PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL

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ROCKY MOUNTAIN ARSENAL
TECHNICAL SUPPORT AND SERVICES

Response Action Plan
for the
Basin F Interim Response Action Waste Pile

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92337R01

ROCKY MOUNTAIN ARSENAL
TECHNICAL SUPPORT AND SERVICES

Response Action Plan
for the
Basin F Interim Response Action Waste Pile

Document Control Number 5300-01-09-AAJQ

October 1992

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U.S. Army Program Manager
For Rocky Mountain Arsenal

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
10/00/92

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
RESPONSE ACTION PLAN FOR THE BASIN F INTERIM RESPONSE ACTION WASTE PILE

5. FUNDING NUMBERS

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
ROY F. WESTON, INC.
LAKEWOOD, CO

8. PERFORMING ORGANIZATION REPORT NUMBER
92337R01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
ROCKY MOUNTAIN ARSENAL (CO.). PMRMA
COMMERCE CITY, CO

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

THE BASIN F WASTE PILE IS CONSTRUCTED WITH A DOUBLE LINER SYSTEM THAT INCLUDES A LEACHATE COLLECTION SYSTEM AND A LEAK DETECTION SYSTEM. THIS RESPONSE ACTION DESCRIBES THE CONSTRUCTION OF THE WASTE PILE AND ITS COMPONENT SYSTEM. IT ALSO DISCUSSES THE MECHANISMS THAT ARE IN PLACE TO ENSURE PROPER, TIMELY DETECTION AND RESPONSE TO ABNORMAL LIQUIDS IN THE LEAK DETECTION AND COLLECTION SYSTEM. THIS RAP ALSO DESCRIBES THE NORMAL WASTE PILE OPERATING CONDITIONS AGAINST WHICH ABNORMAL CONDITIONS WILL BE EVALUATED. THIS REPORT IS ORGANIZED INTO THREE SECTIONS. BACKGROUND INFORMATION ON THE WASTE PILE AND ITS ASSOCIATED SYSTEMS IS DESCRIBED IN SECTION 2. SECTION 3 PRESENTS TECHNICAL INFORMATION TO SUPPORT THE SELECTED ALR AND RLL RATES FOR THE BASIN F WASTE PILE. SECTION 4 PRESENTS THE RESPONSE ACTIONS CORRESPONDING TO ALR AND RLL RATES FOR THE BASIN F WASTE PILE.

14. SUBJECT TERMS
LINERS, IRA F

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

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Attachment 3 Standard Operating Procedures for the Basin F IRA Waste Pile

Attachment 4 Basin F IRA Waste Pile Material Properties and Test Results

GLOSSARY OF ACRONYMS

ALR	Action Leakage Rate
CHWMA	Colorado Hazardous Waste Management Act
EPA	U.S. Environmental Protection Agency
HDPE	High Density Polyethylene
IRA	Interim Response Action
m	meter
mm	millimeter
O&MM	Operation and Maintenance Manual
ORAL	Operational Response Action Level
PVC	Polyvinyl Chloride
RAP	Response Action Plan
RCRA	Resource Conservation and Recovery Act
RLL	Rapid and Large Leakage
RMA	Rocky Mountain Arsenal
sec	second
SOP	Standard Operating Procedure

Response Action Plan
for the
Basin F Interim Response Action
Waste Pile

SECTION 1
OBJECTIVE

1.1 INTRODUCTION

The Interim Response Action (IRA) for the Rocky Mountain Arsenal's (RMA) Basin F included placing soils and sludges, which were contaminated by the constituents of Basin F, into the Basin F Waste Pile. The Waste Pile is being operated in substantive compliance with the requirements of the Resource Conservation and Recovery Act (RCRA), as amended by the 1984 Hazardous and Solid Waste Amendments and the Colorado Hazardous Waste Management Act (CHWMA).

The Basin F Waste Pile is constructed with a double liner system that includes a leachate collection system and a leak detection and collection system. This Response Action Plan (RAP) describes the construction of the Waste Pile and its component systems. It also discusses the mechanisms that are in place to ensure proper, timely detection and response to abnormal liquids in the leak detection and collection system. This RAP also describes the normal Waste Pile operating conditions against which abnormal conditions will be evaluated.

The U.S. Environmental Protection Agency (EPA) has issued guidelines for identifying normal and excessive leakage rates for hazardous waste landfills in its document entitled, "Requirements for Hazardous Waste Landfill Design, Construction and Closure" (EPA/625 4-89/022). This RAP compares observed leakage rates at the Waste Pile to EPA guidance for determining action leakage rates (ALR) and rapid and large leakage

(RLL) rates. In addition, this RAP enumerates response actions that will be taken when threshold leakage rates are discovered in the leak detection system. Operational procedures to monitor the leak detection system and minimize leachate generation also are presented.

The description of the Basin F IRA Waste Pile is based on construction documents that were prepared by Woodward-Clyde Consultants in association with HDR Infrastructures, Inc. These documents were originally prepared for the U.S. Army Corps of Engineers, Omaha District, on 20 May 1987. As-Built drawings were prepared from these documents dated June 6, 1989. The discussions and diagrams included in this report are based on the As-Built drawings, which are the best available information on the construction of the Waste Pile systems.

1.2 REPORT ORGANIZATION

This Basin F Waste Pile RAP is organized into three sections. Background information on the Waste Pile and its associated systems is described in Section 2. Section 3 presents technical information to support the selected ALR and RLL rates for the Basin F Waste Pile, and Section 4 presents the response actions corresponding to ALR and RLL rates for the Basin F Waste Pile.

SECTION 2

BACKGROUND

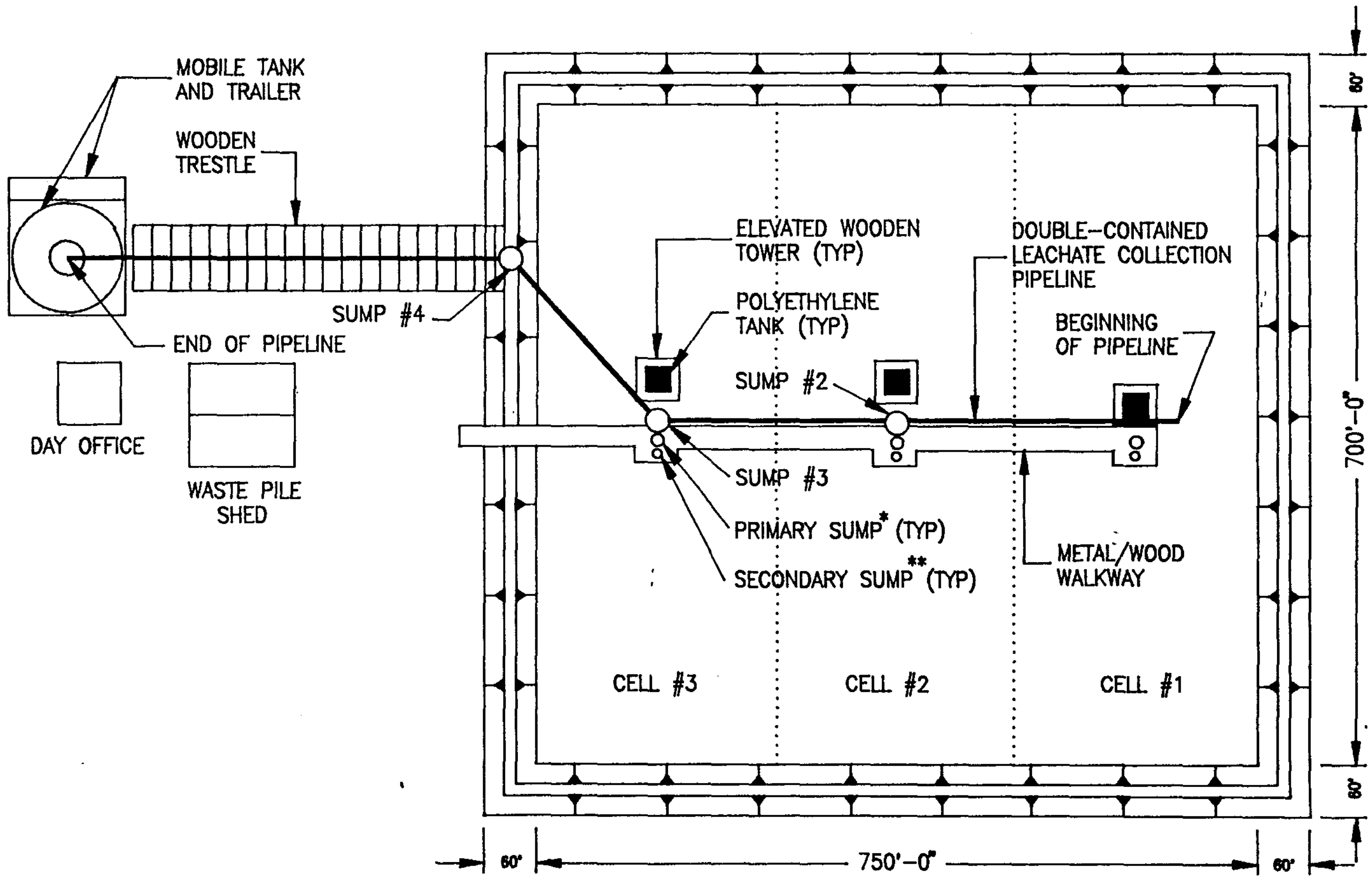
2.1 WASTE PILE

The Basin F IRA Waste Pile is a three-celled, double-lined, enclosed and capped waste pile located over a portion of the former Basin F site in Section 26 of the RMA. The Waste Pile contains materials that were excavated from the former Basin F during the IRA. Approximately 500,000 cubic yards of excavated debris was placed into three double-lined cells. The Waste Pile was then capped to inhibit surface moisture from infiltrating into the cells and contributing to leachate production. The Basin F Waste Pile is contained within a 19.5-acre fenced area, has a surface area of approximately 16 acres, and is approximately 53 feet high at its crown. The top of the Waste Pile is sloped approximately 3 percent to aid in removing precipitation from the cap; the sides are sloped 4 feet horizontal for each foot of vertical rise. As a result of the surface and side slopes, each cell within the Pile is approximately 4.5 acres. Figure 1 shows a plan view and Figure 2 shows a profile of the Waste Pile and associated systems.

2.1.1 Liner System

The liner system is composed of two 60-mil high density polyethylene (HDPE) liners, two 200-mil geonets, a 12-ounce geotextile fabric, and a 36-inch soil layer. The arrangement of these composite layers is shown in Figure 3. The bottom geonet and lower HDPE sheet form the leak detection system, while the upper geonet and HDPE sheet form the leachate collection system. Silt is prevented from entering the leachate collection system by the geotextile fabric. The 36-inch soil layer provided protection to the liner system while the Waste Pile was being filled and also served as a filter medium. According to the As-Built drawings, the base liner system rests upon a 12-inch thick "prepared foundation."

The Waste Pile cap system is composed of a 60-mil HDPE sheet, two 200-mil geonets, and a 12-ounce geotextile fabric, which is covered by 12 inches of soil, 12 inches of compacted clay, 6 inches of topsoil, RMA1528.MNpj–030292



LEGEND:

* THE PRIMARY SUMP COLLECTS LEACHATE FROM THE LEACHATE COLLECTION SYSTEM.

** THE SECONDARY SUMP COLLECTS LEACHATE FROM THE LEAK DETECTION SYSTEM.

NOT TO SCALE

WESTON MANAGERS DESIGNERS/CONSULTANTS 215 Union Boulevard Suite 550 Lakewood, CO 80228 (303) 980-6800	ROCKY MOUNTAIN ARSENAL COMMERCE CITY, COLORADO RESPONSE ACTION PLAN	BASIN F WASTE PILE PLAN	FIGURE 1

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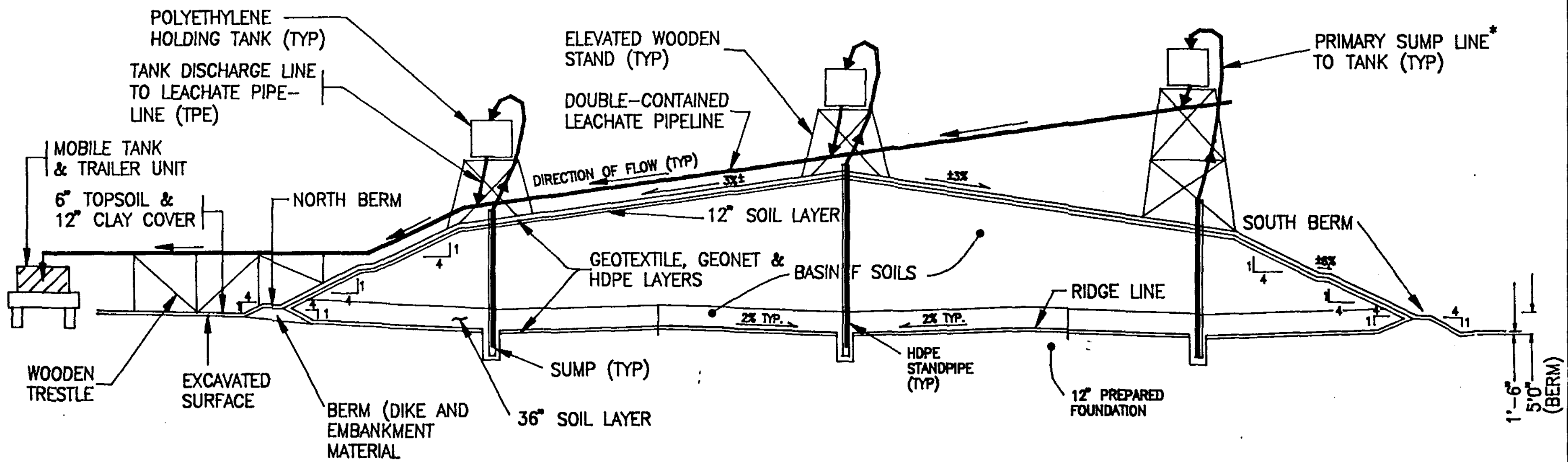

LEGEND:

* THE PRIMARY SUMP COLLECTS LEACHATE FROM THE LEACHATE COLLECTION SYSTEM.

** THE SECONDARY SUMP COLLECTS LEACHATE FROM THE LEAK DETECTION SYSTEM.

NOTE:

LEACHATE COLLECTION SYSTEM NOT SHOWN FOR CLARITY. SECONDARY SUMP LINE IS ALSO PUMPED INTO HOLDING TANK. TANK IS DISCHARGED INTO LEACHATE PIPELINE.

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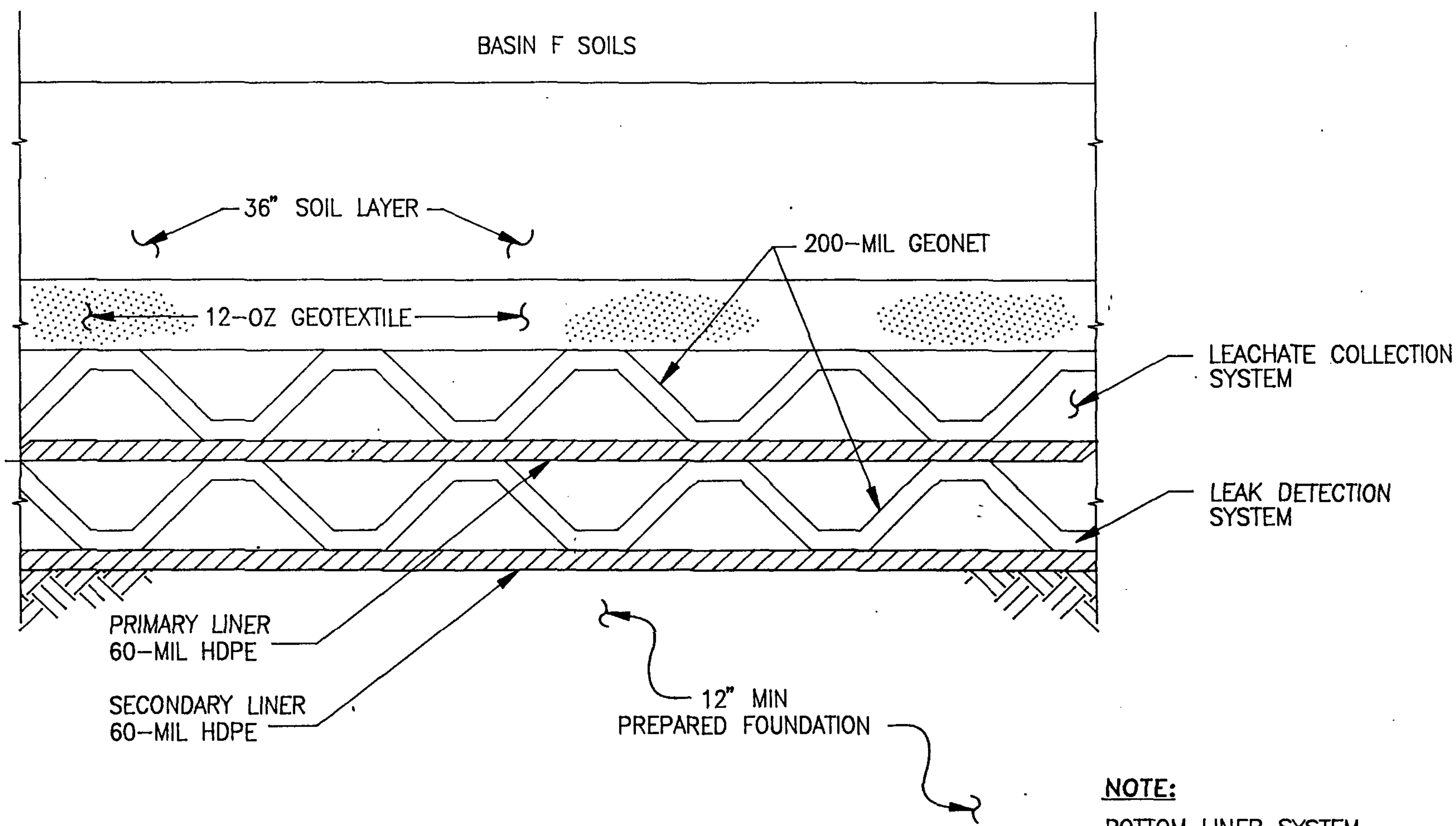

NOTE:

BOTTOM LINER SYSTEM SHOWN AS PER ORIGINAL DESIGN PLANS

NOT TO SCALE

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and a vegetative cover. The upper geonet serves as a drainage layer, which collects and transports infiltration moisture via gravity to the toe of the Waste Pile. The lower geonet serves as the leachate collection system. The cap system rests upon a 12-inch thick soil layer. The configuration of the cap system is shown in Figure 4.

All of the 60-mil HDPE liners are anchored into earth trenches around the perimeter of the Waste Pile. The 60-mil liner from the cap system and the top 60-mil liner from the base system are compression sealed near the base of the Waste Pile. This design encapsulates the entire Waste Pile and creates the leachate collection and detection systems. Figure 5 shows the anchoring detail for the Waste Pile.

2.1.2 Leachate Collection System

The Basin F Waste Pile is divided into three cells, each of which contains a system to collect leachate. The cells were created by grading the base of the Waste Pile during construction to provide a low point within each cell (Figure 6), and a ridge was constructed between each cell. A 2-percent slope in the floor of each cell causes leachate to flow to and collect at a collection sump in each cell. A 6-inch diameter perforated HDPE pipe was installed in the valleys of each cell to convey accumulated leachate to the primary sumps. The 200-mil geonet, described in Section 2.1.1, collects any leachate that permeates through the fill material and geotextile fabric. The leachate flows by gravity into either the valley pipes or directly into the primary leachate collection sumps. At the low point of the cell, a primary HDPE-lined leachate collection sump has been installed (identified as the primary sump). A 24-inch diameter HDPE riser provides access to the primary sump from the top of the Waste Pile. Each primary sump has an air-operated, double-diaphragm pump to lift the collected leachate through a reinforced hose into a polyethylene holding tank at the surface of the Waste Pile. Figure 7 shows the primary collection sumps, along with the pumping apparatus and construction details. Vents were installed in the Waste Pile to prevent the buildup of potentially hazardous gases under the Waste Pile cap system.

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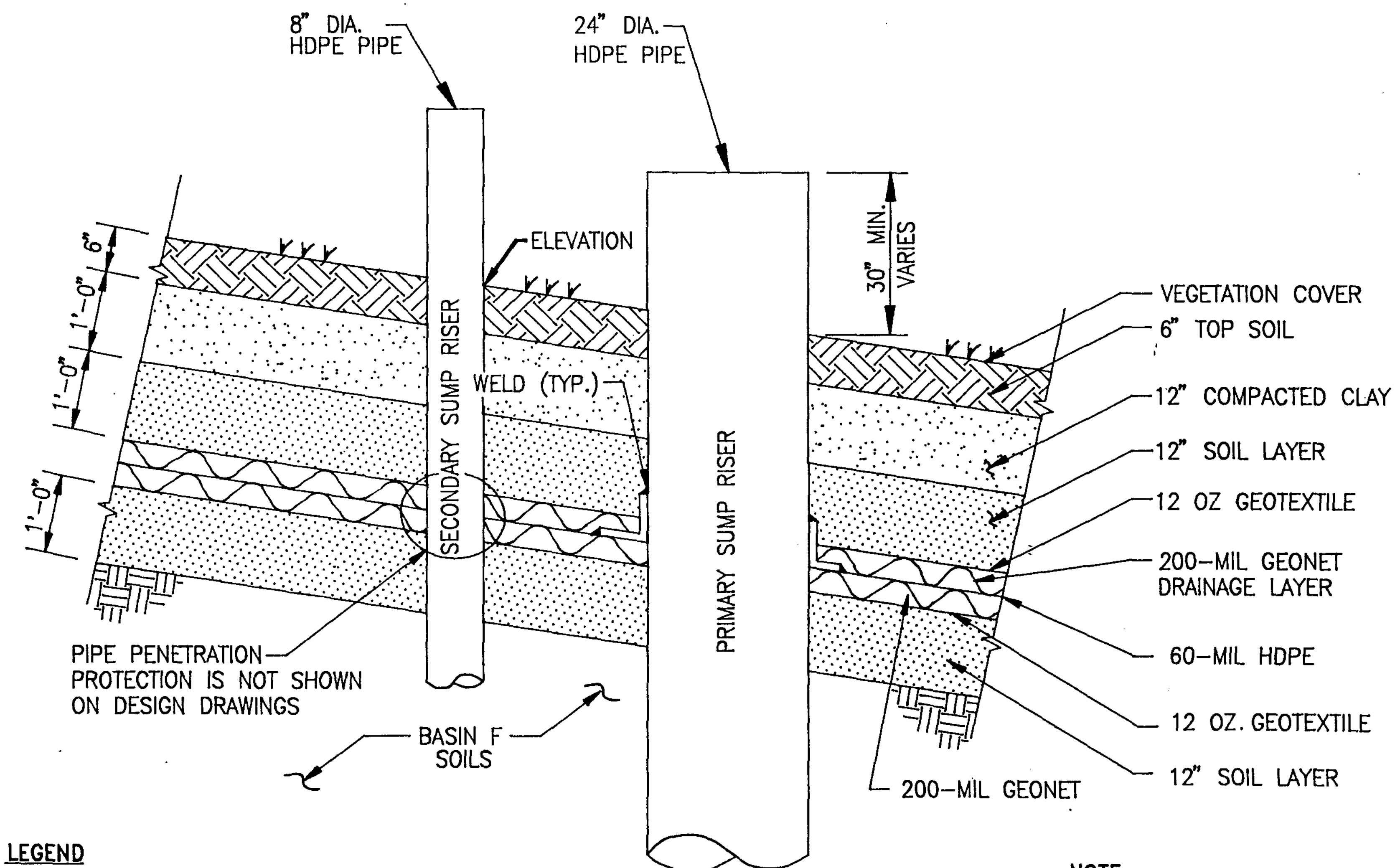

LEGEND

* THE PRIMARY SUMP COLLECTS LEACHATE FROM THE LEACHATE COLLECTION SYSTEM.

** THE SECONDARY SUMP COLLECTS LEACHATE FROM THE LEAK DETECTION SYSTEM.

NOTE:

CAP LINER SYSTEM SHOWN AS PER ORIGINAL PLANS.

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ROCKY MOUNTAIN ARSENAL
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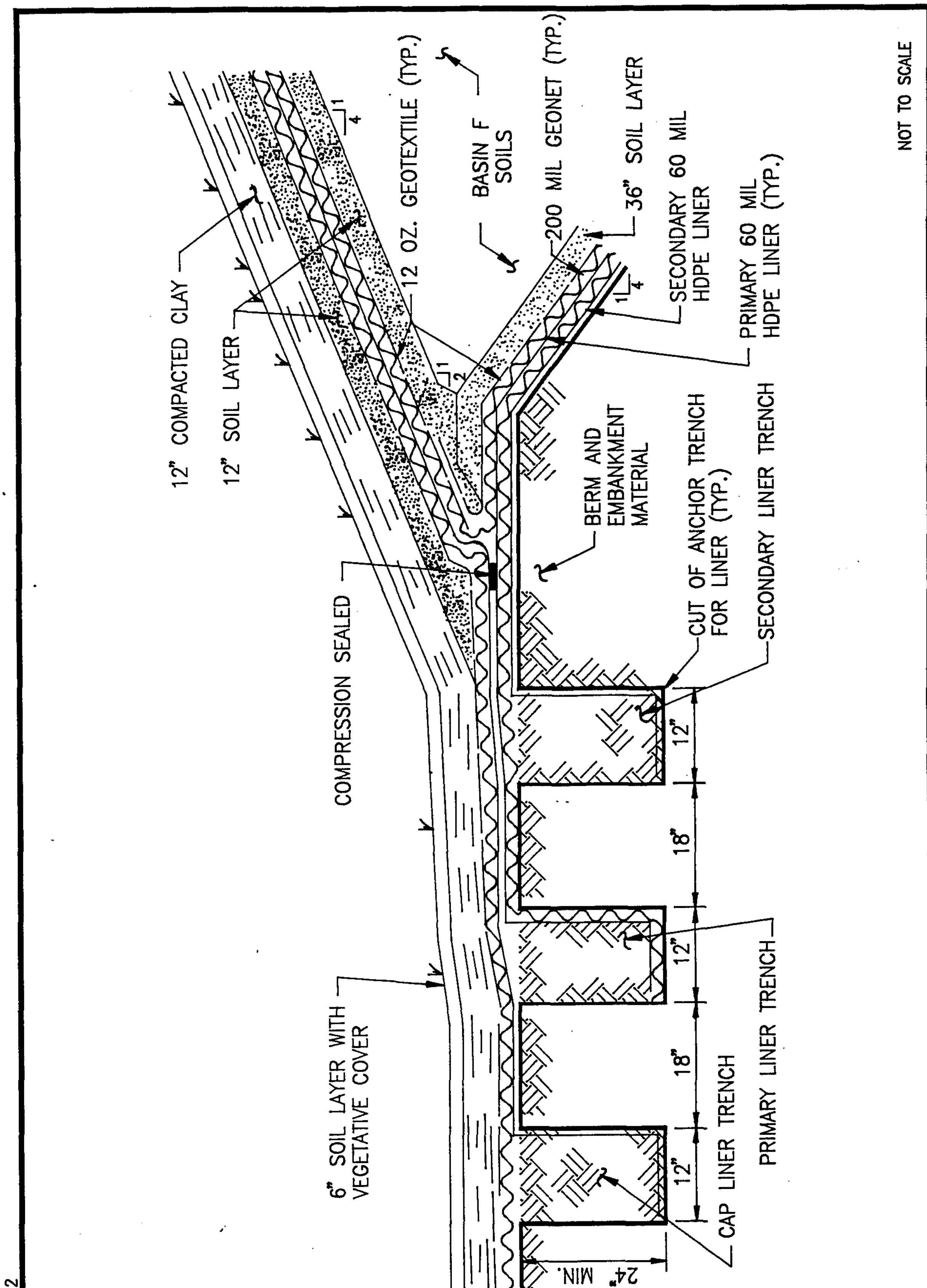
RESPONSE ACTION PLAN

BASIN F WASTE PILE
TOP LINER SYSTEM
AND RISER DETAIL

FIGURE 4



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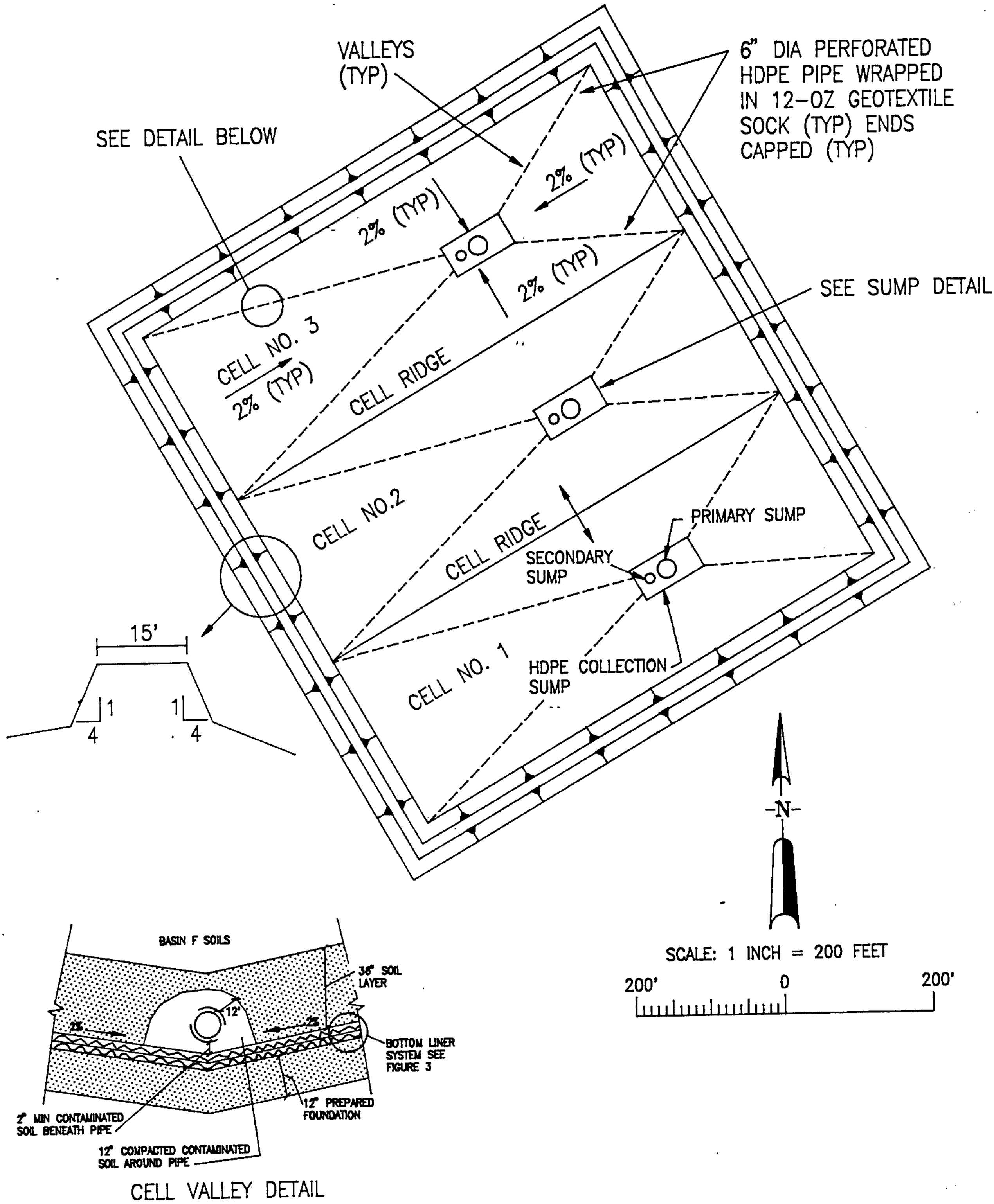
RESPONSE ACTION PLAN

BASIN F WASTE PILE
ANCHOR DETAIL

FIGURE
5



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ROCKY MOUNTAIN ARSENAL
RESPONSE ACTION PLAN

BASIN F WASTE PILE
CELL GRADING PLAN

FIGURE 6

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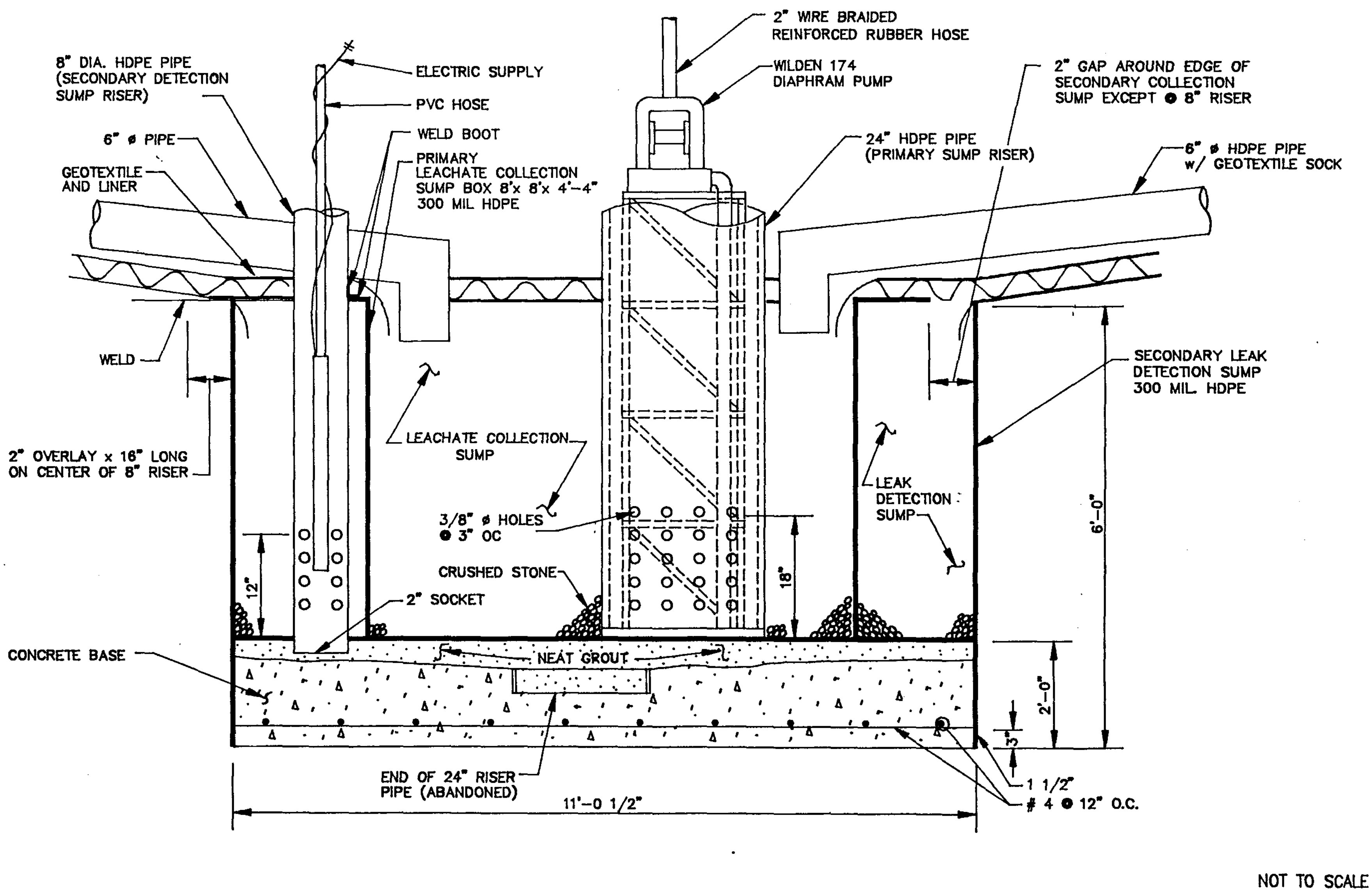

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2.1.3 Leak Detection System

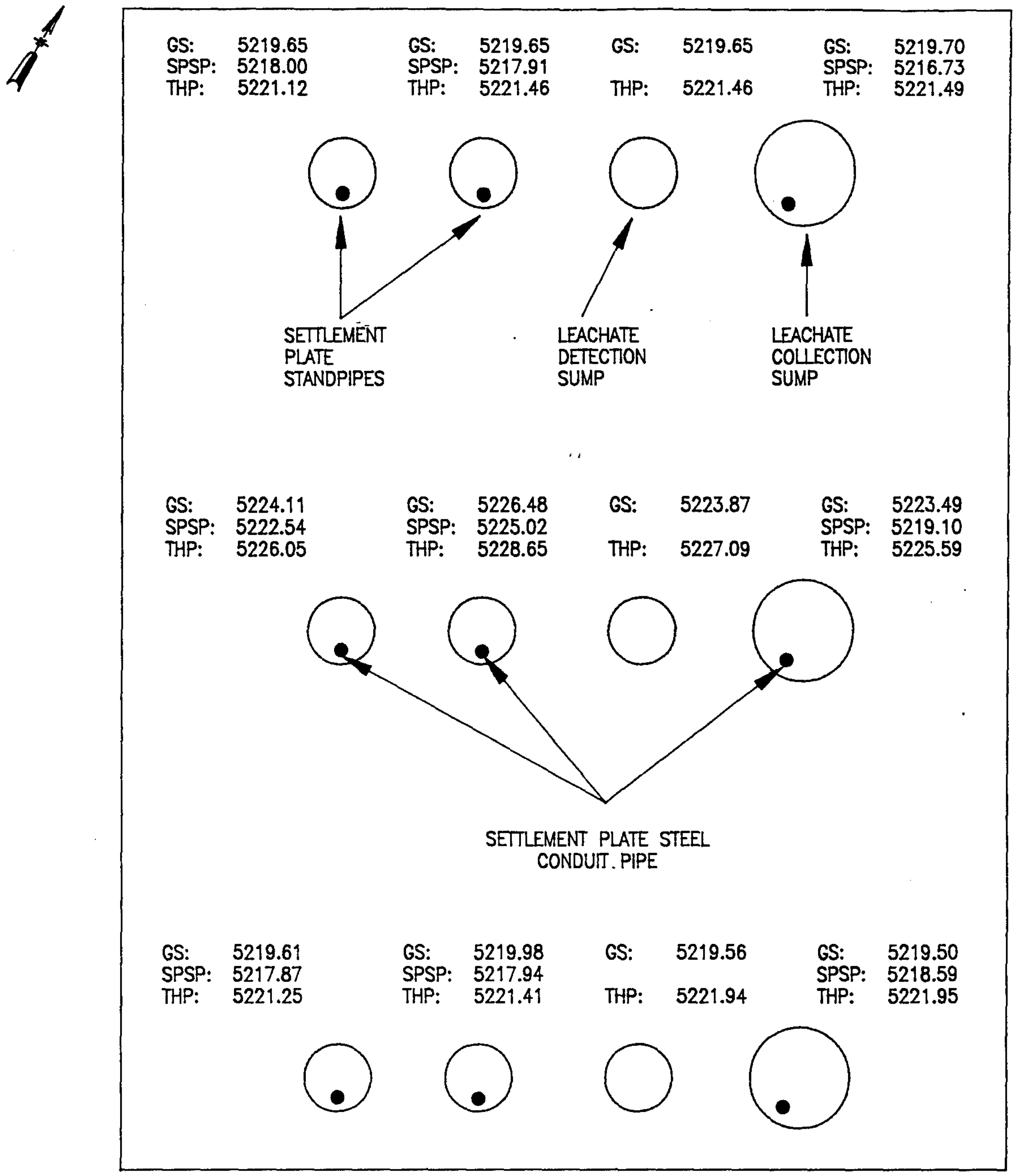
The secondary liner (shown in Figure 3) has been provided as a leak detection system to verify the integrity of the primary liner and to provide the redundancy of a secondary containment system. Any liquid that accumulates in the geonet layer above this outer boundary layer is gravity-drained to the leak detection sump (identified as the secondary sump). The secondary sump encompasses, but is separate from, the primary collection sump. Each cell's secondary sump is accessed from the top of the Waste Pile via an 8-inch diameter HDPE stand pipe. A stainless-steel submersible pump provides the lift to deliver the collected liquid to the polyethylene holding tank on the top of the Waste Pile. Figure 7 shows the secondary sump and construction details as depicted on the design drawings.

2.1.4 Settlement Measuring System

Nine settlement plates were installed at the base of the Waste Pile during its construction. A 1-inch steel pipe rises from each settlement plate to approximately the top of the Waste Pile inside a protective HDPE stand pipe. Three of these settlement pipes are located in the leachate collection sump stand pipes. The other six are in 6-inch diameter stand pipes located in a grid pattern on the surface of the Waste Pile. Elevations of the settlement pipes were taken after installation. Figure 8 shows the locations and elevations of these settlement plates as of October 2, 1989. The plates are used to monitor the absolute settlement of the Waste Pile foundation by comparing their absolute elevations with preset benchmarks located outside the Basin F area. Relative movements of the Waste Pile are measured by comparing the difference between the plates and the top of the Waste Pile.

2.1.5 Venting System

There are 25 top vents spaced at equal distances over the Waste Pile. They are protected by bollards made of 6-inch diameter, orange-colored, schedule 40 polyvinyl chloride (PVC) pipe. Figures 9 and 10 show the location and construction details of the vents. Penetrations of the vent pipes into the Waste Pile liner are



LEGEND

GS: GROUND SURFACE ELEVATION
SPSP: SETTLEMENT PLATE STEEL PIPE ELEVATION
THP: TOP HDPE PIPE ELEVATION

BENCH MARK:

BRASS CAP IN CONCRETE MONUMENT
ELEV. 5188.65 (ABOVE M.S.L.)

±80' SE OF NE CORNER SECTION
26, AT 9TH AND "D" STREETS

RMA1526.MBJL-080891

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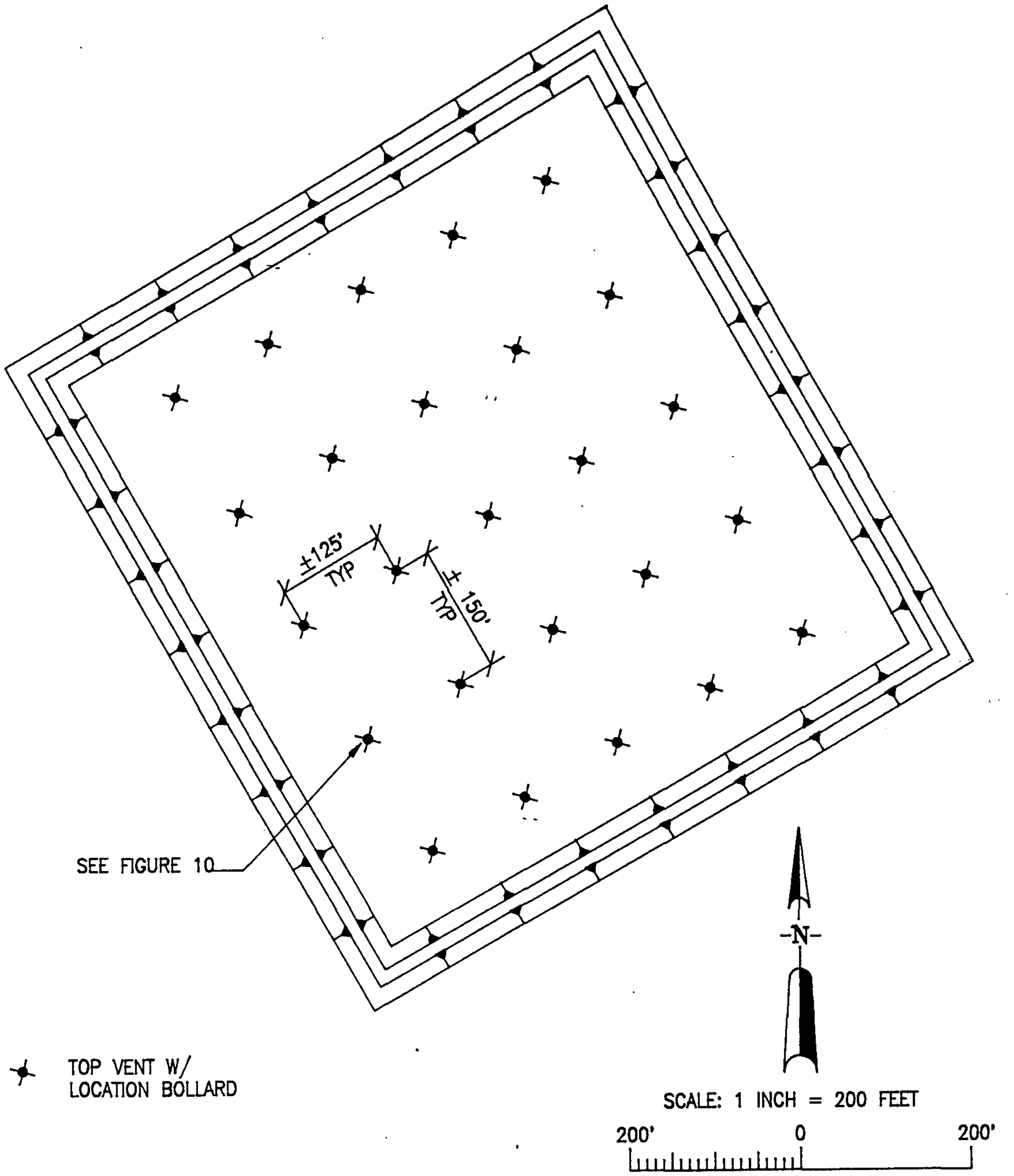
ROCKY MOUNTAIN ARSENAL RESPONSE ACTION PLAN

BASIN F WASTE PILE
HDPE STANDPIPE AND SETTLEMENT PLATE
STEEL PIPE ELEVATIONS AS-BUILT SURVEY

FIGURE 8



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ROCKY MOUNTAIN ARSENAL
RESPONSE ACTION PLAN

BASIN F WASTE PILE
TOP VENT LOCATIONS

FIGURE 9

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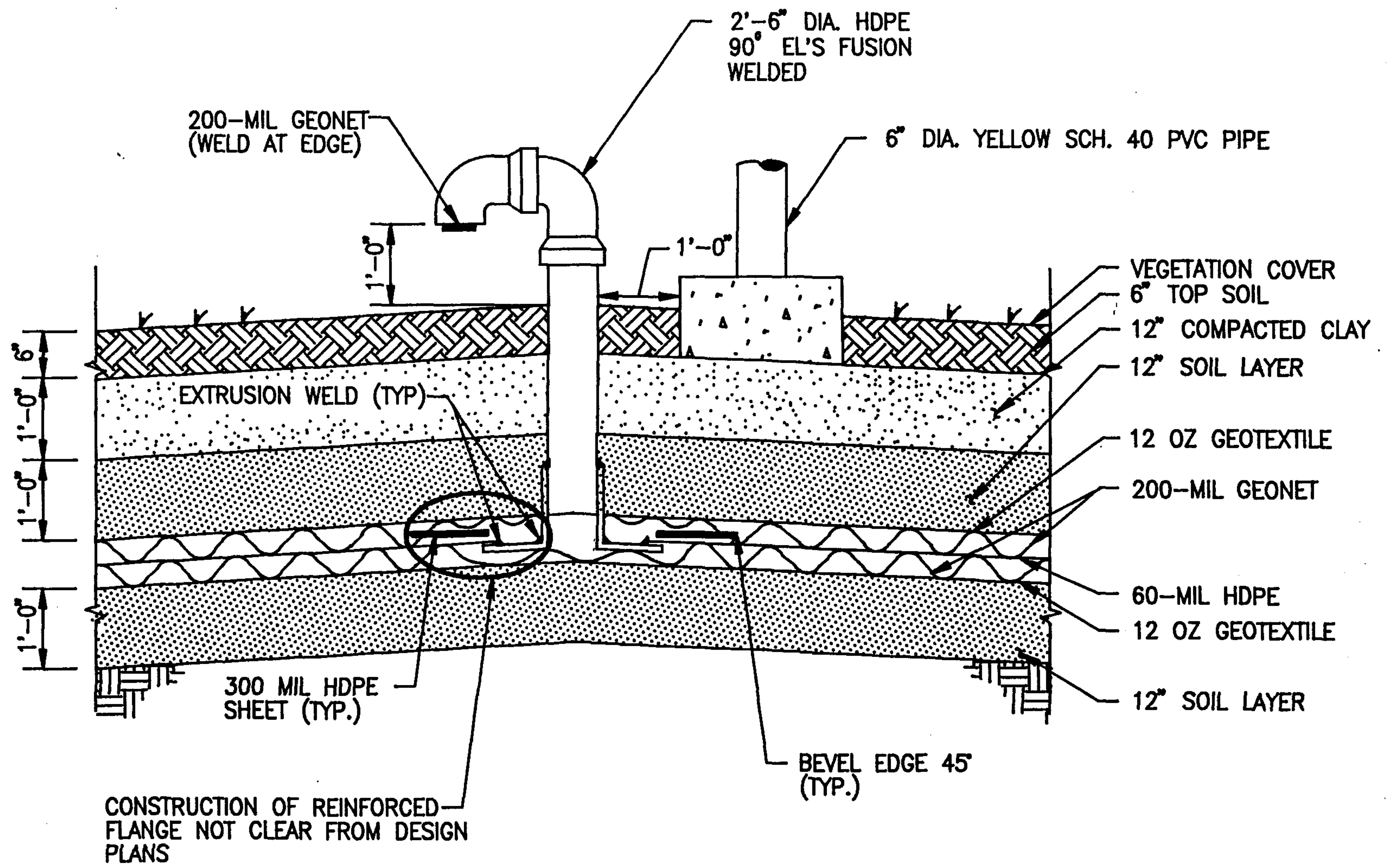

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protected by a strengthened, welded flange. This oversized flange inhibits precipitation from entering the primary leachate collection system and Waste Pile material.

2.2 LEACHATE COLLECTION SYSTEM PIPELINE

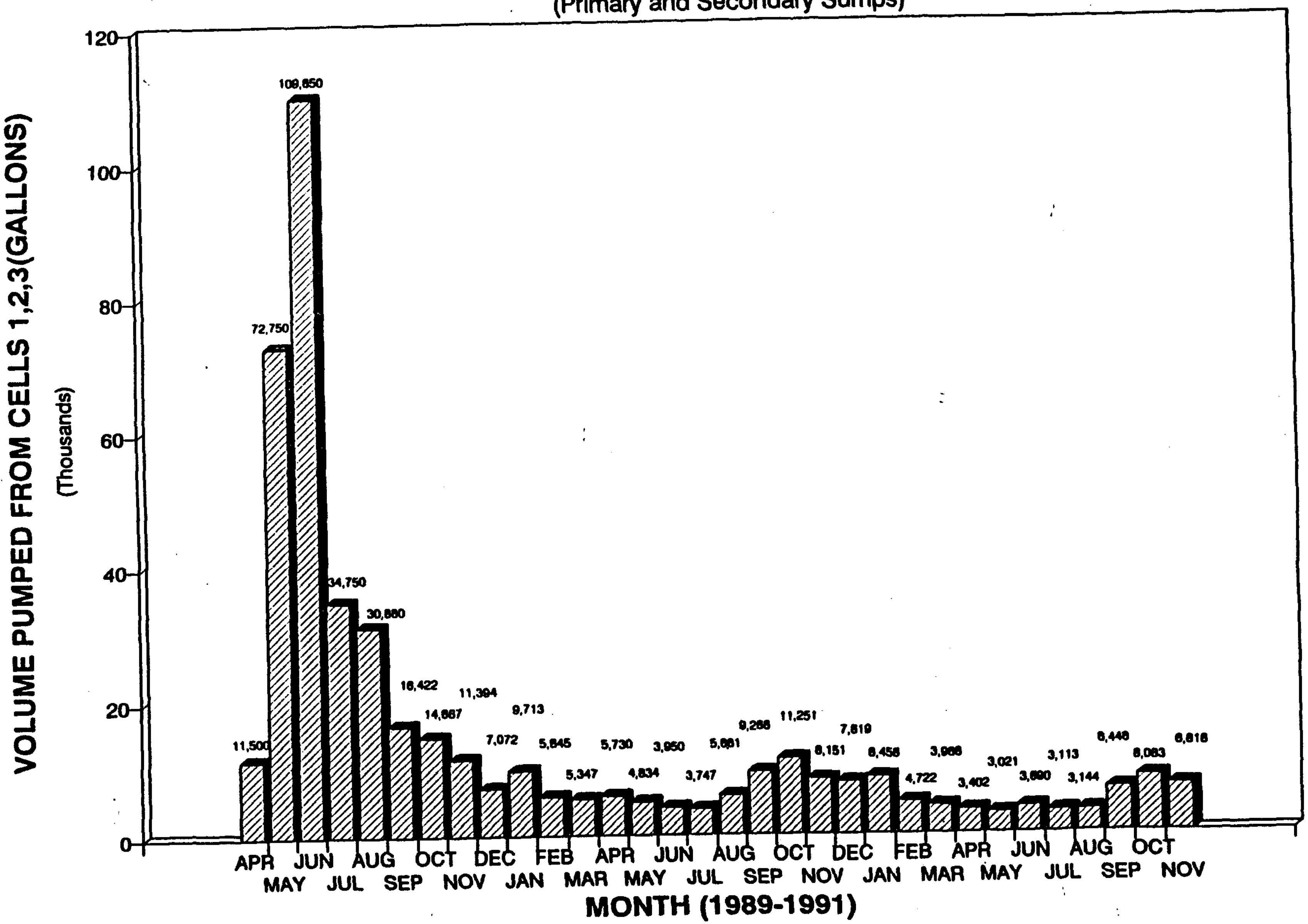
Leachate and other liquids from the primary and secondary collection sumps are pumped to tanks located on top of the Waste Pile. The volume of liquid collected is measured and then discharged into the leachate pipeline system. The leachate pipeline system consists of rigid PVC piping and flexible hose, all enclosed in an outer pipe that provides secondary containment. The pipeline conveys the liquid by gravity from the top of the Waste Pile to a mobile tank at the base of the Waste Pile. The liquid is collected in the mobile tank unit and then transported to Pond A (a covered, double-lined holding pond used to store Basin F liquid). A schematic of the leachate collection pipeline is shown in Figure 2.

Each of the primary and secondary leachate collection sumps are measured daily for the presence of liquid according to Basin F IRA Standard Operating Procedure (SOP) 453.3 - "Waste Pile Maintenance: Sump Pumping" (see Attachment 3). Any leachate present in the sumps is pumped out to the polyethylene holding tanks. SOP 453.3 was developed to ensure that leachate removal operations would keep the liquid level in each sump to a minimum. Historic monthly pumping volumes for the sumps are shown in Graph 1. The pumping volume has been adjusted by deleting the volume of water added for sump testing. After pumping, the liquid level in each sump is remeasured and recorded along with the volume of liquid that was removed from the sump.

2.3 WASTE CONSTITUENTS

According to the requirements of EPA's proposed Leak Detection Rule, a description of the waste constituents must be included in a RAP. Attachment 1 contains a summary of analyses that have been previously conducted on the Basin F liquid by various laboratories. The constituents found in the Basin F liquid and Waste Pile leachate are both organic and inorganic in nature. Tables 1 through 6 of Attachment 1

GRAPH 1
BASIN F WASTE PILE
HISTORIC MONTHLY PUMPING VOLUME
(Primary and Secondary Sumps)



summarize the results of analyses conducted for fiscal year 1989 and 1990 on the Waste Pile leachate. The analytical methods are those used during the Remedial Investigation of the RMA site.

SECTION 3

BASIN F IRA - WASTE PILE

3.1 POTENTIAL SOURCES OF FLUID IN THE LEAK DETECTION SYSTEM

The following list identifies scenarios that could result in liquid entering the Waste Pile's leak detection system:

1. Normal permeation through the primary liner may occur.
2. The primary liner may be torn by a foreign object penetrating the surface or side slopes of the liner.
3. Differential settlement of the foundation or waste within the pile may tear the liner.
4. The primary liner may have a defective seam.
5. Mechanical forces may tear the primary liner or seam.
6. Precipitation may penetrate faulty seams around pipes or sump risers at the top of the Waste Pile that are included within the lined area.
7. Precipitation and moisture may have collected in the geonet or on the liner surface during construction.
8. Ground-water intrusion may occur through separations in the liner system.
9. Seam and liner failures due to chemical exposure, shrinkage, or aging may occur.

A more detailed description of the scenarios is presented below.

Scenario No. 1

Normal or De minimus liquid permeation is defined as leaks through the primary liner from minor, isolated breaches. EPA has stated that some liquid is expected to be found in the leak detection system due to these mechanisms and is considered acceptable.

Scenario No. 2

As noted in Section 2.1.1, the cap liner is covered by 12 inches of soil, 12 inches of compacted clay, and 6 inches of topsoil. This 30-inch cover affords protection to the cap system and minimizes the opportunity for foreign objects to penetrate the primary liner. These cover layers also provide protection to the liner from rapidly changing temperatures and freeze-thaw stresses. In addition to the physical design, operation and maintenance procedures have been developed and implemented to protect the top liner. These procedures include restricting all construction work to the surface of the Waste Pile (i.e., no excavation is allowed) and restricting access to and from the site by using a locked security fence. As indicated in the design drawings, the bottom liner system was covered by 36 inches of soil to protect the liner from damage during the filling operation of the Waste Pile. This 36-inch layer minimizes the likelihood of foreign objects penetrating the bottom liner. As a result of this design, maintenance, and operation of the Waste Pile, the opportunity for scenario No. 2 occurring has been minimized.

Scenario No. 3

In scenario No. 3, two settlement problems must be evaluated. The first is settlement in the underlying foundation soils of the Waste Pile due to the applied weight of the waste within the Pile. As described in Section 2.1.4, nine settlement plates were installed in the Waste Pile to measure foundation settlement. As part of ongoing facilities operation and maintenance, surveys are made to measure the settlement of the foundation (both overall settlement and differential settlement). The second settlement problem is within the material of the Waste Pile. As the material is compacted from its own weight and the loss of moisture, leachate will drain out, possibly causing differential settlement within the Pile. The surface of the Waste Pile may reflect this differential settlement. Topographic surveys of the surfaces monitor the differential settlement over time. For both the top and bottom liners, such a settlement could cause a tear and result in a leak. This failure would result in scenario No. 3 contributing to leachate being found in the leak detection system.

Scenario No. 4

During construction of the Waste Pile, the liner seams were quality checked for integrity by two independent laboratories and found to be non-defective. Thus, there is little reason to suspect excessive leakage would result from a defective seam.

Scenario No. 5

Mechanical forces that could adversely affect the primary liner could be generated by a failure of the anchor trench holding the liners. In this situation, stresses caused by the expansion and contraction of the primary liner due to thermal gradients could affect the integrity of the seams and cause a leak. However, the earth cover limits the expansion and contraction potential of the primary liner. Mechanical forces imposed on the liner seams by a side slope failure of the Waste Pile could also cause a breach in the cap. Changing moisture conditions and settling within the pile may cause situations that could contribute to side slope movements. The slopes of the Waste Pile were designed with factors of safety according to generally acceptable engineering practices (see Figure 2); therefore, there is no reason to suspect a slope failure due to original design defects. Weekly inspections of the Waste Pile are made according to SOP 433.0.

Scenario No. 6

Precipitation infiltration and condensation around the vents and sump risers are other potential sources of leakage into the leak detection system. Figures 4 and 10 show the construction of the pipe penetrations into the liner system. There is a possibility that leaks could develop around these penetrations, but the system was designed to minimize the likelihood of this type of leakage occurring.

Scenario No. 7

During construction of the Waste Pile, precipitation may have entered the leak detection system while it was open and exposed. Most of the precipitation from these events should already have been drained and collected, which may account for in the decreasing pumpage volumes collected from the system (Graph 1). Therefore, this scenario is not likely to contribute additional liquid to the leak detection or the leachate collection systems.

Scenario No. 8

Scenario No. 8 indicates that ground-water infiltration into the leak detection system may contribute to collected leachate and create a "false" leak. Ground-water depth is approximately 30 feet below the bottom of the Waste Pile, making this scenario an unlikely source of liquid.

Scenario No. 9

Scenario No. 9 identifies chemical exposure, shrinkage, or aging as potential causes for liner failure with resulting leakage into the leak detection system. Shell Oil Company conducted extensive testing on various materials proposed to be used for the primary and secondary liners and HDPE was found to have a good resistivity to Basin F liquid constituents (Attachment 4). Nonetheless, potential synergistic effects of these constituents could cause a failure and allow leachate to enter into the leak detection system.

Liner shrinkage is minimized by the earth cover of the Waste Pile and the inherent properties of HDPE. Shrinkage stresses, even though minimal, could cause premature liner failure.

The effects of liner aging from ultra violet light exposure are minimized by the protective earthen cover material. It is not anticipated that aging will be a significant source of leaks.

In summary, any liquid found in the leak detection system will most likely be generated from the following scenarios, which are presented in order of anticipated likelihood:

1. Normal permeation through the primary liner.
3. Differential settlement from the foundation and Waste Pile constituents.
5. Mechanical forces, such as the anchorage system pulling loose or slope failure.
6. Precipitation infiltrating around the vent pipes and sump risers.
9. Chemical exposure and shrinkage.

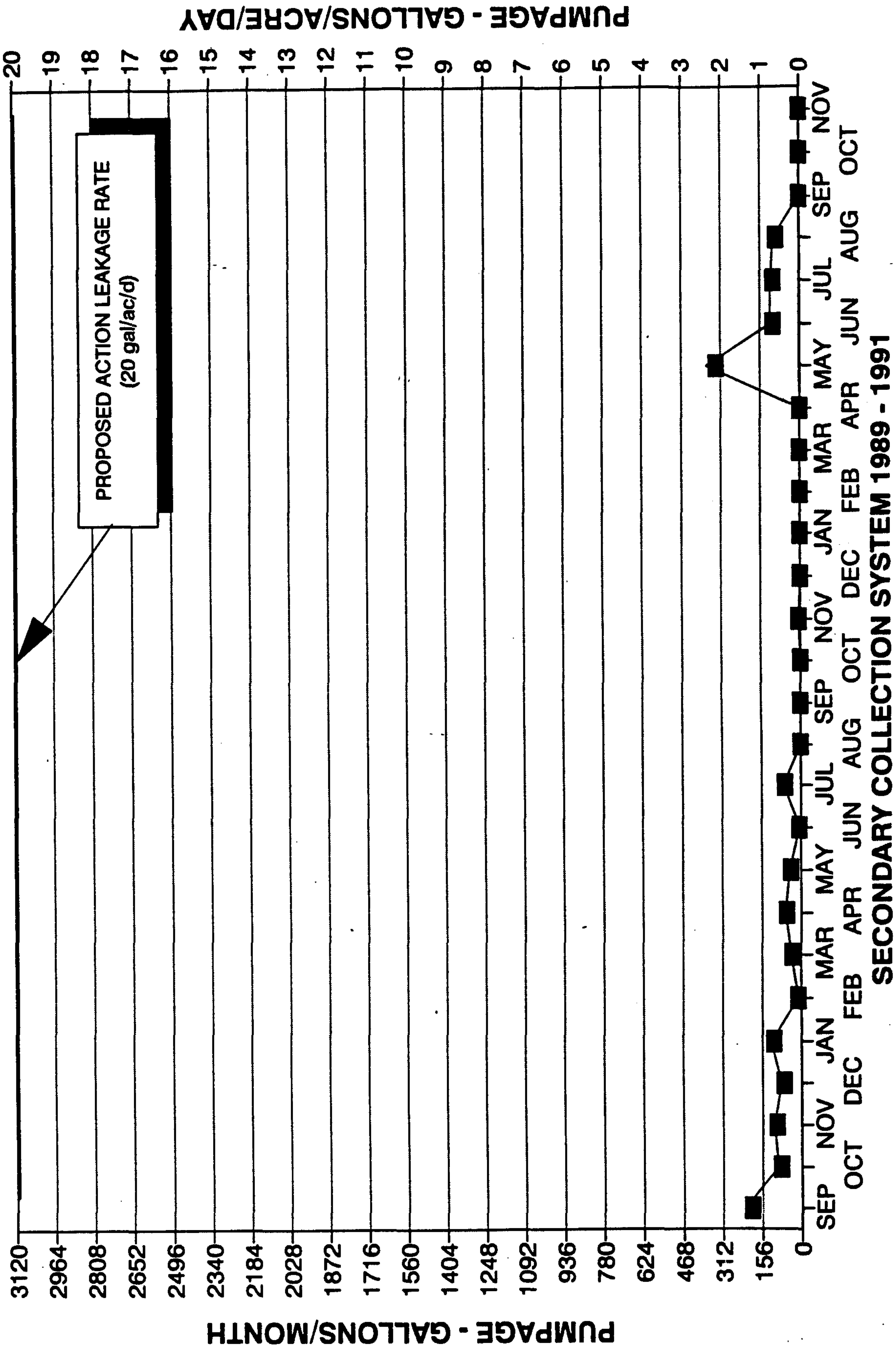
SOPs for the inspection and maintenance of the Waste Pile specifically address and monitor scenarios 3 and 5. These procedures (SOPs 433.0 and 453.1) can be found in the "Basin F IRA Operation/Maintenance Manual and Inspection Procedures" (O&MM). Copies of these SOPs are included in Attachment 3. These procedures would provide early detection for these scenarios, and thus allow remedial steps to be taken to limit any leakage that may occur.

3.2 OBSERVED LEAKAGE RATES

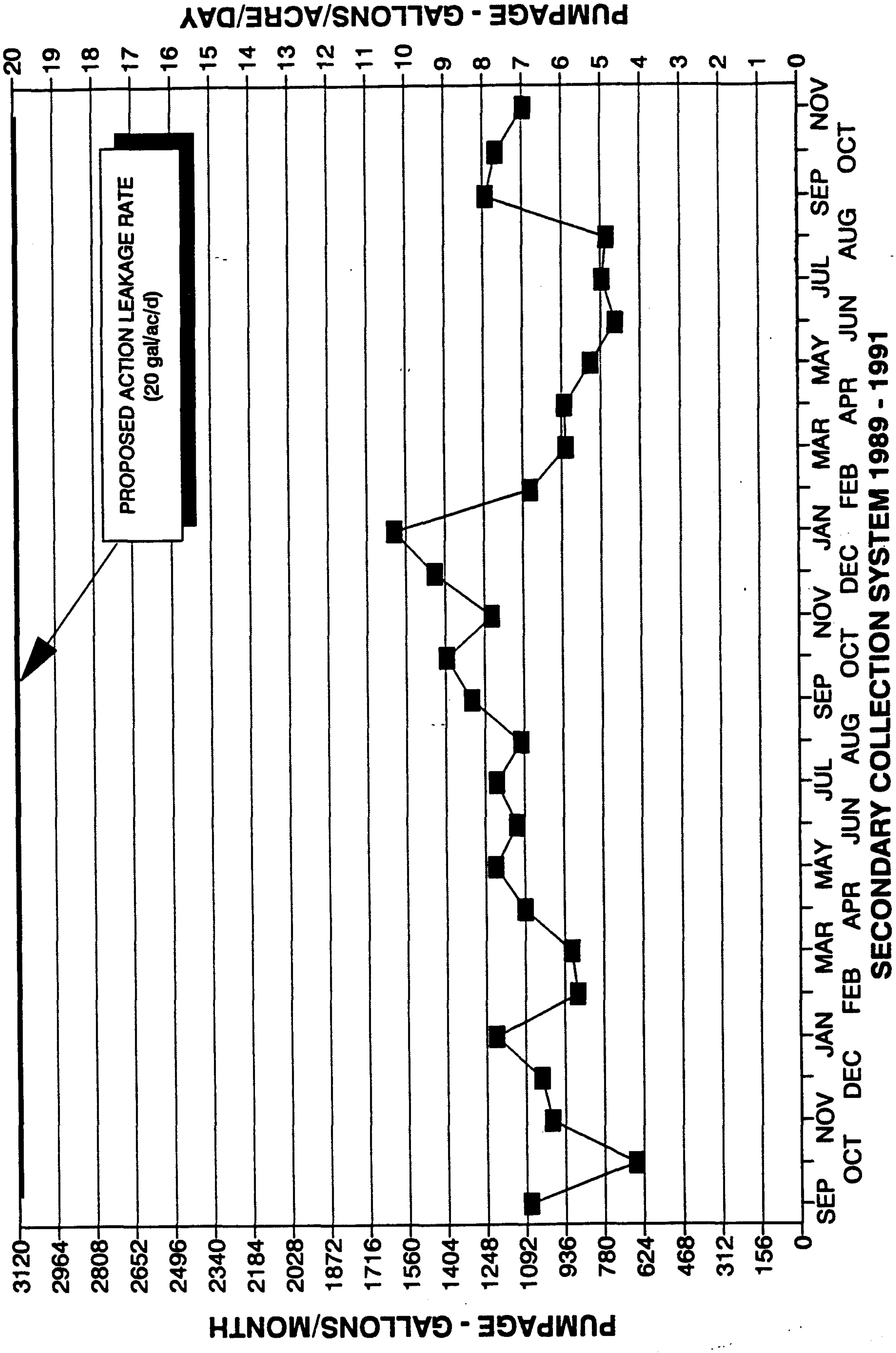
Leachate levels within the secondary sumps are measured on a daily basis, and any liquid found is removed to keep the liquid levels at least 1 foot below the top of the sumps. The liquid levels in each sump are measured before and after pumping. The volume of leachate removed is measured according to SOPs set forth in the Basin F IRA O&MM. The volume of leachate pumped and the level of the liquid in the secondary sumps are presented in Basin F IRA Monthly Operations Reports.

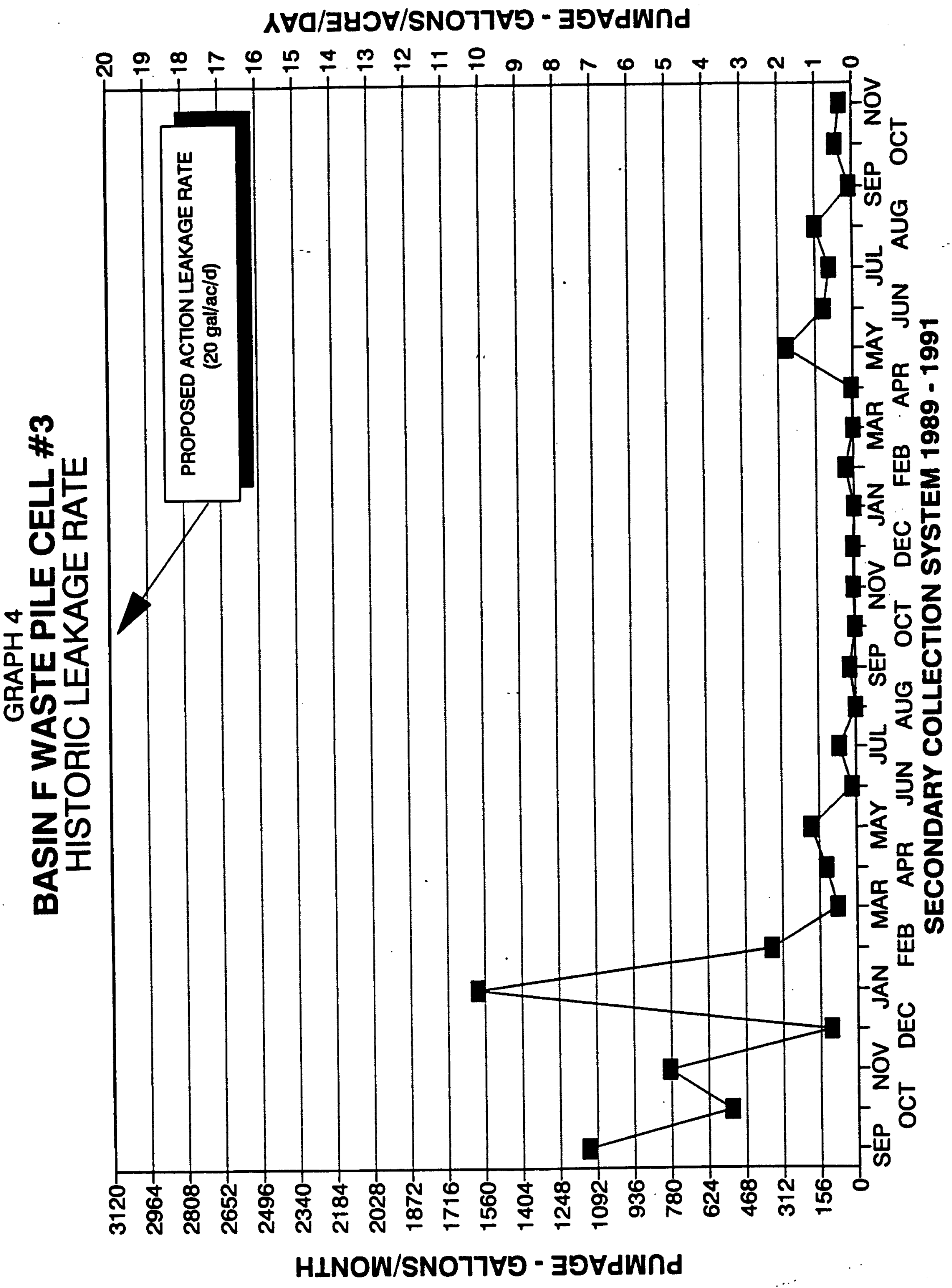
The volume of leachate collected and removed from the leak detection system for the three cells between October 1989, and November 1991, is summarized in Graphs 2, 3, and 4. These figures will be used in Section 3.4 to compare with EPA recognized, normally expected leakage rates.

GRAPH 2
BASIN F WASTE PILE CELL #1
HISTORIC LEAKAGE RATE



GRAPH 3
BASIN F WASTE PILE CELL #2
HISTORIC LEAKAGE RATE




GRAPH 4
BASIN F WASTE PILE CELL #3
HISTORIC LEAKAGE RATE
PROPOSED ACTION LEAKAGE RATE
(20 gal/ac/d)
PUMPAGE - GALLONS/ACRE/DAY
PUMPAGE - GALLONS/MONTH
SECONDARY COLLECTION SYSTEM 1989 - 1991
SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0 156 312 468 624 780 936 1092 1248 1404 1560 1716 1872 2028 2184 2340 2496 2652 2808 2964 3120

A trend analysis of the leachate collection rates shown in Graph 3 for Cell #2 shows that the amount of leachate being collected from the leak detection system for Cell #2 is now decreasing and that the current rate of collection is approaching 5 gallons/acre/day. The same analysis for Cells #1 and #3 generally indicates a trend toward zero. Table 1 compiles the trend in the amount of leachate collection for the secondary cells as shown in Graphs 2, 3, and 4.

Table 1
Secondary Cells
Leachate Collection Trend Summary

Cell	Leachate Collected
1	1 gal/acre/day
2	5 gal/acre/day
3	1 gal/acre/day

The historic data shown in Graphs 5, 6, and 7 indicate that the liquid levels in the secondary sumps have generally been maintained below the top of the HDPE collection sump after the first 9 months of stabilization. Fluctuations are evident in the liquid levels, which may be due to a variety of causes including isolated blockages, meteorological and hydrogeological factors, and pumping problems.

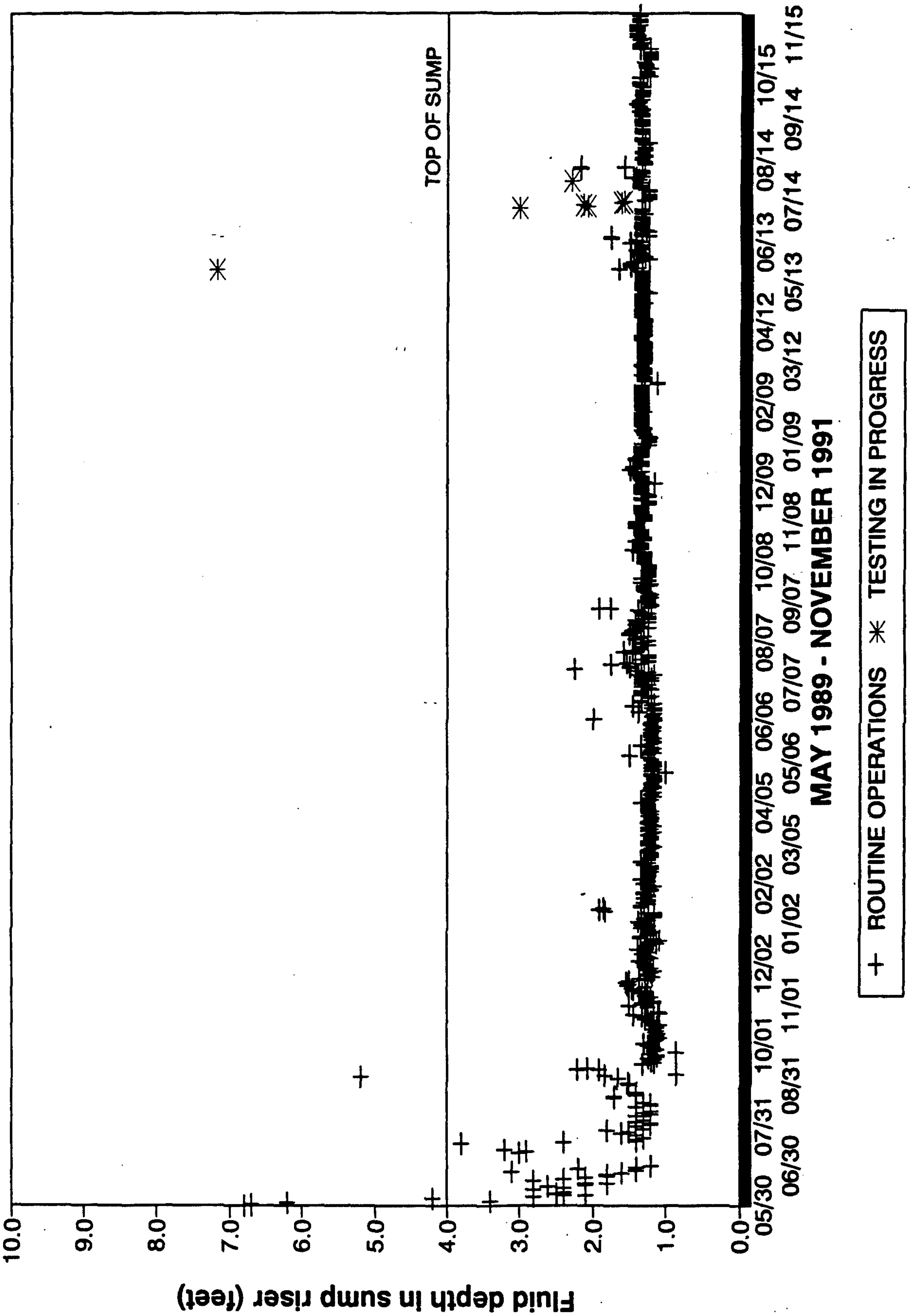
3.3 OPERATIONAL RESPONSE ACTION LEVEL

One of the purposes of this document is to develop operational response actions based on liquid levels in the primary sumps. An operational response action will be initiated depending on the height of the liquid in the primary sumps and is more fully described in SOP 453.3 for sump pumping. The reasons for initiating an operational response action at the operational response action level (ORAL) are to maintain a low hydraulic pressure on the bottom liner, to minimize the accumulation of leachate, and to protect the critical liner/HDPE collection sump interface.

GRAPH 5

BASIN F WASTE PILE MAY 1989-NOV 1991

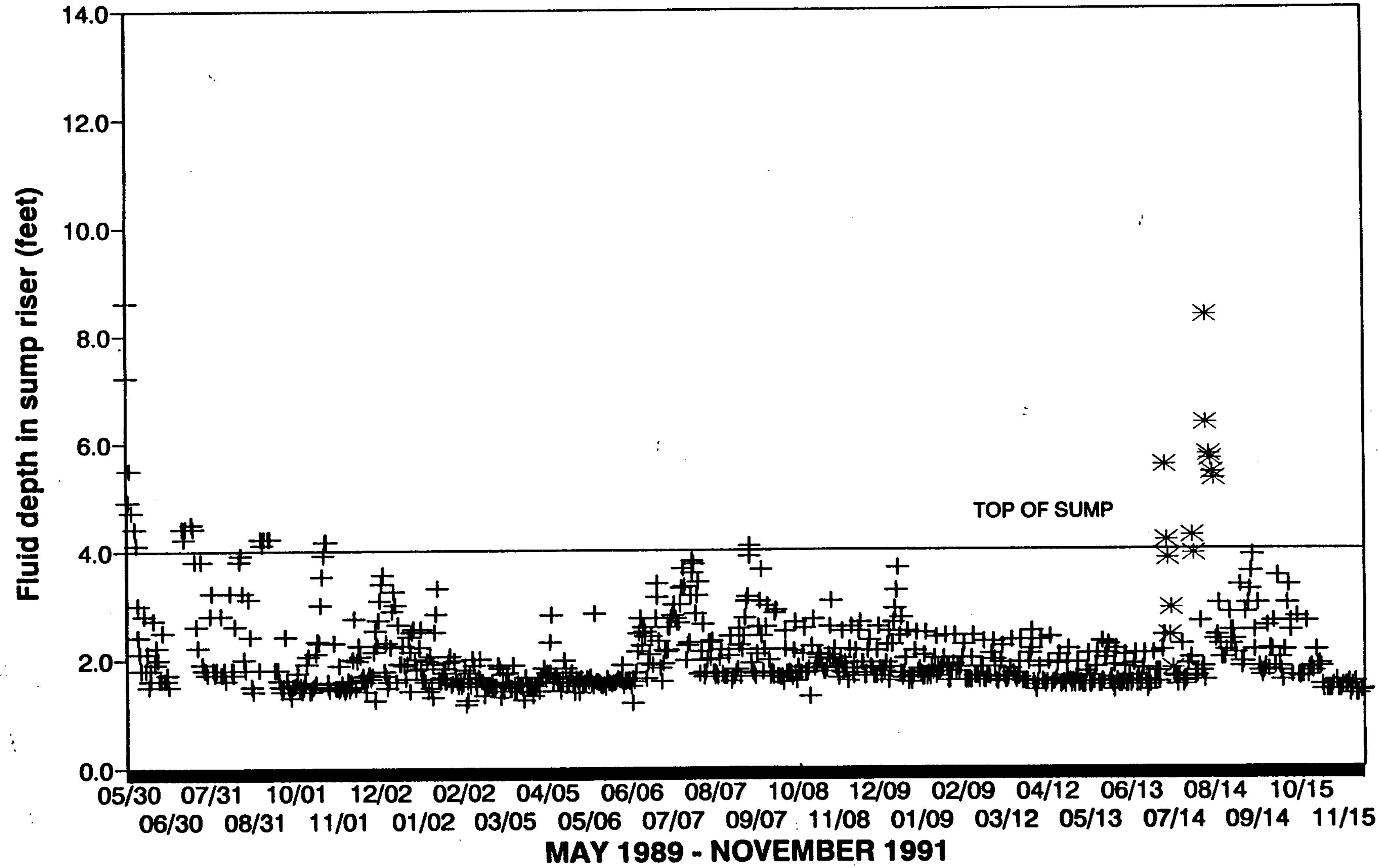
SECONDARY SUMP RISER LEVELS - CELL # 1 - BEFORE PUMPING



GRAPH 6

BASIN F WASTE PILE MAY 1989-NOV 1991

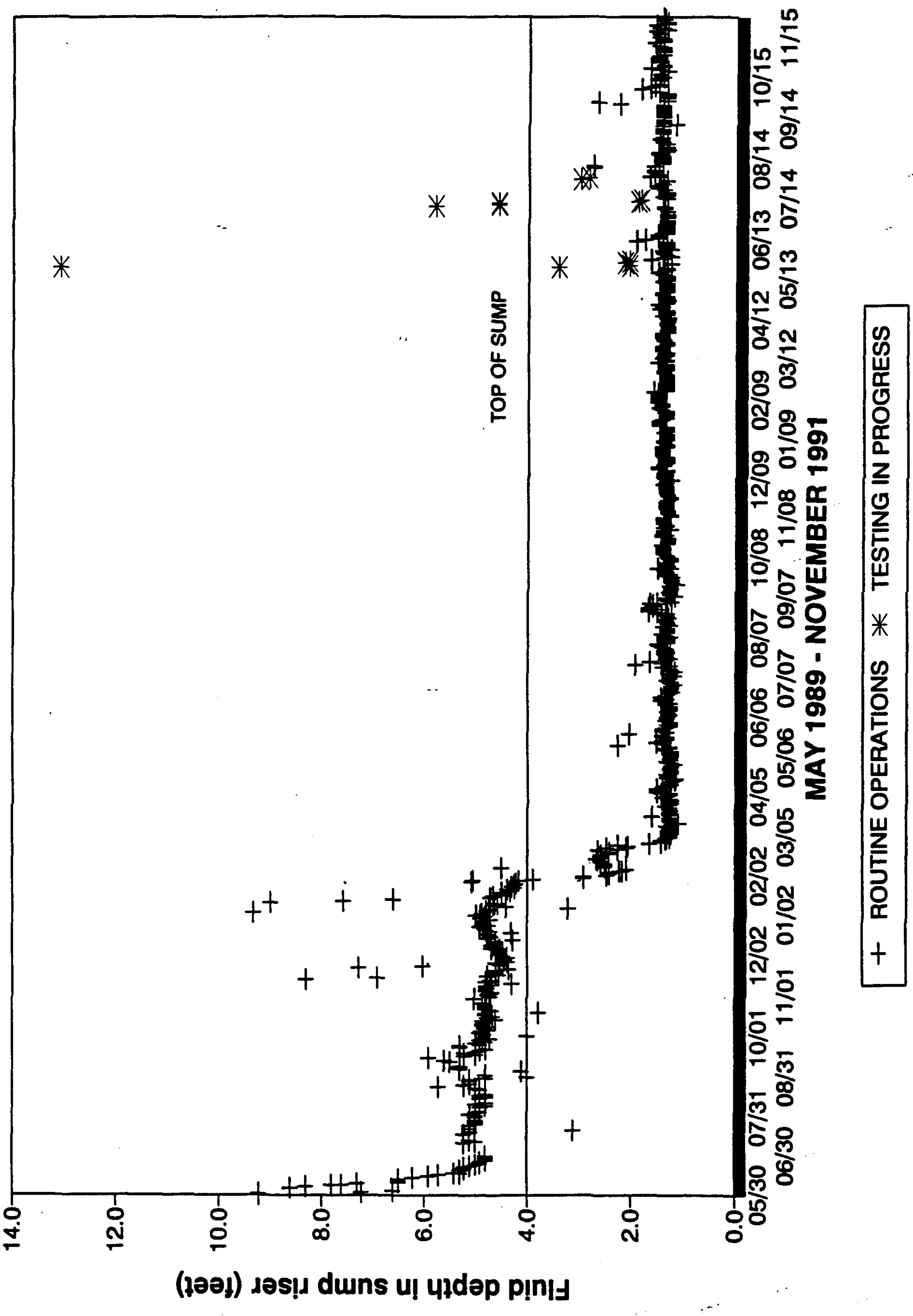
SECONDARY SUMP RISER LEVELS - CELL # 2 - BEFORE PUMPING



GRAPH 7

BASIN F WASTE PILE MAY 1989-NOV 1991

SECONDARY SUMP RISER LEVELS - CELL # 3 - BEFORE PUMPING



Based on historic liquid level readings in the primary sumps, shown in Graphs 8, 9 and 10, three ORALs and corresponding operational response actions have been established. They are as follows:

Title	Liquid Level	Operational Response Action
ORAL 1	3 ft. above base of collection sump	Daily pumping of the primary sump to maintain liquid at lowest level possible.
ORAL 2	Top of collection sump (4 ft. above base of sump)	Increase daily pumping of the primary sump, as required, to maintain liquid at lowest level possible. Notify PMRMA in a weekly report.
ORAL 3	1 ft. above top of collection sump (5 ft. above base of sump)	Increase daily pumping in the primary sump, as required, to maintain levels below top of sump. Notify PMRMA immediately.

The established ORALs and their corresponding response actions will become part of the SOPs for the Basin F IRA - Waste Pile.

3.4 ACTION LEAKAGE RATE

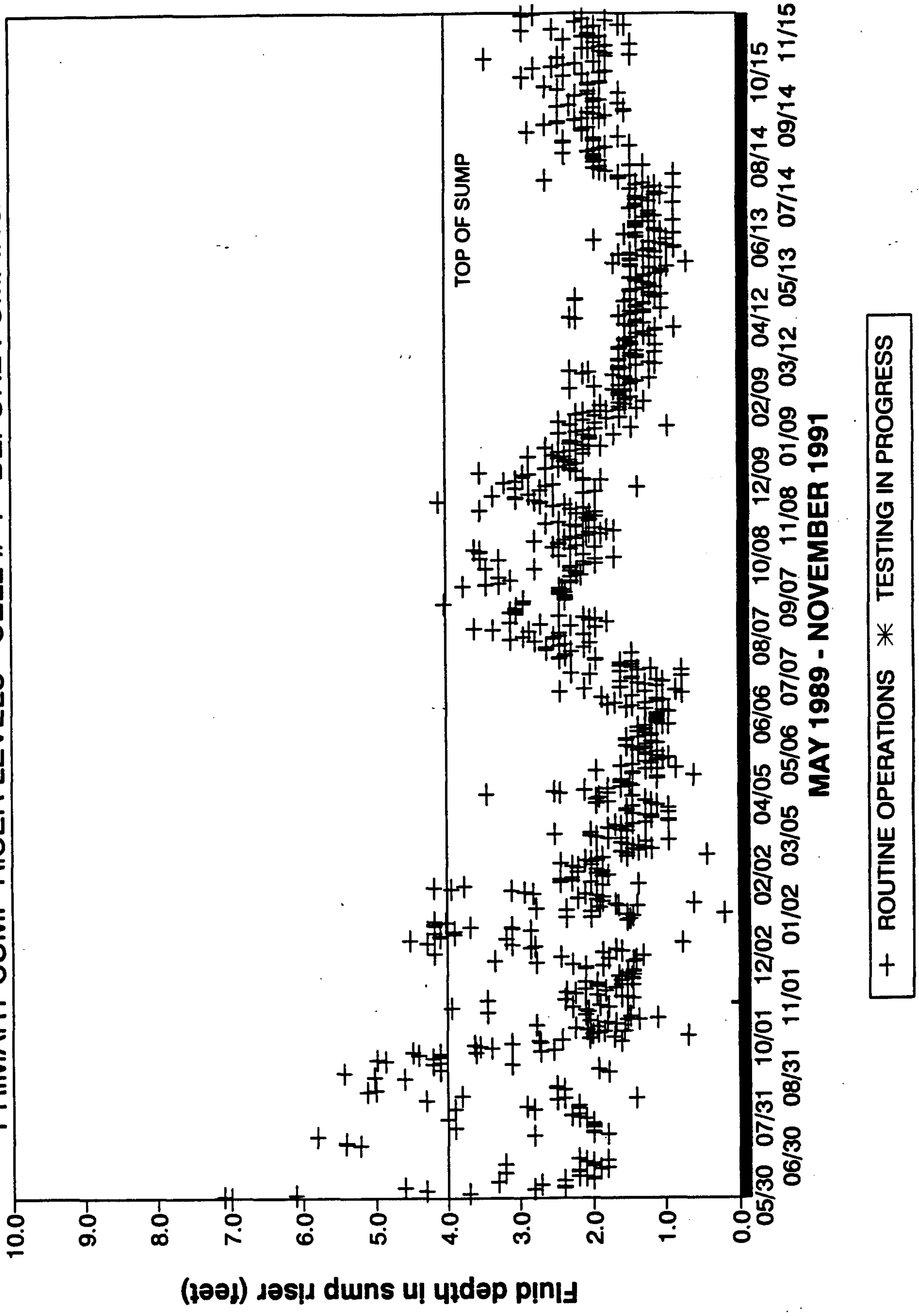
De minimus liquid permeation through the primary liner and through minor isolated breaches in the primary liner are normal with this size of installation. Chapter 10 of EPA's guidance document, "Requirements for Hazardous Waste Landfill Design, Construction, and Closure," recommends that these normal rates be evaluated and that action levels be established. The first action level to be established is the ALR, which is a leakage rate greater than the de minimus rate. The ALR serves to initiate communication between the owner/operator and EPA, and also triggers the first level of response.

The ALR value proposed by the EPA is based on the calculated leakage rate through a 1- to 2-millimeter (mm) hole per acre of the primary liner, which is subject to low hydraulic heads (on the order of 1 inch). The ALR was developed to differentiate leakage rates due to breaches in the primary liner from de minimus rates. The proposed EPA Leak Detection Rule states that ALRs should fall within the range of 5 to 20

GRAPH 8

BASIN F WASTE PILE MAY 1989 - NOV 1991

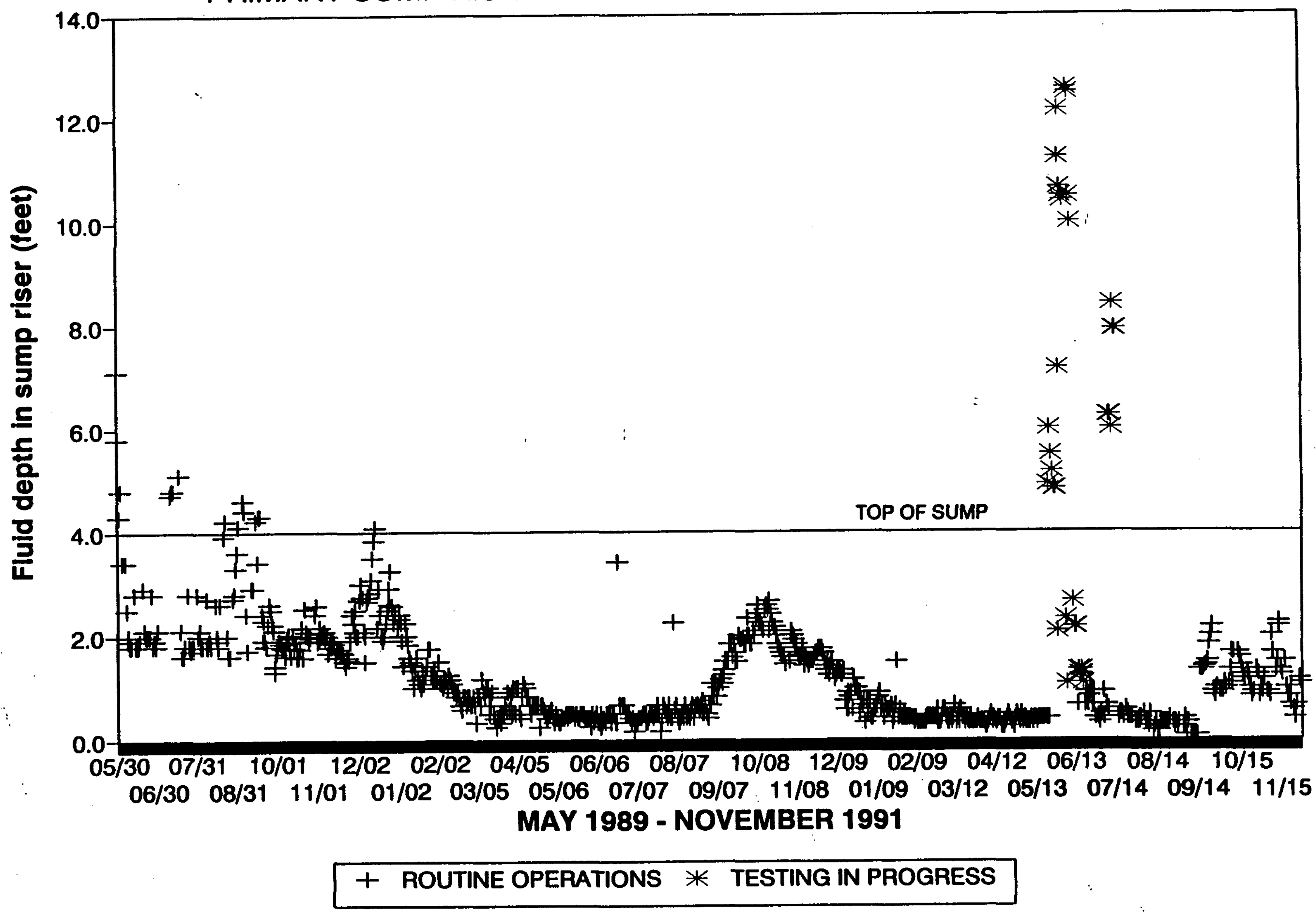
PRIMARY SUMP RISER LEVELS - CELL # 1 - BEFORE PUMPING



GRAPH 9

BASIN F WASTE PILE MAY 1989 - NOV 1991

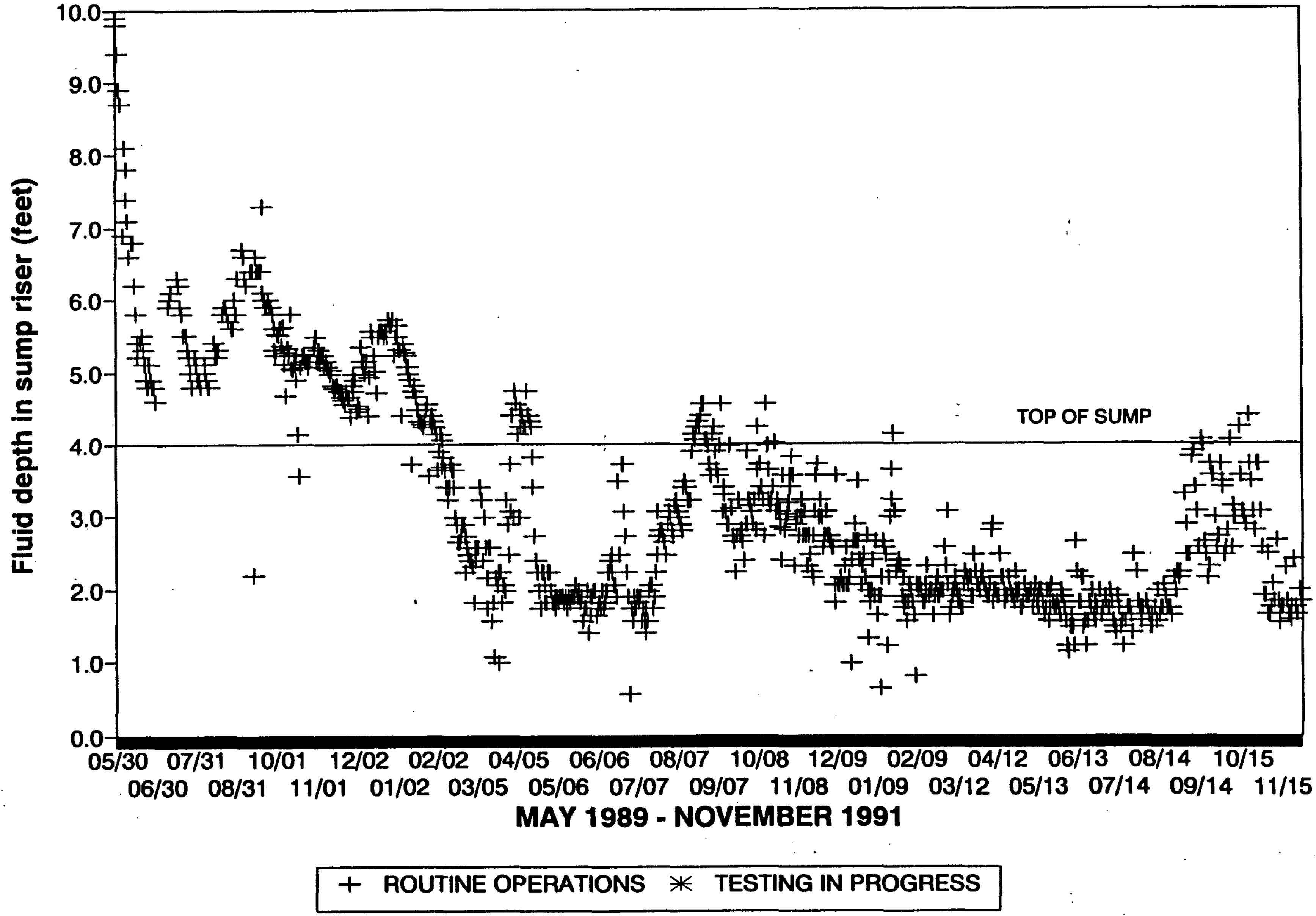
PRIMARY SUMP RISER LEVELS - CELL # 2 - BEFORE PUMPING



GRAPH 10

BASIN F WASTE PILE MAY 1989-NOV 1991

PRIMARY SUMP RISER LEVELS - CELL # 3 - BEFORE PUMPING



gallons/acre/day. Variations in the daily observed leakage rates can be on the magnitude of 10 to 20 percent of the total volume. EPA recognizes this fact and allows an averaging of the daily readings over a 30-day period, as long as the daily leakage rate does not exceed 50 gallons/acre/day for any one day.

The range for the ALR for the Basin F Waste Pile is expected to fall within the range of 5 to 20 gallons/acre/day based on the proposed EPA Leak Detection Rule. The existing observed leakage rates for Cells #1 and #3 are currently below the proposed ALR range, while Cell #2 falls within the ALR range.

3.5 RAPID AND LARGE LEAKAGE RATE

The RLL is the leakage rate that indicates a serious malfunction of the liner system. EPA defines the RLL as the maximum leakage rate that the leak collection and removal system can accept. It is the rate that indicates the primary liner has failed and immediate action is needed. The proposed EPA rule suggests that the owner/operator can calculate a site-specific RLL rate using formulas and procedures of EPA's "Requirements for Hazardous Waste Landfill Design, Construction, and Closure," included in Attachment 2.

The drainage layer between the primary and secondary liner is a 200-mil geonet that provides essentially free drainage of the leachate. Should a penetration of the primary liner occur, the liquid would flow through the geonet drainage layer to the sump, where it would be collected and removed. The maximum leakage rate that the Basin F IRA Waste Pile leak detection and removal system can accept is limited by the thickness of the geonet drainage layer. In other words, fluid can not enter the geonet layer if there is no more available room. The RLL for the Waste Pile can be determined by calculating the flow of leachate through a leak in the primary liner that exceeds the head available in the thickness of the secondary leachate detection system and thereby exceeds the maximum rate that the system can accept.

Equation 5, page 123, of EPA's "Requirements for Hazardous Waste Landfill Design, Construction, and Closure" (Attachment 2) gives a derived formula for calculating the flow base on assumed flow widths and one leak per acre.

Equation 5 is as follows:

$$h = \frac{4.6 \times 10^{-8} q}{(bK\tan\beta)}$$

Where:

h = hydraulic head (meter [m])
q = leakage rate per unit area (liters/1000m^2/day) (roughly equivalent to gal/acre/day)
b = width of saturated flow perpendicular to the flow direction (m)
K = hydraulic conductivity of the leak detection system (m/sec)
Tanβ = slope of the leak detection system (dimensionless)

For the Waste Pile, the following variables are given:

h = 200 mil or .005 m
Tanβ = 0.02

The hydraulic conductivity (K) is derived from the transmissivity (T) that was experimentally found in a test conducted for Gundle Lining System Inc. by J&L Testing Company, Inc. (Attachment 4). This test was conducted specifically for the Basin F IRA Waste Pile composite liner system using the following equation, which gives the hydraulic conductivity/transmissivity correlation:

T = Ka ("Groundwater" by Freeze/Cherry)

Where:

T = transmissivity (m^2/second [sec])
K = hydraulic conductivity (m/sec)
a = thickness of drainage layer (m)

Therefore, the hydraulic conductivity was found to be:

$$K = \frac{T}{a} = \frac{6.2993 \times 10^{-3}}{.005} = 1.26 \text{ m/sec}$$

It is important to note that the transmissivity used in the above equation is in excess of the minimum hydraulic transmissivity of 5×10^{-4} m^2/sec that EPA has proposed for the synthetic drainage materials used in the Waste Pile.

Using the given parameters for h, K, and Tanβ, and allowing b to vary from 1.0 m (3.3 feet) to 2.0 m (6.6 feet), as recommended by the EPA, the following ranges for RLL values were obtained:

$$q = \frac{.005\ b}{1.83 \times 10^{-8}}$$

Width (b) meters	Flow (q) gal/acre/day
1.0	2732
1.5	4098
2.0	5464

Using the above method for calculating the RLL for waste piles, and pending EPA's issuance of a final guidance document, the PMRMA will use a conservative RLL rate of 2,750 gallons/acre/day as an interim value to trigger the RAP for the Basin F IRA Waste Pile. The reason for selecting the RLL rate of 2,750 gallons/acre/day is to try to closely parallel the leachate generation rates of a tear in the liner, which would result in a saturation width (b) of 1 meter. This would represent a uniform and rapid flow width for the purposes of defining a significant leak event. The saturation widths (b) shown above are those used in EPA's "Requirements for Hazardous Waste Landfill Design, Construction, and Closure" (Attachment 2) in an attempt to model the RLL rate of a waste pile. They represent the best available information on the subject. Graphs 2, 3, and 4 show the current leakage rates for the leak detection system. All three cells are below the RLL.

SECTION 4

RESPONSE ACTIONS

Based on the ALR and RLL developed in the previous section, the PMRMA will implement response actions when the leakage rate for the Waste Pile exceeds prescribed values. The objective of these actions is to minimize the buildup of fluids in the leak detection system while the nature of the liner defect and/or source of fluid in the leak detection system is determined. The response actions corresponding to the Waste Pile leakage rates are presented in Table 2.

Table 2

Response Actions for Various Leakage Rates

Observed Leakage Rate (LR) gallons/acre/day	Response Action
LR < 20	**Routine Operations** Pump the leachate collection system daily and measure the level of any liquid in the leak detection system. Notify PMRMA weekly of the leachate levels and maintain the leachate pumping frequency to keep fluid at lowest level possible.
20 ≤ LR ≤ 500	**ALR Response Level I** Notify PMRMA. PMRMA will notify EPA of change in operation status within 7 days. Increase the pumping of leachate to minimize the leachate level in the sump. Begin daily inspections of the Waste Pile area to search for possible sources of the leaks. Prepare daily inspection report to submit to PMRMA. Follow-up reporting to EPA will be in accordance with an EPA-specified schedule.
500 < LR ≤ 2,750	**ALR Response Level II** Notify PMRMA and continue pumping leachate as in ALR Level I. PMRMA will notify EPA of change in operation status within 7 days. Initiate a study to evaluate alternatives. Follow-up reporting to EPA will be in accordance with an EPA-specified schedule.
LR >2,750	**RLL Response** Notify PMRMA, who will notify EPA of change in operation status within 7 days. Continue pumping as in ALR Level I. In conjunction with the relevant parties, develop and implement appropriate corrective actions. Follow-up reporting to EPA will be in accordance with an EPA-specified schedule.

ATTACHMENT 1

CHEMICAL CHARACTERIZATION OF BASIN F FLUIDS

AND

BASIN F IRA WASTE PILE LEACHATE

CHEMICAL CHARACTERIZATION OF BASIN F LIQUIDS

Compound/ Parameter	Unit	Concentration/Range						
							Woodward Clyde(1988)	
		Historical (1978)	RMA (1980)	EBASCO (1986)	Shell (1986)	Weston (1986)	(Unfilt.)	(Filt.)
pH	---	6.9-7.2	*	6.02	6.0	5.7	6.1-6.3**	5.8**
Aldrin	ppb	50.0-400	23.8	2,300	420	na	2,500-2,900	1,100
Isodrin	ppb	2.0-15	7.57	1,980	90	na	nd	nd
Dieldrin	ppb	5.0-110	7.15	459	300	na	nd	nd
Endrin	ppb	5.0-40	1.98	596	180	na	nd	nd
Dithiane	ppb	30.0-100	5.0	---	*	na	+	+
ppDDE	ppb	*	*	109	*	na	nd	nd
ppDDT	ppb	*	*	340	*	na	nd	nd
CPMSO	ppb	4,000-10,000	25,800	1,000	20,000	na	+	+
$CPMSO_2$	ppb	25,000-60,000	80,000	1,000	200,000	na	+	+
Hexachloro-cyclopentadiene	ppb	*	*	1,850	*	na	nd	nd
Atrazine	ppb	*	*	220	*	na	nd	nd
Malathion	ppb	*	*	810	*	na	nd	nd
Parathion	ppb	*	*	110	*	na	nd	nd
Supona	ppb	*	*	340	*	na	nd	nd
Vapona	ppb	*	*	890	*	na	nd	nd
Benzene	ppb	*	*	7.7	*	na	nd	na
Bromomethane	ppb	*	*	*	*	*	nd-18	na
Chloroform	ppb	*	*	*	*	*	1.9-3.1	na

CHEMICAL CHARACTERIZATION OF BASIN F LIQUIDS

		Concentration/Range						
							Woodward Clyde(1988)	
Compound/ Parameter	Unit	Historical (1978)	RMA (1980)	EBASCO (1986)	Shell (1986)	Weston (1986)	(Unfilt.)	(Filt.)
Toluene	ppb	*	*	*	*	*	8.3-9.8	na
4-Nitrophenol	ppb	*	*	*	*	*	8,600-18,000	7,400
DIMP	ppm	10.0-20	123	0.4	<0.1	na	nd	nd
DMMP	ppm	500-2,000	556	na	760	na	nd	+
Ammonia	ppm	*	*	na	57,800	40,700	48,900-60,900	53,000
Urea	ppm	*	*	na	143,000	na	na	na
Dimethyldisulfide	ppm	*	*	na	80-120	na	+	nd
Calcium	ppm	*	*	6.8	270	na	170-190	180
Potassium	ppm	*	*	30	1,100	na	1,000-2,900	1,000-2,700
Sodium	ppm	*	65,000	2,300	49,000-61,000	na	60,000	54,000
Chloride	ppm	48,000-56,000	110,000	120,000	159,000	na	120,000-130,000	130,000
Fluoride	ppm	110-117	170	21	55	na	***	***
Sulfate	ppm	21,000-25,000	*	na	47,000	na	25,000-27,000	27,000
Nitrate	ppm	*	*	*	*	*	1,300	1,300
Nitrogen	ppm	120-145	*	na	*	na	103,700-104,400	101,300
Phosphorus (total)	ppm	2,050-2,150	*	na	16,200	na	8,600-9,140	8,400
Hardness	ppm	2,100-2,800	*	na	*	na	na	na
Alkalinity	ppm	*	*	*	*	*	1,500-1,600	2,000
Aluminum	ppm	*	*	*	*	*	5.0-5.5	3.1
Antimony	ppm	*	*	*	*	*	0.6-1.1	0.6
Arsenic	ppm	1.0-1.3	2.1	3.0	8	3.1	3.0-3.9	3.8

CHEMICAL CHARACTERIZATION OF BASIN F LIQUIDS

Compound/ Parameter	Unit	Concentration/Range						
							Woodward Clyde(1988)	
		Historical (1978)	RMA (1980)	EBASCO (1986)	Shell (1986)	Weston (1986)	(Unfilt.)	(Filt.)
Barium	ppm	*	*	*	*	*	0.4	0.4
Boron	ppm	*	*	*	*	*	19	21
Cadmium	ppb	*	*	8.4	<2,000	na	30-50	40
Chromium	ppb	*	*	85	1,000	na	1,500-1,800	1,900
Cobalt	ppm	*	*	*	*	*	0.82-0.93	0.93
Copper	ppm	700-750	*	210	5,200	5,860	3,900-4,000	4,200
Iron	ppm	5.0-6.0	*	na	75	na	59-62	58
Lead	ppb	*	*	74	<2,000	na	nd	nd
Magnesium	ppm	35-40	*	5.6	220	na	230-250	250
Manganese	ppm	*	*	*	*	*	6.8-7.2	7.1
Mercury	ppb	26-29	*	140	200	na	340	340
Molybdenum	ppm	*	*	*	*	*	2.4-2.5	2.6
Nickel	ppm	*	*	*	*	*	31-34	33
Vanadium	ppm	*	*	*	*	*	2.5-3.0	2.6
Zinc	ppm	*	*	0.95	22	na	23	23
Cyanide	ppm	1.45-1.55	*	na	*	na	0.68-1.2	0.68
COD	ppm	24,500-26,000	*	na	158,000	na	220,000-230,000	210,000
TOC	ppm	20,500-22,500	29,600	na	72,000	97,000	18,000-23,000(S)	22,000(S)
Total Organic Halide (TOX)	ppb	*	*	*	*	*	380,000-570,000	340,000
TSS	ppm	*	*	*	*	*	1,500-1,600++	1,100++

CHEMICAL CHARACTERIZATION OF BASIN F LIQUIDS

Compound/ Parameter	Unit	Concentration/Range						
		Historical (1978)	RMA (1980)	EBASCO (1986)	Shell (1986)	Weston (1986)	Woodward Clyde(1988)	
							(Unfilt.)	(Filt.)
Specific Gravity	---	*	*	*	*	*	1.24	1.24
Conductivity	μmhos/cm	*	*	*	*	*	110,000	110,000
Viscosity 2°C	cP	*	*	*	*	*	4.6-4.7	5.0
Viscosity 10°C	cP						3.4	3.8
Viscosity 15°C	cP						2.9	3.1
Viscosity 20°C	cP						2.5	2.6
Viscosity 25°C	cP						2.1	2.3

*	Exact analytical procedures unclear, assumed to be "not analyzed for"
**	pH for this type of solution must be interpreted with care. Measured 36 days after sample collection.
***	Not quantifiable due to matrix interference
+	tentatively identified compound, see chemical analysis tables
+ +	TSS measured 8 days after sample collection
na	not analyzed for
nd	not detected
S	Suspect due to COD:TOC ratio and past results
cP	centipoises
ppb	parts per billion
ppm	parts per million
μmhos/cm	micro-ohms per centimeter

Data extracted from Final Treatment Assessment Report for Basin F Liquid Treatment Design December 1989 by Woodward-Clyde Consultants.

BASIN F ANALYTICAL DATA TABLE 1

WASTE PILE PRIMARY SUMP 1

LOCATION:	Primary Sump 1	Primary Sump 1	Primary Sump 1	Primary Sump 1	Primary Sump 1	Primary Sump 1	Primary Sump 1
LABORATORY:	RMA	RMA	RMA	RFW	RFW	RFW	RFW
DATE SAMPLED:	7/5/89	7/27/89	8/25/89	10/5/89	2/21/90	4/18/90	7/26/90
UNIT:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DMMP (mg/l)	1.8	9.5	9.6	13.0	7.3	7.4	7.6
CPMSO2 (mg/l)	3.9	13.0	15.3	15.0	9.0	12.0	14.0
Aldrin (mg/l)	NR	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1,2-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethene	NR	NR	25.0	BDL	BDL	BDL	BDL
1,1-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	NR	NR	12.0	BDL	BDL	BDL	BDL
1,2-Dichloropropane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,3-Dimethylbenzene	NR	NR	43.7	BDL	NR	NR	NR
2-Chloroethylvinyl Ether	NR	NR	31.6	BDL	BDL	BDL	BDL
Benzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Carbon Tetrachloride	NR	NR	BDL	BDL	BDL	BDL	BDL
Methylene Chloride	NR	NR	124	BDL	BDL	BDL	BDL
Bromoform	NR	NR	BDL	BDL	BDL	BDL	BDL
Chloroform	NR	NR	58.5	33.0	100	82	80
Chlorobenzene	NR	NR	18.5	BDL	BDL	BDL	BDL
Dicyclopentadiene	NR	NR	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Toluene	NR	NR	15.0	BDL	BDL	BDL	BDL
Tetrachloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Trichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Xylenes	NR	NR	35.3	BDL	BDL	BDL	BDL
==========							
METAL RESUTS (mg/l)							
Calcium Total	NR	130	27.0	BDL	BDL	BDL	6.1
Copper Total	NR	546	210	237	409	331	650
Sodium Total	NR	10300	74000	37000	48200	54300	47600
Zinc Total	NR	2.3	1.9	BDL	4.4	3.3	2.2

BASIN F ANALYTICAL DATA — TABLE 2

WASTE PILE PRIMARY SUMP 2

LOCATION:	Primary Sump 2	Primary Sump 2	Primary Sump 2	Primary Sump 2	Primary Sump 2	Primary Sump 2	Primary Sump 2
LABORATORY:	RMA	RMA	RMA	RFW	RFW	RFW	RFW
DATE SAMPLED:	7/5/89	7/27/89	8/25/89	10/5/89	2/21/90	4/18/90	7/26/90
UNIT:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DMMP (mg/l)	11.2	21.1	34.4	9.9	8.5	22	16
CPMSO2 (mg/l)	12.9	15.5	16.4	14.0	5.1	13	11
Aldrin (mg/l)	NR	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1,2-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethene	NR	NR	44.8	BDL	BDL	BDL	BDL
1,1-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloropropane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,3-Dimethylbenzene	NR	NR	BDL	BDL	NR	NR	NR
2-Chloroethylvinyl Ether	NR	NR	72.6	BDL	BDL	BDL	BDL
Benzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Carbon Tetrachloride	NR	NR	BDL	BDL	BDL	BDL	BDL
Methylene Chloride	NR	NR	27.6	BDL	BDL	BDL	BDL
Bromoform	NR	NR	BDL	BDL	BDL	BDL	BDL
Chloroform	NR	NR	54.5	38	BDL	190	130
Chlorobenzene	NR	NR	62.2	BDL	BDL	BDL	BDL
Dicyclopentadiene	NR	NR	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Toluene	NR	NR	11.9	BDL	BDL	BDL	BDL
Tetrachloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Trichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Xylenes	NR	NR	BDL	BDL	BDL	BDL	BDL
METAL RESUTS (mg/l)							
Calcium Total	NR	170	35.0	BDL	BDL	BDL	14.1
Copper Total	NR	784	320	228	266	300	600
Sodium Total	NR	11500	84000	30800	26800	44,400	48,000
[illegible]	[illegible]		4.00	BDL	4.11	3.0	2.8

BASIN F ANALYTICAL DATA TABLE 3

WASTE PILE PRIMARY SUMP 3

LOCATION:	Primary Sump 3	Primary Sump 3	Primary Sump 3	Primary Sump 3	Primary Sump 3	Primary Sump 3	Primary Sump 3
LABORATORY:	RMA	RMA	RMA	RFW	RFW	RFW	RFW
DATE SAMPLED:	7/5/89	7/27/89	8/25/89	10/5/89	2/21/90	4/18/90	7/26/90
UNIT:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DMMP (mg/l)	9.2	15.2	17.3	23.0	13.0	33	24
CPMSO2 (mg/l)	9.9	8.5	12.4	16.0	8.8	20	16
Aldrin (mg/l)	NR	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1,2-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethene	NR	NR	58.5	BDL	BDL	BDL	BDL
1,1-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloropropane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,3-Dimethylbenzene	NR	NR	BDL	BDL	NR	NR	NR
2-Chloroethylvinyl Ether	NR	NR	BDL	BDL	BDL	BDL	BDL
Benzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Carbon Tetrachloride	NR	NR	74.8	BDL	BDL	BDL	BDL
Methylene Chloride	NR	NR	194	BDL	BDL	BDL	BDL
Bromoform	NR	NR	BDL	BDL	BDL	BDL	BDL
Chloroform	NR	NR	231	290	BDL	250	200
Chlorobenzene	NR	NR	56.1	BDL	BDL	BDL	BDL
Dicyclopentadiene	NR	NR	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Toluene	NR	NR	46.1	BDL	39.0	BDL	BDL
Tetrachloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Trichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Xylenes	NR	NR	BDL	BDL	BDL	BDL	BDL
METAL RESUTS (mg/l)							
Calcium Total	NR	210	39.0	BDL	BDL	BDL	11
Copper Total	NR	723	50.0	169	203	120	450
Sodium Total	NR	12800	50000	45800	44100	32,800	49,000
Zinc Total	NR	3.7	3.5	BDL	3.5	2.1	2.2

BASIN F ANALYTICAL DATA TABLE 4

WASTE PILE SECONDARY SUMP 1

LOCATION:	Secondary Sump 1	Secondary Sump 1	Secondary Sump 1	Secondary Sump 1	Secondary Sump 1	Secondary Sump 1	Secondary Sump 1
LABORATORY:	RMA	RMA	RMA	RFW	RFW	RFW	RFW
DATE SAMPLED:	7/5/89	7/27/89	8/25/89	10/5/89	2/21/90	4/18/90	7/26/90
UNIT:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DMMP (mg/l)	2.2	7.5	6.4	9.4	4.6	6.3	BDL
CPMSO2 (mg/l)	2.2	7.7	6.4	1.1	4.7	10	12
Aldrin (mg/l)	NR	0.06	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1,2-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethene	NR	NR	27.0	BDL	BDL	BDL	BDL
1,1-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloropropane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,3-Dimethylbenzene	NR	NR	BDL	BDL	NR	NR	NR
2-Chloroethylvinyl Ether	NR	NR	BDL	BDL	BDL	BDL	BDL
Benzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Carbon Tetrachloride	NR	NR	BDL	BDL	BDL	BDL	BDL
Methylene Chloride	NR	NR	209.0	1100	BDL	BDL	BDL
Bromoform	NR	NR	BDL	BDL	BDL	BDL	BDL
Chloroform	NR	NR	28.2	BDL	BDL	50	BDL
Chlorobenzene	NR	NR	35.5	BDL	BDL	BDL	BDL
Dicyclopentadiene	NR	NR	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Toluene	NR	NR	BDL	BDL	BDL	BDL	BDL
Tetrachloroethene	NR	NR	52.9	BDL	BDL	BDL	BDL
Trichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Xylenes	NR	NR	26.0	BDL	BDL	BDL	BDL
METAL RESUTS (mg/l)							
Calcium Total	NR	70	5.10	BDL	BDL	BDL	7.2
Copper Total	NR	239	99.0	119	120	348	500
Sodium Total	NR	9300	45900	35000	38200	60,000	60,200
Zinc Total	NR	3.0	1.8	4.5	5.8	3.3	2.4

BASIN F ANALYTICAL DATA

WASTE PILE SECONDARY SUMP 2

TABLE 5

LOCATION:	Secondary Sump 2	Secondary Sump 2	Secondary Sump 2	Secondary Sump 2	Secondary Sump 2	Secondary Sump 2	Secondary Sump 2
LABORATORY:	RMA	RMA	RMA	RFW	RFW	RFW	RFW
DATE SAMPLED:	7/5/89	7/27/89	8/25/89	10/5/89	2/21/90	4/18/90	7/26/90
UNIT:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DMMP (mg/l)	8.1	36.4	18.4	29.0	13.0	30	24
CPMSO2 (mg/l)	8.2	17.3	12.6	14.0	6.0	15	17
Aldrin (mg/l)	NR	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NR	NR	BDL	BDL	BDL	110	BDL
1,1,2-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethene	NR	NR	54.3	BDL	BDL	BDL	BDL
1,1-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloropropane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,3-Dimethylbenzene	NR	NR	BDL	BDL	NR	NR	NR
2-Chloroethylvinyl Ether	NR	NR	116	BDL	BDL	BDL	BDL
Benzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Carbon Tetrachloride	NR	NR	BDL	BDL	BDL	BDL	BDL
Methylene Chloride	NR	NR	95.9	BDL	BDL	BDL	BDL
Bromoform	NR	NR	BDL	BDL	BDL	BDL	BDL
Chloroform	NR	NR	38.8	BDL	BDL	BDL	80
Chlorobenzene	NR	NR	95.9	BDL	BDL	BDL	BDL
Dicyclopentadiene	NR	NR	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Toluene	NR	NR	BDL	BDL	BDL	BDL	BDL
Tetrachloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Trichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Xylenes	NR	NR	36.2	BDL	BDL	BDL	BDL
================							
METAL RESUlTS (mg/l)							
Calcium Total	NR	220	28.0	BDL	BDL	BDL	14.5
Copper Total	NR	854	320	268	404	318	400
Sodium Total	NR	12100	119000	34500	39900	43,900	48,000
Zinc Total	NR	4.0	4.7	3.1	5.7	3.9	2.8

BASIN F ANALYTICAL DATA TABLE 6

WASTE PILE SECONDARY SUMP 3

LOCATION:	Secondary Sump 3	Secondary Sump 3	Secondary Sump 3	Secondary Sump 3	Secondary Sump 3	Secondary Sump 3	Secondary Sump 3
LABORATORY:	RMA	RMA	RMA	RFW	RFW	RFW	RFW
DATE SAMPLED:	7/5/89	7/27/89	8/25/89	10/5/89	2/21/90	4/18/90	7/26/90
UNIT:	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DMMP (mg/l)	7.2	9.5	23.3	23.0	14.0	18.0	24.0
CPMSO2 (mg/l)	6.8	13.0	14.3	14.0	8.9	12.0	16.0
Aldrin (mg/l)	NR	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1,2-Trichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethene	NR	NR	33.4	BDL	BDL	BDL	BDL
1,1-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,2-Dichloropropane	NR	NR	BDL	BDL	BDL	BDL	BDL
1,3-Dimethylbenzene	NR	NR	BDL	BDL	NR	NR	NR
2-Chloroethylvinyl Ether	NR	NR	BDL	BDL	BDL	BDL	BDL
Benzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Carbon Tetrachloride	NR	NR	BDL	BDL	BDL	BDL	BDL
Methylene Chloride	NR	NR	101	BDL	BDL	BDL	BDL
Bromoform	NR	NR	BDL	BDL	BDL	BDL	BDL
Chloroform	NR	NR	BDL	93.0	BDL	100	110
Chlorobenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Dicyclopentadiene	NR	NR	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	NR	NR	BDL	BDL	BDL	BDL	BDL
Toluene	NR	NR	BDL	BDL	BDL	BDL	BDL
Tetrachloroethene	NR	NR	BDL	BDL	BDL	BDL	BDL
Trichloroethene	NR	NR	BDL	BDL	BDL	50	BDL
Xylenes	NR	NR	BDL	BDL	BDL	BDL	BDL
METAL RESUTS (mg/l)							
Calcium Total	NR	270	32.0	BDL	BDL	BDL	13.1
Copper Total	NR	714	150	150	270	170	200
Sodium Total	NR	12100	128000	38400	54500	56,400	40,200
Zinc Total	NR	2.8	4.3	2.5	7.1	2.6	1.8

ATTACHMENT 2

SECTION 10 FROM EPA's "REQUIREMENTS

FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION, AND CLOSURE"

United States Environmental Protection Agency

Technology Transfer EPA/625/4-89/022

EPA

Seminar Publication

Requirements for Hazardous Waste Landfill Design, Construction, and Closure

10. LEAK RESPONSE ACTION PLANS

This final chapter reviews proposed requirements for Response Action Plans, or RAPs, that are contained in the proposed leak detection rule issued in May, 1987. It focuses on the concepts behind the RAPs and the preliminary, technical calculations used in developing them. The main topics of discussion will be the technical basis for the two response action triggers, action leakage rate (ALR) and rapid and large leakage (RLL) rate; the RAPs themselves; and the RAP submittal process.

Background

In the Hazardous and Solid Waste Amendments (HSWA) of 1984, Congress required that leaks from new land disposal facilities be detected at the earliest practical time. However, HSWA did not require or specify actions to be taken once a leak is detected in the leak detection system. Therefore, EPA proposed requirements for response action plans to deal with leaks detected in the leak detection system between the two liners. EPA realizes that even with a good construction quality assurance plan, flexible membrane liners (FMLs) will allow some liquid transmission either through water vapor permeation of an intact FML, or through small pinholes or tears in a slightly flawed FML. Leakage rates resulting from these mechanisms can range from less than 1 to 300 gallons per acre per day (gal/acre/day). If unchecked, these leak rates may result in increased hydraulic heads acting on the bottom liner and potential subsequent damage to the liner system.

The idea behind the RAP is to be prepared for any leaks or clogging of the drainage layer in the leak detection system that may occur during the active life or post-closure care period of a waste facility. The first step is to identify the top liner leak rates that would require response actions. Therefore, in the proposed leak detection rule of May 29, 1987, EPA established two triggers for response actions: the Action Leakage Rate (ALR) and the Rapid and Large Leakage (RLL) rate. The ALR is a low-level leak rate that would indicate the presence of a small hole or defect in the top liner. The RLL is indicative of a severe breach or large tear in the top liner. A different level of responsiveness would be required for leakage rates above these two triggers. RAPs developed by owners or operators may have more than two triggers as appropriate to cover the range of leak rates expected for a landfill unit. In addition to triggers, the proposed rule also defines the elements of a RAP, gives an example of one, and discusses the procedures for submitting and reviewing a RAP.

Action Leakage Rate (ALR)

EPA has historically used the term de minimus leakage when referring to leaks resulting from permeation of an intact FML. Action leakage rate (ALR) was developed to distinguish leak rates due to holes from mere permeation of an intact FML, and to initiate early interaction between the owner/operator of the unit and the Agency. The ALR essentially defines top liner leakage in a landfill, and the proposed value is based on calculated leak rates through a 1 to 2 mm hole in a FML subject to low hydraulic heads on the order of 1 inch. The proposed ALR, therefore, is representative of well-designed and operated landfills, although, as proposed, it would also apply to surface impoundments and waste piles.

Because EPA is considering setting a single ALR value applicable to landfills, surface impoundments, and waste piles, the Agency calculated top liner leak rates for different sizes of holes and for different hydraulic heads. In addition, EPA compared leak rates for a FML top liner with that for a composite top liner, since many new facilities have double composite liner systems. Table 10-1 shows the results of these calculations for FML and composite top liners. Even for FMLs with very small holes (i.e., 1 to 2 mm in diameter), leak rates can be significant depending on the hydraulic head acting on the top liner. The addition of the compacted low permeability soil layer to the FML significantly reduces these leak rates to less than 10 gal/acre/day, even for large hydraulic heads that are common in surface impoundments. These results indicate that, at least for deep surface impoundments with large hydraulic heads, double composite liner systems may be the key to reducing the leak rates to de minimus levels that are below the proposed ALR.

Table 10-1. Calculated Leakage Rates through FML and Composite Liners (gal/acre/day)

FML Alone

Leakage Mechanism	Hydraulic Head, ft 0.1	1	10
Small Hole (1-2 mm)	30	100	300
Standard Hole (1 cm^2)	300	1,000	3,000

Composite Liner (good contact)

Leakage Mechanism	Hydraulic Head, ft 0.1	1	10
Small Hole (1-2 mm)	0.01	0.1	2
Standard Hole (1 cm^2)	0.01	0.2	3

Source: U.S. EPA. 1987. Background document on proposed liner and leak detection rule. EPA/530-SW-87-015.

EPA's proposed rule sets the ALR at 5 to 20 gal/acre/day, a difficult range to achieve with a primary FML alone (especially for surface impoundments). The proposed rule also enables the owner/operator to use a site-specific ALR value that would take into account meteorological and hydrogeological factors, as well as design factors that might result in leak rates that would frequently exceed the ALR value. Using these factors, a surface impoundment that meets the minimum technological requirements of a FML top liner could conceivably apply for a site-specific ALR value.

Daily leakage rates through top liners can vary by 10 to 20 percent or more, even in the absence of major precipitation events. Because of these variations, EPA may allow the landfill owner/operator to average daily readings over a 30-day period, as long as the leakage rate does not exceed 50 gal/acre/day on any 1 day. If the average daily leak rate does not exceed the ALR, then the owner/operator does not have to implement a RAP.

Rapid and Large Leakage (RLL)

The Rapid and Large Leakage (RLL) rate is the high-level trigger that indicates a serious malfunction of system components in the double-lined unit and that warrants immediate action. In developing the proposed rule, EPA defined the RLL as the maximum design leakage rate that the leak detection system can accept. In other words, the RLL is exceeded when the fluid head is greater than the thickness of the secondary leachate collection and removal system (LCRS) drainage layer. The visible expression of RLL leakage in surface impoundments is the creation of bubbles, or "whales," as the FML is lifted up under the fluid pressure. See Chapter Three for further discussion of "whales".

Because the RLL is highly dependent on the design of the leak detection system, EPA's proposed rule requires that owners/operators calculate their own site-specific RLL values. EPA also proposes to require that owners/operators submit a RAP for leakage rates exceeding that value prior to beginning operation of a unit. The EPA Regional Administrator must approve the RAP before a facility can receive wastes.

The following equations represent EPA's preliminary attempt to define a range of potential RLL values for a hypothetical leak detection system, which consists of a 1-foot granular drainage layer with 1 cm/sec hydraulic conductivity. These calculations are for two-dimensional rather than three-dimensional flow. In addition, the equations apply to flow from a single defect in the FML, rather than multiple defects. Therefore, results from this analysis are only preliminary ones, and the EPA will develop guidance on calculating RLL values in the near future.

RLL values can be calculated using the following equation:

$$h = (Q_d/B)/(k_d \tan\beta) \quad (1)$$

where:
- h = hydraulic head
- Q_d = flow rate entering into the drainage layer
- B = width of the drainage layer
- k_d = hydraulic conductivity of the drainage layer
- β = slope of the drainage layer perpendicular to, and in the plane of, flow toward the collection pipe

When the value for h exceeds the thickness of the drainage layer (1 foot in this example), the leakage rate is greater than the RLL value for the unit.

In reality, a leak from an isolated source, i.e., a tear or a hole in the FML, results in a discreet zone of saturation as the liquids flow toward the collection pipe (see Figure 10-1). The appropriate variable representing the width of flow, then, is not really B, the entire width of the drainage layer perpendicular to flow, but b, the width of saturated flow perpendicular to the flow direction. If b were known, the equation could be solved. But to date, the data has not been available to quantify b for all drainage layers and leakage scenarios.

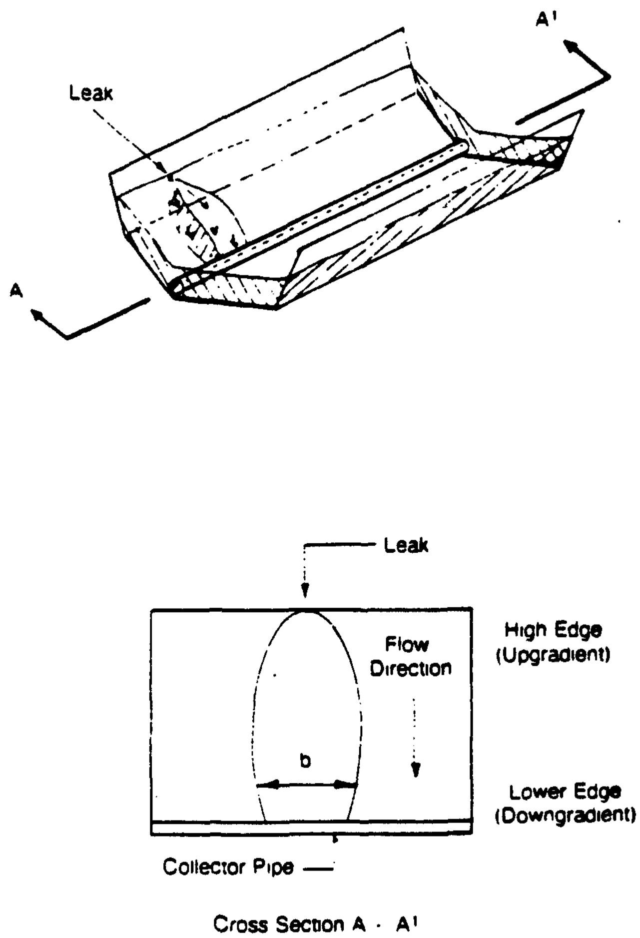


Figure 10-1. Plan view of a leak detection system with a large leak flowing over a width b.

From Equation 1, one can make substitutions for variables B and Q_d and give values for the other variables k_d and $\tan\beta$. If N represents the frequency of leaks in a well-designed and installed unit, then Q, the flow rate in the drainage layer (m^3/s) is directly related to q, the leakage rate per unit area (m/sec):

$$Q = NQ \text{ or } Q = q/N \quad (2)$$

Combining Equations 1 and 2 and substituting b for B, and q for Q:

$$h = q/(Nbk_d\tan\beta) \quad (3)$$

Equation 3 now can be used to define the leakage rate (q) that exceeds the leak detection system capacity. All that is needed are the values for the other variables (N, k_d, $\tan\beta$). For a well-designed and installed unit, the frequency of leaks (N) is 1 hole per acre, or in units of m^2: $N = 1/4{,}000m^2$. Substituting this value into Equation 3:

$$h = 4000q/(bk_d\tan\beta) \quad (4)$$

Where q is in units of liters/1,000 m^2/day (Ltd), Equation 4 can be written as follows:

$$h = 4.6 \times 10^{-8}q/(bk_d\tan\beta) \quad (5)$$

The proposed rule requires leak detection systems to have a minimum bottom slope of 2 percent ($\tan\beta$) and minimum hydraulic conductivity of 10^{-2} m/sec (kd). Substituting these values into Equation 5:

$$h = 2.3 \times 10^{-4} q/b \quad (6)$$

where h is in units of m, q is in units of Ltd, and b is in units of m. For the purposes of these calculations, it is assumed that Ltd is equivalent to about 1 gal/acre/day. The final results were derived by using three different values for b (the unknown variable) and determining what values of q between 100 and 10,000 gal/acre/day (Ltd) result in hydraulic heads exceeding the 1-foot thickness of the drainage layer (h).

Table 10-2 shows the results of these preliminary calculations. For values of q between 100 and 10,000 gal/acre/day and values of b between 3 and 6 foot, the hydraulic head exceeds 1 foot when leak rates are in the range of 2,000 to 10,000 gal/acre/day. Therefore, RLL values for leak detection systems consisting of granular drainage layer are expected to be in the range of 2,000 to 10,000 gal/acre/day. Clogging of the drainage layer would decrease the design capacity of the leak detection system, and hence the RLL value, over time. With respect to the variables described above, clogging of the drainage layer could be represented using smaller values for b, the width of saturated flow, since clogging would result in a reduced width of saturated flow. As shown in Table 10-2, smaller values of b reduce the minimum leakage rate, q, needed to generate heads exceeding the 1-foot thickness. EPA plans to issue guidance on estimating the effect of clogging on RLL values.

Table 10-2. Results of Preliminary Studies Defining Ranges of RLL Values

Width (b) ft	Flow (q) gal/acre/day
3.3	1,000 - 2,000
5.0	2,000 - 5,000
6.6	5,000 - 10,000

Response Action Plans (RAPs)

According to the proposed leak detection rule, the key elements of a RAP are:

- General description of unit.
- Description of waste constituents.
- Description of all events that may cause leakage.
- Discussion of factors affecting amounts of leakage entering LCRS.
- Design and operational mechanisms to prevent leakage of hazardous constituents.
- Assessment of effectiveness of possible response actions.

In developing a RAP, owners/operators of landfills should gather information from Part B of the permit application, available operational records, leachate analysis results for existing facilities, and the construction quality assurance report. The construction quality assurance report is very important because it helps define where potential leaks are likely to occur in the unit.

Sources of Liquids Other than Leachate

Depending on the unit design and location, other liquids besides leachate could accumulate in the leak detection system and result in apparent leak rates that exceed the ALR value. For example, precipitation may pass through a tear in the FML that is located above the waste elevation (e.g. a tear in the FML at a pipe penetration point). The liquids entering the leak detection system under this scenario may not have contacted any wastes and hence would not be considered to be hazardous leachate. In addition, rainwater can become trapped in the drainage layer during construction and installation of the leak detection system, but these construction waters are typically flushed through the system early on in the active life of the facility. In the case of a composite top liner, moisture from the compacted soil component may be squeezed out over time and also contribute to liquids collected in the leak detection sump. These sources of nonhazardous liquids can add significant quantities of liquids to a leak detection system and might result in an ALR being exceeded. Therefore, these other sources of liquids should also be considered when developing a RAP, and steps to verify that certain liquids are not hazardous should be outlined in the plan.

Ground-water permeation is one other possible source of nonhazardous liquids in the leak detection system that can occur when the water table elevation is above the bottom of the unit. The ability of ground water to enter the leak detection sump, however, raises serious questions about the integrity of the bottom liner, which is the backup system in a double-lined unit. If ground water is being collected in the leak detection system, then hazardous constituents could conceivably migrate out of the landfill and into the environment when the water table elevation drops below the bottom of the unit, e.g., in the case of dry weather conditions. As a result, while ground-water permeation is another source of liquids, it is not a source that would ordinarily be used by the owner/operator to justify ALR exceedances.

Preparing and Submitting the RAP

Response action plans must be developed for two basic ranges: (1) leakage rates that exceed the RLL and (2) leakage rates that equal or exceed the ALR but are less than the RLL. In submitting a RAP, a facility owner/operator has two choices. First, the owner/operator can submit a plan to EPA before the facility opens that describes all measures to be taken for every possible leakage scenario. The major drawback to this option is that the RAP may have to be modified as specific leak incidents occur, because there are several variables that affect the selection of suitable response actions. One variable is the time at which the leak occurs. For example, if a leak is discovered at the beginning of operation, the best response might be to locate and repair the leak, since there would be little waste in the unit and the tear or hole may be easy to fix. If, however, a leak is discovered 6 months before a facility is scheduled to close, it would probably make sense to close the unit immediately to minimize infiltration. If the owner/operator chooses to develop and submit one RAP before the unit begins operation, he or she must develop suitable response actions for different leak rates and for different stages during the active life and post-closure care period of the unit.

The second choice an owner/operator has is to submit the RAP in two phases: one RAP for the first range, serious RLL leakage, that would be submitted before the start of operation; and another for the second range of leakage rates (exceeding the ALR but less than the RLL) that would be submitted after a leak has been detected.

EPA developed three generic types of response actions that the owner/operator must consider when developing a RAP for leakage rates greater than or equal to the RLL. The three responses for very serious leakage are straightforward:

- Stop receiving waste and close the unit, or close part of the unit.
- Repair the leak or retrofit the top liner.
- Institute operational changes.

These three response actions also would apply to leakage rates less than RLL, although, as moderate to serious responses, they would apply to leakage rates in the moderate to serious range, i.e., 500 to 2,000 gal/acre/day. For most landfills, 500 gal/acre/day leak rates would be considered fairly serious, even though they may not exceed the RLL. In addition, clogging of the leak detection system could also result in serious leakage scenarios at rates less than 2,000 gal/acre/day. For lower leak rates just above the ALR, the best response would be promptly to increase the liquids removal frequency to minimize head on the bottom liner, analyze the liquids, and follow up with progress reports.

Another key step in developing RAPs is to set up leakage bands, with each band representing a specific range of leakage rates that requires a specific response or set of responses. Table 10-3 shows an example of a RAP developed for three specific leakage bands. The number and range of leakage bands should be site-specific and take into account the type of unit (i.e., surface impoundment, landfill, waste pile), unit design, and operational factors.

Table 10-3. Sample RAP for Leakage < RLL

ALR = 20 gal/acre/day and RLL = 2,500 gal/acre/day

Leakage Band (gal/acre/day)	Generic Response Action
20	Notify RA and identify sources of liquids.
> 20-250	Increase pumping and analyze liquids in sump.
> 250-2,500	Implement operational changes.

The RAP submittal requirements proposed by EPA differ for permitted facilities and interim status facilities. For newly permitted facilities, the RAP for RLL must be submitted along with Part B of the permit application. For existing facilities, the RAP for RLL must be submitted as a request for permit modification. Facilities in interim status must submit RAPs for RLL 120 days prior to the receipt of waste.

If the RAP for low to moderate leakage (greater than ALR but less than RLL) has not been submitted before operation, EPA has proposed that it must be submitted within 90 days of detecting a leak. In any case, the EPA Regional Administrator's approval would be required before that RAP can be implemented.

Requirements for Reporting a Leak

Once a leak has been detected, the proposed procedure is similar for both ALR and RLL leakage scenarios. The owner/operator would need to notify the EPA Regional Administrator in writing within 7 days of the date the ALR or RLL was determined to be exceeded. The RAP should be implemented if it has been approved (as in the case for RLL leaks), or submitted within 90 days for approval if not already submitted. Regardless of whether the RAP for the leak incident is approved, the owner/operator would be required to collect and remove liquids from the leak detection sump. Examples of the liquids should be analyzed for leachate quality parameters, as specified by the Regional Administrator in an approved RAP. Both the need for analysis and the parameters would be determined by the Regional Administrator.

In addition to the leachate sampling, the EPA Regional Administrator would also specify a schedule for follow-up reporting, once the ALR or RLL is exceeded. According to the proposed rule, this follow-up reporting will include a discussion of the response actions taken and the change in leak rates over time. The first progress report would be submitted within 60 days of RAP implementation, and then periodically or annually, thereafter, as specified in an approved RAP. Additional reporting would also be required within 45 days of detecting a significant increase in the leak rate (an amount specified in the RAP). This significant increase in leak rate indicates a failure in the response actions taken and, therefore, may require modifications of the RAP and the implementation of other response actions. These additional reporting and monitoring requirements would be part of the RAP implementation to be completed only when the resulting leak rate drops below the ALR.

Summary

Although the overall containment system consisting of two liners and two LCRSs may achieve the performance objective of preventing hazardous constituent migration out of the unit for a period of about 30 to 50 years, the individual components may at some point malfunction. Liners may leak or LCRS/leak detection systems may clog during the active life or post-closure care period. Therefore, EPA has developed and proposed requirements for early response actions to be taken upon detecting a malfunction of the top liner or leak detection system. These requirements, once finalized, will ensure maximum protection of human health and the environment.

ATTACHMENT 3

STANDARD OPERATING PROCEDURES

FOR THE

BASIN F IRA WASTE PILE

ATTACHMENT 3

Table of Contents for Basin F IRA - Waste Pile Standard Operating Procedures

SOP NUMBER	REVISION NUMBER	DATE	TITLE
433.0	1.6	03/92	Waste Pile Inspections: Weekly
433.1	1.3	03/92	Waste Pile Inspections: Leachate Collection System Pipeline
453.1	1.4	01/90	Waste Pile Maintenance: Fences
453.2	1.4	01/90	Waste Pile Maintenance: Surface Repair
453.3	1.5	09/91	Waste Pile Maintenance: Sump Pumping
453.4	1.4	09/91	Waste Pile Maintenance: Transfer of Liquids to Pond A

ROCKY MOUNTAIN ARSENAL

BASIN F IRA - STRUCTURES

STANDARD OPERATING PROCEDURE

TITLE:	Waste Pile Inspections		
		SOP NO.:	433.0
DATE:	March 1992	**REVISION:**	1.6
PROJECT MGR.:	MEW	**AUTHOR:**	DLB
TASK MGR.:	RAC	**PMRMA REVIEW:**	

PURPOSE: To establish standard inspection procedures for the weekly Basin F Waste Pile inspection.

RELATED SOPS:
404 Basin F Communication
413 Waste Pile Health and Safety
423 Waste Pile Security
453 Waste Pile Maintenance (series)

FREQUENCY OF PROCEDURE: Weekly and after storm events.

PERSONNEL REQUIREMENTS: Two Level C-certified inspectors; at least one who has had on-the-job training (OJT) on the waste pile inspection procedures. The second inspector may be a trainee.

HEALTH AND SAFETY: As per SOP 413; Modified Level D (Tyvek or cotton coveralls and Neoprene boot covers) for routine weekly inspection activities; Modified Level D when measuring liquid level in sumps. Decontamination procedure will be to dispose of personnel protective clothing in PPE drums after completing the inspection.

FIELD EQUIPMENT REQUIRED:

- Two-way radio
- Basin F Waste Pile Weekly Inspection Log (attached)
- Air monitoring instrument (PID or FID)
- Tape measure (100 foot)
- Modified Level D personal protective gear (Tyvek or cotton coveralls and Neoprene boot covers)
- Small bucket and squeeze bottle of water for equipment decon

PROCEDURE:

Weekly Inspections (also to occur after storms):

1. Walk the outside perimeter of the fence around the waste pile and leachate collection pond. This will be done in modified Level D protection. Take the inspection log with you and fill it out as you check the following:

   a. Inspect the fence, gates and locks for damage that would allow unauthorized access by people or animals.

b. Inspect the warning signs to see that they are in place, undamaged, and readable from a distance of 25 feet.

c. Inspect the entire area 100 feet from the outside of the waste pile for indications of the presence of prairie dogs or other burrowing animals. If there are indications that they may be present, report immediately to FTM for action.

2. Inside fenced area:

   a. Inspect the sloped sides of the waste pile for large vegetation which might lead to root damage to the cap, or lack of vegetation which would lead to increased erosion.

   b. Check to see that the waste pile and the leachate collection pond areas are free from signs of animals, such as burrows, tracks, or live animals.

   c. Check to see if area inside of fence is free of debris.

   d. Check the side slopes for signs of erosion or deformation.

3. Take the equipment listed on page 1 of this procedure and walk up on top of the waste pile. Take a tape measure, a PID or FID, and the inspection log with waste pile diagram. Walk along all rows of vents and standpipes. Check the following:

   a. Use the FID or PID to check all vents and standpipes. Record readings on the waste pile diagram. Readings above background in the breathing zone require upgrading to Level C.

   b. Check each vent to ensure that it is in good condition and the screens are in place to prevent birds or animals from entering.

   c. Inspect the top of the waste pile for large vegetation which might lead to root damage to the cap, or lack of vegetation which would lead to increased erosion.

   d. Check to see that the waste pile is free from signs of animals, such as burrows, tracks, or live animals.

   e. Check the waste pile cap for visible cracks, dips, or ponding water.

   f. Use the FID or PID to check readings in the top of the sumps and settlement plates. Record readings on the waste pile diagram. Readings above background in the breathing zone require upgrading to Level C.

4. Walk down the waste pile to the leachate collection pond. Fill out the inspection log as you check the following:

   a. Walk around the top of the liner and inspect for tears or damage.

   b. Measure the depth from top of casing to liquid level in the sump standpipe located on the east side of the pond. Use a well sounder or tape measure coated with indicator paste, and read to the nearest 1/4".

5. Inspect SAPs, APs, other containers, and spill and safety supplies for problems, and note any concerns on the log where provided.

6. An "unacc" response to any item on the log requires completing the two right-most columns indicating the location and nature of any problem and the date and nature of corrective action taken.

After Inspection:

1. Complete personnel decon. A boot wash will be dedicated outside the compressor shed for deconning prior to leaving fenced area.

2. Lock the gate.

3. Return the completed inspection log in the clipboard to the WESTON trailer.

RESPONSE TO PROBLEMS:

Spills or leaks:

Any spills of leaking regardless of size, will require the crew to leave the area and notify FTM/Emergency Coordinator immediately upon discovery. The FTM/Emergency Coordinator will make the determination to implement the contingency plan or direct clean-up operations.

Monitoring Equipment Malfunction:

1. Do not proceed with weekly inspection without a working instrument.

2. Notify the DOM or SSO of any instrument maintenance or repair needed and note on inspection log.

ROCKY MOUNTAIN ARSENAL

BASIN F IRA - STRUCTURES

STANDARD OPERATING PROCEDURE

TITLE:	Waste Pile Inspections: Leachate Collection System Pipeline	**SOP NO.:**	433.1
DATE:	March 1992	**REVISION:**	1.3
PROJECT MGR.:	MEW	**AUTHOR:**	DLB
TASK MGR.:	RAC	**PMRMA REVIEW:**	

PURPOSE: To establish standard operating procedures for inspecting the Basin F Waste Pile Leachate Collection System.

RELATED SOPS:
404 Basin F Communications
413 Basin F Health and Safety
423 Waste Pile Security
453 Waste Pile Maintenance (series)
433.0 Waste Pile Inspection
433.2 Waste Pile Inspection: Thermal Deformations of Pipeline

FREQUENCY OF PROCEDURE: Each operational day at the Waste Pile prior to starting pumping operations

PERSONNEL REQUIREMENTS: Two Level C - certified inspections; at least one who has had on-the-job-training (OJT) on the waste pile inspection procedures. The second inspector may be a trainee.

HEALTH AND SAFETY: As per SOP 413; Modified Level D (CTyvek or cotton coveralls and Neoprene boot covers) for routine weekly inspection activities; Modified Level D when measuring liquid level in sumps. Decontamination procedure will be to dispose of personnel protective clothing in PPE drum after completing the inspection.

FIELD EQUIPMENT REQUIRED:
Two-way radio
Logbook
Cellular phone
Basin F Waste Pile Daily Inspection Log
Modified Level D personnel protective gear (Tyvek, booties)
Air monitoring instrument (PID of FID)

PROCEDURES:

1. During the inspection, record all deficiencies or comments in the logbook and as required on the inspection log.

2. Use the PID or FID to check readings in the breathing zone and in the top of the sumps. Record readings on inspection log. Any reading above background require upgrading to Level C.

3. Determine that radios and cellular phone are operable and note on inspection log.

4. Starting at the northerly most end of the leachate collection system (mobile tank and trailer unit) inspect the tank, trailer, discharge end of leachate collection pipeline, and secondary containment vessel for leachate pipeline.

   - Inspect tanks for visible leaks or warping
   - Inspect secondary containment liner for tears or leaks
   - Inspect secondary containment for accumulation of precipitation or Basin F liquid
   - Check bulkhead fittings, hose and other connections to ensure that they are firmly in place and free from blockage
   - Inspect and record in fieldbook the expansion or contraction in 3" carrier pipe line (see S.O.P. 433.2 for expansion and contraction measurement)

5. Proceed to sump #4 (see attached diagram). Look into plexiglass sump cover and inspect contents.

   - Inspect and record expansion and contraction in 3" carrier pipeline
   - Check the 3" line to ensure that it is intact, free from leaks or cracks
   - Inspect bottom of sump for any spills
   - Make sure tank tracing line has not been severed

6. Starting at Sump #4, proceed North down the wooden trestle.

   - Inspect the polyethylene bellows on the outside of sump #4 for a tight fit around 10" containment pipe and for enough horizontal slack to allow 4 inches of movement in either direction.
   - Inspect the steel support brackets under the 10" containment pipe to ensure that the 10" pipe has room to move laterally.
   - Inspect ball valve in pipeline (near discharge end). Ball valve shall be in an open position during pumping operation, and only when mobile tank is connected. Also check ball valve for alignment in pipe due to expansion and contraction. The handle to the ball valve shall be removed when not in use.

7. Proceed south up the waste pile embankment along the Leachate Collection System pipeline. Inspect pipeline for any leaks or breaks. Inspect the mounting brackets for alignment. Readjust mounting brackets as necessary.

8. Inspect sump #3 (the sump at cell #3) similar to sump #4. In addition, check to make sure sand bag ballast is in place.

9. At cell #3, inspect the following items:

   - Hoses - primary and secondary for leaks and quality connections
   - Valves - for leaks
   - Tanks - for leaks and warping

- Emergency overflow line for quality connections and blockage

- Secondary containment under elevated wooden tower for accumulation of precipitation or spills

10. Proceed south along the pipeline using the walkway. Inspect pipeline for leaks or breaks. Check mounting brackets for alignment. Readjust mounting brackets as necessary.

11. At cell #2, inspect sump #2 similar to sump #4.

12. At cell #2, inspect items listed in step 9.

13. Proceed south along the pipeline using walkway, inspect pipeline and monitoring brackets as before (Step 10).

14. At cell #1 (southerly most station), inspect the following items in addition to the item listed in Step 9.

    - End of pipe movement as per SOP 433.2
    - Heat tracing junction box to see that it is intact

15. After inspecting the Leachate Collection System, the pumping operation may proceed.

16. Record any irregularities in the logbook and follow up by noting the irregularities on the daily inspection log. Any "no" response on inspection log requires an explaination on comments page of inspection log.

17. Finalize daily inspection log and return completed log to WESTON trailer.

RESPONSE TO PROBLEMS:

Leaks or Spills

1. Any spills or leaks, regardless of size, will require the crew to notify the FTM/Emergency Coordinator immediately upon discovery. The FTM/Emergency Coordinator will make the determination to implement the contingency plan or direct clean-up operations.

Leachate Collection System:

1. If pipe support band is out of alignment, readjust bands under pipe.

2. If expansion and contraction movements are creating adverse problems notify WESTON, Denver.

3. If a pipe joint or connection is split, broken or needs repair do not operate system. Notify WESTON, Denver immediately.

4. For loose valves or hose connections, repair as necessary and note location in weekly inspection report.

5. For blockage of pipeline do not operate system. Upgrade to Level C and remove blockage from pipeline by flushing with water (as per SOP 453.5) or by physically removing it. Record the location, type of blockage and amount of water used (if applicable) in weekly inspection report.

ROCKY MOUNTAIN ARSENAL

BASIN F IRA - STRUCTURES

STANDARD OPERATING PROCEDURE

TITLE:	Waste Pile Maintenance: Fences	**SOP NO.:**	453.1
DATE:	June 1991	**REVISION:**	1.4
PROJECT MGR.:	MEW	**AUTHOR:**	CGH
TASK MGR.:	RAC	**PMRMA REVIEW:**	7/7/89

PURPOSE: To establish standard maintenance procedures for the fence at the Basin F Waste Pile.

RELATED SOPS:
404 Basin F Communication
413 Waste Pile Health and Safety
423 Waste Pile Security

FREQUENCY OF PROCEDURE: As needed.

PERSONNEL REQUIREMENTS: A minimum of two people, who are familiar with this SOP, the site health and safety plan, and the tasks to be performed.

HEALTH AND SAFETY: As per SOP 413; Level D outside the fence and Modified Level D (Tyvek or cotton coveralls and Neoprene boot covers) for routine activities inside the fence. Decontamination procedure will be to dispose of personnel protective clothing in a plastic bag after completing the scheduled maintenance.

FIELD EQUIPMENT REQUIRED: Tools as needed for the maintenance scheduled.

PROCEDURE:

1. Repair items needed will be noted on the waste pile inspection form comments page. The DOM is responsible for scheduling repairs.

2. WESTON personnel will be responsible for having repairs completed as quickly as possible. In no situation shall this exceed one week unless repair parts are unavailable.

3. After repairs are completed, the date and work details will be added to the "response" column of the waste pile inspection form comment page.

RESPONSE TO PROBLEMS:

1. Call FTM on radio and describe situation. Proceed as directed.

2. For medical emergency, the FTM will call Arsenal ambulance at 289-0223.

ROCKY MOUNTAIN ARSENAL

BASIN F IRA - STRUCTURES

STANDARD OPERATING PROCEDURE

TITLE:	Waste Pile Maintenance: Surface Repair	**SOP NO.:**	453.2
		REVISION:	1.4
DATE:	June 1991	**AUTHOR:**	CGH
PROJECT MGR.:	MEW	**PMRMA REVIEW:**	7/7/89
TASK MGR.:	RAC		

PURPOSE: To establish standard maintenance procedures for surface repair at the Waste Pile, including erosion control and weed control.

RELATED SOPS:
404 Basin F Communication
413 Waste Pile Health and Safety
423 Waste Pile Security
433 Waste Pile Inspections

FREQUENCY OF PROCEDURE: As needed

PERSONNEL REQUIREMENTS: A minimum of two people, who are familiar with this SOP, the site health and safety plan, and the tasks to be performed.

HEALTH AND SAFETY: As per SOP 413; Modified Level D (Tyvek or cotton coveralls and Neoprene boot covers) for routine maintenance activities; Level C if air monitoring indicates the necessity. Decontamination procedure will be to dispose of personnel protective clothing in a PPE drum after completing the maintenance.

FIELD EQUIPMENT REQUIRED:
Two-way radio
Erosion control: Shovel, hand tools

PROCEDURE:

Erosion Control:

1. Areas in need of repair will be noted on the waste pile inspection form comments page. The DOM is responsible for scheduling repairs.

2. Verify that weather and soil conditions will allow work (i.e. don't work when ground is excessively muddy or frozen).

3. Cover any eroded areas or large cracks in the berm with native soil from the nearby areas.

4. Cover the new soil with seed and straw to stabilize.

5. If erosion is severe, the FTM may opt to call in an outside contractor for repairs, or may bring in specialized equipment.

6. After the work has been completed, the date and work done will be entered into the "response" column of the waste pile inspection form comments page.

Weed Control:

1. Remove any vegetation which might develop deep roots which would damage the liner beneath.

2. After the work has been completed, the date and work done will be entered into the "response" column of the waste pile inspection form comments page.

RESPONSE TO PROBLEMS:

1. Call FTM on radio and describe situation. Proceed as directed.

2. For medical emergency, the FTM will call Arsenal ambulance at 289-0223.

ROCKY MOUNTAIN ARSENAL

BASIN F IRA - STRUCTURES

STANDARD OPERATING PROCEDURE

TITLE:	Waste Pile Maintenance: Sump Pumping	SOP NO.:	453.3
		REVISION:	1.5
DATE:	September 1991	AUTHOR:	PAB
PROJECT MGR.:	MEW	PMRMA REVIEW:	
TASK MGR.:	RAC		

PURPOSE: To establish standard procedures for pumping the leachate collection sumps (primaries) and the leak detection sumps (secondaries) at the Waste Pile.

RELATED SOPS:

404 Basin F Communication
413 Waste Pile Health and Safety
423 Waste Pile Security
433 Waste Pile Inspections

FREQUENCY OF PROCEDURE: Frequency will be determined by daily inspection of liquid levels in sumps. When leachate in the sump is closer than one foot from the top of the sump, frequency shall be increased.

PERSONNEL REQUIREMENTS: A minimum of two people, who are familiar with this SOP, the site Health and Safety Plan, and the tasks to be performed.

HEALTH AND SAFETY: As per SOP 413; Modified Level D (Tyvek or cotton coveralls and Neoprene boot covers) for routine maintenance activities; Level C if air monitoring indicates the necessity. Decontamination procedure will be to dispose of personnel protective clothing in a PPE Drum after completing the maintenance.

FIELD EQUIPMENT REQUIRED:

Two-way radio
Rags
Tape measure (100') with ball float
Water indicating paste
Primary sump daily pumping log
Secondary sump daily pumping log
Air Monitoring Instrument (PID or FID)

PROCEDURE:

1. Back mobile trailer unit into loading area and stop at concrete wheel chocks. Stop truck engine and engage emergency brake.

2. Remove cap from the quick connect end of the leachate collection system pipeline. Elevate cap to ensure that any remaining liquid is drained into clean PVC hosing which is permanently attached to this cap.

3. Extend hose from mobile tank unit to connect with the quick connect coupler on the leachate collection system pipeline.

4. Open ball valve on the leachate collection system pipeline which is located near the north end of the wood trestle.

5. Measure and record fluid levels in leachate collection sumps (24" diameter) and leak detection sumps (8" diameter) by measuring down from the top of the riser pipe to the liquid level.

    a. Lower fiberglass tape with ball float attached down into sump until the tension in the tape becomes slack.

    b. Put tape back up <u>slowly</u> until tension is put back into tape.

    c. Record measurement on the Waste Pile Daily Log form in the column marked "Depth of Fluid Before Pumping." Check to make sure that the column selected is for the correct pump.

6. Start air compressor.

7. Check each of the three holding tanks on top of the Waste Pile located at each sump to verify that the ball valve on the underside of the holding tank is closed.

8. Turn on the pumps to each primary sumps.

9. Allow pumps to run until the leachate is removed to the lowest level possible in each primary sumps.

10. Prior to the daily dumping of the tanks into the mobile tank unit, measure and record the volume of leachate collected from each sump.

11. Repeat steps 8, 9, and 10 for the secondary sumps as required. Turn off pumps.

12. After pumping, remeasure and record the fluid levels as described in step 5.

13. Turn of air compressor.

14. To dump the collected leachate from the holding tanks to the mobile unit, open the ball valves on the underside of the holding tanks.

15. Walk the entire length of the leachate collection system pipeline to check for any leaks into the secondary containment system. Shut all valves if a leak is detected.

16. Allow fluid in the holding tanks and pipeline to drain for a minimum of one (1) hour.

17. Close the ball valve on the underside of the holding tanks.

18. If tank is not three-quarters full, allow ball valve in the leachate collection system pipeline near the north end of the wooden trestle to remain open to drain.

19. If the mobile tank unit is three-quarters or more full, shut ball valve in the leachate collection system pipeline; disconnect the quick connect coupler at the end of the leachate collection system pipeline; and cap the quick connect coupler ends.

20. Transfer liquid to Pond A as per SOP 453.4.

21. Secure area prior to leaving.

RESPONSE TO PROBLEMS:

<u>Leaks or spills</u>

Any leaks or spills, regardless of size, will regquire the crew to notify the FTM/Emergency Coordinator immediately upon discovery. The FTM/Emergency Coordinator will make the determination to implenment the contingency plan or direct clean-up activities.

BASIN F WASTE PILE
PRIMARY SUMP PUMPING DAILY LOG

	CELL #1				CELL #2				CELL #3				
	PUMP TIME		LIQUID LEVEL		PUMP TIME		LIQUID LEVEL		PUMP TIME		LIQUID LEVEL		TOTAL VOLUME PUMPED (GAL)
DATE	TIME ON	SECONDS PUMPED	BEFORE PUMPING	AFTER PUMPING	TIME ON	SECONDS PUMPED	BEFORE PUMPING	AFTER PUMPING	TIME ON	SECONDS PUMPED	BEFORE PUMPING	AFTER PUMPING	

BASIN F WASTE PILE
SECONDARY PUMPING DAILY LOG

DATE	CELL #1				CELL #2				CELL #3				TOTAL VOLUME PUMPED (GAL)
	PUMP TIME		LIQUID LEVEL		PUMP TIME		LIQUID LEVEL		PUMP TIME		LIQUID LEVEL		
	TIME ON	SECONDS PUMPED	BEFORE PUMPING	AFTER PUMPING	TIME ON	SECONDS PUMPED	BEFORE PUMPING	AFTER PUMPING	TIME ON	SECONDS PUMPED	BEFORE PUMPING	AFTER PUMPING	

ROCKY MOUNTAIN ARSENAL

BASIN F IRA - STRUCTURES

STANDARD OPERATING PROCEDURE

TITLE:	Waste Pile Maintenance: Liquids Transfer to Pond A	SOP NO.:	453.4
		REVISION:	1.4
DATE:	September 1991	AUTHOR:	PAB
PROJECT MGR.:	MEW	PMRMA REVIEW:	
TASK MGR.:	RAC		

PURPOSE: To establish standard operating procedures for the transfer of liquids to Pond A.

RELATED SOPS:
404 Basin F Communication
412 Ponds A and B Health and Safety
422 Ponds A and B Security

FREQUENCY OF PROCEDURE: As required when the liquid level in the mobile tank unit is greater than or equal to 1,400 gallons.

PERSONNEL REQUIREMENTS: A minimum of two people, who are familiar with this SOP, the site health and safety plan, and the tasks to be performed.

HEALTH AND SAFETY: As per SOP 412.

FIELD EQUIPMENT REQUIRED:
Mobile tank unit
Basin F Operating Record

PROCEDURE:

1. Transport the mobile tank to the Pond A dumping station location on the northwest side of Pond A. The tank and the trailer should be placed at the end of the containment trough.

2. Connect the side tank drainline to the 4" flex hose that is located above the containment trough.

3. Open the valve connected to the drainline and the tank.

4. Allow the liquid to drain, by way of gravity, until the tank is empty.

5. After the tank has completely drained, close the valve.

6. Return the tank to the waste pile dump station.

RESPONSE TO PROBLEMS:

Leaks or spills

Any leaks or spills, regardless of size, will require the crew to notify the FTM/Emergency coordinator immediately upon discovery. The FTM/Emergency coordinator will make the determination to implement the contingency plan or direct clean-up activities.

BASIN F
OPERATING RECORD OF LIQUID TRANSFERS

DATE	TIME	INITIALS	LIQUID SOURCE	AMOUNT TRANSFERRED (GAL)	POND A LIQUID LEVEL	COMMENTS

ATTACHMENT 4

BASIN F IRA WASTE PILE

MATERIAL PROPERTIES AND TEST RESULTS

June 25, 1990

Job No. 90G741-05

Gundle Lining Systems, Inc.
19103 Gundle Road
Houston, Texas 77073

ATTENTION: Mr. Mark Cadwallader

RE: TRANSMISSIVITY TEST RESULTS

Dear Mr. Cadwallader:

Attached are the results of the transmissivity tests performed on the following section:

POLYFELT TS-700 SOIL GEOTEXTILE
GUNDLE XL-14 GEONET
60 MIL HDPE GEOMEMBRANE

The tests were performed in accordance with ASTM D-4716 using normal loads of 6,500 and 10,000 psf and gradients of 0.02, 0.25, and 0.50.

Should you have any questions, please do not hesitate to call.

Sincerely,

J&L TESTING COMPANY, INC.

Richard S. Lacey, P.E.

Richard S. Lacey, P.E.
Manager-Geosynthetic Testing

RSL/dlz
L-D#318

T-006

TRANSMISSIVITY TEST RESULTS
FOR
GUNDLE LINING SYSTEMS,INC.
ASTM D-4716

TEST CONFIGURATION
TOP LOAD PLATE
SOIL
POLYFELT TS-700
GUNDLE XL-14 GEONET
60 MIL HDPE
BOTTOM LOAD PLATE

DATE: 6-19-90
JOB NO.: 90G741-05
UNIT NO.: 2
TESTED BY: J.B.

SAMPLE: 12"x12"
FLUID: WATER

NORMAL LOAD: 6,500psf

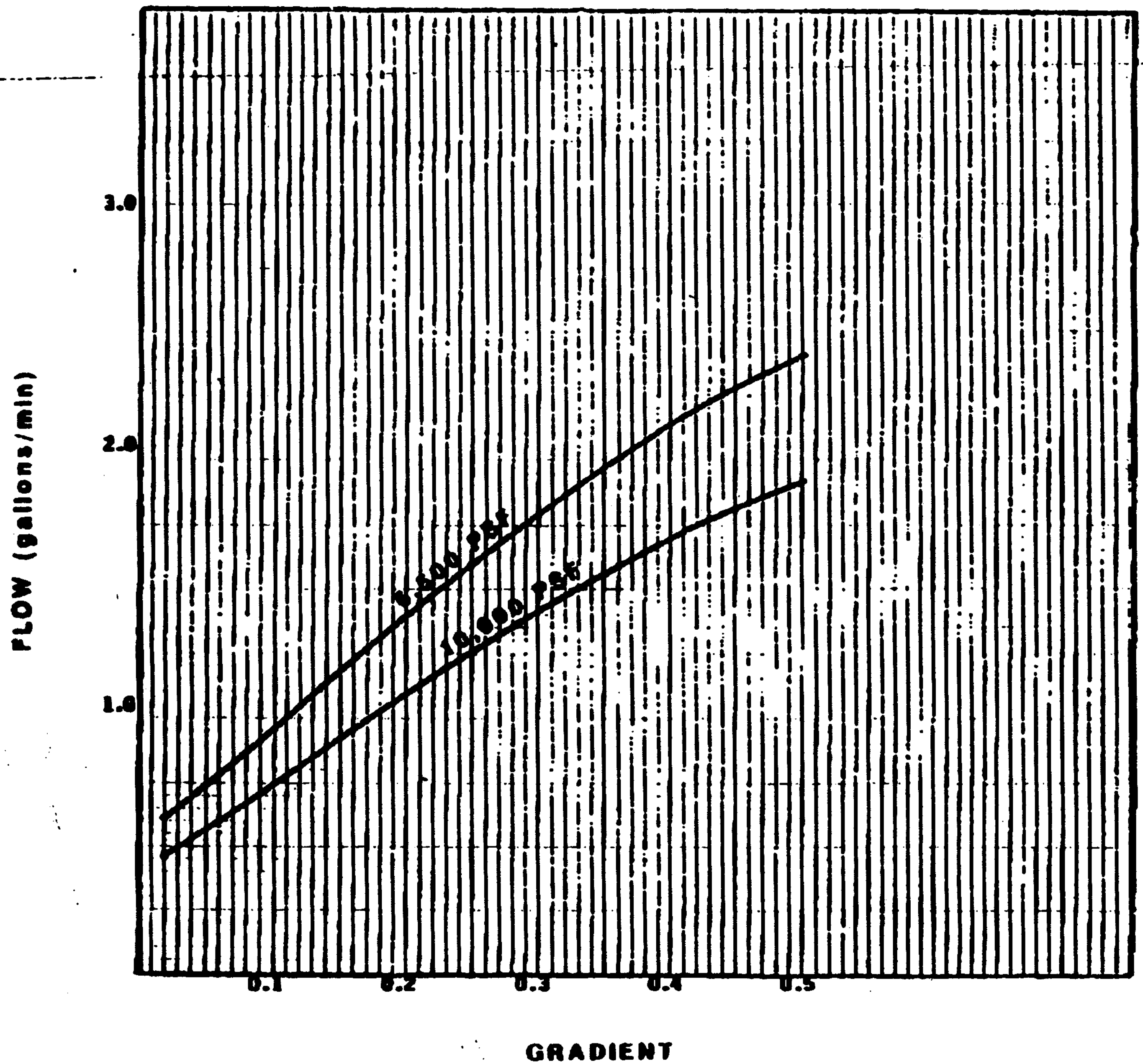
GRADIENT	INITIAL READING (cm)	FINAL READING (cm)	ELAPSED TIME (sec)	FLOW RATE Q (gal/min)	TRANSMISSIVITY M2/SEC
0.02	28.0	30.5	164.3	0.609	6.2993E-03
0.25	32.0	37.0	124.9	1.601	1.3258E-03
0.50	35.0	40.0	82.7	2.418	1.0012E-03

NORMAL LOAD: 10,000psf

GRADIENT	INITIAL READING (cm)	FINAL READING (cm)	ELAPSED TIME (sec)	FLOW RATE Q (gal/min)	TRANSMISSIVITY M2/SEC
0.02	26.0	28.5	218.7	0.457	4.7324E-03
0.25	23.0	28.0	158.7	1.260	1.0435E-03
0.50	33.0	38.0	103.7	1.929	7.9844E-04

Richard S. Lacey, P.E.
Richard S. Lacey, P.E.
Manager Geosynthetic Testing

G 2 0 (6-88)



J & L TESTING COMPANY, IN

Geotechnical Geomembrane and Geotextile Te

MATERIALS:

Gundle XL-14 Geonet
Polyfelt TS-700 Geotextile
Gundle 60 Mil HDPE

FLUID: Water

UNIT NO.: 2 TEMPERATURE: 70°F

SECTION:

UPPER LOAD PLATE
Soil
Geotextile
Geonet
HDPE
LOWER LOAD PLAT

TRANSMISSIVITY TEST RESULTS

Gundle Lining Systems, Inc.

PROJECT NO: 906741-05

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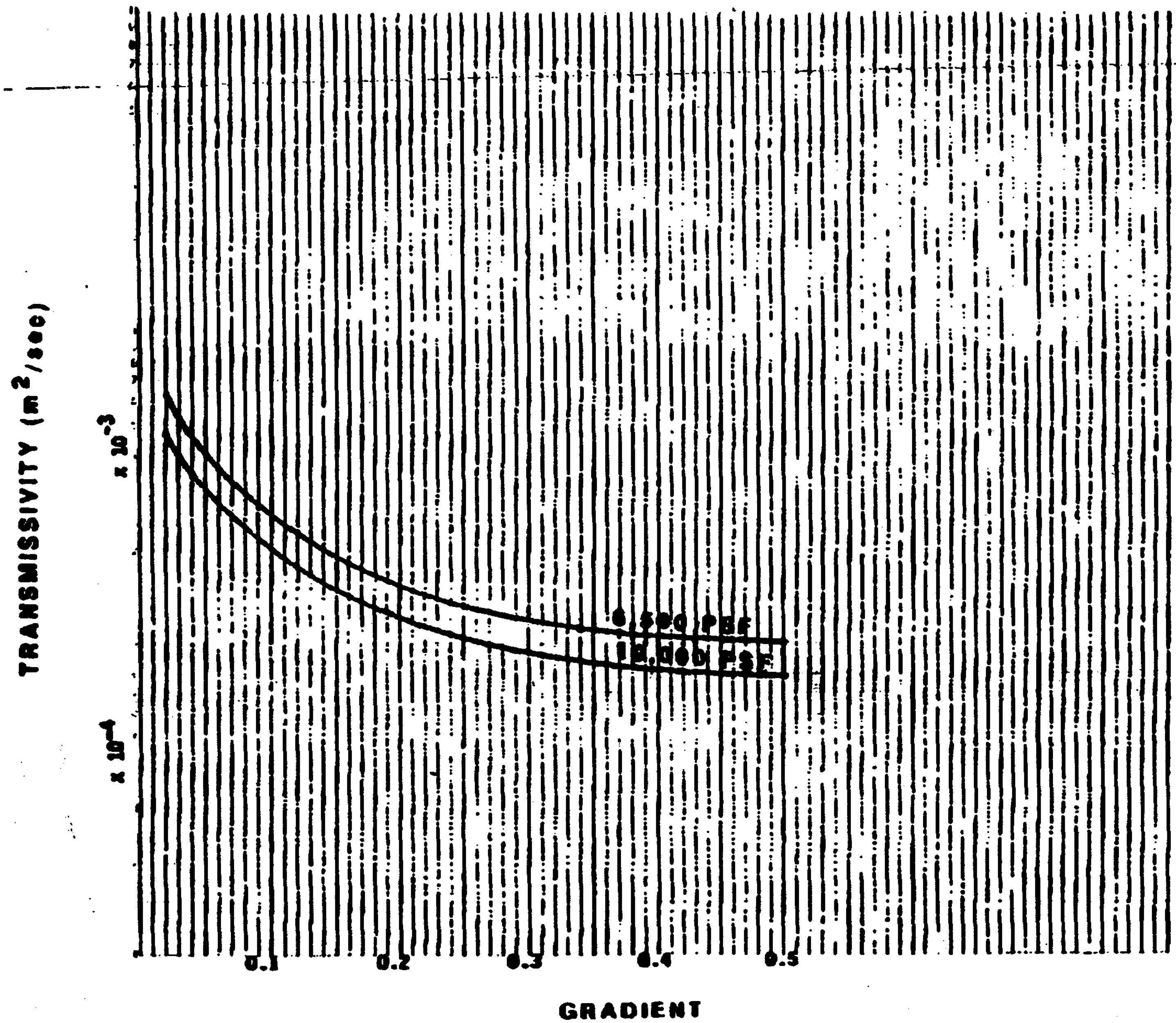

J & L TESTING COMPANY, I

Geotechnical Geomembrane and Geotextile I

MATERIALS:

Gundle XL-14 Geonet
Polyfelt TS-700 Geonet
Gundle 60 Mil HDPE

FLUID: Water

UNIT NO.: 2 TEMPERATURE: 70°F

SECTION:

UPPER LOAD PLAT
Soil
Geotextile
Geonet
HDPE
LOWER LOAD PLA

TRANSMISSIVITY TEST RESULT

Gundle Lining Systems, Inc.

PROJECT NO: 906741-05

DATE: FIGURE

SPECIFICATIONS FOR HDPE GUNDNET XL-14

Test	Method	Gundnet XL-14
Roll Length (maximum)		300 ft.
Roll Width		14 ft.
Roll Weight (average)		840 lbs.
Weight per Square Foot		.20 lbs./sq. ft.
Specific Gravity (g/cm^3)	ASTM D1505	> .94
Melt Flow Index (g/10 min.)	ASTM D1238 Condition E	< .26
Thickness	Micrometer Measurement at Strand Intersection	5.0 - 6.5 mm 200 mil - 265 mil .200 - .265 in.
Percent Carbon Black	ASTM D1603	2 - 3%
Tensile Break Strength	(2 in. x 5 in. specimen pulled apart at 2 in./minute)	
Machine/Roll Direction		50 lbs.
Cross Direction		30 lbs.
UV Stability		Resistant to UV
Transmissivity (minimum) (Minimum)	10,000 psf compressive load between two layers of Gund-line HD; 0.25 Hydraulic Gradient	10g/min./ft. or 2×10^{-3} m^2/sec.

MC
9/89

Gundle

LAB REPORT #2683

PROJECT: To test materials to be used for the Rocky Mountain Arsenal Basin Project in accordance with ASTM Committee D-35 draft Standard Test Method for Testing Hydraulic Transmissivity.

Hydraulic Transmissivity is the flow per unit time divided by the hydraulic gradient and the width of the test specimen. It is determined by measuring the quantity of water which passes through a specimen of drainage material in a specific time interval under a specific normal stress and a specific hydraulic gradient.

APPARATUS AND METHOD: A metal base with a smooth flat bottom and sides holds a test specimen "sandwich" of 1 square foot. The loading mechanism for the apparatus is a water reservoir the full width of the base that can maintain a water level at several elevations. A catch trough extends the entire width of the base, and has an outlet that allows measured samples to be captured.

The test sandwich for this project was as follows:

////////	Simulated Sand (Closed Cell Foam Rubber per Section 6.1.5 ASTM Draft Transmissivity Standard D-35)
--------	TS800 Polyfelt (Nonwoven, continuous filament geotextile)
XXXXXXXX	Gundnet XL-4
________	Gundline 60 mil HDPE

Samples of Gundnet were placed so that flow through the transmissivity device was in the roll direction, as will occur on site. One foot square samples were cut, laid flat insuring that there were no wrinkles, and sealed into the apparatus with silicon sealant. Water was allowed to flow through the test sandwich to thoroughly wet the sample and remove trapped air bubbles. Appropriate perpendicular pressure simulating load on the test sandwich was achieved with a plastic bladder filled with nitrogen gas. The sample stayed under this load for a 15 minute seating period. Volumes were measured as a function of time and hydraulic pressure. Three column readings were averaged at each hydraulic gradient. Tests were performed at room temperature (24° C). Results appear on the attached plot of hydraulic transmissivity versus hydraulic gradient.

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LAB REPORT #2683

REQUIREMENT FOR DRAINAGE LAYER AT BOTTOM OF WASTE PILE

IS	2×10^{-3} M^2/sec or 9.6 gpm/ft. flow rate
FOR	4000 psf
	0.02 hydraulic gradient
TRANSMISSIVITY OF	Gundnet XL-4 is

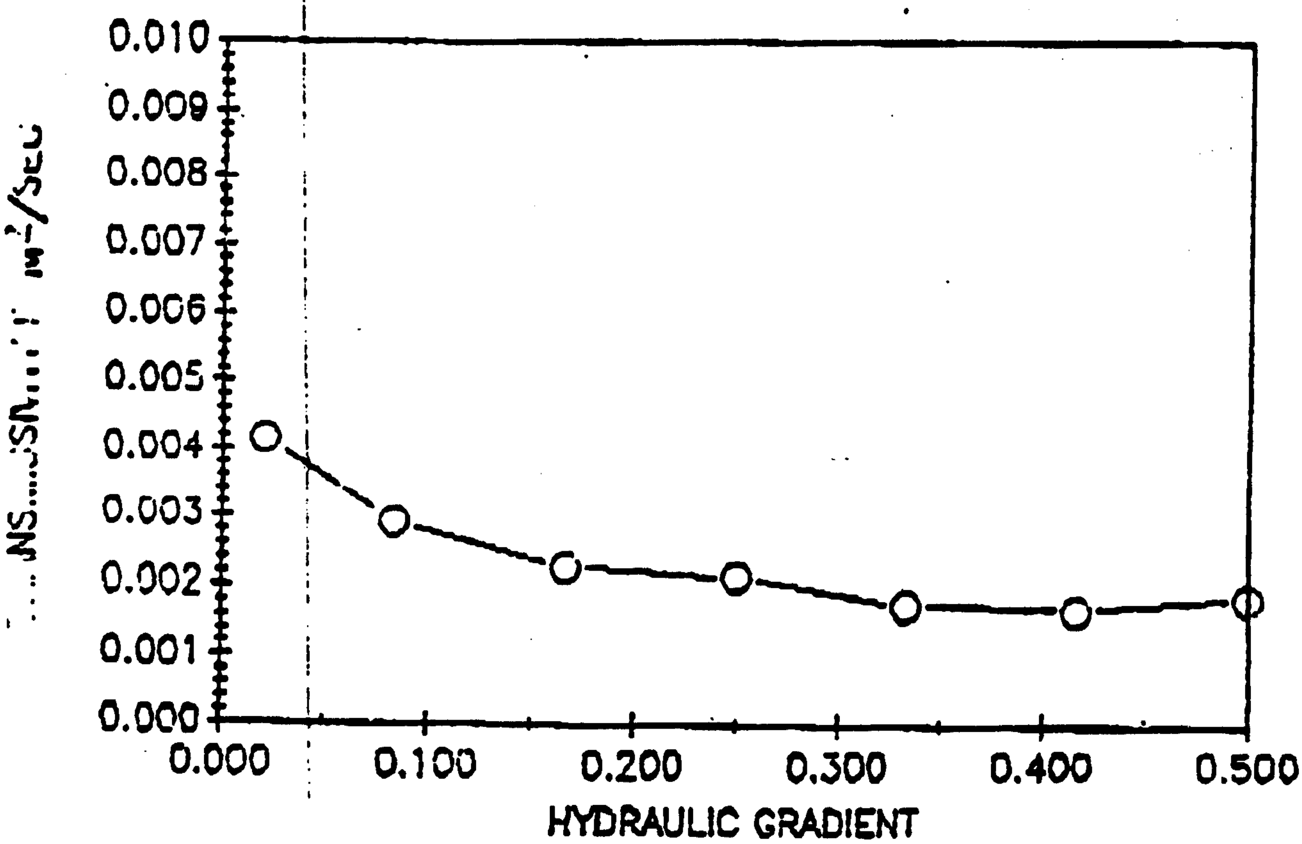
gpm/ft	M^2/sec
20.12	0.0041645

Darlena Phouangsavanh
Laboratory Supervisor

Mark Cadwallader
Director of Research &
Technical Development

Gundle

FALLING HEAD TRANSMISSIVITY
AT 4000 PSF WITH GUNDNET XL-4



Gundle Lining Systems Inc

Gundle

Gundline HD

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 × 10⁵)	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.*