE ATTACHMENTS

FIGURE 3 — MANIFOLD BLOCK

The Model 260 is two completely separate indicators in a single housing and uses a common flow system. Oxygen and combustible gas concentrations shown on separate meters are automatically indicated by red alarm lights and an audible alarm. Other controls provide quick on-site operational checks. The zero and calibrate controls may have "lift-to-adjust" knobs to prevent accidental changing of adjustments.

A small pump pulls the atmospheric sample through a manifold block in which the oxygen sensor and combustible gas diffusion head are mounted (Figure 3). The flow then passes through the pump and to a flow indicator on the control panel prior to being exhausted (Figure 4). The approximate flow rate is 1 liter per minute.

The Model 260 is powered by a rechargeable 2.4 volt Ni-Cd battery pack (Figure 5) sealed in a plastic case. Recharging circuitry is contained within the instrument. Recharging requires only connecting the instrument into a 115V ac outlet using the cord supplied with the instrument.

The battery also can be recharged from a 12V dc source (such as an automobile battery) by the use of an accessory charge cord. The connectors of the charging cords are keyed to the receptacle on the instrument to prevent accidental use of an incorrect power supply. A fully-charged battery provides over 8 hours of continuous non-alarm operation.

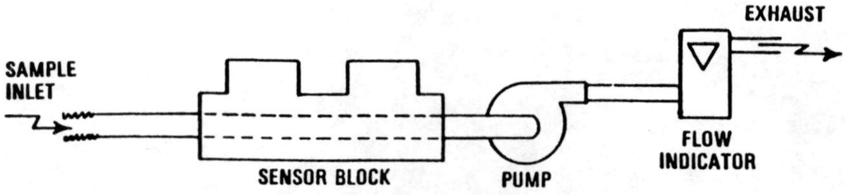

FIGURE 4 — FLOW DIAGRAM

III. USE AND LIMITATIONS

The MSA Model 260 Oxygen and Combustible Gas Alarm provides an efficient and reliable method of testing atmospheres for sufficient oxygen content for life support and/or the presence of combustible gases or vapors which may pose a potential flammability hazard. Common examples of such locations are man-holes, storage tanks, tank cars, confined spaces, pumping stations, etc.

It is important that the instrument response be appraised by someone skilled or experienced in properly interpreting the instrument readings with respect to particular conditions, on-going operations and safe practices. For example, an atmosphere that shows no flammability hazard can still be toxic to workmen. Also a tank or vessel which is safe before work is initiated may be rendered unsafe by work activities which cause a temperature increase, or by stirring or handling bottom sludge in petroleum tanks.

Combustible gases will burn or explode only when the fuel/air mixtures are within certain proportions. For most common hydrocarbon gases this range of proportions runs from approximately 1% to as high as 15% by volume in air. The minimum concentration of a particular combustible gas in air which can be ignited is defined as the LOWER EXPLOSIVE LIMIT; abbreviated L.E.L. The maximum concentration that can be ignited is defined as the UPPER EXPLOSIVE LIMIT; abbreviated U.E.L. In some references the terms are called LOWER and UPPER LIMITS of FLAMMABILITY (LFL or UFL).

The combustible measurement is dependent upon catalytic combustion of the flammable gas in combination with the oxygen in the air. Conditions can exist in a closed space where not enough oxygen remains to provide a correct combustible gas reading. (NOTE: This low oxygen level is far below what is required for human life.) In these instances, the % oxygen reading is most important. A low oxygen concentration in an enclosed atmosphere indicates that: (1) some other gas has displaced much of the air, or (2) some process has consumed much of the available oxygen.

Upon initially opening and probing an enclosed area, move the probe into the area slowly while watching the meters to provide the earliest possible indication of a potentially dangerous condition.

Be prepared to vacate the area if the Model 260 combustible or oxygen meter indicates the possibility of a hazardous condition.

The oxygen sensor responds to the partial pressures of oxygen in the atmosphere being tested. For this reason, changes in atmospheric or sample pressure will change the oxygen reading. Calibration should be checked and adjusted at the elevation where the instrument is to be used.

The oxygen sensor is temperature compensated in the range of 32 to 104°F (0 to 40°C), use down to 0°F is possible when calibrated at the temperature and if more sampling time is allowed for slow sensor response — approximately 3 minutes without sample line.

The life of the oxygen sensor is reduced by exposure to carbon dioxide. The sensor life will be reduced to 2 days in 100% carbon dioxide, 50 days in 5% and 100 days in 1%. The effect is cumulative therefore all tests of atmospheres containing excess concentrations of carbon dioxide should be stopped as soon as a constant reading is obtained. Abnormally slow recoveries to the air calibration point after exposure to high carbon dioxide is to be expected.

Certain materials in the sampled atmosphere affect the catalytic material on the pelement and may cause the indicator to respond incorrectly. Included are organic lead compounds such as are used in leaded gasoline and silicon compounds in the form of silanes, silicones and silicates (often found in hydraulic fluids).

When an atmosphere contaminated with leaded gasoline is tested, the lead produces a solid product of combustion which, upon repeated exposure, may develop a coating upon the detector pelement resulting in a loss of sensitivity. To reduce this possibility, an inhibitor-filter is available for insertion in an external cartridge holder. This device chemically reacts with the tetra-ethyl lead vapors to produce a more volatile lead compound.

The inhibitor-filters are available in packages of six each and identified by part number 47740. Each consists of a glass ampoule wrapped with cotton and filled with chemical. To prepare the item for use, the ampoule should be crushed between the fingers then inserted in the external cartridge holder. One inhibitor-filter will provide instrument protection for eight hours of continuous testing.

Silanes, silicones, silicates and other volatile compounds containing silicon in the tested atmosphere may seriously impair the response of the instrument. Some of these materials rapidly "poison" the detector filament so that it will not function properly. When such materials are even suspected to be in the atmosphere being tested, the instrument calibration must be checked after each series of tests.

As mentioned previously, the battery must have a sufficient charge level for the Alarm to function properly. For this reason, a convenient battery check push-button has been included on the Alarm control panel. The battery should also be performance-checked monthly. See Section VI, MAINTENANCE AND CALIBRATION.

The Model 260 Combustible Gas Indicator is normally calibrated on pentane as being representative of the flammability characteristics of most commonly encountered combustible gases. The meter scale is calibrated from zero to 100% L.E.L. which corresponds to actual volume concentrations of 0 to approximately 1.4% pentane in air. A booklet of response curves is supplied with the Model 260. These curves may be used to interpret meter readings when sampling combustible gases other than pentane. Calibration for combustibles other than pentane may be made on special order.

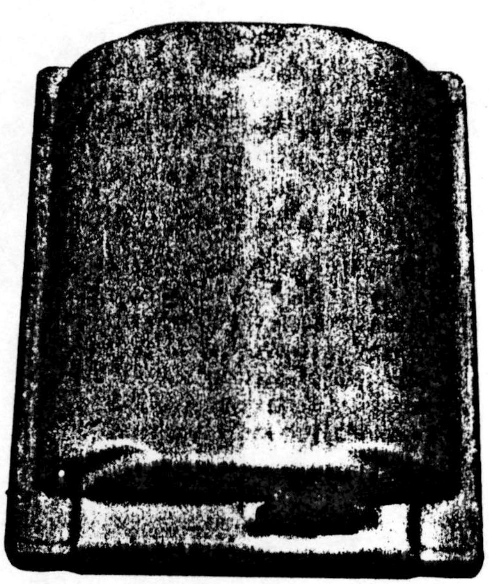

FIGURE 5 — BATTERY PACK

Accessory Items

A number of accessories are available for use with the Model 260 Combustible Gas and Oxygen Alarm. Part numbers are listed in the last section.

Sample lines	special synthetic rubber lines which have minimal gas adsorption characteristics are available in 5, 10, 25 and 50 foot lengths.
Sample probes	3-foot hollow brass probe, a 3-foot plastic probe for possible electrical hazards and a 4-foot solid end probe to prevent liquid pickup from wet tank bottoms, etc.
Dust filter	a cotton filter fitting an external holder provides sensor protection from dirt accumulation in dusty or dirty atmospheres.
Inhibitor filter	protects catalytic filaments from being "poisoned" by leaded fuels. Fits external filter holder.
External filter holder	accommodates either a dust filter or an inhibitor filter.
Line trap assembly	prevents liquids from being drawn into the instrument.

Calibration check equipment	consists of a supply of calibration gas, a flow regulator and an adapter hose.
Harness, carrying	neck and waist straps to hold the Model 260 while climbing etc.

IV. PRINCIPLES OF OPERATION

A block diagram of the MSA Model 260 is shown in Figure 6. The oxygen and combustible gas indicators are operated simultaneously. Each indicator has an alarm warning light which provides a visual alarm signal. An alarm signal on either unit will energize an audible alarm as well. A switch allows the audible alarm to be turned off if so desired. The alarm lights will stay on until the reset button is pushed after the concentration returns to the predetermined level.

Oxygen Analyzer

The oxygen analyzer is a galvanic type cell containing dissimilar metal electrodes in a special electrolyte. The cell is sealed with a membrane which allows oxygen to diffuse into the active area. The current generated by the cell is proportional to the oxygen partial pressure in the atmospheric sample passing over the face of the membrane. The generated current passes through a resistance to provide a voltage input signal for an amplifier. The output of the amplifier drives the oxygen indicating meter and also serves as an input to the alarm comparator circuitry.

Combustible Gas Indicator

The flammable properties of combustible gases are used as a basis of detection for the combustible gas indicator. The sensor consists of a pair of pelletized filaments called "pelements" arranged in an electrically balanced bridge circuit. The detector pelement is treated with a special catalyst. The catalyst causes the combustible gases to combine with oxygen at much lower temperatures than would be required for normal burning. The inactive compensator pelement is also exposed to the sample flow and acts to offset any electrical changes caused by flow conditions, sample temperature, pressure and/or humidity.

Combustible gases in the sample combine with oxygen at the surface of the catalyzed detector pelement. Heat is liberated by this chemical reaction increasing the temperature of this pelement causing an associated increase in the pelement electrical resistance.

Increased resistance of the detector pelement unbalances the bridge causing a voltage change in the mid-point connection between the detector pelement and compensating pelement. This voltage signal is applied to an amplifier which drives the combustible gas indicating meter and provides an input for an alarm comparator circuit.

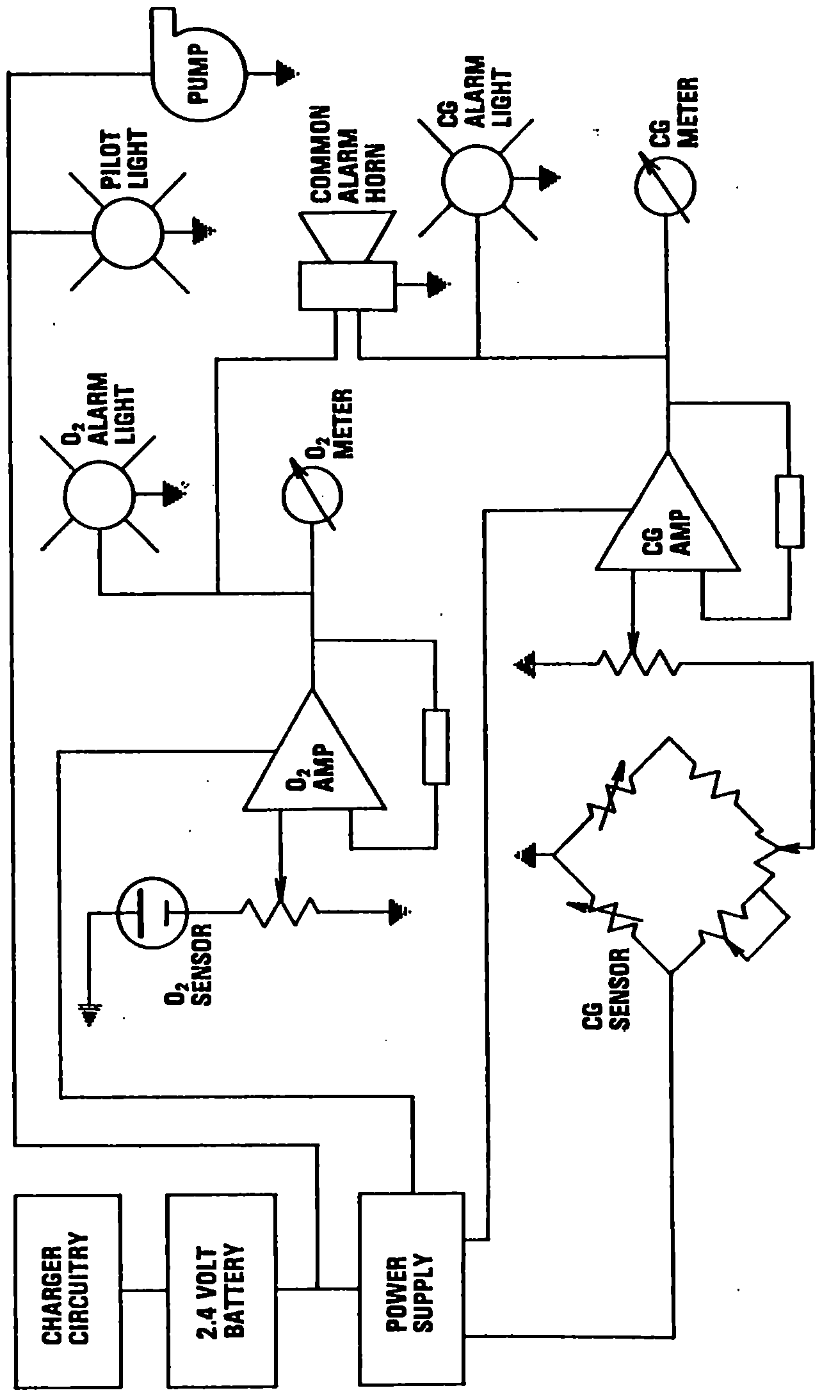

FIGURE 6 — BLOCK DIAGRAM

V. OPERATING PROCEDURE

The Model 260 should be checked and "zeroed" in an uncontaminated atmosphere. Refer to Figure 1 and use the following procedure.

1. Open the instrument lid. Turn the center ON-OFF control to the far right HORN-OFF position. Both meter pointers will move and one or both alarm lights may light.
2. If the % oxygen meter pointer stabilizes at a value other than 20.8%, the pointer should be set to 20.8% by using the CALIBRATE O_2 control.
3. The % LEL meter pointer should be set to zero by adjusting the ZERO LEL control.
4. If either the alarm lights are lighted press the Alarm Reset button.
5. Momentarily place a finger over the sample inlet fitting or the end of the sample line probe. Observe that the flow indicator float drops out of sight indicating no flow. If the float does not drop, check out the flow system for leaks as described under Section VII.
6. Press the CHECK button and observe the % LEL meter. The pointer must read at 80% LEL or higher as marked by the BATTERY zone on the meter. If the pointer reading is less, the batteries must be recharged. No tests should be attempted as the instrument will not perform properly. See Section VI for battery charging instructions.
7. If it is desired that the audible alarm sound for combustible gas or low oxygen concentrations, turn the center ON-OFF control back one position to the ON setting.
8. Accessory equipment such as sampling lines, probes, carrying harness, filters or line traps should be attached as required. See Figure 2.
9. The instrument is ready for atmospheric sampling.

VI. MAINTENANCE AND CALIBRATION

Battery Service

The primary maintenance item of the Model 260 is the rechargeable 2.4 volt nickel cadmium (Ni-Cd) battery (Figure 7). The battery is recharged by simply removing the screw cap covering receptacle and connecting one end of the charging cable to the instrument and the other end to a 115V ac outlet.

If desired, the battery can be recharged from a 12V dc source. An accessory battery charging cable is available, one end of which plugs into the Model 260 while the other end is fitted with an automobile cigarette lighter plug.

Recommended charging time is 16 hours. It may be left on charge for longer periods without damaging the battery.
CAUTION: RECHARGING MUST BE DONE IN A NON-HAZARDOUS LOCATION.

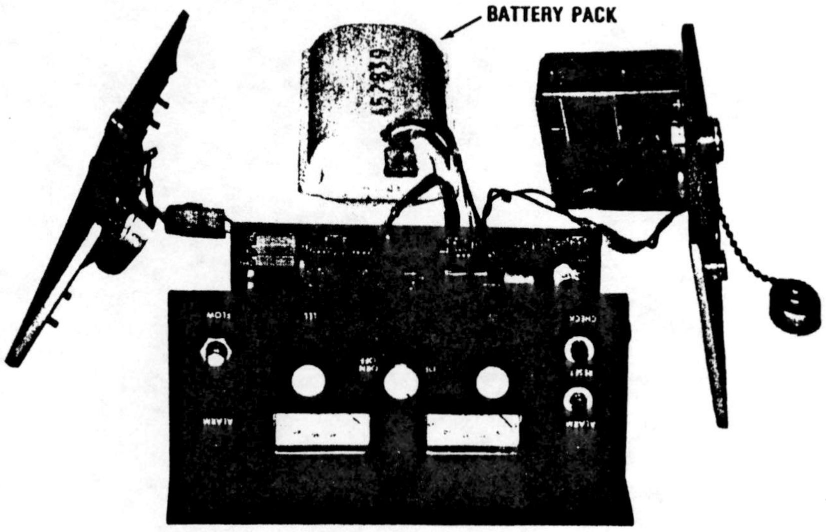

FIGURE 7 — DISASSEMBLY SHOWING BATTERY PACK

The batteries sometimes will not supply full power capacity after repeated partial use between chargings. For this reason, it is recommended that the batteries be "exercised" at least once monthly. Run the Model 260 for 8 to 10 hours and then recharge.

If the instrument has not been used for 30 days, the batteries should be charged prior to use.

Should the battery not respond to recharging or not "hold" a charge, the battery should be replaced. Replacement procedure is as follows:

1. Loosen the knurled screws holding the handle and remove the handle.
2. Looking at the front panel of the instrument, remove the right side (audible alarm side panel) by unscrewing the four side panel screws.
3. Gently pull the side panel loose and tilt the instrument to help the battery case slide out. Disconnect the molded nylon plug.
4. Install new battery in the reverse procedure outlined above.

Calibration

Before the calibration of the combustible gas indicator can be checked, the Model 260 must be in operating condition as described in the OPERATING PROCEDURE, Section V. Optional calibration equipment is shown in Figure 8. Calibration check-adjustment is made as follows:

1. Attach the flow control to the recommended calibration gas tank.
2. Connect the adapter-hose to the flow control.
3. Open flow control valve.
4. Connect the adapter-hose fitting to the inlet of the instrument; after about 15 seconds the L.E.L. meter pointer should be stable and within the range specified on the calibration sheet accompanying the calibration equipment. If the meter pointer is not in the correct range, stop the flow, remove the right hand side cover. Turn on the flow and adjust the "S" control with a small screwdriver to obtain a reading as specified on the calibration sheet.
5. Disconnect the adapter-hose fitting from the instrument.
6. Close the flow control valve.
7. Remove the adapter-hose from the flow control.
8. Remove the flow control from the calibration gas tank.
9. Replace the side cover on the Model 260.

CAUTION: Calibration gas tank contents are under pressure. Use no oil, grease or flammable solvents on the flow control or the calibration gas tank. Do not store calibration gas tank near heat or fire or in rooms used for habitation. Do not throw in fire, incinerate or puncture. Keep out of reach of children. It is illegal and hazardous to refill this tank. Do not attach the calibration gas tank to any other apparatus than described above. Do not attach any gas tank other than MSA calibration tanks to the regulator.

Printed Circuit Board Adjustments

The printed circuit board contains six adjustment pots as shown in Figure 9. These are identified as:

Oxygen Indicator Adjustment

O_2H — The oxygen high alarm point adjustment (factory set at 25%).

O_2L — The oxygen low alarm point adjustment (factory set at 19.5% oxygen).

Combustible Gas Indicator Adjustments

CGA — The combustible gas alarm point adjustment (factory set at 50% L.E.L.)

S — After zeroing, span is adjusted by sampling calibration gas and adjusting the read-out accordingly.

CZ — Coarse zero is adjusted by setting the ZERO L.E.L. control at mid-range; sampling fresh air and adjusting the % L.E.L. meter to read zero.

B-CHK This controls the battery charge indication and is factory set to read at "B" in the word BATTERY on the meter face when the battery voltage measured with a voltmeter is 2.25V.

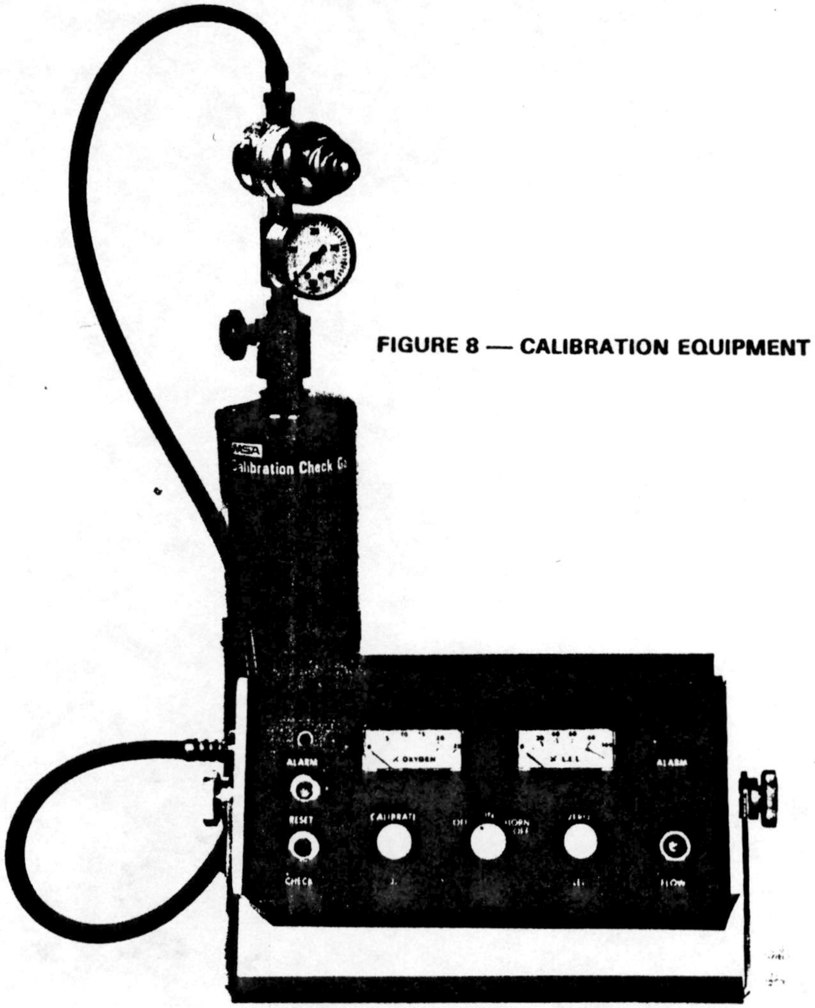

FIGURE 8 — CALIBRATION EQUIPMENT

FIGURE 9 — PRINTED CIRCUIT BOARD ADJUSTMENTS

VII. TROUBLE-SHOOTING AND REPAIR

Difficulties with the Model 260 can be localized by disassembling the instrument and performing a few tests described below. Refer to Figure 10. Disassembly procedure is:

1. If an accessory is attached to the side of the instrument case, disconnect it.
2. Remove the carrying handle.
   a. Loosen both knurled screws.
   b. The arms of the handle ride on a collar. Spread the arms beyond the collar and lift the handle from the shaft of the knurled screw.

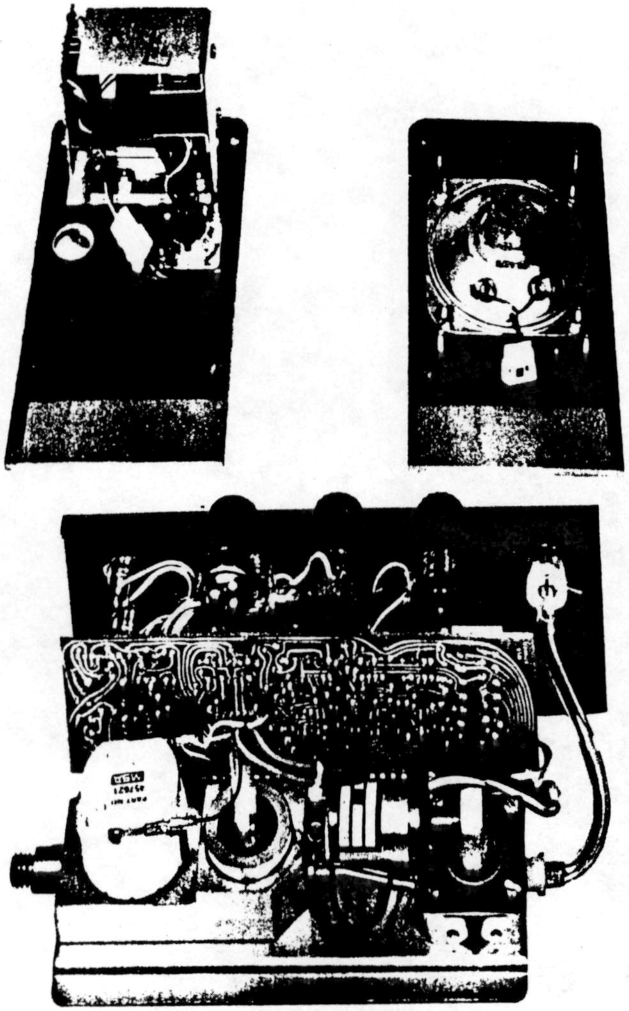

FIGURE 10 — DISASSEMBLY PHOTO

3. Remove both sides of the case by removing the two sets of four screws. Slowly draw the sides away from the case as far as the connecting wires will permit.
4. Disconnect molded nylon plugs from battery and the speaker.
5. Slide the battery out of the case.
6. All of the remaining components and wiring are bolted to the top panel of the case. This panel assembly can be removed as a unit by simply sliding the assembly from the extruded sides of the case.
7. For trouble-shooting, the battery can be re-connected after the instrument is out of the case.

Flow System

Flow problems — should flow continue when the inlet is shut, a leak in the flow system is indicated. Stop off the flow at the pump inlet ascertaining that the pump stalls. Work back the flow path towards the sample inlet until the leak is identified.

Pump — the pump and motor are capable of 750 to 1000 hours of sampling. After this period of time the motor may fail to start or may run erratically. The pump assembly should be replaced if the panel mounted flow indicator indicates no flow when the instrument is turned on and the battery check reading indicates a charged battery. The pump assembly is replaced as follows:

1. Remove the printed circuit board.
2. Unsolder the pump leads.
3. Remove the two screws from the base of the Pump Assembly.
4. Withdraw the Pump Assembly and remove the plastic tubing.
5. Attach the new Pump Assembly (pump and motor) to the mounting plate with the two screws.
6. Connect the plastic tubing to the pump.
7. Solder the pump power leads to the motor terminals.
   a. Solder the red wire to the positive terminal of the motor.
   b. Solder the black wire to the negative terminal of the motor.
8. Insert the printed circuit board, check operation and reassemble the instrument.

Oxygen Cell

The Oxygen Cell should perform for approximately one year without attention or maintenance. Eventually, however, it will lose sensitivity. When it does, the meter needle can no longer be set to 20.8% with the CALIBRATE knob when sampling fresh air. At this time, the cell should be replaced. Use the following procedure.

To remove the Oxygen Cell, disassemble the instrument and remove the printed circuit board.

1. Disconnect the positive (gray) and negative (yellow) slip-on leads from the Oxygen Cell.
2. Turn the Oxygen Cell counterclockwise to remove it and its "O" ring from the manifold.

3. Install the "O" ring and the new Oxygen Cell.
4. Connect the gray lead to the positive terminal and the yellow lead to the negative terminal.
5. Check for leaks in flow system; see step 5 of Operation Procedure.
6. Reassemble the instrument; turn ON and check the O_2 calibration — adjust if necessary.

Combustible Gas Indicator

It is recommended that at least once each week the combustible gas indicating portion of the instrument be checked for operating accuracy with a known gas-air mixture and be adjusted as necessary. (MSA supplies such calibration equipment as accessory items.) If proper calibration cannot be attained and/or the combustible gas meter cannot be zeroed, then the sensor diffusion head should be replaced and the instrument calibrated. Use the following procedure:

1. Unplug the nylon connector from the sensing head.
2. The diffusion head is held to the manifold with a retaining ring. Unscrew the retaining ring by turning it counterclockwise, remove the diffusion head and remove the "O" ring.
3. Insert the "O" ring and the new diffusion head into the manifold.
4. Lock the diffusion head to the manifold with the retaining ring. Use enough finger pressure on the retaining ring to compress the "O" ring.
5. Connect the nylon sensing head plug.
6. Reassemble the instrument.
7. Check for leaks in flow system, see step 5 of Operation Procedure.
8. Check calibration: see Maintenance and Calibration.

If additional servicing is required, send the complete instrument to: **Mine Safety Appliances Company**
Repair Department
Walden Road
Mars, PA 16046

VIII. PARTS AND ACCESSORIES LIST

When ordering MSA Combustible Gas and Oxygen Alarm, or any of the replacement parts or accessories, please use part numbers.

Description	**Part No.**
Combustible Gas and Oxygen Alarm Model 260	449900
5-Foot Synthetic Rubber Sampling Line complete with couplings	11354
10-Foot Synthetic Rubber Sampling Line complete with coupling	11955
15-Foot Synthetic Rubber Sampling Line complete with couplings	11912
25-Foot Synthetic Rubber Sampling Line complete with couplings	11913
50-Foot Synthetic Rubber Sampling Line complete with couplings	11958
Tube, 3-Foot Hollow Grass Probe	11961
Tube, 3-Foot Plastic Probe	73743
Rod, 4-Foot Solid Brass Probe	11960
Filter, Cotton Dust, package of 6	11499
Filter, Inhibitor, package of 6	47740
External Cartridge Holder	14273
Line Trap	74809
Line Trap Adaptor	459641
Oxygen Sensor	457621
Pump Assembly	449965
Harness, Carrying	457754
Cable, Charging, 115V 60Hz ac	449918
Cable, Charging, 12V dc	449919
Diffusion Head	449917
Battery Pack	457839
Printed Circuit Board (replacement)	449906
Calibration:	
Flow Control, 1.5 1/m	459948
Calibration Gas 0.75% Pentane in Air	466193
Calibration Gas 0.6% Propane in Air	459943
Adapter, Hose	449401

WARNING: Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Repair or alteration of the Model 260 beyond the scope of these maintenance instructions, by anyone other than a certified MSA serviceman, may void all warranties and approvals.

Manufactured by

MSA MINE SAFETY APPLIANCES COMPANY
PITTSBURGH, PENNSYLVANIA, U.S.A. 15230

TAL 5811 (L) REV. ■ 5

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ATTACHMENT D

MINI-RAM OPERATION, MAINTENANCE, AND CALIBRATION PROCEDURES

MINIRAM PERSONAL MONITOR

MODEL PDM-3

OPERATIONS MANUAL

November 1983

GCA
GCA CORPORATION
Technology Division

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1.0 DESCRIPTION

1.1 Sensing Method

The MINIRAM (for Miniature Real-time Aerosol Monitor) Model PDM-3 is an ultra-compact personal-size airborne particulate monitor whose operating principle is based on the detection of scattered electromagnetic radiation in the near infrared. The MINIRAM uses a pulsed GaAlAs light emitting source, which generates a narrow-band emission (half-power width of 80 nm) centered at 880 nm. This source is operated at an average output power of about 2 mW. The radiation scattered by airborne particles is sensed over an angular range of approximately 45° to 95° from the forward direction by means of a silicon-photovoltaic hybrid detector with internal low-noise preamplifier. An optical interference-type filter is incorporated to screen out any light whose wavelength differs from that of the pulsed source.

The MINIRAM is a light scattering aerosol monitor of the nephelometric type, i.e., the instrument continuously senses the combined scattering from the population of particles present within its sensing volume (approximately 1 cm^3) whose dimensions are large compared with the average separation between the individual airborne particles.

1.2 Open Sensing Chamber Sampling Method

Air surrounding the MINIRAM passes freely through the open aerosol sensing chamber as a result of air transport caused by convection, circulation, ventilation, and personnel motion. The MINIRAM requires no pump for its operation, and the scattering sensing parameters have been designed for preferential response to the particle size range of 0.1 to 10 micrometers, ensuring high correlation with standard gravimetric measurements of both the respirable and thoracic deposition fractions. Optional flow accessories are available for applications requiring specific inertial particle precollection, extractive sampling, concurrent filter collection, etc.

It should be noted that one of the advantages of direct light scattering aerosol sensing is that the rate at which air passes through the sensor does not influence the indicated concentration because the detection is performed directly on every parcel of air traversing the fixed sensing volume. Therefore, flow velocity through a real-time sensor such as the MINIRAM influences only the response time. So, it should not surprise the first-time user when, upon pressing the MEAS key of the MINIRAM, no pump noise is heard, and this silence will be accompanied by a readout message of "GO" on the liquid-crystal display indicating that the MINIRAM has, indeed, been activated.

1.3 MINIRAM Electronics

The GCA MINIRAM is a very advanced aerosol monitor which incorporates a custom-designed single-chip CMOS microprocessor whose functions are to: process the signal from the light scattering detection circuit, control the measurement sequence program, compute concentration averages, keep record of elapsed time, perform automatic zero correction, control auto-ranging, drive the liquid-crystal-display, store average concentration values as well as timing and identification information, sense battery and overload conditions, sequence playback of stored information, and provide alarm signals.

The MINIRAM derives its power from a set of internal rechargeable Ni-Cd batteries which can provide continuous monitoring operation for over 8½ hours, or retain stored information for up to approximately 6 months. The battery set is packaged as a separable module which allows easy field replacement when recharging is not feasible. The MINIRAM can be run without time limit from an A.C. line using the charger provided with the instrument.

The MINIRAM has two output connectors. One provides a continuous, real-time analog signal output proportional to the aerosol concentration. This signal can be used for continuous recording (e.g. on a strip chart recorder), telemetry, or control purposes, etc. The other connector provides, during the measurement mode, either an ASCII digital output which is updated every 10 seconds, or a switched output for alarm purposes (depending on the user-selected function). Stored information playback can be accomplished either by means of the MINIRAM's own display or through the digital output jack. During the normal monitoring operation, the liquid-crystal-display indicates the aerosol concentration in the units of milligrams per cubic meter, and the displayed reading is updated every 10 seconds. When operating in the measurement or monitoring mode, other functions can be displayed momentarily, i.e., as long as a corresponding touch switch is pressed. All external controls are performed by pressing one or more of 8 sealed touch switches on the MINIRAM panel.

1.4 Modes of Use and Application

The MINIRAM measures the concentration of any airborne particles, both solid and liquid, and the display indicates this level in the units of milligrams per cubic meter, based on its factory calibration, against a filter-gravimetric reference, using a standard test dust (Arizona road dust). The MINIRAM can be used to measure the concentration of all forms of aerosol: dusts, fumes, smokes, fogs, etc.

Its small size and weight, and concentration averaging features permit its use as a personal exposure monitor, attached to a belt, shoulder strap, hard hat, etc. Alternatively, it can be used as an area monitor for both indoor and ambient air situations. Test chamber monitoring, visibility measurements, cloud detection (e.g. radio/drop sonde), aerosol dispersion studies, etc. are additional applications of the MINIRAM.

2.0 WHEN YOU RECEIVE THE MINIRAM.......

Follow these steps when first receiving your MINIRAM:

2.1 Remove the instrument from plastic bag.

2.2 Observe display. It should be blank indicating that the MINIRAM is in the minimum power mode.

2.3 Plug charger into A.C. line (standard charger is for 120V, 60 Hz; optional version available for 220V, 50 Hz).

2.4 Connect charger plug into corresponding MINIRAM receptacle.

2.5 Leave charger connected to MINIRAM for a minimum of 12 hours before using instrument without the charger.

2.6 You can operate the MINIRAM immediately after the charger has been connected. Follow operating instructions described in the next section of this manual.

3.0 OPERATING INSTRUCTIONS

Refer to Figure 1 for the location of control switches, display, and connector jacks. Refer to Figure 2 for the display timing sequences.

3.1 Initial Condition

Assuming that the batteries of the MINIRAM have been recharged (see section 2.0), the display may indicate one of the following conditions:

- Blank display: means that MINIRAM had not been in the measurement mode for 48 hours or more, and is in the minimum power off mode.
- "OFF" display: MINIRAM has been in the off mode for less than 48 hours.
- Concentration display that changes or "blinks" once every 10 seconds: the MINIRAM is in the measurement mode.

3.2 To start Measurement Cycle

- If the MINIRAM shows a blanked display (see above), press OFF and wait until the display reads "OFF" (approximately 5 seconds after pressing OFF), before pressing MEAS to initiate measurement cycle.
- If the MINIRAM shows "OFF" (see above), press MEAS directly to initiate measurement cycle (there is no need to press OFF first, in this case).

The functions performed by pressing each MINIRAM touch switch are as follows:

3.3 MEAS

To start the monitoring operation of the MINIRAM, press MEAS (see automatic timing sequence of Figure 2). The first readout displayed is either "GO" (or "CGO" if TIME is also pressed, section 3.4), followed by the last concentration reading or ".00". Approximately 36 seconds after pressing MEAS the first new 10-second-averaged concentration reading is displayed. All subsequent readings are concentration values in milligrams per cubic meter, updated every 10 seconds. Figure 3 shows a typical digital printout of a sequence of 10-second measurements (second data block).

The MINIRAM will now run in the measurement mode for 500 minutes (8 hours and 20 minutes), after which it will stop, displaying the last 10-second reading, retaining in storage the concentration average and elapsed time information. Once the MEAS mode has been entered this sequence can only be interrupted by pressing OFF; pressing ZERO, TWA, SA, TIME or ID# only affects the display during the time these keys are pressed, without affecting the measurement cycle. Pressing PBK during this cycle has no effect.

The instrument normally operates in the .00 to 9.99 mg/m^3 range. Whenever a 10-second concentration exceeds 9.99 mg/m^3 the MINIRAM display automatically switches to the .0 to 99.9 mg/m^3 range and remains in that range as long as the measured 10-second concentration exceeds 9.99 mg/m^3, otherwise the MINIRAM reverts to its lower range display.

3.4 MEAS and TIME

If both MEAS and TIME are pressed at the same time (press TIME first and while depressing it actuate MEAS) the MINIRAM will display "CGO" (for Continuous "GO"), and will then operate as above (i.e. pressing MEAS only), except that after the first 8.2 hour run it will restart automatically and continue to measure for an indefinite number of 8.3 hour runs, (with the battery charger) until the OFF key is pressed, or until the batteries are exhausted. Concentration averages and timing information for the last seven 8.3 hour runs will remain in storage at any given time.

3.5 OFF

When this key is pressed the MINIRAM will discontinue whatever mode is underway displaying "GCA" followed by the display segments check ("8.8.8=") and finally "OFF" (see timing diagram of figure 2). The MINIRAM will then remain in this reduced power condition (displaying "OFF") for a minimum of 10 minutes or a maximum of 48 hours or until the MEAS key is pressed to resume the measurement cycle.

If OFF is pressed during a measurement run the display will read "OFF" for 48 hours (unless another key is pressed during that period), after which the display will be blanked. Thereafter, if OFF Is pressed the MINIRAM will display the "OFF" reading for only 10 minutes, after which the display will be blanked again unless another key is pressed during that period.

Every time the OFF key is pressed, during a measurement cycle, the MINIRAM will store the concentration average and elapsed monitoring time up to the time of that OFF command. The duration of the off period (up to 48 hours), i.e. between two consecutive measurement cycles, is also stored for each of up to 7 cycles.

If the MINIRAM is not reactivated (i.e. pressing MEAS) within 48 hours of the OFF command, it automatically switches to a minimum power level, with blanked display; however, all data remains stored in memory for up to approximately 6 months without battery recharging (indefinitely, with charger).

OFF must be keyed before any other operating mode can be entered: setting ID#, zero referencing, playing back stored data, or changing the program code. Display functions, however, can be activated during the measurement mode.

3.6 TIME

During the measurement mode, if TIME is pressed the display will show the elapsed time, in minutes, to three significant figures, from the start of the last measurement run. The MINIRAM will automatically return to concentration display after the TIME key is released.

3.7 TWA

This key stands for Time-Weighted-Average. During the measurement mode, if TWA is pressed the display will indicate the average concentration in milligrams/m^3 up to that instant, from the start of the last run. This average is computed by the MINIRAM applying the equation:

$$TWA = \frac{1}{t} \int_{o}^{t} Cdt$$

where t is the elapsed run time and C is the instantaneous concentration at time t. The value of TWA is updated every 10 seconds. After releasing the TWA key the MINIRAM display returns to the 10-second concentration display.

3.8 SA

This key stands for Shift-Average. During the measurement mode, pressing SA will provide a display of the aerosol concentration, up to that moment, averaged over an 8-hour shift period. This average is computed by the MINIRAM applying the equation:

$$SA = \frac{1}{480 \text{ Min.}} \int_{o}^{t} Cdt$$

The shift-average value corresponds to the exposure from the start of the measurement cycle. Thus, for example, if the MINIRAM has been measuring for 3 hours, and the time-weighted average over that period has been 6 mg/m^3

(TWA reading), the shift average value at that time, (SA reading) would be 2 mg/m^3, which is equivalent to an 8-hour exposure to an average concentration of 2 mg/m^3.

The value of SA is updated every 10 seconds. When releasing the SA key the MINIRAM display returns to the 10-second concentration display.

3.9 PBK

With the MINIRAM in the off mode (i.e. not in the measurement mode), the stored information can be played back by pressing PBK. If the PBK key is initially pressed the display will indicate "P" for one second. If PBK continues to be pressed for more than 1 second, then the stored data is automatically played back through the MINIRAM display: First, the identification number is displayed with the ID indicator bar on; next the shift or run number (7 through 1, i.e. starting with the last run) is shown (with the OVR indicator bar on as identification); followed by the sampling (i.e. measurement) time in minutes, for that run; followed by the off-time between the last and next run (in tens of minutes); finally, the average in mg/m^3.* This sequence is repeated seven times. An average reading of 9.99 indicates that a significant overload condition occurred during that run. The total time required for the complete automatic playback on the MINIRAM display is approximately 70 seconds.

If PBK is pressed for less than one second "PA" will be displayed, and the stored data will be fed out through the digital output jack of the MINIRAM for printout, magnetic storage, telemetry, etc. A printout consists of 8 lines of data. Figure 3 shows a typical stored data printout (see data block labeled "Playback of Stored Data"). The first 7 lines show the data for the last 7 measurement periods, and the last line shows the identification number (I), the programmable selection code (F), and the zero value for that data block (Z). In addition a check sum is printed out on a 9th line for modem/computer data transfer purposes. The first 7 data lines are subdivided into 4 columns. The first column identifies the measurement period (starting with the last or 7th); the next column lists the corresponding duration of each measurement period, in minutes; the third column lists the off time between consecutive measurement periods, in minutes divided by 10; and the last column lists the average concentration values for each period in mg/m^3.*

---

*Either the TWA or the SA values, depending on selected user-programmable code (see section 4.2).

Either time-weighted, or shift average values can be printed, depending on the selected programmable code (see section 4.2). The example shown on Figure 3 (F = 0012) indicates that the TWA values are listed. Although the printout heading will indicate "PDM-2 LISTING" (as shown in Figure 3), this format applies equally to the MINIRAM model PDM-3.

The speed of the digital transfer to a printer or other digital device can be user selected through the programmable selection code (see section 4.2). For a 300 baud rate the transfer time for the stored data block is approximately 45 seconds. See sections 10.0 and 11.0 for instructions on how to connect the MINIRAM to a printer or other digital recording/processing device.

3.10 ZERO

The interior walls of the MINIRAM sampling chamber reflect a small amount of the light from the infrared source into the detector. This background level is referred to as the "zero value", and is automatically subtracted from all aerosol concentration readings during the measurement mode. The result is that the displayed readings depend only on the actual dust concentration present within the sensing chamber.

The zero value varies from instrument to instrument as well as with different sensing chambers. It will increase somewhat as the chamber inner walls and windows become contaminated with dust. A zero update should be performed periodically to correct for this. Also, a zero update should be performed after cleaning the sensing chamber (see section 12.0).

Pressing ZERO during a measurement period provides momentary display of the stored zero concentration value used by the MINIRAM to correct all digital concentration readings (the analog output signal is not zero-corrected). To update the ZERO value the MINIRAM must be in its off condition (press OFF in case of doubt). Then, press ZERO and wait until the display again indicates "OFF".

The average of 4 consecutive 10-second zero level measurements will then be stored by the MINIRAM as the new ZERO reference value. (See timing diagram in Figure 2 and digital printout obtained during a typical zero check on Figure 3). When operating the MINIRAM in high particle concentration environments (>5 mg/m^3) the zero value update should be performed approximately every 8 hours. At aerosol concentrations below approximately 1 mg/m^3 this update may only be required once a week, or even less frequently. The zero update should be performed either within a clean-air environment (ideally, a clean room or clean-bench) for dust measurements in the concentration range below 0.5 mg/m^3, approximately, or by flowing clean air through the sensing chamber of the MINIRAM (e.g. by means of an optional clean-air adaptor, GCA model PDM-1FZ Zero Check Module) (see section 17.2) for use at dust concentrations above 0.5 mg/m^3, approximately. Air conditioned offices (without smokers) usually have concentrations below approximately 0.05 mg/m^3 and can thus be used for zeroing purposes. When measurements are performed under essentially clean air conditions, e.g. in the same environment where the zero check was performed, the MINIRAM readings will indicate 0.00 mg/m^3 with small random fluctuations around that value. Positive values (e.g. 0.02) will thus be indicated on the LCD display. Negative values (e.g. -0.02) are suppressed and are also indicated as 0.00. The digital output, however, does include such negative values and these will be printed out by a digital printer (see sections 10.0 and 11.0).

3.11 ID#

Pressing ID# during a measurement period provides momentary display of the identification number stored within the MINIRAM memory.

The ID# key, in combination with other keys, is used for several additional programming functions described in the next section (4.0).

4.0 PROGRAMMABLE FUNCTIONS

4.1 ID# Selection

In order to change the instrument identification number the MINIRAM must first be in the off mode (i.e. press OFF). Then press the ID# key, and the presently stored number (between 1 and 999) will be displayed, as well as the ID indicator bar. To increment the identification number press the ▲ key (same key as TWA), and to decrement the number press the ▼ key (same key as SA). Any number between 1 and 999 can thus be selected and will remain in storage until the batteries are disconnected, or if the MINIRAM is not recharged over a 6-month period.

Pressing the OFF key after the above identificationnumber selection will remove the MINIRAM from the ID# selection routine and lock-in that number until a new number is selected. A complete ID# lock-out (i.e. a routine to preclude panel-control change of that number) can be accomplished by a separate programmable code selection (see section 4.2).

4.2 Programmable Selection Code

The programmable code allows the user to panel-select several alternate functions and operating modes.

The program codes to select specific alternate operating modes are:

1	selects the alarm instead of ASCII digital output
2	selects the ID# lock-out
4	selects the TWA instead of the SA to be stored for playback
8	selects a 1-second pause after each printer carriage return (for slow printers)
32	selects 110 baud digital output rate instead of 300 baud
64	selects 600 baud digital output rate instead of 300 baud

These numbers are entered as a sum, e.g. to implement ID# lock out, TWA storage, and 1-second carriage return delay, the code number would be 14 (2+4+8).

To enter the desired code (e.g. 14) follow these steps;

- Press OFF key and wait until "OFF" is displayed
- Press ID# key and set program code to desired number (e.g. 14) by means of the ▲ and ▼ keys.
- Press TIME key (this will show previously entered code)
- Press ID# key again to lock in the new program code which will then be displayed.
- The preceding steps will cause the ID# to become equal to the programmable selection code. To restore the desired ID# (without affecting the selected code number which is now locked in), use the ▲ and ▼ keys again to select the ID# for the instrument as described in section 4.1.
- Press OFF to exit the ID# selection routine.
- To look at the programmed code number, at any time, start from the off condition; press ID#, then press TIME ("F" will then be dis-

played momentarily), after which the code number will be displayed. Press OFF to exit the code number routine.

If no specific alternate code is entered the MINIRAM will operate in its standard mode (equivalent to code 12) consisting of the following:

- ASCII digital output
- Panel-selectable ID number (preset to 999)
- Time-Weighted Average (TWA) values in memory storage
- 7-bit ASCII resolution
- 300 baud digital output
- Printer carriage return followed by a 1 second delay

4.3 ID# Lock-out

If the ID# lock-out code has been selected (i.e. a 2 as part of the sum, as described in section 4.2) then both the ID# and the programmable code can only be displayed (and printed out), but neither of the two can then be changed by means of the panel keys. In this case, in order to change the ID# if the lock-out code has been selected, or to alter the programmable code, the battery must be unplugged momentarily. Disconnecting the battery, however, causes the MINIRAM to lose all stored data, and cancels all alternate program codes which may then be restored following the procedure described in section 4.2.

4.4 Alarm Level Adjustment

If the selected program code includes a 1, the MINIRAM will not provide an ASCII digital output but instead a switched output (at the digital output connector) which will close every time the measured 10-second concentration value exceeds a presettable threshold concentration level. If a 1 has been included in the code, then the ID# divided by 10 becomes the alarm level in milligrams/m^3. This level can be adjusted following the ID# selection procedure of section 4.1, that is using the ▲ and ▼ keys to increment or decrement the number. For example, if an alarm level of 12.5 mg/m^3 is desired (and starting from the off mode), press ID#, adjust displayed number to 125 with the ▲ and ▼ keys, and press OFF. This number (e.g. 125) then becomes the ID# as well. It is not possible to enter a separate alarm level and ID# number.

5.0 OVERLOAD AND ERROR CODE INDICATORS

5.1 Bar Displays

There are three bar indicators on the MINIRAM display, identified as OVR, ID, and BAT. If the OVR bar is displayed at any time during operation in the measurement mode the MINIRAM detection circuit has been overloaded. A momentary overload can be caused by the insertion of an object into the sensing chamber, sudden exposure to sunlight, etc. If the cause of overload is eliminated, the OVR bar will disappear during the next 10-second display period, unless the overload persists for more than a total of 1½ minutes over an 8 1/3 hour measurement cycle.

The ID bar display is activated only for display identification purposes and not for error conditions.

The BAT bar is displayed when the battery voltage becomes insufficient, indicating that the charger should be plugged into the MINIRAM.

5.2 Error Codes

The MINIRAM will display and output (at the digital output jack) error code numbers along with the corresponding overload indicator bars on the LCD readout. These codes will appear only if the problem persists for more than about 30 seconds.

The error code numbers are as follows:

.01 : low battery condition
.02 : RAM (digital processing)
.03 : A/D (signal) overload

If an overload condition persists for more than approximately 1½ minutes the selected concentration average value (SA or TWA) automatically registers 9.99 and that number will be indicated (or digitally transmitted) upon data playback, signifying an invalid measurement cycle. The OVR bar will then remain on for the rest of that run.

6.0 SENSING CHAMBER REMOVAL AND INSERTION

During normal operation of the MINIRAM the removable sensing chamber (see Figure 1) must be properly inserted, i.e. pushed all the way into the

MINIRAM towards the display/control panel end of the instrument. When this chamber is properly positioned the surface on the opposite end from the display/control panel will be approximately flush with the body of the MINIRAM.

To remove the sensing chamber, gently push it away from the display/control panel end, using both thumbs, sliding it out of its channel. This will expose the shouldered metal button with its small spring-loaded plunger, and the two lenses (illumination and detection lenses). Touching of these lenses should be avoided to prevent their soiling. Lens tissue should be used if cleaning of these lenses becomes necessary. Also, the inside surface of the removable sensing chamber is coated with a special anti-reflectant paint and these surfaces should not be touched, if at all possible.

The removable sensing chamber has two small glass windows which should be kept clean (see section 12.0 on routine maintenance).

The sensing chamber is partially closed at one of its open ends. This end is inserted first when sliding the chamber back into the MINIRAM channel. A small shouldered slot is provided on the underside of the removable sensing chamber for the metal button that serves to retain the chamber.

To reinsert the sensing chamber simply slide it back into position making sure that the chamber is moved parallel to the MINIRAM body. Ensure complete insertion, as mentioned above.

7.0 BATTERY PACK REPLACEMENT

The battery pack of the MINIRAM (GCA Part No. PDM-3B) constitutes an intrinsically safe sealed module that can be removed and replaced. To do so, remove the four central screws from the back of the MINIRAM case (not the two corner screws), and gently lift the battery pack up and out, and gently pull apart the battery connector freeing the battery pack. Reverse order of steps when installing another pack.

CAUTION: All stored data will be lost when disconnecting battery.

After reconnecting battery pack, the ID resets to 999 and an automatic zero reference check is performed by the MINIRAM.

Separate battery packs can be used whenever a.c. line power is unavailable to recharge the pack within the MINIRAM. These spare parts can be recharged independently from the MINIRAM by plugging the charger into the charge receptacle which is an integral part of the battery pack (see figure 1).

8.0 CALIBRATION ADJUSTMENT

Although every MINIRAM has been factory-calibrated using a representative dust (see section 1.4), the user may wish to change the calibration constant of the instrument for a specific type of aerosol. Such a calibration should be performed by obtaining a concurrent filter collection (e.g. by means of a personal filter sampler), sampling from the same environment within which the MINIRAM is placed. The average concentration obtained by the MINIRAM (i.e. TWA reading) at the end of the test should be compared with the filter-gravimetric-determined concentration. The ratio of the two concentration values can then be used to correct the MINIRAM calibration. The comparison run should be replicated several times (to minimize errors) to obtain an average ratio.

To change the MINIRAM calibration proceed as follows:

8.1 Place MINIRAM in a clean environment (e.g. air conditioned office).

8.2 Remove battery pack (follow procedure of section 7.0).

8.3 Disconnect battery connector (remember that all stored data will thus be lost/erased from MINIRAM memory).

8.4 While leaving battery pack lying next to MINIRAM, re-connect the two units (i.e. plug in connector).

8.5 Immediately observe MINIRAM display. It will be performing a slow segment-by-segment display checkout. As soon as it displays ".00", press OFF, thus interrupting the initial automatic zero check (see section 7.0). Wait until the display indicates "OFF" and then press MEAS and wait approximately 36 seconds.

8.6 Observe 10-second readings (typically in the range of 1 to 3 mg/m^3) and record manually a few consecutive readings. Calculate the average of these values.

8.7 Identify small potentiometer screw (visible through an opening in the foil shield of the open MINIRAM) opposite the digital output jack. Adjust this potentiometer, using a fine screw driver, until the average MINIRAM reading is increased or decreased (with respect to the average obtained in 8.6) by the desired ratio (e.g. as determined by previous gravimetric comparison runs).

8.8 Shut off MINIRAM, reposition and secure battery pack, and re-zero instrument as usual. All subsequent concentration readings are now corrected by the desired ratio.

If an optional Reference Scatterer is available, insert in the MINIRAM instead of the normal sensing chamber and follow the same procedure (i.e., follow steps 8.1 through 8.8).

9.0 ANALOG RECORDER CONNECTION

The analog output of the MINIRAM is a negative voltage of 0 to 1.5 V. A high input impedance recorder (>100KΩ), or other signal processing device can be connected to that output. The 0 to -1.5V range corresponds approximately to 0 to 100 mg/m^3 as displayed by the MINIRAM.

This analog output (as opposed to the digital output and readings) is not zero-corrected, and thus a zero concentration results in a bias level of the order of several millivolts.

It is advisable to connect a capacitor in parallel with (i.e. across) the analog output (e.g. 100 microfarads or larger) in order to obtain a steady output signal. The internal time constant of the analog output of the MINIRAM is only 0.2 seconds which, in the absence of an external capacitor, results in excessive signal fluctuations.

Two miniature plugs are provided with the instrument to connect to the analog and/or digital output jacks (both can be used concurrently).

10.0 USE OF OPTIONAL GCA DIGITAL PRINTER

The MINIRAM can be connected to the GCA model PDM-DP-1 digital printer, an optional accessory designed for direct coupling to the MINIRAM. This printer can be used both to print out the continuous concentration data (updated every

10 seconds) in the normal measurement mode, and to print out the data stored in the MINIRAM memory as described in section 3.9.

An example of the printout formats when using the PDM-DP-1 printer in combination with the MINIRAM is presented in figure 3. The PDM-DP-1, a very compact impact dot matrix printer, is provided with a special interconnection cable to the MINIRAM digital output jack. When using the MINIRAM with this printer, the output data rate should be left at 300 baud (the normal MINIRAM default value), as described in section 4.2.

The following are specific operation procedures for use of the printer in combination with the MINIRAM. Other operating and maintenance information is contained in the instruction manual that accompanies the printer.

10.1 Print Paper Loading

A 20 mA current must flow through the PDM-DP-1 printer for it to operate. Plug its cable into the MINIRAM digital output receptacle and press OFF. Turn on the printer power switch (on its side) and press the ON-LINE switch so that the red light above this switch goes out. The ink ribbon should have been previously loaded. Press the FEED button and insert paper into the paper slot in the rear of the printer until it feeds out the top. Refer to the printer User's Manual for details.

10.2 Printer Test

In order to test whether the PDM-DP-1 printer is operating correctly, turn off its power switch (on side of printer), hold down the FEED switch while turning the power switch on. Release the FEED switch. The printer will then print out all of its characters.

10.3 Printout of Stored Data

Plug printer connector into the MINIRAM digital output receptacle. Turn off printer power switch. Press OFF on MINIRAM and wait until it reads "OFF". Turn on printer power switch. Press PBK on MINIRAM for less than one second (see section 3.9) and the LCD display should then indicate "PA". The printer will then print out the stored data block.

10.4 Printout of Zero or of Measurement Data

Interconnect MINIRAM and printer as indicated before and switch off printer power. Press OFF on the MINIRAM. Press either ZERO or MEAS on MINIRAM (depending on which information should be printed out). Observe MINIRAM display until the 2 second blanking occurs (approximately 22 to 25 seconds after pressing MEAS or ZERO), after which the printer power should be switched on immediately (i.e. as soon as the last reading appears again, see figure 3). Printer will print out zero data approximately 72 seconds after pressing ZERO on MINIRAM (see figure 2). The first line of measurement data will be printed out approximately 76 seconds after pressing MEAS, and thereafter every 50 seconds (each line contains five 10-second measurements).

NOTE: In order to test at any time whether the PDM-DP-1 printer is enabled for printout of MINIRAM data, press the ON LINE switch on the printer; this should extinguish the red light above that switch. Then press ON LINE again to turn on red light again. If the red indicator light remains on whenever the ON LINE switch is actuated, the printer is not enabled, in which case turn printer power switch off and then on again, after which actuation of the ON LINE switch should turn the red light on and off, indicating printer readiness (i.e. with red light on). The printer power can be turned off any time during the measurement cycle, and turned on again during a cycle to resume printing. The data line numbers (see figure 3) will then be the current ones as sequenced by the MINIRAM whose output is independent of the operation of the printer.

11.0 DIGITAL OUTPUT CONNECTIONS

A digital printer (other than GCA model PDM-DP-1), data logger, or modem may be coupled to the MINIRAM. The data output is in the form of 20 mA current loop, 300 baud (110 or 600 baud by alternate programming) asynchronous ASCII characters. The output load should be less than 50 ohms.

Figure 4 is a diagram showing the connections and components required for a 20 mA loop interconnection to a printer. A similar diagram is shown for standard RS232 interfacing with a printer (see Figure 5). These connections do not apply when using the PDM-DP-1 printer.

The MINIRAM does not send parity information, but does provide an ASCII check sum which is the sum of all ASCII characters, to insure data integrity.

To use the check sum the host computer must add the ASCII value of all digits, spaces, carriage returns, and line feeds except for the first two carriage returns and line feeds which are sent immediately after pressing the PBK switch. The last eight bits of this sum should then be expressed as a decimal number (0-255) and should agree with the decimal value of the MINIRAM check sum.

12.0 ROUTINE MAINTENANCE

When the MINIRAM is not being operated it should be placed in its plastic bag which should then be closed. This will minimize the amount of particle contamination of the inner surfaces of the sensing chamber.

After prolonged operation within, and exposure to particulate-laden air, the interior walls and the two glass windows of the sensing chamber may have become contaminated with particles. Although repeated updating of the zero reference following the procedure of section 3.10 will correct errors resulting from such particle accumulations, eventually this contamination could affect the accuracy of the measurements as a result of excessive spurious scattering, and significant attenuation to the radiation passing through the glass windows of the sensing chamber.

An indication of excessive chamber contamination is provided by the zero level reading (section 3.10), which should not exceed 3 mg/m^3, approximately.

In order to clean a soiled sensing chamber remove that chamber as described in section 7.0 and wash it with soap and water, rinsing thoroughly to remove any residues from the glass windows and interior of the chamber. Do not use solvents of any type. Do not rub interior surfaces of the chamber. Allow the sensing chamber to dry completely and re-insert into the MINIRAM as indicated in section 7.0.

13.0 PRECAUTIONS AND OPERATING POSITIONS

The interior of the MINIRAM sensing chamber should not be exposed to fluctuations of intense light; flashes of sunlight or bright daylight especially, are to be avoided. Such excessive variable illumination of the scattering detector can result in significant measurement errors that may persist over several 10-second display cycles. In order to operate the MINIRAM under those conditions it is advisable to use the Sunshield accessory (GCA model PDM-SNS, see section 17.5).

Another potential source of error is the presence of reflecting surfaces in close proximity to the sensing chamber openings. Such objects should be kept at least 2 cm (3/4 inch) from the chamber openings.

The removeable sensing chamber should not be used as a carrying handle, especially not while operating the MINIRAM; holding this chamber may affect the measurements.

When using the MINIRAM for personal monitoring it should be positioned vertically, i.e. with the display/control panel facing upwards, by either clipping the MINIRAM to the belt, shoulder strap, etc.

In general, an approximate vertical position is to be preferred for any long-term monitoring purposes, in that this position minimizes potential particle deposition within the removable sensing chamber.

Other monitoring positions are:

a) horizontal, resting on belt clip
b) hand held (while ensuring that hand and fingers are away from edges of sensing chamber)
c) Using the optional MINIRAM table stand
d) Wall mounted using belt clip, or the four battery pack attachment screws on the back of the MINIRAM.

14.0 INTRINSIC SAFETY

The MINIRAM has been designed to satisfy the requirements for intrinsically safe operation in methane-air mixtures. The sealed battery pack incorporates a current-limiting resistor that limits the battery short circuit current to less than 14A. An MSHA 2G approval has been applied for.*

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*Approval granted 1984

15.0 SPECIFICATIONS

- Measurement ranges: 0.01 to 10 mg/m^3 and 0.1 to 100 mg/m^3
- Precision and stability (for 10 sec. readings)* : ± 0.03 mg/m^3 (2-sigma)
- Precision and stability of time-averaged measurements*:
  - ± 0.02 mg/m^3 (for 1 minute averaging)
  - ± 0.006 mg/m^3 (for 10 minute averaging)
  - ± 0.003 mg/m^3 (for 1 hour averaging)
  - ± 0.001 mg/m^3 (for 8 hour averaging)
- Temperature coefficient: 0.005 mg/m^3 per °C (typical)
- Readout resolution: 0.02 mg/m^3 or 0.1 mg/m^3 depending on automatically selected range (3 digit LCD)
- Digital readout updating time: 10 seconds
- Analog output time constant: 0.2 seconds
- Total measurement period: 8 1/3 hours, or indefinite 8 1/3 hour cycles
- Particle size range of maximum response: 0.1 to 10 μm in diameter
- Measurement display: normally 10 second real time measurement; or momentarily: time-weighted average, or 8-hour equivalent shift average, or elapsed sample time (in minutes), or zero value, or identification number, or programmable code
- Data storage: seven concentration averages, sampling periods in minutes (3 significant figure resolution), off time (10 minute resolution), identification number, zero value, programmable code, and check sum
- Real time outputs: analog (0 to -1.5V full scale), and digital ASCII
- Memory playback: either by own LCD display, or by 110, 300 or 600 baud, ASCII digital output (20 mA current loop, or RS232 terminals may be connected with appropriate interface)
- Nominal battery voltage: 7.5V
- Average battery current drain: 40 mA
- Continuous operating time with full battery charge: 10 hours, approximately

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*At constant temperature (typ. 25°C)

- Operating temperature: 0° to 50°C (32 to 120°F) Storage: -20 to 60°C
- Outside dimensions: main body: 10 x 10 x 4 cm (4 x 4 x 2 inches); sensing chamber cover: 7.7 x 3.8 x 1.5 cm (3 x 1.5 x 0.6 inches)
- Weight: 0.45 kg. (16 oz.)

16.0 STANDARD ACCESSORIES

Accessories provided with each MINIRAM are detailed in the following subsections.

16.1 Battery Charger

The battery charger (GCA model PDM-1-157-1) serves the following functions: recharge or maintain the charge of the nickel-cadmium batteries within the MINIRAM, permit continuous a.c. power line operation, and provide power for the operation of pump of the optional GCA model PDM-1FZ Zero Check Module (see section 17.2). The charger can not be used to power the MINIRAM without its batteries, however, it can be used to charge a separate or spare battery pack (GCA model PDM-3B, see section 7.0).

The standard battery charger is designed for a 120V/60 Hz input, however, it can be obtained for 220V/50 Hz if so specified.

16.2 Other Standard Accessories

Other accessories supplied with the MINIRAM are:

- Output connectors (can be used for the analog, and/or the digital output jacks).
- Shipping Case
- Instruction Manual

17.0 OPTIONAL ACCESSORIES

Several optional accessories are available from GCA for the MINIRAM, these are described in the following subsections.

17.1 Flow Adapter (GCA model PDM-1F)

The Flow Adapter (see figure 6a) when used in conjunction with the MINIRAM and any pump or external flow system, allows a sample to be drawn through the instrument sensing chamber. A personal monitoring pump at flow rates of 2 ℓ/minute or less may be used.

To attach the Flow Adapter to the MINIRAM (see figure 6B) loosen the two thumbscrews and pull the front sealing plate forward. Slide the Adapter over the MINIRAM sensing chamber as illustrated above; secure the Adapter to the MINIRAM by tightening the two allen-head screws through the hold down tabs. Tighten the thumbscrews to seal the two end plates to the MINIRAM sensing chamber.

Typically, this accessory would be used when extracting samples from aerosol chambers, detecting leaks from pressurized ducting, or for isokinetic sampling using probes.

17.2 Zero Check Module (GCA model PDM-1FZ)

The Zero Check Module can be used to zero the MINIRAM when a clean air environment is not available. The Zero Check Module should be used when concentrations in the range above 0.5 mg/m^3 are to be measured (see section 3.10).

In addition, this accessory can be used to draw a sample stream through the MINIRAM sensing chamber (in lieu of a separate pump) by disconnecting the small tube at the sensing chamber inlet fitting (see figure 7a).

This accessory consists of a pump, filter and the necessary tubing to circulate clean filtered air through the MINIRAM. The pump may be powered by the MINIRAM battery charger (or a 5-10 VDC power supply). The battery within the MINIRAM cannot be used to operate the Zero Check Module.

Notes:

When using any of the optional accessories that are attached on and around the sensing chamber (models PDM-1F, -1FZ, -1FS, -1FR, and -SNS) to perform measurements at concentrations below 0.5 mg/m^3, it is advisable to zero check the MINIRAM with the accessory in place, making sure that its mounting and sealing screws are properly tightened.

Use an external pump or pressurized air source (well filtered) to drive clean air through the sensing chamber to zero the MINIRAM with any of those accessories (except in the case of the Zero Check Module). To zero check the MINIRAM when using the Sunshield place instrument with the attached sunshield in a clean room environment (see section 3.10).

To zero the MINIRAM, first attach the Zero Check Module (see figure 7b) following the same procedure described for attaching the basic Flow Adapter (see section 17.1). Connect the battery charger to the Zero Check Module and to an A.C. source. Allow at least one minute of operation to purge the sample chamber with clean air. Press the ZERO button on the MINIRAM and continue operating the Zero Check Module until the final average zero reading is displayed (see section 3.10).

17.3 Personal Sampler Adapter (GCA models PDM-1FS and PDM-2FS)

This accessory, when used with the MINIRAM and a personal monitoring pump, permits active sampling of respirable (cyclone preselected) particles through the instrument sensing chamber and collection on a filter. The aerosol sample is drawn through a 10 mm nylon cyclone (with a 50% cut point at 3.5 μm when operated at 2 ℓ/minute), through the sensing chamber of the MINIRAM, and then collected on a filter located in the cassette/filter holder for subsequent gravimetric or other analysis.

The model PDM-1FS is for use with an MSA 37mm filter cassette no. 457193. The model PDM-2FS is compatible with a Millipore 37mm disk filter holder no. 1-XX11-025-03 (see figure 8a).

To attach the Personal Sampler Adapter to the MINIRAM (see figure 8b), follow the same procedure as described for attaching the basic Flow Adapter (see section 17.1). Connect a length of tubing from the exhaust fitting on the filter holder to a personal sampling pump (not provided with the Adapter).

The use of the Personal Sampler Adapter permits concurrent MINIRAM readings and filter collection to facilitate calibration of the MINIRAM for a specific aerosol, or to determine both concentration and chemical composition of the aerosol.

17.4 Respirator Adapter (GCA model PDM-1FR)

The Respirator Adapter, when used in conjunction with the MINIRAM, provides a means of measuring aerosol concentrations inside a respirator. The external concentration can also be measured with the MINIRAM and thus the values obtained with the MINIRAM after connecting it to the respirator can be used to determine protection factors; consequently, quantitative fit checks are possible under field conditions.

WARNING: DO NOT USE THIS ACCESSORY IN A HAZARDOUS (TOXIC DUSTS, FUMES, GASES, ETC.) ENVIRONMENT, SINCE RESPIRATOR INTEGRITY CANNOT BE GUARANTEED BECAUSE OF THE POSSIBILITY OF LEAKS.

A tube should be attached from a tap on the respirator to the inlet (which is located on the smaller sealing plate) of the Respirator Adapter (see figure 9a). When the respirator wearer exhales, a slight positive pressure develops inside the mask resulting in an air flow to the MINIRAM sample chamber, where the concentration is measured. This air then passes through a check valve as it exits the chamber. When the wearer inhales, the check valve closes to prevent exposure to ambient conditions. A back-up filter is also used after the check valve as an additional safety precaution in the event of check valve failure.

To attach the Respirator Adapter to the MINIRAM, follow the same procedure for attaching the basic Flow Adapter (see section 17.1 and figure 9b).

17.5 Sunshield (GCA model PDM-SNS)

The sunshield accessory serves to protect the MINIRAM sensing elements from excessive ambient light fluctuations (see section 13.0). It should be used whenever the MINIRAM is to be operated outdoors or under fluctuating bright light illumination. It is also advisable to use the sunshield to prevent loose clothing or other objects from touching or entering the open sensing chamber. The use of the sunshield causes only a slight retardation of the air exchange rate between the outside and inside of the sensing chamber, an effect that is negligible except when using the analog output in order to follow rapid fluctuations of particle concentration. The sunshield attaches by its two support tabs to the body of the MINIRAM (see figure 10).

17.6 Shoulder Strap (GCA model PDM-SS)

The PDM-SS is a leather strap, worn over the shoulder and across the chest, which attaches to the wearer's belt in front and back. The MINIRAM mounting loop in the upper chest area allows exposure measurements close to the breathing zone while still permitting comfort and freedom of movement (see figure 11).

17.7 Table Stand (GCA model PDM-TS)

The table stand accessory provides a convenient mounting support for the MINIRAM when it is used for area monitoring. The MINIRAM is simply clipped onto the table stand which holds it in a position where reflections from the table surface do not interfere with its operation (see figure 12).

17.8 Dot Matrix Digital Printer is a Star DP-8240 unit specially modified for use with the MINIRAM. It is supplied with a special interconnecting cable which is plugged into the digital output jack of the MINIRAM. The PDM-DP-1 is normally provided for 120V/60 Hz operation. Operation with 220V/50 Hz line can be provided upon customer request. The PDM-DP-1 weighs 4 kg (8.8 lbs), and its dimensions are 28W x 20D x 10H cm (11" x 7 7/8" x 4") (see figure 13).

The use of the PDM-DP-1 in combination with the MINIRAM is described in section 10.0. A separate instruction manual for the printer is supplied with that unit.

17.9 Reference Scatterer (GCA model PDM-RS)

The PDM-RS is a specially modified sensing chamber that includes a diffusing optical filter mounted within the sensing region of the MINIRAM. It is designed to scatter a controlled amount of light from the infrared source to the detector, providing a stable and repeatable reading on the MINIRAM display. The reference scatterer is inserted into the MINIRAM instead of the normal sensing chamber, and the readings are obtained operating in the MEAS mode. If the PDM-RS is ordered from GCA concurrently with a MINIRAM the reference scatterer will be factory marked with the calibration reading to be obtained when inserted into that particular MINIRAM whose serial number will also be shown on the PDM-RS tag. The readings displayed by the MINIRAM when inserting the PDM-RS should be within + 5% of the value marked on that reference scatterer.*
The readings obtained with the reference scatterer may show a small warm-up drift (i.e. gradual change) during the initial 5 to 10 minutes after pressing MEAS.

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*Prior to the use of the reference scatterer the MINIRAM should be zeroed with a clean standard sensing chamber as described in section 3.10.

If the reference scatterer is ordered separately from the MINIRAM, the user will then determine the calibration reading obtained on the MINIRAM and mark it (together with the MINIRAM serial number) on the PDM-RS tag.

Because of small differences in the optical configuration of each reference scatterer, the readings obtained with a given reference scatterer are unique to a given MINIRAM. The response to a given population of airborne particles, however, is the same for all factory calibrated MINIRAMs, within approximately + 5%.

17.10 Carrying Case (GCA model PDM-HC-1)

The PDM-HC-1 is a convenient and compact hard shell carrying case designed to house a MINIRAM and a battery charger. The inside is foam padded for full protection. The outside dimensions of the PDM-HC-1 are: length - 9½ inches, depth - 7 inches, and height - 3½ inches.

List of Figures

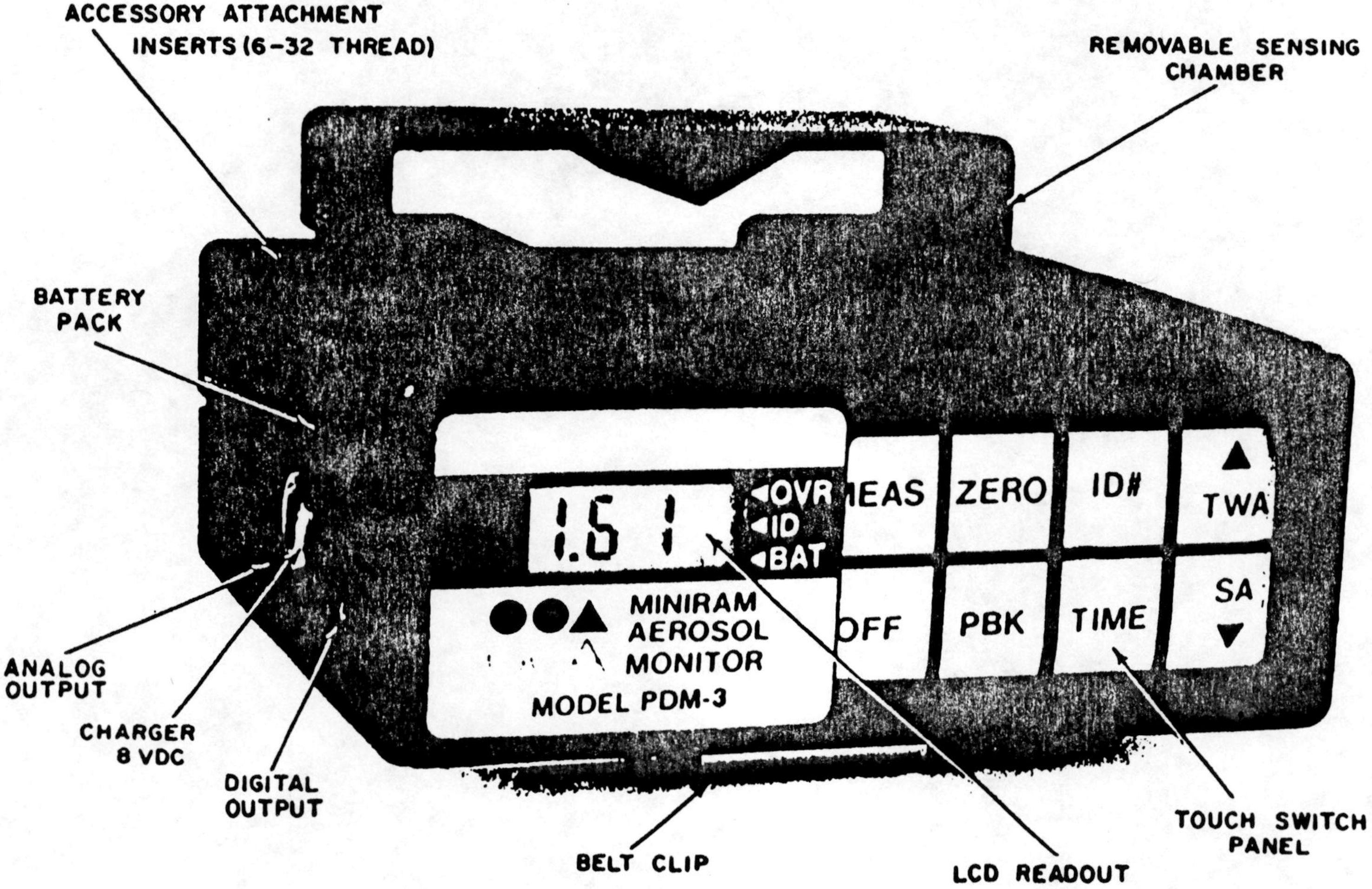


Figure 1. Main view of MINIRAM.

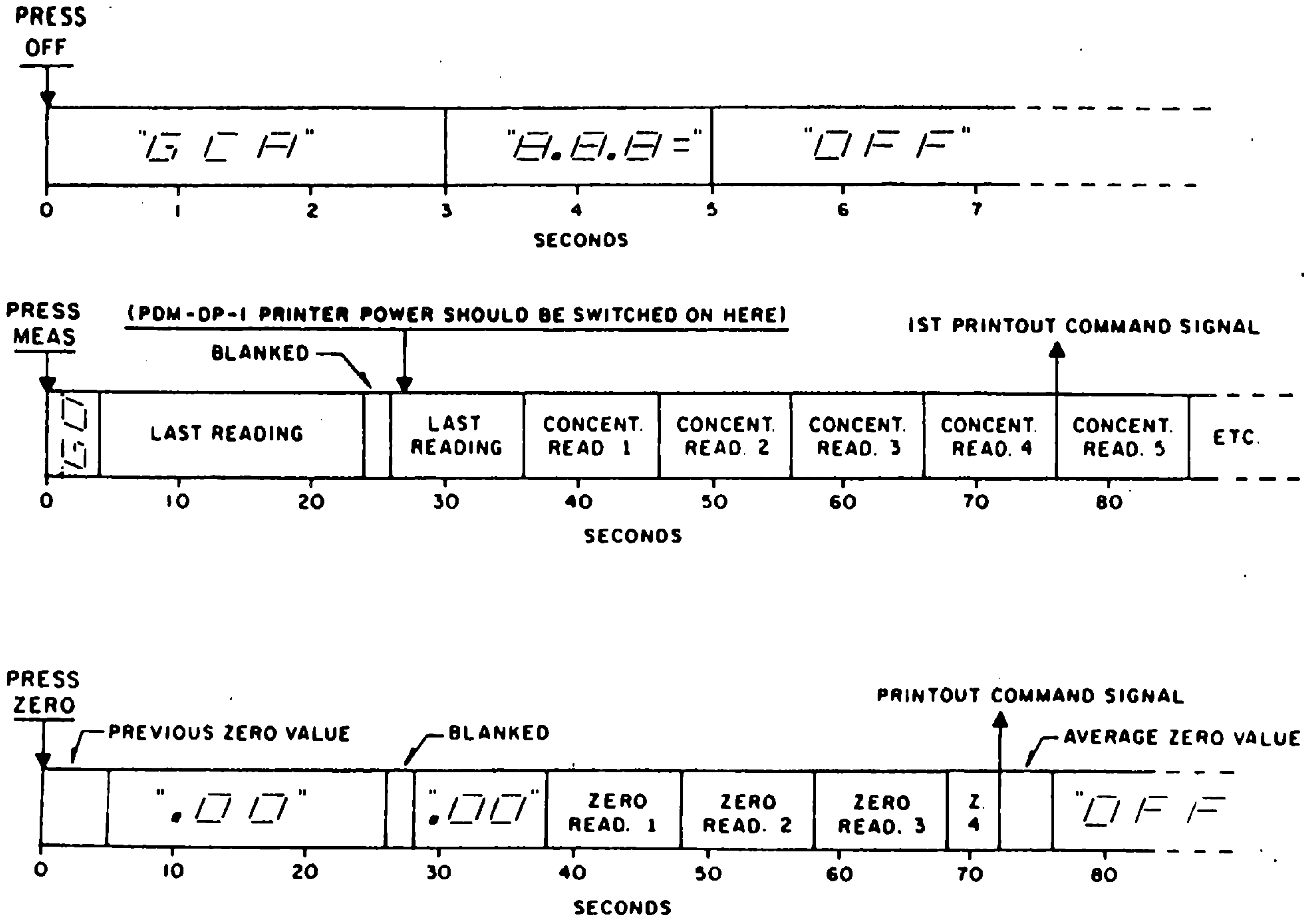
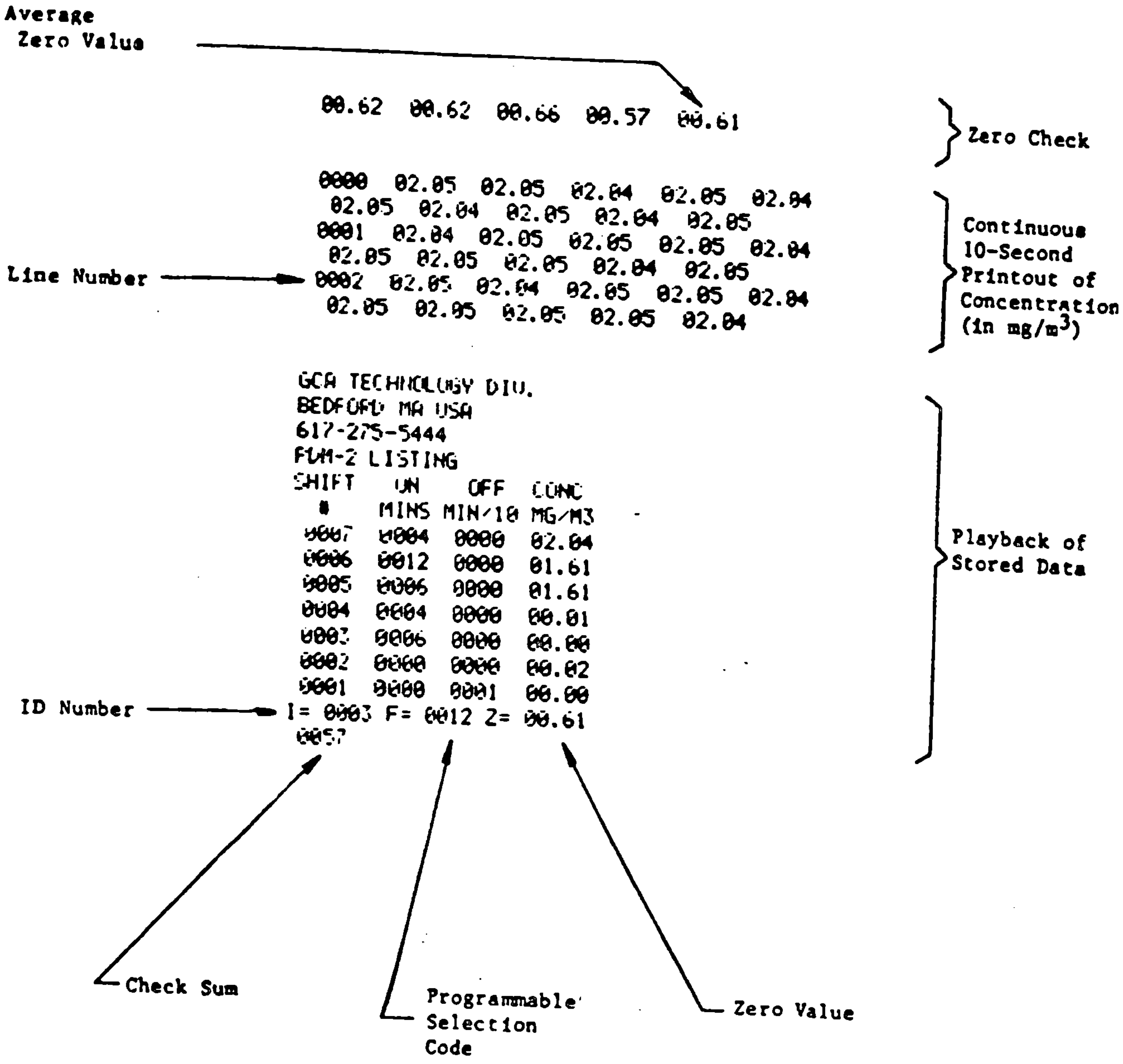


Figure 2. Timing diagram of MINIRAM model PDM-3 when pressing OFF, MEAS. or ZERO (typical times).



```
00.62  00.62  00.66  00.57  00.61

0000  02.05  02.05  02.04  02.05  02.04
 02.05  02.04  02.05  02.04  02.05
0001  02.04  02.05  02.05  02.05  02.04
 02.05  02.05  02.05  02.04  02.05
0002  02.05  02.04  02.05  02.05  02.04
 02.05  02.05  02.05  02.05  02.04

GCA TECHNOLOGY DIV.
BEDFORD MA USA
617-275-5444
PDM-2 LISTING
SHIFT   ON    OFF    CONC
  #    MINS  MIN/10  MG/M3
 0007  0004  0000   02.04
 0006  0012  0000   01.61
 0005  0006  0000   01.61
 0004  0004  0000   00.01
 0003  0006  0000   00.00
 0002  0000  0000   00.02
 0001  0000  0001   00.00
I= 0003 F= 0012 Z= 00.61
0057
```

Figure 3. Typical MINIRAM Model PDM-2 Digital Printout Format

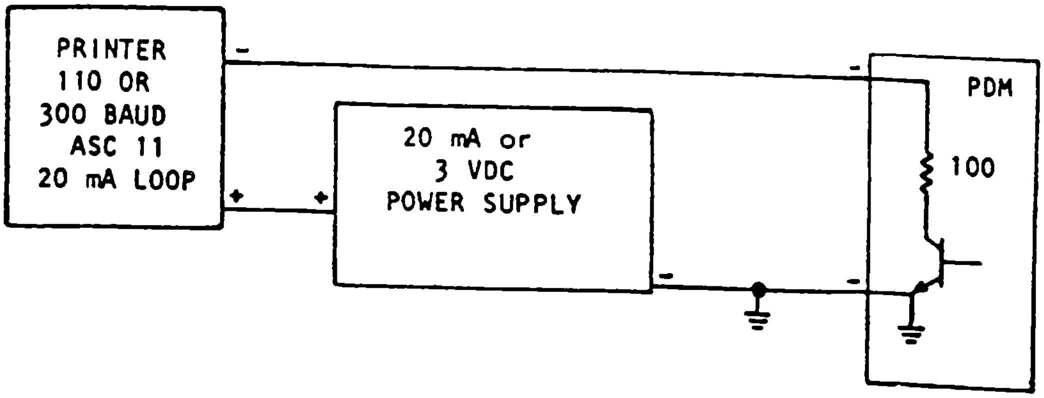


Figure 4. - 20 mA loop connection

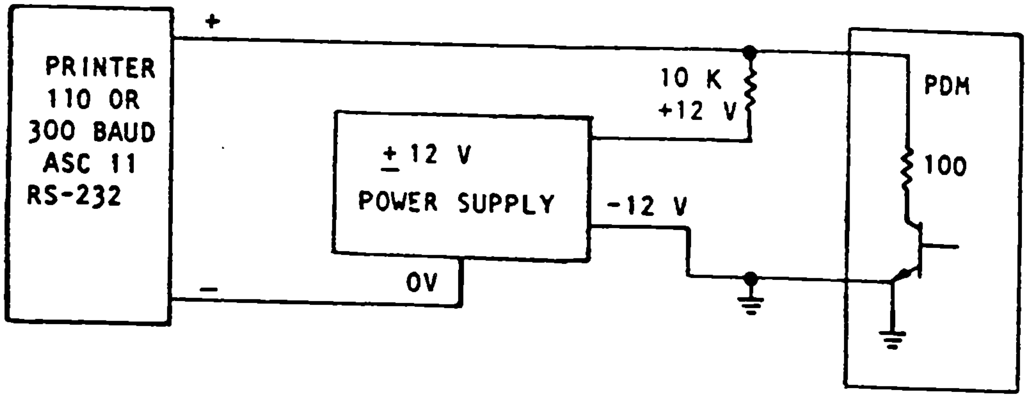


Figure 5. - RS-232 connection

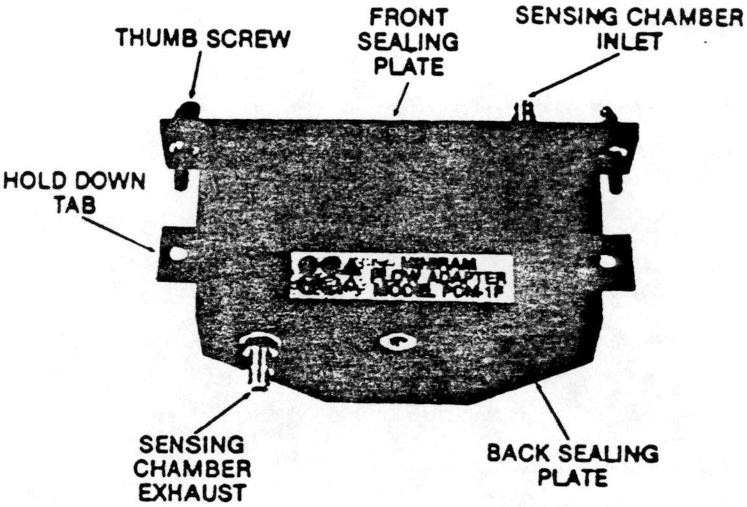


Figure 6a Flow Adapter

Figure 6b MINIRAM with Flow Adapter Attached

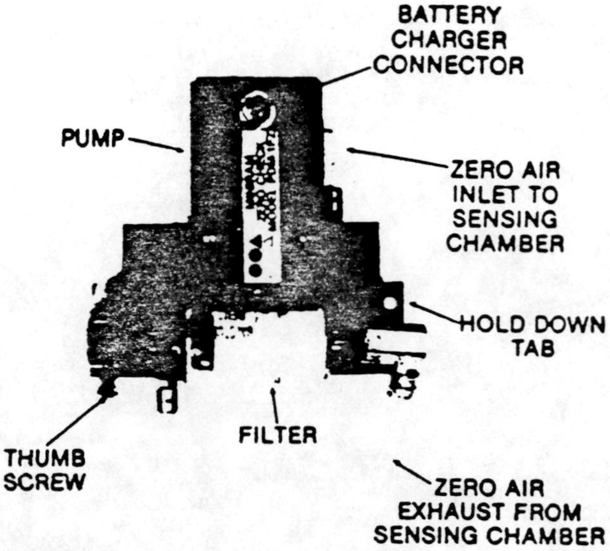


Figure 7a Zero Check Module

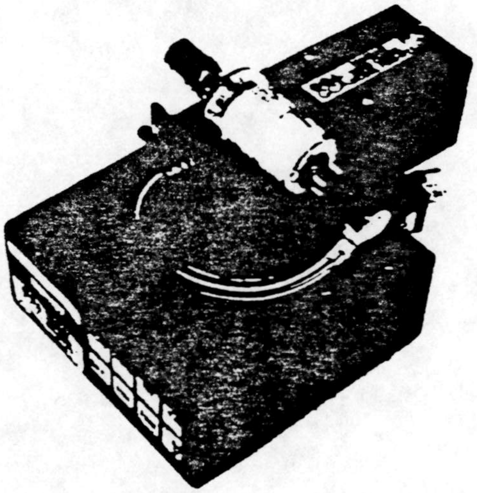


Figure 7b MINIRAM with Zero Check Module Attached

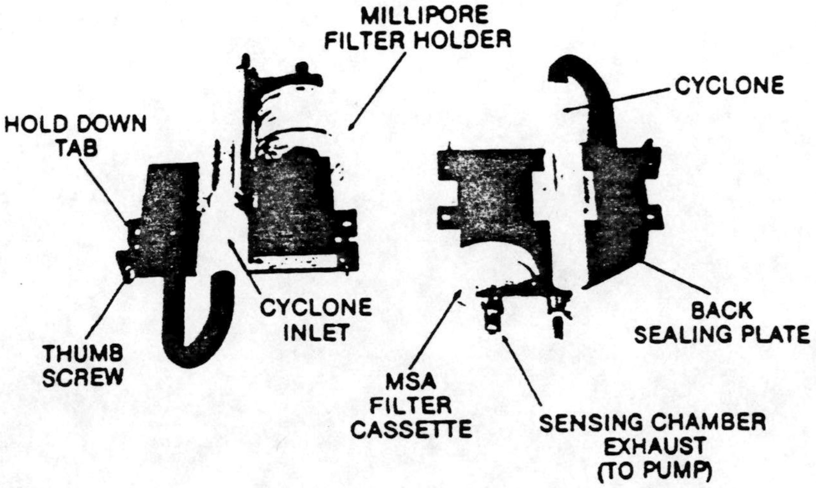


Figure 8a Personal Sampler Adapters

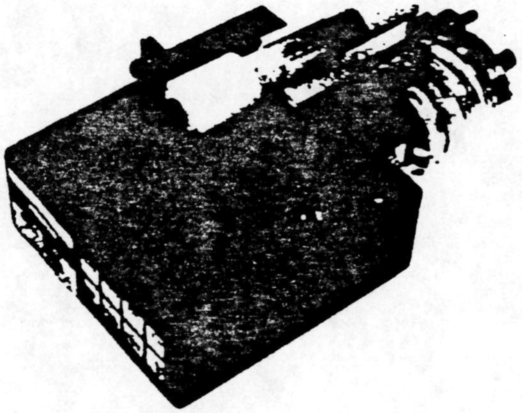


Figure 8b MINIRAM with Personal Sampler Adapter Attached

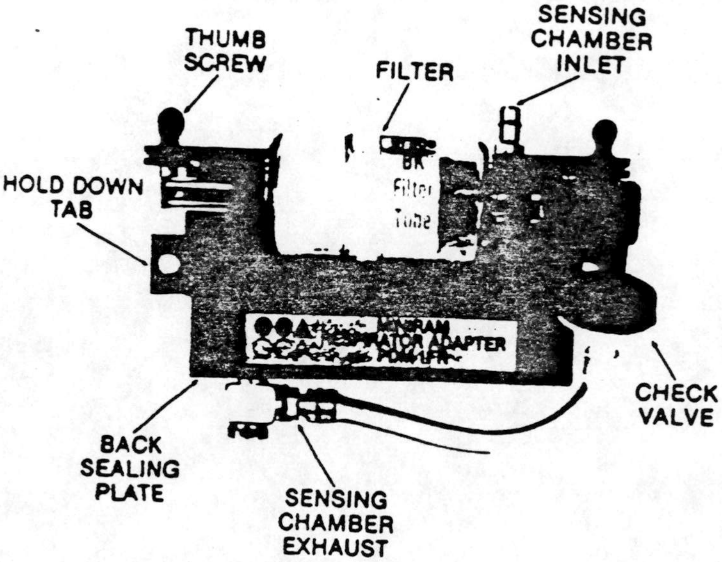


Figure 9a Respirator Adapter

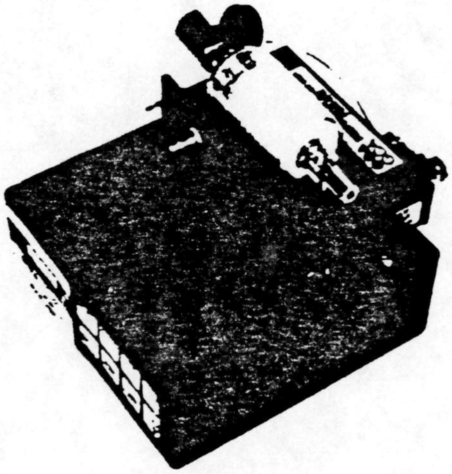


Figure 9b MINIRAM with Respirator Adapter Attached

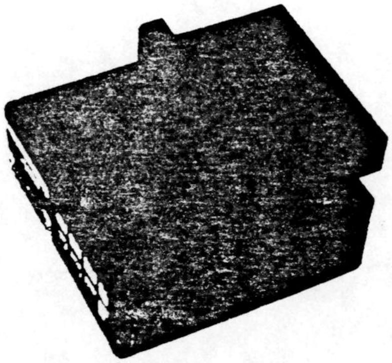


Figure 10. MINIRAM with Sunshield Attached

Figure 11. Model PDM-SS Shoulder Strap

ATTACHMENT E

HEAT STRESS PREVENTION AND MONITORING PROGRAM

Heat Stress Prevention and Monitoring

Heat stress may occur at any time work is being performed at elevated temperatures. Wearing of chemical protective clothing, which may result in decreasing natural body ventilation, increases the risk of heat stress.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur, ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Because heat stress is one of the most common and potentially serious illnesses at hazardous waste sites, regular monitoring and other preventative measures are vital.

Site workers must learn to recognize and treat the various forms of heat stress. The best approach is preventative heat stress management. In general:

- Have workers drink 16 ounces of water before beginning work, such as in the morning or after lunch. Provide disposable 4-ounce cups, and water that is maintained at 50-60°F. Urge workers to drink 1 to 2 of these cups of water every 20 minutes for a total of 1 to 2 gallons per day. Provide a cool area for rest breaks. Discourage the intake of coffee during working hours. Monitor for signs of heat stress.

- Acclimate workers to site work conditions by slowly increasing workloads, i.e., do not begin site work activities with extremely demanding activities.

- Provide cooling devices to aid natural body ventilation. These devices, however, add weight and their use should be balanced against worker efficiency. An example of a cooling aid is long cotton underwear which acts as a wick to absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

- In extremely hot weather, conduct field activities in the early morning and evening.

- Ensure that adequate shelter is available to protect personnel against heat as well as cold, rain, snow, etc. which can decrease physical efficiency and increase the probability of both heat and cold stress. If possible, set up the command post in the shade.

- In hot weather, rotate shifts of workers wearing impervious clothing.

- Good hygienic standards must be maintained by frequent changes of clothing and showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

The following is a discussion of specific results of heat stress:

1.0 Heat Stroke

Heat stroke is an acute and dangerous reaction to heat stress caused by a failure of heat regulating mechanisms of the body; the individual's temperature control system that causes sweating stops working correctly. Body temperature rises so high that brain damage and death will result if the person is not cooled quickly.

- Symptoms - Red, hot, dry skin, although person may have been sweating earlier; nausea; dizziness; confusion; extremely high body temperature; rapid respiratory and pulse rate; unconsciousness or coma.

- Treatment - Cool the victim quickly. If the body temperature is not brought down fast, permanent brain damage or death will result. Soak the victim in cool, but not cold water; sponge the body with cool water or pour water on the body to reduce the temperature to a safe level (102°F). Observe the victim and obtain medical help. Do not give coffee, tea, or alcoholic beverages.

2.0 Heat Exhaustion

Heat exhaustion is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. The condition is much less dangerous than heat stroke, but it nonetheless must be treated.

- Symptoms - Pale, clammy, moist skin; profuse perspiration and extreme weakness. Body temperature is normal, pulse is weak and rapid, breathing is shallow. The person may have a headache, may vomit, and may be dizzy.

- Treatment - Remove the person to a cool, air conditioned place, loosen clothing, place in a head-low position and provide bed rest. Consult physician, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have patient drink 1 to 2 cups of water immediately, and every 20 minutes thereafter until symptoms subside. Total water consumption should be about 1 to 2 gallons per day.

3.0 Heat Cramps

Heat cramps are caused by perspiration that is not balanced by adequate fluid intake. Heat cramps are often the first sign of a condition that can lead to heat stroke.

- Symptoms - Acute painful spasms of voluntary muscles, e.g., abdomen and extremities.

- Treatment - Remove victim to a cool area and loosen clothing. Have patient drink 1 to 2 cups of water immediately, and every 20 minutes thereafter until symptoms subside. Total water consumption should be 1 to 2 gallons per day.

4.0 Heat Rash

Heat rash is caused by continuous exposure to heat and humid air and aggravated by chafing clothes. The condition decreases ability to tolerate heat.

- Symptoms - Mild red rash, especially in areas of the body that come into contact with protective gear.

- Treatment - Decrease amount of time in protective gear and provide powder to help absorb moisture and decrease chafing.

5.0 Heat Stress Monitoring and Work Cycle Management

For strenuous field activities that are part of on-going site work activities in hot weather, the following procedures shall be used to monitor the body's physiological response to heat, and to manage the work cycle, even if workers are not wearing impervious clothing. These procedures are to be instituted when the temperature exceeds 70°F.

- Measure Heart Rate - Heart rate should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 33%, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute at the beginning of the next rest period, the following work cycle should be further shortened by 33%. The procedure is continued until the rate is maintained below 110 beats/minute.

- <u>Measure Body Temperature</u> - When ambient temperature is over 90°F, body temperatures should be measured with a clinical thermometer as early as possible in the resting period. If Oral Temperature (OT) at the beginning of the rest period exceeds 99.6°F, the next work period should be shortened by 33%, while the length of the rest period stays the same. If the OT exceeds 99.6°F at the beginning of the next rest period, the following work cycle should be further shortened by 33%. The procedure is continued until the body temperature is maintained below 99.6°F.

- <u>Physiological Monitoring Schedule</u> - The following Suggested Frequency of Physiological Monitoring Schedule for Fit and Acclimated Workers shall be used as a guideline:

<u>Temperature (Adjusted)</u>	<u>(Level D)</u>	<u>(Level C)</u>
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-32.2°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Measure the air temperature with a standard thermometer. Estimate the fraction of sunshine by judging what percent the sun is out.

100% sunshine = no cloud cover = 1.0
50% sunshine = 50% cloud cover = 0.5
0% sunshine = full cloud cover = 0.0

Adjusted temp. = actual temp. + 13 × (% sunshine factor).

The length of work period is governed by Frequency of Physiological Monitoring. The length of the rest period is governed by physiological parameters (heart rate and oral temperature). For example, if an individual's heart rate exceeds 110 beats/minute at the beginning of the rest period, that individual will remain on rest-time until his/her heart rate drops well below 110 beats/minute and their next work period (= duration of time before suggested physiological monitoring) is decreased by 33%.

ATTACHMENT F

COLD STRESS PREVENTION AND MONITORING PROGRAM

Field Operating Procedure - F1d06 -Cold Stress

Persons working outdoors in low temperatures, especially at or below freezing are subject to cold stress. Exposure to extreme cold for a short time causes severe injury to the surface of the body, or results in profound generalized cooling, causing death. Areas of the body which have high surface area-to-volume ratio such as fingers, toes, and ears, are the most susceptible.

Chemical protective clothing generally does not afford protection against cold stress. In many instances, it increases susceptibility. Chemical hazard site workers must learn to dress carefully to provide chemical protection and thermal insulation while not dressing so warmly that exercise or strenuous activity will result in heat stress.

Provisions must also be made for the fact that after physical activity and accumulation of body heat, sudden chilling during decontamination and rest breaks may increase susceptibility to colds, etc.

Two factors influence the development of a cold injury: ambient temperature and the velocity of the wind. Wind Chill Indices describe the chilling effect of moving air in combination with low temperature.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air; thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is perspiration-soaked.

1.0 Frostbite

Local injury resulting from cold is included in the generic term frostbite. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite is characterized by sudden blanching or whitening of skin.
- Superficial frostbite is characterized by skin with a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep frostbite is characterized by tissues that are cold, pale, and solid.

To administer first aid for frostbite:

- Take the victim indoors and rewarm the areas quickly in water that is between 39°C and 41°C (102°F-105°F).
- Give a warm drink - water, or juices not coffee, tea or alcohol. The victim must not smoke.
- Keep the frozen parts in warm water or covered with warm clothes for 30 minutes, even though the tissue will be very painful as it thaws.
- Then elevate the injured area and protect it from injury.

- Do not allow blisters to be broken.
- Use sterile, soft, dry material to cover the injured areas.
- Keep victim warm and get immediate medical care.

After thawing, the victim should try to move the injured areas a little, but no more than can be done alone, without help. Seek medical attention as soon as possible.

NOTE:

- Do not rub the frostbitten part (this may cause gangrene).
- Do not use ice, snow, gasoline or anything cold on the frostbitten area.
- Do not use heat lamps or hot water bottles to rewarm the part.
- Do not place the part near a hot stove.

2.0 Hypothermia

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages:

- Shivering
- Apathy, listlessness, sleepiness, and
- (sometimes) rapid cooling of the body to less than 95°F.
- Unconsciousness, glassy stare, slow pulse, slow respiration
- Death

If hypothermia is suspected in any field personnel, move person to a warmer location until symptoms recede.