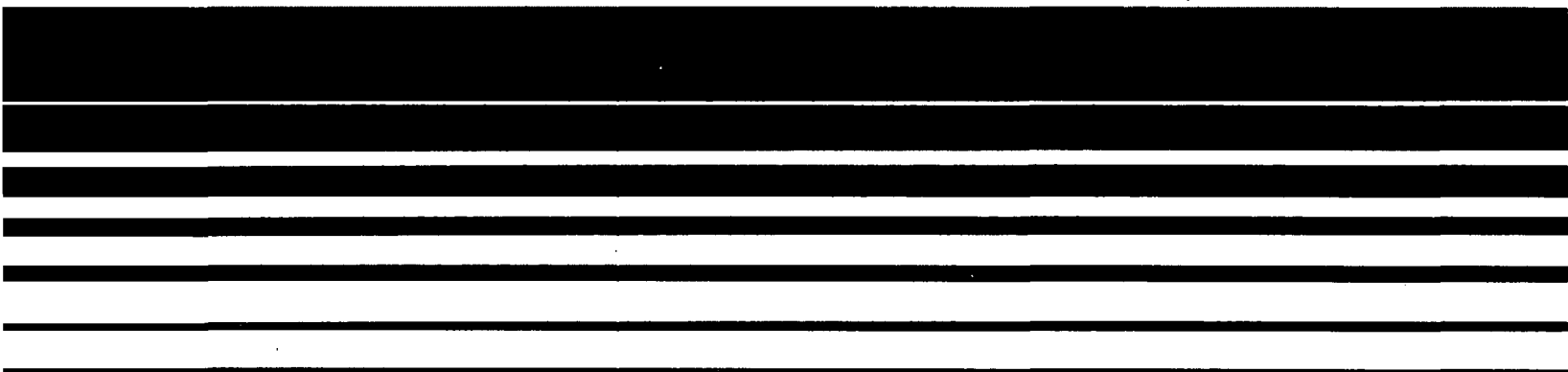


Air



Hazardous Waste Treatment, Storage, and Disposal Facilities

Field Sampling and Analysis Summary Report For Contaminated Fugitive Particulate Emissions



HAZARDOUS WASTE TREATMENT, STORAGE,
AND DISPOSAL FACILITIES

FIELD SAMPLING AND ANALYSIS SUMMARY REPORT FOR
CONTAMINATED FUGITIVE PARTICULATE EMISSIONS

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September 1986

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Order Report No. 85-FPE-10

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1.0 INTRODUCTION

The purpose of this study was to develop a sampling and analytical protocol to assess the potential magnitude of contaminated fugitive particulate emissions from treatment, storage, and disposal facilities (TSDF's) handling hazardous wastes. Eight TSDF sites were selected for implementation of the sampling protocol. Copies of the sampling and analysis protocol were provided to each facility prior to conducting the sampling program. The TSDF sites were then sampled according to the protocol to provide preliminary information on the magnitude of potential fugitive particulate emissions from TSDF's, the degree of contamination of the fugitive particulate, and the particle size dependency of the degree of contamination.

During the implementation of the sampling and analysis protocol at the TSDF sites, sampling techniques were modified to improve sampling efficiency and an alternative sample clean up procedure was developed to allow the analysis of semivolatile organic compounds with a lower quantifiable detection limit. These modifications were incorporated into the revised final sampling and analytical protocol along with repeatability (within-laboratory) and reproducibility (between-laboratory) estimates for the data. The results of the sampling and analysis effort for this study are presented in Section 2.

For this study, eight TSDF's were selected for soil sampling from different TSDF processes considered likely to be contaminated with hazardous inorganic and/or organic compounds. The sites were geographically distributed throughout the continental United States. A total of 29 processes were sampled at the different sites. A description of all the processes sampled, the sampling techniques used, and the location and number of samples collected are presented in Section 3 and are summarized in Table 1.1. The different types of processes that were sampled are listed below:

- Landfills for solid materials,
- Land treatment areas for liquid wastes,
- Stabilization Areas for solidification of liquid wastes,
- Dry Surface Impoundments for liquid wastes,
- Storage Pile of material from a dry surface impoundment, and
- Roadways associated with the processes listed above.

TABLE 1.1. SUMMARY OF PROCESSES SAMPLED AT TSDF's

Process ID	Description	Sampling Technique	Number
<u>Site 1</u>			
A	Landfill, Active Lift	Scooping	8
B	Dry Surface Impoundment	Modified Coring	8 + 8*
C	Roadway, Main Entrance	Modified Sweeping	1
D	Roadway, Lift Access	Modified Sweeping	1
E	Roadway, Impound. Access	Modified Sweeping	1
BGD	Background Sample	Scooping	2
<u>Site 2</u>			
F	Roadway, Landfill Access	Sweeping	1
G	Roadway, Access in Landfill	Sweeping	2
H	Active Landfill	Scooping	6
I	Stabilization Area	Scooping	7
I	Quality Assurance	Scooping	15
BGD	Background Sample	Scooping	2
<u>Site 3</u>			
J	Active Landfill	Scooping	8
K	Active Landfill	Scooping	8
BGD	Background Sample	Scooping	2
<u>Site 4</u>			
L	Land Treatment Cell	Modified Coring	8 + 8*
M	Roadway, Access to Cells	Sweeping	3
N	Land Treatment Cell	Scooping	8
O	Land Treatment Cell	Scooping	8
O	Quality Assurance	Scooping	15
BGD	Background Sample	Scooping	2

(continued)

TABLE 1.1 (continued)

Process ID	Description	Sampling Technique	Number
<u>Site 5</u>			
-	Soil Storage Pile	Random Grab	4
-	Dry Surface Impoundment	Random Grab	2
<u>Site 6</u>			
P	Landfill, Active Lift	Scooping	8
Q	Landfill, Active Lift	Scooping	8
R	Landfill, Active Lift	Scooping	8
X	Land Treatment Cell	Scooping	8
Y	Roadway, Landfill Access	Sweeping	1
BGD	Background Sample	Scooping	2
<u>Site 7</u>			
S	Active Landfill	Scooping	8
T	Stabilization Area	Scooping	7
U	Land Treatment Cell	Scooping	8
V	Land Treatment Cell	Scooping	8
W	Roadways, Access	Sweeping	2
T	Quality Assurance	Scooping	9
BGD	Background Sample	Scooping	2
<u>Site 8</u>			
Z	Landfill, Active Lift	Scooping	8
AA	Roadways, Landfill Access	Scooping	2
BGD	Background Samples	Scooping	2

*Modified coring samples were collected in pairs using a coring tube constructed of stainless steel and a coring tube constructed of plastic.

Background samples were collected at the seven sites sampled by Entropy Environmentalists personnel (sites 1 through 4 and 6 through 8) to determine the degree of contamination not attributable to the TSDF's activities. Three sets of quality assurance (QA) samples were collected from three different types of processes at three different sites. The QA samples were intended to provide a measure of analytical and total (sampling plus analytical) repeatability (within-laboratory), analytical and total reproducibility (between-laboratory), and analytical accuracy, using spiked performance audit samples.

The sampling procedures involved identification of the processes to be sampled at the selected sites and documentation of the process locations by a plot plan, either drawn on-site or obtained from the facility. The process boundaries were then determined and a sampling grid was laid out within the process boundaries. A random number table was used to select which grid cells would be sampled. The number of samples collected was based on the volume of sample required and/or the expected variability of the soil. The sampling technique was also based on the observed soil characteristics. The sampling techniques included scooping, coring, and sweeping. A complete description of the sampling procedures is presented in Section 4.

Analyses of the TSDF soil samples were conducted to determine the physical and chemical parameters necessary for a magnitude assessment of the contaminated fugitive particulate emissions from TSDF's. The first analysis conducted on the samples collected was a loss-on-drying (LOD) determination to 1) give an indirect measure of the moisture content of the soil sample and 2) to determine which sample drying procedure would be used to prepare the sample for the sieving analyses. Two drying procedures were used depending on the average LOD value for a set of samples from a single process. Typically samples with an LOD of less than 10 percent were dried by desiccation and samples with an LOD greater than 10 percent were dried in an oven at 105°C.

Each dried sample was first screened individually to determine the percent silt content. Silt content was defined for this analysis as the total weight of soil sample passing through a 200 mesh screen and having a nominal diameter less than 75 micrometers. All the silt from each process sample was combined to form a homogeneous composite silt sample. From this composite the PM₁₀ content of the silt was determined by sonic sieving. The PM₁₀ particles

represent that part of the silt fraction that has the greatest potential to be inhaled and retained within the lungs. PM_{10} content was defined as the total weight of the silt sample passing through a 625 mesh screen and having a nominal diameter of less than 20 micrometers. The sonic sieving procedure was used to produce a PM_{10} fraction and a "greater than PM_{10} " ($>PM_{10}$) fraction for chemical analyses.

Selected chemical analyses were conducted on the composite silt, PM_{10} , and $>PM_{10}$ fractions produced from the soil samples collected from each process. The chemical analyses were performed for metals, total cyanide, semivolatile organic compounds, pesticides, and PCB's. Samples collected from land treatment cells were also analyzed for oil and grease content. The metals analysis included eight elements covered under the Resource Conservation and Recovery Act. The semivolatile organic compound analyses were conducted for compounds found on the Hazardous Substance List in the U.S. EPA's Contract Laboratory Program, Statement of Work for Organic Analyses, Revision 7/85 (referred to as the CLP in this report). The analytical procedures that were used along with the complete listings of the metals and organic compounds determined can be found in Section 5.

The participants in this program included Mr. Clyde E. Riley and Mr. Lee Beck of the U.S. EPA, Dr. Chatten Cowherd, Mr. Phillip Englehart, and Mr. Tom Lapp of the Midwest Research Institute, and Mr. Steven J. Plaisance, Mr. Bernie von Lehmden, Mr. Kent Spears, Mr. William G. DeWees, Dr. Scott C. Steinsberger, and Ms. Robin R. Segall of Entropy Environmentalists. The analytical work was conducted by Entropy Environmentalists, Research Triangle Institute, Triangle Laboratories, and PEI and Associates. This study could not have been conducted without the patience and participation of the facility representatives at the TSDF sites, and their cooperation and assistance were greatly appreciated.

2.0 SUMMARY AND DISCUSSION OF RESULTS

The results of this study are presented in this section and include all information pertaining to the sampling and analysis of soil samples collected at the eight TSDF sites.

A discussion of the sampling phase of this project is presented first. Next the results of the analyses for weight loss on drying (LOD), silt content, and PM_{10} content are discussed. A summary of the mean values for the silt content, LOD, and PM_{10} content along with the confidence intervals at the 95 percent level for each process sampled is presented (Table 2.1). A summary of the drying procedures used for the samples from each process is presented (Table 2.10) along with a discussion of the problems encountered in drying the samples prior to sieving. The individual determinations for the silt content, LOD, and PM_{10} content for the processes from each site are presented (Tables 2.2 to 2.9) along with discussions of any deviations from the protocol or observations that may have affected the measured results. A comparison of sieving techniques using a full stack and a short stack of sieves was performed using samples from Sites 6 and 8 and the results are presented in Table 2.11.

The oil and grease analysis was performed on aliquots taken from undried samples that were collected from land treatment processes. The results of the oil and grease analyses for the six land treatment processes are summarized in Table 2.12.

A complete chemical analysis plan summarizing the samples that were collected for analysis and the types of chemical analyses performed for each process is presented in Table 2.13. The results of the metals analyses performed on each process sample are shown for each site (Tables 2.14 to 2.21). A summary of the quantifiable detection limits for the semivolatile organic analyses following clean up of the sample extract using the procedure developed for this study is presented in Table 2.22. The results of the organic analyses for Sites 1 through 7 (samples from Site 8 were not submitted for organic analysis) are presented in Tables 2.23 to 2.29. None of the analytical results were adjusted for the compounds found in the background samples collected. The particle size dependency of the degree of contamination is summarized in Tables 2.30 to 2.36 for each process where a PM_{10} fraction

was generated for chemical analysis. The relative percent differences (RPD) of the contamination for the PM₁₀ fraction are shown with bar graphs in Figures 2.1 to 2.24.

Pursuant to the Sampling and Analysis Protocol, samples were collected at three sites (three different type processes) for evaluation of the repeatability (within-laboratory) and reproducibility (between-laboratory). These results provided quality assurance for the individual sampling and analytical procedures, as well as for the overall total test program. The analytical results for repeatability and reproducibility for metals analyses and the analytical results for repeatability for organic analyses are presented in Tables 2.37 to 2.40. The relative standard deviations for the metals and organic compounds present are also presented in Tables 2.41 and 2.42. Performance audit samples for metals and organic compounds were also analyzed and the results are presented in Tables 2.43 to 2.45.

2.1 SAMPLING AT TSDF's

The sampling phase of this project was conducted as planned except for delays associated with the weather. Some modifications were made to the original sampling protocol to increase the efficiency of the sampling effort. The procedure for laying out the sampling grids was the major change made. Instead of laying out a complete grid system for each major process sampled (all except roads and background samples), a modified procedure was developed. Two perpendicular axes were first established from the origin of the sampling grid (near the center) to the edges of the process to be sampled. After determining the size of a grid cell, the axes were marked at the points where the grid cell boundaries would intersect with the axes. The cells to be sampled were then selected using a random number table and the sampling was conducted according to the protocol using tosses of the sampling template within the selected grid cell.

For some processes, certain grid cells selected at random were rejected for reasons that could affect the sampling. Some of the reasons for certain cells being rejected were:

- Water standing in the cell,
- Selected cells too close to the boundary,
- Selected cell too close to other selected cells,
- Grass or other obstructions preventing soil sampling, and
- Dirt piles in selected grid cells.

Rejected cells were replaced by other cells selected at random using the random number table.

One landfill cell at Site 6 (Process R) and the stabilization area at site 7 (Process T) were considered too small to be sampled using a random sampling grid. These processes were divided into equal size cells and all cells were sampled.

All road samples were collected by establishing a rectangular area across the road and then sweeping or scooping (referred to as modified sweeping) the entire area to collect the sample.

Background samples were collected on-site at a point unaffected by the TSDF activity or were collected at a point off-site.

The sampling techniques used to collect the TSDF samples followed the Sampling and Analysis Protocol except for the modified sweeping procedure used for some road samples and the modified coring procedure. The modified sweeping procedure involved using a disposable plastic scoop instead of a brush to collect the sample from the roadway. The sample was scraped directly into the jar with the same scoop.

The coring procedure was modified because of the difficulties involved in removing the cored sample from the coring tube and acquiring sufficient sample material. The modified coring procedure involved coring to a lesser depth and depositing the core into a sample jar. The jar was filled by collecting additional cores and using the same coring tube to scrape up loose material from the collection point.

Of all the samples collected, only three samples were damaged or lost prior to analysis. The samples were all from Site 5 where samples were collected after heavy rains. Processes X and Y at Site 5 had to be sampled at a later date due to the wet conditions. One sample was lost entirely when the jar broke. The other two samples also had broken jars but were recovered. Some of the samples from Process Q had water standing in the jars and the jars may have been broken by the water freezing in the jar.

Samples collected at Sites 3 and 4 were also obtained after heavy rains and may not have been representative of normal soil moisture conditions.

2.2 ANALYSIS OF TSDF SAMPLES

Throughout the project, the quality of the analytical data was evaluated to assure that the goals of the project were being accomplished. In some cases, the analytical techniques were altered to improve the data quality. The major

difficulty encountered in the analysis of the TSDF samples involved the analysis of semivolatile organic compounds found on the Hazardous Substance List (HSL) in the Contract Laboratory Program, Statement of Work for Organic Analysis, 7/85 Revision (CLP). The presence of high concentrations of non-HSL compounds (mostly aliphatic compounds) analyzed from the first two sites resulted in higher quantifiable detection limits than desired for the HSL compounds. A different clean up procedure for the sample extracts was developed which allowed the semivolatile organic HSL compound analysis to be conducted at a lower detection limit. The remaining samples from the other six sites, as well as the process samples from the first two sites were analyzed using the new clean up procedure.

2.2.1 Weight Loss on Drying (LOD) Determination

The weight loss on drying (LOD) procedure was intended to provide a measure of the moisture content of the soil samples. The method used involved determining the weight loss of an accurately weighed sample after 16 hours of oven drying. For some process samples collected in arid regions of the country, the LOD values were considerably higher than could be attributed to moisture in the soil. The higher weight loss observed from the sample was believed to be associated with volatile compounds driven off from the sample during the drying period. The samples collected from stabilization processes (liquid wastes mixed with a solid absorbent) would be particularly susceptible to a high bias for the LOD moisture determination. The LOD determination was also used to determine which drying technique would be suitable for a set of process samples. Typically a set of process samples with an LOD greater than 10% was oven dried and a set of samples with an LOD less than 10% was desiccated. The LOD results and the 95% confidence intervals for each process are summarized along with silt and PM_{10} results in Table 2.1. The individual LOD values are presented with the individual silt content values in Tables 2.2 to 2.9.

2.2.2 Sample Drying

The sample drying procedures were also a point of concern in relation to the subsequent organic analysis. The loss of the more volatile semivolatile compounds during the sample drying and sieving, as well as the degradation of unstable semivolatile compounds during oven drying were the possibilities considered. Although desiccation was the preferred method of drying,

Table 2.1. Summary of Silt Content, LOD, and PM10 Content

Sample ID	Mean Percent +/- 95 Percent Confidence Interval		
Site 1	Silt	LOD	PM10
A	10.9 +/- 2.0	1.0	21.13 +/- 0.69
B	18.2 +/- 1.7	13.3	24.27 +/- 4.10
C	26.2 +/- 6.2	3.1	30.25 +/- 0.35
D	22.6 +/- 3.6	1.4	24.72 +/- 3.77
E	10.8 +/- 1.1	3.7	15.29 +/- 6.06
BGD	34.7 +/- 3.7	9.8	24.32 +/- 0.35
Site 2	Silt	LOD	PM10
F	6.0 +/- 0.6	1.3	20.24 +/- 0.42
G	15.5 +/- 1.8	12.2	34.30 +/- 0.49
H	13.5 +/- 3.7	13.0	35.42 +/- 0.12
I	17.8 +/- 3.8	16.6	57.13 +/- 0.43
I-QA	22.2 +/- 1.8 30.5 +/- 2.0 27.5 +/- 0.8		
BGD	14.8 +/- 7.5	5.7	24.32 +/- 0.35
Site 3	Silt	LOD	PM10
J	13.7 +/- 3.9	31.59 +/- 5.45	49.19 +/- 0.42
K	27.4 +/- 4.5	14.33 +/- 1.55	37.11 +/- 1.79
BGD	19.0 +/- 13.2	13.69 +/- 4.93	37.49 +/- 0.61
Site 4	Silt	LOD	PM10
L	7.1 +/- 1.2	27.53 +/- 1.59	10.57 +/- 4.05
M	12.8 +/- 6.9	1.52 +/- 0.3	18.43 +/- 11.1
N	12.0 +/- 1.0	21.9	17.85 +/- 1.55
O	6.1 +/- 0.7	30.5	5.52 +/- 0.55
O-QA	7.1 +/- 0.8 7.5 +/- 2.4 4.6 +/- 2.3	29.97 +/- 1.6 31.50 +/- 2.4 30.17 +/- 2.0	
BGD	13.7 +/- 2.6	9.5	30.82 +/- 2.16

Table 2.1. (continued)

Sample ID	Mean Percent +/- 95 Percent Confidence Interval		
Site 5	Silt	LOD	PM10
Soil Storage Pile	10.2 +/- 3.1	11.70 +/- 3.60	10.84 +/- 0.83
Surface Impound.	1.0 +/- 1.1	10.62 +/- 2.66	0.93 +/- 0.24
Site 6	Silt	LOD	PM10
P	7.8 +/- 3.3	24.50 +/- 2.44	30.39 +/- 1.12
Q	15.9 +/- 3.3	33.04 +/- 1.90	52.53 +/- 2.14
R	8.4 +/- 4.9	25.20 +/- 1.5	21.76 +/- 1.84
X	2.0 +/- 1.1	11.47 +/- 3.09	2.56 +/- 0.14
Y	13.3	3.70 +/- 0.19	38.75 +/- 2.02
BGD	39.2 +/- 6.5	24.00 +/- 3.16	19.03 +/- 0.01
Site 7	Silt	LOD	PM10
S	12.7 +/- 2.2	16.62 +/- 6.40	40.58 +/- 1.44
T	6.0 +/- 2.4	28.06 +/- 4.30	32.95 +/- 3.80
U	12.8 +/- 1.9	3.78 +/- 0.51	20.40 +/- 0.53
V	9.8 +/- 1.1	6.12 +/- 0.90	4.62 +/- 0.06
W	12.0 +/- 7.9	1.63 +/- 0.83	40.56 +/- 0.25
S-QA	13.3 +/- 1.0	11.10 +/- 2.72	
	17.1 +/- 4.1	22.60 +/- 0.23	
	17.8 +/- 3.4	21.70 +/- 0.79	
BGD	8.6 +/- 7.1	14.04 +/- 9.96	21.52 +/- 0.08
Site 8	Silt	LOD	PM10
Z	4.2 +/- 0.6	9.50 +/- 2.29	38.87 +/- 0.65
AA	12.6 +/- 8.4	8.14 +/- 2.08	51.29 +/- 0.80
BGD	15.0 +/- 2.6	17.37 +/- 0.40	22.85 +/- 0.32

Table 2.2. Silt Content, LOD, and PM10 Content, Site 1

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 1 Landfill, Active Lift (Process A)	A-101	8.3			
	A-102	11.0			
	A-103	5.9			
	A-104	11.0			
	A-105	10.0			
	A-106	14.4			
	A-107	13.1		A-158	21.48
	A-108	13.7	1.0	A-158	20.77
	Average	10.9			21.13
	Std. Dev.	2.9			0.50
Dry Surface Impoundment (Process B)	B-111-M	15.1			
	B-112-M	16.1			
	B-113-M	18.7			
	B-114-M	23.0			
	B-115-M	14.8			
	B-116-M	15.5			
	B-111-O	19.1			
	B-112-O	19.1			
	B-113-O	18.5			
	B-114-O	22.7			
	B-115-O	20.7		B-168	22.17
	B-116-O	14.6	13.3	B-168	26.36
	Average	18.2			24.27
	Std. Dev.	3.0			2.96
Roadway, Main Entrance (Process C)	C-117	29.4		C-173	30.43
	C-117	23.0	3.1	C-173	30.08
	Average	26.2			30.25
	Std. Dev.	4.5			0.25
Roadway, Lift Access (Process D)	D-118	20.7		D-176	26.64
	D-118	24.4	1.4	D-176	22.80
	Average	22.6			24.72
	Std. Dev.	2.6			2.72
Roadway, Impound. Access (Process E)	E-119	11.3		E-179	12.20
	E-119	10.2	3.7	E-179	18.37
	Average	10.8			15.29
	Std. Dev.	0.8			4.37
Background Sample	BGD-109	32.8		BGD-192	24.49
	BGD-109	36.6	9.8	BGD-192	24.14
	Average	34.7			24.32
	Std. Dev.	2.7			0.25

Table 2.3. Silt Content, LOD, and PM10 Content, Site 2

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 2 Roadway, Landfill Access (Process F)	F-201	6.3		F-232	20.03
	F-201	5.7	1.31	F-232	20.45
	Average	6.0			20.24
	Std. Dev.	0.4			0.30
Roadway, Access in Landfill (Process G)	G-202	16.2			
	G-202	16.8			
	G-203	12.9		G-235	34.05
	G-203	16.0	12.19	G-235	34.54
	Average	15.5			34.30
	Std. Dev.	1.8			0.35
Active Landfill (Process H)	H-204	16.3			
	H-205	17.3			
	H-206	11.0	12.99		
	H-207	5.7			
	H-208	13.5		H-248	35.35
	H-209	17.4		H-248	35.48
	Average	13.5			35.42
	Std. Dev.	4.6			0.09
Background Sample	BGD-210	7.8			
	BGD-210	9.6			
	Average	8.7			
	Std. Dev.	1.3			
	BGD-211	17.5	5.67	BGD-251	24.49
	BGD-211	24.4		BGD-251	24.14
	Average	21.0			24.32
Stabilization Area (Process I)					0.25
	I-212	15.4			
	I-213	27.5			
	I-214	17.4			
	I-215	19.6			
	I-216	18.9	16.58		
	I-217	12.0		I-260	57.35
	I-218	13.5		I-260	56.92
	Average	17.8			57.13
	Std. Dev.	5.1			0.31

(continued)

Table 2.3. (continued)

Site and Process	Sample ID	Percent Silt
Stabilization Area Quality Assurance Samples	I-212rr1	20.6
	I-212rr2	22.1
	I-212rr3	20.0
	I-212rr4	23.7
	I-212rr5	24.7
	=====	
	Average	22.2
	Std. Dev.	2.0
	I-213rr1	27.0
	I-213rr2	29.1
	I-213rr3	32.0
	I-213rr4	31.7
	I-213rr5	32.5
	=====	
	Average	30.5
	Std. Dev.	2.3
	I-214rr1	28.0
	I-214rr2	28.7
	I-214rr3	26.7
	I-214rr4	26.7
	I-214rr5	27.6
	=====	
	Average	27.5
	Std. Dev.	0.9

Table 2.4. Silt Content, LOD, and PM10 Content, Site 3

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 3 Active Landfill III (Process J)	J-301	13.9	28.02		
	J-302	16.0	22.96		
	J-303	10.8	38.75		
	J-304	5.7	35.56		
	J-305	24.9	18.26		
	J-306	9.3	35.51		
	J-307	16.5	32.88	J-326	49.40
	J-308	12.7	40.78	J-326	48.97
	Average	13.7	31.59		49.19
	Std. Dev.	5.7	7.87		0.30
Active Landfill I (Process K)	K-309	22.7	17.87		
	K-310	15.1	10.22		
	K-311	28.6	12.69		
	K-312	35.2	13.63		
	K-313	25.6	15.33		
	K-314	30.9	15.39		
	K-315	26.7	14.82	K-336	38.02
	K-316	34.1	14.70	K-336	36.19
	Average	27.4	14.33		37.11
	Std. Dev.	6.5	2.24		1.29
Background Sample	BGD-317	12.2	11.17	BGD-342	37.80
	BGD-318	25.7	16.21	BGD-342	37.18
	Average	19.0	13.69		37.49
	Std. Dev.	9.5	3.56		0.44

Table 2.5. Silt Content, LOD, and PM10 Content, Site 4

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 4 Land Treatment Cell 4 (Process L)	L-401-M	11.8	28.03		
	L-402-M	6.9	21.85		
	L-403-M	8.2	28.50		
	L-404-M	3.5	28.06		
	L-405-M	6.8	26.78		
	L-406-M	11.3	26.02		
	L-407-M	5.7	25.95		
	L-408-M	6.3	33.82		
	L-401-O	9.1	28.09		
	L-402-O	5.6	22.48		
	L-403-O	8.0	22.97		
	L-404-O	3.0	30.07		
	L-405-O	7.4	27.52		
	L-406-O	7.4	32.03		
	L-407-O	4.2	28.75	L-433	8.51
	L-408-O	8.9	29.51	L-437	12.63
	Average	7.1	27.53		10.57
	Std. Dev.	2.5	3.24		2.92
Roadway, Access to Cells (Process M)				M-440	1.29
	M-409	8.2	1.65	M-440	2.76
				Average	2.03
				Std. Dev.	1.04
				M-443	29.92
	M-410	19.7	1.19	M-443	34.94
				Average	32.43
				Std. Dev.	3.55
				M-446	20.52
	M-411	10.4	1.73	M-446	21.12
				Average	20.82
				Std. Dev.	0.42
Land Treatment Cell 8 (Process N)	N-412	10.9	21.89		
	N-413	12.4			
	N-414	14.5			
	N-415	10.3			
	N-416	13.2			
	N-417	11.5			
	N-418	12.9		N-453	17.06
	N-419	10.2		N-453	18.65
	Average	12.0			17.85
	Std. Dev.	1.5			1.12

(continued)

Table 2.5. (continued)

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 4 Land Treatment Cell 3 (Process 0)	O-422	5.6			
	O-423	5.9			
	O-424	5.8			
	O-425	5.6			
	O-426	6.9			
	O-427	4.4			
	O-428	7.7		O-463	5.81
	O-429	7.0	30.49	O-463	5.24
	Average	6.1			5.52
	Std. Dev.	1.0			0.40
Land Treatment Cell Quality Assurance Samples	O422rr1	6.3	28.96		
	O422rr2	7.8	32.71		
	O422rr3	6.8	29.47		
	O422rr4	6.5	30.78		
	O422rr5	8.3	27.91		
	Average	7.1	29.97		
	Std. Dev.	0.9	1.85		
	O423rr1	7.1	31.70		
	O423rr2	8.3	29.23		
	O423rr3	4.5	35.53		
	O423rr4	6.1	28.56		
	O423rr5	11.7	32.48		
	Average	7.5	31.50		
	Std. Dev.	2.7	2.79		
	O425rr1	6.7	27.75		
	O425rr2	1.9	30.41		
	O425rr3	3.7	33.21		
	O425rr4	2.7	31.49		
	O425rr5	7.8	27.98		
	Average	4.6	30.17		
	Std. Dev.	2.6	2.33		
Background Sample	BGD-420	16.4	9.46		
	BGD-420	15.4			
	BGD-421	12.5		BGD-446	31.92
	BGD-421	10.4		BGD-446	29.72
	Average	13.7			30.82
	Std. Dev.	2.7			1.56

Table 2.6. Silt Content, LOD and, PM10 Content, Site 5

Site and Process	Sample ID	Percent Silt *	Percent Loss on Drying	Sample ID	Percent PM-10
Site 5 Soil Storage Pile	11	7.7	16.65		
	12	8.8	8.40		
	13	14.8	9.53	52	11.26
	14	9.3	12.21	52	10.41
	Average	10.2	11.70		10.84
	Std. Dev.	3.2	3.67		0.60
Dry Surface Impoundment	21	1.6	9.26	62	0.81
	22	0.4	11.98	62	1.05
	Average	1.0	10.62		0.93
	Std. Dev.	0.8	1.92		0.17

* All silt values determined using a full stack of sieves

Table 2.7. Silt Content, LOD, and PM10, Site 6

Site and Process	Sample ID	Percent Silt *	Percent Loss on Drying	Sample ID	Percent PM-10
Site 6 Landfill Cell A (Process P)	P-501	3.3	32.54		
	P-502	4.5	23.20		
	P-503	5.8	22.57		
	P-504	5.5	21.25		
	P-505	3.7	25.98		
	P-506	15.0	24.21		
	P-507	9.2	22.90	P-546	29.81
	P-508	15.1	23.34	P-546	30.96
	Average	7.8	24.50		30.39
	Std. Dev.	4.8	3.52		0.81
Landfill Cell Q (Process Q)	Q-509	16.2	33.95		
	Q-510	13.7	29.51		
	Q-511	25.6	33.86		
	Q-512	10.4	34.26		
	Q-513	14.3	31.34	Q-556	53.54
	Q-514	11.5	31.19	Q-556	49.85
	Q-515	15.7	38.45	Q-556	54.90
	Q-516	19.4	31.75	Q-556	51.84
	Average	15.9	33.04		52.53
	Std. Dev.	4.8	2.74		2.18
Landfill Cell C (Process R) Oven dried 1 hour @ 105 C	R-517	0.0	33.91		
	R-518	0.8	28.78		
	R-519	0.7	19.56		
	R-520	0.0	18.53		
	Average	0.4	25.20		
	Std. Dev.	0.4	7.42		
Landfill Cell C (Process R) Oven dried 2.5 hour @ 105 C	R-521	6.1	22.55		
	R-522	6.0	24.77		
	R-523	5.5	21.03	R-566	20.82
	R-524	15.9	22.49	R-566	22.70
	Average	8.4	22.7		21.76
	Std. Dev.	5.0	1.54		1.33

* All silt values determined using a full stack of sieves

(continued)

Table 2.7. (continued)

Site and Process	Sample ID	Percent Silt *	Percent Loss on Drying	Sample ID	Percent PM-10
Site 6 Land Treatment Cell (Process X)	X-527	5.1	5.82		
	X-528	1.2	18.95		
	X-529	1.9	13.61		
	X-530	1.7	8.22		
	X-531	0.6	11.42		
	X-532	1.4	11.88	X-587	2.49
	X-533	2.4	10.39	X-587	2.63
	Average	2.04	11.47		2.56
	Std. Dev.	1.5	4.17		0.10
Roadway, Landfill Access (Process Y)			3.80	Y-597	37.72
	Y-535	13.3	3.60	Y-597	39.78
	Average	13.3	3.70		38.75
	Std. Dev.		0.14		1.46
Background Sample	BGD-525	42.5	22.38	BGD-572	19.02
	BGD-526	35.8	25.61	BGD-572	19.04
	Average	39.2	24.00		19.03
	Std. Dev.	4.7	2.28		0.01

* All silt values determined using a full stack of sieves

Table 2.8. Silt Content, LOD, and PM10 Content, Site 7

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 7 Landfill Cell 1 (Process S)	S-601	14.8	10.35		
	S-602	10.1	25.07		
	S-603	11.6	22.31		
	S-604	10.9	21.97		
	S-605	18.3	5.49		
	S-606	16.0	2.25		
	S-607	10.6	25.84	S-642	41.31
	S-608	9.6	19.68	S-642	39.84
	Average	12.7	16.62		40.58
	Std. Dev.	3.2	9.23		1.04
Stabilization Area (Process T)	T-611	6.6	33.05		
	T-612	1.0 *	20.81		
	T-613	2.2 *	23.45		
	T-614	6.6	35.54		
	T-615	7.3	26.31		
	T-616	9.9	23.94	T-652	31.01
	T-617	8.7	33.33	T-652	34.89
	Average	6.0	28.06		32.95
	Std. Dev.	3.3	5.81		2.74
Land Treatment Cell (Process U)	U-618	14.3	2.98		
	U-619	13.0	4.30		
	U-620	13.5	4.32		
	U-621	10.7	4.09		
	U-622	10.4	4.94		
	U-623	11.0	3.12		
	U-624	10.8	3.01	U-659	20.13
	U-625	18.6	3.47	U-659	20.67
	Average	12.8	3.78		20.40
	Std. Dev.	2.8	0.73		0.38
Land Treatment Cell (Process V)	V-626	7.9	7.37		
	V-627	11.8	8.37		
	V-628	8.6	5.79		
	V-629	10.7	5.61		
	V-630	10.3	6.18		
	V-631	10.9	5.41		
	V-632	7.4	4.04	V-666	4.64
	V-633	10.5	6.16	V-666	4.59
	Average	9.76	6.12		4.62
	Std. Dev.	1.6	1.30		0.04

* These samples were screened with a full stack of sieves (continued)

Table 2.8. (continued)

Site and Process	Sample ID	Percent Silt	Percent Loss on Drying	Sample ID	Percent PM-10
Site 7 Roadways, Access (Process W)	W-634	16.0	2.05	W-669	40.43
	W-635	7.9	1.20	W-669	40.69
	=====				
	Average	12.0	1.63		40.56
	Std. Dev.	5.7	0.60		0.18
Active Landfill Quality Assurance Samples	S-601-RR1	12.3	9.93		
	S-601-RR2	13.6	13.90		
	S-601-RR3	13.9	9.55		
	=====				
	Average	13.3	11.1		
	Std. Dev.	0.9	2.4		
	S-602-RR1	21.1	22.32		
	S-602-RR2	16.1	22.75		
	S-602-RR3	14.1	22.71		
	=====				
	Average	17.1	22.6		
	Std. Dev.	3.6	0.2		
	S-603-RR1	21.2	22.27		
	S-603-RR2	15.6	21.86		
	S-603-RR3	16.7	20.93		
	=====				
	Average	17.8	21.7		
	Std. Dev.	3.0	0.7		
Background Sample	BGD-609		22.08		
	BGD-609	1.4	22.58		
	=====				
	Average		22.33		
	Std. Dev.		0.35		
	BGD-610		9.37	BGD-645	21.56
	BGD-610	8.6	10.16	BGD-645	21.48
	=====				
	Average		9.77		21.52
	Std. Dev.		0.56		0.06

Table 2.9. Silt Content, LOD, and PM10 Content, Site 8

Site and Process	Sample ID	Percent Silt *	Percent Loss on Drying	Sample ID	Percent PM-10
Site 8 Landfill, Active Lift (Process Z)	Z-701	2.6	7.12		
	Z-702	5.5	12.67		
	Z-703	4.1	5.99		
	Z-704	4.8	7.12		
	Z-705	4.8	8.53		
	Z-706	4.2	11.73		
	Z-707	3.6	5.95	Z-726	38.53
	Z-708	3.7	14.50	Z-726	39.20
	Average	4.2	9.50		38.87
	Std. Dev.	0.89	3.31		0.47
Roadways, Landfill Access (Process AA)				AA-732	46.70
	AA-709	4.0	10.26	AA-732	46.41
				Average	46.56
				Std. Dev	0.21
				AA-735	51.70
	AA-710	12.6	8.14	AA-735	50.88
				Average	51.29
				Std. Dev	0.58
Background Sample	BGD-711	16.3	17.08	BGD-739	45.87
	BGD-712	13.6	17.66	BGD-739	45.54
	Average	14.95	17.37		22.85
	Std. Dev.	1.91	0.41		0.23

* All silt values determined using a full stack of sieves

the high moisture content of the samples precluded using the desiccator for drying. A summary of which drying method was used for each set of process samples and the length of time the samples were dried is presented in Table 2.10. The sieving characteristics of the land treatment process samples were also affected by the amount of drying. An odor, presumably associated with the volatilization of organic compounds, was often observed during the drying of the land treatment and the stabilization processes samples.

2.2.3 Silt Content and PM₁₀ Content

The determination of the silt content and PM₁₀ content of the dried samples was performed without difficulty. The silt content and PM₁₀ content, along with the LOD values, and their 95% confidence intervals are summarized in Table 2.1. The silt contents for all samples are presented in Table 2.2 to 2.9 along with the PM₁₀ content of their corresponding silt composite.

The samples needed to be dry (LOD of less than 1 percent) to get an accurate determination of the silt content. Samples with excessive moisture had a tendency to blind (plug) the sieve which resulted in a low bias for the silt content. For samples that did blind the sieves, the samples were returned to the desiccator or the oven for additional drying.

Midway through the project, MRI suggested that a full stack of sieves be used for the silt determinations instead of the short stack of sieves (40 and 200 mesh) specified by the ASTM procedure. The full stack of sieves was employed on the samples from Sites 6 and 8. The rejected material resulting from the sieving using a full stack of sieves was rerun on a short stack of sieves. The comparison showed that additional silt was obtained upon resieving the rejected material on the short stack of sieves (see Table 2.11).

The PM₁₀ determinations were accomplished without difficulty. However, producing sufficient PM₁₀ material for chemical analysis using the sonic proved to be tedious and very time consuming.

2.2.4 Oil and Grease Analysis

The oil and grease analysis for the six land treatment processes (Processes L, N, O, U, V, and X) was conducted without difficulty. The results of the oil and grease analyses are presented in Table 2.12. QA samples from Process O were analyzed and used to demonstrate repeatability (within-laboratory) for the

Table 2.10. Summary of Drying Procedures for TSDF Samples

Sample ID	Process Description	Drying Procedure
Site 1		
A	Landfill, Active Lift	Desiccated for 24 hours
B	Dry Surface Impound.	Oven Dried at 105 C for 1 hour
C	Roadway, Main Entrance	Desiccated for 24 hours
D	Roadway, Lift Access	Desiccated for 24 hours
E	Roadway, Impound. Access	Oven Dried at 105 C for 1 hour
BGD	Background Sample	Desiccated for 24 hours
Site 2		
F	Roadway, Landfill Access	Desiccated for 24 hours
G	Roadway, in Landfill	Oven Dried at 105 C for 1 hour followed by 36 hours of desiccation
H	Active Landfill	Oven Dried at 105 C for 1 hour
I	Stabilization Area	Oven Dried at 105 C for 1 hour
I-R&R	Quality Assurance	Oven Dried at 105 C for 1 hour
BGD	Background Sample	Desiccated for 24 hours
Site 3		
J	Active Landfill	Oven Dried at 105 C for 5.5 hour followed by 19 hours of desiccation
K	Active Landfill	Oven Dried at 105 C for 4 hour
BGD	Background Sample	Oven Dried at 105 C for 5 hour
Site 4		
L	Land Treatment Cell	Oven Dried at 105 C for 6 hour
M	Roadway, Access to Cells	Desiccated for 24 hours
N	Land Treatment Cell	Oven Dried at 105 C for 6 hour
O	Land Treatment Cell	Oven Dried at 105 C for 6 hour
O-R&R	Quality Assurance	Oven Dried at 105 C for 6 hour
BGD	Background Sample	Oven Dried at 105 C for 4 hour
Site 5		
	Soil Storage Pile	Oven Dried at 105 C for 1.5 hour followed by 67.5 hours of desiccation
	Dry Surface Impoundment	Oven Dried at 105 C for 1.5 hour followed by 18.5 hours of desiccation

(continued)

Table 2.10. (continued)

Sample ID	Process Description	Drying Procedure
Site 6		
P	Landfill, Active Lift	Oven Dried at 105 C for 3.5 hour followed by 17 hours of desiccation
Q	Landfill, Active Lift	Oven Dried at 105 C for 6.5 hour followed by 85 hours of desiccation
R	Landfill, Active Lift	Oven Dried at 105 C for 2.5 hour followed by 20.5 hours of desiccation
X	Land Treatment Cell	Oven Dried at 105 C for 2.5 hour followed by 18.25 hours of desiccation
Y	Roadway, Landfill Access	Desiccated for 20.5 hours
BGD	Background Sample	Oven Dried at 105 C for 2.5 hour followed by 18.25 hours of desiccation
Site 7		
S	Active Landfill	Desiccated for 24 hours
T	Stabilization Area	Desiccated for 36 hours followed by 1 hour of oven drying at 105 C
U	Land Treatment Cell	Desiccated for 72 hours
V	Land Treatment Cell	Desiccated for 46 hours followed by 1 hour of oven drying at 105 C
W	Roadway, Access	Oven Dried at 105 C for 1 hour
S-R&R	Quality Assurance	Desiccated for 43 hours followed by 1 hour of oven drying at 105 C
BGD	Background Sample	Oven Dried at 105 C for 1 hour
Site 8		
Z	Landfill, Active Lift	Oven Dried at 105 C for 2.5 hour followed by 14 hours of desiccation
AA	Roadways, Landfill Access	Oven Dried at 105 C for 3.5 hour followed by 18 hours of desiccation
BGD	Background Sample	Oven Dried at 105 C for 3.5 hour followed by 18 hours of desiccation

Table 2.11. Sieving Comparisons for Site 6 and Site 8

Site and Process	Sample ID	Sieve Configuration		Percent Increase with Short Stack
		Full	Short	
Site 6, Process P		(silt)	(silt)	
	P-501	3.3%	5.8%	75.8%
	P-502	4.5%	5.8%	28.9%
	P-503	5.7%	12.3%	115.8%
	P-504	5.5%	9.1%	65.5%
	P-505	3.7%	6.5%	75.7%
	P-506	15.0%	21.4%	42.7%
	P-507	9.2%	13.0%	41.3%
	P-508	14.0%	23.8%	70.0%
	Mean	7.6%	12.2%	64.4%
	Std. Dev.	4.6%	7.0%	27.2%
Site 6, Process Q		(silt)	(silt)	
	Q-509	9.2%	23.5%	155.4%
	Q-510	12.5%	24.3%	94.4%
	Q-511	5.2%	28.8%	453.8%
	Q-512	9.6%	18.7%	94.8%
	Q-513	11.9%	24.2%	103.4%
	Q-514	14.5%	24.1%	66.2%
	Q-515	12.0%	25.4%	111.7%
	Q-516	12.1%	29.1%	140.5%
	Mean	10.9%	24.8%	152.5%
	Std. Dev.	2.8%	3.3%	124.9%
Site 6, Process R oven dried 1 hour at 105 C		(silt)	(silt)	
	R-517	0.0%	0.0%	N.A.
	R-518	0.0%	0.0%	N.A.
	R-519	1.6%	3.2%	100.0%
	R-520	0.7%	3.5%	400.0%
	Mean	0.6%	1.7%	250.0%
	Std. Dev.	0.8%	1.9%	212.1%
Site 6, Process R oven dried 2.5 hours at 105 C	R-521	6.1%	9.5%	55.7%
	R-522	6.0%	12.5%	108.3%
	R-523	5.5%	11.7%	112.7%
	R-524	14.3%	16.7%	16.8%
	Mean	8.0%	12.6%	73.4%
	Std. Dev.	4.2%	3.0%	45.8%
Site 6, Background Samples		(silt)	(silt)	
	BGD-525	41.9%	62.5%	49.2%
	BGD-526	35.8%	50.6%	41.3%
	Mean	38.9%	56.6%	45.3%
	Std. Dev.	4.3%	8.4%	5.5%

(continued)

Table 2.11. (continued)

Site and Process	Sample ID	Sieve Configuration		Percent Increase with Short Stack
		Full	Short	
Site 6, Process X	X-527	(silt) 5.1%	(silt) 7.2%	41.2%
	X-528	1.2%	5.4%	350.0%
	X-529	1.9%	4.6%	142.1%
	X-530	1.7%	3.7%	117.6%
	X-531	0.6%	3.7%	516.7%
	X-532	1.4%	2.7%	92.9%
	X-533	2.4%	4.5%	87.5%
	Mean	2.0%	4.5%	192.6%
Site 6, Process Y	Y-535	(silt) 13.3%	(silt) 16.6%	24.8%
Site 8, Process Z	Z-701	(silt) 2.6%	(silt) 5.4%	107.7%
	Z-702	5.7%	7.1%	24.6%
	Z-703	4.1%	5.1%	24.4%
	Z-704	4.8%	5.7%	18.8%
	Z-705	4.8%	5.4%	12.5%
	Z-706	4.2%	4.6%	9.5%
	Z-707	3.6%	4.2%	16.7%
	Z-708	3.7%	5.0%	35.1%
Site 8, Process AA	AA-711	(silt) 16.3%	(silt) 18.1%	11.0%
	AA-712	13.6%	16.4%	20.6%
	Mean	15.0%	17.3%	15.8%
	Std. Dev.	1.9%	1.2%	6.7%

Table 2.12. Summary of Oil and Grease Analysis

Process ID	Process Description	Site	Oil and Grease
L	Land Treatment, Cell#4	4	6.11%
N	Land Treatment, Cell#8	4	8.46%
O	Land Treatment, Cell#3	4	8.92%
U	Land Treatment, 118-121	7	1.11%
V	Land Treatment, R32-35	7	3.71%
X	Land Treatment	6	7.97%
BGD	Background Sample	7	<0.05%

QUALITY ASSURANCE SUMMARY FOR OIL AND GREASE ANALYSIS

Process ID	Sample Description	Site	Oil and Grease
Total Repeatability			
O	Oil&Grease O-rr1 Comp	4	6.94%
O	Oil&Grease O-rr1 Comp	4	7.91%
		Mean	7.43%
		RPD	6.53%
Analytical Repeatability			
O	Oil&Grease O-rr1 Comp	4	7.91%
O	Oil&Grease O-rr1 Comp	4	7.30%
		RPD	4.01%
Sampling Reproducibility			
O	Oil&Grease O-rr4 Comp	4	8.12%
O	Mean of O-rr1 Comp		7.43%
		RPD	4.47%

Performance Audit

	Expected	Found	Recovery
BGD Spiked with 34 mg of paraffin oil	0.39%	0.36%	92.3%

analytical and total systems (sampling and analytical) and sampling reproducibility between samplers). The relative percent difference (RPD) for the total repeatability, the analytical repeatability, and the sampling reproducibility was 6.5%, 4.0%, and 4.4%, respectively (see Table 2.12). A performance audit for the oil and grease analysis was also conducted by spiking the background sample from Site 7 with an EPA paraffin oil check sample and determining the percent recovery. The percent recovery for the performance audit was 92.3% (see Table 2.12).

2.2.5 Metals and Cyanide Analyses

A summary of the sample fractions (whole sample, silt, PM_{10} , and $>PM_{10}$) submitted for chemical analyses and the type of analyses performed on each is presented in Table 2.13. The analyses for metals and cyanide were conducted without difficulty. The procedures used for the metals and cyanide analyses did not require any modification and are detailed in Section 4. The results of the metals and cyanide analyses for Sites 1 through 8 are presented in Tables 2.14 to 2.21.

2.2.6 Organic Compound Analysis

The analysis of semivolatile HSL compounds was originally specified to be conducted at a quantifiable detection limit of 0.33 g (ug/g) of sample. This detection level was cited in the CLP for samples with low concentrations of organic compounds (less than 20 ug/g of any organic compound). However, for all process sample fractions submitted for analysis, the organic compound levels were too high (over 20 ug/g) for the sample extracts to be analyzed without significant dilutions. (Background samples were analyzed without dilutions.) The dilutions were necessary to protect the gas chromatograph/mass spectrometer (GC/MS) from being overloaded with organic material which would result in the instrument having to be shut down for cleaning. The sample extracts for Site 1, prepared by the low level procedure in the CLP had to be diluted to a level similar to a sample prepared at the medium concentration level (for samples containing over 20 ug/g of any single organic compound). This resulted in a quantifiable detection limit of 19.8 ug/g, which is 60 times higher than the intended level of 0.33 ug/g. Site 2 samples were all extracted by the medium level procedure and analyzed without dilution at a quantifiable detection limit of 19.8 ug/g.

The majority of the semivolatile organic compounds detected in these samples from Sites 1 and 2 were not HSL compounds. And the majority of the

Table 2.13. Summary of Silt Fractions Submitted for Analysis
and the Analyses Performed

Process ID	Fractions Submitted	Analysis Performed
Site 1		
A	Silt, PM ₁₀ , >PM ₁₀	Metals, Cyanide, and Semivolatile Organics
B	Silt, PM ₁₀ , >PM ₁₀	Metals, Cyanide, and Semivolatile Organics
C	Silt	Metals, Cyanide, and Semivolatile Organics
D	Silt	Metals, Cyanide, and Semivolatile Organics
E	Silt	Metals, Cyanide, and Semivolatile Organics
BGD	Silt	Metals, Cyanide, and Semivolatile Organics
Site 2		
F	Silt	Metals, Cyanide, and Semivolatile Organics
G	Silt	Metals, Cyanide, and Semivolatile Organics
H	Silt, PM ₁₀ , >PM ₁₀	Metals, Cyanide, and Semivolatile Organics
I	Silt, PM ₁₀ , >PM ₁₀	Metals, Cyanide, and Semivolatile Organics Pesticides, and PCB's
I-QA	Silt	Metals, Cyanide, and Semivolatile Organics Pesticides, and PCB's
BGD	Silt	Metals, Cyanide, and Semivolatile Organics
Site 3		
J	Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Metals, Cyanide, and Semivolatile Organics
K	Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Metals, Cyanide, and Semivolatile Organics
BGD	Silt	Metals, Cyanide, and Semivolatile Organics

Table 2.13. (continued)

Process ID	Fractions Submitted	Analysis Performed
Site 4		
L	Soil Sample Silt	Oil and Grease Metals and Semivolatile Organics
M	Silt	Metals, and Semivolatile Organics
N	Soil Sample Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Oil and Grease Metals Semivolatile Organics
O	Soil Sample Silt	Oil and Grease Metals and Semivolatile Organics
O-QA	Silt	Metals and Semivolatile Organics
BGD	Silt	Metals and Semivolatile Organics
Site 5		
Soil Pile	Silt	Metals, Cyanide, and Semivolatile Organics
Impoundment	Silt	Metals, Cyanide, and Semivolatile Organics
Site 6		
P	Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Metals, Cyanide, and Semivolatile Organics Pesticides, and PCB's
Q	Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Metals, Cyanide, and Semivolatile Organics Pesticides, and PCB's
R	Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Metals, Cyanide, and Semivolatile Organics Pesticides, and PCB's
X	Soil Sample	Oil and Grease Metals and Semivolatile Organics
Y	Silt	Metals and Semivolatile Organics
BGD	Silt	Metals and Semivolatile Organics

Table 2.13. (continued)

Process ID	Fractions Submitted	Analysis Performed
Site 7		
S	Silt, PM ₁₀ , >PM ₁₀	Metals, Cyanide, Semivolatile Organics Pesticides, and PCB's
T	Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Metals and Cyanide Semivolatile Organics, Pesticides, and PCB's
U	Soil Sample Silt, PM ₁₀ , >PM ₁₀ Silt, PM ₁₀	Oil and Grease Metals Semivolatile Organics
V	Soil Sample Silt	Oil and Grease Metals and Semivolatile Organics
W	Silt	Metals and Semivolatile Organics
S-QA	Silt	Metals, Cyanide, Semivolatile Organics, Pesticides, and PCB's
BGD	Silt	Metals and Semivolatile Organics
Site 8		
Z	Silt, PM ₁₀ , >PM ₁₀	Metals
AA	Silt	Metals
BGD	Silt	Metals

Table 2.14. Analytical Results for Metals and Cyanide, Site 1

Metals Analysis			Lift			Impound.			Dirt	Background
Sample Identity	Active Lift			Access Rd.	Dry Surface Impoundment			Access Rd.	Roadway	Sample
	Silt	>PM-10	PM-10	Silt	Silt	>PM10	PM-10	Silt	Silt	Silt
	A-153	A-157	A-155	D-175	B-160	B-162	B-161	E-178	C-172	26D-191
Elements (ug/g)										
Aluminum (Al)	21,800	19,500	21,300	26,400	29,200	26,600	25,900	20,750	25,500	22,900
Antimony (Sb)	<1	<1	<1	<1	<1	6.8	5.1	<1	3.2	<1
Arsenic (As)	9.3	8.3	9.2	13.5	15.3	10.5	20.4	3.7	10.8	21.9
Barium (Ba)	957	946	215	958	955	950	950	399	955	130
Beryllium (Be)	4.4	3.1	0.9	3.4	2.4	1.6	1.9	2.6	2.5	1.9
Bismuth (Bi)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium (Cd)	5.5	4.2	8.0	16.0	33.2	31.5	36.5	3.6	5.1	1.5
Chromium (Cr)	223	219	154	94	245	224	344	68.2	118	54.2
Cobalt (Co)	21.2	18.3	20.7	26.3	12.2	11.5	11.7	10.1	12.0	11.9
Copper (Cu)	3,570	2,390	10,400	295	1,090	1,010	1,360	129	304	43.8
Iron (Fe)	27,000	25,300	23,300	24,600	20,800	19,600	21,100	19,100	19,700	22,200
Lead (Pb)	1,030	780	1,780	2,960	3,380	3,270	3,930	175	864	15.0
Manganese (Mn)	533	474	482	474	392	368	411	361	358	375
Mercury (Hg)	0.2	0.4	0.4	0.6	0.4	0.4	0.5	0.2	0.5	0.2
Molybdenum (Mo)	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9
Nickel (Ni)	173	159	190	145	340	148	190	58	313	44.8
Osmium (Os)	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Selenium (Se)	2.3	<1	1.8	1.6	2.4	1.4	2.2	0.7	<1	<1
Silver (Ag)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Thallium (Tl)	<1	<1	<1	<1	<1	<1	<1	<1	1.6	<1
Vanadium (V)	105	867	106	131	106	98.2	106	75.8	95.9	65.2
Zinc (Zn)	1,030	966	1,250	856	3,270	3,110	3,950	856	983	83.5
cyanide	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Table 2.15. Analytical Results for Metals and Cyanide, Site 2

Metals Analysis			Access Rd. Access Rd.						Background	
			Active Landfill B-9		in LF B-9	above LF	Stabilization Area			Sample
Sample Identity	Silt	>PM-10	PM-10	Silt	Silt	Silt	>PM10	PM-10	Silt	
	H-243	H-247	H-245	G-234	F-231	I-255	I-259	I-257	B-250	
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	
Aluminum (Al)	27,400	26,100	27,500	26,700	21,250	14,700	17,600	13,000	24,900	
Antimony (Sb)	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Arsenic (As)	11.1	7.9	10.7	9.9	7.8	11.3	9.0	11.9	9.5	
Barium (Ba)	366	336	433	446	950	191	218	166	144	
Beryllium (Be)	1.7	1.6	1.9	1.0	1.4	0.7	0.9	0.6	2.1	
Bismuth (Bi)	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Cadmium (Cd)	9.2	7.8	15.4	64.0	5.2	2.1	2.3	2.2	1.6	
Chromium (Cr)	138	125	161	159	180	67.4	72.9	60.6	56.1	
Cobalt (Co)	22.4	22.3	22.1	22.7	31.6	8.5	11.4	5.9	12.7	
Copper (Cu)	146	120	202	148	95.6	109	101	114	36.6	
Iron (Fe)	30,500	29,500	31,700	29,900	27,500	11,700	15,200	9,400	22,600	
Lead (Pb)	534	400	806	329	179	114	101	117	<10	
Manganese (Mn)	768	671	938	659	889	468	470	477	375	
Mercury (Hg)	0.6	0.4	0.7	0.6	0.3	0.8	0.8	0.8	0.2	
Molybdenum (Mo)	<9	<9	<9	<9	<9	<9	<9	<9	<9	
Nickel (Ni)	112	106	118	137	2.0	34.9	43.0	28.6	45.0	
Osmium (Os)	<4	<4	<4	<4	<4	<4	<4	<4	<4	
Selenium (Se)	<1	<1	<1	<1	1.3	<1	<1	<1	1.00	
Silver (Ag)	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Thallium (Tl)	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Vanadium (V)	79.9	78.6	73.9	71.4	72.0	43.3	55.5	39.1	72.8	
Zinc (Zn)	2,110	1,520	3,450	1,440	488	232	215	242	79.6	
cyanide	3.3	2.0	5.5	26.9	2.5	5.5	2.7	10.0	<0.5	

Table 2.16. Analytical Results for Metals and Cyanide, Site 3

Metals Analysis		Active Landfill 11-III			Active Landfill 11-I			Background
Sample Identity		Silt J-321	PM10 J-323	>PM10 J-325	Silt K-331	PM10 K-333	>PM10 K-335	Silt 860-341
Element		(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aluminum (Al)		19,886	26,458	17,910	10,161	20,483	7,842	10,331
Antimony (Sb)		8.5	10.8	6.8	3.4	8.1	4.5	<0.5
Arsenic (As)		8.5	11.7	6.0	9.0	22.2	10.0	4.2
Barium (Ba)		102	124	96.2	86.9	189	71.2	73.3
Beryllium (Be)		0.47	0.49	0.45	0.34	0.70	<0.3	<0.3
Cadmium (Cd)		<3	4.4	<3	12.2	58.0	23.0	<3
Chromium (Cr)		2,038	3,243	1,786	294	828	374	57.4
Cobalt (Co)		14.0	22.9	13.1	<11	14.4	<11	<11
Copper (Cu)		1,602	2,434	1,459	3,229	7,961	2,770	57.9
Iron (Fe)		17,992	20,088	16,418	16,511	27,448	13,519	15,497
Lead (Pb)		5,562	8,750	4,936	303	1,145	551	43.5
Magnesium (Mg)		11,552	12,754	11,891	16,291	13,437	9,810	7,124
Manganese (Mn)		533	603	513	579	792	463	460
Mercury (Hg)		0.20	1.21	0.23	9.25	30.10	10.90	<0.13
Molybdenum (Mo)		190	299	175	31.3	50.4	22.3	22.0
Nickel (Ni)		345	541	308	197	359	160	12.3
Osmium (Os)		<27	<27	<27	<27	<27	<27	<27
Selenium (Se)		0.6	1.0	1.0	0.9	1.0	0.7	<0.5
Silver (Ag)		46.4	82.1	44.8	<11	17.2	<11	<11
Thallium (Tl)		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vanadium (V)		37.3	43.5	32.8	29.5	48.4	24.1	31.1
Zinc (Zn)		41,469	64,726	35,709	1,301	3,115	1,426	287
cyanide		101	122	91.7	17.2	37.5	22.1	-

Table 2.17. Analytical Results for Metals, Site 4

Metals Analysis	Land Treatment Cell #8			Cell #4	Cell #3	Roads	Background
Sample Identity	Silt N-448	PM10 N-450	>PM10 N-452	Silt L-430	Silt O-458	Silt M-439	Silt BDG-455
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aluminum (Al)	11,100	13,200	940	11,000	11,900	11,400	14,000
Antimony (Sb)	1.1	0.8	0.6	<0.5	0.8	<0.5	2.5
Arsenic (As)	6.7	6.7	6.2	6.6	7.4	5.9	5.2
Barium (Ba)	152	215	272	106	190	114	59.9
Beryllium (Be)	<1	<1	<1	<1	<1	<1	<1
Cadmium (Cd)	<1	<1	1.9	<1	<1	1.4	1.5
Chromium (Cr)	209	255	196	141	142	96.7	21.3
Cobalt (Co)	16.9	20.6	14.7	17.9	17.7	16.5	9.5
Copper (Cu)	207	219	200	164	198	110	31.9
Iron (Fe)	18,400	21,400	17,600	22,400	21,400	19,700	19,400
Lead (Pb)	57.0	81.0	65.0	74.0	92.0	49.0	15.0
Manganese (Mn)	407	473	389	358	508	392	206
Mercury (Hg)	1.3	1.3	1.5	0.9	1.6	0.9	0.1
Molybdenum (Mo)	9.2	9.5	5.7	9.9	<2	<2	<2
Nickel (Ni)	98.3	108	94.4	86.8	150	83.8	13.6
Osmium (Os)	<1	<1	<1	<1	<1	<1	<1
Selenium (Se)	2.3	2.5	3.1	4.2	3.2	2.2	<0.5
Silver (Ag)	<2	<2	<2	<2	<2	<2	<2
Thallium (Tl)	<2	<2	<2	<2	<2	<2	<2
Vanadium (V)	200	227	190	267	352	207	55.0
Zinc (Zn)	248	287	232	225	296	225	35.6

Table 2.18. Analytical Results for Metals and Cyanide, Site 5

Metals Analysis	Soil Storage, RCRA Pond	Pond Bottoms
Sample Identity	51 Silt	61 Silt
Element	(ug/g)	(ug/g)
Aluminum (Al)	23,736	16,461
Antimony (Sb)	<0.5	<0.5
Arsenic (As)	7.4	2.1
Barium (Ba)	222	176
Beryllium (Be)	1.00	0.40
Cadmium (Cd)	16.3	<5
Chromium (Cr)	31.5	21.5
Cobalt (Co)	6.2	4.4
Copper (Cu)	132	362
Iron (Fe)	18,405	12,412
Lead (Pb)	95.7	41.8
Manganese (Mn)	219	126
Mercury (Hg)	<0.03	0.12
Molybdenum (Mo)	<6	<6
Nickel (Ni)	12.8	12.1
Osmium (Os)	<2	<2
Selenium (Se)	<0.5	<0.5
Silver (Ag)	<9	<9
Thallium (Tl)	0.6	<0.5
Vanadium (V)	39.4	26.7
Zinc (Zn)	4,157	298
cyanide	<0.5	<0.5

Table 2.19. Analytical Results for Metals and Cyanide, Site 6

Metals Analysis	Cell A, Acid Wastes			Cell Q, Filter Cake			Cell C, Metal Catalyst Land Treat.			Road	Background	
Sample Identity	Silt P-541	PM10 P-543	>PM10 P-545	Silt Q-551	PM10 Q-553	>PM10 Q-555	Silt R-561	PM10 R-563	>PM10 R-565	Silt Y-581	Silt Y-596	Silt BGD-571
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aluminum (Al)	33,693	49,954	30,775	51,225	55,946	50,668	81,844	22,649	89,102	19,918	15,077	10,258
Antimony (Sb)	0.9	1.2	1.2	90.7	85.1	66.7	1.5	1.6	1.5	1.1	<0.5	<0.5
Arsenic (As)	8.7	13.9	6.0	19.3	24.0	14.2	4.7	6.4	12.0	52.6	3.9	3.4
Barium (Ba)	1,121	1,772	933	3,340	3,632	3,315	103	144	94.4	319	475	53.3
Beryllium (Be)	1.45	1.93	1.05	2.62	2.72	2.50	3.90	2.76	3.74	0.74	0.50	0.44
Cadmium (Cd)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chromium (Cr)	91.2	119	76.7	142	155	132	4,967	8,771	4,278	658	71.2	21.4
Cobalt (Co)	11.2	16.4	10.1	31.3	31.7	31.6	285	421	250	16.7	14.9	<0.4
Copper (Cu)	134	213	113	284	370	190	280	522	248	297	659	79.8
Iron (Fe)	17,198	24,609	15,186	25,182	25,867	24,773	204,890	338,654	173,248	60,205	8,911	5,883
Lead (Pb)	54.4	58.9	40.4	146	135	97.1	113	96.9	97.3	483	12.6	19.9
Manganese (Mn)	156	209	138	170	188	163	209	328	192	380	167	34.0
Mercury (Hg)	0.27	0.50	0.37	0.31	0.37	0.41	<0.03	0.41	<0.03	7.22	<0.03	<0.1
Molybdenum (Mo)	16.4	23.9	12.5	44.1	28.5	122	122	130	89.3	9.9	14.0	<6
Nickel (Ni)	41.9	52.8	39.7	52.7	52.1	50.8	522	258	525	44.1	16.9	<10
Osmium (Os)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium (Se)	0.5	1.1	<0.5	2.8	2.7	2.0	<0.5	<0.5	<0.5	1.1	<0.5	0.5
Silver (Ag)	<9	<9	<9	<9	<9	<9	<9	63.0	52.3	24.7	<9	<9
Thallium (Tl)	<0.5	0.5	<0.5	0.5	1.0	0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5
Vanadium (V)	75.7	110	61.7	161	182	147	122	574	694	38.7	47.8	25.2
Zinc (Zn)	272	389	223	2,940	3,414	2,704	1,054	1,128	963	903	1,353	62.2
cyanide	3.3	4.7	3.0	1,280	1,680	1,250	0.8	2.1	<0.5	-	-	-

Table 2.20. Analytical Results for Metals and Cyanide, Site 7

Metals Analysis	Landfill Cell #1			Stabilization Area #7			Land Treatment 11B-121			R32-R35 Roadway Background		
Sample Identity	Silt S-637	PM10 S-639	>PM10 S-641	Silt T-647	PM10 T-649	>PM10 T-651	Silt U-654	PM10 U-656	>PM10 U-657	Silt V-661	Silt W-668	Silt BGD-644
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)					
Aluminum (Al)	11,500	11,800	11,400	11,100	11,700	11,900	10,600	13,900	11,000	10,300	13,300	12,500
Antimony (Sb)	17.1	11.6	16.7	4.0	4.4	4.2	0.9	0.8	0.5	0.7	1.4	<0.5
Arsenic (As)	21.3	24.3	22.3	14.8	14.6	16.1	7.9	12.5	7.4	10.7	10.1	8.3
Barium (Ba)	888	361	264	202	235	214	276	344	266	280	253	374
Beryllium (Be)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (Cd)	150	170	149	18.8	20.5	19.4	<1	<1	<1	<1	18.4	<1
Chromium (Cr)	447	465	429	337	432	337	90.6	206	74.7	93.1	109	19.2
Cobalt (Co)	12.2	12.2	8.4	6.0	6.2	6.0	4.2	8.4	4.1	4.2	5.2	6.2
Copper (Cu)	951	1,060	956	232	262	243	59.0	92.8	52.0	80.8	196	28.5
Iron (Fe)	63,200	63,500	63,400	13,500	14,700	14,600	9,500	12,700	9,200	9,500	14,800	9,700
Lead (Pb)	6,870	7,746	6,870	866	1,012	926	33.0	45.7	22.2	36.7	630	30.7
Manganese (Mn)	6,480	6,690	6,340	789	928	819	265	356	257	256	671	276
Mercury (Hg)	1.23	1.50	1.21	0.11	0.30	0.16	0.85	2.02	0.59	1.09	0.28	<0.1
Molybdenum (Mo)	82.3	92.0	86.7	127	141	139	<2	<2	2.1	<2	6.6	<2
Nickel (Ni)	85.6	86.2	83.6	30.4	39.2	30.3	8.3	19.8	13.8	13.9	23.7	9.36
Osmium (Os)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Selenium (Se)	4.8	5.4	5.4	1.7	1.2	1.4	1.0	<0.5	<0.5	0.5	0.8	<0.5
Silver (Ag)	18.1	26.9	17.0	11.5	14.7	10.3	<2	<2	<2	<2	<2	<2
Thallium (Tl)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Vanadium (V)	61.9	59.5	55.2	25.6	24.9	27.6	33.9	45.4	33.3	29.2	43.5	31.8
Zinc (Zn)	41,800	47,700	42,900	4,800	5,100	5,200	104	193	99.3	454	3,590	55.5
cyanide	1.23	1.93	0.57	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-

Table 2.21. Analytical Results for Metals, Site 8

Metals Analysis		Landfill			Road	Road	Background
Sample Identity	Silt	PM10	>PM10	Silt	Silt	Silt	
	Z-721	Z-723	Z-725	AA-731	AA-734	BGD-737	
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	
Aluminum (Al)	20,059	23,065	20,178	13,831	10,211	13,493	
Antimony (Sb)	2.3	2.5	2.1	1.9	1.5	1.9	
Arsenic (As)	19.2	22.9	21.5	16.5	27.9	12.6	
Barium (Ba)	163	169	157	208	144	223	
Beryllium (Be)	1.17	1.08	1.21	1.08	0.64	1.20	
Cadmium (Cd)	97.3	121	81.5	80.7	42.7	16.5	
Chromium (Cr)	1,501	1,110	1,692	2,192	1,328	344	
Cobalt (Co)	11.0	8.1	9.4	11.8	11.1	12.1	
Copper (Cu)	718	957	575	548	408	326.0	
Iron (Fe)	144,943	129,723	157,773	190,237	181,727	80,336	
Lead (Pb)	4,324	5,163	3,725	3,874	2,426	945	
Manganese (Mn)	23,963	19,578	26,372	27,377	16,374	422	
Mercury (Hg)	1.10	1.48	0.84	0.55	0.34	0.23	
Molybdenum (Mo)	68.8	66.2	64.1	80.7	76.8	26.1	
Nickel (Ni)	108	110	103	144	99.4	69.5	
Osmium (Os)	<2	<2	<2	<2	<2	<2	
Selenium (Se)	1.4	1.7	1.2	0.9	1.0	0.5	
Silver (Ag)	41.4	36.0	41.6	62.2	30.8	<9	
Thallium (Tl)	<0.5	0.5	<0.5	<0.5	<0.5	0.6	
Vanadium (V)	147	132	156	205	140	61.6	
Zinc (Zn)	32,005	40,314	25,917	42,634	29,267	2,851	

samples determined to be medium level samples, the extracts were subjected to the LH-20 clean up procedure. A summary of the quantifiable detection limits for each process sample after use of the LH-20 clean up procedure is presented in Table 2.22. For Sites 1 and 2, the initial analyses were conducted at a quantifiable detection limit of 19.8 ug/g. For the second analysis of all samples from Site 2, the quantifiable detection limit was at the intended level of 0.33 ug/g. Overall, the land treatment samples did not appear to benefit from the LH-20 clean up, but a comparison to the GPC procedure was not made as part of the study.

The analysis for pesticides and PCB's was not affected as much by the non-HSL compound interference. The pesticide and PCB extracts for Site 2, Process 1 required an 11-fold dilution to allow for the quantitation of toxaphene. The pesticide and PCB analysis for samples from Site 6 were conducted at the desired quantifiable detection limit. For Site 7 the pesticide and PCB analysis required 3 - to 15 -fold dilutions.

The results of the analyses for semivolatile organic HSL compounds, pesticides, and PCB's for Sites 1 through 7 (with no organic analyses were conducted on samples from Site 8) are presented in Tables 2.23 to 2.29.

2.3 PARTICLE SIZE DEPENDENCY OF THE DEGREE OF CONTAMINATION

The particle size dependency of the degree of contamination was determined to see if the hazardous elements or compounds had a tendency to concentrate in the smaller soil particles. The concentration of hazardous chemicals on the inhalable particles could represent a significant health risk associated with fugitive particulate emissions from TSDF's.

For this study, the PM_{10} fractions of the silt (defined for this study as particles with a nominal diameter of less than 20 micrometers) from fourteen processes were chemically analyzed for metals and semivolatile organic compounds. The corresponding $>PM_{10}$ fractions from the fourteen processes were analyzed for metals and the $>PM_{10}$ fractions from five of the processes were analyzed for semivolatile organic compounds (see Table 2.11). The decision was made during the project not to analyze the $>PM_{10}$ fractions for semivolatile organic compounds unless the soil samples had been dried by desiccation. This decision was made primarily as a cost saving measure.

The assessment of the particle size dependency of the degree of contamination involved comparing the contamination level of the PM_{10} fraction to the contamination level of the corresponding silt fraction for each of the compounds. The $>PM_{10}$ fraction was also compared to the silt fraction. The

non-HSL compounds detected in the initial analyses of samples were tentatively identified as aliphatic compounds (i.e. oil and grease).

Because of the higher than anticipated detection limits, alternative methods were investigated for the analysis of semivolatile HSL compounds. Other analytical techniques such as high performance liquid chromatography (HPLC) with simultaneous ultra-violet/fluorescence detection for polynuclear aromatic hydrocarbons (SW-846, Method 8310) and gas chromatography with electron capture detection for chlorinated hydrocarbons (SW-846, Method 8120) were studied because they use specific clean up procedures to remove any interfering compounds. These approaches, however, were too costly in terms of the number of individual analytical procedures required to replace the single GC/MS analysis for the semivolatile HSL compounds.

Another approach for realizing the quantifiable detection limit desired for the project was to improve on the sample clean up procedure used prior to the GC/MS analysis. The CLP recommends the use of a gel permeation chromatography (GPC) procedure to clean sample extracts prepared by the low level extraction procedure. This procedure was used on the extracts from Site 1 samples, yet the samples still required significant dilution prior to the GC/MS analysis. An alternative procedure was investigated for sample clean up where the aliphatic compounds would be separated from the aromatic compounds in the extract. The procedure involved using adsorption chromatography with Sephadex LH-20 that has an affinity for cyclic and aromatic compounds. This procedure appeared to have promise since over 90% of the semivolatile HSL compounds are aromatic. The LH-20 procedure had been successfully applied to analysis for dioxins at part-per-billion detection limits in soil samples treated with waste oil contaminated with dioxins.

The extracts from Site 1 samples were chosen for an initial test of the LH-20 procedure (described in Section 5). The LH-20 procedure resulted in some minor dilutions of some of the sample extracts ranging from 2.3 - to 16.6 - fold. The samples were analyzed at lower quantifiable detection limits than before, with four of the samples having new quantifiable detection limits of less than 0.5 ug/g.

Based on the improved quantifiable detection limits realized for the sample extracts for Site 1, the decision was made to extract the remaining samples following the low level procedure, and screen the extracts to determine the concentration levels (low or medium) of organic compounds in the samples. Any samples (except background samples alone) determined to be low level samples by the screening procedure were analyzed following the CLP procedures. For

Table 2.22. Summary of Quantifiable Detection Limits Samples Analyzed for Semivolatile Organic HSL Compounds after LH-20 Clean Up

Process and Sample ID	Quantifiable Detection Limit (ug/g)
<hr/>	
Site 1	
A silt	0.412
PM ₁₀	0.937
>PM ₁₀	0.472
B silt	5.143
PM ₁₀	6.065
>PM ₁₀	6.650
C silt	0.455
D silt	4.023
E silt	4.023
<hr/>	
Site 2	
F silt	0.33
G silt	0.33
H silt	0.33
PM ₁₀	0.33
>PM ₁₀	0.33
I silt	0.33
PM ₁₀	0.33
>PM ₁₀	0.33
I-QA	0.33
<hr/>	
Site 3	
J silt	4.9
PM ₁₀	7.2
K silt	0.33
PM ₁₀	0.33
<hr/>	
Site 4	
L silt	54.4
M silt	61.2
N silt	78.6
PM ₁₀	49.5
O silt	85.6
<hr/>	

Table 2.22. (continued)

Process and Sample ID	Quantifiable Detection Limit (ug/g)
Site 5	
Soil Pile silt	29.7
Impound. silt	94.0
Site 6	
P silt	3.30
PM ₁₀	3.30
Q silt	1.58
PM ₁₀	1.75
X silt	62.9
Y silt	0.33
Site 7	
S silt	62.1
PM ₁₀	19.6
>PM ₁₀	39.6
S-QA	1.7 to 34.4
T silt	26.4
PM ₁₀	46.2
V silt	4.0
W silt	3.3

Table 2.23. Analytical Results for Semivolatile Organic HSL Compounds, Site 1

Gel Permeation Cleanup				Lift	Impound.			Dirt	Background	
Sample Identity	Active Lift			Access Rd.	Dry Surface Impoundment			Access Rd.	Roadway	Sample
	Silt A-150	>PM-10 A-156	PM-10 A-154	Silt D-174	Silt B-164	>PM10 B-167	PM-10 B-166	Silt E-177	Silt C-171	Silt BGD-190
Compounds	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Benzo(a)pyrene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2.3 J	N.D.	N.D.	N.D.
bis(2-ethylhexyl)phthalate	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	32.0	N.D.	N.D.
2-Chlorophenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	16.0	N.D.	N.D.
Chrysene	N.D.	N.D.	N.D.	N.D.	5.0 J	6.5 J	7.6 J	N.D.	N.D.	N.D.
Fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.	1.9 J	N.D.	N.D.	N.D.	N.D.
Fluorene	2.5 J	N.D.	2.3 J	N.D.	2.2 J	2.5 J	N.D.	N.D.	N.D.	N.D.
2-Methylnapthalene	8.1 J	3.2 J	N.D.	1.2 J	2.0 J	3.3 J	2.7 J	N.D.	N.D.	N.D.
Phenanthrene	8.1 J	6.3 J	9.7 J	6.6 J	13.0 J	12.0 J	14.0 J	7.6 J	2.1 J	N.D.
Pyrene	N.D.	N.D.	N.D.	N.D.	4.3 J	4.9 J	N.D.	N.D.	N.D.	N.D.

N.D. = less than quantifiable detection limit of 19.8 ug/g

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable detection limit.

LH-20 Cleanup				Lift				Impound.		Dirt	Background
Sample Identity	Active Lift			Access Rd.	Dry Surface Impoundment			Access Rd.	Roadway	Sample	
	Silt	>PM-10	PM-10	Silt	Silt	>PM10	PM-10	Silt	Silt	Silt	
	A-150	A-156	A-154	D-174	B-164	B-167	B-166	E-177	C-171	BGD-190	
Compounds	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	
Anthracene	N.D.	N.D.	N.D.	N.D.	N.D.	1.200 J	N.D.	N.D.	N.D.	N.D.	
Benzo(a)anthracene	0.340 J	0.340 J	0.320 J	0.660 J	2.200 J	2.400 J	1.800 J	1.000 J	N.D.	N.D.	
Benzo(b)fluoranthene	N.D.	0.580 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
Benzo(a)pyrene	N.D.	0.350 J	N.D.	N.D.	1.500 J	N.D.	N.D.	N.D.	N.D.	N.D.	
bis(2-ethylhexyl)phthalate	N.D.	N.D.	0.770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.110 J	
Butylbenzylphthalate	N.D.	0.140 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.069 J	
Chrysene	0.610	0.640 J	0.650	2.300	6.500	7.600	N.D.	4.600	1.500	N.D.	
Di-n-butylphthalate	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	3.700 J	N.D.	0.520	
2-Methylnapthalene	1.400	4.100	1.800	0.780 J	3.400 J	3.400 J	N.D.	N.D.	0.170 J	N.D.	
4-Methylphenol	0.310 J	N.D.	0.320 J	N.D.	N.D.	N.D.	N.D.	N.D.	0.070 J	N.D.	
Napthalene	0.570	0.210 J	0.150 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
Phenanthrene	7.800	8.200	7.500	4.500	12.000	13.500	10.000	6.000	2.500	N.D.	
Phenol	0.097 J	N.D.	0.280 J	N.D.	N.D.	N.D.	N.D.	N.D.	0.110 J	N.D.	
Pyrene	N.D.	0.890 J	0.600	1.500 J	3.500 J	4.600 J	3.000 J	2.900 J	N.D.	N.D.	
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	
Sample Detection Limit	0.412	0.937	0.472	4.023	5.143	6.650	6.065	4.023	0.455	0.431	

N.D. = less than quantifiable detection limit for the sample

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable detection limit.

Table 2.24. Analytical Results for Semivolatile Organic HSL Compounds, Pesticides, and PCB's, Site 2

Organic Analysis Medium Level Concentration	Active Landfill B-9			Access Rd. Access Rd. in LF B-9 above LF		Stabilization Area			Background Sample
Sample Identity	Silt H-240	>PM-10 H-246	PM-10 H-244	Silt 6-233	Silt F-230	Silt I-252	>PM10 I-258	PM-10 I-256	Silt BGD-249
Compounds	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Phenol	5.5 J	4.7 J	6.6 J	0.8 J	0.6 J	1.4 J	N.D.	1.8 J	N.D.
bis(2-ethylhexyl)phthalate	19.0 J	16.0 J	18.0 J	26.2	4.3 J	22.0	33.0	23.0	N.D.
2-Methylnaphthalene	N.D.	N.D.	N.D.	1.1 J	N.D.	1.1 J	N.D.	N.D.	N.D.
Isophorone	5.6 J	5.6 J	2.8 J	N.D.	N.D.	4.3 J	8.9 J	3.9 J	N.D.
N-nitrosodiphenylamine *	2.5 J	2.5 J	N.D.	N.D.	N.D.	N.D.	3.0 J	N.D.	N.D.
N.D. = Less than the quantifiable detection limit of 19.8 ug/g									
Organic Analysis Low Level Concentration	Active Landfill B-9			Access Rd. Access Rd. in LF B-9 above LF		Stabilization Area			Background Sample
Sample Identity	Silt H-240	>PM-10 H-246	PM-10 H-244	Silt 6-233	Silt F-230	Silt I-252	>PM10 I-258	PM-10 I-256	Silt BGD-249
Phenol	1.70 B	3.70 B	4.40 B	0.88 B	N.D.	0.79 B	1.90 B	1.60 B	0.44 B
4-Methylphenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.39	N.D.	N.D.
Isophorone	1.10	3.20	2.50	2.90	0.17 J	0.59	4.10	1.90	N.D.
2,4-Dimethylphenol	N.D.	N.D.	N.D.	N.D.	N.D.	0.22 J	0.60	0.58	N.D.
1,2,4-Trichlorobenzene	N.D.	0.09 J	0.13 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Naphthalene	0.16 J	0.26 J	0.29 J	0.34	N.D.	N.D.	0.23 J	0.12 J	N.D.
2-Methylnaphthalene	0.31 J	0.56	0.70	0.73	N.D.	0.20 J	0.71	0.43	N.D.
2,4-Dinitrotoluene	N.D.	N.D.	N.D.	0.67	N.D.	1.10	1.60	0.63	N.D.
Diethylphthalate	N.D.	0.18 J	0.48	N.D.	0.15 J	N.D.	N.D.	N.D.	0.15 J
Fluorene	N.D.	0.11 J	0.28 J	N.D.	N.D.	N.D.	N.D.	0.11 J	N.D.
N-nitrosodiphenylamine (1)	N.D.	N.D.	0.19 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Phenanthrene	0.18 J	0.34	0.50	0.47	0.18 J	N.D.	0.62	N.D.	N.D.
Anthracene	N.D.	N.D.	0.06 J	N.D.	N.D.	0.68	N.D.	N.D.	N.D.
Di-n-butylphthalate	0.09 J	0.10 J	0.12 J	N.D.	0.23 J	N.D.	N.D.	N.D.	N.D.
Fluoranthene	N.D.	0.11 J	0.16 J	N.D.	0.10 J	N.D.	0.44	0.36	N.D.
Pyrene	0.07 J	0.12 J	0.19 J	0.19 J	0.11 J	0.39	0.31 J	0.22 J	N.D.
Butylbenzylphthalate	0.90	1.50	1.60	0.89	1.2	N.D.	0.79	0.34	N.D.
Benzo(a)anthracene	N.D.	N.D.	N.D.	0.10 J	N.D.	N.D.	0.12 J	0.11 J	N.D.
Bis(2-ethylhexyl)phthalate	0.81	N.D.	1.10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chrysene	N.D.	N.D.	N.D.	N.D.	0.12 J	N.D.	0.25 J	0.21 J	N.D.
Di-n-octylphthalate	N.D.	N.D.	1.70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pesticides									
Toxaphene	N.A.	N.A.	N.A.	N.A.	N.A.	6.50	8.40	5.90	N.A.
Sample Detection Limit (ug/g)									
Semivolatile Organics	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Toxaphene	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76

B = Compound found in method blank at a concentration higher than the QC limit

N.A. = Sample not analyzed for pesticides

N.D. = Less than the sample's quantifiable detection limit

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable limit

* = Cannot be separated from Diphenylamine

Table 2.25. Analytical Results for Semivolatile Organic HSL Compounds, Site 3

Organic Analysis	Active Landfill 11-III		Active Landfill 11-I		Background
Sample Identity	Silt J-320	PM10 J-322	Silt K-330	PM10 K-333	Silt 96D-340
Compound	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Phenol	N.D.	3.8 J	1.1	3.1	N.D.
Napthalene	N.D.	N.D.	N.D.	0.06 J	N.D.
Dimethyl-phthalate	N.D.	N.D.	N.D.	0.97 J	N.D.
Fluorene	N.D.	N.D.	N.D.	0.10 J	N.D.
Phenanthrene	N.D.	15.0	0.17 J	N.D.	N.D.
Pyrene	N.D.	1.3 J	0.27 J	0.90	N.D.
Di-n-octylphthalate	N.D.	N.D.	0.74 B	N.D.	0.2 JB
Benzo(a)anthracene	N.D.	N.D.	0.07 J	0.17 J	N.D.
bis(2-ethylhexyl)phthalate	N.D.	N.D.	N.D.	0.19 J	N.D.
Di-n-octylphthalate	N.D.	N.D.	0.48	N.D.	N.D.
Chrysene	N.D.	N.D.	N.D.	0.40	N.D.
Sample Detection Limit (ug/g)	4.9	7.2	0.33	0.33	0.33

N.D. = less than quantifiable detection limit for the sample

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable detection limit.

B = compound detected in method blank as well as sample

Table 2.26. Analytical Results for Semivolatile Organic HSL Compounds, Site 4

Semivolatile Analysis	Land Treatment Cell #8		Cell #4	Cell #3	Roads	Background
Sample Identity	Silt N-447	PM10 N-449	Silt L-434	Silt O-457	Silt M-439	Silt 806-454
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
2-Methylnapthalene	N.D.	N.D.	N.D.	45.0 J	15.0 J	1.4 J
Phenanthrene	N.D.	N.D.	N.D.	22.0 J	36.0 J	0.93 J
Pyrene	N.D.	N.D.	10.0 J	9.5 J	11.0 J	N.D.
Sample Detection Limit	78.6	49.5	54.4	95.6	61.2	3.3

N.D. = less than the sample's quantifiable detection limit

J = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit.

Table 2.27. Analytical Results for Semivolatile Organic HSL
Compounds, Site 5

Organic Analysis	Soil Storage, RCRA Pond	Pond Bottoms
Sample Identity	50 Silt	60 Silt
Compound	(ug/g)	(ug/g)
Napthalene	120	240
2-Methylnapthalene	300	670
Acenapthylene	8.4 J	38.0 J
Acenapthene	680	2,800
Dibenzofuran	420	1,500
Fluorene	650	2,600
Phenanthrene	710	4,800
Anthracene	480	2,300
Fluoranthene	370	2,600
Pyrene	290	2,100
Benzo(a)anthracene	170	790
Chrysene	160	850
Benzo(k)fluoranthene	6.1 J	480
Benzo(a)pyrene	59.0	280
Indeno(1,2,3-cd)pyrene	21.0 J	120
Dibenz(a,h)anthracene	N.D.	30 J
Benzo(g,h,i)perylene	15.0 J	89 J
Sample Detection Limit	29.7	94.0

N.D. = less than the samples detection limit.

J = Estimated value where the compound meets the mass spectral

Table 2.28. Analytical Results for Semivolatile Organic HSL Compounds, Pesticides, and PCB's Site 6

Semivolatile Analysis	Cell A, Acid Wastes		Cell Q, Filter Cake		Cell C, Metal Catalyst Land Treat.		Road	Background	
Sample Identity	Silt P-540	PM10 P-542	Silt Q-550	PM10 Q-552	Silt R-560	PM10 R-562	Silt Y-580	Silt Y-595	Silt BGD-570
Compound	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
2-Methylnaphthalene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.23 J	N.D.
Acenaphthene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.23 J	N.D.
Acenaphthylene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.12 J	N.D.
Anthracene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.06 J	N.D.
Benzo(a)anthracene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.11 J	N.D.
Benzo(b)fluoranthene	N.D.	N.D.	N.D.	0.25 J	N.D.	N.D.	N.D.	0.13 J	N.D.
Bis(2-ethylhexyl)phthalate	N.D.	N.D.	N.D.	N.D.	N.D.	3.10 J	N.D.	N.D.	N.D.
Butylbenzylphthalate	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.13 J	N.D.
Chrysene	N.D.	N.D.	0.21 J	0.21 J	N.D.	N.D.	22.0 J	0.34	N.D.
Di-n-butylphthalate	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1.50	N.D.
Di-n-octylphthalate	N.D.	N.D.	N.D.	0.44 J	N.D.	2.60 J	10.0 J	N.D.	N.D.
Fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.48	N.D.
Napthalene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.04 J	N.D.
Phenanthrene	N.D.	0.37 J	N.D.	N.D.	N.D.	N.D.	27.0 J	1.50	N.D.
Phenol	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.04 J	N.D.
Pyrene	N.D.	N.D.	0.19 J	0.23 J	N.D.	N.D.	47.0 J	1.10	N.D.
Sample Detection Limit Semivolatile Compounds	3.30	3.30	1.58	1.75	3.30	3.30	62.9	0.33	0.33

Pesticide Analysis	Cell A, Acid Wastes		Cell Q, Filter Cake		Cell C, Metal Catalyst Land Treat.		Road	Background	
Sample Identity	Silt P-540	PM10 P-542	Silt Q-550	PM10 Q-552	Silt R-560	PM10 R-562	Silt Y-580	Silt Y-595	Silt BGD-570
Compound	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aroclor-1254	1.00	1.30	N.D.	N.D.	N.D.	N.D.	-	-	-
Sample Detection Limit Aroclor-1254	0.16	0.16	0.16	0.16	0.16	0.16	-	-	-

N.D. = less than the sample's quantifiable detection limit

J = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit.

Table 2.29. Analytical Results for Semivolatile Organic HSL Compounds, Pesticides, and PCB's Site 7

Organic Analysis	Landfill Cell #1			Stabilization Area #7		Land Treatment Cells				
						118-121	R32-R35	Roadway Background		
Sample Identity	Silt	PM10	>PM10	Silt	PM10	Silt	PM10	Silt	Silt	Silt
	S-636	S-638	S-640	T-646	T-648	U-653	U-656	V-660	W-667	86D-643
Semivolatile Compound	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Acenaphthene	N.D.	N.D.	N.D.	21.0	25.0	N.D.	N.D.	N.D.	1.2	N.D.
Anthracene	32.0 J	32.0	26.0 J	20.0	29.0	N.D.	N.D.	7.2	1.1	N.D.
Benzo(a)anthracene	N.D.	13.0 J	N.D.	3.1 J	4.5	N.D.	N.D.	N.D.	1.1	N.D.
Benzo(a)pyrene	N.D.	4.4 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo(b)fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1.3	N.D.
Benzo(k)fluoranthene	N.D.	N.D.	N.D.	1.3 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Bis(2-ethylhexyl)phthalate	N.D.	6.4 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chrysene	12.0 J	18.0 J	11.0 J	3.9 J	5.7	6.4 J	14.0 J	1.5 J	3.3	N.D.
Dibenzofuran	25.0 J	18.0 J	N.D.	14.0	N.D.	N.D.	N.D.	0.44 J	1.7	N.D.
Fluoranthene	54.0 J	62.0	39.0 J	23.0	23.0	N.D.	N.D.	N.D.	12.0	N.D.
Fluorene	N.D.	N.D.	N.D.	5.3 J	14.0	N.D.	N.D.	N.D.	2.4	N.D.
2-Methylnapthalene	120	62.0	89.0	30.0	31.0	3.2 J	5.6 J	18.0	1.4	N.D.
2-Methylphenol	N.D.	N.D.	N.D.	0.7 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
4-Methylphenol	N.D.	N.D.	N.D.	2.3 J	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Napthalene	31.0 J	9.4 J	17.0 J	27.0	14.0	N.D.	N.D.	2.0 J	N.D.	N.D.
Phenanthrene	150	140	120	50.0	36.0	22.0 J	46.0	N.D.	22.0	N.D.
Phenol	60.0 J	30.0	43.0	N.D.	3.0 J	N.D.	N.D.	N.D.	N.D.	N.D.
Pyrene	44.0 J	59.0	34.0 J	18.0	21.0	8.5 J	18.0 J	1.9 J	7.7	N.D.
Sample Detection Limit	62.1	19.6	39.6	5.0	3.8	26.4	46.2	4.0	3.3	0.33

N.D. = Less than the sample's quantifiable detection limit

J. = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit.

comparison was made by calculating the relative percent difference (RPD) of the concentration of the compound in the PM_{10} and $>PM_{10}$ fractions relative to the silt. The calculated RPD's for the fractions are shown in Tables 2.30 to 2.36. Bar graphs were constructed to illustrate the RPD of particle size contamination for each process are shown in Figure 2.1 to 2.24. The bar graphs for each process are presented after the corresponding table containing the calculated RPD's.

The particle size dependency of the degree of contamination for the metals and semivolatile compounds was assessed by a simple statistical model based on the binomial distribution. The ratio of contamination in the PM-10 fraction to the silt fraction was calculated. The ratio was assumed to have an equal probability of being greater than one or less than or equal to one. For each metal and semivolatile compound, the total number of samples considered and the total number of samples with a ratio greater than one were determined. The probabilities of the distribution for samples with ratios greater than one were calculated for the elements and semivolatile compounds listed in Table 2.37.

Of the eight RCRA metals, arsenic, barium, cadmium, lead, and mercury showed significant concentration on the smaller particles. Of the HSL semivolatile compounds, only phenol showed significant concentration on the smaller particles. For the remaining compounds with PM-10 to silt ratios greater than one, there was a high probability that the distributions were random. A process-specific effect such as the soil type or silt pH has influenced the particle size dependency of the contamination.

The PM_{10} and $>PM_{10}$ fractions for a process were derived from the same silt aliquot while the silt fraction for that process came from a different aliquot. This may explain why some of the RPD's for both the PM_{10} fraction and the $>PM_{10}$ fraction are negative. The relative difference between the two fractions can still be used to indicate a particle size dependency of the degree of contamination.

2.4 REPEATABILITY, REPRODUCIBILITY, AND PERFORMANCE AUDITS

A significant portion of this project was designed to provide information on the repeatability (within-laboratory) and reproducibility (between-laboratory) (R&R) of both the analytical phase and the overall sampling and analytical phases. For R&R sampling purposes, three different types of TSDF processes at three different TSDF sites were selected. The processes selected were sampled first using the normal sampling procedures of preparing a sampling

Table 2.30. RPD of Contamination for PM10 and >PM10 Compared to Silt (Processes A and B), Site 1

Metals Analysis	Active Lift					Dry Surface Impoundment				
	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD
Elements	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)	
Aluminum (Al)	21,900	21,300	-2.32%	18,500	-16.38%	29,200	25,900	-11.99%	26,600	-9.32%
Arsenic (As)	8.3	9.2	10.29%	8.3	0.00%	15.3	20.4	28.57%	10.5	-37.21%
Barium (Ba)	957	215	-126.62%	846	-12.31%	955	950	-0.52%	950	-0.52%
Beryllium (Be)	4.4	0.9	-132.08%	3.1	-34.67%	2.4	1.9	-23.26%	1.6	-40.00%
Cadmium (Cd)	5.5	8.0	37.04%	4.2	-26.80%	33.2	36.5	9.47%	31.5	-5.26%
Chromium (Cr)	223	154	-36.60%	219	-1.81%	245	344	33.62%	224	-8.96%
Cobalt (Co)	21.2	20.7	-2.39%	18.3	-14.68%	12.2	11.7	-4.18%	11.5	-5.91%
Copper (Cu)	3570	10400	97.78%	2380	-40.00%	1090	1360	22.04%	1010	-7.62%
Iron (Fe)	27,000	23,300	-14.71%	25,300	-6.50%	20,800	21,100	1.43%	19,600	-5.94%
Lead (Pb)	1030	1780	53.38%	780	-27.62%	3380	3930	15.05%	3270	-3.31%
Manganese (Mn)	533	482	-10.05%	474	-11.72%	392	411	4.73%	368	-6.32%
Mercury (Hg)	0.2	0.4	80.00%	0.4	90.91%	0.4	0.5	11.76%	0.4	0.00%
Nickel (Ni)	173	190	9.37%	159	-8.43%	340	190	-56.60%	148	-78.69%
Selenium (Se)	2.3	1.8	-24.39%	<1	-200.00%	2.4	2.2	-8.70%	1.4	-52.63%
Vanadium (V)	105	106	0.95%	867	156.79%	106	106	0.00%	99.2	-7.64%
Zinc (Zn)	1030	1250	19.30%	966	-6.41%	3270	3850	16.29%	3110	-5.02%
Organic Analysis after Gel Permeation Cleanup	Active Lift					Dry Surface Impoundment				
	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD
Compounds	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)	
Chrysene	N.D.	N.D.	-	N.D.	-	5.0 J	7.6 J	41.27%	6.5 J	26.09%
Fluorene	2.5 J	2.3	-8.33%	N.D.	-	2.2 J	N.D.	-	2.5 J	12.77%
2-Methylnaphthalene	8.1 J	N.D.	-	3.2 J	-86.73%	2.0 J	2.7 J	31.22%	3.3 J	49.06%
Phenanthrene	9.1 J	9.7 J	17.98%	6.3 J	-25.00%	13.0 J	14.0 J	7.41%	12.0 J	-8.00%
Pyrene	N.D.	N.D.	-	N.D.	-	4.3 J	N.D.	-	4.8 J	10.99%
N.D. = less than quantifiable detection limit of 19.9 ug/g										
Organic Analysis after LH-20 Cleanup	Active Lift					Dry Surface Impoundment				
	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD
Compounds	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)	
Benzo(a)anthracene	0.340 J	0.320 J	-6.06%	0.340 J	0.00%	2.200 J	1.800 J	-20.00%	2.400 J	8.70%
Chrysene	0.610	0.650	6.35%	0.640 J	4.80%	6.500	N.D.	-	7.600	15.60%
2-Methylnaphthalene	1.400	1.800	25.00%	4.100	98.19%	3.400 J	N.D.	-	3.400 J	0.00%
4-Methylphenol	0.310 J	0.320 J	3.17%	N.D.	-	N.D.	N.D.	-	N.D.	-
Napthalene	0.570	0.150 J	-116.67%	0.210 J	-92.31%	N.D.	N.D.	-	N.D.	-
Phenanthrene	7.800	7.500	-3.92%	8.200	5.00%	12.000	10.000	-18.18%	13.500	11.76%
Phenol	0.097 J	0.280 J	97.08%	N.D.	-	N.D.	N.D.	-	N.D.	-
Pyrene	N.D.	0.600	-	0.890 J	-	3.500 J	3.000 J	-15.38%	4.600 J	27.16%
Sample Detection Limit	0.412	0.472		0.937		5.143	6.065		6.650	

N.D. = less than quantifiable detection limit for the sample

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable detection limit.

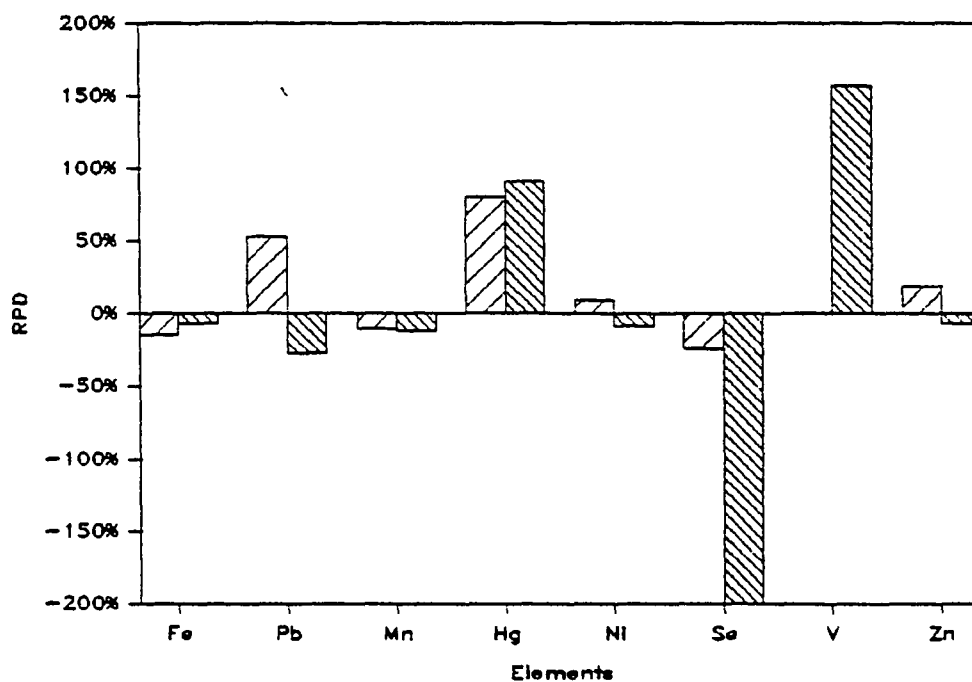
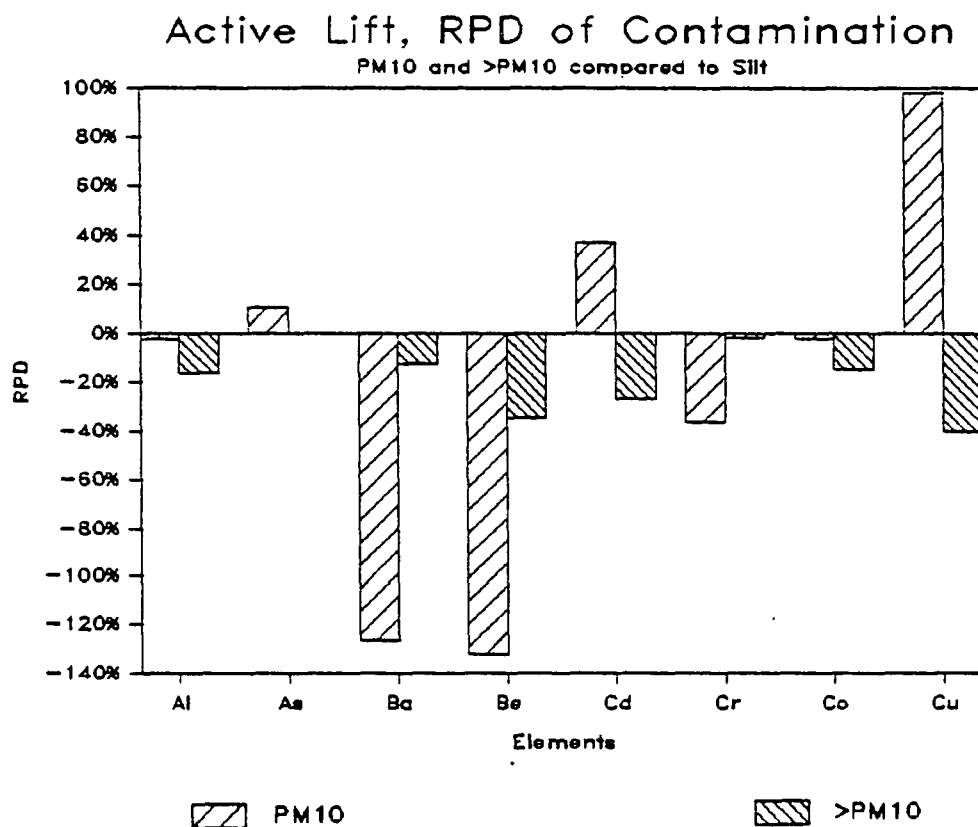


Figure 2.1. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for active lift (Process A) at Site 1.

Surface Impound., RPD of Contamination

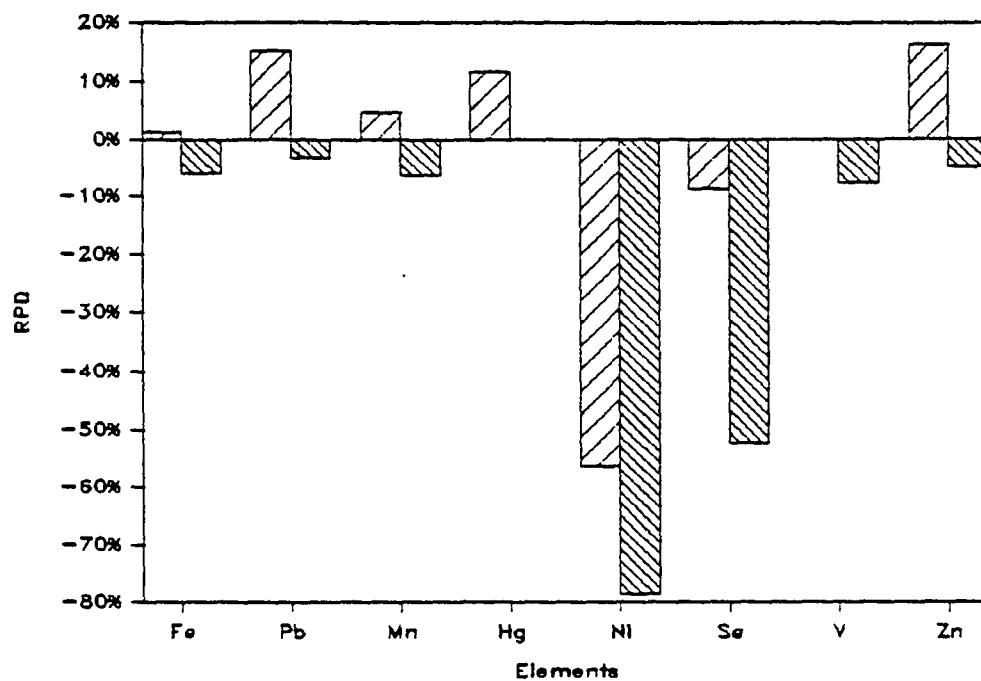
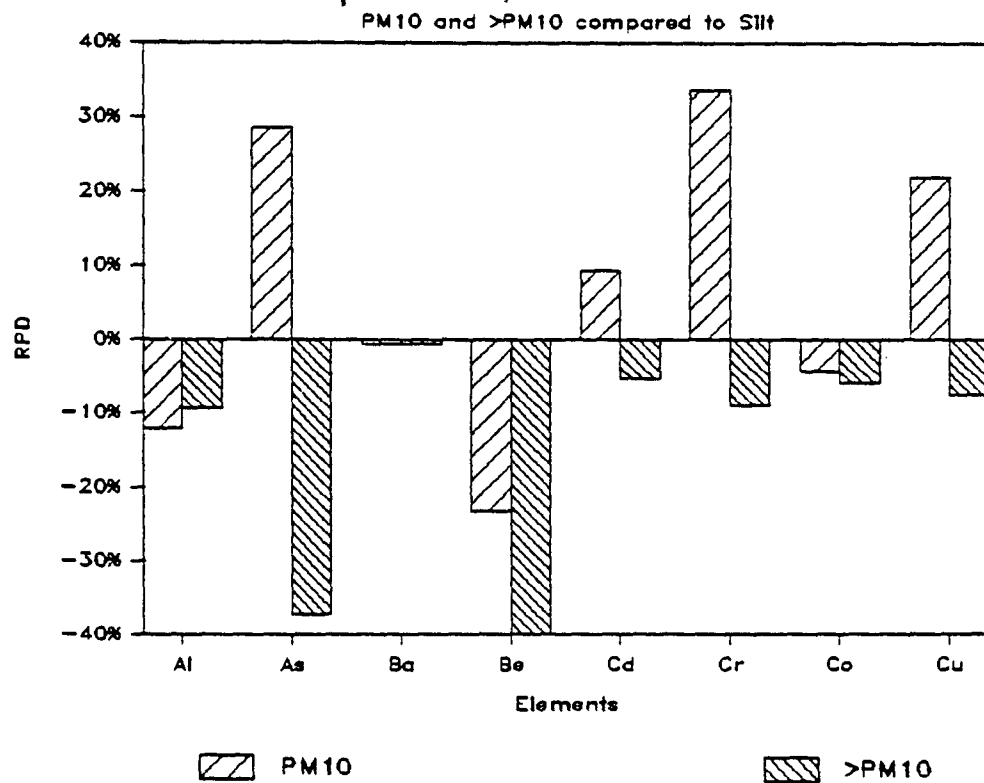


Figure 2.2. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for surface impoundment (Process B) at Site 1.

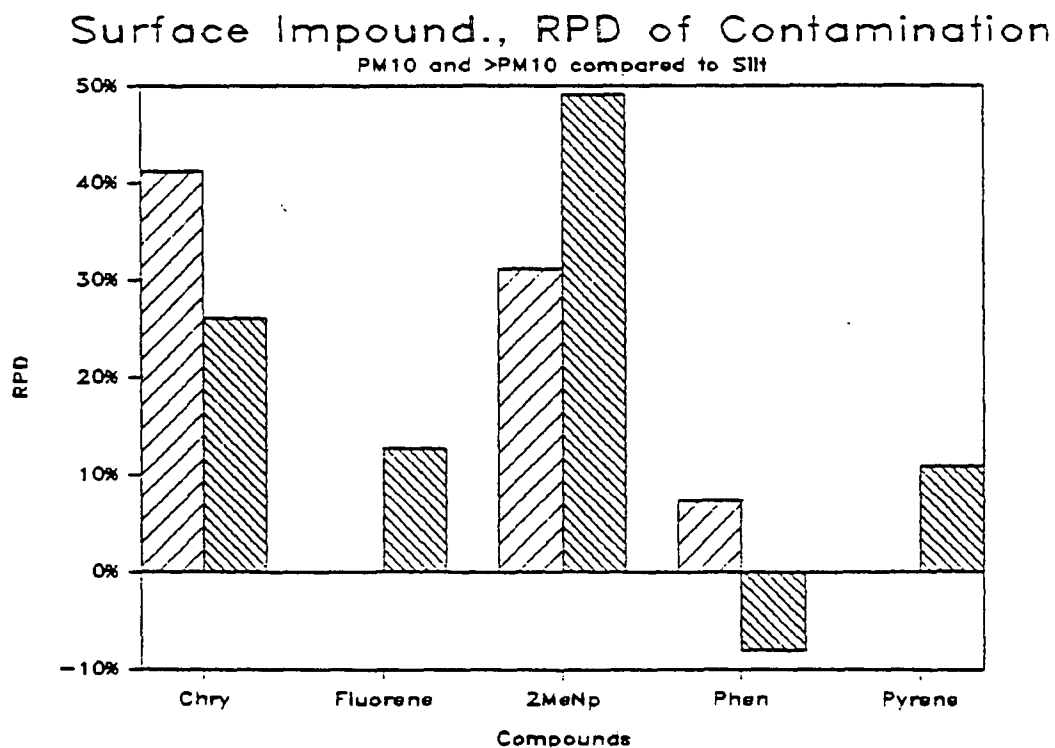
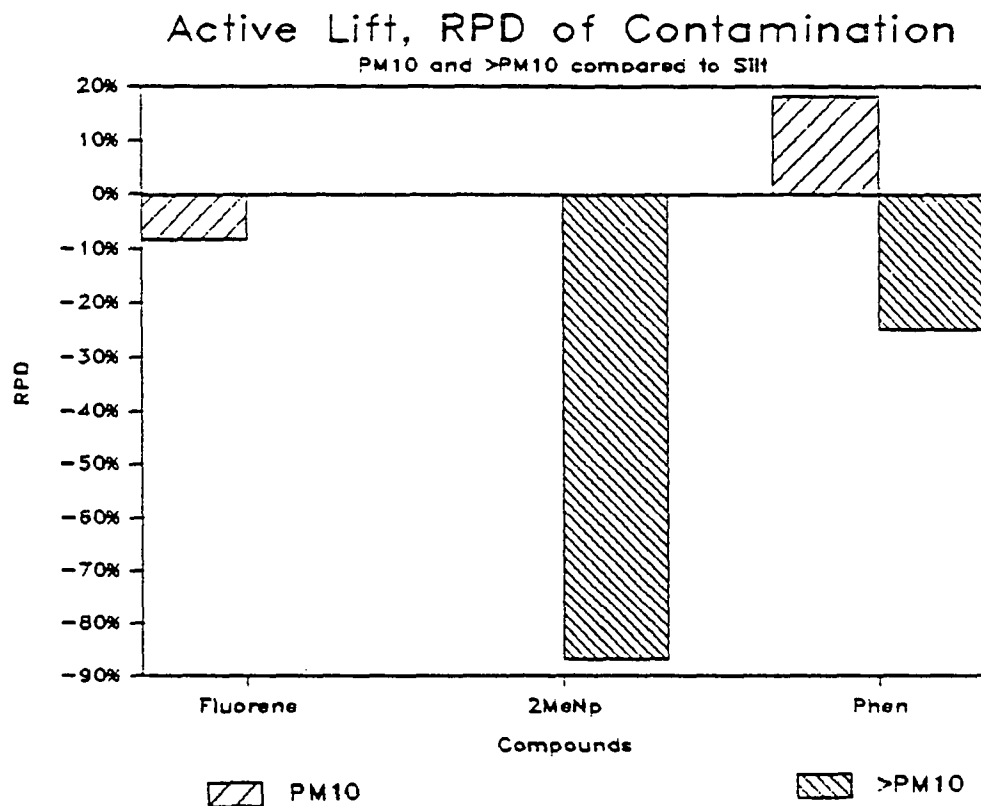


Figure 2.3. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 and >PM10 compared to silt for first analysis of active lift (Process A) and surface impoundment (Process B) at Site 1. (Chry = Chrysene, Phen = Phenanthrene, 2MeNp = 2-Methylnapthalene)

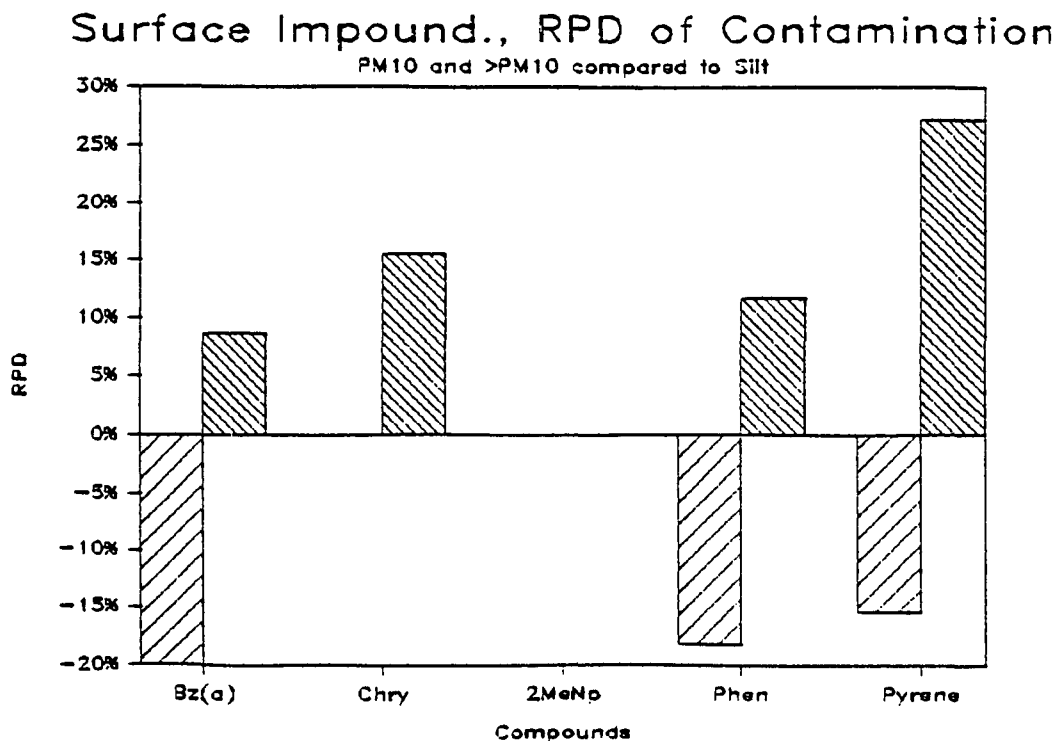
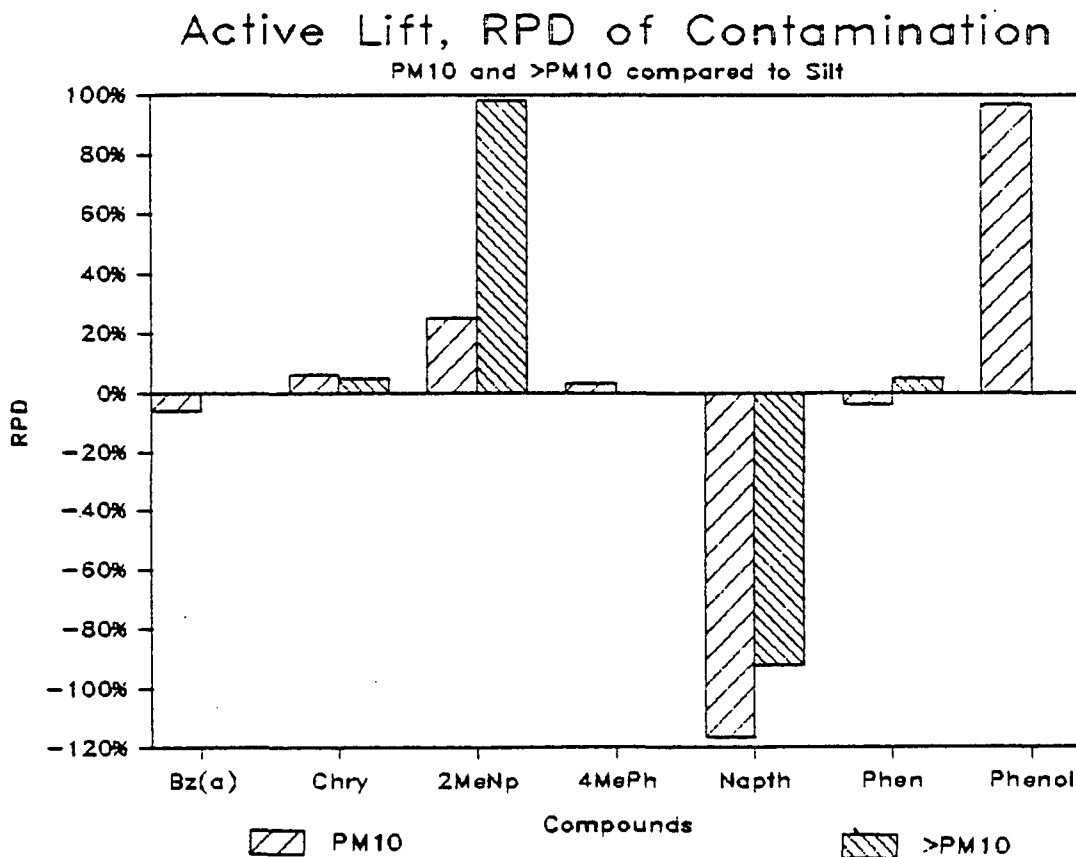


Figure 2.4. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 and >PM10 compared to silt for second analysis of active lift (Process A) and of surface impoundment (Process B) at Site 1. (Chry = Chrysene, Phen = Phenanthrene, 2MeNp = 2-Methylnapthalene, 4MePh = 4-Methylphenol Bz(a) = Benzo(a)anthracene, Napth = Napthalene)

Table 2.31. RPD of Contamination for PM10 and >PM10 Compared to Silt (Processes H and I), Site 2

Metals Analysis	Active Landfill B-9					Stabilization Area				
	Silt	PM10	RPD	>PM10	RPD	Silt	PM-10	RPD	>PM10	RPD
Element	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)	
Aluminum (Al)	27,400	27,500	0.36%	26,100	-4.36%	14,700	13,000	-12.27%	17,600	17.96%
Arsenic (As)	11.1	10.7	-3.67%	7.9	-33.68%	11.3	11.9	5.17%	9.0	-22.66%
Barium (Ba)	366	433	16.77%	336	-8.55%	191	166	-14.01%	218	13.20%
Beryllium (Be)	1.7	1.9	11.11%	1.6	-6.06%	0.7	0.6	-15.38%	0.9	25.00%
Cadmium (Cd)	9.2	15.4	50.41%	7.8	-16.47%	2.1	2.2	4.65%	2.3	9.09%
Chromium (Cr)	138	161	15.38%	125	-9.89%	67.4	60.6	-10.63%	72.9	7.84%
Cobalt (Co)	22.4	22.1	-1.35%	22.3	-0.45%	8.5	5.9	-36.11%	11.4	29.15%
Copper (Cu)	146	202	32.18%	120	-19.55%	109	114	4.48%	101	-7.62%
Iron (Fe)	30,500	31,700	3.86%	29,500	-3.33%	11,700	9,400	-21.80%	15,200	26.02%
Lead (Pb)	534	806	40.60%	400	-28.69%	114	117	2.50%	101	-12.09%
Manganese (Mn)	768	938	19.93%	671	-13.48%	468	477	1.90%	470	0.43%
Mercury (Hg)	0.6	0.7	16.67%	0.4	-44.44%	0.8	0.8	0.00%	0.8	0.00%
Nickel (Ni)	112	118	5.22%	106	-5.50%	34.9	28.6	-19.94%	43.0	20.80%
Vanadium (V)	79.9	73.9	-7.80%	78.6	-1.64%	43.3	39.1	-10.19%	55.5	24.70%
Zinc (Zn)	2,110	3,450	48.20%	1,520	-32.51%	232	242	4.22%	215	-7.61%
cyanide	3.3	5.5	49.04%	2.0	-48.79%	5.5	10.0	58.47%	2.7	-66.93%

Organic Analysis at Medium Level Concentration	Active Landfill B-9					Stabilization Area				
	Silt	PM10	RPD	>PM10	RPD	Silt	PM-10	RPD	>PM10	RPD
Compounds	(ug/g)	(ug/g)		(ug/g)	(ug/g)	(ug/g)	(ug/g)		(ug/g)	
Phenol	5.5 J	6.6 J	18.18%	4.7 J	-15.69%	1.4 J	1.8 J	25.00%	N.D.	-
bis(2-ethylhexyl)phthalate	19.0 J	18.0 J	-5.41%	16.0 J	-17.14%	22.0	23.0	4.44%	33.0	40.00%
Isophorone	5.6 J	2.8 J	-66.67%	5.6 J	0.00%	4.3 J	3.9 J	-9.76%	8.9 J	69.70%
N-nitrosodiphenylamine +	2.5 J	N.D.	-	2.5 J	0.00%	N.D.	N.D.	-	3.0 J	-

N.D. = Less than the quantifiable detection limit of 19.9 ug/g

Organic Analysis at Low Level Concentration	Active Landfill B-9					Stabilization Area				
	Silt	PM10	RPD	>PM10	RPD	Silt	PM-10	RPD	>PM10	RPD
Isophorone	1.10	2.50	77.78%	3.20	97.67%	0.59	1.90	105.22%	4.10	149.68%
2,4-Diaethylphenol	N.D.	N.D.	-	N.D.	-	0.22 J	0.58	90.00%	0.60	92.68%
Napthalene	0.16 J	0.29 J	57.78%	0.26 J	47.62%	N.D.	0.12 J	-	0.23 J	-
2-Methylnapthalene	0.31 J	0.70	77.23%	0.56	57.47%	0.20 J	0.43	73.02%	0.71	112.09%
2,4-Dinitrotoluene	N.D.	N.D.	-	N.D.	-	1.10	0.63	-54.34%	1.60	37.04%
Phenanthrene	0.18 J	0.50	94.12%	0.34	61.54%	N.D.	N.D.	-	0.62	-
Anthracene	N.D.	0.06 J	-	N.D.	-	0.68	N.D.	-	N.D.	-
Di-n-butylphthalate	0.09 J	0.12 J	24.30%	0.10 J	2.11%	N.D.	N.D.	-	N.D.	-
Pyrene	0.07 J	0.19 J	94.57%	0.12 J	55.32%	0.39	0.22 J	-55.74%	0.31 J	-22.86%
Butylbenzylphthalate	0.90	1.60	56.00%	1.50	50.00%	N.D.	0.34	-	0.79	-
Bis(2-ethylhexyl)phthalate	0.91	1.10	30.27%	N.D.	-	N.D.	N.D.	-	N.D.	-
Toxaphene	N.A.	N.A.	-	N.A.	-	6.50	5.90	-9.68%	8.40	25.50%

N.A. = Sample not analyzed for pesticides

N.D. = Less than the sample's quantifiable detection limit

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable limit

+ = Cannot be separated from Diphenylamine

Active Landfill, RPD of Contamination

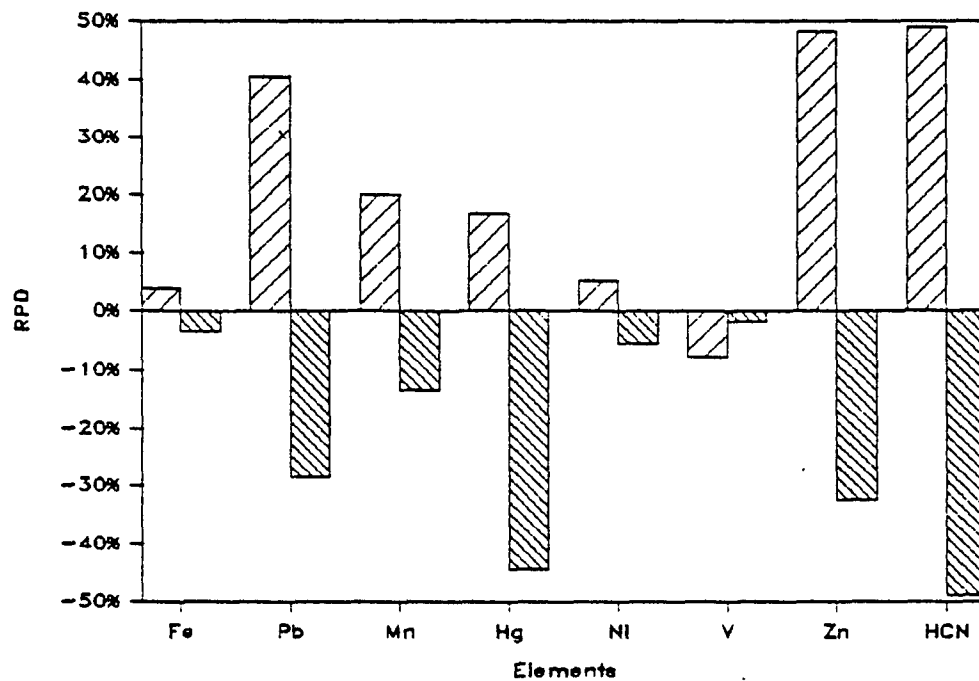
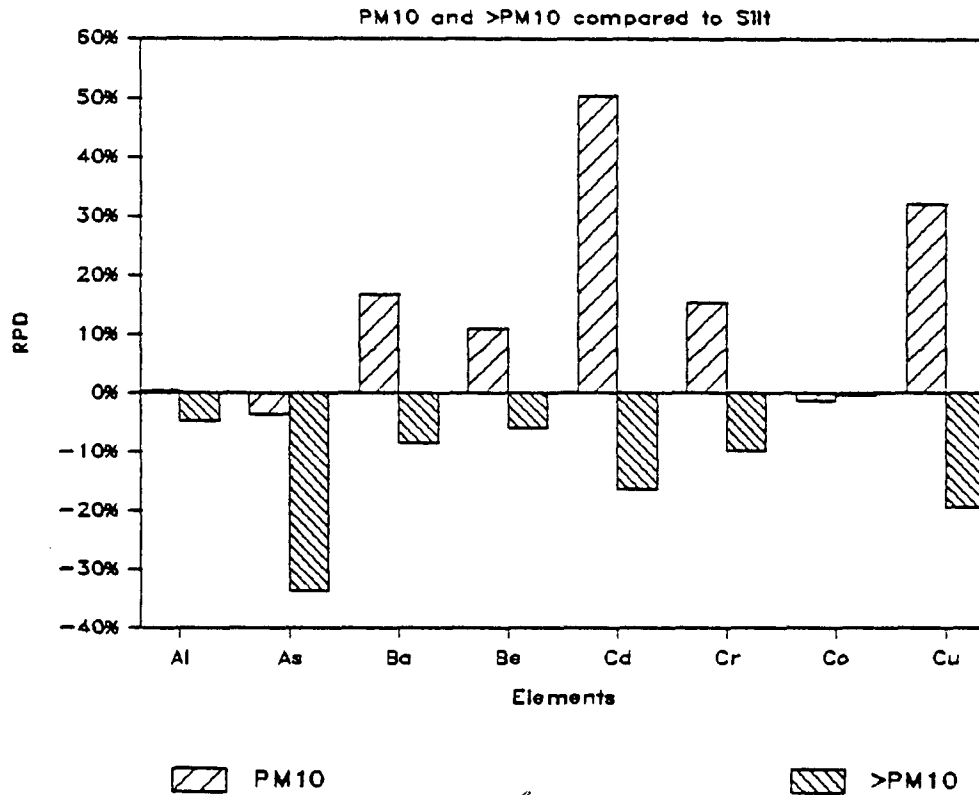


Figure 2.5. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for active landfill (Process H) at Site 2.

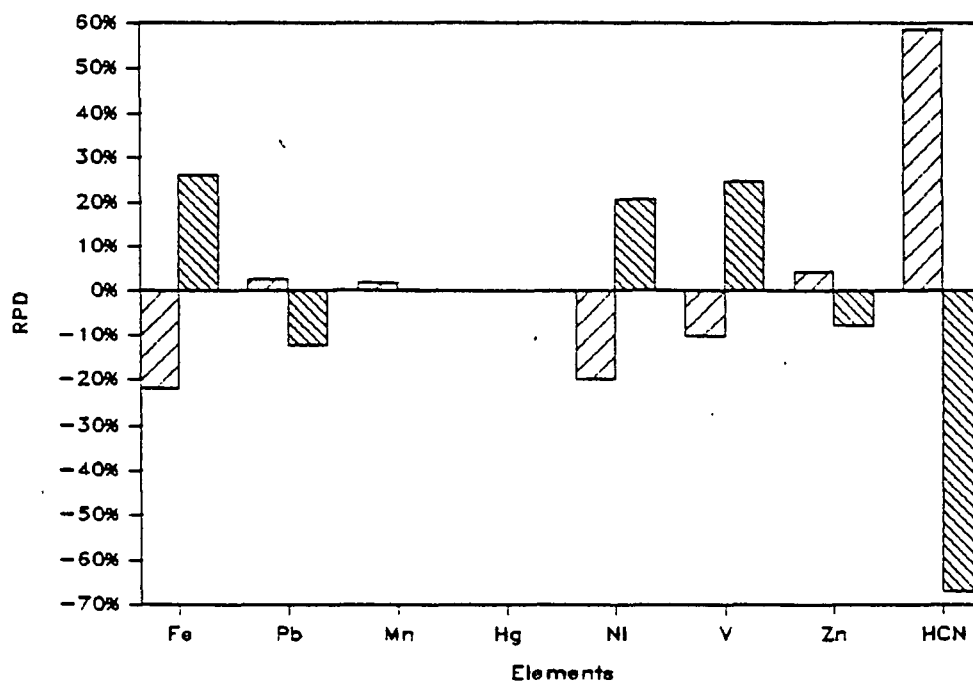
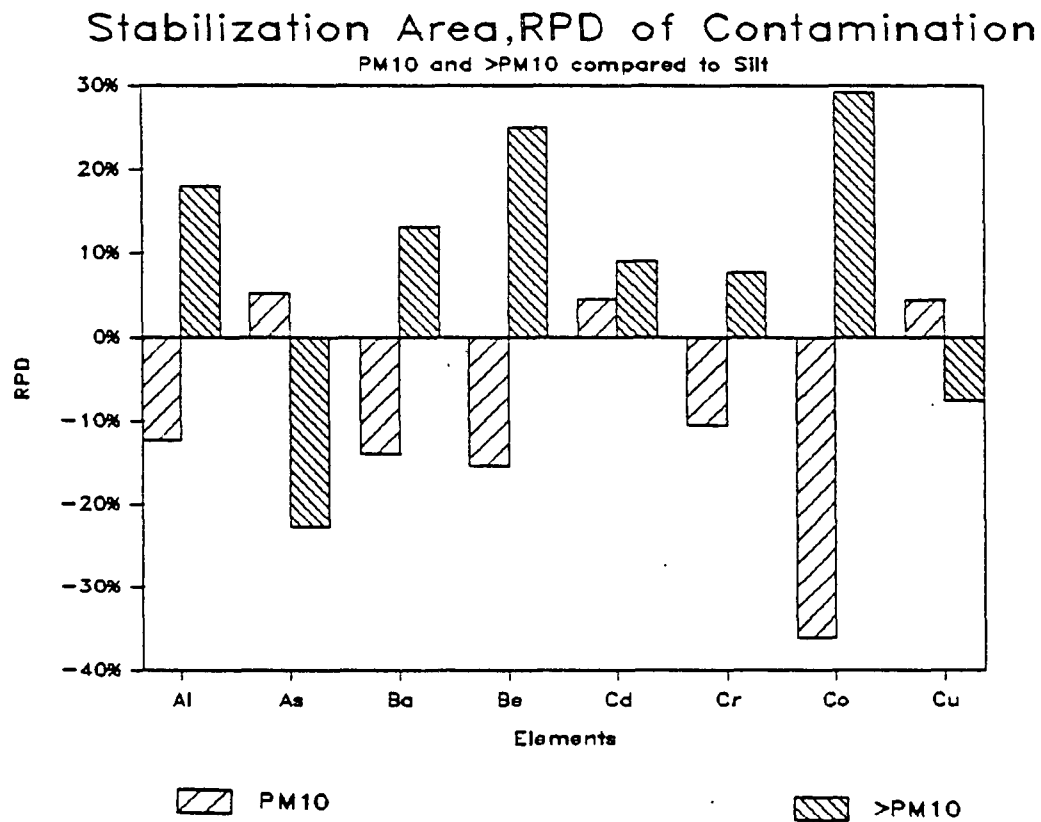


Figure 2.6. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for stabilization area (Process I) at Site 2.

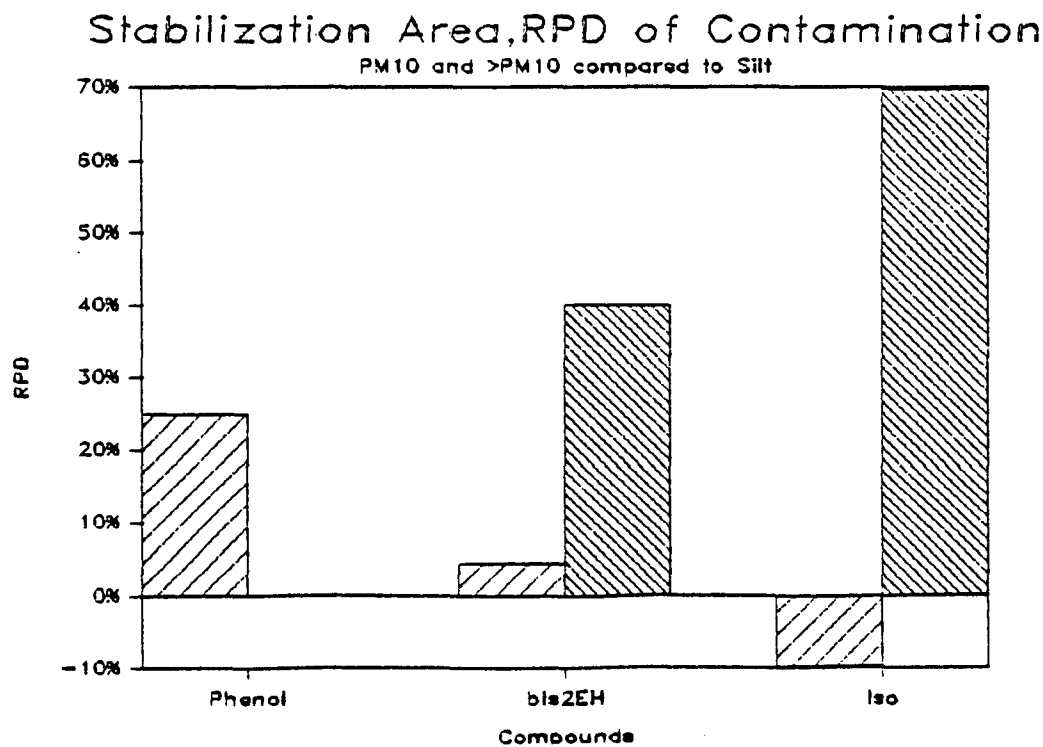
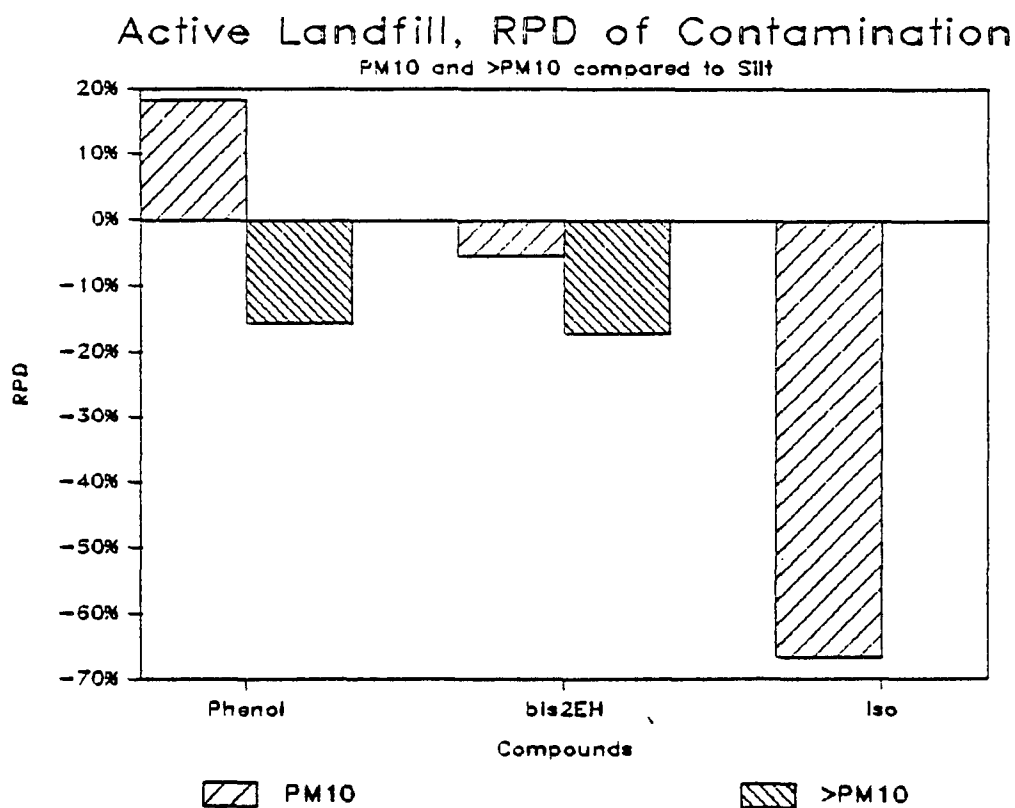


Figure 2.7. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 and >PM10 compared to silt for first analysis of active landfill (Process H) and stabilization area (Process I) at Site 2. (bis2EH = bis(2-Ethylhexyl)phthalate, Iso = Isophorone)

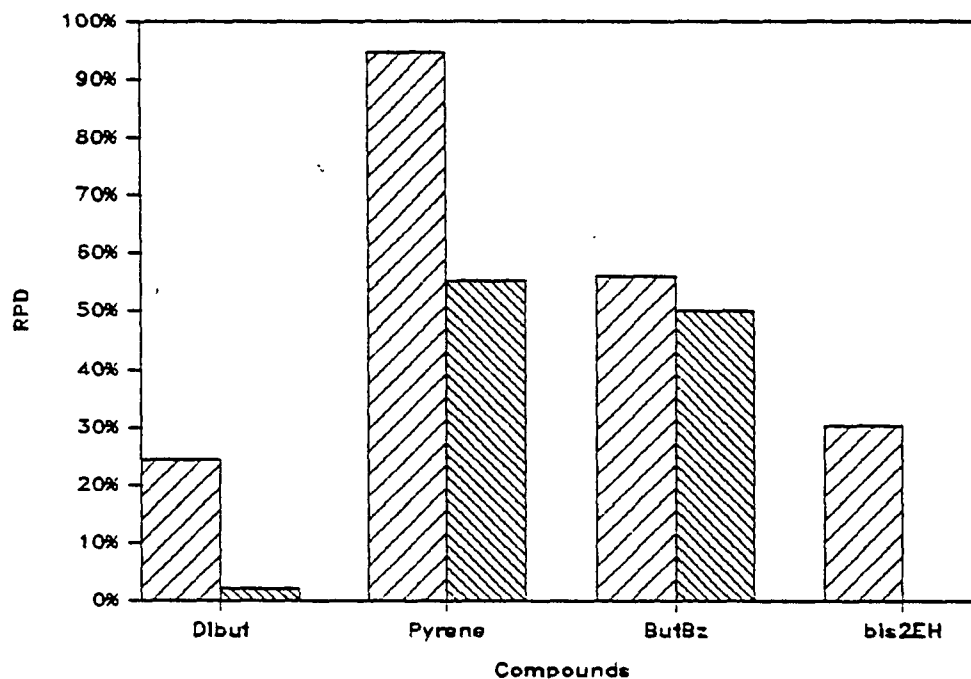
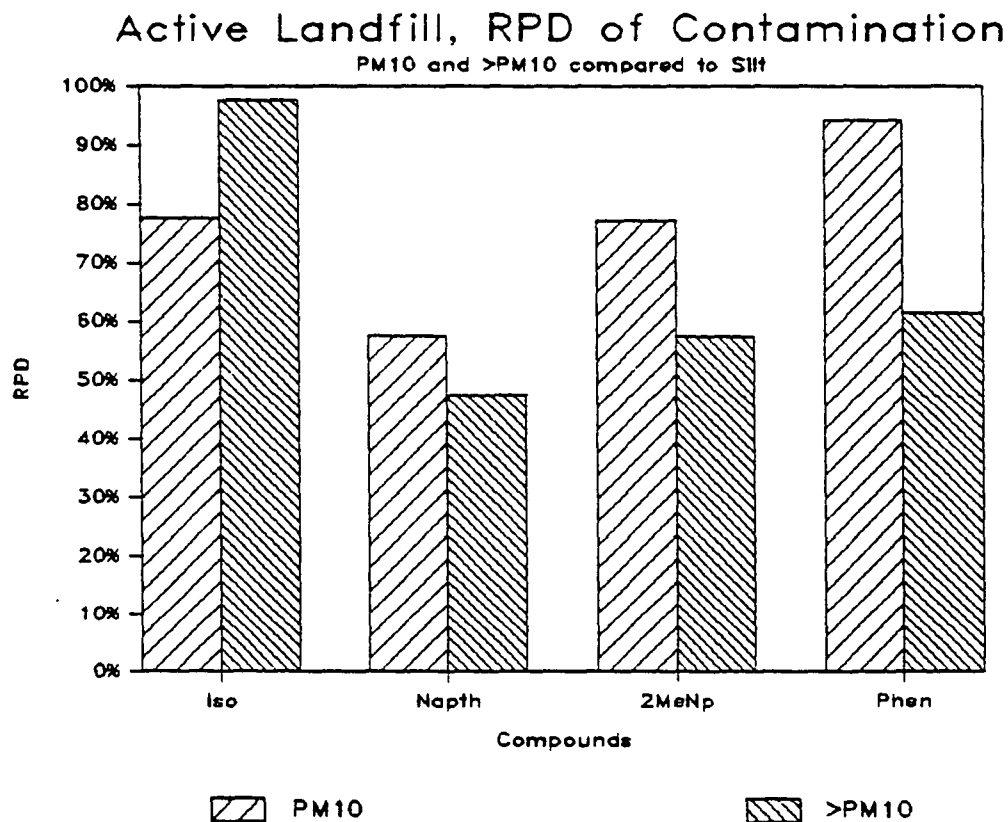


Figure 2.8. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 and >PM10 compared to silt for second analysis of active landfill (Process H) at Site 2. (Iso = Isophorone, Napth = Napthalene, 2MeNp = 2-Methylnapthalene, Phen = Phenanthracene, Dibut = Di-n-butylphthalate, ButBz = Butylbenzylphthalate, bis2EH = bis(2-Ethylhexyl)-phthalate)

Stabilization Area, RPD of Contamination

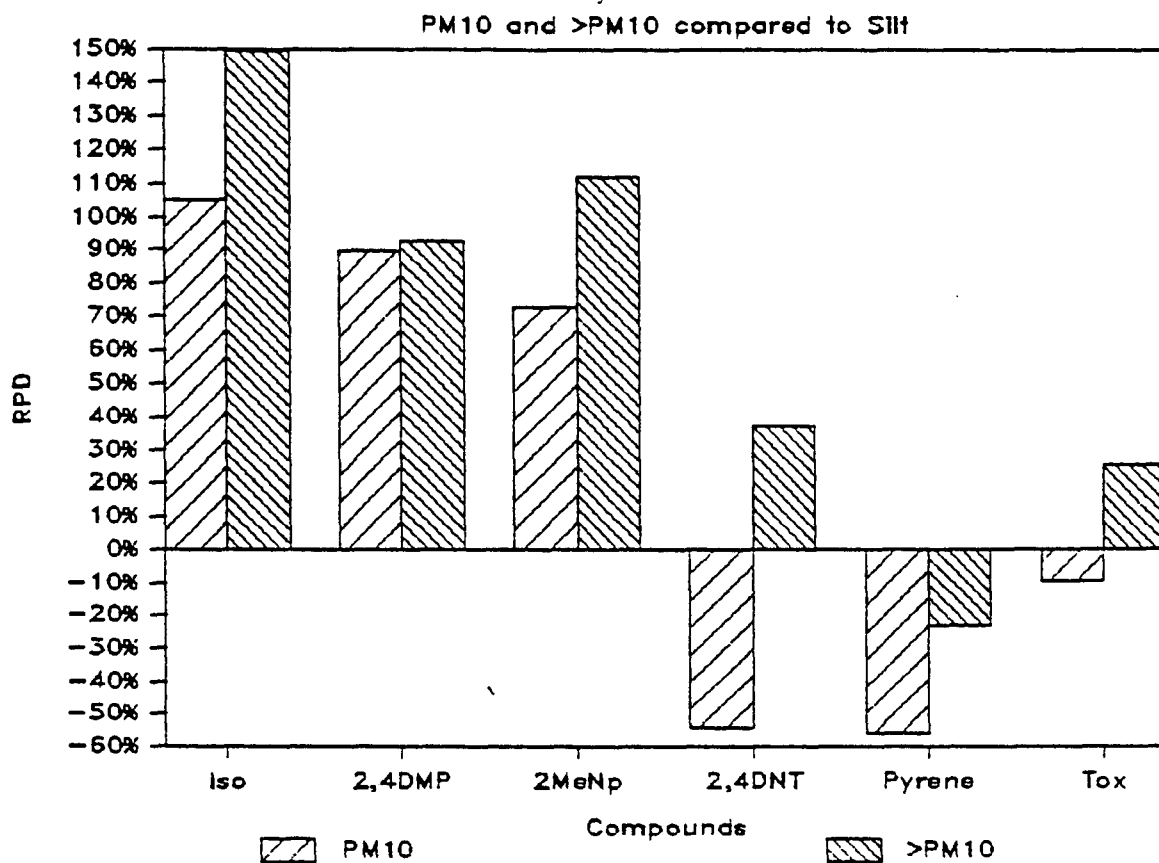


Figure 2.9. Bar graph of RPD of semivolatile organic HSL compound and pesticide contamination for PM10 and >PM10 compared to silt for second analysis of stabilization area (Process I) at Site 2. (Iso = Isophorone, 2,4DMP = 2,4-Dimethylphenol, 2MeNp = 2-Methylnaphthalene, 2,4DNT = 2,4-Dinitrotoluene, Tox = Toxaphene)

Table 2.32. RPD of Contamination for PM10 and >PM10 Compared to Silt (Processes J and K), Site 3

Metals Analysis		Active Landfill 11-III					Active Landfill 11-I				
Sample Identity		Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD
Element		(ug/g)	(ug/g)	(ug/g)			(ug/g)	(ug/g)	(ug/g)		
Aluminum (Al)		19,886	26,458	28.36%	17,910	-10.46%	10,161	20,483	67.37%	7,842	-25.76%
Antimony (Sb)		8.6	10.8	22.68%	6.8	-23.38%	3.4	8.1	81.74%	4.5	27.85%
Arsenic (As)		8.5	11.7	31.68%	6.0	-34.48%	9.0	22.2	84.62%	10.0	10.53%
Barium (Ba)		102	124	19.47%	96.2	-5.85%	86.9	189	74.01%	71.2	-19.86%
Beryllium (Be)		0.47	0.49	3.53%	0.45	-5.43%	0.34	0.70	68.99%	<0.3	-
Cadmium (Cd)		<3	4.4	-	<3	-	12.2	58.0	130.48%	23.0	61.36%
Chromium (Cr)		2,038	3,243	45.64%	1,786	-13.18%	294	828	95.19%	374	23.95%
Cobalt (Co)		14.0	22.9	48.24%	13.1	-6.64%	<11	14.4	-	<11	-
Copper (Cu)		1,602	2,434	41.23%	1,459	-9.34%	3,229	7,961	84.58%	2,770	-15.30%
Iron (Fe)		17,992	20,088	11.01%	16,418	-9.15%	16,511	27,448	49.76%	13,619	-19.20%
Lead (Pb)		5,562	8,750	44.55%	4,936	-11.93%	503	1,145	77.91%	551	9.11%
Magnesium (Mg)		11,652	12,754	9.03%	11,891	2.03%	16,291	13,437	-19.20%	9,810	-49.66%
Manganese (Mn)		533	603	12.32%	513	-3.82%	579	792	31.07%	463	-22.26%
Mercury (Hg)		0.20	1.21	143.26%	0.23	13.95%	9.75	30.10	102.13%	10.90	11.14%
Molybdenum (Mo)		190	289	41.34%	175	-8.22%	31.3	50.4	46.76%	22.3	-33.58%
Nickel (Ni)		345	541	44.24%	308	-11.33%	197	359	58.27%	160	-20.73%
Selenium (Se)		0.6	1.0	50.00%	1.0	50.00%	0.9	1.0	10.53%	0.7	-25.00%
Silver (Ag)		46.4	92.1	55.56%	44.8	-3.51%	<11	17.2	-	<11	-
Vanadium (V)		37.3	43.5	15.35%	32.8	-12.84%	29.5	48.4	48.52%	24.1	-20.15%
Zinc (Zn)		41,469	64,726	43.80%	35,709	-14.93%	1,301	3,115	82.16%	1,426	9.17%
cyanide		101	122	18.83%	91.7	-9.65%	17.2	37.5	74.22%	22.1	24.94%

Organic Analysis		Active Landfill 11-I		
Sample Identity		Silt	PM10	RPD
Compound		(ug/g)	(ug/g)	
Phenol		1.1	3.1	95.24%
Pyrene		0.27 J	0.80	99.07%
Benzo(a)anthracene		0.07 J	0.17 J	80.99%
Sample Detection Limit (ug/g)		0.33	0.33	

N.D. = less than quantifiable detection limit for the sample

J = Estimated value where the compound meets the mass spectral criteria but the result is less than the quantifiable detection limit.

Active Landfill III, RPD of Contamination

PM10 and >PM10 compared to Silt

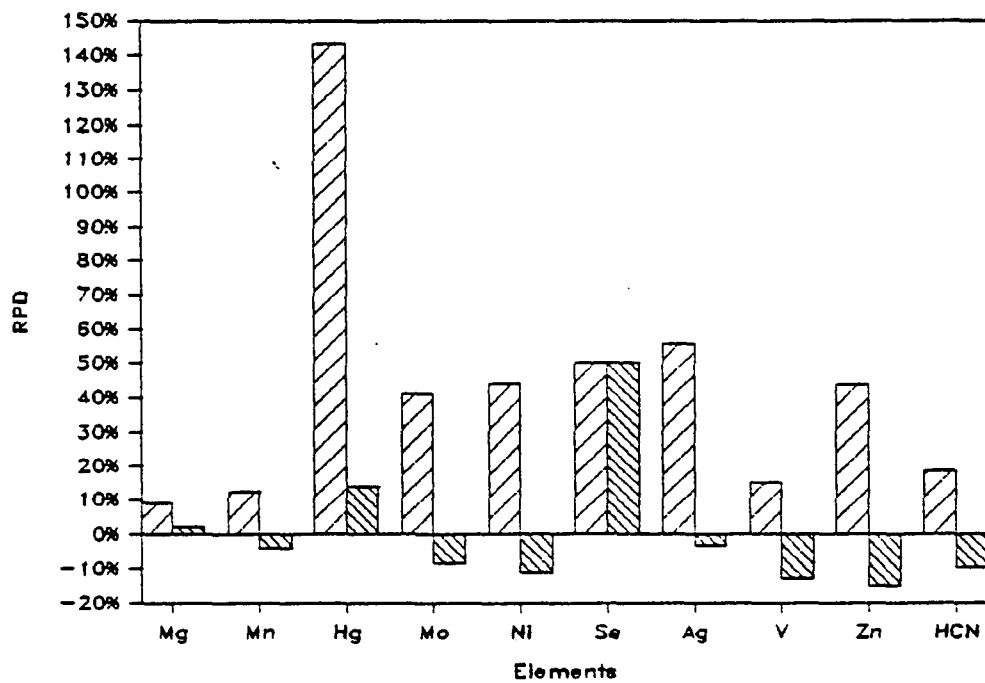
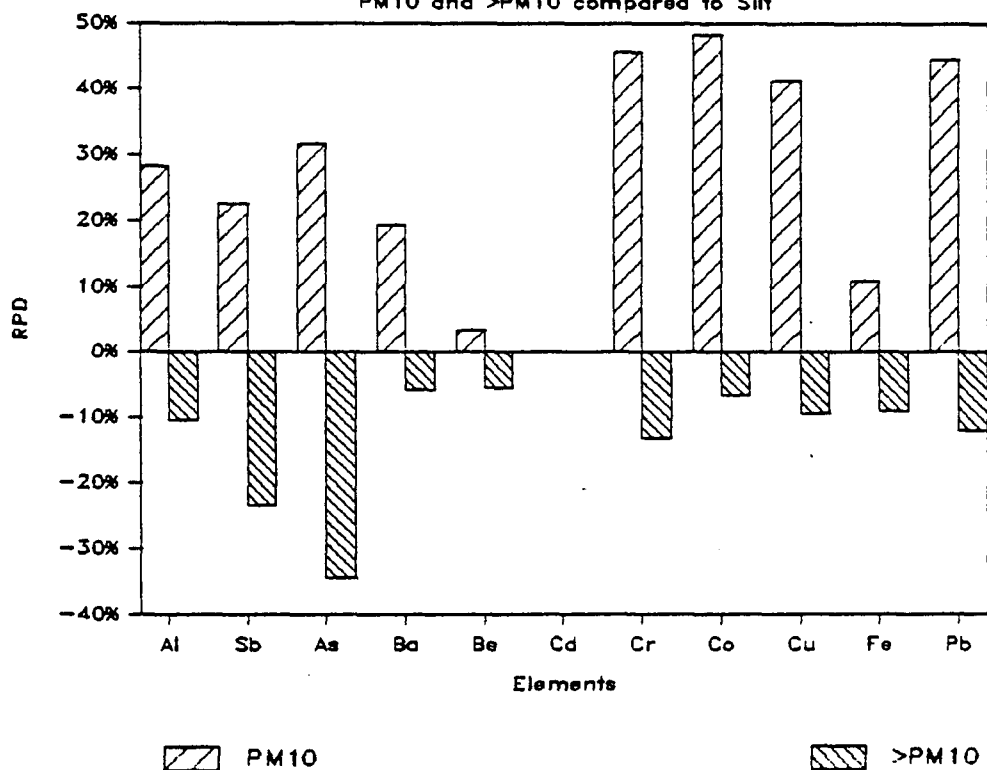


Figure 2.10. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for active landfill III (Process J) at Site 3.

Active Landfill I, RPD of Contamination

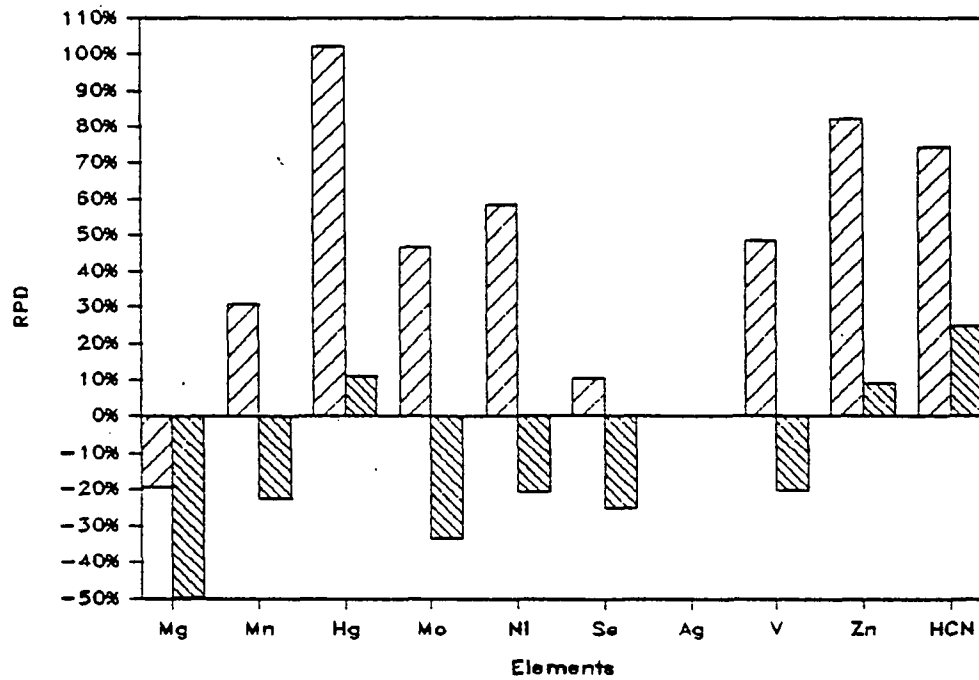
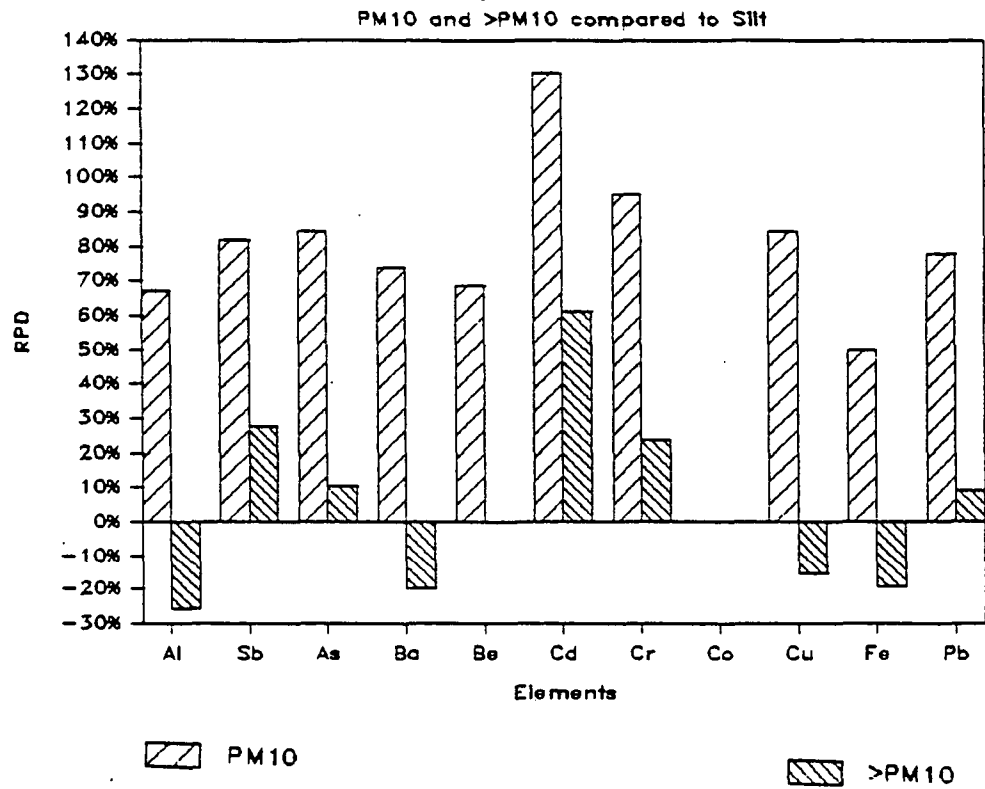


Figure 2.11. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for active landfill I (Process K) at Site 3.

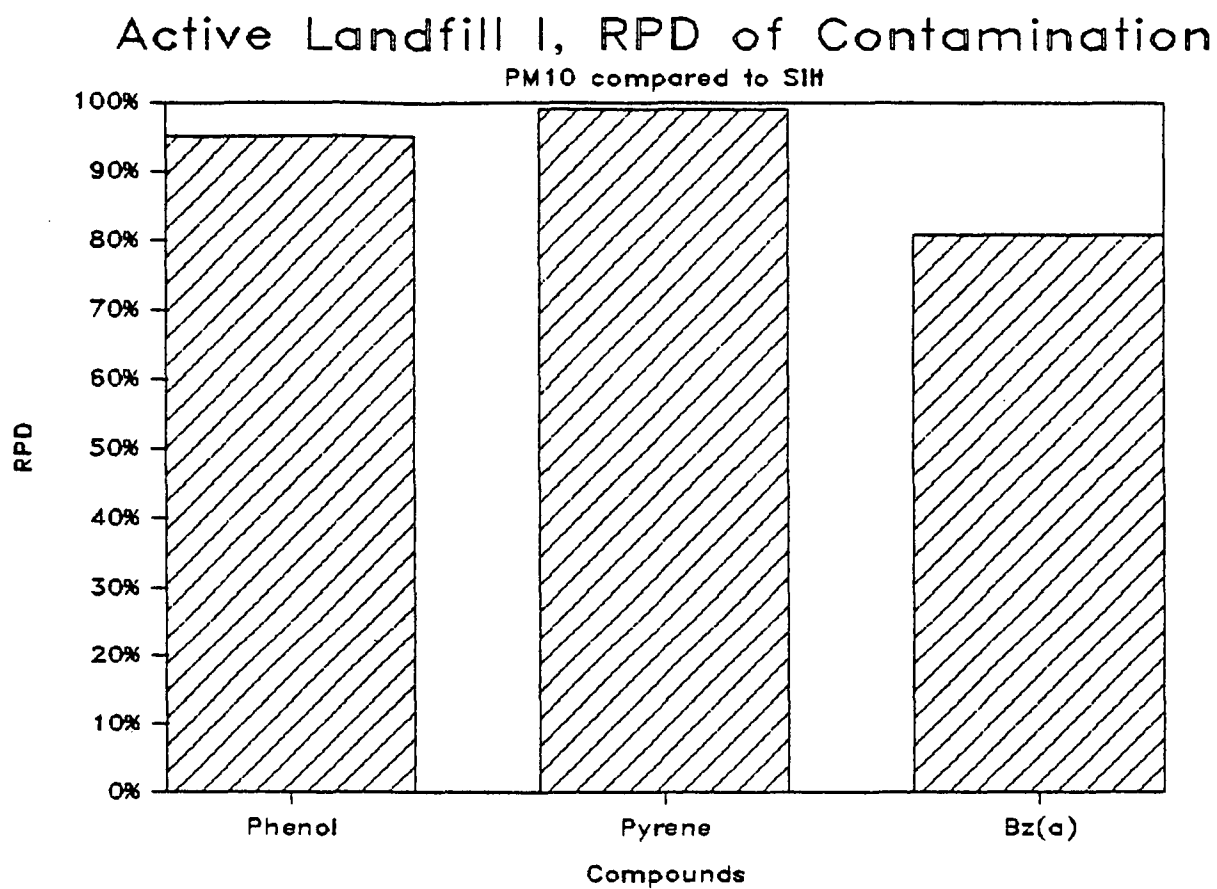


Figure 2.12. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 compared to silt for active landfill I (Process K) at Site 3.
(Bz(a) = Benzo(a)anthracene)

Table 2.33. RPD of Contamination for PM10 and >PM10 Compared to Silt (Process N), Site 4

Metals Analysis	Land Treatment Cell #8				
	Silt	PM10	RPD	>PM10	RPD
Element	(ug/g)	(ug/g)		(ug/g)	
Aluminum (Al)	11,100	13,200	17.28%	940	-168.77%
Antimony (Sb)	1.1	0.8	-31.58%	0.6	-58.82%
Arsenic (As)	6.7	6.7	0.00%	6.2	-7.75%
Barium (Ba)	152	215	34.33%	272	56.60%
Chromium (Cr)	209	255	19.83%	196	-6.42%
Cobalt (Co)	16.9	20.6	19.73%	14.7	-13.92%
Copper (Cu)	207	219	5.63%	200	-3.44%
Iron (Fe)	18,400	21,400	15.08%	17,600	-4.44%
Lead (Pb)	57.0	81.0	34.78%	65.0	13.11%
Manganese (Mn)	407	473	15.00%	389	-4.52%
Mercury (Hg)	1.3	1.3	-1.54%	1.5	13.52%
Molybdenum (Mo)	9.2	9.5	3.21%	5.7	-46.98%
Nickel (Ni)	98.3	108	9.40%	94.4	-4.05%
Selenium (Se)	2.3	2.5	8.33%	3.1	29.63%
Vanadium (V)	200	227	12.65%	190	-5.13%
Zinc (Zn)	248	287	14.58%	232	-6.67%

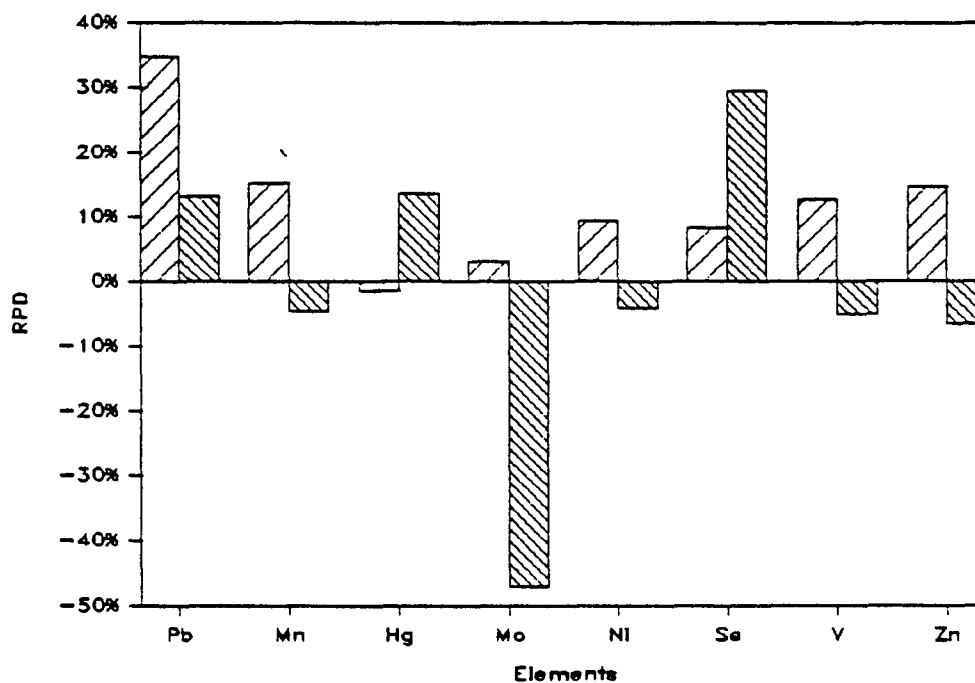
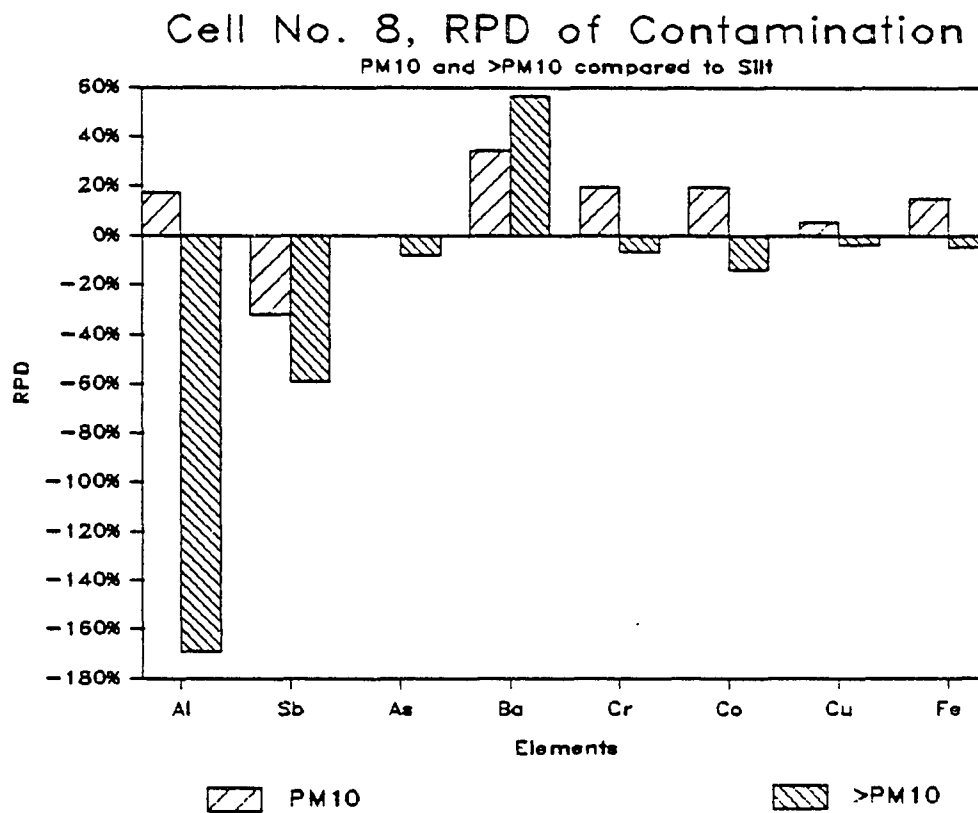


Figure 2.13. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for Land Treatment Cell 8 (Process N) at Site 4.

Table 2.34. RPD of Contamination for PM10 and >PM10 Compared to Silt (Processes P, Q, and R), Site 6

Metals Analysis		Cell A, Acid Wastes					Cell Q, Filter Cake					Cell C, Metal Catalyst				
Sample Identity	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD	
Element	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)		
Aluminum (Al)	33,693	49,954	38.88%	30,775	-9.05%	51,225	55,946	8.91%	50,668	-1.09%	81,844	22,649	-113.30%	89,102	8.49%	
Antimony (Sb)	0.9	1.2	28.57%	1.2	28.57%	90.7	95.1	-6.37%	66.7	-30.50%	1.5	1.6	6.45%	1.5	0.00%	
Arsenic (As)	8.7	13.9	46.02%	6.0	-36.73%	19.3	24.0	21.71%	14.2	-30.45%	4.7	6.4	30.63%	12.0	87.43%	
Barium (Ba)	1,121	1,772	45.01%	933	-18.31%	3,340	3,632	8.38%	3,315	-0.75%	103	144	33.20%	94.4	-8.71%	
Beryllium (Be)	1.45	1.93	29.40%	1.05	-32.00%	2.62	2.72	3.75%	2.50	-4.69%	3.90	2.76	-34.23%	3.74	-4.19%	
Chromium (Cr)	91.2	119	26.45%	76.7	-17.27%	142	155	8.75%	132	-7.30%	4,967	8,771	55.38%	4,278	-14.91%	
Cobalt (Co)	11.2	16.4	37.68%	10.1	-10.33%	31.3	31.7	1.27%	31.6	0.95%	285	421	38.53%	250	-13.08%	
Copper (Cu)	134	213	45.53%	113	-17.00%	284	370	26.30%	190	-39.66%	280	522	60.35%	246	-12.12%	
Iron (Fe)	17,198	24,609	35.45%	15,186	-12.43%	25,182	25,867	2.68%	24,773	-1.64%	204,890	339,654	49.22%	173,248	-16.74%	
Lead (Pb)	54.4	58.9	7.94%	40.4	-29.54%	146	135	-7.83%	97.1	-40.23%	113	96.9	-15.34%	97.3	-14.93%	
Manganese (Mn)	156	209	29.04%	138	-12.24%	170	188	10.06%	163	-4.20%	209	328	44.32%	192	-8.48%	
Mercury (Hg)	0.27	0.50	61.29%	0.37	32.70%	0.31	0.37	16.64%	0.41	26.52%	<0.03	0.41	-	<0.03	-	
Molybdenum (Mo)	16.4	23.9	37.22%	12.5	-26.99%	44.1	28.5	-42.98%	122	93.80%	122	130	6.35%	89.3	-30.95%	
Nickel (Ni)	41.9	52.8	23.02%	39.7	-5.39%	52.7	52.1	-1.15%	50.8	-3.67%	522	258	-67.69%	525	0.57%	
Selenium (Se)	0.5	1.1	75.00%	<0.5	-	2.8	2.7	-3.64%	2.0	-33.33%	<0.5	<0.5	-	<0.5	-	
Vanadium (V)	75.7	110	36.94%	61.7	-20.38%	161	182	12.24%	147	-9.09%	122	574	129.89%	694	140.20%	
Zinc (Zn)	272	389	35.40%	223	-19.80%	2,940	3,414	14.92%	2,704	-8.36%	1,054	1,128	6.78%	963	-9.02%	
Cyanide	3.3	4.7	35.00%	3.0	-9.52%	1,280	1,680	27.03%	1,250	-2.37%	0.8	2.1	89.66%	<0.5	-	

Organic Analysis		Cell A, Acid Wastes			Cell Q, Filter Cake		
		Silt	PM10	RPD	Silt	PM10	RPD
Compound	(ug/g)	(ug/g)			(ug/g)	(ug/g)	
Chrysene	N.D.	N.D.	-		0.21 J	0.21 J	0.00%
Pyrene	N.D.	N.D.	-		0.19 J	0.23 J	19.05%
Aroclor-1254	1.00	1.30	26.09%		N.D.	N.D.	-

N.D. = less than the sample's quantifiable detection limit

J = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit.

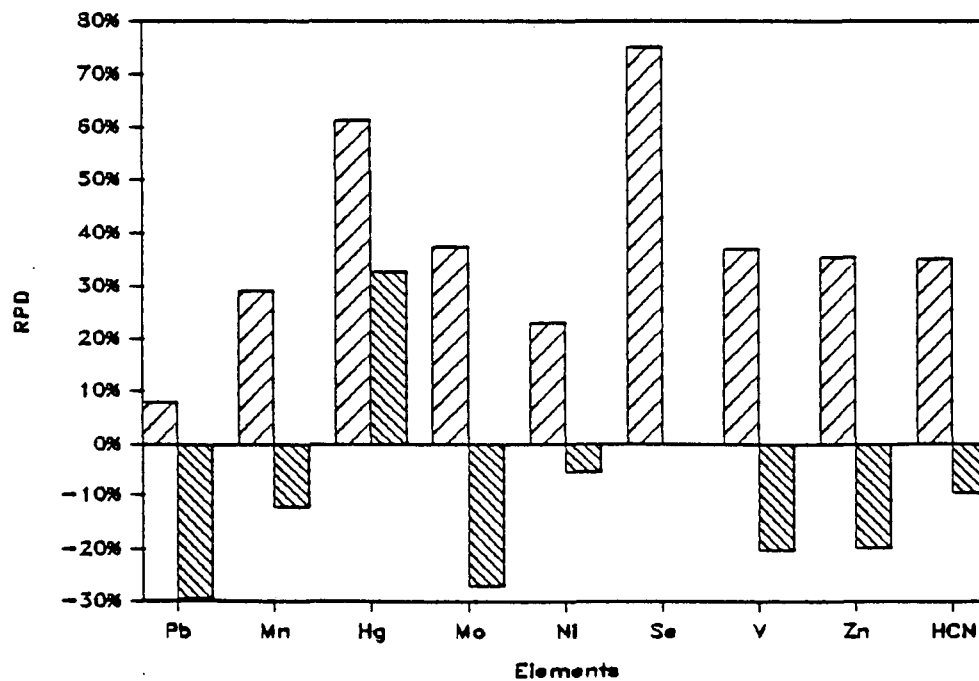
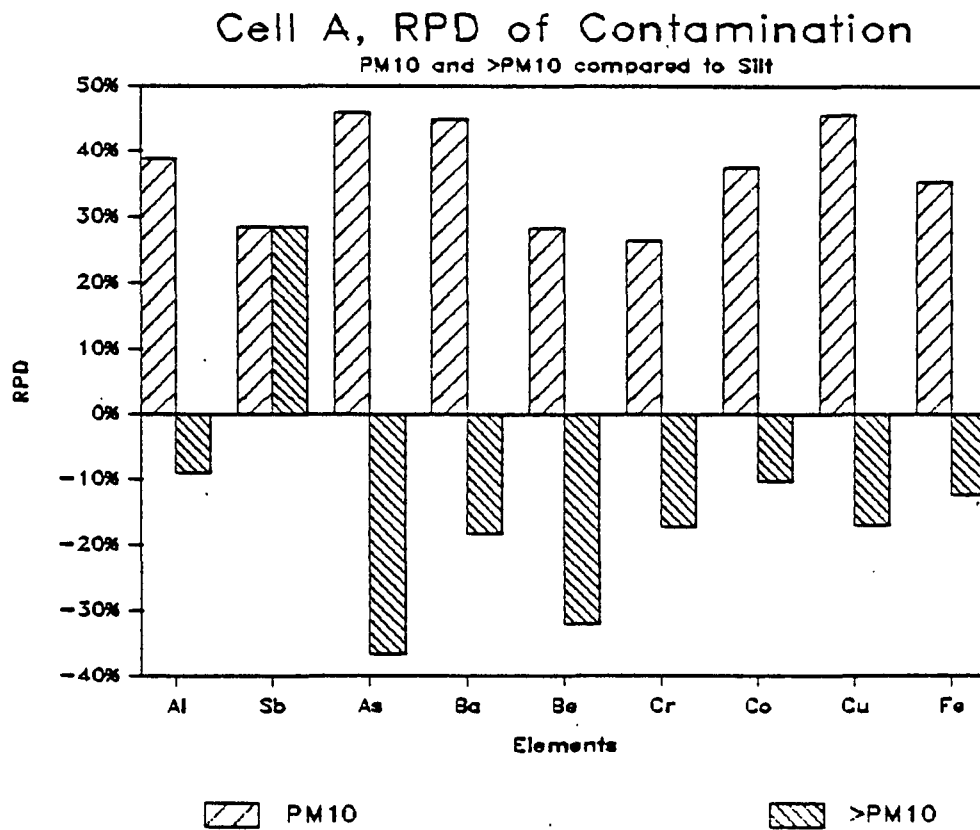


Figure 2.14. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for Landfill Cell A (Process P) at Site 8.

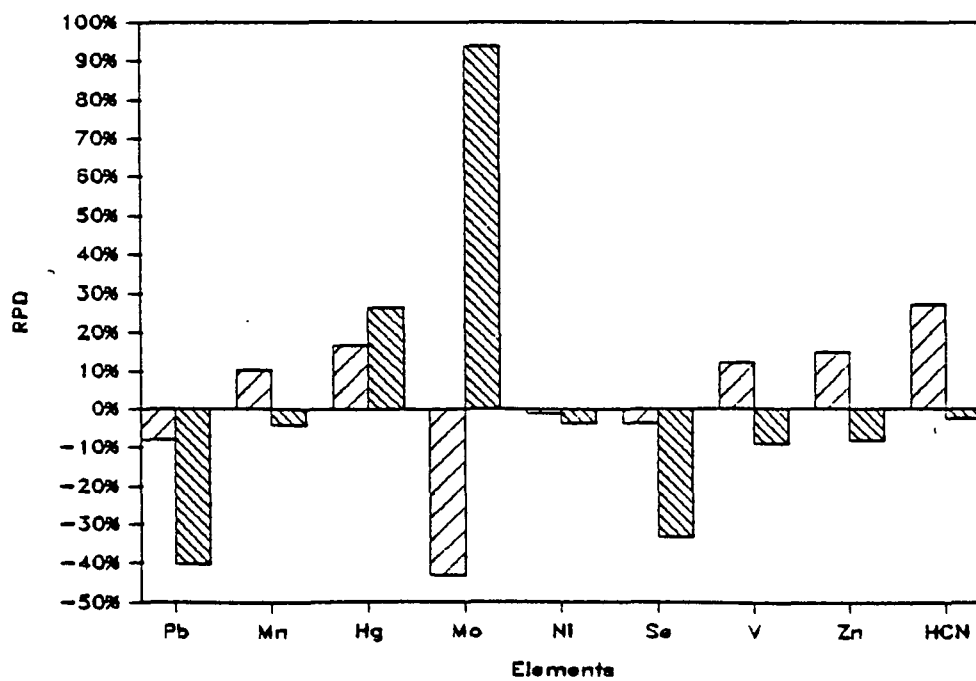
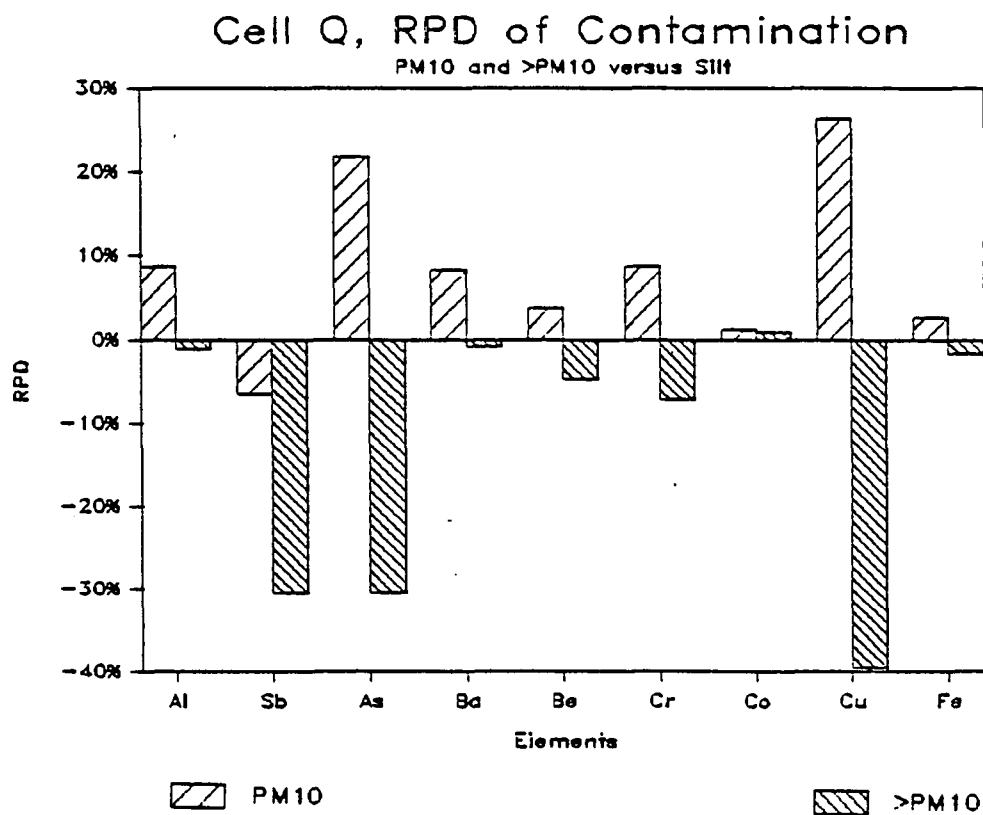


Figure 2.15. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for Landfill Cell Q (Process Q) at Site 6.

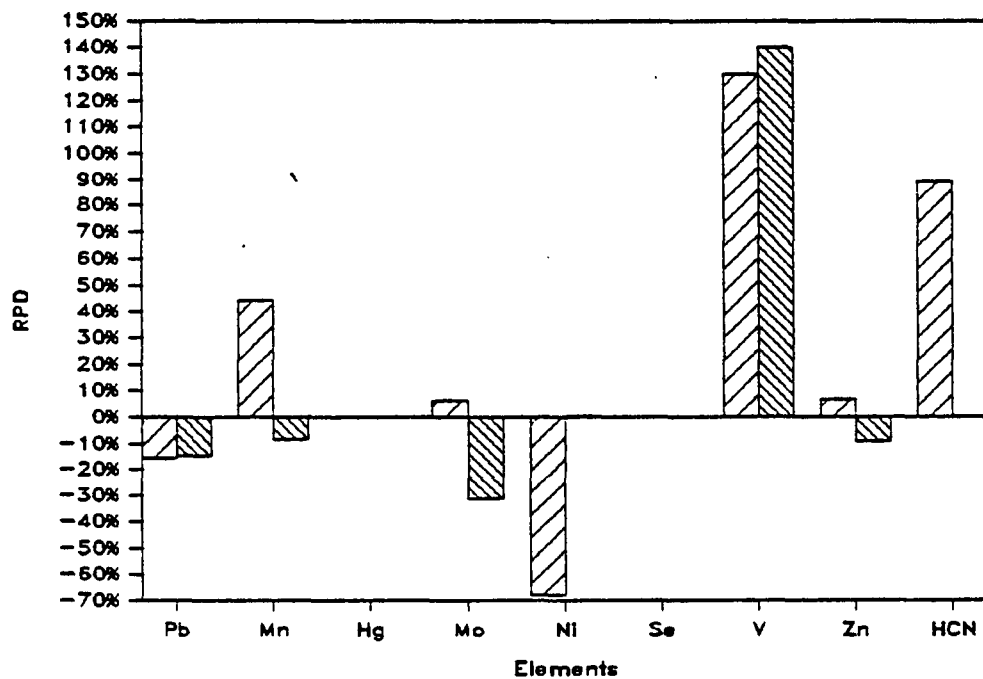
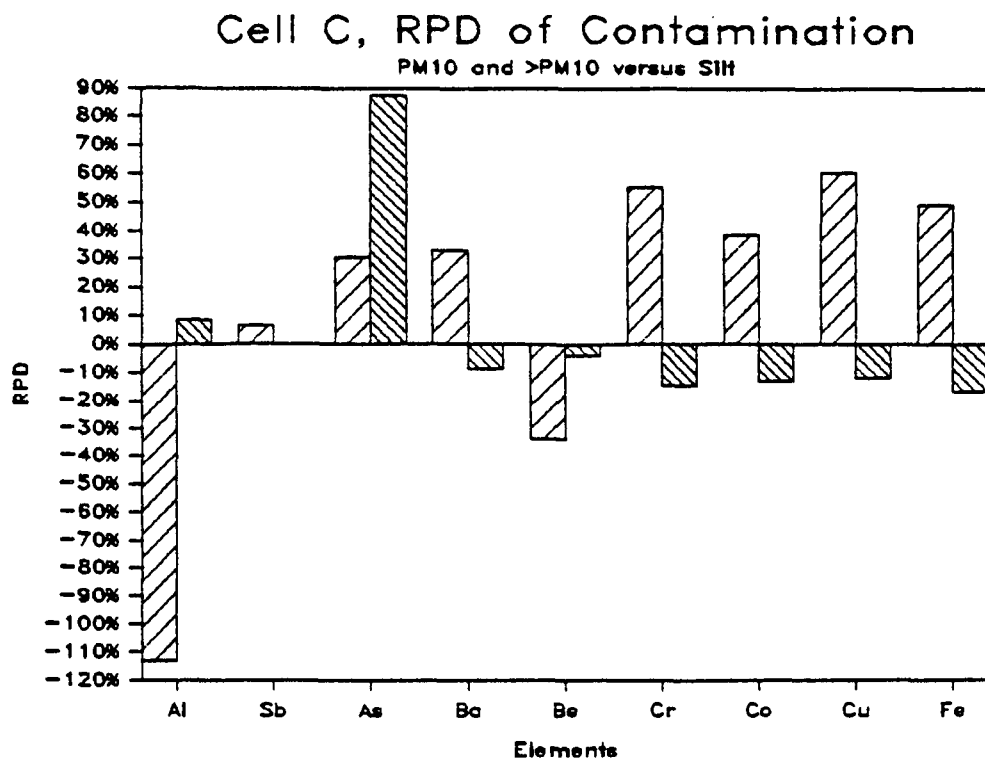


Figure 2.16. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for Landfill Cell C (Process R) at Site 6.

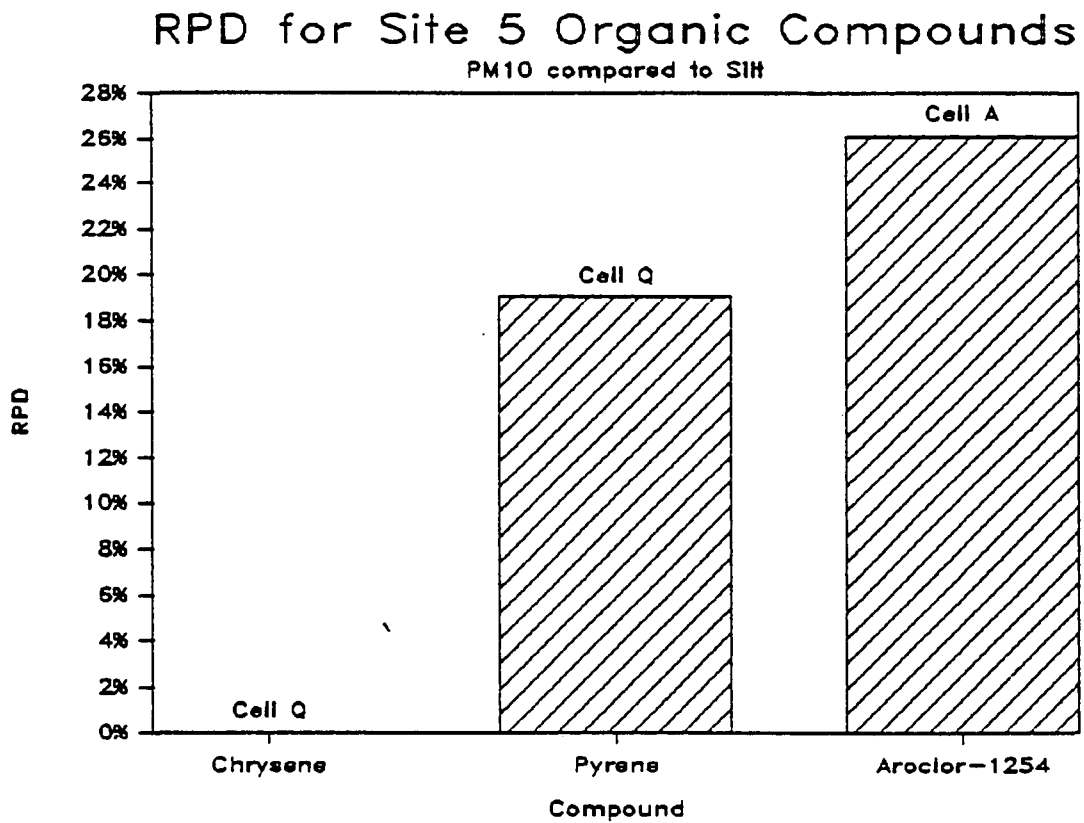


Figure 2.17. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 compared to silt for Landfill Cell A (Process P) and Landfill Cell Q at Site 6.

Table 2.35. RPD of Contamination for PM10 and >PM10 Compared to Silt (Processes S, T, and U), Site 7

Metals Analysis		Landfill Cell #1					Stabilization Area #7					Land Treatment 118-121				
Sample Identity	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	>PM10	RPD	
Element	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)		
Aluminum (Al)	11,500	11,900	2.58%	11,400	-0.87%	11,100	11,700	5.26%	11,900	6.96%	10,600	13,900	26.94%	11,000	3.70%	
Antimony (Sb)	17.1	11.6	-38.33%	16.7	-2.37%	4.0	4.4	9.52%	4.2	4.88%	0.9	0.8	-11.76%	0.5	-57.14%	
Arsenic (As)	21.3	24.3	13.16%	22.3	4.59%	14.9	14.6	-1.36%	16.1	8.41%	7.9	12.5	45.10%	7.4	-6.54%	
Barium (Ba)	888	361	-84.39%	264	-108.3%	202	235	15.10%	214	5.77%	276	344	21.94%	266	-3.69%	
Cadmium (Cd)	150	170	12.50%	149	-0.67%	18.9	20.5	8.65%	19.4	3.14%	<1	<1	-	<1	-	
Chromium (Cr)	447	465	3.95%	429	-4.11%	337	432	24.71%	337	0.00%	90.6	206	77.82%	74.7	-19.24%	
Cobalt (Co)	12.2	12.2	0.00%	8.4	-36.89%	6.0	6.2	3.28%	6.0	0.00%	4.2	8.4	66.67%	4.1	-2.41%	
Copper (Cu)	951	1,060	10.84%	956	0.52%	232	262	12.15%	243	4.63%	59.0	92.8	44.53%	52.0	-12.61%	
Iron (Fe)	63,200	63,500	0.47%	63,400	0.32%	13,500	14,700	8.51%	14,600	7.83%	9,500	12,700	28.83%	9,200	-3.21%	
Lead (Pb)	6,870	7,746	11.99%	6,870	0.00%	866	1,012	15.55%	926	6.70%	33.0	45.7	32.27%	22.2	-39.13%	
Manganese (Mn)	6,480	6,690	3.19%	6,340	-2.18%	789	928	16.19%	919	3.73%	265	356	29.31%	257	-3.07%	
Mercury (Hg)	1.23	1.50	19.78%	1.21	-1.64%	0.11	0.30	92.68%	0.16	37.04%	0.85	2.02	81.53%	0.59	-36.11%	
Molybdenum (Mo)	92.3	92.0	11.13%	86.7	5.21%	127	141	10.45%	139	9.02%	<2	<2	-	2.1	-	
Nickel (Ni)	85.6	86.2	0.70%	83.6	-2.36%	30.4	39.2	25.29%	30.3	-0.33%	8.3	19.8	81.85%	13.8	49.77%	
Selenium (Se)	4.8	5.4	11.76%	5.4	11.76%	1.7	1.2	-34.48%	1.4	-19.35%	1.0	<0.5	-	<0.5	-	
Silver (Ag)	18.1	26.9	39.11%	17.0	-6.27%	11.5	14.7	24.43%	10.3	-11.01%	<2	<2	-	<2	-	
Vanadium (V)	61.9	59.5	-3.95%	55.2	-11.44%	25.6	24.9	-2.77%	27.6	7.52%	33.9	45.4	29.00%	33.3	-1.79%	
Zinc (Zn)	41,800	47,700	13.18%	42,900	2.60%	4,800	5,100	6.06%	5,200	8.00%	104	193	59.93%	99.3	-4.62%	
cyanide	1.23	1.93	44.30%	0.57	-73.33%	<0.5	<0.5	-	<0.5	-	<0.5	<0.5	-	<0.5	-	

Organic Analysis	Landfill Cell #1					Stabilization Area #7			Land Treatment 118-121		
	Silt	PM10	RPD	>PM10	RPD	Silt	PM10	RPD	Silt	PM10	RPD
Compound	(ug/g)	(ug/g)		(ug/g)		(ug/g)	(ug/g)		(ug/g)	(ug/g)	
Acenaphthene	N.D.	N.D.		N.D.		21.0	25.0	17.39%	N.D.	N.D.	-
Anthracene	32.0 J	32.0	0.00%	26.0 J	-20.69%	20.0	29.0	36.73%	N.D.	N.D.	-
Benzo(a)anthracene	N.D.	13.0 J	-	N.D.	-	3.1 J	4.5	36.84%	N.D.	N.D.	-
Chrysene	12.0 J	18.0 J	40.00%	11.0 J	-9.70%	3.9 J	5.7	37.50%	6.4 J	14.0 J	74.51%
Dibenzofuran	25.0 J	18.0 J	-32.56%	N.D.	-	14.0	N.D.	-	N.D.	N.D.	-
Fluoranthene	54.0 J	62.0	13.79%	39.0 J	-32.26%	23.0	23.0	0.00%	N.D.	N.D.	-
Fluorene	N.D.	N.D.	-	N.D.	-	5.3 J	14.0	90.16%	N.D.	N.D.	-
2-Methylnapthalene	120	62.0	-63.74%	89.0	-29.67%	30.0	31.0	3.28%	3.2 J	5.6 J	54.55%
Napthalene	31.0 J	9.4 J	-106.9%	17.0 J	-58.33%	27.0	14.0	-63.41%	N.D.	N.D.	-
Phenanthrene	150	140	-6.90%	120	-22.22%	50.0	36.0	-32.56%	22.0 J	46.0	70.59%
Phenol	60.0 J	30.0	-66.67%	43.0	-33.01%	N.D.	3.0 J	-	N.D.	N.D.	-
Pyrene	44.0 J	59.0	29.13%	34.0 J	-25.64%	18.0	21.0	15.38%	8.5 J	18.0 J	71.70%
Sample Detection	62.1	19.6		39.6		5.0	3.8		26.4	46.2	

N.D. = Less than the sample's quantifiable detection limit

J. = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit.

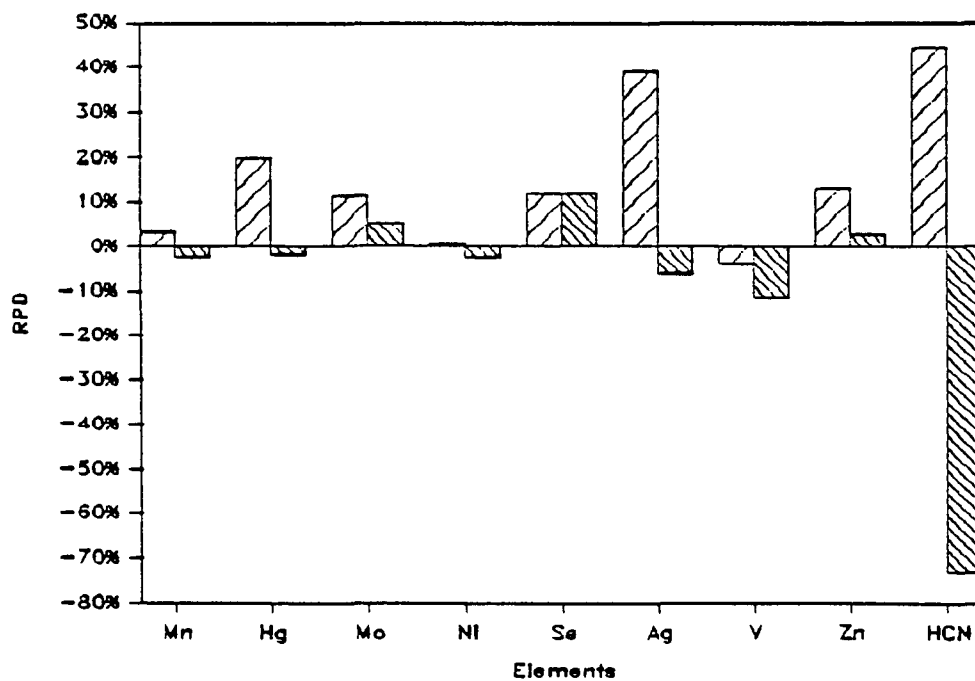
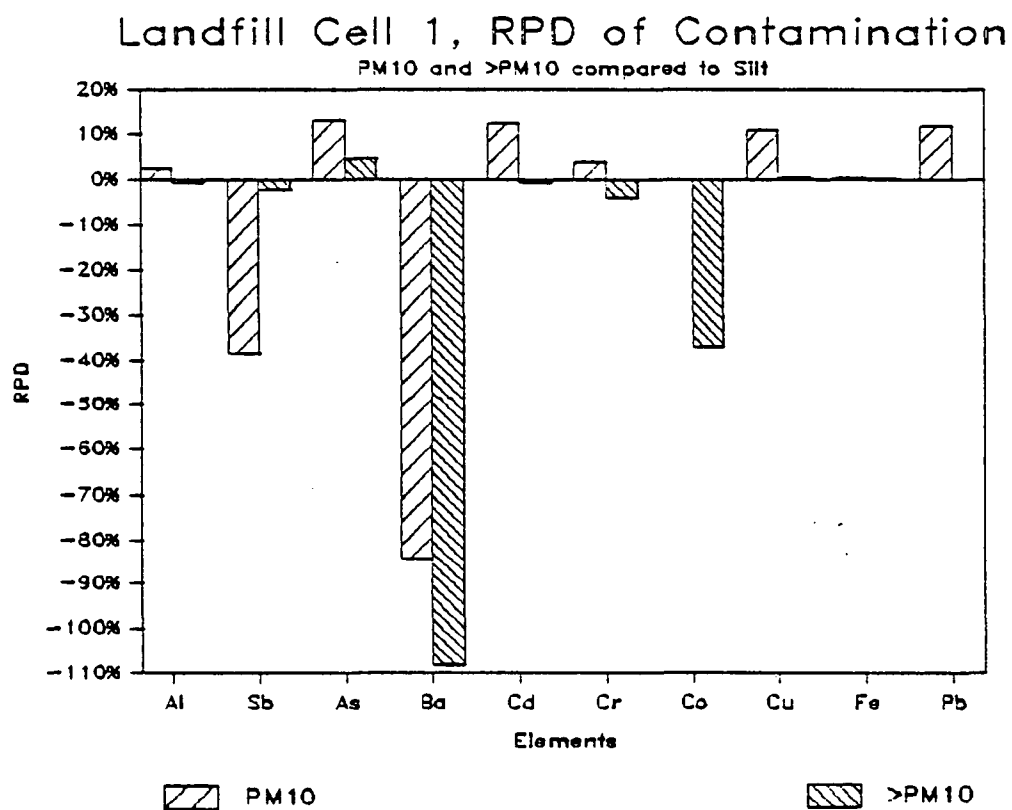


Figure 2.18. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for Landfill Cell 1 (Process S) at Site 7.

Stabilization Unit, RPD of Contamination

PM10 and >PM10 compared to Silt

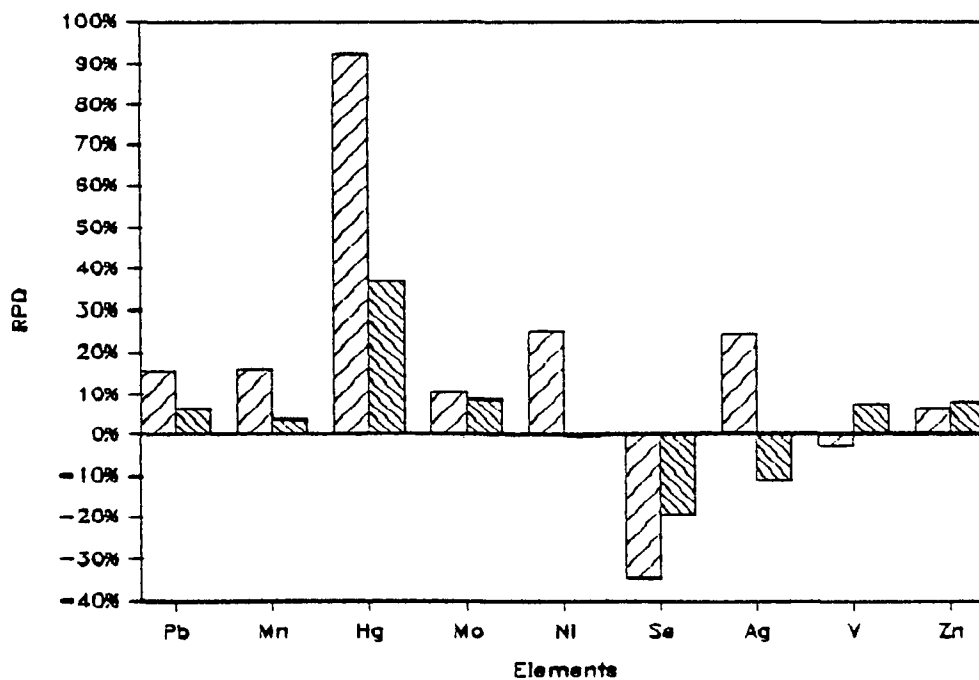
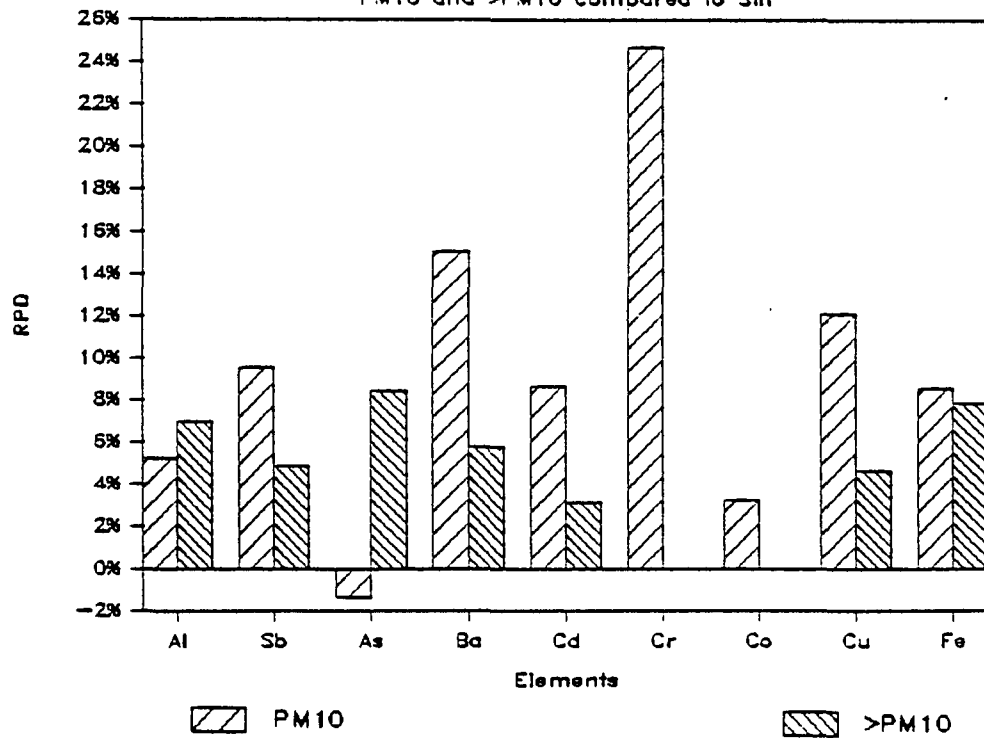


Figure 2.19. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for Stabilization Area 7 (Process T) at Site 7.

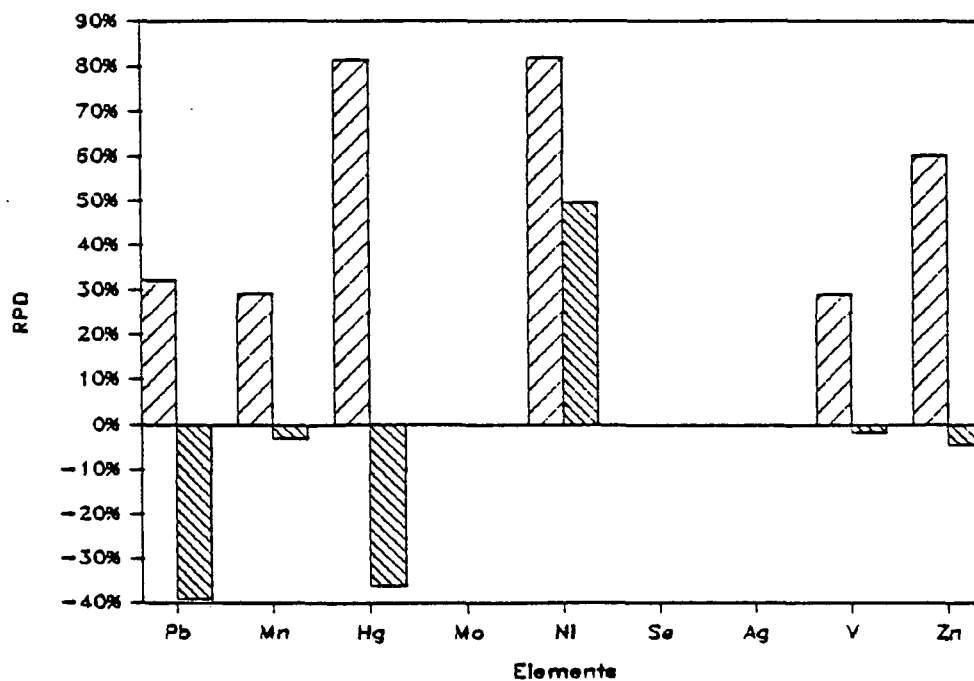
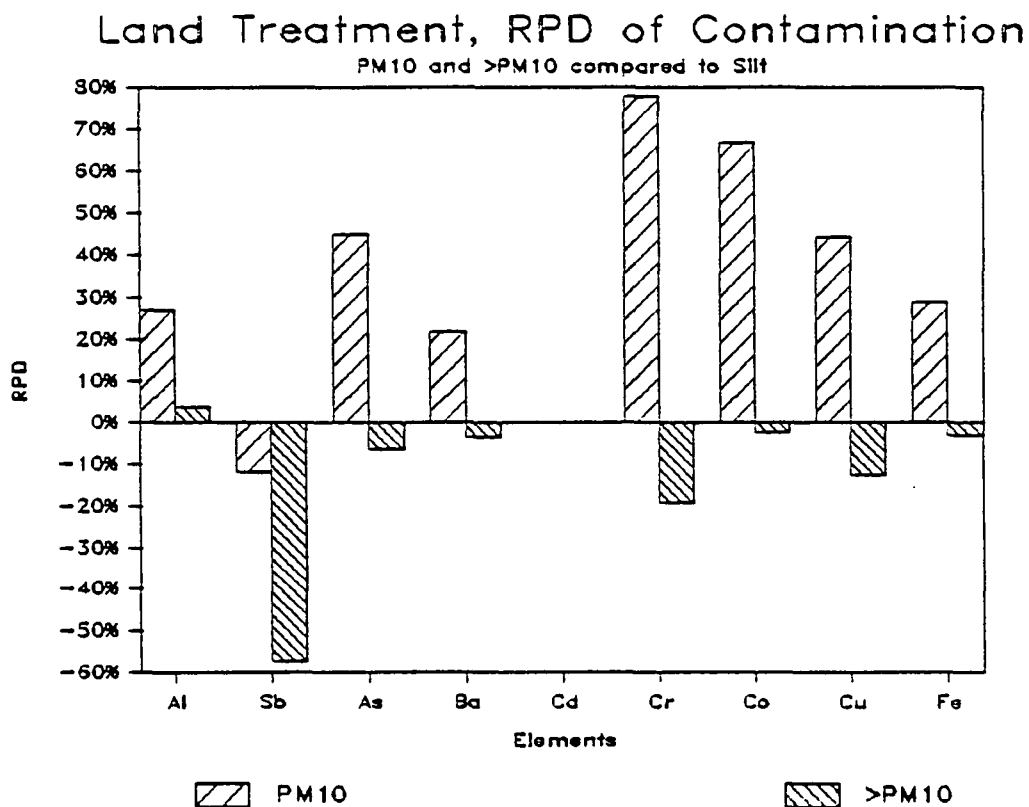


Figure 2.20. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for land treatment Rows 118-121 (Process U) at Site 7.

Landfill Cell 1, RPD of Contamination

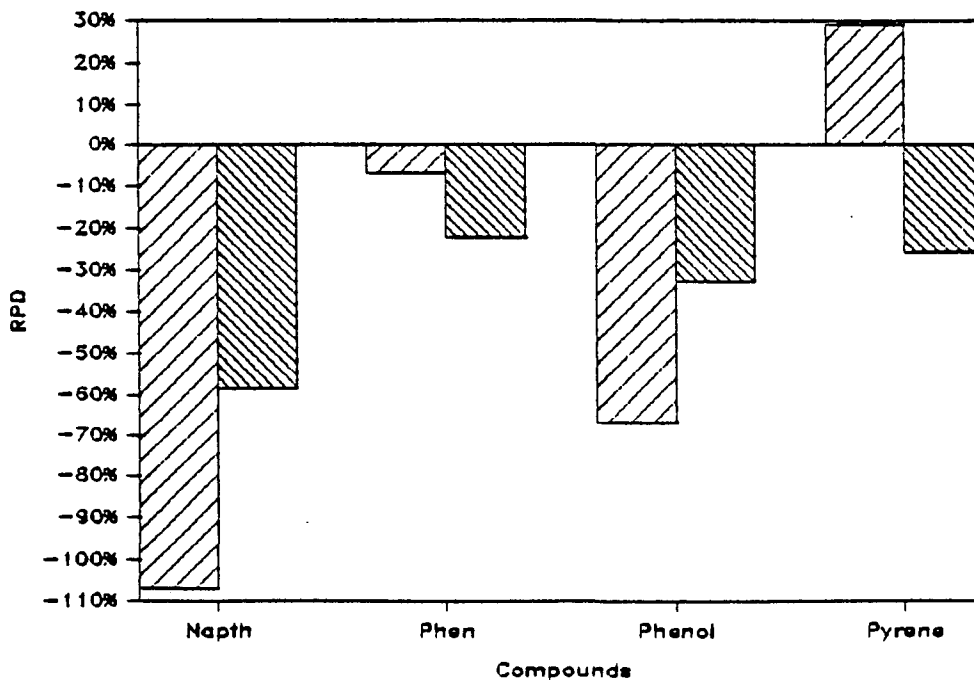
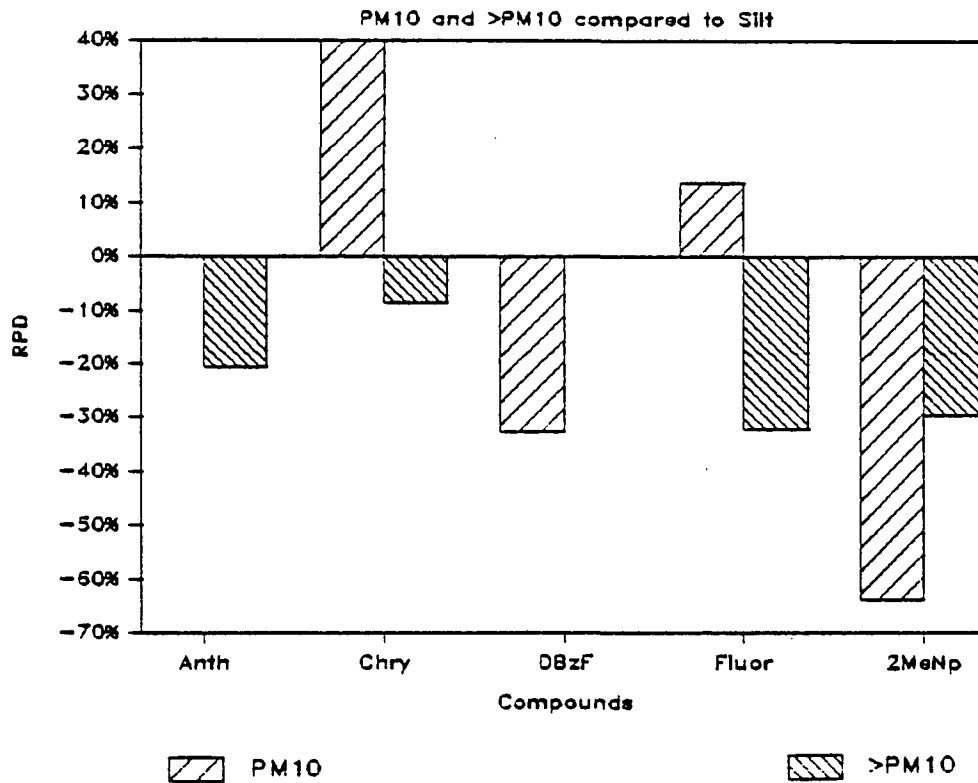


Figure 2.21. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 compared to silt for Landfill Cell 1 (Process S) at Site 7. (Anth = Anthracene, Chry = Chrysene, DBzF = Dibenzofuran, Fluor = Fluorene, 2MeNp = 2-Methylnapthalene, Napth = Napthalene, Phen = Phenanthracene)

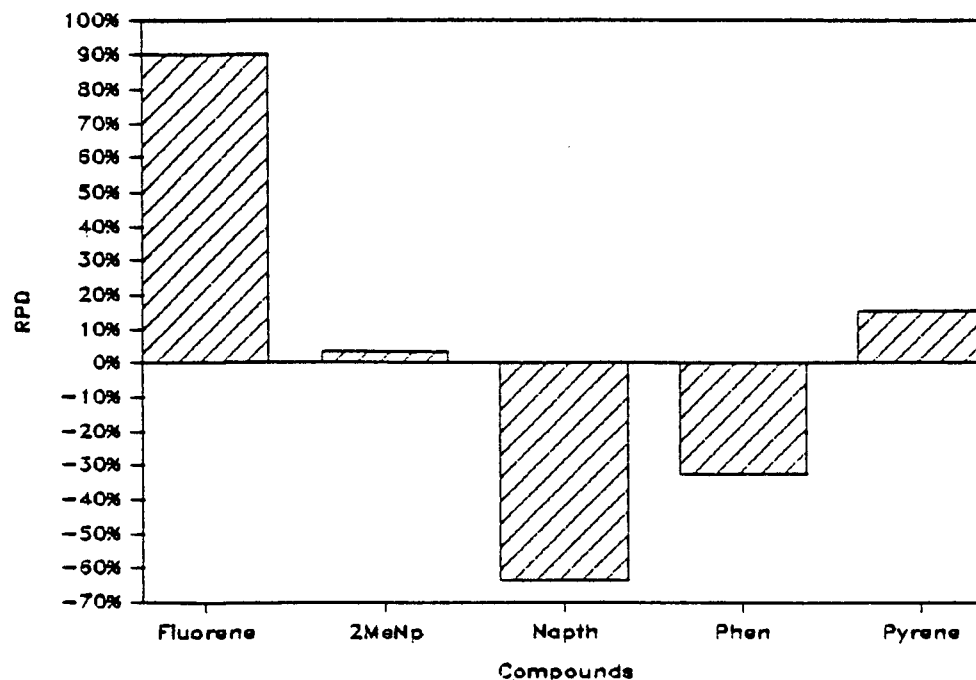
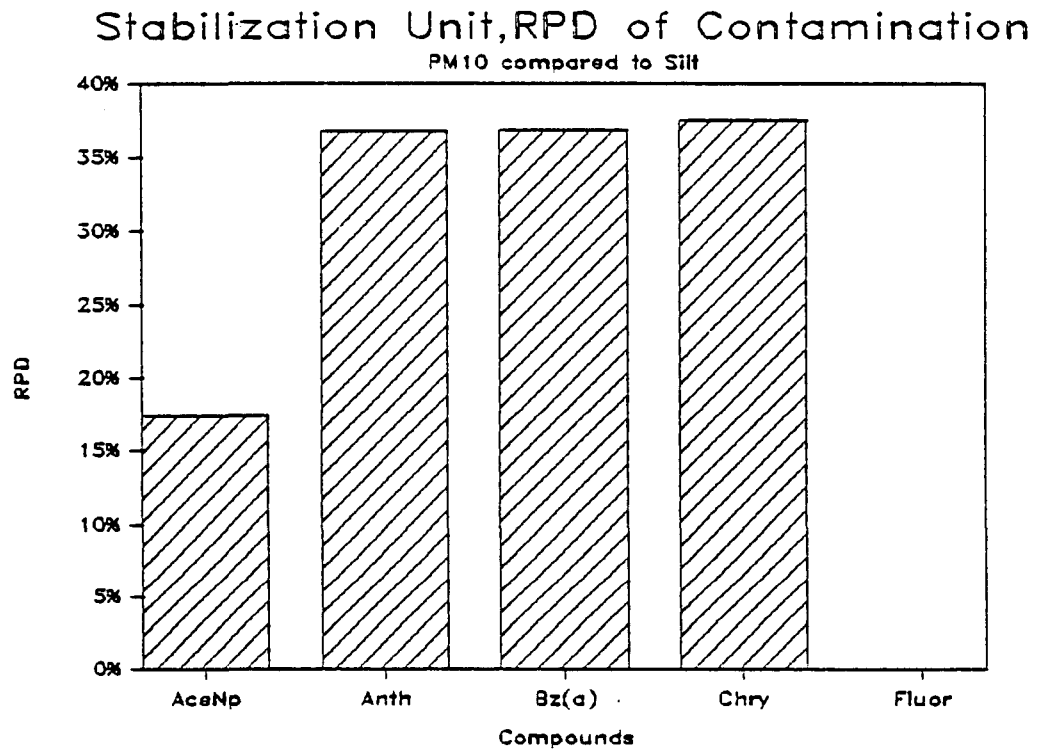


Figure 2.22. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 compared to silt for Stabilization Area 7 (Process T) at Site 7. (AceNp = Acenaphthene, Anth = Anthracene, Bz(a) = Benzo(a)anthracene, Chry = Chrysene, Fluor = Fluorene, 2MeNp = 2-Methylnapthalene, Napth = Napthalene, Phen = Phenanthracene)

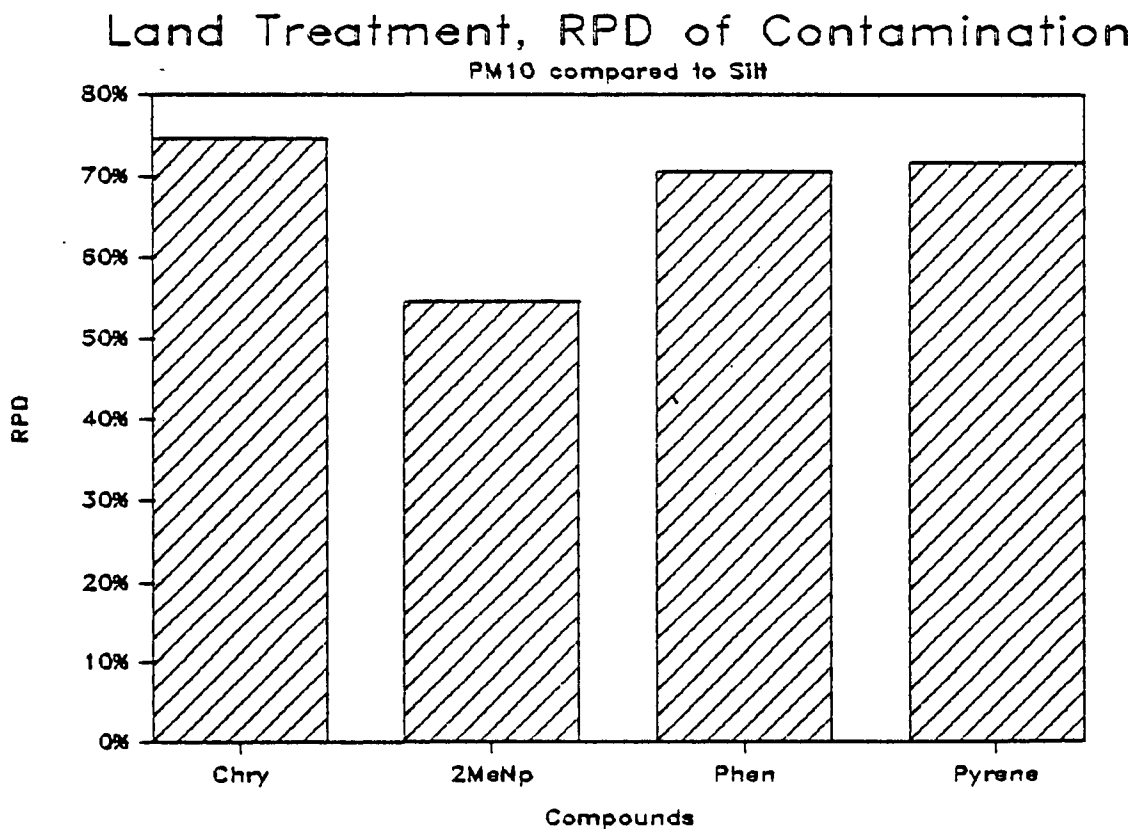


Figure 2.23. Bar graph of RPD of semivolatile organic HSL compound contamination for PM10 compared to silt for land treatment Rows 118-121 (Process U) at Site 7. (Chry = Chrysene, 2MeNp = 2-Methylnaphthalene, Phen = Phenanthracene)

Table 2.36. RPD of Contamination for PM10 and >PM10 Compared to Silt (Process Z), Site 8

Metals Analysis	Landfill				
	Silt	PM10	RPD	>PM10	RPD
Element	(ug/g)	(ug/g)		(ug/g)	
Aluminum (Al)	20,059	23,065	13.94%	20,178	0.59%
Antimony (Sb)	2.3	2.5	8.33%	2.1	-9.09%
Arsenic (As)	19.2	22.9	17.58%	21.5	11.30%
Barium (Ba)	163	169	3.61%	157	-3.75%
Beryllium (Be)	1.17	1.08	-8.00%	1.21	3.36%
Cadmium (Cd)	97.3	121	21.71%	81.5	-17.67%
Chromium (Cr)	1,501	1,110	-29.95%	1,692	11.96%
Cobalt (Co)	11.0	8.1	-30.85%	9.4	-15.26%
Copper (Cu)	718	957	28.54%	575	-22.12%
Iron (Fe)	144,943	129,723	-11.08%	157,773	8.48%
Lead (Pb)	4,324	5,163	17.69%	3,725	-14.88%
Manganese (Mn)	23,963	19,578	-20.14%	26,372	9.57%
Mercury (Hg)	1.10	1.48	29.46%	0.94	-26.45%
Molybdenum (Mo)	68.8	66.2	-3.85%	64.1	-7.07%
Nickel (Ni)	108	110	1.83%	103	-4.74%
Selenium (Se)	1.4	1.7	19.35%	1.2	-15.38%
Silver (Ag)	41.4	36.0	-13.95%	41.6	0.48%
Vanadium (V)	147	132	-10.75%	156	5.94%
Zinc (Zn)	32,005	40,314	22.98%	25,917	-21.02%

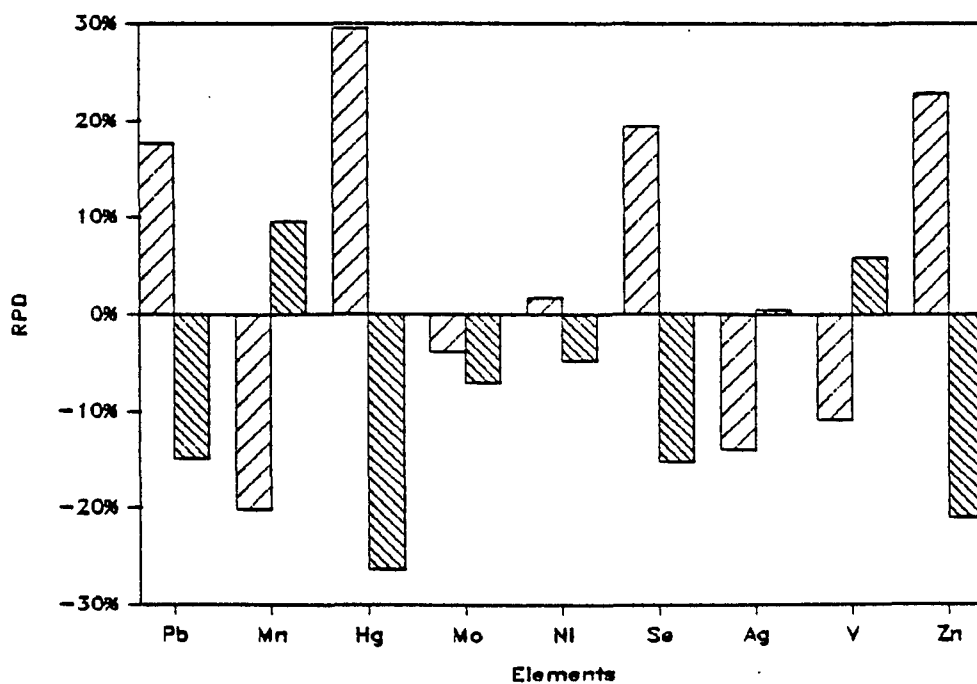
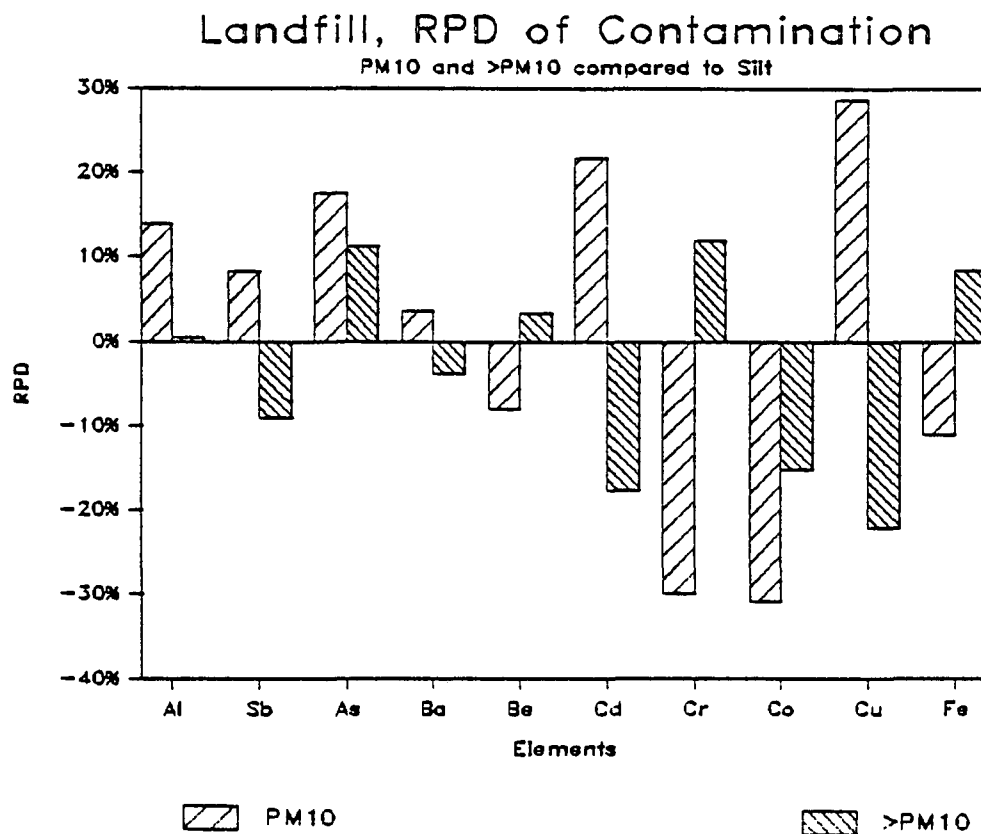


Figure 2.24. Bar graph of RPD of metals contamination for PM10 and >PM10 compared to silt for landfill (Process Z) at Site 8.

Table 2.37. Particle Size Dependency of The Degree of Contamination;
Probabilities According to The Binomial Distribution

RCRA Metals	p(x)*	Samples with Ratios > 1.0 (PM-10 to Silt)	Total Number of Samples
Arsenic (As)	0.090	10	14
Barium (Ba)	0.090	10	14
Cadmium (Cd)	0.002	9	9
Chromium (Cr)	0.029	11	14
Lead (Pb)	0.006	12	14
Mercury (Hg)	0.006	12	14
Selenium (Se)	0.500	6	11
Silver (Ag)	0.109	5	6
Semi-Volatile Organic HSL Compounds			
Acenaphthene	0.500	1	1
Anthracene	0.250	2	2
Aroclor-1254	0.500	1	1
Benzoanthracene	0.688	2	4
bis(2-ethylhexyl)phthalate	0.500	2	3
Butylbenzylphthalate	0.500	1	1
Chrysene	0.227	5	7
Dibenzofuran	1.000	0	1
2,4-Dimethylphenol	1.000	0	1
2,4-Dinitrotoluene	1.000	0	1
Di-n-butylphthalate	0.500	1	1
Fluorene	0.688	2	4
Isophorone	0.938	0	4
2-Methylnapthalene	0.637	4	8
4-Methylphenol	0.500	1	1
Napthalene	0.750	1	4
Phenanthrene	0.363	5	8
Phenol	0.063	4	4
Pyrene	0.254	6	9
Toxaphene	1.000	0	1

* Calculated by assuming equal probability ($p = 0.5$) for the PM-10
Silt Ratio being greater than 1 and less than or equal to 1

grid and selecting the grid cells to be sampled by use of a random number table. The selected cells were sampled to obtain the required number of process samples. Then, three of the cells were chosen for additional R&R sample collection.

For the R&R sample collection at the three sites, two individuals (samplers) collected samples from the three selected grid cells. The primary sampler (for that site) collected two separate samples (primary samples) for repeatability and reproducibility purposes and a secondary sampler collected a sample (secondary sample) for reproducibility purposes. All the R&R samples collected were dried and sieved separately.

The three silt fractions from each grid cell sampled were divided into aliquots as follows:

- Two aliquots from one of the primary samples for metals and organic compound analyses by the in-house laboratories to measure total repeatability;
- One aliquot from the secondary sample for metals analysis by the outside metals analysis laboratory to measure total reproducibility;
- Three aliquots from the second primary sample for metals analysis, two for duplicate metals analyses by the in-house metals analysis laboratory to measure analytical repeatability and one for metals analysis laboratory to measure analytical reproducibility; and
- Two aliquots from the second primary sample for duplicate organic compound analyses by the in-house organics analysis laboratory to measure analytical repeatability.

The results for the metals analysis of the R&R samples from Sites 2, 4, and 7 are presented in Tables 2.38, 2.39, and 2.40, respectively. The results for the semivolatile organics analysis of the R&R samples from Sites 2 and 7 are presented in Tables 2.41 and 2.42, respectively.

For the R&R assessment, only the analytical results for those individual metals measured at two times the detection limit were used since analytical accuracy and precision for elements at or near the detection limit is limited. For the organics analysis, only values for those compounds measured at or above a sample's CLP quantifiable detection limit were used. Under this criteria, only a limited amount of the analytical results for the repeatability analyses for organic compounds could be used for the R&R assessment. For this reason and as a cost saving measure, the EPA decided not to have the reproducibility

Table 2.38. Analytical Results for Repeatability and Reproducibility Samples - Metals, Site 2

Sample Identity	Grid No. 7					Grid No. 8					Grid No. 12				
	RTI	PEI	RTI	RTI	PEI	RTI	PEI	RTI	RTI	PEI	RTI	PEI	RTI	RTI	PEI
	I-262	I-264	I-268	I-269	I-270	I-272	I-274	I-278	I-279	I-280	I-282	I-284	I-288	I-289	I-290
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aluminum (Al)	13,800	10,120	14,100	13,600	10,420	13,200	10,940	13,800	12,900	10,370	13,700	10,850	13,600	12,500	11,380
Arsenic (As)	6.2	8.7	9.0	9.4	9.4	14.8	8.4	7.8	9.8	9.9	6.7	10.9	8.6	9.5	8.5
Barium (Ba)	187	137	178	177	141	150	116	153	149	119	193	176	199	207	173
Beryllium (Be)	0.6	<0.1	0.5	0.5	<0.1	0.7	<0.1	0.6	0.6	<0.1	0.6	<0.1	0.4	0.5	<0.1
Bismuth (Bi)	<10	<18	<10	<10	<18	<10	<18	<10	<10	<18	<10	<18	<10	<10	<18
Cadmium (Cd)	2.7	2.0	3.1	3.1	2.4	2.2	1.7	3.4	2.6	1.9	2.7	2.9	3.7	3.5	2.5
Chromium (Cr)	81.7	62.0	90.5	91.8	65.4	73.6	50.7	82.5	72.8	51.7	84.7	63.9	90.0	87.8	68.0
Cobalt (Co)	7.5	7.8	10.1	10.7	8.1	6.9	6.9	6.5	7.4	7.4	8.7	8.0	8.1	8.4	8.5
Copper (Cu)	91.8	68.7	108	109	85.9	84.6	80.2	122	115	80.6	95.7	107	114	115	88.1
Iron (Fe)	11,200	8,920	11,000	11,000	9,670	12,500	9,040	10,700	10,000	8,505	11,200	9,150	11,000	10,900	14,200
Lead (Pb)	107	55.5	111	120	65.4	116	69.00	132	126	70.2	151	135	182	192	122
Manganese (Mn)	482	316	489	494	338	238	337	487	480	331	490	348	482	492	352
Mercury (Hg)	0.7	0.8	1.1	1.1	0.8	0.3	0.2	0.5	0.3	<0.2	0.5	0.8	0.5	0.6	0.4
Nickel (Ni)	30.2	38.6	30.7	30.3	24.6	30.2	25.4	28.4	31.9	24.4	30.2	30.6	32.0	31.0	26.6
Selenium (Se)	<1	<0.3	<1	<1	<0.3	1.3	<0.3	<1	<1	<0.3	<1	<0.3	<1	<1	<0.3
Silver (Ag)	<10	1.2	<10	<10	9.8	<10	0.8	<10	<10	<0.7	<10	1.1	<10	<10	1.3
Vanadium (V)	40.7	26.5	42.4	41.8	30.3	16.5	31.3	44.2	42.4	31.0	42.8	30.1	41.9	41.6	31.4
Zinc (Zn)	280	163	287	296	218	84.6	172	255	239	174	236	337	310	317	239

Table 2.39. Analytical Results for Repeatability and Reproducibility Samples - Metals, Site 4

Sample Identity	Grid No. 2					Grid No. 7					Grid No. 16				
	RTI	PEI	RTI	RTI	PEI	RTI	PEI	RTI	RTI	PEI	RTI	PEI	RTI	RTI	PEI
	0-465	0-467	0-471	0-472	0-473	0-475	0-477	0-481	0-482	0-483	0-485	0-487	0-491	0-492	0-493
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aluminum (Al)	12,400	7,997	13,700	12,900	10,080	10,500	10,390	10,500	10,100	7,630	13,600	10,050	12,500	12,300	10,970
Arsenic (As)	6.9	10.9	7.7	7.1	7.3	5.6	4.2	6.5	6.4	5.9	7.9	8.6	8.4	7.6	5.7
Barium (Ba)	109	138	121	121	114	105	54.0	113	678	104	146	155	145	228	70
Beryllium (Be)	<1	<0.1	<1	<1	0.2	<1	0.2	<1	<1	0.5	<1	<0.1	<1	<1	<0.1
Cadmium (Cd)	<1	68.3	<1	<1	1.1	<1	0.9	<1	<1	0.8	<1	1.5	<1	<1	1.1
Chromium (Cr)	137	181	121	124	102	108	79.1	116	113	85.6	145	104	149	147	114
Cobalt (Co)	14.5	20.2	15.1	16.9	17.0	14.7	12.2	15.0	15.2	14.4	18.6	21.1	21.1	20.7	15.0
Copper (Cu)	174	346	170	188	154	154	176.0	168	153	134	199	221	212	204	178
Iron (Fe)	21,000	32,500	21,700	21,200	17,920	17,000	7,340	18,600	18,300	14,600	22,900	19,010	22,700	22,500	11,600
Lead (Pb)	69.0	2,620	67.0	58.0	67.2	65.0	38.7	60.5	66.0	50.0	81.3	71.2	86.4	81.0	48.4
Manganese (Mn)	425	2,100	498	499	450	381	504	400	401	330	664	840	671	659	591
Mercury (Hg)	1.1	1.2	1.1	1.2	1.1	0.8	1.2	0.8	0.9	1.0	1.2	2.3	1.3	1.4	1.7
Nickel (Ni)	141	34.4	1645	168	138	504	232	489	485	403	217	269	211	207	176
Selenium (Se)	2.5	2.2	3.4	3.0	0.5	3.2	0.8	2.7	2.9	0.6	3.6	<0.3	2.9	3.8	<0.3
Silver (Ag)	<2	8.3	<2	<2	19.8	<2	<0.7	<2	<2	<0.7	<2	<0.7	<2	<2	<0.7
Vanadium (V)	483	21.0	479	484	384	2,960	551	2,820	2,810	2,160	440	392	414	408	284
Zinc (Zn)	233	27,280	249	248	291	201.0	264	209	207	179	330	419	341	332	309

Table 2.40. Analytical Results for Repeatability and Reproducibility Samples - Metals and Cyanide, Site 7

Sample Identity	Grid No. 7					Grid No. 23					Grid No. 24				
	RTI	PEI	RTI	RTI	PEI	RTI	PEI	RTI	RTI	PEI	RTI	PEI	RTI	RTI	PEI
	S-902	S-904	S-908	S-909	S-910	S-912	S-914	S-918	S-919	S-920	S-922	S-924	S-928	S-929	S-930
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Aluminum (Al)	16,500	13,420	17,100	17,400	13,010	10,300	10,030	11,600	11,200	10,290	10,100	2,300	11,300	10,900	8,320
Arsenic (As)	16.0	14.3	15.3	13.9	13.5	14.9	12.6	14.5	13.3	13.6	14.5	1.4	15.0	14.7	13.2
Barium (Ba)	385	401	356	357	313	195	204	257	228	223	193	3.1	194	192	161
Beryllium (Be)	<1	0.28	<1	<1	0.18	<1	<0.1	<1	<1	<0.1	<1	<0.1	<1	<1	<0.1
Cadmium (Cd)	28.8	45.7	37.2	37.9	32.4	123	63.5	71.3	71.5	67.0	84.1	0.6	90.1	98.0	58.5
Chromium (Cr)	181	255	196	207	141	325	696	937	933	970	255	8.0	289	285	216
Cobalt (Co)	10.4	20.5	25.9	13.7	17.7	7.1	19.4	6.5	7.2	20.4	6.3	<2	5.3	5.0	18.9
Copper (Cu)	326	778	431	435	344	681	470	705	710	654	455	7.9	465	463	347
Iron (Fe)	29,600	31,380	30,900	31,900	22,540	48,300	22,540	36,100	36,200	33,000	39,100	1,002	40,600	40,000	32,960
Lead (Pb)	1,590	2,598	2,140	2,124	1,600	5,230	2,770	3,490	3,480	2,902	3,900	6.0	4,210	4,140	3,180
Manganese (Mn)	1,150	1,587	1,400	1,380	1,130	4,380	2,270	2,740	2,700	2,510	2,920	<110	3,130	3,070	2,520
Mercury (Hg)	0.8	1.1	0.9	0.9	1.0	0.8	0.8	1.0	1.0	0.9	0.7	0.6	0.7	0.8	0.7
Nickel (Ni)	54.7	60.1	54.2	55.6	45.3	62.4	47.6	61.9	63.2	54.8	45.5	4.8	53.0	49.0	36.8
Selenium (Se)	2.3	0.4	1.4	1.5	<0.3	6.4	2.3	4.4	4.8	1.8	5.4	<0.3	5.4	5.7	2.2
Silver (Ag)	<2	5.3	<2	<2	2.3	<2	3.5	16.0	<2	4.7	<2	<0.7	<2	<2	7.0
Vanadium (V)	62.7	39.3	56.5	59.6	33.7	39.3	26.2	44.1	44.5	27.0	38.0	<0.7	42.1	39.7	21.8
Zinc (Zn)	7,760	13,680	8,947	7,010	8,060	38,400	26,570	24,330	24,800	25,380	29,700	172	31,700	31,000	29,540
cyanide	<0.5	3.78	<0.5	0.72	2.77	0.97	3.37	<0.5	1.50	2.82	0.86	1.56	<0.5	<0.5	2.02

Table 2.41. Analytical Results for Repeatability Samples - Semivolatile Organic HSL Compounds, Pesticides, and PCB's, Site 2

Organic Analysis Medium Concentration Level	Grid No. 7			Grid No. 8			Grid No. 12		
Sample Identity	I-261	I-265	I-266	I-271	I-275	I-276	I-281	I-285	I-286
Semivolatile Compounds	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
2-Methylnapthalene	N.D.	1.5J	1.0J	N.D.	1.2J	1.1J	N.D.	1.1J	0.5J
Isophorone	30.0	54.0	53.0	N.D.	N.D.	N.D.	16.0J	11.0J	12.0J
Phenanthrene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1.6J	1.1J
Phenol	2.8J	7.7J	7.6J	N.D.	1.6J	N.D.	8.3J	9.3J	11.0J
bis(2-ethylhexyl)phthalate	20.0	33.0	28.0	37.0	47.0	49.0	26.0	23.0	32.0
Pesticides									
4,4'-DDE	N.D.	0.068J	N.D.	N.D.	N.D.	N.D.	0.049J	0.057J	N.D.
Endosulfan I	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.088J	0.160J	N.D.
Gamma-BHC (Lindane)	N.D.	N.D.	N.D.	N.D.	0.043J	0.160J	0.170J	0.120J	0.140J
Heptachlor	N.D.	N.D.	N.D.	N.D.	0.050J	N.D.	0.070J	N.D.	N.D.
Toxaphene	N.D.	N.D.	N.D.	3.8J	N.D.	N.D.	N.D.	N.D.	0.100J

N.D. = less than quantifiable detection limit of 19.8 ug/g for semivolatiles; for pesticides detection limit see the corresponding pesticides analysis data sheet for the sample.

Organic Analysis Low Concentration Level	Grid No. 7			Grid No. 8			Grid No. 12		
Sample Identity	I-261	I-265	I-266	I-271	I-275	I-276	I-281	I-285	I-286
Semivolatile Compounds	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Phenol	2.10 B	2.30 B	0.77 B	1.80 B	1.00 B	1.30 B	4.30 B	5.30 B	2.80 B
4-Methylphenol	0.45	1.10	1.30	0.34	0.39	0.46	1.20	1.10	0.56
2,4-Dimethylphenol	1.20	1.10	1.30	0.23 J	0.98	0.97	0.43	0.38	0.16 J
Napthalene	0.24 J	0.34	0.41	0.18 J	0.16 J	0.20 J	0.12 J	0.13 J	N.D.
2-Methylnapthalene	0.91	0.98	0.95	0.75	0.70	0.87	0.51	0.56	0.29 J
Isophorone	22.0	24.0	40.0	0.69	1.30	1.40	5.0	1.0	4.4
2,4-Dinitrotoluene	0.47	1.10	0.90	N.D.	N.D.	N.D.	N.D.	0.39	0.22 J
Diethylphthalate	0.47	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Phenanthrene	0.60	0.68	0.54	0.82	0.67	0.83	0.67	0.77	0.31 J
Di-n-butylphthalate	N.D.	N.D.	0.95	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Fluoranthene	N.D.	N.D.	0.21 J	N.D.	N.D.	N.D.	N.D.	N.D.	0.12 J
Pyrene	0.20 J	N.D.	0.19 J	0.32 J	0.29 J	0.33 J	0.26 J	0.38	0.16 J
Butylbenzylphthalate	0.56	N.D.	1.70	N.D.	0.50	0.27 J	0.68	N.D.	0.59
Benz(a)anthracene	0.12 J	N.D.	N.D.	N.D.	N.D.	N.D.	0.12 J	0.17 J	N.D.
bis(2-ethylhexyl)phthalate	0.78	N.D.	4.10	0.68	2.40	1.80	N.D.	0.37	0.68
Chrysene	0.23 J	0.28 J	0.21 J	0.29 J	0.25 J	0.29 J	0.23 J	N.D.	0.20 J
Pesticides									
Gamma-BHC (Lindane)	N.D.	N.D.	N.D.	0.095	0.078 J	0.082 J	0.085 J	0.14	0.14
Toxaphene	2.30	2.90	2.60	17.0	12.0	13.0	2.0	2.6	2.6
Sample Detection Limit (ug/g)									
Semivolatile Compounds	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Gamma-BHC (Lindane)	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088	0.088
Toxaphene	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76

B = Compound detected in method blank at a concentration above GC limit

N.D. = Less than the samples quantifiable detection limit

J = Estimated value where the compound meets the mass spectral or chromatographic criteria but but is below the quantifiable detection limit

Table 2.42. Analytical Results for Repeatability Samples -
Semivolatile Organic HSL Compounds, Pesticides, and
PCB's, Site 7

Organic Analysis	Grid Cell # 7			Grid Cell # 8			Grid Cell # 24		
Sample Identity	S-901 Silt	S-905 Silt	S-906 Silt	S-911 Silt	S-915 Silt	S-916 Silt	S-921 Silt	S-925 Silt	S-926 Silt
Semivolatile Compound	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Acenaphthene	27.0 J	12.0 J	N.D.	38.0	27.0	22.0	28.0	21.0	30.0
Anthracene	N.D.	3.1 J	N.D.	36.0	22.0	35.0	37.0	16.0	30.0
Benzo(a)anthracene	N.D.	2.2 J	N.D.	7.7 J	5.3	5.9	7.6	5.2	N.D.
Benzoic Acid	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1.6 J	N.D.
Benzo(a)pyrene	N.D.	N.D.	N.D.	N.D.	1.3 J	1.5 J	2.2 J	1.5 J	N.D.
Benzo(b)fluoranthene	N.D.	N.D.	N.D.	4.4 J	N.D.	N.D.	4.5	3.2	N.D.
Benzo(k)fluoranthene	N.D.	N.D.	N.D.	N.D.	3.0	3.6 J	N.D.	N.D.	N.D.
Bis(2-ethylhexyl)phthalate	N.D.	N.D.	N.D.	N.D.	N.D.	6.4	N.D.	N.D.	N.D.
Chrysene	4.1 J	N.D.	N.D.	12.0 J	7.8	9.0	11.0	8.0	8.7
Dibenzofuran	20.0 J	7.0 J	9.8 J	27.0	23.0	21.0	29.0	18.0	19.0
Fluoranthene	10.0 J	3.5 J	4.7 J	48.0	18.0	25.0	19.0	15.0	37.0
Fluorene	28.0 J	16.0 J	N.D.	19.0	9.9	13.0	15.0	11.0	13.0
2-Methylnapthalene	310.0	170.0	240.0	83.0	120.0	130.0	100.0	62.0	67.0
2-Methylphenol	N.D.	N.D.	N.D.	N.D.	2.1 J	2.8 J	3.6	3.0	N.D.
4-Methylphenol	N.D.	N.D.	N.D.	14.0 J	9.6	10.0	13.0	9.8	N.D.
N-nitrosodiphenylamine	28.0 J	14.0 J	18.0 J	5.7 J	N.D.	N.D.	18.0	7.1	6.7
Napthalene	59.0	30.0	39.0	39.0	35.0	47.0	25.0	18.0	26.0
Phenanthrene	120.0	66.0	76.0	113.0	N.D.	110.0	55.0	16.0	190.0
Phenol	N.D.	N.D.	N.D.	56.0	74.0	96.0	370.0	140.0	160.0
Pyrene	12.0 J	4.6 J	6.6 J	4.0	16.0	23.0	18.0	13.0	33.0
1,2,4-Trichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1.1 J	N.D.	N.D.
Sample Detection Limit	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Benzoic Acid	152.3	99.0	151.7	88.0	12.0	18.2	12.2	8.0	120.0
Other compounds listed	31.4	18.3	31.3	18.2	2.5	3.8	2.5	1.7	24.8
Pesticides	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
4,4'-DDD	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.21 J	N.D.
4,4'-DDT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	3.60	N.D.
Aroclor-1254	N.D.	5.28	9.09	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sample Detection Limit	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
4,4'-DDD and 4,4'-DDT	0.87	0.32	0.87	0.53	0.74	1.12	0.74	0.48	0.69
Aroclor-1254	8.73	3.20	8.73	5.33	7.38	11.16	7.38	4.80	6.86

N.D. = Less than the sample's quantifiable detection limit

J. = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit.

samples analyzed for organic compounds. At Site 4, because of the presence of oil and grease in the land treatment cell selected for R&R sampling, these samples were not analyzed at all for organic compounds. The EPA felt that the oil and grease would interfere with the organic analysis and would have raised the detection limit such that few compounds would have qualified for the R&R assessment. No organic compounds were detected in the normal process samples from this land treatment cell.

For the R&R assessment, the relative standard deviation (RSD) was calculated for the total and analytical repeatability and reproducibility for each metal (see Table 2.43) and for the total and analytical repeatability for each organic compound (see Table 2.44) meeting the detection limit criteria. The RSD was calculated using the mean value for the duplicate analysis by the in-house laboratory as follows:

$$\text{RSD} = \frac{\text{standard deviation}}{\text{duplicate mean}} \times 100\%$$

The mean and the median value of the individual RSD's for each metal, are shown in Table 2.41. The values were determined for the total and analytical repeatability and reproducibility for each of the nine R&R grid cells. The mean and median value for the organic compound individual RSD's shown in Table 2.43 were determined for the total and analytical repeatability for each of the six R&R grid cells.

For metals, the range of the mean and median RSD total repeatability for the nine grid cells was 4.37% to 20.16% and 2.71% to 14.69%, respectively. For the analytical repeatability for metals, the range of the mean and median RSD was 1.7% to 13.63% and 0.84% to 4.77%, respectively. For the total reproducibility for metals, the range of the mean and median RSD was 290.64% to 11.93% and 69.54% to 11.92%, respectively. The mean RSD of 290.64% for total reproducibility for metals was affected by lead and manganese results on one sample (0-467) reported by the outside laboratory. The manganese result was 4.5 times higher on this sample than the average for the other four samples; for lead, the result was 40 times higher than the average for the other four samples. For the analytical reproducibility for metals, the range of the mean and median RSD was 12.33% to 27.57% and 5.73 to 20.09%, respectively.

For the organic analysis only a limited number of organic compounds met the detection limit criteria for the repeatability assessment. For Site 2 three

Table 2.43. Summary of RSD for Repeatability and Reproducibility for Metals, Sites 2, 4, and 7

Element	Repeatability		Reproducibility		Repeatability		Reproducibility		Repeatability		Reproducibility	
	Total Analytical		Total Analytical		Total Analytical		Total Analytical		Total Analytical		Total Analytical	
Site 2	Grid Cell No. 7				Grid Cell No. 8				Grid Cell No. 12			
Aluminum (Al)	0.26%	2.55%	19.04%	17.51%	0.79%	4.77%	12.76%	15.78%	3.52%	5.96%	11.92%	9.05%
Arsenic (As)	23.06%	3.07%	4.00%	1.46%	48.21%	16.07%	3.21%	9.16%	18.36%	7.03%	14.45%	4.61%
Barium (Ba)	3.78%	0.40%	16.13%	14.54%	0.47%	1.87%	16.39%	14.99%	3.48%	2.79%	9.40%	10.45%
Cadmium (Cd)	9.12%	.00%	24.18%	16.20%	18.86%	18.86%	29.93%	25.22%	17.68%	3.93%	14.53%	21.61%
Chromium (Cr)	7.33%	1.01%	22.61%	19.98%	3.69%	8.83%	24.54%	23.63%	3.34%	1.75%	19.88%	16.62%
Cobalt (Co)	19.72%	4.08%	17.54%	15.91%	0.51%	9.16%	0.51%	4.99%	3.86%	2.57%	1.74%	1.89%
Copper (Cu)	10.88%	0.65%	25.94%	14.73%	20.23%	4.18%	22.85%	22.62%	11.61%	0.62%	4.63%	16.30%
Iron (Fe)	1.29%	0.00%	13.37%	8.55%	14.69%	4.78%	8.95%	12.60%	1.61%	0.65%	11.62%	20.99%
Lead (Pb)	5.20%	5.51%	36.73%	30.67%	7.13%	3.29%	32.89%	32.23%	13.61%	3.78%	19.66%	24.58%
Manganese (Mn)	1.37%	0.72%	25.25%	22.08%	35.90%	1.02%	21.43%	22.30%	0.44%	1.45%	20.18%	19.60%
Nickel (Ni)	0.70%	0.93%	18.78%	13.21%	0.12%	8.21%	11.14%	13.49%	2.92%	2.24%	2.02%	11.00%
Vanadium (V)	2.35%	1.01%	26.20%	19.82%	43.77%	2.94%	19.60%	20.09%	1.78%	0.51%	19.73%	17.53%
Zinc (Zn)	2.79%	2.18%	31.17%	17.83%	46.49%	4.58%	21.47%	20.90%	17.48%	1.58%	5.30%	16.80%
Mean RSD	6.76%	1.70%	21.61%	16.35%	18.53%	6.81%	17.36%	18.31%	7.67%	2.68%	11.93%	14.69%
Median RSD	3.78%	1.01%	22.61%	16.20%	14.69%	4.77%	19.60%	20.09%	3.52%	2.24%	11.92%	16.62%
Site 4	Grid Cell No. 2				Grid Cell No. 7				Grid Cell No. 16			
Aluminum (Al)	4.78%	4.25%	28.19%	17.12%	1.37%	2.75%	0.62%	18.33%	6.84%	1.14%	13.40%	8.15%
Arsenic (As)	4.78%	5.73%	33.44%	1.24%	9.32%	1.10%	24.67%	6.25%	0.88%	7.07%	5.48%	20.15%
Barium (Ba)	7.01%	0.00%	9.93%	4.09%	51.94%	101.02%	61.06%	52.12%	15.36%	31.47%	11.94%	44.32%
Chromium (Cr)	8.37%	1.73%	33.77%	11.83%	4.01%	1.85%	21.86%	17.85%	1.43%	0.96%	21.02%	16.24%
Cobalt (Co)	6.63%	7.95%	18.56%	4.42%	1.87%	0.94%	13.58%	3.28%	7.78%	1.35%	0.68%	19.96%
Copper (Cu)	1.98%	7.11%	65.97%	9.88%	2.86%	6.61%	6.83%	11.67%	3.06%	2.72%	4.42%	10.20%
Iron (Fe)	1.48%	1.65%	36.43%	11.64%	5.56%	1.15%	42.58%	14.76%	0.94%	0.63%	11.23%	34.42%
Lead (Pb)	7.35%	10.18%	2893%	5.32%	1.96%	6.15%	27.45%	14.81%	2.03%	4.56%	10.56%	29.82%
Manganese (Mn)	10.43%	0.14%	227.17%	6.88%	3.44%	0.18%	18.27%	12.45%	0.11%	1.28%	18.61%	7.97%
Mercury (Hg)	3.79%	8.84%	5.05%	1.26%	5.05%	5.05%	30.30%	13.47%	6.52%	6.78%	49.31%	18.00%
Nickel (Ni)	59.71%	115.21%	68.03%	59.95%	2.47%	0.58%	37.03%	12.20%	2.71%	1.35%	20.30%	11.16%
Vanadium (V)	0.22%	0.73%	67.63%	14.32%	3.64%	0.25%	56.87%	16.45%	4.99%	1.03%	3.27%	21.85%
Zinc (Zn)	4.41%	0.28%	7692%	12.09%	2.38%	0.68%	19.04%	9.86%	1.37%	1.89%	17.34%	5.78%
Mean RSD	9.71%	13.63%	290.64%	12.33%	7.79%	10.63%	28.43%	16.14%	4.71%	5.03%	17.18%	19.07%
Median RSD	4.78%	4.25%	36.43%	9.88%	3.44%	1.15%	24.67%	13.47%	2.71%	1.35%	11.94%	18.00%
Site 6	Grid Cell No. 7				Grid Cell No. 8				Grid Cell No. 24			
Aluminum (Al)	3.07%	1.23%	15.70%	17.38%	6.82%	2.48%	8.50%	6.88%	6.37%	2.55%	52.87%	17.71%
Arsenic (As)	6.78%	6.78%	1.45%	5.33%	3.75%	3.50%	7.75%	2.75%	1.67%	1.43%	63.85%	7.86%
Barium (Ba)	5.65%	0.20%	8.83%	8.63%	13.85%	8.46%	11.23%	5.69%	0.00%	0.73%	69.57%	11.72%
Cadmium (Cd)	16.48%	1.32%	15.35%	9.70%	51.10%	0.20%	7.82%	4.36%	3.93%	1.67%	70.27%	16.32%
Chromium (Cr)	7.19%	3.86%	18.77%	21.23%	46.13%	0.30%	18.07%	4.92%	7.88%	0.99%	68.74%	17.49%
Cobalt (Co)	33.57%	43.57%	2.50%	7.50%	2.58%	7.23%	129.55%	139.87%	11.79%	10.48%	70.71%	176.78%
Copper (Cu)	17.47%	0.65%	56.34%	14.53%	2.65%	0.50%	23.74%	5.35%	1.37%	0.30%	69.51%	17.83%
Iron (Fe)	3.95%	2.48%	0.07%	19.87%	24.74%	0.20%	26.62%	6.16%	2.11%	1.05%	68.95%	12.88%
Lead (Pb)	14.66%	0.53%	15.46%	17.64%	35.41%	0.20%	14.51%	11.83%	4.66%	1.19%	70.61%	16.85%
Manganese (Mn)	12.21%	1.02%	10.02%	13.23%	43.15%	1.04%	11.70%	5.46%	4.11%	1.87%	70.71%	10.95%
Mercury (Hg)	6.29%	4.71%	15.71%	7.86%	11.54%	1.44%	12.99%	5.77%	0.94%	5.66%	14.14%	4.71%
Nickel (Ni)	0.26%	1.80%	6.70%	12.36%	0.17%	1.47%	16.90%	8.76%	7.63%	5.55%	64.06%	19.69%
Vanadium (V)	6.33%	2.58%	23.65%	29.30%	7.98%	0.64%	28.89%	27.61%	5.01%	4.15%	70.71%	33.02%
Zinc (Zn)	1.94%	17.17%	50.53%	0.72%	38.71%	0.09%	5.00%	3.03%	3.72%	1.58%	70.32%	4.08%
Mean RSD	10.63%	5.68%	13.91%	12.94%	20.16%	2.25%	24.11%	17.32%	4.37%	2.75%	62.83%	27.57%
Median RSD	6.55%	2.14%	15.40%	12.80%	12.70%	0.84%	13.75%	5.73%	4.02%	1.50%	69.54%	16.58%

Table 2.44. Summary of RSD for Repeatability for Organic Compounds, Sites 2 and 7

Site 2	Grid No. 7			Grid No. 8			Grid No. 12		
	I-261	I-265	I-266	I-271	I-275	I-276	I-281	I-285	I-286
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
4-Methylphenol	0.45	1.10	1.30	0.34	0.39	0.46	1.20	1.10	0.56
Isophorone	22.0	24.0	40.0	0.69	1.30	1.40	8.0	1.0	4.4
Toxaphene	2.3	2.9	2.6	17.0	12.0	13.0	2.0	2.6	2.6
Repeatability	Grid No. 7		Grid No. 8		Grid No. 12				
	Total	Analytical	Total	Analytical	Total	Analytical			
4-Methylphenol	44.19%	11.79%	14.14%	11.65%	31.52%	46.00%			
Isophorone	22.10%	35.36%	34.57%	5.24%	138.80%	89.04%			
Toxaphene	11.57%	7.71%	25.46%	5.66%	16.32%	.00%			
Mean RSD	25.95%	18.28%	24.72%	7.51%	62.21%	45.02%			
Median RSD	22.10%	11.79%	14.14%	5.66%	31.52%	46.00%			
Site 6	Grid Cell # 7			Grid Cell # 8			Grid Cell # 24		
	S-901	S-905	S-906	S-911	S-915	S-916	S-921	S-925	S-926
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
2-Methylnapthalene	310.0	170.0	240.0	83.0	120.0	130.0	100.0	62.0	67.0
Napthalene	59.0	30.0	38.0	39.0	35.0	47.0	25.0	18.0	26.0
Phenanthrene	120.0	66.0	76.0	113.0	N.D.	110.0	55.0	16.0	100.0
Phenol	N.D.	N.D.	N.D.	56.0	74.0	96.0	370.0	140.0	160.0
Pyrene	12.0 J	4.6 J	6.6 J	4.0	16.0	23.0	18.0	13.0	33.0
Repeatability	Grid No. 7		Grid No. 8		Grid No. 24				
	Total	Analytical	Total	Analytical	Total	Analytical			
2-Methylnapthalene	36.22%	24.15%	23.76%	5.66%	38.92%	5.48%			
Napthalene	51.99%	16.64%	3.45%	20.70%	9.64%	25.71%			
Phenanthrene	48.80%	9.96%	-	-	3.66%	102.41%			
Phenol	-	-	24.12%	18.30%	103.71%	9.43%			
Pyrene	-	-	56.21%	25.38%	15.37%	61.49%			
Mean RSD	45.67%	16.91%	26.88%	17.51%	34.26%	40.90%			
Median RSD	36.22%	16.64%	23.91%	19.50%	15.37%	25.71%			

N.D. = Less than the sample's quantifiable detection limit (see Table 2.)

J. = Estimated value where the compound meets the spectral criteria but the result is less than the quantifiable limit

compounds met the detection limit criteria, and for Site 7 five compounds met the criteria (see Table 2.44). For Site 2 the median RSD for analytical repeatability for the organics ranged from 5.66% to 46.0% and for total repeatability for the organics the median RSD ranged from 14.14% to 31.52%. For Site 7 the median RSD for analytical repeatability ranged from 16.64% to 25.71% and for total repeatability the median RSD ranged from 15.37% to 36.22%.

The results for the performance audits and the calculated relative errors for the metals analysis for the in-house laboratory and the outside laboratory are shown in Table 2.45. The range of the relative errors for the nine spiked metals determined by the inside laboratory were 5.7% to -33.3%, 14.3% to -26.9%, and 5.2% to -43.6% for Sites 2, 4, and 7, respectively. The silver determination by the inside laboratory for all three sites showed the greatest negative relative error. The range of the relative errors for the nine spiked metals analyzed by the outside laboratory were -2.1% to -53.3%, -10.9% to -38.0%, and 45.9% to -74.96% for Sites 2, 4, and 7, respectively. For the outside laboratory, the silver determination for Site 2 laboratory also had the greatest negative relative error and for Site 4 and 7 the second greatest negative relative error.

For the performance audit for the organics analysis, the qualitative determination (compound identification) of the spiked semivolatile compounds for Site 2 was better than Site 7. Thirty-six of the 45 spiked compounds (80%) were identified in the sample from Site 2 (see Table 2.46). Only 12 of the 45 spiked compounds (26.6%) were identified in sample from Site 7 (see Table 2.47). For Site 2 the relative error for the compounds identified ranged from 17.3% to -68.1%. For Site 7 the relative error for the compounds identified ranged from 5.3% to -62.9%.

For the spiked pesticide compounds the relative errors for Site 2 ranged from 10.0% to -63.0%. For Site 7 the relative errors ranged from 59.4% to -87.5% with four of the sixteen compounds not being detected.

The fact that a number of the spiked compounds were not identified may have been a result of the dilutions from the clean up procedure and/or dilutions required before the analyses.

A statistical analysis of the R&R data for metals was conducted using the SAS General Linear Models Procedure for unbalanced analysis of variance (ANOVA). The model was constructed with three classes consisting of 1) the sites where R&R samples were collected, 2) the grid cells within a site, and 3) the in-house and outside laboratories. The data from each individual site were

Table 2.45. Results of Performance Audit for Metals Analysis by In-house and Outside Laboratories, Sites 2, 4, and 7

Sample Identity Site 2	Unspiked Samples			Spike Amount	Found I-296	RTI Relative Error	Unspiked Sample I-270	Spike Amount	Found I-298	PEI Relative Error
	I-268	I-269	Mean							
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)		(ug/g)	(ug/g)		
Arsenic (As)	6.2	9.0	7.6	126.6	102	-23.8%	9.4	237.6	161	-34.7%
Barium (Ba)	187	178	183	126.6	309	.0%	141	237.6	371	-2.1%
Beryllium (Be)	0.6	0.5	0.6	126.6	108	-15.1%	<0.1	237.6	172	-27.7%
Cadmium (Cd)	2.7	3.1	2.9	126.6	126	-2.9%	2.4	237.6	172	-28.4%
Copper (Cu)	91.8	108	99.9	126.6	239	5.7%	85.9	237.6	275	-14.9%
Lead (Pb)	107	111	109	126.6	235	-0.2%	65.4	237.6	249	-17.9%
Manganese (Mn)	482	489	486	126.6	557	-9.1%	338	237.6	559	-2.9%
Selenium (Se)	<1	<1	<1	126.6	84.4	-33.3%	<0.3	237.6	126	-47.0%
Silver (Ag)	<10	<10	<10	126.6	118	-7.1%	9.8	237.6	116	-53.3%
Zinc (Zn)	280	287	284	126.6	406	-1.1%	218	237.6	420	-7.8%

Sample Identity Site 4	Unspiked Sample		Spike Amount	Found O-495	RTI Relative Error	Unspiked Sample O-458	Spike Amount	Found O-497	PEI Relative Error
	O-458								
Element	(ug/g)		(ug/g)	(ug/g)		(ug/g)	(ug/g)		
Arsenic (As)	7.4		91.7	74.1	-25.3%	7.4	89.4	74.0	-23.5%
Barium (Ba)	190		91.7	256	-9.0%	190	89.4	211	-24.4%
Beryllium (Be)	<1		91.7	93.1	1.5%	<1	89.4	79.2	-11.4%
Cadmium (Cd)	<1		91.7	90.3	-1.5%	<1	89.4	79.7	-10.9%
Copper (Cu)	198		91.7	316	9.2%	198	89.4	224	-22.2%
Lead (Pb)	92.0		91.7	195	6.2%	92.0	89.4	126	-30.7%
Manganese (Mn)	508		91.7	673	12.1%	508	89.4	422	-29.3%
Selenium (Se)	3.2		91.7	70.0	-26.2%	3.2	89.4	57.4	-38.0%
Silver (Ag)	<10		91.7	67.0	-26.9%	<10	89.4	59.7	-33.2%
Zinc (Zn)	296		91.7	443	14.3%	296	89.4	294	-23.7%

Sample Identity Site 7	Unspiked Samples			Spike Amount	Found S-932	RTI Relative Error	Sample S-910	Spike Amount	Found S-934	PEI Relative Error
	S-908	S-909	Mean							
Element	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)		(ug/g)	(ug/g)	(ug/g)	
Arsenic (As)	15.3	13.9	14.6	279.8	245	-16.7%	13.5	202.3	142	-34.0%
Barium (Ba)	356	357	357	279.8	670	5.2%	313	202.3	130	-74.8%
Beryllium (Be)	<1	<1	<1	279.8	250	-10.7%	0.2	202.3	159	-21.3%
Cadmium (Cd)	37.2	37.9	37.6	279.8	286	-9.9%	32.4	202.3	187	-20.3%
Copper (Cu)	431	435	433	279.8	592	-17.0%	344	202.3	797	45.9%
Lead (Pb)	2,140	2,124	2,132	279.8	2,211	-8.3%	1,600	202.3	1,772	-1.7%
Manganese (Mn)	1,400	1,380	1,390	279.8	1,342	-19.6%	1,130	202.3	1,309	-1.8%
Selenium (Se)	1.4	1.5	1.5	279.8	254	-9.9%	<0.3	202.3	122	-39.7%
Silver (Ag)	<10	<10	<10	279.8	158	-43.6%	2.3	202.3	87.3	-57.3%
Zinc (Zn)	8,947	7,010	7,979	279.8	8,632	4.5%	8,060	202.3	11,351	37.4%

Table 2.46. Results of Performance Audit for Semivolatile Organic
HSL Compound Analysis and Pesticide Analysis by
In-house Laboratory, Site 2

Sample Identity	Unspiked	Found				Unspiked	Found		
Semivolatile Organics	Sample Mean	Spike Amount	-----	Relative	Pesticides	Sample Mean	Spike Amount	-----	Relative
	(ug/g)	(ug/g)	I-295	Error		(ug/g)	(ug/g)	I-295	Error
Spike Compound	(ug/g)	(ug/g)	(ug/g)		Spike Compound	(ug/g)	(ug/g)	(ug/g)	
2,4,5-Trichlorophenol	N.D.	56.3	34.00	-39.7%	Alpha-BHC	N.D.	5.63	2.48	-56.0%
2,4,6-Trichlorophenol	N.D.	56.3	27.00	-52.1%	Beta-BHC	N.D.	5.63	3.04	-46.0%
2,4-Dichlorophenol	N.D.	56.3	41.00	-27.2%	Delta-BHC	N.D.	5.63	2.93	-48.0%
2,4-Dimethylphenol	N.D.	56.3	18.00	-68.1%	Gamma-BHC(Lindane)	N.D.	5.63	2.99	-47.0%
2,4-Dinitrophenol	N.D.	56.3	0.00	-100.0%	Heptachlor	N.D.	5.63	3.66	-35.0%
2-Chlorophenol	N.D.	56.3	38.00	-32.6%	Aldrin	N.D.	5.63	3.66	-35.0%
2-Methylphenol	N.D.	56.3	40.00	-29.0%	Heptachlor Epoxide	N.D.	5.63	6.20	10.0%
2-Nitrophenol	N.D.	56.3	39.00	-30.8%	Endosulfan I	N.D.	5.63	5.19	-8.0%
4,6-Dinitro-2-methylphenol	N.D.	56.3	0.00	-100.0%	Dieldrin	N.D.	5.63	3.94	-30.0%
4-Methylphenol	N.D.	56.3	40.00	-29.0%	4,4'-DDE	0.07	5.63	3.44	-39.7%
4-Nitrophenol	N.D.	56.3	20.00	-64.5%	Endrin	N.D.	5.63	4.23	-25.0%
4-chloro-3-methylphenol	N.D.	56.3	49.00	-13.0%	Endosulfan II	N.D.	5.63	2.65	-53.0%
Benzoic Acid	N.D.	56.3	0.00	-100.0%	4,4'-DDD	N.D.	5.63	2.08	-63.0%
Pentachlorophenol	N.D.	56.3	0.00	-100.0%	Endosulfan Sulfate	N.D.	5.63	3.61	-36.0%
Phenol	7.65 J	56.3	42.00	-34.4%	Methoxychlor	N.D.	5.63	2.48	-56.0%
1,2-Dichlorobenzene	N.D.	11.3	8.20	-27.2%	Endrin Ketone	N.D.	2.92	2.03	-28.0%
1,4-Dichlorobenzene	N.D.	11.3	7.40	-34.3%					
Acenaphthene	N.D.	11.3	8.50	-24.6%					
Anthracene	N.D.	11.3	8.90	-21.0%	Sample Detection				
Benzo(k)fluoranthene	N.D.	11.3	7.10	-37.0%	Limit	(ug/g)	(ug/g)		
Bis(2-ethylhexyl)phthalate	30.50	11.3	49.00	17.3%					
Dibenz(a,h)anthracene	N.D.	11.3	0.00	-100.0%	Alpha-BHC	0.30		0.07	
Dibenzofuran	N.D.	11.3	8.50	-24.6%	Beta-BHC	0.30		0.07	
Fluorene	N.D.	11.3	8.90	-21.9%	Delta-BHC	0.30		0.07	
Hexachlorobenzene	N.D.	11.3	9.30	-17.5%	Gamma-BHC(Lindane)	0.30		0.07	
Hexachlorocyclopentadiene	N.D.	11.3	0.00	-100.0%	Heptachlor	0.30		0.07	
Isophorone	53.50	11.3	71.00	9.6%	Aldrin	0.30		0.07	
N-nitroso-di-propylamine	N.D.	11.3	8.10	-28.1%	Heptachlor Epoxide	0.30		0.07	
Nitrobenzene	N.D.	11.3	8.50	-24.6%	Endosulfan I	0.30		0.07	
Pyrene	N.D.	11.3	9.90	-12.1%	Dieldrin	0.60		0.14	
2-Chloronaphthalene	N.D.	11.3	7.80	-30.8%	4,4'-DDE	0.60		0.14	
4-Bromophenylphenylether	N.D.	11.3	6.50	-42.3%	Endrin	0.60		0.14	
4-Chlorophenylphenylether	N.D.	11.3	5.90	-47.6%	Endosulfan II	0.60		0.14	
Benzo(a)pyrene	N.D.	11.3	6.00	-46.8%	4,4'-DDD	0.60		0.14	
Benzo(g,h,i)perylene	N.D.	11.3	0.00	-100.0%	Endosulfan Sulfate	0.60		0.14	
Benzyl Alcohol	N.D.	11.3	4.80	-57.4%	Methoxychlor	3.00		0.68	
Chrysene	N.D.	11.3	0.00	-100.0%	Endrin Ketone	0.60		0.14	
Di-n-butylphthalate	N.D.	11.3	12.00	6.5%					
Di-n-octylphthalate	N.D.	11.3	11.00	-2.4%					
Diethylphthalate	N.D.	11.3	0.00	-100.0%					
Dimethyl Phthalate	N.D.	11.3	8.40	-25.4%					
Hexachlorobutadiene	N.D.	11.3	9.70	-13.9%					
Hexachloroethane	N.D.	11.3	6.40	-43.2%					
Napthalene	N.D.	11.3	11.00	-2.4%					
bis(2-chloroethyl)ether	N.D.	11.3	6.50	-42.3%					

N.D. = less than quantifiable detection limit of 19800 ug/kg for semivolatile organic compounds;

less than the sample's quantifiable detection limit for pesticides.

J = Estimated value where the compound meets the mass spectral criteria but is below the quantifiable limit.

Table 2.47. Results of Performance Audit for Semivolatile Organic HSL Compound Analysis and Pesticides Analysis by In-house Laboratory, Site 7

Sample Identity	Unspiked		Found			Unspiked		Found	
Sample	Sample	Spike	-----	Relative		Sample	Spike	-----	Relative
Semivolatile Organics	Mean	Amount	S-931	Error	Pesticides	Mean	Amount	S-931	Error
Spike Compound	(ug/g)	(ug/g)	(ug/g)		Spike Compound	(ug/g)	(ug/g)	(ug/g)	
2,4,5-Trichlorophenol *	N.D.	86.2	N.D.	-100.0%	Alpha-BHC	N.D.	8.63	9.50	10.1%
2,4,6-Trichlorophenol	N.D.	86.2	N.D.	-100.0%	Beta-BHC	N.D.	8.63	N.D.	-100.0%
2,4-Dichlorophenol	N.D.	86.2	N.D.	-100.0%	Delta-BHC	N.D.	8.63	N.D.	-100.0%
2,4-Dimethylphenol	N.D.	86.2	N.D.	-100.0%	Gamma-BHC(Lindane)	N.D.	8.63	13.75	59.4%
2,4-Dinitrophenol	N.D.	86.2	N.D.	-100.0%	Heptachlor	N.D.	8.63	6.63 J	-23.2%
2-Chlorophenol	N.D.	86.2	N.D.	-100.0%	Aldrin	N.D.	8.63	10.50	21.7%
2-Methylphenol	N.D.	86.2	N.D.	-100.0%	Heptachlor Epoxide	N.D.	8.63	9.38	8.7%
2-Nitrophenol	N.D.	86.2	N.D.	-100.0%	Endosulfan I	N.D.	8.63	1.08 J	-87.5%
4,6-Dinitro-2-methylphenol	N.D.	86.2	N.D.	-100.0%	Dieldrin	N.D.	8.63	9.38 J	8.7%
4-Methylphenol	N.D.	86.2	N.D.	-100.0%	4,4'-DDE	N.D.	8.63	8.75 J	1.4%
4-Nitrophenol *	N.D.	86.2	N.D.	-100.0%	Endrin	N.D.	8.63	10.50 J	21.7%
4-chloro-3-methylphenol	N.D.	86.2	N.D.	-100.0%	Endosulfan II	N.D.	8.63	N.D.	-100.0%
Benzoic Acid *	N.D.	86.2	N.D.	-100.0%	4,4'-DDD	N.D.	8.63	11.13 J	28.9%
Pentachlorophenol *	N.D.	86.2	N.D.	-100.0%	Endosulfan Sulfate	N.D.	8.63	4.88 J	-43.5%
Phenol	N.D.	86.2	32.0 J	-62.9%	Methoxychlor	N.D.	8.63	N.D.	-100.0%
1,2-Dichlorobenzene	N.D.	17.2	N.D.	-100.0%	Endrin Ketone	N.D.	8.63	3.00 J	-65.2%
1,4-Dichlorobenzene	N.D.	17.2	N.D.	-100.0%					
Acenaphthene	12.0 J	17.2	30.0 J	2.6%	Sample Detection				
Anthracene	3.1 J	17.2	18.0 J	-11.5%	Limit	(ug/g)		(ug/g)	
Benzo(k)fluoranthene	N.D.	17.2	N.D.	-100.0%					
Bis(2-ethylhexyl)phthalate	N.D.	17.2	N.D.	-100.0%	Alpha-BHC	1.4		9.0	
Dibenz(a,h)anthracene	N.D.	17.2	N.D.	-100.0%	Beta-BHC	1.4		9.0	
Dibenzofuran	8.4 J	17.2	23.0 J	-10.3%	Delta-BHC	1.4		9.0	
Fluorene	16.0 J	17.2	35.0 J	5.3%	Gamma-BHC(Lindane)	1.4		9.0	
Hexachlorobenzene	N.D.	17.2	9.3 J	-46.1%	Heptachlor	1.4		9.0	
Hexachlorocyclopentadiene	N.D.	17.2	N.D.	-100.0%	Aldrin	1.4		9.0	
Isophorone	N.D.	17.2	9.5 J	-50.7%	Heptachlor Epoxide	1.4		9.0	
N-nitroso-di-propylamine	16.0 J	17.2	N.D.	-100.0%	Endosulfan I	1.4		9.0	
Nitrobenzene	N.D.	17.2	N.D.	-100.0%	Dieldrin	2.8		18.0	
Pyrene	5.6 J	17.2	21.0 J	-8.1%	4,4'-DDE	2.8		18.0	
2-Chloronaphthalene	N.D.	17.2	N.D.	-100.0%	Endrin	2.8		18.0	
4-Bromophenylphenylether	N.D.	17.2	N.D.	-100.0%	Endosulfan II	2.8		18.0	
4-Chlorophenylphenylether	N.D.	17.2	18.0 J	4.4%	4,4'-DDD	2.8		18.0	
Benzo(a)pyrene	N.D.	17.2	14.0 J	-18.8%	Endosulfan Sulfate	2.8		18.0	
Benzo(g,h,i)perylene	N.D.	17.2	N.D.	-100.0%	Methoxychlor	14.0		90.0	
Benzyl Alcohol	N.D.	17.2	N.D.	-100.0%	Endrin Ketone	2.8		18.0	
Chrysene	N.D.	17.2	18.0 J	4.4%					
Di-n-butylphthalate	N.D.	17.2	N.D.	-100.0%					
Di-n-octylphthalate	N.D.	17.2	N.D.	-100.0%					
Diethylphthalate	N.D.	17.2	N.D.	-100.0%					
Dimethyl Phthalate	N.D.	17.2	N.D.	-100.0%					
Hexachlorobutadiene	N.D.	17.2	N.D.	-100.0%					
Hexachloroethane	N.D.	17.2	N.D.	-100.0%					
Naphthalene	34.0	17.2	48.0	-6.3%					
bis(2-chloroethyl)ether	N.D.	17.2	N.D.	-100.0%					
Sample Detection Limit	(ug/g)		(ug/g)						
* Compounds	120.3		196.6						
All other compounds	24.9		38.5						

N.D. = Less than the sample's quantifiable detection limit

J. = Estimated value where the compound meets the spectral criteria but is below the quantifiable limit.

used to assess between site variation. The data from each of the two laboratories were used to assess between-laboratory variation. Interactions between sites and laboratory analyses were also assessed.

The results of the ANOVA for elements from the five sources (Sites, Cells Nested within Sites, Laboratory, Laboratory/Site Interaction, and Cell/Laboratory Nested within Sites) are shown in Table 2.48. For the Sites source, the ANOVA mean square term for Cells Nested within Sites source was used as an error term. For the Laboratory source and the Laboratory/Site Interaction sources, the mean square term for the Cell/Laboratory Nested within Sites source was used as an error term.

At the 95% confidence level, significant differences were seen between the three sites for arsenic, cadmium, cobalt, iron, lead, manganese, mercury, and nickel. Significant differences were seen between the in-house and outside laboratories for the analyses of aluminum, iron, and selenium. Selenium also showed a site/laboratory interaction at the 94% confidence level. This interaction may have been indicative of a matrix affect.

Table 2.48. Analysis of Variance (ANOVA) for Repeatability and Reproducibility of Sampling and Analysis of Metals

Aluminum				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	1.30E+07	0.29	0.7616
Laboratory	1	9.08E+08	29.70	0.0016
Site/Laboratory Interaction	2	1.32E+06	0.22	0.8112
Arsenic				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	3.10E+02	20.15	0.0022
Laboratory	1	1.16E+01	0.63	0.4585
Site/Laboratory Interaction	2	2.78E+01	0.75	0.5122
Barium				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	6.78E+04	1.42	0.3131
Laboratory	1	9.08E+08	3.91	0.0583
Site/Laboratory Interaction	2	1.32E+06	0.22	0.8112
Cadmium				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	3.28E+04	17.70	0.0030
Laboratory	1	9.22E+01	0.18	0.6879
Site/Laboratory Interaction	2	2.63E+03	2.53	0.1594
Chromium				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	8.47E+05	2.52	0.1606
Laboratory	1	7.33E+03	1.35	0.2901
Site/Laboratory Interaction	2	6.55E+02	0.06	0.9422

Table 2.48. (continued)

Cobalt				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	5.69E+02	5.27	0.0477
Laboratory	1	4.36E+01	2.74	0.1487
Site/Laboratory Interaction	2	1.20E+02	3.77	0.0871
Iron				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	3.40E+09	48.17	0.0002
Laboratory	1	3.78E+08	6.81	0.0402
Site/Laboratory Interaction	2	2.89E+08	2.60	0.1538
Lead				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	7.41E+07	90.86	0.0001
Laboratory	1	8.50E+05	0.94	0.3696
Site/Laboratory Interaction	2	4.98E+06	2.75	0.1418
Manganese				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	2.88E+07	12.46	0.0073
Laboratory	1	5.34E+05	1.42	0.2785
Site/Laboratory Interaction	2	2.35E+06	3.11	0.1181
Mercury				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	3.04E+00	7.01	0.0269
Laboratory	1	7.17E-02	1.19	0.3178
Site/Laboratory Interaction	2	3.44E-01	2.84	0.1353

Table 2.48. (continued)

Nickel				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	9.94E+05	20.53	0.0021
Laboratory	1	8.06E+01	2.33	0.1779
Site/Laboratory Interaction	2	1.33E+05	1.92	0.2269
Selenium				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	3.85E+01	4.70	0.0591
Laboratory	1	4.30E+01	44.06	0.0006
Site/Laboratory Interaction	2	9.26E+00	4.74	0.0582
Silver				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	1.25E+02	2.79	0.1391
Laboratory	1	1.93E+01	0.66	0.4436
Site/Laboratory Interaction	2	2.20E+02	3.79	0.0863
Vanadium				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	9.39E+06	2.39	0.1727
Laboratory	1	5.14E+05	2.16	0.1924
Site/Laboratory Interaction	2	8.86E+05	1.86	0.2356
Zinc				
Source	Degrees of Freedom	ANOVA SS	F Value	Probability > F
Sites	2	3.77E+09	10.16	0.0118
Laboratory	1	1.11E+06	0.00	0.8978
Site/Laboratory Interaction	2	1.76E+08	1.43	0.3103

3.0 PROCESS DESCRIPTIONS, SITE PLOT PLANS, AND SAMPLING GRIDS

For this study, eight TSDF's were selected for sampling of soil from different processes considered likely to be contaminated with hazardous inorganic and/or organic compounds that could likely become airborne. The sites were geographically distributed around the continental United States. A total of 29 processes were sampled at the eight different sites and are summarized below:

- 9 Landfill Operations
- 6 Land Treatment Processes
- 2 Dry Surface Impoundments
- 2 Stabilization Processes
- 1 Soil Storage Pile
- 9 Unpaved Access Roadways

All sites except Site 5 were sampled following the procedures described in Section 4.

3.1 SITE 1

At Site 1 the three different processes sampled were (1) an active lift for the landfill, (2) a dry surface impoundment, and (3) three segments of unpaved access roadways (see Figures 3.1 and 3.2).

3.1.1 Process A, Landfill, Active Lift

Process A encompasses the active lift area (approximately 4 feet deep with the landfilled material) of a landfill operation located at the north end of Site 1. According to the facility, the landfill in the past year prior to sampling had recieved approximately 47,000 cubic yards of solid material considered hazardous. Of this, scrubber salts (4,934 cu. yd.), oil production solids (13,171 cu. yd.), and gasoline contaminated soil (29,436 cu. yd.) were the materials landfilled in the greatest quantity. Except for the scrubber salts, the waste material was typically unloaded onto an area adjacent to the face of the active lift. The material was mixed to enhance volatilization and biodegradation. Moisture was added to control dust and to also enhance biodegradation. The material was moved to the active face when the color of the moist material was light brown, and then incorporated into the active lift. Scrubber salts were directly incorporated into the active lift.

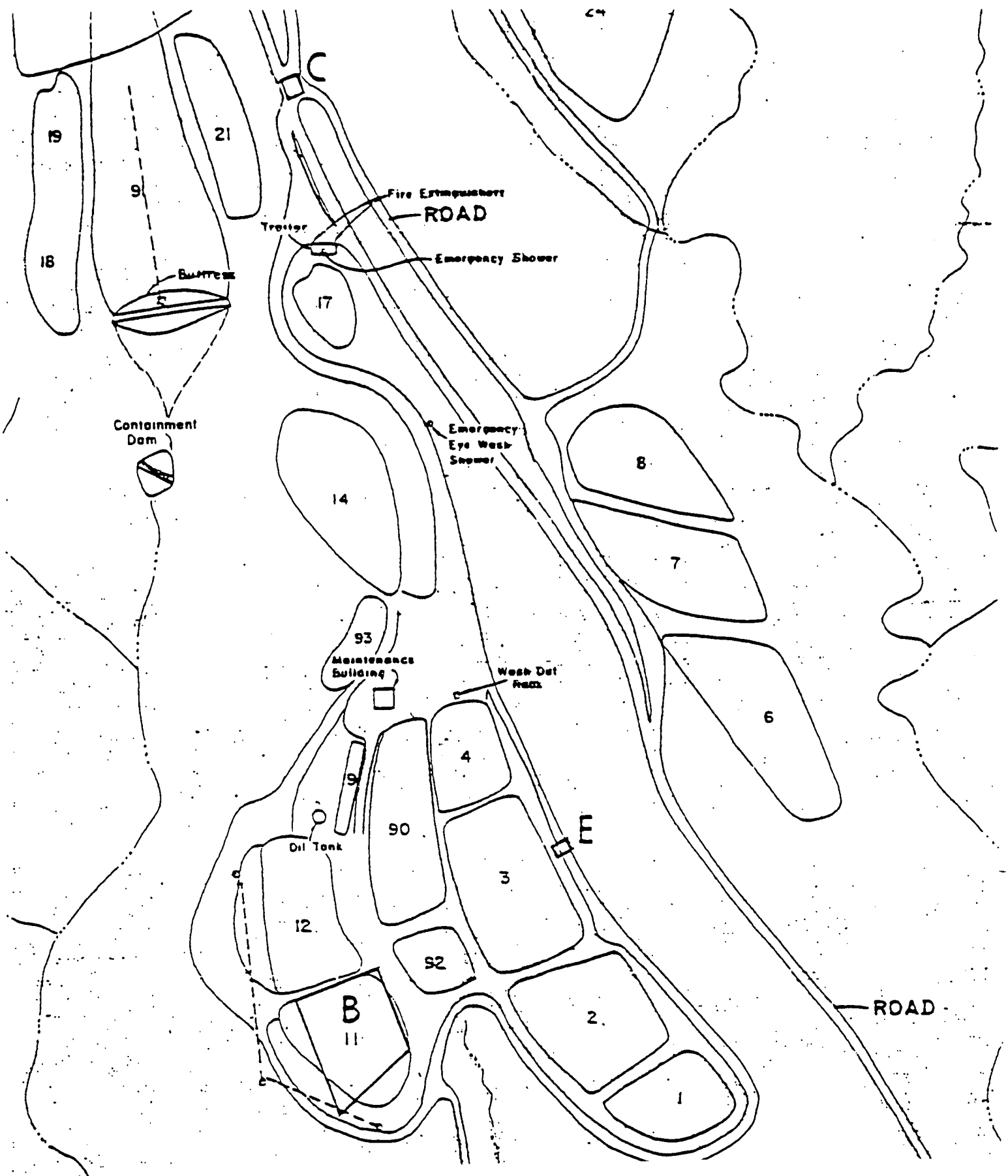


Figure 3.1. Site plot plan for Site 1 showing locations of Processes B, C, and E.

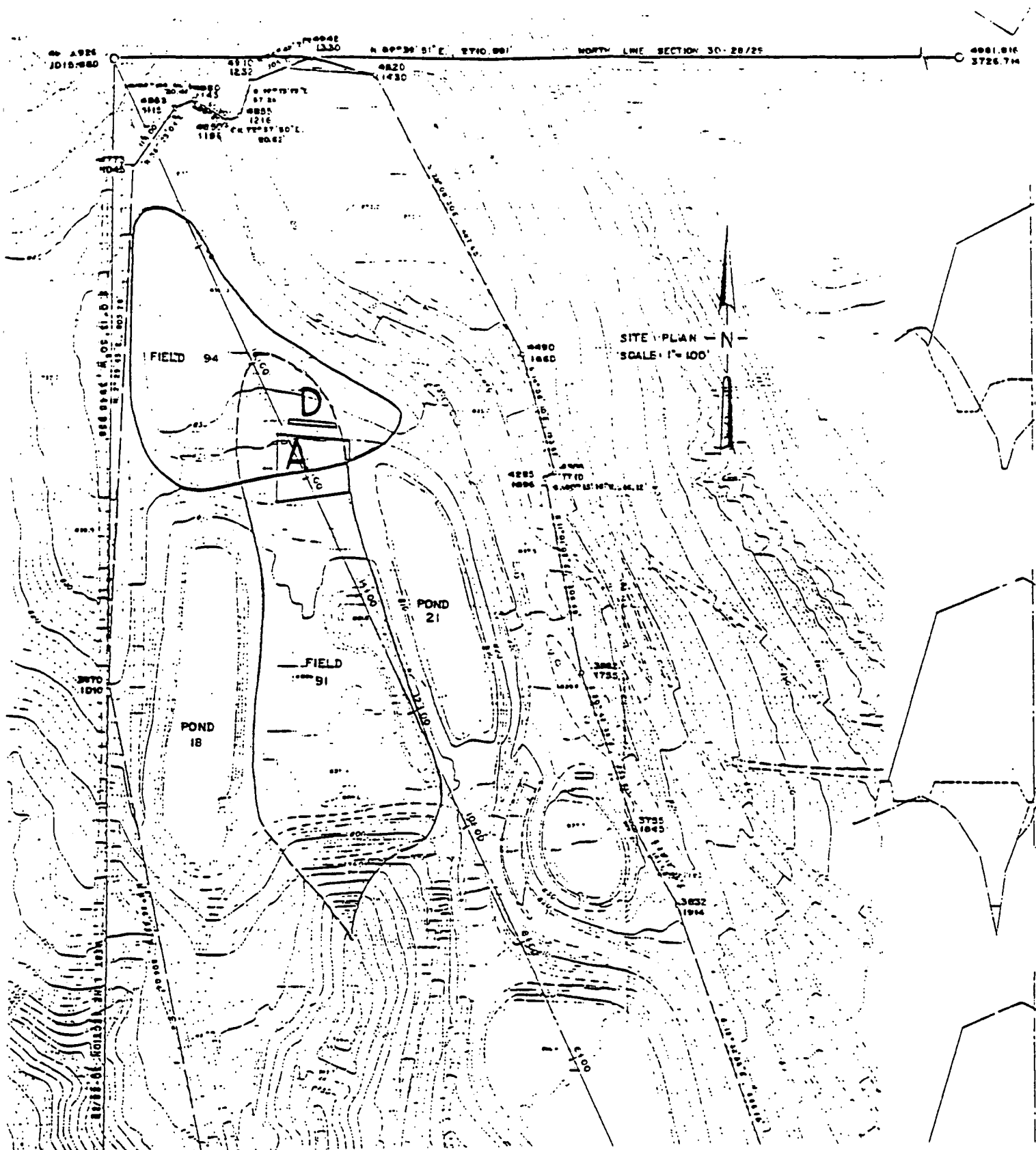


Figure 3.2. Enlargement of section of the Site 1 plot plan showing location of Processes A and D.

The boundaries of Process A at the time of sampling are shown in Figure 3.3 along with the sampling grid and cells selected for sampling. None of the selected grid cells were rejected. The process involved a moderately disturbed temporary soil cover that was sampled using the scooping technique. A total of eight samples were collected from the selected grid cells.

3.1.2 Process B. Dry Surface Impoundment

Process B was a dry surface impoundment field that was typical of fifteen fields located at the southwest corner of Site 1. Surface impoundment fields are used to treat liquid wastes through a combination of evaporation, settling, and biodegradation. A typical surface impoundment field will go through 3 cycles a year consisting of waste application to a maximum of 2.5 feet, followed by evaporation of liquid, mixing and biodegradation, and clean-up of solid residues.

The surface impoundment field selected for sampling had recently undergone clean-up and represented the driest period of the surface impoundment cycle when the surface material is most susceptible to entrainment and dispersion.

The boundaries of Process B, the sampling grid, and cells selected for sampling are shown in Figure 3.4. None of the selected sample cells were rejected. Process B was sampled using a modified coring technique with 6 cells being sampled. Two separate samples were collected from each cell using coring tubes made of plastic (samples for metals analysis) and stainless steel (samples for organic analysis).

3.1.3 Processes C, D, and E, Unpaved Access Roadways

During the sampling at Site 1, the fugitive particulate emissions from the unpaved roadways were being controlled by a spraying of water. Process C was a dirt roadway at the main entrance to a number of disposal processes (see Figure 3.1). The Process C sample was obtained using a modified sweeping technique employing a disposable plastic scoop to collect the sample from a 2-foot wide band across the width of the road (see Figure 3.5). Process D was an unpaved road providing truck access and turn-around space for the active lift of Process A. Process D was also sampled using the modified sweeping technique to collect a sample from a 16-inch by 68-foot strip laid out parallel to the active lift (see Figures 3.2 and 3.5). Process E was an unpaved road located in the southern section of Site 1 providing access to some of the surface impoundment fields, including Process B (see Figure 3.1). Process E was also

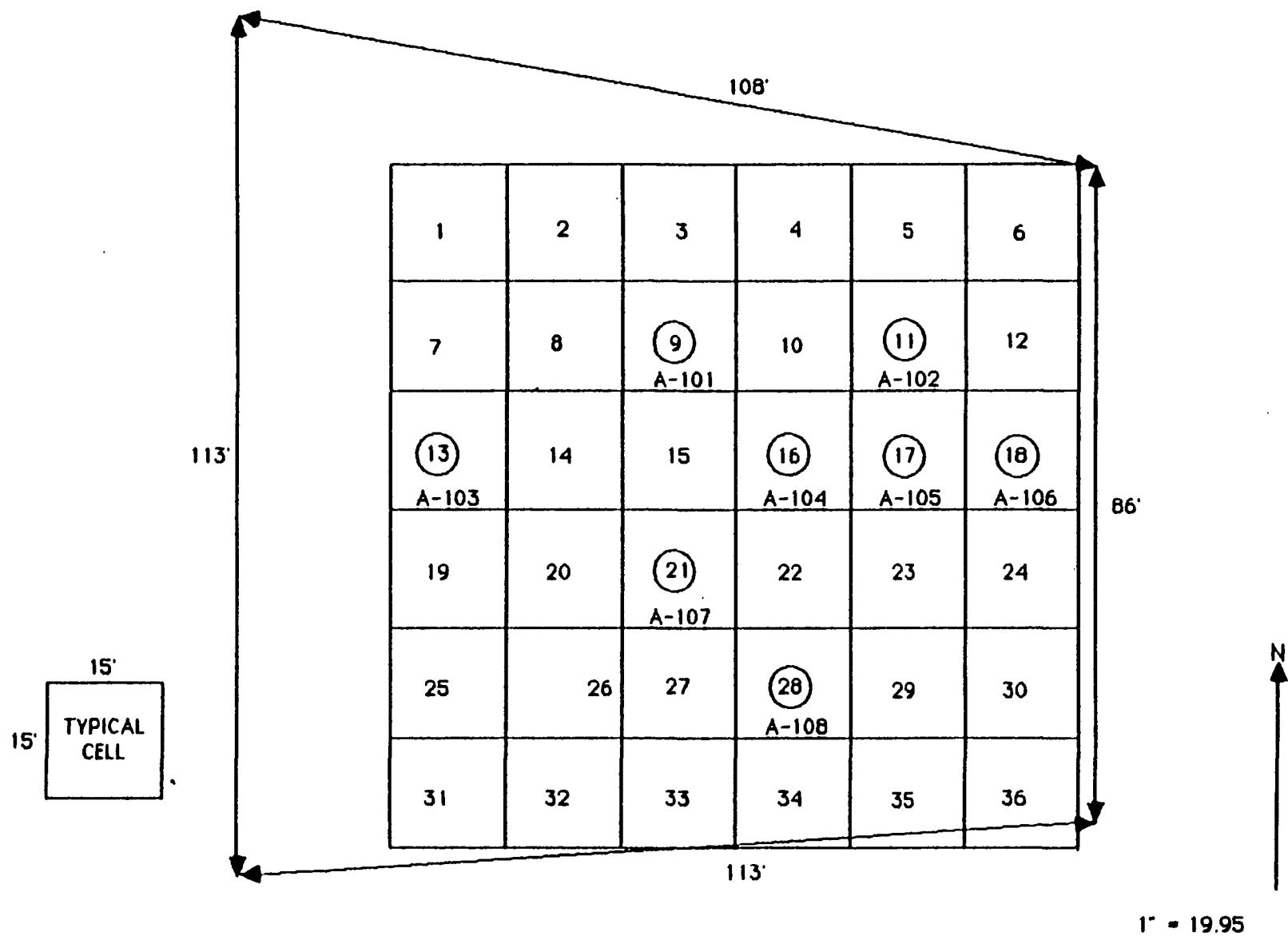


Figure 3.3. Sampling grid and process dimensions for active lift (Process A).

Figure 3.4. Sampling grid and process dimensions for dry surface impoundment (Process B).

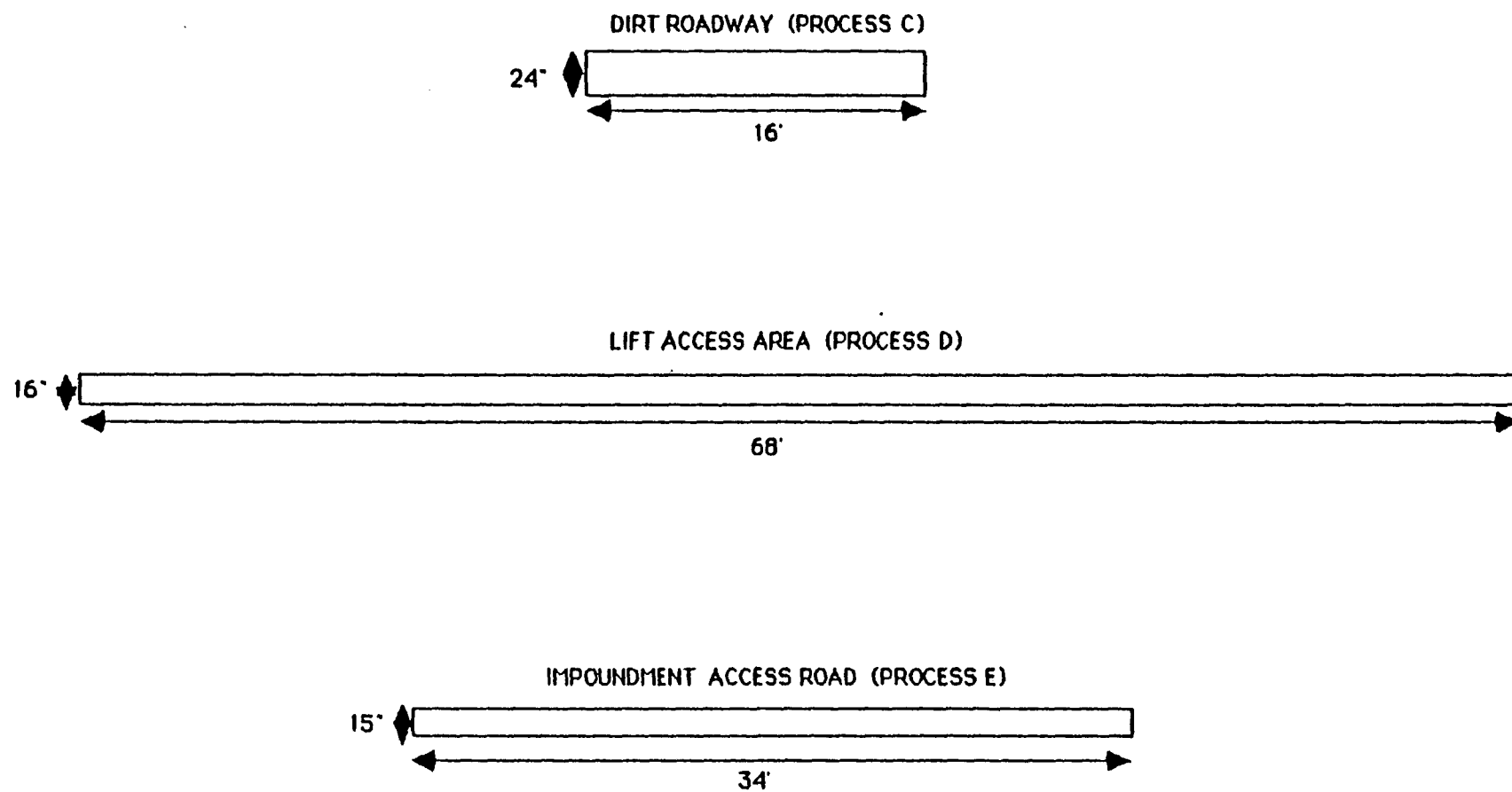


Figure 3.5. Process dimensions for dirt roadway, lift access area, and impoundment access road (Processes C, D, and E).

sampled using the modified sweeping technique to collect a sample from a 15-inch wide strip laid out across the width of the road (see Figure 3.5).

3.1.4 Background Samples

The background samples were collected from a location northeast of Site 1. The scooping technique was used to collect two background samples. Background samples BGD-110 was discarded at the direction of MRI because they considered the sample to be nonrepresentative.

3.2 SITE 2

At Site 2 the three different processes sampled were (1) an active landfill, (2) a stabilization area, and (3) two segments of unpaved access roadways (see Figures 3.6 and 3.7).

3.2.1 Processes F and G, Unpaved Access Roadways

Processes F and G were access roadways above and in the landfill (sampled as Process H) shown in Figure 3.7. Process F was sampled using the sweeping technique to collect a sample from a 2-foot wide strip across the width of the road (see Figure 3.8). Process G was sampled at two points on the access road inside the landfill area. Samples were collected using the sweeping technique from 18-inch bands across the width of the road (see Figure 3.8).

3.2.2 Process H, Active Landfill

Process H was the largest active landfill at Site 2 located in the northwest end of the facility. Landfill activity was concentrated in an area slightly less than 1 acre adjacent to the stabilization area (Process I described below) shown in Figure 3.9. At the time of sampling the landfill operation involved constructing an active lift approximately 50 to 150 feet below the surrounding terrain. The solid material to be landfilled was unloaded onto an area adjacent to the active face of the landfill. Measures to control fugitive particulate emissions from the loadout area included (1) periodic removal of residual waste material, (2) routing of commercial haulers to avoid areas traveled by landfill equipment, and (3) the use of double-bagging, drums, or "shrink-wrapping" to contain solids. The waste materials were covered with layers of temporary soil several times during the working day. The material being landfilled in August of 1985 is listed in Appendix D of the site-specific report and consisted of liquid material from the stabilization area (Process I described below) and solid waste material.

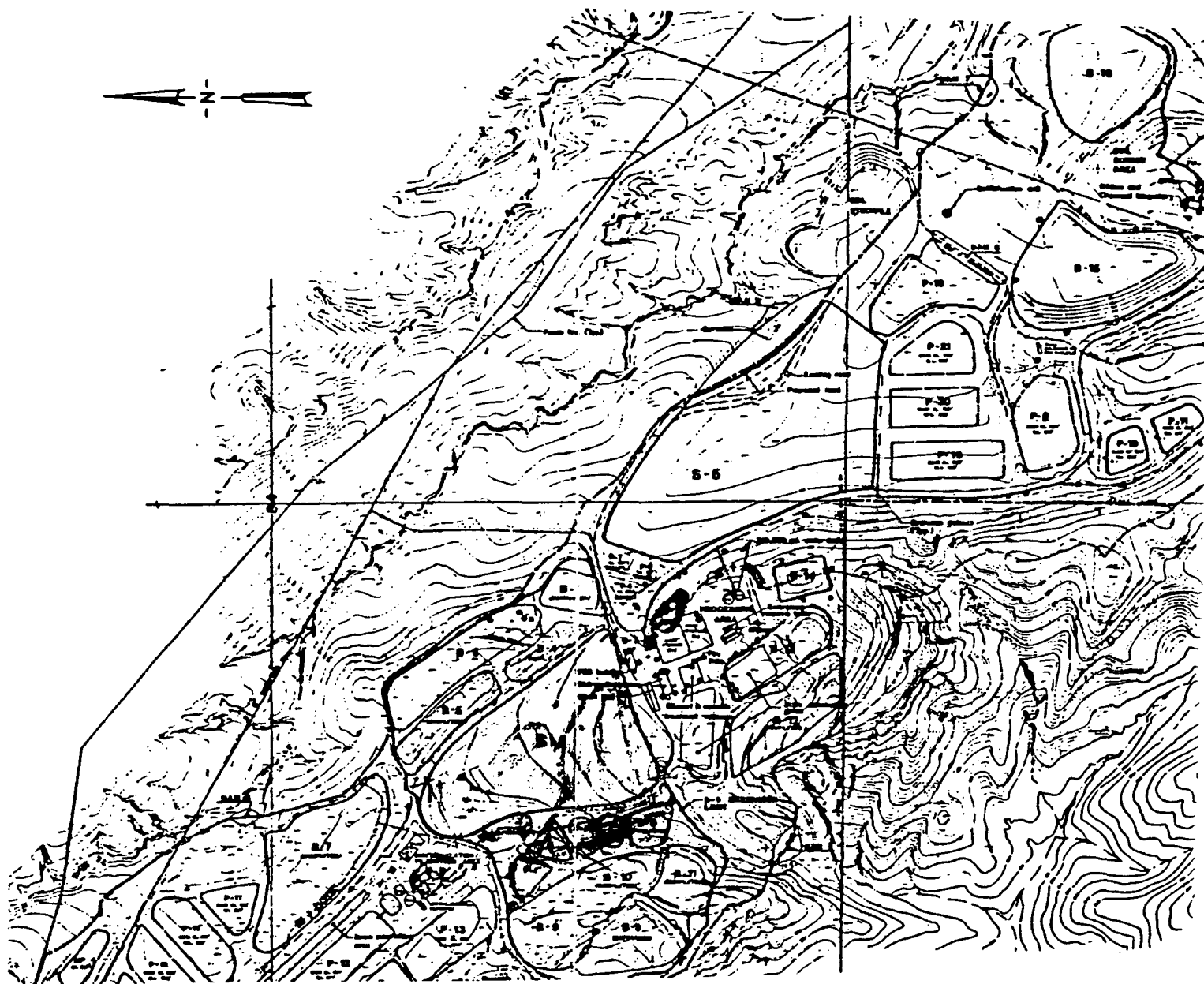


Figure 3.6. Site plot plan for Site 2 showing location of landfill Section B-9.

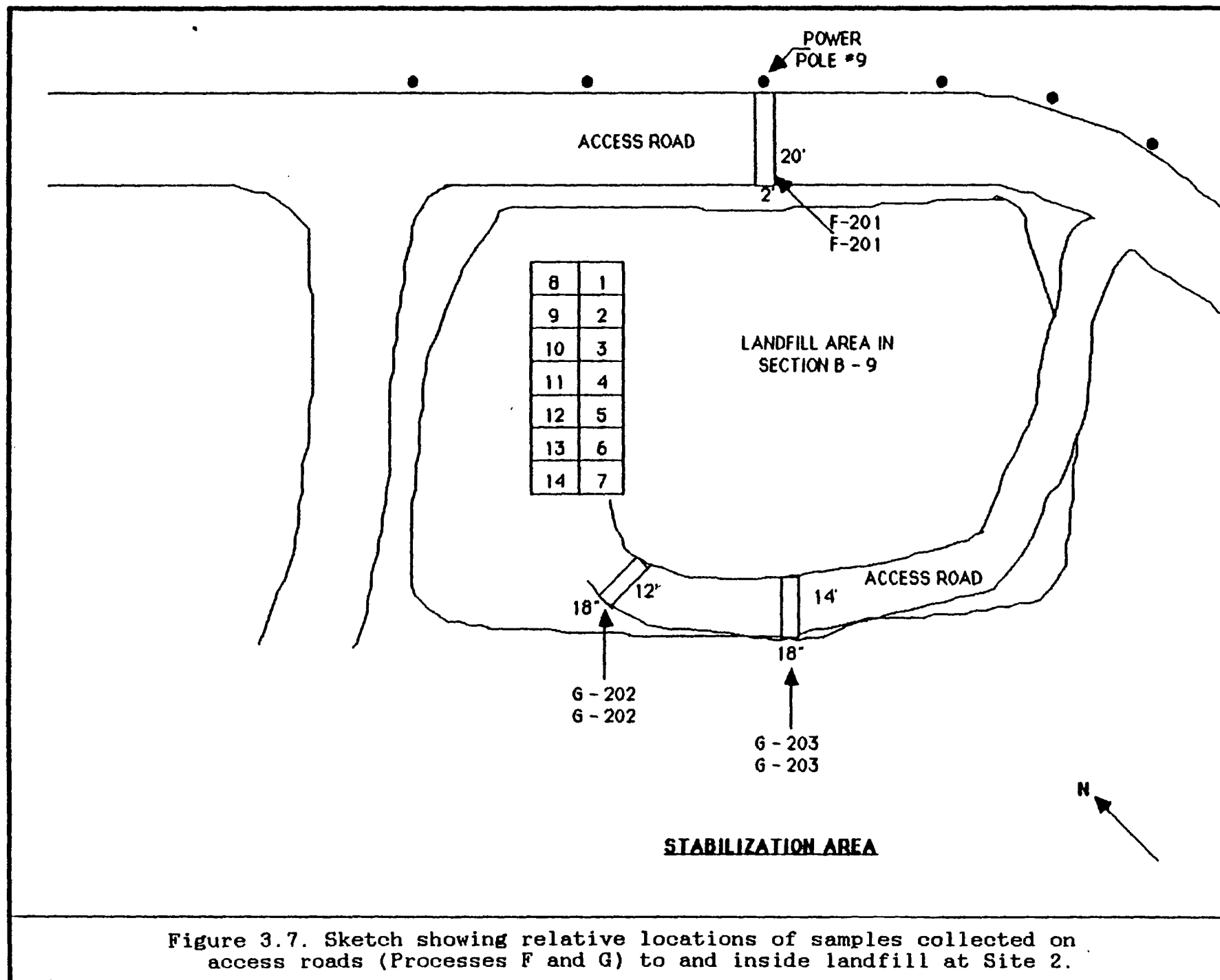


Figure 3.7. Sketch showing relative locations of samples collected on access roads (Processes F and G) to and inside landfill at Site 2.

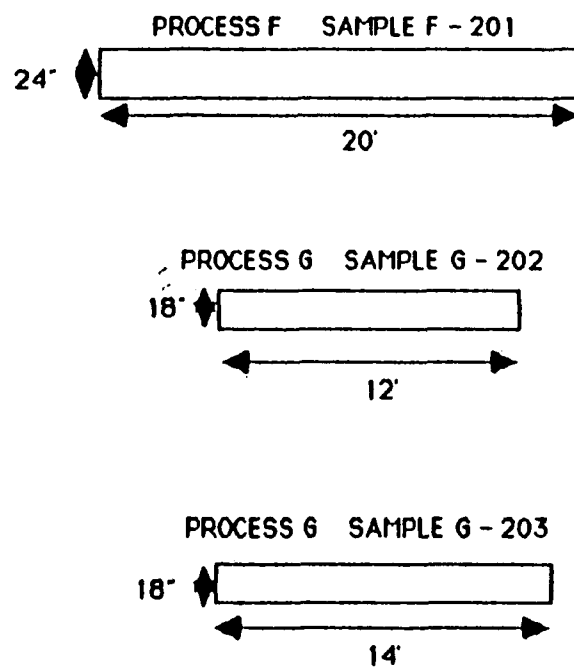


Figure 3.8. Dimensions and sample numbers for areas sampled from access roads to and inside landfill area at Site 2 (Processes F and G).

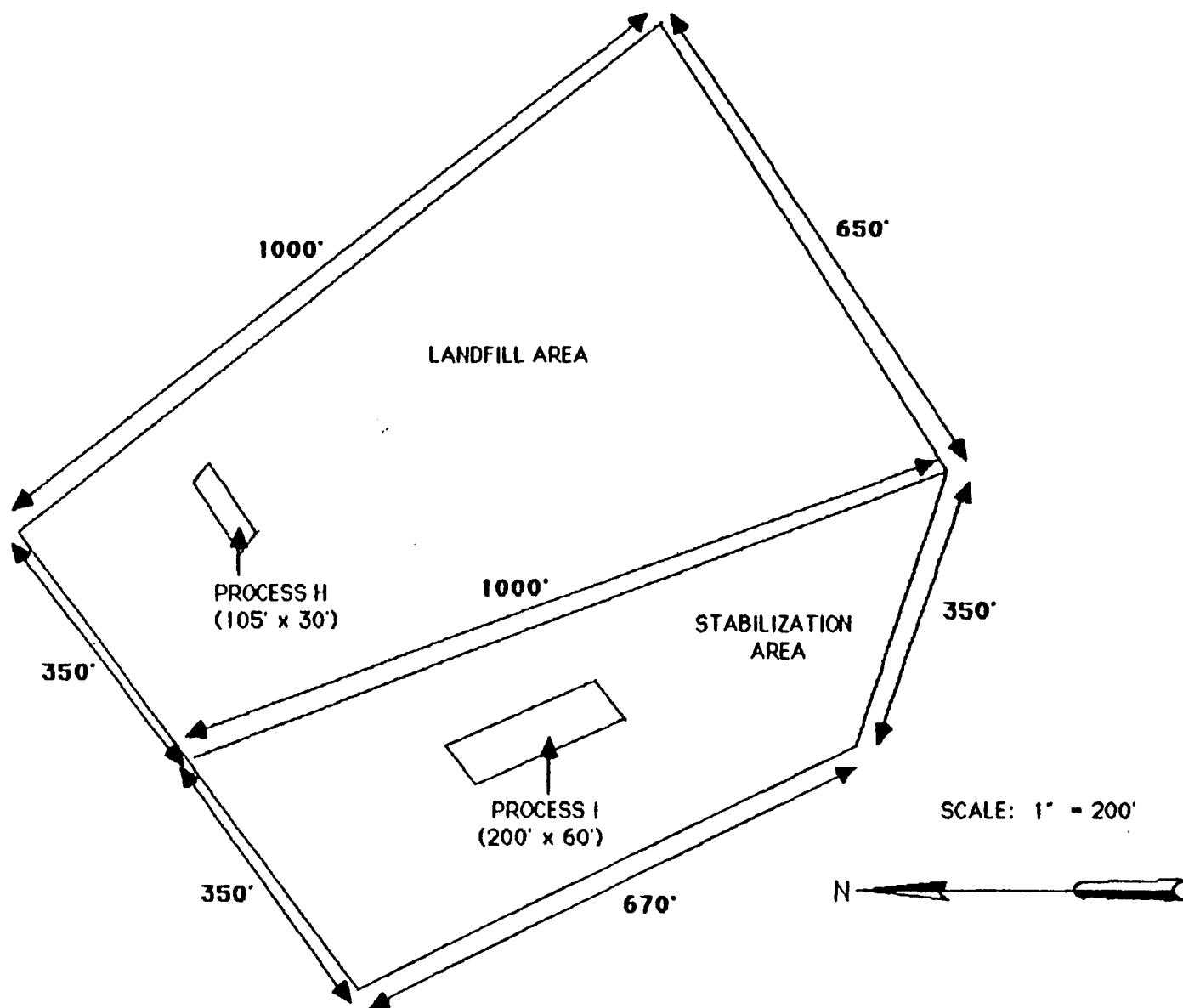


Figure 3.9. Schematic of Site 2 showing dimensions of landfill and stabilization areas and location of process areas sampled.

The boundaries of Process H are shown in Figure 3.10 along with the sampling grid and the grid cells selected for sampling. None of the selected grid cells were rejected. Six samples were collected using the scooping technique.

3.2.3 Process I, Stabilization Area

The stabilization area was located west of the landfill area at Site 2 (see Figure 3.9). Process I in the stabilization area consisted of four steel mixing bins (10 x 40 x 8 ft.) for solidification of liquid wastes by mixing with kiln dust or some other form of sodium silicate. After solidification in the bins, the material was loaded into a truck for hauling to the adjacent landfill (Process H) for disposal.

The grid system shown in Figure 3.11 was laid out in the area around and between the solidification bins. None of the selected grid cells were rejected. Seven samples were collected using the scooping technique.

Quality assurance (QA) samples were also collected from Process I. Fifteen QA samples were collected using the scooping technique, collecting five each from grid cells #7, #8, and #12.

3.2.4 Background Samples

The background samples were collected on a hilltop in the northwest corner of the property. Two samples were collected using the scooping technique.

3.3 SITE 3

At Site 3 two different landfill cells were sampled. One cell (Process J) recieved primarily organic wastes and the second cell (Process K) recieved primarily metals. The two cells were part of a master cell shown in Figure 3.12. The landfill operation at this site recieved only solid wastes. At this site the roads for incoming trucks were paved, with dust on the roads being controlled by a water truck and a road sweeper. Within the landfill, gravel roads were established to minimize contamination of the trucks.

3.3.1 Process J. Landfill

Process J was a landfill cell recieving organic wastes consisting of moderately toxic organics including reducing agents, acid-generating wastes, and solvents. The organics deposited in this subcell represent approximately 20% of waste material landfilled in the master cell.

The boundaries of Process J are shown in Figure 3.13 with the sampling grid and the cells selected for sampling. Grid cells #42 was rejected because of a

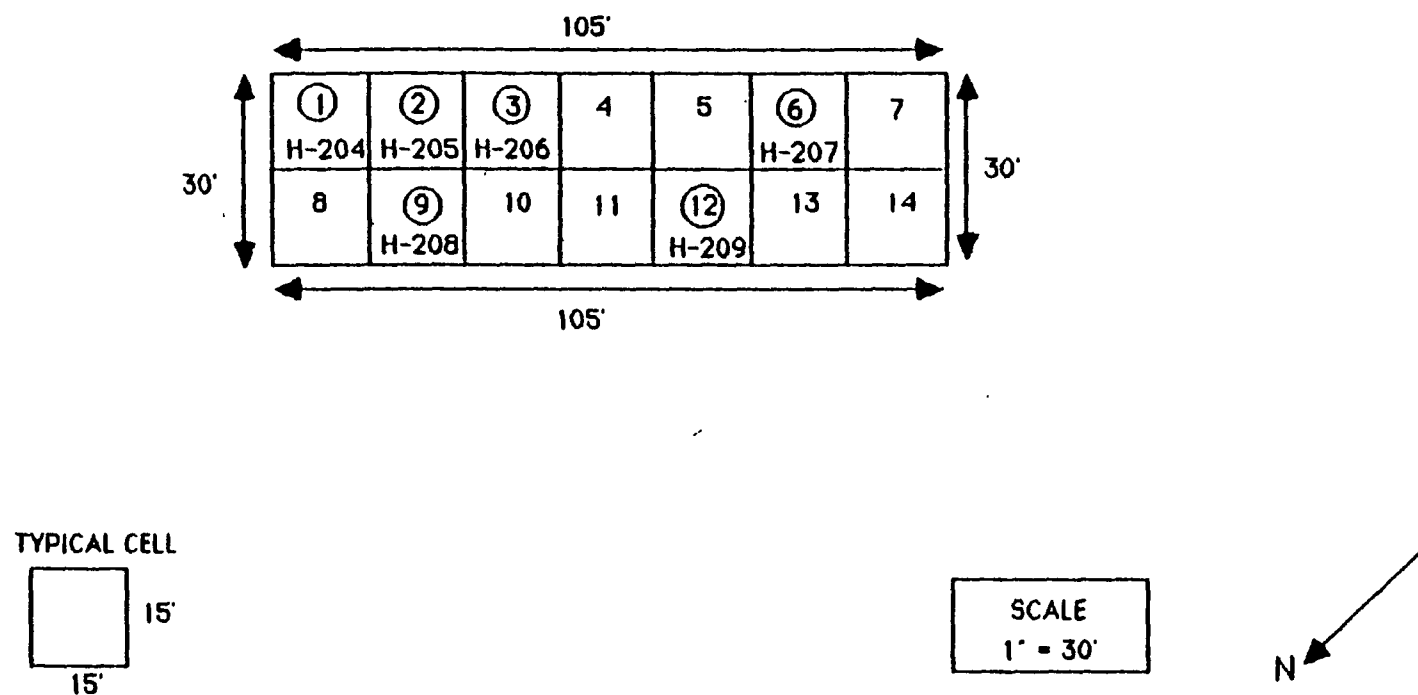


Figure 3.10. Sampling grid, process dimensions, and sample numbers for active landfill at Site 2 (Process H).

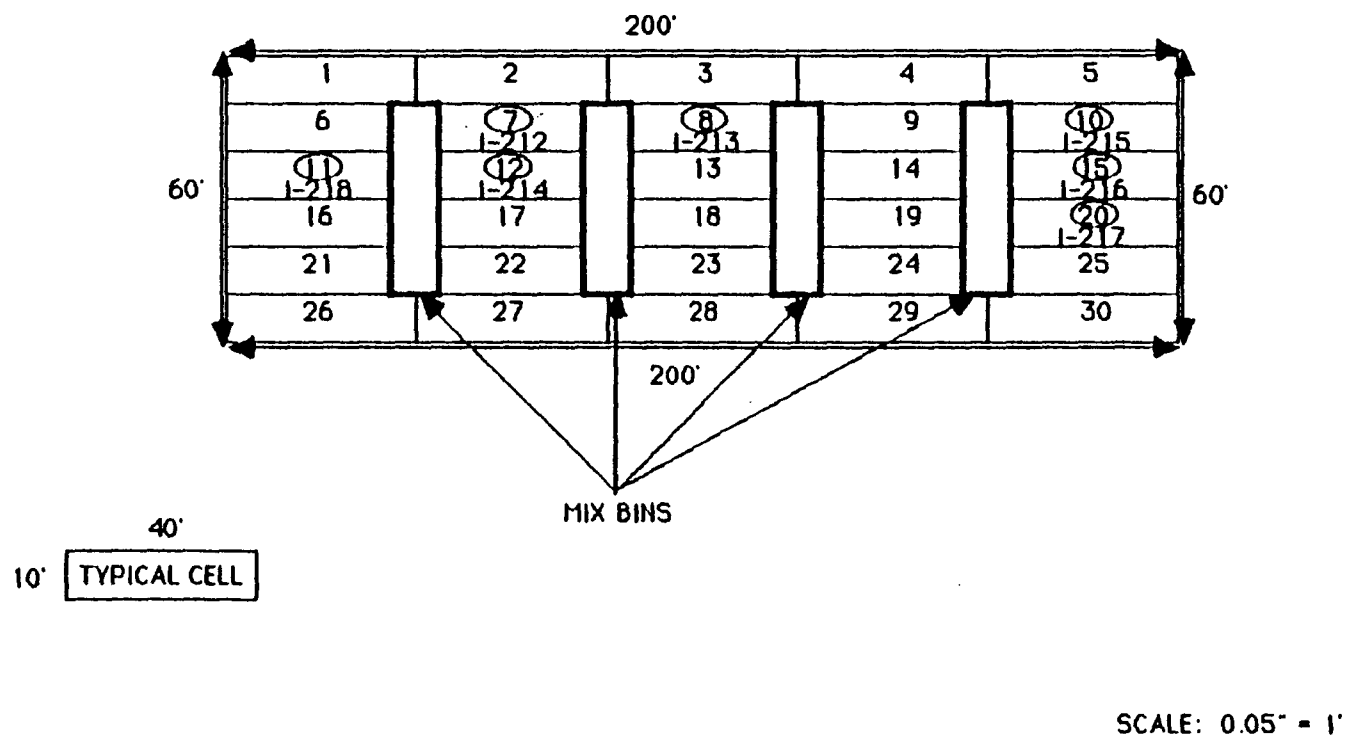


Figure 3.11. Sampling grid, process dimensions, and sample numbers for stabilization area at Site 2 (Process I).

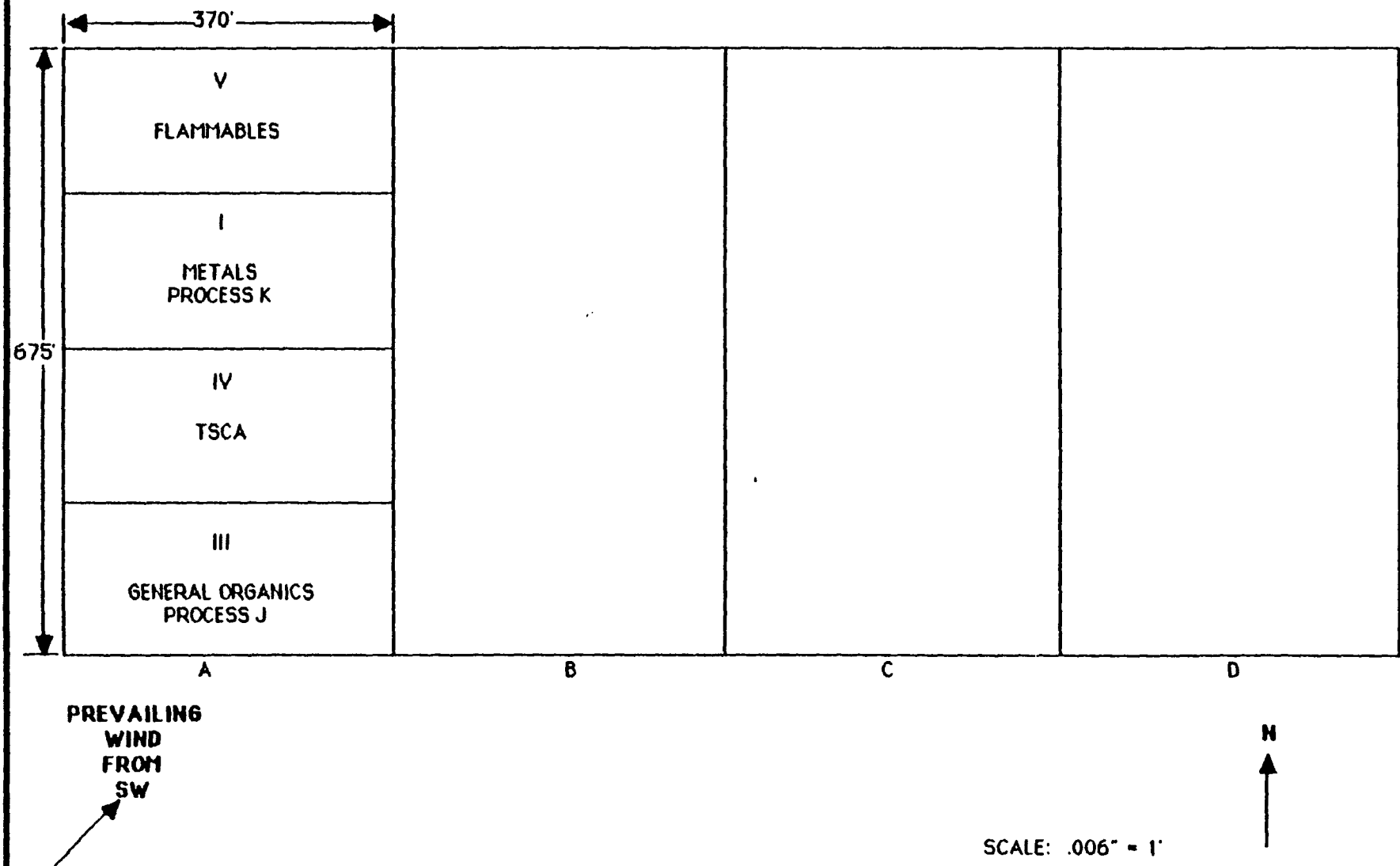


Figure 3.12. Schematic showing dimensions of Cell A and locations of subcells in active landfill at Site 3.

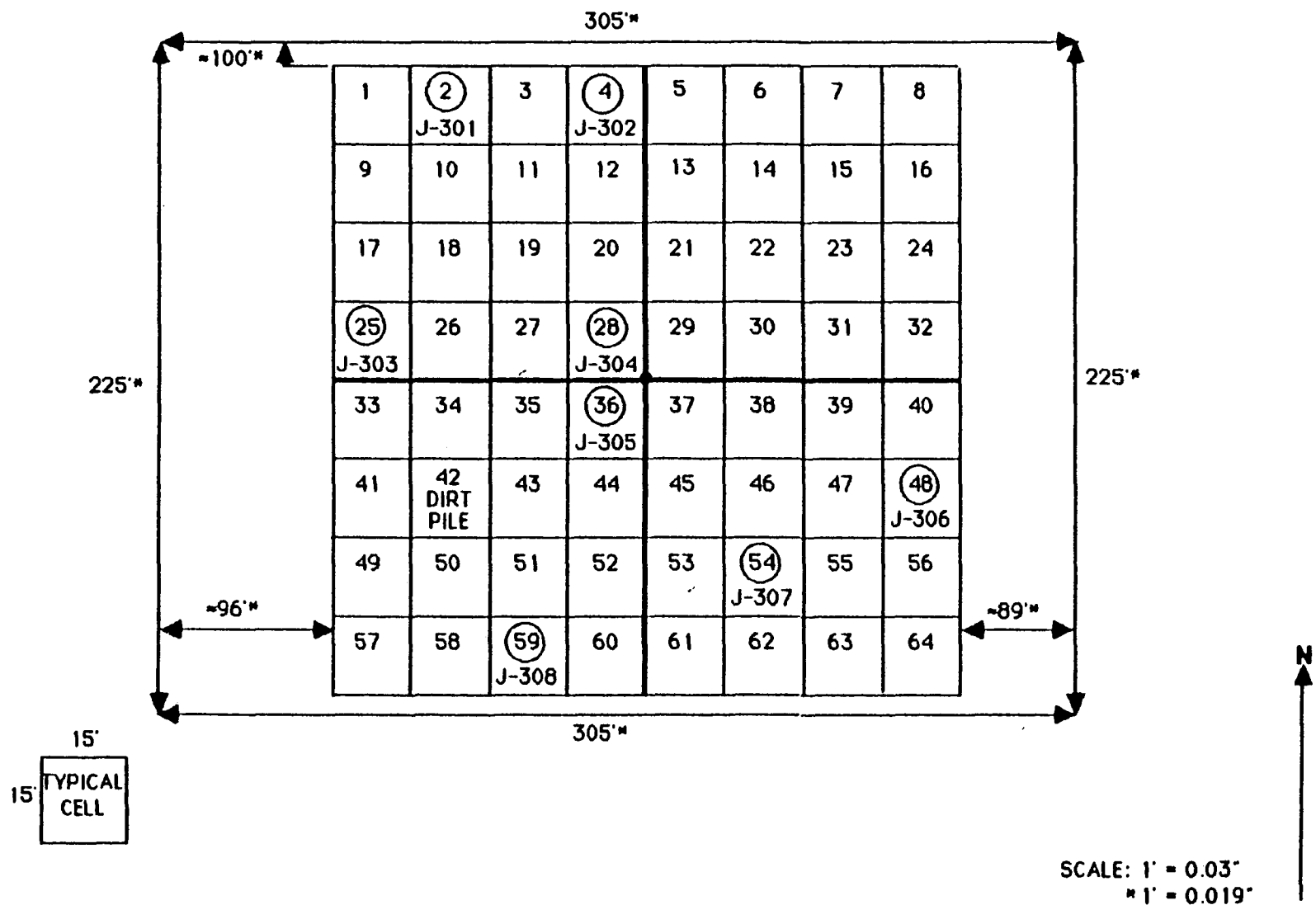


Figure 3.13. Sampling grid, process dimensions, and sample numbers for active landfill at Site 3 (Process J).

dirt pile located within the cell boundary. Cell #42 was replaced with Cell #59. Eight samples were collected from Process J using the scooping technique.

3.3.2 Process K, Landfill

Process K was a landfill receiving primarily heavy metals plus oxidizers and acid-sensitive materials such as cyanides and sulfides. In this subcell, lime was mixed into the landfill cover material to help maintain the landfill leachate pH at 8.5 or greater.

The boundaries of Process K are shown in Figure 3.14 with the sampling grid and the cells selected for sampling. The process boundaries were irregular and the sampling grid was established near the center of the process. An irregular sampling grid was designed to avoid the dirt pile diagrammed in Figure 3.14. None of the selected sample cells were rejected. Eight samples were collected from Process K using the scooping technique.

3.3.3 Background Samples

The background samples for Site 3 were collected from opposite sides of a road on-site (see Figure 3.15). A midpoint of the road approximately 1,445 feet west and 800 feet north of a groundwater monitoring well was used as a reference point. One background sample was collected at a point approximately 100 yards east of the reference point and the other background sample was collected at a point approximately 20 yards west of the reference point. The two samples were collected using the scooping technique.

3.4 SITE 4

At Site 4 three different land treatment cells and three segments of unpaved access roadways were sampled. The land treatment unit at this facility is approximately 34 acres consisting of 12 discrete land treatment cells (see Figure 3.16). The cells range from 2.36 to 3.40 acres in size with the average cell size being 2.85 acres. The cells are used on a rotational basis to treat and dispose of waste generated by the facility. The types of wastes applied to the land treatment cells included primarily sludge and vacuum filter cake from the facility waste water treatment plant (WWTP) and oil-water separator bottoms. The basic sequence of operations for a land treatment cell is as follows:

1. Waste application
2. Waste incorporation

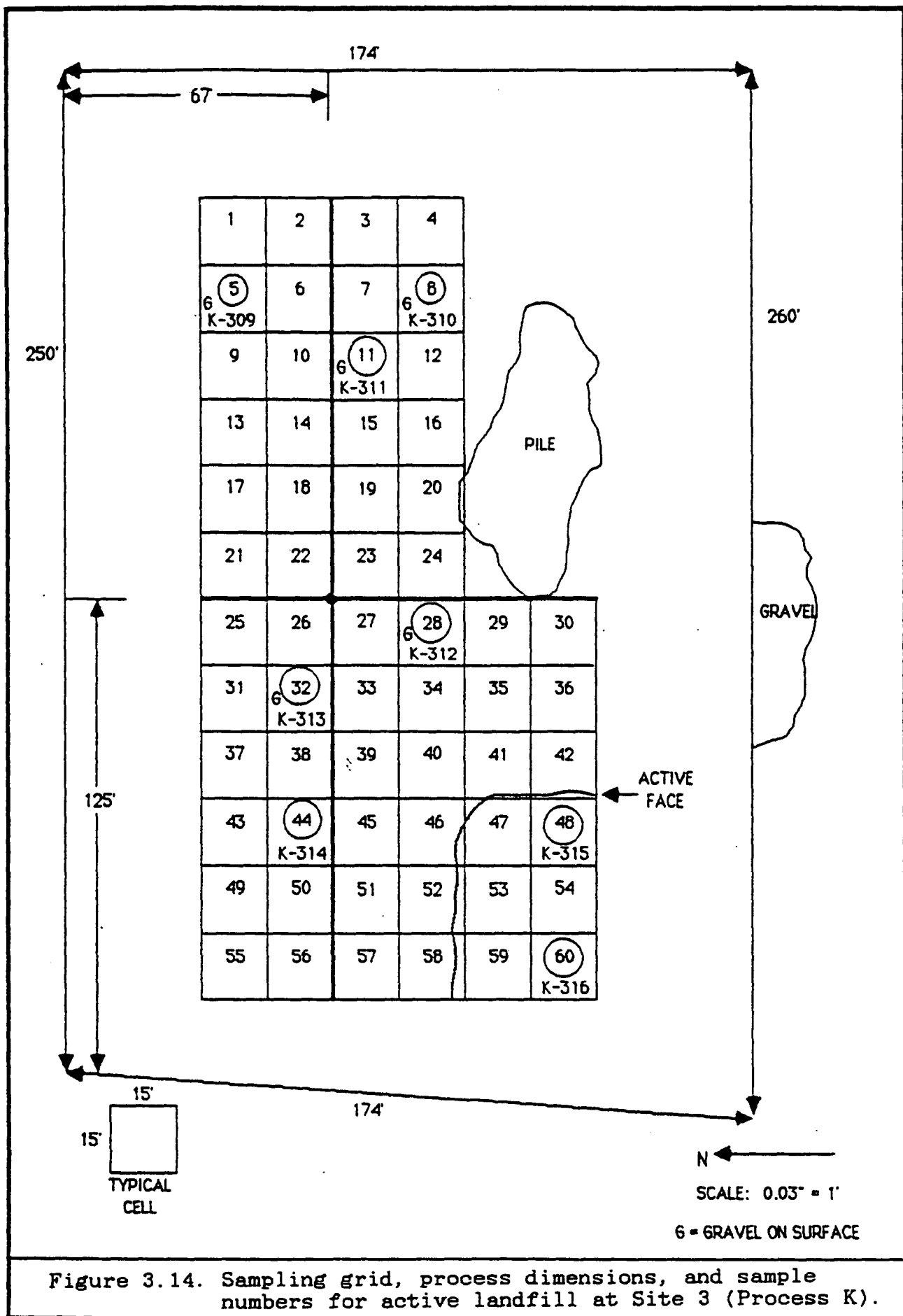


Figure 3.14. Sampling grid, process dimensions, and sample numbers for active landfill at Site 3 (Process K).

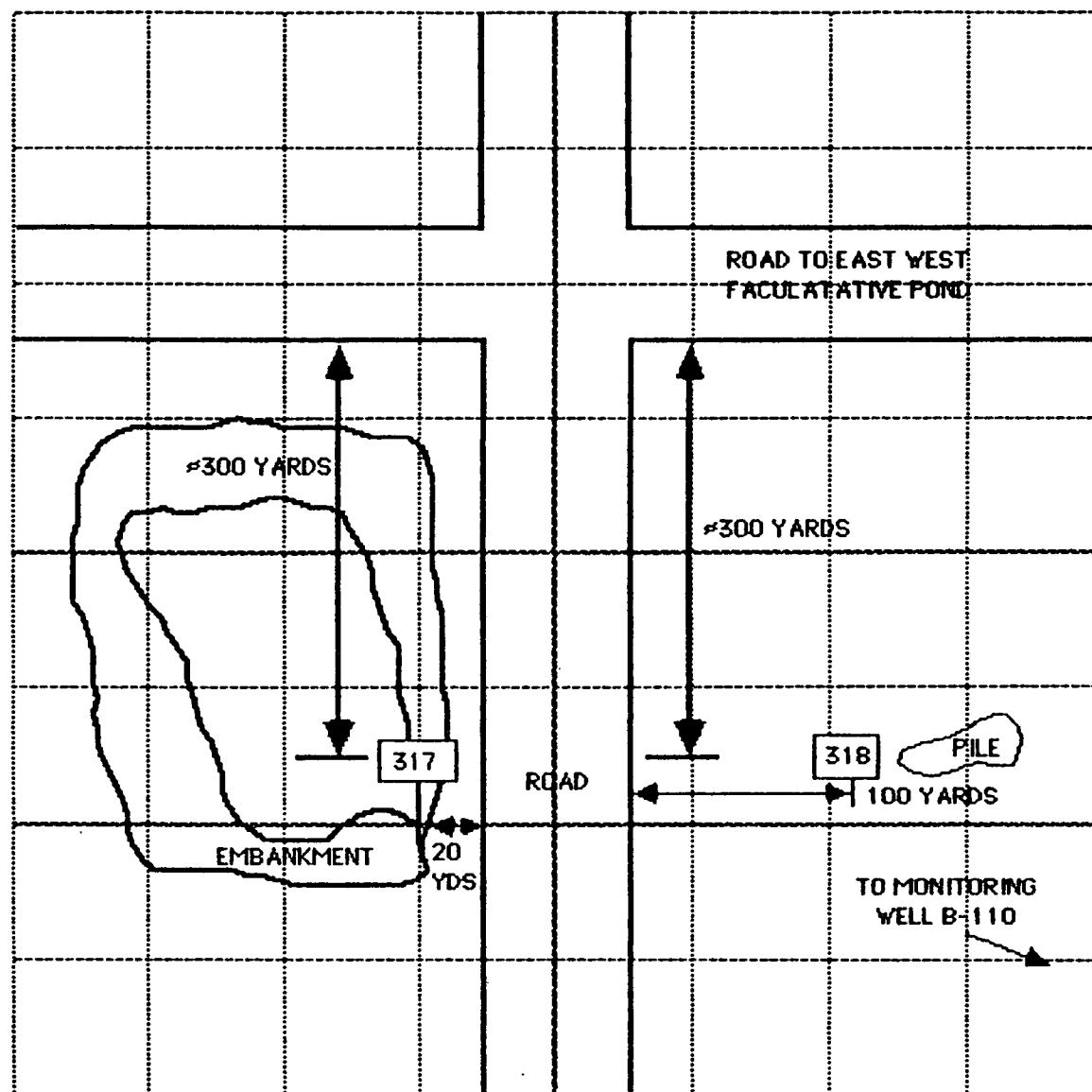


Figure 3.15. Schematic showing approximate location where background samples were taken at Site 3.

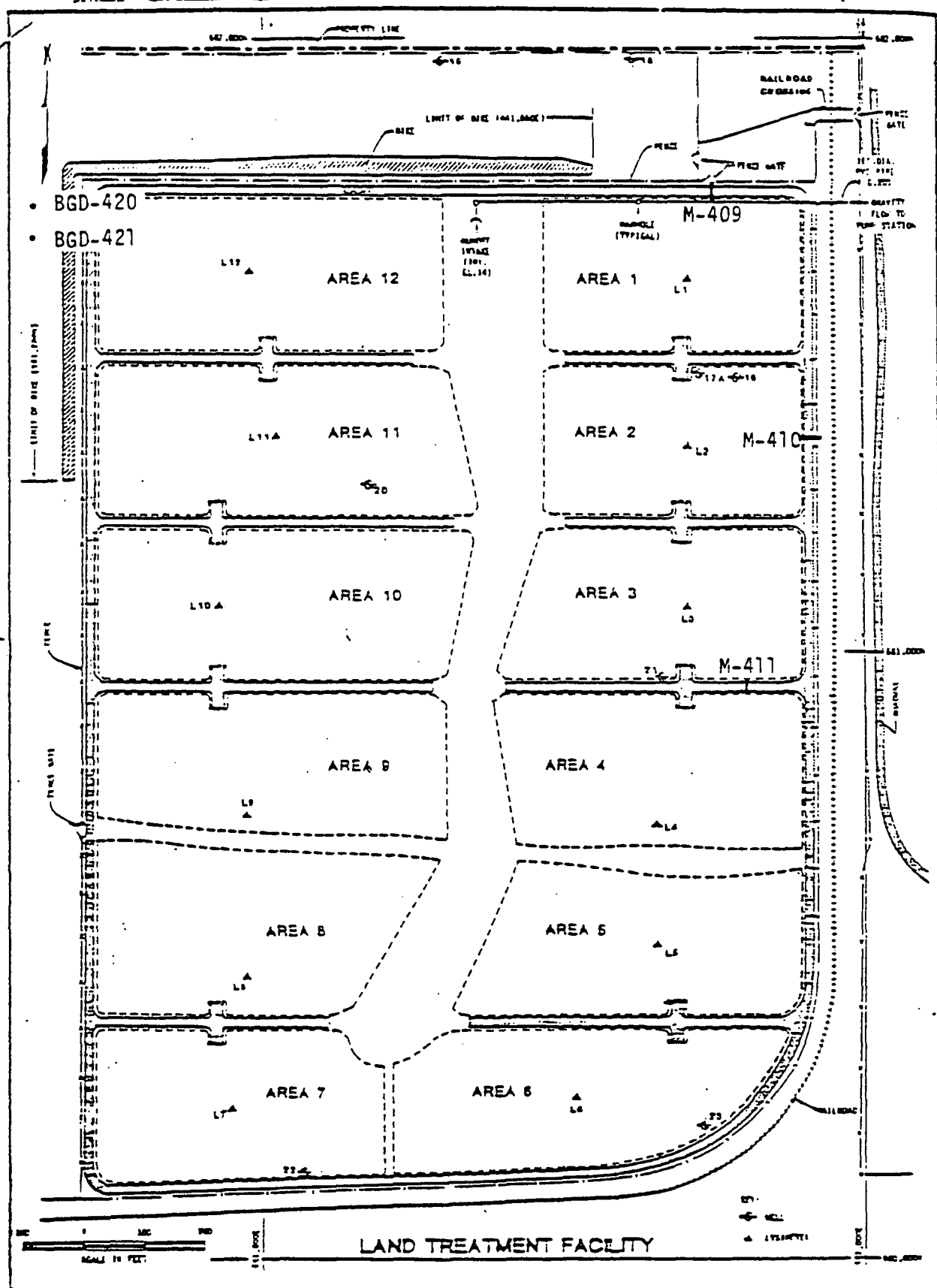


Figure 3.16. Enlargement of site plot plan showing locations of land treatment cells and sampling locations for background and unpaved road samples at Site 4.

3. Lime addition
4. Soil cultivation
5. Surface smoothing
6. Repeat steps 4 and 5

The lime is used to maintain the soil pH at 6.5 to 7.5. This pH range causes a precipitation and immobilization of the metals in the soil.

3.4.1 Process L, Land Treatment Cell

The land treatment cell designated Process L was sampled one week after the most recent waste application (primarily WWTP sludge). The cell dimensions, shown in Figure 3.17, approximated a rectangle with the sampling grid being centered within the cell boundaries. One of the cells selected for sampling (grid cell #1) was rejected because it was too close to the process boundary and was replaced by grid cell #2. Eight sets of samples were collected from Process L using the modified coring technique. Each set consisted of two samples with one collected for metals analysis using a plastic coring tube and the other collected for organic analysis using a metal coring tube.

3.4.2 Process M, Unpaved Access Roads

For Process M three samples were taken from unpaved access roadways within the land treatment unit. The samples were collected at the main gate to the land treatment unit, on a north-south access roadway, and on the east road between Process L and Process O (see Figure 3.16).

The dimensions of the roadway segments for Process M are shown in Figure 3.18. One sample was collected from each unpaved roadway segment using the sweeping technique. The samples were later sieved separately and combined for chemical analysis.

3.4.3 Process N, Land Treatment Cell

The land treatment cell designated Process N was sampled about 40 days after the most recent application of waste. The process dimensions, sampling grid, and the cells selected for sampling are shown in Figure 3.19. Grid cell #28 was rejected because it was too close to grid cells #27 and #32 and was replaced with grid cell #17. Eight samples were collected from Process N using the scooping technique.

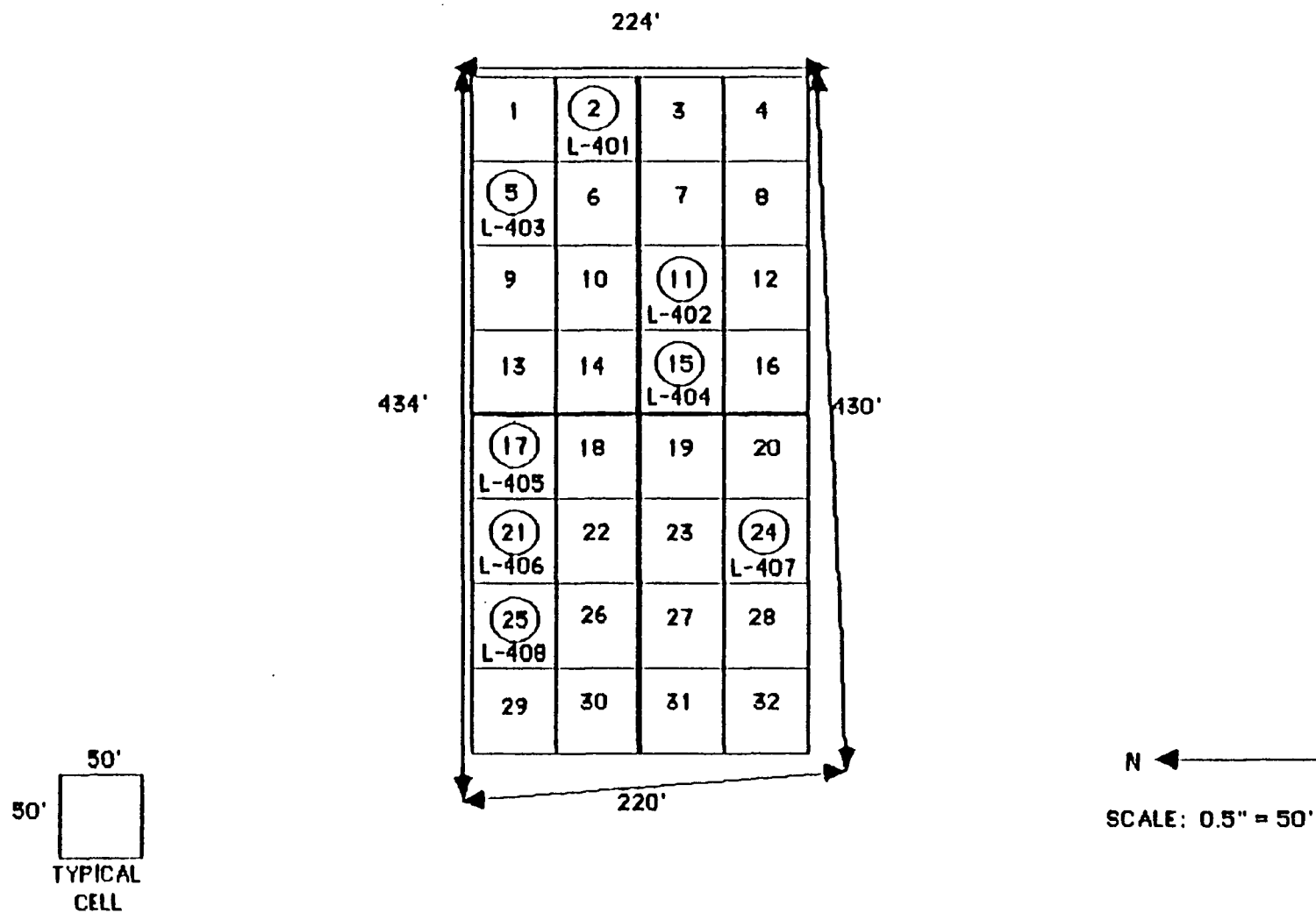


Figure 3.17. Sampling grid, process dimensions, and sample numbers for land treatment Cell #4, at Site 4 (Process L).

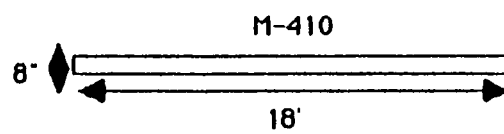
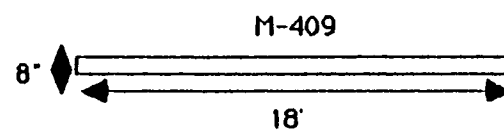


Figure 3.18. Dimensions and sample numbers for the segments of unpaved roads sampled in the land treatment unit at Site 4 (Process M).

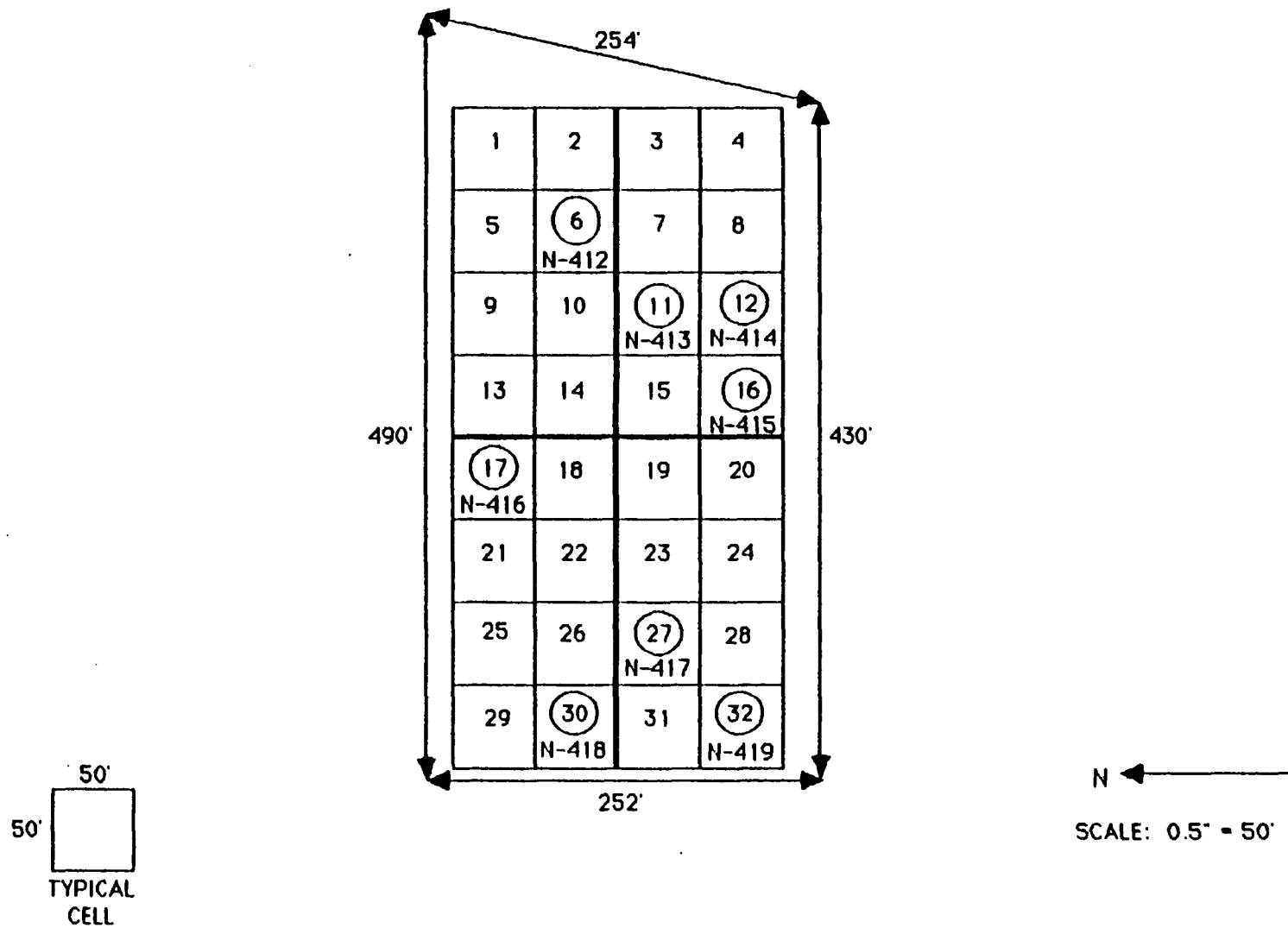


Figure 3.19. Sampling grid, process dimensions, and sample numbers for land treatment Cell #8, at Site 4 (Process N).

3.4.4 Process 0, Land Treatment Cell

The land treatment cell designated Process 0 was sampled less than four hours after the most recent application and incorporation of wastes consisting of WWTP sludge and filter cake. The process dimensions, sampling grid, and the selected cells are shown in Figure 3.20. None of the selected grid cells were rejected. Eight samples were collected from Process 0 using the scooping technique.

Quality assurance (QA) samples were also collected from Process 0. Fifteen QA samples were collected using the scooping technique, collecting five each from grid cells #2, #7, and #16.

3.4.5 Background Samples

The background samples for Site 4 were taken outside the western boundary of the land treatment unit (see Figure 3.16). The first sample was taken from a point approximately 75 feet west and 25 feet north of a ground water sampling well. The second sample was taken from a point approximately 25 feet north of where the first sample was taken. The scooping technique was used for sample collection.

3.5 SITE 5

At Site 5 the two processes sampled were a soil storage pile and dry surface impoundment. Site 5 consisted of two separate TSDF sites operated by the same company about 80 miles apart. The activities at the sites involved excavation of the material from the two processes and combining the excavated material in a storage pile with a double liner of high-density polyethylene (HDPE) under the pile. During the site visit, two pilot plots were observed where experiments were being conducted to determine the environmentally acceptable treatment parameters, such as loading rate and application frequency. Sampling at Site 05 was not conducted by Entropy Environmentalists' personnel. No background samples were collected.

3.5.1 Soil Storage Pile

The soil storage pile contained creosote-contaminated material (EPA Hazardous Waste No. K001). Four samples were taken from the storage pile using a random grab sampling method and no sampling grid.

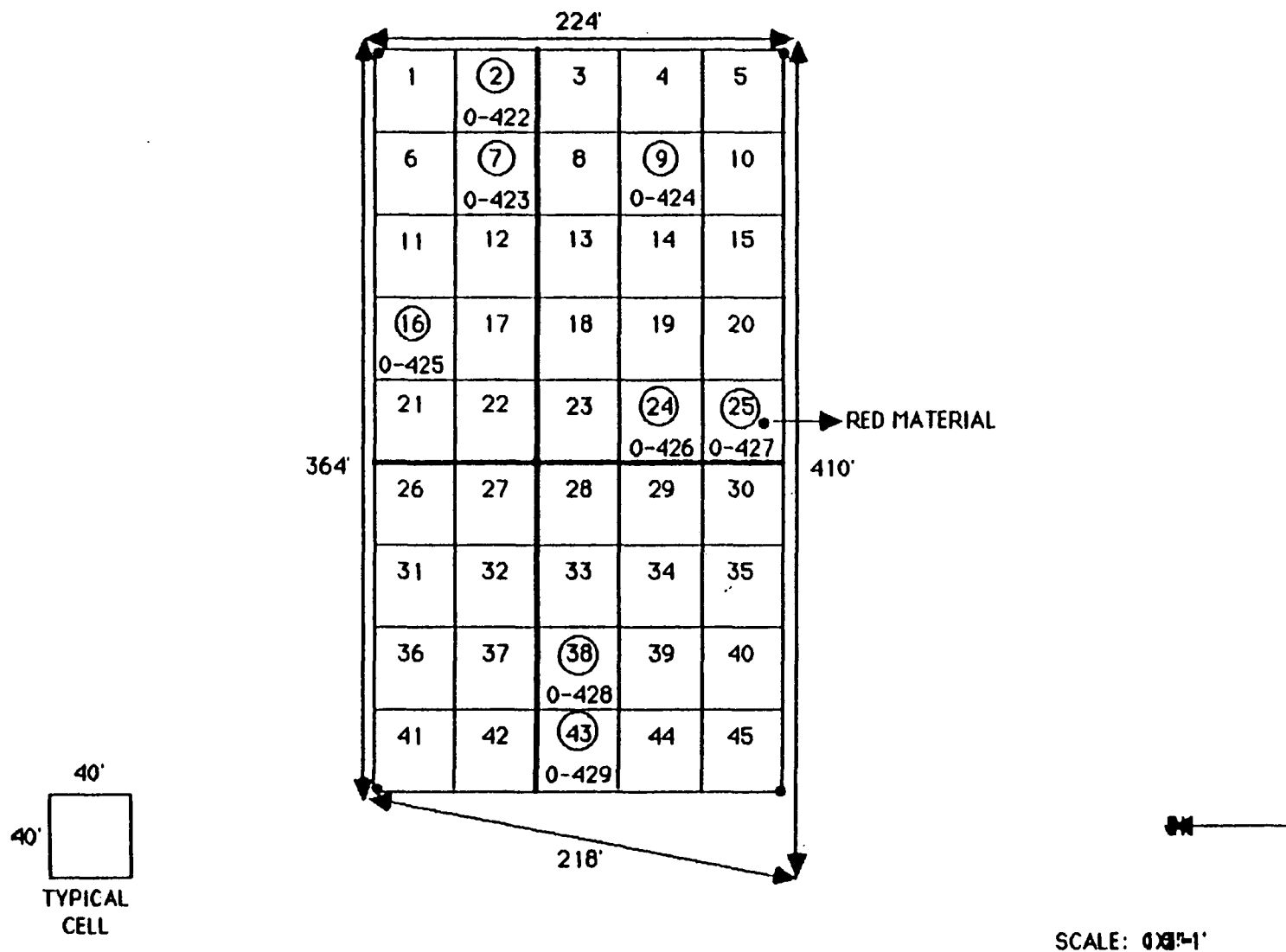


Figure 3.20. Sampling grid, process dimensions, and sample numbers for land treatment Cell #3, at Site 4 (Process O).

3.5.2 Dry Surface Impoundment

The dry surface impoundment also contained creosote-contaminated material. Two samples were taken from the impoundment using a random grab sampling method and no sampling grid.

3.6 SITE 6

At Site 6, the three processes sampled were (1) a landfill (three cells), (2) a land treatment cell, and (3) an unpaved access roadway (see Figure 3.21). The landfill operation, located in the west end of the facility, consisted of 5 subcells for different types of hazardous wastes. Approximately 20% of the waste disposed of in the landfill was defined as hazardous. The landfill operation utilizes an active lift resulting in a nominal depth of 15 feet. The active subcells of the landfill are separated by relatively broad strips of undisturbed grass-covered soil.

3.6.1 Process P, Landfill, Active Lift

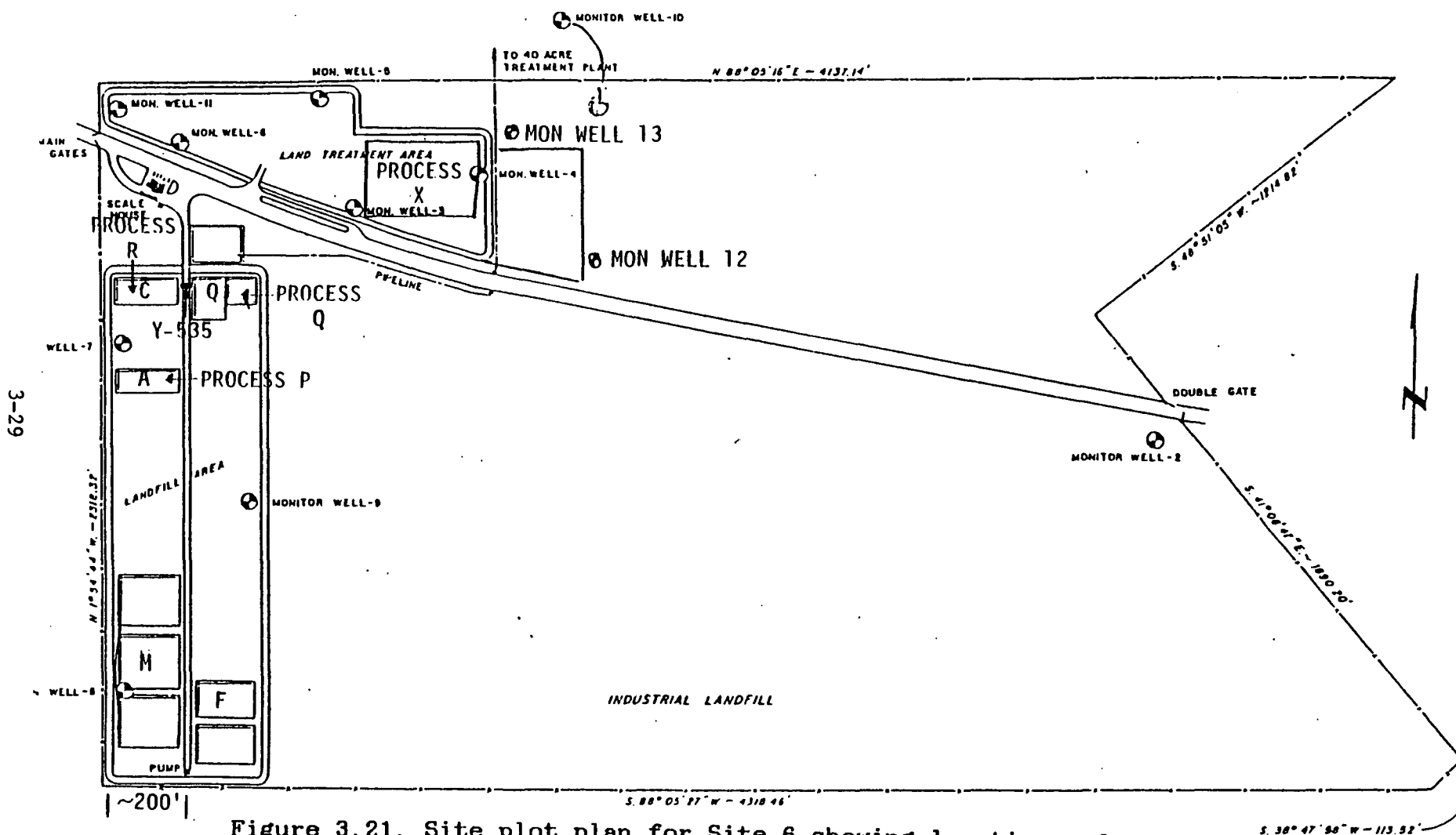
The landfill cell, designated Process P, received primarily acid wastes and polymerization catalysts. The process dimensions, sampling grid, and the cells selected for sampling are shown in Figure 3.22. Grid cell #12 was rejected because the cell was covered by grass and was replaced with grid cell #16. Grid cell #19 was rejected because the cell was under water from a recent rain and was replaced with grid cell #11. Eight samples were taken from Process P using the scooping technique.

3.6.2 Process Q, Landfill, Active Lift

The landfill cell designated Process Q received primarily centrifuge filter cake from acrylonitrile manufacturing. The process dimensions, sampling grid, and cells selected for sampling are shown in Figure 3.23. Grid cells #11 and #31 were rejected because too many of the randomly selected cells were near the sampling grid boundary. Grid cells #2 and #24 were selected to replace the rejected cells. Eight samples were taken from Process Q using the scooping technique.

3.6.3 Process R, Landfill, Active Lift

The landfill designated Process R received primarily reduced metal catalysts. The process dimensions, sampling grid, and cells selected for sampling are shown in Figure 3.24. Process R was too small for random grid cell sampling so the entire active face of the cell was divided into eight



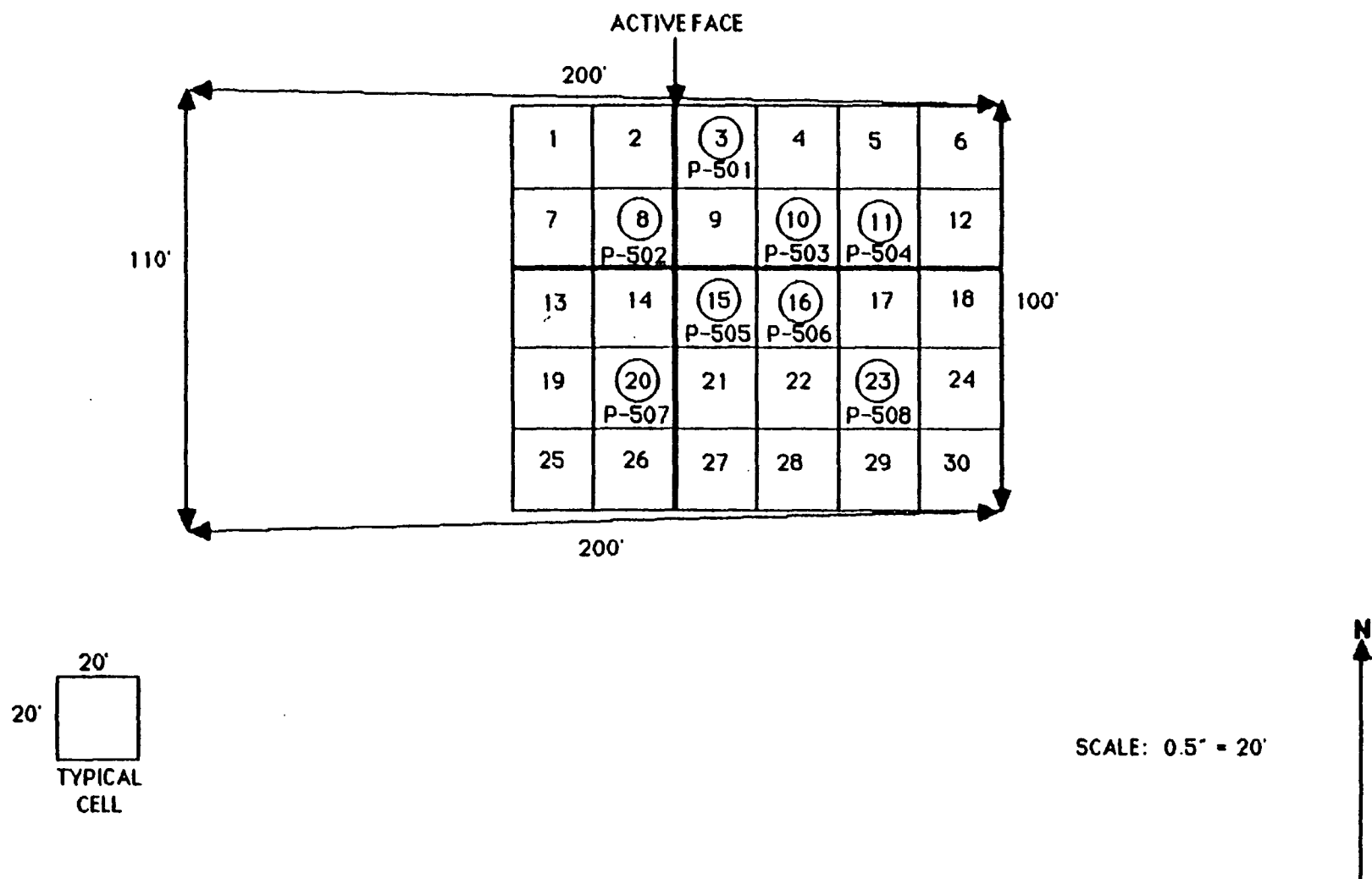


Figure 3.22. Sampling grid, process dimensions, and sample numbers for Landfill Cell A at Site 6 (Process P).

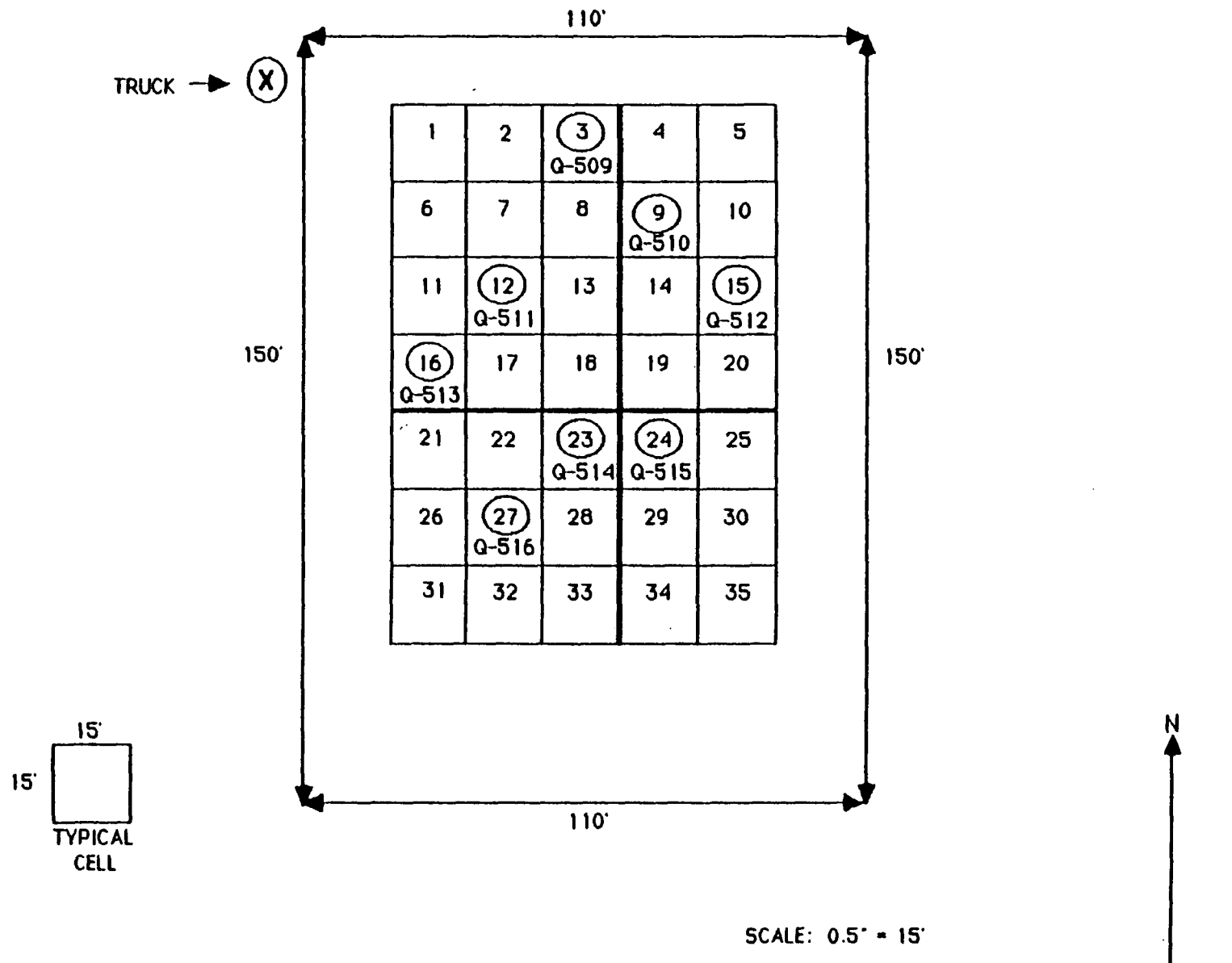
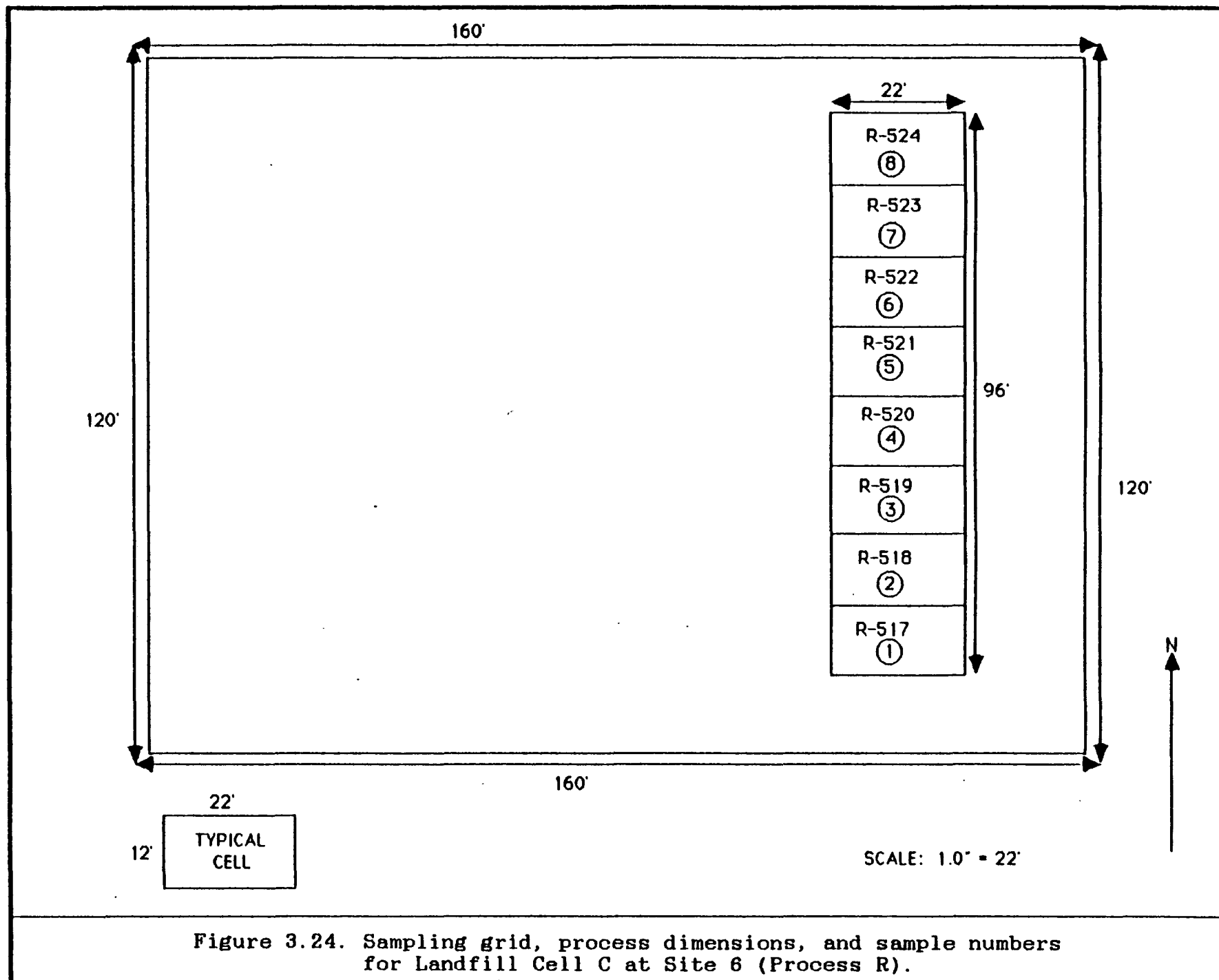


Figure 3.23. Sampling grid, process dimensions, and sample numbers for Landfill Cell Q at Site 6 (Process Q).



equal rectangular cells. A sample was taken from each cell using the scooping technique.

3.6.4 Process X, Land Treatment Unit

The land treatment unit at Site 6 was located on approximately 10 acres in the northeast corner of the facility, and was divided into two plots. The primary plot was 8 acres. The land treatment unit had recieved primarily dissolved air flotation float, API separator sludge, and leaded tank bottoms. The soil moisture associated with heavy rainfall affects the waste application schedule and the cultivation frequency. The land treatment unit is typically cultivated twice a week with the depth of waste incorporation of less than 6 inches.

The process boundaries, the sampling grid, and the cells selected for sampling are shown in Figure 3.25. Selected grid cells #54 and #86 were rejected because water was standing in these cells. (In fact, the sampling of Process X was delayed a week because of heavy rainfall associated with a hurricane.) Grid cells #68 and #90 were selected as alternatives. Eight samples were taken from Process X using the scooping technique.

3.6.5 Process Y, Unpaved Access Roadway

The landfill access roadway was sampled near the entrance to the landfill (see Figure 3.20). The roadway sample was taken from a 2-foot wide strip, 8 feet long across the roadway using the sweeping technique (see Figure 3.26).

3.6.6 Background Samples

Two background samples were taken at Site 5 from an area outside the main gate of the facility (see Figure 3.27). The samples were taken using the scooping technique.

3.7 SITE 7

At Site 7 the four processes sampled were (1) an active landfill, (2) a stabilization area, (3) two sections of a land treatment cell, and (4) two sections of unpaved access roadways (see Figure 3.28).

3.7.1 Process S, Active Landfill

The active landfill cell, designated Process S, was located in the southwest corner of the facility (see Figure 3.28). The landfill operation had recieved the following types of hazardous wastes in 1985:

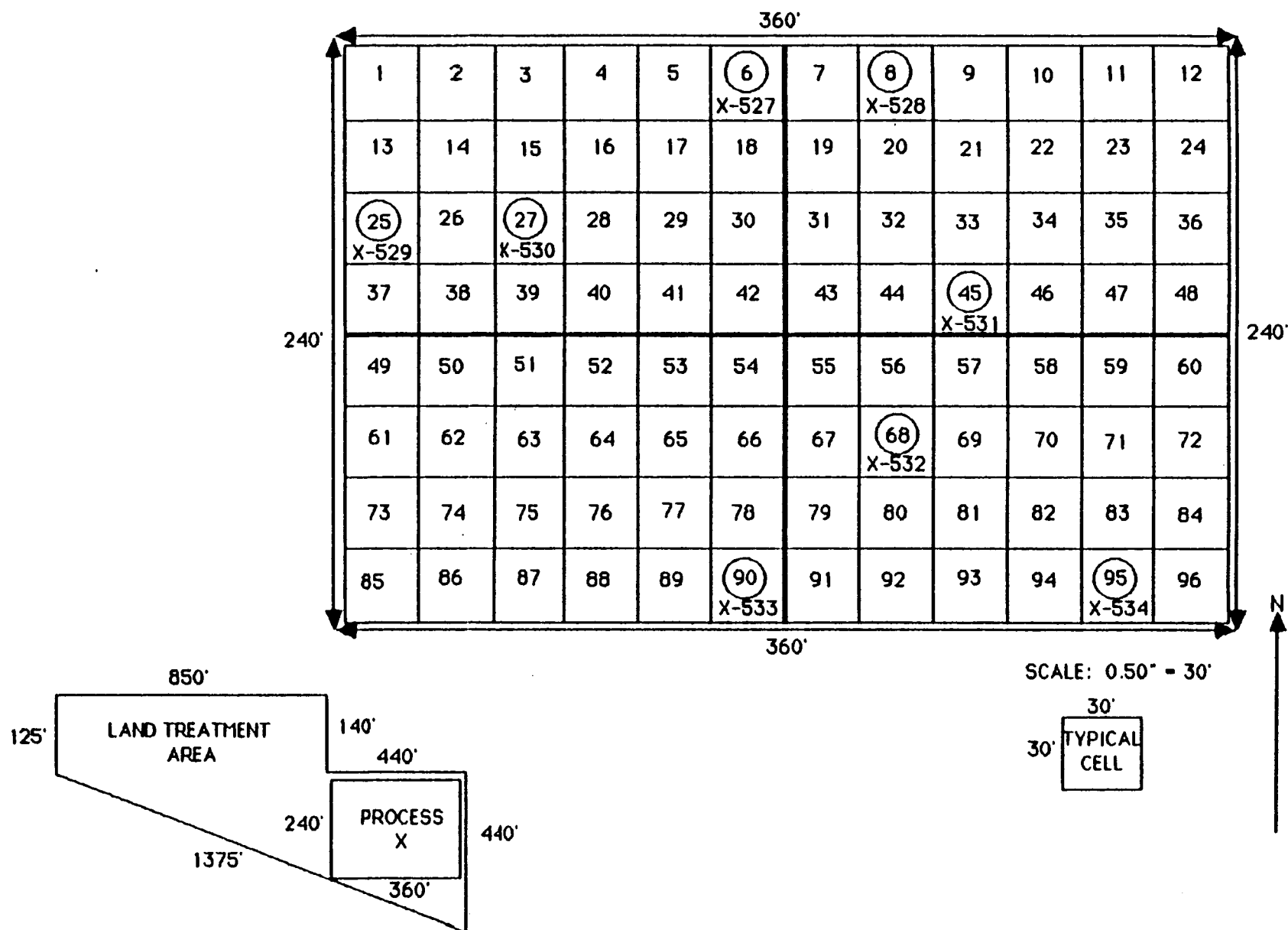


Figure 3.25. Sampling grid, process dimensions, and sample numbers for land treatment unit at Site 6 (Process X).

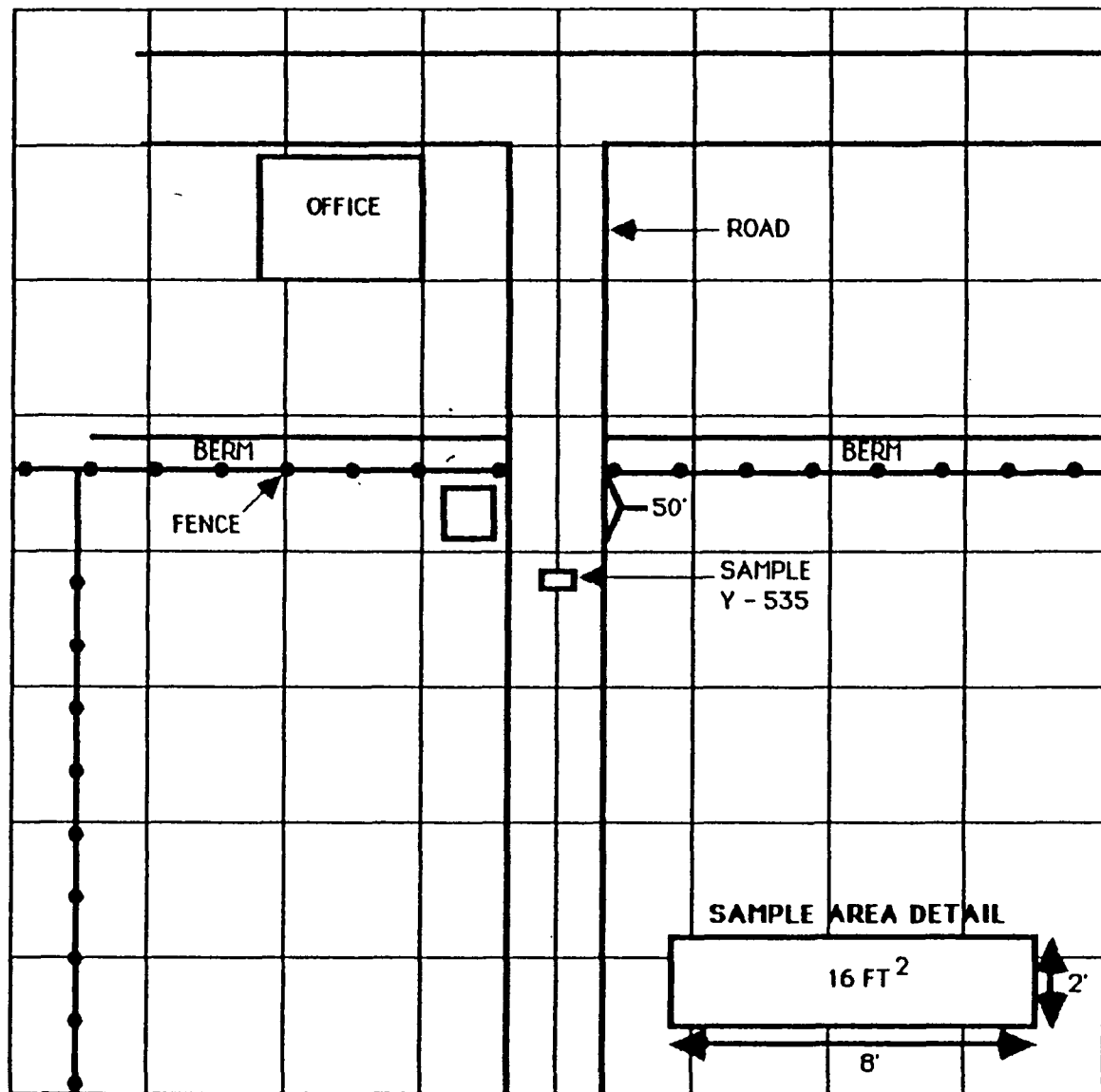


Figure 3.26. Sketch showing approximate location of road sample (including dimensions) taken at Site 6 (Process Y).

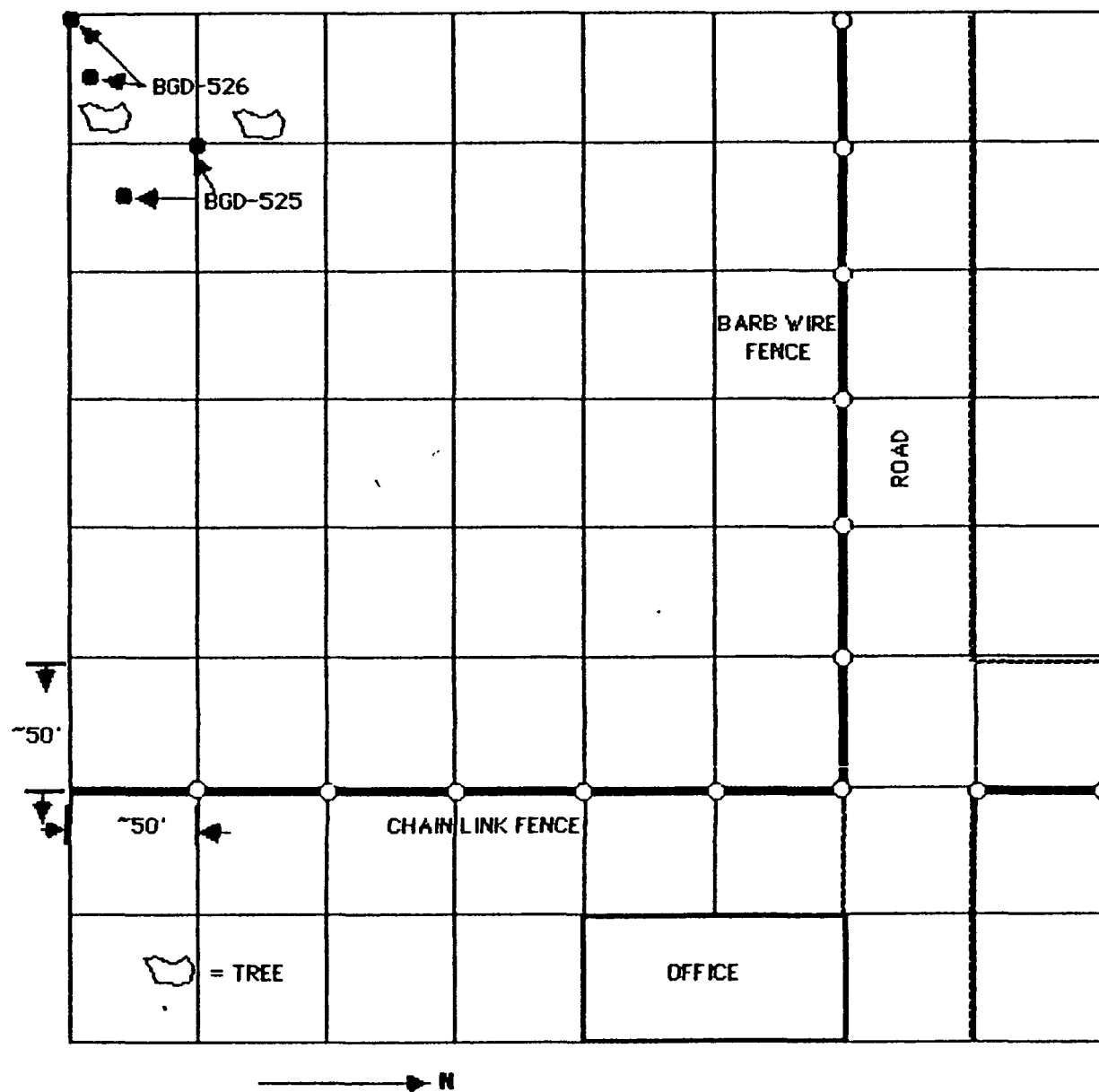
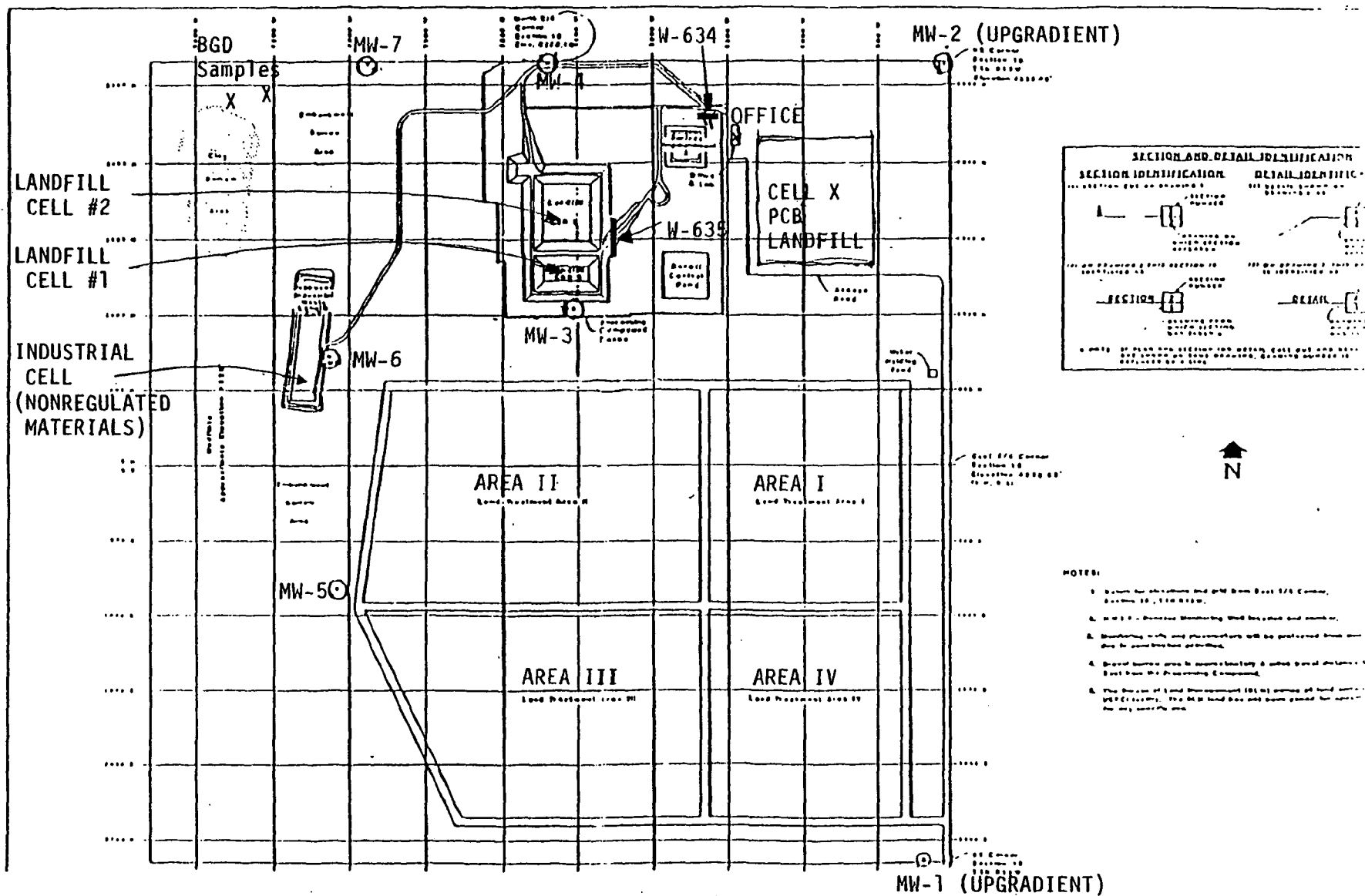


Figure 3.27. Sketch showing approximate location where background sample were taken at Site 6.

Figure 3.28. Site plot plan for Site 7 showing locations where background and road samples were taken.



- Wastewater treatment (WWT) sludge from electroplating facilities,
- Dissolved air flotation float,
- Slop oil emulsion solids,
- Heat exchanger bundle sludge,
- WWT sludge from wood preserving process using creosote and pentachlorophenol,
- API separator sludge,
- Tank bottoms (leaded),
- Electric arc furnace dust, and
- Cresote.

Some of the hazardous materials listed above were landfilled in boxes or drums.

The process boundaries, the sampling grid, and the cells selected for sampling are shown in Figure 3.29. Selected grid cells #103, #71, #10, and #5 were rejected by MRI and replaced by randomly selected grid cells #7, #53, #97, and #42. Eight samples were taken from Process S using the scooping technique.

Quality assurance (QA) samples were also collected from Process S. Nine QA samples were collected using the scooping technique with three each taken from grid cells #7, #8, and #24.

3.7.2 Process T, Stabilization Unit

The stabilization unit, designated Process T, was located adjacent to Process S. The unit consists of a single oil field mix bin with dimensions of 7 x 40 x 5 feet. Fly ash, with approximately 30 to 40% available lime, was used as the primary stabilizing agent. The stabilization unit typically handles 4,000 gallons of waste per day mixed approximately on a 1:1 weight/weight basis with the stabilization agent. The following types of hazardous wastes were processed by the stabilization unit in 1985:

- WWT sludge from electroplating facilities,
- WWT sludge from wood preserving process using creosote and pentachlorophenol,
- Dissolved air floatation float,
- Slop oil emulsions solids, and
- API separator sludge.

The stabilized material was disposed of in the landfill area adjacent to the mix bin.

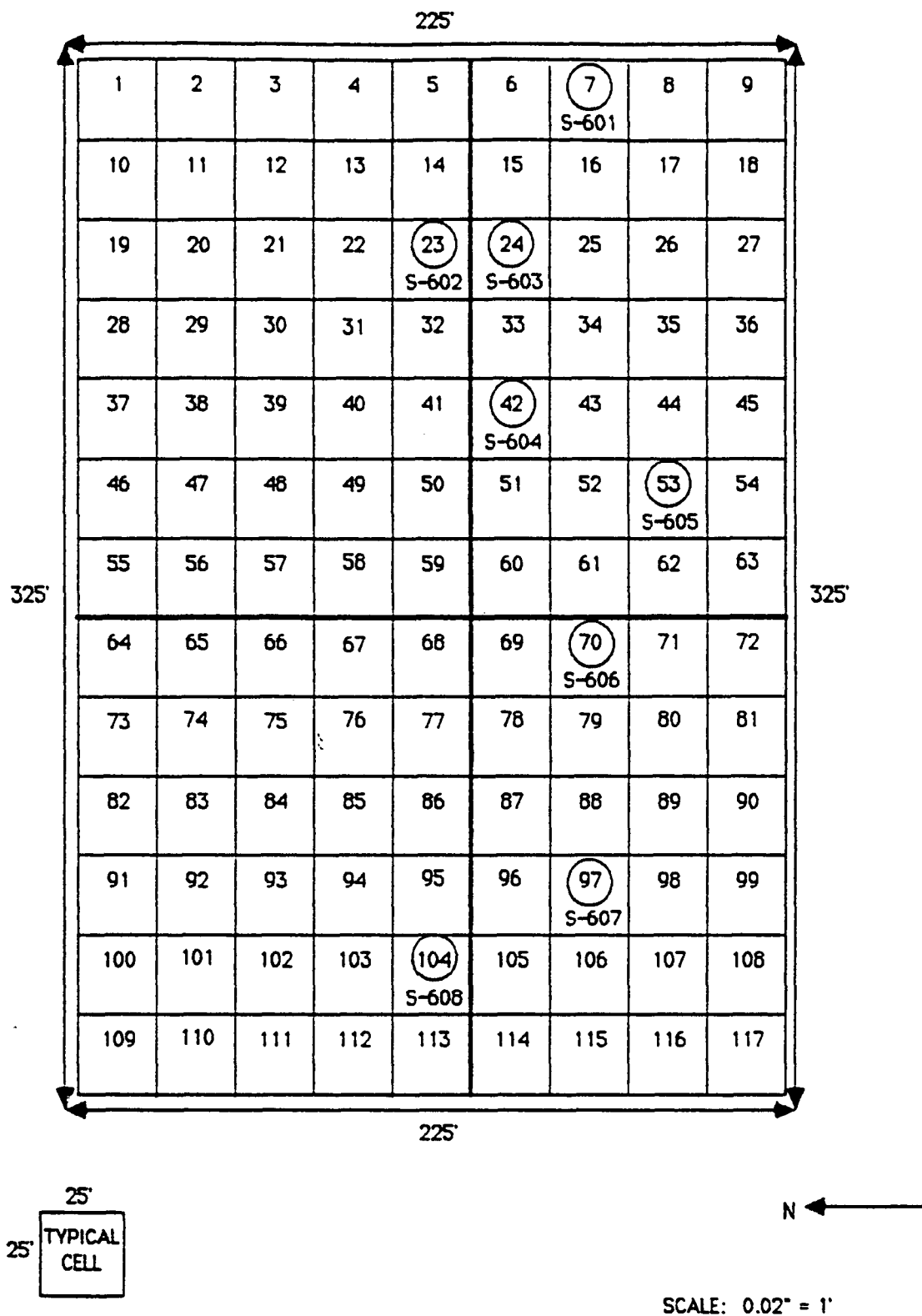


Figure 3.29. Sampling grid, process dimensions, and sample numbers for landfill Cell #1 at Site 7 (Process S).

The process boundaries, the sampling grid, and the cells selected for sampling are shown in Figure 3.30. Process T was too small for random sampling so the entire area was divided into 7 grid cells of equal size. Seven samples were taken from Process T using the scooping technique.

3.7.3 Process U, Land Treatment Cell

The land treatment cells were located in the southeast corner of Site 7. Two sets of samples were taken from the land treatment cell (see Figure 3.31) representing two different time periods following the most recent application of waste material. Process U was a section of the land treatment cell representative of soil conditions about 30 days after the most recent application of waste material. The waste materials applied to the land treatment cells in 1985 were dissolved air flotation floats, slop oil emulsion solids, and API separator sludges. The waste was applied to an 8 to 10 foot wide strip followed by incorporation to a depth of 6 to 8 inches within 1 to 2 days of application. The soil was then cultivated as necessary to maintain aerobic conditions in the soil.

The process boundaries, the sampling grid, and the cells selected for sampling for Process U are shown in Figure 3.32. Based on the process shape, the sampling grid was only one sample cell wide. None of the selected sample cells were rejected. Eight samples were taken from Process U using the scooping technique.

3.7.4 Process V, Land Treatment Cell

Process V was a section of the land treatment cell representative of soil conditions about 5 days after the most recent application of waste material.

The process boundaries, the sampling grid, and the cells selected for sampling for Process V are shown in Figure 3.33. Based on the process shape, the sampling grid was only one sample cell wide. None of the selected sample cells were rejected. Eight samples were taken from Process V using the scooping technique.

3.7.5 Process W, Unpaved Access Roadways

Two separate unpaved roadway segments were sampled for Process W (see Figure 3.28). The first segment sampled was at the beginning of the access roadway to the landfill cells. The second segment sampled was on the roadway adjacent to the entrance to the landfill cells. The process boundaries for the

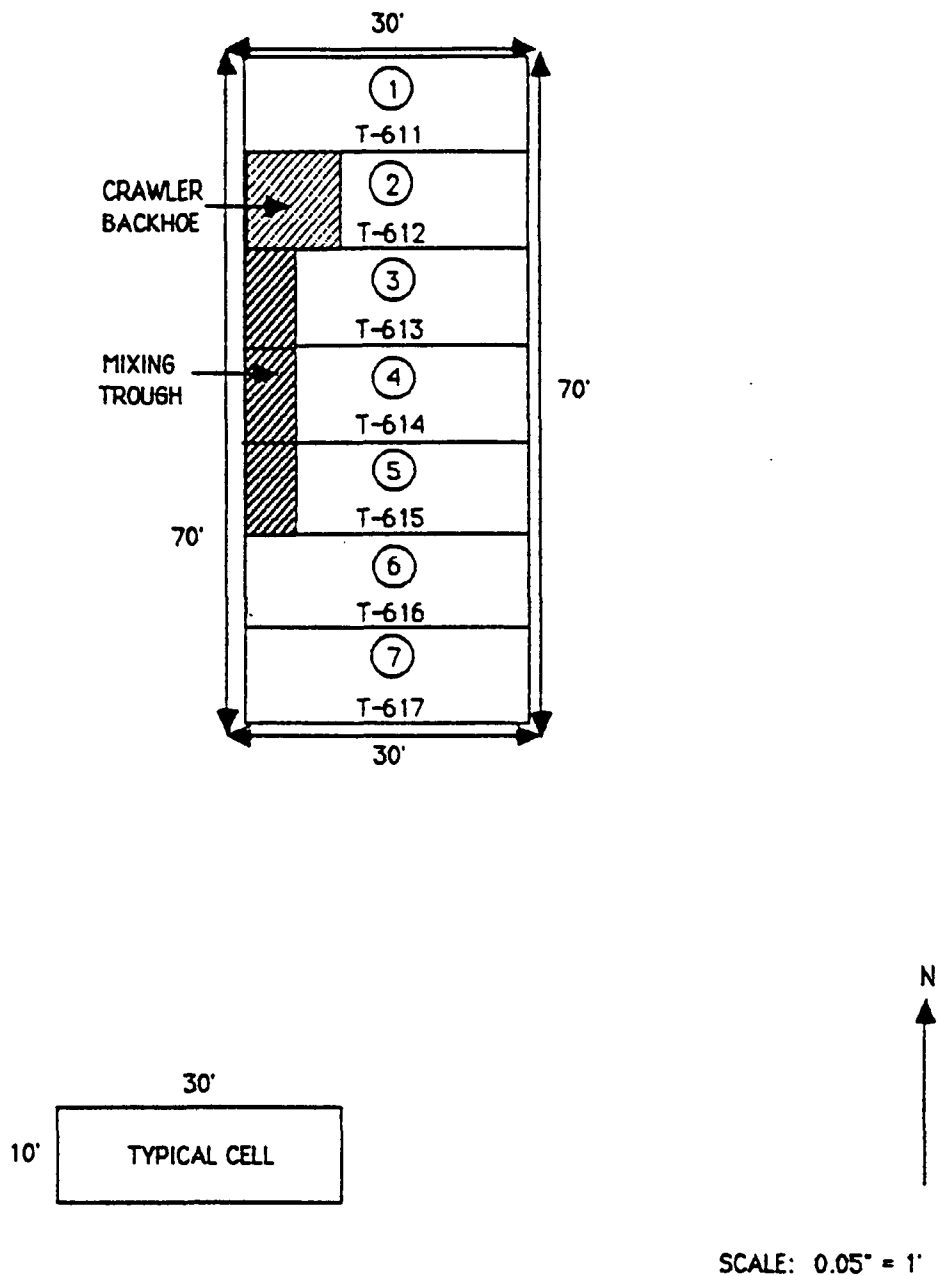


Figure 3.30. Sampling grid, process dimensions, and sample numbers for Stabilization Unit at Site 7 (Process T).

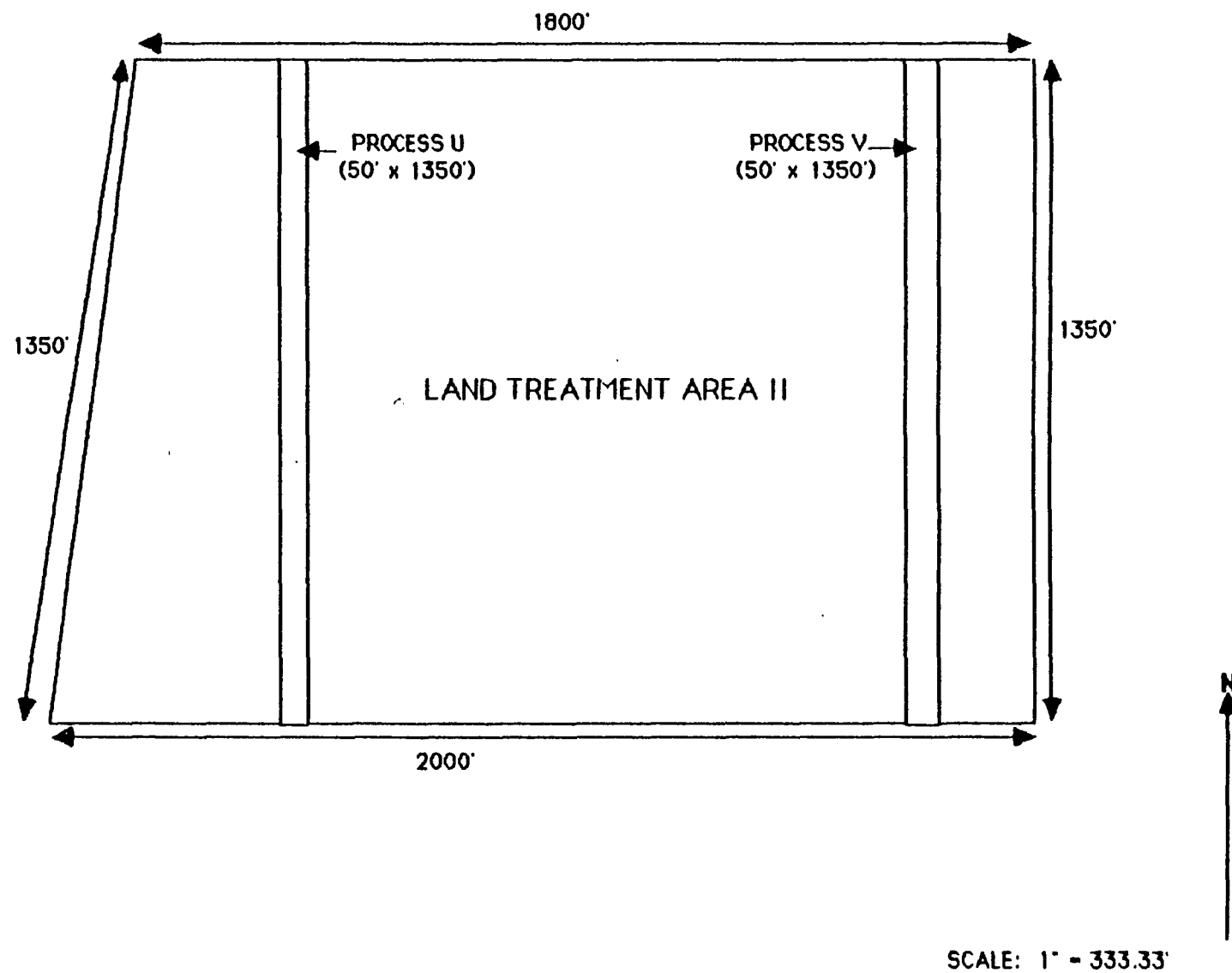


Figure 3.31. Dimensions and locations of Processes U and V in Land Treatment Area II at Site 7.

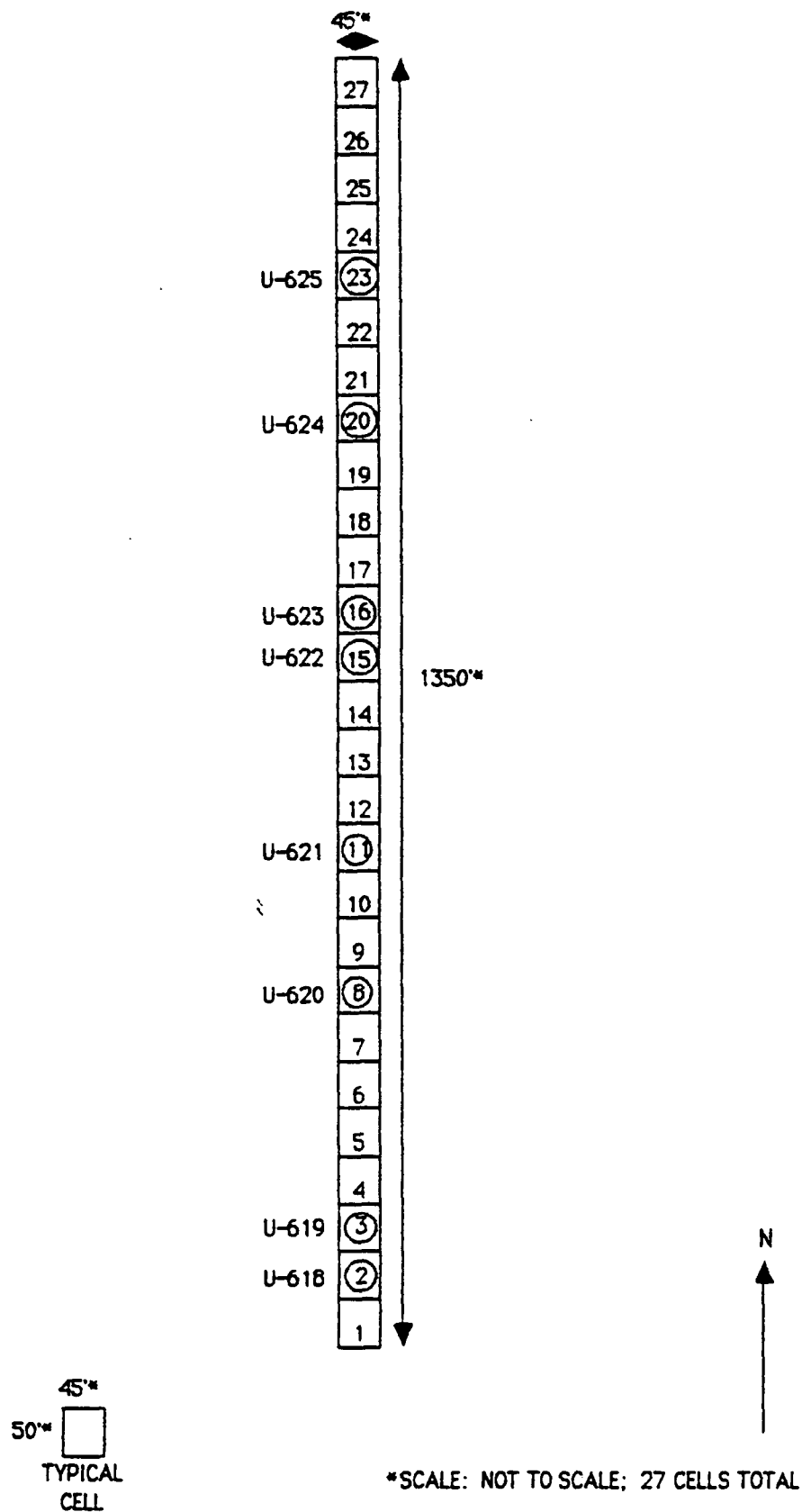


Figure 3.32. Sampling grid, process dimensions, and sample numbers for Process U (Row Markers 118 to 121) at Site 7.

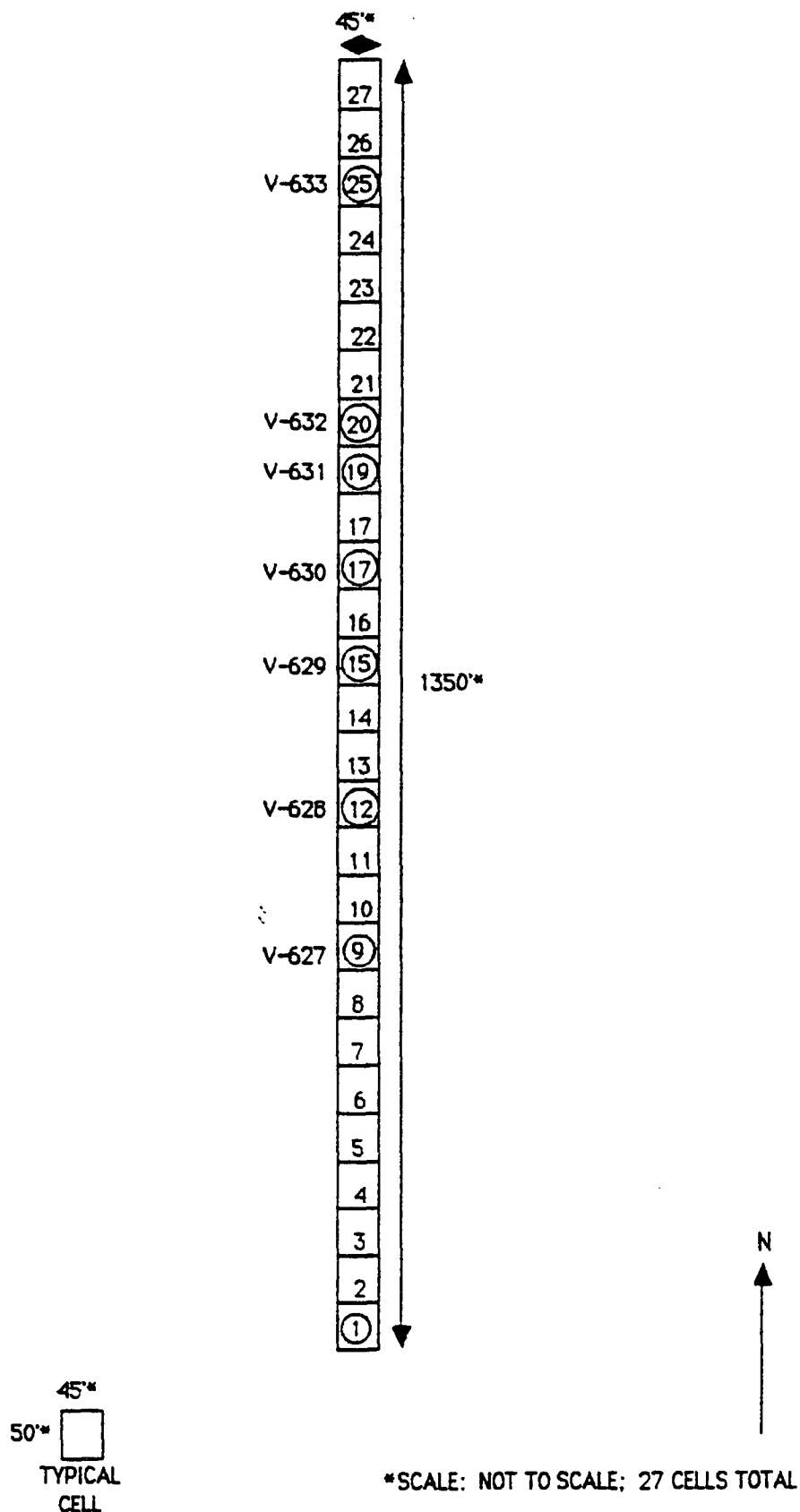


Figure 3.33. Sampling grid, process dimensions, and sample numbers for Process V (Row Markers R-32 to R-35) at Site 7.

two roadway segments for Process W are shown in Figure 3.34. The sweeping technique was used to collect the samples from each unpaved roadway segment.

3.7.6 Background Samples

Two background samples were taken at Site 7. Figure 3.35 shows the approximate location where the background samples were collected using the scooping technique.

3.8 SITE 8

At Site 8, the two processes sampled were an active lift of a landfill and two segments of unpaved access roadways to the landfill (see Figure 3.36). The landfill recieved primarily only dust from electric arc furnaces (EAF) located nearby. The landfill operation involved a truck dumping the EAF dust while traversing the active lift face. A water truck followed the dump truck to wet the dust and suppress particulate dispersion. A porous cover material of furnace slag and mill scale was used on the landfill.

3.8.1 Process Z, Landfill, Active Lift

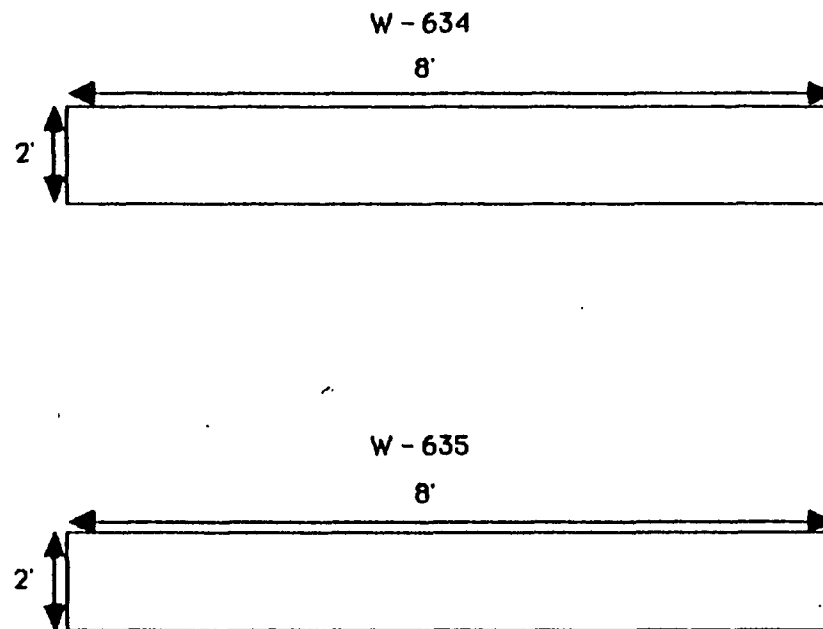
The process boundaries, the sampling grid, and the cells selected for sampling for Process Z are shown in Figure 3.37. Selected grid cell #2 was rejected because it was too close to previously selected cells #1, #3, and #5. Cell #19 was selected to replace cell #2. Eight samples were taken from Process Z using the scooping technique.

3.8.2 Process AA, Unpaved Access Roadways

Two segments of unpaved roadways providing access to the landfill were sampled (see Figure 3.38). The first sample was taken at a railroad crossing on the roadway leading to the landfill. The second sample was taken on the roadway leading down into the landfill. The scooping technique was used to collect the two samples.

3.8.3 Background Samples

Two background samples were taken at Site 8 at a location near the melt shop (see Figure 3.36 and 3.38). The samples were collected using the scooping technique.



SCALE: 0.25" = 1'

Figure 3.34. Dimensions and sample numbers for access roads at Site 7 (Process W).

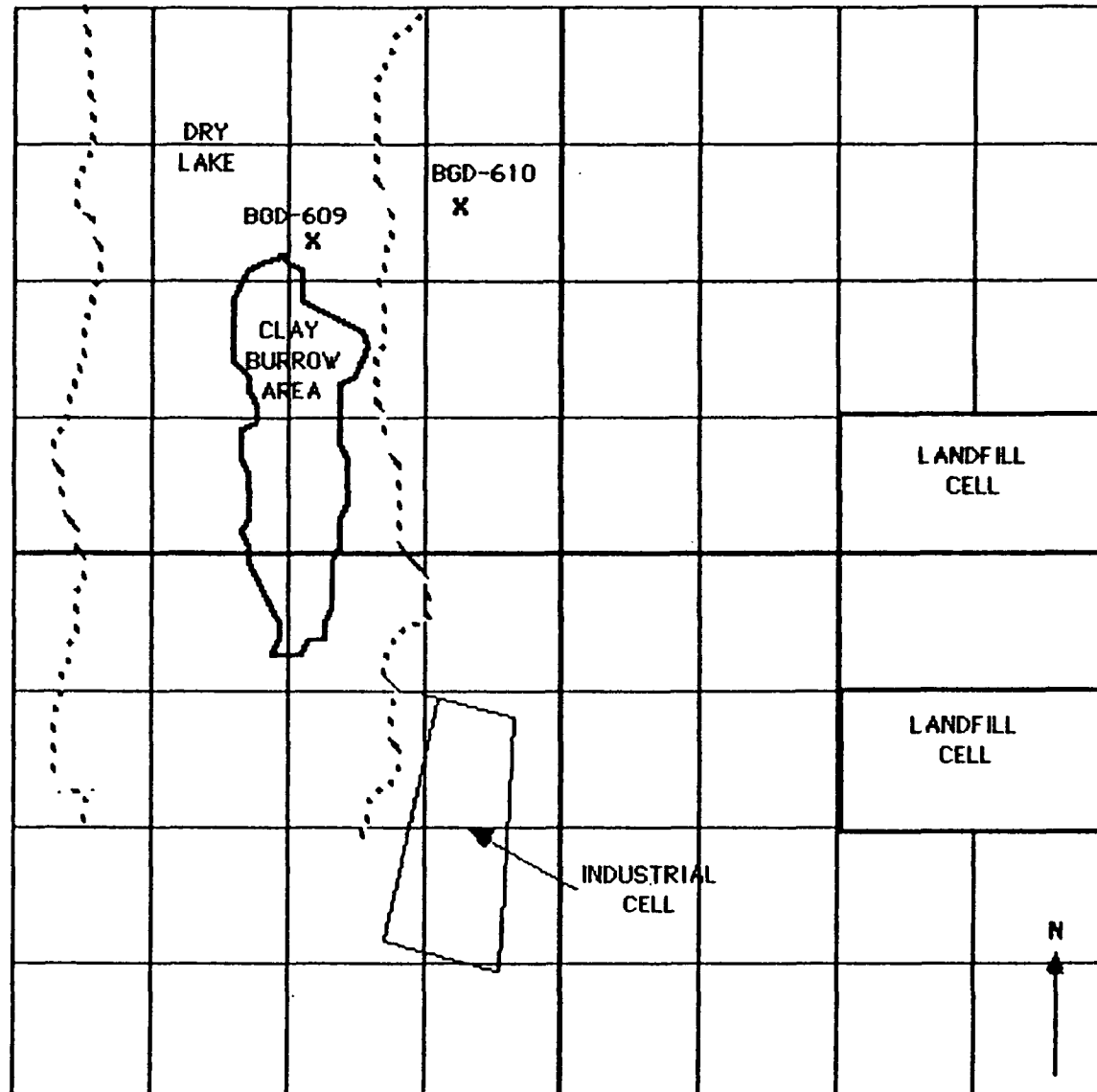


Figure 3.35. Sketch showing approximate locations where background samples were taken at Site 7.

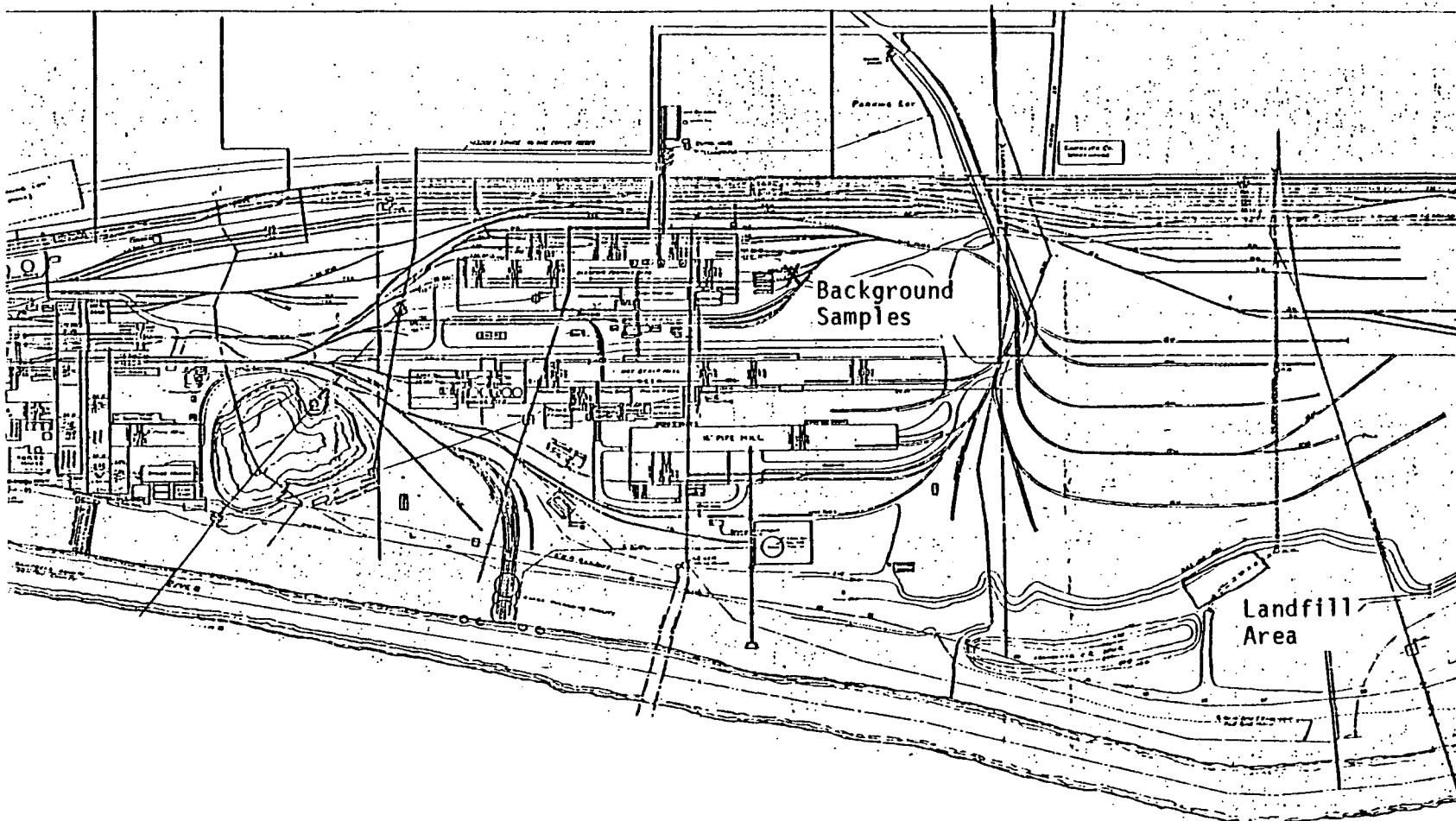


Figure 3.36. Site plot plan for Site 8 showing locations of processes sampled.

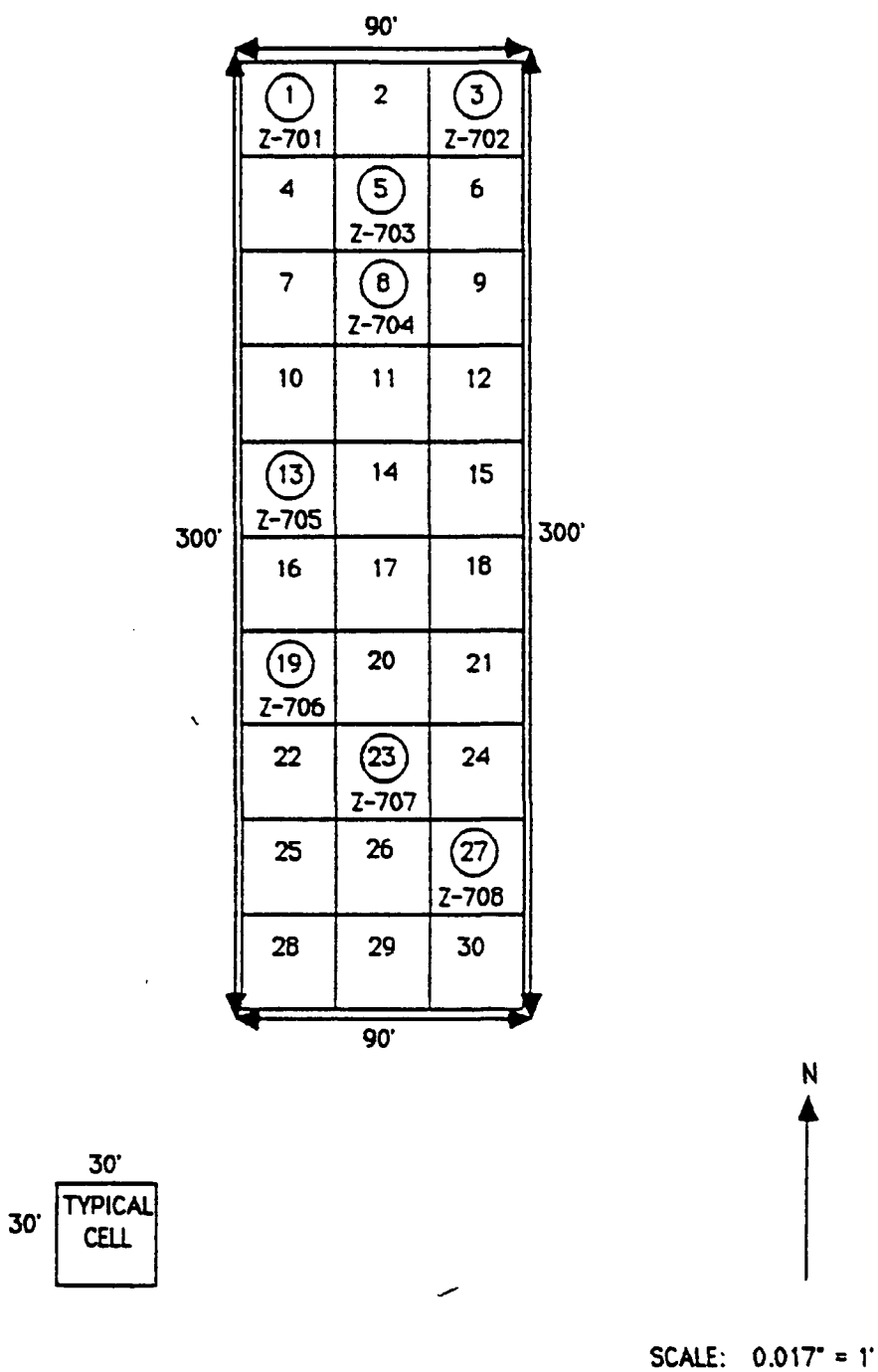


Figure 3.37. Sampling grid, process dimensions, and sample numbers for landfill at Site 8 (Process Z).

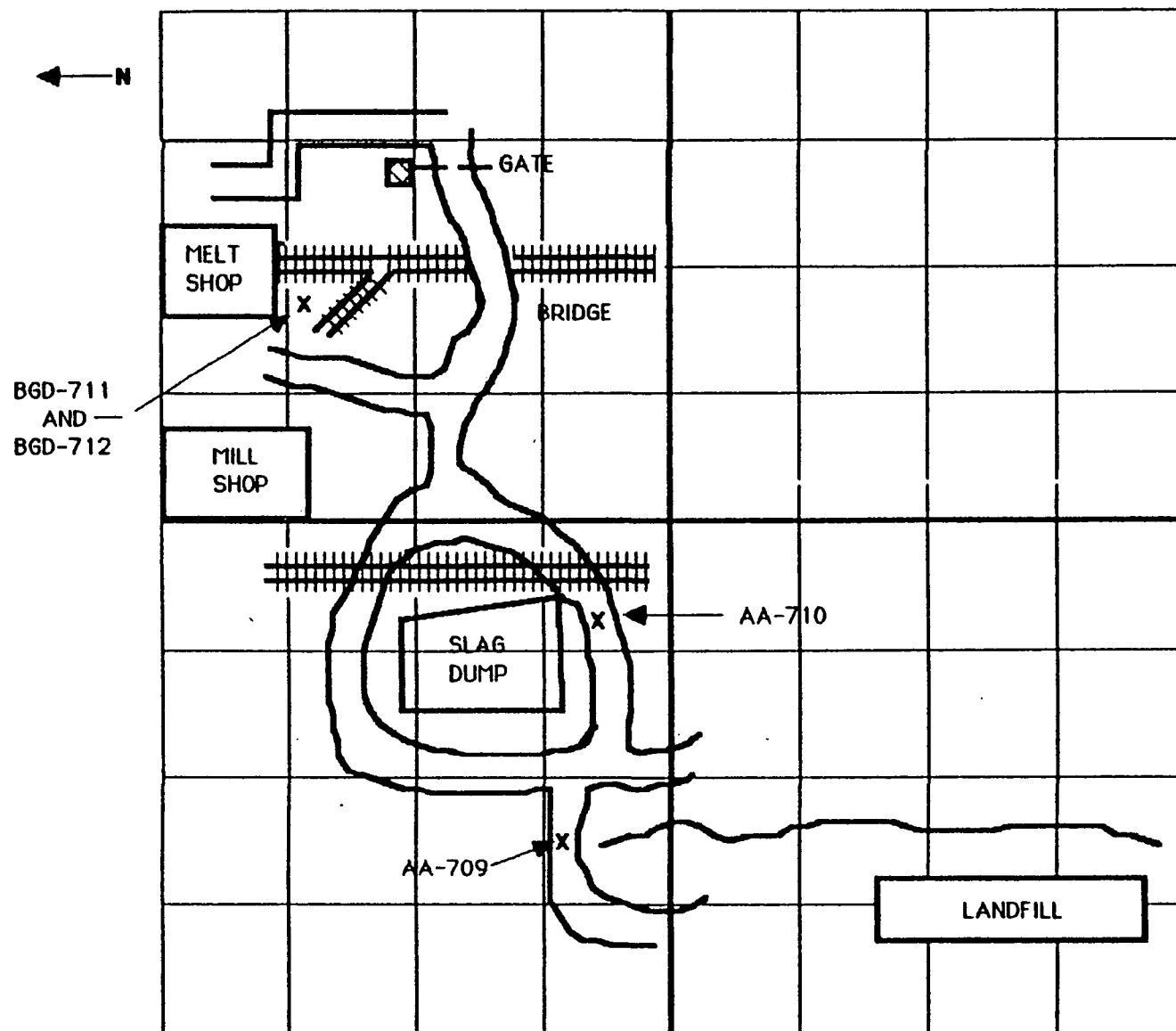


Figure 3.38. Sketch showing locations where unpaved road samples (Process AA) and background samples were taken at Site 8.

4.0 SAMPLING APPARATUS AND METHODS

This chapter presents the general sampling methodology and equipment used for sample collection at each of the sites discussed in this report.

4.1 SAMPLING APPARATUS

The utilization and specifications of the equipment used for sampling are described in this section. The field safety equipment is discussed at the end of this section. The following is an inventory of the sampling equipment used and a description of the function of each specific piece of sampling apparatus. Physical specifications of each item are presented in Table 4.1.

Surveyors Chain - For measuring process dimensions and laying out sampling grids.

Plastic Flagging - For marking sampling grids.

Wooden Survey Stakes - For marking perpendicular grid axes and processes.

Survey Flags - For marking sampling grid cells and processes.

Surveyors Tape - For laying out sampling grid cells.

Sampling Template - For defining the four randomly chosen areas [11.8-inch (30 cm) squares] within a grid cell from which the sample aliquots will be taken.

40 Quart Cooler - For transporting sample jars and ice.

Plastic Sheet Roll - Ground cloth on which to set coolers for sample marking and storage.

Carboy (20 gallon) - To contain distilled water for rinsing and decontamination of tools.

Disposable Scoop - For taking near sub-surface soil samples.

Glass Jar - To contain and transport soil samples.

Cap Liners - To seal glass jars.

Plastic Core Tube - For collecting core samples for metals analysis.

TABLE 4.1. SAMPLING EQUIPMENT SPECIFICATIONS

Description	Dimension	Material	Quantity
Surveyors Chain	200' long, 1/4" wide	Steel	1
Wooden Survey Stakes	1" x 2" x 18"	Wood	200
Surveyors Tape	100' long, 3/8" wide	Steel	2
Plastic Flagging	1-3/10" x 50 yds	Plastic	1 carton
Sampling Template	30 cm x 30 cm	1/2" O.D. PVC plastic pipe	2
Survey Flags	4" x 5" x 30"	Plastic	100
Gutter Spikes	10" long	Aluminum	50
40 Quart Cooler	24" x 24" x 40"	Plastic	3
Plastic Sheet Roll	12' x 100' roll	5 mil poly- ethylene	2
Carboy	20 gallon	Nalgene or glass	1
Disposable Scoop	190 mm long x 118 ml capacity	Styrene	300
Glass Jar	473 ml capacity x 89 mm neck diameter	Glass with phenolic cap	300
Cap Liners	89 mm diameter	Teflon	300
Plastic Core Tube	30 cm long x 3.2 cm I.D.	PVC	24
Steel Core Tube	30 cm long x 3.2 cm I.D.	Stainless steel	24
Dowel	40 cm long x 2.5 cm diameter	Wood	48
Surveyors Hammer	5 lb x 18" handle	Steel/wood	1
Wallpaper Paste Brush	7" handle, 3" bristles, 6" wide	Plastic with nylon bristles	25
Vacuum Sweeper	48" high	Plastic and metal with nylon bristle attachment	1
Shovel	Standard long handle	Steel/wood	1
Pick-ax	Standard long handle	Steel/wood	1
Bucket	12 liter	Stainless steel	1
Bottle Brush	12" long x 1-1/2"	Wire with plastic diameter	2 bristles
Plastic Bags	Assorted: 2-quart and	Polyethylene 20 gallon	50 each
Marking Pens	-----	Permanent ink	20
Log Book	Standard 8-1/2" x 11"	Hard cover	1
Compass	Liquid filled,	Plastic/glass 5° increments	1

Wallpaper Paste Brush - For sweeping and collecting road dust.

Vacuum Sweeper - For collecting road dust from paved surfaces.

Shovel - For general excavation.

Pick-ax - For general excavation.

Stainless Steel Bucket - For washing and decontamination of sampling tools.

Bottle Brush - For cleaning and decontaminating core tubes.

Plastic Bags - To contain contaminated equipment prior to decontamination and materials for disposal.

Black Permanent Marking Pen - For marking sampling scoops/jars.

Bound Log Book - For recording field notes.

Compass - For orienting processes on site plan and laying out process sampling grids.

Site Description Forms - For recording the layout and condition of each process site at the time of sampling.

Chain-of-Custody Forms - For tracing the possession of the samples from origin to analysis.

Stainless Steel Core Tube - For collecting core samples for organics analysis.

Wooden Dowel - For pressing cored soil from the metal and plastic core tubes.

Surveyors Hammer - For driving core tubes into soil.

4.2 SAMPLING APPARATUS PREPARATION AND CLEANUP

Certain sampling equipment items required special pre- and/or postsampling treatment. Presampling activities involved preparation of the sampling equipment to ensure that contaminants were not introduced into the samples. Post-sampling activities involved protecting the samples from external contamination and loss of any constituents, as well as decontamination of sampling equipment for later use and disposal of equipment designed for use at only one site, process, or sampling grid cell. Equipment preparation and cleanup procedures that were used are outlined in Table 4.2. The operations noted on the table are discussed below.

- A Soap and water wash - A solution of laboratory soap and water was used to wash surface contaminants from items which are subsequently rinsed in distilled water.

TABLE 4.2. SAMPLING EQUIPMENT PREPARATION AND CLEAN-UP

Description	Pre-Sampling Preparation	Site	Sampling Process	Cell	Post Sampling Clean-up
Surveyors Chain	A	A	---	---	A
Surveyors Stakes	A	---	E	---	---
Surveyors Tape	A	A	---	---	A
Plastic Flagging	A	---	E	---	A
Sampling Template	A	A	A	---	A
Survey Flags	A	---	E	---	---
Gutter Spikes	A	---	E	---	---
40 Quart Cooler	A	A	A	---	A
Plastic Sheet Roll	---	E	---	---	---
Carboy	A	A	---	---	---
Disposable Scoop	A,B,C	---	---	E	---
Glass Jar	A,B,C,D	---	---	---	---
Cap Liners	A,B,C,D	---	---	---	---
Core Tube (plastic)	A,B,C	---	A,B,C	---	E
Core Tube (steel)	A,B,C,D	---	A,B,C	---	E
Dowel	A	A	---	---	E
Surveyors Hammer	A	A	---	---	A
Wallpaper Paste Brush	---	---	E	---	E
Vacuum Cleaner	A,B,C	A	A	A	A
Bottle Brush	A,B,C	---	A,B,C	---	E
Shovel	A	A	---	---	A
Pick-ax	A	A	---	---	A
Bucket	A	A	---	---	A
Plastic Bags	---	E	---	---	---
Marking Pens	---	E	---	---	---
Log Book	A	A	---	---	A
Compass	A	A	---	---	A

A = Soap and water wash

B = Methylene chloride rinse

C = Nitric acid rinse

D = Oven dry

E = Dispose of

- B Methylene chloride rinse - Items were rinsed in methylene chloride in order to remove surface organic contaminants.
- C Nitric acid rinse - Items were rinsed in a dilute (50/50) nitric acid solution in order to remove surface traces of metals.
- D Oven dry - Items were dried in a 120°C oven for one hour to evaporate moisture and volatiles.
- E Dispose of - Items were disposed of in a proper manner after use, thereby requiring no additional clean-up.

4.3 FIELD SAMPLING PROCEDURES

The field sampling procedures were comprised of four phases: (1) site documentation, (2) process delineation, (3) sample location selection, and (4) sampling procedure selection. The purpose of this phased approach was to systematically identify likely sources of fugitive particulate emissions (processes) and to select sampling techniques for these processes according to their land utilization and surface characteristics. The following sections discuss each of these phases.

4.3.1 Site Documentation

A plot plan was obtained or drawn for each facility or site selected for sampling except for Site 5. Whenever possible, the plot plan obtained was the one originally submitted as part of the Part B permit application for the TSDF. The plans used were drawn to a typical topographical scale and presented each site's orientation to true north and its major topographical features, both natural and man-made. The plot plans were of sufficient detail and scale to show the location and approximate size of the processes sampled.

4.3.2 Process Delineation

Each site was divided into one or more "processes" (area devoted to a particular operation that is a potential source of contaminated fugitive particulate emissions). Possible processes included: (1) active landfill faces, (2) surfaces or pits in which liquid waste streams are mixed with solidifying agents, (3) temporary soil covers, (4) roadways and equipment

access and operation areas, (5) surface impoundments, (6) waste piles, and (7) land treatment facilities. In general, processes were classified into two broad categories: disturbed and undisturbed surfaces. Disturbed surfaces included those areas in which the soil was agitated or overturned to some depth on a routine basis (i.e., daily or biweekly). Examples included storage piles, land treatment facilities, and temporary soil covers. Undisturbed surfaces were those which were not routinely disturbed by mechanical activity including equipment access areas and roads.

Based on information supplied by the facility operators, the approximate boundaries of the processes to be sampled were defined and the location and dimensions of these processes were recorded on the site plot plan. In addition, following consultation with plant representatives, MRI recorded pertinent process operating characteristics expected to impact the generation of fugitive particulate (summarized in Section 3.0).

The boundaries (usually four corners) of the process to be sampled were marked with surveyors flags or wooden stakes. The process boundaries were measured and the area was calculated. In some cases, a process (such as a road or large land treatment area) was too large to sample as a whole. In these cases, a representative area of the process was selected for sampling and the boundaries of the selected area were marked for sampling.

4.3.3 Sample Location Selection

After each process was identified and the boundaries determined, a decision was made regarding "grid sampling" versus unspecified random sampling of the entire process or an area of the process. As a general rule, only roadways and access areas (for equipment, etc.) were not sampled using the grid technique; in these cases, samples were collected from designated areas of the process.

For random "grid" sampling, the point of origin for the grid was located first. The origin for the grid was dependent upon the chosen grid cell dimensions. The dimensions of the typical grid cell used for a process were determined based on the number of cells to be sampled and the number of cells that would fit within the process boundaries. The following parameters were considered when determining the size of the individual sampling grid cell:

- A minimum of 6 (and usually 8) cells were sampled.
- No more than 25% of the cells in a process would be sampled.

- In the majority of cases, the cell size was chosen such that the sides were at least 15 feet in length.
- The shape of the grid cells were mostly rectangular, and in some cases, square.

The sampling grid was marked on the ground by laying a pair of perpendicular grid axes beginning at a stake or flag placed at the origin of the sampling grid. Wooden stakes were layed out marking the axes (at increments equal to the grid cell side lengths) extending to the process boundaries. The grid cells were numbered, beginning with one corner of the grid. The grid cells later selected for sampling would be located using the wooden stakes on each axis.

The actual number of grid cells to be sampled depended on both the volume of sample required and the anticipated variability. The number and volume of the samples were based on prior collection of samples from processes with high variability and moderate to low silt and PM_{10} content since the variability of the degree of contamination and the soil characteristics were unknown.

The numbers of the particular grid cells to be sampled were selected using a random number table. In some cases, a randomly selected cell was not suitable for sampling. Reasons for this included: (1) two or more cells were too close in proximity, (2) a cell was on or too near the process boundary, (3) standing water was covering too much of a cell and/or, (4) the cell was covered with grass. When this occurred, that cell number was eliminated from those to be sampled, and the next cell number generated by the random number table was used.

Following selection of the cells, each of the cells were located using the wooden stakes on the axes. Each grid cell boundry was marked by placing a surveyors flag in the middle and at each of the four corners of the cell.

Four soil aliquots were taken from within each cell selected for sampling. Collection areas were defined based on four (4) random "tosses" of the 11.8 inch (30 cm) square sample template, within the boundaries of the cell. Collection locations selected for sampling were only restricted in that: (1) the template could not touch the cell boundaries and (2) the template could not land closer than 2 meters from a previous aliquot location.

4.3.4 Sample Collection Procedures

The sample collection procedure used for a given process was primarily a function of the process and its surface characteristics (i.e., disturbed or undisturbed surfaces). Three sample collection methods accounted for these variations: scooping, coring, and sweeping. Each is described in detail later in this section.

Since scooping was the method most routinely used, the general activities common to all sampling are described with reference to this method. The initial step in collecting the samples involved establishing a sample-handling area near the process to be sampled. A plastic groundcloth was spread over a 3 to 4 m square area to aid in preventing contamination of the samples by local dust. The boxes containing the prepared sampling jars and the other needed sampling equipment were moved to this groundcloth.

Each sample jar was prelabelled with information to identify the site, date, process, and sample number. The sample numbering scheme employed a letter to identify the process and a three-digit number to identify the sample. For example, sample number 145 of Process "C" was labeled as "C-145." Individual facilities were identified by the numerical series, with samples from the first facility sampled being the 100 series, the second facility being the 200 series, etc.

During sampling, the disposable scoops were used to fill one or two 473 ml sample jars per cell. After the filling of the jar(s) constituting one sample, the scoop was discarded into a large garbage bag; a new scoop was removed from its plastic wrapping and used to gather soil from the next randomly selected cell. Each time the sampling template was thrown in a cell, half the soil from that aliquot (one scoop) was put into each of two sample jars, when two jars were used. Jars were completely filled, leaving no head space. Rocks greater than one-quarter inch in diameter and other non-soil debris were manually removed from the sample. Precleaned plastic putty knives were sometimes used to aid in filling the scoops, particularly during road sampling when a "backstop" was necessary to push material into the plastic scoop. Also, in some cases, a windbreak device was used to prevent any fine dust particles from being blown from the scoop. Immediately after each jar was filled, the label was marked with the sample description.

After sampling all the candidate cells in a process and before the lids were placed securely on the sampling jars for shipment, the jar threads were cleaned with a brush to remove any soil particles. The lid was screwed onto the jar and the jar was wrapped with electrical tape to prevent any loss of

sample. The jar was placed back into the box. At the completion of sampling at a site, the brushes, putty knives, and scoops were discarded. The boxes of sample jars were labeled, sealed, and inventoried before being placed into chilled coolers for transport.

4.3.4.1 Scooping - Near sub-surface samples of moderately disturbed surfaces (i.e., stabilization areas and active landfills) were taken at depths from 0 to 3 cm by digging out the desired sample thickness with disposable plastic scoops. Rocks greater than one-quarter inch in diameter and other non-soil debris were manually removed from this material. As previously detailed, the 30 cm x 30 cm template was thrown four times within each grid cell sampled. Each time the template was thrown, two scoops of soil (constituting an aliquot) were taken from the template area. When two jars were used, one scoop was placed into each. The jars were labeled with the appropriate sample number and sampling information as previously discussed. The used scoops were then discarded into large plastic garbage bags for later disposal.

4.3.4.2 Coring - When possible, disturbed surface areas were sampled using a coring technique to extract samples from depths from 2 to 3 inches. Two types of coring tubes were employed: one made of stainless steel (to collect soil for organics analysis) and one made of PVC plastic (to collect soil for metals analysis). To collect the cored samples, the template was thrown four times as for scooping. Within the 11.8 inch (30 cm) square defined by the template each core tube was driven into the soil to the nominal depth of disturbance for the particular process. The core tube was removed from the soil layer, and the soil core was forced out into the appropriate sample jar by pushing a wooden dowel through the tube. Additional loose material within the template area was scooped up with the appropriate coring tube and placed in the sample jar. Rocks and non-soil debris were removed manually from this material prior to sealing the glass jar.

When the coring technique was used, the soil taken from each randomly selected sample cell consisted of two 473 ml samples: one taken for metals analysis using the plastic core tube and one taken for organics analysis using the stainless steel core tube. The two sample jars were labeled as discussed above, with the addition of an "M" to the sample number for the soil taken for metals analysis and an "O" to the sample number for the soil taken for organics analysis.

4.3.4.3 Sweeping - Hard-crusts, undisturbed soil surfaces, such as unpaved roads and equipment access areas were sampled using a "sweeping" or "brushing" technique. Samples were obtained from a single strip spanning all the travel lanes, usually 1 to 2 feet in width depending upon the amount of road dust. The selected sites had dust loadings and traffic characteristics typical of the entire roadway segment of interest. For other areas sampled with the sweeping technique, a reasonably sized rectangular area was chosen to be representative of the whole area.

Loose particulate matter within the area to be sampled was swept or brushed into piles or a ridge using a disposable brush or scoop (modified sweeping). This material was then picked up or brushed into one of the disposable scoops and deposited into the sample jar. All the loose particulate from the sampling area was collected. Sampling was conducted in a manner to prevent loosening and dislodging any other material from the surface which was not already loose. The sampled material was checked and rocks and non-soil debris removed. The jars were labeled and sealed as previously discussed.

4.4 COLLECTION OF BACKGROUND SAMPLES

At least one background sample was collected at each facility sampled except for Site 5. Background samples were used to determine the nominal value for the elements and/or compounds in the soil at the site that are naturally occurring or are non-process related. Background samples were taken at a point off-site or away from any process operations, which appeared to have the same soil characteristics as the site and which would have a low degree of contamination from the TSDF site. Background samples were collected using the scooping technique and were handled in the same manner as the process samples.

4.5 SAMPLE HANDLING AND TRANSPORT

This section describes the specific techniques that were used to maintain sample integrity.

To avoid contamination, field equipment that was to be exposed to sample material was transported on-site in sealed bags or coolers. The scooped samples were collected using disposable, individually wrapped, sterile, nonreactive plastic scoops. The contents of the scoops were deposited directly into sample jars. In the case of cored samples, the core tubes were cleaned before sampling and packed into sealed plastic bags. The core sample aliquots were deposited directly into the sample jars from the core tube. Swept samples were collected using a new disposable brush or scoop (transported

to the site in sealed plastic bags); disposable scoops were used to deposit the swept samples into the glass sample jars.

In all cases, the sample jars were filled completely, leaving no head space. Each sample jar was labeled with the facility sampled, date, process description, and sample number, and stored in a cooler at a temperature less than 20°C to minimize loss of volatile components.

When all samples had been collected for a particular site, the sample storage cooler was moved to an uncontaminated area and decontaminate prior to transport. This decontamination procedure included washing the cooler with soap and water and a final rinse with distilled water.

Samples were transported from the field in sealed coolers. Air freight was used to transport the samples and during transport, sample jars were maintained at temperatures less than 20°C to prevent the evaporation of any volatile components.

Samples were packed to be shipped by air freight in insulated, impact resistant coolers and cooled with "blue-ice," an airline-approved coolant. All shipping containers were clearly labeled, and arrangements were made with laboratory personnel so that samples were picked up and transferred to the laboratory within 20 hours.

Prior to the initial analyses (moisture, silt, and PM₁₀ determinations), all field samples were kept in a locked refrigerator area at a temperature less than 20°C. During the drying, screening, and sieving operations, samples were handled using techniques to prevent contamination (e.g., using clean gloves). To prevent dispersal of contaminated soil in sample handling areas, screening and sieving operations were within a closed system such as a glove box. Glove boxes, etc., and all equipment used that came into contact with soil samples, were initially decontaminated and then decontaminated after each use or disposed of in the appropriate manner.

Since the chemical analyses were to be performed by another laboratory, the resulting silt and PM₁₀ samples were placed in small amber sample vials for transport or shipment for further analysis. Ten ml vials for metals samples and 40 ml vials for organic samples were used. In cases where the samples were not shipped or analyzed immediately, the samples were stored at or below 20°C. For shipping, the samples were packed in bubble pack in a styrofoam cooler and "blue-ice" was used as the coolant to keep sample temperatures at or below 20°C.

5.0 ANALYTICAL METHODS

The methods for the analysis of soil samples collected at TSDF's involved drying and sieving of the samples followed by chemical determinations of the degree of contamination of the different soil size fractions. The types of organic analyses depended on the chemical contaminants anticipated to be found in the samples.

The scheme for analysis of TSDF soil samples is depicted in Figure 5.1. Ten (10) g aliquots of the "raw" samples (i.e., not dried) were taken for each loss-on-drying (LOD) determination and for each oil and grease determination (land treatment samples). Once the LOD value was determined, the proper sample drying method was selected. After drying, the samples were screened individually to determine percent silt content. The non-silt material was discarded. The individual silt fractions from a single process were combined to make a homogeneous silt composite. The percent PM_{10} content of the silt from the process was determined from the silt composite. Silt samples were taken from the silt composite for the chemical analyses. The organics analysis required 30 g of silt and the metals analysis required 10 g of silt. The remaining silt composite was kept as an archive sample. Background samples were processed in the same manner.

If enough silt composite was available, a PM_{10} fraction and a "greater than PM_{10} " ($>PM_{10}$) fraction were produced for chemical analysis. The $>PM_{10}$ fraction was that portion of the silt material that did not pass through the 20 μm sieve. For the organic analysis, 30 g of each fraction was required, and the metals analysis required 10 g of each fraction. Typically, an excess of $>PM_{10}$ material resulted from the sieving and it was kept in case of accidental loss of the $>PM_{10}$ sample.

The subsections which follow describe each of the analytical operations in more detail.

5.1 DRYING AND SIEVING PROCEDURES

5.1.1 Loss-on-Drying Determination

To determine the percent loss-on-drying (LOD) for the samples, ASTM Method D2216-71 was used ("Laboratory Determination of Moisture Content of Soils").

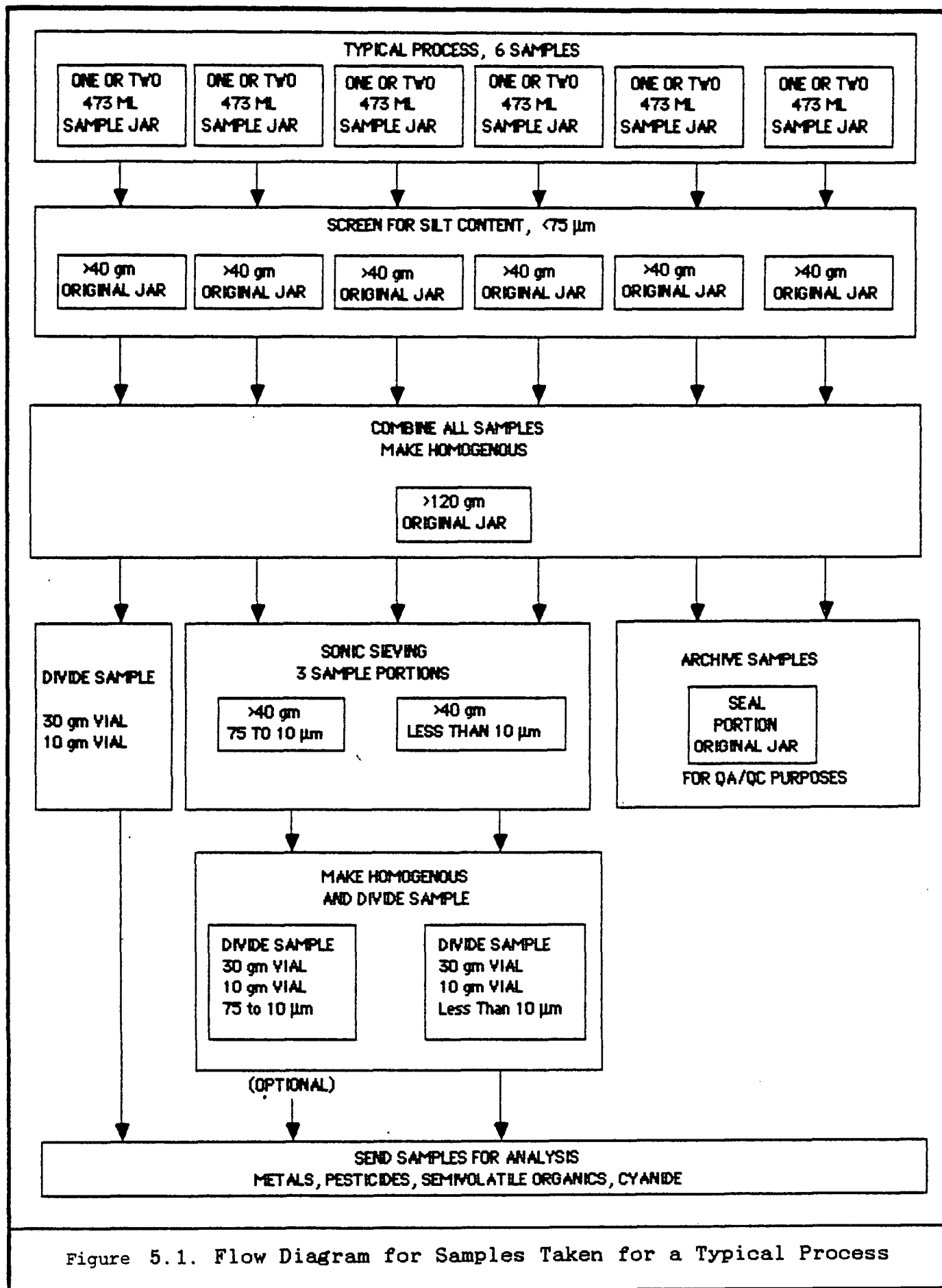


Figure 5.1. Flow Diagram for Samples Taken for a Typical Process

The method provided an indirect measure of the moisture content of a soil sample.

For the LOD determination, a 10 g portion of the soil sample was analytically weighed into a previously tare-weighted, 5 cm diameter glass jar with a tight fitting lid. The jar lid was removed and the LOD sample was dried overnight (12 to 16 hours) in an oven at 105° C. The sample was removed from the oven and placed in a desiccator to cool; the cooled sample was removed from the desiccator and the jar lid replaced. The dried sample was reweighed and the percent LOD determined using the following formula:

$$\text{Percent LOD} = \frac{\text{Jar Wet Wt.} - \text{Jar Dry Wt.}}{\text{Sample Wet Wt.}} \times 100\%$$

5.1.2 Sample Drying Procedure

Each sample was dried by one of the two procedures described below, depending on the percent LOD of the particular sample. For samples with a LOD less than 10 percent, the sample was desiccated over anhydrous calcium sulfate until the samples were dry enough to be sieved. For a sample with a LOD greater than 10 percent, the sample was dried in an oven at 105° C until the sample was dry enough to be sieved.

To desiccate a sample, a desiccator was cleaned by washing the interior with deionized (D.I.) water, followed by an acetone rinse and a final methylene chloride rinse. A one-inch layer of anhydrous calcium sulfate was spread over the bottom of the desiccator. Each sample was split (approximately one kg) between two tare-weighted, 9-inch Pyrex pie plates that had been previously cleaned with D.I. water, acetone, and methylene chloride. The weight of the pie plate and the undried sample was determined before placing the sample in the desiccator. The final weight of the sample after desiccation was determined and the percent loss-on-desiccation calculated using the following formula:

$$\% \text{ Loss-on-Desiccation} = \frac{\text{Plate Wet Wts.} - \text{Plate Dry Wts.}}{\text{Sample Wet Wt.}} \times 100\%$$

To oven-dry a sample, the oven interior was first wiped clean with D.I. water, followed by acetone and methylene chloride. Each sample to be oven-dried was split between two clean, tare-weighted pie plates. The weight of each pie plate and its undried sample contents was determined before placing them in the oven. The oven temperature was set at 105°C. The sample was dried in the oven until it was dry enough to be sieved and then removed to a

clean desiccator to cool. The dry weight of the sample was determined and the percent loss-on-drying was calculated using the following formula:

$$\% \text{ Loss-on-Drying, Oven} = \frac{\text{Plate Wet Wts.} - \text{Plate Dry Wts.}}{\text{Sample Wet Wt.}} \times 100\%$$

The samples were kept in the desiccator and sieved the same day if possible. The desiccated or oven-dried samples were returned to clean, dry sample jars and stored at or below 20°C* if the samples could not be sieved that day.

5.1.3 Silt Screening Procedure

The dried soil samples were sieved through a 40-mesh screen (425 micrometer) stacked on top of a 200-mesh screen (75 micrometer) using a Ro-Tap™ sieve shaker. The silt fraction was collected in a tare-weighed, receiver pan below the 200-mesh screen.

Before processing each sample set, the sieve stack was cleaned with D.I. water, acetone, and methylene chloride. The dried sample weight was determined before screening. Each sample was screened in successive 10 to 15 minute runs until less than 1 percent difference was seen in the cumulative silt yields between successive runs. The percent silt yield was calculated using the following formula:

$$\text{Percent Silt} = \frac{\text{Cumulative Silt and Pan Wt.} - \text{Pan Tare Wt.}}{\text{Sample Wt.}} \times 100\%$$

The difference in silt yields between successive screening runs was calculated using the following formula:

$$\text{Difference in Silt Yield} = \% \text{ Silt on Current Run} - \% \text{ Silt on Previous Run}$$

After a sample was screened, the silt was transferred to a clean, dry jar and stored at or below 20°C.* After the screening of the silt from a set of samples (for a single process, set of roadways, or background samples), the individual silt samples from the set were combined to form a composite silt sample. The silt composite was homogenized by sieving through a stack of two 40-mesh screens. The homogenized silt composites were stored in clean, dry jars at or below 20°C.*

*If not extracted within 14 days after collection, the samples were stored at 4°C.

A full stack of sieves (consisting of a 3/8, 4, 40, 140, and 200 mesh sieves) was used on samples from Sites 5, 6, and 8 to see if the full stack would increase the silt yield. As discussed in Section 2, use of the short stack of sieves resulted in an average increase in silt yield over the full stack ranging from 15.8% to 192.6%. The short stack sieving was conducted on the rejected material (non silt) from the full stack sieving. The short stack silt yield was calculated by the following formula:

$$\text{Short Stack Percent Silt} = \frac{\text{Full Stack Silt Wt.} + \text{Short Stack Silt Wt.}}{\text{Initial Sample dry weight}} \times 100\%$$

5.1.4 Sonic Sieving Procedure

A sonic sieve was used to determine the percent PM_{10} content of the silt from the homogeneous silt composite (approximately 200 to 300 grams) from a set of samples (process, roadways, or background). Sonic sieving of the silt composite was also used to produce sufficient amounts of PM_{10} and $>\text{PM}_{10}$ material for organic and metal analyses.

The equipment for the sonic sieve system consisted of a sonic sifter with variable amplitude and vertical pulsing, a sieve stack with a 270-mesh (53 micrometer) sieve over a 625-mesh (20 micrometer) sieve, and a horizontal pulse attachment. The PM_{10} material was collected in a fines collector located under the 20-micrometer sieve.

For the determination of percent PM_{10} content, the fines collector was tare-weighted on an analytical balance before the sieve stack was assembled. A 1-gram sample (analytically weighed to the nearest 0.1 mg) of silt composite was added to the sieve stack. The sonic sieve was operated for 10- to 15-minute runs using both horizontal and vertical pulsing. The fines collector was weighed after each run. The sieving runs on a 1-gram sample were repeated until less than one percent difference was seen in the cumulative PM_{10} yield. The percent PM_{10} was calculated using the following formula:

$$\% \text{PM}_{10} = \frac{\text{Wt. of Collector with Cumulative PM}_{10} - \text{Collector Tare Wt.}}{\text{Silt Sample Weight}} \times 100$$

The percent difference in PM_{10} yield on successive runs was calculated using the following formula:

$$\% \text{ Difference} = \frac{\text{Wt. of Collector with Cumulative PM}_{10} - \text{Previous Cumulative Wt.}}{\text{Silt Sample Weight}}$$

To produce PM_{10} for chemical analysis, 1 to 5 grams of silt composite (depending on sieving characteristics of the sample) was sonic sieved for 5 to 15 minutes (again depending on sieving characteristics). The material retained on the sieves was removed and stored in a jar labeled $>PM_{10}$. A fresh charge (1 to 5 g) of silt composite was added to the sieve and the sieving was repeated until about 40 grams of PM_{10} material was produced. Ten and 30 grams, respectively, were required for the metals and semivolatile organics analyses.

Before each PM_{10} production run, the sonic sieve stack was cleaned with D.I. water and 1,1,2-trichloro-1,2,2-trifluoroethane. Also, a new fines collector and a new diaphragm was used for each production run after being cleaned with soap and water, and rinsed with D.I. water. During PM_{10} production runs, the sieves had a tendency to blind (plug) and were cleaned by sonication in a beaker with 1,1,2-trichloro-1,2,2-trifluoroethane. The sieves were allowed to air dry before continuing.

5.1.5 Sample Packaging

Silt samples and silt fractions were packed in 40 ml amber vials with Teflon-lined septums and phenolic caps. The vials were cleaned and rinsed, in the following order, with: dilute nitric acid, D.I. water, acetone, and pesticide-grade methylene chloride. Thirty (30) g of each sample for organic analysis and 10 g of each sample for metals analysis were dispensed into the vials for storage and shipping to the appropriate laboratories.

5.2 CHEMICAL ANALYSES

5.2.1 Metals Analysis

For analysis of the metals of interest listed in Table 5.1, the methods used were those outlined in the EPA publication, "Testing Methods for Evaluating Solid Waste," SW-846. The samples for analysis of all metals except mercury (Hg) were prepared by acid digestion using EPA Method 3050 (SW-846). The mercury sample was prepared and analyzed by the cold-vapor atomic absorption procedure following EPA Method 7471 (SW-846). The following two modifications in the final dilutions of the digestates were used. The samples for ICAP determination by EPA Method 6010 (SW-846) and furnace atomic absorption determination of antimony (Sb) by EPA Method 7041 (SW-846) were diluted to achieve a final concentration of 5% hydrochloric acid. The sample digestates for arsenic (As) determination by EPA Method 7060 (SW-846), for selenium (Se) determination by EPA Method 7740 (SW-846), and for thallium (Tl) determination by EPA Method 7841 (SW-846) were diluted to achieve a final concentration of 0.5% nitric acid.

TABLE 5.1. METALS AND MEASUREMENT METHODS

Element	Measurement Method**
Aluminum (Al)	ICAP
Antimony (Sb)	GFAA
Arsenic* (As)	GFAA
Barium* (Ba)	ICAP
Beryllium (Be)	ICAP
Bismuth (Bi)	ICAP
Cadmium* (Cd)	ICAP
Chromium* (Cr)	ICAP
Cobalt (Co)	ICAP
Copper (Cu)	ICAP
Iron (Fe)	ICAP
Lead* (Pb)	ICAP
Manganese (Mn)	ICAP
Mercury* (Hg)	Cold Vapor AA
Molybdenum (Mo)	ICAP
Nickel (Ni)	ICAP
Osmium (Os)	ICAP
Selenium* (Se)	GFAA
Silver* (Ag)	ICAP
Thallium (Tl)	GFAA
Vanadium (V)	ICAP
Zinc (Zn)	ICAP

*Eight RCRA metals

**ICAP = Inductively-Coupled Argon Plasmography

GFAA = Graphite Furnace Atomic Absorption

AA = Atomic Absorption

5.2.2 Cyanide Analysis

Cyanide determinations were performed by colorimetric measurement following EPA Method 335.2 found in "Methods for the Evaluation of Water and Wastewater," EPA 600/4-79-020. The method involved distillation of the cyanide, as hydrocyanic acid, into a sodium hydroxide absorbing solution. The cyanide ion in the absorbing solution was determined colorimetrically.

5.2.3 Semivolatile Organic Analysis

For the semivolatile organic analysis, the samples were prepared by sonication extraction (Method 3550, SW-846) using the procedures specified in the EPA Contract Laboratory Program (CLP), Statement of Work for Organic Analysis. The extracts were prepared at the low concentration level using 30 g of sample and subjected to adsorption chromatography on Sephadex LH-20. The extracts were concentrated and the weight of the concentrated extract was determined. Two hundred (200) mg of the concentrated extract was accurately weighed, and the 200 mg portion was redissolved in 2 ml of a 1:1 mixture of methylene chloride and methanol. The dilution factor for the LH-20 procedure was calculated using the following formula:

$$\text{LH-20 Dilution Factor} = \frac{\text{Weight of Concentrated Extract (mg)}}{\text{Exact Weight of 200 mg Portion}}$$

The LH-20 system was calibrated and monitored according to the procedure in the CLP for the gel permeation chromatography system. For the LH-20 procedure, an eluent solvent system consisting of a 1:1 mixture of methylene chloride and methanol was used. The 200 mg portion of each concentration sample extract, dissolved in the solvent mixture, was loaded directly onto the column. The eluent flow rate was adjusted to 100 ml per hour. The proper fraction containing the aromatic compounds was collected and the fraction was concentrated to one ml.

Extracts were analyzed according to the CLP procedure. They were screened by gas chromatography with a flame ionization detector (GC/FID) to determine the proper dilution level. The amount of dilution was minimized to maintain the detection level at as low a level as possible. A capillary-column gas chromatograph/mass spectrometer (GC/MS) was used to analyze for the organic compounds listed in Table 5.2 as derived from the Hazardous Substances List (HSL) in the CLP. The internal standard calibration method described in the CLP was used to quantitate the HSL compounds found in the extracts.

TABLE 5.2. SEMIVOLATILE ORGANIC COMPOUNDS FOR ANALYSIS

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO (a) ANTHRACENE
BENZOIC ACID
BENZO (a) PYRENE
BENZO (ghi) PERYLENE
BENZO (b) FLUORANTHENE
BENZO (k) FLUORANTHENE
BENZYL ALCOHOL
BIS (2-CHLOROETHOXY) METHANE
BIS (2-CHLOROETHYL) ETHER
BIS (2-CHLOROISOPROPYL) ETHER
BIS (2-ETHYHEXYL) PHTHALATE
4-BROMOPHENYL PHENYL ETHER
BUTYL BENZYL PHTHALATE
4-CHLOROANILINE
4-CHLORO-3-METHYLPHENOL
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
4-CHLOROPHENYL PHENYL ETHER
CHRYSENE
DIBENZO (a,h) ANTHRACENE
DIBENZOFURAN
1,2 DICHLOOROBENZENE
1,3 DICHLOOROBENZENE
1,4 DICHLOOROBENZENE
3,3'-DICHLOOROBENZIDINE
2,4-DICHLOOROPHENOL
DIETHYLPHTHALATE
2,4-DIMETHYLPHENOL
DIMETHYL PHTHALATE
DI-N-BUTYLPHTHALATE
2,4-DINITROPHENOL
2,4-DINITROTOLUENE
2,6-DINITROTOLUENE
DI-N-OCTYL PHTHALATE
FLUORANTHENE
FLUORENE
HEXACHLOOROBENZENE
HEXACHLOOROBUTADIENE
HEXACHLOOROCYCLOPENTADIENE
HEXACHLOOROETHANE
INDENO(1,2,3-cd) PYRENE
ISOPHORONE
2-METHYL-4,6-DINITROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
4-METHYLPHENOL
NAPHTHALENE
2-NITROANILINE
3-NITROANILINE
4-NITROANILINE
NITROBENZENE
2-NITROPHENOL
4-NITROPHENOL
N-NITROSO-DI-N-PROPYLAMINE
N-NITROSODIPHENYLAMINE
PENTACHLOOROPHENOL
PHENANTHRENE
PHENOL
PYRENE
1,2,4-TRICHLOOROBENZENE
2,4,5-TRICHLOOROPHENOL
2,4,6-TRICHLOOROPHENOL

5.2.4 Pesticides Analysis

For samples selected for pesticides analysis, the Contract Laboratory Program (CLP) procedures for pesticides and PCB's was followed. For this analysis, a portion of the sample's semivolatile organic extract was used and the extract was subjected to solvent exchange. The solvent-exchanged extract was analyzed for the pesticides and PCB's (AROCLOLOR's) listed in Table 5.3 using gas chromatography/electron capture detection (GC/ECD).

5.2.5 Oil and Grease Content

All land treatment samples were analyzed for oil and grease content according to Method 503 D in "Standard Methods for the Examination of Water and Wastewater," 16th Edition. The method involved extraction of a 10 g sample with 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) followed by gravimetric determination of the dried extract. The sample was not dried or sieved prior to the oil and grease analysis. An LOD determination was made on each oil and grease sample to adjust the results to a dry weight basis.

Quality assurance analyses for the oil and grease determinations were made using portions of land treatment samples collected at Site 4 for quality assurance purposes. A repeatability measure (in-house laboratory) of the sampling and analytical phases and analytical phases alone were made. Also a performance audit was conducted using the background sample from Site 7 and an EPA QA sample of paraffin oil and Freon 113.

5.3 QUALITY ASSURANCE PROCEDURES

The quality assurance (QA) procedure used in this study included individual laboratory quality control (QC), duplicate analyses, independent analyses by an outside laboratory, and performance audits of each laboratory. For laboratory QC each laboratory followed its own procedures to document that their analytical system was representative.

The internal QC procedures instituted by each laboratory involved the use of known QC samples, spiked samples, duplicate samples, matrix spiked samples, duplicate matrix spiked samples, surrogate spiked samples, and method blanks.

For the metals analysis, a National Bureau of Standards (NBS) water sample (1643 B) was used as a check sample for the accuracy of the instrumentation. A marine sediment reference material (MESS-1) available from the Marine Analytical Chemistry Standard Program of the National Research Council of Canada and an NBS fly ash sample (1633 A) were used as QC samples to check the overall accuracy of the digestion and analysis procedures. One process sample

TABLE 5.3. PESTICIDES AND PCB'S (AROCLOR'S) FOR ANALYSIS

ALDRIN
Alpha - BHC
Beta - BHC
Delta - BHC
Gamma - BHC
CHLORDANE
4,4'-DDD
4,4'-DDE
4,4'-DDT
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN KETONE
HEPTACHLOR
HEPTACHLOR EPOXIDE
TOXAPHENE
AROCLOR 1016
AROCLOR 1221
AROCLOR 1232
AROCLOR 1242
AROCLOR 1248
AROCLOR 1254
AROCLOR 1260

from each site was spiked with the eleven elements listed in Table 5.4. Their percent recoveries were calculated to assess matrix effects. Another sample was prepared and analyzed in duplicate to demonstrate analytical precision.

For the QC on the analysis of the semivolatile organics and pesticides, the procedures in the Contract Laboratory Program (CLP) protocol were followed. These procedures required an extra 60 g of a sample for a matrix spike (MS) and a matrix spike duplicate (MSD). The percent recoveries for the MS and MSD were determined and the relative percent difference (RPD) was calculated for the duplicates. The target results for the MS/MSD, the percent recovery range, and the RPD are specified in the CLP protocol. All samples were spiked prior to extraction with surrogate compounds and the percent recoveries of these compounds were determined. The surrogate and matrix spike compounds used are listed in Table 5.5.

Analyses were conducted on two blank samples that consisted of a purified solid matrix spiked with surrogate compounds and carried through extraction and concentration. One blank was for the samples and the other blank was for the MS and MSD. The results were compared with both the CLP specified surrogate recovery limits for the blanks and with the CLP limits on the levels of common phthalate esters and Hazardous Substances List (HSL) compounds.

One portion of this study was designed to determine the repeatability and reproducibility of the sampling and analytical methods used. This effort and performance audits accounted for about 15 percent of the total effort of this study. The repeatability, defined here as the within-laboratory precision, was determined for the total measurement program (sampling and analysis) and for the analytical phase alone. This was accomplished as follows: (1) for repeatability of the total system, by collecting multiple samples from three grid cells at three different sites (9 samples) in non-similar processes and (2) for analytical repeatability, by collecting twice the sample volume at the same three grid cells at the three different processes with mixing to ensure homogeneity prior to sample splitting. The repeatability analyses were conducted by the in-house laboratories (those performing the analyses for the main part of the study).

The reproducibility, defined here as the between-laboratory precision, was determined for the total system using two individuals to collect duplicate samples in each of three grid cells. These grid cells were the same as those used in the study of repeatability. These two samples were analyzed by different laboratories: the in-house laboratory and an outside laboratory

TABLE 5.4. SPIKING COMPOUNDS: METALS

Solvent: 0.5% Nitric Acid

Compound	Concentration (g/ml)
Arsenic (As)	100
Barium (Ba)	100
Beryllium (Be)	100
Cadmium (Cd)	100
Calcium (Ca)	100
Copper (Cu)	100
Lead (Pb)	100
Manganese (Mn)	100
Selenium (Se)	100
Silver (Ag)	100
Zinc (Zn)	100

TABLE 5.5. SURROGATE COMPOUNDS AND MATRIX SPIKE COMPOUNDS

Surrogate Compounds

Nitrobenzene-d5
2-Fluorobiphenyl
Terphenyl-d14
Phenol-d5
2-Fluorophenol
2,4,6-Tribromophenol
Dibutylchloredate

MATRIX SPIKE COMPOUNDS

1,2,4-Trichlorobenzene
Acenaphthene
2,4-Dinitrotoluene
Pyrene
N-Nitrosodi-n-Propylamine
1,4-Dichlorobenzene
Pentachlorophenol
Phenol
2-Chlorophenol
4-Chloro-3-methylphenol
4-Nitrophenol
Lindane
Heptachlor
Aldrin
Dieldrin
Endrin
4,4'-DDT

independent of the rest of the study. The analytical reproducibility was determined by splitting a homogeneous sample (also collected at the same three grid cells) and these analyses were performed by two different laboratories. The reproducibility samples were not analyzed for organic compounds (see Section 2.2.5.).

The number of samples (3) collected to characterize repeatability/reproducibility was not sufficient to assess the precision of the data relative to an individual process. The repeatability and reproducibility samples were collected over the entire study to assess the overall precision of the data. The calculations for repeatability and reproducibility were performed only for compounds for which both measured values were equal to or greater than two times the detection limit for that compound.

The performance audit was conducted by combining silt samples from a single process and making the resulting composite homogeneous. A total of nine aliquots were removed from the silt composite. Each of the three laboratories (i.e., in-house metals and organics laboratories and outside metals laboratories) analyzed a pair of unspiked silt composites as a part of the repeatability and reproducibility portion described above. For the remaining three silt composite aliquots, one was spiked with EPA reference materials listed in Tables 5.6, 5.7, 5.8, and 5.9, and was analyzed by the in-house organics laboratories. The last two aliquots were spiked with a multi-element standard containing the elements listed in Table 5.10 and were analyzed by the in-house and outside metals laboratories. The measured performance audit value was compared with the true spike value. The performance audit was repeated three times with three different process samples. The spiking amounts for the three performance audits were as follows:

- Acid extractables (Table 5.6) at approximately 25, 50, and 75 ug/g;
- Neutral Extractables (Tables 5.7 and 5.8) at approximately 5, 10, and 15 ug/g;
- Pesticides (Table 5.9) at approximately 5 and 8 ug/g;
- Metals (Table 5.10) also in Appendix C at approximately 75, 150, and 225 ug/g.

The organic performance audit samples were not analyzed by an outside laboratory.

TABLE 5.6. SPIKING COMPOUNDS: ACID EXTRACTABLES II

Standard Code: C-090-01

Solvent: CH₂Cl₂

Compound	Concentration* (ug/ml)
Benzoic acid	2000
<u>p</u> -Chloro- <u>m</u> -cresol	2000
2-Chlorophenol	2000
<u>o</u> -Cresol	2000
<u>p</u> -Cresol ,	2000
2,4-Dichlorophenol	2000
2,4-Dimethylphenol	2000
4,6-Dinitro- <u>o</u> -cresol	2000
2,4-Dinitrophenol	2000
2-Nitrophenol	2000
4-Nitrophenol	2000
Pentachlorophenol	2000
Phenol	2000
2,4,5-Trichlorophenol	2000
2,4,6-Trichlorophenol	2000

*Concentration corrected for purity.

TABLE 5.7. SPIKING COMPOUNDS: NEUTRAL EXTRACTABLES V

Standard Code: C-040

Solvent: CH₂Cl₂

Compound	Purity (%)	Concentration (ug/ml)
Acenaphthene	98+	2000
Anthracene	99+	2000
Benzo(k)fluoranthene	99+	2000
Dibenz(a,h)anthracene	99+	2000
Dibenzofuran	99+	2000
1,2-Dichlorobenzene	99+	2000
1,4-Dichlorobenzene	99+	2000
<u>bis</u> (2-Ethylhexyl)phthalate	99+	2000
Fluorene	99+	2000
Hexachlorobenzene	99+	2000
Hexachlorocyclopentadiene	99+	2000
Isophorone	99+	2000
Nitrobenzene	99+	2000
N-Nitrosodi-n-propylamine	99+	2000
Pyrene	99+	2000

TABLE 5.8. SPIKING COMPOUNDS: NEUTRAL EXTRACTABLES VI

Standard Code: C-041

Solvent: CH₂Cl₂

Compound	Purity (%)	Concentration (ug/ml)
Benzo(a)pyrene	98+	2000
Benzo(g,h,i)perylene	99+	2000
Benzyl alcohol	99+	2000
4-Bromophenyl phenyl ether	99+	2000
<u>bis</u> (2-Chloroethyl)ether	99+	2000
2-Chloronaphthalene	99+	2000
4-Chlorophenyl phenyl ether	99+	2000
Chrysene	99+	2000
Diethyl phthalate	99+	2000
Dimethyl phthalate	99+	2000
Di- <u>n</u> -butyl phthalate	99+	2000
Di- <u>n</u> -octyl phthalate	99+	2000
Hexachlorobutadiene	99+	2000
Hexachloroethane	99+	2000
Naphthalene	99+	2000

TABLE 5.9. SPIKING COMPOUNDS: PESTICIDES II

Standard Code: C-093-01

Solvent: Toluene/Hexane (1:1)

Compound	Concentration* (ug/ml)
Aldrin	2000
-BHC	2000
-BHC	2000
-BHC	2000
-BHC	2000
4,4'-DDD	2000
4,4'-DDE	2000
4,4'-DDT	2000
Dieldrin	2000
Endosulfan II	2000
Endosulfan II	2000
Endosulfan sulfate	2000
Endrin	2000
Endrin aldehyde	2000
Heptochlor	2000
Heptochlor epoxide	2000
Endrin ketone	1000
p,p'-Methoxychlor	2000

*Concentration corrected for purity.