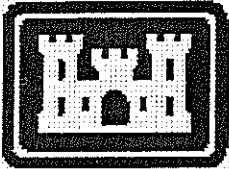


received
2-3-97



U.S Army Corps of Engineers

New England Division

SHEPLEY'S HILL LANDFILL ANNUAL REPORT - 1996

SHEPLEY'S HILL LANDFILL
DEVENS
MASSACHUSETTS

Prepared Under:

DELIVERY ORDER NO. 26
CONTRACT NO. DACW33-94-D-0007

JANUARY 1997



Stone & Webster *

1A 97012 SWES

SHEPLEY'S HILL LANDFILL
ANNUAL REPORT-1996

for

SHEPLEY'S HILL LANDFILL
DEVENS, MASSACHUSETTS

January 1997

Prepared by: _____
Joseph Coyne, Site Engineer

Joseph P. Coyne

Date

1/31/96

Approved by: _____
Pamela Foti, Project Manager

Pamela Foti

Date

1/31/97

Approved by: _____
Richard Skryness, Project Manager

Richard Skryness

Date

1/31/97

STONE & WEBSTER ENVIRONMENTAL TECHNOLOGY & SERVICES

Shepley's Hill Landfill Annual Report
TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
	EXECUTIVE SUMMARY	1
1.0	INTRODUCTION	2
2.0	LANDFILL CAP MAINTENANCE ACTIVITIES	3
3.0	LANDFILL GAS MONITORING RESULTS.....	5
4.0	GROUNDWATER ELEVATIONS	8
5.0	GROUNDWATER SAMPLING.....	9
5.1	Preparation for Sampling	9
5.2	Sampling	9
6.0	LABORATORY TESTING	11
6.1	Analyses	11
6.2	Results	11
7.0	QUALITY CONTROL	15
7.1	Field Quality Control.....	15
7.2	Laboratory Quality Control	15
8.0	CORRECTIVE ACTION.....	16

TABLES

Table 4-1	Groundwater Elevations	7
Table 6-1	Groundwater Sample Analysis and Procedures	12
Table 6-2	Laboratory Results.....	13

APPENDICES

Appendix A	Landfill Maintenance Checklist
Appendix B	Landfill Gas Monitoring Form
Appendix C	Groundwater Field Analysis Forms
Appendix D	Arsenic Concentrations

EXECUTIVE SUMMARY

This annual report has been prepared to document the monitoring and maintenance activities conducted at the Shepley's Hill Landfill in Devens, Massachusetts as required by the Record of Decision (ROD) for areas of contamination 4, 5, and 18 (ABB-ES, Oct 1995). This report was developed for the U.S. Army Corps of Engineers (USCOE), New England Division (NED), by Stone & Webster Environmental Technology and Services (SWEC).

This report documents the results of the first round of the Long Term Monitoring and Maintenance Plan conducted in accordance with the approved LTMMMP (SWEC May 1996) by SWEC in November 1996. Activities conducted as part of the LTMMMP include a yearly inspection of the landfill cover as well as semi-annual groundwater sampling. Post closure monitoring is required for a period of 30 years.

An annual Landfill inspection was conducted and observations were made regarding vegetative cover, unwanted vegetation, erosion, settlement, and the condition of previously repaired areas. The drainage swale leading to Plow Shop Pond is filled with sand outwash and runoff water is cutting into an adjacent hillside causing more sediments to be deposited into Plow Shop Pond. Combustible gas readings were collected from 18 gas vents on the landfill. Five of the vents indicated positive readings for methane, carbon dioxide, Percent Lower Explosive Limit (LEL), and oxygen. The highest readings for methane (0.4%), carbon dioxide (0.6%) and LEL (11%) and the lowest oxygen reading (20.1%) were registered at Vent # 15. Four other vents had slightly elevated methane and carbon dioxide readings.

The first round of groundwater sampling was performed on 14 wells along the northern portion of the landfill. Samples were collected in accordance with the *Draft EPA's Low Flow Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*. (July 1996) Samples were analyzed for Volatile Organic Compounds, Semi-Volatile Organic Compounds, Inorganics, and general water quality parameters. Analytical results from the most recent groundwater sampling have indicated the presence of arsenic above cleanup levels in monitoring wells SHL-20, SHL-11 and SHL-19. This is consistent with previous sampling results from these wells. Arsenic concentrations found in the other monitoring wells samples demonstrate a decreasing trend. The evaluation criteria for these wells will be a 50 percent reduction in the incremental risk between cleanup levels and baseline concentrations for chemicals of concern in each subsequent five-year review, and attainment of cleanup levels by January 2008.

The new wells (SHM-96-5B, SHM-96-5C, and SHM-96-22B) also had arsenic readings above the cleanup levels. These elevated arsenic concentrations may be biased high due to the presence of suspended solids in the groundwater. Analytical data collected from these new wells will be used to calculate baseline concentrations. Risk reduction will be evaluated during the second five year review in 2003.

Corrective actions to address the problems associated with the landfill cap include: the reseeded of depressed areas and an access road; and the installation of a new rip-rap curb to minimize erosion along the drainage ditch which leads to Plow Shop Pond. Corrective actions for future groundwater sampling include redevelopment of the newly installed wells to minimize potential suspended solids and analysis of both filtered and non-filtered groundwater samples for inorganic parameters.

1.0 INTRODUCTION

This annual report has been prepared to document the monitoring and maintenance procedures conducted at the Shepley's Hill Landfill in Devens, Massachusetts (ABB-ES Oct 1995) based on the Record of Decision (ROD) for Shepley's Hill Landfill Areas of Contamination 4, 5, and 18. This report was developed for the U.S. Army Corps of Engineers (USCOE), New England Division (NED), by Stone & Webster Environmental Technology and Services (Stone & Webster).

The Long Term Monitoring and Maintenance Plan (LTMMP) for Shepley's Hill Landfill outlines the landfill closure monitoring and maintenance procedures. These procedures include a semi-annual groundwater sampling program to monitor contaminants, and an annual visual inspection and gas emission monitoring of the landfill cap. This report documents the first round of the LTMMP conducted by Stone & Webster in November 1996. Post closure monitoring is required for a period of 30 years.

2.0 LANDFILL CAP MAINTENANCE ACTIVITIES

Shepley's Hill Landfill cap was inspected on November 15, 1996. The following observations were made regarding vegetative cover, unwanted vegetation, erosion, settlement, and the condition of previously repaired areas. Areas are described in a counter-clockwise direction, beginning at the northern extent of the landfill. Appendix A contains the Landfill Maintenance Checklist which summarizes the observations presented below.

The drainage swale just beyond the northern extent of the cap is severely scoured, in some places 2 feet deep. This was an area that was previously repaired.

The area around the newly installed drainage swale (which drains the depressed area) was hydroseeded following construction. The seed has not germinated satisfactorily. Wetland species (purple loosestrife and woolgrass) are present around the perimeter of the depressed area.

Soil is beginning to erode from a previously repaired area of the hillside, northwest side of landfill, between Vents #1 and #3 and depositing in the drainage swale.

Erosion has reappeared and requires additional repair in the previously repaired area (landfill side of swale) just north of Vent #3.

Wetland species (purple loosestrife and soft rush) are present in the area around Vent #3.

There are four small depressions noted in the vicinity of Vent #6 and between Vents #4 and #7. They range in size from 6 ft x 20 ft to 25 ft x 35 ft. Pooling water was present in all the areas, wetland vegetation was present in the two areas around Vent #6.

The drainage swale northwest of Vent #6, which was mowed to remove overgrown vegetation, has wetland species (purple loosestrife and soft rush) present on the northern edge of the mowed area.

In the drainage swale starting west of Vent #9 and flowing north, wetland species are present all the way up to the southern limit of overgrown vegetation removed from this swale. Species include purple loosestrife, woolgrass, and soft rush. A small area of the swale, approximately 150 ft from Vent #9, is eroded.

The catch basins in the southwest portion of the landfill, which were reset and regraded, look good, grass has grown in.

Standing water and wetland vegetation is present in the drainage swale along the southern boundary of the landfill. It extends from the culvert up to the riprap area north of Vent #13. The vegetation was recently mowed, but there is evidence of the presence of cattails, Phragmites, soft rush, and beggarticks. Some woody species, including birch, pine, and locust, are present on the southeast corner of the cap.

The formerly repaired area east of Vent #11 has eroded again, approximately 6 inches deep. A new area of erosion was noted just south of this area, approximately 12 to 18 inches deep.

The riprap in the drainage swale leading to Plow Shop Pond has been filled by sand outwash again. During high volume runoff, water jumps the rip rap drainage swale at the first bend, cuts into an adjacent hillside and mobilizes more sediment which eventually deposits in Plow Shop Pond. The erosion at the bend of the drainage swale is very severe, extending approximately 15 to 20 feet beyond the edge of the riprap into the sand bank. Sand has been deposited all the way along the swale, and out into Plow Shop Pond. Two guard pipes around Piezometer N-4 have been undermined.

The southeast corner of the repair area east of Vent #8 is eroding back again.

The repair area on the hillside between Vents #2 and #5 has not revegetated successfully and will need to be watched.

3.0 LANDFILL GAS MONITORING RESULTS

The purpose of the landfill gas monitoring program is to establish long-term trends with regard to gas production and venting. A combustible gas survey was performed to determine whether methane, hydrogen sulfide, or volatile organic compounds have accumulated in the subsurface of the landfill site.

The first annual landfill gas sampling was conducted on November 15, 1996. The weather at the time of sampling was sunny, with temperatures in the low 30's (F). Barometric pressure as measured by the Landtec GA-90 landfill gas monitor was 1,033 mb. Gas samples were field analyzed for the following parameters using the listed equipment:

<u>Parameter</u>	<u>Equipment</u>
Total Volatile Organic Compounds (VOC)	HNu Photoionization Detector (PID)
Percent Oxygen	Landtec GA-90 landfill gas monitor
Hydrogen Sulfide (ppm)	Combustible Gas Indicator (CGI)
Percent Lower Explosive Limit (LEL)	CGI
Carbon Monoxide (ppm)	CGI
Percent Carbon Dioxide	Landtec GA-90 landfill gas monitor
Percent Methane	Landtec GA-90 landfill gas monitor

The CGI and the Landtec GA-90 were both calibrated in the shop by Heinrich Environmental. The PID was calibrated in the field to 100 ppm isobutylene.

The 18 gas vents were identified using Drawing 833-90-01 Sheets 1-5 of the Landfill Cap Design. No evidence of venting landfill gas was observed.

Therefore, prior to gas sampling, two vent volumes were purged from the soil gas vent using an exhaust fan arrangement. Samples were collected by holding the monitoring equipment in the exhaust produced by the fan. Results were recorded on the Landfill Gas Monitoring form (Appendix B). After sampling, all vents were marked on two sides with their appropriate number using a black marker.

Results are summarized as follows: No VOCs were found at any of the vents; likewise hydrogen sulfide and carbon monoxide levels were all zero. Methane readings registered at five wells.

- Vent #8 registered methane at 0.1%, with carbon dioxide at 0.1%, an LEL of 2%, and an oxygen level of 21.2%.
- Vent #9 showed methane at 0.1%, an LEL of 1%, and an oxygen level of 21.2%.
- Vent #15 registered the highest readings, with methane at 0.4%, carbon dioxide at 0.6%, an LEL of 11%, and the lowest oxygen level at 20.1%.
- Vent #17 registered methane at 0.1%, carbon dioxide at 0.2%, an LEL of 2%, and an oxygen level of 21.0%.

- Vent #18 showed methane at 0.2%, carbon dioxide at 0.1%, an LEL of 2%, and an oxygen level of 21.2%.

Two other vents, #4 and #16, had LELs of 2% and 1%, respectively. Oxygen levels at the vents which did not register any of the other measured parameters ranged from 21.2% to 21.5%.

No odors were noticed at any of the vent locations.

4.0 GROUNDWATER ELEVATIONS

Groundwater elevations were collected from each well during groundwater sampling activities. Table 4-1 lists the water level elevations for each well. Locations of monitoring wells are found in Figure 4-1.

In addition to these semi-annual groundwater measurements, quarterly groundwater measurements of these wells are conducted by ABB-ES. During the 5-year review, groundwater elevations will be re-evaluated to identify hydraulic gradients and to confirm changes due to the construction of the landfill cap.

TABLE 4-1
Monitoring Wells and Elevations

Well Identification	Groundwater Elevation (ft)
SHL-3	218.29
SHL-4	217.77
SHL-5	215.09
SHL-9	215.41
SHL-10	217.59
SHM-93-10C	218.72
SHL-11	217.22
SHL-19	218.17
SHL-20	217.77
SHL-22	213.73
SHM-93-22C	212.39
SHM-96-22B	*
SHM-96-5B	*
SHM-96-5C	*

ft- feet

TOC - Top of Casing

TOPVC - Top of PVC

* - Indicates these wells will be surveyed before the next scheduled sampling event.

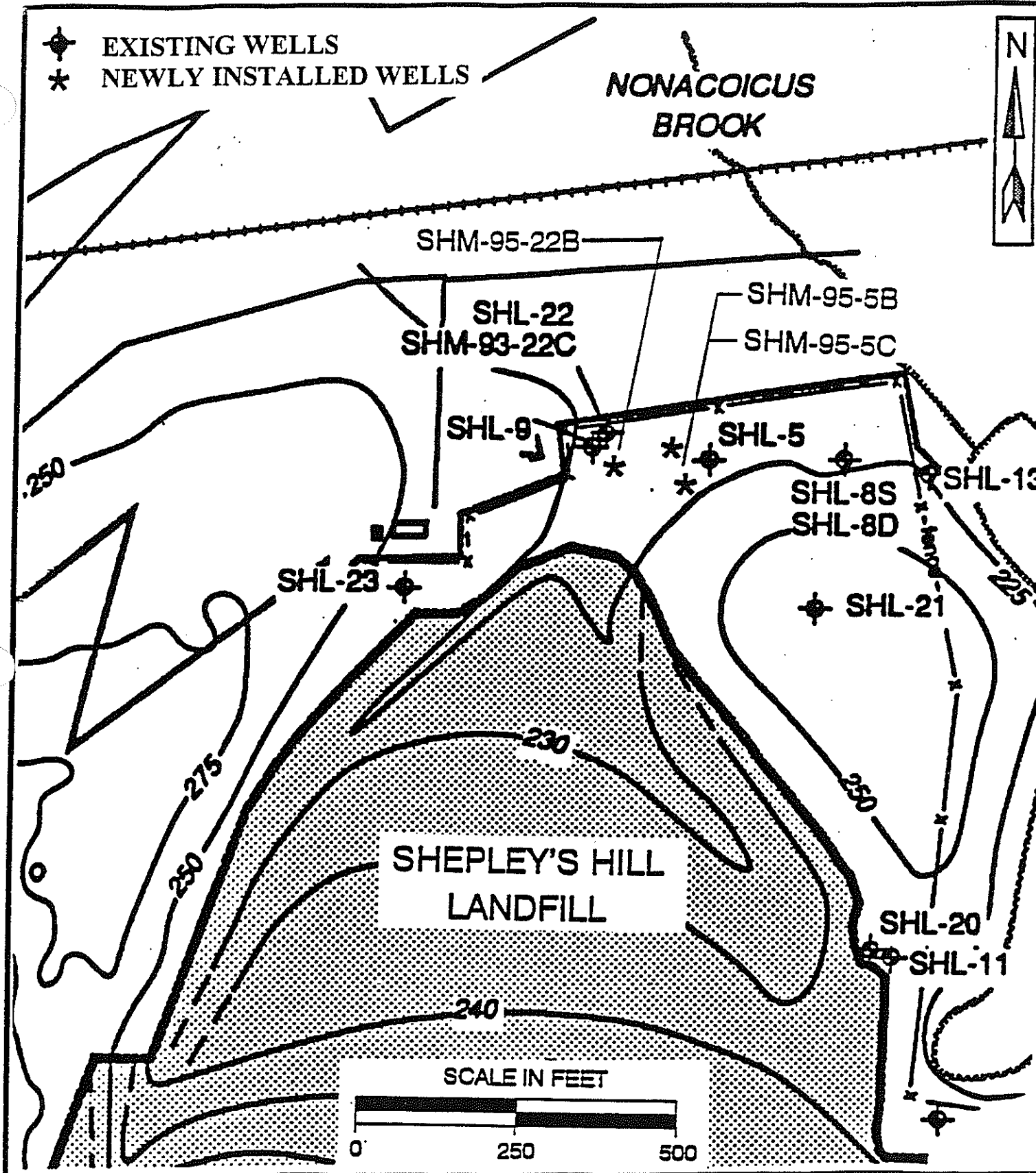


FIGURE 4-1

**WELL LOCATION MAP
 SHEPLEY'S HILL LANDFILL
 FORT DEVENS, MASSACHUSETTS**

5.0 GROUNDWATER SAMPLING

Groundwater sampling activities at the landfill are scheduled to be collected semi-annually, once in the spring (April/May) and once in the fall (October/November). The first round of groundwater sampling was conducted in November 1996.

5.1 Preparation for Sampling

Wells sampled as part of the long term monitoring program included SHL-3, SHL-4, SHL-5, SHL-9, SHL-10, SHL-11, SHL-19, SHL-20, SHL-22, SHM-93-10C, SHM-93-22C, SHM-96-22B, SHM-96-5B, and SHM-96-5C. The contract laboratory was contacted 2 weeks prior to sampling and the necessary coolers and bottles were shipped to Stone and Webster shortly before the sampling date. All sampling equipment (including the Grunfos Rediflow II pump and teflon lined tubing as well as a power converter and generator) was shipped to Stone & Webster the day preceding the sampling event. All equipment was inventoried and tested to ensure it was accounted for and functioning. The well logs of each of the wells to be sampled was reviewed by the field team and brought to the landfill during the sampling event to confirm the screen depths. Ron Difilippo of the BRAC Environmental Office at Devens was contacted for arrangements to obtain access to the landfill and well keys.

5.2 Sampling

The first phase of sampling was conducted by Stone & Webster on November 13-20, 1996. Monitoring wells were purged and sampled in accordance with the *Draft EPA's Low Flow Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (July 1996) using an adjustable rate, low flow submersible pump. Well dedicated teflon lined tubing was used for sample collection and was decontaminated after each well was sampled. The teflon-lined tubing will be stored indoors between sampling rounds, in place of storing it in the well itself, which can cause iron buildup on the tubing.

During sampling, the generator used to power the pump was located at an upwind area at least 30 feet away from the well being sampled, to minimize potential contamination from the exhaust. Upon initial opening of each well, headspace readings and initial water levels measurements were collected. This information was recorded on the groundwater field analysis forms found in Appendix C. The pump intake was lowered to the middle of the screen of each well to be sampled when possible. When the water level was below the top of the screen, the pump was positioned to a depth between the top of the water level and the bottom of the screen.

Once the pumping was initiated, at least one volume greater than the stabilized drawdown volume plus the extraction tubing volume was purged. Water quality parameters, including temperature (temp), specific conductance, pH, oxidation reduction potential (ORP), turbidity, and dissolved oxygen (DO) were collected every 3 to 5 minutes to ensure proper purging of the wells before each well was sampled. The results are listed on Groundwater Field Analysis Forms located in Appendix C. All water quality parameters, except turbidity, were monitored using a flow-thru cell and a Sonde-YSI water meter. Turbidity samples were not collected from the flow through cell due to the silt buildup which commonly occurs in the cell. The tubing was disconnected from the cell for turbidity readings. Sampling was conducted when parameters became stabilized for three

consecutive reading. Samples were collected directly from the tubing connected to the pump. Observations made during the sampling activities include:

- o Due to the low ambient field temperatures, the Sonde-YSI water meter was erratic in reading pH and turbidity levels.
- o There were no headspace concentrations above background recorded from any of the sampled monitoring wells.
- o Due to the water level being deeper than the top of the screen, the pump at well SHL-4 was set at 13 feet bgs instead of 10 feet bgs.
- o Monitoring well SHL-3 was almost dry (depth to water was 30.17 ft and depth of the well is 34 feet). The volume of water in the well was less than the volume of the teflon-lined tubing used and the recharge was very slow. The pump was unable to draw sufficient water from the well and no sample could be collected.

6.0 LABORATORY TESTING

All samples were analyzed by NET Laboratories of Bedford, Massachusetts. Samples were hand delivered to laboratory within 24 hours of collection. Chains of Custody (COCs) were used to identify and document the samples being shipped and were included in the shipment.

6.1 Analyses

Table 6-1 indicates the analysis and procedures used for groundwater samples collected at Shepley's Hill Landfill.

6.2 Results

The evaluation of contaminants at the Shepley's Hill Landfill is based on the reduction of carcinogenic risk rather than reduction of contamination as a measure of progress toward attainment of cleanup. This approach prevents a situation in which failure to attain a concentration reduction goal for a minor contributor to risk (i.e. 1,2-dichloroethane) overshadows the achievement of a 50 percent reduction of concentration of a higher carcinogenic risk (arsenic). Risk reduction will be evaluated during the first five year review in January 1998. However, for the annual reports the contaminant concentrations will be referenced against the cleanup goals as a benchmark. It should be noted that the majority of the risk present at Shepley's Hill landfill is due to elevated arsenic concentrations in the groundwater. Therefore this discussion will focus on this contaminant.

Analytical results for groundwater analysis are presented in the form of a hits only table. (Table 6-2). This table presents only detectable concentrations of contaminants. The results of sampling are summarized below.

Volatile organics were detected at low concentrations. The only trigger compound detected above its clean up goal was dichlorobenzene (total) (6 J $\mu\text{g/L}$) in monitoring well SHL-20. Dichlorobenzene (total) was also detected in monitoring wells SHL-4 (at 1 J $\mu\text{g/L}$), SHL-4 (Dup) (at 1 J $\mu\text{g/L}$), SHM-96-5B (at 2 J $\mu\text{g/L}$) and SHM-96-22B (at 2 J $\mu\text{g/L}$). The trigger compound 1,2-dichloroethane was detected at a maximum concentration of 5 J $\mu\text{g/L}$ in monitoring well SHM-96-22B. 1,2-Dichloroethane was also detected in monitoring wells SHM-96-5B (at 3 J $\mu\text{g/L}$) and SHM-96-5C (at 2 J $\mu\text{g/L}$). Other volatile organic compounds detected in groundwater samples include 1,1-dichloroethane (at 2 J $\mu\text{g/L}$), benzene (at 3 J $\mu\text{g/L}$), chlorobenzene (at 2 J $\mu\text{g/L}$), and m and p-xylene (at 28 $\mu\text{g/L}$).

Semi-volatile organic analysis was conducted only for the presence of dichlorobenzenes, which were detected in wells SHL-22 (1 J $\mu\text{g/L}$), SHL-20 (5 J $\mu\text{g/L}$), SHL-11 (2 J $\mu\text{g/L}$), SHM-96-5B (1 J $\mu\text{g/L}$). These concentrations do not exceed the cleanup goal for dichlorobenzene of 5 $\mu\text{g/L}$.

**TABLE 6-1
Groundwater Sample Analysis and Procedures**

PARAMETERS	METHOD
Volatile Organic Compounds xylenes Acetone 2-butanone 2-methyl pentanone	USEPA 8260 USEPA 8260
Semi-Volatiles 1,2,-dichlorobenzene 1,3,-dichlorobenzene 1,4,-dichlorobenzene	EPA-SW 8270
Inorganics Arsenic Barium Cadmium Chromium Cyanide Iron Lead Manganese Mercury Selenium Silver Copper Zinc	EPA-SW 6010
General Parameters (measured in Laboratory) Total Dissolved Solids Total Suspended Solids Chloride Hardness Nitrite-Nitrate as N Sulfate Alkalinity Biochemical Oxygen Demand Chemical Oxygen	NED METHODS USEPA 160.2 USEPA 300 USEPA 354.1 SW9056 USEPA 310.1
General Parameters (measured in the field) pH Temperature Specific Conductance Dissolved Oxygen Oxygen Reduction Potential VOCs (Headspace)	

USEPA - U.S. Environmental Protection Agency
 VOCs - Volatile Organic Compounds

TABLE 6-2 LABORATORY RESULTS

Long Term Groundwater Monitoring

Shepley's Hill Landfill, Devens, MA

November 14 - 20, 1996

WELL LOCATION:		SHL-10	SHL-11GW	SHL-19/GW	SHL-20/GW	SHL-22/GW	SHL-4	SHM-4(DUP)	SHM-5/GW	SHL-9/GW	SHM-5B	SHM-5C	SHM-93-10C	SHM-93-22/GW	SHM-96-22B
ANALYTE	UOM	Volatile Organic Compound													
1,1-Dichloroethane	ug/L										2 J				
1,2-Dichloroethene (total)	ug/L										3 J	2 J			5 J
Benzene	ug/L										2 J	1 J			3 J
Chlorobenzene	ug/L											2 J			
Dichlorobenzenes (total)	ug/L				6 J	1 J	1 J			2 J	1 J				2 J
TICs (total)	ug/L	8 NJ			20 NJ	7 NJ		9 NJ		54 NJ	10 NJ				16 NJ
TICs (total)	ug/L							6 J							
ANALYTE	UOM	Semivolatile Organic Compound													
Dichlorobenzenes (total)	ug/L		2 J		5 J	1 J					1 J				2 J
TICs (total)	ug/L	14 J		5 J				2 J							
ANALYTE	UOM	Metals													
Arsenic	ug/L	3.4 B													
Barium	ug/L		132 B		93.8 B	20.7 B	45 B	47.2 B		13.8 B	39 B	84.4 B		72 B	61.9 B
Chromium	ug/L													5.2 B	
Copper	ug/L	5.9 B						6.9 B	10.1 B	9.3 B			9.5 B		
Cyanide (total)	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ug/L										2.6 B	2.7 B			
Manganese	ug/L	3.9 B													
Zinc	ug/L	4.5 B	8.5 B	3.3 B	5.3 B		2.9 B	9.7 B	15.5 B	9.6 B					
ANALYTE	UOM	General Chemistry													
Alkalinity	mg/L														
BOD- 5 Day	mg/L	ND		ND	ND		ND	ND	ND		ND	ND	ND	ND	
Chemical Oxygen Demand	mg/L			ND			ND							ND	
Nitrate/Nitrite	mg/L		ND		ND	ND			ND		ND	ND		ND	ND
Solids, dissolved (TDS)	mg/L														ND
Solids, suspended (TSS)	mg/L	ND					ND	ND	ND				ND		
Sulfate, IC	mg/L		ND	ND			ND		ND						

NJ: Estimated non-target concentration (TICs) J: Estimate of Detected Concentration
 ND: Not Detected B: Detected in Associated Method Blank

Arsenic was detected at concentrations greater than the cleanup goal of 50 $\mu\text{g/L}$ in the following monitoring wells: SHL-20 (244 $\mu\text{g/L}$), SHL-11 (332 $\mu\text{g/L}$), SHL-19 (138 $\mu\text{g/L}$), SHM-96-5B (1,440 $\mu\text{g/L}$), SHM-96-5C (71.0 $\mu\text{g/L}$), and (SHM-96-22B) 324 $\mu\text{g/L}$.

Recently installed monitoring wells SHM-96-5B, SHM-96-5C, and SHM-96-22B were sampled for the first time as part of this sampling effort. These new wells, which show exceedences of cleanup levels, will be classified as Group I wells. Reduction of risk will not be evaluated during the first five-year site review following installation. Analytical data collected during the November 1996 sampling will be used to calculate baseline concentrations, and risk reduction will be evaluated in the next five years. The evaluation criteria for these wells will be a 50 percent reduction in the incremental risk between cleanup levels and baseline concentrations for chemicals of concern in each subsequent five-year review, and attainment of cleanup levels by January 2008.

These three newly installed wells (SHM-96-5B, SHM-96-5C, and SHM-96-22B) were not developed as aggressively as the previously installed wells and may have resulted in increased suspended solids in the samples. Therefore the analytical results from the newly installed wells may be biased high. It is unlikely that arsenic would be present at 1440 $\mu\text{g/L}$ in the dissolved phase. These wells will be redeveloped prior to the next sampling round to reduce potential suspended solids. Both filtered and unfiltered samples will be analyzed for arsenic during the next sampling round to confirm this. Samples to be collected for metals analysis will also be both filtered and unfiltered during the next sampling round.

High concentrations of arsenic are also observed at the location of monitoring well SHL-11 and SHL-20. Historically, groundwater analytical results from SHL-11 have always showed arsenic concentrations $> 300 \mu\text{g/L}$. Historical groundwater analytical results from SHL-20 showed a recent increase in the concentration of arsenic. In 1991, groundwater samples from SHL-20 were less than 100 $\mu\text{g/L}$ (98 $\mu\text{g/L}$ in August of 1991 and 89 $\mu\text{g/L}$ in December of 1991). More recent sampling which took place in March of 1993 showed an arsenic concentration of 330 $\mu\text{g/L}$, nearly three times greater than the previous sampling results. The latest round of groundwater sampling by Stone & Webster show SHL-20 having an arsenic concentration of 244 $\mu\text{g/L}$. These results show a consistent presence of arsenic at SHL-11 and SHL-20. Refer to Appendix D for a graphical comparison of arsenic concentrations in monitoring wells for the previous and current sampling periods.

7.0 QUALITY CONTROL

7.1 Field Quality Control

A Photoionization Detector (Hnu) and an explosive meter (LEL meter) were used to monitor ambient air conditions during the groundwater sampling. Both instruments were calibrated prior to sampling on a daily basis. If any instrument calibration drift was evident at any time during sampling, the equipment was recalibrated. During rainy weather, the Hnu and LEL were stored in dry vehicles when not being used to minimize humidity effects on the instruments.

One equipment blank was collected from the pump and tubing after decontamination had been conducted. No contaminants were detected in the Equipment Blanks. One field duplicate was collected from monitoring well SHL-4. Duplicate precision was acceptable within 0.0 to 8.0%. Three trip blanks were sent to the lab with samples. No contaminants were detected the trip blanks.

7.2 Laboratory Quality Control

Seven laboratory blanks were analyzed as part of the Shepley's Hill Landfill groundwater field event. No contaminants were detected in any of the laboratory blanks.

The data validation for the organics and general chemistry found all data to be acceptable. However, data correction was required for inorganic analysis during data validation. These corrections included qualifying non-detects (U) due to action level calculations and qualifying estimated data due to high recoveries for chloride during spiking.

8.0 CORRECTIVE ACTION

Corrective action required for the landfill cover is focused primarily on regrading and reseeding eroded areas. More specifically, it is recommended that the newly installed drainage swale, which drains the depression area, be reseeded in the spring. The access road adjacent to the western drainage swale requires regrading and reseeding as well. Depressed areas should be surveyed to establish current conditions. These areas can then be monitored to determine if depressions are increasing in depth or area. A new rip-rap curb is required in the drainage ditch which leads to Plow Shop Pond. The new rip-rap will serve to keep water in the drainage swale and minimize erosion which has been caused by the overflow of the swale. The final recommendation is to install rip rap adjacent to the repair area east of Vent No. 8.

Corrective action for future groundwater sampling at the Shepley's Hill Landfill includes redeveloping monitoring wells SHL-96-5B, SHL-96-5C, and SHL-96-22B to reduce the TSS concentration in future sampling rounds. It is likely that the high Arsenic (1440 $\mu\text{g/L}$) is attributable to high TSS and is not representative of dissolved arsenic in the groundwater.

It is also recommended that both filtered and unfiltered samples will be analyzed for arsenic during the Spring sampling round to confirm this.

Monitoring well SHL-3, was not sampled during this round due to a very low water table elevation, and slow recharge. For the next round of sampling, a smaller diameter tubing will be utilized. If this is unsuccessful, the well will be purged dry. Once the well recharges a sample will be collected with a bailer and water quality parameters will be recorded.

APPENDIX A
LANDFILL MAINTENANCE CHECKLIST

**APPENDIX A
Landfill Maintenance Checklist**

To be completed in indelible ink.

Inspections are to be performed annually.

DATE: November 15, 1996

INSPECTOR: R. Skryness/R. Perry

TITLE: _____

ORGANIZATION: Stone & Webster

LANDFILL ATTRIBUTE	OBSERVATIONS	RECOMMENDATIONS	SAT/ UNSAT
Monitoring Wells			SAT
Piezometers	Two of the guard pipes around N-4 have fallen over, possibly undermined by erosion and deposition of sand at outlet of swale at Plow Shop Pond.	No Action. Piezometer located in an area not accessible by maintenance equipment or construction vehicles	SAT
Cover Surface	<p>A) No bare spots greater than 100 sq ft.</p> <p>B) The area around the newly installed drainage swale (which drains the depressed area) was hydroseeded following construction. The seed has not germinated satisfactorily.</p> <p>C) The repair area on the hillside between Vents #2 and #5 has not revegetated successfully and will need to be watched.</p> <p>D) Animal burrows were noted around many of the gas vents.</p>	<p>A) No Action</p> <p>B) Reseed in Spring</p> <p>C) Monitor</p> <p>D) Backfill and use commercial rodent repellent "Ropel"</p>	UN- SAT

LANDFILL ATTRIBUTE	OBSERVATIONS	RECOMMENDATIONS	SAT/ UNSAT
Vegetative Growth	<p>Healthy growth. Base cover of clover, taller growth of grasses, goldenrods, asters; as tall as 3 feet, mostly 18 inches to 2 feet.</p> <p>Drainage swales mowed.</p> <p>Areas containing unwanted vegetation are noted on the site plans and described below:</p> <ul style="list-style-type: none"> • Wetland species (purple loosestrife and woolgrass) are present around the perimeter of the depressed area. • Wetland species (purple loosestrife and soft rush) are present in the area around Vent #3. • Wetland vegetation was present in the two depressed areas around Vent #6. • The drainage swale northwest of Vent #6, which was mown to remove overgrown vegetation, has wetland species (purple loosestrife and soft rush) present on the northern edge of the mowed area. (continued on next page) 	Maintain drainage swales by periodic mowing and cleaning	SAT
Vegetative Growth (cont)	<ul style="list-style-type: none"> • In the drainage swale starting west of Vent #9 and flowing north, wetland species are present all the way up to the southern limit of overgrown vegetation removed from this swale. Species include purple loosestrife, woolgrass, and soft rush. • Standing water and wetland vegetation is present in the drainage swale along the southern boundary of the landfill. It extends from the culvert up to the riprap area north of Vent #13. The vegetation was recently mowed, but there is evidence of the presence of cattails, Phragmites, soft rush, and beggarticks. Some woody species, including birch, pine, and locust, are present on the southeast corner of the cap. 	Monitor	SAT
Landfill Gas Vents	No damage observed. Gas venting from Vent #18, other wells could not be observed venting.	Monitor	SAT

LANDFILL ATTRIBUTE	OBSERVATIONS	RECOMMENDATIONS	SAT/ UNSAT
Drainage Swales	<p>Erosion and areas needing repair along drainage swales are noted and described below.</p> <p>A) The gully just beyond the northern extent of the cap is severely eroded, in some places 2 feet deep. This was an area that was previously repaired.</p> <p>B) Erosion has reappeared and requires additional repair in the previously repaired gully in swale just north of Vent #3.</p> <p>C) A small area of the drainage swale, approximately 150 ft northwest from Vent #9, is eroded.</p> <p>D) The riprap in the drainage swale leading to Plow Shop Pond has been backfilled by sand again. The erosion in the bend of the drainage is very severe, extending approximately 15 to 20 feet beyond the edge of the riprap into the sand bank. Sand has been deposited all the way along the swale, and out into Plow Shop Pond.</p>	<p>A) Monitor rip-rap if scouring continues</p> <p>B) Repair eroded areas. Close access road that runs along the western swale of the landfill.</p> <p>C) Monitor</p> <p>D) Provide a rip-rap curb to prevent runoff from spilling out of the rip rap channel.</p>	<p>UN-SAT</p> <p>UN-SAT</p> <p>SAT</p> <p>UN-SAT</p>
Culverts	Okay.		SAT
Catch Basins	The catch basins in the southwest portion of the landfill, which were reset and regraded, look good, grass has grown in.		SAT
Settlement	There are four small depressions noted in the vicinity of Vent #6 and between Vents #4 and #7. They range in size from 6 ft x 20 ft to 25 ft x 35 ft. Pooling water was present in all the areas, wetland vegetation was present in the two areas around Vent #6.	Monitor	SAT

LANDFILL ATTRIBUTE	OBSERVATIONS	RECOMMENDATIONS	SAT/ UNSAT
Erosion	<p>Eroded areas noted on the landfill surface and adjacent hillsides are shown on the site plans and are described below.</p> <p>A) Sand is washing down in the previously repaired area of eroded hillside, northwest side of landfill, between Vents #1 and #3.</p> <p>B) The formerly repaired area east of Vent #11 has eroded again, approximately 6 inches deep. A new area of erosion was noted just south of this area, approximately 12 to 18 inches deep.</p> <p>C) The southeast corner of the repair area east of Vent #8 is eroding back again.</p>	<p>A) Monitor</p> <p>B) Regrade access road to divert runoff</p> <p>C) Extend rip-rap into eroded areas</p>	<p>SAT</p> <p>UN-SAT</p> <p>UN-SAT</p>
Access Roads	Muddy and rutted due to weather.	The access road that parallels the western drainage swale should be regraded and seeded. This road should not be used for routine maintenance	UN-SAT
Security Fencing	No breaks observed.		SAT
Wetland Encroachment	Wetland species observed along landfill perimeter as described under "Vegetative Growth" above. Wetland vegetation also present in two small depressions near Vent #6, in a small area near Vent #3, and along the perimeter of the depressed area.	Monitor	SAT
<p>Immediate Action Required: In spring reseed newly installed drainage swale (which drains the depression area). Regrade and reseed access road that is adjacent to the western drainage swale. Provide a rip rap curb to keep water in the drainage swale that discharges directly into Plow Shop Pond. Rip rap the eroded area adjacent to the repair area east of Vent No.8.</p>			
<p>General Comments: With the exceptions noted above that require attention this spring, the landfill appears to be in reasonable condition and should perform the intended function. Several areas were noted that should be monitored but at this time do not require any action.</p>			

APPENDIX B
LANDFILL GAS MONITORING FORM

**APPENDIX B
Landfill Gas Monitoring**

Monitoring is to be performed annually

To be completed in indelible ink.

DATE: November 15, 1996

INSPECTOR: R. Skrynness TITLE: _____ ORGANIZATION: Stone & Webster

WEATHER: (Temp, rain, sun, etc.) Low 30s F, sunny BAROMETRIC PRESSURE: 1033 mb

Vent Number	VOCs (ppm)	O ₂ (%)	H ₂ S (ppm)	LEL (%)	CO (ppm)	CO ₂ (%)	CH ₄ (%)	REMARKS (Visual observations, odor, etc.)
	PID	GA-90	CGI	CGI	CGI	GA-90	GA-90	
Vent - 1	0	21.4	0	0	0	0	0	animal burrow nearby
Vent - 2	0	21.5	0	0	0	0	0	animal burrow nearby
Vent - 3	0	21.3	0	0	0	0	0	
Vent - 4	0	21.3	0	2	0	0	0	animal burrow nearby
Vent - 5	0	21.4	0	0	0	0	0	
Vent - 6	0	21.4	0	0	0	0	0	
Vent - 7	0	21.4	0	0	0	0	0	animal burrows nearby
Vent - 8	0	21.2	0	2	0	0.1	0.1	
Vent - 9	0	21.2	0	1	0	0	0.1	
Vent - 10	0	21.2	0	0	0	0	0	
Vent - 11	0	21.3	0	0	0	0	0	
Vent - 12	0	21.2	0	0	0	0	0	
Vent - 13	0	21.2	0	0	0	0	0	
Vent - 14	0	21.2	0	0	0	0	0	
Vent - 15	0	20.1	0	11	0	0.6	0.4	animal burrow nearby
Vent - 16	0	21.1	0	1	0	0	0	
Vent - 17	0	21.0	0	2	0	0.2	0.1	
Vent - 18	0	21.2	0	2	0	0.1	0.2	only vent not iced over by frost

Note: See grid for well identifiers and locations.

Mark all vents with appropriate number during initial sampling. ✓

CALIBRATION INFORMATION

PID

Results: Calibrated to 100 ppm with 70 ppm isobutylene Calibrated by: J. Coyne, Stone & Webster

CGI

Results: shop calibrated Calibrated by: Heinrich Environmental

Landtec GA-90 Landfill Gas Monitor

Results: Calibrated to 3.9% O₂, with 4.0% O₂ (N₂ balance) Calibrated by: Heinrich Environmental
Calibrated to 14.8% CH₄, with 14.9% CH₄
Calibrated to 15.0% CO₂, with 15.0% CO₂

APPENDIX C
GROUNDWATER FIELD ANALYSIS FORMS

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHM-96-5B Date 11/20/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 80 ft (top)/ 90 ft (bottom) of screen (bgs)
 Pump intake set at 86 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1334	8.01	92	1.5	15	51.99	0.982	1.97	-794.1	-1.5	-0.49	
1337	8.02	92	1.5	19	52.06	0.969	1.88	-796.4	-1.6	-0.17	
1340	8.05	92	1.5	23	51.97	0.969	1.97	-796.1	-0.5	-0.06	
1343	8.04	92	1.5	27	52.01	0.970	1.96	-798.8	-1.4	-0.01	
1346	8.00	92	1.5	34.5	51.95	0.970	1.94	-798.3	-1.4	0.04	
1350	7.82	92	1.5	42	51.88	0.963	1.97	-803.8	-1.4	0.07	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

hrs = hours
 bgs = below ground surface
 ft = feet
 min = minute

C = Celsius
 uS = microsiemens
 cm = centimeters
 mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHM-96-5C Date 11/20/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 50 ft (top)/ 60 ft (bottom) of screen (bgs)

Pump intake set at 55 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1049	5.19	69-70	1.4	27	49.45	0.804	2.52	-773.5	4.4	0.21	
1052	5.19	69-70	1.4	31	50.3	0.818	2.61	-772.6	1.6	0.28	
1056	5.20	69-70	1.4	34.5	50.35	0.844	1.89	-774.2	13.4	0.31	
1058	5.20	69-70	1.4	36.5	50.37	0.841	1.86	-774.6	0.4	0.34	
1101	5.20	69-70	1.4	38	50.47	0.842	1.89	-774.2	-1.3	0.34	

Note: Readings for pH as well as turbidity were erratic due to instrument problems with cold weather.

hrs = hours

bgs = below ground surface

ft = feet

min = minute

C = Celsius

uS = microsiemens

cm = centimeters

mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHM-96-22 Date 11/20/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 82 ft (top)/ 92 ft (bottom) of screen (bgs)
 Pump intake set at 87 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
923	7.59	76	1.3	31	51.73	1.073	2.43	857.0	8.7	0.21	
932	7.31	76	1.3	46	51.52	1.081	2.29	-858.8	0.2	0.15	
937	7.32	76	1.3	50	52.11	1.078	2.22	-859.1	6.1	0.2	
940	7.32	76	1.3	54	52.09	1.074	2.11	-857.9	6.3	0.21	
943	7.33	76	1.3	58	52.09	1.074	2.01	-857.0	4.6	0.2	

Note: Readings for pH as well as turbidity were erratic due to instrument problems with cold weather.

- hrs = hours
- bgs = below ground surface
- ft = feet
- min = minute
- C = Celsius
- uS = microsiemens
- cm = centimeters
- mv = millivolts
- NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHL-9 Date 11/14/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 15 ft (top)/ 21 ft (bottom) of screen (bgs)
 Pump intake set at 20 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
924	9.05	85	1.3	16	53.90	0.191	2.51	-732.0	4.6	2.57	
929	9.05	85	1.3	17	55.13	0.193	2.45	-734.0	3.3	1.54	
932	9.05	85	1.3	18	55.71	0.194	2.43	-739.6	2.5	1.19	
935	9.04	85	1.3	19	55.63	0.196	2.46	-745.0	4.8	0.95	
938	9.05	85	1.3	21	55.56	0.196	2.57	-749.0	6.4	0.78	
941	9.04	85	1.3	23	55.69	0.196	2.63	-752.0	2.8	0.68	
944	9.03	85	1.3	25	55.82	0.196	2.62	-755.5	4.4	0.63	

Note: Readings for pH as well as turbidity were erratic due to instrument problems with cold weather.

- hrs = hours
- bgs = below ground surface
- ft = feet
- min = minute
- C = Celsius
- uS = microsiemens
- cm = centimeters
- mv = millivolts
- NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHM-93-22C Date 11/14/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 80 ft (top)/ 90 ft (bottom) of screen (bgs)
 Pump intake set at 86 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1225	7.21	77	0.25	11.4	50.74	0.611	2.35	-602.4	-0.4	6.81	
1229	7.26	77	0.25	13.5	50.02	0.639	2.31	-608.1	-0.4	6.79	
1240	7.42	77	0.25	14	52.18	0.665	2.43	-711.0	1.1	5.64	
1250	7.45	77	0.25	14.5	54.1	0.661	2.49	-728.0	0.3	5.76	
1255	7.42	77	0.25	14.8	53.25	0.669	2.43	-728.0	0.2	6.00	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

- hrs = hours
- bgs = below ground surface
- ft = feet
- min = minute
- C = Celsius
- uS = microsiemens
- cm = centimeters
- mv = millivolts
- NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHL-22 Date 11/14/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 105 ft (top)/ 115 ft (bottom) of screen (bgs)
 Pump intake set at 110 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1537	7.12	79	0.5	1	48.19	0.984	2.21	-798.1	6.1	2.92	
1543	7.12	80	0.17	2	48.85	0.997	2.15	-785.0	10.6	2.41	
1550	7.10	79	0.3	4	48.81	1.047	2.11	-781.0	15.2	2.73	
1553	7.06	79	0.33	5	48.40	1.051	2.11	-779.9	12.2	2.17	
1556	7.01	79	0.2	5.6	48.73	1.055	2.15	-778.4	14.2	2.29	
1559	7.02	79	0.466	7	48.01	1.054	2.18	-777.4	20.8	2.41	

Note: Readings for pH as well as turbidity were erratic due to instrument problems with cold weather.

hrs = hours
 bgs = below ground surface
 ft = feet
 min = minute

C = Celsius
 uS = microsiemens
 cm = centimeters
 mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHL-5 Date 11/15/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 3 ft (top)/ 13 ft (bottom) of screen (bgs)

Pump intake set at 10 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
839	3.86	73	1.5	3.5	50.11	0.139	2.15	-702.3	13.9	1.93	
844	3.88	72	0.4	5.5	52.03	0.139	2.13	-709.5	-1.6	1.77	
847	3.83	72	1.5	7.5	52.17	0.143	2.06	-711.7	-1.5	1.57	
854	3.88	72	0.28	9.5	53.85	0.144	2.12	-714.9	3.9	1.6	
900	3.89	72	0.91	15	53.32	0.145	2.13	-718.0	-0.2	1.34	
903	3.85	72	1.5	17	53.59	0.146	2.11	-719.0	-1.2	1.19	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

hrs = hours
bgs = below ground surface
ft = feet
min = minute

C = Celsius
uS = microsiemens
cm = centimeters
mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHL-20 Date 11/15/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 41 ft (top)/ 51 ft (bottom) of screen (bgs)

Pump intake set at 43 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1134	9.19	133	0.66	38.5	53.66	1.119	2.13	-741.0	6.5	0.76	
1137	9.19	133	0.66	39.5	53.45	1.119	2.17	-741.0	-0.6	0.72	
1140	9.19	133	0.66	42	53.57	1.117	2.19	-741.0	5.5	0.71	

Note: Readings for pH as well as turbidity were erratic due to instrument problems with cold weather.

hrs = hours

bgs = below ground surface

ft = feet

min = minute

C = Celsius

uS = microsiemens

cm = centimeters

mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHL-11 Date 11/15/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 15 ft (top)/ 30 ft (bottom) of screen (bgs)

Pump intake set at 23 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1308	19.31	129	1	15	56.7	0.948	2.24	-778.9	-1.9	2.06	
1311	19.32	129	1	18	56.6	0.946	2.28	-779.7	-1.9	2.28	
1315	19.32	129	1	22	56.7	0.954	2.34	-783.2	-1.8	1.85	
1320	19.31	129	1	31	56.7	0.955	2.36	-784.9	-1.9	1.76	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

hrs = hours

bgs = below ground surface

ft = feet

min = minute

C = Celsius

uS = microsiemens

cm = centimeters

mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHL-19 Date 11/15/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 17 ft (top)/ 32 ft (bottom) of screen (bgs)

Pump intake set at 26 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1516	23.21	140	0.40	1	52.45	0.210	2.51	-747.9	-2.4	2.01	
1521	23.22	140	0.40	3	57.38	0.185	2.52	-745.6	-1.9	0.68	
1524	23.22	140	0.33	4	57.37	0.179	2.50	-744.0	-1.9	0.54	
1527	23.23	140	0.66	6	57.43	0.174	2.57	-743.0	-1.9	0.48	
1530	23.22	140	1.33	10	56.9	0.171	2.63	-741.0	-1.9	0.37	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

hrs = hours

bgs = below ground surface

ft = feet

min = minute

C = Celsius

uS = microsiemens

cm = centimeters

mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHL-4 Date 11/18/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 5 ft (top)/ 15 ft (bottom) of screen (bgs)
 Pump intake set at 13 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
917	11.04	99	1.33	6	54.29	0.256	2.09	-724.4	-1.5	0.49	
920	11.04	99	1.33	9	54.43	0.251	2.06	-727.8	-1.6	0.77	
923	11.03	99	1.33	13	54.55	0.248	2.09	-730.9	-0.5	0.95	
926	11.04	99	1.33	17	54.76	0.246	2.07	-733.8	-1.4	1.08	
929	11.04	99	1.33	21	54.9	0.245	2.04	-734.5	-1.4	1.10	
932	11.04	99	1.33	24	54.66	0.242	2.03	-735.4	-1.4	1.21	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

hrs = hours
 bgs = below ground surface
 ft = feet
 min = minute

C = Celsius
 uS = microsiemens
 cm = centimeters
 mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHM-93-10 Date 11/20/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 45 ft (top)/ 55 ft (bottom) of screen (bgs)

Pump intake set at 50 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1128	30.82	159	0.75	4	53.41	0.510	1.94	-658.8	12.6	4.33	
1131	30.77	159	0.75	4.5	53.51	0.512	1.99	-669.4	15.4	4.22	
1134	30.77	159	0.75	4.8	53.38	0.512	2.13	-699.9	16.2	4.55	
1139	30.79	159	0.75	6	54.45	0.513	2.16	-704.9	14.9	4.11	
1142	30.80	159	0.75	7	54.55	0.514	2.14	-719.3	13.7	3.09	
1150	30.81	159	0.75	9	54.48	0.514	2.18	-729	12.1	3.51	
1153	30.81	159	0.75	9.5	54.54	0.514	2.22	-732.2	11.9	3.45	

Note: Readings for pH as well as turbidity were erratic due to instrument problems with cold weather.

hrs = hours
bgs = below ground surface
ft = feet
min = minute

C = Celsius
uS = microsiemens
cm = centimeters
mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens

Well ID: SHL-10 Date 11/18/96

Company: Stone & Webster

Sampler: J. Coyne/ S. Gromko

Depth to 24 ft (top)/ 39 ft (bottom) of screen (bgs)

Pump intake set at 35 feet (bgs)

Purging Device (pump type): Grunfos Redi-flow II

No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
1337	31.69	169	0.6	3	56.48	0.063	2.36	-662.3	-1.3	11.91	
1343	31.68	169	0.6	8	57.11	0.065	2.26	-616.8	-1.7	11.34	
1349	31.65	169	0.6	14	57.41	0.063	2.17	-597.7	-1.7	11.34	
1352	31.65	169	0.6	16	57.63	0.067	2.17	-593.9	-1.7	11.32	
1355	31.65	169	0.6	18	58.19	0.070	2.16	-590.7	-1.4	11.25	
1358	31.66	169	0.6	20	57.69	0.070	2.14	-587.1	-0.8	11.28	
1401	31.65	169	0.6	22	57.67	0.071	2.16	-584.3	-1.4	11.27	

Note: Readings for pH as well as turbidity were unusually low due to instrument problems with cold weather.

hrs = hours

bgs = below ground surface

ft = feet

min = minute

C = Celsius

uS = microsiemens

cm = centimeters

mv = millivolts

NTU = Nephelometric Turbidity Units

GROUND WATER FIELD ANALYSIS FORMS

Location: Shepley's Hill Landfill, Fort Devens
 Well ID: SHL-3 Date 11/18/96
 Company: Stone & Webster
 Sampler: J. Coyne/ S. Gromko

Depth to 25 ft (top)/ 35 ft (bottom) of screen (bgs)
 Pump intake set at 31.5 feet (bgs)
 Purging Device (pump type): Grunfos Redi-flow II
 No headspace readings above background

Time (24 hrs)	Well Depth (bgs) (ft)	Pump Dial (hz)	Pump Rate (liters/min)	Cumulative Volume Purged (liters)	Temp (C)	Specific Cond (uS/cm)	pH	ORP/Eh (mv)	Turbidity (NTU)	DO (mg/L)	Comments
NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	
NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	

Note: Due to the very low water level and slow recharge in the well the field team was unable to extract any water from the well and therefore it could not be sampled.

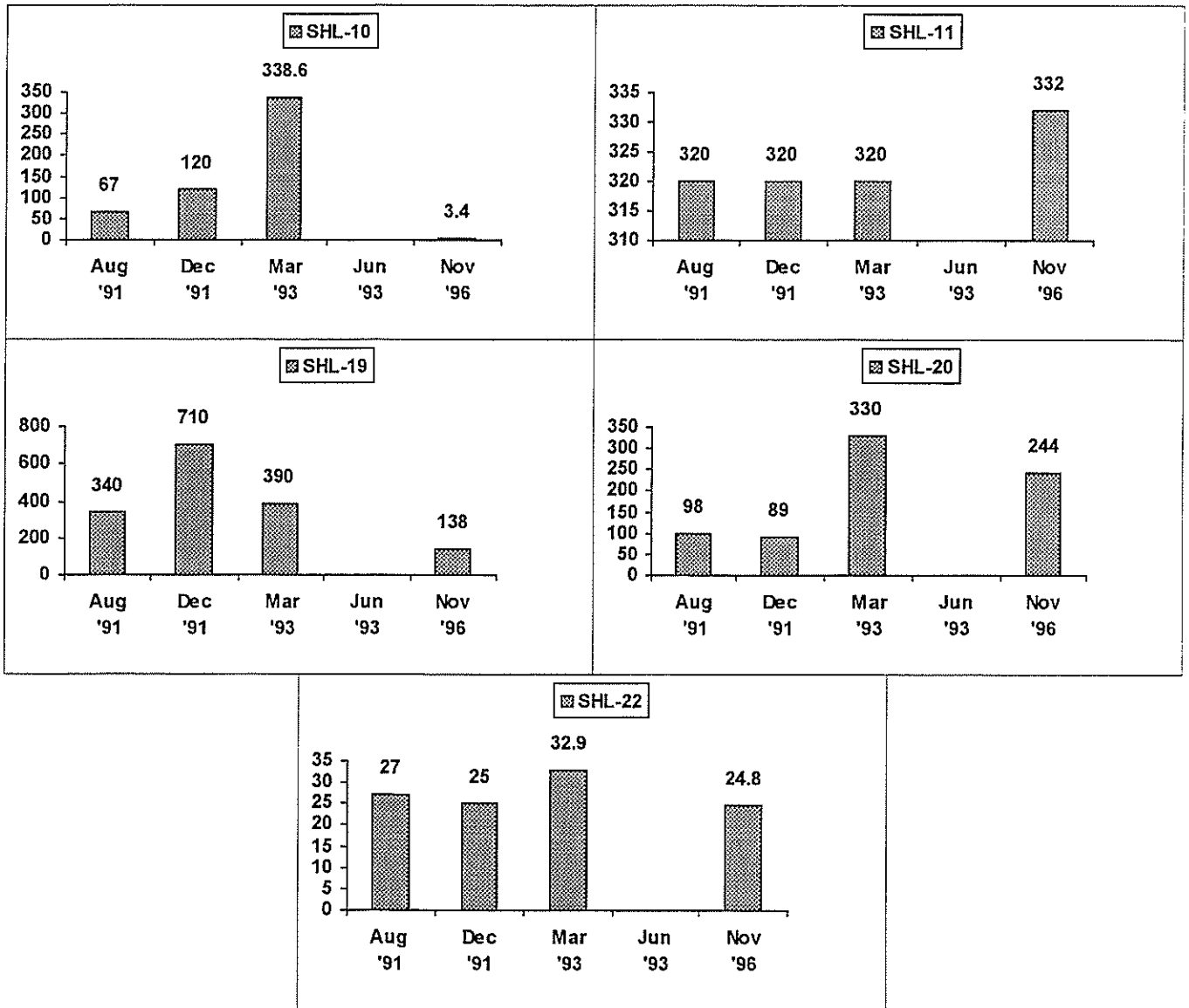
hrs = hours
 bgs = below ground surface
 ft = feet
 min = minute

C = Celsius
 uS = microsiemens
 cm = centimeters
 mv = millivolts

NTU = Nephelometric Turbidity Units

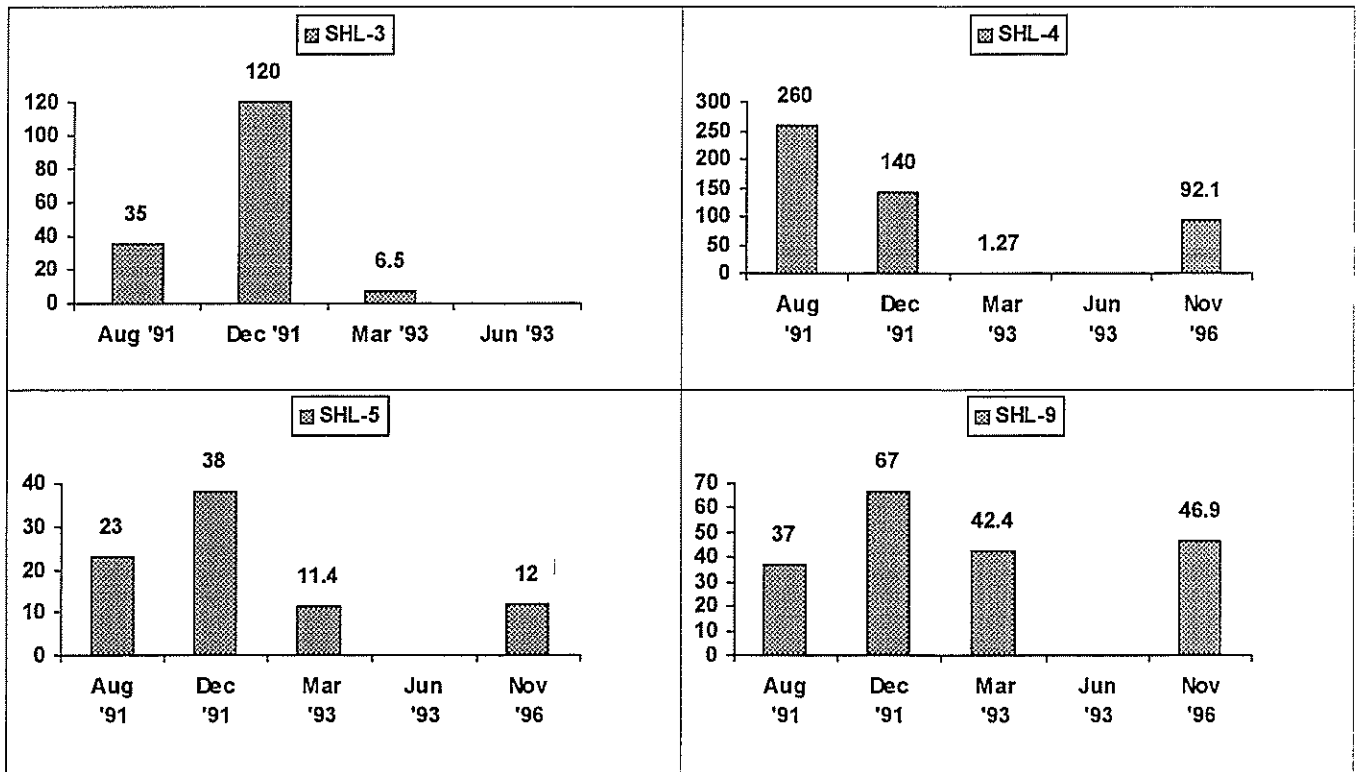
APPENDIX D
COMPARISON OF ARSENIC RESULTS

**SHEPLEY'S HILL LANDFILL GROUNDWATER MONITORING
ARSENIC CONCENTRATIONS
UG/L**



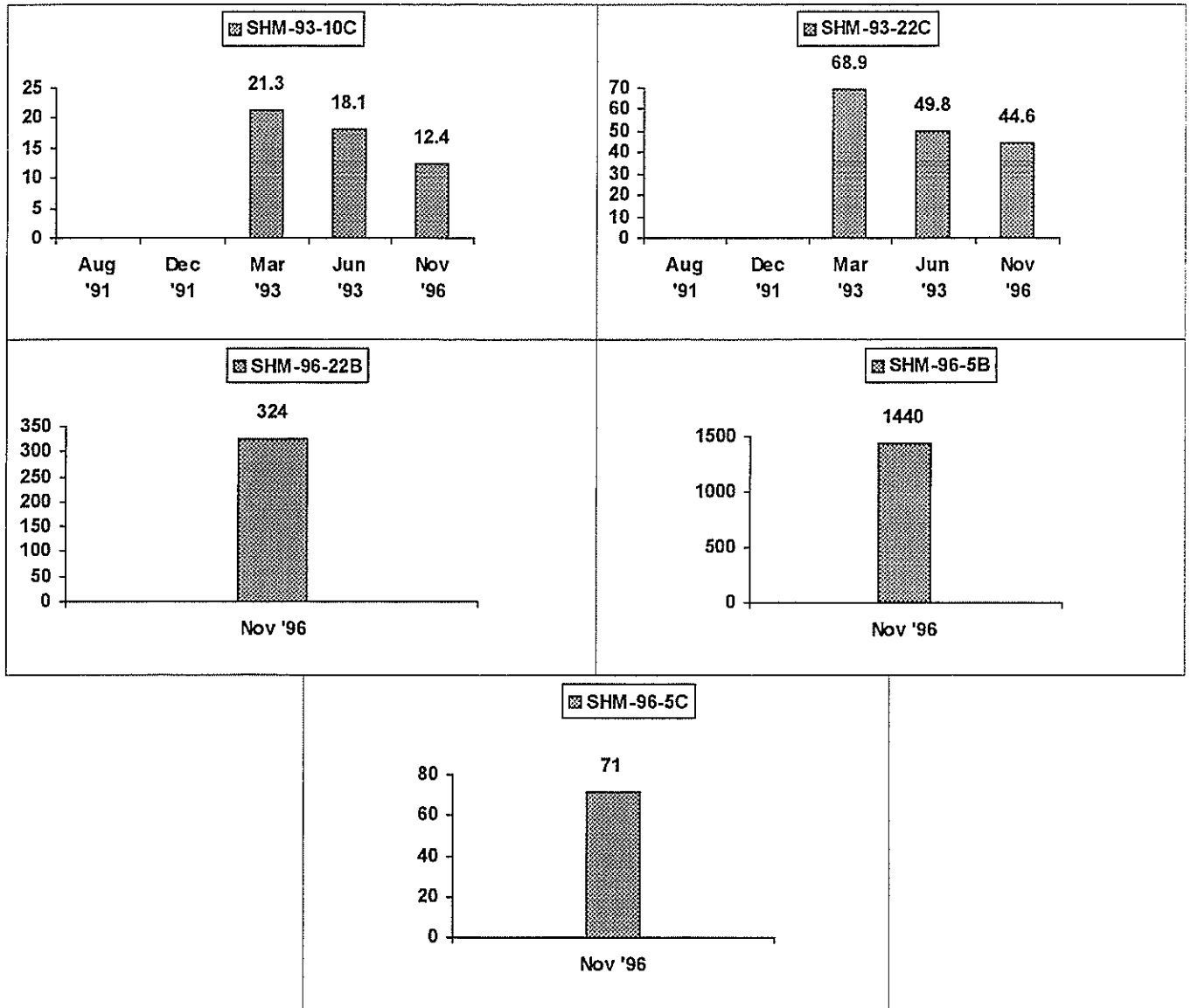
NOTE: Not Detected values are reported as half the detection limit

SHEPLEY'S HILL LANDFILL GROUNDWATER MONITORING
ARSENIC CONCENTRATIONS
UG/L



NOTE: Not Detected values are reported as half the detection limit

**SHEPLEY'S HILL LANDFILL GROUNDWATER MONITORING
ARSENIC CONCENTRATIONS
UG/L**



NOTE: Not Detected values are reported as half the detection limit

Arsenic Graph Data

Well ID	CollectionDate	Concentration
SHL-10	8/1/91	67
SHL-10	12/1/91	120
SHL-10	3/1/93	280
SHL-10	3/1/93	58.6
SHL-10	6/1/93	
SHL-10	11/18/96	3.4
SHL-11	8/1/91	320
SHL-11	12/1/91	320
SHL-11	3/1/93	320
SHL-11	6/1/93	
SHL-11	11/15/96	332
SHL-19	8/1/91	340
SHL-19	12/1/91	710
SHL-19	3/1/93	390
SHL-19	6/1/93	
SHL-19	11/15/96	138
SHL-20	8/1/91	98
SHL-20	12/1/91	89
SHL-20	3/1/93	330
SHL-20	6/1/93	
SHL-20	11/15/96	244
SHL-22	8/1/91	27
SHL-22	12/1/91	25
SHL-22	3/1/93	32.9
SHL-22	6/1/93	
SHL-22	11/14/96	24.8
SHL-3	8/1/91	35
SHL-3	12/1/91	120
SHL-3	3/1/93	6.5
SHL-3	6/1/93	
SHL-4	8/1/91	260
SHL-4	12/1/91	140
SHL-4	3/1/93	1.27
SHL-4	6/1/93	
SHL-4	11/18/96	43.3
SHL-4	11/18/96	48.8
SHL-5	8/1/91	23
SHL-5	12/1/91	38
SHL-5	3/1/93	11.4
SHL-5	6/1/93	
SHL-5	11/15/96	12
SHL-9	8/1/91	37
SHL-9	12/1/91	67
SHL-9	3/1/93	42.4
SHL-9	6/1/93	
SHL-9	11/14/96	46.9
SHM-93-10C	8/1/91	
SHM-93-10C	12/1/91	
SHM-93-10C	3/1/93	21.3
SHM-93-10C	6/1/93	18.1
SHM-93-10C	11/18/96	12.4
SHM-93-22C	8/1/91	
SHM-93-22C	12/1/91	
SHM-93-22C	3/1/93	68.9
SHM-93-22C	6/1/93	49.8
SHM-93-22C	11/14/96	44.6
SHM-96-22B	11/19/96	324
SHM-96-5B	11/20/96	1440
SHM-96-5C	11/20/96	71