SHANLEY, SWEENEY & REILLY, P.C.
ATTORNEYS AND COUNSELORS AT LAW
THE CASTLE AT TEN THURLOW TERRACE
ALBANY, NEW YORK 12203

(518) 463-1415
FAX (518) 463-3210

SARATOGA OFFICE
480 BROADWAY
SARATOGA SPRINGS, N.Y. 12866
(518) 583-0777

MICHAEL P. SHANLEY
ROBERT L. SWEENEY
J. STEPHEN REILLY
JOHN L. ALLEN
FRANK P. MILANO
GREGORY D. FAUCHERT
J. MICHAEL NAUGHTON
MARK R. MARCANTANO*‡
THOMAS A. SANTACROSE
JOHN B. DUCHARME
JOSEPH M. CATALANO
LUCINDA L. HILLERMAN**
JENNIFER M. ASSINITT
TERI A. KLEINMANN‡‡

OF COUNSEL
WILLIAM H. KISSEL

*ALSO ADMITTED IN CONNECTICUT
**ALSO ADMITTED IN MASSACHUSETTS
†ALSO ADMITTED IN FLORIDA
††ALSO ADMITTED IN MARYLAND
‡ALSO ADMITTED IN D.C.
‡‡ALSO ADMITTED IN ILLINOIS

March 21, 1990

Richard J. Brazell, P.E.
Senior Sanitary Engineer
New York State Department of Environmental Conservation
Region 7
615 Erie Boulevard West
Syracuse, new York 13204-2400

RE: APPROVED INTERIM REMEDIATION PLAN - SITE 734048

Dear Mr. Brazell:

This letter is to acknowledge that you have received the Approved Interim Remediation Plan for the above site. The plan includes the following:

1. The written description of the plan components (+ - 9 pages);

2. P.E. stamped drawings (detailed drawings and a site layout plan);

3. Technical Specifications--Temporary Containment Structure (prepared by O'Brien & Gere, Inc.); and manufacturer specifications for Paraseal (provided by John P. Stopen Engineers);

4. The Field Health & Safety Plan (prepared by Dunn Geoscience - consisting of two parts);

5. Approved Confirmatory Sampling Plan;

6. Air Monitoring Program Plan (dated March 15, 1990);

7. Foundation design drawings.

Based on my information, this package constitutes the complete Approved Interim Remediation Plan as approved by the Department to permit the planned activities at the site.

If you have any questions or comments, please do not to hesitate to contact me.

Very truly yours,

SHANLEY, SWEENEY & REILLY

Gregory D. Faucher

dlc

cc Conklin, Ltd.
Dunn Geoscience

APPROVED INTERIM REMEDIATION PLAN

1.0 Introduction

This Approved Interim Remediation Plan (Approved Plan) for Site #734048 has been prepared for the New York State Department of Environmental Conservation (the "Department") to detail the procedures to be followed in implementing the proposed plan, covering in detail the excavation protocols and procedures, the transportation, storage and treatment of VOC contaminated soils and the design and construction of a storage/treatment area and the measures to collect and treat VOC-contaminated groundwater ("the Approved Interim Remediation Plan").

The Approved Plan is comprised of two distinct phases.

Phase 1 will consist of excavation of VOC-contaminated soils in the impacted area followed by transport and storage of such soils in the containment/treatment structure located in the southwestern corner of the site; and the installation and operation of a soil gas extraction system or other appropriate treatment technology to remediate such soils.

Phase 2 will consist of the collection and treatment of groundwater remaining below the building foundation to remove contaminants prior to discharge, as necessary.

Phase 1 and 2 are described below in Sections 2.0 through 5.0 of the Approved Plan.

2.0 Excavation Plan

Excavation will proceed with track-mounted backhoes located in the area to be excavated as shown on the attached Site Layout plan. If stockpiling of VOC contaminated soil is necessary, they will be located on the identified contaminated area. Such soil will be placed on, and covered with polyethylene sheeting until they are to be loaded and transported to the containment/treatment system. The excavated soil will be loaded onto 15 cubic yard dump trucks which will then

proceed to the contained haul road. They will travel on the contained haul road up to the containment structure. The excavation contractor will have supervisory personnel monitoring the flow of traffic. No vehicles will leave the work area except as in accordance with the provisions of the Approved Plan.

Upon reaching the containment structure, excavated soils will be unloaded into the structure and spread with wide-track bulldozers and/or track-mounted backhoes.

Excavation will proceed to the depth of the lowered groundwater table (approximately 15 to 17 feet). At this point, localized dewatering using slit trenches and collector sumps will be utilized to drain out the excess groundwater prior to excavation. This will act to minimize spillage and treat the maximum amount of contaminated groundwater as is practicable. Excavation will proceed until levels of VOC contamination in the unexcavated soil comply with the criteria established in the Approved Plan as described in Section 2.1. The area will then be backfilled to construction grade as necessary and permanent underdrains will be installed. Prior to the installation of the underdrains, plans providing details of the groundwater collection system will be submitted to the Department for review and approval.

Upon completion of excavation, the haul road will be removed and VOC contaminated soil (as described in Section 2.1) above the liner, if any, will be placed in the containment structure. The structure will then be covered with an impermeable polyethylene liner and secured along the perimeter.

2.1 Excavation Criteria

Soil will be excavated from the impacted area to a minimum depth of 13 feet which is the requirement for the installation of the foundation. Additional vertical excavation will be completed until sampling and analysis of soil samples collected from the base of excavation utilizing portable field gas chromatograph

soil analyzed does not exceed 5 ppm and no single volatile organic parameter exceeds 1 ppm ("uncontaminated soil"). Analyses by GC will include the parameters at the site which have been identified in the greatest concentrations in the soil. These include trans-1,2-dichloroethene, cis-1,2-dichloroethene, benzene, trichloroethene, toluene, tetrachloroethene, m&p xylenes and o-xylenes.

The approximate area of excavation is shown on the attached site layout plan. The actual area of excavation will be determined utilizing the criteria described in the above paragraph. Based on available analytical results, excavation in most of the impacted area will not be necessary beyond ± 18-20 feet below grade. However, in some areas, excavation may be as deep as ± 23 feet below grade. The actual depth will depend on the field GC results.

2.2 Dewatering

Dunn anticipates that it will be necessary to further dewater the proposed excavation area if excavation is necessary below ± 15-20 feet below grade. The natural water table has been lowered to that depth during the Pilot Study. This has been achieved by the installation of a sheetpile and/or a slurry wall around the impacted area and continuous withdrawal and treatment of groundwater. Additional sheetpiling and/or slurry wall will be installed if determined appropriate. Excavation below this depth may require localized dewatering via a trenching and/or well point system. In the event that groundwater is encountered and collected during the excavation, the water will be pumped and treated through the existing water treatment system and discharged using the system approved by the Department during the vacuum extraction pilot test (see letter dated January 16, 1990 from the Department to Dunn Geoscience Corporation).

2.3 Health/Safety

Excavation will proceed in accordance with the requirements outlined in the Field Health and Safety Plan prepared by Dunn Geoscience Corporation included in this Plan. This plan consists of the Field Health and Safety Plan approved by the Department for the Pilot Study and an addendum prepared by Dunn to address the site activities to be undertaken.

In accordance with Section 5.2 of the attached addendum to the site Field Health and Safety Plan, monitoring of air emissions and perimeter monitoring will be conducted to control fugitive emissions.

As outlined in the Department's approval of modifications to the Pilot Study dated October 4, 1989, appropriate control measures (e.g., ground cover, temporary work stoppage) will be implemented to ensure that air emissions are minimized and any potential threat to workers or the public are minimized or eliminated.

3.0 Transportation of Excavated Soil

If the analyzed VOC concentrations exceed the established criteria described in Section 2.1, the contaminated soil will be transferred into dump trucks and transported to the containment/treatment structure. The roadway is designed and will be constructed and lined such that any spillage can be contained and collected.

To ensure that there is no risk of contaminating the area outside the excavation or treatment areas, the procedures and steps described in Section 2.1 for loading and unloading contaminated soil will be followed. Additionally, a contained roadway corridor has been designed by O'Brien & Gere Technical Services which will protect underlying uncontaminated soil as described in Section 3.1.

Movement of trucks will be limited to only between the area of excavation and the containment/treatment structure. These two areas will be connected by a roadway wide enough for the safe and efficient passage of two trucks side by side simultaneously (± 25-30 feet) as shown on the attached Site Layout plan. Additionally, measures will be taken to prevent soils from spilling or leaking from the trucks traveling to and from the structure.

Any uncontaminated soil will be excavated as needed to construct the building foundation and to establish the grades necessary for development of the shopping center and will be taken to an off-site area of common ownership. Current plans call for the use of uncontaminated soil in which VOCs have been detected to be limited to use as fill material in an area of common ownership and covered with an asphalt or other impermeable cover.

3.1 Roadway Design

A two-lane roadway corridor will be constructed between the excavation area and the containment/treatment structure. At each end of the roadway there will be a single lane loop to allow trucks to safely enter the loading and unloading zones and maneuver through the roadway corridor. The road itself would consist of the following layers in ascending order as shown on the attached access road drawing.

- Compacted native soils
- Geotextile fabric
- ± 12 inches of crushed stone
- ± 2 inches of sand
- 30 mil HDPE liner
- ± 9 inches of suitable native soil
- Geotextile fabric
- ± 3 inches run-o-crushed stone

The design provides for a 2 foot berm on either side of the road to prevent materials from leaving the contained roadway. This berm will prevent any uncontrolled migration of contaminated soils in the event of a spill. Moreover, the roadway has been sloped so that any such spilled soils (or water) will be controlled. The HDPE liner will extend beneath the entire road and up and over the sides of the side berms. The liner will also extend a sufficient number of feet in each direction beyond the roadway edge to prevent potential contamination of adjacent soil in the event of spillage. In addition to protecting underlying soils from becoming contaminated, the liner will contain any spills which may occur, preventing both vertical and lateral migration.

In the event that significant spillage of contaminated soils occurs on the roadway, suitable equipment will be used to easily remove such soils from the roadway. Such soils will then be transported and placed in the containment/treatment structure.

Upon completion of excavation activities, all soils contaminated with VOCs located on the roadway above the liner will be removed and placed in the containment/treatment structure.

This procedure will ensure that there is no spreading of contamination and that there is no contamination in contact with previously uncontaminated areas.

Trucks transporting the soil from the excavation area will be covered to prevent dispersal of the soil and to minimize air emissions while en route to the containment/treatment structure. Truck movements will be limited to the roadway and areas of loading and unloading.

Prior to leaving the work area (i.e., excavation area, contained roadway and containment/treatment structure), all equipment will be decontaminated in accordance with the procedures established by the Department in its October 4, 1989 letter approving modifications to the Pilot Study. Specifically, equipment leaving the work area must first pass through the decontamination area. Attached is a drawing of a typical decontamination pad. This structure is designed to contain any potentially contaminated water from the decontamination process. Such water will flow through the drain/sump where it will then be pumped to the NYSDEC approved water treatment system prior to discharge.

Decontamination procedures will consist of removal of significant accumulations of soil prior to entering the decontamination pad area. The equipment will then be washed with a high pressure water spray to remove residual soil. Particular attention will be paid to areas such as tracks,] blades and buckets where materials tend to accumulate. Once the equipment has been sufficiently decontaminated, it will exit the opposite (clean) side of the decontamination area.

4.0 Containment/Treatment Structure

Contaminated soil excavated from the impacted area will be transported using previously described methods to a containment/treatment structure as described by O'Brien & Gere Technical Services. A plan view and cross sectional drawings of the structure are attached. The structure will be located on the Carousel Center Site and is expected to be located in the southwest corner of the site as shown on the attached Site Layout Plan. It will be designed as described below or as otherwise determined appropriate and in cooperation with the Department.

4.1 Design

The structure will consist of large, earthen berms (approximately 20 feet in height) which will be consolidated and compacted to maximize their structural integrity and impermeability. The structure will be a double-lined facility utilizing 60 mil HDPE liners separated by a leak detection layer as shown on the Site Layout Plan and the attached detailed drawings. The structure will be roughly triangular in shape with sides of approximately 600 feet by 350 feet by 700 feet. The floor of the structure will slope to a continuous drainage pipe/trench. The essential elements of the structure, in ascending order, are as follows:

- Graded and compacted native soil
- Secondary 60 mil HDPE liner
- Sand, gravel (6± inches) or drainage net leak detection layer
- Primary 60 mil HDPE liner
- ± 3 inches of sand drainage layer
- Geotextile fabric
- ± 9 inches of #2 crushed stone
- Filter fabric

Contaminated soil will be placed above the filter fabric and eventually covered with a 20 mil HDPE liner or compacted clay. The liner will be anchored utilizing tires or other appropriate methods or materials. The top of the facility will be sloped toward the side berm. A 4 inch perforated pipe will be placed along the toe of this top slope to collect surface drainage and control erosion. Water from this surface drainage pipe will be routed away from the structure and the work area.

The use of the earthen berm as containment structure sidewalls, together with a flexible impervious liner, is an ideal compliment to current site conditions. The berms act to spread the load of sidewall over a larger area (decreasing the likelihood of settlement), and the flexible impermeable liner will accommodate shifts or settling of the subgrade. The design (wide earthen beams, together with a solid working surface topped with an impervious flexible liner) will accommodate potential subgrade movement and will simultaneously meet the requirements of an effective containment/treatment structure.

4.2 Water Collection

Soil placed in the structure will be allowed to drain off any excess moisture through an underdrain or water collection system. Furthermore, the structure is designed to accommodate a soil gas extraction system which will minimize and/or eliminate the possibility of vapor releases. When the structure is filled, present plans are to install and operate a soil gas extraction system to remove VOC contaminants from the soils in the structure.

The upper layer of 2 inch crushed stone and the sand drainage layer overlying the primary 60 mil HDPE liner will facilitate drainage of soils placed in the structure toward the drainage collection pipe. Water which collects in the drainage pipe will flow by gravity to the facility sump. The sump will house a pump of appropriate size and specifications to sufficiently evacuate water from the sump. Water which collects in the sump will be pumped to the NYSDEC approved water treatment system prior to discharge.

The drainage layer between the primary and secondary 60 mil HDPE liners will serve as a leak detection layer. In the unlikely event that water passes through the primary liner, it would then flow by gravity to the drainage trench. This drainage layer is isolated within the trench by the primary and secondary liners, as well. Any water accumulating in the trench will flow by gravity to an isolated portion of the sump which will be fitted with a perforated concrete vault specifically for leak detection. A 3 inch access pipe will penetrate the concrete vault for monitoring, if necessary.

In the event that VOC contaminants are detected in the leak detection sump, additional samples will be collected. If additional sampling determines that VOC contaminated water has actually entered the leak detection system, monitoring wells downgradient of the structure will be installed, as required by the Department, in the uppermost water-bearing unit, as appropriate.

5.0 Phase 2

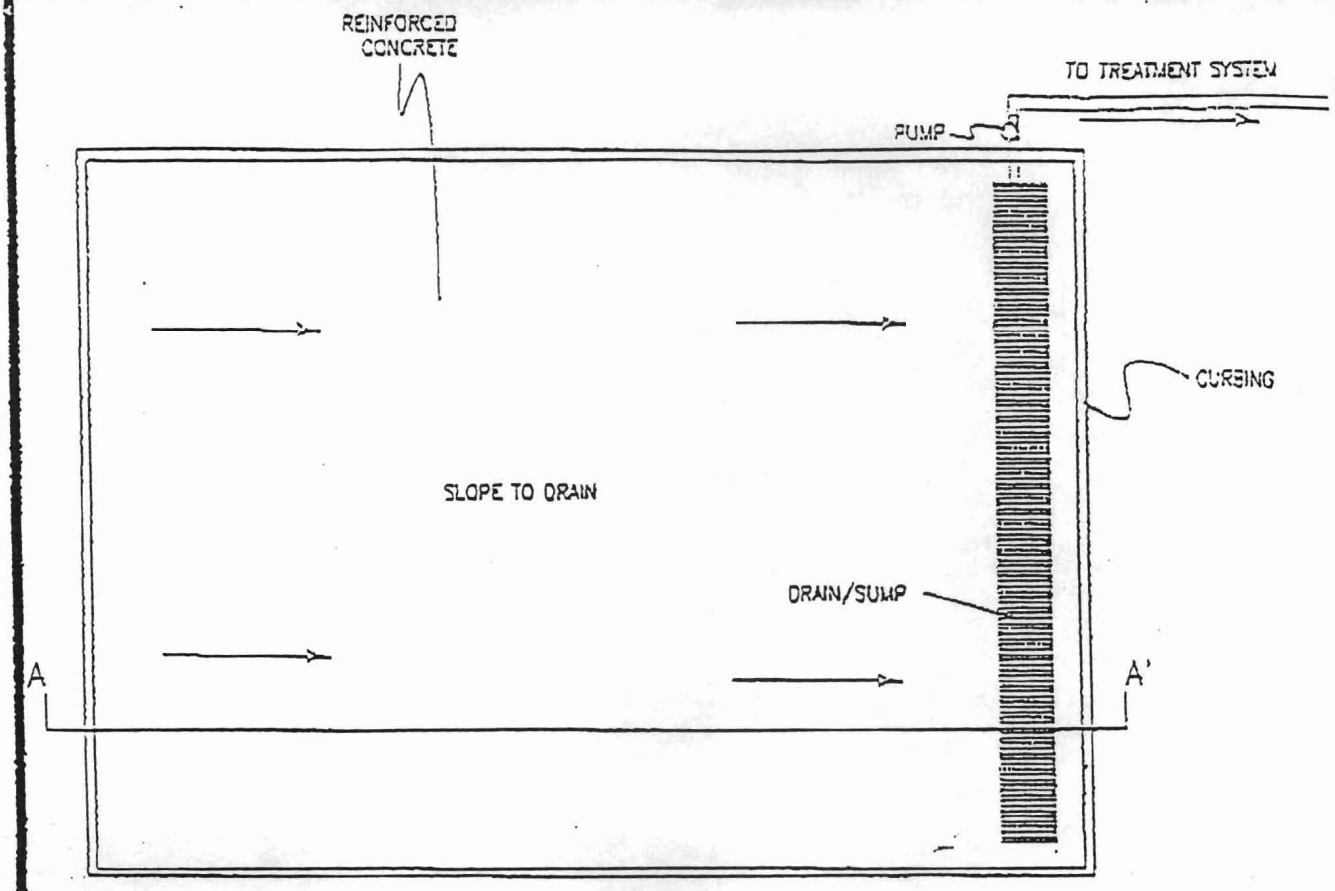
Once the excavated soils are isolated and contained, a detailed study will be undertaken to evaluate available treatment technologies and to select a preferred treatment technology to be implemented. Upon selection of a permanent remedy, this study will be submitted to the Department for its review and approval. A soil gas extraction system or other appropriate remediation technology will be incorporated into this Interim Remedial Plan. Any uncontaminated soil (as described in Section 2.1) in the structure will be handled in accordance with the procedures detailed in Section 3.0.

Prior to construction of the building foundation, plans providing details of the groundwater collection and treatment system to be incorporated into the foundation design will be submitted to the Department for its review and approval. Conceptual details are included in the Supplemental Feasibility Study prepared by Dunn Geoscience Corporation dated February, 1990 at Sections 2.0-Foundation Construction and 4.0-Groundwater Controls and Treatment.

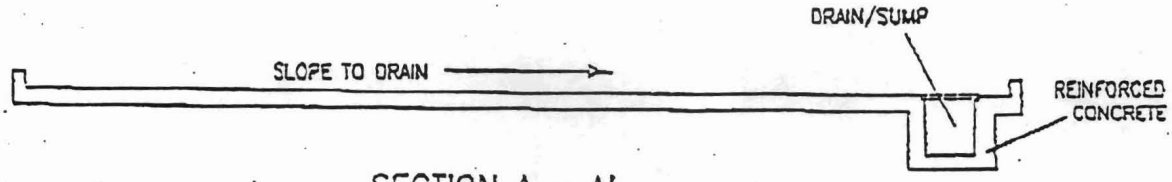
PROJECTED SEQUENCE/TIMELINE

Activity	Projected Completion Date
Fill/Grade Subbase Area	3/6/90
Construct Berms	3/6/90
Install Haul Road	3/5/90
Install Decontamination Pads	3/5/90
Install Containment Structure Drain Troughs	3/5/90
Prepare Subbase for Liner	3/19/90
Install Liners in Structure	3/20/90
Install Drains in Structure	3/22/90
Localized Dewatering	3/25/90
Excavation	3/28/90
Install/Operate Soil Gas Extraction	-----

NOTE: This projected sequence/timeline has been prepared for this document. Actual sequence and timing of construction may be different than shown.



DECONTAMINATION PAD
(PLAN VIEW)



SECTION A – A'

TYPICAL DECONTAMINATION PAD

DUNN
GEOSCIENCE CORP

LINCOLN CENTRE, SUITE 106 •
299 CHERRY HILL ROAD •
PARSIPPANY, NJ 07054
201 299-9001
FAX 201 299-0021

April 26, 1990

Mr. Gary Litwin
New York State Department of Health
II University Place
Albany, NY 12203-3313

Dear Gary:

The following confirms air monitoring program modifications we discussed in response to your letter to Mr. Brazell dated April 16, 1990. This will define the desired air monitoring programs status as of April 23, 1990. Ambient air monitoring for volatile organics planned for the Clark Property will be expanded to cover the containment structure for stockpiled soils and the duration of sampling will be expanded to 5 hours. The analytical laboratory has recommended that sample volumes be maintained at 5 liters or less to avoid instrument overload. This will require sampling at a reduced flow rate (~15cc/minute) to enable a longer sampling interval (~5 hours).

Analytical results will be reviewed as the project progresses to determine whether sample volumes can be increased without adverse effects on the analytical laboratory.

Monitoring points will include 4 locations surrounding the excavation and 4 locations surrounding the containment structure.

Very truly yours,
DUNN GEOSCIENCE CORPORATION

Mark E. Falerios

Mark E. Falerios, C.I.H.
Director Health and Safety

MEF: amp
cc: B. Aho
R. Brazell
T. Johnson
G. Faucher

APR 30

MEF\4-26-2

DUNN
GEOSCIENCE CORP.

LINCOLN CENTRE, SUITE 106 •
299 CHERRY HILL ROAD •
PARSIPPANY, N J 07054
201/299-9001
FAX 201/299-0021

March 26, 1990

Mr. Richard J. Brazell, P. E.
New York State Department of Environmental Conservation
615 Erie Blvd., West
Syracuse, NY 13204-2400

Dear Mr. Brazell:

In addition to real-time and indirect monitoring for organic vapors, particulate concentrations will be monitored during remediation activities at site No. 734048. Monitoring will be performed utilizing the MDA-PCD-1 real-time respirable dust monitor, or equivalent to help control fugitive dust emissions. The units will be capable of measuring 0.01mg/m^3 or greater. The monitors will be calibrated at the factory and electronically in the field prior to sampling.

Monitoring Strategy

Respirable fraction particulate concentrations will be collected by drawing air through a respirable fraction cyclone separator (at 2 liters per minute) attached to the MDA-PCD-1 monitor. Particulate concentrations will be monitored on a real-time basis downwind of the Working Site perimeter. The data will be averaged on a ten minute basis by the instrumentation and recorded as part of project documentation.

If the downwind 10 minute average concentration is found to exceed 150 ug/m^3, an upwind measurement of respirable particulate concentrations will be taken using the same equipment (10 minute average). The concentrations measured at the upwind location will be subtracted from the corresponding concentrations measured at the downwind location.

If the concentration difference exceeds 100 ug/m^3, then corrective action will be taken at the Working Site to reduce the migration of particulates. Corrective action may include the use of dust suppression measures including periodic application of water.

Very truly yours,
DUNN GEOSCIENCE CORPORATION

Mark E. Falerios

Mark E. Falerios, C.I.H.
Director Health and Safety

MEF:amp

MEF\3-26-2

GEOSCIENCE CORP

LINCOLN CENTRE, SUITE 106 •
289 CHERRY HILL ROAD •
PARSIPPANY, N.J. 07054
201/299-9001
FAX 201/299-0021

RECEIVED
MAR 20 1990

March 15, 1990

Mr. Brian Aho
New York State Department of Environmental Conservation
615 Erie Blvd. West
Syracuse, NY 13204-2400

Dear Mr. Aho:

The following documents ambient air monitoring to be performed for site #734048 as per our conversation on March 15, 1990.

Air Monitoring stations will be set up at the 4 major compass points daily around the perimeter of the site. Each station will be set approximately 5 feet off the ground using a self-supporting stand.

Each monitoring station will consist of a small vacuum pump capable of drawing up to 4.0 L/min of air. Air will be collected and analyzed per EPA method TO2 per your recommendation. The vacuum pumps will be operated for a period spanning 100 minutes during the warmest period of the day (e.g. 2:00 - 3:30 PM). A typical total sample volume will be 5 liters of air. The vacuum pumps will be calibrated before and after each sample collection.

Samples will be submitted to an accredited laboratory for analysis with a 48 hour turnaround for initial samples. As we discussed, the results of this monitoring will be reviewed with the Department of Environmental Conservation and a decision made as to needed turnaround time for future samples to be collected as part of the approved plan.

The detection level for these analytes is approximately 20ng or less. This is the total mass adsorbed onto the activated carbon. The total volume of air drawn through the sample tube will be divided into the mass detected to calculate the ug/m3 concentration in the ambient air. The estimated detection limit for materials to be analyzed following EPA method TO2 is 4 ug/m^3.

In addition to monitoring the concentration of analytes at the 4 compass points, wind speed and direction will be noted. The data will be recorded during the course of the air quality sample collection effort. This data will be used to determine the predominant wind direction during the sample period to evaluate the "upwind" and "downwind" directions. Wind speed may be used in evaluating possible source(s) of materials detected. The resulting ambient air concentrations upwind, on-site and downwind of the site will then be recorded.

Background samples will be gathered and analyzed in a similar manner at four (4) locations across the site prior to excavation.

Very truly yours,
DUNN GEOSCIENCE CORPORATION

Mark E. Falerios, C.I.H.
Director Health and Safety

MEF: amp

ADDENDUM:

Approved Interim Remediation Plan

Site #734048

Field Health and Safety Plan

This Field Health and Safety Plan is part of the Approved Interim Remediation Plan. It includes two (2) parts: 1) The Field Health and Safety Plan approved by the Department for the Pilot Study at Site #734048 (Attachment A); and 2) Modifications to that plan determined necessary by DUNN to address potential concerns associated with site activities (Attachment B).

ATTACHMENT "A"

Pilot Study Health and Safety Plan

PILOT STUDY

FIELD HEALTH AND SAFETY PLAN

1.0 INTRODUCTION

This Field Health and Safety Plan (FHSP) has been developed to identify hazardous conditions known or suspected to be present on the site and ensure that they do not adversely impact the health or safety of personnel conducting field activities at the site. It is applicable to all Dunn Geoscience Corporation (Dunn) personnel who visit the site and is intended to ensure that the procedures used during these field activities are protective of human health and safety and of the environment outside of the work areas. This plan incorporates by reference the applicable requirements of the Occupational Safety and Health Administration in 29 CFR Parts 1910 and 1926.

The requirements and guidelines in this FHSP are based on a review of all available information and an evaluation of potential hazards. They have been developed to minimize the potential for exposures of field personnel. These requirements can be modified by the Project Manager, the Corporate Health and Safety Officer (CHSO), or the Site Health and Safety Officer (SHSO) in response to additional information regarding the potential for exposure to hazards.

All field personnel working at the site will be required to familiarize themselves with this FHSP and abide by its requirements. Adherence to this FHSP will minimize the possibility that personnel at the site and the public will be injured or exposed to health hazards. Information on potential health, safety and environmental hazards is discussed in conjunction with appropriate protective measures including assignment of responsibility, personal protective equipment requirements, work practices, and emergency response procedures.

In general, subcontractors are responsible for complying with all regulations and client policies applicable to the work they are performing. Subcontractors must develop their own FHSP's which must be at least as stringent as this one. With Dunn's permission, a subcontractor may adopt this FHSP.

Dunn personnel can and must stop work by a subcontractor who is observed to not be following required health and safety procedures.

This FHSP is specifically intended for those personnel who will be conducting activities within the defined scope of work in specified areas of the site. Future actions that may be conducted at this site may necessitate the modification of task-specific health and safety requirements. The entry of unauthorized personnel into a restricted area will be prohibited.

2.0 DESIGNATION OF RESPONSIBILITIES

The responsibility for implementing this FHSP is shared by the Project Manager, the CHSO and the SHSO. The Project Manager will recommend policy on all safety matters including work practices, training and response actions, and will provide the necessary resources to conduct activities safely. Responsibility for proper implementation of this FHSP lies jointly with the Project Manager and the SHSO.

The CHSO has overall responsibility for developing safety procedures and training programs, maintaining a high level of safety awareness; ensuring compliance with applicable federal and state health and safety regulations; determining appropriate protection including the selection of protective equipment, maintenance schedules and monitoring protocols; and maintaining close communication with the SHSO and field personnel. The CHSO is the final decision point for determination of health and safety policies and protocols.

The SHSO is responsible for establishing operating standards and coordinating all safety and technical activities occurring at the site, with guidance from the CHSO. Specifically, the SHSO is responsible for:

- Assuring that a complete copy of this FHSP is at the site prior to the start of field activities and that all workers are familiar with it.
- Conducting training and briefing sessions.

- Ensuring the availability, use, and proper maintenance of personal protective, decontamination, and other health or safety equipment.
- Maintaining a high level of safety awareness among team members and communicating pertinent matters to them promptly.
- Assuring that all field activities are performed in a manner consistent with Company policy and this FHSP.
- Monitoring for dangerous conditions during field activities.
- Assuring proper decontamination of personnel and equipment.
- Coordinating with emergency response personnel and medical support facilities.
- Initiating immediate corrective actions in the event of an emergency or unsafe condition.
- Notifying the Project Manager and CHSO promptly of any emergency, unsafe condition, problem encountered, or exception to the requirements in this FHSP.
- Recommending improved health and safety measures to the CHSO.

The SHSO has the authority to:

- Suspend field activities or otherwise limit exposures if the health or safety of any person appears to be endangered.
- Notify Company or subcontractor personnel to alter work practices that are deemed not properly protective of human health or the environment.
- Suspend an individual from field activities for infraction of the requirements in this FHSP.

However, the presence of the SHSO shall in no way relieve any person or company of its obligations to comply with the requirements of this Plan and all applicable federal, state and local laws and regulations.

The key element in the responsibility for health and safety is the individual field team member. Each must be familiar with and conform to the safety protocols prescribed in this FHSP, and communicate any relevant experience or observations to provide valuable inputs to improving overall safety.

3.0 SCOPE OF WORK

Specific tasks covered by this FHSP may be found in the appendices addressing Drilling, Trenching etc.

4.0 SITE-SPECIFIC HEALTH AND SAFETY CONCERNS

Site History

Historical Data

Historical information available regarding the site suggests that it had been used by a concrete manufacturing firm at one time. The site survey has revealed no buried metals, containers or vessels containing pockets of chemicals.

Site Concerns

The following are summaries of constituents detected at the site.

- Chlorinated Hydrocarbons — Methylene Chloride, Trichloroethylene, 1,1,1 Trichloroethane (also called Methylchloroform), 1,2 Trans dichloroethylene, 1, 1 dichloroethane, Vinyl chloride
- Organic Hydrocarbons (Acetone, Toluene, Xylenes)

No safety hazards were identified other than those normally associated with on site testing and therefore well-known to the personnel involved. Use of the specified personal protective equipment will minimize the risks.

If field measurements or observations indicate that a potential exposure is greater than the protection afforded by the equipment specified in this Plan, the exposure will be reduced or the degree of personal protection will be increased to provide adequate protection.

5.0 SITE-SPECIFIC HEALTH AND SAFETY REQUIREMENTS

Key Personnel

The key personnel in this study responsible for various aspects of the Health and Safety Plan are as follows:

A. Project Advisor - D. R. Alexander
B. Project Manager - J. P. McBurney
C. On-Site Coordinator - to be designated on a task specific basis
D. Project Health and Safety Office - Mark E. Falerios
E. Corporate Health and Safety Officer - D. R. Alexander/M. E. Falerios

Training

The Project Manager, SHSO and all personnel working at the site will receive training at least meeting the requirements established by the Occupational Safety and Health Administration in 29 CFR 1910.120.

Persons will be briefed by the Project Manager or SHSO as to the potential hazards which may be encountered. Topics will include:

- Availability of this FHSP and the nature of its contents.
- General site hazards and specific hazards in the work areas including those attributable to the chemicals present.
- Selection, use, testing, and care of body, head, eye, hand, foot and respiratory protection to be worn, along with the limitations of each.
- The demarcation system that will be used to identify restricted-access, decontamination, and contamination-free zones.

- o Decontamination procedures for personal protective and other equipment.
- o Emergency alarm systems and other forms of notification, and evacuation routes to be followed.
- o Prohibitions on smoking and carrying of tobacco products, eating, drinking, and open fires (except by permit) in the work area.
- o Methods to obtain outside emergency assistance and medical attention.
- o Site specific health, safety, and emergency response requirements.

Air Monitoring

No immediately dangerous to life or health exposures are expected to be encountered. Specific monitoring for selected materials will be performed to assure adequacy of protective measures. If HNU analysis of breathing zone air indicates readings of 5 ppm or greater of volatile organic compounds, half mask or full-face respirators equipped with organic vapor cartridges should be worn. An explosimeter will also be used to monitor explosive gases, as appropriate.

If air monitoring results exceed 50 ppm of volatile organic compounds, work should be halted until Level B protection or alternate controls will be adopted to reduce emissions to below 50 ppm.

Note: Solvent vapors may concentrate in trenches under certain conditions (e.g. narrow, deep trenches which prevent adequate air movement). If these conditions are present, the area should be tested prior to allowing entry of personnel. (See confined space entry procedures in Appendices).

Personal Protective Equipment:

Table 1 indicates the general levels of personal protective equipment (PPE) that will be used on-site.

Table 1

Protection Levels

	C	Modified C	D
Air-purifying respirator	Yes	(1)	(1)
Chemical-resistant disposable coveralls	Yes	Yes	No
Chemical-resistant outer gloves	Yes	Yes	Yes
Disposable inner gloves	Yes	(2)	No
Overboots (chemically resistant)	Yes	Yes	Yes
Leather shoes/boots or safety shoes	Yes	Yes	Yes
Safety glasses, goggles, or face shield	Yes	Yes	Yes
Hard hat	Yes	Yes	Yes
Coveralls	(2)	(2)	(2)

(1) Required if a steady-state HNU reading in the breathing zone exceeds 5 ppm above the background readings. If site specific information includes likely exposure to highly toxic particulates, 1/2 mask respirators equipped with combination organic vapor - high efficiency filter cartridges will be required. Otherwise optional at the discretion of the employee and SHSO.

(2) Optional at the discretion of the employee and SHSO depending on site specific conditions.

Table 2 lists the chemicals and chemical classes of concern on the site, along with the specific protection level and PPE materials of construction for each.

Table 2

Task-Specific PPE

Task(s)	Chemical(s) of Concern	PPE Level	Respirator* Cartridge Type	Gloves & Boots	Coveralls
Direct Contact with contaminated soil of water (Trench entry, handling of removed soils) etc	Halogenated and aromatic solvents	C	Org. vapor/ high efficiency filters	Viton rubber	Tyvek
Site Visit	None	D	N/A	Viton rubber	N/A
Activity with no direct soil or contact (e.g. removal of volatile organics from soil by air vacuuming), etc	Halogenated and aromatic solvents	Modified C	Org. vapor/ high efficiency filters	Viton rubber	N/A

* Upon detection of organic vapors (HNU) or generation of dusts bearing toxic particulates. Unless the SHSO directs otherwise, when respirators are used, the cartridges should be changed after eight hours of use, or at the end of each shift, or when any indication of breakthrough or excess resistance to breathing is detected.

Other Protective Equipment

A first aid kit, portable eyewash, and vehicle will be kept in close proximity to the site. A fire extinguisher rated 20A-B-C (or higher) will be kept in the immediate vicinity of any trenching or drilling equipment.

Decontamination Procedures

To minimize the movement of contaminants from the work areas to other areas, a decontamination station will be established in a designated contaminant reduction zone at one edge of where activities occur. This station will consist at a minimum of a plastic-covered table with decontamination supplies and a plastic-covered seat. Galvanized or plastic tubs will be used to hold detergent solution and rinse water. Walkways and the area under the decontamination tubs will be plastic covered.

The following steps must be taken to decontaminate personnel leaving a work area:

- Place equipment and sample containers that must be decontaminated on a plastic drop cloth.
- Place disposable supplies and equipment in a labeled drum.
- Scrub non-disposable gloves and outer boots (if used) with a brush in detergent water, then rinse in clear water.
- Remove disposable protective garments and place in a appropriately labeled drum.
- Remove respirator (if worn).
- Wash hands and face thoroughly.

Personnel must take the following steps to decontaminate equipment and sample containers leaving a Level A, B, or C work area:

- Don protective equipment.
- Wash reusable equipment in detergent solution and/or an appropriate solvent, or steam clean.

- o Dry sample containers with paper towels (if necessary) and place on a clean drop cloth.
- o Remove and discard used respirator cartridges. Wash respirators in fresh detergent water, rinse in clear water, and disinfect with isopropanol. Store in a closed plastic bag, away from sources of contamination.
- o Dispose of or launder clothing before reuse (or place in appropriately labeled impervious containers for transport to laundry or disposal).

The following steps will be required to clean up following completion of work:

- o Dispose of all washing and rinsing solutions into designated containers or an approved wastewater treatment system.
- o Place all solid waste materials into (disposable gloves and garments, tape, plastic drop cloths, etc.) into appropriately labeled drums or other impervious containers for disposal.

6.0 EMERGENCY PROCEDURES

The following standard emergency procedures will be implemented on-site as necessary. The SHSO will be notified of any on-site emergency and be responsible for ensuring that the appropriate procedures are followed and the CHSO and Project Manager are notified. A first aid kit, eye wash unit, and fire extinguisher will be readily available to field personnel.

Notification

Direct verbal notification will be used in an emergency to alert all personnel to leave a work area immediately.

The following standard hand signals will also be used as necessary:

Hand gripping throat	Can't breathe/Out of air
Grip partner's wrist	Leave area immediately
	- No debate!

Hands on top of head	Need assistance
Thumbs up	Yes/Okay
Thumbs down	No/A problem

Personnel Injury

If anyone within a work area cannot leave the restricted area without assistance, due to chemical exposure, all site personnel will assemble in the decontamination area. After donning appropriate protective equipment as determined by the SHSO, a rescue team will enter the area to assist or remove the injured person. The SHSO will evaluate the nature of the injury, and the affected person will be decontaminated to the extent feasible prior to movement. Appropriate first aid will be initiated, and if required contact will be made for an ambulance and with the designated medical facility. No person will reenter the work area until the cause of the injury or symptoms is determined.

Fire/Explosion

Upon notification of a fire beyond the incipient stage or an explosion anywhere on the site, the fire department will be alerted and all personnel moved to a safe distance.

Heat Stress

Any person who experiences signs of distress will be instructed to stop work immediately. Medical attention will be sought if there is any doubt that prompt, full recovery will result. Symptoms of distress include muscle cramps; pale and clammy or hot, dry and flushed skin; confusion, disorientation and incoherent speech; nausea; and convulsions.

Personal Protective Equipment Failure

If any worker experiences a failure or alteration of protective equipment that affects the protection factor (e.g., torn protective suit, odor inside

respirator), that person (and his/her partner) will immediately leave the work area. Re-entry will not be permitted until the equipment has been repaired or replaced and the cause of the problem is known.

Other Equipment Failure

If any other equipment at the work area fails to operate properly, the Project Manager and/or SHSO will be notified and will then determine the effect of this failure on continuing operations. If it is determined that the failure affects the safety of personnel (e.g., failure of monitoring equipment) or prevents completion of the planned tasks, all personnel will leave the work area until appropriate corrective actions have been taken.

Site Control

The work area will be segregated into three work zones based upon monitoring data, the nature of work to be performed and topography. The on site coordinator will establish the following areas with consultation of the project health and safety coordinator and project team lead:

1. Exclusion Zone - This will be the actual work zone involved with contaminated soil disturbance. An outer boundary will be established and clearly marked. The area of the exclusion zone will be established based on onsite work conditions, exposure monitoring, etc.

    a. Access to the exclusion zone will be limited to those employees who have the requisite training, protective equipment and responsibilities for work in this area. A log of employees who enter the exclusion zone shall be maintained.

    b. The area of exclusion zone will be changed as necessary depending on the site coordinators judgement regarding work conditions, air sampling, etc.

2. Contamination Reduction Zone (CRZ) - An area between the actual work zone (exclusion zone) and support zone will be established to facilitate employee and equipment decontamination, protective equipment storage and supply, and employee rest areas (wash and toilet facilities, liquids, benches, etc:).

    a. The location of the CRZ will be established in an area offering minimal contamination and will be subject to charge based on the site coordinators judgment considering work conditions, air monitoring etc.

3. Support Zone - An area free of contamination will be identified and clearly marked where administrative and other support functions (not requiring entrance to the exclusion or contamination reduction zone) can be performed. The actual siting of the support zone will be established by the project leader and site coordinator considering distance from exclusion zone, visibility, accessibility, freedom of cross contamination from the exclusion zone, air monitoring data etc.

Security measures will be established by the site coordinator in conjunction with other project team members to control access to the site and prevent unauthorized access during working and non-working hours.

Emergency Services

Emergency Service	Telephone Number
Fire Department	(315) 471-1161
Police Department	(315) 425-6111
Ambulance	(315) 471-0102
Hospital/Emergency Care Facility	(315) 424-5111
Poison Control Center	(800) 282-3171
or	(315) 476-4766
Chemical Emergency Advice (CHEMTREC)	(800) 424-9300

Directions to St. Joseph's Hospital

- o On leaving site through main gate make a left onto W. Hiawatha Blvd.,
- o continue approximately 1/2 mile - cross over Route 81,
- o Make right onto North Salina Street,
- o continue on Salina (veers Right) for approximately 1 mile,
- o At intersection of Prospect and Salina continue straight onto Prospect Avenue,
- o Follow Prospect Street 2 blocks to St. Joseph Hospital

A sketch showing site evacuation routes and a map showing the preferred route to the nearest emergency health care facility are attached.

7.0 APPENDICES

General Field Safety Rules
Drilling Safety Concerns

lar

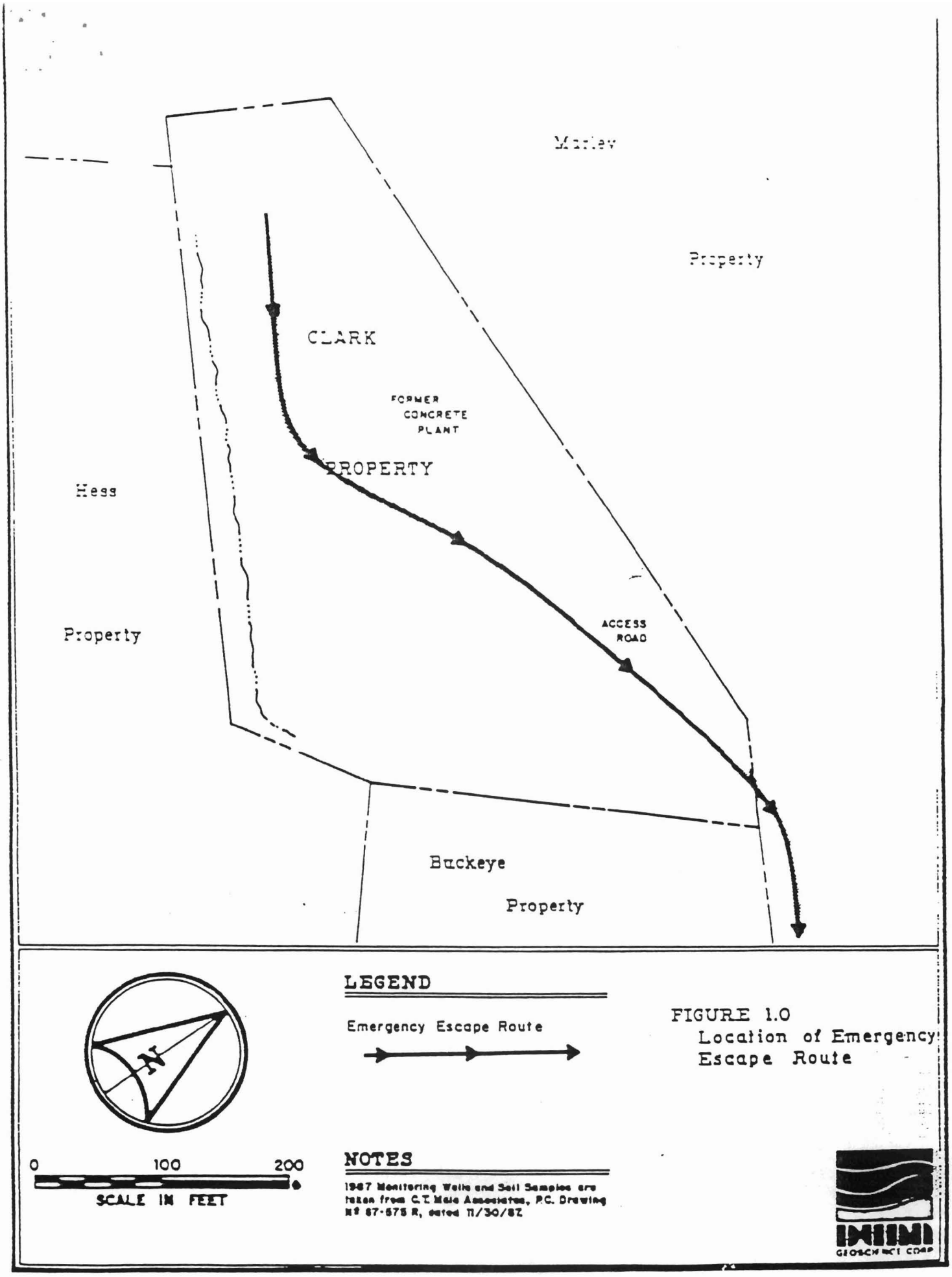


FIGURE 1.0
Location of Emergency Escape Route

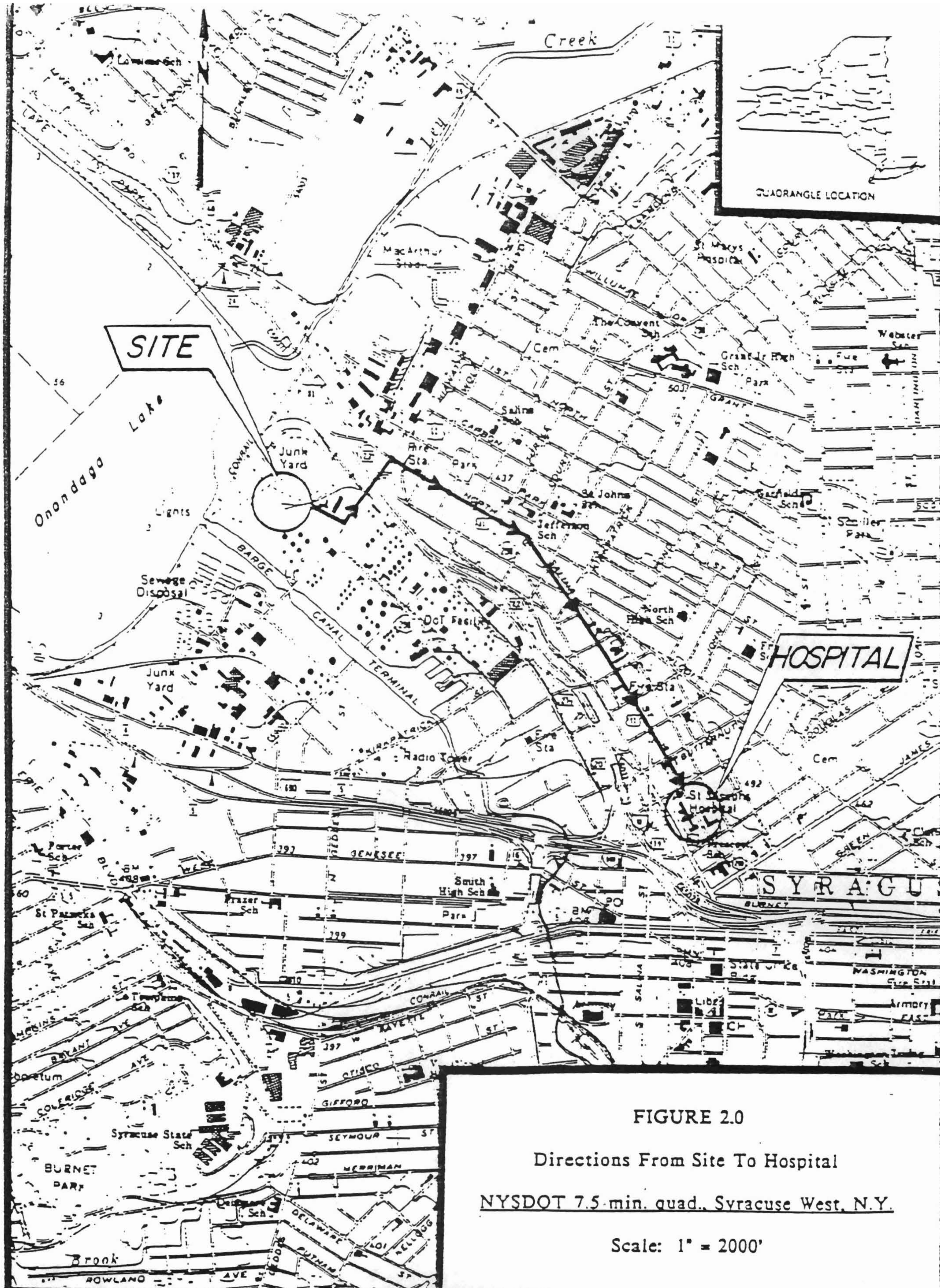


FIGURE 2.0

Directions From Site To Hospital

NYSDOT 7.5 min. quad., Syracuse West, N.Y.

Scale: 1" = 2000'

FIELD SAFETY

GENERAL SAFETY RULES

1. Field Service personnel should maintain communications with their office counterparts. Periodic phone calls may be warranted to assure no mishaps have occurred.

2. The location and phone numbers of the nearest emergency care facility and local fire and police department should be determined and readily available to field service employees prior to site access.

3. During initial site characterization potential hazards arising from unstable topography, presence of water, construction debris, plants, insects or animals should be identified and measures taken to avoid them.

4. Access to remote locations warrants careful consideration of protective clothing and/or first aid supplies to prevent and/or address insect or animal bites/strips etc. Proper first aid supplies and use of a buddy system are especially important for employees who have known allergies (e.g. sensitivity to bee stings).

4. Dunn Geoscience employees who are at a customer's facility will be expected to adhere to the plant or facility safety and health rules in addition to the health and safety plan for the project. Where there are conflicts between the facility rules and the Dunn Geoscience's health and safety plan, the project manager and corporate health and safety officer should be contacted for resolution of inconsistencies. Wherever possible, the two plans should be reviewed prior to site access to identify and resolve any conflicts.

DRILLING - GENERAL HEALTH AND SAFETY CONCERNS

1. Work around heavy equipment has potential for trauma due to contact with overhead objects, cables etc. Minimum protection for protection from these hazards includes safety shoes, hard hats and safety glasses.

2. Special precautions may be necessary to assure the drilling is performed in an area free of underground objects including power or gas lines (generally less than 4 feet deep). Precautionary measures include a thorough review of plans and careful siting of the rig. Depending on the thoroughness of available information, non destructive geotechnical testing surveys for the presence of buried objects may be necessary.

3. Care must be taken in the positioning of drilling and or other heavy equipment such that it is unstable or blocks emergency access/site evacuation routes.

4. Equipment operators and field personnel should be familiar with the proper selection and operation of fire extinguishing equipment. Fully charged and inspected fire extinguishers should be immediately available at the drilling site. Contingency plans should be adopted to assure safe and timely evacuation and recruitment of outside assistance.

5. Field service personnel should be alert to the potential for exposure to noise levels in excess of 90 dBA. Hearing protection should be available if work patterns will require sustained exposure (> 1 hour) to noise.

6. NIOSH has recently declared that diesel exhaust fumes should be considered carcinogenic. Unnecessary exposure to diesel exhaust fumes should be avoided by positioning (upwind, etc.) or respiratory protection (organic vapor cartridges with filters for dust and mist) where avoidance of exposure is impossible.

7. Chemically impervious protective clothing and/or respiratory protection should be provided (or made available) consistent with anticipated contaminated soil/water contact and/or emissions.

ATTACHMENT "B"

Field Health and Safety Plan

FIELD HEALTH AND SAFETY PLAN
Site #734048

3.0 SCOPE OF WORK

Specific tasks covered by this FHSP may include, but are not limited to:

- o Performing inspections to characterize environmental or other hazards.
- o Collecting soil samples using a drilling rig, excavation equipment, or hand tools.
- o Conducting non-intrusive inspections and instrument surveys.
- o Excavating earthen materials, fill, debris, etc.
- o Remediating areas where hazardous substances are, or may be present.
- o Decontaminating personnel and equipment.
- o Performing tasks considered immediately dangerous to life and health (IDLH) such as, entry to confined spaces.

4.0 SITE-SPECIFIC HEALTH AND SAFETY CONCERNS

Site History and Setting

1. Available historical information indicates that the Clark property site was previously a concrete manufacturing firm. A site investigation has revealed no buried metals, containers or vessels containing pockets of chemicals.

2. The site monitoring collected December 1989 has found the following chemicals to be present in soil at varying depths:

	MAXIMUM LEVELS
Trichloroethylene	(to 1601 ppm)
1,1,1 Trichloroethane	(to 631 ppm)
Toluene	(to 948 ppm)
Xylenes	(to 77 ppm)
Acetone	(to 150 ppm)
Ethyl Benzene	(to 6 ppm)

Suspect Chemicals

Table 1 lists those substances which are known or suspected to be present at the site at concentrations of concern for human health, and Table 2 lists any published permissible exposure limits for those substances.

Field measurements or observation devices will be utilized to indicate if a potential exposure greater than the protection afforded by the requirements in this Plan is present. This monitoring will detect expected and unexpected materials of potentially hazardous nature. Detection of hazardous material will result in specified procedures dictated in this FHSP.

Table 1

VOCs Known or Suspected To Be Present

Substance	Known to be Present or Suspected	In Which Media	Known/Expected Maximum Concentration Range	Quality and Quantity of Available Data*
Trichloroethylene	Known	Soil	(to 1601 ppm)	1
1,1,1 Trichloroethane	Known	Soil	(to 631 ppm)	1
Toluene	Known	Soil	(to 948 ppm)	1
Xylenes	Known	Soil	(to 77 ppm)	1
Acetone	Known	Soil	(to 150 ppm)	1

* Level (1) - Considerable data available and substantial level of comfort data is reliable and adequately characterizes expected site conditions.

Level (2) - Limited data or data of uncertain representativeness

Level (3) - No data, or data not considered representative

Table 2

Published Airborne Exposure Limits (ppm) For Substances Known or Suspected To Be Present

SUBSTANCE	OSHA PEL/STEL	ACGIH TLV/STEL	IDLH	CARCINOGEN
Trichloroethylene	50/200	50/200	1000	Suspect
1,1,1 Trichloroethane	350/450	350/450	1000	Suspect
Toluene	100	100/500	2000	
Xylenes	100/150	100/150	10,000	No
Acetone	100/150	750/1000	20,000	Suspect

Notes:

"Carcinogen" means a substance identified as a suspect or confirmed human carcinogen in one or more of the following documents:

- National Toxicology Program (NTP) Annual Report on Carcinogens
- International Agency for Research on Cancer (IARC) Monographs
- OSHA regulations on Occupational Health and Environmental Control at 29 CFR 1910, Subpart Z.

Definitions of PEL, REL, STEL, TLV and IDLH are on the next page.

5.0 SITE-SPECIFIC HEALTH AND SAFETY REQUIREMENTS

Key Personnel

Project Manager -

Tom Johnson (518) 458-1313

Corporate Health and Safety Officer -

Mark Falerios (201) 299-9001

Home: (201) 538-9709

Site Health and Safety Officer -

Senior Dunn Representative on the Site

Regional Office Manager -

Dave King (518) 458-1313

5.2 Air Monitoring

5.2.1 Air Emission - Monitoring

The planned excavation activities also increase the potential for generation of emissions of airborne chemicals. An on-site monitoring program and feasible emission suppression strategies will be implemented to closely monitor and control emissions.

The following chemicals are those most likely to be present (based on the December 1989 Soil Monitoring data) in airborne emissions as a result of excavation activities:

Trichloroethylene, Toluene, 1,1,1 Trichloroethane and Xylene

Real-time exposure monitoring will be conducted rather than indirect monitoring methods because real-time monitoring allows for exposure intervention and control.

Indirect monitoring may be more accurate but is not useful as a preventative tool due to the time lag between sample collection and analysis.

Real-time monitoring of employee breathing zones at the source of emissions will be performed using a photoionization detector (PID) calibrated according to manufacturer's specifications. Calibrations will include appropriate instrument adjustments to enable accurate detection of Trichloroethylene.

Proposed work site action levels include protective equipment upgrades at work zone exposures of 5 ppm above background (Level C) and 50 ppm above background (Level B). The threshold limit values for the parameters of concern are shown on Table 4.

5.2.2 Perimeter Monitoring

Prior to the initiation of excavation for the foundation, background concentrations will be established. Detection of work zone concentrations at greater than 5 ppm above background will trigger property perimeter monitoring using the photoionization detector. Detection of property perimeter readings 5 ppm above background will activate investigation and implementation of emission control measures (e.g. ground cover, vapor suppression foams, temporary work stoppage) until these perimeter levels decrease to below 5 ppm above background. In addition, work zone levels greater that 5 ppm above background will trigger monitoring using a portable gas chromatograph for vinyl chloride and benzene to assure emissions remain below threshold limit values as shown on the following table.

Concentrations of site chemicals have historically been well below their respective TLV's when PID measurements are less than 50 ppm above background; a 5 ppm above background threshold (PID monitoring) will provide more than adequate health and safety protection from contaminants known or suspected to be present.

THRESHOLD LIMIT VALUES

COMPOUND	THRESHOLD LIMIT VALUE
1,1,1 Trichloroethane	350 ppm
Trichloroethylene	50 ppm
Toluene	100 ppm
Xylene	100 ppm
Acetone	750 ppm
Vinyl Chloride	1 ppm
Benzene	1 ppm/5 ppm (STEL)

5.3 Personal Protective Equipment:

The following procedures should be followed when donning protective equipment:

- Inspect equipment to ensure it is in good condition.
- Don protective suit and gather suit around waist.
- Put on outer boots over feet of the suit and tape at boot/suit junction.
- Don inner gloves.
- Don top half of protective suit and seal (as necessary).
- Don respiratory protection (if necessary).
- Don outer gloves and tape at glove/suit junction (as necessary).
- Have assistant check all closures and observe wearer to ensure fit and durability of protective gear.

Table 3 indicates the general levels of personal protective equipment (PPE) that will be used on-site. Site and task specific levels of PPE assigned according to the chemicals of concern are listed in Table 4 below.

Table 3

Protection Levels

	B	C	D
Air-purifying respirator	No	Yes	No
Chemical-resistant disposable coveralls	Yes	Yes	(1)
Chemical-resistant outer gloves	Yes	Yes	(1)
Disposable inner gloves	Yes	Yes	No
Overboots (chemically resistant)	Yes	Yes	(1)
Leather shoes/boots or safety shoes	Yes	Yes	Yes
Safety glasses, goggles, or face shield	No	Yes	Yes
Hard hat	Yes	Yes	(1)
Coveralls	(1)	(1)	(1)

(1) Optional at the discretion of the employee and SHSO depending on site specific conditions.

Level C respiratory protection is to be full-face-piece or half-face-piece NIOSH - approved air purifying respirators equipped with organic vapor cartridges and/or high efficiency particulate filters.

Level B respiratory protection is to be supplied air or SCBA.

Table 4 lists the chemicals and chemical classes of concern on the site, along with the specific protection level and PPE materials of construction for each.

Table 4

Task(s)	Chemicals of of Concern	PPE Level	Cartridge Type	Gloves	Coveralls
General field surveys (No direct chemical contact)	Volatile Organics	D	----------	Viton or North Silver Shield	Optional
Well drilling or handling of contaminated soils or sludges (direct skin contact possible)	" "	D/C*	Organic Vapor Cartridges (if HNU readings > 5 ppm)	Viton or Silver Shield	Tyvek, Polycoated-Tyvek or Sararex-Tyvek
Well sampling - pump tests etc. (whole body direct skin contact not likely)	" "	D/C	" "	Viton or Silver Shield	
Trenching/ Excavation Entry (Direct Skin contact likely)	" "	C/B**	No	Viton or Silver Shield	" "

* If Levels of Volatile Organics as determined by HNu (or equivalent are greater than 5 ppm above background).

** If Levels of Volatile Organics as determined by HNu (or equivalent are greater than 50 ppm above background).

Unless the SHSO directs otherwise, when air purifying respirators are used, the cartridges should be changed after eight hours of use, or at the end of each shift, or when any indication of breakthrough or excess resistance to breathing is detected.

6.0 SITE CONTROL

3. Support Zone - An area away from known contamination will be identified and clearly marked where administrative and other support functions (not requiring entrance to the exclusion or contamination reduction zone) can be performed. The actual siting of the support zone will be established by the project leader and site coordinator considering distance from exclusion zone, visibility, accessibility, freedom of cross contamination from the exclusion zone, air monitoring data, etc.

Security measures will be established by the site coordinator in conjunction with other project team members to control access to the site and prevent unauthorized access during working and non-working hours.

7.0 EMERGENCY ACTION PLAN

The following standard emergency procedures will be implemented as necessary. The SHSO will be notified of any on-site emergency and be responsible for ensuring that the appropriate procedures are followed and the CHSO and Project Manager are notified. A first aid kit, eye wash unit, and fire extinguisher will be readily available to field personnel.

Notification

Upon notification, employees will proceed to a designated assembly area for further instruction. The Buddy System will be used to help account for proper evacuation of personnel.

A hand operated horn will alert personnel to evacuate the restricted area. If at any time two horn blasts are heard, all personnel are to immediately evacuate the restricted area.

The following standard hand signals will also be used as necessary:

Hand gripping throat	Can't breath/Out of air
Grip partner's wrist	Leave area immediately - No debate!
Hands on top of head	Need assistance
Thumbs up	Yes/Okay
Thumbs down	No/A problem

Personnel Injury

If anyone within a restricted area and cannot leave the restricted area without assistance, all site personnel will assemble in the decontamination area. After donning appropriate

protective equipment as determined by the SHSO, a rescue team will enter the area as necessary to assist or remove the person. (If entry requires the use of P.P.E. for I.D.L.H. Environments (S.C.B.A. or Equivalent), similarly equipped support personnel shall be on hand to lend assistance as necessary). The SHSO will evaluate the nature of the injury, and the affected person will be decontaminated to the extent feasible prior to movement. Appropriate first aid will be initiated, and if required, contact will be made for an ambulance and with the designated medical facility. No person will reenter the work area until the cause of the injury or symptoms is determined.

Fire/Explosion

Upon the occurrence of a fire beyond the incipient stage or an explosion anywhere on the site, the fire department will be alerted and all personnel moved to a safe distance.

Personal Protective Equipment Failure

Any worker in a Level A, B or C area who experiences a failure or alteration of protective equipment that affects the protection factor (e.g. torn protective suit, odor inside respirator), that person (and his/her buddy, if in a regulated area) will immediately leave the work area. Re-entry will not be permitted until the equipment has been repaired or replaced and the cause of the problem is known.

Other Equipment Failure

If any other equipment at the work site fails to operate properly, the Project Manager and/or SHSO will be notified and will then determine the effect of this failure on continuing operations. If it is determined that the failure affects the safety of personnel (e.g. failure of monitoring equipment) or prevents completion of the planned tasks, all personnel will leave the work area until appropriated corrective actions have been taken.

Off-site Emergency Response

Emergency response requiring actions beyond evacuation of personnel from the work area will be handled by notification of off-site emergency response agencies. Phone numbers for these agencies and other support services are listed below:

Emergency Services

Emergency Service	Telephone Number
Fire Department	(315) 471-1161
Police Department	(315) 425-6111
Ambulance	(315) 471-0102
Hospital/Emergency Care Facility - St. Joseph's Hospital	(315) 424-5111
Poison Control Center	(800) 282-3171 or (315) 476-4766
Chemical Emergency Advice (CHEMTREC)	(800) 424-9300

Directions to St. Joseph's Hospital:

- On leaving site through main gate, make a left onto W. Hiawatha Blvd.,
- Continue approximately 1/2 mile - cross over Route 81,
- Make a right onto North Salina Street,
- Continue on Salina (veers right) for approximately 1 mile,
- At intersection of Prospect and Salina, continue straight onto Prospect Avenue,
- Follow Prospect Street 2 blocks to St. Joseph's Hospital

8.0 APPENDICES

Trench/Test Pit Excavation Concerns
Confined Space Entry

TRENCH OR TEST PIT DIGGING

Trench or test pit digging can be expected to present hazards in addition to those encountered during general field work or drilling. Added control measures to be considered include the following:

1. Equipment should be carefully positioned with respect to the presence of known submerged objects.

   a. Where possible, power to underground electrical lines should be turned off (and locked out) while excavation activities are in process or until the area is secure from entrance of personnel.

   b. Known gas (or chemical) lines adjacent to the immediate excavation site should also be secured (valves turned off and locked out) while excavation is underway or access by outside personnel possible. Where possible, it is desirable to purge these lines of their contents prior to start of excavation.

2. Digging should be at a controlled rate under careful observation of a watch person who has clear communication with the equipment operator. The watch person should be alert to notice the presence of (unknown) buried objects by visual inspection or metal detection surveyance of the immediate excavation area.

3. Significant surface area of ground is exposed to the atmosphere as part of the trenching process. This may increase vapor exposures from volatile contaminants. Provisions should be made for air monitoring to trigger appropriate protective actions including temporary work stoppage. Use of vapor emissions controls or suppressants or use of personal protective equipment may be necessary.

4. Trenches or pits greater than 4 feet deep should be considered confined spaces which may contain concentrated vapors, gases or oxygen deficient atmospheres. Large scale shallow excavations (e.g. areas) should not be considered confined spaces as sufficient ventilation is present to control

emissions. These areas must be checked to assure non-explosive, non-hazardous atmospheres before allowing entry and periodically (or continuously) thereafter. See confined space entry procedures for greater details regarding control measures considerations.

5. OSHA provisions regarding shoring and sloping of trench sides (29 CFR 1926) may apply.

6. Pits or trenches should be inspected daily for evidence of cracks, slides or scaling. Inspection should be more frequent if it is raining.

7. Heavy equipment should be kept away from the sides of trenches or pits.

8. Means of egress (e.g., steps, ladders) should be readily available (within 25') of employees working in pits or other excavations from which rapid exit is difficult.

9. Excavations, mud pits, etc., must be protected with barricades or covers. Temporary pits/trenches should be backfilled upon completion of work.

CONFINED SPACE ENTRY PROGRAM

Purpose

Confined spaces are potential sources of immediately dangerous to life and health environments which must be treated with special caution. A confined space is any area where toxic, flammable or oxygen deficient (<19.5%) atmospheres could develop or where entrance and escape routes are difficult due to the size of openings etc. Examples of equipment related confined spaces include tanks, vessels, hoppers, boilers, chimneys and baghouses. Other structures such as underground tunnels and pits or trenches greater than 4 feet in depth should be considered confined spaces.

The most common causes of confined-space related mishaps are improper training of employees who must enter confined spaces or observers who must watch the entry and trigger evacuation or render first aid assistance. Detailed procedures and good communication systems are necessary for safe confined space related work.

General Procedures

The following are recommended procedures to be utilized, where applicable, in work involving confined space entry. Site specific procedures will be documented in the form of a permit system which is described later. Any proposed variation in procedures from those described below, must be reviewed and approved by the corporate health and safety officer.

1. The confined space must be physically isolated from all supply, vent or exit lines or other connections which introduce chemicals or gases to the confined area. Physical isolation includes disconnection and blanking of chemical or gas lines and closing and locking of water or steam line valves.

2. Sources of electrical power to the confined space must be locked out or otherwise disconnected (e.g. pulling of fuses) and so tagged to prevent accidental actuation during the entry.

3. Chemicals in the confined space must be removed and the space cleaned of residues by washing, purging with water or other appropriate inert agent, where possible.

4. The atmosphere within the confined space must be tested for the presence of flammables, toxic materials and oxygen deficiency using properly calibrated equipment prior to entry. Frequent (approximately every 15 minutes) or continuous (where feasible) monitoring of the atmosphere must be performed throughout the duration of the entry.

   Entry shall not be allowed (or will be suspended) if airborne levels of toxics exceed exposure limits (established in consultation with the health and safety manager), or if flammables exceed 10% of the LEL above background or if oxygen deficient conditions (< 19.5%) are noted.

5. Entry into enclosed vessels will require provision of fresh air using a forced draft supply introduced so as to thoroughly purge the confined space (i.e. no "dead air" spaces) throughout the duration of entry. Provision of air to other confined space structures is desirable, where feasible. Manholes or other vessel openings will be secured in the open position to facilitate air movement.

6. Illumination to confined spaces must be provided using explosion proof, low voltage (< 24 volt) lighting supplies. Only properly grounded tools with perfect electrical connections will be allowed in confined spaces. In locations where flammable atmospheres could develop or flammable residues are present, the space must be isolated from all sources of ignition.

7. Respiratory protection for confined space entry must be selected (in consultation with the safety and health manager) based upon anticipated hazards including toxic chemicals with poor warning properties or potential oxygen deficient atmospheres.

8. Personnel who must enter confined spaces should be equipped with life lines, harnesses or wristlets. Wristlets are preferred where removal of the individual is complicated by tight access or small openings (e.g. manholes).

9. Where ladders are necessary for entry to confined areas, they must be made secure at the top and remain in place throughout the entry. Any ladders used for entry must be in good condition, properly positioned (approximately 1/4 of the climbing height away from the wall at the base) and equipped with non-slip feet.

10. Entry shall be under the continuous watch of a designated observer who is knowledgeable in the use of emergency rescue equipment and has immediate access to communication equipment, alarms or other means to summon emergency assistance including personnel trained in appropriate first aid procedures. The observer shall be alert to developing signs of hazardous exposure or conditions, and be in constant communication with the personnel inside.

    a. The observer will not enter the confined space, but will initiate evacuation or trigger emergency rescue should the need arise.

11. Emergency equipment necessary to effect emergency rescue including, life lines, positive pressure self contained breathing apparatus, and fire extinguishers (where flammability is a concern) must be immediately available at the confined space entry site.

12. Sufficient standby personnel shall be immediately available to effect emergency rescue and render first aid.

13. The occurrence of an injury, a spill or fire in the confined space, or job interruption for more than one hour, shall void the current confined space entry permit.

Authorization Procedure

A authorization procedure for confined space entry is necessary to assure adequate support personnel and supplies are present and proper procedures are followed. Completed authorizations shall be signed by employees who perform the entry, designated observers and the project manager's on site delegate.

Authorizations should be considered valid for one shift only. The authorization shall be immediately available at the job site. Completed authorizations shall be retained as part of project documentation.

The authorization will contain site specific details regarding hazards anticipated and precautions to be used during the entry.

Confirmatory Sampling Plan

Introduction

Pursuant to the Approved Interim Remediation Plan for site #734048, soil will be excavated from the impacted area. The Sampling Plan has been prepared to detail the procedures to be followed for sampling and analysis of soil for post excavation confirmation at the listed portion of the Clark Property as described and shown in Appendix A of the Agreement and Determination ("Clark Site").

A. Soil Excavation

Soil will be excavated from the Clark Site to a minimum depth of 13 feet which is the requirement for the installation of the proposed foundation. Additional vertical excavation in selected areas will continue until a field HNU meter indicates that the VOC levels in the remaining unexcavated soils may be below the 5 ppm total and 1 ppm individual volatile organic parameter criteria, as described in Section 2.1 of the Approved Interim Remediation Plan.

At that point samples will be taken from the base of the unexcavated area and analyzed by an on-site gas chromatograph (GC) to determine whether the area from which the sample was taken fulfills the "5 and 1" criteria.

If the criteria is met, excavation will end in that portion of the Clark Site. If the "5 and 1" criteria is not met, excavation will continue in that area (the soil transported to the treatment structure) until a GC-analyzed sample indicates the representative area meets the "5 and 1" criteria.

For purposes of this plan, any soil excavated from the Clark Site which is not tested in accordance with the procedures detailed in this plan will be handled as contaminated soil and transported to the treatment structure.

B. **Post Excavation Sampling**

Lateral and vertical excavation will continue until VOC screening of soil using the PID, followed by GC analysis, demonstrates that uncontaminated soil remains. Confirmatory samples will be collected from the base and walls of the excavation using a 50-foot grid spacing. Samples will be collected with a stainless steel trowel and analyzed for VOC's with on-site GCs. If, after excavation has proceeded sufficiently to enable building foundation construction and sample results confirm that remaining soil meets the "5 and 1" criteria, excavation will cease. If on-site GC results indicate a sample contains a VOC concentration greater than the "5 and 1" criteria, excavation will continue in the vicinity of that sample using the same post excavation sampling procedures as stated.

C. **Quality Assurance/Quality Control**

Analysis by GC will include the parameters at the site which have been identified in the greatest concentration in the soil. These include trans-1,2-dichloroethene, cis-1,2-dichloroethene, benzene, trichloroethene, toluene, tetrachloroethene, vinyl chloride, meta- & para-xylenes, and ortho-xylenes. **The reporting limit for these** compounds is 0.5 ppm (mg/kg). Chromatograms generated during GC analysis as a result of this Plan will be retained and available on-site for review and submitted to the Department following completion of the excavation activities. Each chromatogram generated pursuant to this Plan will be labelled with the date and time of analysis, sample number, dilution information and volume of sample injected into the gas chromatograph. In addition, all peaks will be labeled with either the retention time or compound identification.

Quality assurance/quality control measures used during on-site GC analysis will include the initial and continuing calibration of the gas chromatograph, the analysis of laboratory blanks, laboratory spikes and spike duplicates. Prior to analysis a three point initial calibration curve will be prepared for each compound of interest with the reporting limit concentration as the low concentration standard of the calibration curve. Utilizing a mid-point concentration standard for each compound of interest (continuing calibration standard), the field laboratory will analyze the continuing calibration standard along with a laboratory blank once every twelve hours. If the percent difference between the initial and continuing

calibration of any compound of interest exceeds 25%, an initial calibration for the gas chromatograph will be prepared and any sample that exhibits an individual compound concentration of less than 1.0 ppm will be reanalyzed. In addition, the retention time of each peak must fall within the retention time window ($\pm$0.30 minutes). If the retention time falls outside the window, the field laboratory will either reanalyze the affected sample or evaluate the chromatogram with either the expanded or shifted windows. The field laboratory will not make any corrections to the analytical results to compensate for any blank contamination. Laboratory spikes and spike duplicates will be analyzed either once every twelve hours or once every twenty samples analyzed.

Confirmatory analyses by US EPA SW-846, third edition (Nov. 1986) Method 8240 will also be provided by testing split samples from ten percent (10%) of samples at an acceptable off-site analytical laboratory, or as required by the Department. Additionally confirmatory soil sampling will be conducted for the Target Compound List (TCL) parameters by Contract Laboratory Procedure (CLP) protocol as required by the Department.

Quality assurance/quality control measures used during soil sampling will include one blind duplicate sample per 10 samples collected and one equipment blank per day. Collection tools, including stainless steel trowels, hand augers or hollow rods, will be decontaminated between samples by employing the following procedures:

- tap water rinse
- Alconox detergent scrub
- tap water rinse
- methanol rinse
- deionized water rinse
- air dry

Quality assurance/quality control measures used during soil screening will include calibration of the PID equipment at least once per work shift.

Gundle Lining Systems Inc

Gundle®

19103 Gundle Rd.
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 GUNDLE HOU
Fax: (713) 875-6010

February 23, 1990

Mr. Dave Hill
PYRAMID ONONDAGA
Clinton Exchange - 4 Clinton Street
Syracuse, NY 13202

Dear Mr. Hill:

It was interesting talking with you on the telephone. As I mentioned, Gundle Lining Systems Inc is the leader in the manufacturing and installation of High Density Polyethylene (HDPE) flexible membrane lining systems.

Gundle's proprietary process of manufacturing 22.5 foot wide, homogeneous sheets (no factory seams), coupled with our patented extrusion welding system for field installation, allows us to provide secure and cost effective containment in diverse applications such as hazardous waste landfills, sewage lagoons, oil field ponds, solid waste landfills, brine ponds, heap leach pads and water storage facilities along with floating covers, tanks, secondary containment, etc.

I hope that you will find the enclosed information useful. Please do not hesitate to contact me if you have any questions or need additional information.

Regards,

SPECIALTY APPLICATIONS DIVISION

Don, RB.

Don Hildebrandt
National Sales Manager

/rmb

Gundle Lining Systems Inc

Gundle®

19103 Gundle Rd.
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620261 GUNDLE HOU
Fax: (713) 875-6010

February 22, 1990

VIA FACSIMILE
(315) 451-6271

Mr. Don Carsto
COENGEL-PLANSCAR
4615 Crossroads Park Drive
Liverpool, NY 13088

Dear Mr. Carsto:

As per our conversation regarding an impermeable liner below the access road to your containment structure, Gundle recommends the installation of a 30 mil High Density Polyethylene (HDPE) Liner. HDPE is a very chemically resistant product with excellent strength characteristics, and is used in every RCRA (Superfund) Landfill as the primary liner.

If you have any questions regarding this product, please do not hesitate to contact me at (800) 435-2008.

Regards,

SPECIALTY APPLICATIONS DIVISION

Steven L. Baker
Regional Manager

SLB/rb

2593.014

TECHNICAL SPECIFICATIONS

TEMPORARY CONTAINMENT STRUCTURE

CAROUSEL CENTER

CITY OF SYRACUSE

ONONDAGA COUNTY, NEW YORK

* * * *

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT.

Michael S. Kolceski

MICHAEL S. KOLCESKI, P.E.
VICE PRESIDENT

O'BRIEN & GERE ENGINEERS, INC.
5000 BRITTONFIELD PARKWAY
SYRACUSE, NEW YORK 13221

1990

TABLE OF CONTENTS

MATERIALS AND PERFORMANCE

MATERIALS SPECIFICATIONS

MATERIALS AND PERFORMANCE - SECTION 1

EARTHWORK

MP-1.01 GENERAL

A. Work Specified
   1. Excavation and backfilling including the loosening, removing, refilling, transporting, storage and disposal of all materials classified as "earth" necessary to be removed for the construction and completion of all work under the Contract.
   2. Excavation to the widths and depths shown on the Contract Drawings, specified or directed.

B. Related Work Specified Elsewhere
   1. Rock Removal
   2. Structural Excavation, Backfill and Compaction
   3. Trenching, Backfilling and Compacting
   4. Selected Fill
   5. Embankment

C. Definitions
   1. Excavation (or Trenching)
      a. Grubbing, stripping, removing, storing and re-handling of all materials of every name and nature necessary to be removed for all purposes incidental to the construction and completion of all the work under construction;
      b. All sheeting, sheetpiling, bracing and shoring, and the placing, driving, cutting off and removing of the same;
      c. All diking, ditching, fluming, cofferdamming, pumping, bailing, draining, well pointing, or otherwise disposing of water;
      d. The removing and disposing of all surplus materials from the excavations in the manner specified;
      e. The maintenance, accommodation and protection of travel and the temporary paving of highways, roads and driveways;
      f. The supporting and protecting of all tracks, rails, buildings, curbs, sidewalks, pavements, overhead wires, poles, trees, vines, shrubbery, pipes, sewers, conduits or other structures or property in the vicinity of the work, whether over- or underground or which appear within or adjacent to the excavations, and the restoration of the same in case of settlement or other injury;
      g. All temporary bridging and fencing and the removing of same.

2. Earth
   a. All materials such as sand, gravel, clay, loam, ashes, cinders, pavements, muck, roots or pieces of timber, soft or disintegrated rock, not requiring blasting, barring, or wedging from their original beds, and specifically excluding all ledge or bedrock and individual boulders or masonry larger than one-half cubic yard in volume.
3. Backfill
   a. The refilling of excavation and trenches to the line of filling indicated on the Contract Drawings or as directed using materials suitable for refilling of excavations and trenches; and the compacting of all materials used in filling or refilling by rolling, ramming, watering, puddling, etc., as may be required.
4. Spoil
   a. Surplus excavated materials not required or not suitable for backfills or embankments.
5. Embankments
   a. Fills constructed above the original surface of the ground or such other elevation as specified or directed.
6. Limiting Subgrade
   a. The underside of the pipe barrel for pipelines.
   b. The underside of footing lines for structures.
7. Excavation Below Subgrade
   a. Excavation below the limiting subgrades of structures or pipelines.
   b. Where materials encountered at the limiting subgrades are not suitable for proper support of structures or pipelines, the Contractor shall excavate to such new lines and grades as required.

D. Applicable Codes, Standards and Specifications
   1. American Society for Testing and Materials (ASTM)

MP-1.02 DESCRIPTION OF MATERIALS

A. Wood Sheeting and Bracing
   1. Shall be sound and straight; free from cracks, shakes and large or loose knots; and shall have dressed edges where directed.
   2. Shall conform to National Design Specifications for Stress Grade Lumber having a minimum fiber stress of 1200 pounds per square inch.
   3. Sheeting and bracing to be left-in-place shall be pressure treated in accordance with ASTM D 1760 for the type of lumber used and with a preservative approved by the Engineer.

B. Steel Sheeting and Bracing
   1. Shall be sound.
   2. Shall conform to ASTM A 328 with a minimum thickness of 3/8 inch.

MP-1.03 UNAUTHORIZED EXCAVATION

A. Whenever excavations are carried beyond or below the lines and grades shown on the Contract Drawings, or as given or directed by the Engineer, all such excavated space shall be refilled with special granular materials, concrete or other materials as the Engineer may direct. All refilling of unauthorized excavations shall be at the Contractor's expense.

B. All material which slides, falls or caves into the established limits of excavations due to any cause whatsoever, shall be removed and disposed of at the Contractor's expense and no extra compensation will be paid the Contractor for any materials ordered for refilling the void areas left by the slide, fall or cave-in.

MP-1.04 REMOVAL OF WATER

A. General
   1. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the removal of all water entering the excavations, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work or the proper placing of pipes, structures, or other work.
   2. Unless otherwise specified, all excavations which extend down to or below the static groundwater elevations shall be dewatered by lowering and maintaining the groundwater beneath such excavations at all times when work thereon is in progress, during subgrade preparation and the placing of the structure or pipe thereon.
   3. Water shall not be allowed to rise over or come in contact with any masonry, concrete or mortar, until at least 24 hours after placement, and no stream of water shall be allowed to flow over such work until such time as the Engineer may permit.
   4. Where the presence of fine grained subsurface materials and a high groundwater table may cause the upward flow of water into the excavation with a resulting quick or unstable condition, the Contractor shall install and operate a well point system to prevent the upward flow of water during construction.
   5. Water pumped or drained from excavations, or any sewers, drains or water courses encountered in the work, shall be disposed of in a suitable manner without injury to adjacent property, the work under construction, or to pavements, roads, drives, and water courses. No water shall be dis-

charged to sanitary sewers. Sanitary sewage shall be pumped to sanitary sewers or shall be disposed of by an approved method.

6. Any damage caused by or resulting from dewatering operations shall be the sole responsibility of the Contractor.

B. Work Included

1. The construction and removal of cofferdams, sheeting and bracing, and the furnishing of materials and labor necessary therefor.
2. The excavation and maintenance of ditches and sluiceways.
3. The furnishing and operation of pumps, well points, and appliances needed to maintain thorough drainage of the work in a satisfactory manner.

C. Well Point Systems

1. Installation
   a. The well point system shall be designed and installed by or under the supervision of an organization whose principal business is well pointing and which has at least five consecutive years of similar experience and can furnish a representative list of satisfactory similar operations.
   b. Well point headers, points and other pertinent equipment shall not be placed within the limits of the excavation in such a manner or location as to interfere with the laying of pipe or trenching operations or with the excavation and construction of other structures.
   c. Detached observation wells of similar construction to the well points shall be installed at intervals of not less than 50 feet along the opposite side of the excavation from the header pipe and line of well points, to a depth of at least five feet below the proposed excavation. In addition, one well point in every 50 feet shall be fitted with a tee, plug and valve so that the well point can be converted for use as an observation well. Observation wells shall be not less than 1-1/2" in diameter.
   d. Standby gasoline or diesel powered equipment shall be provided so that in the event of failure of the operating equipment, the standby equipment can be readily connected to the system. The standby equipment shall be maintained in good order and actuated regularly not less than twice a week.
2. Operation
   a. Where well points are used, the groundwater shall be lowered and maintained continuously (day and night) at a level not less than two feet below the bottom of the excavation. Excavation will not be permitted at a level lower than two feet above the water level as indicated by the observation wells.

b. The effluent pumped from the well points shall be examined periodically by qualified personnel to determine if the system is operating satisfactorily without the removal of fines.
c. The water level shall not be permitted to rise until construction in the immediate area is completed and the excavation backfilled.

MP-1.05 STORAGE OF MATERIALS

A. Sod
1. Any sod cut during excavation shall be removed and stored during construction so as to preserve the grass growth. Sod damaged while in storage shall be replaced in like kind at the sole expense of the Contractor.

B. Topsoil
1. Topsoil suitable for final grading shall be removed and stored separately from other excavated material.

C. Excavated Materials
1. All excavated materials shall be stored in locations so as not to endanger the work, and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly piled and trimmed, so as to cause as little inconvenience as possible to public travel or to adjoining property holders.
2. Special precautions must be taken to permit access at all times to fire hydrants, fire alarm boxes, police and fire department driveways, and other points where access may involve the safety and welfare of the general public.

MP-1.06 DISPOSAL OF MATERIALS

A. Spoil Material
1. All spoil shall be transported and placed on the site of the work at the locations and to the elevations and grades shown on the Contract Drawings, or if spoil areas are not shown, all spoil materials shall be disposed off the site at locations selected and obtained by the Contractor.
2. The surface of all spoil areas shall be graded and dressed and no unsightly mounds or heaps shall be left on completion of the work.

MP-1.07 SHEETING AND BRACING

A. Installation
1. The Contractor shall furnish, place and maintain such sheeting, bracing and shoring as may be required to support the sides and ends of excavations in such manner as to prevent any movement which could, in any way, injure the pipe, structures, or other work; diminish the

width necessary for construction; otherwise damage or delay the work of the Contract; endanger existing structures, pipes or pavements; or cause the excavation limits to exceed the right-of-way limits.

2. In no case will bracing be permitted against pipes or structures in trenches or other excavations.
3. Sheeting shall be driven as the excavation progresses, and in such manner as to maintain pressure against the original ground at all times. The sheeting shall be driven vertically with the edges tight together, and all bracing shall be of such design and strength as to maintain the sheeting in its proper position.
4. The Contractor shall be solely responsible for the adequacy of all sheeting and bracing.

B. Removal

1. In general, all sheeting and bracing, whether of steel, wood or other material, used to support the sides of trenches or other open excavations, shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a pipe or structural foundation shall not be withdrawn, unless otherwise directed, before more than six inches of earth is placed above the top of the pipe or structural foundation and before any bracing is removed. The voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.
2. The Contractor shall not remove sheeting and bracing until the work has attained the necessary strength to permit placing of backfill.

C. Left in Place

1. If, to serve any purpose of his own, the Contractor files a written request for permission to leave sheeting or bracing in the trench or excavation, the Engineer may grant such permission, in writing, on condition that the cost of such sheeting and bracing be assumed and paid by the Contractor.
2. The Contractor shall leave in place all sheeting, shoring and bracing which are shown on the Contract Drawings or specified to be left in place or which the Engineer may order, in writing, to be left in place. All shoring, sheeting and bracing shown or ordered to be left in place will be paid for under the appropriate item of the Contract. No payment allowance will be made for wasted ends or for portions above the proposed cutoff level which are driven down instead of cut-off.
3. In case sheeting is left in place, it shall be cut off or driven down as directed so that no portion of the same shall remain within 12 inches of the street subgrade or finished ground surface.

MP-1.08 BACKFILLING

A. General
1. All excavations shall be backfilled to the original surface of the ground or to such other grades as may be shown, specified or directed.
2. Backfilling shall be done with suitable excavated materials which can be satisfactorily compacted during refilling of the excavation. In the event the excavated materials are not suitable, Special Backfill as specified or ordered by the Engineer shall be used for backfilling.
3. Any settlement occurring in the backfilled excavations shall be refilled and compacted.

B. Unsuitable Materials
1. Stones, pieces of rock or pieces of pavement greater than one cubic foot in volume or greater than 1.5 feet in any single dimension shall not be used in any portion of the backfill.
2. All stones, pieces of rock or pavement shall be distributed through the backfill and alternated with earth backfill in such a manner that all interstices between them shall be filled with earth.
3. Frozen earth shall not be used for backfilling.

C. Compaction and Density Control
1. The compaction shall be as specified for the type of earthwork, i.e., structural, trenching or embankment.
   a. The compaction specified shall be the percent of maximum dry density.
   b. The compaction equipment shall be suitable for the material encountered.
2. Where required, to assure adequate compaction, in-place density test shall be made by an approved testing laboratory.
   a. The moisture-density relationship of the backfill material shall be determined by ASTM D698, Method D.
      1) Compaction curves for the full range of materials used shall be developed.
   b. In-place density shall be determined by the methods of ASTM D1556 or ASTM D2922 and shall be expressed as a percentage of maximum dry density.
3. Where required, to obtain the optimum moisture content, the Contractor shall add, at his expense, sufficient water during compaction to assure the specified maximum density of the backfill. If, due to rain or other causes, the material exceeds the optimum moisture content, it shall be allowed to dry, assisted if necessary, before resuming compaction or filling efforts.
4. The Contractor shall be responsible for all damage or injury done to pipes, structures, property or persons due to improper placing or compacting of backfill.

MP-1.09 OTHER REQUIREMENTS

A. Drainage
   1. All material deposited in roadway ditches or other water courses shall be removed immediately after backfilling is completed and the section, grades and contours of such ditches or water courses restored to their original condition, in order that surface drainage will be obstructed no longer than necessary.

B. Unfinished Work
   1. When, for any reason, the work is to be left unfinished, all trenches and excavations shall be filled and all roadways, sidewalks and watercourses left unobstructed with their surfaces in a safe and satisfactory condition. The surface of all roadways and sidewalks shall have a temporary pavement.

C. Hauling Material on Streets
   1. When it is necessary to haul material over the streets or pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on the streets or pavements. In all cases where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as required to keep the crosswalks, streets and pavements clean and free from dirt, mud, stone and other hauled material.

D. Dust Control
   1. It shall be the sole responsibility of the Contractor to control the dust created by any and all of his operations to such a degree that it will not endanger the safety and welfare of the general public.

E. Test Pits
   1. For the purpose of obtaining detail locations of underground obstructions, the Contractor shall make excavations in advance of the work. Payment for the excavations ordered by the Engineer will be made under an appropriate item of the Contract.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 2

ROCK REMOVAL

MP-2.01 GENERAL

A. Work Specified
1. Rock removal to the widths and depths shown on the Contract Drawings or as directed by the Engineer, including the loosening, removing, transporting, storing and disposal of all materials requiring blasting, barring, or wedging for removal from their original beds.
2. Backfill of rock excavations with acceptable materials.

B. Related Work Specified Elsewhere
1. Earthwork
2. Structural Excavation, Backfill and Compaction
3. Trenching, Backfilling and Compacting
4. Selected Fill
5. Embankment

C. Definitions
1. Rock
   a. All pieces of ledge or bedrock, boulders or masonry larger than one-half cubic yard in volume.
   b. Any material requiring blasting, barring, or wedging for removal from its original bed.

MP-2.02 SUBMITTALS

A. Before any blasting operations begin the Contractor shall obtain all permits and licenses required.

MP-2.03 BLASTING

A. General
1. Handling of explosives and blasting shall be done only by experienced persons.
2. Handling and blasting shall be in accordance with all Federal, State and local laws, rules and regulations relating to the possession, handling, storage and transportation and use of explosives.
3. All blasts in open cut shall be properly covered and protected with approved blasting mats.
4. Charges shall be of such size that the excavation will not be unduly large and shall be so arranged and timed that adjacent rock, upon or against which pipelines or structures are to be built, will not be shattered.
5. Blasting will not be permitted within 25 feet of pipelines or structures.

6. All existing pipes or structures exposed during excavation shall be adequately protected from damage before proceeding with the blasting.

B. Repair of Damages Due to Blasting
1. Any injury or damage to the work or to existing pipes or structures shall be repaired or rebuilt by the Contractor at his expense.
2. Whenever blasting may damage adjacent rock, pipes or structures, blasting shall be discontinued and the rock removed by drilling, barring, wedging or other methods.

C. Explosives
1. At no time shall an excessive amount of explosives be kept at the site of the work. Such explosives shall be stored, handled and used in conformity with all applicable laws and regulations.
2. Accurate daily records shall be kept showing the amounts of explosives on hand, both at the site and at any storage magazine, the quantities received and issued, and the purpose for which issued.
3. The Contractor shall be responsible for any damage or injury to any persons, property or structures as a result of his handling, storage or use of explosives.

D. Rock Clearance in Trenches
1. Ledge rock, boulders and large stones shall be removed from the sides and bottom of the trench to provide clearance for the specified embedment of each pipe section, joint or appurtenance; but in no instance shall the clearance be less than 6-inches. Additional clearance at the pipe bell or joint shall be provided to allow for the proper make-up of the joint.
2. At the transition from an earth bottom to a rock bottom the minimum bottom clearance shall be 12-inches for a distance of not less than five (5) feet.

E. Rock Clearance at Structures
1. Concrete for structures shall be placed directly on the rock and the excavation shall be only to the elevations and grades shown on the Contract Drawings.

MP-2.04 EXCAVATION AND BACKFILL

A. Rock removal and backfilling shall be performed in accordance with the applicable provisions of the Section entitled "Earthwork".

B. The rock excavated which cannot be incorporated into the backfill material, as specified, shall be disposed of as spoil and shall be replaced with the quantity of acceptable material required for backfilling.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 4

TRENCHING, BACKFILLING AND COMPACTING

MP-4.01 GENERAL

A. Work Specified
   1. Excavation and backfill as required for pipe installation or other construction in the trench in accordance with the applicable provisions of the Section entitled "Earthwork" unless modified herein.
   2. The removal and disposal of water.

B. Related Work Specified Elsewhere
   1. Earthwork
   2. Rock Removal
   3. Selected Fill
   4. Section pertinent to the type of pipe to be installed.
   5. Pipeline Installation
   6. Restoration of Surfaces

MP-4.02 EXCAVATION

A. The trench excavation shall be located as shown on the Contract Drawings or as specified. Under ordinary conditions, excavation shall be by open cut from the ground surface. Where the depth of trench and soil conditions permit, tunneling may be required beneath cross walks, curbs, gutters, pavements, trees, driveways, railroad tracks and other surface structures. No additional compensation will be allowed for such tunneling over the price bid for open cut excavation of equivalent depths below the ground surface unless such tunnel excavation is specifically provided for in the Contract Documents.

B. Trenches shall be excavated to maintain the depths as shown on the Contract Drawings or as specified for the type of pipe to be installed.

C. The alignment and depth shall be determined and maintained by the use of a string line installed on batter boards above the trench, a double string line installed along side of the trench or a laser beam system.

D. The minimum width of trench excavation shall be 6-inches on each side of the pipe hub for 21-inch diameter pipe and smaller and 12-inches on each side of the pipe hub for 24-inch diameter pipe and larger.

E. Trenches shall not be opened for more than 300 feet in advance of pipe installation nor left unfilled for more than 100 feet in

the rear of the installed pipe when work is in progress without the consent of the Engineer. Open trenches shall be protected and barricaded as required.

F. Bridging across open trenches shall be constructed and maintained where required.

MP-4.03 SUBGRADE PREPARATION FOR PIPE

A. Where pipe is to be laid on undisturbed bottom of excavated trench, mechanical excavation shall not extend lower than the finished subgrade elevation at any point.

B. Where pipe is to be laid on special granular material the excavation below subgrade shall be to the depth specified or directed. The excavation below subgrade shall be refilled with special granular material as specified or directed, shall be deposited in layers not to exceed 6-inches and shall be thoroughly compacted prior to the preparation of pipe subgrade.

C. The subgrade shall be prepared by shaping with hand tools to the contour of the pipe barrel to allow for uniform and continuous bearing and support on solid undisturbed ground or embedment for the entire length of the pipe.

D. Pipe subgrade preparation shall be performed immediately prior to installing the pipe in the trench. Where bell holes are required they shall be made after the subgrade preparation is complete and shall be only of sufficient length to prevent any part of the bell from becoming in contact with the trench bottom and allowing space for joint assembly.

MP-4.04 STORAGE OF MATERIALS

A. Traffic shall be maintained at all times in accordance with the applicable Highway Permits. Where no Highway Permit is required at least one-half of the street must be kept open for traffic.

B. Where conditions do not permit storage of materials adjacent to the trench, the material excavated from a length as may be required, shall be removed by the Contractor, at his cost and expense, as soon as excavated. The material subsequently excavated shall be used to refill the trench where the pipe had been built, provided it be of suitable character. The excess material shall be removed to locations selected and obtained by the Contractor.

1. The Contractor shall, at his cost and expense, bring back adequate amounts of satisfactory excavated materials as may be required to properly refill the trenches.

C. If directed by the Engineer, the Contractor shall refill trenches with select fill or other suitable materials and excess excavated materials shall be disposed of as spoil.

MP-4.05 REMOVAL OF WATER AND DRAINAGE

A. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the removal of all water entering the trench, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work.

B. The removal of water shall be in accordance with the Section entitled "Earthwork".

MP-4.06 PIPE EMBEDMENT

A. All pipe shall be protected from lateral displacement and possible damage resulting from superimposed backfill loads, impact or unbalanced loading during backfilling operations by being adequately embedded in suitable pipe embedment material. To ensure adequate lateral and vertical stability of the installed pipe during pipe jointing and embedment operations, a sufficient amount of the pipe embedment material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted on each side, and back of the bell, of each pipe as laid.

B. Concrete cradle and encasement of the class specified shall be installed where and as shown on the Contract Drawings or ordered by the Engineer. Before any concrete is placed, the pipe shall be securely blocked and braced to prevent movement or flotation. The concrete cradle or encasement shall extend the full width of the trench as excavated unless otherwise authorized by the Engineer. Where concrete is to be placed in a sheeted trench it shall be poured directly against sheeting to be left in place or against a bond-breaker if the sheeting is to be removed.

C. Embedment materials placed above the centerline of the pipe or above the concrete cradle to a depth of 12-inches above the top of the pipe barrel shall be deposited in such manner as to not damage the pipe. Compaction shall be as required for the type of embedment being installed.

MP-4.07 BACKFILL ABOVE EMBEDMENT

A. The remaining portion of the pipe trench above the embedment shall be refilled with suitable materials compacted as specified.
   1. Where trenches are within the ditch-to-ditch limits of any street or road or within a driveway or sidewalk, or shall be under a structure, the trench shall be refilled in

horizontal layers not more than 8 inches in thickness, and compacted to obtain 95% maximum density, and determined as set forth in the Section entitled "Earthwork".

2. Where trenches are in open fields or unimproved areas outside of the ditch limits of roads, the backfilling may be by placing the material in the trench and mounding the surface.
3. Hand tamping shall be required around buried utility lines or other subsurface features that could be damaged by mechanical compaction equipment.

B. Backfilling of trenches beneath, across or adjacent to drainage ditches and water courses shall be done in such a manner that water will not accumulate in unfilled or partially filled trenches and the backfill shall be protected from surface erosion by adequate means.
   1. Where trenches cross waterways, the backfill surface exposed on the bottom and slopes thereof shall be protected by means of stone or concrete rip-rap or pavement.

C. All settlement of the backfill shall be refilled and compacted as it occurs.

D. Temporary pavement shall be placed as specified in the Section entitled "Restoration of Surfaces".

* * * * *

MATERIALS AND PERFORMANCE - SECTION 5

SELECTED FILL

MP-5.01 GENERAL

A. Work Specified
   1. Selected fill materials shall be used in either embedment or special backfill as specified or as directed by the Engineer.

B. Related Work Specified Elsewhere
   1. Earthwork
   2. Rock Removal
   3. Structural Excavation, Backfill and Compaction
   4. Trenching, Backfilling and Compaction
   5. Embedment
   6. Restoration of Surfaces

C. Definitions
   1. Embedment or Lining
      a. Any type granular material specified or directed placed below an imaginary line drawn one foot above the inside diameter of the pipe and within the trench limits.
   2. Special Backfill
      a. Pipelines
         Any selected fill material specified or directed placed above an imaginary line drawn one foot above the inside diameter of the pipe and within the trench limits.
      b. Structures
         Any selected fill material specified or directed placed within the excavation limits, either in, under or adjacent to the structure.
   3. Special Granular Material
      a. Special granular material shall mean any of the granular materials listed below or other materials ordered by the Engineer.

MP-5.02 SUBMITTALS

A. The name and location of the source of the material.

B. Samples and test reports of the material.

MP-5.03 GRANULAR MATERIALS

A. Type A

1. Crushed Gravel

Thoroughly washed crushed, durable, sharp angled fragments of gravel free from coatings. Crushed particles shall be a minimum of 85% by weight of the particles with at least two fractured faces. The total area of each fractional face shall exceed 25% of the maximum cross-sectional area of the particle.

Crushed gravel shall have the following gradation by weight:

% Passing	Sieve
100%	1-1/2-inch
0-25%	3/4-inch
0-5%	1/2-inch

B. Type B

1. Crushed Stone

Thoroughly washed clean, sound, tough, hard crushed limestone or approved equal free from coatings. Gradation for crushed stone shall be the same as specified for Type A material.

C. Type C

1. Crushed Stone

Thoroughly washed, clean, sound, tough, hard, crushed limestone or approved equal free from coatings. It shall have a gradation by weight of 100% passing a one-inch square opening and 0 - 15% passing a 1/4-inch square opening.

D. Type D

1. Washed Sand

Washed coarse sand having the following gradation by weight:

% Passing	Sieve
100	3/8-inch
95 - 100	No. 4
80 - 100	No. 8
50 - 85	No. 16
25 - 60	No. 30
10 - 30	No. 50
2 - 10	No. 100

E. Type E

1. Run-of-Bank Gravel
   Run-of-bank gravel or other acceptable granular material free from organic matter with a gradation by weight of 100% passing a 1-1/2 inch square opening, 30 to 65% passing a 1/4 inch square opening and not more than 10% passing a No. 200 mesh sieve as determined by washing through the sieve in accordance with ASTM D422.

F. Type F

1. Run-of-crusher Stone
   Run-of-crusher hard durable limestone or approved equal having the following gradation by weight:

% Passing	Square Opening (inches)
100	1-1/2
95 - 100	1
65 - 80	1/2
40 - 60	1/4
0 - 10	#200 Sieve

G. Type G

1. A mixture of Type E material and Portland cement mixed in a ratio of 15:1 and placed and compacted in a dry state.

H. Type H

1. A specially blended mixture of materials as specified in the Payment Items.

MP-5.04 INSTALLATION

A. Special granular material as specified or directed for pipeline embedment shall be placed in accordance with the Section entitled "Trenching, Backfilling and Compacting".

B. Special backfill where specified or directed shall be placed in accordance with the backfilling provisions of the Section entitled "Trenching, Backfilling, and Compacting", and the Section entitled "Earthwork".

MP-5.05 DISPOSAL OF DISPLACED MATERIALS

A. Materials displaced through the use of the above materials shall be wasted or disposed of by the Contractor and the cost of such disposal shall be included in the unit price bid for each of the materials.

MP-5.06 SETTLEMENTS

A. Any settlements in the finished work shall be made good by the Contractor at his cost and expense.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 7

EMBANKMENT

MP-7.01 GENERAL

A. Work Specified
   1. Earth embankments shall be constructed to established lines and grades at the locations shown on the Contract Drawings and as directed by the Engineer. Embankment materials shall be obtained from acceptable soils on the site, or approved off-site sources.
   2. Embankment material shall be free from frost, stumps, trees, roots, sods, muck, mari, vegetable matter or other unsuitable material and shall be suitable for compaction as described in the following provisions. Where embankments are to be placed underwater only acceptable granular materials shall be used.
   3. Embankments shall be constructed to such elevations as to make allowance for any settlement that may occur. Prior to the construction of any structure, roadway or other ground feature and before final acceptance of the contract, the Contractor shall regrade the embankments to conform to the established lines and grades.

B. Related Work Specified Elsewhere
   1. Earthwork
   2. Restoration of Surfaces
   3. Topsoil and Seeding

MP-7.02 TESTING

A. All testing, including field and laboratory services, shall be at the Contractor's expense without additional compensation, except where separate payment is specified.

MP-7.03 SUBMITTALS

A. Proposed testing laboratory

B. Source of off-site materials

C. Compaction curves for all materials to be used.

MP-7.04 PREPARATION OF SUBGRADE

A. The entire surface to be covered with embankment shall be grubbed and stripped of all grass, vegetation, topsoil, rubbish, or other unsuitable materials before any embankment material is placed.

1. Topsoil shall be stockpiled or placed as designated.
2. Other grubbed and stripped materials shall be removed as spoil.

B. Stripped or excavated surfaces on which embankments are to be placed shall be compacted to the required density of the embankment prior to any fill being placed.

MP-7.05 PLACEMENT AND COMPACTION

A. Materials shall be placed in lifts not greater than 8 inches of thickness unless greater thicknesses are allowed by the Engineer upon demonstration by the Contractor that the materials and compaction efforts are adequate to obtain the required density.

B. Material shall be placed in a uniform lift and thoroughly compacted by compaction equipment suitable for the material encountered to obtain the required density prior to the placement of succeeding lift.
   1. Each lift shall be tested for proper compaction before successive lifts are applied.

C. Stones shall not exceed 6 inches in greatest dimension and shall be well distributed throughout the soil mass. Stone shall be defined as rock material either in its natural or broken state.

D. Stones not well mixed with soil material shall not be used in earth embankments unless the stone material is sufficiently deteriorated or friable so as to be compactible to achieve minimum voids and required density.

E. If the required density is not obtained, compaction of the embankment shall continue until specified densities are obtained, before any additional embankment is placed. Improperly compacted embankment shall be removed.

F. Where required, the Contractor shall, at his expense, add sufficient water during the compaction effort to assure proper density. If, due to rain or other causes, the material exceeds the optimum moisture content for satisfactory compaction, it shall be allowed to dry, assisted by discing or harrowing, if necessary, before compaction or filling effort is resumed.

G. The Contractor shall be required to seal the working surface at the close of each day's operation and when practical prior to rainfall. Sealing shall be accomplished by rolling the surface with a smooth wheel steel roller.

H. Compaction or consolidation achieved by travelling trucks, machines and other equipment will not be accepted unless such procedures are approved by the Engineer and proper compaction density is achieved.

I. Hand tamping shall be required around buried utility lines or other subsurface features that could be damaged by mechanical compaction equipment.

MP-7.06 DENSITY CONTROL

A. Embankments shall be compacted to 90% of maximum dry density as determined by the density tests designated in ASTM D 698, Method D.
   1. Compaction curves for the full range of soil materials to be used in the embankment shall be developed by an approved independent testing laboratory.

B. Field control samples shall be taken and tested by the testing laboratory as required to assure that adequate compaction of the embankment material is being achieved.

C. A minimum of one (1) in-place density test shall be made for every 10,000 square feet of compacted area per lift.
   1. In-place density of soils shall be determined by the methods described in ASTM D 1556 or ASTM D 2922 and expressed as a percentage of the maximum dry density.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 8

RESTORATION OF SURFACES

MP-8.01 GENERAL

A. Work Specified
   1. All types of surfaces, sidewalks, curbs, gutters, culverts and other features disturbed, damaged or destroyed during the performance of the work under or as a result of the operations of the Contract, shall be restored and maintained, as specified herein or as modified or described in the Special Provisions.
   2. The quality of materials and the performance of work used in the restoration shall produce a surface or feature equal to the condition of each before the work began.

B. Related Work Specified Elsewhere
   1. Earthwork
   2. Structural Excavation, Backfill and Compaction
   3. Trenching, Backfilling and Compacting
   4. Embankment
   5. Topsoil and Seeding
   6. Concrete

MP-8.02 SCHEDULE OF RESTORATION

A. A schedule of restoration operations shall be submitted by the Contractor for review.
   1. After an accepted schedule has been agreed upon it shall be adhered to unless otherwise revised with the approval of the Engineer.

B. In general, permanent restoration of paved surfaces will not be permitted until one months' time has elapsed after excavations have been completely backfilled as specified. A greater length of time, but not more than nine months may be allowed to elapse before permanent restoration of street surfaces is undertaken, if additional time is required for shrinkage and settlement of the backfill.

C. The replacement of surfaces at any time, as scheduled or as directed, shall not relieve the Contractor of responsibility to repair damages by settlement or other failures.

MP-8.03 TEMPORARY PAVEMENT

A. Immediately upon completion of refilling of the trench or excavation, the Contractor shall place a temporary pavement over all disturbed areas of streets, driveways, sidewalks, and other traveled places where the original surface has been disturbed as a result of his operations.

B. Unless otherwise specified or directed the temporary pavement shall consist of compacted run-of-crusher limestone to such a depth as required to withstand the traffic to which it will be subjected.

C. Where concrete pavements are removed, the temporary pavement shall be surfaced with "cold patch". The surface of the temporary pavement shall conform to the slope and grade of the area being restored.

D. For dust prevention, the Contractor shall treat all surfaces, not covered with cold patch, as frequently as may be required.

E. The temporary pavement shall be maintained by the Contractor in a safe and satisfactory condition until such time as the permanent paving is completed. The Contractor shall immediately remove and restore all pavement as shall become unsatisfactory.

MP-8.04 PERMANENT PAVEMENT REPLACEMENT

A. The permanent and final repaving of all streets, driveways and similar surfaces where pavement has been removed, disturbed, settled or damaged by or as a result of performance of the Contract shall be repaired and replaced by the Contractor, by a new and similar pavement.
   1. The top surface shall conform with the grade of existing adjacent pavement and the entire replacement shall meet the current specifications of the local community for the particular types of pavement.
   2. Where the local community has no specification for the type of pavement, the work shall be done in conformity with the State Department of Transportation Standard which conforms the closest to the type of surfacing being replaced, as determined by the Engineer.

MP8.05 PREPARATION FOR PERMANENT PAVEMENT

A. When scheduled and within the time specified, the temporary pavement shall be removed and a base prepared, at the depth required by the local community or Highway Permit, to receive the permanent pavement.
   1. The base shall be brought to the required grade and cross-section and thoroughly compacted before placing the permanent pavement.
   2. Any base material which has become unstable for any reason shall be removed and replaced with compacted base materials.

B. Prior to placing the permanent pavement all service boxes, manhole frames and covers and similar structures within the area shall be adjusted to the established grade and cross-section.

C. The edges of existing asphalt pavement shall be cut a minimum of one foot beyond the excavation or disturbed base whichever is greater.
   1. All cuts shall be parallel or perpendicular to the centerline of the street.

MP-8.06 ASPHALT PAVEMENT

A. The permanent asphalt pavement replacement for streets, driveways and parking area surfaces shall be replaced with bituminous materials of the same depth and kind as the existing unless otherwise specified.

B. Prior to placing of any bituminous pavement a sealer shall be applied to the edges of the existing pavement and other features.

C. The furnishing, handling and compaction of all bituminous materials shall be in accordance with the State Department of Transportation Standards.

MP-8.07 CONCRETE PAVEMENT AND PAVEMENT BASE

A. Concrete pavements and concrete bases for asphalt, brick or other pavement surfaces shall be replaced with Class "B" Concrete, air-entrained.

B. Paving slabs or concrete bases shall be constructed to extend one foot beyond each side of the trench and be supported on undisturbed soil. Where such extension of the pavement will leave less than two feet of original pavement slab or base, the repair of the pavement slab or base shall be extended to replace the slab to the original edge of the pavement or base unless otherwise indicated on the Contract Drawings.

C. Where the edge of the pavement slab or concrete base slab falls within the excavation, the excavation shall be backfilled with Special Backfill compacted to 95% maximum dry density as determined by ASTM D 698 up to the base of the concrete.

D. The new concrete shall be of the same thickness as the slab being replaced and shall contain reinforcement equal to the old pavement.
   1. New concrete shall be placed and cured in accordance with the applicable provisions of the State Department of Transportation Standards.

MP-8.08 STONE OR GRAVEL PAVEMENT

A. All pavement and other areas surfaced with stone or gravel shall be replaced with material to match the existing surface unless otherwise specified.

1. The depth of the stone or gravel shall be at least equal to the existing.
2. After compaction the surface shall conform to the slope and grade of the area being replaced.

MP-8.09 CONCRETE WALKS, CURBS AND GUTTER REPLACEMENT

A. Concrete walks, curbs and gutters removed or damaged in connection with or as a result of the construction operations shall be replaced with new construction.
   1. The minimum replacement will be a flag or block of sidewalk and five feet of curb or gutter.

B. Walks shall be constructed of Class "B" concrete, air-entrained with NYSDOT #1 stone aggregate on a 4-inch base of compacted gravel or stone.
   1. The walk shall be not less than 4 inches in thickness or the thickness of the replaced walk where greater than 4 inches, shall have construction joints spaced not more than 25 feet apart, shall have expansion joints spaced not more than 50 feet apart and shall be sloped at right angles to the longitudinal centerline approximately 1/8 inch per foot of width.

C. One-half inch expansion joint material shall be placed around all objects within the sidewalk area as well as objects to which the new concrete will abut, such as valve boxes, manhole frames, curbs, buildings and others.

D. Walks shall be hand-floated and broom-finished, edged and grooved at construction joints and at intermediate intervals matching those intervals of the walk being replaced.
   1. The intermediate grooves shall be scored a minimum of 1/4 of the depth of the walk.
   2. The lengths of blocks formed by the grooving tool, and distances between construction and expansion joints shall be uniform throughout the length of the walk in any one location.

E. The minimum length of curb or gutter to be left in place or replaced shall be 5 feet. Where a full section is not being replaced, the existing curb or gutter shall be saw cut to provide a true edge.
   1. The restored curb or gutter shall be the same shape, thickness and finish as being replaced and shall be built of the same concrete and have construction and expansion joints as stated above for sidewalks.

F. All concrete shall be placed and cured as specified in the Section for concrete.

MP-8.10 LAWNS AND IMPROVED AREAS

A. The area to receive topsoil shall be graded to a depth of not less than 4 inches or as specified, below the proposed finished surface.
   1. If the depth of existing topsoil prior to construction was greater than 4 inches, topsoil shall be replaced to that depth.

B. The furnishing and placing of topsoil, seed and mulch shall be in accordance with the Section entitled "Topsoil and Seeding".

C. When required to obtain germination, the seeded areas shall be watered in such a manner as to prevent washing out of the seed.

D. Any washout or damage which occurs shall be regraded and reseeded until a good sod is established.

E. The Contractor shall maintain the newly seeded areas, including regrading, reseeding, watering and mowing, in good condition.

MP-8.11 CULTIVATED AREA REPLACEMENT

A. Areas of cultivated lands shall be graded to a depth to receive topsoil of not less than the depth of the topsoil before being disturbed. All debris and inorganic material shall be removed prior to the placing of the topsoil.

B. The furnishing and placing of topsoil shall be in accordance with the Section entitled "Topsoil and Seeding".

C. After the topsoil has been placed and graded, the entire area disturbed during construction shall be cultivated to a minimum depth of 12 inches with normal farm equipment.
   1. Any debris or inorganic materials appearing shall be removed.
   2. The removal of stones shall be governed by the adjacent undisturbed cultivated area.

D. Grass areas shall be reseeded using a mixture equal to that of the area before being disturbed, unless otherwise specified.

MP-8.12 OTHER TYPES OF RESTORATION

A. Trees, shrubs and landscape items damaged or destroyed as a result of the construction operations shall be replaced in like species and size.
   1. All planting and care therof shall meet the standards of the American Association of Nurserymen.

B. Water courses shall be reshaped to the original grade and cross-section and all debris removed. Where required to prevent erosion, the bottom and sides of the water course shall be protected.

C. Culverts destroyed or removed as a result of the construction operations shall be replaced in like size and material and shall be replaced at the original location and grade. When there is minor damage to a culvert and with the consent of the Engineer, a repair may be undertaken, if satisfactory results can be obtained.

D. Should brick pavements be encountered in the work, the restoration shall be as set forth in the Special Provisions or as directed.

MP-8.13 MAINTENANCE

A. The finished products of restoration shall be maintained in an acceptable condition for and during a period of one year following the date of Substantial Completion or other such date as set forth elsewhere in the Contract Documents.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 61

VAULTS AND INLETS

MP-61.01 GENERAL

A. Work Specified

1. Valve and meter vaults, catch basins, curb inlets, surface water inlets, and similar structures, complete with frames and covers, manhole steps and appurtenances as shown on the Contract Drawings.

B. Related Work Specified Elsewhere

1. Concrete

C. Applicable Codes, Standards and Specifications

1. American Society for Testing and Materials (ASTM)

MP-61.02 SUBMITTALS

Prior to any field construction, the Contractor shall submit for review drawings and conformance data for materials to be used in the construction of vaults and inlets.

MP-61.03 MATERIALS

A. Concrete

1. Cast-in-place concrete for vaults and inlets shall be as specified under the Section entitled "Concrete".
2. Precast concrete sections shall be in accordance with ASTM C478 for manhole sections and ASTM C913 for other structures with a minimum wall thickness of 5 inches. Top sections shall withstand H-20 wheel loads and shall be of the type shown.

   a. Bell and spigot joints of precast sections shall have an appropriate "O" ring supplied by the manufacture or other types of joints as shown on the Contract Drawings.

B. Masonry Units

1. Brick shall meet the requirements of ASTM C-62, Grade SW and shall be of a hard-burned manufacture.

2. Concrete blocks shall conform to the requirements of ASTM C139 and shall be solid and of the size shown on the Contract Drawings.

C. Mortar

Masonry cement for mortar shall meet the requirements of ASTM C 91, Type II and shall be mixed with a graded quality sand conforming to ASTM C 144.

Mix shall be 1 part masonry cement to 3 parts sand using the minimum amount of clean water required for workability.

D. Castings

1. Frames and covers, grates, inlets, and other castings shall be as shown on the Contract Drawings and be in accordance with ASTM A 48, Class 30. All castings shall be manufactured to withstand H-20 wheel loads. Lettering shall be "Storm Sewers" or other appropriate designation cast as directed. Frames and covers shall have machined bearing surfaces.

2. Steps shall be manhole steps manufactured of cast iron in accordance with ASTM A 48, Class 30 or others acceptable to the Engineer.
   a. **Steps shall have a minimum tread width of 12 inches.**

MP-61.04 INSTALLATION

A. Precast Sections

1. Precast section shall be installed level on a flat stable subgrade. Where an unstable condition exists, the Contractor shall excavate the unstable material and replace with compacted granular material.

2. All joints shall be filled inside and out with mortar to provide a smooth and continuous surface.

B. Benchwalls and Inverts

Mortar surfaces of benchwalls and concrete floors shall be given a broom finish. Where inverts are required they shall be lined with a half section of pipe of the same type used for the sewer or shall be constructed of Class "C" concrete, shaped and troweled to produce a smooth circular cross-section.

C. Frames and Castings

Frames and castings shall be set in a full bed of mortar a maximum of 1/2" thick. Where required to adjust the frames and castings to grade there shall be installed to a maximum of four brick courses.

D. Steps

1. Steps shall be installed in vertical alignment spaced 12-inches on center.

2. In concrete sections the steps shall be cast into the section or secured with cadmium plated bolts to threaded inserts which are precast into the concrete.

3. In masonry construction the steps shall be built into the masonry walls.

E. Plastering

1. Plaster shall be with mortar not less than 1/2-inch thick and troweled smooth.

2. Outside of masonry structures.

3. Inside and outside of brick courses under frames and castings.

F. Sumps

Sumps of the size specified shall be built into the floors of vaults and similar structures. Floors shall be sloped to the sump.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 63

PRECAST CONCRETE MANHOLES

MP-63.01 GENERAL

A. Work Specified

Precast manholes of the type scheduled with construction as shown on the Standard Details for Manholes. All manholes shall consist of the combination of base and barrel sections resulting in the fewest number of joints.

B. Applicable Codes, Standards and Specifications

1. American Society for Testing and Materials (ASTM)

MP-63.02 SUBMITTALS

A. Prior to any field construction, the Contractor shall submit for review drawings and conformance data for manhole sections, slabs, steps, frames and covers, location and size of base section opening and manhole step locations.

MP-63.03 MATERIALS

A. Manhole Sections

1. Precast concrete pipe sections and slabs shall be constructed and reinforced in accordance with ASTM C478, with a minimum wall thickness of 5 inches and with joints having an "O" ring seal.

   a. Manhole sections shall be waterproofed with bituminous material on the exterior.

2. Base sections shall have reinforced flat bottoms protruding 6 inches beyond the outside face of the riser section. The flat bottoms shall be:

   a. Minimum of 6 inch thickness for risers up to and including 48 inch diameter.

   b. Minimum of 8 inch thickness for risers of larger diameter.

3. Each opening in the base section for sewers up to and including 20 inch diameter shall contain a flexible rubber connection installed by the manufacturer of the base section.

   a. Openings for drop inlet pipes are excepted from this requirement.

b. Flexible rubber connectors shall be

1) KOR-N-SEAL
2) Lock Joint Flexible Manhole Sleeve
3) Or equal

4. Top sections, tapered or flat, shall be adequate to withstand H-20 wheel loads. All top sections shall have concentric or eccentric opening as specified or shown for the type of manhole. The edge of eccentric openings for flat top sections shall be a maximum of 2 inches from the inside wall of the barrel section.

B. Manhole Steps

1. Steps for manholes shall be cast iron, ASTM A48, Class 30 or others acceptable to the Engineer.

2. Steps shall be installed in each manhole in vertical alignment spaced 12-inches on center and shall be placed over the largest benchwall of the manhole.

3. Steps shall have a minimum tread width of 12-inches and shall be precasted into the manhole sections or other methods of installation with prior acceptance of the Engineer.

C. Frames and Covers

1. Manhole frames and covers shall be in accordance with ASTM A-48, Class 30, and as listed by the following manufacturers, or equal.

Syracuse Castings:	24" Nominal Casting No. 1255-B
	36" Nominal Casting No. 1024
Neenah Castings:	24" Nominal Casting No. R-1780
	36" Nominal Casting No. R-1744

2. Covers shall be provided with a minimum of two watertight pickholes and shall be solid unless otherwise noted. Frames and covers shall be adequate to bear H-20 wheel loads and shall be provided with machined bearing surfaces. Lettering shall be either "Sanitary Sewer" or "Storm Sewer", depending on the use, unless otherwise directed. When required for bolting, holes shall be provided in the frames.

D. Mortar and Bricks

1. Masonry cement for mortar shall meet the requirements of ASTM C91, Type II and shall be mixed with a graded quality sand conforming to ASTM C144. Mix shall be 1 part masonry cement to 3 parts sand using the minimum amount of clean water required for workability.

2. Brick shall meet the requirements of ASTM C62, Grade SW of a hard-burned manufacture.

E. Observation Pipe

1. Each manhole base section shall have a 3/4-inch diameter rigid plastic pipe installed through the wall one foot above the top of the lowest pipe opening.

2. The pipe shall have a threaded plastic plug or cap on the inside end.

3. The outside end shall be encased in 1 cubic foot of clean gravel.

MP-63.04 DROP MANHOLES - SPECIAL CONSTRUCTION

A. Type D or H manholes shall be constructed in accordance with the Standard Detail as follows:

1. The polyvinyl chloride (PVC) pipe and fittings shall meet the requirements of ASTM D-3034. Joints shall be solvent welded except for those installed vertically. The drop section, tee and nipple shall be of the same diameter as the influent sewer up to the maximum of 12-inches in diameter. For influent sewers over 12-inches in diameter, a 12-inch branch tee, nipple and drop section shall be used.

2. The PVC nipple and the influent sewer shall be joined with a flexible coupling which shall be Tylox o-Dapter, Band Seal Rubber Adapter, or equal. Tee shall be plugged with a removable plug consisting of two conical aluminum discs, a rubber compression gasket and a permanently extended operating handle. The plug shall provide a watertight seal as the gasket is forced against the pipe wall by drawing the aluminum discs together with the operating handle. The operating handle shall be coated to protect against corrosion.

3. The opening in the manhole barrel for the drop inlet does not require a flexible pipe connector. A watertight seal shall be made between the manhole wall and PVC inlet pipe using a universal compression type annular space sealer constructed of hard rubber links, joined together by bolts of corrosion resistant plated carbon steel or other type seal acceptable to the Engineer. The rubber link material shall remain flexible and be resistant to water and chemical action.

MP-63.05 INSTALLATION

A. Precast manhole bases shall be installed level on a flat stable subgrade. Where an unstable condition exists, the Contractor

shall excavate the unstable material and replace with compacted granular material.

B. All joints on the inside and outside of the manhole shall be filled with mortar to provide a smooth and continuous surface.

C. Manhole inverts shall be lined with a half section of pipe of the same type and size as the pipe used for the sewer or shall be constructed of Class C concrete, shaped and troweled to produce a smooth circular cross-section. Manholes having sewer intersections of less than 90° shall have the alignment of a Type "A" benchwall as shown on Standard Detail SD-10. Benchwalls shall have a slope of 1/2" on 12" and the mortar surface shall be given a broom finish.

D. Mortar beds for brick or manhole frames shall be a maximum thickness of 1/2 inch.

E. Manhole frames for Type E & I manholes shall set on a bed of mortar and be bolted to the flat slab top with 4-3/4-inch bolts evenly spaced around the frame using concrete expansion anchors. For other types of manholes, the Contractor shall furnish and install up to a maximum of four brick courses as required to adjust the frames to grade. The brick courses shall be plastered with 1/2" minimum of cement mortar inside and out.

F. In drop manholes Type D or H, the space sealer between the manhole wall and PVC inlet pipe shall be assembled with the heads of the bolts on the inside of the manhole.

MP-63.06 MARKERS

A. Unless otherwise specified, two (2) 2" x 4" markers shall be placed adjacent to each completed manhole except those installed in roadways. The markers shall be buried in the ground a minimum of 6 feet and shall extend above the top of the manhole a minimum of 2 feet.

B. The portion of the marker extending above the ground shall be painted green.

MP-63.07 TESTING

A. Each sanitary sewer manhole shall be tested in accordance with the Section entitled "Leakage Tests".

* * * * *

MATERIALS AND PERFORMANCE

SECTION 70 - PIPELINE INSTALLATION

MP-70.01 GENERAL

A. Work Specified

1. All metallic and non-metallic pipe, fittings and specials of the type and quality as shown in the pipe schedule or on the Contract Drawings and as specified for the pipe.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling and Compacting
2. Selected Fill
3. Section pertinent to the type of pipe to be installed
4. Pipe Hangers and Supports
5. Leakage Tests
6. Chlorination

MP-70.02 MATERIALS

A. Pipe

1. Materials for the piping, joints and fittings shall be as specified in the Section for the type of pipe to be installed, shown in the pipe schedule or on the Contract Drawings.

    a. Pipe and appurtenances shall comply with the applicable standards for its type of material.

B. Joints

1. Type of joints shall be as scheduled in the pipe schedule or as shown or noted on the Contract Drawings.

2. Grooved and shoulder type joints of the rigid design may be used in lieu of flanged joints on ductile iron or steel pipe with the prior acceptance of the Engineer.

C. Inspection

1. Pipe and appurtenances shall be inspected by the Contractor on delivery and prior to installation for conformance with the standards and specifications.

    a. Materials not conforming to the standards and specifications shall not be stored on site but removed at once and replaced with material conforming to the specifications.

MP-70.03 SUBMITTALS

A. Test reports, certifications, shop drawings and samples are required as set forth in the sub-section entitled "Submittals" for the type of pipe to be installed.

B. Layout drawings are required for pipelines to be installed within structures showing the location including the support system, sleeves and appurtenances.

MP-70.04 INSTALLATION - UNDERGROUND

A. General

1. Excavation and backfilling shall be in accordance with the applicable provisions of the Section entitled "Trenching, Backfilling and Compacting".

2. Blocking will not be permitted under pipe, except where the pipe is to be laid with concrete cradle or encasement.

3. No pipe shall be laid upon a foundation in which frost exists; nor at any time when there is danger of the formation of ice or the penetration of frost at the bottom of the excavation.

4. Temporary bulkheads shall be placed in all open ends of pipe whenever pipe laying is not actively in process. The bulkheads shall be designed to prevent the entrance of dirt, debris or water.

5. Precautions shall be taken to prevent the flotation of the pipe in the event of water entering the trench.

B. Location and Grade

1. Pipelines and appurtenances shall be located as shown on the Contract Drawings or as directed and as established from the control survey in accordance with the Special Provisions.

2. The alignment and grades shall be determined and maintained by a method acceptable to the Engineer.

C. Subgrade

The subgrade for pipelines shall be earth or special embedment as specified or directed and shall be prepared in accordance with the Section entitled "Trenching, Backfilling and Compacting".

D. Joints

1. Joints shall be assembled using gaskets, lubricants and solvents as furnished by the pipe manufacturer and in accordance with the manufacturer's recommendations.

E. Embedment

1. Embedment shall be deposited and compacted in accordance with the Section entitled "Trenching, Backfilling and Compacting", and the Section for the type of pipe being installed and shall be one of the embedments shown below unless otherwise specified or directed.

2. Type "A" Embedment

Pipe of
- Asbestos Cement
- Cast Iron Soil
- Copper
- Corrugated Steel
- Ductile Iron
- Reinforced Concrete
- Prestressed Concrete
- Vitrified Clay
- Wrought Steel.

a. The embedment shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2 inches in size or debris.

b. It shall be deposited and tamped in 6-inch layers to the centerline of the pipe.

c. Native material placed above the centerline of the pipe to a depth of 12 inches above the pipe shall be deposited in such manner as to not damage the pipe.

d. When specified or directed, Selected Fill material shall be used in lieu of the native material for a or c above.

3. Type "B" Embedment

Pressure Pipe of
- Fiberglass
- Polyvinyl Chloride
- Steel
- Thermal Plastic

a. The embedment shall consist of compacted Type "F" granular material placed from a depth of 4" below the pipe to the centerline of the pipe.

1) It shall be deposited and hand-compacted in 6-inch maximum layers.

b. From the centerline to the top of the pipe the embedment shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2" in size and shall be lightly compacted.

c. From the top of the pipe to one foot above the pipe, acceptable native material shall be deposited in such manner as to not damage the pipe.

d. When the native material under b or c above is not acceptable, to the Engineer, Selected Fill materials shall be used.

4. Type "C" Embedment

Non-pressure pipe of Fiberglass
Polyvinyl chloride
Thermal Plastic

a. The embedment shall consist of compacted Type "F" granular materials placed from a depth of 4" below the pipe to a depth of 12" over the pipe.

1) It shall be deposited and hand-compacted in 6-inch maximum layers.

F. Thrust Restraints

1. Pressure pipelines shall have thrust restraints in the form of thrust blocks, tie rods, or anchors of the size and type specified or as required by the pressure and stability of the supporting surface.

a. Thrust restraints shall be installed at all changes in direction, changes in size, dead ends or other locations where shown.

b. Thrust restraints shall be in place, and when of concrete (Class C) shall have developed the required strength, prior to testing of the pipeline.

c. Tie rods and nuts for thrust restraints shall be of high tensile steel and shall have a minimum yield strength of 70,000 psi.

1. Tie rods and nuts installed underground shall be coated with two coats of coal tar pitch preservative coating after installation.

G. Service Connections

1. Connections to in-service pressure pipelines shall be in accordance with the applicable provisions of the Section entitled "Tapped Connections".

2. Connections to sewers shall be saddle, wye or tee branches as specified.

   a. Saddle and wye branches shall be installed, in general, so that the top of the branch is at the top of the pipe.

3. Laterals of the kind and size of pipe as specified shall be installed as shown, specified or directed.

   a. Bends, as required, shall be used between the connection and the lateral, to obtain the correct slope and to allow the horizontal angle of the lateral to be at 90 degrees to the main line or other angle as specified or directed.

   b. Minimum slope for a lateral shall be 1/4 inch per foot.

   c. Maximum slope for a lateral shall be 2 feet per foot unless otherwise specified.

   d. Each lateral having a slope of 1 foot per foot or greater shall have a concrete cradle which shall be Class C concrete and shall be placed 6" each side of and from a depth of 3" below to the centerline of the lateral pipe.

   e. Laterals specified to exceed the maximum slope shall be supported to prevent excessive load being applied to the main line pipe.

   f. The end of each connection or lateral shall be sealed by means of a removable watertight plug as shown on the Contract Drawings.

   g. The end of each connection or lateral shall have a 2 x 4 inch marker extending vertically from the stopper to 3 feet above the ground surface. The portion of the marker extending above the ground shall be painted green.

4. Connections and ends of laterals shall not be backfilled until a record has been made of the "as-built" location of each.

H. Connection to Existing Structures or Manholes

1. Where a stub has been provided the connection shall be made to the existing pipe.

2. Where no stub has been provided, the Contractor shall make an opening for inserting the connecting pipe.

a. When specified, a sleeve shall be installed and a watertight joint formed.

1) The carrier pipe shall be installed in the sleeve and the joint made watertight.

b. Where no sleeve is specified, the space between the pipe and the wall of the structure or manhole shall be made watertight.

c. A joint shall be in the pipe at or within 5 feet of a structure or manhole.

d. A channel shall be built or the existing channel revised, to direct the flow from or into the new pipe.

e. Care shall be taken to avoid damage to the existing structure or manhole and to prevent debris from entering any existing channel. Any damage shall be repaired and debris removed.

MP-70.05 INSTALLATION - EXPOSED

A. Exposed pipelines shall be carefully erected and neatly arranged.

1. Run parallel to wall of structures

B. Supports and anchors shall be adequate to support the pipe filled with water with a minimum safety factor of 5 and for the test pressure specified.

C. Special supports shall be as specified in the Section for the type of pipe being installed.

MP-70.06 FINAL INSPECTION OF SEWERS

A. Each section of pipe between manholes shall be inspected before final acceptance.

1. In larger pipelines the inspection shall be by traversing the inside of the pipe.

2. In smaller pipelines the inspection shall be by observation with illumination.

3. Where specified, the inspection shall be by closed circuit television.

a. Shall be monitored by both the Engineer and the Contractor.

B. The inspection shall determine the pipeline to be true to line and grade, to show no leaks, to have no obstruction to flow, to have no projections or protruding of connecting pipes or joint materials, shall be free from cracks and shall contain no deposits of sand, dirt or other materials.

C. All deficiencies located during the inspection shall be corrected.

MP-70.07 CUTTING AND SPECIAL HANDLING

A. Field cuts of pipes shall be in accordance with the manufacturer's instructions.

B. Where a pipe requires special handling or installation it shall be in accordance with the Section for that type of pipe.

MP-70.08 FLEXIBLE COUPLINGS

Flexible couplings shall be provided where shown or scheduled and shall be in accordance with the Section entitled "Flexible Pipe Couplings".

MP-70.09 WALL CASTINGS AND SLEEVES

All pipelines passing through walls, floors or slabs of structures shall be installed in a wall casting or sleeve. The wall castings and sleeves shall be in accordance with the Section entitled "Wall Castings and Sleeves".

MP-70.10 LEAKAGE TEST

A. All pipelines shall be tested for leakage in accordance with the Section entitled "Leakage Test".

MP-70.11 CHLORINATION

A. All pipelines designed to convey potable water shall be chlorinated in accordance with the Section entitled "Chlorination".

* * * * *

MATERIALS AND PERFORMANCE - SECTION 71

LEAKAGE TESTS

MP-71.01 GENERAL

A. Work Specified

1. Testing of all hydraulic structures, pressure and non-pressure piping for leakage as specified.

   a. The Contractor shall furnish all labor, equipment, test connections, vents, water and materials necessary for carrying out the pressure and leakage tests.

2. All testing shall be witnessed by the Engineer.

MP-71.02 LEAKAGE TESTS FOR STRUCTURES

A. Tanks, vaults, wells and other fluid containing structures, (excluding manholes) shall be tested before backfilling by filling the structure with water to overflowing, or other level as may be directed by the Engineer, and observing the water surface level twenty-four hours thereafter.

1. When testing absorbent materials such as concrete, the structure shall be filled with water at least 24 hours before the test is started.

B. The exterior surface, especially at the construction joint, will be inspected for leakage during and upon completion of the twenty-four hour test.

1. Leakage will be considered to be within the allowable limits when there is no visible sign of leakage on the exterior surface and where the water surface does not drop except as associated with evaporation.

2. A slight dampness on the exterior wall surface during the test period will not be considered as leakage, except in the case of prestressed concrete structures.

MP-71.03 TESTS ON PRESSURE PIPING FOR TRANSPORT OF WATER OR SEWAGE

A. General

1. Pipelines designed to transport water or sewage under pressure shall be tested hydrostatically and for leakage prior to being placed in service.

2. The length of piping and sections included in the tests shall meet the approval of the Engineer.

3. Equipment in or attached to the pipes being tested shall be protected. Any damage to such equipment during the test shall be repaired by the Contractor at his expense.

4. When piping is to be insulated or concealed in a structure, tests shall be made before the pipe is covered.

5. All fittings, hydrants and appurtenances must be properly braced and harnessed before the pressure is applied. Thrust restraining devices which will become a part of the system must also be tested at the test pressure.

6. When testing absorbent pipe materials such as asbestos cement or concrete, the pipeline shall be filled with water at least 24 hours before the test is made.

7. If the line fails the test, the Contractor shall explore for the cause of the excessive leakage and after repairs have been made the line shall be retested. This procedure shall be repeated until the pipe complies.

B. Pressure Test

1. Test pressure shall be as scheduled or, where no pressure is scheduled, at 150 psi.

2. Test pressure shall be held on the piping for a period of at least 2 hours, unless a longer period is requested by the Engineer.

C. Leakage Test

1. The leakage test shall be conducted concurrently with the pressure test.

2. The rate of leakage shall be determined at 15 minute intervals by means of volumetric measurement of the makeup water added to maintain the test pressure. The test shall proceed until the rate of leakage has stabilized or is decreasing below an allowable value, for three consecutive 15 minute intervals. After this, the test pressure shall be maintained for at least another 15 minutes.

   a. At the completion of the test the pressure shall be released at the furthermost point from the point of application.

3. All exposed piping shall be examined during the test and all leaks, defective material or joints shall be repaired or replaced before repeating the tests.

4. The allowable leakage for pressure pipelines shall not exceed the following in gallons per 24 hours per inch of diameter per mile of pipe:

Type of Pipe	Leakage
Ductile iron	10
Asbestos-cement	20
Polyvinyl chloride, thermal plastic or fiberglass with rubber joints	10
Polyvinyl chloride, thermal plastic or fiberglass with sovent-cemented joints	0
Concrete with steel and rubber joints	10
Steel with welded joints	0
Steel with harnessed joints	10
Wrought steel	0
Copper	0
All piping inside structures	0

5. Regardless of the above allowables, any visible leaks shall be permanently stopped.

MP-71.04 TEST FOR NON-PRESSURE PIPELINES FOR TRANSPORT OF WATER OR SEWAGE

A. General

1. Pipelines designed to carry water or sewage in open channel flow or at minimal pressures shall be tested for leakage prior to being placed in service.

2. The leakage shall be determined by exfiltration, infiltration or low pressure air.
   a. The testing method directed by the Engineer shall take into consideration the groundwater elevation of the section of pipe being tested.

   b. The maximum non-pressure pipeline to be tested for leakage shall be the section between manholes or 600 feet as directed by the Engineer.

3. Intermediate leakage tests during construction shall be made at the Contractor's discretion. Upon completion of any pipeline, the entire system including manholes shall be tested for compliance to allowable leakage.

4. When testing absorbent pipe materials such as asbestos-cement or concrete, the pipeline shall be filled with water at least 24 hours before the test is made.

5. Groundwater level shall be determined by the Contractor prior to any testing by reading the water level at the observation pipe in the manholes.

6. If the line fails the test, the Contractor shall explore for the cause of the excessive leakage and after repairs have been made the line shall be retested. This procedure shall be repeated until the pipe complies.

B. Exfiltration Testing

1. Exfiltration tests shall be made by filling a section of pipeline with water and measuring the quantity of leakage.

2. The head of water at the beginning of the test shall be at least two feet above the highest pipe within the section being tested.

   a. Should groundwater be present within the section being tested, the head of water for the test shall be two feet above the hydraulic gradient of the groundwater.

   b. Should the requirement of two feet of water above the highest pipe subject any joint at the lower end of the test section to a differential head of greater than 11.5 feet another method of testing shall be employed.

C. Infiltration Testing

1. Infiltration tests will be allowed only when the water table gauges determine the groundwater level to be two feet or more above the highest pipe of the section being tested.

2. Infiltration test shall be made by measuring the quantity of water leaking into a section of pipeline.

3. Measurement of the infiltration shall be by means of a calibrated weir constructed at the outlet of the section being tested.

D. Allowable Leakage for Non-Pressure Pipelines

The allowable leakage (exfiltration or infiltration) for non-pressure pipelines shall not exceed the following in gallons per 24 hours per inch of diameter per 1000 feet of pipe:

Type of Pipe	Leakage
Ductile iron - mechanical or push-on joints	10
Asbestos-cement "O" ring joints	20
Polyvinyl chloride, thermal plastic or fiberglass with rubber joints	10
Polyvinyl chloride, thermal plastic or fiberglass with solvent-cemented joints	0
Concrete with rubber joints	20
Concrete with steel and rubber joints	10
Corrugated Steel	95
Clay with rubber gasket joints	20
Cast iron soil pipe	
1. drains and vents	0
2. sewer laterals	*
All piping inside structures	0

*The same allowable as pipe to which it is connected.

Regardless of the above allowable leakage any spurting leaks detected shall be permanently stopped.

E. Air Testing

1. For the acceptance of air testing in lieu of hydrostatic testing (exfiltration or infiltration), the Contractor shall perform hydrostatic and air tests on at least three sections of pipeline for each type of pipe being used. The Engineer shall select the sections for the corroborative tests. If these duel tested sections indicate the same results, that is, acceptance under both tests, air testing will be allowed in lieu of hydrostatic testing to meet the project requirements.

2. Air testing for acceptance shall not be performed until the backfilling has been completed.

3. Low pressure air tests shall conform to ASTM C 828 except as specified herein and shall not be limited to type or size of pipe.

4. All sections of pipelines shall be cleaned and flushed prior to testing.

5. The air test shall be based on the average holding pressure of 3 psi gauge, a drop from 3.5 to 2.5 psi, within the period of time allowed for the size of pipe and the length of the test section. The time allowed for the 1 psi drop in pressure, measured in seconds, will be computed by the Engineer and will be based on the limits of ASTM C 828.

   a. When groundwater is present the average test pressure of 3 psig shall be above any back pressure due to the groundwater level.

   b. The maximum pressure allowed under any condition in air testing shall be 10 psig. The maximum groundwater level for air testing is 13 feet above the top of the pipe.

6. The equipment required for air testing shall be furnished by the Contractor and shall include the necessary compressor, valves and gauges to allow for the monitoring of the pressure, release of pressure and a separable test gauge.

   a. The test gauge shall be sized to allow for the measuring of the one psig loss allowed during the test period and shall be on a separate line to the test section.

MP-71.05 MANHOLE TESTING

A. General

1. Each manhole shall be tested by either exfiltration or infiltration.

2. A manhole will be acceptable if the leakage does not exceed an allowable of one gallon per vertical foot of depth for 24 hours. Regardless of the allowable leakage any leaks detected shall be permanently stopped.

B. Exfiltration test may be performed prior to or after backfilling. The test shall be made by filling the manhole with water and observing the level for a minimum of eight hours.

C. Infiltration tests shall be performed when the groundwater level is above the joint of the top section of a precast manhole.

MP-71.06 AIR, OIL AND GAS PIPING

A. All pipelines for air, oil and gas shall be cleaned and tested with air at the pressure specified and no leakage will be allowed. After these tests are complete, fuel gas lines shall be flushed out with nitrogen or carbon dioxide before fuel gas is admitted.

MP-71.07 CHLORINE GAS PIPING

A. All pipelines for chlorine gas shall be initially tested with nitrogen gas with no leakage allowed. After the pipelines have been charged with chlorine gas all joints shall be checked for leakage using ammonia water.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 95

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE FOR BURIED PIPELINES 4-INCH AND LARGER

MP-95.01 GENERAL

A. Work Specified
   1. Polyvinyl chloride pipe of the classification, and size and with fittings and joints as specified in the pipe schedule and shown on the Contract Drawings.

B. Related Work Specified Elsewhere
   1. Trenching, Backfilling and Compacting
   2. Pipeline Installation
   3. Leakage Tests
   4. Chlorination

C. Applicable Codes, Standards and Specifications
   1. American National Standards Institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. American Water Works Association (AWWA)
   4. National Sanitation Foundation (NSF)

MP-95.02 MATERIALS

A. General
   1. Polyvinyl chloride pipe shall be made from Class 12454-B materials or better in accordance with ANSI/ASTM D 1784.
   2. Polyvinyl chloride pipe and accessories shall conform to the requirements of:
      a. Water mains — AWWA C900
      b. Pressure rated — ANSI/ASTM D2241
   3. Polyvinyl chloride pipe and accessories to be used for potable-water shall be certified as suitable by the NSF or other approved testing agency and shall be marked with the seal of the agency.

B. Fittings and Couplings
   1. Ductile-iron fittings shall conform to the requirements of ANSI/AWWA C110.
   2. Polyvinyl chloride fittings and couplings shall conform to the requirements of the PVC pipe for classification and size.

C. Joints
   1. Joints for pipe and fitting shall be of the type shown in the pipe schedule and on the Contract Drawings and in accordance with the standard for the type of material.
      a. Ductile iron fittings shall be push-on or mechanical.
      b. Polyvinyl chloride pipe and fittings shall be elastomeric or solvent-cemented.

1) Rubber gaskets for elastomeric joints shall conform to ANSI/ASTM F477.
   a) The rubber gasket shall be factory installed in the pipe, fittings and couplings.

2. The plain end of the pipe shall be marked by the manufacturer to show the depth of penetration into the bell or coupling.

MP-95.03 SUBMITTALS

A. Drawings and manufacturers data of the pipe, joints and fittings showing compliance with this specification.

B. Submit five (5) copies of manufacturer's affidavit that all delivered materials comply with the requirements of the specified Standards.

MP-95.04 INSTALLATION

A. Polyvinyl chloride pipe shall be installed in accordance with the applicable provisions of the Sections entitled "Trenching, Backfilling and Compacting" and "Pipeline Installation".

B. Polyvinyl chloride pipe shall be handled and stored in accordance with the manufacturer's recommendations.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 151

SUBMERSIBLE SUMP PUMPS

MP-151.01 GENERAL

A. Work Specified
   1. Single or duplex centrifugal type submersible sump pumps located as shown on Contract Drawings.

B. Related Work Specified Elsewhere
   1. Miscellaneous Electric Motors

C. Pumps shall be manufactred by:
   1. Enpo-Cornell
   2. Hydro-O-Matic
   3. Deming
   4. Or equal.

MP-151.02 CONSTRUCTION

A. Pumps
   1. Capacity and head as scheduled or shown on Contract Drawings
   2. Semi-open impellers
   3. Perforated strainers on suction

B. Motors
   1. Permanently sealed and rigidly coupled to the pump
   2. Grease-sealed lifetime lubricated bearings
   3. 115 volts, 60 cycle, single phase with capacitor start
   4. Integral overload protection with automatic restart
   5. Water-resistant extension cord
   6. Other requirements as required under the Section entitled "Miscellaneous Electric Motors".

C. Appurtenances

   1. Start and stop by floatable motor case, pressure switch or floats activated by change in water level.
   2. Duplex assembly shall have automatic alternator.
      a. Back-up pump to start on lead pump failure or on rising water level.

MP-151.03 SUBMITTALS

A. Shop Drawings
   1. Submit detail drawings showing compliance with these specifications including materials of construction and parts list.

B. Operation and Maintenance Manuals
   1. Furnish three sets of the manuals as required by the General Provisions.

MP-151.04 INSTALLATION

A. Installed as shown on Contract Drawings
   1. 12-inch flexible rubber hose at pump discharge connection.
   2. Two check valves shall be installed in the discharge piping near pump and approximately two feet apart.

B. Testing
   1. After installation each sump pump shall be cycled a minimum of five times.
      a. Water shall be discharged at rate scheduled.
      b. Pump and motor shall show no strain or vibrations.

* * *

MATERIALS AND PERFORMANCE - SECTION 250

PLACEMENT OF CONTAMINATED MATERIALS

MP-250.01 GENERAL

A. Work Specified

1. Work to be performed under this section shall consist of all labor, materials, supplies and equipment necessary for the hauling, handling and placement of contaminated materials into the temporary containment structure.

MP-250.02 INSTALLATION

A. Handling and Hauling

1. Any stockpiling of contaminated materials prior to placement into the landfill cell shall be as approved by the Engineer.

2. At all times when being stockpiled, contaminated materials shall be protected from erosion due to stormwater or wind. Any water which comes into contact with contaminated materials shall be contained, collected and treated in the on-site treatment system.

3. Hauling of contaminated materials from the point of excavation to the landfill area shall be conducted only on the temporary haul roads constructed as shown or specified. During hauling operations, extreme care shall be taken and all necessary measure employed to ensure that no material is lost from the haul vehicles.

B. Placement Into Landfill Cell

1. All materials placed into the landfill cell shall be dry, as defined by the absence of free liquids.

2. No contaminated materials shall be placed into the landfill cell until the berms, liners, drainage layers and leachate collection and holding systems have been placed into operation.

3. Contaminated materials shall be placed into the landfill cell in maximum two (2) foot lifts.

4. After placement into the landfill cell, measures shall be taken to minimize the amount of rainfall which is allowed to come into contact with the contaminated materials. Water which does contact the contaminated materials shall be collected and treated in the on-site treatment system.

5. Prior to demobilization at the end of each work day, the contaminated material shall be graded to promote positive drainage to the sump.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 255

FLEXIBLE MEMBRANE LINER (FML)

MP-255.01 GENERAL

A. Work Specified

1. The work to be performed under this section shall consist of all labor, materials, supplies, and equipment necessary to furnish and install the flexible membrane liners as specified herein and as shown on the Contract Drawings.

B. Acceptable Manufacturers

1. Gundle Lining Systems, Inc.
2. Or Approved Equal

MP-255.02 SUBMITTALS

A. In order to qualify as an approved synthetic liner, the Contractor shall submit lining material samples and a minimum specification sheet to the Engineer for approval prior to construction. The specification sheet shall give full details of minimum physical properties and test methods used, site seaming methods, and a manufacturer's certificate confirming compliance of the material with the minimum specifications. A list of similar projects completed in which the manufactured material has been successfully used shall be submitted to the Owner.

B. The Contractor shall also submit a list of liner installers approved and/or licensed by the liner manufacturer, who have been trained and who are qualified to install the manufacturer's material.

C. The manufacturer shall provide the Contractor with complete written instructions for the storage, handling, installation, and seaming of the liner in compliance with this specification and the condition of his warranty. Contractor shall forward a copy of this information to the Engineer.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer results of quality control testing identified in Section 1.03 of this specification. This shall be submitted prior to installation.

E. Contractor's certification that liner bedding is satisfactory (see Part 3).

F. Prior to construction, the Contractor shall furnish the Owner with panel layout drawings as required for the liner installation. The panel layout shall be designed by the manufacturer

and seams of the liner laid on the slopes shall be perpendicular to the landfill bottom. Field seam lengths shall be minimized.

MP-255.03 QUALITY CONTROL

A. Manufacturer's Experience

1. The manufacturer of the lining material described herein shall have previously demonstrated his ability to produce this membrane by having successfully manufactured a minimum of ten million square feet of similar liner material for hydraulic lining installations.

B. Raw Material

1. All compound ingredients of the liner materials shall be randomly sampled on delivery to the manufacturing plant to ensure compliance with specifications. Tests to be carried out shall include Density, ASTM D1505.68; and Melt Index, ASTM D1238-79 Procedure A, Conditions E & P.

C. Manufactured Roll Goods

1. Samples of the production run shall be obtained and tested in accordance with the following performance standards for the 30 mil flexible membrane liner.

Parameter	Performance Standard	Performance Validation
1. Thickness	30 mil (-10% max.) (ASTM D1593)	Measurement, two samples from each day's production.
2. Tensile Strength	70 lb/in. width at yield (ASTM D638)	Tensile test, two samples from each day's production.
3. Puncture Resistance	40 lbs. (FTMS 101B) Method 2065	Test, one sample per roll.
4. Tear Resistance	22 lbs. (ASTM D1004 C)	Test, one sample per roll.
5. Carbon Black Content	2% min, 3% max	One test per roll car or 45,000 lb.

2. Samples of the production run shall be obtained and tested in accordance with the following performance standards for the 60 mil flexible membrane liner:

Parameter	Performance Standard	Performance Validation
1. Thickness	60 mil (-10% max.) (ASTM D1593)	Measurement, two samples from each day's production.
2. Tensile Strength	140 lb/in. width at yield (ASTM D638)	Tensile test, two samples from each day's production.
3. Puncture Resistance	80 lbs. (FTMS 101B) Method 2065	Test, one sample per roll.
4. Tear Resistance	45 lbs. (ASTM D1004 C)	Test, one sample per roll.
5. Carbon Black Content	2% min, 3% max	One test per roll car or 45,000 lb.

D. All welding material shall be of a type recommended and supplied by the manufacturer and shall be delivered in the original sealed containers - each with an indelible label bearing the brand name, manufacturer's mark number, and complete directions as to proper storage.

E. The installer shall employ on-site physical non-destructive testing on all welds to ensure watertight homogeneous seams. All welded seams shall be tested over their entire length by vacuum box or ultrasonic methods. All test results shall be submitted to the Owner.

F. Should visual inspection of the liner reveal irregular blemishes or suspect areas of undispersed carbon black, a thermal Gravimetric Analysis will be performed at the Contractor's expense to ensure the 2 percent minimum and 3 percent maximum carbon black content is met. Should requirements not be met, the Contractor will be liable for replacement.

G. A factory-trained quality-control technician shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with the manufacturer's repair procedures.

H. A test weld three (3) feet long from each welding machine shall be run each day prior to liner welding and under the same conditions as exist for the liner welding. The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of weld approximately 3/8" wide shall be cut from the test weld and tested in shear and peel. Seams shall be stronger than the material. The weld sample shall be kept for subsequent testing on laboratory tensometer equipment in accordance with the applicable ASTM standards. Random weld samples may be removed from the installed welded sheeting at a frequency of one sample per 500 feet of weld.

I. The welder(s) of the HDPE liner material shall have previous experience with the material and shall demonstrate evidence of training under the manufacturer of the liner material.

J. The Owner, or his designated representative, reserves the right of access for inspection of any or all phases of this installation.

MP-255.04 MATERIALS

A. Flexible Membrane Liner

1. Liner material shall be ultra high molecular weight High Density Polyethylene (HDPE). The nominal thickness of the liner shall be 30 or 60 mils as specified.

2. The lining material shall be manufactured a minimum 22.0-foot seamless width. Labels on the roll shall identify the thickness, length, width, and manufacturer's mark number.

3. The 30 mil flexible membrane liner material shall meet or exceed the following material performance requirements.

Property	Test Method	Result
Density	ASTM D1505	0.94 g/cc
Tensile @ Break	ASTM D638 Type IV dumb-bell at 2 ipm	120 lb/in width
Tensile @ Yield	" " "	70 lb/in width
Elongation @ Break	" " "	700%
Elongation @ Yield	" " "	13%
Modulus of Elasticity	ASTM D882	110,000 psi
Tear Resistance	ASTM D1004 Die C.	22 lb. (min)
Puncture Resistance	FTMS 101B Method 2065	40 lb. (min)
Hydrostatic Resistance	ASTM D751 Method A Procedure 1	240 psi
Carbon Black Content	ASTM D1603	2% min, 3% max

4. The 60 mil flexible membrane liner material shall meet or exceed the following material performance requirements:

Property	Test Method	Result
Density	ASTM D1505	0.94 g/cc
Tensile @ Break	ASTM D638 Type IV dumb-bell at 2 ipm	240 lb/in width
Tensile @ Yield	" " "	140 lb/in width
Elongation @ Break	" " "	700%
Elongation @ Yield	" " "	13%
Modulus of Elasticity	ASTM D882	110,000 psi
Tear Resistance	ASTM D1004 Die C.	45 lb. (min)
Puncture Resistance	FTMS 101B Method 2065	80 lb. (min)
Hydrostatic Resistance	ASTM D751 Method A Procedure 1	490 psi
Carbon Black Content	ASTM D1603	2% min, 3% max

MP-255.05 INSTALLATION

A. Area Subgrade Preparation

1. Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or breaks in grade. No standing water or excessive moisture shall be allowed. The Contractor shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

B. Contractor Approval

1. The installation contractor shall have met the manufacturer's minimum requirements to become a licensed or approved installer of the manufacturer's product using the manufacturer's state-of-the-art equipment and welding methods. The manufacturer shall certify that the installer is approved or licensed.

C. Field Seams

1. Individual panels of liner material shall be laid out and overlapped by a minimum of 3 inches for extrusion welding, 4 inches for hot wedge seaming prior to welding. Extreme care shall be taken by the installer in the prepa-

ration of the areas to be welded. The area to be welded shall be cleaned and prepared according to the procedures identified by the material manufacturer. All sheeting shall be joined together using a homogeneous overlap extrusion fusion or hot wedge welding process. The composition of the extrudate shall be identical to the lining material.

D. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures and pressures in the zone of contact where the machine is actually fusing the lining material, to ensure that changes in environmental conditions will not affect the integrity of the weld. Only welding systems which utilize the extrusion fusion or hot wedge welding process shall be used for bonding these lining materials.

E. No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap fusion weld or hot wedge weld shall be applied. All welds on completion of the work shall be tightly bonded. Any membrane areas showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional section of liner material.

F. Seam defects detected by vacuum box testing shall be corrected by the Contractor.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 260

FLEXIBLE MEMBRANE COVER (FMC)

MP-260.01 GENERAL

A. Work Specified

1. The work to be performed under this section shall consist of all labor, materials, supplies, and equipment necessary to furnish and install the flexible membrane cover as specified herein and as shown on the Contract Drawings.

B. Acceptable Manufacturers

1. Gundle Lining Systems, Inc.

2. Or Approved Equal

MP-260.02 SUBMITTALS

A. In order to qualify as an approved flexible membrane cover, the Contractor shall submit lining material samples and a minimum specification sheet to the Engineer for approval prior to construction. The specification sheet shall give full details of minimum physical properties and test methods used, site seaming methods, and a manufacturer's certificate confirming compliance of the material with the minimum specifications. A list of similar projects completed in which the manufactured material has been successfully used shall be submitted to the Owner.

B. The Contractor shall also submit a list of liner installers approved and/or licensed by the liner manufacturer, who have been trained and who are qualified to install the manufacturer's material.

C. The manufacturer shall provide the Contractor with complete written instructions for the storage, handling, installation, and seaming of the cover in compliance with this specification and the condition of his warranty. Contractor shall forward a copy of this information to the Engineer.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer results of quality control testing identified in Section 1.03 of this specification. This shall be submitted prior to installation.

E. Contractor's certification that liner bedding is satisfactory (see Part 3).

F. Prior to construction, the Contractor shall furnish the Owner with panel layout drawings as required for the liner installation. The panel layout shall be designed by the manufacturer and seams of the liner laid on the slopes shall be perpendicular to the landfill bottom. Field seam lengths shall be minimized.

MP-260.03 QUALITY CONTROL

A. Manufacturer's Experience

1. The manufacturer of the lining material described herein shall have previously demonstrated his ability to produce this membrane by having successfully manufactured a minimum of ten million square feet of similar liner material for hydraulic lining installations.

B. Raw Material

1. All compound ingredients of the liner materials shall be randomly sampled on delivery to the manufacturing plant to ensure compliance with specifications. Tests to be carried out shall include Density, ASTM D1505.68; and Melt Index, ASTM D1238-79 Procedure A, Conditions E & P.

C. Manufactured Roll Goods

1. Samples of the production run shall be obtained and tested in accordance with the following performance standards:

Parameter	Performance Standard	Performance Validation
1. Thickness	20 mil (-10% max.) (ASTM D1593)	Measurement, two samples from each day's production.
2. Tensile Strength	50 lb/in. width at yield (ASTM D638)	Tensile test, two samples from each day's production.
3. Puncture Resistance	26 lbs. (FTMS 101B) Method 2065	Test, one sample per roll.
4. Tear Resistance	15 lbs. (ASTM D1004 C)	Test, one sample per roll.
5. Carbon Black Content	2% min, 3% max	One test per roll car or 45,000 lb.

D. All welding material shall be of a type recommended and supplied by the manufacturer and shall be delivered in the original sealed containers - each with an indelible label bearing the brand name, manufacturer's mark number, and complete directions as to proper storage.

E. The installer shall employ on-site physical non-destructive testing on all welds to ensure watertight homogeneous seams. All welded seams shall be tested over their entire length by vacuum box or ultrasonic methods. All test results shall be submitted to the Owner.

F. Should visual inspection of the liner reveal irregular blemishes or suspect areas of undispersed carbon black, a thermal Gravimetric Analysis will be performed at the Contractor's expense to ensure the 2 percent minimum and 3 percent maximum carbon black content is met. Should requirements not be met, the Contractor will be liable for replacement.

G. A factory-trained quality-control technician shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with the manufacturer's repair procedures.

H. A test weld three (3) feet long from each welding machine shall be run each day prior to liner welding and under the same conditions as exist for the liner welding. The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of weld approximately 3/8" wide shall be cut from the test weld and tested in shear and peel. Seams shall be stronger than the material. The weld sample shall be kept for subsequent testing on laboratory tensometer equipment in accordance with the applicable ASTM standards. Random weld samples may be removed from the installed welded sheeting at a frequency of one sample per 500 feet of weld.

I. The welder(s) of the HDPE liner material shall have previous experience with the material and shall demonstrate evidence of training under the manufacturer of the liner material.

J. The Owner, or his designated representative, reserves the right of access for inspection of any or all phases of this installation.

MP-260.04 MATERIALS

A. Flexible Membrane Cover

1. Liner material shall be ultra high molecular weight High Density Polyethylene (HDPE). The minimum nominal thickness of the liner shall be 20 mils.

2. The lining material shall be manufactured a minimum 22.0-foot seamless width. Labels on the roll shall identify the thickness, length, width, and manufacturer's mark number.

3. The liner material shall meet or exceed the following material performance requirements:

Property	Test Method	Result
Density	ASTM D1505	0.94 g/cc
Tensile @ Break	ASTM D638 Type IV dumb-bell at 2 ipm	80 lb/in width
Tensile @ Yield	" " "	50 lb/in width
Elongation @ Break	" " "	700%
Elongation @ Yield	" " "	13%
Modulus of Elasticity	ASTM D882	110,000 psi
Tear Resistance	ASTM D1004 Die C.	15 lb. (min)
Puncture Resistance	FTMS 101B Method 2065	26 lb. (min)
Hydrostatic Resistance	ASTM D751 Method A Procedure 1	160 psi
Carbon Black Content	ASTM D1603	2% min, 3% max

MP-260.05 INSTALLATION

A. Area Subgrade Preparation

1. Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or breaks in grade. No standing water or excessive moisture shall be allowed. The Contractor shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

B. Contractor Approval

1. The installation contractor shall have met the manufacturer's minimum requirements to become a licensed or approved installer of the manufacturer's product using the manufacturer's state-of-the-art equipment and welding methods. The manufacturer shall certify that the installer is approved or licensed.

C. Field Seams

1. Individual panels of liner material shall be laid out and overlapped by a minimum of 3 inches for extrusion welding, 4 inches for hot wedge seaming prior to welding.

Extreme care shall be taken by the installer in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according to the procedures identified by the material manufacturer. All sheeting shall be joined together using a homogeneous overlap extrusion fusion or hot wedge welding process. The composition of the extrudate shall be identical to the lining material.

D. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures and pressures in the zone of contact where the machine is actually fusing the lining material, to ensure that changes in environmental conditions will not affect the integrity of the weld. Only welding systems which utilize the extrusion fusion or hot wedge welding process shall be used for bonding these lining materials.

E. No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap fusion weld or hot wedge weld shall be applied. All welds on completion of the work shall be tightly bonded. Any membrane areas showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional section of liner material.

F. Seam defects detected by vacuum box testing shall be corrected by the Contractor.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 265

FML BEDDING LAYER

MP-265.01 GENERAL

A. Work Specified

1. The scope covered in these specifications covers the testing and installation of the FML bedding layer.

B. Testing

1. All soil testing services as specified herein necessary for the Contractor to obtain an approved material for the FML bedding layer shall be provided by the Contractor. All testing including laboratory and field services required during construction of the FML bedding layer shall be provided by the Contractor.

MP-265.02 MATERIALS

A. FML Bedding Layer

1. Material used as FML bedding layer material shall be obtained from a source approved by the Contracting Officer.

2. The FML bedding layer material shall be uniform in composition and texture, clean and free from stones, weeds, stumps, roots, toxic substances, and debris or similar substances.

3. The Contractor shall submit testing methods (prior to conducting tests), test results, and a certification from the approved soils testing laboratory that the FML bedding layer material meets the requirements of this Section. The results of all testing specified herein shall be submitted to the Engineer for approval.

4. The FML bedding layer material shall meet the following requirements in accordance with ASTM D422-63:

Sieve Size	Percent Passing by Weight
4	90-100
10	70-95
20	50-80
40	20-65
100	10-40
200	0-5

5. If at any time during the Contract the Engineer requests further soils testing to insure that the characteristics of the FML bedding layer material obtained from the borrow area(s) have not changed, the Contractor shall perform these tests at no additional cost to the Government.

MP-265.03 SUBMITTALS

A. Source of borrow material for FML bedding layer layer material.

B. Location of spoil area(s).

C. Location of samples collected within borrow areas for laboratory testing.

D. Proposed soils testing laboratory.

E. Laboratory testing methods to be used.

F. Results of laboratory testing.

G. Laboratory certification of FML bedding layer material.

MP-265.04 INSTALLATION

A. Placement of the FML bedding layer material shall be in accordance with the provisions of this Section. Any FML bedding layer material which cannot comply with the provisions of this section will be considered as spoil and will be removed and disposed of at the Contractor's expense.

B. The FML bedding layer material shall be constructed by placing suitable material in minimum 6-inch lifts. Compaction of the lifts shall be accomplished by a minimum of 6 passes of a 3.5 ton double vibratory roller.

C. In areas adjacent to the concrete sumps, the FML bedding layer material shall be compacted as approved by the Contracting Officer with a manually operated vibrating tamper or other method approved by the Contracting Officer.

D. Compaction or consolidation achieved by traveling trucks, machines, and other equipment will not be accepted unless such procedures are approved by the Engineer and proper compaction criteria are achieved.

E. Any damage to the completed surface of the FML bedding layer, whether caused by erosion, the Contractor's work or any other occurrences, shall be immediately repaired and maintained in good condition until completion of the work.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 270

DRAINAGE NET

MP-270.01 GENERAL

A. Work Specified

1. The work to be performed under this section shall consist of all labor, materials, supplies, and equipment necessary to furnish and install the drainage net layers as specified herein and as shown on the Contract Drawings.

B. Applicable Codes, Standards and Specifications

1. American Society for Testing and Materials (ASTM).

2. Federal Register, Vol. 52, No. 103, Friday, May 29, 1987.

C. Acceptable Manufacturers

1. Tensar (NS 1400)

2. or Approved Equal

MP-270.02 SUBMITTALS

A. Manufacturer's technical data, including test data to demonstrate transmissivity at the specified gradient.

B. Manufacturer's installation requirements

C. Samples

D. Certifications

E. Test Reports

MP-270.03 MATERIALS

A. Drainage Net

1. Drainage net shall consist of an integrally formed polyethylene net structure. It shall have uniform channels, open area and thickness to assure uniform flow throughout the structure. It shall have high tensile strength and tear strength to resist installation damage and loading on steep slopes. It shall also have a low compressibility under high loadings to maintain a high transmissivity under a range of loading conditions. The drainage net shall also be resistant to ultraviolet degradation. The transmissivity of the drainage net must be a minimum of 5×10^{-4} m2/sec at a gradient of 0.02.

2. The drainage net shall exhibit the following properties, at a minimum:

Property	ASTM Method	Unit	Values
Polymer Specific Gravity	D1505	-	0.92
Polymer Melt Index	D1238	g/10 min	0.2
Carbon Black Content	D4218	%	2.2
Nominal Thickness	(1)	mm	5±1
Aperture Size	-	mm	7±1
Mass Per Unit Area	(1)	g/m^2(oz/sq yd)	640(19)
Transmissivity (2)	-	m^2/s(gpm/ft)	$5x10^{-4}$(2.5)
Nominal Conductivity (3)	-	m/s(cm/s)	minimum
Compressive Stress Limit (4)	-	kPa(psf)	750(15,000)
Tensile Strength MD (5)	(1)	kN/m(1b/in)	4(23)

Notes: (1) Use tentative methods being prepared by ASTM Committee D35 on Geotextiles and Related Products

(2) The transmissivity is the transmissivity of a net measured using water at 20°C (68°F) with a gradient of 0.02, under a compressive stress of 4,000 psf, using the following test set-up:

- upper load plate
- FML bedding layer
- HDPE liner
- geonet
- HDPE liner
- lower load plate

(3) The nominal conductivity is obtained by dividing the transmissivity by the nominal thickness.

(4) Value of the compressive stress at which the hydraulic transmissivity is 25% of the transmissivity.

(5) MD = Machine Direction

MP-270.04 INSTALLATION

A. Contractor shall take care to clear subgrade of sharp objects, stumps and debris, and ensure that grades are properly established prior to placement of drainage net.

B. Drainage net shall be unrolled on the subgrade and installed and anchored in accordance with the manufacturer's written instructions.

C. Adjacent rolls of drainage net shall be overlapped approximately 2-4 inches and secured by plastic ties approximately every five feet along the roll length. Plastic ties shall be white or other bright color for easy inspection. Metallic ties shall not be allowed.

D. The Owner's representative will perform the following activities:

1. Observations to document that the drainage nets are placed in accordance with the design plans and specifications, and the manufacturer's instructions;

2. Measurements to show that there are no gaps between adjacent panels of material; and

3. Observations to ascertain that the drainage nets are not damaged during the installation process.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 275

GRANULAR DRAINAGE MATERIAL

MP-275.01 GENERAL

A. Work Specified

1. Excavation, backfilling, and compacting including the loosening, removing, working, transporting, storage, fill, and disposal of all materials necessary for construction of the drainage layer, as shown or specified or as directed by the Engineer.

B. Testing

1. All soil testing services as specified herein necessary for the Contractor to obtain an approved drainage layer material shall be provided by the Contractor. All testing including laboratory and field services required during construction of the drainage layer shall be provided by the Contractor.

C. Applicable Codes, Standards, and Specifications

1. American Society for Testing and Materials (ASTM). The publications listed below form a part of the specification to the extent referred to in the text by basis designation only.

ASTM D422-63	Method for Particle Size Analysis of Soil
ASTM D698-78	Moisture-Density Relations of Soil-Aggregate Mixtures Using 5-lb Rammer and 12-in. Drop
ASTM D2434-68	Test Method for Permeability of Granular Soils (Constant Head)

MP-275.02 MATERIALS

A. Drainage Layer Materials

1. Drainage layer material shall be obtained from a source approved by the Engineer and processed to meet the grain size specified.

2. The drainage layer material shall be characterized as a granular material with a minimum permeability of 1x10-2 cm/sec as determined by laboratory testing performed in accordance with ASTM D2434-68. The drainage layer material shall have 100 percent passing the 3/4 inch sieve by weight and less than 5 percent passing the 3/8 inch sieve based on analyses performed in accordance with ASTM D422-63.

3. The drainage layer material must be uniform in composition and texture, clean and free from stones, weeds, stumps, roots, toxic substances, and debris or similar substances.

4. The Contractor shall submit testing methods (prior to conducting tests), test results, and a certification from the approved soils testing laboratory that the drainage layer material meets the requirements of this section. The results of all soils testing specified herein shall be submitted to the Engineer for approval.

5. During installation of the drainage layer, material from the source shall be tested in accordance with the following standards and frequencies:

Parameter	Standard	Minimum Frequency	Criteria
Particle-Size Analysis	ASTM D422-63	Once per 1,000 cy	100% passing the 3/4 inch sieve and less than 5% passing the 3/8 inch sieve.
Permeability	ASTM D2434-68	Once per 1,000 cy	Minimum permeability of $1x10^{-2}$ cm/sec

6. The results of all testing shall be submitted to the Engineer for approval. Any materials not meeting the requirements of this section shall be considered as spoil.

7. Following installation of each lift of the drainage layer, each lift of the drainage layer shall be tested in accordance with the following standards and frequencies.

Parameter	Standard	Minimum Frequency	Criteria
In-Place Density	ASTM D2922-81	3 tests per acre per lift of soil placed	85% of maximum dry density attained by ASTM D698-78 Method D

8. If at any time during this Contract the Engineer requests further soils testing to insure that the characteristics of the drainage layer material obtained from the borrow area(s) have not changed, the Contractor shall perform these tests at no additional cost to the Owner.

MP-275.03 SUBMITTALS

A. Source of borrow materials for drainage layer.

B. Proposed soil testing laboratory.

C. Laboratory testing methods to be used.

D. Results of laboratory testing methods.

E. Laboratory certification of drainage layer material.

MP-275.04 INSTALLATION

A. Drainage Layer Material

1. Placement of the drainage layer material shall be in accordance with the provisions of this Section. Any drainage layer material which cannot comply with the provisions of this Section will be considered as spoil and will be removed and disposed of at the Contractor's expense.

2. The drainage layer material shall be constructed by placing suitable material in minimum 12-inch loose lifts. The drainage layer shall be spread by dozer. The Contractor shall minimize travel of the dozer over the work area to the greatest extent possible to achieve the lines and grades specified. Compaction of the lifts shall be accomplished by a smooth wheel roller, without vibration. Compaction of the drainage layer shall be 85 percent of the Standard Proctor Compaction as determined by ASTM D698-78.

3. Compaction or consolidation achieved by traveling trucks, machines, and other equipment will not be accepted unless such procedures are approved by the Engineer and proper compaction criteria are achieved.

4. Any damage to the completed surface of the drainage layer, whether caused by erosion, the Contractor's work, or any other occurrences, shall be immediately repaired and maintained in good condition until completion of the work.

5. Any damage to pipe or HDPE membrane liner occurring during installation of the drainage layer shall be replaced at no additional cost to the Owner.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 280

GEOTEXTILE FILTER

MP-280.01 GENERAL

A. Work Specified

1. Furnishing of all plant, labor, material, and equipment and performing all operations required for furnishing, hauling, and placing geotextile filter, complete as specified herein and as shown on the drawings or specified by the Engineer.

B. Testing

1. All geotextile testing services as specified herein necessary for the Contractor to obtain an approved geotextile filter material shall be provided by the Contractor. All testing including laboratory and field services required during installation of the geotextile shall be provided by the Contractor.

C. Acceptable Manufacturers

1. Polyfelt TS800

2. Or Approved Equal

MP-280.02 SUBMITTALS

A. Manufacturer's certification of the geotextile indicating that the geotextile meets the chemical, physical, and manufacturing requirements stated in this Section.

MP-280.03 MATERIALS

A. Geotextile Filter

1. The geotextile filter shall consist of a long-chain geosynthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, amids, or vinylidene-chloride, and shall contain stabilizers and/or inhibitors added to the base plastic if necessary to make the filaments resistant to deterioration due to ultra-violet and heat exposure.

2. The geotextile shall be a non-woven pervious sheet of plastic yarn and shall provide a minimum Apparent Opening Size (AOS) of 0.150 mm.

3. The geotextile shall have a minimum mass of 12 oz/yd^2 as determined by ASTM D 3776-84.

4. The geotextile shall conform to the following physical strength requirements:

Property	Standard	Criteria
Geotextile Permittivity	ASTM D 4491-85	Minimum permittivity of 1.2 sec^{-1}
Mass per Unit Area	ASTM D 3776-85	Minimum 12 oz/yd^2
Grab Tensile Strength	ASTM D 4632-86	300 lbs.
Grab Tensile Elongation	ASTM D 4632-86	60%
Trapezoid Tear	ASTM D 4533-85	105 lbs.
Puncture Strength	ASTM D 3786-87	130 lbs.
Burst Strength	ASTM D 3787-80	400 psi

5. During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet light, temperatures greater than 140°F, mud, dirt, dust, and debris. To the extent possible, the geotextile shall be maintained wrapped in a heavy duty protective covering.

B. Temporary Pins

1. Temporary securing pins shall be 3/16 inches in diameter, of steel, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of no less than 1.5 inches.

MP-280.04 INSTALLATION

A. Geotextile Filter

1. Prior to installation of the geotextile filter fabric, the material on which the filter fabric is to be installed will be free of organic matter, irregularities, protrusions, and any abrupt changes in grade that could damage the filter fabric. The supporting layer will be maintained in a smooth, uniform, and compacted condition during installation of the filter fabric.

2. The geotextile shall be placed in manner and at the locations shown on the drawings. At the time of the installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage.

3. The geotextile shall be placed with the long dimension parallel to the line of maximum slope and shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips shall be placed to provide minimum overlaps of 18 inches.

4. Temporary pinning of the geotextile to help hold it in place shall be allowed. The temporary pins shall be removed as the soil layers is placed to relieve high tensile stress which may occur during placement of material on the geotextile. Additional pins regardless of location shall be installed as necessary to prevent any slippage of the geotextile. The geotextile shall be placed so that the upper strip of geotextile will overlap the next lower strip. Each securing pin shall be pushed through the geotextile until the washer bears against the geotextile and secures it firmly to the foundation.

5. The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during its installation or during placement of soil layers shall be replaced by the Contractor at the Contractor's expense.

6. The work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 5 days after placement of the geotextile. Failure to comply shall require replacement of geotextile.

7. The geotextile shall be protected from damage due to the placement of materials by limiting the height of drop of the material to less than 1 foot.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 285

GEOTEXTILE STABILIZATION FABRIC

MP-285.01 GENERAL

A. Work Specified

1. The scope covered in these specifications covers the Furnishing of all plant, labor, material, and equipment and performing all operations required for furnishing, hauling, and placing the geotextile stabilization fabric, complete as specified herein and shown on the Contract Drawings.

B. Testing

1. All geotextile testing services as specified herein necessary for the Contractor to obtain an approved geotextile stabilization material shall be provided by the Contractor. All testing including laboratory and field services required during installation of the geotextile shall be provided by the Contractor.

C. Acceptable Manufacturers

1. Mirafi 500X

2. Or Approved Equal

MP-285.02 SUBMITTALS

A. Manufacturer's certification of the geotextile indicating that the geotextile meets the chemical, physical, and manufacturing requirements stated in this Section.

MP-285.03 MATERIALS

A. Geotextile Stabilization Fabric

1. The geotextile filter fabric shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, amids, or vinylidene-chloride, and shall contain stabilizers and/or inhibitors added to the base plastic if necessary to make the filaments resistant to deterioration due to ultra-violet and heat exposure.

2. The geotextile shall be a woven pervious sheet of plastic yarn as defined by ASTM D123. The geotextile shall provide an Apparent Opening Size (AOS) no finer than the U.S. Standard Sieve No. 100 and no coarser than the U.S. Standard Sieve No. 20.

3. The geotextile shall have a minimum mass of 4 oz/yd^2 as determined by ASTM D3766-85.

4. The geotextile shall conform to the following physical strength requirements:

Property	Standard	Criteria
Apparent Opening Size	ASTM D4751-87	Apparent Opening Size (AOS) no finer than the U.S. Standard Sieve No. 100 and no coarser than the U.S. Standard Sieve No. 20
Mass Per Unit Area	ASTM D3776-85	Minimum 4 oz/yd^2
Grab Tensile Strength	ASTM D4632-86	200 lbs
Grab Tensile Elongation	ASTM D4632-86	20%
Trapezoid Tear Strength	ASTM D4533-85	115 lbs
Puncture Strength	ASTM D3786-87	75 lbs
Burst Strength	ASTM D3787-80	400 psi

5. The geotextile should be fixed so that the yarns will retain their relative position with respect to each other. The edges of the geotextile shall be finished to prevent the outer yarn from pulling away from the geotextile.

6. The geotextile shall be manufactured in widths not less than 12.5 feet.

B. Temporary Pins

1. Temporary securing pins shall be 3/16 inch in diameter, of steel, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of no less than 1.5 inches.

MP-285.04 INSTALLATION

A. Geotextile Stabilization Fabric

1. Prior to installation of the geotextile stabilization fabric, the material on which the stabilization fabric is to be installed will be free of organic matter, irregularities protrusions, and any abrupt changes in grade that could damage the stabilization fabric. The supporting layer will

be maintained in a smooth, uniform, and compacted condition during installation of the stabilization fabric.

2. The geotextile shall be placed in the manner and at the locations shown on the drawings. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacturer, transportation or storage.

3. The geotextile shall be placed with the long dimension parallel to the centerline of the road and shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips shall be placed to provide a minimum width of 12 inches of overlap for each joint.

4. Temporary pinning of the geotextile to help hold it in place until the access road is placed shall be allowed. The temporary pins shall be removed as the soil layers is placed to relieve high tensile stress which may occur during placement of material on the geotextile.

   Additional pins regardless of location shall be installed as necessary to prevent any slippage of the geotextile. The geotextile shall be places so that the upper strip of geotextile will overlap the next lower strip. Each securing pin shall be pushed through the geotextile until the washer bears against the geotextile and secures it firmly to the foundation. The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during its installation or during placement of soil layers shall be replaced by the Contractor at the Contractor's expense. The work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 5 days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage due to the placement by limiting the height of drop of the material to less than 1 foot.

* * * * *

MATERIALS AND PERFORMANCE - SECTION 290

PERFORATED POLYVINYL CHLORIDE DRAINAGE PIPE

MP-290.01 GENERAL

A. Work Specified

1. Work under this section shall consist of all labor, materials, supplies, and equipment necessary to furnish and install the perforated polyvinyl chloride drainage pipe as specified herein and as shown on the Contract Drawings.

B. Applicable Codes, Standards, and Specifications

1. American Society for Testing and Materials (ASTM)

C. Acceptable Manufacturers

1. National Pipe Company

2. Or Approved Equal

MP-290.02 SUBMITTALS

A. Drawings and manufacturers data of the pipe, joints, and fittings showing compliance with this specification.

B. Submit five (5) copies of manufacturer's affidavit that all delivered materials comply with the requirements of the specified standards.

MP-290.03 MATERIALS

A. General

1. Perforated drain pipe and fittings shall be made of polyvinyl chloride (PVC) compound having a cell classification of Class 12454C materials or better in accordance with ASTM D 1784.

2. Perforated drain pipe and accessories shall conform to the requirements of the following with a minimum pipe stiffness of the 46 psi at a maximum deflection of 5%:

ASTM	F758	4" - 8" pipe

B. Joints

1. Joints for perforated drainage pipe and fittings shall be of the bell and spigot push on type with flexible elastomeric seals which meet the requirements of ASTM D 3212.

2. The plain end of the pipe shall be marked by the manufacturer to show the depth of penetration into the bell or coupling.

3. Lubricant for the joints shall be furnished by the manufacturer.

C. Perforations

1. Perforation shall be in accordance with ASTM F 758.

2. Pipe shall be installed with perforations down.

MP-290.04 INSTALLATION

A. Pipe Delivery, Storage and Handling

1. All pipe supplied under this Contract shall be shipped, stored, and handled in accordance with the recommendations of the manufacturer.

B. Initiation of Installation

1. Inspection

a. Prior to installation, all pipe, fittings, and specials will be inspected by the Contractor in the presence of the Engineer for conformance with the standards and specifications.

b. All pipe not meeting the requirements of the applicable specifications will be rejected.

c. The Contractor shall furnish all labor required to handle the material during inspection and shall remove the rejected material from the site, as directed.

2. Discrepancies

a. In the event that the inspection reveals discrepancies, the Contractor shall suspend installation.

C. Installation

1. General

a. Polyvinyl chloride pipe shall be installed in accordance with the applicable provisions of the Sections titled "Trenching, Backfilling, and Compacting" and "Pipeline Installation" and as shown on the Contract Drawings.

b. All pipelines in the trenches shall be laid on a flat bottom.

c. Blocking will not be permitted under pipe.

d. Temporary bulkheads shall be placed in all open ends of pipe whenever pipe laying is not actively in process. The bulkheads shall be designed to prevent the entrance of dirt, debris, or water.

e. Precautions shall be taken to prevent the flotation of the pipe in the event of water entering the trench.

f. Push-on joints shall be made by guiding the plain end into the bell until contact is made with the gasket and exerting sufficient force to drive the pipe home until penetration is made to the depth recommended by the manufacturer.

D. Inspection

1. All non-pressure perforated PVC pipe shall be inspected and lamped after placement to insure a complete working installation. The inspection shall determine if the pipeline is true to line and grade, has obstructions to flow, or has projections or protrusions of connecting pipes or joint materials. The pipeline shall be free from cracks and shall contain no deposits of backfilled materials. Any deficiencies identified during inspection shall be corrected by the Contractor at his expense.

2. Pipe deflection shall be checked by passing a deflection gauge through all completed pipelines.

a. Maximum deflection allowed - 5%.

b. The test for deflection shall be made not less than 30 days after completion of the installation.

c. Deflection gauge shall be pulled through the pipe by hand.

d. Any section of pipe found to have a deflection in excess of 5% shall be corrected by the Contractor at his expense.

* * * * *

CAROUSEL MALL

PROPOSED TEMPORARY CONTAINMENT FACILITY

LISTING OF ACCEPTABLE MANUFACTURERS

MATERIAL	ACCEPTABLE MANUFACTURER
Flexible Membrane Liner (FML)	Gundle 60 mil; Gundle 30 mil
Flexible Membrane Liner (FMC)	Gundle 30 mil; Poly-Flex 20 mil
Drainage Net	Tensar NS 1400 or equal
Geotextile Filter	Polyfelt TS800
Geotextile Stabilization Fabric	Mirafi 500X
Perforated PVC Drainage Pipe	National Pipe Company

Gundle Lining Systems Inc

(800) 435-2008
(713) 443-8564

Gundle®

TABLE OF CONTENTS

Gundle Lining Systems Inc

Gundle®

GUNDLINE® HD is a high quality formulation of High Density Polyethylene containing approximately 97.5% polymer and 2.5% of carbon black, anti-oxidants and heat stabilizers. The product was designed specifically for exposed conditions. It contains no additives or fillers which can leach out and cause embrittlement over time.

GUNDLINE® HD SPECIFICATIONS

TYPICAL PROPERTIES*	TEST METHOD	GAUGE (NOMINAL)							
		30 mil (0.75 mm)	**40 mil** (1.0 mm)	**50 mil** (1.25 mm)	**60 mil** (1.5 mm)	**80 mil** (2.0 mm)	**100 mil** (2.5 mm)	**120 mil** (3.0 mm)	**140 mil** (3.5 mm)
Density, g/cc. (Min.)	ASTM D1505	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Melt Flow Index, g/10 min. (Max.)	ASTM D1238 **Condition E (190°C, 2.16 kg.)**	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Tensile Properties (Typical)	ASTM D 638 Type IV Dumb-bell at 2 ipm.								
1. Tensile Strength at Break (Pounds/inch width)		120	160	200	240	320	400	480	560
2. Tensile Strength at Yield (Pounds/inch width)		70	95	115	140	190	240	290	340
3. Elongation at Break (Percent)		700	700	700	700	700	700	700	700
4. Elongation at Yield (Percent)		13	13	13	13	13	13	13	13
5. Modulus of Elasticity (Pounds per square inch $\times 10^5$)	ASTM D882	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Tear Resistance Initiation, lbs. (Typical)	ASTM D1004 Die C	22	30	37	45	55	65	80	95
Low Temperature Brittleness, °F (Typical)	ASTM D746 Procedure B	−112	−112	−112	−112	−112	−112	−112	−112
Dimensional Stability, % Change Each direction. (Max.)	ASTM D1204 **212°F 1 hr.**	±2	±2	±2	±2	±2	±2	±2	±2
Resistance to Soil Burial. Percent change in original value. (Typical)	ASTM D3083 using ASTM D638 Type IV Dumb-bell at 2 ipm.								
Tensile Strength at Break and Yield	% Change	±10	±10	±10	±10	±10	±10	±10	±10
Elongation at Break and Yield	% Change	±10	±10	±10	±10	±10	±10	±10	±10
Environmental Stress Crack. Hours. (Min.)	ASTM D1693 **(10% Igepal, 50°C)**	1500	1500	1500	1500	1500	1500	1500	1500
Puncture Resistance. Pounds. (Typical)	FTMS 101 Method 2065	30	52	65	80	105	130	150	169
Coefficient of Linear Thermal Expansion. $\times 10^{-4}$ $\frac{cm}{cm\ °C}$ (Typical)	ASTM D696	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Thermal Stability Oxidative Induction Time (OIT). Minutes. (Min.)	ASTM D3895 **130°C, 800 psi O_2**	2000	2000	2000	2000	2000	2000	2000	2000

**Note: All values except when specified as minimum or maximum are typical test results.*

PRODUCT DESCRIPTION

JOINING SYSTEMS

Critical to the success of any flexible membrane liner is the joining system. Gundle's Hot-Wedge Welding System and patented Extrusion Welding System are used to join individual panels of GUNDLINE HD. Request your copy of the Gundle Joining Systems Bulletin for complete details.

CHEMICAL RESISTANCE

GUNDLINE HD is resistant to a wide range of chemicals including acids, alkalis, salts, alcohols, amines, oils, and other hydrocarbons. Since combinations of chemicals of different concentrations and temperatures have different characteristics, consult Gundle for specific application details. Write for Gundle's chemical compatibility information.

SUPPLY SPECIFICATIONS

The following describes typical roll dimensions for GUNDLINE HD.

THICKNESS		WIDTH		LENGTH		AREA		ROLL WEIGHT	
mil	mm	ft	m	ft	m	ft^2	m^2	lb	kg
30	0.75	22.5	6.86	840	256	18,900	1756	2800	1272
40	1.0	22.5	6.86	650	198	14,625	1359	2800	1272
50	1.25	22.5	6.86	500	152	11,250	1043	2800	1272
60	1.5	22.5	6.86	420	128	9,450	878	2800	1272
80	2.0	22.5	6.86	320	98	7,200	670	2800	1272
100	2.5	22.5	6.86	250	76	5,625	522	2800	1272
120	3.0	22.5	6.86	210	64	4,725	439	2800	1272
140	3.5	22.5	6.86	180	55	4,050	377	2800	1272

GUNDLINE HD is rolled on 6" I.D. hollow cores.
Each roll is provided with 2 slings to aid handling on site.
Dimensions and weights are approximate. Custom lengths available on request.

Gundle Lining Systems Inc

Gundle Lining Systems Inc
19103 Gundle Road
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 Gundle Hou
Fax: (713) 875-6010

 20CS 889

Printed in the U.S.A.

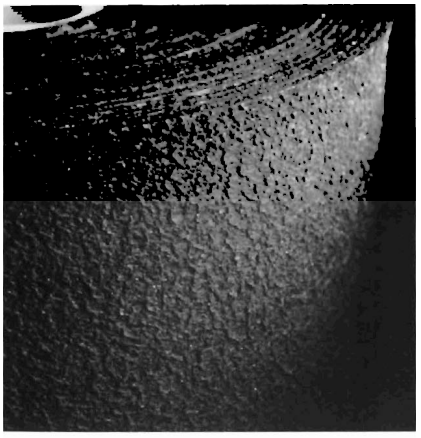
Gundle Lining Systems Inc

Gundle®

Textured Gundline® HDT Maximizes Slope Stability.

Gundle Lining Systems has developed a method for adding a rough texture to the surface of our durable High Density Polyethylene (HDPE) liners. The result is a high performance product called Gundline HDT which increases slope stability in engineered landfills and other lining applications.

Gundline HDT's special textured surface dramatically improves slope stability by increasing friction between the synthetic liner and soils, geotextiles, and other geosynthetics. Cover soils are held on the liner with greatly increased friction, and safety-conscious engineers can improve factors of safety on slopes of varying steepness. Table 1 lists the improvements in friction angle for Gundline HDT, determined by direct shear box testing.



The innovative friction surface of Gundline HDT is manufactured simultaneously with extrusion of the solid barrier portion of the liner as opposed to being added after extrusion. It's a rough surface, fully integrated with the sheet during the molten phase of manufacture. As a result, it has excellent abrasion resistance and remains intact regardless of chemicals contacting the sheet surface.

TABLE 1: DIRECT SHEAR BOX FRICTION ANGLES

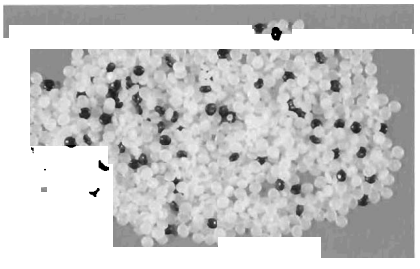
	FRICTION ANGLE (DEGREES)	
SLIDING SURFACE	*GUNDLINE HD*	*GUNDLINE HDT*
Gundline/H.R. Clay	16	24
Gundline/Ottawa Sand	17	26
Gundline/Geotextile (Nonwoven)	11	29

*Note: Friction angles for the products listed are typical only and may vary with local soil conditions. Accordingly, engineers must test friction angles for the product using site specific soil composition for all designs incorporating the product.

Gundline HDT Retains The Important Advantages Of Gundline® HD.

Manufactured in 22.5 foot wide seamless rolls and in thicknesses ranging from 40–80 mils of barrier wall, Gundline HDT features the same important qualities that have made Gundline HD the world's leading lining system. Tensile strength before yielding, biaxial elongation, tear resistance, puncture resistance, ultraviolet light resistance, chemical resistance, dimensional stability, heat resistance, and stress crack resistance are all excellent. So is resistance to microorganisms and rodent damage.

As with Gundline HD, Gundle manufactures Gundline HDT with only the top performing pipe grade HDPE resin. The superior high grade resin creates an ideal structure to the finished sheet.



HDPE resin and carbon black used in manufacturing.

Innovation And Quality Control Ensure Product Performance.

Quality control testing of the friction surface of every Gundline HDT sheet produced exemplifies our commitment to the highest industry standards. We measure friction angles across both sides of each roll with an incline plane friction test. Along with this sheet testing, Gundle also conducts regular field seam integrity tests. The technologically advanced welding system and seam testing for Gundline HDT is the same as for our HD liners. In addition Gundline HDT can be welded to smooth Gundline HD.

Gundline HDT Provides Solutions To Difficult Applications.

A recent problem at Islip, New York illustrates the effectiveness of Gundline HDT. It began when the city's municipal landfill neared capacity. The problem was then compounded by the lack of available land for expansion. But Gundle provided the solution. After considering all available options, it was decided to expand vertically—a process dubbed "piggybacking." A new cell would be created to sit atop the existing closed and capped landfill. However, it was critical to establish slope stability for the new, steep slopes of this 80-foot high addition. So Gundle manufactured and installed 1.2 million square feet of Gundline HDT and successfully increased the friction angle between the liner and the sand over sixty percent.

Today, not only does Islip have 1.8 million cubic yards of new refuse disposal capacity, but they also have peace of mind knowing it's lined with the industry's most stable and durable liner.

GUNDLINE® HDT TEXTURED SHEET SPECIFICATIONS

GUNDLINE® HDT is a high quality formulation of High Density Polyethylene containing approximately 97.5% polymer and 2.5% of carbon black, anti-oxidants and heat stabilizers. The product was designed specifically for exposed conditions. It contains no additives or fillers which can leach out and cause embrittlement over time.

TYPICAL PROPERTIES*	TEST METHOD	GAUGE (NOMINAL)		
		40 mil (1.0 mm)	**60 mil** (1.5 mm)	**80 mil** (2.0 mm)
Tensile Properties (Typical)	ASTM D638 Type IV Dumb-bell at 2 ipm.			
1. Tensile Strength at Break (Pounds/inch width)		23	35	46
2. Tensile Strength at Yield (Pounds/inch width)		84	126	168
3. Elongation at Break (Percent)		100	100	100
4. Elongation at Yield (Percent)		13	13	13
Tear Resistance Initiation. Pounds. (Typical)	ASTM D1004 Die C	30	45	60
Puncture Resistance. Pounds. (Typical)	FTMS 101 Method 2065	45	70	95

**Note: All values are typical test results.*

SUPPLY SPECIFICATIONS

The following describes typical roll dimensions for Gundline HDT

NOMINAL THICKNESS		WIDTH		LENGTH		AREA		ROLL WEIGHT	
mil	mm	ft.	m	ft.	m	$ft.^2$	m^2	lb.	kg.
40	1.0	22.5	6.86	500	152	11,250	1045	2780	1261
60	1.5	22.5	6.86	420	128	9,450	878	3270	1483
80	2.0	22.5	6.86	320	97	7,200	669	3200	1452

GUNDLINE HDT is rolled on 6″ I.D. hollow cores. Each roll is provided with 2 slings to aid handling on site. Dimensions and weights are approximate. Custom lengths available on request.

Gundle Lining Systems Inc

19103 Gundle Road
Houston, Texas 77073 U.S.A.
Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 GundleHou
Fax: (713) 875-6010

These specifications are to be used only as a general guideline for use by engineers in formulating preliminary specifications, and should not be relied upon absent site-specific product testing; and Gundle assumes no responsibility for the improper reliance upon or misuse of such data. In addition, product design and specifications are subject to change without notice.

Gundle Lining Systems Inc

Gundle®

"Hyperlastic" VLDPE Lining System.

Now, there's a proven, cost-effective solution to flexibility requirements in many of your liner applications... Gundle's "Hyperlastic" Very Low Density Polyethylene (VLDPE) Liner. As its name suggests, this high-performance polyolefin (also known as "FLEXOMER") has exceptional elastic properties. So, in applications such as landfill caps, tunnel lining, and potable water containment, where flexibility and elongation are more important than

thickness, Hyperlastic is ideal over PVC. Hyperlastic also offers many of the traditional advantages of Gundline® HD liner such as UV light stability; low temperature resistance; microorganism, insect, and rodent resistance; 22.5-foot seamless widths and effective heat-seaming techniques.

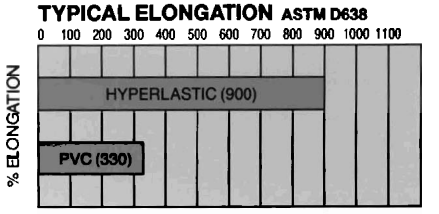
The Alternate Choice for Landfill Caps and Closures.

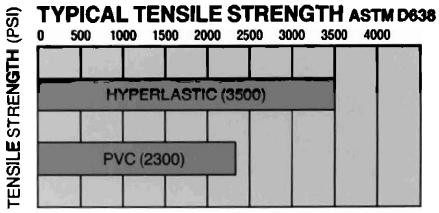
Landfill cap design usually presents unique problems, especially potential differential settlement of the landfill. Hyperlastic, with its excellent elongation, offers tremendous insurance against problems due to settling. Clay liners, on the other hand, are known to lose much of their barrier properties due to the absence of elasticity, difficulties of proper compaction, weathering and root growth.

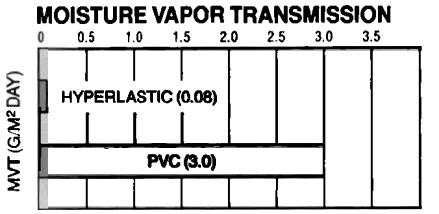
Not only does the liner have excellent elasticity, but Hyperlastic also offers excellent barrier properties to rainwater from outside the landfill while acting as a collector of gas from inside the landfill. Because of its flexibility, Hyperlastic conforms very well to non-uniform surfaces. It "hugs" these surfaces tightly, providing good slope stability and puncture resistance over the closures.

A Hyperlastic cap also promotes good vegetative growth in the topsoil cover of the closure by blocking the seepage of landfill gas through the vegetation. This enhances slope stability even further and provides better erosion control for the final closure.

Hyperlastic Liner Compared to PVC.







While Polyvinyl Chloride (PVC) has been used in applications where flexibility is more important than chemical resistance, the material achieves its flexibility from the addition of plasticizers. Present in PVC liners at 30% weight or more, plasticizers are low molecular-weight compounds such as oils.

These lower molecular-weight plasticizers can leach out because of heat, soil chemicals, and stresses in the liner, causing the liner to become brittle later on. Plasticizers are also food for rodents and microorganisms.

A Flexomer, Hyperlastic VLDPE, on the other hand, contains no plasticizers. It achieves all of its flexibility and elongation from its inherent polymer structure. Hyperlastic can also be made in one color or in a layer of colors. So go with Gundle's Hyperlastic and stay with the leader.

GUNDLE HYPERLASTIC VLDPE SPECIFICATIONS

Gundle Hyperlastic is a special formulation of very low density polyethylene containing approximately 97.5% polymer and 2.5% carbon black, anti-oxidants and heat stabilizers.

TYPICAL PROPERTIES*	TEST METHOD	GAUGE (NOMINAL)		
		20 mil (0.5 mm)	**30 mil** (0.75 mm)	**40 mil** (1.0 mm)
Tensile Properties. (Typical)				
1. Tensile Strength at Break (Pounds/inch-width)	ASTM D638 Type IV Dumb-bell at 2 ipm	63	94	126
2. Elongation at Break (Percent)		900	900	900
Puncture Resistance. Pounds. (Typical)	FTMS 101 Method 2065	38	51	64
Tear Resistance Initiation. Pounds. (Typical)	ASTM D1004 Die C	10	12	18
Dimensional Stability. % Change. Each Direction. (Max.)	ASTM D1204 212° F 1 hr.	±2	±2	±2
Low Temperature Brittleness. °F (Typical)	ASTM D746M Procedure B	−112	−112	−112
Resistance to Soil Burial. Percent change in original value. (Typical)	ASTM D3083 Type IV Dumb-bell at 2 ipm			
Tensile Strength at Break.		±10	±10	±10
Environmental Stress Crack. Hours. (Min.)	ASTM D1693 10% Igepal, 50°C	1500	1500	1500

*Note: All values, except when specified as minimum or maximum, are typical test results.

SUPPLY SPECIFICATIONS

The following describes typical roll dimensions for Hyperlastic VLDPE

THICKNESS		WIDTH		LENGTH		AREA		ROLL WEIGHT	
mil	mm	ft	m	ft	m	ft^2	m^2	lb	kg
20	0.5	22.5	6.86	1250	381	28,125	2613	2800	1272
30	0.75	22.5	6.86	840	256	18,900	1756	2800	1272
40	1.0	22.5	6.86	650	198	14,625	1359	2800	1272

HYPERLASTIC is rolled on 6" I.D. hollow cores. Each roll is provided with 2 slings to aid handling on site. Dimensions and weights are approximate. Custom lengths available on request.

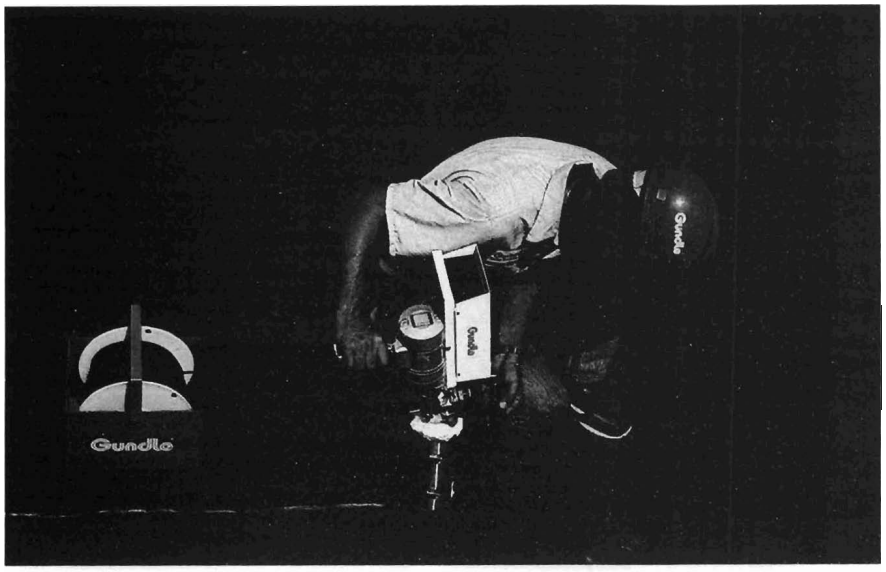
Gundle Lining Systems Inc

Gundle

19103 Gundle Road
Houston, Texas 77073 U.S.A.
Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 GundleHou
Fax: (713) 875-6010

These specifications are offered as a guide for consideration to assist engineers with their specifications; however, Gundle assumes no liability in connection with the use of this information. The specifications on this data sheet are subject to change without notice.

The Seam: Critical To The Integrity Of The Lining System



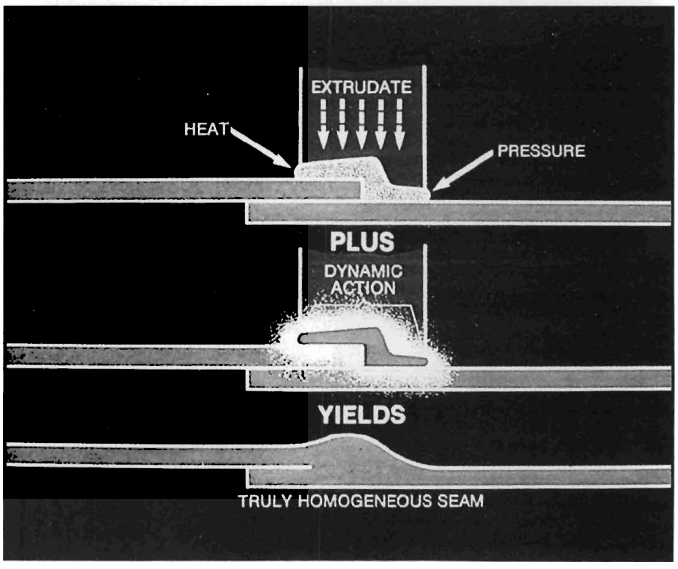
Proper containment of waste by any liner depends on seam quality. In the same way that a chain is only as strong as its weakest link, a containment liner performs only as well as the seams joining the liner sheets.

The joining together of liner sheets has progressed over the years from adhesives, to hot air/hot wedge, to conventional extrusion welding methods. This progression has led to a remarkable method for joining liner sheets, Gundle's patented Extrusion Welding System. Gundle's Extrusion System creates a weld that is completely homogeneous with the liner material being joined. And because the weld extrudate contains the same material as the Gundline® HD liner, resistance to the effects of weather, age, chemicals, and physical stress are unmatched.

The Gundle Extrusion Weld Seam: As Strong As The Sheet

Only Gundle Lining Systems' patented Extrusion Weld provides the combination of: heating, extrudate deposition, and mixing action that results in a truly homogeneous bond between liner sheets.

Gundle's special extrusion welding gun stirs the molten extrudate against and into the liner sheets. This mixing action greatly improves heat transfer and blends the extrudate bead into both sheets, creating a homogeneous mass. The result is a fully integrated connection through the seam. Since there is a continuous connection through the seam, and because the extruded bead is as thick as the liner sheet, the resulting seam is as strong as the sheet itself. Due to the extremely efficient heat transfer created by Gundle's patented mixing action, projects constructed at 15°F have been found to test the same as projects constructed at 70°F.



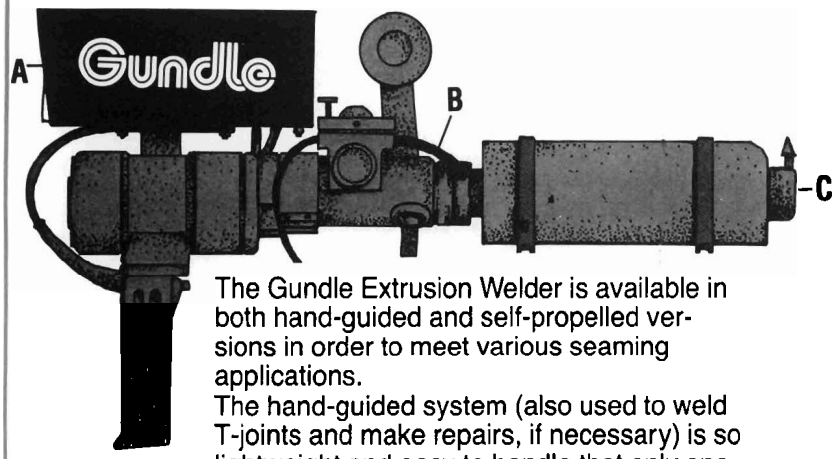
The Gundle Weld: As Chemically Resistant As The Sheet Itself

The Gundle welder extrudes the identical polymer mix that is found in Gundline HD. The high quality pipe grade HDPE extruded to form the seam is resistant to most waste solutions such as metal hydroxides, salts, acids, alkalis, oils, and hydrocarbon solvents including most chlorinated hydrocarbons, along with many other chemicals.

And because the Gundle Extrusion Weld results in a truly homogenous bond between the liner sheets, there is no interface between the sheets which could be disrupted by absorbed solvents.

Therefore, the Gundle Extrusion Weld seam offers the same chemical resistance as the Gundline HD sheet.

The Gundle Extrusion Welder



The Gundle Extrusion Welder is available in both hand-guided and self-propelled versions in order to meet various seaming applications.
The hand-guided system (also used to weld T-joints and make repairs, if necessary) is so lightweight and easy to handle that only one technician is required to operate it.

Since it is so easy to manage, Gundle's hand-guide welder allows the operator to concentrate on his work. Only Gundle's certified trained technicians operate the extrusion welder during a Gundle Lining Construction project.

Callouts Diagram

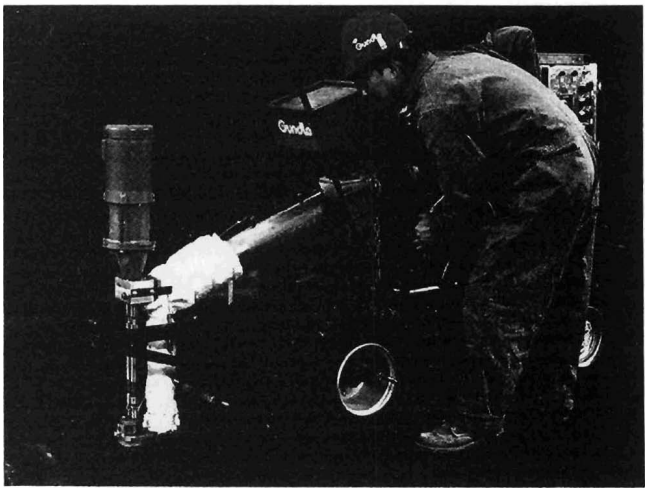
A. Electronic controls automatically compensate for field conditions by adjusting molten bead temperature. After conditions are set, control is automatic and requires no operator input.

B. The molten HDPE bead (extrudate) is formed from the same material as the sheet. The bead is simultaneously deposited and mixed into the liner sheets at a constant temperature.

C. The dynamic mixing action that takes place at the nozzle touches the surface layer of the sheet, mixing the extrudate into the sheets to form a totally homogeneous weld.

Automatic Welder

This machine, which embodies Gundle's proven patented extrusion welding system, also includes a unique, articulated, head that automatically conforms to the contours of the surface being lined. The self-propelled welder is designed for use in larger projects, where long uninterrupted lengths of seam are the norm. Because it is self-propelled by a powerful electric motor, the welder carries a large extruder allowing for higher volume extrudate deposition and a welding rate greater than that of a manual unit. The self-propelled welder is also equipped with a chain winching system so that it can weld on a slope.



Lab Testing

All Gundle seams are subjected to destructive testing in the laboratory according to ASTM D413 (peel test) and ASTM D638 (shear test). More rigorous versions of the peel test are also carried out at elevated temperatures (70 Deg. C, 158 Deg. F). These tests prove the quality of the Gundle weld. Weld samples are sent to Gundle's laboratory in Houston from project sites worldwide.

On-Site Testing

In addition to its extensive destructive testing program in the laboratory, Gundle regularly conducts both destructive and nondestructive seam tests at the jobsite.

Sample welds are randomly tested with a field tensometer to confirm the seam quality. In addition, Gundle technicians use a vacuum chamber to test 100% of the seamed footage. This test confirms that no voids are present in the seam at the conclusion of the project.

Since the Gundle Extrusion Weld is on the top of the sheet, important visual inspection of the weld area takes place on all Gundle installations.

Gundle Lining Systems Inc

Gundle Lining Systems Inc
19103 Gundle Road
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 GundleHou
Fax: (713) 875-6010

Gundle®

HOT WEDGE WELDING

Gundle Lining Systems Inc. has perfected hot wedge welding with its new generation automatic hot wedge welder. The hot wedge welding method consists simply of melting opposing surfaces of liner together using a hot wedge of steel which passes between the sheets followed by pressure rollers which press the molten sheets together.

The Gundle Hot Wedge welder automatically feeds the sheet across the hot wedge and through the pressure rollers. The welder also automatically positions the wedge accurately at the edge of the top sheet and automatically adjusts the roller gap to accommodate different sheet thicknesses! These features of the Gundle Hot Wedge enable it to achieve welding speeds of up to 15 feet per minute. With appropriate temperature settings, the hot wedge welder also gives excellent results in peel and shear destructive testing (ASTM D4437). This is proven by many years of lining experience worldwide with the hot wedge welder.

With the Gundle Hot Wedge welder, nondestructive testing is made more efficient because of air pressure testing of the "split" or "dual" wedge of the Gundle system. The dual wedge system leaves a gap between two separate wedge weld tracks. In the air pressure test, the gap is pressurized to about 30 psi and possible leaks are noted by the reduction in pressure over 5 minutes.

Buffing of the sheet is not necessary with the hot wedge, unlike with extrusion techniques. This, along with the increased welding rates, makes the hot wedge welder very cost effective for high quality construction of liner systems in waste containment.

With its new generation hot wedge welder and with the patented mixing tips in its fillet extrusion welders, Gundle offers the most advanced welding systems available today. Fillet extrusion welding is always necessary at penetrations and in patching. Therefore, with the advanced Gundle Hot Wedge welder, Gundle offers the best of both worlds - extrusion and non-extrusion welding systems.

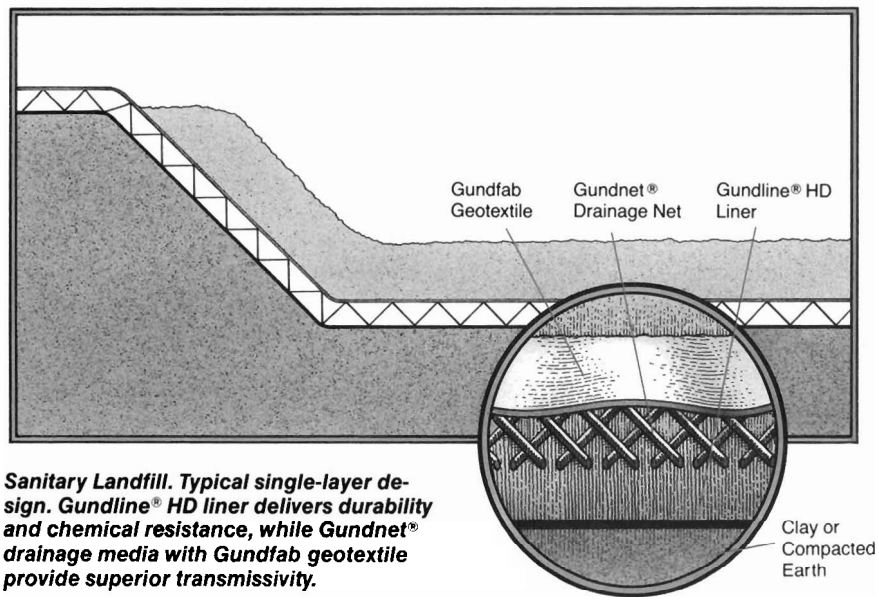
Gundle Lining Systems Inc

Gundle®

Sanitary Landfills

Modern household wastes deposited in sanitary landfills contain many of the same hazardous chemicals that require special treatment at hazardous waste facilities. Toxic pollutants in household garbage come from chemicals in cleaning products, paints, oils, insecticides, and solvents in addition to other products. The primary problem with these wastes is their high potential for mobility from the disposal site to the surrounding soil and ground water.

Numerous countries around the world and a growing number of state legislatures in the USA are facing the problem and now require the use of synthetic lining systems for solid waste containment. High Density Polyethylene (HDPE) lining materials offer many advantages over conventional soil liners. And Gundle has multiplied these advantages through the manufacturing and installing of over 300 million square feet of HDPE (Gundline® HD) liner systems worldwide. Gundle liners are inherently flexible to allow for differential settlement; suitable for all types of soils; resistant to decay, rodents, microorganisms and chemicals; and easy to install.



Sanitary Landfill. Typical single-layer design. Gundline® HD liner delivers durability and chemical resistance, while Gundnet® drainage media with Gundfab geotextile provide superior transmissivity.

Private Industry, Owners and Municipal Landfills

Many of the nearly 2,000 U.S. Superfund Priority Sites are municipal landfills. These and many other owners and operators of both public and private sanitary landfill sites are becoming acutely aware of the consequences that await improper waste containment.

Many chemicals contained in the waste materials at landfill sites cannot be properly impounded using traditional clay liners alone. Research has shown that these chemicals interact with clay particles causing structural changes which allow migration of toxic substances outside of the site.

Case History

Anchorage, Alaska. Recently, a new HDPE-lined landfill was opened on a 26-acre site to accept solid waste from both refuse firms and individuals.

The site also processes leachate that is removed by a collection sump for final disposal at a waste water treatment facility.

The most critical element of the new composite system is its 80 mil Gundline HD liner, manufactured and installed by Gundle. The liner was delivered and installed in 22.5 ft. seamless widths using Gundle's patented extrusion welding system for field seaming. A leachate collection system was then placed above the liner installation.

Resource Recovery

Waste-to-energy companies and municipal incineration facilities can produce an end product ash that is a more concentrated source of hazardous materials than the incoming solid waste. Heavy metals such as lead and cadmium, in addition to harmful organic chemicals precipitated in flu stacks, frequently cause the ash to fail EPA toxicity tests. To impound this material safely, the ash residue is starting to be landfilled in approved lined facilities.

Gundle can provide a system that includes Gundline HD as the bottom liner, Gundnet® drainage media as the leachate collection zone with Gundfab Geotextile placed over the Gundnet. A protective soil cover is then placed over the collection system. Some states are now requiring double liner systems such as those mandated by the Resource Conservation and Recovery Act (RCRA). Gundle also offers a liner system that meets these requirements.

Case History

Shrewsbury, Massachusetts. Approximately 375 tons of incinerator ash are trucked daily from a nearby waste-to-energy plant and are deposited at an ash monofill site located on 13 acres. The process begins each day with the burning of up to 1,500 tons of solid waste collected from the central part of the state.

The ash landfill incorporates a single composite liner, comprising a 60-mil Gundline HD liner manufactured and installed by Gundle on top of two feet of compacted clay. During and after installation, complete quality-control measures were carried out including both destructive and nondestructive testing of the liner and weld seams.

Gundle Lining Systems Inc

19103 Gundle Road
Houston, Texas 77073 U.S.A.
Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 GundleHou
Fax: (713) 875-6010

Landfill Closures

Once a sanitary landfill site has been filled to capacity, a barrier cap of Gundline HD is installed over the landfill. An effective closure eliminates the spreading of contaminating pollutants to the surrounding surface and ground water where a bottom liner had not been previously installed. The cap also eliminates leachate generated by precipitation.

HDPE liner materials are well-suited for landfill closures. Unlike clay caps, which can become highly permeable in a short time when exposed to the weather and vegetative growth, Gundline HD is highly resistant to weathering and chemical attack, not penetrated by root growth, flexible and can therefore handle differential settlement.

Case History

Western Pennsylvania. A third-party consultant recommended to the operator of this landfill that a 650,000 sq. ft. closure system be employed to cover two of the cells in the fill. Gundline HD, in a 50-mil thickness, was chosen as the primary closure material because this membrane would not only produce an impermeable closure, but also because its flexibility would protect the already installed leachate detection system. Gundnet drainage media and Gundfab geotextile were installed over the HDPE membrane to drain off surface precipitation.

When installation and all quality checks were complete, 18 inches of cover soil were applied and seeded.

Gundle Lining Systems Inc

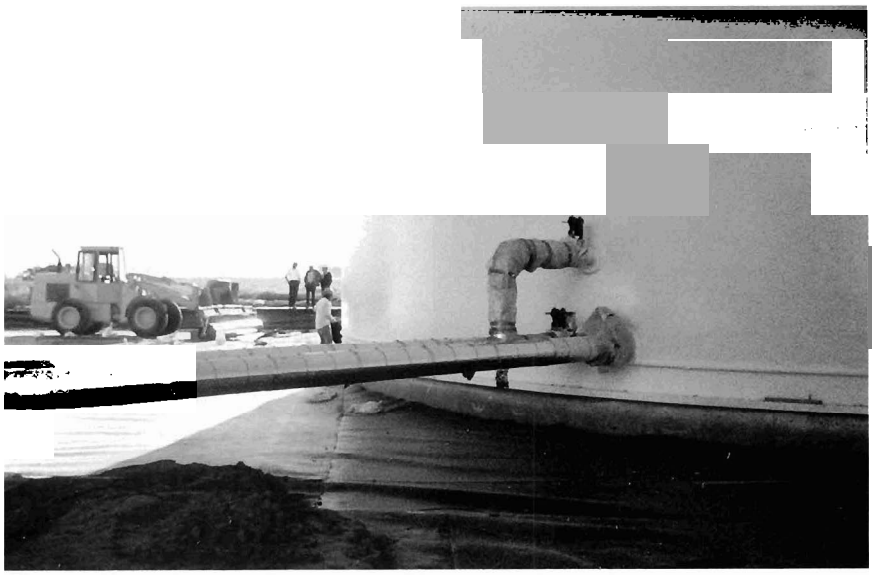
Gundle®

The Problem of Leaking Tanks

The problems associated with leaking tanks, whether they are above ground or below, are both serious and wide ranging. Deteriorating fuel and chemical tanks can threaten the public health and safety when they leak or spill hazardous wastes into the environment. And billions of gallons of potable water, a precious resource, are lost each year from leaks that could be prevented.

Most of these problems can be traced to a common source. As a tank ages it can lose its structural integrity. In steel tanks, for example, seams can weaken through expansion and contraction. Concrete surfaces become weakened the supporting soil structure, and leakage is accelerated by corrosion of metals from galvanic action, chemical or other sources. Even large natural structures can eventually lose their containment ability as a result of soil shifting, settling, expansion and contraction.

Gundle's solution for conserving drinking water is to use Gundline HDPE liner. Gundline® HD liner presents several distinct advantages as a permanent barrier for containment of drinking water. Our material is manufactured 30 to 140 mils thick and requires no special adhesives or chemicals to join the 22.5 foot wide seamless sheets. It doesn't support bacterial growth and is resistant to cracking and chemical attack.



High Density Polyethylene (HDPE), the base resin for Gundline HD, is a pure polyethylene resin. It is chemically inert, imparts no taste or odor, and is approved by the EPA for use in this application (refer to drawings 3 and 4).

Regulations Emphasize Secondary Containment And Leak Detection

Proposed Environmental Protection Agency (EPA) regulations address the most serious and wide-ranging problem of deteriorating fuel and chemical tanks which threaten the public health and safety when they spill and leak hazardous wastes into the environment. Because of the seriousness of the problem in the United States, the proposed new federal regulations will require that all tanks and tank systems be retrofitted or incorporate new secondary containment systems. HDPE liner systems play a critical role in meeting the objectives of these regulations (refer to drawings 1, 2 and 6).

The Gundle Answer To Tank Leakage Monitoring

The EPA has determined that secondary containment with interstitial monitoring is the most proven method for guarding against release to the environment and its water sources. The major advantage of secondary containment is the detection of leaks before a release to the environment occurs.

Gundle offers two key solutions to the problem of tank leakage through unique application of its High Density Polyethylene (HDPE) lining systems. These systems, utilizing our Gundline HD and specialized installation technology, can eliminate tank leakage problems permanently.

In existing tanks, Gundline HD is deployed over the existing tank floor, providing secondary containment integrity by sealing the floor surfaces. Over this liner, a typical leak detection system is made up of Gundnet® drainage media and Geotextile filter fabric and installed with drainage flowing to the outside

of the tank with leak monitoring piping. A supporting structure of sand or concrete is then used, upon which a new steel floor is installed (refer to drawing 6).

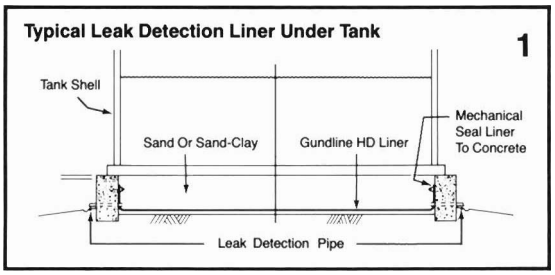
In a new application, before the tank is installed, an impermeable barrier of Gundline HDPE is deployed and sealed inside the ringwall foundation. Any possible leakage is then contained and monitored through leak detection piping (refer to drawing 1).

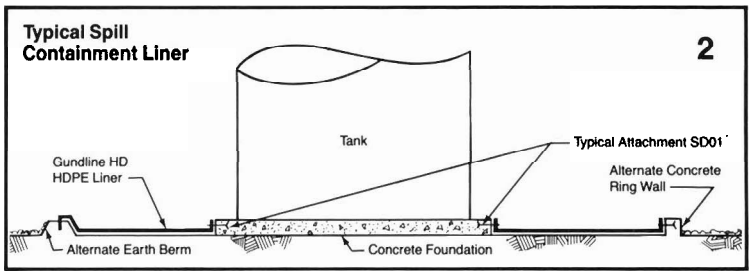
For the containment of catastrophic spills and day-to-day loading and unloading leaks and spills, Gundline® HD is used to permanently seal the spill containment area around the tank's perimeter and containment berm (refer to drawing 2).

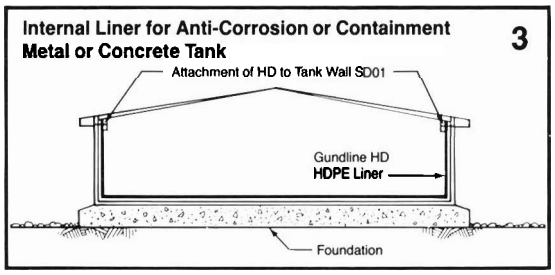
For underground or buried tanks, the tanks are contained in a vault-like structure manufactured from HDPE. A sump is constructed for monitoring of leakage and containment of spillage (refer to drawing 5).

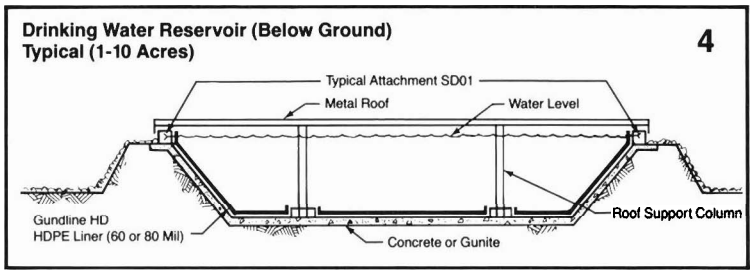
Whether used for sealing of concrete or steel tanks, new or retrofit, Gundle's Gundline HD system is the worldwide first choice for permanent solutions to leaking tanks.

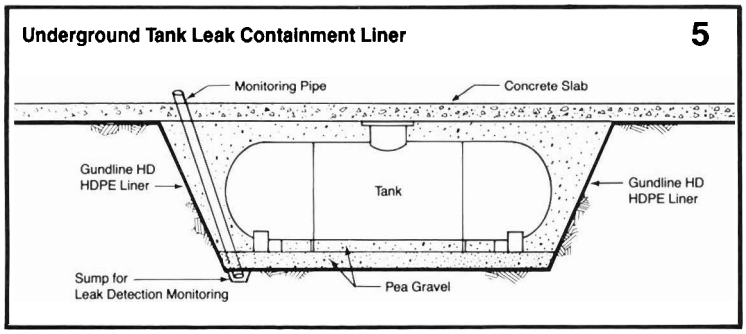
Tank Lining Applications

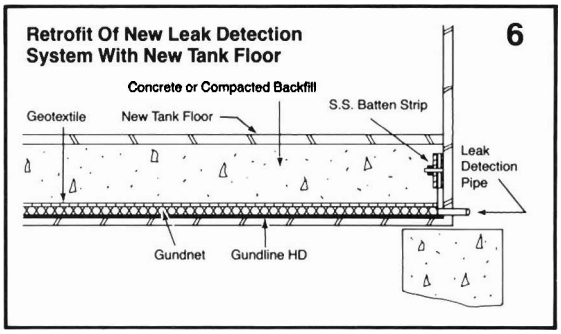












A series of eight detailed drawings are available upon request.

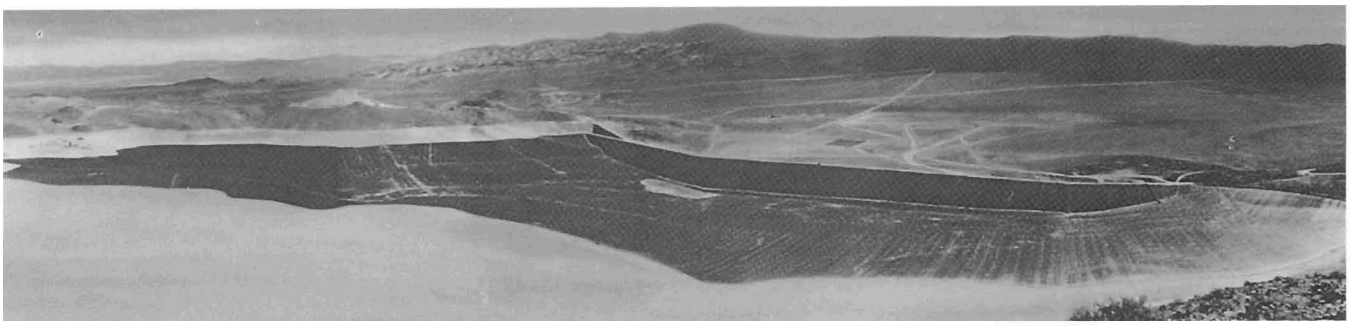
Gundle Lining Systems Inc

Gundle Lining Systems Inc
19103 Gundle Road
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 Gundle Hou
Fax: (713) 875-6010

Gundle Lining Systems Inc

Gundle®



Gundle Provides Secure Lining Containment For Leach Pads and Tailings Dams

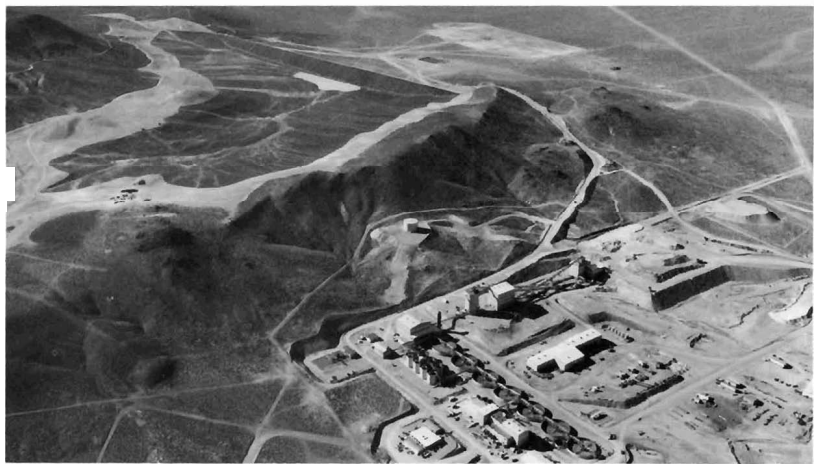
Today's mining industry demands optimal performance from a lining containment system. Such specialized applications as heap leach pads and tailing dams rely upon an effective lining system in order to securely retain valuable ores and process chemicals as well as protect the groundwater from chemical contamination. Gundle Lining Systems Inc meets the demands of the mining industry by providing a combination of high performance lining materials, dependable installation technology, and a level of experience unapproached by any other lining company.

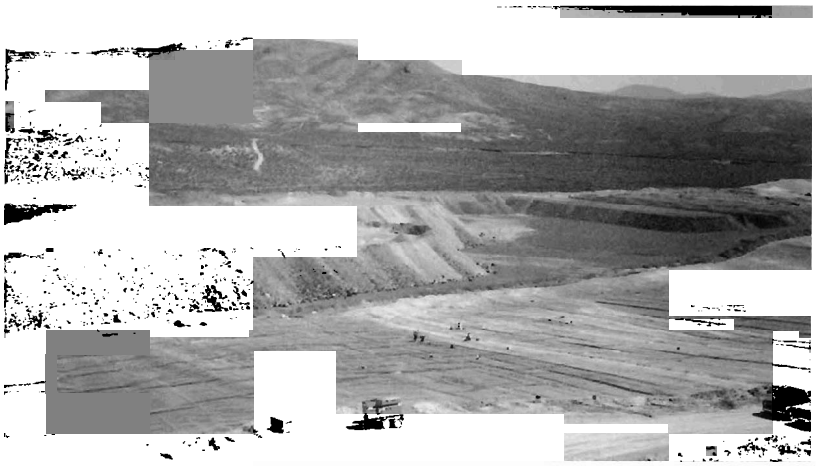
Gundle's credentials in servicing the mining industry are underscored by the fact that the company has successfully manufactured and installed over 300 million square feet of lining material, including systems for major mining projects throughout the world. The knowledge derived from this wealth of experience plays a key role in each new project produced by Gundle.

Heap Leaching Process

The growth in popularity of heap leaching as an economically viable process has created a need to securely contain all process areas of the heap leaching operation. Gundle has met this need, successfully lining many of the world's largest heap leaching operations, including a leach pad requiring over 6 million square feet of installed liner.

In order to securely contain this heap leaching process, Gundle lines all process areas including leach pad, leachate drainage system, and holding pond with its proven Gundline® HD High Density Polyethylene material. Depending upon the application, 20-140 mil Gundline HD is used. Impervious to the effects of the acids and cyanide used in the leaching process, Gundline HD creates a secure barrier between the process and the soil. This Gundline seal ensures that all ore and process chemicals are contained and the groundwater protected from possible chemical contamination.





Tailings Dams

The large volume of tailings generated by the mining process creates a major disposal concern. In many applications, Gundline® HD has been used to line the entire tailings containment area, creating a secure seal between the tailings and groundwater.

The physical properties of Gundline HD makes it optimal for this demanding application. The combination of pressure exerted by tons of rock and the sharp features of the individual tailings puts a premium on the puncture resistance of the material. Gundline HD, with a puncture resistance of 440 pounds (FTMS 101B Method 2031 for 100 mil), meets the strength requirements presented by the tailings pile.

Along with its excellent puncture resistant properties, Gundline HD also offers secure seams created by Gundle's patented extrusion welding system and superior resistance to the chemicals and acids left as residues in the tailings pile.

Case History, Tailings Dam Gabbs, Nevada

Gundline HD was recently used to line a new tailings dam for FMC Corp. at Gabbs, Nevada. The entire project required in excess of 4.8 million square feet of liner, with 100 mil Gundline HD used for the dam and 60 mil HD for the storage surface. Gundline HD was selected for the dam because of its overall strength and durability which makes it resistant to tears and punctures by the tailings.

The storage area for the tailings was created by building an 85′-90′ high earthen dam. Both the dam and the storage surface were then lined with 22½′ wide Gundline HD sheets and joined securely by Gundle's patented Extrusion Welding System.

To ensure the safe containment of the mining tailings, this project featured strict Quality Control procedures involving three independent groups (Gundle's QC staff, the engineer's QC staff, and an independent lab). Included in the QC procedures were destructive samples taken at every 500 feet.

The Gabbs, Nevada, Tailings Dam is another example of Gundle's success in the unique application of ore processing. Now completed, this dam will be in use for 12 or more years while the Gundline HD liner ensures an active life in excess of 20 years.

Case History, Heap Leaching San Manuel, Arizona

In a recent application of Gundline HD, an eighty-three acre heap leaching site, used for the extraction of copper ore, was lined with 60, 80, and 100 mil Gundline HD. The process begins by placing the copper oxide ore on the lined leach pad. The copper oxide is extracted as a copper sulfate solution by reaction with dilute sulfuric acid, which is sprayed onto the ore. The copper solution formed is then drained into holding ponds, where the copper is extracted from solution by an electrolytic process.

According to operations management for the processing site, the heap leaching method provides a number of advantages over conventional process methods. Heap leaching allows for economically justifiable processing of relatively low ore content rock, with economies stemming from the elimination of such expensive procedures as crushing, milling, smelting, and refining. The overall result is a processing cost of approximately one-half that of conventional methods.

This site, located at San Manuel, Arizona, represents one of many successful heap leaching sites lined with Gundline HD.

Gundle Lining Systems Inc

Gundle®

Gundle Lining Systems Inc
19103 Gundle Road
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 Gundle Hou
Fax: (713) 875-6010

GUNDNET AND FABRI-NET: FOR FLUID DRAINAGE IN WASTE FACILITIES

GUNDNET

Gundnet is a structure made of two sets of plastic strands arranged together to form a "net" or "mesh". The special arrangement of these strands allows fluids to be easily conveyed along the plane of the net.

Gundnet is a drainage net particularly well suited to the requirements of waste disposal facilities. Gundnet is made of high density polyethylene and enjoys all the advantages offered by HDPE for use in waste containment. These include: superior chemical resistance to a wide variety of chemicals; good durability over time; high tensile yield strengths; and good heat resistance.

The in-plane flow is high enough that even though the net sheets are 6mm (1/4 inch) thick or less, they have a hydraulic transmissivity more than a hundred times greater than the hydraulic transmissivity of the drainage layer required in the RCRA Guidance Documents for landfills, surface impoundments, and waste piles.

FABRI-NET

Fabri-Net is a Polyfelt filter fabric/Gundnet composite with the geotextile fabric heat bonded to one or both sides of the Gundnet. This composite allows one-step installation of drainage media for primary leachate collection (where filter fabric is needed to prevent soil particles from clogging Gundnet flow channels). With the geotextile bonded to both sides, a textile surface is available on the backside of the Gundnet to grip the textured surface of Gundline HDT with velcro-like friction incorporating the many benefits of synthetic drainage media in steep slope design.

GUNDNET AND FABRI-NET

Gundnet and Fabri-Net are both simply unrolled to form a blanket for drainage in waste disposal facilities wherever drainage is desired. The ease and safety of installation of the synthetic drainage media is important to consider since no heavy equipment is required to lay it down.

Installation of Gundnet and Fabri-Net can occur immediately after seaming of the liner. This is not usually the case for sand or gravel layers where the entire liner layer must be in place before grading of the sand begins. Installation of the drainage layer using synthetic drainage media requires only a few days whereas grading of sand or gravel drainage can require a few weeks. And movement of heavy bulldozers over the liner is avoided if Gundnet or Fabri-Net are used in place of sand or gravel. Sand can also be easily disturbed during construction by wind, rainfall and worker's footsteps.

Gundnet and Fabri-Net are cost effective because they are thinner than a granular layer, in addition to Fabri-Net's ability to be placed on steep slopes. Both factors increase the capacity of a landfill or surface impoundment.

STANDARD SPECIFICATIONS
FOR HDPE LINING MATERIAL

1. SCOPE

These specifications describe High Density Polyethylene (HDPE) Lining Membranes. The supply and installation of these materials shall be in strict accordance with the Engineer's specifications and engineering drawings and be subject to the terms and conditions of the contract.

2. MANUFACTURER'S EXPERIENCE

The manufacturer of the lining material described hereunder shall have previously demonstrated his ability to produce this membrane by having successfully manufactured a minimum of one hundred million square feet (9,290,226 meters) of similar liner material for hydraulic lining installations. The manufacturer must be listed by the NSF (National Sanitation Foundation) Standard 54.

3. LINING MATERIAL

3.1 The new membrane liner shall comprise HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures.

3.2 The Contractor shall, at the time of bidding, submit a certification from the manufacturer of the sheeting, stating that the sheeting meets physical property requirements for the intended application.

3.3 The liner material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Any such defect shall be repaired using the extrusion fusion welding technique in accordance with the manufacturer's recommendations.

3.4 The lining material shall be manufactured a minimum of 22.5 feet (6.8 meters) seamless widths. Labels on the roll shall identify the thickness, length, and manufacturer's roll number. There shall be no factory seams.

3.5 The liner material shall meet the specification values according to the specification sheet for HDPE.

4. FACTORY QUALITY CONTROL

4.1 Raw Material

All compound ingredients of the HDPE materials shall be randomly sampled on delivery to the HDPE manufacturing plant to ensure compliance with specifications. Tests to be carried out shall include Density ASTM D1505 and Melt Index ASTM D1238, Condition E.

4.2 Manufactured Roll Goods

Samples of the production run shall be taken and tested according to ASTM D638 to ensure that tensile strength at yield and break, elongation at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

4.3 All welding material shall be of a type supplied by the manufacturer.

5. INSTALLATION

5.1 Area Subgrade Preparation

Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade. No standing water or excessive moisture shall be allowed. The installation contractor shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

5.2 Contractor Approval

The installation of the HDPE must be done by the manufacturer using the manufacturer's extrusion or hot wedge welding equipment and installation methods. All supervisors overseeing the liner installation must have ten million square feet of supervisory liner experience. All field technicians must have over one million square feet of seaming experience.

5.3 Field Seams

Individual panels of liner material shall be laid out and overlapped by a maximum of four inches (101 millimeters) for extrusion weld prior to welding or five inches (127 millimeters) for hot wedge weld prior to welding. Extreme care shall be taken by the installer in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according to the procedures laid down by the material manufacturer. All sheeting shall be welded together by means of integration of the extrudate bead with the lining material. The composition of the extrudate shall be identical to the lining material, or all sheeting shall be welded together using the hot wedge welding system.

5.4 The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

5.5 No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap extrusion weld shall be applied.

6. FIELD SEAM TESTING/QUALITY CONTROL

6.1 The installer shall employ on-site physical non-destructive testing on all welds.

6.2 A quality-control technician shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with HDPE repair procedures.

6.3 A test weld three (3) feet long [one (1) meter] long from each welding machine shall be run each day prior to liner welding and under the same conditions as exist for the liner welding. The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of weld 1/4" to 1/2" (10mm to 20mm) wide shall be cut from the test weld and pulled by hand in peel. The weld should not peel. Seams should exhibit a film tear bond. The weld sample shall be kept for subsequent testing on laboratory tensometer equipment in accordance with the applicable ASTM standards. Random weld samples may be removed from the installed welded sheeting at a frequency to be agreed (e.g. 1/500' of weld).

6.4 The end user company, or his designated representative, reserves the right of access for inspection of any or all phases of this installation at their expense.

7. WARRANTY AND GUARANTEE

The manufacturer/installer shall provide a written warranty.

QUALITY CONTROL MANUAL

1. QUALITY CONTROL

1.1 Company Statement

This quality control manual is intended to satisfy the basic quality control needs of the company.

The procedures herein must be adhered to at all times. This supercedes all previous procedures relating to quality control. Personnel may only deviate from these procedures if instructed to by the President of the company.

These procedures apply to all production. They should be updated at least annually. Conformance to procedures will be monitored by an audit at least annually.

2. OBJECTIVE

2.1 The objective of this manual is to lay down procedures:

a. For achieving a structured approach towards attaining the high quality of the products demanded by customers, and,

b. To satisfy the Company's need for systematic procedures operated by an effective and efficient quality control department within the organization.

3. SAMPLING FREQUENCY

3.1 Raw Materials - A sample from each hopper compartment will be tested.

3.2 Finished Goods - Products must be sampled at least twice per shift. Samples must be taken even if they cannot be tested until a later date. Sampling is done by production personnel.

4. TESTING PROCEDURE

4.1 Raw Material testing involves short term testing aimed at "fingerprinting" the material supplied. Every resin demonstrates its own individual characteristics that are determined by its chemical make-up and molecular weight. For reference purposes, density and melt index serve to identify the material as being acceptable or not. A visual inspection for contaminants is also performed.

4.1.1 The melt index (ASTM D1238) is a numerical qualification of the molecular weight of the material as demonstrated by flow through a .0825 inch (2.09mm) diameter orifice at constant pressure and temperature. Lower molecular weight materials flow faster than higher molecular weight materials, thus giving an exact value particular to any grade of resin.

4.1.2 The density of the material (ASTM D1504) is expressed as the weight per unit volume of the material at 23 degrees C. The density of the material serves as a reference to a range of properties including tensile strength, hardness, and chemical resistance.

4.1.3 A visual inspection of the sample is performed to identify any possible contaminants.

4.2 Finished goods testing involves short and long term testing aimed at confirming the physical properties of the material.

4.2.1 Tensile and elongation properties are determined according to ASTM D638. The tensile strength at yield and break is determined and must meet pre-defined specifications. Elongation at the yield point as well as the ultimate elongation of the material is determined and must meet pre-defined specifications.

Tensile testing is performed parallel and transverse to the production direction. A 2-inch (50.8mm) per minute testing rate is used in conjunction with type IV tensile specimens.

4.2.2 The thickness of the material is tested according to ASTM D1593 and D374. Measurements are taken across the width every seven inches and along the length of the sheet every five minutes.

4.2.3 The carbon black content is monitored according to ASTM D1603. Samples of the liner material are weighed and then pyrolyzed under nitrogen which vaporizes the polyethylene, leaving the carbon black as a residue. The weight of the carbon is taken and the percent carbon black content calculated. Maintaining a minimum carbon black content of 2% ensures resistance to ultraviolet exposure.

4.2.4 A visual inspection is made of the liner material to ensure that it is free of pores, pinholes, or other detrimental defects.

4.2.5 Environmental stress crack testing is performed according to ASTM D1693. Notched specimens of sheeting are bent 180 degrees and tested at 50 degrees C in 10% igepal CO-630 solution. No failures should occur.

4.2.6 From the daily production testing, a quality document is issued by the laboratory.

4.3 Field Quality Control testing involves both non-destructive and destructive testing. The non-destructive testing is primarily centered on determining "watertightness", whereas the destructive testing is based on the ASTM D4437 test method.

4.3.1 One inch strips cut with the weld centrally located are tested by stressing the weld in a "shear" configuration. That is, the top sheet is stressed in relation to the bottom sheet in a direction away from the weld. A pass result occurs when the upper or lower sheet yields. A fail result occurs when the weld fails.

4.3.2 One inch strips cut with the weld centrally located are tested by stressing the top sheet in relation to the overlapped edge of the lower sheet in an effort to peel the weld away. A pass result occurs when the sheeting yields. A fail result occurs when the weld peels.

4.3.3 A sample weld shall be made twice during each shift with each welding machine. Samples from the weld shall be tested in shear and peel, and no welder may start work until the sample weld has been approved.

4.3.4 A visual examination of the seam provides the most useful means of ensuring watertightness. As Gundle fusion welds are visible on the surface, any suspect areas, brakes, or holes in the weld are easily seen and marked for repair.

4.3.5 Destructive shear and peel tests shall be done by random selection of an actual field weld no less than one sample per 500 feet (150 meters) of weld.

4.3.6 Vacuum testing follows no specific standard. A glass-faced suction box, typically 3 feet (1 meter) long and wide enough to cover the weld, is placed over a section of the seam which has been wet with a soap solution. Suction is applied to the seam and any leaks are demonstrated by the formation of bubbles. Holes are marked and repaired.

QUALITY CONTROL UPDATE

TECHNIQUE, QUALITY CONTROL & FIELD SEAM TESTING PROCEDURE

1. Field Seams

All Gundle HD sheeting shall be welded together by means of a homogeneous overlap extrusion fusion process which provides continuous dynamic integration of the extrudate bead with the lining material. The composition of the extrudate is identical to the lining material.

2. Welding Equipment

The welding equipment used shall be capable of continuously monitoring and controlling the temperature of the extrudate and the zone of contact where the machine is actually fusing the lining material so as to ensure changes in environmental conditions will not affect the integrity of the weld. Only welding systems which utilize the extrusion process shall be used for bonding lining materials.

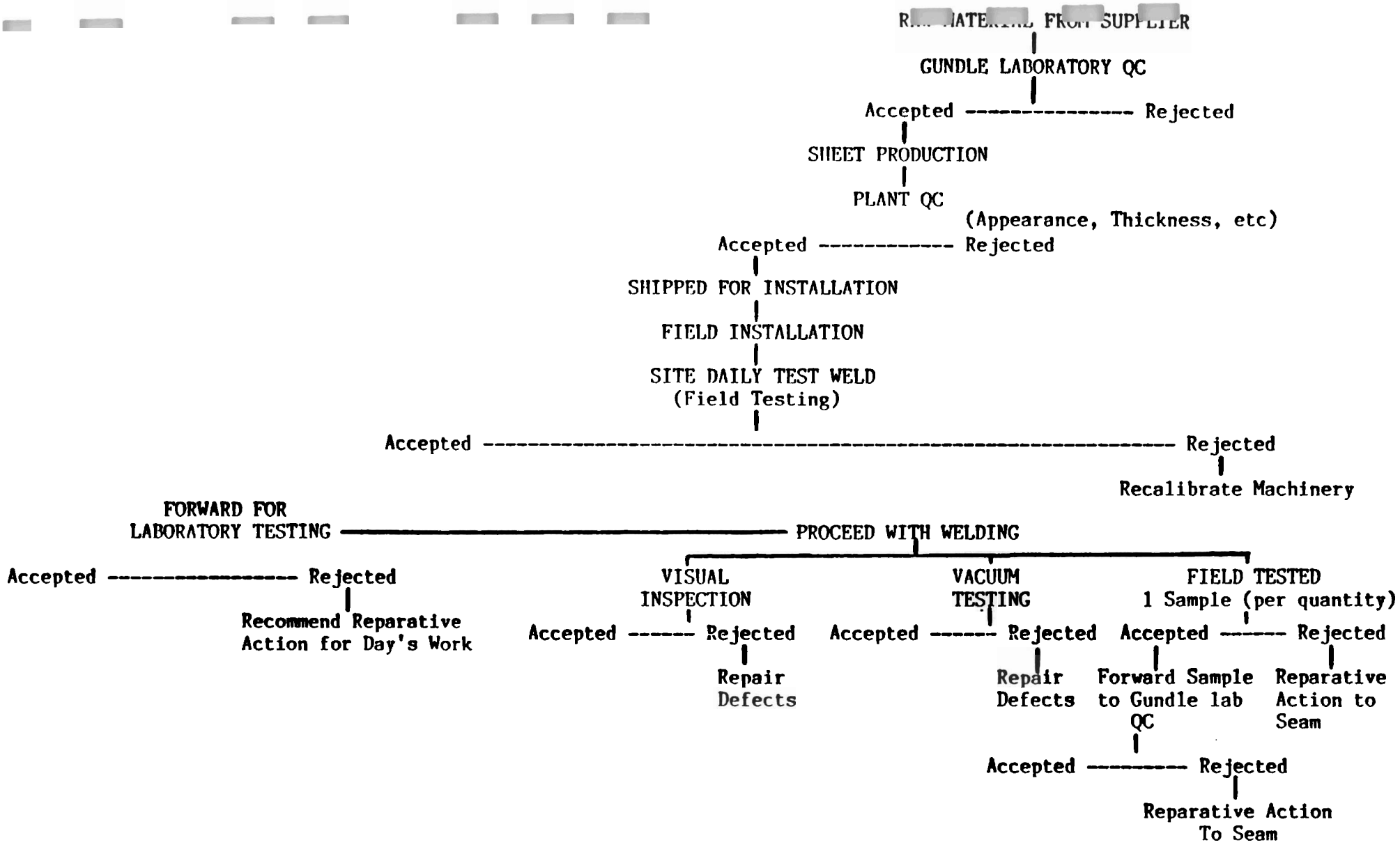
3. Weld Quality Control and Testing

3.1 A test weld, three (3) feet [one (1) meter] long, from each welding machine shall be run each day prior to liner welding and under the same conditions as exist for the liner welding. The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of weld 1/4" or 1/2" (10mm to 20mm) wide shall be cut from the test weld and pulled by hand in peel. The welds should not peel. seams should be stronger than the yield strength of the material. The weld sample shall be kept for subsequent testing on laboratory tensometer equipment in accordance with the applicable ASTM tests.

3.2 All welds, on completion of the work, shall be tightly bonded. Any membrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of Gundline membrane.

3.3 A quality-control technician shall follow behind each seam crew and perform a visual inspection of the seamed area. Defective seams should be marked and repaired in accordance with Gundle's published repair procedure.

3.4 No "fish-mouths" shall be allowed within the seam area. Where "fishmouths" occur, the material shall be cut, overlapped, and an overlap-extrusion weld shall be applied.


R... MATERIAL FROM SUPPLIER
GUNDLE LABORATORY QC
Accepted
Rejected
SHEET PRODUCTION
PLANT QC
(Appearance, Thickness, etc)
Accepted
Rejected
SHIPPED FOR INSTALLATION
FIELD INSTALLATION
SITE DAILY TEST WELD
(Field Testing)
Accepted
Rejected
Recalibrate Machinery
FORWARD FOR
LABORATORY TESTING
PROCEED WITH WELDING
Accepted
Rejected
Recommend Reparative
Action for Day's Work
VISUAL
INSPECTION
Accepted
Rejected
Repair
Defects
VACUUM
TESTING
Accepted
Rejected
Repair
Defects
FIELD TESTED
1 Sample (per quantity)
Accepted
Rejected
Forward Sample
to Gundle lab
QC
Reparative
Action to
Seam
Accepted
Rejected
Reparative Action
To Seam

QUALITY CONTROL CERTIFICATE

GUNDLINE HD

MATERIAL _____ DATE _____

PITCH # _____ PROJECT _____

ROLL # _____ _____

TEST PARAMETER	REQUIRED SPECIFICATIONS	TEST RESULTS	ASTM TEST METHOD
Thickness, mils			D 1593
Density, gms/cm^3			D 1505
Tensile Strength (psi) Yield			D 638 Type IV 2 ipm
Break			
% Elongation, Break			D 638

CERTIFIED BY:

_____

Darlene Phouangsavanh
Lab Supervisor

LABORATORY REPORT#_____

DATE_____

SUBJECT:

Resin quality control_____Batch #_____

TEST METHOD:

Melt Index	ASTM D1238 E & P
Density	ASTM D1505

TEST RESULTS:

Melt Index, E	_____g/10 min.
P	_____g/10 min.
Density	_____g/cm3

CONCLUSION:

CERTIFIED BY:

_____

Darlene Phouangsavanh
Lab Supervisor

SITE WELDING QUALITY CONTROL REPORT

PROJECT _____ CONTRACT # _____

SITE _____ DATE _____

MATERIAL _____ THICKNESS _____

Weld Reference _____

Weld Inspection _____ Observations _____

Weld Re-Inspection _____ Observations _____

Sample Weld Location _____

Sampled By: _____

Sample Weld Test Results

Sample Weld #	Specimen	Peel Results
	1	
	2	
	1	
	2	
	1	
	2	

CERTIFIED BY:

_____

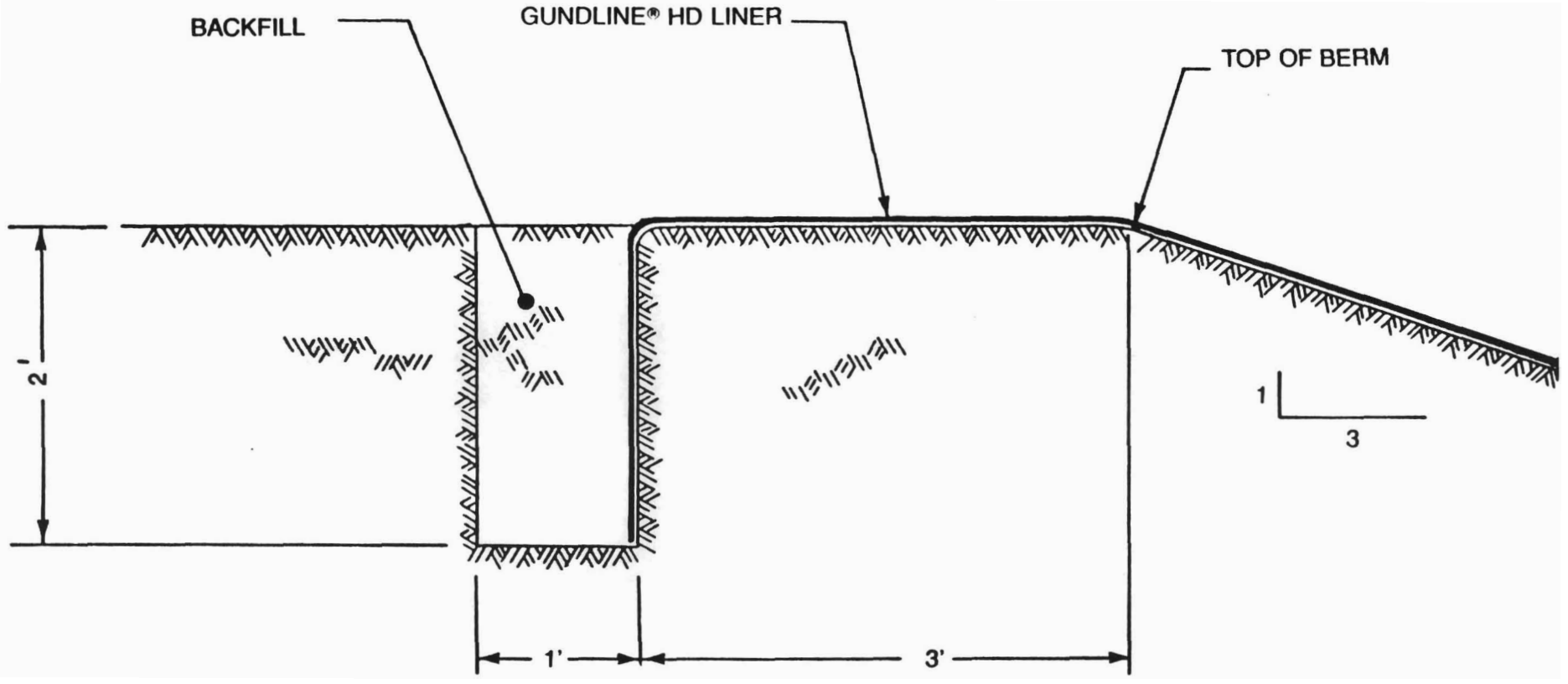
Lab Technician

Gundle®

GUNDLINE INSTALLATIONS

FOR COMPLETE INSTALLATIONS LIST,
CALL GUNDLE LINING SYSTEMS, INC., HOUSTON, TX
(713-443-8564 OR 1-800-435-2008)

CONTACT: ANNA SPENCER



ANCHOR TRENCH DETAIL

NOT TO SCALE

Gundle®
Lining Construction Corp
1340 E. RICHEY RD. HOUSTON, TEXAS 77073

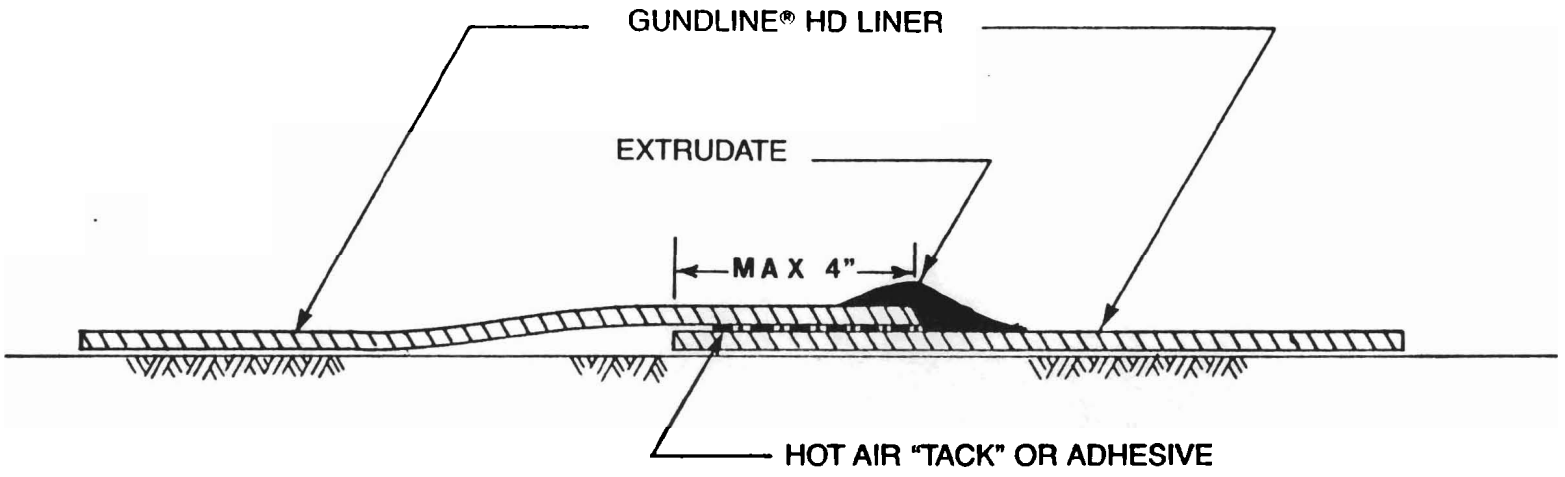
DATE: 11-16-84

DRAWING No. SD06

APPROVED BY:

TYPICAL DETAIL

BY:



GUNDLE FUSION EXTRUSION WELD

NOT TO SCALE

Gundle®
Lining Construction Corp
1340 E. RICHEY RD. HOUSTON, TEXAS 77073

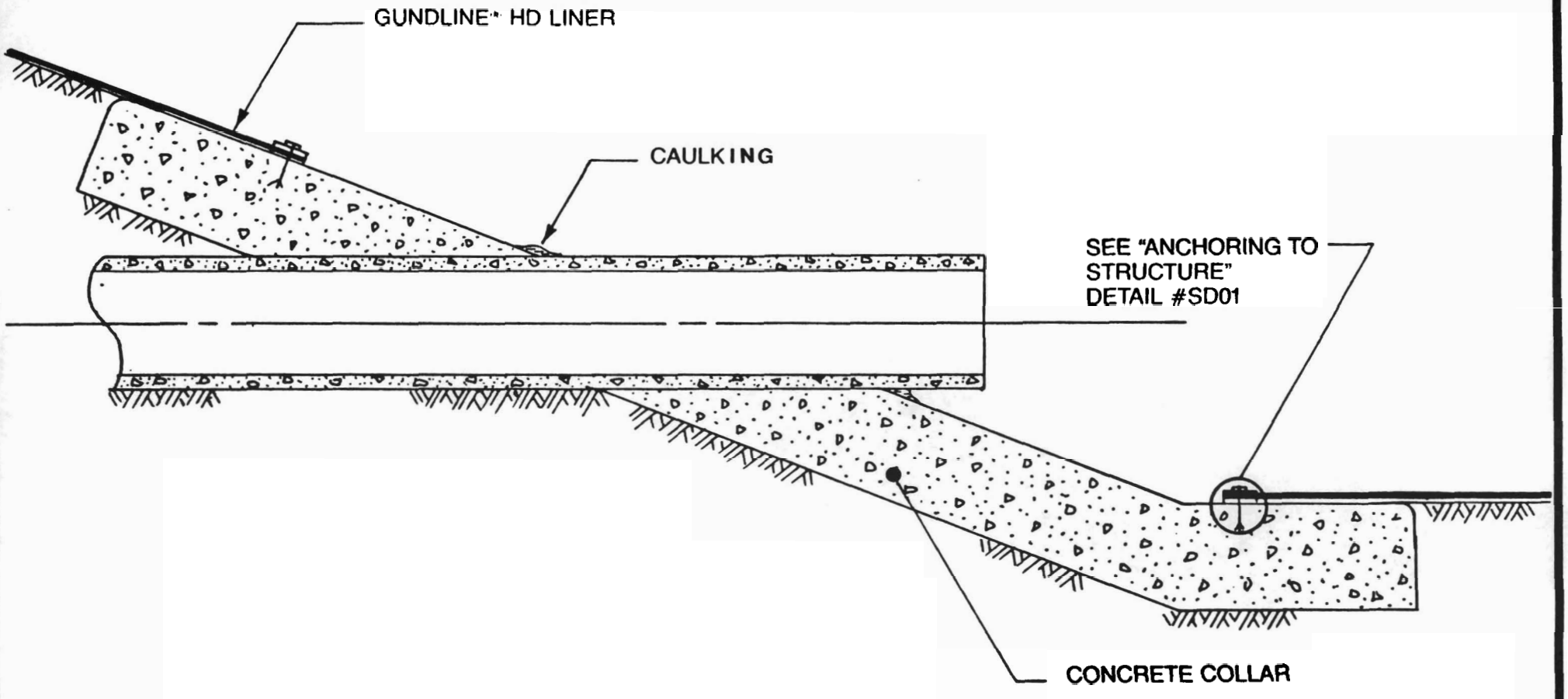
DATE: 11-19-84

DRAWING No. SD07

APPROVED BY:

TYPICAL DETAIL

BY:



REINFORCED CONCRETE PIPE PENETRATION

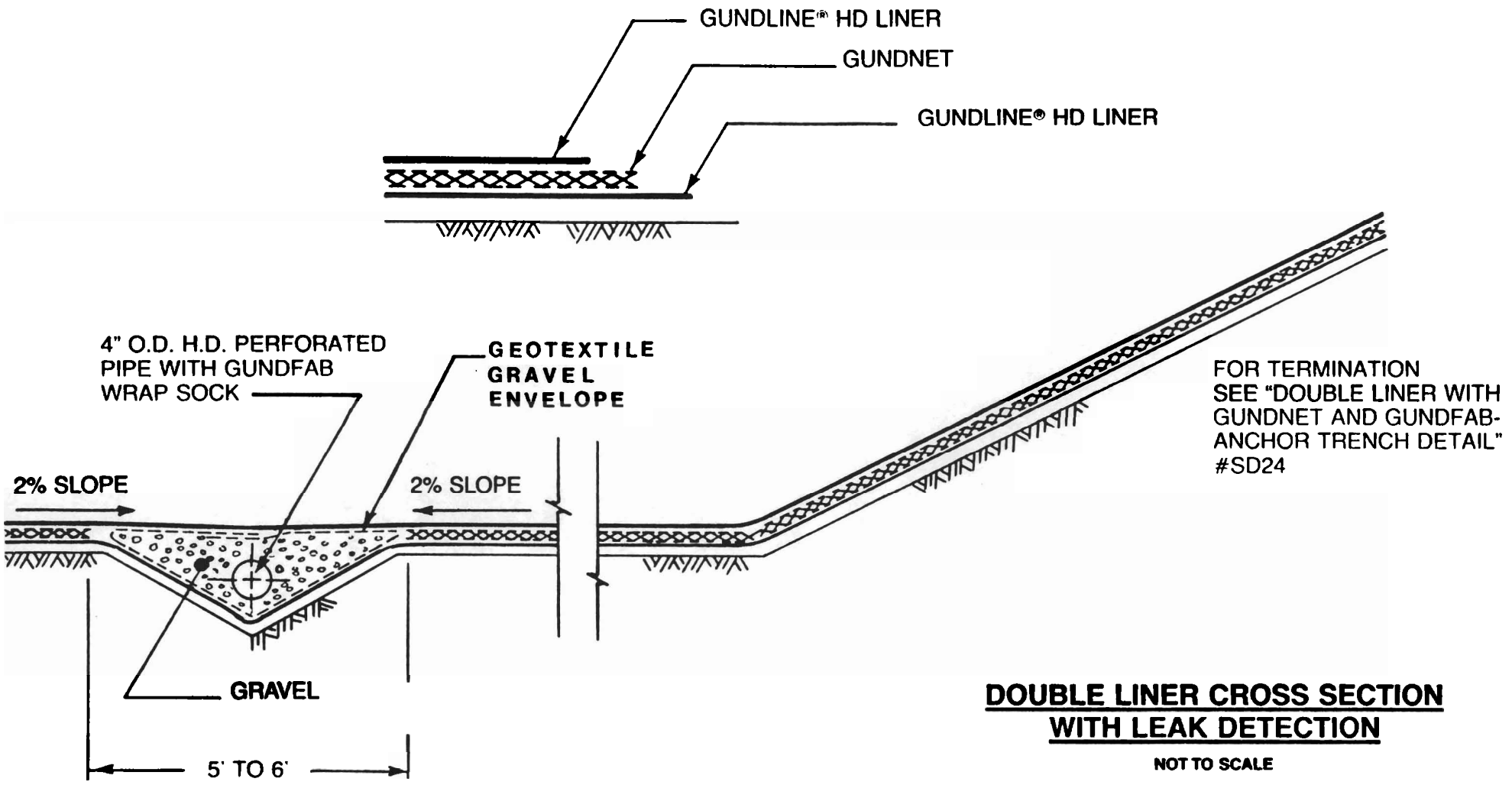
NOT TO SCALE

Gundle®
Lining Construction Corp
1340 E. RICHEY RD. HOUSTON, TEXAS 77073

DATE: 11-27-84
DRAWING No. SD17
APPROVED BY:

TYPICAL DETAIL

BY:



DOUBLE LINER CROSS SECTION WITH LEAK DETECTION

NOT TO SCALE

Gundle®
Lining Construction Corp
1340 E. RICHEY RD. HOUSTON, TEXAS 77073

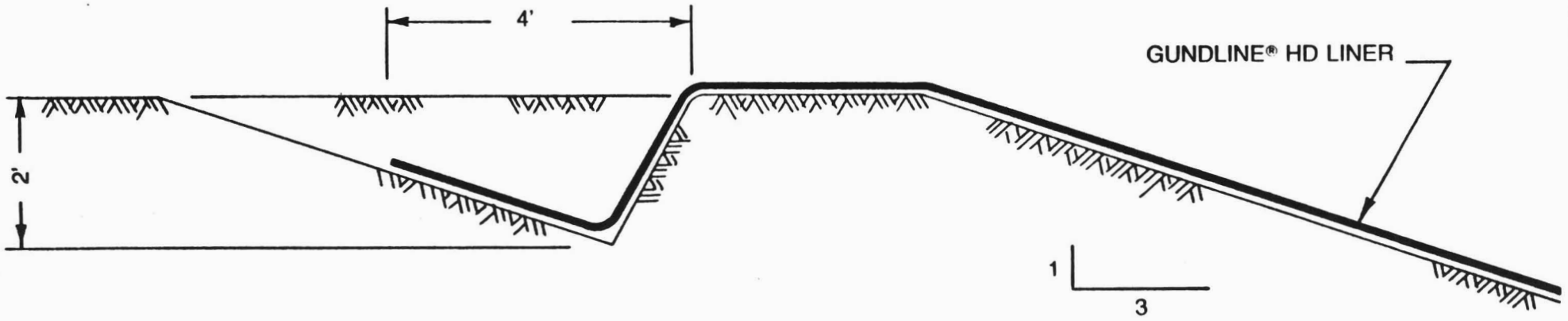
DATE: 11-30-84

DRAWING No. SD23

APPROVED BY:

TYPICAL DETAIL

BY:



V-ANCHOR TRENCH

NOT TO SCALE

Gundle®
Lining Construction Corp
1340 E. RICHEY RD. HOUSTON, TEXAS 77073

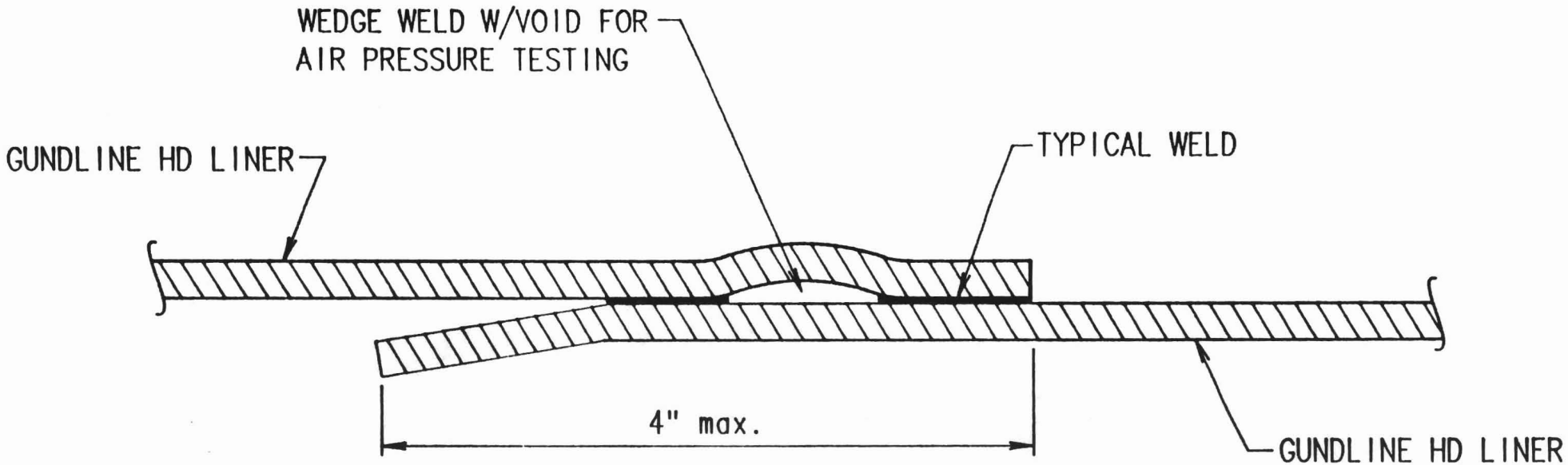
DATE: 1-7-85

DRAWING No. SD26

APPROVED BY:

TYPICAL DETAIL

BY:



TYPICAL WEDGE WELD DETAIL

(not to scale)

Gundle

19100 GUNDLE ROAD
HOUSTON, TEXAS 77073

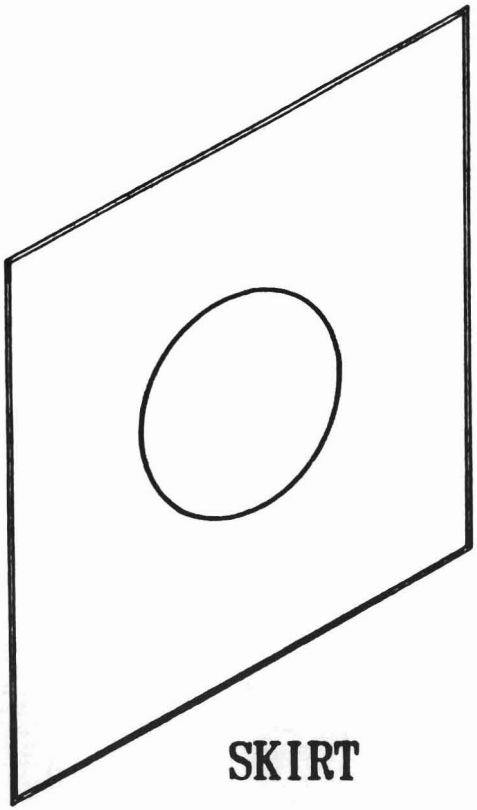
DATE:

DRAWING No.

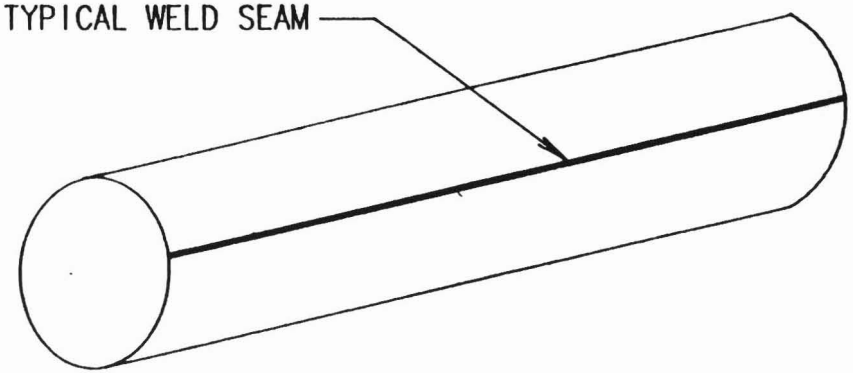
APPROVED BY:

project / owner

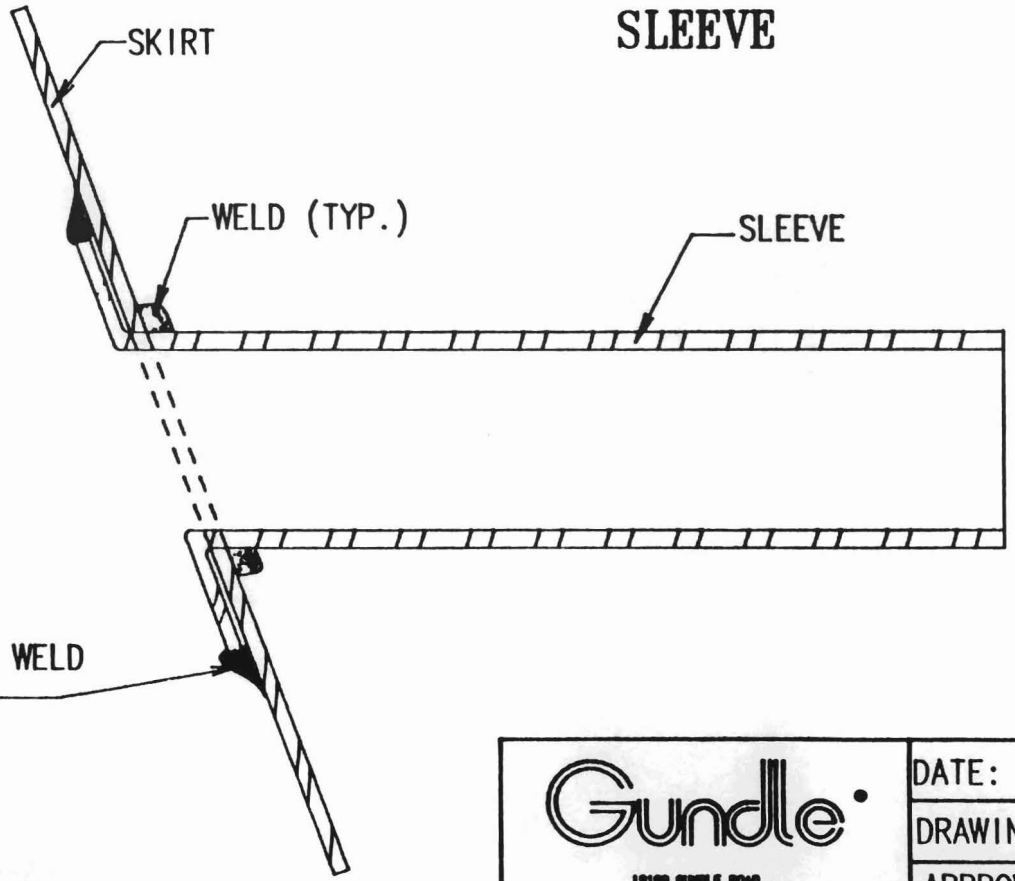
BY:



SKIRT



SLEEVE



PIPE BOOT DETAIL

NOT TO SCALE

Gundle

19100 GUNDLE ROAD
HOUSTON, TEXAS 77073

DATE: 10-23-89

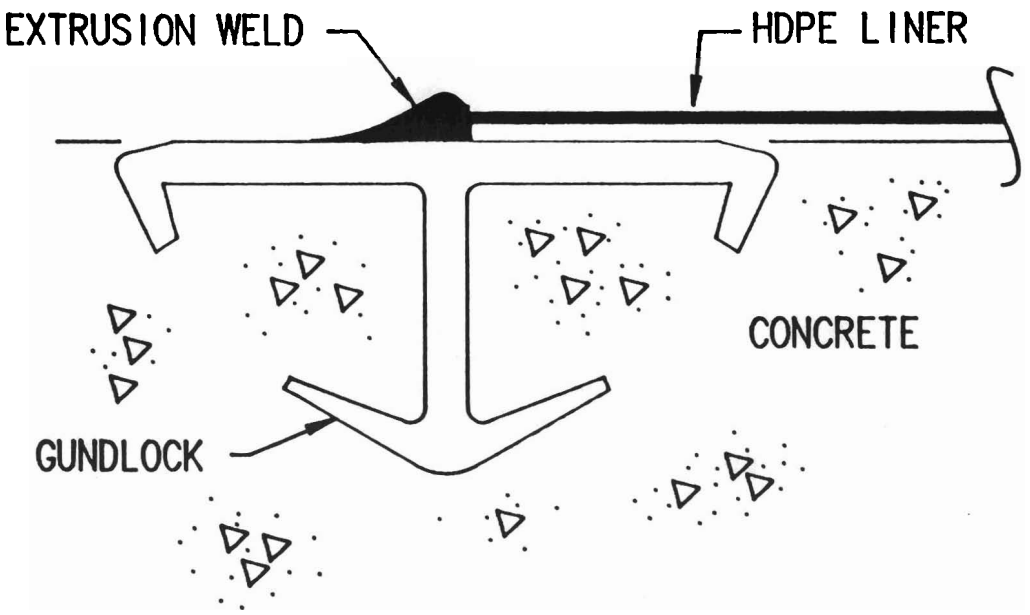
DRAWING No. STDR-B3

APPROVED BY:

project / owner

TYPICAL PIPE BOOT DETAIL

BY: BK



TYPICAL GUNDLOCK DETAIL

(not to scale)

Gundle

DATE: 10-23-89

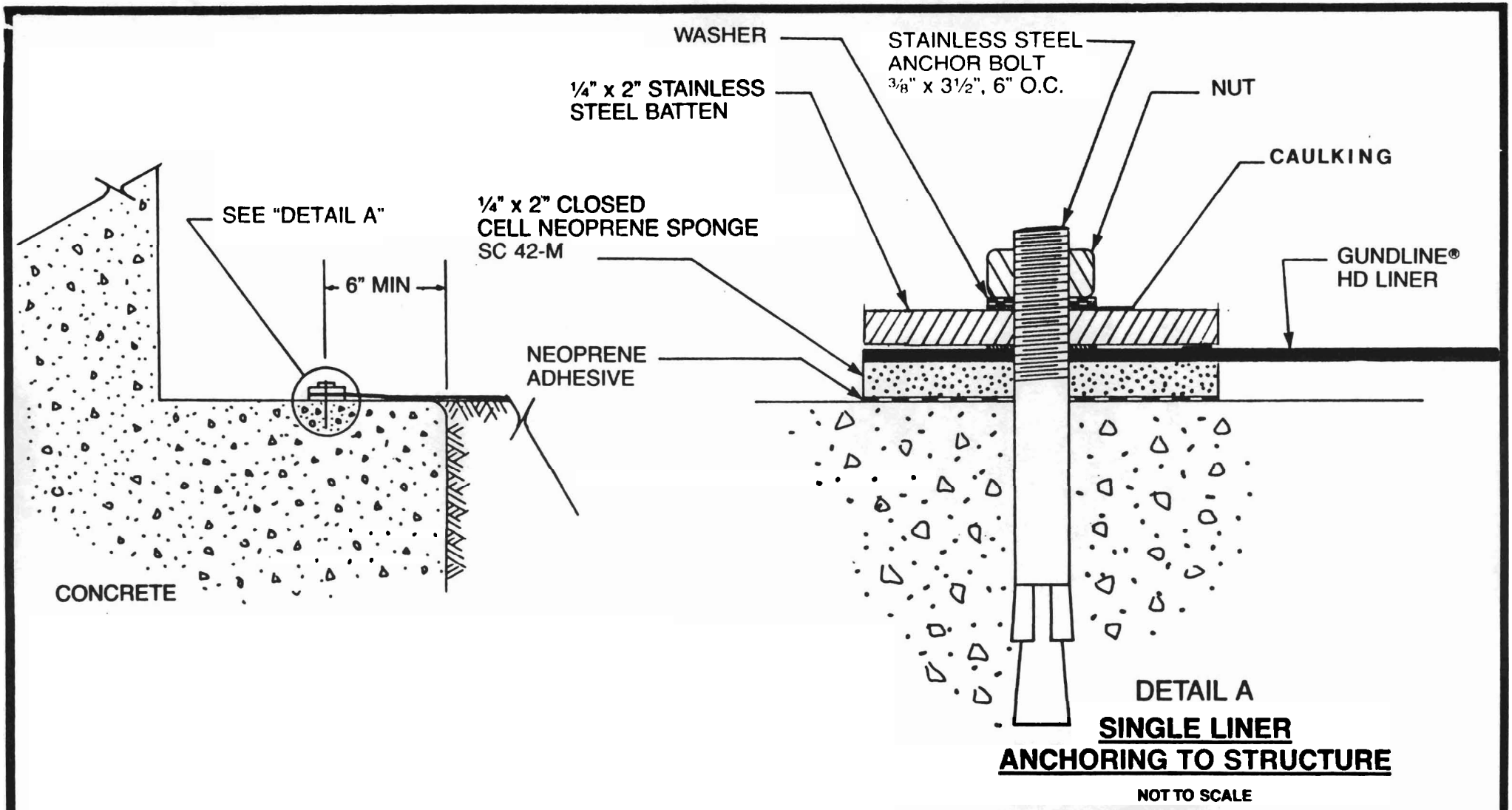
DRAWING No. STDR-82

APPROVED BY: PSP

project / owner

GUNDLOCK STRIP

BY: PP

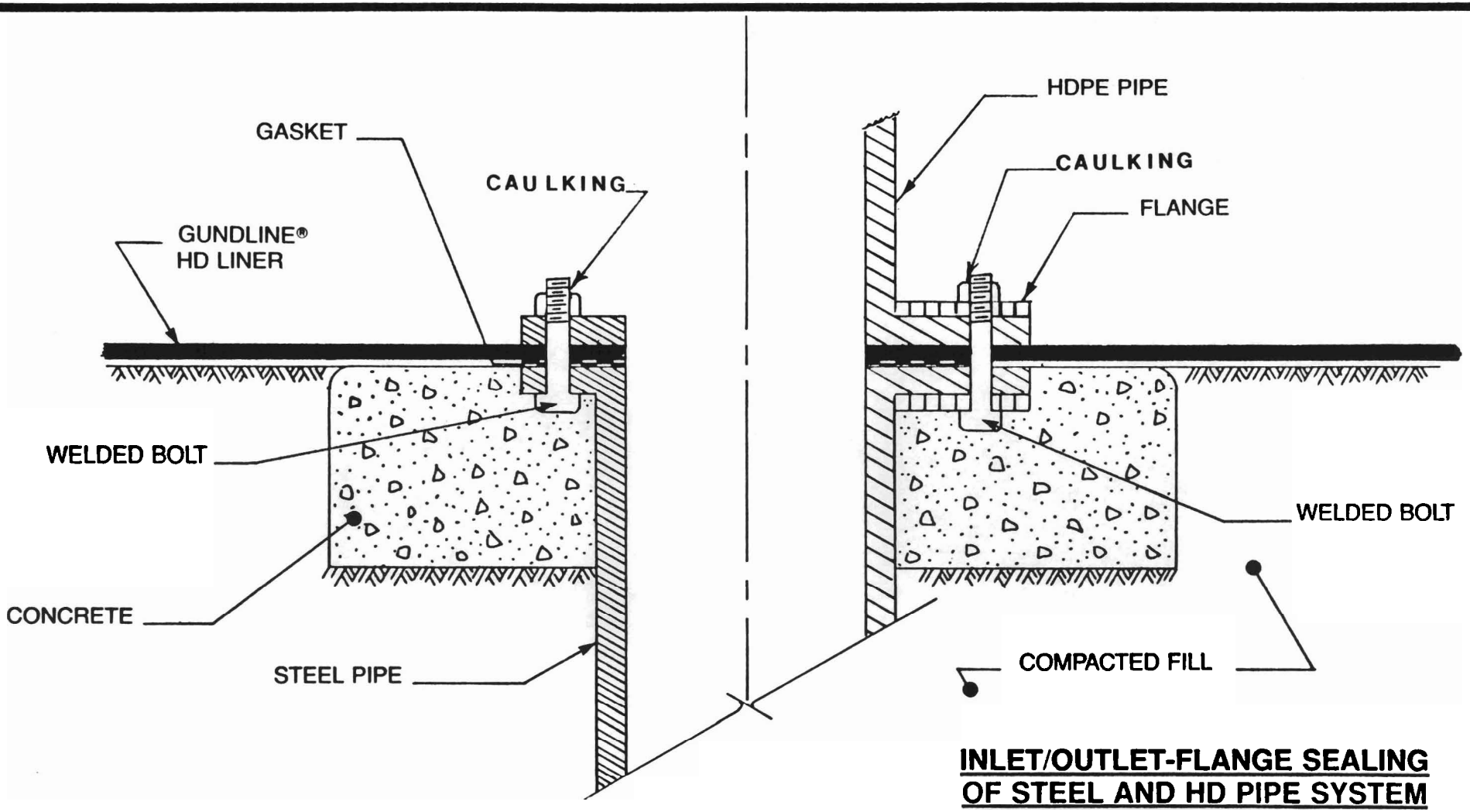


DETAIL A

SINGLE LINER
ANCHORING TO STRUCTURE

NOT TO SCALE

Gundle® Lining Construction Corp 1340 E. RICHEY RD. HOUSTON, TEXAS 77073	DATE: 11-15-84 DRAWING No. SD01 APPROVED BY:
TYPICAL DETAIL	BY:



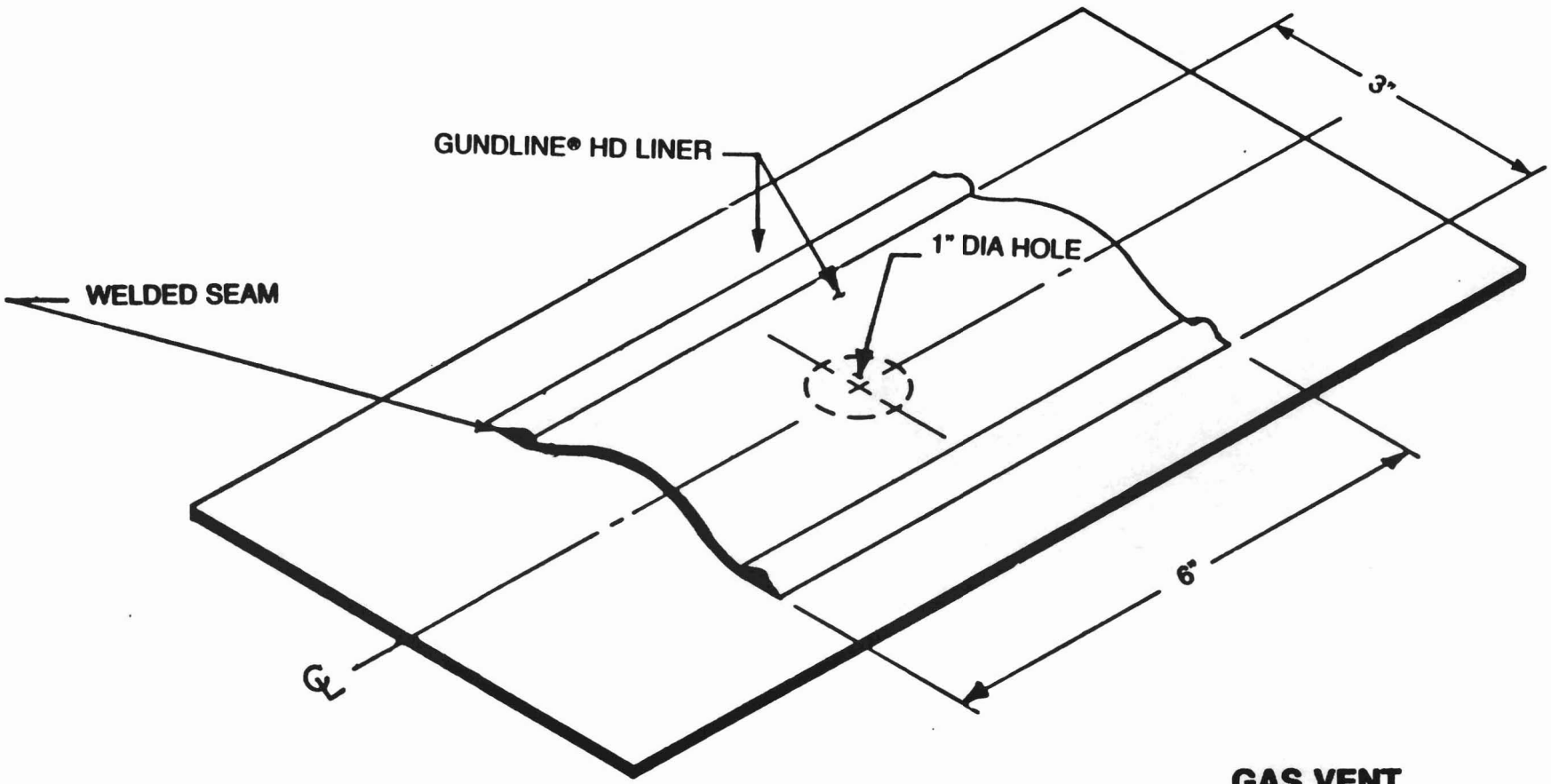
INLET/OUTLET-FLANGE SEALING OF STEEL AND HD PIPE SYSTEM

NOT TO SCALE

Gundle®
Lining Construction Corp
1340 E. RICHEY RD. HOUSTON, TEXAS 77073

DATE: 11-16-84
DRAWING No. SD04
APPROVED BY:
BY:

TYPICAL DETAIL



GAS VENT

NOT TO SCALE

Gundle® Lining Construction Corp 1340 E. RICHEY RD. HOUSTON, TEXAS 77073	DATE: 11-16-84 DRAWING No. SD05 APPROVED BY:
TYPICAL DETAIL	BY: