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SECOND DRAFT

OPERATION AND MAINTENANCE MANUAL

MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS

OCTOBER 1991
Ref. No. 2980 (1)

CONESTOGA-ROVERS & ASSOCIATES

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1
1.1 BACKGROUND 1
1.2 REVISIONS TO THE O & M MANUAL 2
1.3 FILE MAINTENANCE 3
1.4 PROGRESS REPORTS 4

2.0 OPERATION AND MAINTENANCE PROGRAM 5
2.1 INTRODUCTION 5
2.2 ROUTINE INSPECTION AND MAINTENANCE 5
2.2.1 Inspection Schedule 5
2.2.2 Weekly Inspection 6
2.2.3 Monthly Inspection 7
2.2.4 Problem Identification and Corrective Action 7
2.3 MAINTENANCE 8
2.3.1 Grass Cutting and Fertilizing 9
2.3.2 Site Roads and Gravel Cover 11
2.3.3 Asphaltic Concrete Pavement Surface Repairs 12
2.3.4 Stormwater Catch Basins, Culverts, Ditches and Sewer Mains 12
2.3.5 Surface Erosion/Washouts 13
2.3.6 Cover Settlement, Surface Cracking and 13
2.3.7 Fencing, Gates, Locks, Signs 14
2.4 POTENTIAL PROBLEMS 14

3.0 MATERIAL SPECIFICATIONS AND PLACEMENT 16
3.1 GENERAL 16
3.2 VEGETATED SOIL COVER 16
3.2.1 General 16
3.2.2 Materials 16
3.2.3 Placement 18
3.3 ACCESS ROADS AND GRAVEL COVER 18
3.3.1 General 18
3.3.2 Materials 19
3.3.3 Placement 19
3.4 RIPRAP 20
3.4.1 General 20
3.4.2 Materials 20
3.4.3 Placement 21

TABLE OF CONTENTS

Page

3.5 PERIMETER FENCING AND SIGNAGE 22
3.5.1 General 22
3.5.2 Fencing 22
3.5.2.1 Materials 22
3.5.2.2 Installation 24
3.5.3 Perimeter Signs 25
3.5.3.1 Materials 25
3.5.3.2 Installation 25
3.6 DREDGING PLAN 26
3.6.1 General 26
3.6.2 Pre-Dredging Preliminary Steps 27
3.6.3 Post-Dredging Steps 28
3.7 ASPHALTIC CONCRETE PAVEMENT PATCHING OR SURFACING 28
3.7.1 West Parking Area 28
3.7.2 Bituminous Surface Areas 29

4.0 LONG TERM SITE MONITORING 30
4.1 GENERAL 30
4.2 GROUNDWATER AND SURFACE WATER MONITORING 30
4.3 AIR MONITORING 31
4.4 SOIL COVER MONITORING 32
4.4.1 Visual Monitoring 32
4.4.2 Soil Boring 33
4.4.3 Remedial Soil Cover Contingency Plan 34
4.5 QUALITY ASSURANCE/QUALITY CONTROL AND PERSONNEL PROTECTION 34

LIST OF FIGURES

		Following Page
FIGURE 1.1	SITE LOCATION MAP	1
FIGURE 1.2	REMEDIATED AREAS	1
FIGURE 1.3	DOCUMENT ACCESS RECORD	3
FIGURE 2.1	SITE INSPECTION SCHEDULE	5
FIGURE 2.2	WEEKLY INSPECTION LOG	6
FIGURE 2.3	MAINTENANCE RECORD LOG	6
FIGURE 2.4a	MONTHLY INSPECTION LOG (PAGE 1)	7
FIGURE 2.4b	MONTHLY INSPECTION LOG (PAGE 2)	7
FIGURE 2.4c	MONTHLY INSPECTION LOG (PAGE 3)	7
FIGURE 2.5	LOCATION OF VEGETATIVE SOIL COVER	9
FIGURE 2.6	LOCATION OF ASPHALTIC CONCRETE PAVING COVER	12
FIGURE 3.1	24-INCH THICK SOIL COVER	16
FIGURE 3.2	CLASS I GRAVEL ROADWAY OR COVER	19
FIGURE 3.3	CLASS II GRAVEL ROADWAY OR COVER	19
FIGURE 3.4	RIPRAP SLOPE PROTECTION	20
FIGURE 3.5	TYPICAL PERIMETER SIGN	25
FIGURE 3.6	ACTIVE WASTEWATER TREATMENT SYSTEM	26
FIGURE 3.7	TYPICAL DREDGING OPERATION	27
FIGURE 4.1	GROUNDWATER/SURFACE WATER SAMPLING LOCATION PLAN	30
FIGURE 4.2	SOIL BORING LOCATIONS ROUND 1 SOIL COVER MONITORING	33

LIST OF TABLES

		Following Page
TABLE 2.1	POTENTIAL PROBLEMS VEGETATED SOIL COVER	14
TABLE 2.2	POTENTIAL PROBLEMS ACCESS ROADS	14
TABLE 2.3	POTENTIAL PROBLEMS SURFACE WATER BODIES	14
TABLE 2.4	POTENTIAL PROBLEMS GENERAL	14
TABLE 3.1	SEEDING MIXTURES	17
TABLE 3.2	PERIMETER BENCH MARK ELEVATIONS	27
TABLE 3.3	MAXIMUM ALLOWABLE DREDGING DEPTH ELEVATIONS	27
TABLE 4.1	LONG TERM MONITORING SCHEDULE	30

LIST OF APPENDICES

APPENDIX A	HEALTH AND SAFETY PLAN C. C. JOHNSON & MALHOTRA JUNE 1988, REVISED SEPTEMBER 1988
APPENDIX B	SPECIFICATION C. C. JOHNSON & MALHOTRA JUNE 1988, REVISED SEPTEMBER 1988
APPENDIX C	PARTIAL IDOT SPECIFICATIONS
APPENDIX D	QUALITY ASSURANCE PROJECT PLAN C. C. JOHNSON & MALHOTRA JUNE 1988, REVISED SEPTEMBER 1988

1.0 INTRODUCTION

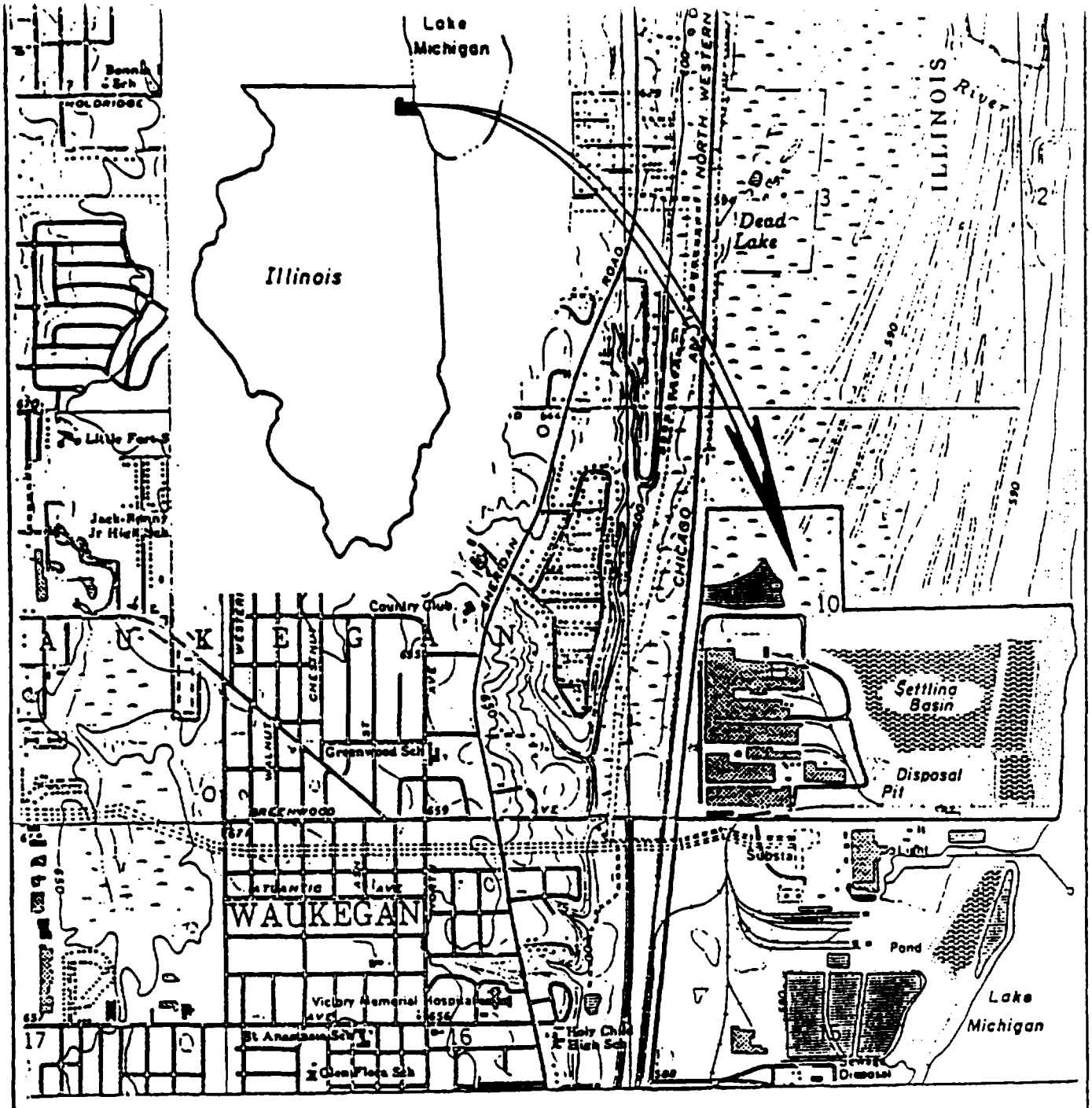
1.1 BACKGROUND

As of August 21, 1990, Manville Sales Corporation (Manville) completed remedial construction activities at the former Waste Disposal Area (Site) located in Waukegan, Illinois (Figure 1.1) in accordance with the Consent Decree signed December 31, 1987 and all subsequent attachments. The Site was remediated to eliminate the potential for exposure to asbestos containing materials (ACM), disposed of on Site. An operations and maintenance (O & M) manual presented hereafter has been prepared to guide post construction activities at the Site. Long term O & M activities will be the responsibility of the Manville Waukegan Manufacturing facility. Figure 1.2 illustrates the remediated area at the Manville Waukegan Manufacturing facility covered by the O & M program and provides area names as used in the O & M manual.

The O & M program for the Site is designed to ensure the integrity of the various covers overlying areas of the Site where ACM waste is present. These covers include those constructed of vegetated soil, asphaltic concrete and granular. Additionally, some areas of former ACM waste disposal are overlain by surface water bodies.

The O & M Manual specifically addresses five major areas of concern in regard to post construction activities. These are:

i) Vegetated soil cover



N

1"=2000'

figure 1.1

SITE LOCATION MAP
MANVILLE PLANT SITE
Waukegan, Illinois

Map adapted from USGS Zion Quad. Map

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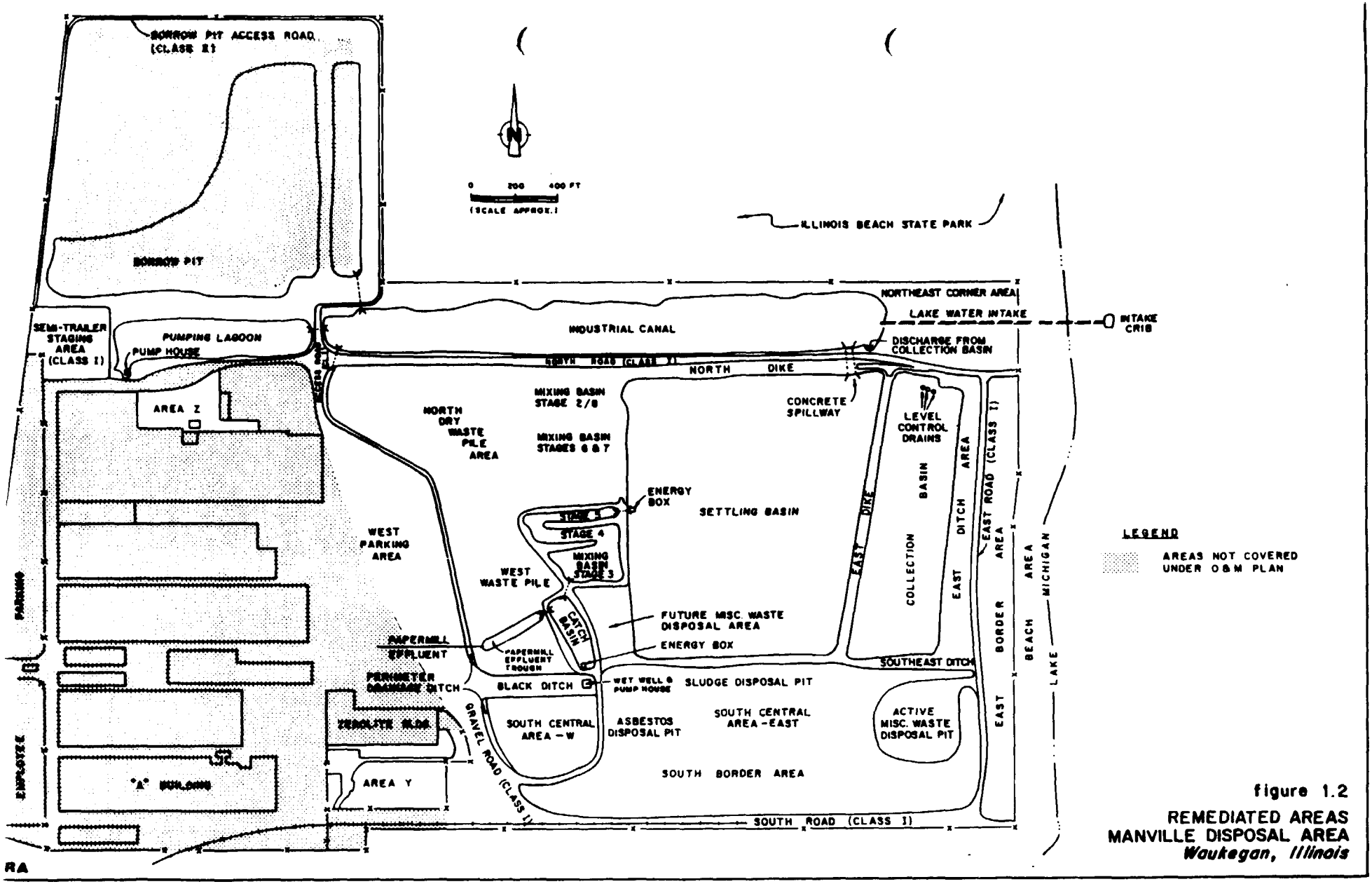

figure 1.2

REMEDIATED AREAS
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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ii) Surface water bodies

iii) Site security

iv) Access roads

v) Asphaltic concrete surfaces

In addition, a schedule and discussion of future soil, air and water sampling events is presented.

Maintenance requirements for the Site include routine inspection, scheduled maintenance, unscheduled maintenance, and record keeping of these activities. The weekly and monthly inspection requirements are detailed in Section 2.0 of the O & M Manual. The procedures for implementing unscheduled maintenance are also presented and discussed in Section 2.0.

1.2 REVISIONS TO THE O & M MANUAL

Over the course of implementation of the O & M Program, revisions to the O & M manual, tables and figures may be required. Such revisions shall be added as an addendum to this manual. Periodically this manual and its revisions will be reviewed by the Waukegan Plant Manager or his delegate and all revisions incorporated into the manual. The

frequency of integration of revisions to the manual shall be determined based upon the quantity of changes involved. Such revisions shall be added as an addendum to this manual following review and approval by the United States Environmental Protection Agency, Region V (USEPA) and the Illinois Environmental Protection Agency (IEPA).

1.3 FILE MAINTENANCE

In accordance with Article XIII Paragraph A, of the Consent Decree, Manville must make available to USEPA and IEPA representatives all records and documents which pertain to the implementation of remedial construction, post construction monitoring, and maintenance of the Site for a period of at least ten (10) years after termination of the Consent Decree. These documents include, but are not limited to, results of all sampling and tests, construction administrative records and Site maintenance records.

These documents shall be kept in locked filing cabinets at the Waukegan Plant Manager's office or other secure Plant Manager designated area. The files shall be kept current by the Plant Manager's delegate and all document access shall be controlled through the delegate.

A Document Access Record, as shown in Figure 1.3 shall be maintained to record by whom and when files are accessed and reviewed.

DOCUMENT ACCESS RECORD

DATE	NAME	RECORDS ACCESSED	COMMENTS

figure 1.3

DOCUMENT ACCESS RECORD
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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1.4 PROGRESS REPORTS

In accordance with the Consent Decree and Amended Work Plan, Manville will provide USEPA and IEPA written progress reports on a semi-annual (twice yearly) basis following the completion of remedial construction activities. The semi-annual progress report will include a minimum of the following items:

- a description of actions taken during the previous six-month period;
- plans and procedures completed in accordance with the O & M manual during the previous six-month period;
- a description of actions and plans scheduled for the next six-month period;
- copies of sampling and testing results, as well as other data received including all necessary Quality Assurance/Quality Control (QA/QC) data and a Quality Assurance (QA) review; and
- all statistical analysis and determinations performed in conjunction with the Contingency Plans.

The first semi-annual progress report shall be submitted to USEPA and IEPA in late February, 1992. Subsequent progress reports will be submitted every six months until completion of O & M activities.

2.0 OPERATION AND MAINTENANCE PROGRAM

2.1 INTRODUCTION

A successful O & M program for the Site cover is dependent upon frequent and thorough inspections of the Site. Failure to identify problem areas limits the effectiveness of all remaining measures contained within the O & M program. The intent of the regular inspections is to identify and remediate areas where uncovering of contained ACM waste may occur.

In addition to natural deterioration of the cover, other on-going plant production modifications and/or maintenance activities may affect the integrity of the cover. Any work which may involve potential penetration of the Site cover (i.e., pipe installation or repair) must first be approved by USEPA and IEPA and must adhere to the Health and Safety (H & S) protocols specified in the H & S Plan, dated June, 1988 and prepared by C. C. Johnson & Malhotra (CCJM), presented in Appendix A.

2.2 ROUTINE INSPECTION AND MAINTENANCE

2.2.1 Inspection Schedule

Inspections of the remediated Site will be performed according to the schedule provided in Figure 2.1. Every effort will be made to

ACTIVITY	FREQUENCY Weekly	Monthly	Comments
Inspect Vegetated Soil Cover[1]	*	*	
Inspect Access Roads	*	*	
Inspect Surface Water Bodies	*	*	
Inspect Site Security Fence	*	*	
Inspect Monitoring Wells	*	*	
Inspect Length of Grass		*	Maintain Grass Height
Inspect Concrete Spillway		*	Between 6" - 15"
Inspect Collection Basin Level Control Drains		*	
Inspect Collection Basin		*	
Inspect Benchmarks		*	
Inspect Papermill Effluent Trough		*	
Inspect Black Ditch Area		*	
Inspect Perimeter Drainage Ditches		*	
Inspect Catch Basin, Mixing Basin Stages 3, 4, 5		*	
Inspect Settling Basin		*	
Inspect Sludge Disposal Pit		*	
Inspect Mixing Basin Stages 6 and 7		*	
Inspect West Parking Area		*	
Inspect Area Y and Area Z		*	

Note:
[1]For areas to inspect and items to inspect or refer to corresponding daily, weekly or monthly inspection log.

figure 2.1

SITE INSPECTION SCHEDULE
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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have consistent inspections by the same trained personnel who are familiar with the Site plans.

2.2.2 Weekly Inspection

An overall Site inspection shall be performed on a weekly basis and following heavy rainfall events. The inspection shall consist of a general Site drive along all access roads and the perimeter security fence. In areas inaccessible to vehicle traffic (e. g., East Border Area and East Ditch), the inspection shall be performed by walking the areas. Particular attention shall be given to the condition of the roads, surface water bodies, vegetated soil cover and associated slopes, ditches and installations, Active Miscellaneous Waste Disposal Area, and perimeter fencing.

Weekly inspections performed will be recorded on the Weekly Inspection Log (Figure 2.2). Once a month, the Monthly Inspection Log shall be completed in lieu of the Weekly Inspection Log as discussed in Section 2.2.3. Completed logs shall be kept on file at the Plant Manager's office or other designated Plant area and will be accessible for USEPA and/or IEPA review as required. Any maintenance performed as a result of the weekly inspections should be recorded on the Maintenance Record Log (Figure 2.3) and kept in a separate file in the Plant Manager's office or other designated Plant area.

WEEKLY INSPECTION LOG

Inspector:_____ Date:_____

Areas: All access roads and gravel cover, perimeter security fence, surface water bodies, vegetated soil cover and associated slopes, ditches and installations, Active Miscellaneous Waste Disposal

Inspect	*Inspect for*	*Action Required*		*Location Comments*
Vegetated Soil Cover	Erosion/Washouts	Yes	No	
	Bare Areas	Yes	No	
	Distressed Vegetation	Yes	No	
	Ponding	Yes	No	
	Other			
Access Roads and Gravel Cover	Erosion	Yes	No	
	Obstructions	Yes	No	
	Grading/Potholes	Yes	No	
	Drainage/Puddles	Yes	No	
	Debris	Yes	No	
	Other			
Surface Water Bodies	Riprap	Yes	No	
	Slope/Bank Erosion	Yes	No	
	Flooding	Yes	No	
	Debris	Yes	No	
	Other			
Monitoring Wells	Integrity of Bollards	Yes	No	
	Integrity of Casings	Yes	No	
	Security of Locks	Yes	No	
	Other			
Site Security Fence	Integrity of Fence	Yes	No	
	Integrity of Gates	Yes	No	
	Security of Locks	Yes	No	
	Placement and Integrity of Signs	Yes	No	
	Other			

figure 2.2

WEEKLY INSPECTION LOG
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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MAINTENANCE RECORD LOG

Date	Maintenance Performed	Performed By	Comments

figure 2.3

MAINTENANCE RECORD LOG
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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2.2.3 Monthly Inspection

A complete and thorough Site inspection shall be performed on a monthly basis. The monthly inspections shall address items covered during the weekly inspections and shall place emphasis on more specific installations. The inspection shall consist of a complete Site walk of all access roads, perimeter security fence, west parking area, surface water bodies, vegetated soil cover and associated ditches, slopes and installations.

Monthly inspections performed should be recorded on the Monthly Inspection Log (Figures 2.4a, 2.4b and 2.4c). The Monthly Inspection Log shall be completed in lieu of the Weekly Inspection Log for that week. Completed logs shall be kept on file at the Plant Manager's Office or other designated Plant area along with the Weekly Inspection Logs and will be accessible for review by USEPA and/or IEPA representatives as required. Any maintenance performed as a result of the monthly inspections should be recorded in the Maintenance Record Log and kept on file in the Plant Manager's office or other designated Plant area.

2.2.4 Problem Identification and Corrective Action

Should any problem be identified during the weekly or monthly inspections, the inspector shall refer to the corresponding item in Section 2.4 for a detailed description and appropriate corrective action. An additional heading marked "other" has been added to the Weekly and Monthly Inspection Log to be used if unforeseen problems or concerns which

MONTHLY INSPECTION LOG

Inspector:_____ Date:_____

Areas: All access roads and gravel cover, perimeter security fence, west parking area, surface water bodies, vegetated soil cover and associated slopes, ditches and installations

Inspect	*Inspect for*	*Action Required*		*Location Comments*
Vegetated Soil Cover	Erosion/Washouts	Yes	No	
	Bare Areas	Yes	No	
	Length of Grass	Yes	No	
	Distressed Vegetation	Yes	No	
	Ponding	Yes	No	
	Animal Holes/Burrows	Yes	No	
	Other			
Access Roads and Gravel Cover	Erosion/Washouts	Yes	No	
	Obstructions	Yes	No	
	Grading/Potholes	Yes	No	
	Sufficient Cover	Yes	No	
	Drainage/Puddles	Yes	No	
	Debris	Yes	No	
	Other			
Concrete Spillway	Intake Obstructions	Yes	No	
	Outfall Obstructions	Yes	No	
	Structural Integrity	Yes	No	
	Other			
Collection Basin Level Control Drains	Intake Obstructions	Yes	No	
	Outfall Obstructions	Yes	No	
	Free Flowing	Yes	No	
	Rise in Water Level	Yes	No	
	Other			
Benchmarks	Damage	Yes	No	
Industrial Canal and Pumping Lagoon	Erosion/Washouts	Yes	No	
	Riprap	Yes	No	
	Distressed Vegetation	Yes	No	
	Pipeline Obstructions	Yes	No	

figure 2.4a

MONTHLY INSPECTION LOG
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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MONTHLY INSPECTION LOG CONTINUED

Inspect	*Inspect for*	*Action Required*		*Location Comments*
Papermill Effluent Trough	Riprap	Yes	No	
	Erosion/Washouts	Yes	No	
	Pipeline Obstructions	Yes	No	
	Sediment Deposits	Yes	No	
	Other			
Black Ditch Area	Integrity of Sheet Pile	Yes	No	
	Storm Drains Clear	Yes	No	
	Gratings Over Wet Well	Yes	No	
	Condition of Wet Well	Yes	No	
	Other			
Perimeter Drainage Ditches	Sediment Deposits	Yes	No	
	Distressed Vegetation	Yes	No	
	Riprap	Yes	No	
	Erosion/Washouts	Yes	No	
	Other			
Catch Basin, Mixing Basin Stages 3,4,5	Condition of Energy Box	Yes	No	
	Pipeline Obstructions	Yes	No	
	Sediment Depth	Yes	No	
	Erosion/Washouts	Yes	No	
	Flooding	Yes	No	
	Riprap	Yes	No	
	Other			
Settling Basin	Condition of Energy Box	Yes	No	
	Pipeline Obstructions	Yes	No	
	Riprap	Yes	No	
	Erosion/Washouts	Yes	No	
	Other			
Sludge Disposal Pit U-Shaped Pond Mixing Basin Stages 6 and 7	Settling of Cover	Yes	No	
	Erosion/Washouts	Yes	No	
	Distressed Vegetation	Yes	No	
	Ponding	Yes	No	
	Drainage	Yes	No	
	Other			

figure 2.4b

MONTHLY INSPECTION LOG
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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MONTHLY INSPECTION LOG CONTINUED

Inspect	*Inspect for*	*Action Required*		*Location Comments*
West Parking Area (East of Railroad)	Broken or Loose Asphalt	Yes	No	
	Vegetation Growing Through Asphalt	Yes	No	
	Cracking	Yes	No	
	Grading/Potholes	Yes	No	
	Other			
Area Y and Area Z	Surficial ACM	Yes	No	
	Broken or Loose Asphalt	Yes	No	
	Vegetation Growing Through Asphalt	Yes	No	
	Cracking	Yes	No	
	Grading/Potholes	Yes	No	
	Drainage/Ponding	Yes	No	
	Other			
Monitoring Wells	Integrity of Bollards	Yes	No	
	Integrity of Casings	Yes	No	
	Security of Locks	Yes	No	
	Other			
Site Security Fence	Integrity of Fence	Yes	No	
	Integrity of Gates	Yes	No	
	Security of Locks	Yes	No	
	Placement and Integrity of Signs	Yes	No	
	Other			

figure 2.4c

MONTHLY INSPECTION LOG
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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may potentially impact the integrity of the Site are identified by the inspector. If the inspector is in doubt about the impact of a specific item, the item should be recorded in the inspection log and the Plant Manager or his delegate notified so that appropriate measures may be taken.

2.3 MAINTENANCE

Required maintenance identified by the weekly or monthly inspections should be performed as soon as possible but in no event later than 30 days, subject to the Force Majeure provisions in Article XI of the Consent Decree. Maintenance items may include, but are not limited to, the following:

1. cutting and/or fertilizing of the Site grass;

2. grading of the Site access roads;

3. patching of potholes and surface cracks in asphaltic surfaced areas including the parking area west of the disposal area and those in Area Y and Area Z;

4. cleaning of the stormwater catch basins, culverts, ditches and/or sewer mains;

5. repair of surficial erosion and sloughing along the Site perimeter slopes;

6. repair of areas of settlement or subsidence;

7. repair of cover damage caused by burrowing wildlife, presence of deep-rooted weeds, or other foreign vegetation; and

8. repair or replacement of fencing, signs and locks.

Following inspection activities and identification of maintenance items, execution of the maintenance items shall be scheduled through the Plant Manager's office or his delegate to be performed as soon as possible to prevent enlargement of the problem. Unforeseen problems, identified by the inspection activities shall be recorded and referred to the Plant Manager or his delegate for proper handling. Further discussion of some of the above routine maintenance activities follows:

2.3.1 Grass Cutting and Fertilizing

An important maintenance activity to be performed on the Site vegetative cover is periodic cutting and fertilizing. Maintaining a consistent length of vegetation will limit the growth of deep rooted plants, and broad leaf and noxious weeds that may impact the integrity of the subsurface clayey soil cover. Approximately 100 acres of vegetative soil cover is designated to be cut and maintained periodically. These areas are illustrated, by shading, on Figure 2.5. The length of the vegetative cover shall

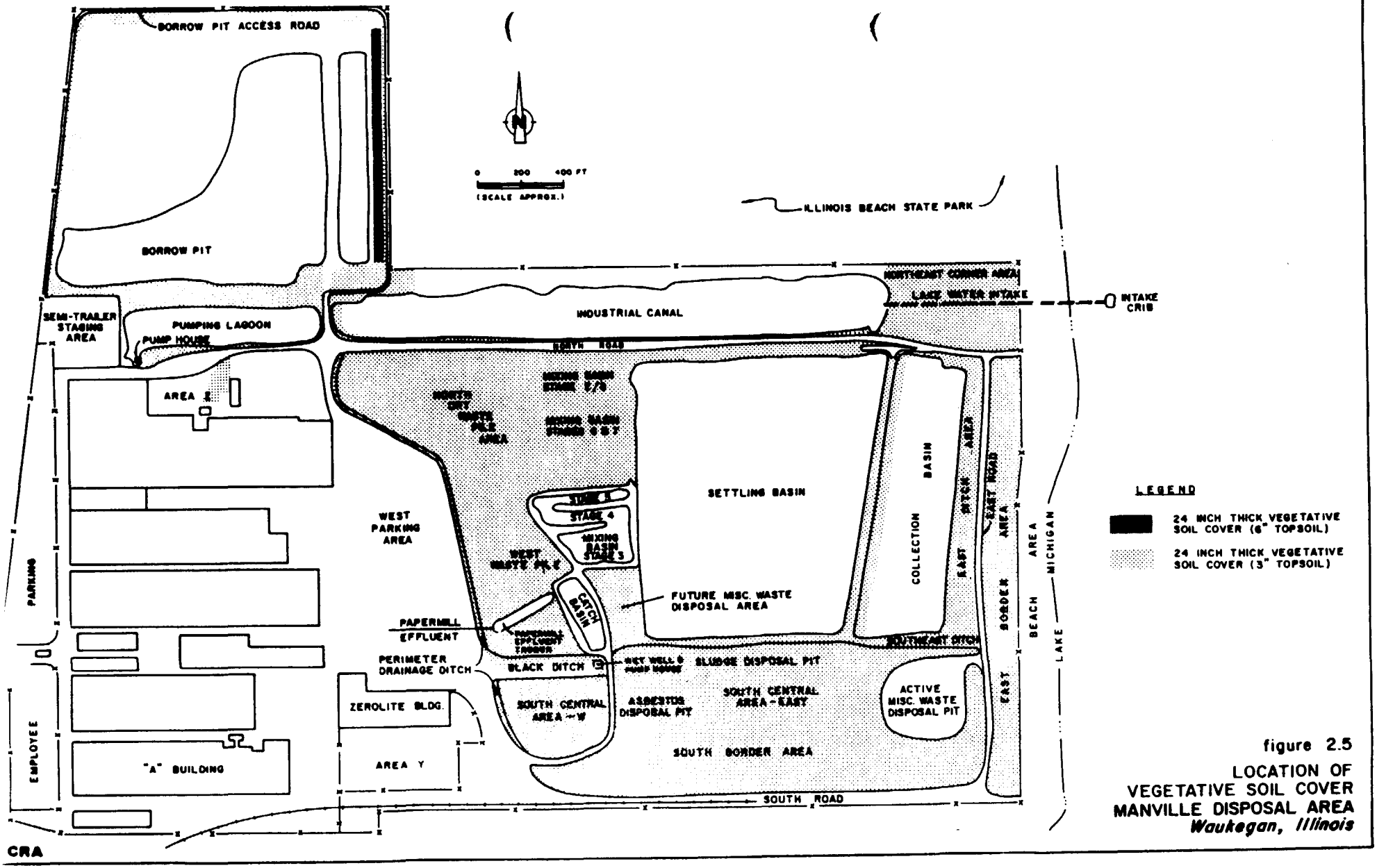

figure 2.5

LOCATION OF VEGETATIVE SOIL COVER MANVILLE DISPOSAL AREA

Waukegan, Illinois

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be maintained between six inches and 15 inches in height. In addition to the vegetative cover on the flat or gradually sloped areas on-Site, vegetative cover on sloped areas, not adjacent to waterways, shall be periodically cut. All cutting shall be performed by qualified and trained personnel with support of mechanical lawn mowing equipment. Vegetative and riprap covered sloped areas adjacent to waterways shall not be cut as these areas were seeded with Crownvetch, a low growing ground cover. Washouts occuring, if any, on such sloped areas shall be repaired in accordance with this O & M manual.

To ensure development and maintenance of a substantial root base, commercial fertilizer shall be applied yearly or at other frequencies as directed by the topsoil composition analysis as discussed below to the designated vegetative cover areas. The fertilizer for refertilizing shall be premixed commercial product conforming to IDOT Article 717.07 and shall contain the following percentages by weight: Nitrogen 12%, Phosphoric Acid 24%, Potash 12% and 52% inert materials. The inert materials shall contain a minimum of 13% soil sulfur. The above fertilizer/nutrient formula was determined through soil analysis data of samples collected from the Site topsoil in June 1991 and on recommendations provided by the U. S. Department of Agriculture (USDA). Every two years, composite topsoil samples shall be collected and analyzed for soil nutrient levels and soil pH. USDA will determine, on the basis of the resulting analysis, the need for modifying the fertilizer/nutrient ratio (i.e. Nitrogen, Phosphoric Acid, Potash and inert material percentages) from those listed above to ensure that the optimal nutrient mix is applied to the vegetative cover and recommend the modified fertilizer/nutrient formula. Additional soil sulfur may be applied

to the soil cover to control the soil pH, as recommended by the USDA, as discussed below.

Fertilizer conforming to the above fertilizer/nutrient formula shall be applied to vegetative cover areas in accordance with the manufacturers suggested application rate of 4 lbs/1,000 SF and with support of a commercial spreader in late summer to early fall or other frequency as recommended by USDA. Soil sulfur for controlling the soil pH may be applied at the manufacturers suggested application rate of 3.5 lb/1,000 SF in conjunction with fertilizer application. Core aeration of the topsoil cover is recommended prior to fertilizing to allow nutrients to effectively penetrate the full depth of topsoil cover.

During the weekly and monthly Site inspections, the Site shall be visually inspected for noxious and deep rooting broad leaf weeds. Heavy weed growth may require the application of commercial, ready mixed herbicides to reduce weed growth. Weed control should be performed on affected areas by application of 2,4-D, MCPP or dicamba in accordance with manufacturers recommendations. Application of weed control chemicals shall be performed by a licensed applicator.

2.3.2 Site Roads and Gravel Cover

Repair to surface gravel cover may be required periodically. Work will include filling potholes, depressions and spreading of

surface gravel on gravel cover and road areas worn from plant vehicular traffic, snow removal activities or surficial erosion from stormwater run off.

Areas identified through Site inspections as requiring surficial gravel repairs shall be maintained by applying imported crush granular materials and grading to promote positive drainage. Deep gravel repairs (depth greater then 4 inches) require mechanical compaction as discussed in Section 3.3.3.

2.3.3 Asphaltic Concrete Pavement Surface Repairs

Areas identified on Figure 2.6 which have a bituminous surface pavement must be inspected for surface cracking, wear and potholes during the monthly Site inspections. Patching and repair of the pavement areas, as identified by the monthly Site inspections shall be scheduled and performed as discussed in Section 3.7.

2.3.4 Stormwater Catch Basins, Culverts, Ditches and Sewer Mains

Stormwater catch basins, culverts, ditches and sewer mains shall be inspected visually for sediment buildup and blockage during the monthly Site inspections and following heavy rainfall events. As identified by these inspections, periodic cleaning of sediment from these installations shall be performed to promote free, unobstructed flow of

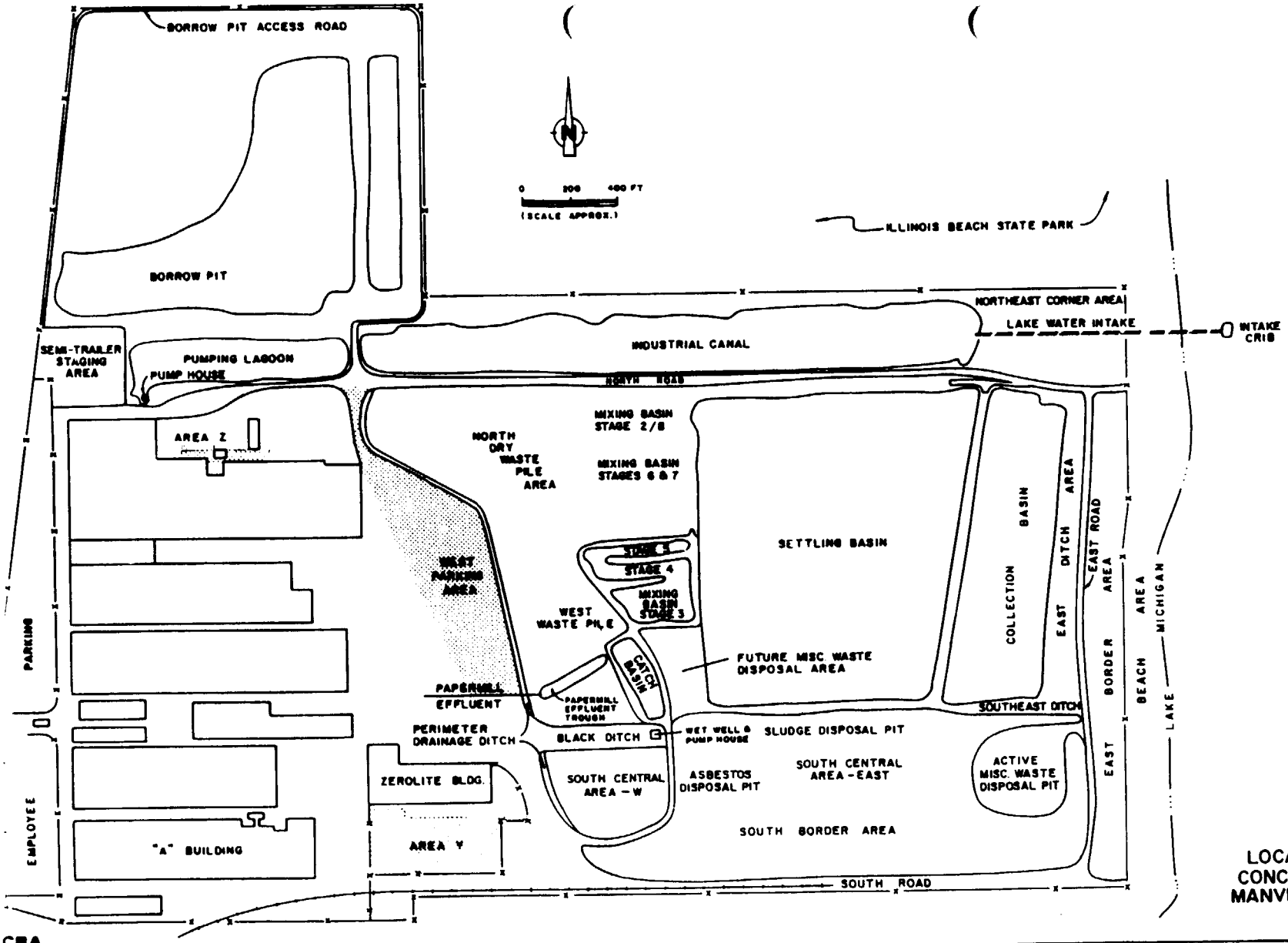

figure 2.6

LOCATION OF ASPHALTIC CONCRETE PAVING COVER MANVILLE DISPOSAL AREA

Waukegan, Illinois

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stormwater run off. All sediment removed during cleaning shall be disposed of in the Active Miscellaneous Waste Disposal Area.

2.3.5 Surface Erosion/Washouts

The Site remedial soil cover shall be inspected on a weekly and monthly basis and after each heavy rainfall event to identify areas of surface erosions/washouts. As identified by these inspections surface erosions/washouts shall be routinely repaired to prevent enlargement of the impacted area(s). All remedial soil cover repair shall be performed as discussed in appropriate subsections of Section 3.0.

2.3.6 Cover Settlement, Surface Cracking and Miscellaneous Surface Failures

The Site remedial soil cover shall be inspected on a weekly and monthly basis to identify areas of soil cover settlement, surface cracking, deep rooted vegetation (e.g. poplar tree saplings), burrowing animals and other surface failures or intrusions. Maintenance items identified through the Site inspections shall be scheduled for repair as appropriate and maintained as discussed in appropriate subsections of Section 3.0.

2.3.7 Fencing, Gates, Locks, Signs

The Site fencing, gates, locks and warning signs shall be inspected during the weekly and monthly inspection to identify any areas of breaching and/or vandalism. Areas identified shall be reported to the Plant Manager so that appropriate repair activities may be scheduled. Plant security should also be notified of any breaching of the Site perimeter fencing and gates. All repair work shall be performed as discussed in Section 3.0.

2.4 POTENTIAL PROBLEMS

This section summarizes the potential problems which may be encountered during the weekly and monthly Site inspections. The appropriate corrective actions to be taken are respectively identified. The specific areas of concern addressed in this section are as follows:

i) Vegetated Soil Cover (Table 2.1);

ii) Access Roads (Table 2.2);

iii) Surface Water Bodies (Table 2.3);and

iv) General (Table 2.4), which includes:

a) perimeter fence;

b) signs;

c) monitoring wells;

d) perimeter drainage ditches;

TABLE 2.1
POTENTIAL PROBLEMS
VEGETATED SOIL COVER
MANVILLE DISPOSAL AREA

Potential Problems	*Concern*	*Action*[1]
Erosion	Wash out of grass, topsoil, clay or sand Typically on steep slopes. Immediate action should be taken to prevent further erosion and consistent with exposure of underlying ACM.	Recover washed out soil. This material may be used to restore the eroded area. Backfill with additional soil to original cover design thickness (24 inches thick) consistent with this O & M manual. Reseed with grasses existing conditions. If seeding slopes, erosion control mat or jute netting placement is recommended.
Bare Areas	Potential for erosion.	Loosen and till topsoil. Reseed and mulch as necessary. Restoration should be performed as soon as feasible
Puddles	Settlement of original cover. Standing water. Bare areas once dryed up.	Till topsoil and grade. Add additional topsoil if necessary. Check final elevation to ensure adequate drainage. Reseed and mulch. If ponding is minor, grading of topsoil should be sufficient. If significant ponding is present, additional soil may be required.
Dead/Dying Grass	As with bare areas, potential for erosion.	Till topsoil and reseed. Cover with erosion control mat or mulch.
Weeds/Bushes	Deterioration of grasses. Potential penetration through cover if left unattended.	Remove all bushes and tall weeds. Reseed as required. Perform annually as a minimum.
Animal Holes/Burrows	Movement of ACM to surface. Safety hazard. Potential for initiation of soil cover erosion.	Contact Waukegan Animal Control Department regarding trapping and relocation of persistent rodents. Seal all holes with compacted clay. Replace topsoil, seed and mulch.
Sediment in Swale	Smothering and killing of sod and interruption of normal surface water flow pattern.	Remove sediment and place in on-Site topsoil stockpile. Replace sod or reseed and mulch if damaged.
Grass Length	Vegetation above 15 inches in height should be cut and maintained from 6" to 15" in length. Tall vegetation shades out and kills underlying species.	Schedule for routine grass cutting.

[1]Required actions should be made within 30 days, subject to the Force Majeure provisions in Article XI of the Consent Decree.

TABLE 2.2
POTENTIAL PROBLEMS
ACCESS ROADS
MANVILLE DISPOSAL AREA

Potential Problems	*Concern*	*Action*[1]
Erosion/Washouts	Washed out surface gravel or subbase material. Potential exposure of underlying ACM.	Recover washed out gravel. This material may be used to restore the eroded area. Backfill and compact to grade. See detail plan for material specifications.
Potholes	Potential exposure of underlying ACM. Safety hazard.	Backfill and compact to grade. See detail plan specifications
Puddles	Settlement of original cover. As with potholes potential exposure of underlying ACM.	Backfill and compact to grade. See detail plan for material specifications.
Obstructions	Safety hazard.	Remove obstructions as soon as possible. Place in secure area pending off-site removal.
Animal Holes/Burrows	Movement of ACM to surface. Safety hazard. Potential for erosion initiation.	Contact Waukegan Animal Control Department regarding trapping and relocation of persistent rodents. Fill all holes with granular subbase and surface coarse gravel.
Soil on road surface from washing from adjacent soil cover areas	Potential for washouts and impassible condition, hindering daily active waste dumping operations and Site inspections.	Clear off all soil and repair soil cover. Avoid disturbing gravel road if possible, otherwise repair gravel road as necessary.
Snow on road	Potential for impassible road condition, hindering daily active waste dumping operations and Site	Clear roadways required for plant operations or inspections with snow plow. Note gravel road damaged by plow, if any, and schedule road repair for early spring.

[1]Required actions should be made within 30 days, subject to the Force Majeure provisions in Article XI of the Consent Decree.

TABLE 2.3
POTENTIAL PROBLEMS
SURFACE WATER BODIES
MANVILLE DISPOSAL AREA

Potential Problems	*Concern*	*Action*[1]
Water Level	Overflow or dramatic variations in water level have potential for erosion.	If levels are rising dramatically, check for obstructions in out falls and notify Plant Manager for immediate action.
Storm Drains	Plugged storm drains may cause overflow and ponding leading to erosion and exposure of underlying ACM.	Remove obstructions and clean sediment as needed. Gather debris and place in Active Miscellaneous Waste Disposal Area. Inspect for damage and repair as necessary.
Sediment at Water Surface	Capacity of water body to hold sediment is at maximum. Potential for sediment migration to down line water bodies. Potential for shoreline erosion.	Notify Plant Manager. Schedule and perform dredging operations as soon as possible.
Riprap	Displaced riprap. Potential for erosion in bare areas and exposure of underlying ACM.	Replace riprap cover to nominal 12" thickness. Repair or replace underlying geotextile and sand as needed.
Slope/Bank Erosion	Wash out of grass, topsoil, sand, rip rap or clay typically on steep slopes. Immediate action should be taken to prevent exposure of underlying ACM.	Backfill or replace displaced materials to match original cover. Sod or seed with turf grasses to match existing conditions, mulch if necessary. Restore riprap cover. Refer to detail plan for construction and material specifications.
Energy Dissipation Boxes and Spillway	Obstructions causing overflow. Structural damage. Debris.	Remove obstructions and/or debris. Inspect for cracks or structural damages. Initiate repair as soon as possible.

[1]Required actions should be made within 30 days, subject to the Force Majeure provisions in Article XI of the Consent Decree.

TABLE 2.4
POTENTIAL PROBLEMS
GENERAL
MANVILLE DISPOSAL AREA

Potential Problem	*Concern*	*Action*[1]
Locks Secure	Tampering. Site security. Monitoring wells and gates.	Replace and secure locks as necessary. Make sure locks are operational.
Perimeter Fence	Forced entry or seasonal damage.	Repair or replace as needed.
Warning Signs	Tampering or theft. Correct placement (maximum spacing 500 feet).	Replace any damaged or stolen signs. See detail plan for installation specifications.
Bollards (Protective Posts)	Bollards damaged or displaced. Need paint.	Replace or repair damaged or displaced bollards. Paint as needed.
Monitoring Well Casings	Damage or tampering.	Repair or replace as necessary. If tampering is suspected, determine whether foreign objects or materials have been introduced into the well and replace monitoring well as necessary.
Perimeter Drainage Ditches	Sod drying out. Riprap intact. Obstructions or debris.	Irrigate dry areas. Replace stone cover as specified in detail plan. Remove obstructions or debris which may affect flow.
Black Ditch Area	Movement of sheet pile slope retention wall. Storm drains clear. Grating over wet well not obstructed.	Remove any obstructions or debris and dispose in Active Miscellaneous Waste Disposal Pit. Notify Plant Manager for immediate action if problem is with retention wall.
Asphaltic Concrete Pavement Cover Areas	Broken or loose asphalt, vegetation growing through asphalt. Cracks or potholes.	Remove broken or loose asphalt and dispose of in accordance with Federal regulations. Remove protruding vegetation. Apply herbicide as appropriate. Repair disturbed areas with cold patch or bituminous surface treatment and compact to grade. Patch cracks and potholes.

[1]Required actions should be made within 30 days, subject to the Force Majeure provisions in Article XI of the Consent Decree.

TABLE 2.4
POTENTIAL PROBLEMS
GENERAL
MANVILLE DISPOSAL AREA

Potential Problem	*Concern*	*Action1*
General Debris	Debris migrating off Site. Debris becoming lodged in Site maintenance equipment.	Pickup and dispose of debris in Active Miscellaneous Waste Disposal Pit.
Shingle Tab Covered Areas	Conditions that could lead to exposure of material beneath the shingle tabs to the atmosphere.	Provide additional cover as necessary.
Other unforeseen		Record problem on Inspection Log. Notify Plant Manager for appropriate action.

[1]Required actions should be made within 30 days, subject to the Force Majeure provisions in Article XI of the Consent Decree

e) Black Ditch area;

f) asphaltic concrete pavement cover areas;

g) gravel debris;

h) shingle tab covered areas; and

i) other.

3.0 MATERIAL SPECIFICATIONS AND PLACEMENT

3.1 GENERAL

The intent of this Material Specifications and Placement section is to present a discussion of the construction of the Site remedial cover. It should be used as a detailed guide in the event that repairs to the remedial cover are necessary.

3.2 VEGETATED SOIL COVER

3.2.1 General

The typical 24-inch thick vegetated soil cover for the Site consists of a six-inch thick sand layer overlain by a 15-inch thick compacted clay layer and a three-inch lightly rolled vegetated topsoil layer as detailed on Figure 3.1. On sloped surfaces (greater than 20%), the six-inch sand layer is replaced with eight inches of clayey soil for a total of 23 inches of clay.

3.2.2 Materials

All sand used for backfill on Site shall be contaminant-free beach sand which may be obtained from the Borrow Pit or from off-Site locations. Sand shall be tested for asbestos in accordance with Section 02200.0.01 of Appendix B prior to its use on Site.

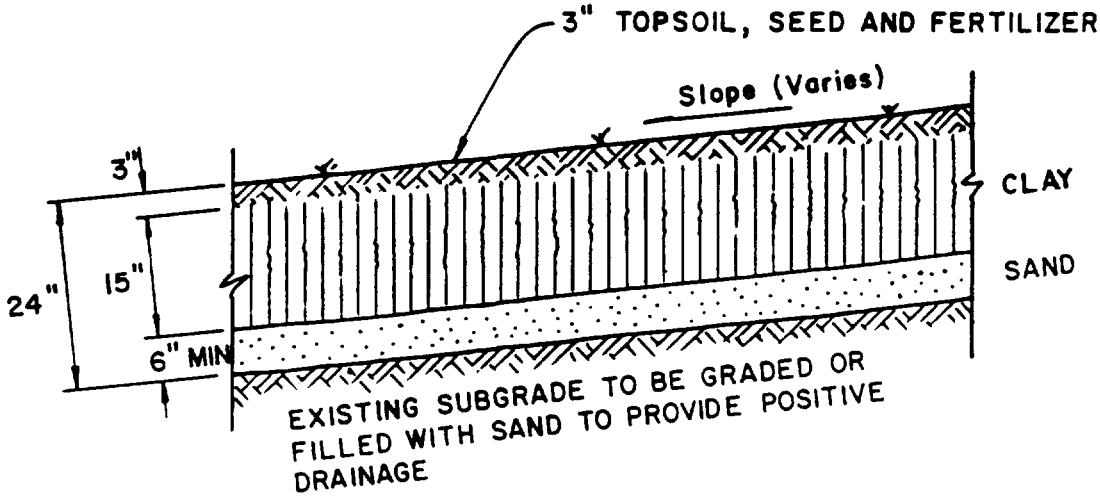

figure 3.1

24-INCH THICK SOIL COVER
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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Replacement clay cover material shall be obtained from off-Site non-contaminated borrow locations. The material shall meet the Corps of Engineers Classification ML-CL or CL for silty clays, (clay content between 25% and 65%) and may contain up to 10% organic material. Clay shall be tested for asbestos, particle size, moisture content, organic content, pH and Standard Proctor density in accordance with Section 02200.3.01 of Appendix B prior to its use on Site. USEPA and IEPA shall be notified if and when repairs are required to the clay layer.

Replacement topsoil shall be a loamy mixture free of roots, sticks, weeds, brush, stones, litter and waste products. It shall contain not less than 12% nor more than 50% clay, and not less than 1% nor more than 10% organic matter. Topsoil shall be tested for asbestos, particle size, moisture content, organic content and pH in accordance with Section 02200.3.01 of Appendix B prior to its use on Site. Topsoil shall also conform to Illinois Department of Transportation (IDOT) Article 717.04 (see Appendix C).

The fertilizer shall be pre-mixed commercial product conforming to IDOT Article 717.07 (see Appendix C). The fertilizer for new seeding shall contain the following nutrient percentages by weight: Nitrogen - 6%, Phosphoric Acid - 25%, Potash - 25%, inert material-44%. Fertilizer/nutrient formulation for reseeding existing vegetative soil cover areas shall be determined by soil analysis as discussed in Section 2.3.1.

The seed mixture shall be as specified in Table 3.1.

TABLE 3.1
SEEDING MIXTURES

Type	*Seeds*	*lbs/acre*
Flat Areas (IDOT Class 2)	Ky 31 or Alta Fescue	50
	Perennial Rye Grass	30
	Creeping Red Fescue	20
	Cover Crop (note 1)	
Slopes adjacent to Water Bodies	Crownvetch	15
	Perennial Rye Grass	10
	Alsike Clover	7
	Cover Crop (note 1)	

Note 1 - Cover crop consists of either Spring Oats or Winter Rye at an application rate of 48 lbs/acre or 56 lbs/acre respectively, depending upon when seeding is placed.

3.2.3 Placement

The cover (sand and clay materials) shall be placed in layers of a thickness that will allow adequate compaction but not exceeding one foot in thickness. Each layer shall be compacted to 90% standard Proctor density prior to placement of subsequent layers. On steep sloped areas where use of mechanical compaction is not practical, each layer shall be compacted with soil placement equipment tires or tracks until 90% Standard Proctor density is achieved, in accordance with Appendix B.

The topsoil shall be placed to provide a minimum of three inches rolled thickness. Topsoil shall be fertilized uniformly over areas to be seeded in accordance with the applicable rates listed in Table 3.1 and IDOT Section 642 (see Appendix C). Repaired areas which are subject to erosion should be mulched or blanketed with erosion mat or jute netting to optimize seed germination and growth.

3.3 ACCESS ROADS AND GRAVEL COVER

3.3.1 General

The access roads and gravel covered areas on-Site are either designated Class I (heavily travelled) or Class II (lightly travelled). Roadways and gravel cover are constructed of aggregate material to a thickness of 24 inches. Depending on class designation, material placement

thickness varies. Typical construction details for Class I and Class II gravel roadways or cover are presented in Figures 3.2 and 3.3, respectively.

3.3.2 Materials

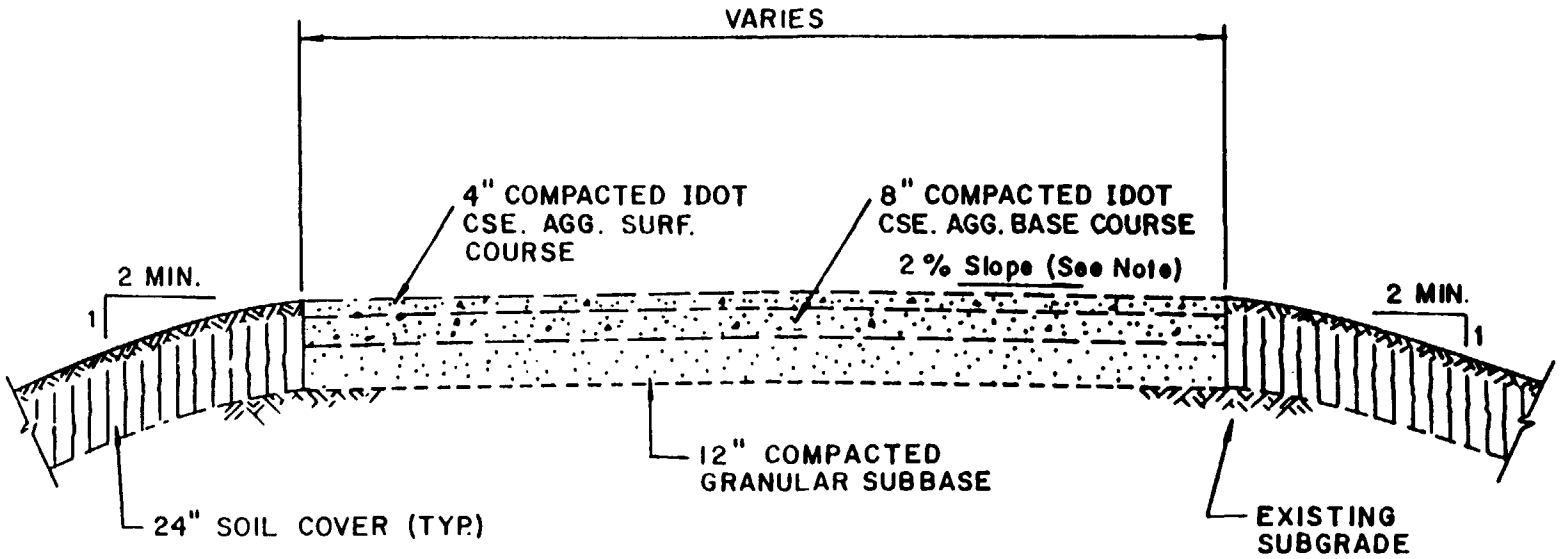
The granular subbase material shall be contaminant-free beach sand, as specified in Section 3.2.2.

The coarse aggregate for surface course shall be Class D quality or better, meeting IDOT Type B Gradation CA6, CA9 OR CA10. The coarse aggregate base course shall meet IDOT gradation CA6, CA2 or CA4. The applicable IDOT specification is presented in Appendix C.

3.3.3 Placement

A twelve-inch thickness of compacted granular subbase material (sand) compacted to 95% standard Proctor density shall be placed on roadways designated Class I while a 14-inch thickness of compacted granular subbase material compacted to 95% standard Proctor density shall underlay roadways designated Class II.

An eight-inch thickness of compacted coarse aggregate base course followed by a four-inch thickness of compacted coarse aggregate surface course shall be placed on roadway sections designated Class I.



NOTE :
DIRECTION OF SLOPING VARIES.

figure 3.2
CLASS I GRAVEL ROADWAY OR COVER
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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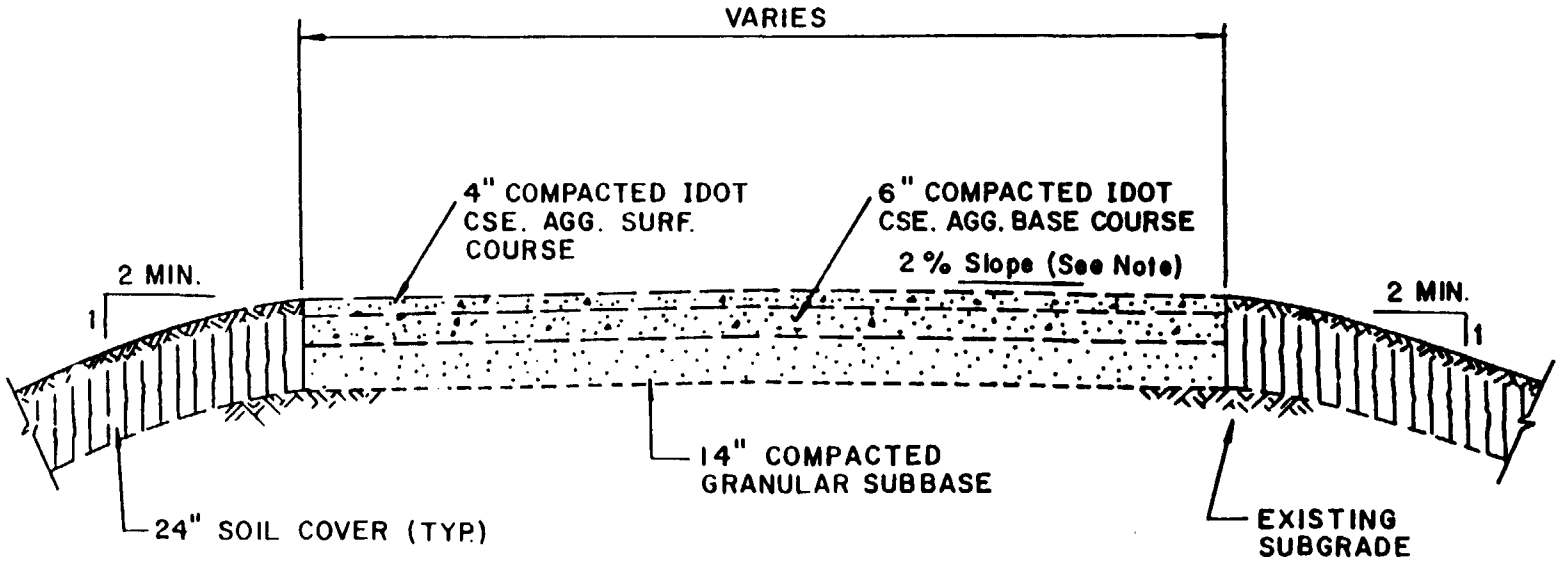

NOTE :
DIRECTION OF SLOPING VARIES.

figure 3.3

CLASS II GRAVEL ROADWAY OR COVER
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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Compaction of base course and surface course will be to 95% standard Proctor density.

A six-inch thickness of compacted coarse aggregate base course followed by a four-inch thickness of compacted coarse aggregate surface course shall be placed on roadways sections designated Class II. Compaction of base course and surface course will be to 95% standard Proctor density.

3.4 RIPRAP

3.4.1 General

In areas of potential erosion, such as interior slopes of water bodies and drainage swales, a stone cover (riprap) was placed. The integrity of the riprap must be maintained to prevent erosion of the underlying soil cover and potential ACM exposure. A typical riprap detail is presented in Figure 3.4.

3.4.2 Materials

The riprap bedding material shall be contaminant free beach sand as specified in Section 3.2.2.

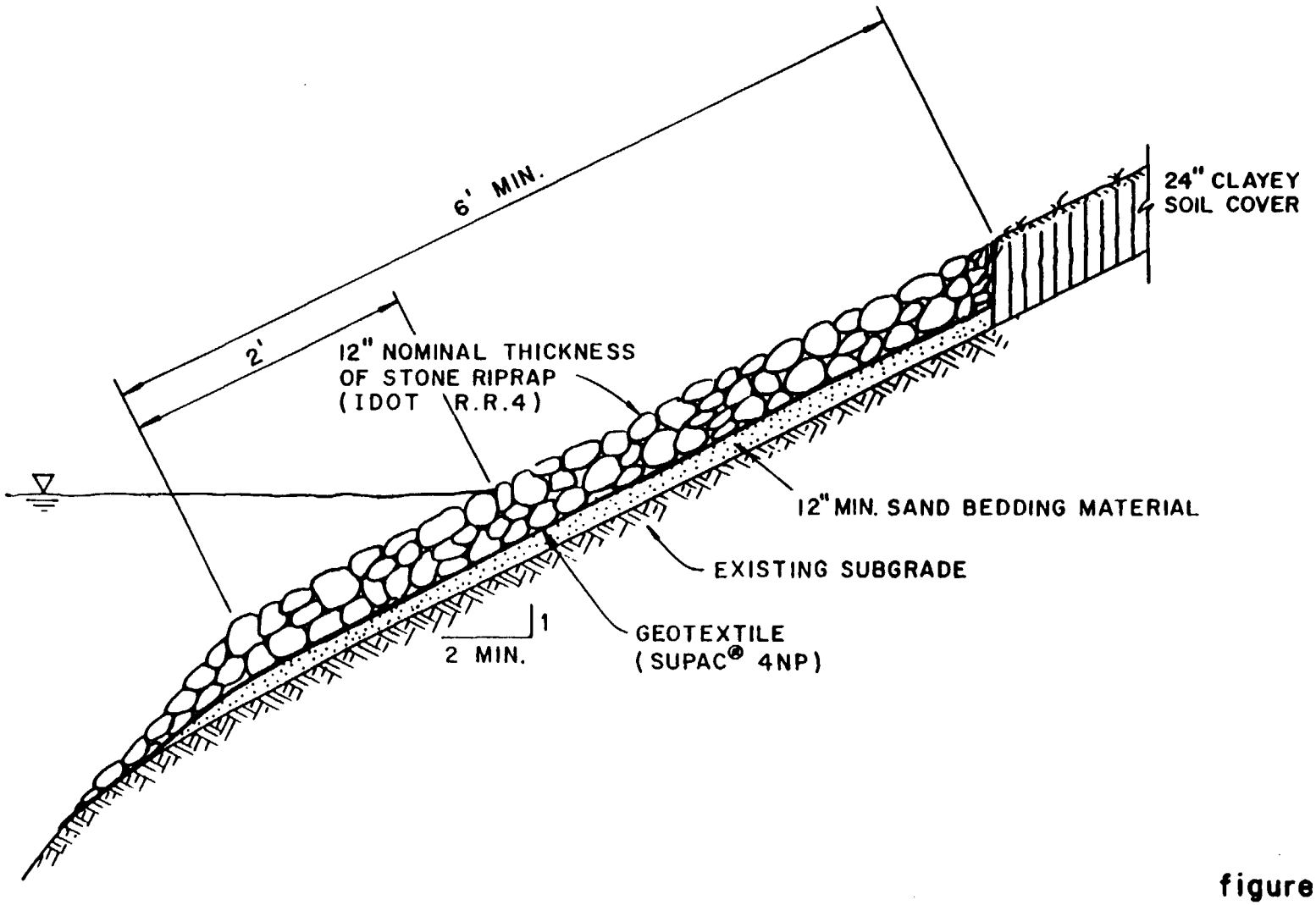

figure 3.4

RIPRAP SLOPE PROTECTION
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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Geotextile for the riprap underlayment shall be Phillips Supac® 4NP or equivalent. Equivalent geotextile shall conform to or exceed all physical properties of Supac® 4NP.

The riprap stone shall have a maximum weight per piece of 150 pounds and not more than five percent shall weigh less than three pounds per piece. The material shall be evenly graded and 30 to 70 percent of the material shall weigh 60 pounds or more per piece. The riprap stone shall conform to IDOT Article 704.01, Coarse Aggregate, Class A quality $Na_2 SO_4$ soundness requirement (see Appendix C). The existing riprap is R.R.4 stone, supplied by Vulcan Materials Company of Countryside, Illinois.

3.4.3 Placement

Prior to placement of the riprap and geotextile, the sand bedding depth should be measured to ensure a minimum twelve inch thickness. Areas requiring sand shall be backfilled and graded with sand to a slope of 2:1 or less.

Following sand placement, damaged or missing geotextile fabric shall be placed over the sand layer and anchored by pinning. Pins for this purpose may be obtained through the geotextile supplier.

The riprap stone shall then be placed over the geotextile fabric to a nominal thickness of 12 inches.

3.5 PERIMETER FENCING AND SIGNAGE

3.5.1 General

Site security consists of a six-foot high, two-inch mesh chain link fence encompassing the perimeter of the Site. Swinging gates are located along the eastern fence line at the southeast corner and near the northeast corner of the Site and are equipped with key entry padlocks. Keys for all Site pad locks shall be maintained by the Plant manager or his delegate, in the Plant managers office. The top rail of the fence is bordered with three tiers of barbed wire. The integrity of the Site fencing and gates must be maintained in good operating condition to ensure adequate Site security.

In addition, perimeter warning signs are placed along the perimeter fence lines and along the west perimeter of the disposal area at a maximum spacing of 500 feet to inform the public of the presence of a former ACM disposal Site, as required by USEPA and OSHA.

3.5.2 Fencing

3.5.2.1 Materials

The chain link shall be two-inch mesh fabricated from nine-gage wire, 72 inches high; ASTM A392, Class II zinc coated or ASTM A491 aluminum coated steel.

The fasteners shall be metal bands or nine-gage steel wire galvanized in accordance with ASTM A641 Class III coating or aluminum.

The line posts shall be a nominal 2-5/8 inch O.D., Schedule 40 galvanized steel pipe weighing 3.65 pounds per foot.

The end and corner posts shall be Schedule 40 galvanized steel pipe, 2-7/8 inch O.D., 5.79 pounds per lineal foot. The braces shall be provided as follows:

-horizontal braces of 1-5/8 in O.D. Schedule 40 galvanized steel pipe, connected corner to corner, and gate posts with suitable metal connections;

-horizontal braces at midpoint of fabric;

-diagonal brace rod from end of horizontal brace back to end, corner and gate posts, complete with turnbuckle.

-bottom tension wire, 7 gage galvanized or aluminum coated steel.

The top rails shall be 1-5/8 inch O.D. Schedule 40 galvanized steel pipe with suitable metal connectors.

The gate posts shall be 4-inch Schedule 40 galvanized steel pipe, 2'-8" higher than the height of the fence fabric.

The gates shall be double swing, consisting of two eight-foot wide by six-foot high sections. The gate frame shall be constructed of 2-inch O.D. Schedule 40 steel pipe of all welded construction. The gate shall be fitted with three tiers of barbed wire, the same as fencing.

The fence post concrete footings shall be 12 inches in diameter for line posts, 18 inches in diameter for end, corner and gate posts and shall extend six inches below bottom of post.

3.5.2.2 Installation

The posts shall be set a maximum of 10'-0" center to center. Line posts shall be set 30 inches into the ground; gate and corner posts shall be set 42 inches into the ground. All line, corner and gate posts shall be anchored in concrete as discussed above.

Each end, corner and gate post shall be braced with one horizontal brace installed with diagonal brace rod and turnbuckle. The diagonal brace rod shall be attached to the end, corner or gate post at bottom of fabric.

Where the fence line crosses drainage swales or other uneven areas, fabric bottom extensions shall be placed to close openings to within three inches of final grade.

3.5.3 Perimeter Signs

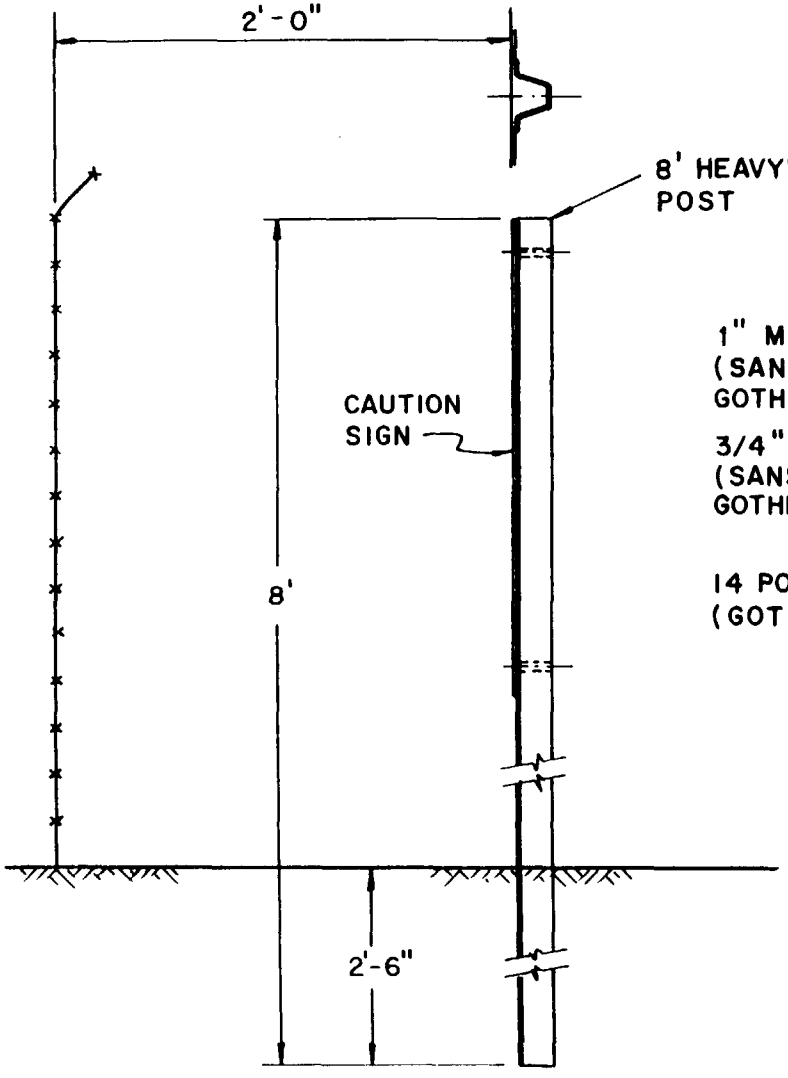
3.5.3.1 Materials

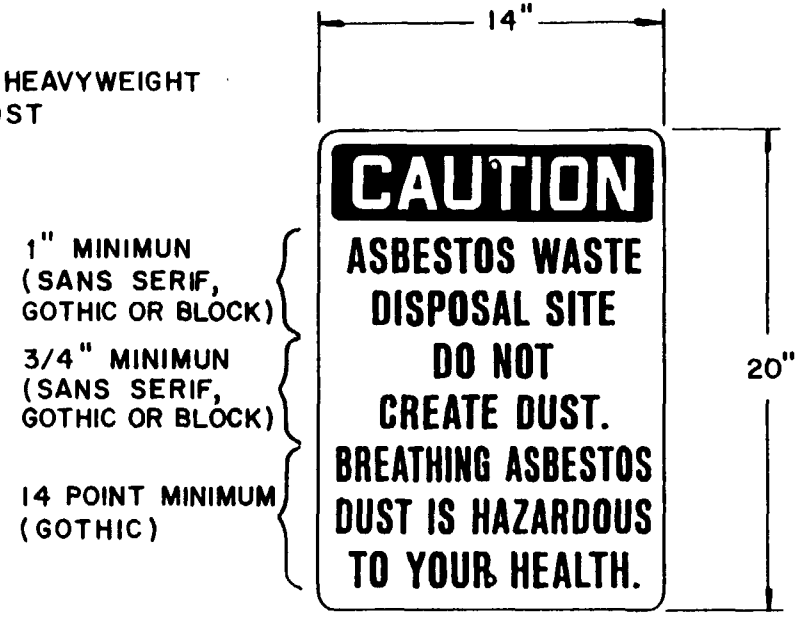
Sign posts shall be eight feet long steel U-channel sign posts made of high tensile steel, with prepunched 3/8-inch holes on one inch centers.

Signs shall be made of aluminum or steel. Signs shall conform to the requirements for 20" x 14" upright format signs specified in OSHA 29CFR 1910.145 (d)(4) and shall be worded as specified in the current issue of NESHAP 40CFR Part 61.153 (b)(1)(iii). Typical sign dimensions and wording are detailed on Figure 3.5.

3.5.3.2 Installation

Signs shall be placed on sign posts 24 inches inside of the existing fence line to minimize vandalism of the signs. In addition, signs shall be placed along the west boundary of the Site. The signs shall be spaced at a maximum spacing of 500 feet plus one at each Site access gate. The posts shall be set at least 30 inches into firm ground. In unconsolidated ground,





NOTE: Spacing between any two lines must be at least equal to the height of the upper two lines. Lettering shall be black on yellow background except "CAUTION" which shall be reversed as shown. Wording shall be in accordance with most recent issue of 40CFR PART M 61.153 (b)(1)(iii). Formatting shall be in accordance with most recent issue of 29CFR 1910.145 (d)(4).

figure 3.5

TYPICAL PERIMETER SIGN
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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sign posts shall be set in concrete. Signs shall be fastened to the sign posts with 5/16" x 2 1/2" double washered, galvanized hex bolts and positioned so that the bottom of the sign is at least four feet above the existing ground surface.

3.6 DREDGING PLAN

3.6.1 General

During the monthly Site inspections as noted in Section 2.2.4 a visual inspection of sediment depth within the Catch Basin and Mixing Basin Stages 3, 4, and 5, as identified in Figure 3.6, shall be conducted. Sediment is continuously deposited in these waterways from Plant operations. If sediment appears at the water surface in any water body, the Plant Manager or his delegate should be notified so that removal of the sediment may be scheduled.

The following subsections present methods and procedures to be performed in the event that hydraulic dredging systems are utilized to remove the sediment from the active wastewater treatment system. Although hydraulic dredging is the suggested method, an alternative method may be used to remove the sediment provided the method used is consistent with maintaining the integrity of the remediated soil cover and sloped areas. In any event, the dredging depth will be determined using standard surveying methods and practices.

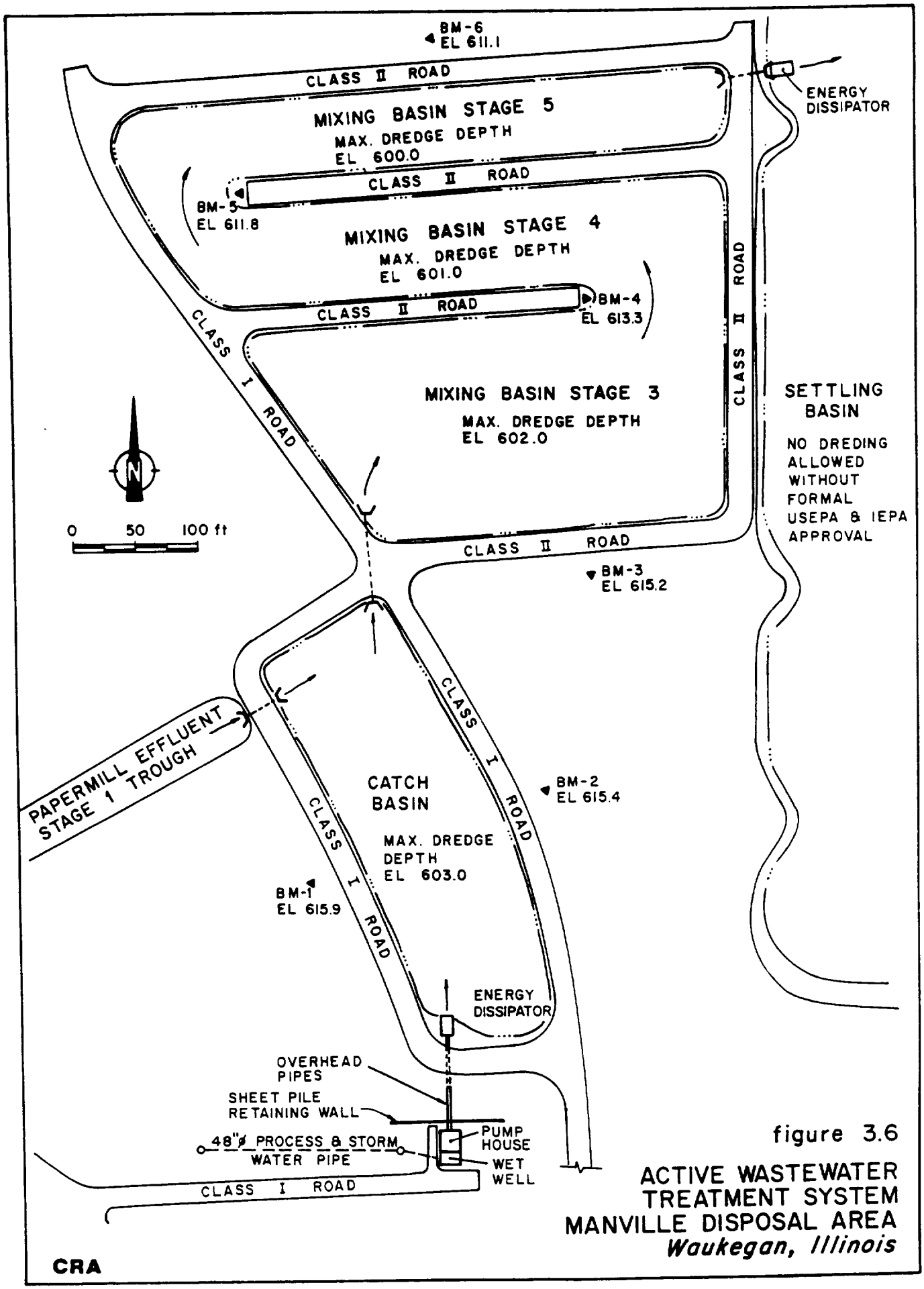

figure 3.6

ACTIVE WASTEWATER TREATMENT SYSTEM
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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3.6.2 Pre-Dredging Preliminary Steps

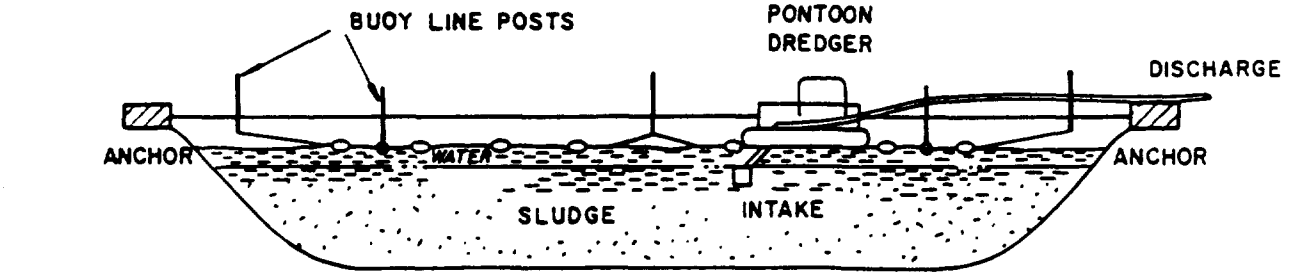
Prior to setting up dredging equipment, the following steps shall be performed to ensure the integrity of the banks during dredging operations:

1) Mobilize and set up buoy lines and aluminum extension arms in the waterway to be dredged, connecting the lines to existing buoy line support posts as shown in Figure 3.7;

2) Determine allowable dredging depth from top of water referencing permanent benchmarks adjacent to the Catch Basin and the Mixing Basin areas. Elevations and locations for each benchmark are presented in Table 3.2 and identified on Figure 3.6.

In accordance with Attachment D of the Revised Amended Remedial Work Plan, dredging depth cannot exceed an elevation greater than two feet above the dredge depth established during the remedial construction. Allowable dredging depth elevations are presented in Table 3.3.

To minimize the potential for undermining the banks, extreme care shall be exercised to ensure that dredging is performed only within the area delineated by the buoy lines. In the event that portions of the banks are undermined by the dredging operations, the banks shall be reestablished with soil cover consistent with the remaining cover.



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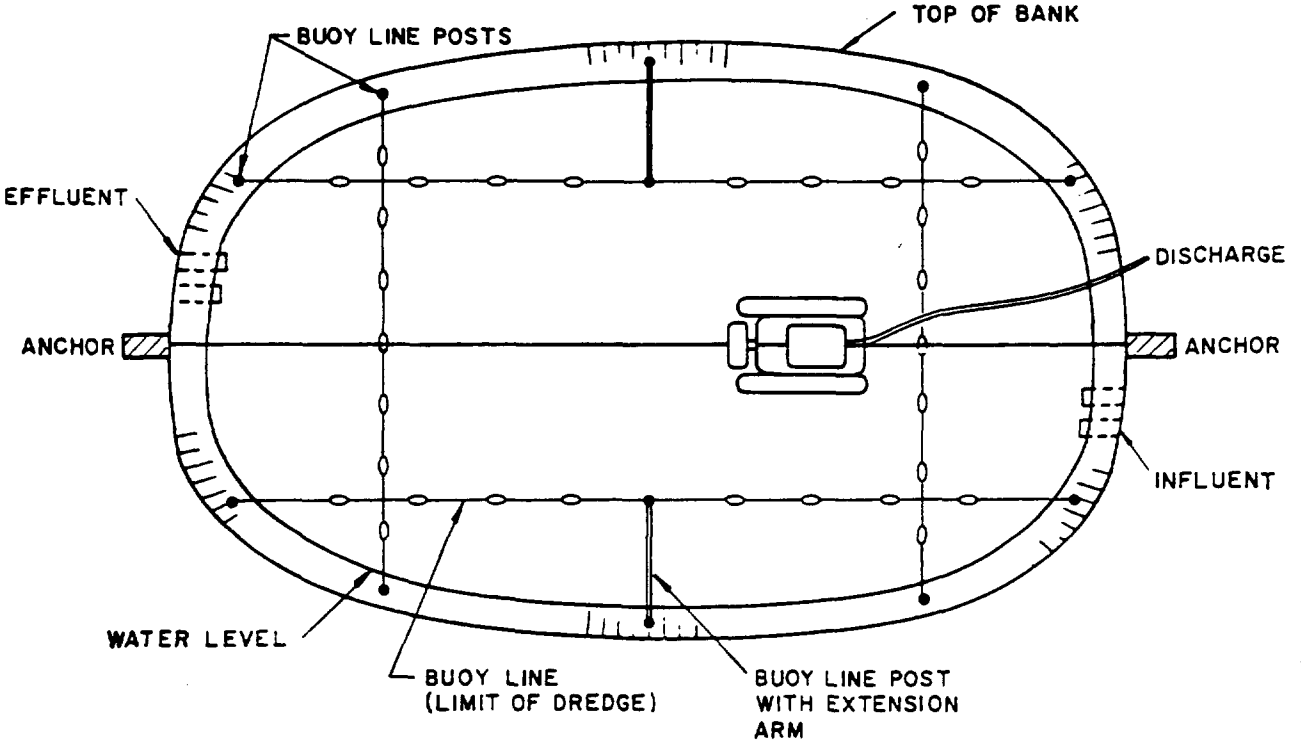

PLAN
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figure 3.7

TYPICAL DREDGING OPERATION
MANVILLE DISPOSAL AREA
Waukegan, Illinois

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TABLE 3.2
PERMANENT BENCHMARK ELEVATIONS

Benchmark ID	*Location*	*Coordinates*		*USGS*
		Northing	*Easting*	*Elevation* [1]
BM-1	West of Catch Basin	8317.70	11089.21	615.9
BM-2	East of Catch Basin	8375.66	11276.07	615.4
BM-3	South of Mixing Basin Stage 3	8553.16	11314.54	615.2
BM-4	East end of finger between Stages 3 and 4	8773.38	11299.91	613.3
BM-5	West end of finger between Stages 4 and 5	8855.55	11033.78	611.8
BM-6	North of Mixing Basin Stage 5	8969.92	11184.55	611.1

[1]Notch on top of 4" pipe surveyed 5/29/90 by Lake County Land Survey Company, Zion, Illinois.

TABLE 3.3
MAXIMUM ALLOWABLE
DREDGING DEPTH ELEVATIONS

Waterway	*USGS Elevation*
Catch Basin	603.0
Mixing Basin Stage 3	602.0
Mixing Basin Stage 4	601.0
Mixing Basin Stage 5	600.0
Settling Basin	No dredging allowed without prior authorization from USEPA

3.6.3 Post-Dredging Steps

Following completion of all dredging operations;

1) buoy lines and extension arm supports shall be disassembled and stored in the on-Site storage shed;

2) soil cover and/or other areas disturbed by the dredging operations shall be repaired to original conditions as discussed in this O & M Manual.

3.7 ASPHALTIC CONCRETE PAVEMENT PATCHING OR RESURFACING

3.7.1 West Parking Area

All significant stress cracks and potholes in the west parking area were patched with hot asphaltic concrete mix or backfilled with bituminous cold patch mix and compacted to grade as part of the remedial construction. Smaller cracks were sealed with hot tar.

The parking area will be inspected monthly to ensure that new potholes or stress cracks are located and remediated. Any maintenance work required shall be recorded on the Monthly Inspection Log and scheduled for repair. Normally, repair work will be performed routinely once per year, as required, by an outside contractor. Repair shall be made within

30 days of discovery if the potholes or stress cracks result in the exposure of the underlying ACM, subject to the Force Majeure provisions of Article XI of the Consent Decree.

3.7.2 Bituminous Surface Areas

A gravel base and asphaltic concrete pavement cover was constructed over portions of Areas Y & Z as shown on Figure 2.6. Surface cracking, wear and potholes in these areas shall be identified during the monthly inspections and remediated as for the West Parking Area.

Asphaltic concrete pavement cover in Area Y and Area Z shall be inspected monthly for surface cracking, wear and potholes and repair items noted in the Monthly Inspection Log. The Plant Manager should be notified and maintenance items scheduled for repair. Repair work, including, but not limited to, patching, sealing or resurfacing, normally shall be performed routinely once per year, as required, by an outside contractor.

4.0 LONG TERM SITE MONITORING

4.1 GENERAL

Post construction monitoring programs include groundwater, air and soil sampling, as well as bi-annual visual monitoring events of the Site. The frequency and duration of monitoring programs will be in accordance with the Consent Decree and all subsequent attachments. All monitoring activities shall be performed in accordance with the Quality Assurance Project Plan (QAPP), dated June 1988 and prepared by CCJM (Appendix D). Any changes in monitoring activities from that specified in the QAPP must be formally approved by USEPA and IEPA. The monitoring event schedule is presented in Table 4.1. The intent of the following discussion on long term Site monitoring is to familiarize the user of this O&M plan with the program.

4.2 GROUNDWATER AND SURFACE WATER MONITORING

A groundwater and surface water monitoring plan commenced in fall 1988 and is scheduled to continue for a minimum period of thirty-three (33) years. Samples were collected in eight quarterly rounds during 1989 and 1990 from location identified on Figure 4.1 and analyzed for asbestos, lead, chromium, arsenic, aluminum, antimony, polychlorinated biphenyls (PCBs) polybrominated biphenyls (PBBs) and a full scan of semi-volatile and volatile organic compounds. Following the completion of remedial construction, subsequent groundwater and surface water samples will be collected every five years for a minimum of six rounds. Prior to the

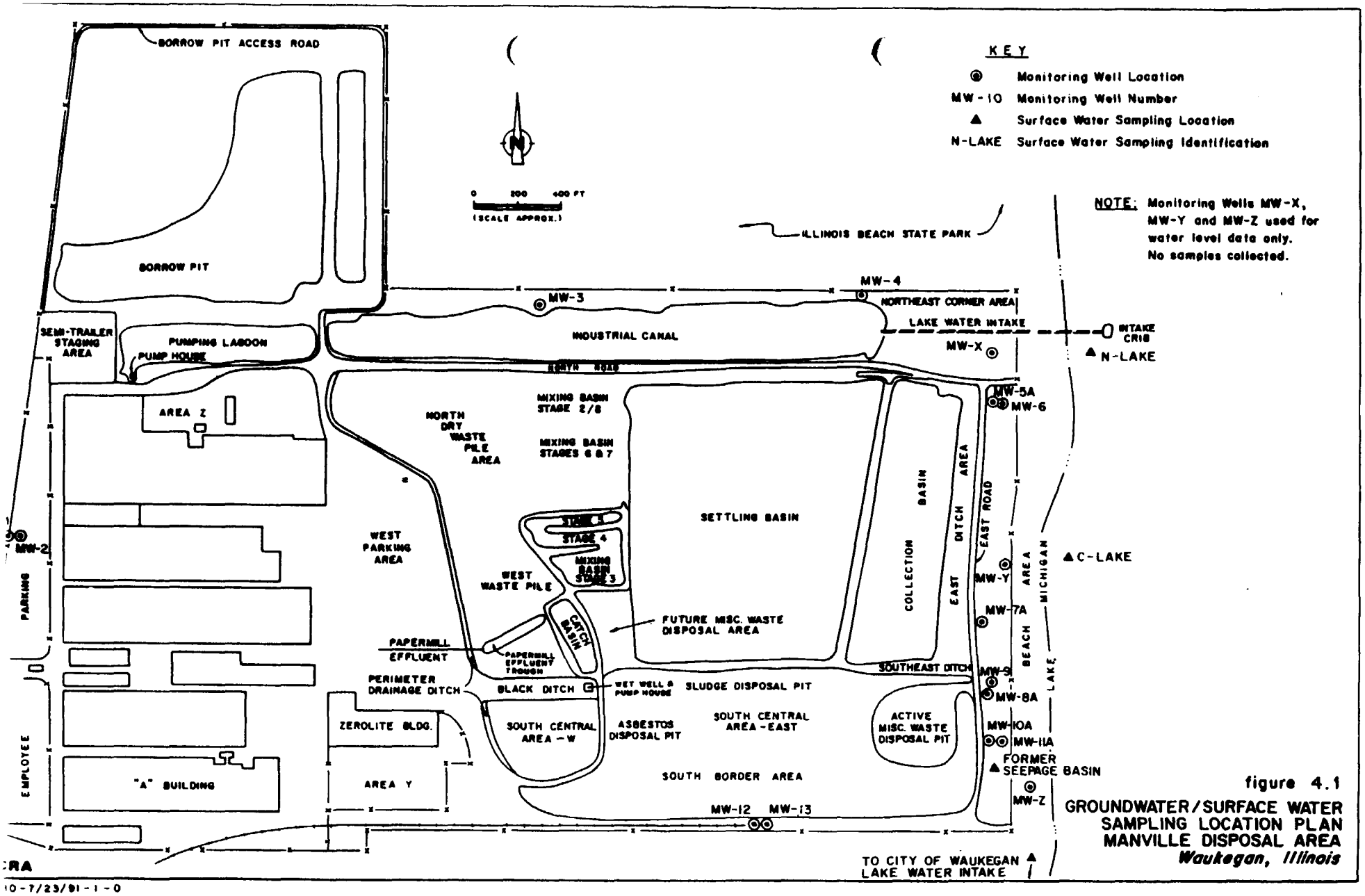


figure 4.1

GROUNDWATER/SURFACE WATER SAMPLING LOCATION PLAN
MANVILLE DISPOSAL AREA
Waukegan, Illinois

CRA

10-7/23/91-1-0

TABLE 4.1
LONG TERM MONITORING SCHEDULE[1]

	Minimum Number of Events	
Soil		
Visual Inspections		
Fall	30	Beginning 1991, yearly for 30 years until 2021.
Spring	30	Beginning 1992, yearly for 30 years until 2022.
Soil Borings[2]	5	Beginning 1991, again in 1996, then every ten years until 2026.
Water		
Groundwater and Surface Water	6	Beginning 1996, every 5 years until 2021.
Air		
PM_{10}, Lead and Total Chromium	4	Beginning 1991, every five years until 2006
Asbestos	4	Beginning 1991, every five years until 2006

[1]USEPA and IEPA should be notified at least seven days prior to monitoring events.
[2]If ACM is encountered, then frequency of borings, thereafter, will be once every five years.

first of the five year sampling rounds, scheduled to occur in 1996, parameter list for these sampling events shall be agreed to between USEPA, IEPA and Manville on the basis of the water quality data generated during the eight quarterly sampling rounds.

During the 30-year period of post remedial construction monitoring, if any measured groundwater or surface water quality parameter is statistically determined to exceed background/upgradient values or established drinking water standards (e.g., Maximum Contaminant Levels), a groundwater or surface water Remedial Contingency Plan will be put into effect.

4.3 AIR MONITORING

Air sampling for PM_{10}, lead, total chromium, and asbestos will be conducted after the establishment of soil and vegetative cover and every five years thereafter for a period of 15 years (number of sampling events = 4) in accordance with Appendix D. After the 15 years, USEPA will evaluate the need for further monitoring.

4.4 SOIL COVER MONITORING

4.4.1 Visual Monitoring

Visual monitoring will consist of two separate visual events each year for a minimum period of thirty (30) years (number of events = 60). USEPA and IEPA should be notified at least seven days prior to these monitoring events and may be present during the monitoring. Monitoring requirements will be reviewed after the 30-year period. The two annual monitoring events will include:

1) soil cover monitoring (late spring season)
2) vegetative cover monitoring (late fall season)

The visual monitoring to be conducted in the late spring shall be conducted after all winter frost has left the soil cover and the soil cover is workable. The entire surface of the soil cover shall be primarily monitored for cave-ins and asbestos migration up through the soil cover resulting from freeze-thaw phenomenon (i.e., ACM at the ground surface).

The visual monitoring to be conducted in the late fall shall be conducted prior to the first snowfall. The soil cover shall be monitored for areas of distressed or eroded vegetation similar to that performed during the monthly inspections.

A copy of the record kept for each of the above monitoring events shall be forwarded to USEPA and IEPA for review. This record may

consist of a copy of the Monthly Inspection Logs from the period specified (i.e., late spring and late fall).

4.4.2 Soil Boring

In addition to the visual monitoring as presented above, ten soil borings, 24 inches in depth, will be collected by an outside contractor, retained by Manville, to monitor upward migration of ACM through the soil cover. The procedure for this monitoring effort will involve hand driving a split spoon to a total depth of 24 inches, and visually inspecting the core in six-inch sections for ACM. If no ACM is observed visually in any core, the lower six-inch core sample will be analyzed for asbestos. In the event ACM is observed in any of the cores, all six-inch core samples (total of four samples) for that boring will be analyzed for bulk asbestos. Boreholes will be backfilled with sand from Borrow Pit. If no ACM is encountered in the 12 inch to 18 inch depth range of the sample core, the soil borings will be taken every ten years after the two, initial boring events. If ACM is encountered within the 12 inch to 18 inch depth range, the frequency of soil borings thereafter will be once every five years (number of sampling events = 5). The general location of soil borings for the first soil boring event are a shown on Figure 4.1. Exact location of each soil boring will be field determined and agreed to by USEPA, IEPA and Manville at the time of sampling.

The total period of soil borings will be a minimum of thirty years, similar to that visual monitoring. After the period of thirty

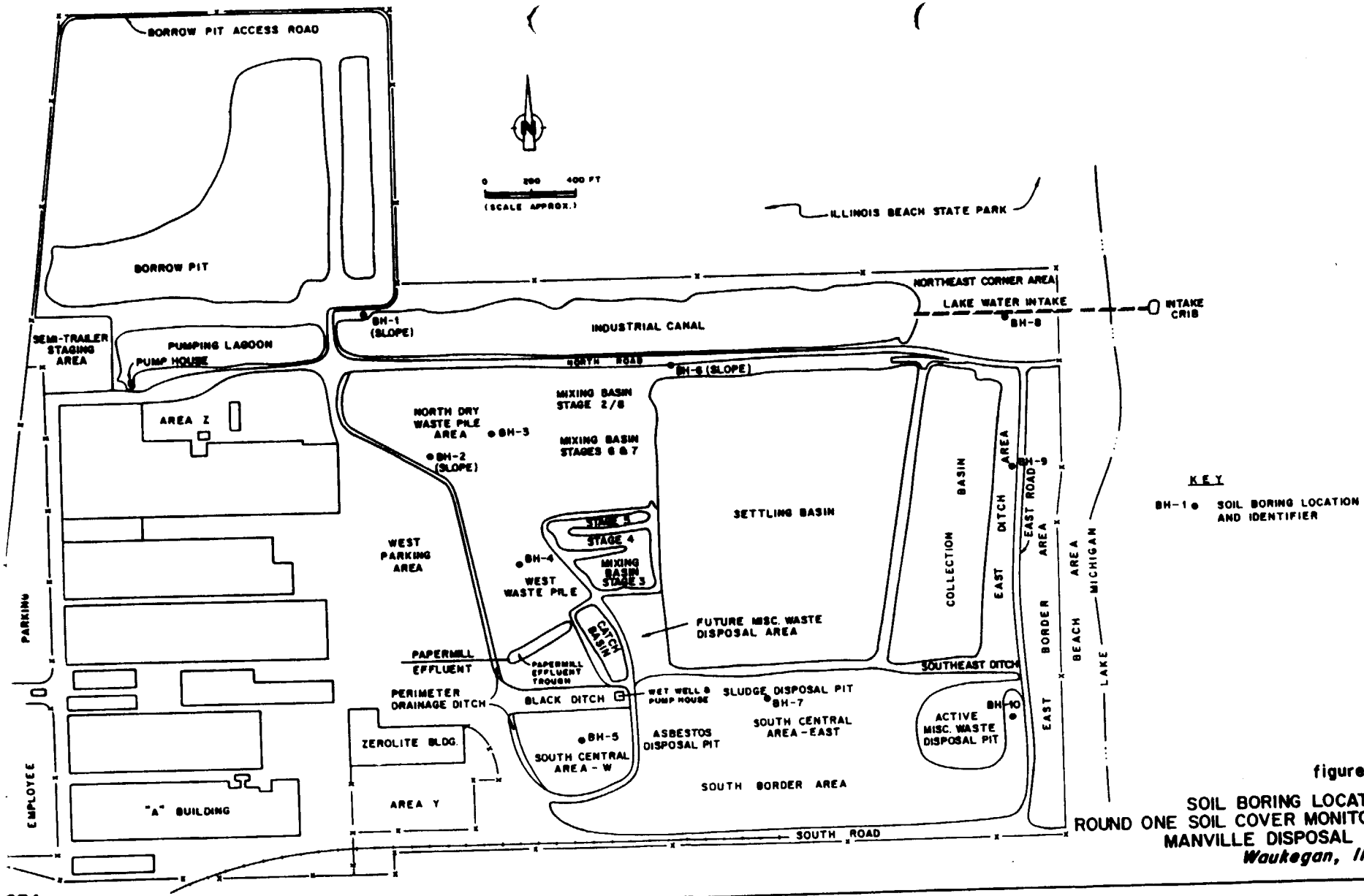


figure 4.2

SOIL BORING LOCATIONS
ROUND ONE SOIL COVER MONITORING
MANVILLE DISPOSAL AREA
Waukegan, Illinois

CRA

80-7/23/91-1-0

Superceded by p. 34 attached to 11/15/91 letter at front cover

years, the need for further monitoring, if any, will be evaluated and approved by the USEPA and IEPA.

4.4.3 Remedial Soil Cover Contingency Plan

In the event that ACM is encountered during the soil boring sampling program within the six-inch to 12-inch soil boring depth interval of any core, a remedial soil cover contingency plan will be developed and submitted to USEPA and IEPA. The contingency plan developed will address the proposed work plan for remediation of the soil cover and the proposed schedule for its implementation.

USEPA and IEPA will evaluate the remedial soil cover contingency plan and determine the need for its implementation based on the standards contained in Section 104A of CERCLA 42 USC Section 9604A.

4.5 QUALITY ASSURANCE/QUALITY CONTROL AND PERSONNEL PROTECTION

To ensure a high degree of quality for analytical data generated from the long term monitoring events involving sample collection (groundwater and surface water samples, air monitoring samples, soil boring samples), detailed and systematic procedures for sample collection, transport and analysis shall be followed. These procedures are discussed in Appendix D.

In addition, to provide long term monitoring personnel with appropriate protection from potential exposure to ACM during sample collection events, personnel shall follow a systematic procedure for utilizing personnel protective equipment and a decontamination procedure as discussed in Appendix D.

APPENDIX A

HEALTH AND SAFETY PLAN
C. C. JOHNSON & MALHOTRA
JUNE 1988, REVISED SEPTEMBER 1988

ATTACHMENT G

HEALTH AND SAFETY PLAN

FOR

REMEDIAL ACTION

AT

JOHNS-MANVILLE DISPOSAL AREA
MANVILLE SALES CORPORATION
WAUKEGAN, ILLINOIS

JUNE 1988

(Revised September, 1988)

JOHNSON & MALHOTRA, P.C.
ENVIRONMENTAL ENGINEERS

GRAND RAPIDS, MICHIGAN

ATTACHMENT G

SITE HEALTH & SAFETY PLAN

Including

DECONTAMINATION PROCEDURES

The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other site without prior research and evaluation by trained health and safety specialists. Nothing in this plan shall relieve the contractor/consultant of any obligation to comply with applicable Federal, State and Local regulations.

HEALTH AND SAFETY PLAN

FOR THE

REMEDIAL ACTION
AT
JOHNS-MANVILLE DISPOSAL AREA

WAUKEGAN, ILLINOIS

Signatures

Brad Bradley
U.S. EPA Remedial Project
Manager (RPM)

Marvin Clumpus, P.E.
Manville Sales Corporation
Project Coordinator

Manville Remedial Construction
Manager (RCM)

SITE HEALTH & SAFETY PLAN

Table of Contents

		Pages
1.0	Introduction	G-1
2.0	General Directives	G-1
3.0	Site Hazards	G-5
4.0	Safety Procedures and Levels of Protection	G-7
5.0	Decontamination Protocol	G-10
6.0	Dust Control	G-11
7.0	Emergency Resources	G-12
	Signature Page	G-14

Appendices

G-A Soil Contaminant Data

G-B U.S. EPA Recommended Standard Operating Safety Guides

G-C Personal Air Monitoring Program During Remedial Construction

List of Figures

Figure G-1: Site Location Map G-2

Figure G-2: Field Operations Organization G-4

Figure G-A-1: Boring and Monitoring Well Location Map G-A-1

List of Tables

Table G-A-1: Summary of Results of Chemical Analyses G-A-2

SITE HEALTH AND SAFETY PLAN

1.0 INTRODUCTION

1.1 Site Location and Description

The Manville Sales Corporation (Manville), formerly Johns-Manville Sales Corporation, operates a manufacturing waste disposal area adjacent to its manufacturing plant site located in Waukegan, Illinois. The Disposal Area covers approximately 120 acres of the 300+ acres owned by Manville. The Disposal Area consists of currently active solid waste disposal areas, process wastewater treatment areas and inactive waste disposal area, as shown in Figure G-1.

1.2 Site History

Process and product related materials generated since 1922 have been disposed of in the Disposal Area. The wastes disposed of are primarily cuttings and waste products from manufacturing of asbestos-cement, roofing and insulating products. Wastes containing friable and non-friable asbestos were used to form portions of the dikes of the process wastewater treatment basins. Also, other inactive waste disposal areas are believed to have received sludges and waste materials containing asbestos, and trace amounts of lead and chromium in their oxidized form. All wastes known to contain friable asbestos have been disposed of properly in the Asbestos Disposal Pit.

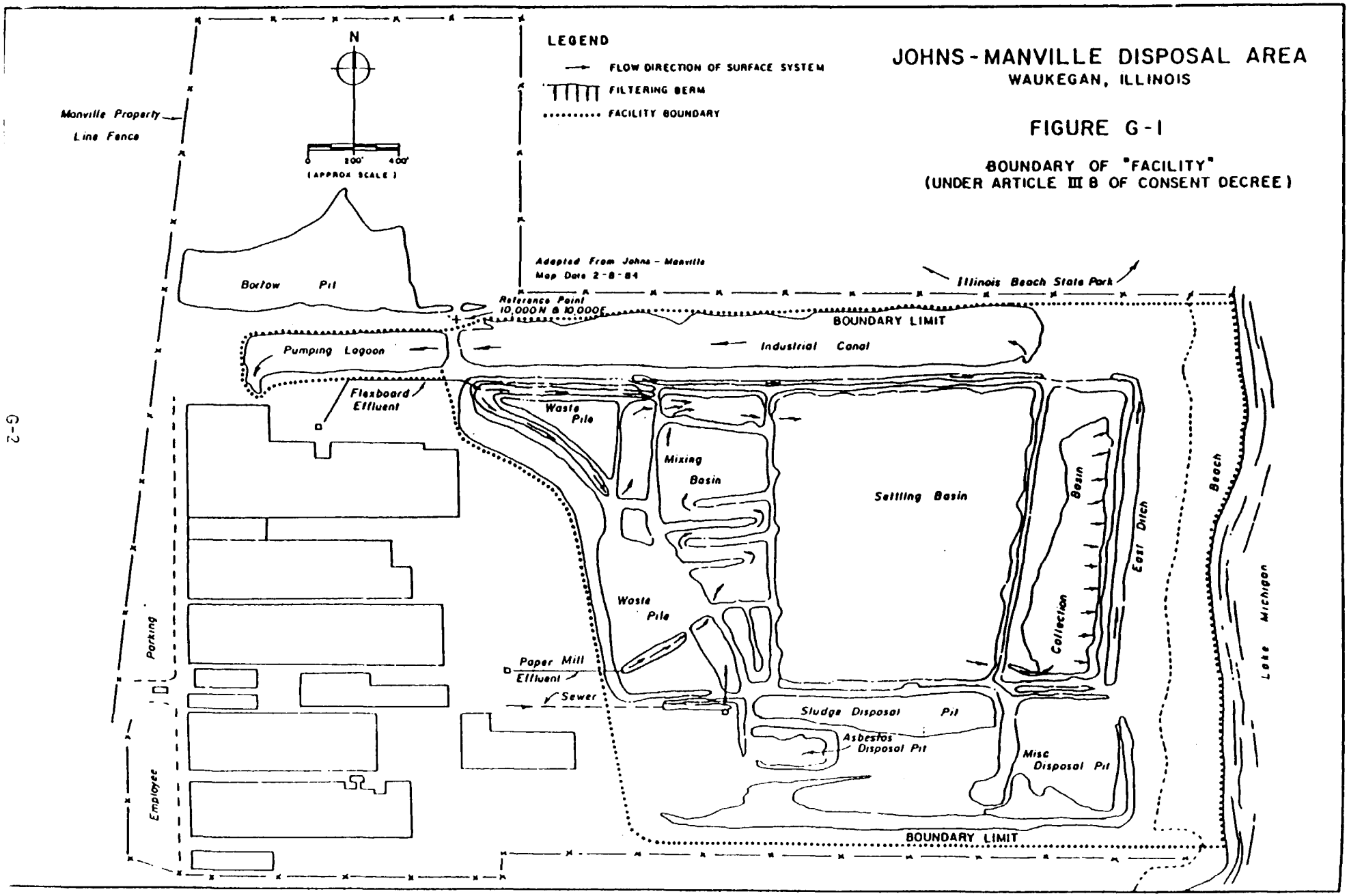
No asbestos has been used in the manufacturing processes in the recent past. Small quantities of asbestos-containing wastes generated from plant equipment and building asbestos decontamination activities were disposed of in the Asbestos Disposal Pit.

In 1982 this site was included in the National Priorities List. Since then, under the June 1984 Consent Order, Manville completed Remedial Investigation and Feasibility Study. U.S. EPA subsequently issued a Record of Decision (ROD) and Manville signed a Consent Decree for Remedial Action on Dec. 31, 1987. Under this Consent Decree, a Remedial Action involving a soil cover over the inactive waste disposal areas with vegetation and other improvements is being implemented. This Health and Safety Plan is to be followed for various site activities to be carried out during the implementation of the Remedial Action.

2.0 GENERAL DIRECTIVES

2.1 Purpose

The purpose of this Health and Safety Plan (HSP) is to establish personnel safety/protection standards, define responsibilities of


JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
FIGURE G-1
BOUNDARY OF "FACILITY"
(UNDER ARTICLE III B OF CONSENT DECREE)
LEGEND
FLOW DIRECTION OF SURFACE SYSTEM
FILTERING BERM
FACILITY BOUNDARY
N
0 200' 400'
(APPROX SCALE)
Adapted From Johns-Manville
Map Date 2-8-84
Manville Property
Line Fence
Borrow Pit
Reference Point
10,000 N & 10,000 E
BOUNDARY LIMIT
Illinois Beach State Park
Industrial Canal
Pumping Lagoon
Flexboard
Effluent
Waste
Pile
Mixing
Basin
Settling Basin
Collection
Basin
East Ditch
Beach
Lake Michigan
Waste
Pile
Parking
Paper Mill
Effluent
Sewer
Sludge Disposal Pit
Asbestos
Disposal Pit
Misc
Disposal Pit
Employee
BOUNDARY LIMIT

different organizations and personnel involved, establish safety operating procedures relative to physical and chemical conditions encountered on the site, delineate Contamination Areas (Designated Work Areas), establish decontamination procedures, and provide for contingencies which may arise during the course of the Remedial Action.

2.2 Applicability

This HSP addresses the safety procedures that will be followed by personnel visiting the site or involved in the Remedial Activities during the Remedial Work.

This Protocol will be read and signed by all personnel entering the site. This protocol will remain in effect until the Manville Remedial Construction Manager (RCM) certifies that the activity is terminated or otherwise modifies the HSP. This HSP does not supercede any Federal, State or local regulations. In the event of a conflict between this plan and a regulation, the more stringent of the two would be followed.

2.3 Health and Safety Responsibilities

The field operations organization for Health and Safety related activities is shown in Figure G-2. The General Contractor has primary responsibilities for implementing and monitoring all health and safety related activities on the site.

2.3.1 Site Health & Safety Manager

The responsibilities of the Manville Remedial Construction Manager/Site Health and Safety Manager will be:

- To ensure that all personnel allowed to enter the site (i.e., EPA, contractors, State, visitors) are aware of the potential hazards associated with substances known or suspected and the ongoing activities at the site;
- To ensure that the personnel working in a hazardous environment have appropriate health and safety training and are enrolled in an adequate medical monitoring program;
- To ensure that all personnel allowed to enter the site are aware of the provisions of this plan and are instructed in the safety practices defined in the plan, including its emergency procedures;
- To ensure that the appropriate safety equipment is available and properly utilized by all personnel on the site.

Field Operations Organization

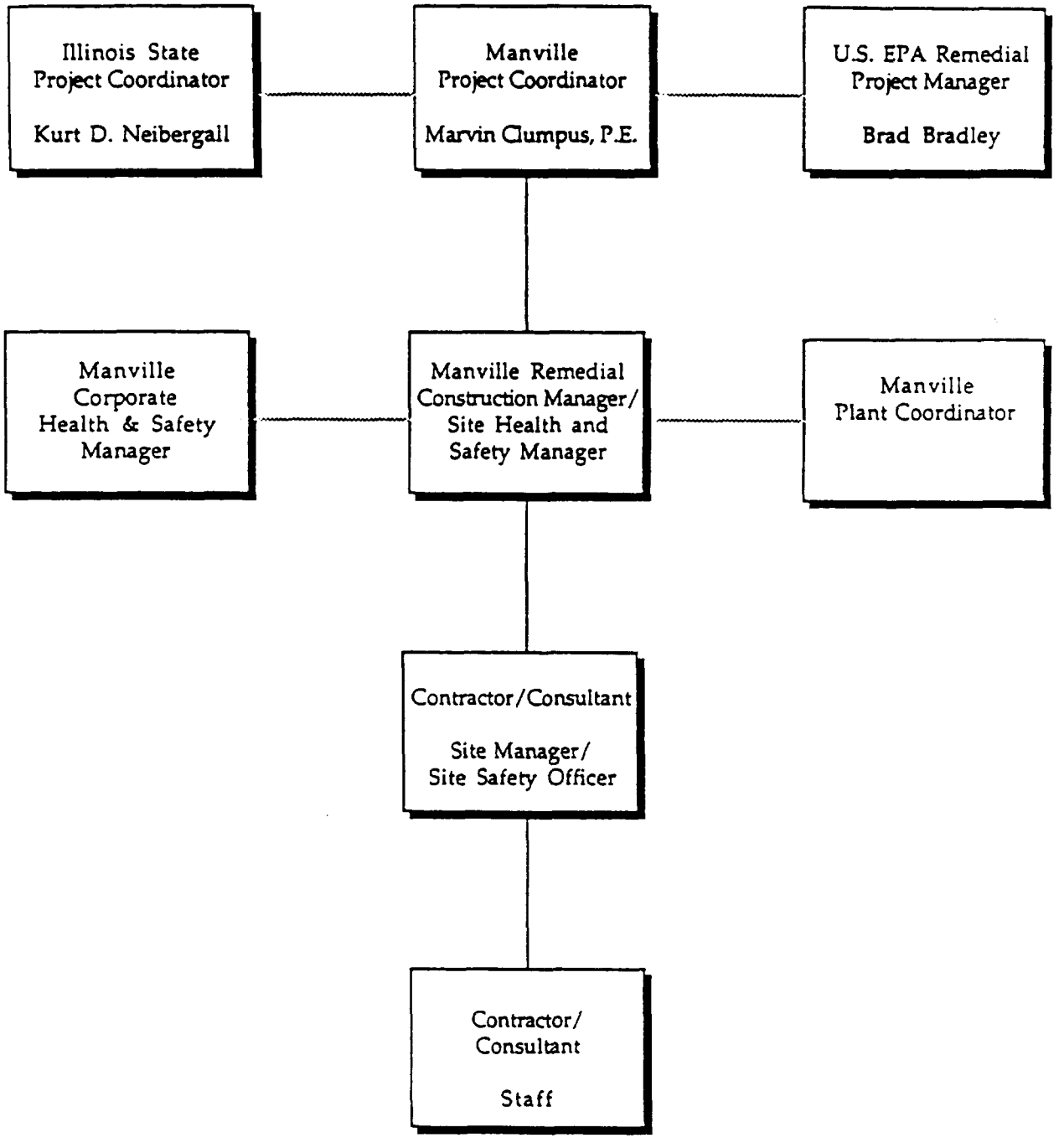


Figure G-2

The Health and Safety Manager may alter this Safety Plan to fit on-site conditions. U.S. EPA and IEPA will be made aware of the modifications to the Health and Safety Plan.

2.3.2 Site Safety Officer

Each contractor will designate a Site Safety Officer who will be responsible for implementing the Health and Safety Plan at the site. The Site Safety Officer will:

- Monitor compliance of workers relative to safety training, medical monitoring program and pre-established personal protection levels (i.e., use of necessary clothing and equipment to ensure the safety of personnel);
- Notify Manville Health and Safety Manager of discrepancies or violations of the Health and Safety Plan;
- Recommend to the H&S Manager any necessary modifications to Health and Safety Plan and personal protection levels to maintain personnel safety (based on weather and other conditions);
- Direct the action of all personnel and ensure compliance with health and safety procedures;
- Record and report accidents and injuries to site H&S Manager.

3.0 SITE HAZARDS

3.1 CHEMICAL CONTAMINANTS

The concentrations of the contaminants detected in the soil during Remedial Investigation are presented in Appendix G-A (reproduced from RI report).

Asbestos, lead and chromium have been identified as the contaminants of primary concern and are discussed in this section.

3.1.1 Asbestos

Asbestos is a general name given to a variety of fibrous minerals. The major asbestos mineral on site is chrysotile.

Inhalation of asbestos may cause asbestosis, pleural or peritoneal mesothelioma, and/or lung cancer.

Asbestos related disease usually develops after long exposure

to high concentrations of airborne respirable asbestos fiber. Risk varies directly with the length of exposure and concentration. Smoking has been found to increase health risk significantly. Threshold Limit Value - Time Weighted Average (TLV-TWA) for asbestos is 0.2 fibers per c.c.

3.1.2 Lead

Some elevated levels of lead were detected at the site. Inhalation and ingestion of lead has been associated with blood disorder, neurological dysfunctions and may be associated with cancer. Threshold Limit Value (TLV) for inorganic lead (dust or fumes) is 150 ug/m^3 as set by American Conference of Governmental Industrial Hygienists.

3.1.3 Chromium

Slightly elevated levels of chromium were detected at the site.

Inhalation and dermal contact with hexavalent chromium compounds has been associated with respiratory problems, kidney and liver disorders, contact dermatitis and skin ulceration. Chromium in ambient air is not regulated so far.

Full face respirators with GMC-H cartridges may be used to protect against these airborne, chemical contaminants.

3.2 Physical Hazards

The site consists of embankments, steep slopes and process wastewater treatment basins and involves vehicular traffic due to on going waste disposal activities. These can be sources of physical hazards. Contractor would make his employees aware of the nature of the physical hazards of this site and establish proper safety procedures including on-site traffic patterns to route vehicles in an orderly manner to avoid accidents.

3.3 Heat and Cold Stress

The heat stress load on the site workers will be assessed continuously by contractor's supervisors and the SSO. Heat stress monitoring may not be done if temperatures do not present any immediate health hazard.

The wearing of protective clothing in warm environments creates a heat stress potential. Some of the following control measures may be used to help control heat stress.

- Provision of adequate liquids to replace lost body fluids;

- Electrolyte replacement fluids should be available for use;
- A work regime established such that it provides adequate rest periods for cooling down;
- Rest area to be a cool area;

Temperatures at or below freezing may cause frostbite to the persons working outdoors. Extreme cold for a short time may cause severe injury to the body surface or result in profound general cooling, causing death. The SSO will monitor the workers for the cold stress symptoms and warm rest areas will be provided. Warm clothing should be worn by personnel during cold temperatures.

4.0 SAFETY PROCEDURES AND LEVELS OF PROTECTION

4.1 Respiratory Protection Program

All personnel involved in on-site activities will be given a respiratory protection program. All personnel wearing air-purifying respirators on-site are required to be fit tested, be physically qualified to wear a respirator, and must be properly trained in their use. All respiratory protection equipment is to be properly decontaminated at the end of each workday. A respirator cartridge will be used only when it comes from a properly sealed container and its shelf life has not expired. Cartridges will be changed once a day or more frequently if the wearer begins to smell any material or notices increased resistance to breathing. No bent, distorted or wet cartridge will be used.

Persons having beards will not enter areas requiring respiratory protection.

4.2 Training

Personnel will have appropriate health and safety instructions/training (formal training or on-the-job training) for those tasks they are assigned to perform on the site.

4.3 General Safety Rules and Equipment

- There will be absolutely no smoking on site.
- Work areas will be designated regularly. Level C/D Protection, as appropriate, will be used in the Designated Work Area (Contamination Area). All other areas will be considered as Support Areas.
- There will be no eating or drinking on site except in designated areas.

- All personnel must pass through the Decontamination Area/Facility, before entering or exiting Contamination Area (Designated Work Area).

- As a minimum, an emergency deluge shower/spray facility is to be located on the clean side of the Decontamination Area/Facility.

- Fire extinguishers will be available on-site.

- Each contractor will have his own emergency procedures and First Aid measures.

- OSHA approved First-Aid kit will be located on the site.

- Parking of non-essential vehicles inside of the Designated Work Area will not be permitted.

- No work will be performed in the Contamination Area (Designated Work Area) during hours of darkness as determined by the Site Health and Safety Manager.

4.4 Morning Tool Box Meetings

This H & S plan will be discussed as part of the Contractor's daily Tool Box meetings.

4.5 Site Control

Site access must be controlled to minimize risk of exposure to regulated substances on site. The site access will be controlled by proper fencing and appropriate warning signs. Except in an emergency, all personnel will enter and exit through the Decontamination Area/Facility.

4.6 Personnel Protection

Personnel protective equipment and safety requirements must be appropriate to protect against the known hazards on the site. The appropriate level of protection will be determined using U.S. EPA recommended standard, safety operating guidelines (see Appendix G-B). Changes in work conditions may result in changing of the original protection level selected. Protection levels C and D will be used for Remedial Work at this site.

4.7 Levels of Personnel Protection

4.7.1 Level C

Level C protection is selected when the types and concentrations of respirable materials are known, have adequate warning properties, or are reasonably assumed to be

not greater than the protection factors associated with air-purifying respirators. A modified level C personnel protection outlined below will be used for work performed in the Designated Contamination Area. In addition, continuous monitoring of site and/or individuals will be established as discussed in Section 6.0 of this H & S plan.

4.7.1.1 Personnel Protection Equipment recommended for Level C protection at this site is a slight modification of the standard Level C Protection Equipment discussed in Appendix G-B and will include:

- Full-face, air-purifying respirator (NIOSH approved) with combination (GMC-H) cartridges.
- Tyvek coverall with hood;
- Gloves - Outer;
- Gloves - Inner;
- Hard Hat (face shield, optional);
- Boots (Chemical-protective with steel toe and shank)
- Two-way radio communications, when required;
- Equipment operators may use half-face respirators and dust proof goggles in place of full-face respirators.

4.7.2 <u>Level D</u>

Level D is the basic work uniform and should be worn for all site operations except when Level C protection is required.

4.7.2.1 Personnel Protection Equipment Recommended for Level D protection at this site:

- Coveralls (cotton or tyvek)
- Boots/Shoes (Leather or chemical-resistant with steel-toe and shank);
- Dust Masks (mouth pieces only), when necessary;
- Half-face respirators immediately available, when necessary;
- Safety glasses or safety goggles, when necessary;

- Gloves (optional);
- Hard hat (face shield optional).

4.8 Designation of Work Areas at the Site

At all times the entire site will be divided into three areas by the Manville Remedial Construction Manager(Site Health and Safety Manager). These areas will be designated as follows:

- Contamination Area (CA), where contaminant exposure hazards exist and requires Level C protection.
- Decontamination Area, where decontamination of personnel and equipment exiting the Contamination Area is performed;
- The Support Area, which is the remaining site area not requiring Level C protection.

5.0 DECONTAMINATION PROTOCOL

Decontamination Protocol will involve the thorough decontamination of all equipment and personnel leaving the Contamination Area. Changes to the decontamination techniques will be dictated by the Site Health and Safety Manager to accommodate changing site operations.

The basic outline for Decontamination Protocol will involve:

5.1 Personnel Decontamination

Upon exiting the Contamination Area, all personnel are required to be decontaminated by means of the following procedure:

- Remove any gross contaminants;
- Scrub down outer boots in decon solution containing soap and water and wash off boots in rinse (tap water) solution;
- Remove boots and place upside down on boot-rack
- If wearing reusable rain gear, it should be scrubbed down with decon solution, rinsed, and then hung on pegs;
- Disposable tyveks should be removed and placed in trash barrels located outside of the decon trailer;
- Remove disposable gloves and place in trash barrel;
- Use a new set of disposable gloves to clean any equipment;

- Remove respirator and place spent cartridges in the trash barrel;

- Hard hats, respirators, and deconned equipment can be stored inside the decon trailer. Respirators should be rinsed in sanitizing solution at the end of each day.

- Showers should be available in the decontamination trailer. Shower and dress for exit to Support Area.

5.2 Equipment Decontamination

5.2.1 Decontamination of large equipment (vehicles, drill rigs, augers and associated equipment) entering and exiting the Restricted Areas (Designated Work Areas) will be performed at a vehicle/large equipment decontamination station. This decontamination station would be constructed according to the details contained in Attachment B.

Cleaning of tires and undercarriage will consist of Industrial Canal water or City water sprays using a high pressure hose. Additional scrubbing may be required to remove encrusted materials. Decontaminated equipment may be stored on plastic sheeting and/or platforms above the ground surface. Contaminated water can be disposed in Asbestos Disposal Pit.

5.2.2 Decontamination of large vehicles, equipment which are permanently on site will be accomplished once after completion of grading and smoothing and at the end of the construction phase. The equipment will be decontaminated using water sprays. The contaminated wash water can be disposed of in Asbestos Disposal Pit.

6.0 DUST CONTROL

No visible emission will be allowed in the Restricted/Contamination/Designated Work Area. Wetting of the work areas is the preferred method for the prevention of visible dust/emissions. It will be the responsibility of the contractor's Site Health and Safety Officer to observe that this requirement of no visible emission is maintained. In the event any visible emissions are noted, work will stop immediately, and the area will be wetted sufficiently before work is started again. Work should not be done at any time when visible emissions cannot be observed, such as dusk/dawn /nighttime.

An Ambient Air Monitoring program presented in QAPP-3 (Attachment C3) will be implemented during initial phases of the Remedial Work from site grading to placing of first layer of soil cover. The objective of this monitoring is to assure that the quality of air in the vicinity of

the construction area is not impaired due to handling of the asbestos-contaminated materials.

Ambient air monitoring will consist of meteorological measurements (local wind speed and direction) by using a recording anemometer, perimeter downwind air asbestos fiber monitoring using 24-hour sampling and perimeter downwind asbestos fiber monitoring using 4 to 8 hour sampling. The details of sampling locations, number of samples and methods of analysis are presented in QAPP-3.

A continuous personnel air-monitoring program (presented in Appendix G-C) will be implemented during the on-site working hours during construction activities from site grading to placing of first layer of soil cover.

Personal air monitoring will be conducted daily with the personal sampling surveys by 0.8 micrometer porosity cellulose ester filter with air flow rates of 0.5 liters/min. to 2.5 liters/min. Four personal air monitoring samples will be taken daily and only two will be analyzed daily (as outlined in Appendix G-C). The objective of this monitoring is to assure that asbestos fiber concentrations in the breathing zone of on-site personnel do not exceed permissible time-weighted average exposure concentrations. Exposure of any worker would not exceed 8-hr. weighted average airborne asbestos concentration of 0.2 fibers/cc. An action level of 0.1 fibers/cc may be used for Support Areas. Personal air monitoring data will be summarized and made available to U.S. EPA and IEPA by telephone or otherwise when received from the contractor. In general, all air monitoring data will be due (by telephone or in the written form) from the contractor within 24 hours of monitoring.

The samples will be analyzed by the Phase Contrast Microscopy (PCM) NIOSH method 7400.

It will be the duty of the contractor's Site Health and Safety Officer to ensure that the various elements of this Airborne Particle Control System are properly maintained and any discrepancies must be reported to Manville H&S Manager/Remedial Construction Manager.

7.0 EMERGENCY RESOURCES

The following emergency information will be posted prominently at each trailer and telephone on-site for appropriate use of the Contractor personnel. This will be in addition to the contractor's emergency procedures and first aid measures for on-site personnel.

AREA CODE (312)

AREA RESOURCES

Ambulance:	623-2121	Waukegan Fire Dept.
Hospital Emergency Room:	578-4181	Victoria Memorial Hospital
Poison Control Center:	1-800-942-5969	Rush Presbyterian, St. Luke's Hospital, Chicago General.
Police Emergency:	623-2131 684-7550	Waukegan Police Dept.
Fire Department:	623-2121	Waukegan Fire Dept.
Airport:	244-0055,	Waukegan Memorial Airport
Explosives Unit:	623-2121	Waukegan Fire Dept.
EPA Contact:	1-886-4742	Brad Bradley

SITE RESOURCES

Water Supply:	Manville Sales Corp.	City of Waukegan
Telephone:	Contractor's Trailer	

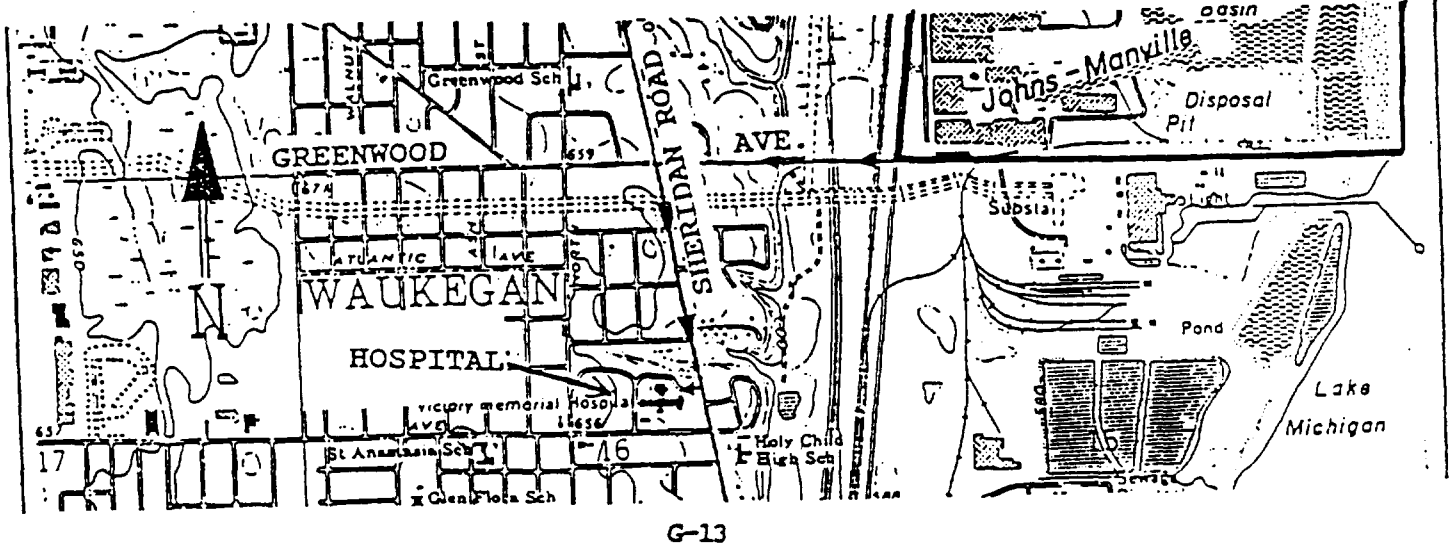
EMERGENCY CONTACTS

Site Safety Officer: _____

Site H&S Manager: _____

Hospital: Victory Memorial Hospital
1324 N. Sheridan Road
Waukegan, Illinois 60085

Hospital Route:



SIGNATURE PAGE

I have read and reviewed the site-specific Health and Safety Plan for the Johns-Manville Disposal Area and understand the information presented. I will comply with the provisions contained therein.

NAME _____ ORGANIZATION _____ DATE _____

APPENDIX G-A

SOIL CONTAMINANT DATA

(Reproduced from 1985 RI Report)

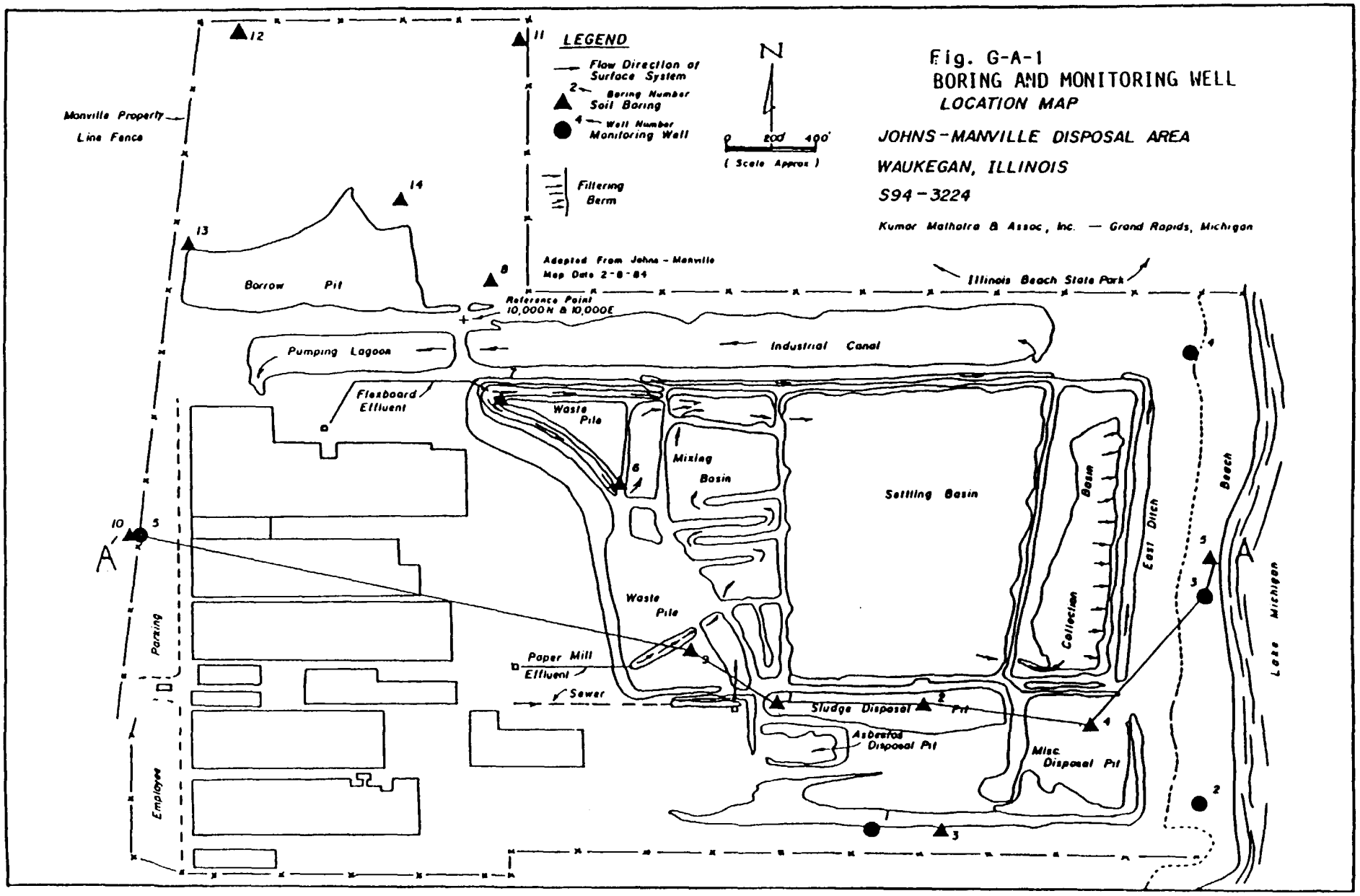

LEGEND
Flow Direction of Surface System
Boring Number
Soil Boring
Well Number
Monitoring Well
Filtering Berm
N
0 200' 400'
(Scale Approx)
Fig. G-A-1
BORING AND MONITORING WELL
LOCATION MAP
JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
S94-3224
Kumar Malhotra & Assoc, Inc. — Grand Rapids, Michigan
Adapted From Johns - Manville
Map Date 2-8-84
Manville Property Line Fence
Borrow Pit
Reference Point 10,000N & 10,000E
Pumping Lagoon
Industrial Canal
Illinois Beach State Park
Flexboard Effluent
Waste Pile
Mixing Basin
Settling Basin
Collection Basin
East Ditch
Beach
Lake Michigan
Waste Pile
Paper Mill Effluent
Sewer
Sludge Disposal Pit
Asbestos Disposal Pit
Misc. Disposal Pit
Parking
Employee
A
A

Table. G-A-1 SUMMARY OF RESULTS OF CHEMICAL ANALYSIS

BORING NUMBER	B-1			B-2			B-3				B-4			B-5
Boring Depth in Feet	Near Surface	14-15.5	31.5 33.0	Surface	21.5-23.0	34-35.5	Surface	Near Surface	39.5-40	Field Blank	Near Surface	6.5-8.0	14-15.5	At 20
Chemical Parameter (mg/kg)														
Chromium, Total	16	29	9	81	42	6.6	23	12	6.1	3.8	4.4	25	5.8	1.3
Lead, Total	86	3700	630	1100	2600	190	4700	1300	13	2.4	22	1400	140	8.2
Asbestos %	< 1	<1	<1	<1	<1	<1	<1	<1	<1	0	<1	<1	<1	<1
Toluene (U220)	< .02	.31	0.14	-	0.51	-	-	-	-	-	0.31	-	0.62	-
Ethyl Benzene	< .02	-	-	-	.08	-	-	-	-	-	-	-	1.4	-
Di-N-Butylphthalate	< .028	0.31	0.74	-	1.2	0 28	-	-	-	0.53	0.31	0.14	0.26	-
1,2-Dichlorobenzene (U070)	0.12	0.27	-	0.58	0.78	-	<.028	-	-	-	-	-	0.20	-
1,3-Dichlorobenzene (U071)	< .028	-	-	0.077	0.061	-	-	-	-	-	-	-	-	-
Bis(2-Ethylhexyl) Phthalate (U028)	3.6	2.5	3.3	4.6	14	5.1	-	-	-	24	8.9	3.5	4.2	-
Di-N-Octyl Phthalate (U107)	< .028	0.55	0.49	-	1.5	3.3	-	-	0.064	9	1.7	1.0	0.52	-
Fluorene	< .028	0.051	-	-	0.18	-	-	-	-	-	.077	-	0.43	-
Fluoranthene	0.12	0.053	0.035	0.085	0.33	0.20	0.088	<.028	-	-	.093	-	0.34	-
Pyrene	0.13	0.089	0.043	0.098	0.30	0.19	0.092	0.16	-	-	-	.046	0.33	-
Phenanthrene	0.046	0.16	<.055	0.19	0.56	0.06	0.16	0.10	-	-	0.15	0.062	0.57	-
Anthracene	< 0.028	0.037	-	-	0.15	<0.028	0.040	0.084	-	-	-	-	.092	0.032
Benzo (A) Anthracene	< 0.028	-	-	-	-	0.20	0.045	0.074	-	-	-	-	-	-
Naphthalene (U165)	0.054	0.78	0.089	0.050	1.8	<.028	0.095	0.057	-	-	0.95	0.097	2.1	-
p-Chloro-m-Cresol (U039)	0.42	1.0	<0.02	-	0.47	-	-	-	-	-	-	-	-	-
Pentachlorophenol (U242)	< 0.3	-	-	-	-	-	6.5	-	-	-	-	-	-	12
2,4,6 Trichloro Phenol (U231)	< 0.03	-	-	-	0.45	-	-	-	-	-	-	-	-	-
PCB 1254	0.2	0.2	<0.1	0.3	0.2	-	0.2	-	-	-	-	-	-	-
Thiram	< 0.028	-	-	-	-	-	-	-	-	-	-	-	-	-

- Non Detectable

Table. G-A-1 (continued)

SUMMARY OF RESULTS OF CHEMICAL ANALYSIS

BORING NUMBER	B-6					B-7					B-8	B-9			B-10		
Boring Depth in Feet	Surface	Near Surface	11.5-13.0	24-25.5	Field Blank	Near Surface	Near Surface Replicate	16.5 18.0	16.5 18.0 Replicate	29-30.5	At 20	Near Surface	9.0-10.5	29-30.5	Near Surface	At 20	Field Blank
Chemical Parameter (mg/kg)																	
Chromium, Total	29	5.4	18	6.4	3.6	22	18	14	18	1.8	1.3	28	26	3.8	8.2	4.8	1.2
Lead, Total	2200	330	2000	3900	< 1.0	82	129	< 1.0	-	-	5.4	250	28	6	20	9.6	-
Asbestos %	<1	< 1	<1	<1	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0
Toluene (U220)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethyl Benzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-N-Butylphthalate	0.27	0.18	0 21	0.12	0.21	0.33	0.24	0.30	0.18	-	-	-	-	0.054	-	-	-
1,2-Dichlorobenzene (U070)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3-Dichlorobenzene (U071)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-Ethylhexyl) Phthalate (U028)	5.2	4.0	72	4.2	81	120	8.8	5.9	-	-	-	-	-	-	-	1.3	3.1
Di-N-Octyl Phthalate (U107)	-	2.5	30	1.9	47	56	9.3	4.4	0.59	0.58	-	0.40	0.20	0.31	-	-	1.0
Fluorene	-	.032	0.10	0.031	-	-	0.14	-	-	-	-	-	-	-	-	-	-
Fluoranthene	0.28	0.50	0.14	0.12	-	0.29	0.14	-	-	-	-	0.64	-	-	-	-	-
Pyrene	0.33	0.48	0.14	0.11	-	0.35	0.18	-	-	-	-	0.44	-	-	-	-	-
Phenanthrene	0.18	0.59	0.19	0.27	-	0.40	0.27	-	-	-	-	0.27	-	0.12	-	-	-
Anthracene	.051	0.21	0.10	-	-	0.11	.082	-	-	-	-	0.20	-	0.048	-	-	-
Benzo (A) Anthracene	0.23	0.42	-	-	-	14	0.082	-	-	-	-	0.20	-	-	-	-	-
Naphthalene (U165)	0.22	0.16	0.10	0.26	-	0.15	0.16	-	0.20	-	-	-	-	0.56	-	-	-
4-Chloro-m-Cresol (U039)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol (U242)	-	-	-	-	-	-	-	-	-	-	19	30	27	-	7.9	-	-
2,4,6 Trichloro Phenol (U231)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB 1254	-	-	0.4	-	-	0.90	2.0	-	-	-	-	0.40	-	-	-	-	-
Tiram	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Non Detectable

APPENDIX G-B

U.S. EPA RECOMMENDED
STANDARD OPERATING SAFETY GUIDES

STANDARD OPERATING SAFETY GUIDES

November 1984

ENVIRONMENTAL RESPONSE BRANCH

HAZARDOUS RESPONSE SUPPORT DIVISION

OFFICE OF EMERGENCY AND REMEDIAL RESPONSE

U.S. ENVIRONMENTAL PROTECTION AGENCY

SITE ENTRY - LEVELS OF PROTECTION

I. INTRODUCTION

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

Equipment to protect the body against contact with known or anticipated toxic chemicals has been divided into four categories according to the degree of protection afforded:

- Level A: Should be worn when the highest level of respiratory, skin, and eye protection is needed.

- Level B: Should be worn when the highest level of respiratory protection is needed, but a lesser level of skin protection.

- Level C: Should be worn when the criteria for using air-purifying respirators are met.

- Level D: Should be worn only as a work uniform and not on any site with respiratory or skin hazards. It provides no protection against chemical hazards.

The Level of Protection selected should be based on:

- Type and measured concentration of the chemical substance in the ambient atmosphere and its toxicity.

- Potential for exposure to substances in air, splashes of liquids, or other direct contact with material due to work being done.

In situations where the type of chemical, concentration, and possibilities of contact are not known, the appropriate Level of Protection must be selected based on professional experience and judgment until the hazards can be better identified.

While personnel protective equipment reduces the potential for contact with toxic substances, ensuring the health and safety of responders requires, in addition, safe work practices, decontamination, site entry protocols, and other safety procedures. Together, these provide an integrated approach for reducing harm to workers.

II. LEVELS OF PROTECTION

A. Level A Protection

1. Personnel protective equipment

   - Supplied-air respirator approved by the Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH).
     Respirators may be:

     -- pressure-demand, self-contained breathing apparatus (SCBA)

     or

     -- pressure-demand, airline respirator (with escape bottle for Immediately Dangerous to Life and Health (IDLH) or potential for IDLH atmosphere)

   - Fully encapsulating chemical-resistant suit

   - Coveralls*

   - Long cotton underwear*

   - Gloves (inner), chemical-resistant

   - Boots, chemical-resistant, steel toe and shank. (Depending on suit construction, worn over or under suit boot)

   - Hard hat* (under suit)

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

   - Cooling unit*

   - 2-Way radio communications* (inherently safe)

2. Criteria for selection

   Meeting any of these criteria warrants use of Level A Protection:

   - The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on:

     -- measured (or potential for) high concentration of

*Optional

atmospheric vapors, gases, or particulates

or

-- site operations and work functions involves high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials highly toxic to the skin.

- Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible.

- Operations must be conducted in confined, poorly ventilated areas until the absence of substances requiring Level A protection is determined.

- Direct readings on field Flame Ionization Dectors (FID) or Photoionization Detectors (PID) and similar instruments indicate high levels of unidentified vapors and gases in the air. (See Appendixes I and II.)

3. Guidance on selection

a. Fully encapsulating suits are primarily designed to provide a gas or vapor tight barrier between the wearer and atmospheric contaminants. Therefore Level A is generally worn when high concentrations of airborne substances are known or thought to be present and these substances could severely effect the skin. Since Level A requires the use of a self-contained breathing apparatus, the eyes and respiratory system are also more protected.

Until air surveillance data are available to assist in the selection of the appropriate Level of Protection, the use of Level A may have to be based on indirect evidence of the potential for atmospheric contamination or other means of skin contact with severe skin affecting substances.

Conditions that may require Level A protection include:

- Confined spaces: Enclosed, confined, or poorly ventilated areas are conducive to build up of toxic vapors, gases, or particulates. (Explosive or oxygen-deficient atmospheres also are more probable in confined spaces.) Confined space entry does not automatically warrant wearing Level A protection, but should serve as a cue to carefully consider and to justify a lower Level of Protection.

- Suspected/known highly toxic substances: Various substances that are highly toxic especially through skin

absorption for example, fuming corrosives, cyanide compounds, concentrated pesticides, Department of Transportation Poison "A" materials, suspected carcinogens, and infectious substances may be known or suspected to be involved. Field instruments may not be available to detect or quantify air concentrations of these materials. Until these substances are identified and concentrations measured, maximum protection may be necessary.

- Visible emissions: Visible air emissions from leaking containers or railroad/vehicular tank cars, as well as smoke from chemical fires and others, indicate high potential for concentrations of substances that could be extreme respiratory or skin hazards.

- Job functions: Initial site entries are generally walk-throughs in which instruments and visual observations are used to make a preliminary evaluation of the hazards. In initial site entries, Level A should be worn when:

  -- there is a probability for exposure to high concentrations of vapors, gases, or particulates.

  -- substances are known or suspected of being extremely toxic directly to the skin or by being absorbed.

Subsequent entries are to conduct the many activities needed to reduce the environmental impact of the incident. Levels of Protection for later operations are based not only on data obtained from the initial and subsequent environmental monitoring, but also on the probability of contamination and ease of decontamination.

Examples of situations where Level A has been worn are:

- Excavating of soil to sample buried drums suspected of containing high concentrations of dioxin.

- Entering a cloud of chlorine to repair a value broken in a railroad accident.

- Handling and moving drums known to contain oleum.

- Responding to accidents involving cyanide, arsenic, and undiluted pesticides.

b. The fully encapsulating suit provides the highest degree of protection to skin, eyes, and respiratory system if the suit material resists chemicals during the time the suit is worn. While Level A provides maximum protection, all suit material may be rapidly permeated and degraded by certain chemicals

from extremely high air concentrations, splashes, or immersion of boots or gloves in concentrated liquids or sludges. These limitations should be recognized when specifying the type of fully encapsulating suit. Whenever possible, the suit material should be matched with the substance it is used to protect against.

B. Level B Protection

1. Personnel protective equipment

- Supplied-air respirator (MSHA/NIOSH approved). Respirators may be:

  -- pressure-demand, self-contained breathing apparatus

  or

  -- pressure-demand, airline respirator (with escape bottle for IDLH or potential for IDLH atmosphere)

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

- Long cotton underwear*

- Coveralls*

- Gloves (outer), chemical-resistant

- Gloves (inner), chemical-resistant

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

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

- Hard hat (face shield)*

- 2-Way radio communications* (intrinsically safe)

2. Criteria for selection

Meeting any one of these criteria warrants use of Level B protection:

- The type and atmospheric concentration of toxic substances has been identified and requires a high level of respiratory protection, but less skin protection than Level A. These would be atmospheres:

*Optional

-- with concentrations Immediately Dangerous to Life and Health, but substance or concentration in the air does not represent a severe skin hazard

or

-- that do not meet the selection criteria permitting the use of air-purifying respirators.

- The atmosphere contains less than 19.5% oxygen.

- It is highly unlikely that the work being done will generate high concentrations of vapors, gases or particulates, or splashes of material that will affect the skin of personnel wearing Level B protection.

- Atmospheric concentrations of unidentified vapors or gases are indicated by direct readings on instruments such as the FID or PID or similar instruments, but vapors and gases are not suspected of containing high levels of chemicals toxic to skin. (See Appendixes I and II.)

3. Guidance on selection

a. Level B does not afford the maximum skin (and eye) protection as does a fully encapsulating suit since the chemical-resistant clothing is not considered gas, vapor, or particulate tight. However, a good quality, hooded, chemical-resistant, one-piece garment, with taped wrist, ankles, and hood does provides a reasonable degree of protection against splashes and to lower concentrations in air. At most abandoned hazardous waste sites, ambient atmospheric gas or vapor levels have not approached concentrations sufficiently high to warrant Level A protection. In all but a few circumstances (where highly toxic materials are suspected) Level B should provide the protection needed for initial entry. Subsequent operations at a site require a reevaluation of Level B protection based on the probability of being splashed by chemicals, their effect on the skin, the presence of hard-to-detect air contaiminants, or the generation of highly toxic gases, vapors, or particulates, due to the work being done.

b. The chemical-resistant clothing required in Level B is available in a wide variety of styles, materials, construction detail, and permeability. One or two-piece garments are available with or without hoods. Disposal suits with a variety of fabrics and design characteristics are also available. Taping joints between the gloves, boots and suit, and between hood and respirator reduces the possiblity for splash and vapor or gas penetration. These

factors and other selection criteria all affect the degree of protection afforded. Therefore, a specialist should select the most effective chemical-resistant clothing based on the known or anticipated hazards and job function.

Level B equipment does provides a high level of protection to the respiratory tract. Generally, if a self-contained breathing apparatus is required for respiratory protection, selecting chemical-resistant clothing (Level B) rather than a fully encapsulating suit (Level A) is based on needing less protection against known or anticipated substances affecting the skin. Level B skin protection is selected by:

- Comparing the concentrations of known or identified substances in air with skin toxicity data.

- Determining the presence of substances that are destructive to or readily absorbed through the skin by liquid splashes, unexpected high levels of gases, vapor, or particulates, or other means of direct contact.

- Assessing the effect of the substance (at its measured air concentrations or potential for splashing) on the small areas left unprotected by chemical-resistant clothing. A hooded garment taped to the mask, and boots and gloves taped to the suit further reduces area of exposure.

c. For initial site entry and reconnaissance at an open site, approaching whenever possible from upwind, Level B protection (with good quality, hooded, chemical-resistant clothing) should protect response personnel, providing the conditions described in selecting Level A are known or judged to be absent.

C. <u>Level C Protection</u>

1. Personnel protective equipment

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

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

- Coveralls*

- Long cotton underwear*

- Gloves (outer), chemical-resistant

- Gloves (inner), chemical-resistant*
- Boots (outer), chemical-resistant, steel toe and shank
- Boot covers (outer), chemical-resistant (disposable)*
- Hard hat (face shield*)
- Escape mask*
- 2-Way radio communications* (inherently safe)

2. Criteria for selection

   Meeting all of these criteria permits use of Level C protection:

   - Oxygen concentrations are not less than 19.5% by volume.
   - Measured air concentrations of identified substances will be reduced by the respirator below the substance's threshold limit value (TLV) and the concentration is within the service limit of the canister.
   - Atmospheric contaminant concentrations do not exceed IDLH levels.
   - Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any body area left unprotected by chemical-resistant clothing.
   - Job functions do not require self-contained breathing apparatus.
   - Direct readings are a few ppms above background on instruments such as the FID or PID. (See Appendices I and II.)

3. Guidance on selection

   a. Level C protection is distinguished from Level B by the equipment used to protect the respiratory system, assuming the same type of chemical-resistant clothing is used. The main selection criterion for Level C is that conditions permit wearing air-purifying respirators.

      The air-purifying device must be a full-face respirator (MSHA/NIOSH approved) equipped with a canister suspended from the chin or on a harness. Canisters must be able to

*Optional

remove the substances encountered. Quarter-or half-masks or cheekcartridge, full-face masks should be used only with the approval of a qualified individual.

In addition, a full-face, air-purifying mask can be used only if:

- Substance has adequate warning properties.

- Individual passes a qualitative fit-test for the mask.

- Appropriate cartridge/canister is used, and its service limit concentration is not exceeded.

b. An air surveillance program is part of all response operations when atmospheric contamination is known or suspected. It is particularly important that the air be thoroughly monitored when personnel are wearing air-purifying respirators. Periodic surveillance using direct-reading instruments and air sampling is needed to detect any changes in air quality necessitating a higher level of respiratory protection.

c. Level C protection with a full-face, air-purifying respirator should be worn routinely in an atmosphere only after the type of air contaminant is identified, concentrations measured and the criteria for wearing air-purifying respirator met. To permit flexibility in precribing a Level of Protection at certain environmental incidents, a specialist could consider using air-purifying respirators in unidentified vapor/gas concentrations of a few parts per million above background as indicated by a needle deflection on the FID or PID. However a needle deflection of a few parts per million above background should not be the sole criterion for selecting Level C. Since the individual components may never be completely identified, a decision on continuous wearing of Level C must be made after assessing all safety considerations, including:

- The presence of (or potential for) organic or inorganic vapors/gases against which a canister is ineffective or has a short service life.

- The known (or suspected) presence in air of substances with low TLVs or IDLH levels.

- The presence of particulates in air.

- The errors associated with both the instruments and monitoring procedures used.

*Optional

- The presence of (or potential for) substances in air which do not elicit a response on the instrument used.

- The potential for higher concentrations in the ambient atmosphere or in the air adjacent to specific site operations.

d. The continuous use of air-purifying respirators (Level C) must be based on the identification of the substances contributing to the total vapor or gas concentration and the application of published criteria for the routine use of air-purifying devices. Unidentified ambient concentrations of organic vapors or gases in air approaching or exceeding a few ppm above background require, as a minimum, Level B protection.

D. Level D Protection

1. Personnel protective equipment

- Coveralls

- Gloves*

- Boots/shoes, leather or chemical-resistant, steel toe and shank

- Safety glasses or chemical splash goggles*

- Hard hat (face shield)*

2. Criteria for selection

Meeting any of these criteria allows use of Level D protection:

- No contaminants are present.

- Work functions preclude splashes, immersion, or potential for unexpected inhalation of any chemicals.

Level D protection is primarily a work uniform. It can be worn only in areas where there is no possibility of contact with contamination.

*Optional

PERSONAL AIR MONITORING PROGRAM DURING REMEDIAL CONSTRUCTION

1.0 INTRODUCTION

The initial phases of the Remedial Work involve site grading and smoothing and placement of the first layer of sand/soil cover. The air monitoring program outlined herein and in QAPP-3 (Attachment C3) will be implemented during these initial phases of the Remedial Work. The ambient air monitoring program is presented in Appendix C3-B and the personal air monitoring program is presented herein. The air monitoring is to be conducted to satisfy the requirements of the December 31, 1987 Consent Decree.

2.0 OBJECTIVES

It is intended that Remedial Activities be carried out such that asbestos concentrations in the breathing zone of on-site personnel do not exceed permissible time-weighted average exposure concentrations.

3.0 PROPOSED PERSONAL AIR MONITORING PROGRAM

The proposed methods and equipment to be used for personal monitoring are presented herein.

3.1 Monitoring Plan

Personal monitoring for airborne asbestos will be conducted by the Remedial Work Contractor according to the procedure described in the June 20, 1986 Federal Register. In this method, air is drawn at a rate of approximately 0.5 to 2.5 liters per minute through mixed cellulose ester filters (0.8 um pore size and 25/37 mm diameter) mounted in open-faced cassettes over a full workshift duration. Constant-flow personal air sampling pumps will be used which will be calibrated with a primary standard prior to and following use. During workdays, individuals representing various working groups will be fitted with the sampling pumps (on their belts) and the filter cassettes will be attached to their lapels, (i.e., in their breathing zones). The filter cassettes will be returned to the laboratory daily for selected analysis by Optical Phase Contrast Microscopy (PCM).

Four personal samples will be taken daily; one from each of the four different working groups (i.e., truck drivers, scraper operators, backhoe/bulldozer operators and laborers). The selection of individuals from groups will be based upon those most likely to be exposed to asbestos fibers during the day. The installation of sampling equipment on individuals will be done on a daily basis by the Contractor's Site Safety Officer. Four additional samplers (ready for operation) will be available on-site for use on the following day of measurements. At the end of the workday, samplers will be removed and, after a review of the

daily activities, two samples (filter cassettes) will be selected for PCM analysis based on the potential for greatest exposure.

It is anticipated that, on most occasions, analytical results will be available the next working day following sampling. The results will be recorded as airborne concentrations (# fibers >5 um/cc of air) and provided each day to Manville's Remedial Construction Manager. These results will then be compared to the permissible time-weighted average exposure concentrations of 0.2 fibers/cc. For each set of weekly sample filters, two blank filters will be prepared and loaded into cassettes in a similar fashion to sample filters. Of these, one blank filter will also be analyzed. All remaining unanalyzed filters will be retained by the Remedial Work Contractor.

3.2 Sample Handling and Storage

Throughout the program filters will be loaded in individual filter cassettes in a clean room. Samples (cassettes) will be clearly identified, marked and recorded. Filter cassettes will be taken to the site and stored with caps during overnight intervals prior to sampling. All exposed filter cassettes will be capped after sample collection and hand carried or transported to the laboratory using precautions to minimize dislodgment of collected material. All collected samples and blanks will be stored until completion of air monitoring program by Manville and/or completion of Remedial Construction. Appropriate precautions will be taken to avoid contamination during all sample handling and storage.

3.3 Sample Analysis

Samples will be analyzed using optical PCM methods in accordance with the procedures outlined in the June, 1986 Federal Register for measuring airborne asbestos fibers.

3.4 Data Reporting

Daily reporting of analytical results from selected personal samples to the Manville Remedial Construction Manager will be done on the working day following sample collection. These will be communicated to U.S. EPA and IEPA by telephone or otherwise when received. Summaries of monitoring activities and data will be reported monthly to Manville by the Contractor. Summary Report from the Contractor will include raw data from sample analysis. Manville will include such summaries in the monthly progress report. A final report at the completion of the monitoring program will be prepared by Manville which will include: a description of sampling and analytical methods, any problems encountered, summarized monitoring data and the significance of results. Raw data from sample analysis will form an appendix to the report. This report will be submitted to U.S. EPA and IEPA.

4.0 PROJECTED WORK SCHEDULE

It is projected that the initial phases of the remedial activities requiring air monitoring will commence within 30 calendar days of the award of the construction contract and be completed after a period of five to six months. Personal air monitoring will be scheduled to coincide with these activities. It is anticipated that the final report will be completed within approximately 60 calendar days after completion of the personal air monitoring program.

APPENDIX B

SPECIFICATION
C. C. JOHNSON & MALHOTRA
JUNE 1988, REVISED SEPTEMBER 1988

ATTACHMENT B

SPECIFICATIONS

FOR

REMEDIAL CONSTRUCTION WORK

AT

JOHNS-MANVILLE DISPOSAL AREA
MANVILLE SALES CORPORATION
WAUKEGAN, ILLINOIS

JUNE 1988

(REVISION B', OCTOBER, 1988)

JOHNSON & MALHOTRA, P.C.
ENVIRONMENTAL ENGINEERS

GRAND RAPIDS, MICHIGAN

ATTACHMENT B

SPECIFICATIONS

Table of Contents

		Pages
Section 01001	General Requirements	1 - 16
Section 02102	Clearing and Grubbing	1
Section 02200	Earthwork	1 - 9
Section 02300	Excavation & Backfill	1 - 3
Section 02360	Sheet Piling	1
Section 02500	Drainage	1 - 8
Section 02709	Chain Link Fence	1 - 3
Section 03300	Cast-In-Place Concrete	1 - 2
Section 05500	Miscellaneous Metals	1
Section 15400	Plumbing	1
Appendix B-A:	Previous Boring and Well Logs	A-1 - A-19
	Format for Compliance Certificate For Health and Safety Training and Medical Monitoring	

1.0 GENERAL

The work to be completed under this contract includes obtaining all necessary permits, furnishing all tools, equipment, labor, and materials (unless specifically omitted herein) necessary to complete remedial construction work at Johns-Manville Disposal Area at Manville Corporation, Waukegan, Illinois plant, as specifically outlined under "Scope of Work" and other project requirements presented herein. The Contractor shall be bound by the General Conditions presented in different sections for work under this project.

Without prejudice to the foregoing, the quality of construction shall be as stipulated in these specifications and all work done by the contractor shall be completed to the satisfaction of the Owner. The Owner requires materials and workmanship equal to present good industrial construction standards.

2.0 SCOPE OF WORK

2.1 The project is designed to remove sludge from certain process wastewater treatment basins, close certain areas containing asbestos contaminated waste material, lead contaminated waste material and areas containing sludge by covering such areas and is generally described as follows:

a. Wet areas to be graded to minimize and control airborne asbestos levels.

b. Clear all areas of trees, brush, stumps and other debris and rough grade all areas.

c. Place fill on rough graded areas to reach a relatively smooth surface to top surfaces and sideslopes.

d. Place six (6) inches of contaminant free compacted sand fill. Use Level C Personnel Protection and Personal Air Monitoring for asbestos exposure as outlined in the Health and Safety Plan for work items 2.1.b, c and d.

e. Place fifteen (15) inches of contaminant free compacted clayey (natural silty clay) fill.

f. Place three (3) inches of contaminant free lightly rolled topsoil.

g. Fertilize, seed and mulch as specified herein. Use Level D Personnel Protection without personal air monitoring as outlined in the Health and Safety Plan for work items 2.1.e, f and g.

2.2 For surfaces with a slope of greater than 20 percent, twenty three (23) inches of contaminant free compacted thickness of clay (natural silty clay fill) may be substituted for the six (6) inches of sand and fifteen (15) inches of clay indicated in items 2.1.d and 2.1.e above.

2.3 Material stock piled on the site is not to be used by the contractor for rough grading, filling depressions and cover over waste scrubbed brush and trees.

2.4 Dredge sludge from ponds and ditches where shown on the drawings and/or specified herein.

2.5 Place a cover of four (4) inches of bedding material and twelve (12) inches nominal size Rip-Rap on interior slopes of settling basins and catch basin as shown on the drawings.

2.6 Grade the north, west, south and southeast slopes of the waste disposal area, and other bermed areas as shown on the drawings to maximum slope of one vertical to two horizontal and cover as indicated in Paragraph 1 above.

2.7 Regrade site roadways and cover with twenty-four (24) inches of compacted roadway material as shown on the drawings and/or specified herein.

2.8 Construct peripheral ditches as shown on the drawings.

2.9 Construct a dike along the north side of the Industrial Canal where shown on the drawings.

2.10 Provide construction equipment and personnel decontamination facilities as specified herein and in the Health and Safety Plan.

2.11 Construct sheet piling, fencing and signs as shown on the drawings and/or specified herein.

2.12 Construct dike drainage/seepage collection system, drainage structures, manholes, piping, and all other work items shown on the drawings and/or specified herein.

2.13 Construct pumping station wet well as shown on the drawings.

Use Level C Personnel Protection for all clearing and grubbing, and for placing the first layer of bedding material or sand/soil cover, including sections 2.2, 2.5, 2.6 and 2.7.

Use Level D Personal Protection without personal air monitoring as outlined in the Health and Safety Plan for work items 2.4 and 2.8 through 2.13.

3.0 OWNERS ONGOING ACTIVITIES

Manville staff regularly removes sludge from the existing waterways and basins and disposes in the sludge pit. This sludge may be temporarily piled for drainage or other purposes on the Disposal Area. It is not the Contractor's responsibility to remove or grade any sludge deposited by Manville staff during the Contract Performance Period. Similarly, Manville staff will not deposit any miscellaneous waste on areas other than the designated miscellaneous waste disposal areas unless specifically requested by the Contractor and approved by the Owner to fill a depression prior to placing the soil cover. Contractor's on-site activities shall not interfere with the routine operation and maintenance activities of Manville, Waukegan Plant Staff at the Disposal Area.

The Owners' operations on the site will continue during the period of this construction. Where construction requires joint use of roadways, dewatering operations, pump shutdowns and any other Contractor operations affecting the Owner, such operations shall be coordinated with the Owner to minimize such interferences.

4.0 WORK SCHEDULE

4.1 Construction Startup

Contractor shall begin work upon receipt of Notice to Proceed, scheduled for October, 1988.

4.2 Project Completion Date

Remedial Construction Work shall be completed on or before May 31, 1990.

4.3 CONSTRUCTION SCHEDULES AND PROGRESS MEETING

4.3.1 Preconstruction Meeting

Prior to beginning work a preconstruction conference will be scheduled by the Owner to review General Contract terms, responsibilities, supervision, schedules, testing and approvals, construction procedures, payment and labor requirements.

4.3.2 Construction Schedules

Within fifteen (15) calendar days after receipt of notification to proceed with the Contract, the General Contractor shall submit to the Owner for his approval, six copies of a detailed Construction Schedule.

The Construction Schedule shall show a sequence of operations agreeable to all parties; be prepared as a Bar Chart for planning, control, and scheduling of submittals and work performed, and indicate plan and method of completion of Construction Work within the agreed Contract Time.

The Construction Schedule will incorporate a manpower curve by trade and a procurement schedule for all materials and equipment to be supplied by the Contractor.

The schedule, manpower curves, and procurement record shall be in such detail as to allow the weekly tracking of the Contractor's performance under this Contract. The Contractor shall be fully responsible for obtaining the above information from his subcontractors.

4.3.3 Progress Meetings

Progress Meetings will be scheduled weekly by the Owner at the job site for the Contractor, all Subcontractors actively working on the job site and other interested parties.

During weekly job meeting, Contractor and Owner will review schedules and all items affecting the schedules, including change orders, delivery of material and equipment, and manpower. All Subcontractors will be expected to attend the weekly job meeting and review their portion of the project.

4.3.4 Schedule Updating

The Contractor shall submit updated Schedule, accurately depicting the progress to the last working day of the previous month, on or before the fifth day of each month. The Contractor shall distribute updated copies of the schedule to each concerned Subcontractor.

5.0 OWNER SUPPLIED MATERIAL

5.1 Temporary Water Supply for Site Wetting

A temporary water supply for site wetting may be obtained from the Industrial Canal at locations approved by the Owner. The Owner will make available to the Contractor a source of three phase 480V power adequate to drive the Contractors pumps. This electrical source for the pumping system is located in the "Flexboard Effluent" pump station as shown on Drawing 43161B -1. The Owner asks that electric powered rather than gasoline or diesel powered units be provided because of the greater reliability. The cost of power used on site will be paid directly by the Owner. The

Contractor is responsible for all distribution of such water supply, including pumps, piping, hoses, sprinklers and related equipment.

6.0 INSPECTIONS AND TESTS

The Owner will arrange and pay for all tests and inspections of the Work, except tests on proposed off-site borrow material that he may require for proper control of the Work. Any tests or inspections the Contractor may require will be paid for by the Contractor.

7.0 RESPONSIBILITY FOR LOSS OF MATERIALS

7.1 The Owner will not be responsible for the Contractor's loss of tools, materials, etc. The Contractor must safeguard his own property.

8.0 APPROVED SUBCONTRACTORS

8.1 Only Owner approved Subcontractors shall work on the Disposal Site. The Owner must approve all selection of Subcontractors before a Sub-contract is let.

9.0 SAFETY, FIRE PROTECTION

9.1 The Contractor shall adhere strictly to all local, state, OSHA, RCRA, CERCLA, NESHAP, and Plant rules and regulations for industrial construction and hazardous waste handling.

9.2 The Contractor shall also adhere strictly to fire protection recommendations as covered by NFPA 241. The Contractor shall undertake the following actions, where appropriate.

9.2.1 Construction practices during construction shall be in accordance with the published standards of the Factory Insurance Association and the National Fire Protection Association, which, by reference, are made a part of these specifications.

9.2.2 Provide a suitable number of portable fire extinguishers (non-freeze type in cold weather) distributed about the project.

9.2.3 Store gasoline and other flammable liquids in U.L. listed safety containers in safe location away from any building. Distribute the liquids directly from the containers.

9.2.4 Tarpaulins used for any purpose during construction shall be made from material resistant to fire, water, and weather, shall comply with Federal specification CCC-D-746, and shall have U.L. approval.

9.2.5 Furnish ground fault circuit protection for all portable tools as per National Electric Code, Section 210-8, latest edition.

9.3 The Owner is not responsible for the Contractor's compliance with any applicable safety requirements, but is empowered to stop any activities of the Contractor (or its employees) that he considers dangerous.

9.4 The Contractor will be responsible for holding weekly safety meetings on the site, and a safety record must be posted in a conspicuous place.

9.5 The Owner may request the Contractor to have a Safety Engineer on the site if the accident rate of the Contractor or his Sub-contractors is considered excessive.

9.6 Health and Safety training for each employee working on the site shall be provided in accordance with the Superfund Amendment and Reauthorization Act of 1986 (SARA).

9.7 A Medical Surveillance Program for each employee working on the site shall be provided in accordance with SARA.

9.8 Level C Personnel Protection is required for all site activities in the designated Contamination Area until the first layer of cover material is in place.

9.9 A certificate (as presented at the end of this document) of compliance with sections 9.6 and 9.7 will be supplied by the Contractor to Manville.

10.0 CLEANUP

10.1 The Contractor shall maintain the work area in a clean and satisfactory manner. Do not allow debris to accumulate. A clean-up shall be done once a week. Construction debris must be removed from site. No burning of grubbed brushes and trees shall be allowed on Owner's property.

11.0 CODES, ORDINANCES AND PERMITS

11.1 No local construction permits for remedial construction at the Disposal Area are required. Permits such as those required for electrical work will be obtained by the Contractor and Manville will pay all such permit fees.

12.0 CHANGE ORDERS

12.1 Quoted prices, submitted by the Contractor on all change orders over $1,000, including firm price changes, must be completely documented. This would include complete detailed estimates with man-hours, material quantities, etc..

12.2 The above applies to all Sub-contractors' prices to the General Contractor unless changed otherwise by the Owner.

12.3 No requests for Contract extras will be honored unless Owner's representative is notified prior to start of any work considered to be extra by Contractor and a change order has been approved by the Owner covering such work.

13.0 SITE VISIT (SITE EXAMINATION)

13.1 The Contractor must visit the site with the Owner's representative and acquaint himself with existing conditions prior to preparation of his bid. Each Contractor shall be held responsible for having visited the site and acquainted himself with all existing conditions, including all procedures, conditions and obstacles which may affect the work. Locations of previous borings made at the site are shown on the Drawings and Boring Logs are included in Appendix B-A.

13.2 The Contractor shall, at no time after the visit, assert that there is any misunderstanding in regard to the nature or extent of the work or working conditions.

14.0 FACILITIES AND SERVICE BY OWNER

14.1 The Owner will furnish one outlet of service listed below without charge. The Contractor must maintain and extend these services.

14.1.1 Electric Service 460 V, 3 Phase, 100 amps.

14.1.2 City drinking water 1" hose connection with estimated water pressure of 40 to 60 psi.

14.2 Uncovered storage space will be provided at locations approved by the Owner.

14.3 The Owner will not unload any of the Contractor's material or equipment.

14.4 Construction parking will be in an area designated by Owner. The Contractor shall be responsible for the maintenance and security of this area as directed by the Owner.

14.5 The Contractor will provide toilet facilities for his personnel. The Owner's toilet facilities and lunchrooms are not to be used by Contractor's personnel.

14.6 All construction operations will be confined to the area within the Contract Limit Line and the Sand Borrow Area.

14.7 Manville will provide a guard shack and security guard at the Contractor's entrance. Only persons authorized by Manville shall be permitted to enter the site.

15.0 OTHER CONTRACTS

15.1 The Owner may have separate contracts in force at the same time and in the same areas. It will be important that this Contractor schedules his work and cooperates with such other Contractors.

16.0 OWNER'S OPERATIONS

16.1 The Contractor shall not interfere in any way with the Owner's present operations. The Contractor shall not remove any existing construction or move any pipes and structures without prior approval of the Owner. All existing pipes and structures shall be properly protected. The Owner's operations must be maintained at all times.

16.2 This plant is in operation around the clock, seven days a week. The Contractor shall not make any connection to existing services that will interfere with plant operation. Any such connections that are required in accordance with the specifications and drawings shall be authorized by and accomplished under the supervision of the Owner.

17.0 STANDARDS

17.1 References made to trade, technical, governmental or other codes, standards or specifications shall be interpreted as the minimums and not maximums required.

18.0 WELDING

18.1 Welding machines shall be grounded directly to the work. The use of building or equipment steel or conduits of any kind as common ground point is not allowed under any conditions. The Contractor shall be responsible for any wiring, instrumentation, computer or other electrical pieces of equipment damaged by not using the welding grounding method described above.

19.0 SHOP DRAWINGS

19.1 The Contractor shall submit for approval all drawings required for installation of materials and drawings and/or catalog cuts of equipment supplied by the Contractor or any of his Sub-contractors.

19.2 Approval of shop drawings shall not be construed as relieving the Contractor of any responsibilities assigned to him in the Contract Documents.

19.3 The Contractor is to submit to the Owner one print and one reproducible for each shop drawing and catalog information. The Engineer will return two prints to Contractor marked in one of the following ways:

19.3.1 Approved for construction
19.3.2 Approved except as noted
19.3.3 Not approved

19.4 Shop drawings marked "Approved except as Noted" and "Not Approved" are to be corrected and re-submitted.

20.0 TAXES

20.1 All applicable taxes shall be paid by the Contractor and included in the Contract Price.

21.0 INVOICING

21.1 Contractor will be expected to break down his lump sum price and submit monthly billings on special forms approved by the Owner.

22.0 FIELD MEASUREMENTS, LAYOUT AND STAKING

22.1 Contractor shall be responsible for taking of all field measurements and checking for any interferences before starting construction. Contractor shall notify Owner of any changes required to clear existing facilities.

22.2 The Contractor shall stake out the work and provide all field measurements to assure that the installation of the Work is in accordance with lines, dimensions and elevations shown on the drawings.

23.0 SOIL EROSION AND SEDIMENTATION CONTROL

23.1 Construction operations shall be conducted in such a manner as to reduce erosion and sedimentation to a practical minimum. Prior to disturbing areas, temporary erosion controls shall be constructed, if needed.

23.2 Permanent soil erosion controls for all slopes, channels, ditches or other disturbed land areas shall be completed within fifteen (15) calendar days after final grades have been achieved. Where it is not possible to permanently stabilize a disturbed area, temporary erosion controls shall be implemented within five (5) calendar days.

23.3 The surface area of erodible earth material exposed at any one time will be subject to the approval of the Owner.

24.0 JOB ACCIDENTS

24.1 The Contractor has the responsibility of notifying the Owner of all job accidents to the Contractor's or Sub-contractor's personnel.

24.2 The Contractor shall provide at the site, and make available to all workmen, medical supplies and equipment necessary to supply First Aid service to all persons injured in connection with the work.

24.3 The Contractor must promptly report in writing to the Owner, all accidents whatsoever arising out of, or in connection with, the performance of the work, whether on or off the site, which caused death, personal injury or property damage, giving full details and statements of witnesses. In addition, if death or serious damages are caused, the accident shall be reported immediately by telephone or messenger. If any claim is made by anyone against the Contractor or any Subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Owner giving full details of the claim.

24.4 In the case of a lost-time accident, the Owner must be notified immediately. In all cases, a written report must be made within two days of an accident.

25.0 NO SMOKING POLICY

25.1 The Contractor is advised that smoking is prohibited in all areas of this plant site.

25.2 This regulation applies not only to Contractor's personnel working on site, but to his vendors, truck drivers, etc., who visit the site.

25.3 If someone is smoking, they will be asked to extinguish their smoking material. Non-compliance with this request will result in the individual or Contractor being asked to leave the premises.

25.4 There will be no exceptions made to this regulation.

26.0 ASBESTOS CONTAINING MATERIALS

26.1 The Contractor shall comply with all Occupational Safety and Health Administration (OSHA), NESHAPS 40 CFR 61, Environmental Protection Agency (EPA), and all state and local regulations for the safe handling of asbestos-containing materials. This includes all procedures and, specifically, procedures for handling or removal of existing asbestos-containing materials. The Contractor also agrees to follow guidelines included in the Site Health and Safety Plan outlining personnel protection and monitoring to be used during handling of asbestos-containing materials/wastes.

27.0 HAZARD COMMUNICATION REQUIREMENTS

27.1 It is Manville's intention to comply with the requirements of OSHA's "Hazard Communication" rule, 29CFR 1910.1200. The Contractor's supervisor of on-site personnel shall be responsible for obtaining information on any hazardous chemical to which his personnel have potential exposure while on the premises prior to the start of any field work. The Manville Contract Supervisor or Owner should be requested to provide this data from the Plant Hazard Communication Program Coordinator. If this information is not forthcoming, the Contractor is to advise the Manville purchasing department.

27.2 The Contractor's Supervisor shall provide the Manville Hazard Communication Program Coordinator with MSDS (Material Safety Data Sheet) documentation on any "hazardous" chemicals that the Contractor plans to bring onto the Plant premises. In addition, the Contractor's Supervisor is responsible for meeting container warning label requirements of the OSHA rule.

28.0 DRAWINGS

28.1 All drawings are the property of Manville Corp. and are returnable on request. They are for confidential use of the drawing recipient and must not be used in any manner detrimental to Manville Corp.

28.2 The bid Drawings are as follows:

Drawing No.	Title	Remarks
43161B -1	Cover Sheet	
43162B-1	Site Plan	
43163B-1	Site Plan Borrow Area	
43164B -1	Site Plan Northwest Quadrant	
43165B -1	Site Plan Northeast Quadrant	
43166B -1	Site Plan Southwest Quadrant	
43167B -1	Site Plan Southeast Quadrant	
43168B -1	Sections and Details	
43169B-1	Sections and Details	
43170B-1	Sections and Details	
43171B -1	Sections and Details	
43172B-1	Sections and Details	
43173B-1	Pumping Station and Black Ditch	

29.0 OTHER CONTRACT REQUIREMENTS

29.1 Temporary Storage

29.1.1 Provide suitable weathertight facilities for all equipment which would be damaged if stored in the open.

29.1.2 Remove all such temporary structures from the site upon completion of the work.

29.2 Temporary Toilets

29.2.1 Provide and maintain temporary toilet facilities acceptable to local health authorities for use by the guard, Owners Office Group and construction workers. Remove same at completion of project.

29.3 Dust Control/Work Area Wetting and Air Asbestos Monitoring

29.3.1 No visible emission will be allowed in the work areas. If any visible emmissions are observed in the designated Work Area the work will be shut down immediately until the visible emmissions are eliminated. Wetting of the work areas is the preferred method for the prevention of visible dust/ emissions.

29.3.2 Prior to any grubbing, rough grading and surface smoothing of an area, the Contractor shall adequately wet the waste material and soil to be displaced or disturbed to minimize releases of airborne asbestos and other contaminants to the environment. Wetting should be done by using portable water spraying equipment. All wetted areas shall be approved by

the Owner prior to grubbing, rough grading and surface smoothing. The effectiveness of wetting during rough grading and surface smoothing shall be monitored daily by the Contractor. A continuous personnel air monitoring program will be implemented by the Contractor (during the on-site working hours) for construction activities from site grubbing and grading through placing of first layer of soil cover as outlined in the Site Health and Safety Plan.

29.3.3 Roads accessed for construction shall have dust control measures.

29.3.4 Dust control measures in the work areas shall be implemented for 24 hours a day and seven days a week until the first layer of cover material is in place.

29.4 Field Office

29.4.1 The Owner will provide temporary office facilities at the site for use of his personnel and for job meetings.

29.5 Decontamination Facilities and Personnel Protective Equipment

29.5.1 The Contractor shall provide a decontamination trailer for use of all persons who visit the site within ten days of placement (Award) of the Contract. This trailer would also be available for use of the regulatory agencies, and Owner's staff associated with the Remedial Work. This trailer shall consist of a decontamination area, shower area and clean/dressing area. Contractor shall provide and maintain adequate supply of all disposable and non-disposable Personnel Protective Equipment and decontamination supplies normally required for a Level C equipped decontamination trailer. The requirements for Level C Personnel Protective Equipment are outlined in the Health and Safety Plan. This trailer would be located near the entrance to the site as designated by the Owner. Contractor shall provide and pay for installation of all utilities required, including cold and hot water supply, heat and electricity. The discharge of washwaters (not sanitary) from the Decontamination Trailer and from the Owners trailers shall be routed to the Equipment Decontamination (Truck Washing) drain sump. Note that the effluent from the Equipment Decontamination facility must be discharged to the Asbestos Disposal Pit, if disposed of on site. After November 15, 1989, when the entire Asbestos Disposal Pit is closed with a cover, the effluent could be disposed in the process water treatment catch basin.

29.5.2 The Contractor shall provide an Equipment Decontamination Facility as specified herein. This facility shall be used to decontaminate (spray wash on outside) each vehicle which has

been used by the Contractor on the site for Remedial or Monitoring activities prior to its moving off the disposal site. The Contractor shall provide an approximately 12' x 60' paved and sloped washing area and appurtenances, necessary water supply and power supply and the drainage collection and disposal system for the wash water and sediments. The facility will be used during all phases of the Remedial Work and shall be capable of operation during freezing weather conditions. This facility shall be located on a site designated by the Owner.

29.6 Protection of Existing Facilities

29.6.1 The Contractor shall provide all required temporary protection to assure the Owner that the existing facilities, including underground and above ground structures, piping conduit, paving, monitoring wells, fencing, power poles, etc., are undamaged by the Contractors operations. The Contractor shall remove all temporary protective materials upon completion of the work.

29.6.2 Any damage to the Owners facilities, caused by the Contractors operations will be repaired by the Contractor at his expense.

29.6.3 Monitoring Wells: Damaged monitoring wells must be replaced by a well drilling firm having experience in construction of monitoring wells. Well installation will be under Level D Personnel Protection. All provisions in current practice to prevent contamination of such wells must be observed. Any existing wells damaged must be pulled and sealed. Elevation of top of any replaced wells must be surveyed by a licensed surveyor to assure accurate ground water measurements. Every effort should be made to employ the same Contractor who installed the damaged well so that the replacement well construction is the same as of the damaged well.

29.6.4 Roadway, Pavement, Sidewalk Restoration: Any roadways, pavements, sidewalks, curbs, etc. opened or damaged by the Contractor's operations, on or off the site, shall be restored in a manner prescribed by the authority having jurisdiction.

30.0 INGRESS AND EGRESS

30.1 Contractor will be provided means of ingress and egress to and from the Manville Facility and the Disposal Area in accordance with the Contractor's proposed method of operation. Locations of ingress and egress will be subject to Owner's approval.

31.0 CONTRACTOR'S ENTRANCE

31.1 The Owner has furnished and installed a new 20' double swing entrance gate where shown on the drawings. This gate shall be maintained and left in place upon completion of the project.

32.0 CONTRACTOR'S RAILROAD CROSSING

32.1 The Owner has constructed an access roadway and railroad grade crossing for use by Contractors vehicles. All maintenance and repair of these facilities are the Contractor's responsibility. This is an active railroad siding handling daily rail traffic into the Manville Plant and must be maintained in service at all times. Replacement of any lost ballast, track realignment, clearing flangeways, leveling and/or placing additional roadway surfacing material shall be performed as required, by the contractor.

33.0 FUEL STORAGE CONTAINMENT

33.1 A diked containment area lined with a minimum of 6 mil polyethylene liner below a 12" thick clay liner shall be provided. The containment volume shall be at least 150 percent of the fuel storage tank(s) volume.

34.0 CONTAMINATED AREA

34.1 The Contaminated Area (CA) or the Designated Construction Area shall be enclosed by a barrier such as plastic snow fence, highly visible, with no more than two points of entry. The Decontamination Area shall be similarly enclosed.

35.0 POWER AND POTABLE WATER

35.1 Both power and potable water are available from the east end of A Building. The Contractor shall bring power and potable water to the trailer site within five days of Award of Contract. Power connections shall be made by the Contractor to the Owners trailer and guard house. Potable water connections to the Owners trailer shall similarly be made, including any necessary weather protection to prevent freezing.

36.0 CONTRACTORS WORK FORCE IDENTIFICATION

36.1 All employees or representatives of the Contractor shall wear distinctive badges, that identify the employee by either name or number.

37.0 COMMUNICATION

37.1 The Contractors Project Superintendent on site shall be provided by the Contractor with a suitable 2-way radio compatible with the Owners system (Motorola or equivalent).

38.0 STOCKPILE AREA

38.1 The areas east of the rail siding and north of the Boat Storage Building will be available for stock piling sand or soil, exclusively.

PART 1 - GENERAL

1.01 Description

Work includes all clearing and grubbing.

PART 3 - EXECUTION

3.01 Performance

Clear all areas to be disturbed for Remedial Work of trees, bushes, brush, stumps and other debris which may affect cover and other Remedial operations.

Trees on dikes shall be cut off approximately at the surface of existing grade. Stumps shall not be pulled from dikes. Stumps in other areas may be left in place if they do not interfere with cover operations. Threes, limbs, brush, etc. buried on the site shall be placed such that specified compaction can be obtained below, around and above such buried items.

Loose items such as sections of pipe, baled goods, sheet goods, and/or debris of any type located on the site within the contract limit lines is to be picked up and disposed of by the Contractor.

3.02 Disposal

Tree cuttings, stumps, brush and debris may be buried on site in the Asbestos Disposal Pit or on other areas of the Manville property if approved by Owner. All stumps should be treated as asbestos-contaminated. The deposited debris/trees/shrubs will be provided with a 24"/26" soil cover as required by the Consent Decree.

PART 1 - GENERAL

1.01 Description

A. Work included:

1. Wetting of areas to be graded.
2. Rough grade all areas to receive cover.
3. Place sand backfill to smooth out all rough graded areas.
4. Place six (6) inches of compacted sand fill on designated areas.
5. Place fifteen (15) inches of compacted clay cover on designated areas. Use twenty-three (23) inches of compacted clay cover where 6" sand layer is not used.
6. Place three (3) inches lightly rolled topsoil on designated areas.
7. Fertilize, seed and mulch designated areas.
8. Place Rip-Rap bedding material on interior slopes of settling basins and where indicated on Drawings.
9. Place Rip-Rap on interior slopes of settling basins and where indicated on the Drawings.
10. Regrade all steeply sloped areas to a maximum slope of two horizontal to one vertical.
11. Regrade on-site roadways and cover with twenty-four (24) inches of compacted roadway materials where shown on the Drawings.
12. Construct new gravel roadways where shown on the Drawings.
13. Construct peripheral drainage ditches where shown on the Drawings.
14. Construct compacted earth dike along north side of Industrial Canal where shown on the Drawings.
15. Excavate for piping, drainage system and flow structures, place bedding material and backfill for such structures.
16. Test all materials proposed for use as cover materials.
17. Dredge where shown on the Drawings.

PART 2 - PRODUCTS

2.01 Materials

A. Waste Wetting Water

Waste wetting water will be from the Industrial Canal, as described in the General Requirements.

B. Sand Backfill

Sand backfill shall be contaminant free beach sand which may be obtained from the Borrow Area designated on the Drawings or from off-site locations.

PART 2 - PRODUCTS

C. Clay Cover Material

Clay cover material shall be obtained by the Contractor from off-site non-contaminated borrow locations. The material shall meet the Corps of Engineer's Classification ML-CL or CL for silty clays, (clay content between 25% and 65%) and may contain up to 10% organic material.

D. Rip-Rap Bedding Material

Rip-Rap bedding material shall be well graded stone between three (3) inches and No. 4 sieve. 100% shall pass the three (3) inch sieve with no more than 5% passing the No. 4 sieve (2-1/2" to 3" size). Bedding materials shall be reasonably free from thin, flat or elongated pieces, and shall contain no organic matter nor soft friable particles in quantities considered objectionable by the Owner. Rip-Rap bedding material shall conform to I.D.O.T. (Standard Specifications For Road and Bridge Construction, October 1, 1983) Article 704.01, CAI, Coarse Aggregate, Class A quality Na_2SO_4 soundness requirement.

E. Rip-Rap

Rip-Rap stone shall have a maximum weight per piece of 150 pounds and not more than 5% shall weigh less than three (3) pounds per piece. The material shall be evenly graded and 30 to 70% of the material shall weigh 60 pounds or more per piece. The Rip-Rap stone shall conform to I.D.O.T. Article 704.01, Coarse Aggregate, Class A quality Na_2SO_4 soundness requirement.

F. Coarse Aggregate for Surface Course

Coarse aggregate for surface course shall be Class D quality or better, meeting I.D.O.T. Type B gradation CA6, CA9 or CA10.

G. Coarse Aggregate for Base Course

Coarse aggregate for base course shall meet I.D.O.T gradation CA6, CA2 or CA4.

H. Topsoil

Topsoil shall be a loamy mixture free of roots, sticks, weeds, brush and stones, litter and waste products. It shall contain not less than 12% nor more than 50% clay, and not less than 1% nor more than 10% organic matter. Topsoil shall conform to I.D.O.T. Article 717.04. The finished subgrade surface will be approved by the Owner before any topsoil is placed on it.

PART 2 - PRODUCTS

I. Fertilizer

Fertilizer shall be ready mix material conforming to I.D.O.T Article 717.07. The fertilizer shall contain the following percentages by weight: Nitrogen - 10%; Phosphoric Acid - 6%; Pot Ash - 4%; inert material - 80%.

J. Seed

Seed mixture shall be I.D.O.T. mixture Class 1A or Class 11A, specified below:

CLASS	SEEDS	LBS/ACRE	SEASON TO USE
IA	Ky. Bluegrass	30	Spring
	Perennial Ryegrass	10	
	Dawson Red Fescue	10	
	Scaldis Hard Fescue	10	
	Fults Salt Grass*	30	
	Ky. Bluegrass	30	Fall
	Perennial Ryegrass	10	
	Dawson Red Fescue	10	
	Scaldis Hard Fescue	10	
	Fults Salt Grass*	30	
	Oats, Spring (Note 1)	48	
IIA	Ky. 31 or Alta. Fescue	30	Spring
	Perennial Ryegrass	10	
	Dawson Red Fescue	10	
	Scaldis Hard Fescue	10	
	Fults Salt Grass*	30	
	Ky. 31 or Alta. Fescue	30	Fall
	Perennial Ryegrass	10	
	Dawson Red Fescue	10	
	Scaldis Hard Fescue	10	
	Fults Salt Grass	30	
	Oats, Spring (Note 1)	48	

*Fults pucinnellia Distans
Note 1. Winter Rye @ 56 lbs/acre may be used in lieu of spring oaks.

K. Mulch

Mulch material for seeding may be straw, hay, shredded tree bark, or hydromulch, in accordance with I.D.O.T. Article 717.05.

PART 2 - PRODUCTS

L. Ditch Lining

Ditch lining, where shown on the Drawings, shall be stone lined with coarse aggregate Class D quality in accordance with I.D.O.T. Article 704.08.

M. All materials proposed for use as cover material must be tested for asbestos as outlined in Section 3.01.B.2. Contaminated material will not be permitted for any use on the Job Site.

N. Compacted granular subbase material shall be clean sand, free of humus, clay or other debris. This material may be obtained from the designated Borrow Area.

PART 3 - EXECUTION

3.01 Performance

A. Testing by Owner

1. The Owner, will furnish soil engineering services required for testing and inspections specified for this project. The Contractor shall coordinate the testing services as required by construction with the Owner.

2. The Owner will test materials to determine their acceptability and suitability and the compaction of in-place material.

3. The Owner shall have the power of rejection of materials, equipment or operating procedures, of the filling or backfilling operation if they do not meet the construction requirements. The Contractor shall replace, rework or correct work which does not meet the specifications as directed by the Owner.

PART 3 - EXECUTION

B. Testing by Contractor

1. The Contractor shall provide soil samples and analysis of same from proposed borrow areas.

2. Each soil sample shall be tested for asbestos by a qualified testing laboratory approved by the Engineer.

3. Soils approved as contaminant free shall be tested for particle size (% sand, silt and clay), moisture content, organic content, pH and optimum density (maximum compaction).

4. Soil tests shall be performed at the rate of one (1) per acre of the borrow pits, or about one sample per 20 acre-foot of soil.

5. The Contractor shall use a minimum of four (4) personal air samplers to assure compliances with NIOSH Regulations and provide results to the Owner within 24 hours of sample collection.

6. Contractor may check compaction of each layer of soil cover (except top soil and sand layers) for his benefit prior to testing and approval by the Owner.

C. Subgrade Preparation

1. Wet areas to be graded or disturbed to minimize and control visible dust/emissions. Wetting should be done by a portable water spraying equipment and prior to any rough grading or surface smoothing. Wetting shall be continued until all visible emmissions are eliminated.

2. Rough grade existing roadways and sideslopes to profiles shown on the Drawings. Rough grade other areas that will receive cover to a generally flat surface but with positive drainage. Leave no depressions, bird baths, etc.

3. After subgrades are cut to shape, fill in low spots and generally level up by placing sand backfill in such low spots and depressions.

4. Compact to 90% of Standard Proctor Density on areas where Proctor Density(ies) can be determined; otherwise compact to a hard firm surface acceptable to the Owner.

PART 3 - EXECUTION

D. Placing Cover

Place cover in layers not exceeding one (1) foot in thickness. Compact each layer to 90% Standard Proctor; if compaction is not met, recompact and retest before placing additional cover. Owner will survey, for checking purposes, all areas prior to placement and after placement of cover to assure that minimum cover depths are achieved.

E. Placing Topsoil

1. Place sufficient topsoil to provide a minimum of three (3) inches rolled thickness.

2. Prepare surface to receive topsoil and finish topsoil in accordance with I.D.O.T. Section 216.

F. Fertilizer Application

Spread/apply fertilizer uniformly over areas to be seeded at a minimum rate of 20 lbs. per 1000 square feet.

G. Placing Seed

Prepare seed bed and place seed in conformance with I.D.O.T. Section 642.

H. Placing Mulch

Apply mulch in accordance with I.D.O.T. Section 643.

I. Ditch Lining

Place stone aggregate ditch lining on prepared subgrade without bedding material. The layer shall be twelve (12) inches thick, to the lines and grades shown on the Drawings. Place aggregate beginning at lower elevations and proceed up slope to construct a well graded mass of stone free from pockets of small stones and clusters of large stones.

J. Placing Rip-Rap

Place Rip-Rap bedding material a minimum of four (4) inches thick in accordance with I.D.O.T. Section 601. Place stone dumped Rip-Rap, minimum of twelve (12) inches thick in accordance with I.D.O.T. Section 601.

PART 3 - EXECUTION

K. Roadway Construction

1. Excavate and finish grade existing material to bottom of sub-base course. Level and compact surface to 95% of Standard Proctor or to satisfaction of the Owner.

2. Place twelve (12) inch thickness of compacted granular subbase material compacted to 95% Standard Proctor Density on Roadways designated Class I and fourteen (14) inch thickness of compacted granular subbase material compacted to 95% Standard Proctor Density on roadways designated Class II. Clean beach sand from the Manville sand borrow area may be used in place of granular subbase material if it contains less than 15 percent sand finer than 200 mesh.

3. On roadway sections designated Class I, place four (4) inch thickness of compacted coarse aggregate base course followed by eight (8) inch thickness of compacted coarse aggregate surface course. Compact base course and surface course to 95% Standard Proctor Density.

4. On roadway sections designated Class II, place a four (4) inch thickness of compacted coarse aggregate base course followed by six (6) inch thickness of compacted coarse aggregate surface course. Compact base course and surface course to 95% Standard Proctor Density.

L. Cover Areas

1. On surfaces with slopes less than 20%, place six (6) inches of compacted sand, followed by fifteen (15) inches of compacted clay and three (3) inches of rolled topsoil, fertilized, seeded and mulched.

2. On surfaces with slopes greater than 20%, eight (8) inches of compacted clay may be used in place of six (6) inches of compacted sand.

M. Maintenance of Seeded Areas

Seeded areas shall be maintained by mowing and reseeding through one full growing season following the season in which the areas were seeded. Maintenance includes placing additional topsoil, seed, fertilizer and mulch to correct any areas damaged by settlement or erosion. All seeded areas shall receive at least three mowings before acceptance.

PART 3 - EXECUTION

N. Dredging

1. Dredge sludge and sediment from ditches, troughs, catch basins and mixing basins to the elevations indicated on the drawings. Dredge the perimeter of such areas close in to the banks to allow for full thickness of sideslope cover as specified; either Rip-Rap or clay cover.

2. Complete all dredging to the Owner's satisfaction before placing sideslope cover on dredged areas.

3. Dredging may be performed hydraulically or mechanically with a backhoe and drag line. Ponds to be dredged may be dredged wet or may be dewatered before dredging. Mechanical equipment may not be operated in the dewatering ponds. The dredging shall be deposited in the southern half of the 33 acre Settling Basin. The Contractor shall spread the sludge evenly over the southern half of the Settling Basin such that the top of the deposited sludge is at least three feet below the water surface.

4. All dredged material shall be considered asbestos-contaminated.

5. Sludge dredging operations shall proceed from upstream to downstream basins so that the dredged basins do not get contaminated with asbestos-containing sludge solids transported by wastewater flow.

O. Black Ditch Area

1. Reroute power cables to Pumping Station to eliminate this potential hazard.

2. Furnish and install new steel pipe in place of the existing Transite Pumping Station discharge pipelines. The new pipe shall be 16" diameter, Schedule 30 steel pipe, coal tar epoxy coated inside and outside with two coats, 8 mil dry thickness per coat.

3. Furnish and install all required pipe supports including columns, footings, bracing, pipe hangers and attachments.

4. Submit shop drawings for pipe and fittings, pipe supports and all related items.

5. Paint all previous metal pipe support items with two coats of coal tar epoxy, 8 mils dry thickness per coat.

PART 3 - EXECUTION

6. Relocate power poles as required to clear new construction.

7. Reinstall power supply cables to Pumping Station. Provice new cable on all spans that were rerouted.

8. Plant operates around the clock seven days a week. Therefore, the wastewater flow is more or less continuous. Any temporary interruptions in the operation of the Pump Station shall be coordinated with Manville.

P. Flow Rerouting for Dewatering of Mixing Basins

The Contractor may dewater all mixing basins by rerouting flow temporarily as outlined below:

1. Relocated Pumping Station discharge pipelines to discharge into the 33 Acre Settling Basin.

2. Construct energy dissipator where pipelines discharge into the Settling Basin. This structure shall be 12 feet wide by 18 feet long timber crib, constructed of railroad ties or equivalent. Crib is to be anchored by filling with two (2) feet of stone and backfilling on three sides with stone to the top of the crib. The discharge side of the crib shall have a ten (10) feet wide spillway, twelve (12) inches deep, with spillway crest level set approximately at the Settling Basin water level.

3. Provide all pipe support structures to adequately support piping.

Q. 33 Acre Settling Basin

1. Settling Basin water level is to be lowered as required to provide for construction of the new overflow structure in dry conditions. Dewatering may be accomplished by pumping or syphoning water from the Settling Basin into the Industrial Canal. Contractor shall utilize a floating intake.

2. The lower pair of discharge pipelines through the East Dike are not to be activated.

3. Construction of the new overflow structure shall not be started until all pumping into the Settling Basin associated with dredging and dewatering operations have been completed.

PART 1 - GENERAL

R. Dike Protection

1. Excavation, reshaping of material, pulling stumps, and any other activities which may weaken or endanger existing dikes below the water line are to be strictly avoided.

2. Freeboard at dikes shall remain approximately as it exists except for shaping and leveling which may be needed to properly place cover material.

1.01 Description

A. Work included under this section includes all excavation and backfilling for piping, inlet and headwall structures, box culverts and pumping station and all dewatering equipment for removal and disposal of water from trenches and other excavations.

PART 2 - PRODUCTS

2.01 Materials

A. Backfill

1. Fine aggregate for bedding and trench backfill shall consist of sand, stone or stone screenings, reasonably free from soft or unsound particles. Gradation for bedding shall be IDOT FA1, FA2 or FA6; and for trench backfill, gradation FA6.

2. Coarse aggregate for trench backfill shall consist of gravel, crushed gravel, pit run gravel or crushed stone. Gradation for trench backfill shal be IDOT CA18.

PART 3 - EXECUTION

3.01 Performance

A. Excavation

1. Excavate all materials to a depth and width sufficient to permit installation of piping, placing of pipe bedding, and construction of the pumping station wet well and other structures.

2. All excavated material shall be considered asbestos-contaminated and disposed of in the Asbestos Disposal Pit or other areas on the site approved by the Owner.

3. The dimensions of the excavations shall be sufficient for dewatering equipment and to provide adequate working area around the formwork for structures.

PART 3 - EXECUTION

4. Excavations shall be kept dewatered until pipe bedding has been placed and compacted, pipes have been installed and backfilled, and concrete for structures has been placed and reached its initial set. No concrete shall be placed under water.

5. In order to limit excessive loads on pipe, the maximum trench width shall be 30 inches for pipe 6" to 10" and not more than 2 feet greater than the outside diameter of the pipe for pipe larger than 10".

6. Where excavation is carried below the required elevation for piping or structures, the subgrade shall be prepared by backfilling with an approved granular material in 3-inch compacted layers. Such layers shall be shaped and compacted to provide uniform and continuous bearing for piping and/or structures to be supported thereon.

B. Sheeting, Shoring and Bracing

1. Sheeting, Shoring and Bracing shall be provided to properly support excavation surfaces, adjacent work, adjacent structures, and workmen.

2. Pipe-laying boxes may be used where safety or workmen is the sole consideration. Care shall be taken in moving boxes, sheeting, shoring and bracing to avoid dislocation of piping, loosening of pipe joints, collapse of excavations or damage to adjacent structures.

C. Pumping, Bailing and Drainage

1. Provide and maintain adequate pumping and drainage equipment for removal and disposal of water from trenches and other excavations.

D. Temporary Sheeting

1. Provide and maintain adequate temporary sheeting to contain areas required to be dewatered. Maintain sheeting in place until construction contained in sheeted areas has been completed.

E. Backfilling

1. Backfilling around pipes from the bottom of the trench to 1 foot above the top of the pipe shall be placed by hand with approved backfill material, compacted in 3-inch layers, to 95% Standard Procter Density.

PART 3 - EXECUTION

2. Backfill from 1 foot above top of pipe to the underside of cover material may be placed by mechanical means, in 1 foot thick compacted layers, compacted to 95% of Standard Procter Density.

3. Backfill around structures may be placed by mechanical means, in 1 foot thick compacted layers, compacted to 95% of Standard Procter Density.

4. Backfill at structures shall be placed only after structures have reached 75% of concrete design strength.

PART 1 - GENERAL

1.01 Description

A. This work includes all sheet piling and related items as shown on the Drawings and specified herein.

B. Submittals: Provide shop drawings of each item.

PART 2 - PRODUCTS

2.01 Materials

A. Sheeting

1. Sheeting shall meet the requirements of the Standard Specification for Steel Sheet Piling ASTM A 328.

2. Sheeting shall be true, straight and uniform in section. The sides of each sheet shall contain interlocks continuous for the full length of the sheet, with sufficient clearance to allow for slippage of the adjoining sheet.

3. Splicing of sheet piling will not be permitted.

4. Handling holes: Provide standard handling holes in each section.

PART 3 - FABRICATION

3.01 Performance

A. Fabricate to required lengths. Field splicing will not be permitted.

B. Drive piling vertical on lines and grades shown on the Drawings.

SECTION 02500

PART 1 - GENERAL

1.01 Description

A. The Work includes:

1. Subgrade underdrain at edge of gravel roadways.
2. Underdrain at East Ditch outlet.
3. Dike seepage collection drains.
4. New underground inlet and/or outlet piping including tapered end sections.
5. Shortening or lengthening of existing inlet and/or outlet piping.
6. Manholes, catch basins and inlets.
7. Settling Basin outlet structures and piping.

PART 2 - PRODUCTS

2.01 Materials

A. Subgrade underdrains at edge of gravel roadways.

1. Six inch ASTM D3033 or D3034 perforated PVC drain pipe for collectors piping.
2. 6" Schedule 80 PVC solid pipe for drain piping.
3. Geotex fabric wrap around collector drains.
4. Coarse aggregate filter material as shown on the Drawings.

B. Underdrain at East Ditch outlet

1. Ten inch ASTM C14X perforated concrete pipe as shown on the Drawings.
2. Coarse aggregate filter material where shown on the Drawings.
3. Geotex filter fabric wrap around coarse aggregate filter material as shown on the Drawings.

C. Dike Seepage Collection Drains

1. Six inch ASTM D3033 or D3034 PVC drain pipes.
2. Hitek prefabricated subsoil drainage system PDS 40, or approved equal. System to include prefabricated, slotted collector drain, prefabricated drain end cap, and Cordrain sheet drainage material with geotextile filter fabric on one side.

D. Inlet and/or outlet underground pipe: reinforced concrete ASTM C76, class as shown on the Drawings with ASTM C443 rubber joints or approved equal.

PART 2 - PRODUCTS

E. Lengthen existing pipes with reinforced concrete ASTM C76 Class IV or approved equal. Provide sizes as required to match existing piping.

F. Manholes, Catch Basins and Inlets: precast units, ASTM C76 Class III or approved equal with cement mortar joint. Manhole steps: 10" deep x 10" wide, 5" tread depth, 1" x 1" tread section.

G. Manhole Casting: East Jordan 1120, B Cover or approved equal.

H. Catch Basin and Inlet Castings: East Jordan 3130 with Type N grate or approved equal.

PART 3 - EXECUTION

3.01 Preparation

A. Pipe Alignment and Grade

1. The Contractor shall furnish all line and grade control and shall furnish all necessary labor, material, equipment and instruments required.

a. Batter Boards. If batter boards are used, they shall have sufficient length to span the trench and set at intervals no greater than 25 feet. Batter boards shall be strong and straight. Each batter board erected shall be checked by sighting across the two previously placed batter boards. No less than three (3) batter boards shall be in place at all times. Line and grade shall be obtained by plumbing down and measuring down from a centerline parallel to an established offset line directly over the center of the pipe. Sighting in of line and grade by eye will not be permitted.

b. Laser Beam. If laser beam equipment is used, line and grade for the piping shall be obtained by using the laser beam through the pipe being laid. Prior to placement of each section of pipe, the laser target shall be repositioned in the pipe previously laid to recheck beam accuracy. Check line and grades at 50' intervals maximum.

B. Pipe Laying

1. Lay pipe starting at lower end and proceed up-grade.

2. Lay pipes with spigot or tongue end downstream.

PART 3 - EXECUTION

C. Bedding

1. Lay pipe with firm and even bearing along the full length of the pipe.

2. Provide a minimum of 3" compacted granular bedding material under the full length of each pipe unless indicated otherwise on the Drawings.

3. Provide additional excavation under pipe bells to assure a minimum of 3" thickness of bedding material.

4. Backfill the full width of trench to 1'-0" minimum above the pipe with granular backfill compacted to a minimum of 95% Standard Proctor Density.

D. Placing

1. All pipes shall be laid with joints fully made, true to line and grade.

2. Carefully center successive pipes so that they form a drain with uniform invert.

3. Hold each pipe firmly in place against the previous pipe while the joint is being made and fix in place by immediate pipe bedding to 1' above the top of the pipe.

4. On pipes 30" diameter and above, pressure must be applied to each pipe as it is laid by a winch or other mechanical means to assure the joint is fully made.

5. Care shall be exercised to prevent pipe joint from opening up as subsequent lengths are laid or pipe laying box is pulled ahead.

6. Leave joints smooth and clean.

7. No pipe shall be laid on frozen ground.

8. No pipe shall be laid underwater. Pipe trenches shall be kept completely dry while all bedding and pipe laying is being performed and for a sufficient time thereafter to allow jointing material to become fully set and/or grout to be set sufficient to not be damaged by water.

E. Cleaning

1. The interior of all pipes shall be cleared of all jointing materials, dirt and all other debris.

SECTION 3 - EXECUTION

F. Manholes, Catch Basins and Inlets

1. Details of construction for standard manholes, catch basins and inlets are included herein.

2. Manhole bases shall be poured in place on undisturbed ground or, if ground is uneven fill material, poured on 4" of compacted granular fill. If precast, place in 4" minimum of compacted granular fill or pea gravel.

3. No manhole, inlet or catch basin shall be constructed on frozen ground.

4. Manholes, inlets and catch basins shall be constructed on dry subgrades.

5. Manhole invert: pipe shall be laid through the manhole. Concrete grout shall be placed up to the spring line of the pipe and sloped upward to the inside manhole perimeter. The pipe above the spring line shall be removed.

6. Set castings accurately to finish flush with finish grade or ditch invert.

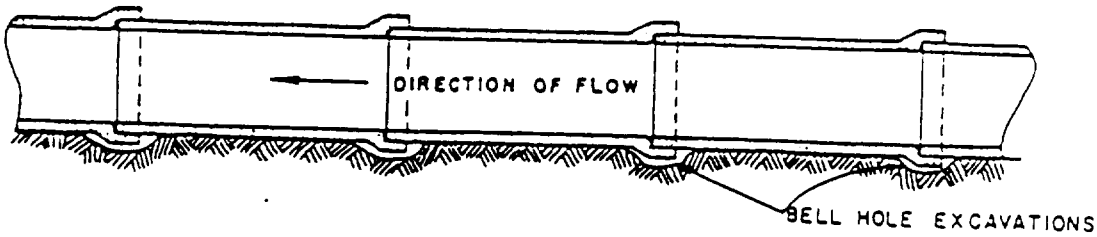
G. Underdrain at East Ditch Outlet ,Subgrade Underdrains at Edge of Gravel Roadways and Dike Seepage Collection Drains

1. Install at line and grade of roadway above.

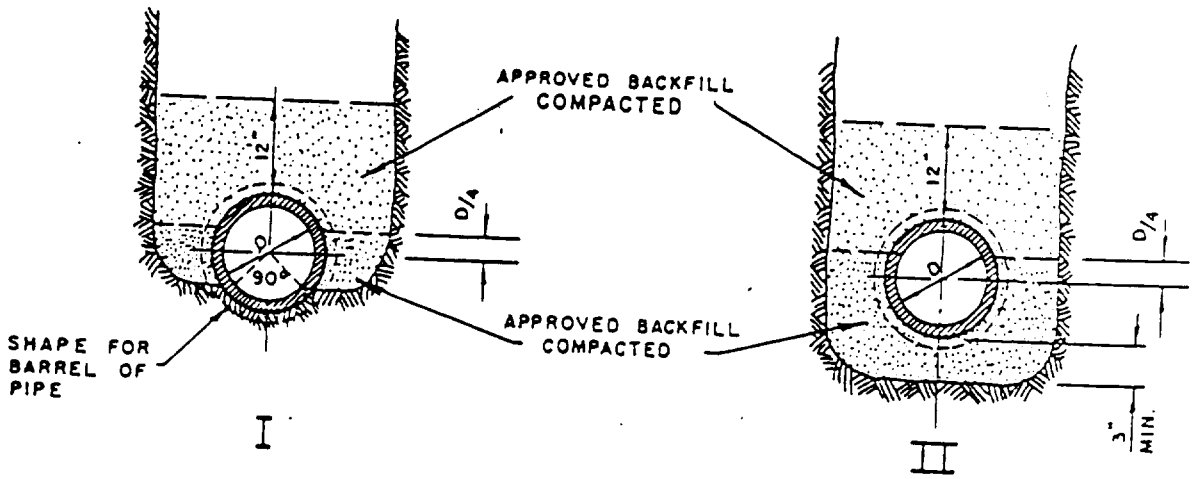
2. Keep trenches completely dry until all pipes are laid.

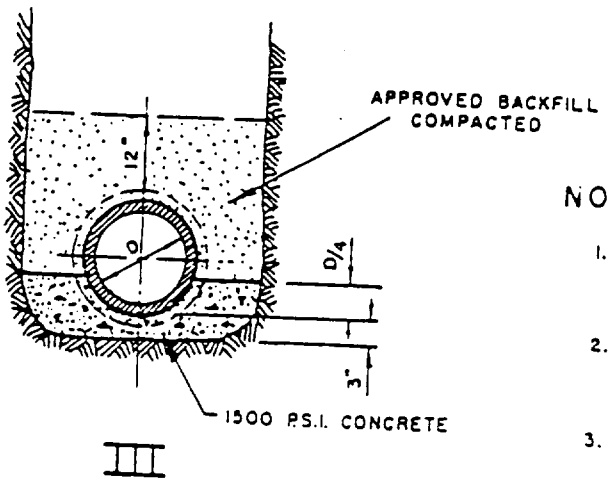
3. Install Cordrain sheet drainage material and geotextile fabrics in accordance with the manufacturer's recommendations.

4. Locate sections of dike seepage collection drains where instructed by the Owner.



EXCAVATION FOR BELLS



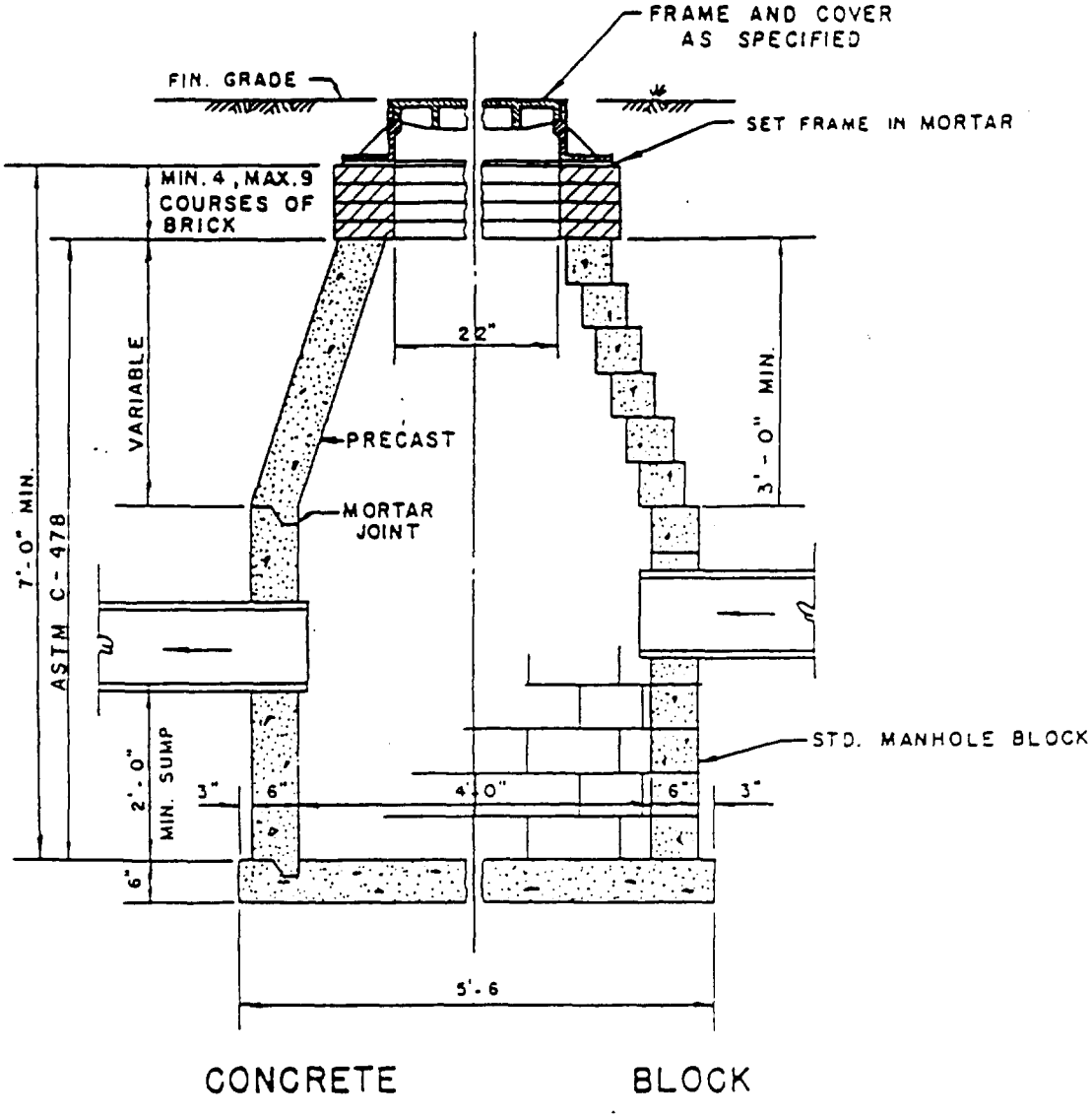


NOTES–

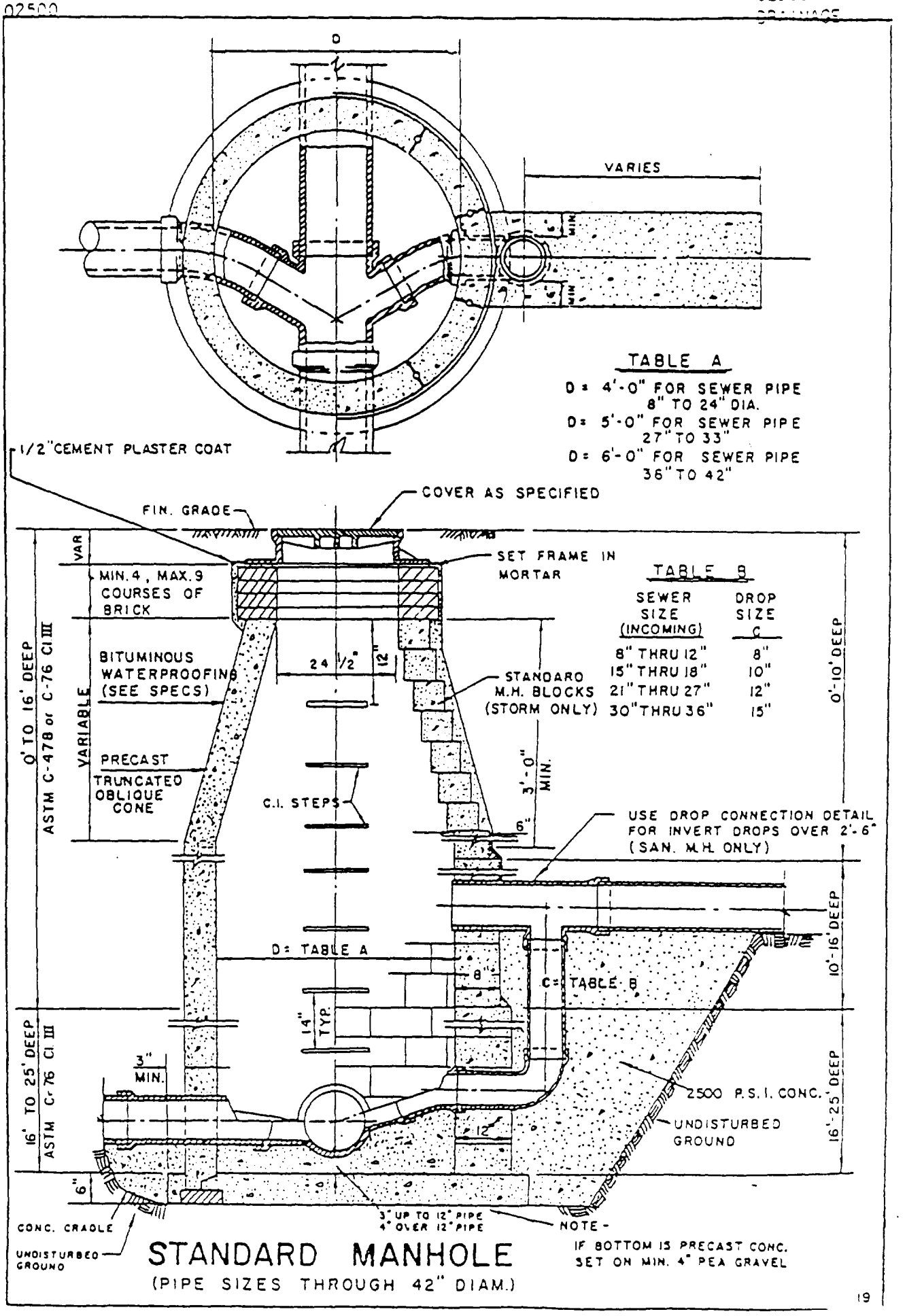
1. METHOD I SHALL BE USED IN AREAS OF UNCONSOLIDATED SOILS. (SAND, GRAVEL & ETC.)
2. METHOD II SHALL BE USED IN AREAS OF CONSOLIDATED SOILS. (CLAY HARDPAN, ROCK & ETC.)
3. METHOD III - CONCRETE BEDDING IN AREAS AS NOTED ON PLANS.

ALL BACKFILL INDICATED SHALL BE HAND COMPACTED TO 95% OF MAXIMUM DENSITY.

METHODS OF LAYING SEWER PIPE

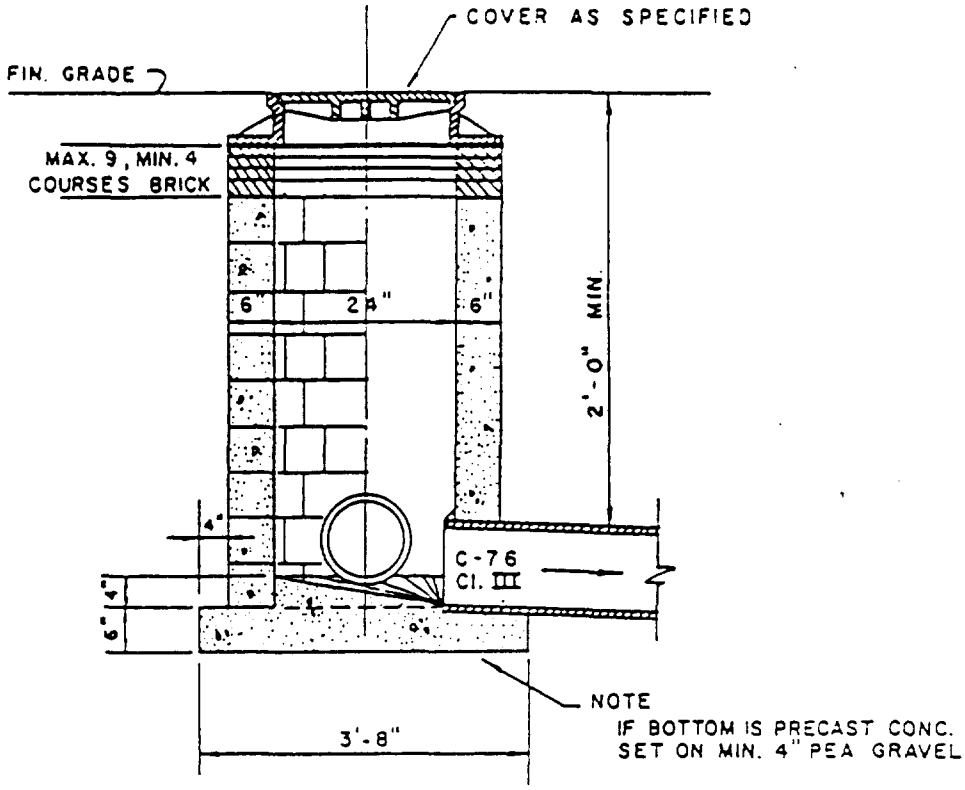


STANDARD CATCH BASIN

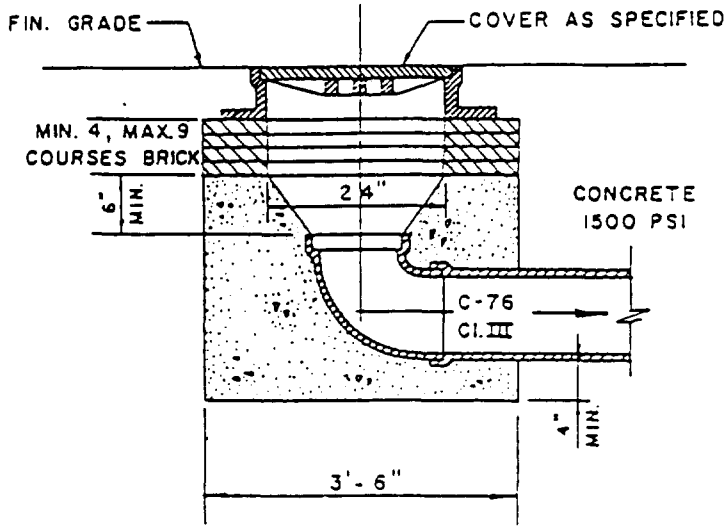


STANDARD MANHOLE

(PIPE SIZES THROUGH 42" DIAM.)



2' DIA. INLET



CURB INLET

STANDARD INLETS

PART 1 - GENERAL

1.01 Description

The work includes all chain link fencing and gates, including fabric, line posts, corner posts, gate posts, tension wire, braces, barbed wire, offset brackets, concrete for post encasement attachments, and all related items. The Owner has awarded a contract to install 2580± linear feet of chain link fence plus two 16-foot double swing gates on the east side of the site. This work is, therefore, excluded from the work under this Contract.

1.02 Submittals

Provide shop drawings for all fencing materials.

PART 2 - PRODUCTS

2.01 Materials

A. Fabric

Two inch mesh fabricated from 9 gage wire, 72 inches high; ASTM A392, Class II zinc coated or ASTM A491 aluminum coated steel.

B. Fasteners

Metal bands or 9 gage steel wire galvanized in accordance with ASTM A641 Class III coating or aluminum.

C. Line posts

Nominal 2-5/8 inch O.D. Schedule 40 steel pipe weighing 3.65 pounds per foot, galvanized. Place posts 10'-0" c/c maximum.

D. End and Corner Posts

Schedule 40 galvanized steel pipe, 2-7/8 inch O.D., 5.79 pounds per lineal foot.

E. Braces

Provide horizontal braces of 1-5/8 inch O.D. Schedule 40 galvanized steel pipe, connect to corner and gate posts with suitable metal connections. Provide horizontal braces at mid-point of fabric. Provide diagonal brace rod from end of horizontal brace back to end, corner and gate posts, complete with turnbuckle. Provide bottom tension wire, 7 gage galvanized or aluminum coated steel.

PART 2 - PRODUCTS

F. Top Rail

One and five eighths (1-5/8") inch O.D. Schedule 40 galvanized steel pipe with suitable metal connectors.

G. Gate posts

Gate posts shall be 4 inch Schedule 40 galvanized steel pipe, 2'-8" higher than the height of the fence fabric.

H. Gates

Gate shall be double swing, consisting of two (2) eight foot wide by six feet high sections. Gate frame shall be constructed of 2 inch O.D. Schedule 40 steel pipe of all welded construction. Furnish intermediate braces and truss rods of sufficient strength to prevent sagging. Furnish gate complete with approved hinges, latches, keepers and stops. Gate fabric shall be the same as fence fabric. Fit gate with extension arms and three rows of barbed wire same as fencing.

I. Foundations

Provide concrete encasement for all gate, corner and line posts. Encasement shall be twelve (12) inches in diameter for line posts, eighteen (18) inches in diameter for end, corner and gate posts, and extending six (6) inches below bottom of post.

J. Bottom extension

Provide extension to bottom of fabric at drainage swale. Fabric shall be same as fence fabric and extend downward to three (3) inch maximum above finish grade.

K. Provide No.7 gage tension wire having a coating meeting the requirements for Class II zinc coating, ASTM A392; or aluminum coated with not less than 0.40 ounces of aluminum per square foot of uncoated wire service; in accordance with ASTM A491.

PART 3 - EXECUTION

3.01 Performance

A. Posts

Set posts maximum 10'-0" c/c. Set line posts 2'-6" into the ground; set gate and corner posts 3'-6" into the ground.

PART 3 - EXECUTION

B. Braces

Brace each end, corner and gate post with one horizontal brace installed with diagonal brace rod and turnbuckle. Attach diagonal brace rod to end, corner or gate post at bottom of fabric.

C. Where fence line crosses drainage swales or other uneven areas, place fabric bottom extensions to close openings to within three (3) inches of final grade.

D. Installation of fencing gates and connection to existing fencing shall conform to IDOT Section 629.

E. The finished fence shall be substantially true to line, taut and solid. Surplus excavated material shall be leveled nearby on site. Other debris shall be removed from the site. Tire ruts shall be filled in leaving the site in a neat and workmanlike appearance.

PART 1 - GENERAL

1.01 Description

Work includes all cast-in-place concrete.

PART 2 - PRODUCTS

2.01 Materials

A. Concrete Mix: Standard weight
B. Reinforcing ASTM A615 or A616 Grade 60

PART 3 - EXECUTION

3.01 Performance

A. Standard Specifications

Concrete work shall conform to all requirements of the latest edition of ACI 301, "Specifications for Structural Concrete for Building", except as modified by the "Supplemental Requirements" below.

B. Supplemental Requirements

1. Chapter 1 - General
   a. Paragraph 1-4:
   The latest edition of all ASTM Standards shall apply.

2. Chapter 2 - Materials for Concrete

   a. Paragraph 2.2: calcium chloride shall not be used.
   b. Paragraph 2.4: delete reference to light weight aggregates.

3. Chapter 3 - Proportioning

   a. Paragraph 3.2: Concrete strengths; (1) 4000 psi-foundations; (2) 3000 psi - other.
   b. Paragraph 3.3: not applicable.
   c. Paragraph 3.4: Durability - All concrete exposed to Freeze-Thaw conditions shall contain 5% to 7% air entrainment.
   d. Paragraph 3.7: Calcium chloride shall not be used as an additive.

4. Chapter 4 - Form Work

   a. Earth cuts used as forms: not permitted.
   b. Interior corners of permanently exposed surfaces: beveling required only where indicated.

PART 3 - EXECUTION

c. Paragraph 4.1.4: shop drawings for form work not required.

5. Chapter 5 - Reinforcement

a. ASTM A615 or A616, Grace 60.
b. Welding of reinforcing: not permitted.

6. Chapter 6 - Joints and Embedded Items

a. Bonding joints: Paragraph 6.1.4.3 applies.
b. Premolded joint filler: ASTM D1752.

7. Chapter 10 - Finishing of Formed Surfaces

a. Fill all holes, cracks and other surface blemishes with grout to provide smooth, finished appearance.
b. Provide as Cast Finish for surfaces not exposed to view.
c. Provide smooth Form Finish, grout cleaned for surfaces exposed to view.

SECTION 05500 MISCELLANEOUS METALS

PART 1 - GENERAL

1.01 Description

Work includes furnishing and installation of miscellaneous metal work.

1.02 Submittals

Shop drawings are required for all grating-screens, closure plates and all support angles and channels.

PART 2 - PRODUCTS

2.01 Materials

A. Grating shall be constructed of 2-1/2" x 1/4" bearing bars spaced 1-3/16" c/c with rectangular cross bars, as manufactured by Dravo Corp., Reliance Steel Products Co. or equal.

B. Bar screens shall be constructed of 3" x 1/4" bars spaced 2" c/c set in 4" x 1-5/8" channel frame, of ASTM A-36 steel.

C. Grating support angles, pipe anchor straps, closure plates and other anchoring devices shall be constructed of ASTM A-36 steel.

D. All miscellaneous metal shall be hot dipped galvanized after fabrication.

PART 3 - EXECUTION

A. Grind smooth all welded, drilled or cut surfaces to remove all rough edges, burrs and sharp corners.

B. Coat any areas where galvanized surfaces are damaged with cold applied galvanizing.

SECTION 15400

PLUMBING

PART 1 - GENERAL

1.01 Description

Work includes furnishing and installing all pump suction piping including straight pipe, elbows, braced fittings, flange and butt sets and anchorage items.

1.02 Submittals

Submit shop drawings for all items.

PART 2 - PRODUCTS

2.01 Materials

A. Pipe: Ductile Iron ANSI A21.51.

B. Fittings: Ductile Iron ANSI A21.10.

C. Companion flanges: ANSI A21-15 flat faced threaded.

D. Nuts and Bolts: ASTM A307 Grade B with 1/8" to 3/8" projection after makeup.

E. Gaskets: ASTM D1330 Grade 1, red rubber, full face type, 1/8" thick.

F. Conduit, wiring and supports: as required for relocation of pump controls.

PART 3 - EXECUTION

3.01 PERFORMANCE

1. Install new pump suction piping in accordance with approved shop drawings.

2. Verify all proposed pipe measurements affected by existing piping by field measurements before preparing shop drawings or fabrication of piping.

3. Remove existing suction elbows.

4. Coordinate all the changes in existing conditions during installation of new piping with the Owner to avoid interference with the Owner's on-going operations.

5. Relocate existing pump control devices to control pumps at new high and low water levels shown on the Drawings.

APPENDIX B-A

OF

ATTACHMENT B

Previous Boring and Well Logs

KMA
• ENGINEERS • CONSULTANTS • PLANNERS •
KUMAR MALHOTRA & ASSOCIATES, INC
3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

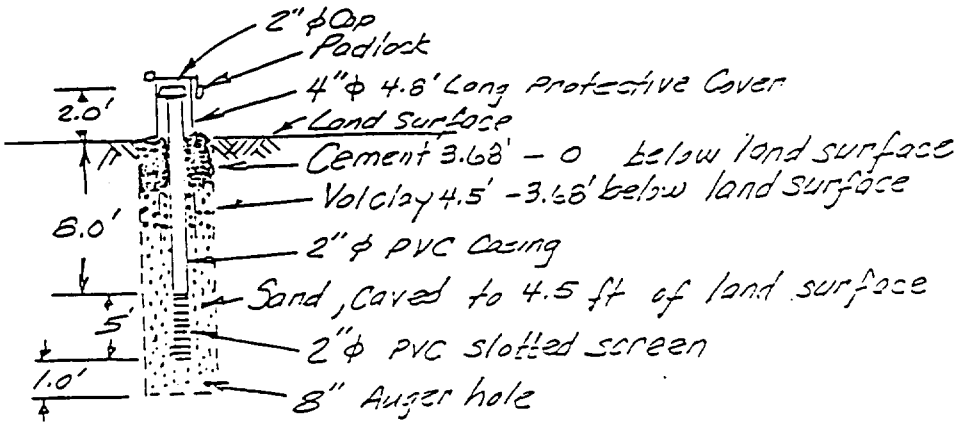
Project No. 894-3224
Well File No.
Owner's Well No. 1
Client Johns-Manville
Date Sept. 19. 1984
2:15-4:05 pm

RECORD OF WELL

1. LOCATION: State Illinois County: Lake Township: Benton
   Distances Grid: 7,526.322 North ; SE ¼ SW ¼ SE ¼ Sec. 10 T. 45 N. R. 12 E.
   11,804.300 East
2. OWNER John-Manville Address Waukegan, Illinois
   CONTRACTOR American Geotechnical* Address Novi, Michigan
3. ELEVATION of top of well: 591.16 ft. (above, the level of: mean sea level Reprd.)
4. TYPE of well: Monitoring Date Constructed Sept 19, 84 Driller R&R Near
5. DEPTH of well: 13.0 ft. meas Depth to bedrock ____ ft. Formation ____
6. DIAMETER: 2 in.
   CASING: kind PVC ; size 2 ; length 10.0 ft. between +2.0 & 8.0 ft.
   kind ____ ; size ____ ; length ____ ft. between ____ & ____ ft.
   SCREEN: make and material PVC slotted ; length 5.0 ft.; Dia. 2 in.
   size of openings 8 slot depth to (packer or top of slots) ____ ft.
7. WATER LEVEL: 6.35 ft. (below) Top of Casing Meas'd. ; Sept.19,1984
8. PUMP: make and serial number ____ Cap. ____ gpm @ ____ ft. (head)
   power ____; motor h.p. ____; length of column & shaft ____ ft. dia. of column & shaft ____ in.
   bowls ____ ft.; ____ stages; tail pipe ____ ft.; strainer ____; lubrication ____
9. YIELD: original yield ____; pumped ____ gpm for ____ hours with ____ drawdown
10. LOG and REMARKS: * Hydrogeologic Engineering, Inc.

0	- 2'	Sand, fine
2	- 4'	Cinders, pipe fragments
4	- 14'	Sand, fine to med., black cleaning to tan with depth

Pumped 108 gallons of water during development



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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

Project No. S94-3224
Well File No.
Owner's Well No. 2
Client Johns-Manville
Date Sept 19, 1984
8:00-9:08 am

RECORD OF WELL

1. LOCATION: State Illinois County: Lake Township: Benton

Distances Grid: 7,629.600 North, SW ¼ SW ¼ SW ¼ Sec. 11 T. 45 N R. 12 E
13,257.249 East

2. OWNER Johns-Manville Address Waukegan, Illinois
CONTRACTOR American Geotechnical* Address Novi, Michigan

3. ELEVATION of top of well: 587.88 ft. (above, the level of: mean sea level Repr'd.)

4. TYPE of well: Monitoring Date Constructed Sept 19, 8' Driller R&R Near

5. DEPTH of well: 13.0 ft. meas. Depth to bedrock ____ ft. Formation ____

6. DIAMETER: 2 in.

CASING: kind PVC ; size 2 ; length 10.0 ft. between +2 & 8 ft.
kind ____ ; size ____ ; length ____ ft. between ____ & ____ ft.

SCREEN: make and material PVC slotted ; length 5.0 ft.; Dia. 2 in.
size of openings 8 slot ; depth to (packer or top of slots) ____ ft.

7. WATER LEVEL: 5.66 ft. (above, below) Top of Casing Repr'd. Sept 19, 1984

8. PUMP: make and serial number ____ Cap ____ gpm @ ____ ft. (head)
power ____ ; motor h.p. ____ ; length of column & shaft ____ ft. dia. of column & shaft ____ in.
bowls ____ ft.; ____ stages; tail pipe ____ ft.; strainer ____ ; lubrication ____

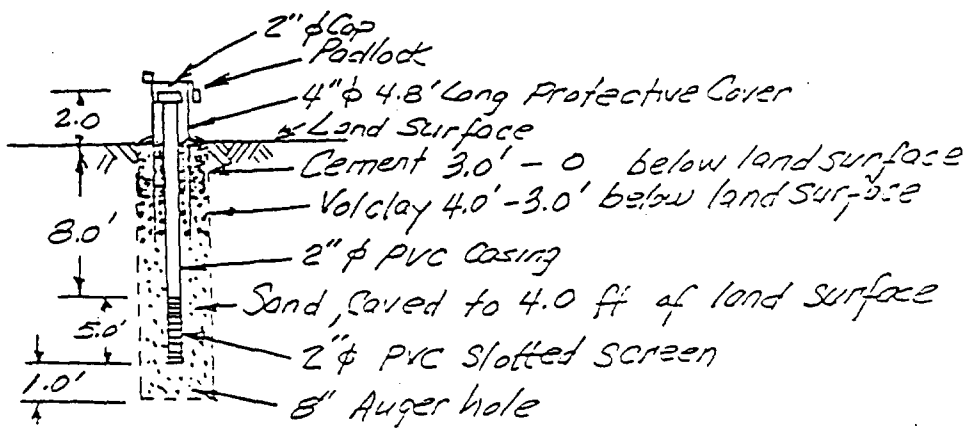
9. YIELD: original yield ____ ; pumped ____ gpm for ____ hours with ____ drawdown

10. LOG and REMARKS: * & Hydrogeologic Engineers, Inc.

0 - 2.5' Sand, fine to coares, gravelly, beach cobbles

2.5 - 14' Sand, fine to med., gravelly, waterbearing

Pumped 105 gallons of water during development



Y

KMA

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

Project No. S94-3224
Well File No.
Owner's Well No. 3
Client Johns-Manville
Date Sept. 19, 1984
9:15-10:20 am

RECORD OF WELL

1. LOCATION: State Illinois County: Lake Township: Benton

   Distances Grid: 8,604.949 North SW ¼ NW ¼ SW ¼ Sec. 11 T. 45 N R. 12 E
   13,276.405 East

2. OWNER Johns-Manville Address Waukegan, Illinois
   CONTRACTOR American Geotechnical * Address Novi, Michigan

3. ELEVATION of top of well: 588.92 ft. (, below) the level of: mean sea level Rep'd.)

4. TYPE of well: Monitoring Date Constructed Sept19,84 Driller R&R Near

5. DEPTH of well: 13.0 ft. meas Depth to bedrock ft. Formation

6. DIAMETER: 2 in.

   CASING: kind PVC ; size 2 ; length 10 ft. between +2.0 & 8.0 ft.
   kind ; size ; length ft. between & ft.

   SCREEN: make and material PVC slotted ; length 5.0 ft.; Dia. 2 in.
   size of openings 8 slot ; depth to (packer or top of slot) ft.

7. WATER LEVEL: 6.28 ft. below) Top of casing Meas'd. Sept 19, 1984

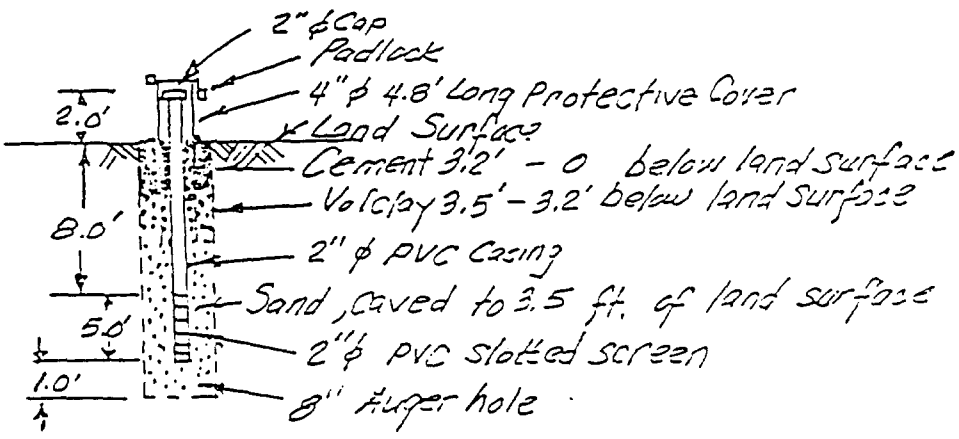
8. PUMP: make and serial number Cap gpm @ ft. (head)
   power ; motor h.p ; length of column & shaft ft. dia. of column & shaft in.
   bowls ft.; stages; tail pipe ft.; strainer ; lubrication

9. YIELD: original yield ; pumped gpm for hours with drawdown

10. LOG and REMARKS: * Hydrogeologic Engineers, Inc.

    0 - 3' Sand , fine to coarse, gravelly, fine
    3 - 14' Sand, fine to coarse, gravelly, fine, waterbearing

    Pumped 120 gallons of water during development



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KUMAR MALHOTRA & ASSOCIATES, INC.

3070 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

Project No. S94-3221
Well File No.
Owner's Well No. 4
Client Johns-Manville
Date Sept 18, 1984
12:50-2:07 pm

RECORD OF WELL

1. LOCATION: State Illinois County: Lake Township: Benton

   Distances Grid: 9,757.456 North NW ¼ NW ¼ SE ¼ Sec. 11 T. 45 N R. 12 E
   13,271.289 East

2. OWNER Johns-Manville Address Waukegan, Illinois

   CONTRACTOR American Geotechnical & * Address Novi, Michigan

3. ELEVATION of top of well: 587.20 ft. (above, the level of mean sea level(Rep'd.)

4. TYPE of well: Monitoring Date Constructed Sept 19, 84 Driller R&R Near

5. DEPTH of well: 13.0 ft. meas Depth to bedrock ft. Formation

6. DIAMETER: 2 in.

   CASING: kind PVC ; size 2 ; length 10 ft. between +2.0 & 8.0 ft.

   kind ; size ; length ft. between & ft.

   SCREEN: make and material PVC slotted ; length 5.0 ft.; Dia. 2 in.

   size of openings 8 slot depth to (packer or top of slots) ft.

7. WATER LEVEL: 4.58 ft. (below) Top of casing Meas'd. Sept 19, 1984

8. PUMP: make and serial number Cap gpm @ ft. (head)

   power ; motor h.p. ; length of column & shaft ft. dia. of column & shaft in.

   bowls ft.; stages; tail pipe ft.; strainer ; lubrication

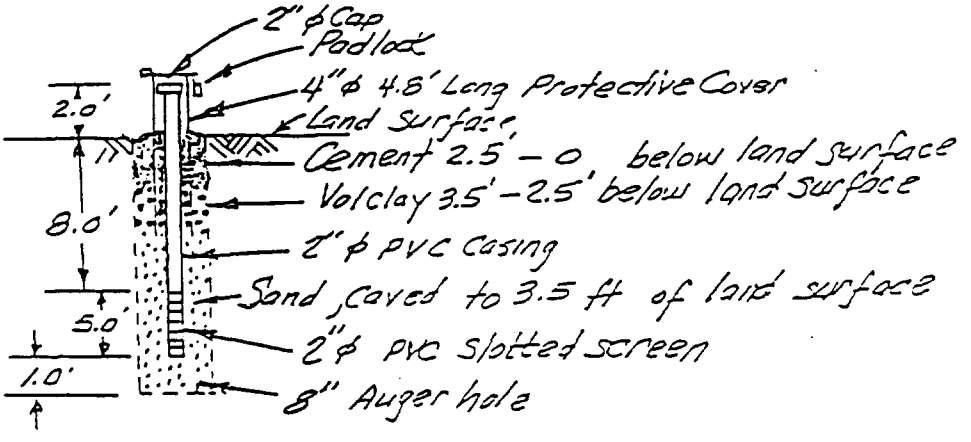
9. YIELD: original yield ; pumped gpm for hours with drawdown

10. LOG and REMARKS: * Hydrogeologic Engineers, Inc.

    0 - 3' Sand, fine to coarse, gravelly

    3 - 14' Sand, fine to coarse, waterbearing

    Pumped 90 gallons of water during development



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3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

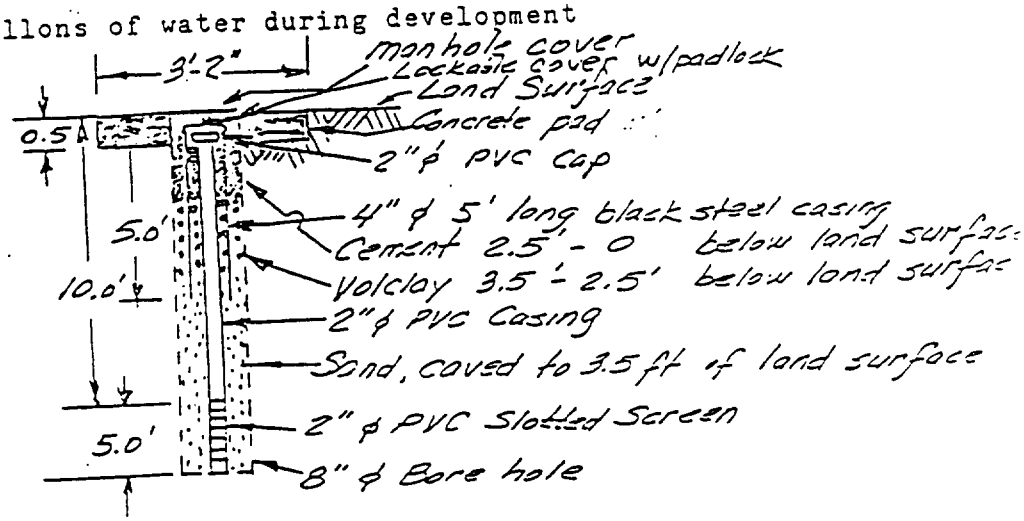
Project No. _____
Well File No. _____
Owner's Well No. 5
Client Johns-Manville
Date Sept 19, 1984
2:45-5:00 pm

RECORD OF WELL

1. LOCATION: State Illinois County: Lake Township: Benton
   Distances Grid: 8,869.430 North SE ¼ NW ¼ SW ¼ Sec 10 T 45 N R 12 E
   8,463.178 East
2. OWNER Johns-Manville Address Waukegan, Illinois
   CONTRACTOR American Geotechnical & * Address Novi, Michigan
3. ELEVATION of top of well: 588.00 ft. (above, the level of: mean sea level Reprd.)
4. TYPE of well: Monitoring Date Constructed Sept 19, 84 Driller R&R Near
5. DEPTH of well: 15.0 ft. meas. Depth to bedrock _____ ft. Formation _____
6. DIAMETER: 2 in.
   CASING: kind PVC ; size 2 ; length 10 ft. between 0 & 10 ft.
   kind _____ ; size _____ ; length _____ ft. between _____ & _____ ft.
   SCREEN: make and material PVC slotted ; length 5.0 ft.; Dia 2 in.
   size of openings 8 slot depth to (packer or top of slot) _____ ft.
7. WATER LEVEL: 4.71 ft. (above, below) Top of casing Meas'd. Sept 19, 1984
8. PUMP: make and serial number _____ Cap _____ gpm @ _____ ft. (head)
   power _____; motor h.p. _____; length of column & shaft _____ ft. dia. of column & shaft _____ in.
   bowls _____ ft.; _____ stages; tail pipe _____ ft.; strainer _____; lubrication _____
9. YIELD: original yield _____; pumped _____ gpm for _____ hours with _____ drawdown
10. LOG and REMARKS: * Hydrogeologic Engineers, Inc.

0 - 4' Cinders
4 - 5' Sand, fine, tan
5 - 15" Sand, fine to med., tan, waterbearing

Pumped 90 gallons of water during development



SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 11, 1984 (1:47-5:30p

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East 8-Mile Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill.

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 1

SURFACE ELEV. 613.0'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 8,103.645 North
11, 407.718 East

BORING DEPTH (Ft.) FROM	TO		DEPTH OF TEST	NO. BLOWS 1st 6"	NO. BLOWS 2nd 6"	NO. BLOWS 3rd 6"	NO. BLOWS LAST 12"
0	9.0	Sludge, fiber	1.5	1	1	1	2
9.0	26.5	Sludge, fiber, moist	3.0	←	1	→	1
26.5	30.5	Sand, black tar like with some stones and	4.5	←	1	→	1
		service board	6.0	←	1	→	1
			7.5	←	1	→	1
			9.0	←	1	→	1
			11.5	←	1	→	1
			14.0	←	1	→	1
			16.5	←	1	→	1
			19.0	←	1	→	1
			21.5	←	2	→	2
			24.0	pushed			
			26.5	6	10	14	24
			29.0	5	2	2	4
			31.5	←	1	→	1

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 25.66 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 12, 1984(9:30-11:20a

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CMa 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 2

SURFACE ELEV. 615.2'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 8,102.959 North
12,059.802 East

BORING DEPTH (ft.) FROM	TO		DEPTH OF TEST	NO. BLOWS 1st 6"	NO. BLOWS 2nd 6"	NO. BLOWS 3rd 6"	NO. BLOWS LAST 12"
0	16.5	Sludge.	0	1	2	1	3
16.5	19.0	Sand, fine, shingle sand, moist	1.5	1	2	2	4
19.0	26.5	Sludge, moist	4.0	—	2	—	2
26.5	28.0	Sludge with 2" layer of shingle sand	6.5	—	1	—	1
28.0	31.5	Sludge	9.0	—	2	—	2
31.5	34.0	Sludge, marl, sand, layered	11.5	—	1	—	1
34.0	35.5	Sand & gravel layers, black	14.0	—	1	—	1
			16.5	2	4	2	6
			19	—	1	—	1
			21.5	1	1	1	2
			24	—	2	—	2
			26.5	7	9	9	18
			29	7	9	14	23
			31.5	6	2	2	4
			34	6	20	42	62

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 27.16 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE / Time Sept 17, 1984 (8:30-11:05am

PERMIT NO. ____

PROJECT Johns-Manville, Waukegon, Ill

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 3

SURFACE ELEV. 589.4'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 7,522.115 North
12,110.323 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	2.5	Road gravel, cinders	0	4	8	10	18
2.5	5.0	Sand, fine to med., black, waterbearing	4	4	7	8	15
5.0	9.0	Sand, fine to med., tan, waterbearing	9	27	25	24	49
9.0	14.0	Sand fine to med. & gravel, fine to med., waterbearing	14	5	8	16	24
14.0	37.0	Sand, fine to med., waterbearing					
37.0	39.5	Sand, fine to very fine, silty, waterbearing					
39.5	40.0	Clay, occ. stone, gray					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 1.5 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 12, 1984(1:30-4:30pm

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 4

SURFACE ELEV. 595.2'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 8,027.120 North
12,825.040 East

BORING DEPTH (Ft) FROM	TO		DEPTH OF TEST	NO. BLOWS 1st 6"	NO. BLOWS 2nd 6"	NO. BLOWS 3rd 6"	NO. BLOWS LAST 12"
0	9.0	Sludge, brich, concrete (6.5-9.0 moist)	0	4	8	8	16
9.0	13.0	Wood	1.5	2	3	4	7
13.0	15.5	Sand, fine, black, waterbearing	4.0	1	1	2	3
			6.5		1		1
			9.0	25	67	47	1[illegible]
			11.5	92	68	170	2
			14	6	4	3	7

GROUNDWATER:

ENCOUNTERED AT ____ FT.

AFTER COMPLETION ____ FT.

AFTER ____ HRS ____ FT.

BORING CAVE IN 8.0 FT.

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

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• ENGINEERS • CONSULTANTS • PLANNERS •
KUMAR MALHOTRA & ASSOCIATES INC.
3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 17,1984(2:00-3:15pm)

PERMIT NO. ____

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 5

SURFACE ELEV. 587.2'

HOLE PLUGGED WITH Bentonite

BORING LOCATION

Grid: 8,766.143 North
13,313.880 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	1.5	Sand, fine, beach	0	1	3	6	9
1.5	3.0	Sand, fine, beach, cobbls & gravel	4	4	7	4	11
3.0	12.0	Sand, fine, beach, cobbles & gravel, waterbearing					
12.0	13.0	Sand, fine to med., occ stone, waterbearing					
13.0	15.0	Sand, fine to med.& gravel, fine to med.,cobbles waterbearing					
15.0	30.0	Sand, fine to med., gravelly, fine, waterbearing					
30.0	38.5	Sand, fine to very fine					
38.5	40.0	Clay, gray, occ. fine stone					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 1.5 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE / Time Sept 13, 1984 (3:00-4:30pm)

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 6

SURFACE ELEV. 613.0'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 9,144.640 North
10,696.141 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	2.0	Ash, shingles, brick, stones	0	3	15	14	29
2.0	9.0	Cinders & shingles layers	1.5	3	7	4	11
9.0	10.5	Wood & voids, water	4	2	2	2	6
10.5	14.0	Sludge, gray & reddish layers	6.5	←	1	→	1
14.0	19.0	Cinders & sludge, layered	0	10	4	1	5
19.0	24.0	Sludge, water (very little soil retention in spoon)					
24.0	25.5	Sand, fine, color lightening with depth from	11.5	←	1	→	1
		black to tan	14	←	1	→	5
			16.5	22	37	10	[illegible]
			19	1	1	3	[illegible]
			21.5	←	0	→	[illegible]
			24	1	3	10	11

GROUNDWATER:

ENCOUNTERED AT 7.8 FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 8.0 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT. ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

KMA

• ENGINEERS • CONSULTANTS • PLANNERS •

KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 14,1984(8:30-11:00am

PERMIT NO. ____

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 7

SURFACE ELEV. 615.6'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 9,550.905 North
10,132.841 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	11.0	Cinders, shingles, sludge	0	6	8	7	15
11.0	14.0	Sludge with shingles and cinders	1.5	5	4	3	7
14.0	16.5	Sludge with shingles and cinders, wet	4	1	1	3	4
16.5	27.8	Sludge	6.5	14	22	23	45
27.8	30.5	Sand, fine black, color turning to red brown	9	8	32	25	58
		in the 29 ft. split-spoon	11	5 6	3	1	4
			14		1		1
			6.5		1		1
			10	0	2	2	4
			11.5	1	1	1	2
			24	1	1	1	2
			16.5	1	1	2	3
			29	14	23	45	68

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT

BORING CAVE IN 5 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. 89/-3224

DATE /Time Sept 17, 1984(4:05-5:40pm

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill.

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 8

SURFACE ELEV. 582.5'

HOLE PLUGGED WITH Natural Soils

BORING LOCATION

Grid: 10,159.369 North
10,173.709 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	0.5	Sand, fine, moist, occ. stone	0	2	2	3	5
0.5	26.0	Sand, fine to med., waterbearing	4	7	11	18	29
26.0	33.0	Clay, occ. fine stone, gray					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 0.5 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 13,1984(8:15-10:10 a

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 9

SURFACE ELEV. 612.9'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 8,358.081 North
11,002.337 East

BORING DEPTH (Ft.) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	14.0	Sludge.	0	1	1	1	2
14.0	20.0	Sludge, moist with wet lense like areas	1.5	←	1	—	1
20.0	22.8	Gravel, fine to med., fill	4	←	2	→	2
22.8	23.0	Shingles	6.5	←	2	—	2
23.0	29.0	Shingles, gravel, sludge	9	←	1	—	1
29.0	30.5	Sand, fine, black, waterbearing	11.5	←	1	—	1
			14	←	1	→	1
			16.5	←	2	→	2
			19	1	1	3	3
			11.5	3	7	10	17
			24	13	14	24	38
			26.5	3	6	10	16
			29	3	5	7	12

GROUNDWATER:

ENCOUNTERED AT ____ FT.

AFTER COMPLETION ____ FT.

AFTER ____ HRS ____ FT.

BORING CAVE IN 8.0 FT.

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept. 18, 1984/8:25-9:45am

PERMIT NO. ____

PROJECT Johns-Manville, Waukegan, Ill

LOCATION See Map

EQUIPMENT CME 45 6" augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 10

SURFACE ELEV. 588.4'

HOLE PLUGGED WITH Cement & Bentonite

BORING LOCATION

Grid: 8,866.236 North
8,453.392 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	0.8	Topsoil, cinders	0	1	2	4	6
0.8	5.0	Sand, fine, tan, dry	4	4	5	5	10
5.0	22.0	Sand, fine to med., tan, waterbearing	9	1	1	2	3
22.0	25.0	Sand, fine, waterbearing					
25.0	34.0	Clay, gray, occ. fine stone					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 3.6 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 19, 1984 (12:05-12:25

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC.

3070 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill.

LOCATION 85ft. S & 33ft. W of the NE fence corner of the "north 40"

EQUIPMENT CME 45 6" augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 11

SURFACE ELEV. 584.4'

HOLE PLUGGED WITH Natural Soils

BORING LOCATION

Grid: 11,230.498 North
10,309.609 East

BORING DEPTH (ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	2.0	Sand, fine to med., occ. fine stone with trace of topsoil	.5	7	12	12	24
			4	7	13	16	29
2.0	4.0	Sand, fine to coarse & gravel, fine, waterbearing					
4.0	5.5	Sand, fine to med., occ. fine stone. waterbearing					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 2.0 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Beltline N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE / Time Sept 19, 1984 (12:35-12:55)

PERMIT NO. ____

PROJECT Johns-Manville, Waukegan, Ill.

LOCATION 185 ft E & 30 ft S of the NW fence corner of the "north 40"

EQUIPMENT CME 45 6" Hs augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 12

SURFACE ELEV. 586.3'

HOLE PLUGGED WITH Natural Soils

BORING LOCATION

Grid; 11,286.558 North
8,927.484 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	0.5	Topsoil	1.5	4	4	7	11
0.5	3.0	Sand, fine	4	7	8	10	13
3.0	5.5	Sand, fine, waterbearing					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 3.0 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

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KUMAR MALHOTRA & ASSOCIATES, INC.

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 19, 1984 (1:00-1:15pm)

PERMIT NO. ____

PROJECT Johns-Manville, Waukegan, Ill.

LOCATION 15 ft N & 10 ft W of the NW corner of the pond in "north 70"

EQUIPMENT CME 45 6" HS augers

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 13

SURFACE ELEV. 585.8'

HOLE PLUGGED WITH Natural Soils

BORING LOCATION

Grid: 10,353.410 North
8,659.999 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	1.0	Cinders	.5	5	8	9	17
1.0	2.5	Sand, fine to med., waterbearing	4	5	7	13	20

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 2.5 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT. ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

SHEET ____ OF ____

CLIENT Johns-Manville

PROJECT NO. S94-3224

DATE /Time Sept 19,1984(1:45-1:50pm

PERMIT NO. ____

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KUMAR MALHOTRA & ASSOCIATES, INC

3000 East Bell Line N.E.
Grand Rapids, Michigan 49505
Telephone (616) 361-5092

PROJECT Johns-Manville, Waukegan, Ill.

LOCATION 123 ft N & 15 ft W of the NE corner of the pond in the "N 40"

EQUIPMENT Hand auger

TECHNICIAN Larry Austin & Herman DeLano

BORING NO. 14

SURFACE ELEV. 583.0'

HOLE PLUGGED WITH Natural Soils

BORING LOCATION

Grid: 10,562.279 North
9,750.761 East

BORING DEPTH (Ft) FROM	TO		NO. BLOWS LAST 12"	NO. BLOWS 3rd 6"	NO. BLOWS 2nd 6"	NO. BLOWS 1st 6"	DEPTH OF TEST
0	1.3	Sand, fine, moist					
1.3	1.5	Sand, fine, waterbearing					

GROUNDWATER:

ENCOUNTERED AT ____ FT

AFTER COMPLETION ____ FT

AFTER ____ HRS ____ FT.

BORING CAVE IN 1.3 FT

WELL DATA:

CASING USED: TYPE ____

DIAMETER ____

LENGTH ____

SCREEN LENGTH & SLOT SIZE ____

HT ABOVE GROUND ____

SOIL BORING/WELL LOG DATA SHEET

FORMAT

FOR

COMPLIANCE CERTIFICATE

FOR

HEALTH AND SAFETY TRAINING AND

MEDICAL MONITORING

EMPLOYER CERTIFICATION OF HEALTH AND SAFETY
TRAINING AND MEDICAL MONITORING

Date _____

Mr. George Davis
Construction Manager
Johns-Manville Disposal Area Remediation
Waukegan, Illinois

Dear Mr. Davis:

The following individuals are scheduled to participate in field activities at the site from _____ to _____.

Name	Anticipated Workdays with Respirator

All of these individuals are in compliance with the following health and safety protocols or equivalent as prescribed in 29 CFR 1910, Dec. 19, 1986:

- Have received a minimum of forty (40) hours of instruction related to work at hazardous waste sites.
- Have received a minimum of three (3) days of actual on-site field experience under the direct supervision of an experienced supervisor.
- Receive eight (8) hours of refresher training annually.
- Have completed an initial physical examination and are participating in a medical monitoring program.
- Have been medically certified fit to wear respiratory equipment.
- Have been fit-tested with respiratory equipment they will be using in the field.

_____
Employer Signature

Name _____

Title _____

APPENDIX C

PARTIAL IDOT SPECIFICATIONS

Standard Specifications for Road and Bridge Construction

Adopted July 1, 1988

Price: $10.00

Illinois Department of Transportation

SECTION 601. RIPRAP

601.01 **Description.** This item shall consist of furnishing, transporting and placing a protective course of stone, broken concrete or precast concrete blocks laid as riprap for erosion protection, sediment control or rockfill on slopes or in channels.

601.02 **Materials.** Materials shall meet the requirements of the following Articles of Section 700 - Materials.

	Item	Article
(a)	Stone for erosion protection, sediment control and rockfill	705.01
(b)	Concrete Blocks and Broken Concrete for Riprap	705.02

CONSTRUCTION REQUIREMENTS

601.03 **Foundation Preparation.** The bed for the riprap shall be trimmed and shaped to allow the finished surface to conform to the lines specified. At the toe of the slope, the riprap shall commence on a continuation of the slope after excavation to accommodate the full depth of fabric, bedding layer, and riprap specified.

601.04 **Placing.** After the Engineer has approved the foundation preparation a layer of filter fabric shall be installed. Installation of the filter fabric will be required under gradations RR4, RR5, RR6 and RR7. The fabric shall be installed in accordance with the plans. A bedding layer will be required for stone riprap. No bedding is required for concrete block riprap, broken concrete riprap or for stone or broken concretge dumped riprap, unless specified.

(a) Stone Riprap. Bedding material shall be spread uniformly on the filter fabric in a satisfactory manner, to the neat lines specified. Placing of material by methods which will tend to segregate particle sizes within the bedding will not be permitted. Any damage to the surface of the bedding base or the filter fabric during placing of the bedding shall be repaired before proceeding with the work. Compaction of the bedding layers will not be required but it shall be finished to present a reasonably even surface free from mounds, windrows, or depressions.

Thickness of the stone riprap layer shall be according to the following table:

Gradation	Min. Thickness	Bedding Thickness
RR1 & RR2	6 inches	-
RR3	8 inches	-
RR4	16 inches	6 inches
RR5	22 inches	8 inches
RR6	26 inches	10 inches
RR7	30 inches	12 inches

Stone shall be placed on the bedding layer in such manner as to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids providing maximum interlocking of stones and shall be constructed to the lines and grades shown.

The riprap shall not be placed or dropped from a height of more than one foot. The stone riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the bedding material. Placing of material shall begin at the lower elevations, progressing up the slope and, from the center outward, unless otherwise determined by the Engineer. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified. There shall be no abrupt changes in the riprap surface. All tapers between minimum thickness and any high points shall be at a uniform rate. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing or by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above.

(b) Concrete Block Riprap. Concrete blocks shall be laid with the joints approximately perpendicular to the slope. The individual blocks in each horizontal course shall be placed by hand so that they will break joints with the blocks in the course below. Each tenth course shall be embedded into the slope with the long dimension of the blocks perpendicular to the slope.

(c) Broken Concrete Riprap. The individual pieces of broken concrete shall be placed by hand, flat upon the

slope. The pieces shall be laid with close joints, the larger pieces being placed in the lower courses. Any open joints shall be filled with spalls thoroughly rammed into place. The finished surface of the riprap shall present an even, close surface, true to the lines, grades and sections given.

(d) Stone or Broken Concrete Dumped Riprap. The dumped riprap shall be a minimum of 12 inches thick, unless otherwise specified. Placement shall begin at the lower elevations and progress up the slope. Dumped riprap of stone or broken concrete, as specified, shall be placed on slopes or in channels by mechanical means. End dumping of material using mechanical equipment will be permitted, provided the larger stone or pieces of broken concrete are well distributed, and the entire mass, in final position, is roughly graded to conform to the gradation specified. Placement by dumping into chutes or other methods likely to cause segregation will not be permitted.

The finished riprap shall be reasonably free from objectionable pockets of small pieces and clumps of large pieces, and the surface shall be shaped to follow the grade of the slope or channel. Rearranging of the dumped stone or broken concrete by mechanical equipment or by hand will be required only to the extent necessary to remove objectionable pockets or clumps of small or large material, and to obtain a surface reasonably true to line and grade.

601.05 **Disposal of Surplus Material.** Surplus or waste material resulting from the riprap operations shall be disposed of by the Contractor, at his own expense, in accordance with Article 202.03.

601.06 **Method of Measurement.** Riprap will be measured in place, and the area computed in square yards. The area for measurement will include the upper sloped surface of the riprap and upper horizontal surface of the toe anchor.

601.07 **Basis of Payment.** This work will be paid for at the contract unit price per square yard for STONE RIPRAP of the class specified, CONCRETE BLOCK RIPRAP, BROKEN CONCRETE RIPRAP, STONE DUMPED RIPRAP or BROKEN CONCRETE DUMPED RIPRAP of the class specified, measured as specified herein.

Excavation and aggregate bedding will not be paid for as a separate item but the cost shall be considered incidental to the cost of the riprap.

SECTION 602. CORRUGATED STRUCTURAL PLATE DRAINAGE STRUCTURES

602.01 **Description.** This work shall consist of furnishing and installing corrugated structural plate pipe culverts,

The work shall be performed in a manner approved by the Engineer of the municipality, or the Water District.

641.02 **Basis of Payment.** This work will be paid for at the contract unit price each for DOMESTIC METER VAULTS TO BE MOVED or DOMESTIC WATER SERVICE BOXES TO BE MOVED, which price shall be payment in full for all excavation; furnishing all materials, except any necessary pipe; wiping joints; backfilling, including fine aggregate; and disposal of surplus materials.

SECTION 642. SEEDING

642.01 **Description.** This work shall consist of preparing the seed bed, and furnishing, transporting and placing the seed and other materials required in the seeding operations on the shoulders, slopes and other areas.

642.02 **Materials.** Materials shall meet the requirements of the following Articles of Section 700 - Materials:

	Item	Article
(a)	Seeds	717.03
(b)	Agricultural Ground Limestone	717.06
(c)	Fertilizer	717.07

642.03 **Equipment.** Equipment shall meet the requirements of the following Articles of Section 800 - Equipment:

	Item	Article
(a)	Disk	801.08(a)
(b)	Slope Harrow	801.08(b)
(c)	Hydraulic Seeder	801.08(c)
(d)	Cultipacker	801.08(d)
(e)	Spinning Disk Seeders	801.08(e)
(f)	Tractor Drawn or Mounted Seeders	801.08(f)
(g)	Rangeland Type Grass Drill	801.08(g)

CONSTRUCTION REQUIREMENTS

642.04 **Fertilizer and Agricultural Ground Limestone.** Immediately prior to the seed bed preparation, fertilizer nutrients and agricultural ground limestone (if agricultural ground limestone is included on the plans) shall be uniformly spread at the specified rate over the areas designated.

Fertilizer and ground limestone will not be required for Class 4, 5 and 7 Seeding.

642.05 **Seed Bed Preparation.** Seed bed preparation shall not be started until all stones, boulders, debris and similar material larger than 3 inches in diameter have been removed and all the other requirements of Section 217 have been completed. The area to be seeded shall be worked to a minimum depth of 3 inches with a disk or other equipment approved by the Engineer, reducing all soil particles to a size not larger

than 2 inches in the largest dimension. The prepared surface shall be relatively free from all weeds, clods, stones, roots, sticks, rivulets, gullies, crusting and caking. No seeds shall be sown until the seed bed has been approved by the Engineer.

Seed bed preparation will not be required for Class 7 Seeding if the soil is in a loose and pliable condition. Light discing shall be done if the soil is hard or caked.

642.06 **Seeding Methods.** No seed shall be sown during high winds or when the ground is not in a proper condition for seeding, nor shall any seed be sown until the purity test has been completed for the seeds to be used, and shows that the seed meets the noxious weed seed requirements. The Engineer will examine and then approve any equipment to be used. Prior to starting work, seeders shall be calibrated and adjusted to sow seeds at the proper seeding rate. Equipment shall be operated in a manner to ensure complete coverage of the entire area to be seeded. The Engineer shall be notified 48 hours prior to beginning the seeding operations so that the Engineer may determine by trial runs that a calibration of the seeder will provide uniform distribution at the specified rate per acre. When seed or fertilizer is applied with a hydraulic seeder, the rate of application shall be not less than 1000 gallons of slurry per acre. This slurry shall contain the proper quantity of seed or fertilizer specified per acre. When using a hydraulic seeder, the fertilizer nutrients and seed shall be applied in two separate operations.

Within 12 hours, all seeded areas, including slopes 3 to 1 or flatter, shall be rolled at right angles to the run off with an approved type roller or cultipacker to compact the seed bed and place the seed in contact with the soil. Slopes steeper than 3 to 1 need not be rolled. Rolling will not be required in the following conditions:

On slopes steeper than 3 to 1.

When a mulch stabilizer is used to anchor the mulch.

When a hydraulic seeder is used to apply the seed.

When a rangeland type grass drill is used.

When the seeding equipment is equipped with a roller that achieves the desires compaction.

When Class 7 Seeding is called for on the plans, a harrow, approved by the Engineer, may be substituted for the roller.

The optimum depth for seeding shall be 1/4 inch.

All legumes (clover, vetch, birdsfoot trefoil, lespedeza and alfalfa) shall be inoculated with the proper bacteria in the amounts and manner recommended by the manufacturer of the inoculant before sowing or being mixed with other seeds for

sowing. The inoculant shall be furnished by the Contractor and shall be approved by the Engineer. The seed shall be sown as soon as possible after inoculation and seed that has been standing more than 24 hours after inoculation shall be reinoculated before sowing. If legumes are applied by hydro seeder, 3 times the normal amount of inoculant shall be used. The Contractor shall furnish the inoculant and the cost of furnishing same shall be included in the contract unit price per acre for Seeding of the class specified.

(a) Class 4 and Class 5 Native Seed Mixtures. Class 4 and Class 5 Seed Mixtures shall be done by hydraulic seeders or with a rangeland type grass drill meeting the approval of the Engineer.

If a hydraulic seeder is used, the water application rate shall be not less than 500 gallons per acre.

Seeding operations for new construction (bare earth) shall be May 15 to June 30 or October 15 to December 1. Seeding operations on existing turf shall be between October 15 and December 1. All areas of existing turf to be seeded except as listed below shall be mowed one or more times to a height of not more than three inches. The equipment used shall be capable of completely severing all growth at the cutting height and distributing it evenly over the mowed area. The cut material shall not be windrowed or left in a lumpy or bunched condition. Subsequent mowing may be required on certain areas in order to disperse the mowed material and allow penetration of the seed.

The Contractor will not be required to mow within one foot of the right-of-way fence, continuously wet ditches and drainage ways, slopes 3:1 and greater, or areas which may be designated as not mowable by the Engineer.

Debris encountered during the mowing and seeding operations which may hamper the operation or be visible from the roadway shall be removed and disposed of in accordance with Article 642.05. Damage to the right of way and turf, such as ruts or wheel tracks more than two inches in depth, shall be repaired to the satisfaction of the Engineer prior to the time of seeding.

(b) Class 7 Erosion Control Mixture.

This method shall be considered a temporary erosion control method and shall be used as a temporary cover when permanent seeding cannot be accomplished. All areas that are to be left bare for more than one month will be considered for Class 7 Seeding. Any areas that cannot receive permanent seeding before winter shut down shall be seeded with Class 7 Seeding.

642.07 **Seeding Mixtures.** The classes of seeding mixtures will be designated on the plans and will consist of one or more of the Classes listed in Table 1. The beginning and termination dates for seeding will be specified on the plans and shall not be adjusted except as approved by the Engineer in writing.

Table 1 - SEEDING MIXTURES

CLASS	TYPE	SEEDS	LBS./ACRE
1	Lawn Mixture	Ky Bluegrass	50
		Perennial Ryegrass	30
		Creeping Red Fescue	20
1A	Salt Tolerant Lawn Mixture	Ky Bluegrass	30
		Perennial Ryegrass	10
		Dawsons Red Fescue	10
		Scaldis Hard Fescue	10
		Fults Salt Grass*	30
2	Roadside Mixture	Ky 31 or Alta Fescue	50
		Perennial Ryegrass	30
		Creeping Red Fescue	20
		Oats, Spring	48
2A	Salt Tolerant Roadside Mixture	Ky 31 or Alta Fescue	30
		Perennial Ryegrass	10
		Dawsons Red Fescue	10
		Scaldis Hard Fescue	10
		Fults Salt Grass*	30
3	Slope Mixture	Ky 31 or Alta Fescue	40
		Perennial Ryegrass	20
		Alsike Clover**	5
		Birdsfoot Trefoil**	10
		Little Bluestem	5
		Side Oats Grama	10

4[1]/	Native Grass Mixture	Big Blue Stem	4
		Little Blue Stem	5
		Prairie Switchgrass	2
		Indian Grass	2
		Prairie Dropseed	1
		June Grass	1
		Side Oats Grama	5
		Perennial Ryegrass	20

5[2/3]/ Native Forb Mixture

Amorpha canescens - Lead Plant (6)**
Asclepias tuberosa - Butterfly Milkweek (1)
Aster laevis - Smooth Aster (2)
Aster novae-angliae - New England Aster (2)
Ceanothus americanus - New Jersey Tea (3)
Coreopsis palmata - Prairie Coreopsis (6)
Dodecatheon Meadii - Shooting Star (4)
Echinacea pallida - Pale Purple Coneflower (8)
Eryngium yuccifolium - Rattlesnake Master (8)
Liatris aspera - Button Blazing Star (8)
Liatris pyscostachya - Prairie Blazing Star (6)
Monarda fistulosa - Prairie Bergamot (6)
Parthenium integrifolium - Prairie Quinine (3)
Petalostemum candidum - White Prairie Clover (1)**
Petalostemum purpureum - Purple Prairie Clover (6)**
Rudbeckia hirta - Black-eyed Susan (9)
Ratibida pinnata - Yellow Coneflower (8)
Silphium laciniatum - Compass Plant (1)
Silphium terebinthinaceum - Prairie Dock (1)
Solidago rigida - Rigid Goldenrod (6)
Veronicastrum virginicum - Culvert's Root (5)

6	Conservation Mixture	Smooth Brome Grass	40
		Vernal Alfalfa**	15
		Oats, Spring	48
6A	Salt Tolerant Conservation Mixture	Smooth Brome Grass	40
		Vernal Alfalfa**	15
		Oats, Spring	48
		Fults Salt Grass*	20
7	Erosion Control Mixture	Perennial Ryegrass	50
		Oats, Spring	64

*Fults pucinnellia distans
**Legumes - inoculation required

1/ The Perennial Ryegrass is to be deleted when seeding over existing turf.
2/ The number in the ( ) indicates the suggested percentage by weight of each item in the mixture. The total weight of the mixture shall be 2 lbs./acre.
3/ The mixture shall contain at least 1% (one percent) and not more than 10 percent by weight of each variety listed.

Variation in the Class 5 seed quantities or varieties will be allowed in the event of a crop failure or other unforeseen conditions. The Contractor shall provide for the approval of the Engineer a written description of the changed Class 5 Mixture, the reasons for the change, and the name of the seed supplier.

642.08 **Reserved.**

642.09 **Method of Measurement.** All classes of seeding shall be measured in acres of surface area seeded. Mowing will be measured in acres of surface area mowed.

When the work is constructed essentially to the lines, grades or dimensions shown on the plans and the Contractor and the Engineer have agreed in writing that the plan quantities for Class 1, Class 1A, Class 2, Class 2A, Class 3, and Class 4, Class 5, Class 6, Class 6A and Class 7 Seeding and Mowing are accurate, no further measurement will be required and payment will be made for the quantities shown in the contract for the various items involved except that if errors are discovered after work has been started, appropriate adjustments will be made.

When the plans have been altered or when disagreement exists between the Contractor and the Engineer as to the accuracy of the plan quantities, either party shall, before any work is started which would affect the measurement, have the right to request in writing and thereby cause the quantities involved to be measured as specified.

The quantities and application rates of fertilizer nutrients and agricultural ground limestone specified on the plans are subject to adjustment and will be determined on the basis of the analysis of soil samples taken by the Engineer.

Fertilizer will be measured by weight in pounds of actual nutrients. The following formula will be used to determine the pounds of fertilizer nutrients applied:

(Total weight of mixed fertilizer in pounds) X (Percentage of each nutrient in the fertilizer applied) = pounds of each fertilizer nutrient.

Agricultural Ground Limestone will be measured by weight in tons of Agricultural Ground Limestone having an effective neutralizing value of 67.5 (four-year base, a source correction factor of 1.0). Pay quantity will be computed according to procedures established by the Department. Applied quantity shall be the plan quantity multiplied by the source correction factor. The pay quantity shall be corrected for variations in applied quantity.

Payment will not be made for fertilizer nutrients in excess of 103 percent or agricultural ground limestone in excess of 108 percent of the amount specified by the Engineer.

642.10 **Basis of Payment.** This work will be paid for at the contract unit price per acre for SEEDING CLASS 1, SEEDING CLASS 1A, SEEDING CLASS 2, SEEDING CLASS 2A, SEEDING CLASS 3, SEEDING CLASS 4, SEEDING CLASS 5, SEEDING CLASS 6, SEEDING CLASS 6A and SEEDING CLASS 7 and at the contract unit prices per pound for NITROGEN FERTILIZER NUTRIENT, PHOSPHORUS FERTILIZER NUTRIENT, POTASSIUM FERTILIZER NUTRIENT and per ton for AGRICULTURAL GROUND LIMESTONE, measured as specified. Mowing will be paid for at the contract unit price per acre for MOWING. Only the initial mowing will be paid for. Any subsequent mowing required to obtain a height of not more than three inches or to disperse mowed material will be considered incidental to the initial mowing.

SECTION 643. MULCH AND EXCELSIOR BLANKET

643.01 **Description.** This item shall consist of furnishing, transporting and placing mulch or excelsior blanket.

643.02 **Materials.** Materials shall meet the requirements of the following Articles of Section 700 - Materials:

	Item	Article
(a)	Bituminous Materials (Note 1)	713.01 - 713.06, 713.09
(b)	Mulch Material	717.05
(c)	Excelsior Blanket	717.09
(d)	Wire Staples	717.09

Note 1. Bituminous material shall be SS-1, SS-1h, CSS-1 or CSS-1h.

CONSTRUCTION REQUIREMENTS

643.03 **Mulching Seeded or Planted Areas.** Within 24 hours from the time seeding, or planting of seedling trees, shrubs or vines has been performed, the seeded or planted area shall be given a covering of mulch by one of the following methods as designated on the plans. On slopes steeper than 3:1 mulch shall be applied the same day as seeded or planted. Mulch shall be applied uniformly at the rate specified.

Method 1. This method shall consist of hand or machine application of straw mulch. The mulch shall be loose enough to permit air to circulate but compact enough to reduce erosion. If baled mulch material is used, care shall be taken that the material is in a loosened condition and contains no lumps or knots of compacted material.

Method 2. This method shall consist of applying a layer of asphalt-coated straw mulch on seeded areas or planted areas.

This mulch shall have a partial coating of Emulsified Asphalt.

The coated mulch shall be placed by equipment which will blow or eject, by means of a constant air stream, controlled quantities of the mulch and asphalt in a uniform pattern over the specified area. If the mulch is excessively cut or broken, the Contractor shall take measures to reduce the cutting or breakage to a limit approved by the Engineer.

The asphalt shall be introduced into the air stream by means of a spray arranged in such a manner that it will partially coat the mulch with a spotty asphalt tack prior to the depositing of the mulch covering. The rate of application will be determined by the Engineer; however, the rate of application shall be not less than 75 gallons per ton of mulch.

Method 3. The straw shall be applied in accordance with all of the requirements of Method 1, except a mulch stabilizer shall be used to anchor mulch into the soil by means of dull blades or disks. These blades or disks shall be without camber, be approximately 20 inches in diameter.

The disks shall be notched and shall be spaced at approximately 3-inch intervals and shall be equipped with scrapers. The stabilizer shall weigh approximately 1000 pounds and shall have a working width not to exceed 72 inches and shall be equipped with a ballast compartment, so that when directed, weight can be increased.

Method 4. This method shall consist of a hand or machine application of an approved shredded tree bark mulch material conforming to the requirements of Article 717.05. The processed bark mulch shall be uniformly applied over the seeded area at a rate determined by the Engineer; however, the rate of application shall not be less than 35 cubic yards per acre on Class I or II seeded areas and not less than 40 cubic yards per acre on Class III seeded areas. Care shall be taken that the material is in a loosened condition and contains no lumps or knots of compacted material.

Method 5. This method shall consist of machine application of straw mulch at the specified rate using an approved mulch blower followed immediately by an overspray application of hydraulic mulch. The hydraulic mulch shall be applied as a slurry of 750 pounds of mulch and 1000 gallons of water per acre by an approved hydraulic mulch applicator. The hydraulic mulch slurry shall be agitated a minimum of 5 minutes before application and shall be agitated during application.

Method 6. This method shall consist of machine application of straw mulch at the specified rate using an approved mulch blower with chemical mulch binder applied simultaneously with the hay or straw as in Mulch Method 2 or with chemical mulch binder applied as an overspray in accordance with Mulch Method 5. Chemical mulch binder shall be applied at the rate and manner recommended by the supplier and approved by the Engineer.

Method 7. This method shall consist of machine application of wood or paper fiber hydraulic mulch at the specified rate using an approved hydraulic seeder. The hydraulic mulch shall be applied as a slurry of 2000 pounds of mulch and not less than 2000 gallons of water per acre. THe hydraulic mulch slurry shall be agitated a minimum of 5 minutes before application and shall be in continuous agitation during application. The seeding will not be applied concurrently with this operation.

Following the mulching operation, every precaution shall be taken to prohibit foot or vehicular traffic, or the movement of equipment over the mulched area. At any location where mulching has been displaced by any Contractor's equipment or personnel, the seeding or other work damaged as a result of that displacement shall immediately be replaced and the mulch covering replaced, at the Contractor's expense, in a manner satisfactory to the Engineer.

643.04 **Excelsior Blanket.** The excelsior blanket shall be placed within 24 hours after seeding operations have been completed on the areas specified. Prior to placing the mat, the areas to be covered shall be relatively free of all rocks or clods over 1 1/2 inches in diameter, and all sticks or other foreign material which will prevent the close contact of the blanket with the seed bed. If as a result of a rain, the prepared seed bed becomes crusted or eroded, or if eroded places, ruts or depressions exist for any reason, the Contractor will be required to rework the soil until it is smooth and to reseed such areas which are reworked. After the area has been properly shaped, fertilized and seeded, the blanket shall be laid out flat, evenly and smoothly, without stretching the material.

Jute or paper mat used as a ditch lining shall be applied with the lengths running parallel to the flow of water. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil.

In ditches, the blankets shall be applied in the direction of the flow of the water and butted snugly against each other. Use 4 staples across at the start of each roll and continue to staple each side and the center on 4-foot intervals. Use a common row of staples on adjoining blankets.

On slopes, the blanket shall be applied either horizontally or vertically to the contour. Staple similar to ditch applications except the space interval shall be 6 feet.

643.05 **Reserved.**

643.06 **Method of Measurement.** Straw or hydraulic mulch under Method 1, 2 ,3, 5, 6 or 7 will be measured in tons. Shredded tree bark under Method 4 will be measured in cubic yards at the unloading point. The basis of measurement being the cubic yards of volume in the truck or other conveyance used for transporting the material. No allowance will be made for wastage or shrinkage which occurs during transportation to the unloading point. Payment will not be made for mulch in excess of 103 percent of the amount specified by the Engineer. The mulch binder for Methods 5 and 6 will be measured in pounds of mulch binder. The weight of the water used to make the slurry will not be included in the measured weight. Emulsified Asphalt will be measured as specified in Article 713.03 and the unit of measurement will be shown on the plans. The area of Excelsior Blanket will be measured in place in square yards of actual surface area protected.

When mulch is measured in acres of surface area mulched, the Contractor will have the option of using either Method 2 or Method 3 for placing the mulch. The emulsified asphalt used in Method 2 will not be measured separately but shall be included in the cost per acre of mulch.

643.07 **Basis of Payment.** This work will be paid for at the contract unit price per ton for MULCH, METHOD 1; MULCH, METHOD 2; MULCH, METHOD 3; MULCH, METHOD 5; MULCH, METHOD 6; or MULCH, METHOD 7 and per cubic yard for MULCH, METHOD 4; per square yard for EXCELSIOR BLANKET; per pound for MULCH BINDER; and at the contract unit price per gallon for EMULSIFIED ASPHALT or per ton for EMULSIFIED ASPHALT measured as specified herein.

When the Contractor has the option of using either Method 2 or Method 3, this work will be paid for at the unit price per acre for MULCH measured as specified herein.

SECTION 644. SODDING

644.01 **Description.** This work shall consist of preparing the ground surface and furnishing, transporting and placing sod and other materials required in the sodding operations.

644.02 **Materials.** Materials shall meet the requirements of the following Articles of Section 700 - Materials:

	Item	Article
(a)	Sod	717.02
(b)	Agricultural Ground Limestone	717.06
(c)	Fertilizer	717.07

CONSTRUCTION REQUIREMENTS

644.03 **Ground Preparation.** The area to be sodded shall be finished in accordance with Section 217 before sodding operations are begun. Immediately prior, but not in excess of 24 hours before the sod is placed, the soil surface shall be worked until it is relatively free from debris, washes, gullies, clods and stones, and is in a satisfactory condition. The surface shall be worked to a depth of not less than 3 inches with a disk, tiller or other equipment approved by the Engineer. Prepared surfaces that become crusted shall be reworked to an acceptable condition for sodding.

All soil surfaces shall be moist when the sod is placed. When directed by the Engineer, the Contractor shall be required to apply water to dry soil surfaces at a minimum rate of one gallon per square yard immediately prior to placing the sod.

When specified, agricultural ground limestone and fertilizer nutrients shall be applied at the designated rates over the areas to be sodded.

644.04 **Sodding Time.** Sod shall be placed when the ground is in a workable condition and temperatures are less than 90° F. Sod shall not be placed when the sod or ground surface is frozen or during an extended drought.

644.05 **Transportation.** All sod shall be properly covered when transported to prevent it from drying out. Adequate shading and ventilation must be provided for the sod to prevent it from decomposing while it is transported.

Sod cut for more than 48 hours shall only be used with the approval of the Engineer. Any sod that has dried out, has heated to over 100° F. or is frozen prior to placing will be rejected and shall be immediately removed from the job site by the Contractor.

644.06 **Placing Sod.** The sod shall be placed on the prepared surface with the edges in close contact and alternate courses staggered.

In ditches, the sod shall be placed with the longer dimension perpendicular to the flow of water in the ditch. On slopes, starting at the bottom of the slope, the sod shall be placed with the longer dimension parallel to the contours of the ground. The exposed edges of sod shall be buried flush with the adjacent soil.

On slopes where the sod may be displaced during sodding operations, the workmen shall work from ladders or treaded planks.

644.07 **Staking Sod.** The sod shall be staked on all slopes of 2:1 or steeper. Sod shall be staked with not less than 4 stakes per square yard with at least one stake for each piece of sod. Stakes shall be a minimum of 6" long. Stakes shall be installed so that they hold the sod firmly in place yet present no danger to pedestirans or mowing crews. The type of stake and the method of installation shall meet the approval of the Engineer.

644.08 **Sod Watering.** Within 8 hours after the sod has been placed, 5 gallons of water per square yard shall be applied. Thereafter, on days designated by the Engineer, additional water shall be applied at the rate of 3 gallons per square yard. The number of additional applications shall not exceed 7 during the period of establishment, defined as the period of time between sod placement and when the sod becomes knitted to the soil and growing in place.

The Contractor shall have on hand enough equipment to completely water all sodded areas in 2 days at watering rates specified during the period of establishment. The Engineer will make periodic checks of the Contractor's equipment to determine its adequacy and operating condition.

All watering described herein shall be done with a spray application. An open end hose will not be acceptable. The method of watering shall meet the approval of the Engineer.

644.09 **Supplemental Watering.** During periods of intense heat or subnormal rainfall, supplemental watering may be required after the first initial and 7 additional waterings

and prior to acceptance of the work. Supplemental watering shall be performed when directed by the Engineer. Water shall be applied at the rate specified by the Engineer within 24 hours of notice. Supplemental watering may be performed during the period of establishment or any time prior to final acceptance of the project.

644.10 **Disposal of Surplus Material.** Surplus and waste materials resulting from sodding operations shall be disposed of by the Contractor, at his/her own expense, in accordance with Article 202.03.

644.11 **Inspection.** The Contractor shall notify the Engineer of the localities from which the sod is to be obtained so that an authorized representative may inspect the fields for approval.

All sod used shall comply with the State and Federal laws with respect to inspection for plant diseases and insect infestation. An inspection certificate required by law to this effect shall accompany each shipment and on arrival shall be filed with the Engineer. The Contractor shall notify the Department of Agriculture, Division of Plant Industries, and furnish the information required by that Department.

644.12 **Reserved.**

644.13 **Method of Measurement.** Sodding will be measured for payment in square yards in place. To be acceptable, the sod shall be in a live, healthy condition and be knitted to the soil. When directed by the Engineer, any defective or unacceptable sod on the initial installation shall be removed, replaced and watered in accordance with this Section.

Supplemental watering will be measured in units of 1000 gallons of water applied on the sodded areas.

Fertilizer will be measured by weight in pounds of actual nutrients. The following formula will be used to determine the pounds of each fertilizer nutrient applied:

(Total weight of mixed fertilizer in pounds) X (Percentage of each nutrient in the fertilizer applied) = pounds of each fertilizer nutrient.

Agricultural Ground Limestone will be measured by weight in tons of Agricultural Ground Limestone having an effective neutralizing value of 67.5 (four-year base, a source correction factor of 1.0). Pay quantity will be computed according to procedures established by the Department. Applied quantity shall be the pay quantity multiplied by the source correction factor. The pay quantity shall be corrected for variations in applied quantity.

Payment will not be made for fertilizer nutrients in excess of 103 percent or agricultural ground limestone in excess of 108 percent of the amount specified by the Engineer.

644.14 **Basis of Payment.** This work will be paid for at the contract unit prices per square yard for SODDING, per unit for SUPPLEMENTAL WATERING, per pound for NITROGEN FERTILIZER NUTRIENT, PHOSPHORUS FERTILIZER NUTRIENT, POTASSIUM FERTILIZER NUTRIENT and per ton for AGRICULTURAL GROUND LIMESTONE, measured as specified.

SECTION 645. PLANTING

645.01 **Description.** This work shall consist of digging and preparing plant holes, and of furnishing, transporting and planting trees, shrubs, vines, seedlings and other materials.

It shall also include all incidental operations such as mulching, bracing, wrapping, care of living plants and replacements of unsatisfactory plants.

645.02 **Materials.** Materials shall meet the requirements of the following Articles of Section 700 - Materials:

	Item	Article
(a)	Trees, Shrubs, Vines and Seedlings	717.01
(b)	Topsoil	717.04
(c)	Mulch Material	717.05
(d)	Fertilizer	717.07
(e)	Peat Moss	717.08
(f)	Bracing	717.10

CONSTRUCTION REQUIREMENTS

645.03 **Planting Time.** Except for container grown items, plants must be dormant when delivered to the storage site or project.

In reference to the following planting dates, that portion of the State that lies north of a line formed by the southern boundaries of Hancock, Schuyler, Mason, Tazewell, McLean, Ford and Iroquois Counties shall be considered the northern zone, while that portion of the State that lies south of this line shall be considered the southern zone.

Bare root plant material shall be planted only when the air temperatures exceed 35° F.

The Contractor shall begin this work not later than September 1, following the award date of the contract.

(a) Spring Planting. This work shall be performed from the time the soil can be worked until the plant, under field conditions, is not dormant except that:

(1) Evergreen planting shall end April 1 in the southern zone and April 30 in the northern zone.

(2) Seedlings shall be planted only during the spring planting season.

(c) Gradation. The fine aggregate for trench backfill shall be Gradation FA 6 and for bedding FA 1, FA 2 or FA 6. The fine aggregate for porous granular embankment and backfill and french drains shall be Gradation FA 1 or FA 2.

703.06 **Fine Aggregate for Membrane Waterproofing.** The aggregate shall conform to the requirements of Article 703.01 and the following specific requirements:

(a) Description. The fine aggregate shall consist of sand, stone sand, wet bottom boiler slag, slag sand or chats.

(b) Quality. The fine aggregate shall meet the Class B Quality Deleterious Count, and when subjected to 5 cycles of the department's sodium sulfate soundness test (AASHTO T 104) the weighted average loss shall not be more than 10 percent.

(c) Gradation. The fine aggregate shall be Gradation FA 8.

SECTION 704. COARSE AGGREGATE

704.01 **Materials.** The aggregate materials shall conform to the following requirements:

(a) Description. The natural and manufactured materials used as coarse aggregate are defined as follows:

Gravel. Gravel shall be the coarse granular material resulting from the reduction of rock by the action of the elements and having subangular to rounded surfaces. It may be partially crushed.

Chert Gravel. Chert gravel shall be the coarse granular material occurring in alluvial deposits resulting from reworking by weathering and erosion of chert bearing geological formations and containing a minimum of 80 percent chert or similar siliceous material.

Crushed Gravel. Crushed gravel shall be the product resulting from crushing by mechanical means, and shall consist entirely of particles obtained by crushing gravel, all of which before crushing will be retained on a screen with openings equal to or larger than the maximum nominal size of the resulting crushed material. If approved by the Engineer, final product gradations may be obtained by screening or blending various sizes of crushed gravel material.

Pit or Bank Run Gravel. Pit or bank run gravel shall be a mixture of sand, gravel, silt and clay occurring naturally in a deposit, which is of such quality that it may be used with only minor processing.

Novaculite Gravel. Novaculite gravel shall be material occurring in natural deposits, composed of angular particles of siliceous origin and mixed with ferruginous clay.

Crushed Stone. Crushed stone shall be the angular fragments resulting from crushing by mechanical means the following types of rocks quarried from undisturbed, consolidated deposits: granite and similar phanerocrystalline igneous rocks; limestone; dolomite sandstone; or massive metamorphic quartzite, or similar rocks. Dolomite shall be a carbonate rock containing 11.0 percent or more magnesium oxide (MgO). Limestone shall be a carbonate rock containing less than 11.0 percent magnesium oxide (MgO).

Wet Bottom Boiler Slag. Wet bottom boiler slag shall be the hard, angular by-product of the combustion of coal in wet bottom boilers.

Crushed Slag. Crushed slag shall be the graded product resulting from the processing of air cooled blast furnace slag. Air cooled blast furnace slag shall be the nonmetallic product, consisting essentially of silicates and alumino-silicates of lime and other bases, which is developed in a molten condition simultaneously with iron in a blast furnace. It shall be air cooled and shall have a compact weight (AASHTO T 19) of not less than 70 pounds per cubic foot.

Crushed Sandstone. Crushed sandstone shall be the angular fragments resulting from crushing, by mechanical means, a cemented sand composed predominantly of quartz grains.

Crushed Concrete. Crushed concrete shall be the angular fragments resulting from crushing Portland cement concrete by mechanical means.

Chats. Chats shall be the tailings resulting from the separation of metals from the rocks in which they occur.

Crushed Steel Slag. Crushed steel slag shall be the graded product resulting from the processing of steel slag. Steel slag shall be the nonmetallic product which is developed in a molten condition simultaneously with steel in an open hearth, basic oxygen or electric furnace.

(b) Quality. The coarse aggregate shall be from an approved source and shall meet the following quality standards and will be accepted on the basis of these tests unless unfavorable conditions showing up in usage indicate the material is unsatisfactory. All

coarse aggregate materials shall meet the specified quality requirements before being proportioned for mix or combined to adjust gradation.

COARSE AGGREGATE QUALITY

QUALITY TEST	CLASS A	B	C	D
Na_2SO_4 Soundness 5 Cycle, AASHTO T 104[4/] Max. % Loss	15	15	20	25[9/]
Los Angeles Abrasion AASHTO T 96 Max. % Loss	40[6/]	40[8/]	40[7/]	45
Minus No. 200 Sieve Mat'l. AASHTO T 11 Max. % Deleterious Mat'ls.	1.0[1/]		2.5[2/]	
- Shale Max. %	1.0	2.0	4.0[5/]	
- Clay Lumps Max. %	0.25	0.5	0.5[5/]	
- Coal & Lignite Max. %	0.25			
- Soft & Unsound Frag. Max. %	4.0	6.0	8.0[5/]	
- Other Deleterious Max. %	4.0[3/]	2.0	2.0	
- Total Deleterious Max. %	5.0	6.0	10.0[5/]	

1/ For crushed aggregate, if the material finer than the No. 200 sieve consists of the dust from fracture, essentially free from clay or silt, this percentage may be increased to 2.5.

2/ Does not apply to aggregates for Class I Binders, Class B Mixtures, and Bituminous Base Course Mixtures.

3/ Includes deleterious chert. In gravel and crushed gravel aggregate, deleterious chert shall be the light weight fraction separated in a 2.35 heavy media separation. In crushed stone aggregate, deleterious chert shall be the lightweight fraction separated in a 2.55 heavy media separation.

4/ As modified by the Department.

5/ Does not apply to Class A Seal and Cover Coats.

6/ For Portland cement concrete, the maximum percent loss shall be 45.

7/ For Class I Bituminous Binder Courses and Bituminous Base Course, except when used as Surface Course, the maximum percent loss shall be 45.

8/ Does not apply to crushed slag or crushed steel slag.

9/ For aggregate surface course, the maximum percent loss shall be 30.

All varieties of chert contained in gravel coarse aggregate for Portland cement concrete, whether crushed or uncrushed, pure or impure, and irrespective of color, will be classed as chert and shall not be present in the total aggregate in excess of 25 percent by weight.

Aggregates used in handrail, parapet, end post and all other superstructure concrete shall contain no more than 2 percent total by weight of deleterious materials or substances whose disintegration is accompanied by an increase in volume which may cause spalling of the concrete.

At the time of use, the coarse aggregate shall be free from frozen materials and all foreign materials which may have become mixed with it during handling. Cars used for shipping the aggregate shall not be caulked with hay, straw, excelsior, grass or similar materials.

(c) Gradation. The coarse aggregate shall be uniformly graded from coarse to fine and, when tested by means of laboratory sieves (square openings), shall conform to the following gradations.

The sizes prescribed may be manufactured by any suitable commercial process and by the use of any sizes or shapes of plant screen openings necessary to produce the sizes within the limits of the sieve analysis specified.

The gradation limits specified represent the limits which will determine suitability for use from all approved sources of supply. The gradation of the material from any one source shall be reasonably close to the gradation specified and shall not be subject to the extreme percentages of gradation represented by the tolerance limits for the various sieve sizes. The sizes are based on the use of square opening sieves in making analysis.

COARSE AGGREGATE GRADATIONS**

Grad No.	Sieve Size Percent Passing 3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 16	No. 50	No. 200*
CA 1	100	95±5	60±15	15±15	3±3		50±15		30±10	20±15		8±4
CA 2		100	95±5		75±15		3±3					
CA 3		100	93±7	55±20	8±8							
CA 4			100	95±5	85±10		60±15		40±10	20±15		8±4
CA 5				93±3 1/	40±25		5±5		3±3			
CA 6				100	95±5		75±15		43±13	25±15		8±4
CA 7				100	95±5 2/		45±15 2/		5±5			
CA 8				100	97±3	85±10	55±10		10±5	3±3		5±4
CA 9				100	97±3		60±15		30±15	10±10		
CA 10					100	95±5	80±15		50±10	30±15		5±4
CA 11					100	92±8	45±15 2/		6±6	3±3 4/		
CA 12						100	95±5	85±10	60±10	35±10		8±4
CA 13 5/						100	97±3	80±10	30±15	3±3 5/		
CA 14							90±10 3/	45±20	3±3			
CA 15							100	75±15	7±7	2±2		
CA 16 6/								100	97±3	30±15	2±2 5/	
CA 17	100								65±20	45±20	20±10	10±5
CA 18	100			95±5					75±25	55±25	10±10	2±2
CA 19	100			95±5					60±15	40±15	20±10	10±5

* Subject to Maximum percent allowed in Coarse Aggregate Quality Table.
** When an optional range is specified, once the range is selected, it shall not be changed.
1/ Shall be 100 percent passing the 1 3/4" sieve.
2/ When using gradation CA 7 for A binder, the percent passing the 1/2" sieve may also be 35±10 or 15 ± 10.
3/ 100 percent passing 5/8" sieve.
4/ The No. 16 requirement will be waived when CA 11 is used in the manufacture of Portland Cement Concrete.
5/ When using gradation CA 13 and CA 16 for Class I bituminous mixtures, the No. 16 requirement may be 4±4 if produced from a washed aggregate.
6/ When crushed slag or crushed steel slag is used for Class I Bituminous Surface Course, Mixture C, D, or E, the percent passing the No. 16 sieve may also be 7±7 and the percent passing the No. 200 Sieve may also be 3±3.
7/ When using gradation CA 11 for B binder, the percent passing the 1/2" sieve may also be 75±10.

(d) Incompatibility. Incompatibility of any of the gradations or combinations of gradation permitted resulting in unworkable mixtures, non-adherence to the final mix gradation limits, or any other indication of incompatibility shall be just cause for rejection of one or both of the sizes.

(e) Storage of Coarse Aggregate. Sites for stockpiles shall be grubbed and cleaned prior to storing the aggregates.

The stockpiles shall be built in layers not exceeding 5 feet in height, and each layer shall be completely in place before the next layer is started. A stockpile may be expanded by again starting the expansion from the ground and building layers as before. End dumping over the sides will not be permitted. Steel track equipment will not be permitted on stockpiles of specified Class A Quality coarse aggregate. When loading out of stockpiles, vertical faces shall be limited to reasonable heights to eliminate segregation due to tumbling. Aggregate producer's stockpiling methods currently in use and proven satisfactory to the Engineer may be continued at the source. Segregation or degradation due to improper stockpiling or loading out of stockpiles shall be just cause for rejecting the material.

Separate stockpiles shall be provided for the various kinds of aggregates. Stockpiles shall be separated to prevent intermingling at the base. If partitions are used, they shall be of sufficient heights to prevent intermingling. Coarse aggregates for Portland cement concrete and bituminous mixtures shall be handled in and out of the stockpiles in such a manner that will prevent contamination and degradation.

Crushed slag for Portland cement concrete shall be stockpiled in a moist condition (saturated surface dry or greater) and the moisture content shall be maintained uniformly throughout the stockpile by periodic sprinkling.

704.02 **Coarse Aggregate for Portland Cement Concrete.** The aggregate shall conform to the requirements of Article 704.01 and the following specific requirements:

(a) Description. The coarse aggregate shall be gravel, crushed gravel, crushed stone, crushed concrete, crushed slag or crushed sandstone.

(b) Quality. The coarse aggregate shall be Class A quality.

(c) Gradation. The gradations used in the construction of concrete pavement shall be Gradation CA 5, CA 7 and CA 11. CA 14 may be used in concrete pavement when the

aggregate proposed for use is rated in the Department's Freeze-thaw list as CA 14 only. The gradations used in the construction of Class A concrete for structures shall be Gradation CA 3, CA 5, CA 7 and CA 11. The gradations used in the construction of Class X Concrete shall be a unit coarse aggregate Gradation CA 7 or CA 11. CA 14 may be used for Class X concrete whenever the Contractor's aggregate source has been limited to CA 14 for paving. The sizes prescribed may be manufactured by any suitable commercial process. Washing equipment will be required where producing conditions warrant.

(d) Combining Sizes. Each size shall be stored separately and care shall be taken to prevent them being mixed until they are ready to be proportioned. The Engineer reserves the right to determine as the work progresses, the proportions of the separated sizes of coarse aggregate which, combined with fine aggregate, cement and water in accordance with these Specifications, will produce the most workable mixture. The Contractor will be permitted to mix more than two sizes of coarse aggregate, provided the separate sizes selected and the proportions used in combining them are approved by the Engineer and that separate compartments are provided to proportion each size.

At the option of the Contractor, a unit coarse aggregate Gradation CA 7 or CA 11 may be used for any Portland cement concrete. When a unit coarse aggregate is used, the cement content shall be not less than 5.65 hundredweight per cubic yard, except that if the concrete is produced by a transit mix or shrink mix operation, the cement content shall be not less than 6.05 hundredweight per cubic yard.

If the coarse aggregate is furnished in separate sizes, they shall be combined in proportions to provide a uniformly graded coarse aggregate grading within the following limits:

Type of Construction	Combined Sizes	Percent Passing Sieves							
		2 1/2"	2"	1 3/4"	1 1/2"	1"	1/2"	No. 4
Portland Cement Concrete Pavement and Base Courses 1/	CA 5 & CA 7	---	---	100	98±2	72±22	22±12	3±3
	CA 5 & CA 11	---	---	100	98±2	72±22	22±12	3±3
Class A Concrete For Structures 1/	CA 3 & CA 7	100	95±5	---	---	55±25	20±10	3±3
	CA 3 & CA 11	100	95±5	---	---	55±25	20±10	3±3
	CA 5 & CA 7	---	---	100	98±2	72±22	22±12	3±3
	CA 5 & CA 11	---	---	100	98±2	72±22	22±12	3±3

1/ Either combination of sizes shall be optional.

(e) Mixing Gravel, Crushed Gravel, Crushed Stone and Crushed Slag Coarse Aggregates. Two different specified sizes of crushed stone, gravel and crushed gravel from one source or any two sources may be combined in any consistent ratio in a mix, but the use of alternate batches of crushed stone, gravel or crushed gravel of any one size or combination of sizes will not be permitted. Coarse aggregates of any one size from different sources shall not be mixed without permission from the Engineer. Crushed slag shall not be combined or mixed with gravel, crushed gravel or crushed stone aggregates.

(f) When coarse aggregate is used to produce Portland cement concrete pavement, base course and base course widening, the gradation permitted will be determined from the results of the Department's Freeze-Thaw Test. At regular intervals, the Department will provide each District Engineer of Materials a list of freeze-thaw ratings for all A-quality coarse aggregate sources. The gradations permitted for each rating shall be as follows:

Freeze-Thaw Rating (Top Size, Inch)	Gradation Permitted
1-1/2	Combined CA 5 & CA 7, or Combined CA 5 & CA 11, or CA 7, or CA 11
1	CA 7, or CA 11
3/4	CA 11
1/2	CA 14
N.A.	Not Acceptable

Additional requirements may be placed on coarse aggregates when used in continuously reinforced concrete pavement. Such requirements will be stipulated on the most recent Freeze-Thaw Rating List.

704.03 **Coarse Aggregate for Bituminous Courses.**

(a) Description. The coarse aggregate for all bituminous mixtures except Class I Surface Mixture E shall be crushed gravel, crushed stone (other than limestone), crushed sandstone, crushed slag, or chats. For Class I, Type 1 and 2 Surface Mixture E, the coarse aggregate shall be crushed slag, crushed steel slag, crushed sandstone, or a blend in equal proportions by volume of crushed slag, crushed steel slag or crushed sandstone with crushed gravel, chats, or a crushed stone other than limestone. Additional coarse aggregate for the other specific bituminous mixtures may also be used according to the following table:

Class	Use	Additional Coarse Aggregate Types Permitted
A	Seal or Cover	Gravel Crushed Concrete Crushed Steel Slag Limestone
B	Mixture	Gravel Crushed Concrete Limestone
I, Type 2	Mixture A	Crushed Concrete Limestone
I, Type 1 and 2	Mixture B	Crushed Concrete Limestone
I, Type 1 and 2	Mixture C	Crushed Concrete Crushed Steel Slag Limestone
I, Type 1 and 2	Mixture D	Crushed Steel Slag Limestone[1/]

[1/] Limestone may be used in Mixture D if blended in equal proportions by volume with crushed slag, crushed steel slag, crushed sandstone, or novaculite coarse aggregate.

(b) Quality. For Class A and B bituminous courses, the coarse aggregate shall be Class C quality or better. For Class I, Type 1 and 2 surface courses and Class I, Type 1 and 2 binder courses when used as surface course, the coarse aggregate shall be Class B quality or better. For other courses, the coarse aggregate shall be Class C quality or better.

(c) Gradation. The coarse aggregate gradations shall be as follows:

Class	Use	Gradation No.
A-1, 2 & 3	Seal 3/8	CA 16
A-1	Seal 1/2	CA 15
A-2 & 3	Cover	CA 14
B	Mixture	CA 6[1/] or CA 10[1/]
I Type 2	Mixture A	CA 7[2/] or CA 8[3/]
I Type 1 & 2	Mixture B	CA 11[5/]
I Type 1 & 2	Mixture C, D & E	CA 13[4/] or CA 16

1/ In Class B Mixture aggregate where the aggregates are deficient in fines, the material added to compensate shall not be soil materials such as clay, loam or silt. The material added to make up deficiencies shall be a granular material approved by the Engineer. Plasticity Index of Class B Mixture material shall not exceed 4.

Gradation CA 12 may be used in lieu of CA 6 or CA 10, when specified. When lifts of nominal 1 3/4 inches or less compacted thickness are placed, Gradations CA 10 or CA 12 shall be used. The required gradation may be obtained by blending aggregates of Class C Quality or better. The gradation of the individual aggregates shall be approved by the Engineer. When the aggregates are blended, aggregate feeders for each size shall be provided according to Article 802.01(d). If Mineral Filler is used, the mineral filler equipment requirements under Article 802.01(l) or (r) shall apply.

2/ When directed by the Engineer CA 13 or CA 16 shall be blended with CA 7 for Class I Type 2, Mixture A.

3/ Gradation CA 8 for Class I Mixture A may, at the option of the Contractor, be obtained by blending either gradation CA 7 or CA 7 (as modified in Article 704.01(c) Note 2) with CA 13 or CA 16.

4/ Gradation CA 16 shall be used in lieu of CA 13 when the bituminous course is designed for 1 1/4 inches or less in thickness.

5/ When directed by the Engineer, CA 13 or CA 16 shall be blended with CA 11 for Class I, Type 1 and 2, Mixture B.

(d) Sources of Supply. All sources of supply shall be approved by the Engineer. The Contractor shall submit to the Engineer a statement giving the sources of the coarse aggregate. Only coarse aggregates from these sources shall be used on the job unless approval in writing is obtained from the Engineer.

704.04 **Coarse Aggregate for Waterbound Macadam Base Course.** The aggregate shall conform to the requirements of Article 704.01 and the following specific requirements:

(a) Description. The coarse aggregate shall consist of crushed stone, crushed concrete, or crushed slag.

(b) Quality. The coarse aggregate shall be Class D Quality or better.

(c) Gradation. The coarse aggregate shall be Gradation CA 1.

704.05 **Coarse Aggregate for Aggregate and Stabilized Aggregate Base, Sub-base and Shoulder Courses; Aggregate Surface Course; and Granular Embankment Special.** The aggregate shall conform to the requirements of Article 704.01 and the following specific requirements:

(a) Description. The coarse aggregate shall be pit run gravel, gravel, crushed gravel, novaculite, crushed stone, crushed concrete, crushed slag or crushed sandstone.

The granular material for stabilized aggregate base, sub-base, and shoulder courses, if approved by the Engineer, may be produced by blending aggregates from more than one source, provided the method of blending results in a uniform product. The components of a blend need not be of the same kind of material. The source of material shall not be changed during the progress of the work without written permission from the Engineer. Where a natural aggregate is deficient in fines, the material added to make up deficiencies shall be a material approved by the Engineer.

(b) Quality. The coarse aggregate shall be Class D Quality or better.

(c) Gradation. The coarse aggregate gradation shall be used as follows:

For aggregate surface course Type B Gradation CA 6, CA 9 or CA 10 may be used. If approved by the Engineer, Gradation CA 4 or CA 12 may be used.

For aggregate sub-base Type B Gradation CA 6, CA 10, CA 12 or CA 19 shall be used. If approved by the Engineer, Gradation CA 2 or CA 4 may be used.

For aggregate sub-base Type C Gradation CA 7 as specified in Article 704.01 or combined size CA 5 and CA 7 as specified in Article 704.02 shall be used. If separate sizes are furnished, combining by proper mixing will be required either at the source or at the job site.

For granular aggregate courses -- base, sub-base, and shoulder except sub-base Types B and C -- Gradation CA 6 shall be used. If specified, Gradation CA 2 or CA 4 may be used in lieu of CA 6.

Unless otherwise specified herein, stabilized aggregate courses -- base, sub-base, and shoulder -- Gradation CA 6, or CA 10 shall be used. If specified, Gradations CA 2, CA 4, or CA 12 may be used in lieu of CA 6 or CA 10.

For aggregate surface course Type A and granular embankment special, CA 6 or CA 10 shall be used. If approved by the Engineer, Gradation CA 2, CA 4, CA 9 or CA 12 may be used in lieu of CA 6 or CA 10.

(d) Plasticity. All material shall comply with the plasticity index requirements listed below. The plasticity index requirement for crushed gravel, crushed stone and crushed slag may be waived if the ratio of the percent passing the No. 200 sieve to that passing the No. 40 sieve is 0.60 or less.

Type of Construction	Plasticity Index - Percent 1/	
	Gravel	Crushed Gravel, Stone & Slag
Granular Embankment, Special	0 to 6	0 to 4
Aggregate Sub-base		
Type A	0 to 9	. . . . .
Type B	0 to 9	. . . . .
Aggregate Shoulders		
Type A	2 to 9	. . . . .
Type B	2 to 9	. . . . .
Aggregate Base Course		
Type A	0 to 6	0 to 4
Type B	0 to 6	0 to 4
Aggregate Surface Course		
Type A	2 to 9	. . . . .
Type B 2/	2 to 9	. . . . .
Stabilized Aggregate Mat'l.	0 to 9	0 to 9

1/ Plasticity Index shall be determined by the method given in AASHTO T 90. Where shale in any form exists in the producing ledges, crushed stone samples shall be soaked a *minimum of eighteen hours before* processing for plasticity index or minus No. 40 material. When clay material is added to adjust plasticity index, the clay material shall be in a minus No. 4 sieve size.

2/ When Gradation CA 9 is used, the plasticity index requirement will not apply.

704.06 **Coarse Aggregate for Membrane Waterproofing.** The aggregate shall conform to the requirements of Article 704.01 and the following specific requirements:

(a) Description. The coarse aggregate shall be gravel, crushed gravel, crushed stone, crushed concrete, crushed slag, crushed sandstone or chats.

(b) Quality. The coarse aggregate shall consist of tough durable particles reasonably free of objectionable material and, when subjected to 5 cycles of the sodium sulphate soundness test (AASHTO T 104), the weighted average loss shall not be more than 15 percent.

(c) Gradation. The coarse aggregate shall be Gradation CA 16.

704.07 **Coarse Aggregate for Blotter, Embankment, Backfill and French Drains.** The aggregate shall conform to the requirements of Article 704.01 and the following specific requirements:

(a) Description. The coarse aggregate shall be gravel, crushed gravel, pit run gravel, crushed stone, crushed concrete, crushed slag, chats, crushed sandstone or wet bottom boiler slag.

(b) Quality. The coarse aggregate shall consist of sound durable particles reasonably free of objectionable deleterious material.

(c) Gradation. The coarse aggregate gradation shall be as follows:

Blotter.....CA 15

Nonporous Granular Embankment and Backfill.....CA 17

Porous Granular Embankment and Backfill, and French Drains.....CA 18

704.08 **Reserved.**

SECTION 705. STONE, CONCRETE BLOCKS AND BROKEN CONCRETE FOR EROSION PROTECTION, SEDIMENT CONTROL AND ROCKFILL

705.01 **Stone for Erosion Protection, Sediment Control and Rockfill.** Stone, sediment and rockfill shall meet the following requirements:

(a) Description. The material shall be stone quarried from undisturbed, consolidated deposits of rock reasonably free of shale and shaly stone. The ledges shall be sufficiently thick to produce the desired dimensions. The stone shall be reasonably free of laminations, seams, cracks and other structural defects or imperfections tending to destroy its resistance to weather. Field stone or boulders will not be accepted. Bedding material shall be crushed stone, gravel, crushed sandstone, or crushed slag. The crushed slag shall meet the Department's "Test for Leachate".

(b) Quality. Stone for erosion protection, sediment control or rockfill shall be quarried from ledges meeting one of the listed quality designations. All ledges shall be sufficiently thick to produce the desired dimensions. Ledges shall be checked with rock samples sized to CA-7/11 and run in the IDOT sodium sulfate soundness test.

Quality Designation	Definition
A	The stone shall not exceed 15% sodium sulfate soundness loss. Elongated pieces (length is greater than 5 times average thickness) shall not exceed 10% by weight. The stone shall have a specific gravity (dry) greater than 2.45 when checked in a full gradation product.
B	The stone shall not exceed 25% sodium sulfate soundness loss. Elongated pieces (length is greater than 5 times average thickness) shall not exceed 10% by weight.
C	The stone shall only have to conform to the above paragraph (a), Description.

(c) Gradation. Stone for erosion protection or sediment control shall meet one of the listed gradation designations. All gradations produced shall be well-graded. A minimum of one gradation check for each gradation produced shall be run during initial production each year. Additional checks may be done by visual inspection if no gradation problem exists.

BEDDING MATERIAL					
	Sieve Size Percent Passing				
GRAD. NO.	4"	3"	2	1 1/2	No. 4
RR 1		100		53±23	8±8
RR 2	100		53±23		8±8

EROSION PROTECTION, SEDIMENT CONTROL AND ROCKFILL

Grad. No.	Rock Size (lb.) Percent Passing													
	1000 1/	600 1/	400 1/	300	170	150 1/	90	50 1/	40	12	10	6	3	1
RR 3								100						8+8
RR 4						100								8+8
RR 5			100				50+20		50+20		50+20			
RR 6		100		50+20	50+20							8+8	8+8	
RR 7	100									8+8				

1/ 5% by weight may be oversize. Each oversize piece shall not exceed the maximum size of the gradation by more than 20%.

(d) Usage. Stone for use as erosion protection and sediment control shall be designated by class. The class shall be a combination of a quality designation and a gradation designation. The various uses with their allowable classes shall be specified by the designer in accordance with the latest Bureau of Materials and Physical Research policy memorandum.

Rockfill shall meet Quality Designation #C and may be shot rock, primary crusher run, or other specified gradations.

705.02 **Concrete Blocks and Broken Concrete for Riprap.** The concrete blocks shall be cast solid; shall be made from aggregates meeting all requirements for physical properties, soundness and wear specified in Articles 703.02 and 704.02 and shall contain not less than 6 bags of Portland cement per cubic yard of concrete. The concrete shall have a minimum compressive strength of not less than 3500 pounds per square inch at the age of 14 days, as determined by the Engineer, either from tests of entire blocks or from tests of blocks subdivided by sawing or drilling into prisms or cylinders. Specimens for testing will be selected by the Engineer and at such intervals as will ensure control of the production of blocks. The blocks may be made from plastic concrete, or they may be machine made, utilizing the type of equipment ordinarily employed in the fabrication of building blocks.

(a) Blocks Produced from Plastic Concrete. The blocks shall be made from concrete containing not less than 4 nor more than 7 percent entrained air and having a slump of not more than 1 1/2 inches. The concrete shall be consolidated in the molds by vibratory equipment and in a manner meeting the approval of the Engineer. The blocks shall be finished to uniform and true dimensions.

(b) Machine Made Blocks. The concrete shall be made with aggregate sizes and of a consistency suitable for production of the blocks by machine methods. The concrete shall have an air-entrainment (Note 1) meeting the approval of the Engineer. The blocks shall be of uniform and true dimensions.

Note 1. The experience in the manufacture, inspection and use of machine made blocks for riprap is very limited. It is known that air-entrained concrete of the type and consistency suitable for manufacture of the blocks will also contain entrapped air. Available test methods do not differentiate between the two, and some experimentation may be necessary at the beginning of the production. Manufacturers in general have had little experience in the manufacture of blocks from mixtures having cement contents as high as specified

herein, and some adjustment of the usual proportion of fine to coarse aggregate may be required, in order that the equipment may work satisfactorily.

(c) Size of Blocks. The concrete blocks shall conform, as to minimum dimensions, to the nominal dimension of the standard 8" x 8" x 16" concrete building block, unless otherwise shown on the plans. The length of the blocks shall be an even multiple of the width.

(d) Broken Concrete. The material shall be made from newly broken, sound concrete pavement or other suitable concrete debris from demolished concrete construction having a minimum thickness of 6 inches between unbroken surfaces. Concrete showing excessive popping, spalling, cracking or any other type of disintegration indicating poor resistance to weathering shall not be acceptable. No reinforcing steel or other such material shall be protruding from the broken pieces.

The gradation or sizing of the pieces shall conform to Article 705.01(c).

SECTION 706. BRICK

706.01 **Description.** This Specification covers brick for use in brick masonry construction.

706.02 **Building Brick (Made From Clay or Shale).** Building brick, made from clay or shale, shall conform to the requirements of AASHTO M 114. The brick shall be of the grade designated as Grade SW.

706.03 **Concrete Building Brick.** Concrete building brick shall conform to the requirements of ASTM C 55. The brick shall be of the grade designated as Grade S-II.

SECTION 707. CONCRETE MASONRY UNITS

707.01 **Description.** This Specification covers solid, precast, segmental concrete masonry units.

707.02 **Requirements.** Concrete masonry units shall conform to the requirements of ASTM C 139 except that the aggregate shall conform to the requirements of Articles 703.02 and 704.02 with the exception of gradation. When the concrete has attained the required strengths, but not prior to 4 days after casting, the units may be loaded, shipped and used. Chert gravel may be used based on past in-service satisfactory performance in the environment in which the product is used.

SECTION 708. PRECAST REINFORCED CONCRETE MANHOLE SECTIONS

708.01 **Description.** This Specification covers reinforced concrete pipe used for the construction of catch basins and manholes.

708.02 **Requirements.** Precast reinforced concrete manhole sections shall conform to the requirements of AASHTO M 199 except that the minimum wall thickness shall be 3 inches, and the aggregate shall conform to the requirements of Articles 703.02 and 704.02 with the exception of gradation. When the concrete has attained the required strengths, but not prior to 4 days after casting, the units may be loaded, shipped and used. Chert gravel may be used based on past in-service satisfactory performance in the environment in which the product is used.

SECTION 709. DRAIN PIPE AND TILE

709.01 **Description.** This Specification covers plain concrete, reinforced concrete, clay, structural clay, bituminized-fiber, acrylonitrile-Butadiene-Styrene, Perforated Poly (Vinyl Chloride, Poly (Vinyl Chloride), and tile.

709.02 **Extra Strength Clay Pipe.** Extra strength clay pipe shall conform to the requirements of AASHTO M 65.

709.03 **Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.** Reinforced concrete culvert, storm drain and sewer pipe shall conform to the requirements of AASHTO M 170 Classes I to V, Tables I to V, except that the use of elliptical reinforcement in circular pipe will not be permitted and the aggregate shall conform to the requirements of Articles 703.02 and 704.02 with the exception of gradation. When the concrete has attained the required strengths, but not prior to 4 days after casting, the units may be loaded, shipped and used. Chert gravel may be used based on past in-service satisfactory performance in the environment in which the product is used.

709.04 **Clay Sewer Pipe.** Clay sewer pipe shall conform to the requirements of AASHTO M 65.

709.05 **Drain Tile.** Drain tile shall conform to the requirements of AASHTO M 179. The tile furnished, unless otherwise provided, shall be that designated as Heavy-Duty Drain Tile.

The maximum length of the units shall be 24 inches.

709.06 **Concrete Sewer, Storm Drain and Culvert Pipe.** Concrete sewer, storm drain and culvert pipe shall conform to the requirements of AASHTO M 86, except that the aggregate shall conform to the requirements of Articles 703.02 and 704.02 with the exception of gradation, the pipe furnished to be of the class designated. When the concrete has attained the

1/ Shall be grown in Kansas or farther north; shall be free from any mixture with southern or foreign seeds, blends or adulterations with screenings, frosted or damaged seeds; and shall not contain more than 0.2 percent bur or sweet clover mixture.

2/ Shall be free from blends or adulterations with screenings, blasted, shriveled or immature seeds.

3/ Shall be hulled and free from blends or adulterations with blasted, shriveled or immature seeds.

4/ Shall be recleaned.

5/ Shall not contain more than 5 percent adulteration with Canada Blue Grass, Merion Blue Grass or other hybrids or varieties of blue grass.

6/ Shall be scarified.

† No primary Noxious Weeds are permitted.

717.04 **Topsoil.** Topsoil shall be relatively free from large roots, sticks, weeds, brush or stones larger than 1 inch in diameter or other litter and waste products. It shall be a loamy mixture having at least 90 percent passing the No. 10 sieve. A sample, free from extraneous materials, shall comply with the following requirements:

It shall contain not less than 1 percent nor more than 10 percent organic matter as determined by the test for organic matter in accordance with AASHTO T 194.

It shall contain not less than 12 percent nor more than 50 percent clay as determined in accordance with AASHTO T 88.

The sand content shall not exceed 55 percent as determined in accordance with AASHTO T 88.

The pH of the sample shall not be lower than 5.0 nor higher than 8.0. The pH shall be determined with an acceptable pH meter, on that portion of the sample passing the No. 10 sieve, in accordance with the "Suggested Methods of Tests for Hydrogen Ion Concentration (pH) of Soils" included in the procedures for Testing Soils issued December, 1964 by the American Society for Testing and Materials.

717.05 **Mulch Material.** Mulch material for seeding and planting shall be non-toxic to vegetation and to the germination of seed and shall be approved by the Engineer.

(a) Seeding. Mulch material for seeding shall be as follows:

(1) Straw. Straw shall be stalks of wheat, rye, oats or other approved straw, and shall be air-dried.

(2) Shredded Tree Bark. Shredded tree bark mulch shall be those materials produced when raw round wood products are mechanically debarked by conventional type debarking units. The processed shredded bark material shall consist of an array of bark shreds and particle sizes ranging from fines (1/32") up to and including coarse shreds and particles large enough to be refused by an 1" mesh screen. Bark slabs and particles greater than 3" will not be permitted. Bark seeding mulch particle size distribution shall be ascertained and approved as acceptable by the Engineer prior to application.

(3) Hydraulic Mulch. Hydraulic mulch shall be virgin wood cellulose fibers containing no growth or germination inhibiting factors. Hydraulic mulch shall disperse evenly and rapidly and remain in slurry when agitated with water. The slurry shall be green in color to allow visual metering of its application and, when sprayed uniformly on the surface applied to, shall form an absorbent cover

allowing percolation of water to the underlying surface. Hydraulic mulch shall be packaged in moisture resistant packages or bags with the net weight of the packaged material plainly shown on each such package. The wood cellulose fibers shall not be water soluble and shall comply with the following properties when tested in accordance with the procedures outlined in the latest revision of Federal Specification Q-P-166.

Moisture content, as received basis, percent by weight, maximum	15
Organic matter, wood fiber, oven dried basis, percent by weight, minimum	95
pH	4.3-8.5
Water holding capacity, oven dried basis, percent by weight, minimum	400

(4) Chemical Mulch Binder. Chemical mulch binder shall be an approved nontoxic and nonstaining styrene butadiene latex, sodium lamarin - calcium sulphate or other mulch binder which will disperse evenly and rapidly and remain in suspension when agitated in water. The mulch binder and water suspension or slurry shall be green in color to allow visual metering of its application. Chemical mulch binder shall be packaged, stored and shipped in accordance with the manufacturer's recommendations with the net quantity plainly shown on each package or container.

(b) Planting. The type of mulch material for planting will be specified in the Special Provision or on the plans and shall be approved by the Engineer.

717.06 **Agricultural Ground Limestone.** Agricultural limestone shall meet the following requirements:

Agricultural Ground Limestone shall contain particles ground sufficiently fine so that essentially all material passes a No. 4 sieve and is graded relatively uniform through the Nos. 8, 30 and 60 sieves. Approved sources of Agricultural Ground Limestone shall be tested by the Department of Agriculture and rated with a source correction factor.

717.07 **Fertilizer.** Fertilizer shall be ready-mixed material of an analysis specified on the plans or as directed by the Engineer. In cases where a single nutrient is requested, unless otherwise specified, the analysis shall be optional, provided that it carries sufficient filler to ensure adequate distribution of the nutrient.

The following information shall be shown on the fertilizer bag or package or on a tag attached thereto:

(a) Name and address of manufacturer
(b) Name, brand or trademark
(c) Number of net pounds of ready-mixed material in the package
(d) Chemical composition or analysis
(e) Guarantee of analysis

If a brand or grade of fertilizer is delivered in the bulk, a written statement having the above listed information must accompany each load.

Custom mixed fertilizers shall have a written statement containing the following information with each load:

(a) Weight of each commercial fertilizer used in the custom mixing.
(b) The guaranteed analysis of each commercial fertilizer used in the custom mixing.
(c) Total weight of fertilizer delivered in each load.
(d) The manufacturer of each of the commercial fertilizers used in the custom mix.
(e) Guaranteed analysis of each load to be stated as follows:

(1) Percent of total Nitrogen (N)

(2) Percent of total available Phosphoric (P_2O_5)

(3) Percent of total Soluble Potash (K_2O)

(f) Name and address of the person selling the fertilizer.

717.08 **Peat Moss.** Peat moss shall conform to the following requirements:

(a) Peat moss shall be partially decomposed fibrous or cellular stems and leaves of any of several species of sphagnum mosses, and shall conform to the following requirements:

(1) Texture and Composition. Its texture may vary from porous fibrous to spongy fibrous, and it shall be either crumbly or compact, but fairly elastic and substantially homogeneous. It shall be free from decomposed colloidal residue, excessive woody materials (roots and stems), and mineral matter such as iron and sulphur. It shall be essentially dark brown in color. Shredded particles shall not exceed 1/4 inch in size.

(2) Acidity. The pH value shall be not less than 3.2 and not greater than 5.5, at approximately 25° C.

(3) Ash. The ash content, based on the oven-dry weight of the material, shall be not more than 5 percent.

(4) Water Holding Capacity. The water holding capacity shall be not less than 400 percent, by weight, on an oven-dry basis.

(b) Sampling. A test sample weighing at least one pound shall be taken from each 50 ton lot or fraction thereof. Such samples shall be taken 6 inches below the surface of one or more bales, thoroughly mixed, and placed in a clean, dry, air-tight metal container or in a strong plastic bag, sealed and forwarded to the testing laboratory.

(c) Testing. The samples will be tested in accordance with the requirements of Article 4.5 of the Federal Specifications for Peat Moss; Peat, Humus; and Peat, Reed-Sedge, Q-P-166e, of the issue in effect on the date of invitation for bids.

(d) Packing. Unless otherwise specified, the air-dried peat moss shall be packed in bales of the type, size and kind commonly used. Damaged bales will not be accepted.

The peat moss shall be packed in the bales at a compression ratio of at least 2 to 1. Each bale shall be clearly marked with the type of peat moss, the brand name, the country of origin, the cubic feet compressed size, the compression ratio used, and the approximate weight of the bale. In the absence of such marking, each shipment shall be accompanied by a certificate stating the desired information.

717.09 **Special Erosion Control Materials.**

(a) Excelsior Blanket. Excelsior blanket shall consist of a machine produced mat of wood excelsior of 80 percent 6 inches or longer fiber length. The wood from which the excelsior is cut shall be properly cured to achieve adequately curled and barbed fibers.

The blanket shall be of consistent thickness, with the fiber evenly distributed over the entire area of the blanket. The excelsior blanket shall be covered on the top side with a 90 day biodegradable extruded plastic mesh netting having an approximate minimum opening of 5/8 inch x 5/8 inch to an approximate maximum opening of 2 inches x 1 inch. The netting shall be entwined with the excelsior mat for maximum strength and ease of handling.

The excelsior blanket shall comply with the following Specifications:

Minimum width, inches, minus 1 inch.....24
Minimum weight per square yard, pounds,
minus 10 percent.....0.9
Minimum length of roll, feet, approximately....150

The excelsior blanket shall be smolder resistant and shall withstand the following test:

The excelsior blanket specimen shall not flame or smolder for more than a distance of 12 inches from a spot where a lighted cigarette is placed on the surface of the blanket.

Certification. The manufacturer shall furnish a certification with each shipment of excelsior blanket stating the number of rolls furnished and that the material complies with the requirements of the Specifications.

(b) Staples. Staples shall be made from No. 11 gage or heavier wire, width 1 or 2 inches at the throat and 6 inches from top to bottom after bending. The staples shall be packaged in cartons.

(c) Fiber Mat. Fiber mat shall consist of a bulky structure of entangled nylon monofilaments, melt-bonded at their intersections, forming a stable mat of suitable weight and configuration. The mat shall be resilient, permeable and highly resistant to environmental conditions and ultraviolet degradation.

The mat shall comply with the following physical properties:

Material Type - Nylon 6 plus a Min. Content of 0.5% by weight of Carbon Black.

Filament Diameter inch, Min.....0.016
Weight lb./sq. yd.....0.75
Thickness inch, Min.....0.70
Width inch.....38
Roll Length yard.....109
Color.....Black

Tensile Properties*

Strength lb./inch, Min.
Length Direction.....7.8
Width Direction.....4.4

Elongation %, Min.
Length Direction.....50
Width Direction.....50

Resiliency**

30 min. Recovery %, Min.....80
(3 cycles)

*ASTM D 1682 Strip test procedure modified to obtain filament bond strength to indicate tensile properties of Fiber Mat.

**Compression load cycling of 100 psi on 2 inch x 2 inch sample size, crosshead speed of 2 inches per minute.

Certification. The manufacturer shall furnish a certification with each shipment of fiber mat stating the number of rolls furnished and that the material complies with the requirements of the Specification.

717.10 **Bracing.**

(a) Steel Posts. Steel posts for bracing shall be of a type normally used for agricultural fencing; have a steel anchor plate welded or riveted to each post approximately 18 inches from the bottom of the post; be 6 feet minimum in length and shall weigh not less than 1 lb. per foot. The post shall be finished with a suitable paint of acceptable color or galvanizing.

(b) Earth Anchors. Earth anchors shall consist of a metal rod with attached spiral or helical metal anchor plate; shall conform to the following minimum requirements:

Length 42", rod diameter 5/8", eye opening 1", anchor plate diameter 4".

SECTION 718. MISCELLANEOUS MATERIALS

718.01 **Concrete Admixtures.**

(a) General. Admixtures shall be furnished in liquid form ready for use. The admixtures may be delivered to the job in the manufacturer's original containers, bulk tank trucks or such containers or tanks as are acceptable to the Engineer. Delivery shall be accompanied by a ticket which clearly identifies the manufacturer and trade name of the material. In all cases, containers remaining on the job shall be readily identifiable to the satisfaction of the project personnel as to manufacturer and trade name of the material they contain.

When AASHTO M 194 is specified herein, the following modifications thereto shall be effected: The test mixture for AASHTO M 194 shall contain a cement content of 5.65 cwt. per cubic yard.

When ASTM C 672 is specified herein, the following modifications thereto shall be effected: The test mixture shall contain a coarse aggregate meeting the requirements of AASHTO M 43, gradation 67, and a cement content of 5.65 cwt. per cu. yd.; the de-icing agent shall be rock salt (sodium chloride) applied at a rate of 2/3 gram per square inch of surface area. Tests shall be continued until 60 cycles have been completed. 8-1/2" x 11" glossy photos of each specimen, at the conclusion of testing, will be required for evaluation by the Engineer.

Prior to approval of a product, two copies of a report prepared by a laboratory regularly inspected by the Cement Reference Laboratory of the National Bureau of Standards shall be forwarded to the Engineer of Materials and Physical Research. The report shall show the results of physical tests using materials and methods specified herein on a "test" concrete and a "reference" concrete, together with a certification that no changes have been made in the formulation of the material since the performance of the tests.

Prior to the final approval of any brand or type of admixture, the Engineer may conduct all or part of the applicable tests listed herein on a sample that is representative of the material to be furnished. To this end, the manufacturer shall submit to the Engineer a sample of not less than one gallon. In addition, a field experimental section may be required.

If the admixture previously has been approved by the Engineer, approval of its use will be granted upon the certification by the manufacturer that the admixture is of the same formulation as that previously approved. If minor changes have been made, the certification shall state that the admixture is essentially the same as previously approved, and the Engineer may, at his/her option, conduct such tests as deemed desirable to check the properties of the material before approval is granted.

In all cases, the manufacturer shall submit certification giving the average and manufacturing range of specific gravity at 77° F., the average and manufacturing range of solids in the solution based on the residue dried for 3 hours at 221° F., the average and manufacturing range of pH, and including an infrared spectrophotometer trace of current production material. The certification further shall state that, for all except chloride-based accelerators, the admixture contains no more than 0.3 percent chloride by weight. The material shall not be used until it has been shown to conform with the specified requirements.

APPENDIX D

QUALITY ASSURANCE PROJECT PLAN
C. C. JOHNSON & MALHOTRA
JUNE 1988, REVISED SEPTEMBER 1988

2980

ATTACHMENT C

QUALITY ASSURANCE PROJECT PLAN

FOR

REMEDIAL ACTION

AT

JOHNS-MANVILLE DISPOSAL AREA
MANVILLE SALES CORPORATION
WAUKEGAN, ILLINOIS

JUNE 1988

(Revised September, 1988)

JOHNSON & MALHOTRA, P.C.
ENVIRONMENTAL ENGINEERS

GRAND RAPIDS, MICHIGAN

ATTACHMENT C

QUALITY ASSURANCE PROJECT PLAN

ATTACHMENT C-1

QUALITY ASSURANCE PROJECT PLAN - 1

FOR

SAMPLING AND MONITORING OF
SOIL COVER, ACTIVE WASTE DISPOSAL AREA,
GROUNDWATER AND SURFACE WATER

QUALITY ASSURANCE PROJECT PLAN - 1

Table of Contents

		Page
1.0	Introduction	C1-1
2.0	Project Description	C1-1
3.0	Project Organization And Responsibilities	C1-2
4.0	QA Objectives for Data Measurements	C1-6
5.0	Sampling/Monitoring Procedures	C1-16
6.0	Sample and Document Custody Procedures	C1-17
7.0	Calibration Control	C1-18
8.0	Analytical Procedures	C1-19
9.0	Data Reduction, Validation Reporting and Assessment	C1-21
10.0	Internal QC checks	C1-22
11.0	Performance and System Audits	C1-23
12.0	Preventive Maintenance	C1-23
13.0	Data Measurement Assessment Procedures	C1-23
14.0	Corrective Action	C1-24
15.0	Quality Assurance Reports	C1-25
16.0	Sampling and Monitoring Programs	C1-25

APPENDICES

		Page
C1-A	Soil Cover Monitoring Plan	C1-A-1
C1-B	Active Waste Disposal Areas Sampling Plan	C1-B-1
C1-C	Groundwater and Surface Water Monitoring Program	C1-C-1
C1-D	Sample Containers, Volumes and Preservation	C1-D-1
C1-E	Methodology for PBB Analysis	C1-E-1

LIST OF FIGURES

C1-1	Project Organization	C1-4
C1-B-1	Active Waste Disposal Areas Sampling Locations	C1-B-2
C1-C-1	Monitoring Well/Surface Water Sampling Locations	C1-C-2

LIST OF TABLES

C1-1	Monitoring Parameters	C1-3
C1-2	QC Level of Effort for Analytical Testing	C1-7
C1-3	Target Compound List (TCL) and Required Detection Limits (RDL)	C1-10
C1-4	Accuracy and Precision Criteria for Analytical Testing	C1-14
C1-5	Analytical Methods	C1-20

QUALITY ASSURANCE PROJECT PLAN - 1

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP-1) presents the organization, objectives, functional activities, quality assurance (QA) and quality control (QC) activities associated with certain aspects of Remedial Action being implemented at the Johns-Manville Waste Disposal Area in Waukegan, Illinois. The QAPP is designed to achieve the specific goals of certain remedial activities presented below by describing minimum procedures to assure that the precision, accuracy, sensitivity, completeness, and representativeness of the collected data are known and documented. Enclosed as appendices are four documents:

C1-A: Soil Cover Monitoring Plan
C1-B: Active Waste Disposal Areas Sampling Plan
C1-C: Groundwater and Surface Water Monitoring Program
C1-D: Sampling Quantities, Containers and Preservatives

Preparation of this plan, in general, is in accordance with the following guidance document:

- U.S. EPA, February 1983, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.

2.0 PROJECT DESCRIPTION

The primary objective of Remedial Action at the Johns-Manville Disposal Area is to protect human health and the environment at the site, through a program designed to control the release of hazardous substances, pollution or contaminants into the environment. All tasks and sub-tasks are directed toward accomplishment of this primary objective.

2.1 Background

Pursuant to a Consent Decree signed by Manville on December 31, 1987, Manville will undertake Remedial Action consisting of a soil cover over the asbestos containing areas, and long term monitoring of groundwater, surface water, soil cover and air to detect any releases of contaminants (notably asbestos, lead and chromium) to the environment. Also included is sampling of active waste disposal areas to confirm that no asbestos is present in the exposed wastes and no hazardous substances are entering the process wastewater treatment basins.

2.2 Objectives and Use of Data

The objectives of sampling/monitoring activities described in this QAPP are 1) to detect specified contaminants in surface water or groundwater, 2) to detect asbestos-containing wastes at or near the surface of the established soil cover and 3) to detect any hazardous contaminants in the active waste disposal areas. Water and soil cover monitoring will continue in accordance with the

required SARA 5-year review scenario while active wastes will be sampled once with the exception of the wastewater treatment system, which will be sampled after each significant process change.

The data obtained will be used for purposes specified in the Consent Decree.

2.3 Sampling Schedule

The schedule for the sampling/monitoring activities is presented in Figure 2 of the Work Plan. The parameters for which groundwater, surface water, soil cover and active waste disposal areas will be monitored or tested are presented in Table C1-1.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Illustrated below is the project organization and line of authority for the field investigation. Both project technical management personnel and quality assurance personnel are indicated.

3.1 Organization

Project organization for field sampling/monitoring is presented in Figure C1-1.

3.2 Responsibilities

Overall project supervision and coordination will be the responsibility of Manville Project Coordinator. He will be responsible for accomplishing the tasks as per the directives of "Consent Decree", as well as interacting with and reporting to U.S. EPA and Illinois EPA (IEPA).

All project functional responsibilities lie with the Manville Remedial Construction Manager (RCM). He will be responsible for overseeing project tasks and ensuring their accomplishment. He will be responsible for reporting the project progress to the Manville Project Coordinator and interacting with U.S. EPA and IEPA on an as-needed basis.

Overall coordination of on-site sampling/monitoring activities will be the primary responsibility of the Contractor/Consultant Site Manager. An independent Quality Assurance Monitor will be responsible for reviewing project documents and reports with respect to their conformance to the quality assurance objectives.

TABLE C1-1

MONITORING PARAMETERS

1. Groundwater, Surface Water Monitoring

   Asbestos
   Chromium (total)
   Lead
   Arsenic (total)
   Phenols
   Antimony
   Aluminum
   Volatile Organics
   Semi-volatile organics
   PCBs
   PBBs
   pH)
   Specific Conductance) under field conditions
   Temperature)

2. Soil Cover Monitoring

   Visual for asbestos-containing wastes and vegetative cover
   soil borings - asbestos

3. Active Waste Disposal Areas Testing

Matrix	Parameter
Sludge (Sludge Disposal Pit)	Asbestos
Miscellaneous waste (Misc. Disposal Pit)	Asbestos
Process wastewater (influent)	Same as for ground water and surface water (excluding field measurements for pH, temperature, specific conductance and asbestos)

Project Organization

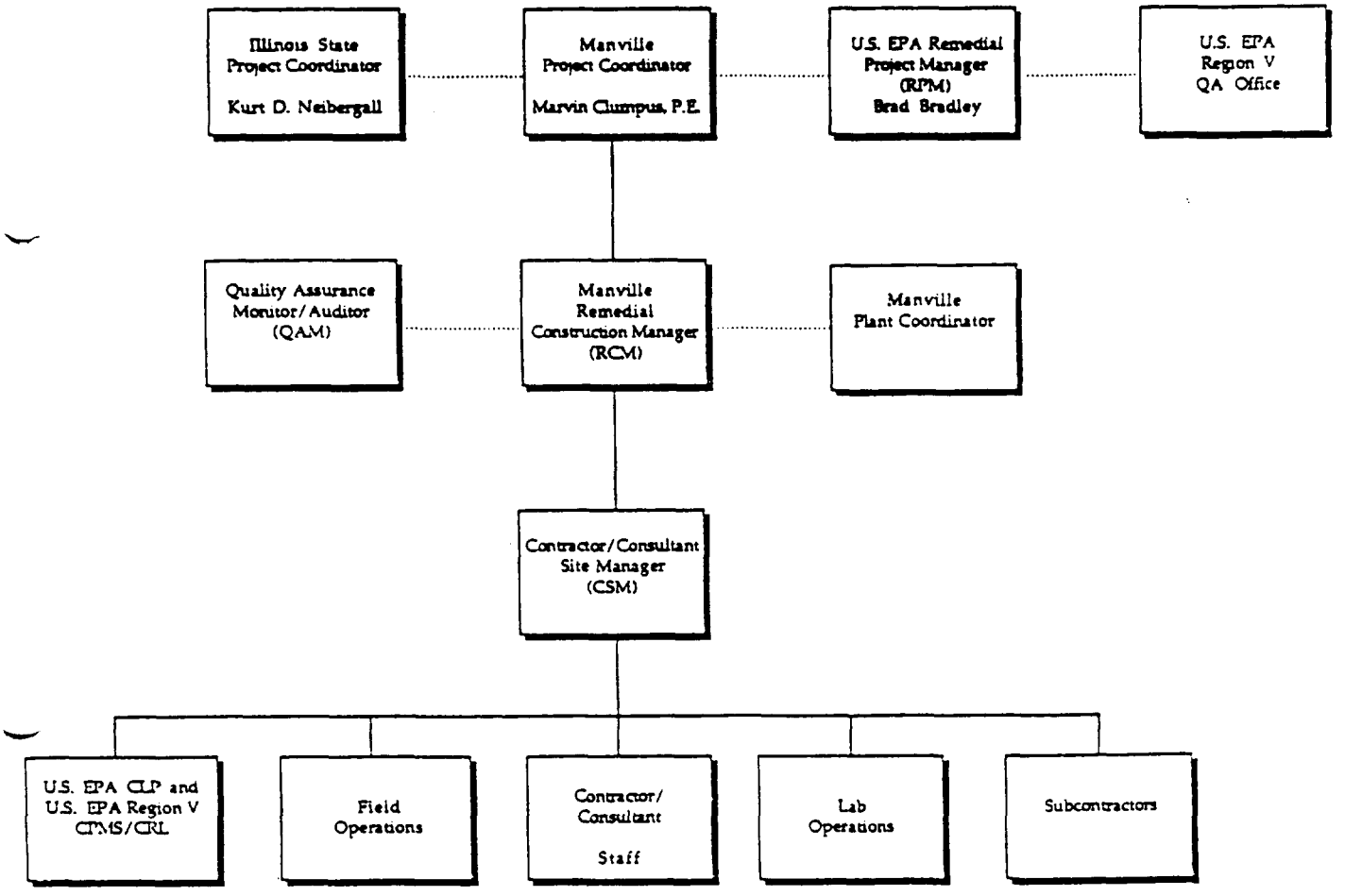


Figure C1-1

A contractor/laboratory will be identified for field sampling and measurement and data assessment. The following laboratories will be used for sample analysis:

1.) Asbestos

Clayton Environmental Consultants
22345 Roethel Drive
Novi, MI 48052
(313)344-1770

or

E.M.S. Laboratories, Inc.
507 Mission St.
South Pasadena, CA 91030
(818)441-7054

2.) Organics including PBB

Clayton Environmental Consultants
22345 Roethel Drive
Novi, MI 48052
(313)344-1770
(currently in CLP)

3.) Inorganics

Vegas Analytical Laboratories
3894 Schiff Drive
Las Vegas, Nevada 89103
(701)365-1201
(currently in CLP)

The groundwater monitoring wells will be approved by U.S. EPA/IEPA representatives in the field. U.S. EPA/IEPA representatives will be notified in advance of all sampling activities.

U.S. EPA CLP and Region V CRL may be involved in the collection and analysis of split samples. U.S. EPA Region V Quality Assurance Office will be one of the parties involved during the entire project, as shown in Figure C1-1.

4.0 QA OBJECTIVES FOR DATA MEASUREMENTS

The overall QA objective is to develop and implement procedures for sampling/monitoring, laboratory analyses, field measurements and reporting that will provide data to a degree of quality consistent with its intended use. This section defines the goals for levels of QC effort; and the accuracy, precision, sensitivity, completeness, representativeness and comparability of laboratory analyses.

4.1 Level of QC Effort

Field duplicate, field blanks and trip blanks (methods and locations described in the Sampling Plans) will be taken and submitted to the analytical laboratory to provide means to assess the quality of the data resulting from the field sampling program. Field duplicate samples will be analyzed to check for sampling and analytical reproducibility. Field blank samples will be analyzed to check for procedural contamination of samples. The general level of this QC effort will be one field duplicate and one field blank for every 10 or less investigative groundwater or surface water samples. One field duplicate sample of soil and sludge will be collected for every 10 or less investigative samples, but field blanks are not required. Two trip blanks (for water VOA only) will be included with each VOA shipping package to the laboratory to check sample contamination during shipping, if any.

The level of QC effort provided by the laboratory will be equivalent to the level of QC effort specified under the CLP program, for the Routine Analytical Services (RAS) parameters to be tested. The level of QC effort for testing of inorganics (metals) will conform to the procedures in the CLP Statement of Work (SOW) for Inorganic Analysis, SOW-7-87-Inorganic. The level of QC effort for testing of Hazardous Substance List (HSL) organics (volatiles, semi-volatiles and PCBs) will conform to the procedures in the CLP Statement of Work (SOW) for Organic Analysis, SOW-7-87-Organic. The level of laboratory QC effort for PBBs testing will be similar to that of PCBs testing. The laboratory QC effort for asbestos will include lab blanks and calibration standard checks for every 10 or less samples as outlined in the "Interim Method for Determining Asbestos in Water", EPA-600-4-80-005. The level of QC effort for analytical testing is provided in Table C1-2.

All instruments used in the field for collection of field measurements will be calibrated daily according to their standard operating procedures. The QC level of effort for the field measurement of pH will consist of pre-measurement calibration. QC effort for field conductivity measurements will include daily

Table C1-2
QC Level of Effort for Analytical Testing

Parameters	Audit	Frequency
Metals	Calibration Blank (ICP and AA and Cold Vapor)	Each calibration beginning and end of each run, 10% frequency
	Initial Calibration Verification (ICP and AA and Cold Vapor	Daily and each instrument setup
	Continuing Calibration Verification (ICP and AA and and Cold Vapor)	Beginning and end of each run; 10% frequency or every 2 hrs, whichever is more frequent
	Preparation Blank (ICP and AA and Cold Vapor)	One per batch or one per 20 samples received, whichever is more frequent
	Matrix Spike Analysis (ICP and AA and Cold Vapor)	One per case or one per 20 samples received, whichever is more frequent
	Duplicate Sample Analysis (ICP and AA and Cold Vapor)	One per case or one per 20 samples received, whichever is more frequent
	Laboratory QC Sample Analysis (ICP and AA and Cold Vapor)	One per batch or one per 20 samples received, whichever is more frequent
	Duplicate Injections (AA-Furnace)	Each sample
	Interference Check Sample (ICP)	Beginning and end of each run or two per 8-hr shift, whichever is more frequent
	Serial Dilution Analysis (ICP)	One per case or one per 20 samples received, whichever is more frequent
	Preparation Blank Spike (AA-Furnace)	One per batch or 20 samples received, whichever is more frequent
	Analytical matrix spike (AA-Furnace)	Each sample

Table C1-2 (continued)

Parameters	Audit	Frequency
	Analytical matrix spike (AA-Furnace)	Each sample
Volatile Organics	Laboratory Blank	One per case or one per 20 samples received, whichever is more frequent
	Matrix Spike/Matrix Spike Duplicate Analysis	One per case or one per 20 samples received, whichever is more frequent
	Surrogate Spike Analysis	Each sample
	Continuous Calibration Check	After the initial calibration; daily before analysis of samples and/or every 8-hr shift
PBBs and PCBs	Laboratory Blank	One per case or one per 20 samples received, whichever is more frequent
	Matrix Spike	One per case or one per 20 samples received, whichever is more frequent
	Continuous Calibration Check	After the initial calibration; daily before analysis of samples and/or every 8-hour shift
Asbestos	Calibration Blank (Standard)	One per 8-hour shift or one for every 10 samples
	Laboratory Blank	One for every 10 or less samples
	Duplicate Sample Analysis	One for every 10 or less samples

calibration of the instrument using a standard solution of known conductivity.

4.2. Accuracy, Precision and Sensitivity of Analysis

The QA objective with respect to accuracy, precision and sensitivity of laboratory analytical methods is to achieve the QC acceptance criteria of the analytical protocols. The accuracy, precision and sensitivity requirements for testing of all parameters will be equivalent to those specified under the CLP and "Interim Method for Determination of Asbestos in Water", EPA-600-4-80-005 (Anderson and Long Method) and "Interim method for determination of Asbestos in Bulk Insulation Samples", EPA, Dec. 1982.

The requirements for testing of inorganics (metals) will be in accordance with SOW-7-87-Inorganics. The requirements for testing of HSL organics (volatiles, semi-volatiles and PCBs) will be in accordance with SOW-7-87-Organics. The sensitivity required for the parameters to be tested are the detection limits shown in Table C1-3. The accuracy and precision criteria for the parameters to be tested are shown on Table C1-4.

Table C1-3
Target Compound List (TCL) and
Required Detection Limits (RDL)*

	VOLATILES	CAS Number	Detection Limits** Water ug/L	Low Soil/Sediment[a] ug/Kg
1.	Chloromethane	74-87-3	10	10
2.	Bromomethane	74-83-9	10	10
3.	Vinyl Chloride	75-01-4	10	10
4.	Chloroethane	75-00-3	10	10
5.	Methylene Chloride	75-09-2	5	5
6.	Acetone	67-64-1	10	10
7.	Carbon Disulfide	75-15-0	5	5
8.	1,1-Dichlorethane	75-35-4	5	5
9.	1,1-Dichloroethene	75-34-3	5	5
10.	1,2-Dichloroethene (total)	550-59-0	5	5
11.	Chloroform	67-66-3	5	5
12.	1,2-Dichloroethane	107-06-2	5	5
13.	2-Butanone	78-93-3	10	10
14.	1,1,1-Trichloroethane	71-55-6	5	5
15.	Carbon Tetrachloride	56-23-5	5	5
16.	Vinyl Acetate	108-05-4	10	10
17.	Bromodichloromethane	75-27-4	5	5
18.	1,2-Dichloropropane	78-87-5	5	5
19.	cis-1,3-Dichloropropene	10061-01-5	5	5
20.	Trichloroethene	79-01-6	5	5
21.	Dibromochloromethane	124-48-1	5	5
22.	1,1,2-Trichloroethane	79-00-5	5	5
23.	Benzene	71-43-2	5	5
24.	trans-1-3-Dichloropropene	10061-02-6		
25.	Bromoform	75-25-2	5	5
26.	4-Methyl-2-pentanone	108-10-1	10	10
27.	2-Hexanone	591-78-6	10	10
28.	Tetracloroethene	127-18-4	5	5
29.	Toluene	108-88-3	5	5
30.	1,1,2,2-Tetrachloroethane	79-34-5	5	5
31.	Chlorobenzene	108-90-7	5	5
32.	Ethyl Benzene	100-41-4	5	5
33.	Styrene	100-42-5	5	5
34.	Xylenes (Total)	1330-20-7	5	5
35.	Phenol	108-95-2	10	330
36.	bis(2-Chloroethyl) ether	111-44-4	10	330
37.	2-Chlorophenol	95-57-8	10	330
38	1,3-Dichlorobenzene	541-73-1	10	330
39.	1,4-Dichlorobenzene	106-46-7	10	330

Table C1-3 (continued)
Target Compound List (TCL) and
Required Detection Limits (RDL)*

	SEMI-VOLATILES	CAS Number	Detection Limits** Water ug/L	Low Soil/Sediment[a] ug/Kg
40.	Benzyl alcohol	100-51-6	10	330
41.	1,2-Dichlorobenzene	95-50-1	10	330
42.	2-Methylphenol	95-48-7	10	330
43.	bis(2-Chloroisopropyl) ether	108-60-1	10	330
44.	4-Methylphenol	106-44-5	10	330
45.	N-Nitroso-di-n-dipropylamine	621-64-7	10	330
46.	Hexachloroethane	67-72-1	10	330
47.	Nitrobenzene	98-95-3	10	330
48.	Isophorone	78-59-1	10	330
49.	2-Nitrophenol	88-75-5	10	330
50.	2,4-Dimethylphenol	105-67-9	10	330
51.	Benzoic acid	65-85-0	50	1600
52.	bis(2-Chloroethoxy) methane	111-19-1	10	330
53.	2,4-Dichlorophenol	120-83-2	10	330
54.	1,2,3-Trichlorobenzene	120-82-1	10	330
55.	Naphthalene	91-20-3	10	330
56.	4-Chloroaniline	106-47-8	10	330
57.	Hexachlorobutadiene	87-68-3	10	330
58.	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59.	2-Methylnaphthalene	91-57-6	10	330
60.	Hexachlorocyclopentadiene	77-47-4	10	330
61.	2,4,6-Trichlorophenol	88-06-2	10	330
62.	2,4,5-Trichlorophenol	95-95-4	50	1600
63.	2-Chloronaphthalene	91-58-7	10	330
64.	2,Nitroaniline	88-74-4	50	1600
65.	Dimethylphthalate	131-11-3	10	330
66.	Acenaphthylene	208-96-8	10	330
67.	2,6-Dinitrotoluene	606-20-2	10	330
68.	3-Nitroaniline	99-09-2	50	1600
69.	Acenaphthene	83-32-9	10	330
70.	2,4-Dinitrophenol	51-28-5	50	1600
71	4-Nitrophenol	100-02-7	50	1600
72.	Dibenzofuran	132-64-9	10	330
73.	2,4-Dinitrotoluene	121-14-2	10	330
74.	Diethylphthalate	84-66-2	10	330

Table C1-3 (continued)
Target Compound List (TCL) and
Required Detection Limits (RDL)*

	SEMI-VOLATILES	CAS Number	Detection Limits** Water ug/L	Low Soil/Sediment[a] ug/Kg
75.	4-Chlorophenyl-phenyl ether	7005-72-3	10	330
76.	Fluorene	86-73-7	10	330
77.	4-Nitroaniline	100-01-6	50	1600
78.	4-6-Dinitro-2-methylphenol	534-52-1	50	1600
79.	N-nitrosodiphenylamine	86-30-6	10	330
80.	4-Bromophenyl-phenylether	101-55-3	10	330
81.	Hexachlorobenzene	118-74-1	10	330
82.	Pentachlorophenol	87-86-5	50	1600
83.	Phenanthrene	85-01-8	10	330
84.	Anthracene	120-12-7	10	330
85.	Di-n-butylphthalate	84-74-2	10	330
86.	Fluroanthene	206-44-0	10	330
87.	Pyrene	129-00-0	10	330
88.	Butylbenzylphthalate	85-68-7	10	330
89.	3,3'-Dichlorobenzidine	91-94-1	20	660
90.	Benzo(a)anthracene	56-55-3	10	330
91.	Chrysene	218-01-9	10	330
92.	Bis(2-Ethylhexyl)phthalate	117-81-7	10	330
93.	Di-n-octylpthalate	117-84-0	10	330
94.	Benzo(b)fluoranthene	205-99-2	10	330
95.	Benzo(k)fluoranthene	207-08-9	10	330
96.	Benzo(a)pyrene	50-32-8	10	330
97.	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98.	Dibenz(a,H0anthracene	53-70-3	10	330
99.	Benzo(g,h,i)perylene	191-24-2	10	330
	PCBs			
100.	Aroclor-1016	12674-11-2	0.5	80.0
101.	Aroclor-1221	11104-28-2	0.5	80.0
102.	Aroclor-1232	11141-16-5	0.5	80.0
103.	Aroclor-1242	53467-21-9	0.5	80.0
104.	Aroclor-1248	12672-29-6	0.5	80.0
105.	Aroclor-1254	11097-69-1	1.0	160.0
106.	Aroclor-1260	11096-82-5	1.0	160.0
107.	PBBs (hexa bromo biphenyl)	-	0.5	-

Table C1-3 (continued)

Notes:

[a]Medium Soil/Sediment Required Detection Limits (RDL) for Pesticide/PCB. TCL compounds are 15 times the individual Low Soil/Sediment RDL.

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

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

TABLE C1-3 (CONTINUED)
INORGANIC TARGET ANALYTE LIST (TAL)

Analyte	Required Detection Limit (1) ug/L
Aluminum	200
Antimony	60
Total Arsenic	10
Total Chromium	10
Asbestos	
Lead	5

(1) Subject to the restrictions specified in SOW-7-87-Inorganics.

Table C1-4
Accuracy and Precision Criteria for Analytical Testing

Method	Audit	Control Units
AA Flame	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Matrix Spike Analysis	75-125%
	Duplicate Sample Analysis	±D.L. or 20% RPD*
	Laboratory QC Sample Analysis	80-120%

*RPD = Relative % Difference

AA-Furnace	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Matrix Spike Analysis	75-125%
	Duplicate Sample Analysis	±D.L. or 20% RPD
	Laboratory QC Sample Analysis	80-120%
	Duplicate Injections	±20% RPD

ICP	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Interference Check Sample	±20%
	Serial Dilution Analysis	±10%
	Matrix Spike Analysis	75-125%
	Duplicate Sample Analysis	±D.L. or 20% RPD
	Laboratory QC Sample Analysis	80-120%
	Duplicate Injections	±20% RPD

Table C1-4 (continued)

SURROGATE SPIKES

Fraction	Surrogate Compound	Recovery Limits Low/Medium Water	Recovery Limits Low/Medium Soil/Sediment
VOA	Toluene-d_8	88-110	81-117
VOA	4-Bromofluorobenzene	86-115	74-121
VOA	1,2-Dichloroethane-d_4	76-114	70-121
BNA	Nitrobenzene-d_5	35-114	23-130
BNA	2-Fluorobiphenyl	43-116	30-115
BNA	p-Terphenyl-d_{14}	33-141	18-137
BNA	Phenol-d_5	10-94	24-113
BNA	2,4,6-Tribromophenol	10-123	19-122

MATRIX SPIKE/MATRIX SPIKE DUPLICATES*

Fraction	Matrix Spike Compound	Recovery Limits Water	RPD Water	Recovery Limits Soil/ Sediment	RPD Soil/ Sediment
VOA	1,1-Dichloroethene	61-145	14	59-172	22
VOA	Trichloroethene	71-120	14	62-137	24
VOA	Chlorobenzene	75-130	13	60-133	21
VOA	Toluene	76-125	13	59-139	21
VOA	Benzene	76-127	11	66-142	21

Fraction	Matrix Spike Compound	Recovery Limits Water	RPD Water	Recovery Limits Soil/ Sediment	RPD Soil/ Sediment
BN	Pyrene	26-117	31	35-142	36
Acid	Phenol	12-89	42	26-90	35

PCBs) To be developed by selected
) contractor/laboratory
PBBs Fire Master BP-6)

*These limits are for advisory purposes only. They will not be used to determine if a sample should be reanalyzed. Spiking levels and procedures will be in accordance with CLP Statement of Work for Organic Analysis, SOW-7-87-Organics.

Table C1-4
Accuracy and Precision Criteria for Analytical Testing

Method	Audit	Control Units
AA Flame	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Matrix Spike Analysis	75-125%
	Duplicate Sample Analysis	±D.L. or 20% RPD*
	Laboratory QC Sample Analysis	80-120%

*RPD = Relative % Difference

AA-Furnace	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Matrix Spike Analysis	75-125%
	Duplicate Sample Analysis	±D.L. or 20% RPD
	Laboratory QC Sample Analysis	80-120%
	Duplicate Injections	±20% RPD

ICP	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Interference Check Sample	±20%
	Serial Dilution Analysis	±10%
	Matrix Spike Analysis	75-125%
	Duplicate Sample Analysis	±D.L. or 20% RPD
	Laboratory QC Sample Analysis	80-120%
	Duplicate Injections	±20% RPD

The accuracy of field measurements of pH will be assessed through pre-measurement calibrations using at least two standard buffer solutions. The two measurements must each be within ± 0.05 standard units of the buffer solution values. Precision will be assessed through replicate measurements. (The electrode will be withdrawn, rinsed with deionized water, and re-immersed between each replicate). The instrument used will be capable of providing measurements to 0.1 standard unit.

4.3. Completeness, Representativeness and Comparability

It is expected that the laboratory will provide data meeting QC acceptance criteria for 95 percent or more of all samples tested. Valid data are required for samples to be used in assessing background concentrations.

The sampling network was designed to satisfy Consent Decree requirements. During development of this network, consideration was given to past site operations and practices, existing analytical data and physical setting and processes. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data, as documented in this QAPP, are expected to provide comparable data.

4.4. Field Measurements

Measurements and observations will be made in many field activities that are incidental to collecting samples for analytical testing or unrelated to sampling. These activities include, but are not limited to, the following:

- Documenting time and weather conditions,
- Locating and determining the elevation of sampling stations,
- Determining depths in a borehole or well,
- Calculating pumping rates, and
- Verifying well development and pre-sampling purge volumes.

The general QA objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of such data through the documented use of standard procedures.

5.0 SAMPLING/MONITORING PROCEDURES

Procedures for sampling/monitoring to be conducted as part of the Remedial Action are described in the following documents presented as Appendices C1-A, C1-B and C1-C.

A. Soil Cover Monitoring Plan

B. Active Waste Disposal Areas Sampling Plan

C. Groundwater and Surface Water Monitoring Program

Procedures for 1) sampling 2) equipment and sampler decontamination, 3) sample numbering, and 4) collecting field blanks and duplicates are specified where appropriate. Also included (in Appendix C1-D) are listings of the type, size and number of sample bottles to be used.

6.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Successful implementation of a sampling or monitoring program depends on the capability to produce valid data and to demonstrate such validity. In addition, proper sample collection, preservation, storage and handling, as well as appropriate sample identification and chain of custody procedures are necessary to help ensure the validity of the data.

Sample custody procedures for this project will be similar to the procedures detailed under "Sample Identification and Custody Procedures" of the User's Guide to the EPA Contract Laboratory Program dated August, 1982. A brief summary is presented in this section.

6.1 Sample Handling, Shipping and Custody

U.S. EPA sample handling, shipping and custody procedures will be followed. The samples will be collected in pre-washed containers. Sample containers, quantities and preservation techniques are presented in Appendix C1-D. Following sampling, the sample containers will be decontaminated. The sample containers will be identified by a sample label. Labels on field blanks and duplicate samples will be marked with an "FB" or "D" suffix, respectively.

A chain of custody will be maintained for each sample collected. The chain of custody will provide an accurate written record which can be used to trace the possession and holding of samples from the time of collection through data analysis and reporting. The following information will be specified for each sample on the sample label and chain of custody form: 1) sequential sample number, 2) sample date, 3) sample time, 4) sample location (and depth where appropriate), and 5) analyses to be performed. The chain of custody form will be signed by each sampling participant. It will be placed in a water tight plastic bag and taped to the underside of the lid of the cooler containing the samples designated on the form. The lid of the cooler will be securely taped shut, utilizing evidence tape to allow detection of any possible tampering. Upon arrival in the laboratory, samples will be checked in by the laboratory representative. All samples contained in the shipment will be compared to the chain of custody form to ensure that all samples designated have been received. Also, record of chain of custody within the laboratory will be maintained.

6.2 Field Documentation

Field log books (also field notebooks) will provide the means of recording data collection activities performed. As such, entries will be described in as much detail as possible so that persons

going to the site could reconstruct a particular situation without reliance on memory. Photographs may be used to supplement field notes where applicable.

Field log books will be bound, field survey notebooks. Log books will be assigned to field personnel, but will be stored in the field project file when not in use. Each log book will be identified by a project specific number. The title page of each notebook will contain: 1) person or organization to whom the book is assigned, 2) book number, 3) project name, 4) start and end dates.

Entries into the log book will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling and/or investigative personnel present, and the signature of the person making the entry will be entered. The names of visitors to the site and the purpose of their visit will be recorded in the field log book.

Measurements and observations made as well as information on samples collected will be recorded. All entries will be made in waterproof ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Wherever a sample is collected or a measurement/observation is made, a detailed description will be recorded. All equipment used to make measurements will be identified.

The equipment used to collect samples will be noted, along with the time of collection, sample description, depth at which sample was collected, volume and number of containers. Sample identification numbers, assigned prior to sample collection, are presented in the Sampling/Monitoring Plans. Duplicates and field blanks, which receive separate sample numbers, will be noted under sample description.

6.3 Project File

A project file will be maintained by the Manville Remedial Construction Manager which will contain complete project documentation. This file will include: project plans and specifications, field logbook and data records, photographs, maps and drawings, sample identification documents, chain of custody records, process and technical reports, correspondence and other information. The file will also contain analytical data provided by the laboratory (Section 9.0): QC documentation, copies of raw data, gas chromatographs, mass spectographs, data validation notes, references and literature, report notes and calculations.

7.0 CALIBRATION CONTROL

Laboratory calibration procedures for testing analytical parameters will be performed in accordance with the CLP Statement of Work. Calibration of instrumentation used in the analyses of inorganics will conform to the procedures in SOW-7-87-Inorganics. Calibration of

instrumentation used in the anlayses of HSL organics (volatiles, semi-volatiles, and PCBs) will conform to the procedures in SOW-7-87-Organics. Calibration of instruments for PBBs will be in conformance with the analytical procedure attached in Appendix C1-E.

The field instruments will be calibrated prior to their use. The calibration procedures will follow standard manufacturer's instructions to assure that the equipment is functioning within tolerances established by the manufacturer and analytical requirements. In absence of manufacturer's instructions, a specific calibration and operations instruction sheet will be prepared.

Field calibration procedures will be performed on field instrumentation as follows:

- pH Meter - premeasurement calibration using at least two standard buffer solutions for each sample tested. The buffer solutions should bracket the sample pH. The two measurements must be within ±0.05 standard pH unit of buffer solution values.

- Conductivity Meter - daily calibration using potassium chloride (KCl) standard solution. The meter measurement must read within ±10 percent of the standard solution value.

- Temperature - temperature is measured using a thermostat built into the Conductivity Meter. The readings will be checked at least once at the start of the field use of the instrument using a quality grade thermometer.

8.0 ANALYTICAL PROCEDURES

The analytical methods which will be used to test each parameter in water, sediments and soils are listed in Table C1-5. The analytical procedures for testing the RAS parameters will be in accordance with those specified in the CLP Statements of Work or equivalent. The analytical procedures for testing the inorganics (metals) will conform to those specified in SOW-7-87-Inorganics. The analytical procedures for testing the HSL organics (volatiles, semi-volatiles, and PCBs) will conform to those specified in SOW-7-87-Organics.

The analytical procedure for PBB testing will be the same as for PCBs/Pesticides except that a different column and an Electron Capture Detector will be utilized.

Bulk asbestos in the soil/sediment sludge will be analyzed by the standard Polarized Light Microscopic procedures as outlined in the "Interim Method for Determination of Asbestos in Bulk Insulation Samples", EPA - December, 1982. Asbestos in water samples will be anlayzed by standard Transmission Electron Microscopic procedures as outlined in the "Interim Method for Determining Asbestos in Water", EPA-600-4-80-005.

Table C1-5
Analytical Methods

PARAMETERS	ANALYTICAL METHODS				
Metals (1)(2)(3)	ICP 200.7 CLP-M	or	AA-Flame CLP-M	or	AA-Furnace CLP-M
Volatile Organic	EPA Method 624 CLP-M (GC/MS)				
Semi-Volatile Organics	EPA Method 625 CLP-M (GC/MS)				
PCBs/PBB	EPA Method 608 CLP-M (GC with ECD) (Detailed method enclosed)				
Asbestos (soil)	PLM Method - EPA - Interim Method				
Asbestos (water)	TEM Method - EPA-600-4-80-005				

Notes:

(1) Testing for metals will conform to the procedures in Contract Laboratory Program Statement of Work (SOW) for Inorganic Analysis, SOW-7-87-Inorganics.

(2) Preparation of samples for metals testing will conform with the following procedures in SOW-7-87-Organics:

- Furnace Digestion Procedures for Water
- ICP/Flame AA Digestion Procedures for Water
- Sample Preparation of Sediments, Sludges and Soils (acid digestion).

(3) Any analytical method listed in the SOW may be used as long as the documented instrument or method detection limits meet the detection limit requirement shown on Table C1-3. Analytical methods with higher detection lmits may be used only if the sample concentration exceeds twice the documented detection limit of the instrument or method.

9.0 DATA REDUCTION, VALIDATION, REPORTING AND ASSESSMENT

The contractor/analytical laboratory will review appropriate laboratory quality control data to assure the validity of the analytical results provided to the Contractor. "Laboratory Data Validation, Functional Guidelines for Evaluating Organic Analyses", February 1, 1988 and "Laboratory Data Validation", Functional Guidelines for Evaluating Inorganic Analyses, April, 1988 will be used for organic (including PBB) and inorganic analyses data validation, respectively. For asbestos lab blanks, calibration standard, field blanks and duplicate sample results as well as sample integrity, data entry and calculations and sample representativeness will be evaluated during data validation. The analytical laboratory will prepare and retain full analytical and QC documentation.

Analytical laboratory will follow CLP protocols for data reduction and reporting. Data reporting would include raw data on laboratory blanks, calibration checks, chromatograms, surrogate spike recovery data etc. Any deviation from the analytical method shall be reported by the analytical laboratory. Special reporting such as concentrations in soil on a dry or wet weight basis shall be delineated in reporting of the data. All data will be reported in the generally acceptable reporting units.

Data reduction and data reporting for asbestos will be in comformance with "Interim Method for Determining Asbestos in Water", EPA-600-4-80-005 and "Interim Methods for Determination of Asbestos in Bulk Insulation Samples," U.S. EPA, December, 1982.

The analytical laboratory will also provide the following information to the RCM and CSM.

9.1 Test Methods and Results

-analytical test methods and results for submitted samples, field blanks, duplicates and trip blanks (VOA only) with appropriate quality notations, and indication of test methods used.

9.2 Miscellaneous Information

-miscellaneous information, including a statement of samples received, a description of deviations from the QAPP, or explanation of qualifications regarding data quality and other significant items encountered during analysis.

9.3 QA/QC report:

9.3.1 Organic Parameters:

- surrogate spike results for each sample
- matrix spike and matrix spike duplicate results
- method blank results
- initial calibration verification results
- continuous calibration check

9.3.2 Inorganic Parameters:

- spike and duplicate results
- method blank results
- initial calibration verification results
- continuous calibration check

9.3.3 Asbestos:

- lab blanks and calibration standard results

9.4 Data Assessment

Each analytical data package submitted will contain items 9.1 through 9.3 above for a discrete set or case of samples analyzed. Where such grouping is not applicable, the analytical laboratory will identify the test results associated with each QC sample.

Data assessment will be accomplished by the joint efforts of the laboratory and the RCM/CSM. The data assessment by the RCM/CSM will be based on the criteria that the sample was properly collected and handled according to the Sampling Plans and Section 6.0 of this QAPP.

The RCM/CSM will conduct a systematic review of the data omissions and interact with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the RCM/CSM based on the extent of the deficiencies and their importance in the overall context of the project.

All data generated during this project will be stored in the Project File (see Section 6.3).

Following data review, all data generated for the project will be put in a format organized to facilitate data review and evaluation. The data set will include the data flags provided by the laboratory (in accordance with the CLP Statments of Work), as well as additional comments of the data reviewer. The laboratory provided data flags include such items as: 1) concentration below required detection limit, 2) estimated concentrations due to poor spike recovery, and 3) concentrations of chemicals also found in laboratory blank. Additional comments will address if the data is: 1) useable as a quantitative concentration, 2) useable with caution as an estimated concentration, or 3) unuseable due to out-of-control QC results.

10.0 INTERNAL QC CHECKS

Inorganic and organic testing will be performed in accordance with procedures specified in the CLP Statements of Work, SOW-7-87-Inorganics and SOW-7-87-Organics for inorganic and organic analysis respectively.

There are two types of quality assurance used to ensure the production of analytical data of known and documented useable quality: analytical method quality control (QC), and program quality assurance (QA). The internal quality control procedures associated with testing of the parameters have been described in Section 4.0.

It will be the laboratory's responsibility to document, in each data package provided, that both initial and ongoing instrument and analytical QC functions have been met. Any samples analyzed in non-conformance with QC criteria will be reanalyzed by the laboratory when sufficient sample volume is available and the allowed holding time is not exceeded.

11.0 PERFORMANCE AND SYSTEM AUDITS

System audits are performed on a semi-continuous basis as appropriate throughout the duration of the project. The Contractor/Consultant Site Manager (CSM) is responsible for supervising and checking that samples are collected and handled in accordance with the approved project plans and that documentation of field work is adequate and complete. The RCM/CSM is responsible for overseeing that the project performance satisfies the QA objectives, as set out in this QAPP.

Performance audits of laboratories participating in the CLP or approved for CLP-type testing are performed in accordance with the procedures and frequencies established for the CLP by EPA.

The Quality Assurance Auditor is responsible for monitoring and auditing the performance of the QA procedures listed in this plan. He will maintain continuous communication with the RCM/CSM. Also, external audits will be performed by the Contract Project Management Section (CPMS) of Region V, Central Regional Laboratory (CRL).

12.0 PREVENTIVE MAINTENANCE

A routine preventive maintenance program is conducted by the laboratory to minimize the occurrence of instrument failure and other system malfunction. Field instruments will be checked and calibrated prior to their use on-site and batteries will be charged daily, where applicable.

13.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

Data assessment will be accomplished by the joint efforts of the Quality Assurance Auditor and RCM/CSM. The Quality Assurance Auditor will review the analytical results for compliance with the established QC criteria as described in Section 9.0. The data assessment by the RCM/CSM will be based on the criteria that the sample was properly collected and handled in accordance with the Sampling Plans and Section 6.0; and the QA/QC Criteria of Section 9.0 of this QAPP. Any problems arising during sample collection, packing, shipping or analysis will be taken into consideration during the data assessment.

14.0 CORRECTIVE ACTION

Quality control corrective action consists of those corrective actions following a failure to meet quality control criteria specified in this QAPP. Actions taken will consist of two types: those resolved within the analytical laboratory and those resolved outside the laboratory. Examples outlining the differences between these two types of corrective actions are as follows:

WITHIN LABORATORY ACTION:

QC Failure	Department Action
o Tuning results for GC/MS fail criteria	Analyst retunes instrument
o RPD and percent recoveries fail criteria, and sample holding times have not expired	Analyst investigates problem and reruns analyses
o Standard curve correlation coefficient is less than 0.995	Analyst reruns curve

OUTSIDE LABORATORY ACTION:

QC Failure	Department Action
o Holding times are exceeded	Notify QA Auditor resampling may be necessary

The Project QA Auditor along with the RCM/CSM will be responsible for initiating the corrective action. Nonconformance with the established quality control procedures will be identified and controlled. The U.S. EPA Remedial Project Manager will be responsible for approving the corrective action.

15.0 QUALITY ASSURANCE REPORTS

The complete and correct implementation of this QAPP will be reviewed by the RCM/CSM. Any deviations from this QAPP or any concern arising during the project requiring significant changes in the QAPP also will be identified by the RCM/CSM. The RCM/CSM will propose adjustments required to Manville Corporation, Project Coordinator and U.S. EPA, and after approval by U.S. EPA, will ensure their implementation. The QA related information will be contained within the monthly progress reports to U.S. EPA, as applicable. No separate QA reports will be submitted.

16.0 SAMPLING/MONITORING PROGRAMS

The objective of a sampling/monitoring plan is to provide a document detailing procedures and practices to be used during the Remedial Action. Sampling/Monitoring plans for soil cover, groundwater and surface water, and the active waste disposal areas are part of this QAPP and are presented in Appendices C1-A to C1-C.

APPENDIX C1-A

SOIL COVER MONITORING PLAN

SOIL COVER MONITORING PLAN

1.0 INTRODUCTION

As part of the Remedial Action at the Johns-Manville Disposal Area in Waukegan, Illinois, a 24-inch thick soil cover with vegetation will be placed over specified areas. All cover materials will be tested for asbestos prior to placement, and the cover density will be tested in the field, as described in Attachment B of the Amended Work Plan. This Monitoring Plan documents procedures to be followed during the monitoring events.

2.0 MONITORING AND SAMPLING PROCEDURES

2.1 Visual Monitoring

Visual monitoring will begin after completion of the Remedial Construction Work and will consist of two separate visual events each year for a minimum period of thirty (30) years and monitoring requiqrements will be reevaluated at that time. The two annual monitoring events will be:

1. Soil cover monitoring. (Late Spring Monitoring)
2. Vegetative cover monitoring. (Late Fall Monitoring)

The visual monitoring will be conducted during late spring and will involve visual monitoring of the entire surface of the covered waste disposal areas for asbestos-containing waste materials and cave-ins. The vegetative cover monitoring will be conducted during late fall and will involve visual monitoring for bare or eroded surfaces/areas.

The procedure for visual monitoring of soil and vegetative covers will involve walking the entire site and looking for:

1. Asbestos-containing materials on the surface.
2. Cave-ins and ponded areas.
3. Bare spots.
4. Soil-eroded spots.

2.2 Soil Boring

In addition to the visual monitoring as presented above, soil borings will be made to monitor up-migration of asbestos-containing plant (manufacturing) waste material and collect soil samples for bulk asbestos analysis as required. Twenty-four inch (24") deep borings in the soil cover will be made at ten locations. The locations for soil borings will be mutually agreed upon by Manville and U.S. EPA after the soil cover is completed.

The procedure for this monitoring effort will involve hand driving a split spoon to a total depth of 24", and visually inspecting the core in six inch sections for asbestos-containing waste material.

core in six inch sections for asbestos-containing waste material. If no asbestos-containing waste material is observed visually in any core, the lower 6" core/sample will be analyzed for asbestos. In the event asbestos-containing waste material is observed in any of the cores, all 6" cores/samples (total of 4 samples) for that boring will be analyzed for bulk asbestos. Boreholes will be backfilled with sand from the borrow area.

Soil samples will be transferred from the split spoon to a stainless steel bowl, split lengthwise and placed in two 8 oz. glass jars. When analyzed, both halves will be treated as a single sample. The number of jars will be determined by the frequency of soil sampling events and the observance of asbestos in the soil. One duplicate sample will be collected for every 10 soil samples.

Soil cover boring will be conducted immediately after completion of the Remedial Construction Work and once again after five years. If no asbestos-containing plant waste material is encountered in the 12"-18" depth range of the sample core, the soil cover borings will be made every ten years after the two, initial boring events. If asbestos-containing material is encountered within 12" - 18" depth range, then the frequency of soil cover borings, thereafter, will be once every five years.

The total period of soil cover boring efforts will be a minimum of thirty years, similar to that of visual monitoring. After the period of thirty years, the need for further monitoring, if any, will be evaluated and approved by U.S. EPA and IEPA.

3.0 REMEDIAL CONTINGENCY PLAN

A contingency plan will be developed and submitted to U.S. EPA and IEPA for review and approval or conditional approval for evaluation of the upward migration of asbestos-containing material when it is encountered at levels above cover background levels at a 12" depth (6"-12" interval) in any core. The contingency plan developed will address remedial measures and a schedule for implementation.

U.S. EPA will evaluate the contingency plan and determine the need for implementation of remedial measures identified in the contingency plan based on the standards contained in Section 104A of CERCLA 42 USC Section 9604A.

4.0 SAMPLE ANALYSIS

Soil boring core samples will be analyzed for bulk asbestos using the NIOSH method 7400 (or currently accepted method).

5.0 PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION PROCEDURES

Level D personal protection will be utilized, including:

- Work clothes
- Outer gloves
- Particle/dust masks (Optional)
- Steel toe boots and hard hats (Optional)

All sampling equipment will be decontaminated between boreholes with a soap wash, tap water rinse and distilled water rinse to avoid cross-contamination by asbestos. Outer gloves will be cleaned between sample locations. Wash and rinse waters will be disposed of on-site.

6.0 SAMPLE DOCUMENTATION

A sample numbering system will be used for positive identification and to allow tracking, retrieval and cross referencing of sample information. Examples of sample numbers are shown below.

Example: MRA-SC01-02-D

where:

MRA	=	Manville Remedial Action
SC01	=	soil cover location no. 1
02	=	second depth range (6-12")
D	=	duplicate

MRA-SC10-04

SC10	=	soil cover location no. 10
04	=	fourth depth range (18-24")

Measurements and observations will be documented in the field notebook. Additional information on sampling documentation can be found in Section 6.2 of the QAPP (C1).

7.0 SAMPLE PRESERVATION, PACKAGING AND SHIPPING

As outlined in Appendix C1-D, soil samples to be analyzed for asbestos will be placed in two 8 oz. wide-mouth glass jars with a Teflon-lined cap. No ice or preservatives are required. Packaging and shipping information is included in Section 6.1 of the QAPP (C1).

APPENDIX C1-B

ACTIVE WASTE DISPOSAL AREAS SAMPLING PLAN

ACTIVE WASTE DISPOSAL AREAS SAMPLING PLAN

1.0 INTRODUCTION

The miscellaneous disposal pit will be sampled to verify that no asbestos-containing waste materials have been deposited in this pit. The sludge disposal pit will be sampled to verify that no asbestos-containing sludge is near the surface. The influent to the process wastewater treatment system will be sampled and tested for total chromium, lead, total arsenic, antimony, aluminum, full scan of HSL volatiles, semi-volatiles, PCBs and PBBs. These sampling activities are designed to be carried out once for initial monitoring and after each significant process change, if any, in the future. A significant process change would be defined as one which is likely to alter the type and/or the level of hazardous pollutant(s) in the process waste water.

This sampling plan details the procedures to be followed for sampling the active waste disposal areas (miscellaneous disposal pit, sludge disposal pit and wastewater treatment influent); it documents sample collection, sample processing and sample documentation procedures.

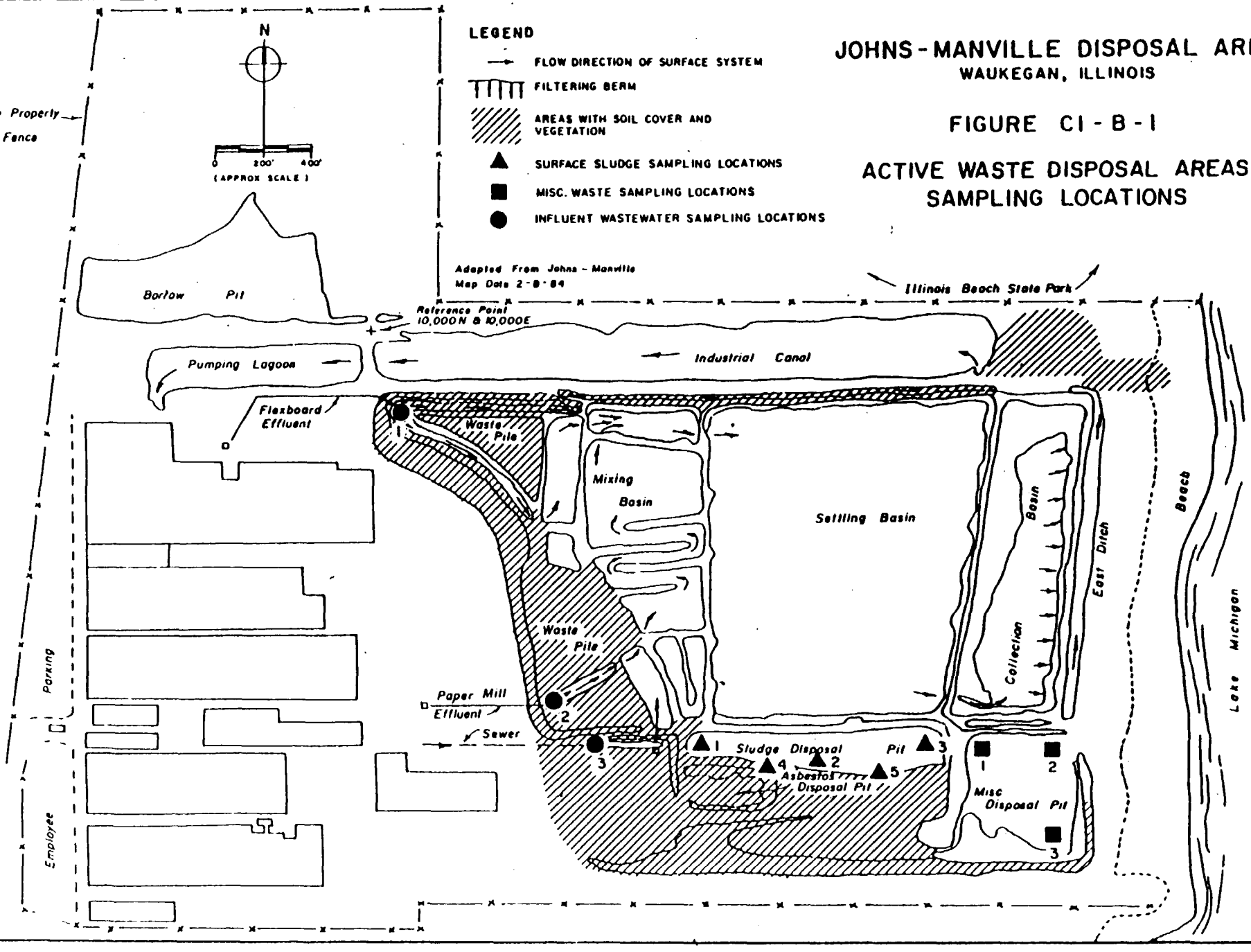
2.0 SAMPLE LOCATIONS

The miscellaneous disposal pit will be sampled at three locations and the sludge disposal pit will be sampled at five locations, as shown in Figure C1-B-1. Samples (for asbestos only) will be collected from three different areas around each of the sampling locations and composited to make one representative sample for that location. Sample Nos. 4 and 5 in the sludge disposal pit will be collected from the side slopes. Locations shown in Figure C1-B-1 are approximate and may be modified by U.S. EPA representatives on-site.

There are three potential process wastewater discharge lines (influent sewer line, paper mill effluent and flexboard effluent) and the flexboard effluent line is not in use at this time. Only the lines active at the time of sampling will be monitored at their entry to the respective treatment ditches at the locations shown in Figure C1-B-1.

3.0 EQUIPMENT

- Brass or steel shovels
- Isco samplers
- Clean glass jars, polyethylene and glass sample bottles, VOA vials
- Stainless steel spatula
- Brushes, buckets, pans, and bowls
- Plastic bags
- Soap (Alconox or equivalent)
- Water (distilled and tap)


JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
FIGURE CI-B-1
ACTIVE WASTE DISPOSAL AREAS
SAMPLING LOCATIONS
LEGEND
FLOW DIRECTION OF SURFACE SYSTEM
FILTERING BERM
AREAS WITH SOIL COVER AND VEGETATION
SURFACE SLUDGE SAMPLING LOCATIONS
MISC. WASTE SAMPLING LOCATIONS
INFLUENT WASTEWATER SAMPLING LOCATIONS
Adapted From Johns - Manville
Map Date 2-8-84
N
0 200' 400'
(APPROX SCALE)
Manville Property Line Fence
Borlow Pit
Reference Point 10,000N & 10,000E
Illinois Beach State Park
Industrial Canal
Pumping Lagoon
Flexboard Effluent
Waste Pile
Mixing Basin
Settling Basin
Collection Basin
East Ditch
Beach
Lake Michigan
Waste Pile
Paper Mill Effluent
Sewer
Sludge Disposal Pit
Asbestos Disposal Pit
Misc Disposal Pit
Parking
Employee

4.0 SAMPLING PROCEDURES

Sludge samples from the Sludge Disposal Pit and Miscellaneous Disposal Pit will be collected from the surface (0 to 12" depth) and near surface (12" to 24" depth) of both pits by using shovels. Waste/sludge samples from three different areas (within a 5 foot radius) around each sampling location will be thoroughly mixed in a stainless steel bowl and used to fill two glass jars from each of the eight sampling locations. Each sample will be split into two jars in case there is any breakage. All sample containers will be supplied by the analytical laboratories. No preservatives are necessary. A total of 18 samples (34 + jars) will be collected in 8 oz. glass jars, as summarized below:

Location	0-12"	12-24"		Total # of Jars	Number of Samples Analyzed
Sludge Disposal Pit					
1	2	2	=	4	2
2	3 (D)	2	=	5	3
3	2	2	=	4	2
4	2	2	=	4	2
5	2	2	=	4	2
Miscellaneous Disposal Pit					
1	2	2	=	4	2
2	2	2	=	4	2
3	3 (D)	2	=	5	3
				34	18

D = Duplicate sample

Wastewater influent samples from the active lines will be collected during weekdays and composited over a period of 24 hours using automatic samplers. An ISCO sampler or any other 24-hour sampling device will pump a representative aliquot of sample from each of the influent locations into a glass jar. No flow proportioning device is planned. Production of the manufactured products is more or less uniform 24 hours/day on weekdays; therefore, any sample collected over a period of 24 hours during weekdays will be a representative sample for a typical weekday production. The wastewater will be analyzed for chromium, lead, arsenic, antimony, aluminum, volatiles, semi-volatiles, PCB's and PBB's. Only volatile organics samples will be grab samples and not out of the 24-hour sampler. All other samples will be collected from each location over 24-hour periods, once for initial monitoring and again after each significant process change, if any, in the future. A maximum of 19 samples (if all the three lines are active) will be collected as follows:

Location	HDPE metals 1 l.	Glass Organic VOAs 40 ml.	Glass Extractables 1 l.	No. of Samples Analyzed
1	1	2	2	3
2 (Matrix spike and MSD)	1	6	6	7
3 (D,FB)	3	6	6	9
				19

A maximum of 19 samples will be analyzed during the initial sampling of wastewater influent. The number of samples will decrease to 16 if one waste line is permanently shut down; otherwise it will be sampled as soon as it is in use again. These samples will be preserved and stored as specified in Appendix C1-D. The appearance and condition of collected samples will be recorded in the field log book.

5.0 SAMPLE ANALYSIS

As summarized above, 18 samples from the disposal pit (including two duplicates) will be analyzed for asbestos.

In addition, 16 samples (if one wastewater line is permanently shut down) or 19 influent wastewater samples will be analyzed for total arsenic, total chromium, lead, antimony, aluminum, full scan of HSL volatiles, semi-volatiles, PCB's and PBB's. One duplicate and one field blank sample will be collected and analyzed for every 10 samples or less collected. Also, one matrix spike and one MSD will be collected for every 20 or less samples. Also, one trip blank (two 40-ml vials) will be shipped with each VOA shipping. Trip blanks will be prepared using HPLC grade distilled water in the office, transported to the field and shipped without being opened in the field. The number of VOA vials needed for trip blanks will be determined by the number of VOA shipping packages.

6.0 PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION PROCEDURES

Level D personal protection will be utilized, including:

- Disposable Tyvek coveralls,
- Outer gloves,
- Particle/dust masks,
- Steel-toed boots,
- and Hard hats,

unless the site safety officer determines that greater protection is needed.

All the sampling equipment will be decontaminated between samples to avoid cross-contamination between samples and sampling locations. Equipment will be decontaminated near each sampling location, and placed in plastic bags or wrapped in a plastic sheet for transportation to the next sampling location. The decontamination will consist of:

- Soap (alconox or equivalent) solution wash
- Potable water rinse
- Distilled water rinse

Personnel decontamination will be conducted as described in the Health and Safety Plan, Attachment G to the Work Plan. Outer gloves will be decontaminated between samples and sampling locations. Wash and rinse solutions can be disposed of on-site.

7.0 SAMPLE DOCUMENTATION

Documentation will provide a complete record of procedures followed in the field; will permit accurate identification of samples and tracking of their status in the field, during shipment and at the laboratory; and will facilitate chain of custody and accountability procedures by providing legible and concise information.

A sample numbering system will be used for positive identification and to allow tracking, retrieval and cross referencing of sample information. Examples of sample numbers are shown below:

Example: MRA-SDP02-01-D

Where:

MRA	=	Manville Remedial Action
SDP02	=	Sludge Disposal Pit location no. 2
01	=	first depth range (0-12")
D	=	duplicate sample

MRA-MDP01-02

MDP01	=	Miscellaneous Disposal Pit location no. 1
02	=	second depth range (12-24")

MRA-WW01-01-FB

WW01	=	wastewater location no. 1
01	=	first 24 hr. round of sampling
FB	=	field blank collected at the location

Influent wastewater and sludge and waste disposal pit sampling activities will be documented through written entries in a field notebook as outlined in the QAPP. All field measurements and any other information specific to the sample will also be recorded.

Additional information on sampling documentation can be found in Section 6.2 of the QAPP (C-1).

8.0 SAMPLE PRESERVATION, PACKAGING AND SHIPPING

All samples will be preserved as presented in Appendix C1-D. Each sample container will be decontaminated and identified by a sample label. Labels on field blanks, duplicate samples or trip blank will be identified by "FB", "D" or "TB" suffix, respectively. The lid of each container will be taped shut to prevent any leakage. Each container will be stored and shipped in a cooler. Each cooler will be cushioned by vermiculite or other packaging material and at least two bags of ice will be placed in each cooler (except for coolers containing asbestos samples). Also, each cooler will contain the chain-of-custody form as detailed under Section 6.1 of QAPP C-1. The coolers will be either shipped or transported personally to the laboratory maintaining the chain-of-custody.

9.0 REMEDIAL CONTINGENCY PLANS

Remedial Contingency Plans are detailed in the following sections for Miscellaneous and Sludge Disposal pits and the Wastewater Treatment System.

9.1 Miscellaneous and Sludge Disposal Pits Remedial Contingency Plan

If any asbestos is detected in the Miscellaneous Disposal Pit or Sludge Disposal Pit, that pit will be provided with a soil cover consistent with the Consent Decree, and completed by May 31, 1990.

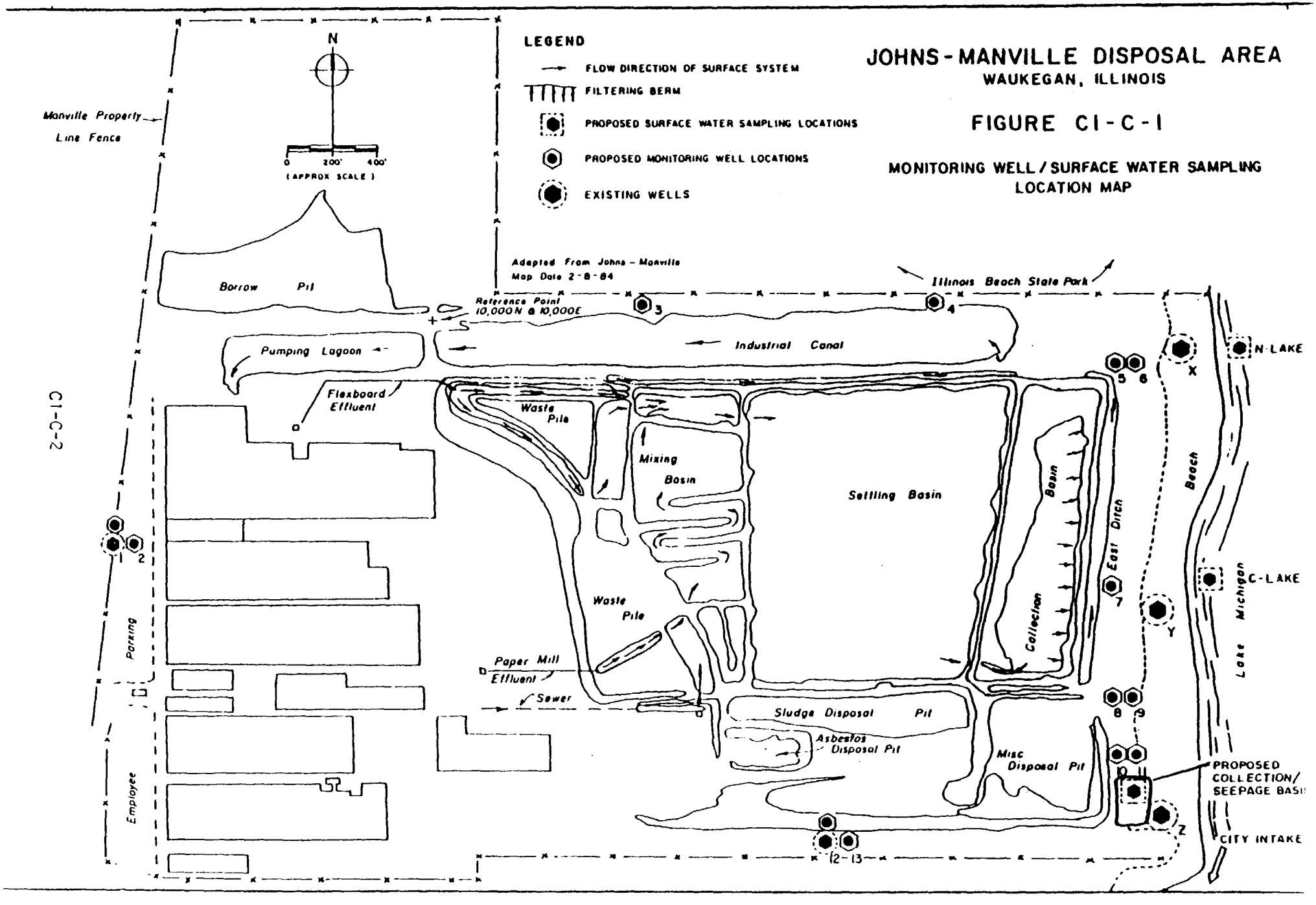
9.2 Wastewater Treatment System Remedial Contingency Plan

In the eveny any hazardous waste is identified to enter the process wastewater treatment system, a remedial contingency plan will be implemented. The Contingency Plan will include the identification of the compound against the list of materials received and manufactured by Manville. On the basis of this identification, discontinuance of the identified hazardous material or separate disposal of that hazardous waste stream will be evaluated.

A draft Work Plan, including a schedule for implementation of the above mentioned Contingency Plan, will be submitted to U.S. EPA and IEPA within 90 days of the sampling event for which analyses indicated hazardous waste entering the wastewater treatment system. A final Work Plan will be submitted within 30 days of Manville's receipt of U.S. EPA and IEPA comments on the draft work plan.

APPENDIX C1-C

GROUNDWATER AND SURFACE WATER MONITORING PROGRAM


JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
FIGURE CI-C-I
MONITORING WELL / SURFACE WATER SAMPLING LOCATION MAP
LEGEND
FLOW DIRECTION OF SURFACE SYSTEM
FILTERING BERM
PROPOSED SURFACE WATER SAMPLING LOCATIONS
PROPOSED MONITORING WELL LOCATIONS
EXISTING WELLS
N
0 200' 400'
(APPROX SCALE)
Adapted From Johns-Manville
Map Date 2-8-84
Manville Property Line Fence
Borrow Pit
Reference Point 10,000N & 10,000E
Illinois Beach State Park
Pumping Lagoon
Industrial Canal
Flexboard Effluent
Waste Pile
Mixing Basin
Settling Basin
Collection Basin
East Ditch
Beach
Lake Michigan
N-LAKE
C-LAKE
Waste Pile
Parking
Employee
Paper Mill Effluent
Sewer
Sludge Disposal Pit
Asbestos Disposal Pit
Misc Disposal Pit
PROPOSED COLLECTION/ SEEPAGE BASIN
CITY INTAKE
1
2
3
4
5
6
7
8
9
10
11
12-13
X
Y
Z

3.0. SAMPLING OF GROUNDWATER

Static water levels referenced to the top of well casing will be measured to the nearest 0.01 foot and recorded for the purpose of monitoring the groundwater gradient at the site. Three established wells near the beach (labelled X, Y and Z), although not used for sampling, will be used for water level readings. Prior to sampling, water levels will be recorded using a level indicator, such as an electrical probe or woven tape with sinker. In the case of cluster wells, both water levels will be taken before any water is removed. The reference point (top of casing) elevation on the wells will be established by survey with respect to U.S. Datum, Mean Sea Level Elevation.

A minimum of three times the volume of standing water in the wells will be removed/purged prior to sampling. Purge water will be disposed of on site. If the well goes dry before three casing volumes have been taken out, samples will be collected as soon as the well recovers. Purging and sampling will be done by gently lowering a Teflon bailer attached to nylon rope or twine. During the sample withdrawal process, care will be taken to avoid physically altering or chemically contaminating the water. Observations of water clarity/turbidity, color and odor will be written in the field notebook. Also, temperature, pH and specific conductance will be measured and recorded in the field. The groundwater samples for dissolved metals will be filtered in the field using 0.45 micron filters. These samples will be preserved (acidified) after filtering. Sample containers will be provided by the laboratory. Standard VOA sample collection procedures, assuring elimination of headspace, will be used.

4.0 SAMPLING OF SURFACE WATER

Surface water samples will be grab samples from the Lake Michigan near-shore (N, C, and the City of Waukegan Lake Michigan water intake) and the site drainage collection/seepage basin location shown in Figure C1-C-1. Locations shown are approximate; U.S. EPA representatives may modify sampling locations in the field. Lake Michigan samples will be collected from an approximate 4 foot depth using a Niskin bottle/sampler. The City of Waukegan Lake Michigan water intake will be used for background water quality. Samples will be collected with the required volume of water using proper preservation techniques, as described in Appendix C1-D. No filtration of surface water samples for dissolved metals is needed. Preservative (acid) for dissolved metals is needed. Preservative will be added to the sample, as well as the field blanks, without filtering. Sample containers will be provided by the laboratory. During the sample collection process, care will be taken to avoid undue agitation, physically altering/chemically contaminating the samples. Observations on water clarity/turbidity, color and odor will be written in the field notebook. Also, temperature, pH and specific conductance will be noted in the field. Hip boots or waders can be worn, but for reasons of safety, a depth of four feet should not be exceeded.

5.0 FIELD BLANKS, DUPLICATES AND TRIP BLANKS

Field blanks and duplicates samples will be taken at two monitoring well locations and at one surface water location. Exact locations for these extra sample collections will be determined in the field during each sampling event, with preference given to those locations with a greater potential for contamination (e.g.-MW8, N-Lake). Duplicates (D) will be collected in the same manner as the respective sample. Field blanks (FB) will consist of deionized water. For the groundwater blank, the water will be poured into the decontaminated Teflon bailer at the monitoring well location, then transferred to the sample container. The field blank for dissolved metals will also be filtered and preserved. For the surface water blank, deionized water will be poured into the decontaminated Niskin bottle/sampler at a shoreline location, then transferred to the sample container. Preservative will be added.

For each shipping package (i.e. - cooler) which includes volatile organics (VOAs), two trip blanks (2 VOA vials) will be included. These blanks will contain HPLC-grade distilled water to detect any volatile organic contamination reaching a closed container. Trip blanks will be prepared in the office or laboratory, transported to the field and shipped without being opened in the field. "TB" will be used to identify all trip blank samples.

6.0 SAMPLE CONTAINERS

A summary of the sample containers used for each sampling event is presented; the number of glass containers is increased in case of breakage.

Monitoring Well Location	Polyethylene metals, 1 l	Polyethylene asbestos, 1 l	glass extractables, 1 l amber	glass VOAs, 40 ml	Number of samples analyzed
1	1	1	2	2	4
2	1	1	2	2	4
3	1	1	2	2	4
4	1	1	2	2	4
5	1	1	2	2	4
6	1	1	2	2	4
7	1	1	2	2	4
8	1	1	2	2	4
9	1	1	2	2	4
10	1	1	2	2	4
11	1	1	2	2	4
12	1	1	2	2	4
13	1	1	2	2	4
Duplicates, Field Blanks	4	4	8	8	16
Matrix Spike, and MSD	0	0	4	4	4
Surface Water Location					
N-Lake	1	1	2	2	4
C-Lake	1	1	2	2	4
City Intake	1	1	2	2	4
Seepage Basin	1	1	2	2	4
Duplicates, Field Blanks	2	2	4	4	8
Matrix Spike, and MSD	0	0	4	4	4

Totals = (46 polyethylene bottles) (54 glass bottles) (54 VOA vials)
= 154 bottles, total samples to be analyzed = 100

Samples will be preserved and stored as specified in Appendix C1-D. The number of VOA vials needed for trip blanks will be determined by the number of VOA shipping packages. Therefore, additional VOA vials and VOA analyses associated with trip blanks are not indicated in the table.

7.0 EQUIPMENT

- Clean polyethylene and glass sample bottles, VOA vials
- Teflon bailer, rope/twine
- Wading boots
- Plastic bags
- Soap (Alconox or equivalent)
- Water (tap and deionized)
- Brushes and buckets

8.0 SAMPLE ANALYSIS

As summarized in Section 6.0, a minimum of 100 samples from each event will be analyzed, which include samples for metals (aluminum, antimony, total arsenic, total chromium and lead), asbestos, extractables (full scan semi-volatiles, PBBs, PCBs) and volatile organics.

Analytical procedures used for each parameter are discussed in QAPP C1, Section 8.0.

9.0 PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION PROCEDURES

Because all sampling sites are located outside of the Manville disposal areas, level D personal protection will be utilized, including:

- Tyvek coveralls
- Outer gloves
- Particle/dust masks, if needed
- Safety boots/shoes
- Hard hats, if needed

Between each sample location (including individual wells in a well cluster), outer gloves and sampling equipment will be decontaminated using a soap wash (50/50 mix of trisodium phosphate and sodium carbonate), tap water rinse and distilled/deionized water rinse. For monitoring well samples, the nylon rope or twine will either have its saturated length removed or the entire line will be discarded in a garbage bag. Decontamination rinse and wash waters can be disposed of on site.

10.0 SAMPLE DOCUMENTATION

Documentation will provide a complete record of procedures followed in the field; will permit accurate identification of samples and tracking of their status in the field, during shipment and at the laboratory; and will facilitate chain of custody and accountability procedures by providing legible and concise information.

A sample numbering system will be used for positive identification and to allow tracking, retrieval and cross referencing of sample information. Examples of sample numbers are shown:

MRA - SWN - 01 - D

Where MRA = Manville Remedial Action
SWN = Surface water location "N-Lake" (northern)
01 = 1st round of sampling
D = Duplicate

MRA - MW05 - 13 - FB

Where MW05 = Monitoring Well no. 05
13 = 13th round of sampling
FB = field blank collected at the location

The date and time of collection will be recorded along with the sample number, on both the sample label and the field notebook. The sample parameter to be analyzed will also be written on all documentation.

All field measurements, as well as observations of water clarity/ turbidity, color and odor, will be written in the field notebook. Additional information on sampling documentation can be found in Section 6.2 of the QAPP(C1).

11.0 SAMPLE PACKAGING AND SHIPPING

All samples will be preserved as presented in Appendix C1-D. Each sample container will be decontaminated and identified by a unique sample number. Labels on field blanks, duplicate samples or trip blanks will be identified by "FB", "D" or "TB" suffix, respectively. The lid of each container will be taped shut to prevent any leakage. Each container will be stored and shipped in a cooler. Each cooler will be cushioned by vermiculite or other packaging material and at least two bags of ice will be placed in each cooler (except for coolers containing asbestos samples). In addition, the cooler will contain the chain-of-custody form as detailed under Section 6.1 of QAPP C1. The coolers will be either shipped or transported personally to the laboratory maintaining the chain-of-custody.

APPENDIX C1-D

SAMPLE QUANTITIES, CONTAINERS AND PRESERVATIVES

SAMPLE CONTAINERS, VOLUMES AND PRESERVATION

Matrix	Test Parameters	Sample Bottles and Volume[1]	Preservation Requirements
Surface Water	Metals (Total)	1 1-Liter HDPE Bottle, Fill to Shoulder	5 ml 1:1 HNO_3
	Organic Volatiles	2 40-ML Glass VOA Vials, No Headspace[3]	Iced to 4°C
	Organic Extractables[2]	2 1-Liter Amber Glass Bottle; Fill to Neck[3]	Iced to 4°C
	Asbestos	1 1-Liter HDPE Bottle, Fill to Shoulder	None
Ground Water	Metals (Total)	1 1-Liter HDPE Bottle, Fill to Shoulder	5 ml 1:1 HNO_3
	Metals (Dissolved)	1 1-Liter HDPE Bottle; Fill to Shoulder	5 ml 1:1 HNO_3 Filtering, Iced
	Organic Volatiles	2 40-ML Glass VOA Vials; No Headspace[3]	Iced to 4°C
	Organic Extractables[2]	2 1-Liter Amber Glass Bottle, Fill to Neck[3]	Iced to 4°C
	Asbestos	1 1-Liter HDPE Bottle, Fill to Shoulder	None
Active Waste Water	Metals (Total)	1 1-Liter HDPE Bottle, Fill to Shoulder	5 ml 1:1 HNO_3
	Organic Volatiles	2 40-Ml Glass VOA Vials, No Headspace [3]	Iced to 4°C
	Organic Extractables[2]	2 1-Liter Amber Glass Bottles; Fill to Neck[3]	Iced to 4°C
Soils/ Sludge	Asbestos	2 8-ounce Glass Jars[3]	None

(1) Specific Sample bottles are shown as guidelines; sampling requiring similar bottle materials and preservation may be combined. The preferred number and size of bottles will be indicated by the laboratory.

(2) Organic Extractables include full-scan Semi-volatiles, Pesticides/PCB's, PBB's.

(3) Sample bottles will have teflon-lined caps.

APPENDIX C1-E

METHODOLOGY FOR PBB ANALYSIS

Methodology for PBB Analysis

1.0 Scope and Application

1.1 This method is applicable to the determination of trace amounts of polybrominated biphenyls (hexa bromo biphenyl) i.e., BP6 (PBB) in groundwater and surface water samples.

1.2 Method detection limits are listed in Table 2 of the Special Analytical Services Contract (SAS) No. 2902-E, of May 1987, between the U.S. EPA, Region V, Sample Management Office and Clayton Environmental Consultants. Due to the variety of interferences encountered, the method detection limits may not be obtainable on all samples. These detection limits will be adjusted to account for the interferences encountered, required dilutions, and any variation in sample size.

2.0 Summary of Method

2.1 Extraction, concentration and clean-up using solvents such as methylene chloride and n-hexane will be done in accordance with U.S. EPA's method 608, "Organochlorine Pesticides and PCBs", Federal Register, 49:209, Oct. 26, 1984.

2.2 The compounds will be analyzed by gas chromatography with capillary column and electron capture detector (GC/EC). When unknown samples are analyzed by this method, the identification of any single peak compound is supported by a second analysis utilizing a capillary column of different stationary phase polarity. In the case of a highly complex sample, confirmation of the analysis is done by gas chromatography/mass spectrometry (GC/MS) provided the sample is sufficiently concentrated. Recommended columns and operating conditions are listed elsewhere (see footnotes in Table 1 of the above-mentioned SAS, No. 2902-E) in this method.

3.0 Sample Collection, Handling and Preservation

3.1 The samples will be collected in 1-liter amber glass bottles and sealed with teflon-lined screw caps.

3.2 Samples will be stored in ice and will be refrigerated at 4°C in the lab until extraction.

4.0 Interferences

4.1 Interferences may be encountered due to a number of sources including: glassware, solvents, sorbents and the sample itself. Glassware and supplies will be routinely monitored through the use of reagent blanks to demonstrate the absence of interferences. The use of high quality supplies will reduce the occurrence of interferences.

4.1.1 Glassware (old and new) must be scrupulously clean. The glassware is to be cleaned as soon as possible after use. A rinse with the last solvent used will remove surface traces of the compounds of interest. The rinse is followed by scrubbing in hot soapy water. Stubborn stains may require Nochromix acid cleaning. The glassware is then rinsed with tap water followed by acetone. Prior to its next usage, the glassware will be pre-rinsed with petroleum ether. All solvents used for cleaning glassware will be discarded.

4.1.2 Interferences (i.e., aliphatic hydrocarbons) co-extracted with the sample are minimized through the use of gel permeation chromatography and silica gel chromatography. Some interferences may still exist after this cleanup. These interferences may be accounted for through the analysis with an alternate column and/or GC/MS confirmation and the initial results may be adjusted for the interference.

4.1.3 Sulfide poisons electron capture detectors. Sulfides may be removed by adding one to three drops of mercury to the fraction prior to analysis.

NOTE: Mercury is toxic to humans; therefore, handle with care and dispose of properly.

5.0 Apparatus

Apparatus required for extraction, concentration and cleanup will be the same as described in U.S. EPA Method 608.

Analytical (qualitation/quantitation) equipment needed are described below.

5.1 Gas chromatograph - Varian 3700 (or equivalent) system capable of temperature programming and with split/splitless/direct capillary injector capabilities. This also includes necessary accessories such as auto sampler (Varian 8000 or equivalent), vials, caps, septa, electron capture detector, recorder, etc.

5.2 Capillary Columns - Capillary Columns will be the same as described in item 10, page 2 of the SAS, No. 2902-E.

5.3 Gas chromatograph/mass spectrometer (GC/MS) - Hewlett Packard Model 5985E complete with a model 5840 temperature programmable gas chromatograph suitable for split/splitless capillary injection. Mass spectrometer capable of scanning from 45 to 400 amu every second utilizing 70 eV (nominal) electron energy in the electron impact ionization mode. The Fused Silica Capillary Column (FSCC) is interfaced directly into the ion source. Continuous acquisition and storage of mass spectra is obtained throughout the duration of the gas chromatographic program by a Hewlett Package model 1000-E Series computer.

6.0 Extraction, Concentration, Cleanup

Extraction, concentration and cleanup, etc. for the PCBs/PBBs will be in accordance with the U.S. EPA's CLP protocols for pesticides/PCBs as per SOW-7-87-Organics and as described in EPA Method 608 CLP-M, "Organochlorine Pesticides and PCBs", Federal Register, 49:209, Oct. 26, 1984.

7.0 Analysis by Gas Chromatography

7.1 Sample analysis will be carried out using GC/EC.

7.2 Page 2 of item 10 of the SAS, No. 2902-E, summarizes the recommended capillary columns and operating conditions for the instrument. Included in the table are estimated retention times that should be obtained.

7.3 Two microliters will be injected from each standard and sample via autosampler.

7.4 If the response of any identified compound is greater than that of the compound found in the standard, a dilution is to be performed and the sample will be reanalyzed.

7.5 Single peak compounds are to be analyzed on a capillary column of differing polarity for confirmation. If the sample is highly complex, confirmation will be performed by GC/MS if the levels are sufficiently high.

7.6 Confirmation of Positive Results by GC/MS.

7.6.1 Performance criteria for the MS is given in Tables 10 and 11 of the SAS, No. 2902-E.

7.6.2 Once a week the system is calibrated according to manufacturer's specifications using Perfluorotributylamine (PFTBA). The resulting mass spectrum must meet the criteria established in Table 11 of the SAS, No. 2902-E.

7.6.3 Daily check the GC/MS performance by injecting a 50 ng/ul of Decafluoro Triphenyl Phospine (DFTPP) and verifying that the resulting mass spectrum meets the criteria of Table 10 of the SAS, No. 2902-E.

7.6.4 Stable isotope Anthracene d_{10} will be used as the reference spike. About 20 ng of the standard will be added to each sample just before injecting onto the GC column.

7.6.5 Inject 1.0 ul of sample onto the GC column using a 10.0 ul calibrated needle syringe. Record the volume injected to the nearest 0.1 ul.

7.6.6 If the response of any ion exceeds the working range of the GC/MS system, dilute the extract and reanalyze.

7.6.7 To qualitatively identify a compound, an extracted ion current profile for the characteristic ions is obtained.

7.6.8 The characteristic ion for the compound must be found to maximize in the same or within ± 0.05 of the relative retention time (RRT). If coelution of interfering components prohibits accurate assignment of the sample component from the total ion chromatograph, the RRT should be assigned by using extracted ion current profiles for ions characteristic of the compound of interest.

7.6.9 The relative intensities of ions must agree within ±20% between the standard and sample spectra.

7.6.10 Structural isomers that have very similar mass spectra can be explicitly identified only if the resolution between isomers is less than 25% of the sum of the two peaks. Otherwise, structural isomers will be identified as isomeric pairs.

8.0 Quality Control

8.1 Sample Control

8.1.1 The sample batch will consist of 19 samples, one reagent blank, one matrix blank and two matrix spikes.

8.1.2 Cleanup control is intiated at the GPC step and consists of two GPC blanks and one working standard.

8.1.3 All samples will be spiked with known concentrations of 2,4-Dichlorotuluene and Decachlorobiphenyl prior to extraction. The percent recovery of these compounds indicates possible problems which may occur during extraction and clean-up of individual samples.

8.1.4 The GC analysis sequence includes standards, blanks, spikes and samples of which only standards are considered as known. There are a maximum of ten injections of unknown samples between standards. If evidence exists that maxtrix is causing shifts in sensitivity or retention times, the frequency of standard injections will be increased.

8.2 GC Controls

8.2.1 All injections will be performed using an autosampler. The injector is modified to perform all injections using the splitless technique utilizing a 0.7 min valve closure upon injection of 2.0 microleters.

8.2.2 The system is calibrated by using a standard containing compounds of approximately 75% of their linear range. The linearily is checked by injecting a low standard at or near 25% of the linear range of each compound. Means and 95% confidence limits are established for each compound. The

performance was originally established based on ten consecutive runs. A minimum of seven injections are required to adjust calibration. Values for calibration standards must fall within the 99% confidence limits before the analysis may be performed. Outliers indicate possible performance problems which require appropriate action.

8.2.3 A known concentration of a,a,2,6-tetrachlorotoluene and trichloropropane will be added to every sample prior to GC analysis. These compounds are used to monitor retention time shifts, injection problems, and detector response.

8.2.4 Reference samples containing known concentrations of analytes will be obtained from U.S. EPA and extracted, cleaned, and analyzed four times per year.

9.0 Calculations

9.1 All compounds identified will be quantified by external standard method. The equation for this calculation is:

$$\text{Concentration (ug/kg)} = \frac{P_X \, C_S \, D \, V_S}{P_S \, V_X \, W_O}$$

Where:
- P_X = area of the compound in the sample
- P_S = area of the compound in the standard
- C_S = concentration of the compound in the standard
- D = dilution factor for the sample
- V_S = volume of standard injected
- V_X = volume of sample injected
- W = mass of the original sample in kg

9.2 Multiple peaks will be similarly calculated

9.2.1 The analyst must be experienced in recognizing the peak pattern of the compounds prior to calculations.

9.2.2 Select five to ten major peaks from the standard and calibrate each peak for quantification. If no interferences are apparent, the average concentration is obtained from the identified and calibrated peaks with the same retention time as the standard.

9.2.3 Calibrated peaks which indicate the presence of interference are not included in the calculation.

All results are to be reported in ug/kg. The results may not be corrected for percent recovery, but results will be coded if the percent recovery falls outside the method validation recovery range.

10.0 Method Validation

10.1 Method Detection Limit - The method detection limit (MDL) for each compound will be determined from low level spikes of tap water using the MDL procedure from Appendix B, Part 136: "Definition and Procedure for the Determination of the Detection Limit", Federal Register, 49:209, Oct. 26, 1984.

10.2 Precision - The precision will be determined by standards and duplicate matrix spikes. The standards indicate the precision generated by the analysis and the duplicate matrix spikes define the precision of the extraction, cleanup and analysis.

10.3 Accuracy - Accuracy will be assessed in determining the recovery of the duplicate matrix spikes.

11.0 Reported Detection Limits

11.1 The MDL is the optimal performance of the method. This is not always obtainable due to variations in sample matrix and variability in extraction and cleanup which may adversely affect performance. For these reasons, the laboratory routinely uses reported detection limits (RDLs) which are generally higher than the MDLs.

11.2 RDL's for specific comounds may be raised because of interferences encountered during analysis.

11.3 If the original sample weight differs from 20 grams, the RDL for all compounds will be adjusted proportionally.

ATTACHMENT C-2

QUALITY ASSURANCE PROJECT PLAN - 2

AMBIENT AIR MONITORING

OF

PM_{10}, LEAD AND TOTAL CHROMIUM

QUALITY ASSURANCE PROJECT PLAN - 2

Table of Contents

		Pages
1.0	Introduction	C2-1
2.0	Project Description	C2-1
3.0	Project Organization And Responsibilities	C2-2
4.0	Quality Assurance Objectives	C2-2
5.0	Sampling Procedure	C2-4
6.0	Sample Custody	C2-7
7.0	Equipment Calibration	C2-8
8.0	Analytical Procedures	C2-8
9.0	Data Reduction, Validation and Reporting	C2-8
10.0	Internal QC Checks	C2-8
11.0	Performance and System Audits	C2-8
12.0	Preventive Maintenance	C2-9
13.0	Data Assessment Procedures	C2-9
14.0	Corrective Action	C2-9
15.0	Quality Assurance Reports	C2-9
16.0	Sampling Plan	C2-9

Appendices

C2-A: Ambient Air Sampling Plan for PM_{10}, Lead and Total Chromium

C2-B: U.S. EPA-Recommended Sampling and Analysis Procedures for PM_{10} and Lead

List of Figures

Pages

C2-1 Project Organization.....C2-3

C2-A-1 Off-Site Air Sampling Locations.....C2-A-2

C2-A-2 On Site Air Sampling Locations for PM_{10}, Lead and Chromium Monitoring.....C2-A-3

List of Tables

C2-1 QC Level of Effort for Analytical Testing.....C2-5

C2-2 Accuracy and Precision Criteria for Analytical Testing of Lead and Chromium.....C2-6

C2-A-1 Number of Samples and Analyses.....C2-A-5

QUALITY ASSURANCE PROJECT PLAN - 2

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP-2) presents the organization, objectives, functional activities, quality assurance (QA) and Quality Control (QA) activities associated with air sampling for lead, total chromium and particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}). Its format is the same as QAPP 1 (Attachment C1), with attempts to avoid repetition. Air sampling is a part of the Remedial Action being implemented at Johns-Manville Disposal Area.

2.0 PROJECT DESCRIPTION

2.1 Background

The Johns-Manville Disposal Area is located in the city of Waukegan, Illinois. Since 1922, all the manufacturing wastes from the plant have been disposed of at the Disposal Area. Some of these wastes contained encapsulated asbestos, friable asbestos, and trace amounts of lead, chromium, and other contaminants. Presently, no asbestos is being used in manufacturing.

In 1982, this site was included in the National Priorities List. A Remedial Investigation (RI) and Feasibility Study (FS) were conducted by Manville Corporation. Pursuant to the Consent Decree signed by Manville on December 31, 1987, Manville Corporation will carry out a Remedial Action.

2.2 Objective and Use of Data

The objective of sampling activities described in this QAPP is to detect potential ambient air contamination by PM_{10}, lead or chromium after the establishent of soil cover. For PM_{10} sampling, EPA-approved PM_{10} samplers or modified hi-volume samplers, will be utilized and hi-volume samplers will be used for lead and chromium sampling. Data obtained will be used to determine the need for any contingency measures needed to control and minimize detected or potential contamination.

2.3 Sampling Schedule

The schedule for sampling activities, is presented in Figure 2 of the Work Plan. Air sampling will be conducted after thhe establishment of soil and vegetative cover and every five years thereafter for a period of 15 years (number of sampling events = 4). After the 15 years, U.S. EPA will evaluate the need for further monitoring.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 Organization

The project organization is presented in Figure C2-1.

3.2 Responsibilities

Overall project supervision and coordination will be the responsibility of Johns-Manville Project Coordinator. He will be responsible for accomplishing the tasks as per the directives of "Consent Decree", as well as interacting with and reporting to U.S. EPA and Illinois EPA (IEPA).

All project functional responsibilities lie with the Manville Remedial Construction Manager (RCM). He will be responsible for overseeing certain project tasks and ensuring their accomplishment. He will be responsible for reporting the project progress to the Johns-Manville Project Coordinator and interacting with U.S. EPA and IEPA on an as-needed basis.

Overall coordination of on-site sampling/monitoring activities will be the primary responsibility of the Contractor/Consultant Site Manager (CSM). The independent Quality Assurance Monitor will be responsible for reviewing project documents and reports with respect to their conformance to the quality assurance objectives.

A contractor/laboratory will be identified for field sampling and measurement and data assessment. Laboratories identified earlier in QAPP-I will be used for sample analysis. U.S. EPA/IEPA representatives will be notified in advance of all monitoring/sampling activities.

4.0 QUALITY ASSURANCE OBJECTIVES

The overall QA objective is to develop and implement procedures for sampling, laboratory analyses, field measurements and reporting that will provide data to a degree of quality consistent with its intended use.

4.1 Level of QC Effort

Field blanks, lab blanks, lab duplicates and spike duplicates will be taken and analyzed to provide a means to assess the quality of the data resulting from the field sampling and lab analysis program. Field blank samples will be analyzed to check for procedural contamination of the samples.

The general level of this QC effort will be a collection of field blanks and an analysis of one lab duplicate (for lead and chromium only), and one lab blank for every ten or less investigative samples collected on-site. One lab matrix spike and one laboratory matrix spike duplicate will be analyzed for every twenty or less investigative samples collected.

Project Organization

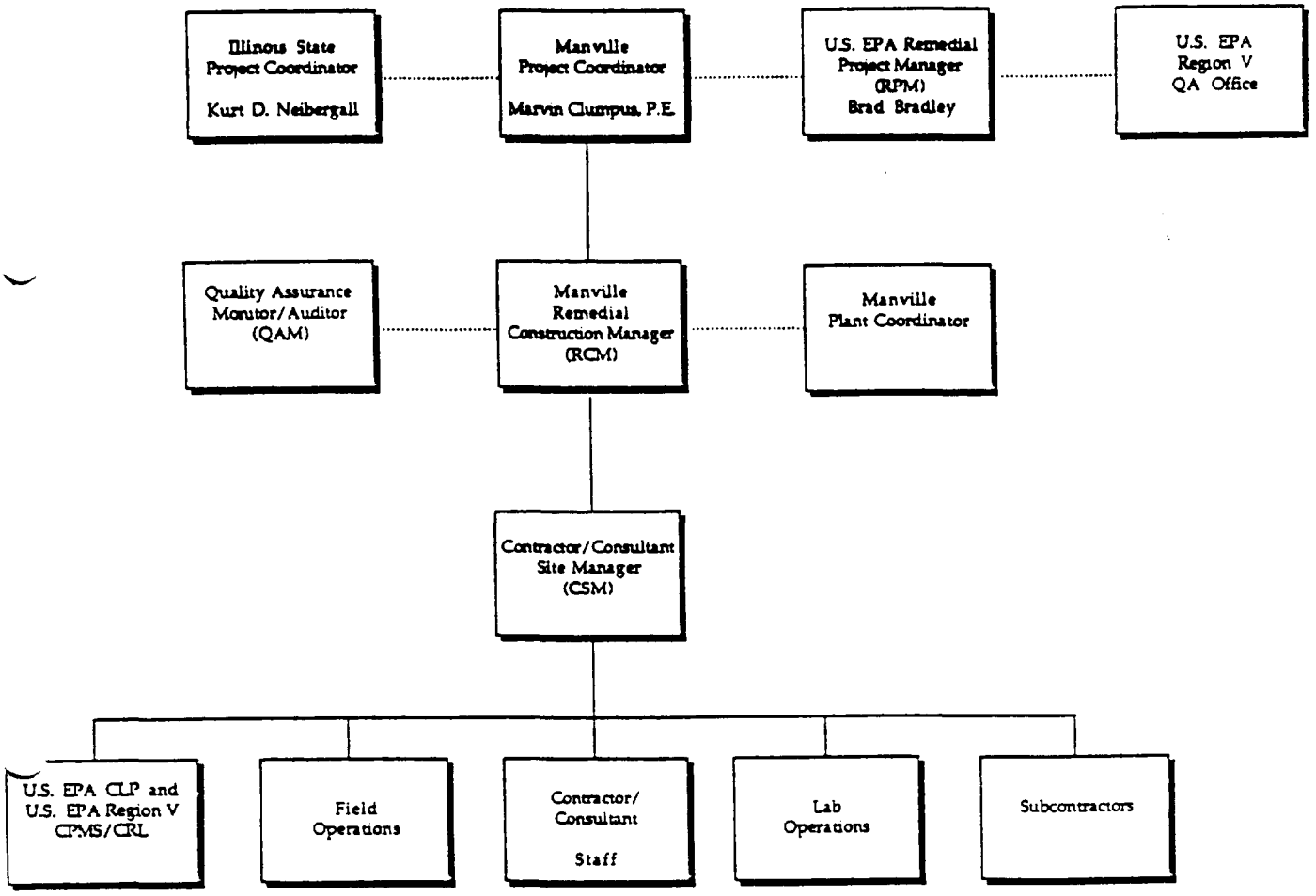


Figure C2-1

Field blanks for on-site and off-site sampling will be one for each type of samples per day. Hence, three blanks for on-site and three blanks for off-site group of locations will be collected. Two field blanks for on-site and one blank for off-site locations will be analyzed for lead and total chromium. Two field blanks for on-site and one field blank for off-site locations will be analyzed for PM_{10}. The number of samples to be collected and analyzed are presented in Table C2-A-1 of Appendix C2-A. The QC level of effort for testing is presented in Table C2-1.

The field instruments will be calibrated as prescribed under U.S. EPA regulations presented in Appendix C2-B. In general, the flow measuring device will be calibrated once, before the start of sampling event.

4.2 Accuracy and Precision

Accuracy and precision requirements of all parameters will be in accordance with standard requirements for sampling procedures published by U.S. EPA and presented in Appendix C2-B. The detection limits for lead and chromium testing will be 0.02 mg per filter and the accuracy of lead and chromium measurement from the filter will be $\pm 10\%$. Table C2-2 presents the accuracy and precision criteria for lead and chromium by AAS.

4.3 Completeness, Representativeness and Comparability

The procedures used to obtain the analytical data, as documented in this QAPP, are expected to be complete, representative and will provide comparable data. It is expected that the lab chosen for analysis will provide data meeting QA criteria for 95 percent or more of all samples tested.

4.4 Facilities and Equipment

The field sampling equipment will be identified in the sampling plan (Appendix C2-A). A laboratory having facilities similar to those listed under U.S. EPA Contract Laboratory Program (CLP) will be selected for analysis of air samples. The laboratory selected will be subject to performance and system audits for approval/disapproval by the Contract Project Management Section (CPMS) of the U.S. EPA Revion V, Central Regional Laboratory (CRL).

5.0 SAMPLING PROCEDURE

The objectives of sampling procedures is to obtain samples that represent the environmental matrix being investigated. Procedures to collect the samples during the project are described in the sampling plan (attached as Appendix C2-A), and sampling and analysis procedures described in 40 CFR 50.12 (attached as Appendix C2-B).

Table C2-1
QC Level of Effort For Analytical Testing

Parameters	Audit	Frequency
Metals	Calibration Blank (AA or AA-Furnace)	Each calibration beginning and end of each run, 10% frequency
	Initial Calibration Verification (AA or AA-Furnace)	Daily and each instrument setup
	Continuing Calibration Verification (AA or AA-Furnace)	Beginning and end of each run; 10% frequency or every 2 hrs, whichever is more frequent
	Preparation Blank (AA or AA-Furnace)	One per batch or one per 20 samples received, whichever is more frequent
	Analytical Matrix Spike Analysis (AA)	One per case or one per 20 samples received, whichever is more frequent
	Duplicate Sample Analysis (AA or AA-Furnace)	One per case or one per 20 samples received, whichever is more frequent
	Laboratory QC Sample Analysis (AA or AA-Furnace)	One per batch or one per 20 samples received, whichever is more frequent
	Duplicate Injections (AA-Furnace)	Each sample
	Preparation Blank Spike Recovery (AA-Furnace)	One per batch or one per 20 samples received, whichever is more frequent
	Analytical Matrix Spike Analysis (AA-Furnace)	Each sample

Table C2-2
Accuracy and Precision Criteria for Analytical Testing of Lead and Total Chromium

Method	Audit	Control Units
AA Flame or Furnace	Calibration Blank	≤D.L.
	Initial Calibration Verification	90-110%
	Continuing Calibration Verification	90-110%
	Preparation Blank	≤D.L.
	Matrix Spike Analysis	75-125%
	Laboratory QC Sample Analysis	80-120%
	Preparation Blank Spike Recovery	75-125%

6.0 SAMPLE CUSTODY

6.1 Sample Handling, Shipping and Custody

U.S. EPA-recommended sample handling, shipping and custody procedures will be followed. After sampling, the filter will be removed from the sampler, and placed in the filter holder as prescribed by the manufacturer and U.S. EPA, and presented in Appendix C2-B.

Each sample (filter) will be issued a unique project identification number.

The protective filter holders will be either hand-carried or shipped to the laboratory in a manner such as to prevent dislodging of particulate matter or breakage of the filter holders.

6.2 Field Documentation

A field logbook will be maintained and the following information will be recorded:

- Name and signature of field operator;
- Lot or assigned batch number (or any other identifiable number);
- Date of record;
- Station location and name;
- Use of filter, (i.e., field blank or test filter);
- Condition of sample;
- Sample flow rate at start of sampling period;
- Start time;
- Stop time;
- Sample flow rate at end of sampling period;
- Any specific instructions/comments.

A traceability packing slip will be filled out in the field. The samples will be either hand carried or shipped to the laboratory for chemical analyses, where the package contents will be compared to the traceability packing slip (chain of custody). After the samples are logged in, they will be placed in suitable storage areas in the lab.

6.3 Project File

A project file will be maintained by Manville Remedial Construction Manager which will contain complete project documentation including project plans, specifications, field sampling documents, and the analytical data provided by the lab.

7.0 EQUIPMENT CALIBRATION

All field equipment utilized during this project will be calibrated and operated according to the standard operating procedures as presented in Appendix C2-B. Calibration of instruments used for the analysis of lead and total chromium will conform to the procedures in SOW-7-87-Inorganics.

8.0 ANALYTICAL PROCEDURES

All samples collected will be analyzed for the appropriate parameter using U.S. EPA approved procedures, as presented in the Sampling Plan. Lead and chromium will be analyzed by atomic adsorption after acid extration using HNO_3. PM_{10} will be analyzed by weighing the filter on a scientific balance.

9.0 DATA REDUCTION, VALIDATION AND REPORTING

The analytical laboratory will review appropriate laboratory quality control data to assure the validity of the analytical results provided to the contractor. Full analytical and QC documentation will be prepared and retained by the laboratory. All raw data generated from analyses of samples, blanks, duplicates and matrix spikes will be checked for compliance with QA objectives and reported to the RCM/CSM. Where test data have been reduced, the method of reduction will be described in the lab report.

10.0 INTERNAL QC CHECKS

Testing for metals will be performed using methods similar to the analytical procedures specified in CLP SOW 7-87-Inorganics. The internal QC procedures associated with testing of these parameters have been described in Section 4.0.

11.0 PERFORMANCE AND SYSTEM AUDITS

System audits are performed on a semi-continuous basis as appropriate throughout the duration of the project. The Contractor/Consultant Site Manager (CSM) is responsible for supervising and checking that samples are collected and handled in accordance with the approved project plans and that documentation of field work is adequate and complete. The RCM/CMS is responsible for overseeing that the project performance satisfies the QA objectives, as set out in this QAPP.

Performance audits of laboratories participating in the CLP or approved for CLP-type testing are performed in accordance with the procedures and frequencies established for the CLP by EPA.

The Quality Assurance Auditor is responsible for monitoring and auditing the performance of the QA procedures listed in this plan. He will maintain continuous communication with the RCM/CSM. Also, external audits will be performed by the Contract Project Management Section (CPMS) of Region V, Central Regional Laboratory (CRL).

The Quality Assurance Monitor is responsible for the review of work quality and will ensure that quality assurance procedures are being implemented.

12.0 PREVENTIVE MAINTENANCE

Preventive maintenance on all field equipment will be carried out in accordance with their standard operating procedures and as described in in Appendix C2-B. A routine preventative maintenance program may be conducted by the laboratory for laboratory equipment.

13.0 DATA ASSESSMENT PROCEDURES

The Quality Assurance Monitor/Auditor will review the analytical results for compliance with established QC criteria. Any problems arising during sample collection, packing, shipping or analysis will be taken into consideration during the data assessment.

14.0 CORRECTIVE ACTION

Any non-conformance to the previously established criteria or protocol in equipment, instruments, data, methods, etc. would be immediately reported to the supervisor and/or task leader. Necessary corrective action will be initiated by the Quality Assurance Monitor and implemented by the Remedial Site Project Coordinator (RSPC).

15.0 QUALITY ASSURANCE REPORTS

The complete and correct implementation of this QAPP will be reviewed by the RCM/CSM. Any deviations from this QAPP or any concern arising during the project requiring significant changes in the QAPP also will be identified by the RCM/CSM. The RCM/CSM will propose adjustments required to Manville Corporation, Project Coordinator and U.S. EPA, and after approval by U.S. EPA, will ensure their implementation. The QA-related information will be included in the monthly progress reports to U.S. EPA and IEPA, as applicable. No separate QA reports will be submitted.

16.0 SAMPLING PLAN

The Ambient Air Sampling Plan for PM_{10}, lead and chromium is presented as Appendix C2-A of this QAPP.

APPENDIX C2-A

AMBIENT AIR SAMPLING PLAN

FOR

PM_{10}, LEAD AND TOTAL CHROMIUM

AMBIENT AIR SAMPLING PLAN
FOR
PM_{10}, LEAD AND TOTAL CHROMIUM

1.0 INTRODUCTION

This sampling plan presents the procedures to be followed during ambient air sampling for particulate matter, lead and total chromium to be carried out at the Johns-Manville Disposal Area. Initial sampling is scheduled to be conducted after the completion of Remedial Work and establishment of vegetative cover on the site, and every five years thereafter for a minimum period of 15 years (number of sampling events = 4), as shown in Figure 2 of the Work Plan. After 15 years, U.S. EPA will evaluate the need for further monitoring. Establishment of vegetation will be considered adequate after three mowings of planted grass. Ambient air will be sampled for particulate matter, lead and total chromium using on-site and off-site locations. Sample collection, processing, analyses and documentation procedures are presented in this sampling plan.

2.0 SAMPLE LOCATIONS

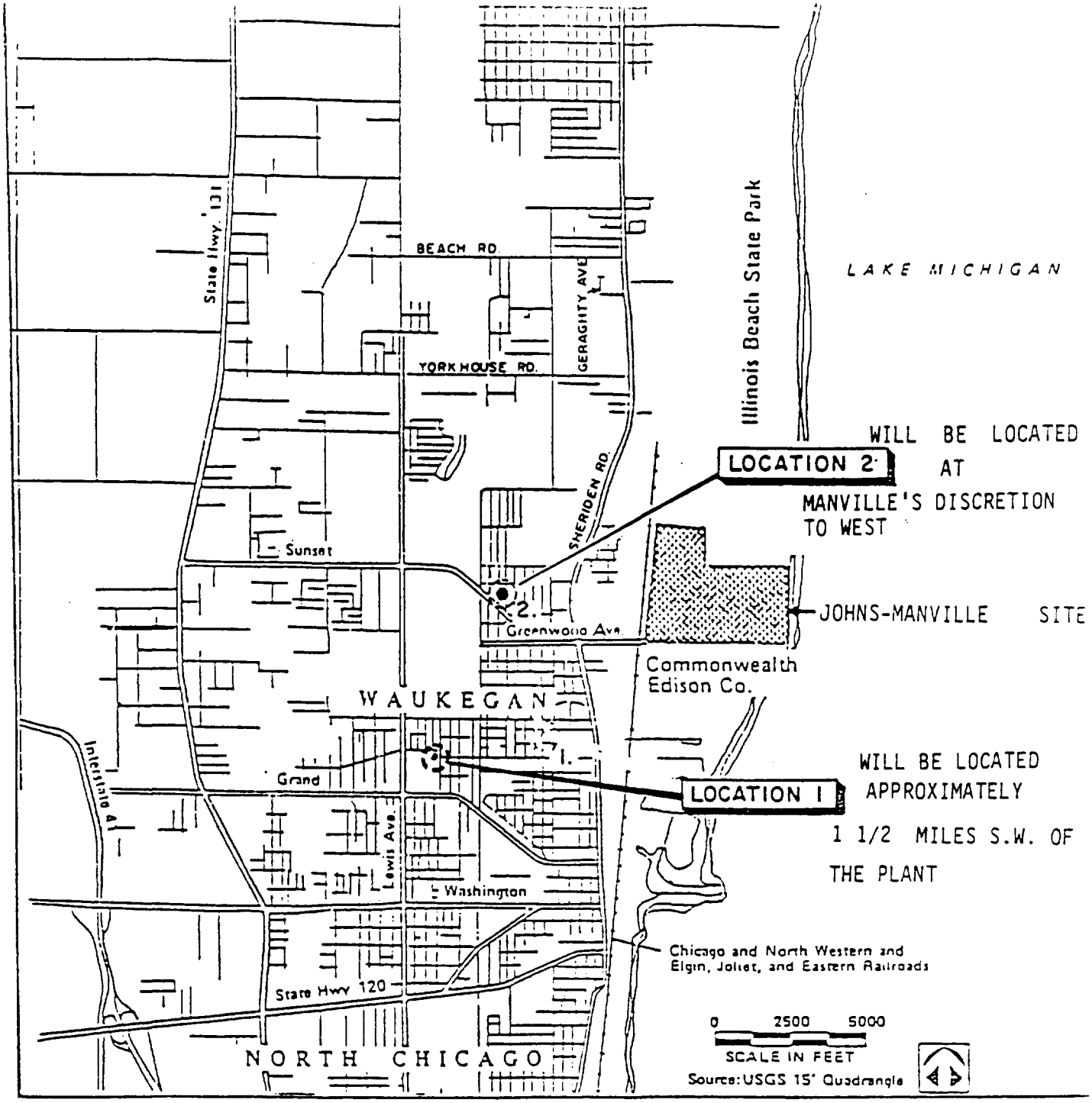
Air sampling locations should be such that air samples collected are representative of air quality on and around the Disposal Area. To accomplish this, two off-site and five on-site sampling locations have been selected, as shown in Figures C2-A-1 and C2-A-2. These locations are the same as proposed for air sampling for asbestos.

3.0 EQUIPMENT

- PM_{10} samplers
- High volume samplers
- Glass fiber filters
- Portable power generators
- Sampler shelter
- Air flow measurement device (rotameter)
- Thermometer
- Barometer
- Wind vane and Anemometer

4.0 SAMPLING PROCEDURE

Lead (Pb) and total chromium (Cr) samples will be collected on an 8" x 10" IPM 2000 spectograde filter using a high volume (Hi-Vol) sampler. The air volume will be between 39 cfm and 60 cfm. The Hi-Vol samplers will be calibrated and operated in accordance with the procedures outlined in Appendix C2-B of QAPP 2. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}) will be collected using a PM_{10} sampler or modified hi-volume



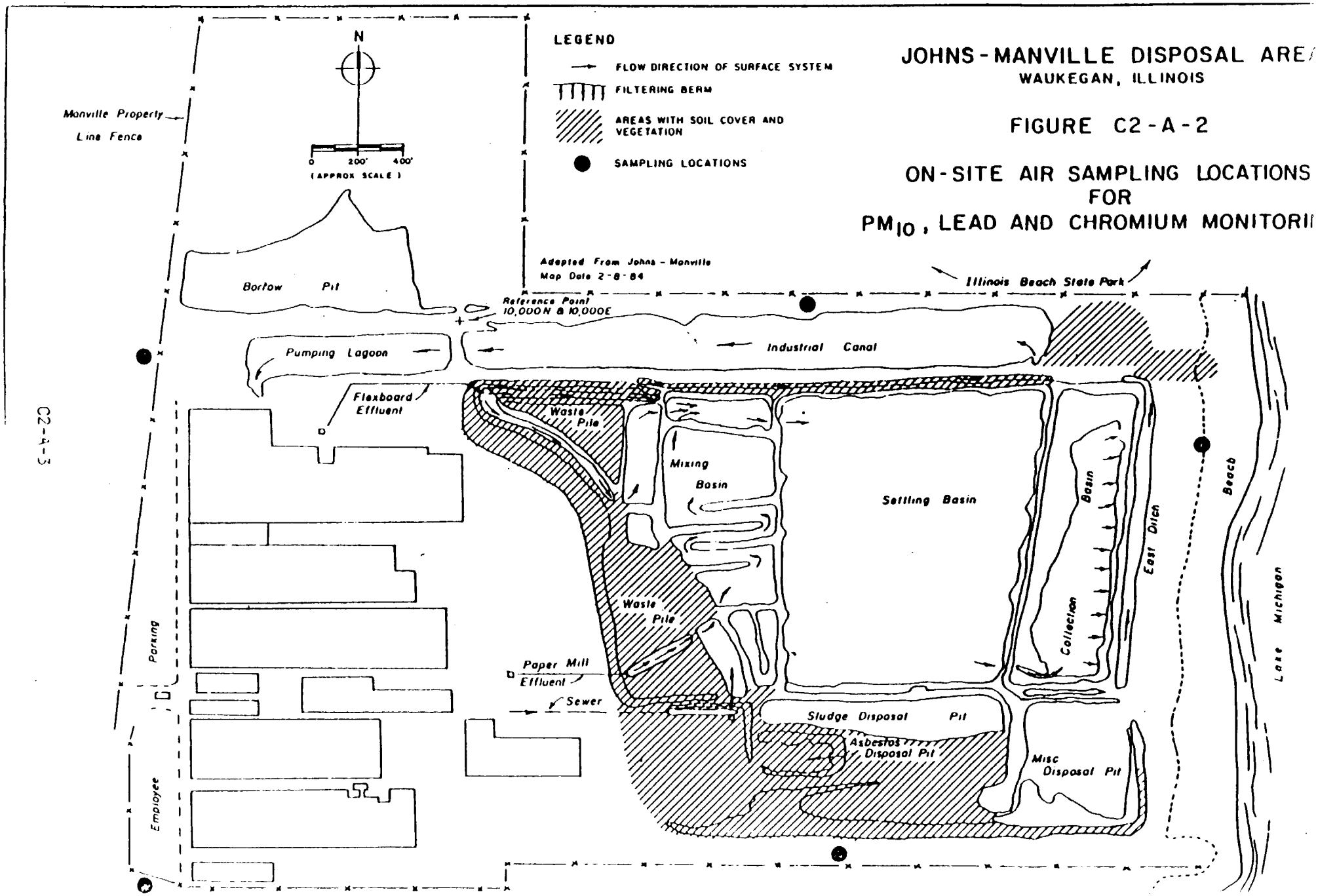
LEGEND

OFF-SITE LOCATIONS

JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS

FIGURE C2-A-1

OFF-SITE AIR SAMPLING LOCATIONS


JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
FIGURE C2-A-2
ON-SITE AIR SAMPLING LOCATIONS
FOR
PM10, LEAD AND CHROMIUM MONITORI
LEGEND
FLOW DIRECTION OF SURFACE SYSTEM
FILTERING BERM
AREAS WITH SOIL COVER AND VEGETATION
SAMPLING LOCATIONS
N
0 200' 400'
(APPROX SCALE)
Adapted From Johns - Manville
Map Date 2-8-84
Manville Property Line Fence
Borrow Pit
Reference Point
10,000N & 10,000E
Illinois Beach State Park
Pumping Lagoon
Industrial Canal
Flexboard Effluent
Waste Pile
Mixing Basin
Settling Basin
Collection Basin
East Ditch
Beach
Lake Michigan
Waste Pile
Parking
Paper Mill Effluent
Sewer
Sludge Disposal Pit
Asbestos Disposal Pit
Misc Disposal Pit
Employee

sampler approved by U.S.EPA as a reference or equivalent method. This PM_{10} sampler will be calibrated and operated in accordance with manufacturer's instructions and the procedures outlined in Appendix C2-B. All the samples will be collected over a period of 24±1.0 hours, on three (3) separate days at each of the seven (7) locations. The field blanks will be collected for lead and chromium as well as PM_{10} analyses. A filter will be removed from the box of clean filters (touching only the outer edges of filter) and placed in the labelled filter holder in the field. The number of samples and analyses are presented in Table C2-A-1. Air temperature, pressure, wind direction and velocity at each sampling location will be recorded twice daily. Sampling will be conducted during the dry season and will not immediately follow a rainfall event, as approved by the U.S. EPA technical staff.

5.0 SAMPLE ANALYSIS AND HANDLING

PM_{10} and lead sample analysis will be carried out as presented in Appendix C2-B. Total Chromium will be extracted from the filter with nitric acid and the extract will be analyzed by Atomic Absorption Spectrophotometry (AAS). Filters will be handled in a manner consistent with those described in Appendix C2-B to maintain sample integrity.

6.0 PERSONAL PROTECTIVE EQUIPMENT

During collection of air samples, level D personnel protection, including outer gloves and work boots will be used.

7.0 DOCUMENTATION

Proper documentation of sample custody procedures, followed in the field and in the laboratory, will be maintained for accurate identification and tracking of each sample filter. A sample number to designate each sample location and frequency will be used to positively identify each sample collected.

8.0 SAMPLE PRESERVATION, PACKAGING AND SHIPPING

After sampling, the filters will be carefully removed from the sampler following manufacturer's instructions. Only outer edges of the filter will be touched. The filter will be placed in a filter holder as prescribed by U.S. EPA and presented in Appendix C2-B. The protective filter holders, containing filters, will be either hand carried or shipped in a manner such as to prevent dislodging of collected particulate matter or breakage of the filter holders. A chain-of-custody form will be included in the shipping package.

Table C2-A-1

Number of Samples and Analyses

	Field Blanks				Test Samples (filters)				Lab Blank		Duplicates	
	Offsite		On Site		Off Site		On Site				Spike	Sample
	PM_{10}	PB/Cr	PM_{10}	Pb/Cr	PM_{10}	Pb/Cr	PM_{10}	Pb/Cr	PM_{10}	Pb/Cr	PM_{10}	Pb/Cr
Filters to be collected in the field	3	3	3	3	6	6	15	15	-	-	-	-
Filters to be collected in the lab	-	-	-	-	-	-	-	-	2	2	-	-
Filters to be analyzed	1	1	2	2	6	6	15	15	1	1	4*	2

*Two on-site filters to be spiked for lead
Two on-site filters to be spiked for chromium

APPENDIX C2-B

U.S. EPA RECOMMENDED SAMPLING AND ANALYSIS PROCEDURE

FOR

- LEAD/TOTAL CHROMIUM (C2-B, p. 1-16)
- PM_{10} (C2-B, p. 17-22)

ENVIRONMENTAL PROTECTION AGENCY REGULATIONS ON NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS

(40 CFR 50; 36 FR 22384, November 25, 1971; as amended by Code of Federal Regulations, Volume 40, revised as of July 1, 1976; 41 FR 52686, December 1, 1976; 43 FR 46258, October 5, 1978; 44 FR 8220, February 8, 1979; 44 FR 37915, June 29, 1979; 46 FR 44163, September 3, 1981; 47 FR 54899, December 6, 1982; 48 FR 628, January 5, 1983; 48 FR 2529, January 20, 1983; Corrected by 48 FR 17355, April 22, 1983)

SUBCHAPTER C—AIR PROGRAMS

PART 50—NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS

Authority: Sec. 109, Clean Air Act, as amended 42 U.S.C. 7409.

[Amended by 48 FR 628, January 5, 1983]

§ 50.1 Definitions.

(a) As used in this part, all terms not defined herein shall have the meaning given them by the Act.

(b) "Act" means the Clean Air Act, as amended (42 U.S.C. 1857–18571, as amended by Pub. L. 91–604).

(c) "Agency" means the Environmental Protection Agency.

(d) "Administrator" means the Administrator of the Environmental Protection Agency.

(e) "Ambient air" means that portion of the atmosphere, external to buildings, to which the general public has access.

(f) "Reference method" means a method of sampling and analyzing the ambient air for an air pollutant that is specified as a reference method in an appendix to this part, or a method that has been designated as a reference method in accordance with Part 53 of this chapter; it does not include a method for which a reference method designation has been cancelled in accordance with §53.11 or §53.16 of this chapter.

(g) "Equivalent method" means a method of sampling and analyzing the ambient air for an air pollutant that has been designated as an equivalent method in accordance with Part 53 of this chapter; it does not include a method for which an equivalent method designation has been cancelled in accordance with §53.11 or §53.16 of this chapter.

(h) "Traceable" means that a local standard has been compared and certified either directly or via not more than one intermediate standard, to a primary standard such as a National Bureau of Standards Standard Reference Material (NBS SRM), or a USEPA/NBS-approved Certified Reference Material (CRM).

[50.1 (h) added by 48 FR 2529, January 20, 1983]

§ 50.2 Scope.

(a) National primary and secondary ambient air quality standards under section 109 of the Act are set forth in this part.

(b) National primary ambient air quality standards define levels of air quality which the Administrator judges are necessary, with an adequate margin of safety, to protect the public health. National secondary ambient air quality standards define levels of air quality which the Administrator judges necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Such standards are subject to revision, and additional primary and secondary standards may be promulgated as the Administrator deems necessary to protect the public health and welfare.

(c) The promulgation of national primary and secondary ambient air quality standards shall not be considered in any manner to allow significant deterioration of existing air quality in any portion of any State.

(d) The proposal, promulgation, or revision of national primary and secondary ambient air quality standards shall not prohibit any State from establishing ambient air quality standards for that State or any portion thereof which are more stringent than the national standards.

§ 50.3 Reference conditions.

All measurements of air quality are corrected to a reference temperature of 25° C. and to a reference pressure of 760 millimeters of mercury (1,013.2 millibars).

§ 50.4 National primary ambient air quality standards for sulfur oxides (sulfur dioxide).

The national primary ambient air quality standards for sulfur oxides measured as sulfur dioxide by the reference method described in Appendix A to this part, or by an equivalent method, are:

(a) 80 micrograms per cubic meter (0.03 p.p.m.)—annual arithmetic mean.

(b) 365 micrograms per cubic meter (0.14 p.p.m.)—Maximum 24-hour concentration not to be exceeded more than once per year.

§ 50.5 National secondary ambient air quality standards for sulfur oxides (sulfur dioxide).

The national secondary ambient air quality standard for sulfur oxides measured as sulfur dioxide by the reference method described in Appendix A to this part, or by any equivalent method is 1,300 micrograms per cubic meter (0.5 p.p.m.) maximum 3-hour concentration not to be exceeded more than once per year.

§ 50.6 National primary ambient air quality standards for particulate matter.

The national primary ambient air quality standards for particulate matter, measured by the reference method described in Appendix B to this part, or by an equivalent method are:

(a) 75 micrograms per cubic meter annual geometric mean.

(b) 260 micrograms per cubic meter—maximum 24-hour concentration not to be exceeded more than once per year.

§ 50.7 National secondary ambient air quality standards for particulate matter.

The national secondary ambient air quality standards for particulate matter, measured by the reference method described in Appendix B to this part, or by an equivalent method are:

(a) 60 micrograms per cubic meter annual geometric mean, as a guide

Published by THE BUREAU OF NATIONAL AFFAIRS INC., Washington, D.C. 20037

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Appendix B—Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)

[Appendix B revised by 47 FR 54899, December 6, 1982]

1.0 *Applicability.*

1.1 This method provides a measurement of the mass concentration of total suspended particulate matter (TSP) in ambient air for determining compliance with the primary and secondary national ambient air quality standards for particulate matter as specified in § 50.6 and § 50.7 of this chapter. The measurement process is nondestructive, and the size of the sample collected is usually adequate for subsequent chemical analysis. Quality assurance procedures and guidance are provided in Part 58, Appendixes A and B, of this chapter and in References 1 and 2.

2.0 *Principle.*

2.1 An air sampler, properly located at the measurement site, draws a measured quantity of ambient air into a covered housing and through a filter during a 24-hr (nominal) sampling period. The sampler flow rate and the geometry of the shelter favor the collection of particles up to 25–50 μm (aerodynamic diameter), depending on wind speed and direction.(3) The filters used are specified to have a minimum collection efficiency of 99 percent for 0.3 μm (DOP) particles (see Section 7.1.4).

2.2 The filter is weighed (after moisture equilibration) before and after use to determine the net weight (mass) gain. The total volume of air sampled, corrected to EPA standard conditions (25° C, 760 mm Hg (101 kPa)), is determined from the measured flow rate and the sampling time. The concentration of total suspended particulate matter in the ambient air is computed as the mass of collected particles divided by the volume of air sampled, corrected to standard conditions, and is expressed in micrograms per standard cubic meter (μg/std m³). For samples collected at temperatures and pressures significantly different than standard conditions, these corrected concentrations may differ substantially from actual concentrations (micrograms per actual cubic meter), particularly at high elevations. The actual particulate matter concentration can be calculated from the corrected concentration using the actual temperature and pressure during the sampling period.

3.0 *Range.*

3.1 The approximate concentration range of the method is 2 to 750 μg/std m³. The upper limit is determined by the point at which the sampler can no longer maintain the specified flow rate due to the increased pressure drop of the loaded filter. This point is affected by particle size distribution, moisture content of the collected particles, and variability from filter to filter, among other things. The lower limit is determined by the sensitivity of the balance (see Section 7.10) and by inherent sources of error (see Section 6).

3.2 At wind speeds between 1.3 and 4.5 m/sec (3 and 10 mph), the high-volume air sampler has been found to collect particles up to 25 to 50 μm, depending on wind speed and direction.(3) For the filter specified in Section 7.1, there is effectively no lower limit on the particle size collected.

4.0 *Precision.*

4.1 Based upon collaborative testing, the relative standard deviation (coefficient of variation) for single analyst precision (repeatability) of the method is 3.0 percent. The corresponding value for interlaboratory precision (reproducibility) is 3.7 percent.(4)

5.0 *Accuracy.*

5.1 The absolute accuracy of the method is undefined because of the complex nature of atmospheric particulate matter and the difficulty in determining the "true" particulate matter concentration. This method provides a measure of particulate matter concentration suitable for the purpose specified under Section 1.0, Applicability.

6.0 *Inherent Sources of Error.*

6.1 *Airflow variation.* The weight of material collected on the filter represents the (integrated) sum of the product of the instantaneous flow rate times the

instantaneous particle concentration. Therefore, dividing this weight by the average flow rate over the sampling period yields the true particulate matter concentration only when the flow rate is constant over the period. The error resulting from a nonconstant flow rate depends on the magnitude of the instantaneous changes in the flow rate and in the particulate matter concentration. Normally, such errors are not large, but they can be greatly reduced by equipping the sampler with an automatic flow controlling mechanism that maintains constant flow during the sampling period. Use of a contant flow controller is recommended.*

6.2 *Air volume measurement.* If the flow rate changes substantially or nonuniformly during the sampling period, appreciable error in the estimated air volume may result from using the average of the presampling and postsampling flow rates. Greater air volume measurement accuracy may be achieved by (1) equipping the sampler with a flow controlling mechanism that maintains constant air flow during the sampling period.* (2) using a calibrated, continuous flow rate recording device to record the actual flow rate during the samping period and integrating the flow rate over the period, or (3) any other means that will accurately measure the total air volume sampled during the sampling period. Use of a continuous flow recorder is recommended, particularly if the sampler is not equipped with a constant flow controller.

6.3 *Loss of volatiles.* Volatile particles collected on the filter may be lost during subsequent sampling or during shipment and/or storage of the filter prior to the postsampling weighing.(*5*) Although such losses are largely unavoidable, the filter should be reweighed as soon after sampling as practical.

6.4 *Artifact particulate matter.* Artifact particulate matter can be formed on the surface of alkaline glass fiber filters by oxidation of acid gases in the sample air, resulting in a higher than true TSP determination.(*6 7*) This effect usually occurs early in the sample period and is a function of the filter pH and the presence of acid gases. It is generally believed to account for only a small percentage of the filter weight gain, but the effect may become more significant where relatively small particulate weights are collected.

6.5 *Humidity.* Glass fiber filters are comparatively insensitive to changes in relative humidity, but collected particulate matter can be hygroscopic.(*8*) The moisture conditioning procedure minimizes but may not completely eliminate error due to moisture.

6.6 *Filter handling.* Careful handling of the filter between the presampling and postsampling weighings is necessary to avoid errors due to loss of fibers or particles from the filter. A filter paper cartridge or cassette used to protect the filter can minimize handling errors. (See Reference 2, Section 2).

6.7 *Nonsampled particulate matter.* Particulate matter may be deposited on the filter by wind during periods when the sampler is inoperative. (*9*) It is recommended that errors from this source be minimized by an automatic mechanical device that keeps the filter covered during nonsampling periods, or by timely installation and retrieval of filters to minimize the nonsampling periods prior to and following operation.

6.8 *Timing errors.* Samplers are normally controlled by clock timers set to start and stop the sampler at midnight. Errors in the nominal 1,440-min sampling period may result from a power interruption during the sampling period or from a discrepancy between the start or stop time recorded on the filter information record and the actual start or stop time of the sampler. Such discrepancies may be caused by (1) poor resolution of the timer set-points, (2) timer error due to power interruption, (3) missetting of the timer, or (4) timer malfunction. In general, digital electronic timers have much better set-point resolution than mechanical timers, but require a battery backup system to maintain continuity of operation after a power interruption. A continuous flow recorder or elapsed time meter provides an indication of the sampler run-time, as well as indication of any power interruption during the sampling period and is therefore recommended.

6.9 *Recirculation of sampler exhaust.* Under stagnant wind conditions, sampler exhaust air can be resampled. This effect does not appear to affect the TSP measurement substantially, but may result in increased carbon and copper in the collected sample. (*10*) This problem can be reduced by ducting the exhaust air well away, preferably downwind, from the sampler.

7.0 *Apparatus.*

(See References 1 and 2 for quality assurance information.)

Note.—Samplers purchased prior to the effective date of this amendment are not subject to specifications preceded by (†).

7.1 *Filter.* (Filters supplied by the Environmental Protection Agency can be assumed to meet the following criteria. Additional specifications are required if the sample is to be analyzed chemically.)

7.1.1 *Size:* 20.3 ± 0.2 × 25.4 ± 0.2 cm (nominal 8 × 10 in).

7.1.2 *Nominal exposed area:* 406.5 cm^2 (63 in^2).

7.1.3 *Material:* Glass fiber or other relatively inert, nonhygroscopic material. (*8*)

7.1.4 *Collection efficiency:* 99 percent minimum as measured by the DOP test (ASTM-2986) for particles of 0.3 μm diameter.

7.1.5 *Recommended pressure drop range:* 42–54 mm Hg (5.6–7.2 kPa) at a flow rate of 1.5 std m^3/min through the nominal exposed area.

7.1.6 *pH:* 6 to 10. (*11*)

7.1.7 *Integrity:* 2.4 mg maximum weight loss. (*11*)

7.1.8 *Pinholes:* None.

7.1.9 *Tear strength:* 500 g minimum for 20 mm wide strip cut from filter in weakest dimension. (See ASTM Test D828–60).

7.1.10 *Brittleness:* No cracks or material separations after single lengthwise crease.

7.2 *Sampler.* The air sampler shall provide means for drawing the air sample, via reduced pressure, through the filter at a uniform face velocity.

7.2.1 The sampler shall have suitable means to:

a. Hold and seal the filter to the sampler housing.

b. Allow the filter to be changed conveniently.

c. Preclude leaks that would cause error in the measurement of the air volume passing through the filter.

d. (†) Manually adjust the flow rate to accommodate variations in filter pressure drop and site line voltage and altitude. The adjustment may be accomplished by an automatic flow controller or by a manual flow adjustment device. Any manual adjustment device must be designed with positive detents or other means to avoid unintentional changes in the setting.

7.2.2 *Minimum sample flow rate, heavily loaded filter:* 1.1 m^3/min (39 ft^3/min).**

7.2.3 *Maximum sample flow rate, clean filter:* 1.7 m^3/min (60 ft^3/min).**

7.2.4 *Blower Motor:* The motor must be capable of continuous operation for 24-hr periods.

7.3 *Sampler shelter.*

*At elevated altitudes, the effectiveness of automatic flow controllers may be reduced because of a reduction in the maximum sampler flow.

(†) See note at beginning of Section 7.

** These specifications are in actual air volume units; to convert to EPA standard air volume units, multiply the specifications by $(P_a/P_{std})(298/T)$ where P_a and T are the barometric pressure in mm Hg (or kPa) and the temperature in K at the sampler, and P_{std} is 760 mm Hg (or 101 kPa).

[Appendix B]

7.3.1 The sampler shelter shall:

a. Maintain the filter in a horizontal position at least 1 m above the sampler supporting surface so that sample air is drawn downward through the filter.

b. Be rectangular in shape with a gabled roof, similar to the design shown in Figure 1.

c. Cover and protect the filter and sampler from precipitation and other weather.

d. Discharge exhaust air at least 40 cm from the sample air inlet.

e. Be designed to minimize the collection of dust from the supporting surface by incorporating a baffle between the exhaust outlet and the supporting surface.

7.3.2 The sampler cover or roof shall overhang the sampler housing somewhat, as shown in Figure 1, and shall be mounted so as to form an air inlet gap between the cover and the sampler housing walls. [†]This sample air inlet should be approximately uniform on all sides of the sampler. [†]The area of the sample air inlet must be sized to provide an effective particle capture air velocity of between 20 and 35 cm/sec at the recommended operational flow rate. The capture velocity is the sample air flow rate divided by the inlet area measured in a horizontal plane at the lower edge of the cover. [†]Ideally, the inlet area and operational flow rate should be selected to obtain a capture air velocity of 25 ±2 cm/sec.

7.4 *Flow rate measurement devices.*

7.4.1 The sampler shall incorporate a flow rate measurement device capable of indicating the total sampler flow rate. Two common types of flow indicators covered in the calibration procedure are (1) an electronic mass flowmeter and (2) an orifice or orifices located in the sample air stream together with a suitable pressure indicator such as a manometer, or aneroid pressure gauge. A pressure recorder may be used with an orifice to provide a continuous record of the flow. Other types of flow indicators (including rotameters) having comparable precision and accuracy are also acceptable.

7.4.2 [†]The flow rate measurement device must be capable of being calibrated and read units corresponding to a flow rate which is readable to the nearest 0.02 std m^3/min over the range 1.0 to 1.8 std m^3/min.

7.5 *Thermometer,* to indicate the approximate air temperature at the flow rate measurement orifice, when temperature corrections are used.

7.5.1 *Range:* −40° to ±50° C (223–323 K).

7.5.2 *Resolution:* 2° C (2 K).

7.6 *Barometer,* to indicate barometric pressure at the flow rate measurement orifice, when pressure corrections are used.

7.6.1 *Range:* 500 to 800 mm Hg (66–106 kPa).

7.6.2 *Resolution:* ±5 mm Hg (0.67 kPa).

7.7 *Timing/control device.*

7.7.1 The timing device must be capable of starting and stopping the sampler to obtain an elapsed run-time of 24 hr ±1 hr (1,440 ±60 min).

7.7.2 *Accuracy of time setting:* ±30 min. or better. (See Section 6.8).

7.8 *Flow rate transfer standard,* traceable to a primary standard. (See Section 9.2).

7.8.1 *Approximate range:* 1.0 to 1.8 m^3/min.

7.8.2 *Resolution:* 0.02 m^3/min.

7.8.3 *Reproducibility:* ±2 percent (2 times coefficient of variation) over normal ranges of ambient temperature and pressure for the stated flow rate range. (See Reference 2, Section 2.)

7.8.4 Maximum pressure drop at 1.7 std m^3/min: 50 cm H_2O (5 kPa).

7.8.5 The flow rate transfer standard must connect without leaks to the inlet of the sampler and measure the flow rate of the total air sample.

7.8.6 The flow rate transfer standard must include a means to vary the sampler flow rate over the range of 1.0 to 1.8 m^3/min (35–64 ft^3/min) by introducing various levels of flow resistance between the sampler and the transfer standard inlet.

7.8.7 The Conventional type of flow transfer standard consists of: An orifice unit with adapter that connects to the inlet of the sampler, a manometer or other device to measure orifice pressure drop, a means to vary the flow through the sampler unit, a thermometer to measure the ambient temperature, and a barometer to measure ambient pressure. Two such devices are shown in Figures 2a and 2b. Figure 2a shows multiple fixed resistance plates, which necessitate disassembly of the unit each time the flow resistance is changed. A preferable design, illustrated in Figure 2b, has a variable flow restriction that can be adjusted externally without disassembly of the unit. Use of conventional, orifice-type transfer standard is assumed in the calibration procedure (Section 9). However, the use of other types of transfer standards meeting the above specifications, such as the one shown in Figure 2c, may be approved: see the note following Section 9.1.

7.9 *Filter conditioning environment*

7.9.1 *Controlled temperature:* between 15° and 30° C with less than ± 3° C variation during equilibration period.

[Corrected by 48 FR 17355, April 22, 1983]

7.9.2 *Controlled humidity:* Less than 50 percent relative humidity, constant within ±5 percent.

7.10 *Analytical balance.*

7.10.1 *Sensitivity:* 0.1 mg.

7.10.2 Weighing chamber designed to accept an unfolded 20.3 x 25.4 cm (8 x 10 in) filter.

7.11 *Area light source,* similar to X-ray film viewer, to backlight filters for visual inspection.

7.12 *Numbering device,* capable of printing identification numbers on the filters before they are placed in the filter conditioning environment, if not numbered by the supplier.

8.0 *Procedure.*

(See References 1 and 2 for quality assurance information.)

8.1 Number each filter, if not already numbered, near its edge with a unique identification number.

8.2 Backlight each filter and inspect for pinholes, particles, and other imperfections: filters with visible imperfections must not be used.

8.3 Equilibrate each filter in the conditioning environment for at least 24-hr.

8.4 Following equilibration, weigh each filter to the nearest milligram and record this tare weight (W_i) with the filter identification number.

8.5 Do not bend or fold the filter before collection of the sample.

8.6 Open the shelter and install a numbered, preweighted filter in the sampler, following the sampler manufacturer's instructions. During inclement weather, precautions must be taken while changing filters to prevent damage to the clean filter and loss of sample from or damage to the exposed filter. Filter cassettes that can be loaded and unloaded in the laboratory may be used to minimize this problem (See Section 6.6).

[Corrected by 48 FR 17355, April 22, 1983]

8.7 Close the shelter and run the sampler for at least 5 min to establish run-temperature conditions.

8.8 Record the flow indicator reading and, if needed, the barometric pressure (P_a) and the ambient temperature (T_a) see NOTE following step 8.12). Stop the sampler. Determine the sampler flow rate (see Section 10.1); if it is outside the acceptable range (1.1 to 1.7 m^3/min (39–60 ft^3/min)), use a different filter, or adjust the sampler flow rate. (Warning: Substantial flow adjustments may affect the calibration of the orifice-type flow indicators and may necessitate recalibration.

8.9 Record the sampler identification information (filter number, site location or identification number, sample date, and starting time).

8.10 Set the timer to start and stop the sampler such that the sampler runs 24-hrs. from midnight to midnight (local time).

[Corrected by 48 FR 17355, April 22, 1983]

[†] See note at beginning of Section 7.

[††] These specifications are in actual air volume units: to convert to EPA standard air volume units, multiply the specifications by $(P_a/P_{std})(298/T)$ where P_a and T are the barometric pressure in mm Hg (or kPa) and the temperature in K at the sampler, and P_{std} is 760 mm Hg (or 101 kPa).

8.11 As soon as practical following the sampling period, run the sampler for at least 5 min to again establish run-temperature conditions.

8.12 Record the flow indicator reading and, if needed, the barometric Pressure (P_a) and the ambient temperature (T_a).

Note.—No onsite pressure or temperature measurements are necessary if the sampler flow indicator does not require pressure or temperature corrections (e.g., a mass flowmeter) or if average barometric pressure and seasonal average temperature for the site are incorporated into the sampler calibration (see step 9.3.9). For individual pressure and temperature corrections, the ambient pressure and temperature can be obtained by onsite measurements or from a nearby weather station. Barometric pressure readings obtained from airports must be station pressure, not corrected to sea level, and may need to be corrected for differences in elevation between the sampler site and the airport. For samplers having flow recorders but not constant flow controllers, the average temperature and pressure at the site *during the sampling period* should be estimated from weather bureau or other available data.

8.13 Stop the sampler and carefully remove the filter, following the sampler manufacturer's instructions. Touch only the outer edges of the filter. See the precautions in step 8.6.

8.14 Fold the filter in half lengthwise so that only surfaces with collected particulate matter are in contact and place it in the filter holder (glassine envelope or manila folder).

8.15 Record the ending time or elapsed time on the filter information record, either from the stop set-point time, from an elapsed time indicator, or from a continuous flow record. The sample period must be 1,440 ± 60 min. for a valid sample.

8.16 Record on the filter information record any other factors, such as meteorological conditions, construction activity, fires or dust storms, etc., that might be pertinent to the measurement. If the sample is known to be defective, void it at this time.

8.17 Equilibrate the exposed filter in the conditioning environment for at least 24-hrs.

8.18 Immediately after equilibration, reweigh the filter to the nearest milligram and record the gross weight with the filter identification number. See Section 10 for TSP concentration calculations.

9.0 *Calibration.*

9.1 Calibration of the high volume sampler's flow indicating or control device is necessary to establish traceability of the field measurement to a primary standard via a flow rate transfer standard. Figure 3a illustrates the certification of the flow rate transfer standard and Figure 3b illustrates its use in calibrating a sampler flow indicator. Determination of the corrected flow rate from the sampler flow indicator, illustrated in Figure 3c, is addressed in Section 10.1

Note.—The following calibration procedure applies to a conventional orifice-type flow transfer standard and an orifice-type flow indicator in the sampler (the most common types). For samplers using a pressure recorder having a square-root scale, 3 other acceptable calibration procedures are provided in Reference 12. Other types of transfer standards may be used if the manufacturer or user provides an appropriately modified calibration procedure that has been approved by EPA under Section 2.8 of Appendix C to Part 58 of this chapter.

9.2 *Certification of the flow rate transfer standard.*

9.2.1 *Equipment required:* Positive displacement standard volume meter traceable to the National Bureau of Standards (such as a Roots meter or equivalent), stop-watch, manometer, thermometer, and barometer.

9.2.2 Connect the flow rate transfer standard to the inlet of the standard volume meter. Connect the manometer to measure the pressure at the inlet of the standard volume meter. Connect the orifice manometer to the pressure tap on the transfer standard. Connect a high-volume air pump (such as a high-volume sampler blower) to the outlet side of the standard volume meter. See Figure 3a.

9.2.3 Check for leaks by temporarily clamping both manometer lines (to avoid fluid loss) and blocking the orifice with a large-diameter rubber stopper, wide cellophane tape, or other suitable means. Start the high-volume air pump and note any change in the standard volume meter reading. The reading should remain constant. If the reading changes, locate any leaks by listening for a whistling sound and/or retightening all connections, making sure that all gaskets are properly installed.

9.2.4 After satisfactorily completing the leak check as described above, unclamp both manometer lines and zero both manometers.

9.2.5 Achieve the appropriate flow rate through the system, either by means of the variable flow resistence in the transfer standard or by varying the voltage to the air pump. (Use of resistance plates as shown in Figure 1a is discouraged because the above leak check must be repeated each time a new resistance plate is installed.) At least five different but constant flow rates, even distributed, with at least three in the specified flow rate interval (1.1 to 1.7 m^3/min [39–60 ft^3/min]), are required.

9.2.6 Measure and record the certification data on a form similar to the one illustrated in Figure 4 according to the following steps.

9.2.7 Observe the barometric pressure and record as P_t (item 8 in Figure 4).

9.2.8 Read the ambient temperature in the vicinity of the standard volume meter and record it as T_t (item 9 in Figure 4).

9.2.9 Start the blower motor, adjust the flow, and allow the system to run for at least 1 min for a constant motor speed to be attained.

9.2.10 Observe the standard volume meter reading and simultaneously start a stopwatch. Record the initial meter reading (V_i) in column 1 of Figure 4.

9.2.11 Maintain this constant flow rate until at least 3 m^3 of air have passed through the standard volume meter. Record the standard volume meter inlet pressure manometer reading as ΔP (column 5 in Figure 4), and the orifice manometer reading as ΔH (column 7 in Figure 4). Be sure to indicate the correct units of measurement.

9.2.12 After at least 3 m^3 of air have passed through the system, observe the standard volume meter reading while simultaneously stopping the stopwatch. Record the final meter reading (V_f) in column 2 and the elapsed time (t) in column 3 of Figure 4.

9.2.13 Calculate the volume measured by the standard volume meter at meter conditions of temperature and pressures as $V_m = V_f - V_i$. Record in column 4 of Figure 4.

9.2.14 Correct this volume to standard volume (std m^3) as follows:

$$V_{std} = V_m \frac{P_t - \Delta P}{P_{std}} \frac{T_{std}}{T_t}$$

where:

V_{std} = standard volume, std m^3

V_m = actual volume measured by the standard volume meter;

P_t = barometric pressure during calibration, mm Hg or kPa;

ΔP = differential pressure at inlet to volume meter, mm Hg or kPa;

P_{std} = 760 mm Hg or 101 kPa;

T_{std} = 298 K;

T_t = ambient temperature during calibration, K.

Calculate the standard flow rate (std m^3/min) as follows:

$$Q_{std} = \frac{V_{std}}{t}$$

where:

Q_{std} = standard volumetric flow rate, std m^3/min

t = elapsed time, minutes.

Record Q_{std} to the nearest 0.01 std m^3/min in column 6 of Figure 4.

9.2.15 Repeat steps 9.2.9 through 9.2.14 for at least four additional constant flow rates, evenly spaced over the approximate range of 1.0 to 1.8 std m^3/min (35–64 ft^3/min).

9.2.16 For each flow, compute

$$\sqrt{\Delta H (P_t / P_{std})(298/T_t)}$$

(column 7a of Figure 4) and plot these value against Q_{std} as shown in Figure 3a. Be sure to use consistent units (mm Hg or kPa) for

[Appendix B]

6-3-83 Published by THE BUREAU OF NATIONAL AFFAIRS INC., Washington, D.C. 20037

arometric pressure. Draw the orifice transfer andard certification curve or calculate the near least squares slope (m) and intercept ,) of the certification curve:

$$\sqrt{\Delta H\,(P_a/P_{std})(298/T_a)}$$

$= mQ_{std} + b$. See Figures 3 and 4. A ertification graph should be readable to 0.02 d m^3/min.

9.2.17 Recalibrate the transfer standard nnually or as required by applicable quality control procedures. (See Reference 2.)

9.3 *Calibration of sampler flow indicator.*

Note.—For samplers equipped with a flow ontrolling device, the flow controller must be disabled to allow flow changes during calibration of the sampler's flow indicator, or e alternate calibration of the flow controller ven in 9.4 may be used. For samplers using an orifice-type flow indicator downstream of the motor, do not vary the flow rate by djusting the voltage or power supplied to the r.

9.3.1 A form similar to the one illustrated in Figure 5 should be used to record the calibration data.

9.3.2 Connect the transfer standard to the nlet of the sampler. Connect the orifice manometer to the orifice pressure tap, as illustrated in Figure 3b. Make sure there are o leaks between the orifice unit and the ampler.

9.3.3 Operate the sampler for at least 5 minutes to establish thermal equilibrium prior o the calibration.

9.3.4 Measure and record the ambient emperature, T_a, and the barometric pressure, P_a, during calibration.

9.3.5 Adjust the variable resistance or, if pplicable, insert the appropriate resistance late (or no plate) to achieve the desired flow rate.

9.3.6 Let the sampler run for at least 2 min o re-establish the run-temperature tions. Read and record the pressure across the orifice (ΔH) and the sampler flow rate indication (I) in the appropriate columns of Figure 5.

9.3.7 Calculate $\sqrt{\Delta H(P_a/P_{std})(298/T_a)}$ and determine the flow rate at standard conditions (Q_{std}) either graphically from the certification curve or by calculating Q_{std} from the least square slope and intercept of the transfer standard's transposed certification curve: $Q_{std} = 1/m \sqrt{\Delta H(P_a/P_{std})(298/T_a)} - b$. Record the value of Q_{std} on Figure 5.

[Corrected by 48 FR 17355, April 22, 1983]

9.3.8 Repeat steps 9.3.3, 9.3.6, and 9.3.7 for several additional flow rates distributed over a range that includes 1.1 to 1.7 std m^3/min.

9.3.9 Determine the calibration curve by plotting values of the appropriate expression involving I, selected from Table 1, against Q_{std}. The choice of expression from Table 1 depends on the flow rate measurement device used (see Section 7.4.1) and also on whether the calibration curve is to incorporate geographic average barometric pressure (P_a) and seasonal average temperature (T_a) for the site to approximate actual pressure and temperature. Where P_a and T_a can be determined for a site for a seasonal period such that the actual barometric pressure and temperature at the site do not vary by more than ±60 mm Hg (8 kPa) from P_a or ±15° C from T_a, respectively, then using P_a and T_a avoids the need for subsequent pressure and temperature calculation when the sampler is used. The geographic average barometric pressure (P_a) may be estimated from an altitude-pressure table or by making an (approximate) elevation correction of −23 mm Hg (−3.46 kPa) for each 305 m (1,000 ft) above sea level (760 mm Hg or 101 kPa). The seasonal average temperature (T_a) may be estimated from weather station or other records. Be sure to use consistent units (mm Hg or kPa) for barometric pressure.

[Corrected by 48 FR 17355, April 22, 1983]

9.3.10 Draw the sampler calibration curve or calculate the linear least squares slope (m), intercept (b), and correlation coefficient of the calibration curve: [Expression from Table 1] = $mQ_{std} + b$. See Figures 3 and 5. Calibration curves should be readable to 0.02 std m^3/min.

9.3.11 For a sampler equipped with a flow controller, the flow controlling mechanism should be re-enabled and set to a flow near the lower flow limit to allow maximum control range. The sample flow rate should be verified at this time with a clean filter installed. Then add two or more filters to the sampler to see if the flow controller maintains a constant flow: this is particularly important at high altitudes where the range of the flow controller may be reduced.

9.4 Alternate calibration of flow-controlled samplers. A flow-controlled sampler may be calibrated solely at its controlled flow rate, provided that previous operating history of the sampler demonstrates that the flow rate is stable and reliable. In this case, the flow indicator may remain uncalibrated but should be used to indicate any relative change between initial and final flows, and the sampler should be recalibrated more often to minimize potential loss of samples because of controller malfunction.

9.4.1 Set the flow controller for a flow near the lower limit of the flow range to allow maximum control range.

9.4.2 Install a clean filter in the sampler and carry out steps 9.3.2, 9.3.3, 9.3.4, 9.3.6, and 9.3.7.

9.4.3 Following calibration, add one or two additional clean filters to the sampler, reconnect the transfer standard, and operate the sampler to verify that the controller maintains the same calibrated flow rate: this is particularly important at high altitudes where the flow control range may be reduced.

TABLE 1. EXPRESSIONS FOR PLOTTING SAMPLER CALIBRATION CURVES

Type of sampler flow rate measuring device	Expression: For actual pressure and temperature corrections	Expression: For incorporation of geographic average pressure and seasonal average temperature
Mass flowmeter	I	I
Orifice and pressure indicator	$\sqrt{I\left(\frac{P_2}{P_{std}}\right)\left(\frac{298}{T_2}\right)}$	$\sqrt{I\left(\frac{P_2}{P_a}\right)\left(\frac{T_a}{T_2}\right)}$
Rotameter, or orifice and pressure recorder having square root scale*	$I\sqrt{\left(\frac{P_2}{P_{std}}\right)\left(\frac{298}{T_2}\right)}$	$I\sqrt{\left(\frac{P_2}{P_a}\right)\left(\frac{T_a}{T_2}\right)}$

*This scale is recognizable by its nonuniform divisions and is the most commonly available for high-volume samplers.

TABLE 2. EXPRESSIONS FOR DETERMINING FLOW RATE DURING SAMPLER OPERATION

Type of sampler flow rate measuring device	Expression: For actual pressure and temperature corrections	Expression: For use when geographic average pressure and seasonal average temperature have been incorporated into the sampler calibration
Mass flowmeter	I	I
Orifice and pressure indicator	$\sqrt{I\left(\frac{P_3}{P_{std}}\right)\left(\frac{298}{T_3}\right)}$	$\sqrt{I}$
Rotameter, or orifice and pressure recorder having square root scale*	$I\sqrt{\left(\frac{P_3}{P_{std}}\right)\left(\frac{298}{T_3}\right)}$	I

*This scale is recognizable by its nonuniform divisions and is the most commonly available for high-volume samplers.

Calculations of TSP Concentration

Determine the average sampler flow ...ing the sampling period according to ...0.1.1 or 10.1.2 below.

1. For a sampler without a continuous ...recorder, determine the appropriate ...ssion to be used from Table 2 ...sponding to the one from Table 1 used in ...9.3.9. Using this appropriate expression, ...mine Q_{std} for the initial flow rate from ...mpler calibration curve, either ...ically or from the transposed regression ...tion:

Appropriate expression from Table 2(–b)

...arly, determine Q_{std} from the final flow ...ng, and calculate the average flow Q_{std} ...one-half the sum of the initial and final ...rates.

...1 For a sampler with a continuous ...recorder, determine the average flow ...device reading, I, for the period. ...ermine the appropriate expression from ...e 2 corresponding to the one from Table ...d in step 9.3.9. Then using this ...ession and the average flow rate reading, ...ermine Q_{std} from the sampler calibration ...e, either graphically or from the ...sposed regression equation:

...=

Appropriate expression from Table 2(–b)

If the trace shows substantial flow change ...ing the sampling period, greater accuracy ...be achieved by dividing the sampling ...od into intervals and calculating an ...erage reading before determining Q_{std}.

10.2 Calculate the total air volume ...mpled as:

( ) Xt

...ere:

...= total air volume sampled, in standard volume units, std m^3/;

...= average standard flow rate, std m^3/min;

...sampling time, min.

Corrected by 48 FR 17355, April 22, ...983]

...0.3 Calculate and report the particulate ...tter concentration as:

$$TSP = \frac{(W_f - W_i) \times 10^6}{V}$$

...ere:

TSP = mass concentration of total suspended particulate matter, µg/std m^3;

W_i = initial weight of clean filter, g;

W_f = final weight of exposed filter, g;

V = air volume sampled, converted to standard conditions, std m^3.

10^6 = conversion of g to µg.

10.4 If desired, the actual particulate matter concentration (see Section 2.2) can be calculated as follows:

$$(TSP)_a = TSP\,(P_a/P_{std})(298/T_a)$$

where:

$(TSP)_a$ = actual concentration at field conditions, µg/m^3;

TSP = concentration at standard conditions, µg/std m^3;

P_a = average barometric pressure during sampling period, mm Hg;

P_{std} = 760 mn Hg (or 101 kPa);

T_a = average ambient temperature during sampling period, K.

11.0 *References.*

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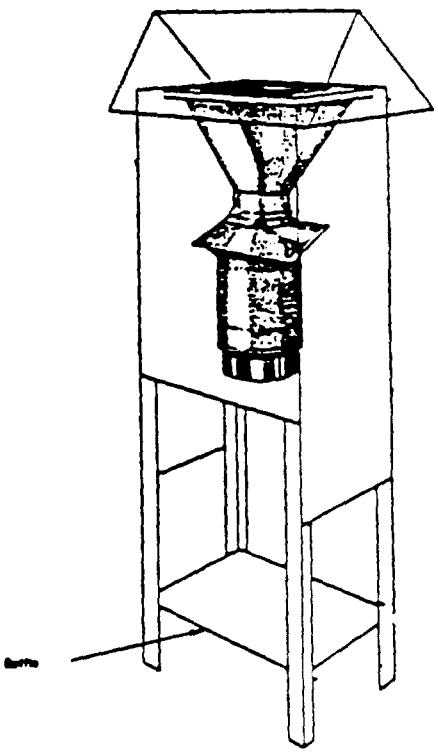
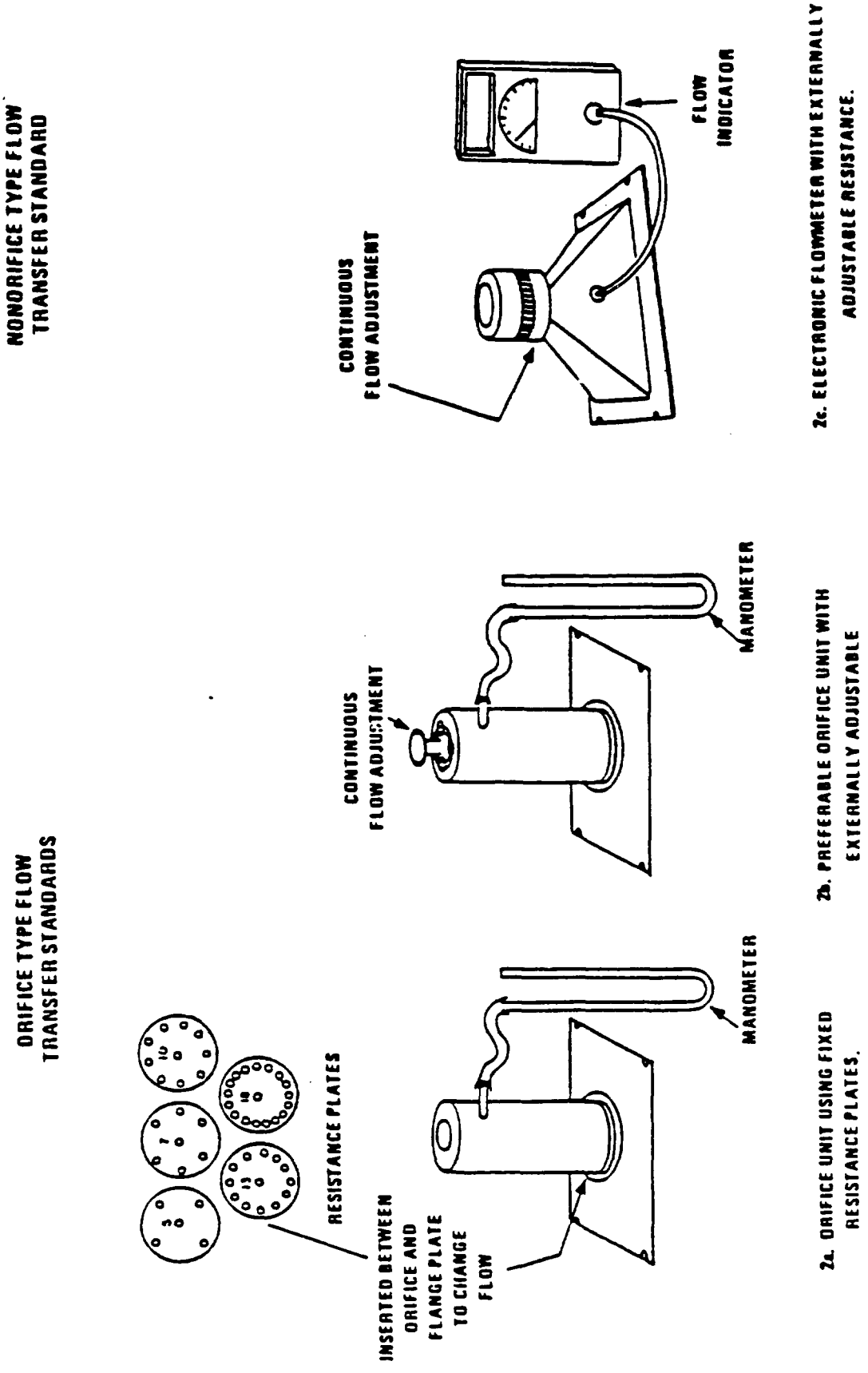


Figure 1. High-volume sampler in shelter.



2c. ELECTRONIC FLOWMETER WITH EXTERNALLY ADJUSTABLE RESISTANCE.

2b. PREFERABLE ORIFICE UNIT WITH EXTERNALLY ADJUSTABLE RESISTANCE.

2a. ORIFICE UNIT USING FIXED RESISTANCE PLATES.

Figure 2. Various types of flow transfer standards. Note that all devices are designed to mount to the filter inlet area of the sampler.

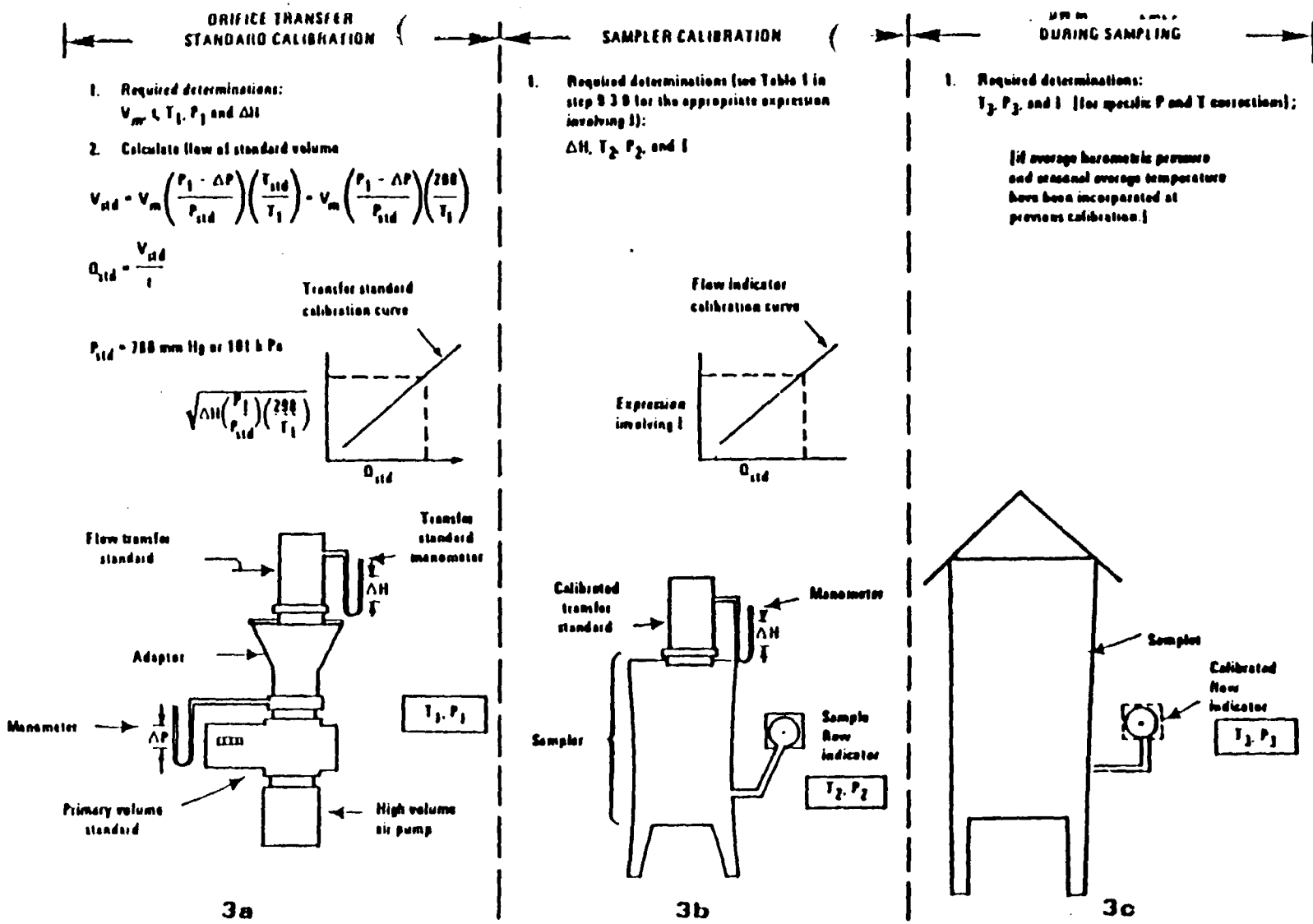


Figure 3. Illustration of the 3 steps in the flow measurement process.

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET

Run No.	(1) Meter reading start V_i (m^3)	(2) Meter reading stop V_f (m^3)	(3) Sampling time t (min)	(4) Volume measured V_m (m^3)	(5) Differential pressure (at inlet to volume meter) ΔP (mm Hg or kPa)	(6) (X) Flow rate Q_{std} (std m^3/min)	(7) Pressure drop across orifice ΔH ☐ (in) or ☐ (cm) of water	(7a) (Y) $\sqrt{\Delta H\left(\frac{P_1}{P_{std}}\right)\left(\frac{298}{T_1}\right)}$
1								
2								
3								
4								
5								
6								

RECORDED CALIBRATION DATA

Standard volume meter no. _____

Transfer standard type: ☐ orifice ☐ other

Model No. _____ Serial No. _____

(8) P_1: _____ mm Hg (or kPa) (10) P_{std}: 760 mm Hg (or 101 kPa)

(9) T_1: _____ K (11) T_{std}: 298 K

Calibration performed by: _____

Date: _____

CALCULATION EQUATIONS

(1) $V_m = V_f - V_i$

(2) $V_{std} = V_m\left(\frac{P_1 - \Delta P}{P_{std}}\right)\left(\frac{T_{std}}{T_1}\right)$

(3) $Q_{std} = \frac{V_{std}}{t}$

LEAST SQUARES CALCULATIONS

Linear ($Y = mX + b$) regression equation of $Y = \sqrt{\Delta H(P_1/P_{std})(298/T_1)}$ on $X = Q_{std}$ for Orifice Calibration Unit (i.e., $\sqrt{\Delta H(P_1/P_{std})(298/T_1)} = mQ_{std} + b$)

Slope (m) = _____ Intercept (b) = _____ Correlation coefficient (r) = _____

To use for subsequent calibration: $X = \frac{1}{m}(Y-b)$; $\boxed{Q_{std} = \frac{1}{m}\left(\sqrt{\Delta H\left(\frac{P_2}{P_{std}}\right)\left(\frac{298}{T_2}\right)} - b\right)}$

Figure 4. Example of orifice transfer standard certification worksheet.

HIGH-VOL AIR SAMPLER CALIBRATION WORKSHEET

Site Location: _____

Date: _____ Barometric Pressure, P_2 mm Hg (or kPa) _____

Calibrated By: _____ Temperature, T_2 (K) _____

Sampler No. _____ Serial No. _____

Transfer std. type: _____ Serial No. _____

P_{std} = 760 mm Hg (or 101 kPa)

Optional:

Average barometric pressure: P_a = _____

Seasonal average temperature: T_a = _____

No.	ΔH Pressure drop across orifice ☐(in) or ☐(cm) of water	$\sqrt{\Delta H\left(\frac{P_2}{P_{std}}\right)\left(\frac{298}{T_2}\right)}$	(X) Q_{std} (from orifice certification) std m^3/min	I Sampler flow rate indication (arbitrary)	(Y) For specific pressure and temperature corrections (see Table 1)	(Y) For incorporation of average pressure and seasonal average temperature (see Table 1)
					☐ I or ☐ $\sqrt{I\left(\frac{P_2}{P_{std}}\right)\left(\frac{298}{T_2}\right)}$ or ☐ $I\sqrt{\left(\frac{P_2}{P_{std}}\right)\left(\frac{298}{T_2}\right)}$	☐ I or ☐ $\sqrt{I\left(\frac{P_2}{P_a}\right)\left(\frac{T_a}{T_2}\right)}$ or ☐ $I\sqrt{\left(\frac{P_2}{P_a}\right)\left(\frac{T_a}{T_2}\right)}$
1						
2						
3						
4						
5						
6						

LEAST SQUARES CALCULATIONS

Linear regression of Y on X: Y = mX + b; Y = appropriate expression from Table 1; X = Q_{std}.

Slope (m) = ____ Intercept (b) = ____ Correlation Coeff. (r) = _____

To determine subsequent flow rate during use: $X = \frac{1}{m}(Y-b)$; $\boxed{Q_{std} = \frac{1}{m}([\text{appropriate expression from Table 2}] - b)}$

Figure 5. Example of high-volume air sampler calibration worksheet.

toring and Support Laboratory, Research Triangle Park, North Carolina 27711).

[References 14 and 15 added by 48 FR 2529, January 20, 1983]

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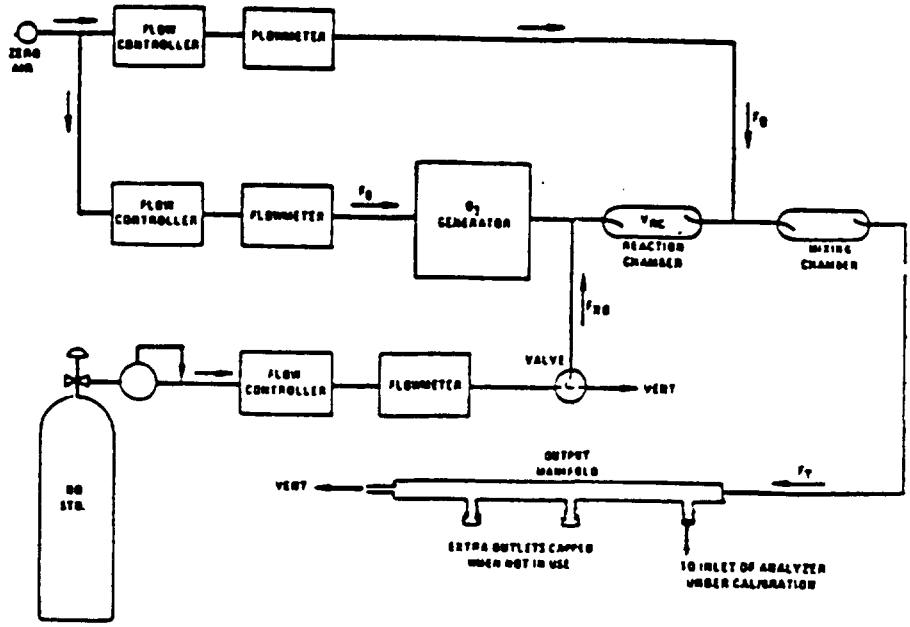

Figure 1. Schematic diagram of a typical GPT calibration system.

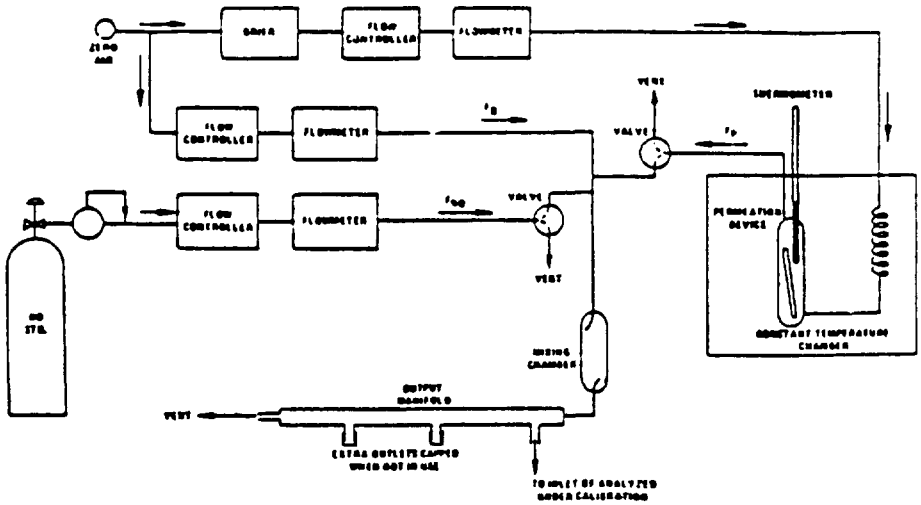

Figure 2. Schematic diagram of a typical calibration apparatus using an NO_2 permeation device.

Appendix G—Reference Method for the Determination of Lead in Suspended Particulate Matter Collected From Ambient Air

1. *Principle and applicability.*

1.1 Ambient air suspended particulate matter is collected on a glass-fiber filter for 24 hours using a high volume air sampler. The analysis of the 24-hour samples may be performed for either individual samples or composites of the samples collected over a calendar month or quarter, provided that the compositing procedure has been approved in accordance with section 2.8 of Appendix C to Part 58 of this chapter — *Modifications of methods by users.* (Guidance or assistance in requesting approval under Section 2.8 can be obtained from the address given in section 2.7 of Appendix C to Part 58 of this chapter.)

[Section 1.1 amended by 46 FR 44163, September 3, 1981]

1.2 Lead in the particulate matter is solubilized by extraction with nitric acid (HNO_3), facilitated by heat or by a mixture

of HNO_3 and hydrochloric acid (HCl) facilitated by ultrasonication.

1.3 The lead content of the sample is analyzed by atomic absorption spectrometry using an air-acetylene flame, the 283.3 or 217.0 nm lead absorption line, and the optimum instrumental conditions recommended by the manufacturer.

1.4 The ultrasonication extraction with HNO_3/HCl will extract metals other than lead from ambient particulate matter.

2. *Range, sensitivity, and lower detectable limit.* The values given below are typical of the methods capabilities. Absolute values will vary for individual situations depending on the type of instrument used, the lead line, and operating conditions.

2.1 Range. The typical range of the method is 0.07 to 7.5 μg Pb/m³ assuming an upper linear range of analysis of 15 μg/ml and an air volume of 2,400 m³.

2.2 *Sensitivity.* Typical sensitivities for a 1 percent change in absorption (0.0044 absorbance units) are 0.2 and 0.5 μg Pb/ml for the 217.0 and 283.3 nm lines, respectively.

2.3 Lower detectable limit (LDL). A typical LDL is 0.07 μg Pb/m³. The above value was calculated by doubling the between-laboratory standard deviation obtained for the lowest measurable lead concentration in a collaborative test of the method.(15) An air volume of 2,400 m³ was assumed.

3. *Interferences.* Two types of interferences are possible: chemical and light scattering.

3.1 *Chemical.* Reports on the absence (1, 2, 3, 4, 5) of chemical interferences far outweigh those reporting their presence. (6) therefore, no correction for chemical interferences is given here. If the analyst suspects that the sample matrix is causing a chemical interference, the interference can be verified and corrected for by carrying out the analysis with and without the method of standard additions.(7)

3.2 Light scattering. Nonatomic absorption or light scattering, produced by high concentrations of dissolved solids in the sample, can produce a significant interference, especially at low lead concentrations. (2) The interference is greater at the 217.0 nm line than at the 283.3 nm line. No interference was observed using the 283.3 nm line with a similar method.(1)

Light scattering interferences can, however, be corrected for instrumentally. Since the dissolved solids can vary depending on the origin of the sample, the correction may be necessary, especially when using the 217.0 nm line. Dual beam instruments with a continuum source give the most accurate correction. A less accurate correction can be obtained by using a nonabsorbing lead line that is near the lead analytical line. Information on use of these correction techniques can be obtained from instrument manufacturers' manuals.

If instrumental correction is not feasible, the interference can be eliminated by use of the ammonium pyrrolidinecarbodithioate-methylisobutyl ketone, chelation-solvent extraction technique of sample preparation.(8)

4. *Precision and bias.*

4.1 The high-volume sampling procedure used to collect ambient air particulate matter has a between-laboratory relative standard deviation of 3.7 percent over the range 80 to 125 μg/m³.(9) The combined extraction-analysis procedure has an average within-laboratory relative standard deviation of 5 to 6 percent over the range 1.5 to 5 μg Pb/ml, and an average between laboratory relative standard deviation of 7 to 9 percent over the same range. These values include use of either extraction procedure.

4.2 Single laboratory experiments and collaborative testing indicate that there is no significant difference in lead recovery between the hot and ultrasonic extraction procedures.(15)

5. *Apparatus.*

5.1 Sampling.

5.1.1 High-volume sampler. Use and calibrate the sampler as described in reference 10.

5.2 Analysis.

5.2.1 Atomic absorption spectrophotometer. Equipped with lead hollow cathode or electrodeless discharge lamp.

5.2.1.1 Acetylene. The grade recommended by the instrument manufacturer should be used. Change cylinder when pressure drops below 50–100 psig.

5.2.1.2 Air. Filtered to remove particulate, oil, and water.

5.2.2 Glassware. Class A borosilicate glassware should be used throughout the analysis.

5.2.2.1 Beakers. 30 and 150 ml, graduated, Pyrex.

5.2.2.2 Volumetric flasks. 100-ml.

5.2.2.3 Pipettes. To deliver 50, 30, 15, 8, 4, 2, 1 ml.

5.2.2.4 Cleaning. All glassware should be scrupulously cleaned. The following procedure is suggested. Wash with laboratory detergent, rinse, soak for 4 hours in 20 percent (w/w) HNO_3, rinse 3 times with distilled-deionized water, and dry in a dust free manner.

5.2.3 Hot plate.

5.2.4. Ultrasonication water bath, unheated. Commercially available laboratory ultrasonic cleaning baths of 450 watts or higher "cleaning power," i.e., actual ultrasonic power output to the bath have been found satisfactory.

5.2.5 Template. To aid in sectioning the glass-fiber filter. See figure 1 for dimensions.

5.2.6 Pizza cutter. Thin wheel. Thickness <1mm.

5.2.7 Watch glass.

5.2.8 Polyethylene bottles. For storage of samples. Linear polyethylene gives better storage stability than other polyethylenes and is preferred.

5.2.9 Parafilm "M".* American Can Co., Marathon Products, Neenah, Wis., or equivalent.

6. *Reagents.*

6.1 Sampling.

6.1.1 Glass fiber filters. The specifications given below are intended to aid the user in obtaining high quality filters with reproducible properties. These specifications have been met by EPA contractors.

6.1.1.1 Lead content. The absolute lead content of filters is not critical, but low values are, of course, desirable. EPA typically obtains filters with a lead content of <75 μg/filter.

It is important that the variation in lead content from filter to filter, within a given batch, be small.

6.1.1.2 Testing.

6.1.1.2.1 For large batches of filters (>500 filters) select at random 20 to 30 filters from a given batch. For small batches (<500 filters) a lesser number of filters may be taken. Cut one ¾"x8" strip from each filter anywhere in the filter. Analyze all strips, separately, according to the directions in sections 7 and 8.

6.1.1.2.2 Calculate the total lead in each filter as

$$F_b = \mu g\ Pb/ml \times \frac{100\ ml}{strip} \times \frac{12\ strips}{filter}$$

where:

F_b = Amount of lead per 72 square inches of filter, μg.

6.1.1.2.3 Calculate the mean, F_m, of the values and the relative standard deviation (standard deviation/mean x 100). If the relative standard deviation is high enough so that, in the analysts opinion, subtraction of F_m (section 10.3) may result in a significant error in the μg Pb/m³ the batch should be rejected.

6.1.1.2.4 For acceptable batches, use the value of F_b to correct all lead analyses (section 10.3) of particulate matter collected using that batch of filters. If the analyses are below the LDL (section 2.3) no correction is necessary.

6.2 Analysis.

6.2.1 Concentrated (15.6 *M*) HNO_3. ACS reagent grade HNO_3 and commercially available redistilled HNO_3 has found to have sufficiently low lead concentrations.

6.2.2 Concentrated (11.7 *M*) HCl. ACS reagent grade.

6.2.3 Distilled-deionized water. (D.I. water).

6.2.4 3 *M* HNO_3. This solution is used in the hot extraction procedure. To prepare, add 192 ml of concentrated HNO_3 to D.I. water in a 1 *l* volumetric flask. Shake well, cool, and dilute to volume with D.I. water. *Caution:* Nitric acid fumes are toxic. Prepare in a well ventilated fume hood.

6.2.5 0.45 *M* HNO_3. This solution is used as the matrix for calibration standards when using the hot extraction procedure. To prepare, add 29 ml of concentrated HNO_3 to D.I. water in a 1 *l* volumetric flask. Shake well, cool, and dilute to volume with D.I. water.

6.2.6 2.6 *M* HNO_3 + 0 to 0.9 *M* HCl. This solution is used in the ultrasonic extraction procedure. The concentration of HCl can be varied from 0 to 0.9 *M*. Directions are given for preparation of a 2.6 *M* HNO_3 + 0.9 *M* HCl solution. Place 167 ml of concentrated HNO_3 into a 1 *l* volumetric flask and add 77 ml of concentrated HCl. Stir 4 to 6 hours, dilute to nearly 1 *l* with D.I. water, cool to room temperature, and dilute to 1 *l*.

6.2.7 0.40 *M* HNO_3 + X *M* HCl. This solution is used as the matrix for calibration standards when using the ultrasonic extraction procedure. To prepare, add 26 ml of concentrated HNO_3, plus the ml of HCl required, to a 1 *l* volumetric flask. Dilute to nearly 1 *l* with D.I. water, cool to room temperature, and dilute to 1 *L*. The amount of HCl required can be determined from the following equation:

$$y = \frac{77\ ml \times 0.15 \times}{0.9\ M}$$

*Mention of commercial products does not imply endorsement by the U.S. Environmental Protection Agency.

where:

y = ml of concentrated HCl required.
x = molarity of HCl in 6.2.6.
0.15 = dilution factor in 7.2.2.

6.2.8 Lead nitrate, $Pb(NO_3)_2$. ACS reagent grade, purity 99.0 percent. Heat for 4 hours at 120° C and cool in a desiccator.

6.3 Calibration standards.

6.3.1 Master standard, 1000 µg Pb/ml in HNO_3. Dissolve 1.598 g of $Pb(NO_3)_2$ in 0.45 *M* HNO_3 contained in a 1 *l* volumetric flask and dilute to volume with 0.45 *M* HNO_3.

6.3.2 Master standard, 1000 µg Pb/ml in HNO_3/HCl. Prepare as in 6.3.1 except use the HNO_3/HCl solution in 6.2.7.

Store standards in a polyethylene bottle. Commercially available certified lead standard solutions may also be used.

7. *Procedure.*

7.1 Sampling. Collect samples for 24 hours using the procedure described in reference *10* with glass-fiber filters meeting the specifications in 6.1.1. Transport collected samples to the laboratory taking care to minimize contamination and loss of sample (16).

[7.1 corrected by 44 FR 37915, June 29, 1979]

7.2 Sample preparation.

7.2.1 Hot extraction procedure.

7.2.1.1 Cut a 3/4" x 8" strip from the exposed filter using a template and a pizza cutter as described in Figures 1 and 2. Other cutting procedures may be used.

Lead in ambient particulate matter collected on glass fiber filters has been shown to be uniformly distributed across the filter.[1,3,11] Another study[11] has shown that when sampling near a roadway, strip position contributes significantly to the overall variability associated with lead analyses. Therefore, when sampling near a roadway, additional strips should be analyzed to minimize this variability.

[7.2.1.1 corrected by 44 FR 37915, June 29, 1979]

7.2.1.2 Fold the strip in half twice and place in a 150-ml beaker. Add 15 ml of 3 *M* HNO_3 to cover the sample. The acid should completely cover the sample. Cover the beaker with a watch glass.

7.2.1.3 Place beaker on the hot-plate, contained in a fume hood, and boil gently for 30 min. Do not let the sample evaporate to dryness. *Caution:* Nitric acid fumes are toxic.

7.2.1.4 Remove beaker from hot plate and cool to near room temperature.

7.2.1.5 Quantitatively transfer the sample as follows:

7.2.1.5.1 Rinse watch glass and sides of beaker with D.I. water.

7.2.1.5.2 Decant extract and rinsings into a 100-ml volumetric flask.

7.2.1.5.3 Add D.I. water to 40 ml mark on beaker, cover with watch glass, and set aside for a minimum of 30 minutes. This is a critical step and cannot be omitted since it allows the HNO_3 trapped in the filter to diffuse into the rinse water.

7.2.1.5.4 Decant the water from the filter into the volumetric flask.

7.2.1.5.5 Rinse filter and beaker twice with D.I. water and add rinsings to volumetric flask until total volume is 80 to 85 ml.

7.2.1.5.6 Stopper flask and shake vigorously. Set aside for approximately 5 minutes or until foam has dissipated.

7.2.1.5.7 Bring solution to volume with D.I. water. Mix thoroughly.

7.2.1.5.8 Allow solution to settle for one hour before proceeding with analysis.

7.2.1.5.9 If sample is to be stored for subsequent analysis, transfer to a linear polyethylene bottle.

7.2.2 Ultrasonic extraction procedure.

7.2.2.1 Cut a ¾" x 8" strip from the exposed filter as described in section 7.2.1.1.

7.2.2.2 Fold the strip in half twice and place in a 30 ml beaker. Add 15 ml of the HNO_3/HCl solution in 6.2.6. The acid should completely cover the sample. Cover the beaker with parafilm.

The parafilm should be placed over the beaker such that none of the parafilm is in contact with water in the ultrasonic bath. Otherwise, rinsing of the parafilm (section 7.2.2.4.1) may contaminate the sample.

7.2.2.3 Place the beaker in the ultrasonication bath and operate for 30 minutes.

7.2.2.4 Quantitatively transfer the sample as follows:

7.2.2.4.1 Rinse parafilm and sides of beaker with D.I. water.

7.2.2.4.2 Decant extract and rinsings into a 100 ml volumetric flask.

7.2.2.4.3 Add 20 ml D.I. water to cover the filter strip, cover with parafilm, and set aside for a minimum of 30 minutes. This is a critical step and cannot be omitted. The sample is then processed as in sections 7.2.1.5.4 through 7.2.1.5.9.

NOTE.—Samples prepared by the hot extraction procedure are now in 0.45 *M* HNO_3. Samples prepared by the ultrasonication procedure are in 0.40 *M* HNO_3 + X *M* HCl.

8. *Analysis.*

8.1 Set the wavelength of the monochromator at 283.3 or 217.0 nm. Set or align other instrumental operating conditions as recommended by the manufacturer.

8.2 The sample can be analyzed directly from the volumetric flask, or an appropriate amount of sample decanted into a sample analysis tube. In either case, care should be taken not to disturb the settled solids.

8.3 Aspirate samples, calibration standards and blanks (section 9.2) into the flame and record the equilibrium absorbance.

8.4 Determine the lead concentration in µg Pb/ml, from the calibration curve, section 9.3.

8.5 Samples that exceed the linear calibration range should be diluted with acid of the same concentration as the calibration standards and reanalyzed.

9. *Calibration.*

9.1 Working standard, 20 µg Pb/ml. Prepared by diluting 2.0 ml of the master standard (6.3.1 if the hot acid extraction was used or 6.3.2 if the ultrasonic extraction procedure was used) to 100 ml with acid of the same concentration as used in preparing the master standard.

9.2 Calibration standards. Prepare daily by diluting the working standard, with the same acid matrix, as indicated below. Other lead concentrations may be used.

Volume of 20 µg/ml working standard, ml	Final volume, ml	Concentration µg Pb/ml
0	100	0
1.0	200	0.1
2.0	200	0.2
2.0	100	0.4
4.0	100	0.8
8.0	100	1.6
15.0	100	3.0
30.0	100	6.0
50.0	100	10.0
100.0	100	20.0

9.3 Preparation of calibration curve. Since the working range of analysis will vary depending on which lead line is used and the type of instrument, no one set of instructions for preparation of a calibration curve can be given. Select standards (plus the reagent blank), in the same acid concentration as the samples, to cover the linear absorption range indicated by the instrument manufacturer. Measure the absorbance of the blank and standards as in section 8.0. Repeat until good agreement is obtained between replicates. Plot absorbance (y-axis) versus concentration in µg Pb/ml (x-axis). Draw (or compute) a straight line through the linear portion of the curve. Do not force the calibration curve through zero. Other calibration procedures may be used.

To determine stability of the calibration curve, remeasure—alternately—one of the following calibration standards for every 10th sample analyzed: concentration ≤ 1µg Pb/ml; concentration ≥ 10 µg Pb/ml. If either standard deviates by more than 5 percent from the value predicted by the calibration curve, recalibrate and repeat the previous 10 analyses.

10. *Calculation.*

10.1 Measured air volume. Calculate the measured air volume at Standard Temperature and Pressure as described in Reference 10.

[10.1 corrected by 44 FR 37915, June 29, 1979]

10.2 Lead concentration. Calculate lead concentration in the air sample.

$$C = \frac{(\mu g\ Pb/ml \times 100\ ml/strip \times 12\ strips/filter) - F_b}{V_{STP}}$$

where:

C = Concentration, μg Pb/sm³.

μg Pb/ml = Lead concentration determined from section 8.

100 ml/strip = Total sample volume.

12 strips = Total usable filter area 8" x 9"

filter = Total area of one strip 3/4 x 8"

F_b = Lead concentration of blank filter, μg, from section 6.1.1.2.3.

V_{std} = Air volume from 10.2.

[10.2 corrected by 44 FR 37915, June 29, 1979]

11. *Quality control.*

¾" x 8" glass fiber filter strips containing 80 to 2000 μg Pb/strip (as lead salts) and blank strips with zero Pb content should be used to determine if the method—as being used—has any bias. Quality control charts should be established to monitor differences between measured and true values. The frequency of such checks will depend on the local quality control program.

To minimize the possibility of generating unreliable data, the user should follow practices established for assuring the quality of air pollution data, (*13*) and take part in EPA's semiannual audit program for lead analyses.

12. *Trouble shooting.*

1. During extraction of lead by the hot extraction procedure, it is important to keep the sample covered so that corrosion products—formed on fume hood surfaces which may contain lead—are not deposited in the extract.

2. The sample acid concentration should minimize corrosion of the nebulizer. However, different nebulizers may require lower acid concentrations. Lower concentrations can be used provided samples and standards have the same acid concentration.

3. Ashing of particulate samples has been found, by EPA and contractor laboratories, to be unnecessary in lead analyses by atomic absorption. Therefore, this step was omitted from the method.

4. Filtration of extracted samples, to remove particulate matter, was specifically excluded from sample preparation, because some analysts have observed losses of lead due to filtration.

5. If suspended solids should clog the nebulizer during analysis of samples, centrifuge the sample to remove the solids.

13. *Authority.*

(Secs. 109 and 301(a), Clean Air Act as amended, (42 U.S.C. 7409, 7601(a)).)

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[Corrected by 44 FR 37915, June 29, 1979]

diameter less than or equal to a nominal 10 micrometers) by:

(1) A reference method based on Appendix J and designated in accordance with Part 53 of this chapter, or

(2) An equivalent method designated in accordance with Part 53 of this chapter.

§50.7 [Removed and reserved]

3. Section 50.7 is removed and reserved.

4. In Appendix G, reference 10 is removed and reserved and section 5.1.1 is revised to read as follows:

5.1.1 *High-Volume Sampler.* Use and calibrate the sampler as described in Appendix B to this Part.

5. Appendix I is added and reserved.

Appendix I [Reserved]

6. Appendix J is added to read as follows:

Appendix J—Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere

1.0 *Applicability.*

1.1 This method provides for the measurement of the mass concentration of particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}) in ambient air over a 24-hour period for purposes of determining attainment and maintenance of the primary and secondary national ambient air quality standards for particulate matter specified in § 50.6 of this chapter. The measurement process is nondestructive, and the PM_{10} sample can be subjected to subsequent physical or chemical analyses. Quality assurance procedures and guidance are provided in Part 58, Appendices A and B, of this chapter and in References 1 and 2.

2.0 *Principle.*

2.1 An air sampler draws ambient air at a constant flow rate into a specially shaped inlet where the suspended particulate matter is inertially separated into one or more size fractions within the PM_{10} size range. Each size fraction in the PM_{10} size range is then collected on a separate filter over the specified sampling period. The particle size discrimination characteristics (sampling effectiveness and 50 percent cutpoint) of the sampler inlet are prescribed as performance specifications in Part 53 of this chapter.

2.2 Each filter is weighed (after moisture equilibration) before and after use to determine the net weight (mass) gain due to collected PM_{10}. The total volume of air sampled, corrected to EPA reference conditions (25° C, 101.3 kPa), is determined from the measured flow rate and the sampling time. The mass concentration of PM_{10} in the ambient air is computed as the total mass of collected particles in the PM_{10} size range divided by the volume of air sampled, and is expressed in micrograms per standard cubic meter (μg/std m³). For PM_{10} samples collected at temperatures and pressures significantly different from EPA reference conditions, these corrected concentrations sometimes differ substantially from actual concentrations (in micrograms per actual cubic meter), particularly at high elevations. Although not required, the actual PM_{10} concentration can be calculated from the corrected concentration, using the average ambient temperature and barometric pressure during the sampling period.

2.3 A method based on this principle will be considered a reference method only if (a) the associated sampler meets the requirements specified in this appendix and the requirements in Part 53 of this chapter, and (b) the method has been designated as a reference method in accordance with Part 53 of this chapter.

3.0 *Range.*

3.1 The lower limit of the mass concentration range is determined by the repeatability of filter tare weights, assuming the nominal air sample volume for the sampler. For samplers having an automatic filter-changing mechanism, there may be no upper limit. For samplers that do not have an automatic filter-changing mechanism, the upper limit is determined by the filter mass loading beyond which the sampler no longer maintains the operating flow rate within specified limits due to increased pressure drop across the loaded filter. This upper limit cannot be specified precisely because it is a complex function of the ambient particle size distribution and type, humidity, filter type, and perhaps other factors. Nevertheless, all samplers should be capable of measuring 24-hour PM_{10} mass concentrations of at least 300 μg/std m³ while maintaining the operating flow rate within the specified limits.

4.0 *Precision.*

4.1 The precision of PM_{10} samplers must be 5 μg/m³ for PM_{10} concentrations below 80 μg/m³ and 7 percent for PM_{10} concentrations above 80 μg/m³, as required by Part 53 of this chapter, which prescribes a test procedure that determines the variation in the PM_{10} concentration measurements of identical samplers under typical sampling conditions. Continual assessment of precision via collocated samplers is required by Part 58 of this chapter for PM_{10} samplers used in certain monitoring networks.

5.0 *Accuracy.*

5.1 Because the size of the particles making up ambient particulate matter varies over a wide range and the concentration of particles varies with particle size, it is difficult to define the absolute accuracy of PM_{10} samplers. Part 53 of this chapter provides a specification for the sampling effectiveness of PM_{10} samplers. This specification requires that the expected mass concentration calculated for a candidate PM_{10} sampler, when sampling a specified particle size distribution, be within ±10 percent of that calculated for an ideal sampler whose sampling effectiveness is explicitly specified. Also, the particle size for 50 percent sampling effectiveness is required to be 10±0.5 micrometers. Other specifications related to accuracy apply to flow measurement and calibration, filter media, analytical (weighing) procedures, and artifact. The flow rate accuracy of PM_{10} samplers used in certain monitoring networks is required by Part 58 of this chapter to be assessed periodically via flow rate audits.

6.0 *Potential Sources of Error.*

6.1 *Volatile Particles.* Volatile particles collected on filters are often lost during shipment and/or storage of the filters prior to the post-sampling weighing [3]. Although shipment or storage of loaded filters is sometimes unavoidable, filters should be reweighed as soon as practical to minimize these losses.

6.2 *Artifacts.* Positive errors in PM_{10} concentration measurements may result from retention of gaseous species on filters [4, 5]. Such errors include the retention of sulfur dioxide and nitric acid. Retention of sulfur dioxide on filters, followed by oxidation to sulfate, is referred to as artifact sulfate formation, a phenomenon which increases with increasing filter alkalinity [6]. Little or no artifact sulfate formation should occur using filters that meet the alkalinity specification in section 7.2.4. Artifact nitrate formation, resulting primarily from retention of nitric acid, occurs to varying degrees on many filter types, including glass fiber, cellulose ester, and many quartz fiber filters [4, 7, 8, 9, 10]. Loss of true atmospheric particulate nitrate during or following sampling may also occur due to dissociation or chemical reaction. This phenomenon has been observed on Teflon® filters [6] and inferred for quartz fiber filters [11, 12]. The magnitude of nitrate artifact errors in PM_{10} mass concentration measurements will vary with location and ambient temperature; however, for most sampling locations, these errors are expected to be small.

6.3 *Humidity.* The effects of ambient humidity on the sample are unavoidable. The filter equilibration procedure in section 9.0 is designed to minimize the effects of moisture on the filter medium.

6.4 *Filter Handling.* Careful handling of filters between presampling and postsampling weighings is necessary to avoid errors due to damaged filters or loss of collected particles from the filters. Use of a filter cartridge or cassette may reduce the magnitude of these errors. Filters must also meet the integrity specification in section 7.2.3.

6.5 *Flow Rate Variation.* Variations in the sampler's operating flow rate may alter the particle size discrimination characteristics of the sampler inlet. The magnitude of this error will depend on the sensitivity of the inlet to variations in flow rate and on the particle distribution in the atmosphere during the sampling period. The use of a flow control device (section 7.1.3) is required to minimize this error.

6.6 *Air Volume Determination.* Errors in the air volume determination may result from errors in the flow rate and/or sampling time measurements. The flow control device serves to minimize errors in the flow rate determination, and an elapsed time meter (section 7.1.5) is required to minimize the error in the sampling time measurement.

7.0 *Apparatus.*

7.1 *PM_{10} Sampler.*

7.1.1 The sampler shall be designed to:

a. Draw the air sample into the sampler inlet and through the particle collection filter at a uniform face velocity.

b. Hold and seal the filter in a horizontal position so that sample air is drawn downward through the filter.

c. Allow the filter to be installed and removed conveniently.

d. Protect the filter and sampler from precipitation and prevent insects and other debris from being sampled.

e. Minimize air leaks that would cause error in the measurement of the air volume passing through the filter.

f. Discharge exhaust air at a sufficient distance from the sampler inlet to minimize the sampling of exhaust air.

g. Minimize the collection of dust from the supporting surface.

7.1.2 The sampler shall have a sample air inlet system that, when operated within a specified flow rate range, provides particle size discrimination characteristics meeting all of the applicable performance specifications prescribed in Part 53 of this chapter. The sampler inlet shall show no significant wind direction dependence. The latter requirement can generally be satisfied by an inlet shape that is circularly symmetrical about a vertical axis.

7.1.3 The sampler shall have a flow control device capable of maintaining the sampler's operating flow rate within the flow rate limits specified for the sampler inlet over normal variations in line voltage and filter pressure drop.

7.1.4 The sampler shall provide a means to measure the total flow rate during the sampling period. A continuous flow recorder is recommended but not required. The flow measurement device shall be accurate to ±2 percent.

7.1.5 A timing/control device capable of starting and stopping the sampler shall be used to obtain a sample collection period of 24 ±1 hr (1,440 ±60 min). An elapsed time meter, accurate to within ±15 minutes, shall be used to measure sampling time. This meter is optional for samplers with continuous flow recorders if the sampling time measurement obtained by means of the recorder meets the ±15 minute accuracy specification.

7.1.6 The sampler shall have an associated operation or instruction manual as required by Part 53 of this chapter which includes detailed instructions on the calibration, operation, and maintenance of the sampler.

7.2 *Filters.*

7.2.1 *Filter Medium.* No commercially available filter medium is ideal in all respects for all samplers. The user's goals in sampling determine the relative importance of various filter characteristics (e.g., cost, ease of handling, physical and chemical characteristics, etc.) and, consequently, determine the choice among acceptable filters. Furthermore, certain types of filters may not be suitable for use with some samplers, particularly under heavy loading conditions (high mass concentrations), because of high or rapid increase in the filter flow resistance that would exceed the capability of the sampler's flow control device. However, samplers equipped with automatic filter-changing mechanisms may allow use of these types of filters. The specifications given below are minimum requirements to ensure acceptability of the filter medium for measurement of PM_{10} mass concentrations. Other filter evaluation criteria should be considered to meet individual sampling and analysis objectives.

7.2.2 *Collection Efficiency.* >99 percent, as measured by the DOP test (ASTM-2986) with 0.3 μm particles at the sampler's operating face velocity.

7.2.3 *Integrity:* ±5 μg/m³ (assuming sampler's nominal 24-hour air sample volume). Integrity is measured as the PM_{10} concentration equivalent corresponding to the average difference between the initial and the final weights of a random sample of test filters that are weighed and handled under actual or simulated sampling conditions, but have no air sample passed through them (i.e., filter blanks). As a minimum, the test procedure must include initial equilibration and weighing, installation on an inoperative sampler, removal from the sampler, and final equilibration and weighing.

7.2.4 *Alkalinity.* <25 microequivalents/gram of filter, as measured by the procedure given in Reference 13 following at least two months storage in a clean environment (free from contamination by acidic gases) at room temperature and humidity.

7.3 *Flow Rate Transfer Standard.* The flow rate transfer standard must be suitable for the sampler's operating flow rate and must be calibrated against a primary flow or volume standard that is traceable to the National Bureau of Standards (NBS). The flow rate transfer standard must be capable of measuring the sampler's operating flow rate with an accuracy of ±2 percent.

7.4 *Filter Conditioning Environment.*

7.4.1 Temperature range: 15° to 30° C.

7.4.2 Temperature control: ±3° C.

7.4.3 Humidity range: 20% to 45% RH.

7.4.4 Humidity control: ±5% RH.

7.5 *Analytical Balance.* The analytical balance must be suitable for weighing the type and size of filters required by the sampler. The range and sensitivity required will depend on the filter tare weights and mass loadings. Typically, an analytical balance with a sensitivity of 0.1 mg is required for high volume samplers (flow rates >0.5 m³/min). Lower volume samplers (flow rates <0.5 m³/min) will require a more sensitive balance.

8.0 *Calibration.*

8.1 *General Requirements.*

8.1.1 Calibration of the sampler's flow measurement device is required to establish traceability of subsequent flow measurements to a primary standard. A flow rate transfer standard calibrated against a primary flow or volume standard shall be used to calibrate or verify the accuracy of the sampler's flow measurement device.

8.1.2 Particle size discrimination by inertial separation requires that specific air velocities be maintained in the sampler's air inlet system. Therefore, the flow rate through the sampler's inlet must be maintained throughout the sampling period within the design flow rate range specified by the manufacturer. Design flow rates are specified as actual volumetric flow rates, measured at existing conditions of temperature and pressure (Q_a). In contrast, mass concentrations of PM_{10} are computed using flow rates corrected to EPA reference conditions of temperature and pressure (Q_{std}).

8.2 *Flow Rate Calibration Procedure.*

8.2.1 PM_{10} samplers employ various types of flow control and flow measurement devices. The specific procedure used for flow rate calibration or verification will vary depending on the type of flow controller and flow indicator employed. Calibration in terms of actual volumetric flow rates (Q_a) is generally recommended, but other measures of flow rate (e.g., Q_{std}) may be used provided the requirements of section 8.1 are met. The general procedure given here is based on actual volumetric flow units (Q_a) and serves to illustrate the steps involved in the calibration of a PM_{10} sampler. Consult the sampler manufacturer's instruction manual and Reference 2 for specific guidance on calibration. Reference 14 provides additional information on the use of the commonly used measures of flow rate and their interrelationships.

8.2.2 Calibrate the flow rate transfer standard against a primary flow or volume standard traceable to NBS. Establish a calibration relationship (e.g., an equation or family of curves) such that traceability to the primary standard is accurate to within 2 percent over the expected range of ambient conditions (i.e., temperatures and pressures) under which the transfer standard will be used. Recalibrate the transfer standard periodically.

8.2.3 Following the sampler manufacturer's instruction manual, remove the sampler inlet and connect the flow rate transfer standard to the sampler such that the transfer standard accurately measures the sampler's flow rate. Make sure there are no leaks between the transfer standard and the sampler.

8.2.4 Choose a minimum of three flow rates (actual m³/min), spaced over the acceptable flow rate range specified for the inlet (see 7.1.2) that can be obtained by suitable adjustment of the sampler flow rate. In accordance with the sampler manufacturer's instruction manual, obtain or verify the calibration relationship between the flow rate (actual m³/min) as indicated by the transfer standard and the sampler's flow indicator response. Record the ambient temperature and barometric pressure. Temperature and pressure corrections to subsequent flow indicator readings may be required for certain types of flow measurement devices. When such corrections are necessary, correction on an individual or daily basis is preferable. However, seasonal average temperature and average barometric pressure for the sampling site may be incorporated into the sampler calibration to avoid daily corrections. Consult the sampler manufacturer's instruction manual and Reference 2 for additional guidance.

8.2.5 Following calibration, verify that the sampler is operating at its design flow rate (actual m³/min) with a clean filter in place.

8.2.6 Replace the sampler inlet.

9.0 *Procedure.*

9.1 The sampler shall be operated in accordance with the specific guidance provided in the sampler manufacturer's instruction manual and in Reference 2. The

general procedure given here assumes that the sampler's flow rate calibration is based on flow rates at ambient conditions (Q_a) and serves to illustrate the steps involved in the operation of a PM_{10} sampler.

9.2 Inspect each filter for pinholes, particles, and other imperfections. Establish a filter information record and assign an identification number to each filter.

9.3 Equilibrate each filter in the conditioning environment (see 7.4) for at least 24 hours.

9.4 Following equilibration, weigh each filter and record the presampling weight with the filter identification number.

9.5 Install a preweighed filter in the sampler following the instructions provided in the sampler manufacturer's instructional manual.

9.6 Turn on the sampler and allow it to establish run-temperature conditions. Record the flow indicator reading and, if needed, the ambient temperature and barometric pressure. Determine the sampler flow rate (actual m^3/min) in accordance with the instructions provided in the sampler manufacturer's instruction manual. NOTE.—No onsite temperature or pressure measurements are necessary if the sampler's flow indicator does not require temperature or pressure corrections or if seasonal average temperature and average barometric pressure for the sampling site are incorporated into the sampler calibration (see step 8.2.4). If individual or daily temperature and pressure corrections are required, ambient temperature and barometric pressure can be obtained by on-site measurements or from a nearby weather station. Barometric pressure readings obtained from airports must be station pressure, not corrected to sea level, and may need to be corrected for differences in elevation between the sampling site and the airport.

9.7 If the flow rate is outside the acceptable range specified by the manufacturer, check for leaks, and if necessary, adjust the flow rate to the specified setpoint. Stop the sampler.

9.8 Set the timer to start and stop the sampler at appropriate times. Set the elapsed time meter to zero or record the initial meter reading.

9.9 Record the sample information (site location or identification number, sample date, filter identification number, and sampler model and serial number).

9.10 Sample for 24±1 hours.

9.11 Determine and record the average flow rate (Q_a) in actual m^3/min for the sampling period in accordance with the instructions provided in the sampler manufacturer's instruction manual. Record the elapsed time meter final reading and, if needed, the average ambient temperature and barometric pressure for the sampling period (see note following step 9.6).

9.12 Carefully remove the filter from the sampler, following the sampler manufacturer's instruction manual. Touch only the outer edges of the filter.

9.13 Place the filter in a protective holder or container (e.g., petri dish, glassine envelope, or manila folder).

9.14 Record any factors such as meteorological conditions, construction activity, fires or dust storms, etc., that might be pertinent to the measurement on the filter information record.

9.15 Transport the exposed sample filter to the filter conditioning environment as soon as possible for equilibration and subsequent weighing.

9.16 Equilibrate the exposed filter in the conditioning environment for at least 24 hours under the same temperature and humidity conditions used for presampling filter equilibration (see 9.3).

9.17 Immediately after equilibration, reweigh the filter and record the postsampling weight with the filter identification number.

10.0 *Sampler Maintenance.*

10.1 The PM_{10} sampler shall be maintained in strict accordance with the maintenance procedures specified in the sampler manufacturer's instruction manual.

11.0 *Calculations.*

11.1 Calculate the average flow rate over the sampling period corrected to EPA reference conditions as Q_{std}. When the sampler's flow indicator is calibrated in actual volumetric units (Q_a), Q_{std} is calculated as:

$$Q_{std} = Q_a \times (P_{av}/T_{av})(T_{std}/P_{std})$$

where

Q_{std} = average flow rate at EPA reference conditions, std m^3/min;

Q_a = average flow rate at ambient conditions, m^3/min;

P_{av} = average barometric pressure during the sampling period or average barometric pressure for the sampling site, kPa (or mm Hg);

T_{av} = average ambient temperature during the sampling period or seasonal average ambient temperature for the sampling site, K;

T_{std} = standard temperature, defined as 298 K;

P_{std} = standard pressure, defined as 101.3 kPa (or 760 mm Hg).

11.2 Calculate the total volume of air sampled as:

$$V_{std} = Q_{std} \times t$$

where

V_{std} = total air sampled in standard volume units, std m^3;

t = sampling time, min.

11.3 Calculate the PM_{10} concentration as:

$$PM_{10} = (W_f - W_i) \times 10^6 / V_{std}$$

where

PM_{10} = mass concentration of PM_{10}, μg/std m^3;

W_f, W_i = final and initial weights of filter collecting PM_{10} particles, g;

10^6 = conversion of g to μg.

Note.—If more than one size fraction in the PM_{10} size range is collected by the sampler, the sum of the net weight gain by each collection filter [$\Sigma(W_f - W_i)$] is used to calculate the PM_{10} mass concentration.

12.0 *References.*

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7. Appendix K is added to read as follows:

Appendix K—Interpretation of the National Ambient Air Quality Standards for Particulate Matter

1.0 *General.*

This appendix explains the computations necessary for analyzing particulate matter data to determine attainment of the 24-hour and annual standards specified in 40 CFR 50.6. For the primary and secondary standards, particulate matter is measured in the ambient air as PM_{10} (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers) by a reference method based on Appendix J of this part and designated in accordance with Part 53 of this chapter, or by an equivalent method designated in accordance with Part 53 of this chapter. The required frequency of measurements is specified in Part 58 of this chapter.

Several terms used throughout this appendix must be defined. A "daily value" for PM_{10} refers to the 24-hour average concentration of PM_{10} calculated or measured from midnight to midnight (local time). The term "exceedance" means a daily value that is above the level of the 24-hour standard after rounding to the nearest 10 $\mu g/m^3$ (i.e., values ending in 5 or greater are to be rounded up). The term "average" refers to an arithmetic mean. All particulate matter standards are expressed in terms of expected annual values: expected number of exceedances per year for the 24-hour standard and expected annual arithmetic mean for the annual standards. The "expected annual value" is the number approached when the annual values from an increasing number of years are averaged, in the absence of long-term trends in emissions or meteorological conditions. The term "year" refers to a calendar year.

Although the discussion in this appendix focuses on monitored data, the same principles apply to modeling data, subject to EPA modeling guidelines.

2.0 *Attainment Determinations.*

2.1 *24-Hour Primary and Secondary Standards.*

Under 40 CFR 50.6(a) the 24-hour primary and secondary standards are attained when the expected number of exceedances per year at each monitoring site is less than or equal to one. In the simplest case, the number of expected exceedances at a site is determined by recording the number of exceedances in each calendar year and then averaging them over the past 3 calendar years. Situations in which 3 years of data are not available and possible adjustments for unusual events or trends are discussed in Sections 2.3 and 2.4. Further, when data for a year are incomplete, it is necessary to compute an estimated number of exceedances for that year by adjusting the observed number of exceedances. This procedure, performed by calendar quarter, is described in Section 3. The expected number of exceedances is then estimated by averaging the individual annual estimates for the past 3 years.

The comparison with the allowable expected exceedance rate of one per year is made in terms of a number rounded to the nearest tenth (fractional values equal to or greater than 0.05 are to be rounded up; e.g., an exceedance rate of 1.05 would be rounded to 1.1, which is the lowest rate for nonattainment).

2.2 *Annual Primary and Secondary Standards.*

Under 40 CFR 50.6(b), the annual primary and secondary standards are attained when the expected annual arithmetic mean PM_{10} concentration is less than or equal to the level of the standard. In the simplest case, the expected annual arithmetic mean is determined by averaging the annual arithmetic mean PM_{10} concentrations for the past 3 calendar years. Because of the potential for incomplete data and the possible seasonality in PM_{10} concentrations, the annual mean shall be calculated by averaging the four quarterly means of PM_{10} concentrations within the calendar year. The formulas for calculating the annual arithmetic mean are given in Section 4. Situations in which 3 years of data are not available and possible adjustments for unusual events or trends are discussed in Sections 2.3 and 2.4. The expected annual arithmetic mean is rounded to the nearest 1 $\mu g/m^3$ before comparison with the annual primary standard (fractional values equal to or greater than 0.5 are to be rounded up).

2.3 *Data Requirements.*

40 CFR 58.13 specifies the required minimum frequency of sampling for PM_{10}. For the purposes of making comparisons with the particulate matter standards, all data produced by National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS) and other sites submitted to EPA in accordance with the Part 58 requirements must be used, and a minimum of 75 percent of the scheduled PM_{10} samples per quarter are required.

To demonstrate attainment of either the annual or 24-hour standards at a monitoring site, the monitor must provide sufficient data to perform the required calculations of Sections 3 and 4. The amount of data required varies with the sampling frequency, data capture rate and the number of years of record. In all cases, 3 years of representative monitoring data that meet the 75 percent criterion of the previous paragraph should be utilized, if available, and would suffice. More than 3 years may be considered, if all additional representative years of data meeting the 75 percent criterion are utilized. Data not meeting these criteria may also suffice to show attainment; however, such exceptions will have to be approved by the appropriate Regional Administrator in accordance with EPA guidance.

There are less stringent data requirements for showing that a monitor has failed an attainment test and thus has recorded a violation of the particulate matter standards. Although it is generally necessary to meet the minimum 75 percent data capture requirement per quarter to use the computational formulas described in Sections 3 and 4, this criterion does not apply when less data is sufficient to unambiguously establish nonattainment. The following examples illustrate how nonattainment can be demonstrated when a site fails to meet the completeness criteria. Nonattainment of the 24-hour primary standards can be established by (a) the observed annual number of exceedances (e.g. four observed exceedances in a single year), or by (b) the estimated number of exceedances derived from the observed number of exceedances and the required number of scheduled samples (e.g. two observed exceedances with every other day sampling). Nonattainment of the annual standards can be demonstrated on the basis of quarterly mean concentrations developed from observed data combined with one-half the minimum detectable concentration substituted for missing values. In both cases, expected annual values must exceed the levels allowed by the standards.

2.4 *Adjustment for Exceptional Events and Trends.*

An exceptional event is an uncontrollable event caused by natural sources of particulate matter or an event that is not expected to recur at a given location. Inclusion of such a value in the computation of exceedances or averages could result in inappropriate estimates of their respective expected annual values. To reduce the effect of unusual events, more than 3 years of representative data may be used. Alternatively, other techniques, such as the use of statistical models or the use of historical data could be considered so that the event may be discounted or weighted according to the likelihood that it will recur. The use of such techniques is subject to the approval of the appropriate Regional Administrator in accordance with EPA guidance.

In cases where long-term trends in emissions and air quality are evident, mathematical techniques should be applied to account for the trends to ensure that the expected annual values are not inappropriately biased by unrepresentative data. In the simplest case, if 3 years of data are available under stable emission conditions, this data should be used. In the event of a trend or shift in emission patterns, either the most recent representative year(s) could be used or statistical techniques or models could be used in conjunction with previous years of data to adjust for trends. The use of less than 3 years of data, and any adjustments are subject to the approval of the appropriate Regional Administrator in accordance with EPA guidance.

3.0 *Computational formulas for the 24-hour standard.*

3.1 *Estimating Exceedances for a year.*

If PM_{10} sampling is scheduled less frequently than every day, or if some scheduled samples are missed, a PM_{10} value will not be available for each day of the year. To account for the possible effect of incomplete data, an adjustment must be made to the data collected at each monitoring location to estimate the number of exceedances in a calendar year. In this adjustment, the assumption is made that the fraction of missing values that would have exceeded the standard level is identical to the fraction of measured values above this level. This computation is to be made for all sites that are scheduled to monitor throughout the entire year and meet the minimum data requirements of Section 2.3. Because of possible seasonal imbalance, this adjustment shall be applied on a quarterly

basis. The estimate of the expected number of exceedances for the quarter is equal to the observed number of exceedances plus an increment associated with the missing data. The following formula must be used for these computations:

$$e_q = v_q + [(v_q/n_q) \times (N_q - n_q)] = v_q \times N_q/n_q \quad [1]$$

where

e_q = the estimated number of exceedances for calendar quarter q,

v_q = the observed number of exceedances for calendar quarter q,

N_q = the number of days in calendar quarter q,

n_q = the number of days in calendar quarter q with PM_{10}, and

q = the index for calendar quarter, q = 1, 2, 3 or 4.

The estimated number of exceedances for a calendar quarter must be rounded to the nearest hundredth (fractional values equal to greater than 0.005 must be rounded up).

The estimated number of exceedances for the years, e, is the sum of the estimates for each calendar quarter.

$$e = \sum_{q=1}^{4} e_q \quad [2]$$

The estimated number of exceedances for a single year must be rounded to one decimal place (fractional values equal to or greater than 0.05 are to be rounded up). The expected number of exceedances is then estimated by averaging the individual annual estimates for the most recent 3 or more representative years of data. The expected number of exceedances must be rounded to one decimal place (fractional values equal to or greater than 0.05 are to be rounded up).

The adjustment for incomplete data will not be necessary for monitoring or modeling data which constitutes a complete record, i.e., 365 days per year.

To reduce the potential for overestimating the number of expected exceedances, the correction for missing data will not be required for a calendar quarter in which the first observed exceedance has occurred if: (a) there was only one exceedance in the calendar quarter, (b) everyday sampling is subsequently initiated and maintained for 4 calendar quarters in accordance with 40 CFR § 58.13 and (c) data capture of 75 percent is achieved during the required period of everyday sampling. In addition, if the first exceedance is observed in a calendar quarter in which the monitor is already sampling every day, no adjustment for missing data will be made to the first exceedance if a 75 percent data capture rate was achieved in the quarter in which it was observed.

Example 1

During a particular calendar quarter, 39 out of a possible 92 samples were recorded, with one observed exceedance of the 24-hour standard. Using formula (1), the estimated number of exceedances for the quarter is

$e_q = 1 \times 92/39 = 2.359$ or 2.36

If the estimated exceedances for the other 3 calendar quarters in the year were 2.30, 0.0 and 0.0, then, using formula (2), the estimated number of exceedances for the year is $2.36 + 2.30 + 0.0 + 0.0$ which equals 4.66 or 4.7. If no exceedances were observed for the 2 previous years, then the expected number of exceedances is estimated by $(1/3) \times (4.7 + 0 + 0) = 1.57$ or 1.6. Since 1.6 exceeds the allowable number of expected exceedances, this monitoring site would fail the attainment test.

Example 2

In this example, everyday sampling was initiated following the first observed exceedance as required by 40 CFR § 58.13. Accordingly, the first observed exceedance would not be adjusted for incomplete sampling. During the next three quarters, 1.2 exceedances were estimated. In this case, the estimated exceedances for the year would be $1.0 + 1.2 + 0.0 + 0.0$ which equals 2.2. If, as before, no exceedances were observed for the two previous years, then the estimated exceedances for the 3-year period would then be $(1/3) \times (2.2 + 0.0 + 0.0) = 0.7$, and the monitoring site would *not* fail the attainment test.

3.2 *Adjustments for Non-Scheduled Sampling Days.*

If a systematic sampling schedule is used and sampling is performed on days in addition to the days specified by the systematic sampling schedule, e.g., during episodes of high pollution, then an adjustment must be made in the formula for the estimation of exceedances. Such an adjustment is needed to eliminate the bias in the estimate of the quarterly and annual number of exceedances that would occur if the chance of an exceedance is different for scheduled than for non-scheduled days, as would be the case with episode sampling.

The required adjustment treats the systematic sampling schedule as a stratified sampling plan. If the period from one scheduled sample until the day preceding the next scheduled sample is defined as a sampling stratum, then there is one stratum for each scheduled sampling day. An average number of observed exceedances is computed for each of these sampling strata. With nonscheduled sampling days, the estimated number of exceedances is defined as

$$e_q = (N_q/m_q) \times \sum_{j=1}^{m_q} (v_j/k_j) \quad [3]$$

where

e_q = the estimated number of exceedances for the quarter,

N_q = the number of days in the quarter,

m_q = the number of strata with samples during the quarter,

v_j = the number of observed exceedances in stratum j, and

k_j = the number of actual samples in stratum j.

Note that if only one sample value is recorded in each stratum, then formula (3) reduces to formula (1).

Example 3

A monitoring site samples according to a systematic sampling schedule of one sample every 6 days, for a total of 15 scheduled samples in a quarter out of a total of 92 possible samples. During one 6-day period, potential episode levels of PM_{10} were suspected, so 5 additional samples were taken. One of the regular scheduled samples was missed, so a total of 19 samples in 14 sampling strata were measured. The one 6-day sampling stratum with 6 samples recorded 2 exceedances. The remainder of the quarter with one sample per stratum recorded zero exceedances. Using formula (3), the estimated number of exceedances for the quarter is

$e_q = (92/14) \times (2/6 + 0 + \ldots + 0) = 2.19$

4.0 Computational Formulas for Annual Standards.

4.1 Calculation of the Annual Arithmetic Mean.

An annual arithmetic mean value for PM_{10} is determined by averaging the quarterly means for the 4 calendar quarters of the year. The following formula is to be used for calculation of the mean for a calendar quarter:

$$\bar{x}_q = (1/n_q) \times \sum_{i=1}^{n_q} \bar{x}_i \quad [4]$$

where

$\bar{x}_q$ = the quarterly mean concentration for quarter q, q = 1, 2, 3, or 4,

n_q = the number of samples in the quarter, and

$\bar{x}_i$ = the ith concentration value recorded in the quarter.

The quarterly mean, expressed in $\mu g/m^3$, must be rounded to the nearest tenth (fractional values of 0.05 should be rounded up).

The annual mean is calculated by using the following formula:

$$\bar{x} = (1/4) \times \sum_{q=1}^{4} \bar{x}_q \quad [5]$$

where

$\bar{x}$ = the annual mean, and

$\bar{x}_q$ = the mean for calendar quarter q.

The average of quarterly means must be rounded to the nearest tenth (fractional values of 0.05 should be rounded up).

The use of quarterly averages to compute the annual average will not be necessary for

monitoring or modeling data which results in a complete record, i.e., 365 days per year.

The expected annual mean is estimated as the average of three or more annual means. This multi-year estimate, expressed in $\mu g/m^3$, shall be rounded to the nearest integer for comparison with the annual standard (fractional values of 0.5 should be rounded up).

Example 4

Using formula [4], the quarterly means are calculated for each calendar quarter. If the quarterly means are 52.4, 75.3, 82.1, and 63.2 $\mu g/m^3$, then the annual means is

$$\bar{x} = (1/4) \times (52.4 + 75.3 + 82.1 + 63.2 = 68.25 \text{ or } 68.3$$

4.2 Adjustments for Non-scheduled Sampling Days.

An adjustment in the calculation of the annual mean is needed if sampling is performed on days in addition to the days specified by the systematic sampling schedule. For the same reasons given in the discussion of estimated exceedances (Section 3.2), the quarterly averages would be calculated by using the following formula:

$$\bar{x}_q = (1/m_q) \times \sum_{j=1}^{m_q} \sum_{i=1}^{k_j} (x_{ij}/k_j) \qquad [6]$$

where

$\bar{x}_q$ = the quarterly mean concentration for quarter q, q = 1, 2, 3, or 4,

x_{ij} = the ith concentration value recorded in stratum j,

k_j = the number of actual samples in stratum j, and

m_q = the number of strata with data in the quarter.

If one sample value is recorded in each stratum, formula [6] reduces to a simple arithmetic average of the observed values as described by formula [4].

Example 5

During one calendar quarter, 9 observations were recorded. These samples were distributed among 7 sampling strata, with 3 observations in one stratum. The concentrations of the 3 observations in the single stratum were 202, 242, and 180 $\mu g/m^3$. The remaining 6 observed concentrations were 55, 68, 73, 92, 120, and 155 $\mu g/m^3$. Applying the weighting factors specified in formula [6], the quarterly mean is

$$\bar{x}_q = (1/7) \times [(1/3) \times (202 + 242 + 180) + 55 + 68 + 73 + 92 + 120 + 155] = 110.1$$

Although 24-hour measurements are rounded to the nearest 10 $\mu g/m^3$ for determinations of exceedances of the 24-hour standard, note that these values are rounded to the nearest 1 $\mu g/m^3$ for the calculation of means.

[FR Doc. 87-13707 Filed 6-30-87; 8:45 am]

BILLING CODE 6560-50-M

ATTACHMENT C-3

QUALITY ASSURANCE PROJECT PLAN - 3

FOR

AIR SAMPLING OF ASBESTOS

QUALITY ASSURANCE PROJECT PLAN - 3

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP-3) presents the organization, objectives, functional activities, quality assurance and quality control activities associated with air sampling for asbestos at the Johns-Manville Disposal Area. Air sampling is a part of the Remedial Action being implemented at the Johns-Manville Disposal Area. Air sampling is planned before, during and after Remedial Construction.

The Quality Assurance Project Plan for airborne asbestos sampling after Remedial Construction is an abridged and modified version of the Sample Quality Assurance Project Plan used during the October 1984 asbestos air sampling during Remedial Investigation.

2.0 PROJECT DESCRIPTION

2.1 Background

The Johns-Manville Disposal Area is located in the City of Waukegan, Illinois. Since 1922, manufacturing wastes from the plant have been disposed of at the Disposal Area. Some of these wastes contained encapsulated asbestos, friable asbestos and trace amounts of lead, chromium and other contaminants. Presently, no asbestos is being used in manufacturing.

In 1982, this site was included in the National Priorities List. A Remedial Investigation and Feasibility Study were conducted by Manville Corporation. Pursuant to the Consent Decree signed by Manville on December 31, 1987, Manville Corporation will carry out a Remedial Action.

2.2 Objectives and Use of Data

The primary objectives of air sampling activities described in this QAPP are to detect asbestos in ambient air before and during the initial phases of Remedial Construction and after establishment of a soil and vegetative cover.

Different sampling activities at different times are proposed to achieve the objectives mentioned above, as follows:

2.2.1 Air Sampling for Asbestos Before Starting Remedial Construction:

Ambient air sampling for asbestos will be conducted before the start of Remedial Construction (i.e. before the start of grading activities) for a period of five days to estimate the existing on-site air quality. Five (5) samples (one on each day) will be selected for TEM asbestos analysis based on predominant wind direction.

The data obtained from this sampling event will indicate existing, on-site, airborne asbestos concentrations, if any.

2.2.2 Air Monitoring for Asbestos During the Initial Phases of Remedial Construction:

Initial phases of Remedial Construction work involve site clearing, grading and smoothing, and placing the first layer of a sand/soil cover on the Disposal Area. During these initial phases, perimeter air monitoring/sampling for asbestos will be conducted. This perimeter air sampling will involve 24-hour sampling on all working days.

A short duration, concurrent perimeter air sampling also will be conducted which will involve sampling for 4 -8 hours every work day.

Data obtained from short duration sample analyses (by PCM method) will indicate the air quality downwind of the construction activities and will be the basis for selection of perimeter air samples to be analyzed by TEM. The short duration sample location with the highest loading will determine which perimeter sample will be tested by TEM.

Data obtained from analysis of selected perimeter air samples (24-hour sample) by TEM will be evaluated within 24 hours of the receipt of the data (data turn around time for TEM is 7 to 10 days) and will be used to indicate any potential threat to the surrounding environment due to ongoing Remedial Construction. Also, this data will be utilized to determine the need for additional dust suppressing measures, if any, to be implemented during Remedial Construction. All such data will be available for inspection on site.

2.2.3 Air Monitoring for Asbestos after the Establishment of a Soil and Vegetative Cover:

Post-Remedial Construction airborne asbestos air sampling will be initiated after the establishment of a soil and vegetative cover. Establishment of a vegetative cover will be considered adequate after three mowings of the planted grass.

The data obtained from these monitoring events will be utilized to determine the ambient air quality around the Disposal Area, and the need for any contingency measures.

2.3 Sampling/Monitoring Schedule

As mentioned earlier, pre-remedial construction sampling will be conducted for a period of five days before the start of remedial construction. The perimeter air sampling during construction will be carried out during initial phases of construction (approximately the first six to eight months after the start of Remedial Construction) as defined earlier.

The Post-Remedial Action sampling for asbestos will be conducted after the establishment of a soil and vegetative cover and every five years thereafter for a period of 15 years (number of sampling events = 4). After the 15 years, U.S. EPA will evaluate the need for further monitoring.

The project schedule for Post-Remedial Action air monitoring for asbestos is presented in Figure 2 of the Work Plan. Provisions for personal-air-monitoring during Remedial Construction are presented in the Health and Safety Plan (Attachment G).

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 Organization

The project organization for air sampling/monitoring activities is presented in Figure C3-1.

3.2 Responsibilities

Overall project supervision and coordination will be the responsibility of the Manville Project Coordinator. He will be responsible for accomplishing the tasks as per the directives of the "Consent Decree", as well as interacting with and reporting to the U.S. EPA and Illinois EPA (IEPA).

All project functional responsibilities lie with Manville's Remedial Construction Manager (RCM). He will be responsible for overseeing project tasks and ensuring their accomplishment. He will also be responsible for reporting the project progress to the Manville Project Coordinator and interact with U.S. EPA and IEPA on an as needed basis.

Overall coordination of on-site sampling activities will be the responsibility of the Contractor/Consultant Site Manager (CSM). He will coordinate, direct and supervise subcontractors and sampling teams.

An independent Quality Assurance Monitor (QAM) will be responsible for reviewing project documents and reports with respect to their conformance to the quality assurance objectives.

A contractor/laboratory will be identified for field sampling and measurement and data assessment. Clayton Environmental Consultants and Environmental Monitoring Systems (EMS) will be utilized for asbestos analyses as discussed earlier in QAPP C-1. However, asbestos fiber counting of one sample from short duration perimeter air monitoring may be accomplished on site by using PCM - NIOSH 7400 method to obtain timely information needed to modify dust suppression activities. U.S. EPA/IEPA representatives will be notified in advance of all monitoring/sampling activities.

Project Organization

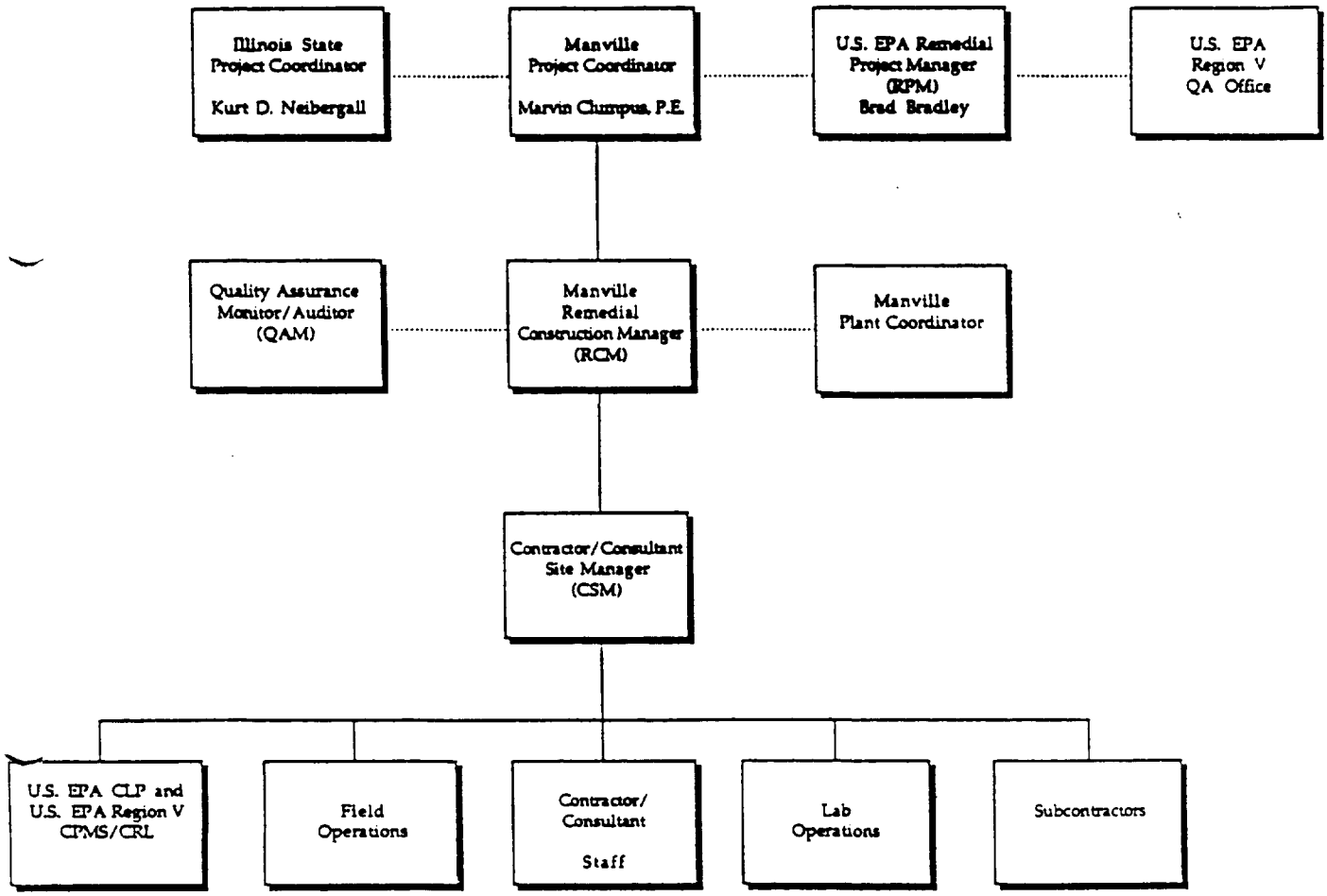


Figure C3-1

4.0 QA OBJECTIVES

4.1 Level of QC Effort

Field blanks, lab blanks, lab duplicates/replicates and calibration standards will be analyzed to provide a means to assess the quality of data resulting from the field sampling and lab analysis.

The general level of the QC effort for Post Remedial Construction Air Monitoring Activity will be analyses of one field blank for every group of sampling location on-site and off-site. Also, one sample filter will be analyzed as a lab replicate and one as the lab duplicate (a lab duplicate filter counted by different technician) for every ten or less samples (filters) collected from on-site sampling locations (excluding blanks). The lab replicate is defined as preparation and analysis of one more 3 square mm. (grid) filter piece by the same analyst. The lab duplicate analysis will involve one preparation only, but counting will be performed on the same grid by two analysts.

The general level of QC effort for pre-construction and first week of heavy construction air monitoring and perimeter air monitoring during construction will include the analysis of one field blank, one lab duplicate and one lab replicate for every ten or less samples to be analyzed by TEM method.

The general level of QC effort for short-duration, concurrent air monitoring during construction will be analysis of one field blank and one lab duplicate for every ten or less samples analyzed by PCM (NIOSH 7400) method.

4.2 Accuracy and Precision

The short duration, concurrent perimeter monitoring samples will be analyzed by Phase Contrast Microscopy (PCM) - NIOSH 7400 method. PCM method does not differentiate between asbestos or any other types of fibers. All selected 12-hour and 24-hour monitoring samples will be analyzed by transmission electron microscopy (TEM), as outlined in the "Methodology for the Measurement of Airborne Asbestos by Electron Miscoscopy", prepared by Yamate et al under U.S. EPA contract number 68-02-3266, which is the best available technique for differentiating asbestos fibers from non-asbestos fibers. Also, TEM allows measurement of small as well as large individual fibers. If bundles or clusters are present, TEM, like any other optical technique, will lead to underestimate fiber mass concentration. Fiber counts by TEM can be expected to range from 1 to 1000. Thus, from 1 to 3 significant figures may be reported. The precision for analysis of replicate/duplicate samples will be $\pm 25\%$.

Sample sizes for post-remedial Construction asbestos air monitoring have been selected to ensure that asbestos fiber concentrations at the waste disposal site and off-site will be estimated with reasonable precision. If the coefficient of variation (standard deviation divided by the mean) is 150%, the estimated concentrations are expected to have estimation errors which are no greater than the true mean by ±75%.

Estimated limit of detection by PCM is 7 fibers/mm^2 of the filter area.

4.3 Completeness, Representativeness and Comparability

The procedures used to obtain the analytical data, as documented herein, are expected to be complete, representative and will provide comparable data. It is expected that the labs chosen for analysis will provide data meeting QA criteria for 95 percent of all samples tested. All samples will be analyzed using same PCM or TEM Analytical Methods as discussed in Sections 4.1 and 4.2. The results will be expressed in fibers/c.c. of air at standard conditions. All samples will be collected by following the method specified in the QAPP. Chain of custody procedures will be carried out to preserve the integrity of the samples. Sample handling will be such that fibers deposited are not disturbed from the filters.

4.4 Facilities and Equipment

The field sampling equipment is identified in the monitoring/ sampling plans (Appendices C3-A and C3-B). Selected laboratories are properly equipped to perform the asbestos analyses. The selected laboratory will be subject to performance and system audits for approval/disapproval by the CPMS of U.S. EPA Region V.

5.0 SAMPLING PROCEDURES

Procedures to collect ambient air samples for asbestos analysis during different monitoring activities are described in the sampling/ monitoring plans presented in Appendices C3-A and C3-B.

6.0 SAMPLE CUSTODY

6.1 Sample Handling, Shipping and Custody

Samples will be handled and shipped as described in the sampling plans C3-A and C3-B. Each sample will be issued a unique project identification number to be determined in the field.

6.2 Field Documentation

A field logbook will be maintained and the following information will be recorded:

- Name and signature of field operator.
- Lot or assigned batch number (or any other identifiable number).
- Filter type e.g., Millipore (MCE), Nuclepore (polycarbonate).
- Date of record.
- Station Location and Number.
- Use of filter, (i.e., field blank, lab blank, or test blank).
- Condition of sample.
- Sample flow rate at start of sampling period.
- Start time.
- Stop time.
- Sample flow rate at end of sampling period.
- Any specific instructions/comments.

A traceability packing slip will be filled out in the field. The samples will be either hand carried or shipped to the laboratory for chemical analyses, where the package contents will be compared to the traceability packing slip (chain of custody). After the samples are logged in, they will be placed in suitable storage areas in the lab.

6.3 Project File

A project file will be maintained by Manville Remedial Construction Manager which will contain complete project documentation including project plans, specifications, field sampling documents, and the analytical data provided by the lab.

7.0 EQUIPMENT CALIBRATION

All field equipment, as appropriate, will be calibrated according to the standard operating procedures recommended by the manufacturer. Also, some of the field equipment will be calibrated as follows:

7.1 Rotameter Calibration

Rotameters will be checked, cleaned if necessary, then calibrated prior to the first sampling trip, as per the standard operating procedures. Air bubble calibration may be used for air flow calibration of rotameter as well as sampling pumps.

7.2 Dry Gas Meter Calibration

The Dry Gas Meter will be checked and calibrated prior to the

start of the sampling event and once every week, as per the manufacturer's standard operating procedures.

All the laboratory equipment will be calibrated as per the laboratory's standard procedures and as prescribed herein.

7.3 TEM Calibration

The microscope shall be calibrated routinely for camera constant and magnification. The camera constant determination and ED pattern analysis will be achieved by using a carbon coated grid on which a thin film of gold has been sputtered or evaporated. The magnification calibration must be done on the fluorescent screen at the grid opening magnification (if used) and at the magnification used for fiber counting.

Standard materials of known asbestos type will be used as reference for fiber morphology and electron diffraction patterns.

National Bureau of Standards standard filter preparations of known asbestos concentration will be used to assess the accuracy of the TEM method.

For the TEM calibration, manufacturer's standard procedures and U.S. EPA recommended procedures will be used.

7.4 Routine calibration of microscope will include a calibration of Walton-Beckett graticule, a check of microscope adjustments, a check of phase-shift-detection limit, a quality control of fiber counts and reproducibility as per manufacturer's and OSHA's procedural guidelines as specified in Appendix A of 20CFR1926, published on June 20, 1986.

8.0 ANALYTICAL PROCEDURES

All air samples will be transported to the laboratory carrying out the chemical analysis and will be kept encoded during microscopic analyses. They will be decoded by the QA monitor after all analyses are completed. Upon receipt of filters, the laboratory will record in a laboratory logbook the sample numbers, date they were received, and any macroscopic identifying characteristics of particular filter samples. This includes damaged or smudged areas on the filter surface, lack of uniform sample deposition, unattached particulate or debris, unusually heavy-appearing deposit concentrations, or other evidence of unusual condition.

Analysis will be by PCM for short-duration, concurrent perimeter air samples and by TEM for all selected 12-hour and 24-hour monitoring air samples. One of the two laboratories, Clayton Environmental Consultants and Environmental Monitoring Systems (EMS) will be utilized for asbestos analysis.

8.1 Analysis by PCM

Analysis of filters by PCM method will be in accordance with procedures outlined in Appendix A of 29CFR 1926, published on June 20, 1986 and summarized below.

8.1.1 Fiber counts shall be made by positive phase contrast using a microscope with an 8 to 10 X eyepiece and a 40 to 45 X objective for a total magnification of approximately 400 X and a numerical aperture of 0.65 to 0.75. The microscope shall also be fitted with a green or blue filter.

8.1.2 The microscope shall be fitted with a Walton-Beckett eyepiece graticule calibrated for a field diameter of 100 micrometers (±2 micrometers).

8.1.3 The phase-shift detection limit of the microscope shall be about 3 degrees measured using the HSE phase shift test slide as outlined below:

a: Place the test slide on the microscope stage and center it under the phase objective.

b: Bring the blocks of grooved lines into focus.

Note: The slide consists of seven sets of grooved lines (20 grooves to each block) in descending order of visibility from sets 1 to 7, seven being the least visible. The requirements for asbestos, tremolite, anthophyllite, and actinolite counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 and 7 must be invisible. Sets 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope that fails to meet these requirements has either too low or too high a resolution to be used for asbestos, tremolite, anthophyllite, and actinolite counting.

c: If the image deteriorates, clean and adjust the microscope optics. If the problem persists, consult the microscope manufacturer.

8.1.4 Each set of samples taken will include 10 percent field blanks for asbestos analysis. The blank field results shall be averaged and subtracted form the analytical results before reporting. Any samples represented by a field blank having a fiber count in excess of 7 fibers/100 fields shall be rejected.

8.1.5 The samples shall be mounted by the acetone/triacetin method or a method with an equivalent index of refraction and similar clarity.

8.1.6 Observe the following counting rules:

a: Count only fibers equal to or longer than 5 micrometers. Measure the length of curved fibers along the curve.

b: Count all particles as asbestos, tremolite, anthophyllite, and actinolite that have a length-to-width ratio (aspect ratio) of 5:1 or greater.

c: Fibers lying entirely within the boundary of the Walton-Beckett graticule field shall receive a count of 1. Fibers crossing the boundary once, having one end within the circle, shall receive the count of one half (1/2). Do not count any fiber that crosses the graticule boundary more than once. Reject and do not count any other fibers even though they may be visible outside the graticule area.

d: Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of an individual fiber.

e: Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields; stop counting at 100 fields regardless of fiber count.

8.1.7 Blind recounts (lab replicate) shall be conducted at the rate of 10 percent.

8.2 Analysis by TEM

Level II analysis, as stipulated in "Methodology for the Measurement of Airborne Asbestos by Electron Microscopy" by Yamate, Agarwal & Gibbons under U.S. EPA contract no. 68-02-3266 will be carried out. Level II analysis will include Level I analysis plus chemical elemental analyses. Morphology, size, SAED pattern and chemical analysis will be obtained sequentially. By a process of elimination, mineral fibers will be identified as chrysotile, amphibole, ambiguous, or "no-identity" by morphology and SAED pattern. X-ray elemental analysis may be used to categorize the amphibole fibers, identify the ambiguous fibers,and confirm or validate chrysotile fibers. Alternately, the TEM method, utilized during earlier sampling during RI may be used as described below.

8.2.1 Any damaged areas removed prior to sample preparation will be mounted on glass slides using double-sided adhesive and the

diameter of the effective filter area will be measured. The total effective filter area and damaged areas of sample removed should be accurately recorded for subsequent calculation of asbestos concentration.

8.2.2 Sample Preparation

If a Mixed Cellulose Ester (millipore) filter is used during sampling, then the sample preparation method utilized will be one of the methods presented in Section 7, page 61, of the "Methodology for the Measurement of Airborne Asbestos by Electron Microscopy" by Yamate, et.al.

If the polycarbonate (nucleopore) filter is used during the sampling, then the procedures described in this Section (8.2.2) or as described in Section 5 of of the above mentioned document by Yamate et.al. shall be followed.

Attach the Nuclepore filter tautly to a clean, labeled (sample no., date) 1 x 3 in. glass slide. Coat the filter with an approximately 40-mm thick carbon film (National Spectroscopic Laboratories carbon rods) by vacuum evaporation. The film thickness need be sufficient only to provide support for the deposit sample.

Transfer the polycarbonate filter deposit to a 200-mesh electron microscopy copper grid (E.G. Fullam) by cutting a 3-mm square portion from the filter using a clean, single-edged razor blade. Place this deposit side down on the electron microscopy (EM) grid which, in turn, has been set upon a small, correspondingly labeled portion of lens tissue paper. Place the film, grid and lens paper on a Jaffe dish consisting of a copper screen supported on a bent glass rod in a covered 90-mm glass petri dish. Pour reagent grade chloroform (J.T. Baker Company) into the dish to saturate the lens paper without submersing the grid and sample. Keep the dish covered at room temperature for 2 hours. Shift the prepared sample to a clean petri dish with fresh chloroform. Heat to 40° C for 10 minutes to provide a washing procedure. While it is still wet, place the sample grid in a small gelatin capsule. Tape the capsule to the slide that has the remaining coated polycarbonate filter, and store until analysis.

8.2.3 Microscopic Procedure

Examine the EM grid under low magnification in the transmission electron microscope to determine its suitability for examination under high magnification. Ascertain that the loading is suitable and is uniform, that a high number of grid openings have their carbon film intact, and that the sample is not contaminated excessively with extraneous debris or bacteria.

Scan the EM grid at a screen magnification of 20,000X. Record the length and breadth of all fibers that have an aspect ratio of greater than 5:1 and have substantially parallel sides. Observe the morphology of each fiber through the 10X binoculars and note whether a tubular structure characteristic of chrysotile asbestos is present. Switch into selective area electron diffraction (SAED) mode and observe the diffraction pattern. Note whether the pattern is typical of chrysotile or amphibole, ambiguous, or neither chrysotile nor amphibole. Use energy disbursing X-ray analysis where necessary to further characterize the fiber. Take pictures as desired representing the sample type, fiber/particulate distribution, or characteristic SAED patterns of chrysotile and specific amphibole types.
Count the fibers in the grid openings until at least 100 fibers, or the fibers in a minimum of 10 grid openings, have been counted. Once counting of fibers in a grid opening has started, the count will be continued though the total count of fibers may be greater than 100. To insure uniformity of grid opening dimensions, examine several 200-mesh grids by optical microscopy and measure roughly 100 openings per grid. Average these dimensions to provide a standard grid opening area.

8.2.4 Calculations

Calculate using the following equation, fiber number concentration expressed as the total number of fibers/volume of air:

$$\text{Fiber Count } (f/m^3) = \text{no. of fibers counted} \times \text{area* factor} \times \frac{\text{dilution factor**}}{\text{volume sampled, } m^3}$$

Where:

$$\text{*Area Factor} = \frac{(\text{total effective filter area, } cm^2)}{(\text{no of grids examined})\ (\text{average area of an EM grid opening, } cm^2)}$$

**Dilution factor takes into account sample dilution during ashing and refiltering and transfer to the EM Grid. The factor = 1.0 for samples collected on Nuclepore filters.

Calculate fiber mass for each type of asbestos in the sample by assuming that the breadth measurement is a diameter, thus, the mass can be calculated from:

$$\text{Mass (ug)} = \frac{\pi}{4}\ [(\text{length, um}) \times (\text{diameter, um})^2]\ (\text{density, } g/cm^3) \times 10^{-6}$$

The density of chrysotile is assumed to be 2.6 g/cm^3. and of amphibole, 3.0 g/cm The mass concentration for each type of asbestos is then calculated from:

$$\text{Mass Concentration of a particular type } (ug/m^3) = \frac{\text{Total mass of all fibers of that type, ug)} \times \text{area factor} \times \text{dilution factor}}{\text{volume of air sampled } (m^3)}$$

Record the fiber bundles and clusters as such but do not include them in the mass calculation or the fiber count. The fiber clusters and fiber bundles are not included in the mass calculation because (1) it is difficult to assign the third dimension to the two-dimensional observation of the aggregates, (2) it is difficult to determine void space within bundles and clusters, and (3) since the bundles and clusters make up only about 2% of the item count, one cannot be certain of the even distribution throughout the filter.

9.0 DATA REDUCTION, VALIDATION AND REPORTING

The analytical laboratory will review appropriate laboratory quality control data to assure the validity of the analytical results provided to the contractor. As a minimum, the guidelines listed below will be followed:

- When calculations are made by hand, 2 people will spot check some calculations independently and then compare results; correct if necessary.
- When computer is used, data entry will be verified; programs, formulae, etc., will be tested with sample data previously worked out by hand.
- When statistical software packages are used, tests of reason will be applied; on outputs, double-check sample sizes, degrees of freedom, variable codes, etc.; be alert for outliers.
- When reporting numerical results, computer generated outputs rather than retyped tables will be used to the extent possible. When possible, reported tables will be compared for consistency in variable codes and values, sample sizes, etc. In all cases, data validation activities shall be documented and records kept of any necessary corrective action in the appropriate notebook.

Full analytical and QC documentation will be prepared and retained by the laboratory. All raw data generated from analyses of samples, blanks, duplicates and replicates will be checked to meet established QA objectives and reported to the RCM/CSM. Where test data have been reduced, the method of reduction will be described in the lab report.

Standard statistical techniques will be used to estimate mean airborne asbestos concentration for the on-site and off-site samples collected during post Remedial Action air monitoring events. A 95% confidence interval will be obtained to provide a measure of the error involved in the estimation.

Comparisons between the disposal site and background concentrations will be made. Power (confidence level) calculations will be made to indicate the power of the statistical tests to detect differences between means.

No statistical techniques will be used to estimate fiber concentrations for samples collected during Pre-Remedial and during Remedial Construction monitoring activities.

10.0 INTERNAL QC CHECKS

The internal QC procedures associated with testing of asbestos will be in accordance with Section 4.0 of this document. Also, data entry checks and data transfer checks will be carried out as part of internal QC checks.

11.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits provide the primary means for external monitoring of this project. These audits will be performed during the field sampling by an individual appointed by the QA monitor.

11.1 Performance Audits

11.1.a

Device to be Audited	Audit Device
Pump	Flow Meters

11.1.b Performance Audit Procedure

- Verify calibration of the flow meters against standard reference device.
- Review EPA standard methods and/or other test protocols.
- directly measure flow rate against rotameter.
- Record all data on performance audit form. In general, all reported values should be within 10% as compared to the audit device.

11.2 System Audit

11.2.a Area to be Audited

- Entire sampling procedure

11.2.b System Audit Procedure

- Review test procedures and protocols.
- Obtain standard audit form.
- Observe the performance of each task.
- Ask questions as required.

The Quality Assurance Auditor is responsible for monitoring and auditing the performance of the QA procedures listed in this plan. He will maintain continuous communication with the RCM/CSM. Also, external audits may be performed by the Contract Project Management Section (CPMS) of Region V, Central Regional Laboratory (CRL).

12.0 PREVENTIVE MAINTENANCE

Preventive maintenance on all field equipment will be carried out in accordance with their standard operating procedures. A routine preventative maintenance program may be conducted by the laboratory for laboratory equipment.

13.0 DATA ASSESSMENT PROCEDURES

The Quality Assurance Monitor/Auditor will review the analytical results for compliance with established QC criteria. Any problems arising during sample collection, packing, shipping or analysis will be taken into consideration during the data assessment.

14.0 FEEDBACK AND CORRECTIVE ACTION

The types of corrective action procedures which will be used are:

- On-the-spot, immediate corrective action.
- Closed-loop, long-term corrective action.

14.1 On-the-Spot Corrective Action

This type of corrective action is usually applied to spontaneous, non-recurring problems, such as an instrument malfunction. The individual who detects or suspects non-conformance to previously established criteria or protocol in equipment, instruments, data, methods, etc., immediately notifies his/her supervisor. The supervisor and the appropriate task leader then investigate the extent of the problem and take the necessary corrective steps. If

a large quantity of data is affected, the task leader must prepare a memo to CSM/RCM/Manville Project Coordinator and the Quality Assurance Monitor (QAM). These individuals will collectively decide how to proceed after due approval from U.S. EPA and IEPA Remedial Work representatives.

14.2 Closed-Loop, Long-Term Corrective Action

Long-term, corrective action procedures are devised and implemented in order to prevent the reoccurrence of a potentially serious problem. The QAM is notified of the problem and conducts an investigation of the problem to determine its severity and extent. The QAM then files a corrective action request with the appropriate Task Leader, with a copy to the CSM/RCM, requesting that corrective measures be put into place. Suggestions as to the appropriate corrective action will also be made. The U.S. EPA Remedial Project Manager is responsible for approval of the corrective action proposed by Manville Project Coordinator and QAM.

15.0 QUALITY ASSURANCE REPORTS

The complete and correct implementation of this QAPP will be reviewed by the RCM/CSM. Any deviation from this QAPP or any concern arising during the project requiring significant changes in the QAPP also will be identified by the RCM/CSM. The RCM/CSM will propose adjustments required to Manville Corporation, Project Coordinator and U.S. EPA. After approval by U.S. EPA he will ensure their implementation. The QA-related information will be included in the monthly progress reports to U.S. EPA, as applicable. No separate QA reports will be submitted.

16.0 SAMPLING PLANS

A plan for Ambient Air asbestos sampling/monitoring to be conducted after Remedial Construction is presented in Appendix C3-A. Appendix C3-B presents the sampling to be conducted before and during the Remedial Construction.

QUALITY ASSURANCE PROJECT PLAN - 3

Table of Contents

		Pages
1.0	Introduction	C3-1
2.0	Project Description	C3-1
3.0	Project Organization And Responsibilities	C3-3
4.0	Quality Assurance Objectives	C3-5
5.0	Sampling Procedures	C3-6
6.0	Sample Custody	C3-6
7.0	Equipment Calibration	C3-7
8.0	Analytical Procedures	C3-8
9.0	Data Reduction, Validation and Reporting	C3-13
10.0	Internal QC Checks	C3-14
11.0	Performance and System Audits	C3-14
12.0	Preventive Maintenance	C3-15
13.0	Data Assessment Procedures	C3-15
14.0	Feedback and Corrective Action	C3-15
15.0	Quality Assurance Reports	C3-16
16.0	Sampling Plan	C3-16

Appendix

C3-A: Ambient Air Sampling Plan, For Asbestos, after Remedial Construction C3-A-1

C3-B: Ambient Air Sampling Plan, For Asbetos, Before and During Remedial Construction C3-B-1

List of Figures

Page

C3-1 Project Organization..... C3-4

C3-A-1 Off-Site Air Sampling Locations..... C3-A-6

C3-A-2 On-Site Air Sampling Locations..... C3-A-7

C3-B-1 Locations for Perimeter Air Monitoring..... C3-B-3

C3-B-2 Schematic of Ambient Air Nutech Sampler..... C3-B-4

List of Tables

C3-A-1 Calculating Sample Sizes..... C3-A-2

C3-A-2 The Relationship Between Sample Size, Coefficient of Variation and Estimation Error..... C3-A-4

C3-A-3 Number of Samples and Asbestos Analyses..... C3-A-10

APPENDIX C3-A

AMBIENT AIR SAMPLING PLAN, FOR ASBESTOS, AFTER REMEDIAL CONSTRUCTION

AMBIENT AIR SAMPLING PLAN FOR ASBESTOS AFTER REMEDIAL CONSTRUCTION

1.0 INTRODUCTION

This sampling plan presents the sampling location, rationale for the number of sample locations, sampling frequency, sampling procedures and sample handling and field documentation procedures to be followed during each sampling event for airborne asbestos after establishment of a soil and vegetative cover at the Johns-Manville Disposal Area.

Initial air sampling for asbestos will be carried out after the establishment of a soil and vegetative cover on the site and repeated thereafter at five-year intervals for a total period of 15 years. A complete schedule of sampling events is presented in Figure 2 of the Work Plan.

2.0 SELECTION OF SAMPLING LOCATIONS, NUMBER, FREQUENCY, TIMES AND VOLUME

2.1 Number of Samples

The number of samples needed for a desired level of precision in the results depends on the magnitude of the variability associated with all the phases of the sampling and analysis process. The variations involved in air monitoring activities at this site would be:

- Sampling variability - variability due to wind speed and direction and atmospheric site stabilizing conditions.
- Analytical variability - variability between and within laboratories with respect to air sampling instrumentation and chemical analyses procedures.

Due to the variability associated with sampling and analysis, it is unlikely that a single air sample concentration will be equal to the concentration averaged over the entire site for a long time. The degree to which a single estimate departs from the area-wide, long-term average is called the estimation error. The estimation error can be reduced by repeated measurements at a number of locations.

A range of possible variabilities relative to the expected concentration can be assumed by using a term called coefficient of variation (standard deviation divided by the mean). A large coefficient of variation reflects a high level of variability. The method to determine the sample sizes (Table C3-A-1) and the relationship between sample size, coefficient of total variation and estimation error (Table C3-A-2) have been reproduced from Exhibit I of June 14, 1984 Consent Agreement for RI/FS at Johns -

TABLE C3-A-1

Calculating Sample Sizes

The term "estimation error", as used in this plan refers to half of the length of the 95% confidence interval for the true mean. This confidence interval will be calculated from the data after they have been collected and will indicate the magnitude of the error associated with the estimation of the true mean. If the coefficient of total variation is small and/or the sample size is large, then the confidence interval will be short and one will be confident that the true mean is not very different from the value estimated from the data. By "confident" it is meant that 95% of the time the procedure for calculating a 95% confidence interval results in an interval which actually includes the true mean.

The formula for the 95% confidence interval is:

$$\bar{x} \pm t_{(0.025,\ n-1)}\sqrt{s^2/n}$$

where $\bar{x}$ and s^2 are the calculated sample mean and sample variance, respectively, and t(0.025, n-1) is the upper 2.5 percent point of the t distribution with n-1 degrees of freedom. Note that

$t_{(0.025,n-1)}\sqrt{s^2/n}$ is the estimation error. The aim is to

choose the sample size n so that $t(0.025,n-1)\ \sqrt{s^2/n}$

is not too large. Suppose it is decided that this quantity should be no larger than d where is the true mean and d is a fixed proportion. For example, if the estimation error is required to be no more than 60% of the mean, then d would be made equal to 0.6. Then n has to be chosen so that

$$t_{(0.025,n-1)}\sqrt{s^2/n} \text{ is less than du.}$$

It is not possible to be absolutely sure that for a given sample size the resulting confidence interval is sufficiently small, but it is possible to attach a probability to the chance that it will be. For example, it is possible to find n such that the probability that the confidence interval is sufficiently small is 0.9 or 0.95, or any other desired level. If the desired level is 1-B then it is necessary to find n such that

$$P[\ t_{(0.025,n-1)}\sqrt{s^2/n} \leq du] = 1-B$$

Table C3-A-1 (continued)

This is equivalent to

$$P\left(\frac{(n-1)s^2}{2} \leq \frac{(n-1)nd^2u^2}{2(t_{0.025,n-1})^2}\right) = 1-B$$

If it is assumed that the n samples are independent observations from a normal distribution with mean u and variance σ^2 then $(n-1)(s^2/\sigma^2$ has a x^2 distribution with (n-1) degrees of freedom. The problem is thus reduced to finding n such that

$$\frac{(n-1)nd^2u^2}{\sigma^2[t_{(0.025,n-1)}]^2} = x_{n-1}$$

where x_{n-1} is the upper (100%) B percentage point of the x^2_{n-1} distribution. Substituting $\sigma^2 = c^2u^2$ gives

$$n = \frac{1+4[t_{(0.025,n-1)}]^2 (c/d)^2 x_{n-1}}{2}$$

which can be solved by trial and error.

Table C3-A-2 shows the values of n for different values of the coefficient of variation (c), the size of the 95% confidence probability of obtaining an error as small or smaller. For example, if the coefficient of variation is 100% and one wants to ensure with probability 0.95 that the estimation error is no greater than ±50% of the true mean, then 27 samples are required. If only 22 samples are collected then the probability is reduced to 0.8.

TABLE C3-A-2

*The Relationship Between Sample Size, Coefficient of Variation, and Estimation Error

Coefficient of Variation[a]	Maximum acceptable estimation error as a percentage of the true mean[b]	Required Sample Size[c] 80%	90%	95%
100%	25%	73	78	81
	50%	22	25	27
	60%	17	19	30
	75%	13	14	15
	80%	12	13	14
	100%	9	10	11
150%	25%	154	160	176
	50%	44	48	50
	60%	32	35	38
	75%	22	25	27
	80%	21	22	24
	100%	15	16	17

[a] Standard deviation divided by the mean and expressed as a percentage.

[b] Based on the 95% confidence interval for the true mean calculated from the observed data.

[c] The number of samples required to ensure that the estimation error is less than the specified amount in the second column, with a probability of 80%, 90% and 95%.

*Reproduced from Exhibit J of June 14, 1984 Consent Decree for RI/FS at Johns-Manville Disposal Area between U.S. EPA and Johns-Manville Sales Corporation.

Manville Disposal Area between U.S. EPA and Johns-Manville Sales Corporation (see RI Volume II). Based on this data, a minimum of 25 samples on the site will be collected. This sample size would provide an estimation error of ± 50% of the true mean at a coefficient of variation of 100%; or an estimation error of ± 75% if the coefficient of variation is 150%, with a 90% probability.

For measurements at the off-site/background locations, a larger estimation error is tolerable. A sample size of 10, collected at two locations, should suffice.

2.2 Sampling Locations

To achieve 25 on-site and 10 off-site samples, five on-site and two off-site locations have been selected as per U.S. EPA's suggestions. These off-site and on-site sampling locations are presented in Figures C3-A-1 and C3-A-2, respectively.

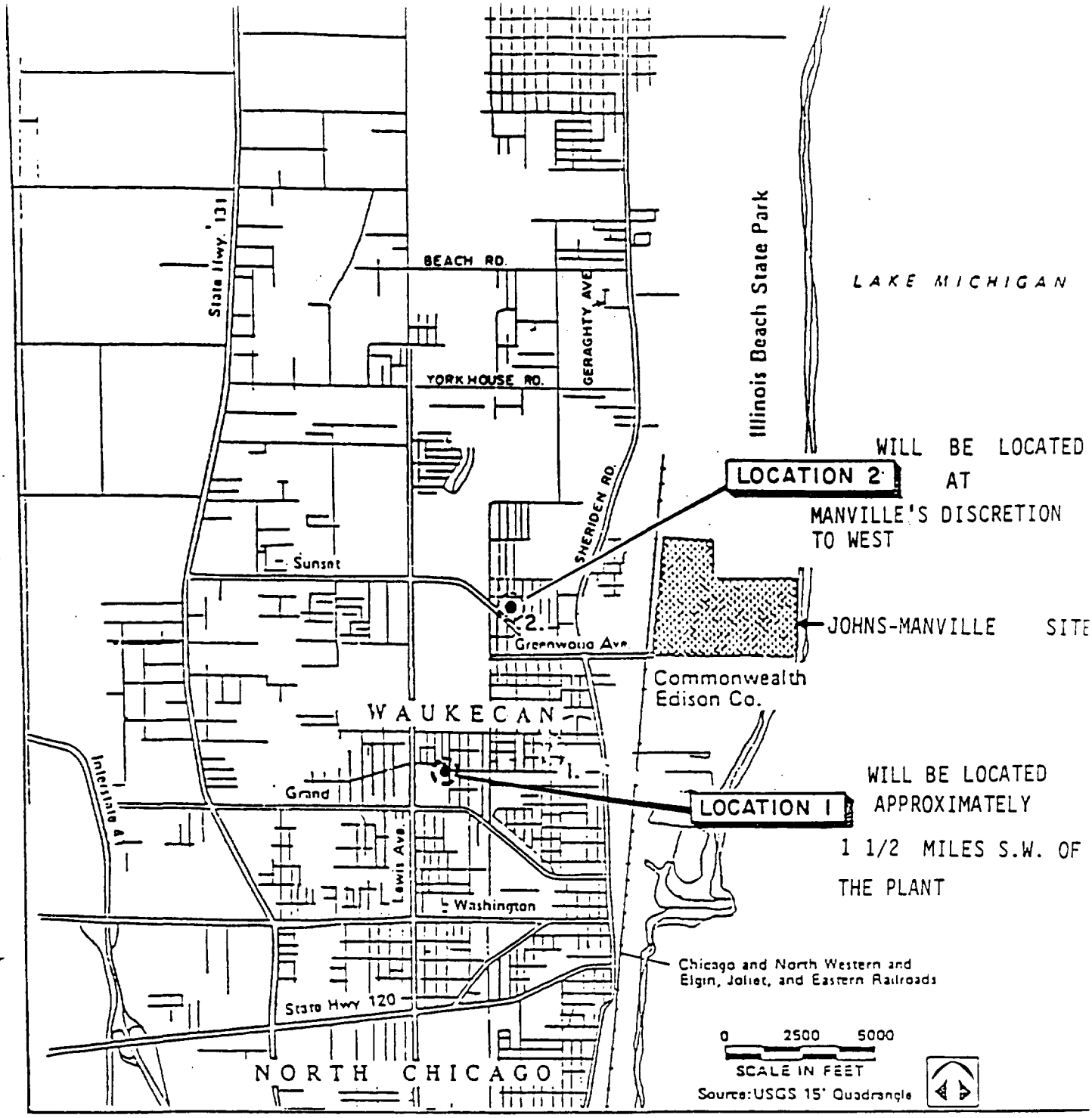
2.3 Sampling Times, Volumes and Filter Selection

To obtain comparable data with earlier air sampling events at this site and based on the likelihood of day-to-day variability in on-site activity and meteorological conditions; sampling will be conducted on five separate days, each, with a sampling period of 12± hours.

If dust or any other non-asbestos containing particles are present in the air at high concentrations, they will overload (clog) the filters if high sampling flow rates are utilized.

Establishing a soil and vegetative cover should alleviate the problems of any excessive dust particles in the air. Preloaded cassettes with Mixed Cellulose Ester filters (25 mm or 37 mm diameter, with pore size of 0.45 microns or less) or polycarbonate filters (37 mm diameter, with pore size of 0.40 micron or less) will be utilized for sampling. Approximately 1200 to 1800 liters of air flow for a 25 mm. diameter filter or 2600 to 4000 liters of air flow for a 37 mm diameter filter will be used per sample.

A flow control orifice will be used in the assembly, if lower flow rates are warranted, due to filter clogging problems.

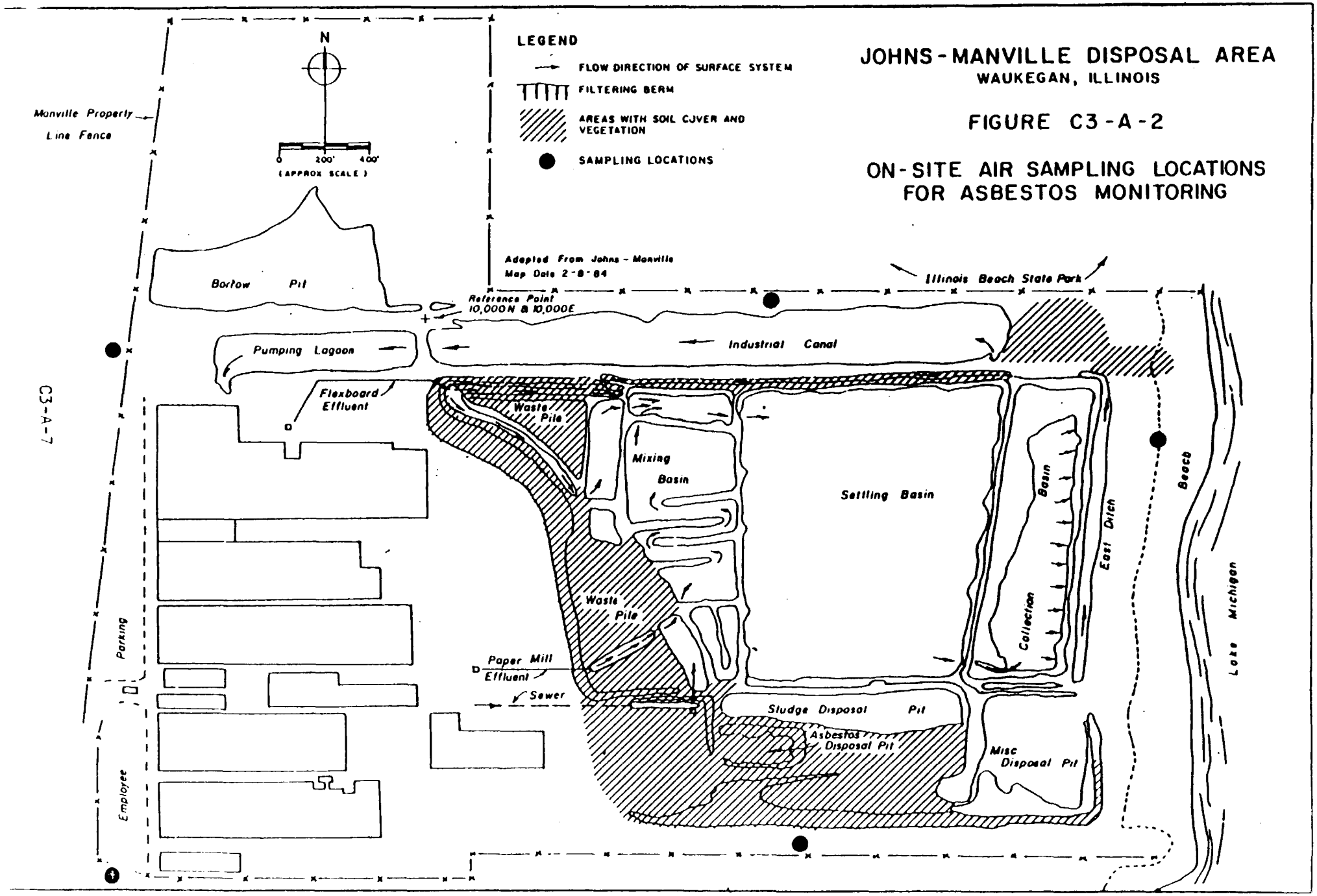


LEGEND

OFF-SITE LOCATIONS

JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS

FIGURE C3-A-1

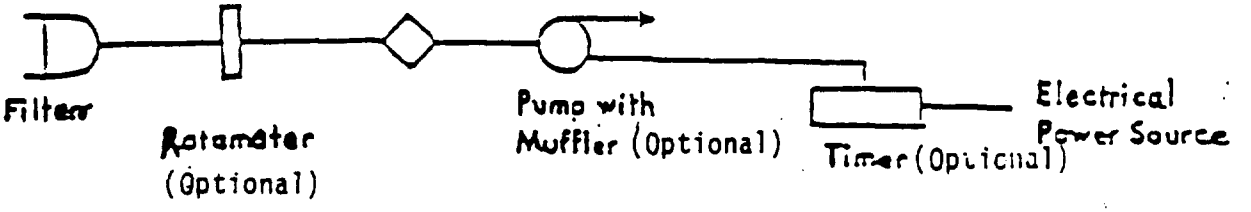

JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
FIGURE C3-A-2
ON-SITE AIR SAMPLING LOCATIONS FOR ASBESTOS MONITORING
LEGEND
FLOW DIRECTION OF SURFACE SYSTEM
FILTERING BERM
AREAS WITH SOIL COVER AND VEGETATION
SAMPLING LOCATIONS
N
0 200' 400'
(APPROX SCALE)
Adapted From Johns - Manville
Map Date 2-8-84
Manville Property Line Fence
Borlow Pit
Reference Point 10,000N & 10,000E
Illinois Beach State Park
Pumping Lagoon
Industrial Canal
Flexboard Effluent
Waste Pile
Mixing Basin
Settling Basin
Collection Basin
East Ditch
Beach
Lake Michigan
Waste Pile
Paper Mill Effluent
Sewer
Sludge Disposal Pit
Asbestos Disposal Pit
Misc Disposal Pit
Parking
Employee

3.0 EQUIPMENT AND SAMPLER SETUP

3.1 The sampling system includes:

- An open-face filter holder
- A flow control orifice
- A pump with muffler
- A method of measuring sampling time

A sampler setup during calibration can be schematically as follows:



Air bubble calibrator may be used for pump calibration.

3.2 Equipment for Meteorological Observations

A wind vane and anemometer shall be used to record wind direction and speed on site. Recorded data will then be used to draw a wind rose for each day of sampling. Wind velocity and direction measurements at each of the sampling locations, twice per day, may be used instead of the recorded data collection at one location.

4.0 SAMPLING PROCEDURES

4.1 Sampling Protocol

- Number the filter cassette on outside.
- Place the filter cassette in the clamp such that it is oriented downward at approximately 45 degrees from the horizontal.
- Start the pump and check plumbing for leak.
- Check the flow with flowmeter.
- Ensure that the mechanical vibrations from the pump are minimal.
- Make appropriate log book entries.
- Conduct sampling.
- After sampling period, check flow with flowmeter and record it. Record the time on timer and record it.
- Stop the pump, remove the cassette and cap it.
- Place the cassette in a cassette holder.
- Prepare for the transportation as required.

4.2 Laboratory Blanks

Use filter cassettes from the same production lot number, if possible. Prior to field sampling, select six filter cassettes (at least one per box) to serve as laboratory blanks and keep in laboratory until analysis. These blanks are used to check that

the filters are not contaminated prior to or after sampling. At least one of these filters will be analyzed for asbestos.

4.3 Field Blanks

During each of the five sampling periods, randomly select one field blank (filter cassette) from a new box of filter cassettes at each sampling site (i.e., on-site and off-site). This will result in a total of approximately 10 field blanks. Encode and handle the blank filters according to the same protocol as the test filters. Only one blank filter for on-site and off-site group of locations will be analyzed for asbestos. The total number of field blanks to be analyzed will be two for every sampling event.

5.0 SAMPLE ANALYSIS

Total number of on-site and off-site samples, number of field and lab blanks, number of duplicates and replicates to be analyzed in the lab are specified in Table C3-A-3.

6.0 PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION

Level D personal protection will be utilized, including:

- Disposable Tyvek coveralls,
- Outer gloves,
- Steel-toed boots

unless the Site Safety Officer determines that greater protection is needed.

Personnel decontamination will be conducted as described in the Health and Safety Plan (Attachment G) of the Work Plan. Outer gloves will be decontamined at the end of each sampling period. Wash and rinse solutions can be disposed of on site.

7.0 SAMPLE DOCUMENTATION

An important part of any field program are the observations and accurate records of the field team. As a minimum, logbook entries shall include:

- Name of field operator
- Date of record
- Number and location of site
- Position of sampler within site
- Brief site description (sketch)
- Filter number
- Identification number of pump and timer

TABLE C3-A-3

NUMBER OF SAMPLES AND ASBESTOS ANALYSES

	Field Blanks		Test Samples (filters)		Within the lab	Within the lab	Laboratory
	Off Site	On Site	Off Site	On Site	Duplicate	Replicate	Blanks
Filters to be Collected in the field	5	5	10	25	-	-	-
Filters to be Collected in the lab	-	-	-	-	-	-	6
Filters to be Analyzed	1	1	10	25	3	3	1

Total analyses within lab = 44

- Sample flow rate at start of sampling period
  - Start time
  - Stop time
  - Sample flow rate at end of sampling period
  - Wind rose for the sampling period
  - Description of meteorological conditions
  - Comments

8.0 SAMPLE PRESERVATION, PACKAGING AND SHIPPING

After the completion of sampling for 12± hours, filter will be handled in accordance with the following instructions:

- Before stopping the pump, rotate filter to horizontal position, stop the pump and remove the cassette.

- Cap the cassette and place in a cassette holder.

- Using a rigid shipping container, pack the holder upright in a non-contaminating, non-fibrous medium such as "bubble pack". Expanded polystyrene will not be used because of its static charge potential.

- Include a traceability slip (chain-of-custody) detailing number of samples, their descriptions, and all identifying numbers or marks, sampling data, shippers name, etc.

- Pack and transport the samples in a container to the laboratories for analyses.

- Label the transporting container in a way that will keep the holders and the filter cassettes in a horizontal position.

APPENDIX C3-B

AMBIENT AIR SAMPLING PLAN, FOR ASBESTOS, BEFORE AND DURING REMEDIAL CONSTRUCTION

AMBIENT AIR SAMPLING PLAN FOR ASBESTOS BEFORE AND DURING REMEDIAL CONSTRUCTION

1.0 INTRODUCTION

This sampling plan presents the sampling locations, sampling frequency, sampling and sample handling procedures to be followed during the sampling events to be conducted before and during initial phases of Remedial Construction Work.

Pre-Remedial Construction sampling for airborne asbestos will be conducted before the start of grading activities. This sampling event will be conducted once, for a period of five days. The data obtained will indicate the existing airborne asbestos concentrations, if any, and serve as background data for other sampling activities to be conducted during Remedial Construction.

Also, long-duration (24 hours) perimeter air monitoring and short-duration (4-8 hours) concurrent perimeter air monitoring will be conducted during initial phases of Remedial Construction Work. Initial phases of Remedial Construction involve site grading and smoothing and placement of the first layer of sand/soil cover. Data obtained by long-duration perimeter air sampling will be utilized to assess the potential impact on the surrounding environment of on-going Remedial Construction, and to implement additional dust suppressing measures, if any are desired. The monitoring results obtained will be compared to the 24-hour pre-remedial Construction air monitoring data. In the absence of any guideline on ambient air asbestos fiber concentrations, 0.02 fibers/cubic centimeters by PCM and 0.01 fibers/cubic centimeters by TEM, for fibers greater than 5 microns in length will be used for routine evaluation of dust-suppressing activities. The data obtained by short-duration concurrent perimeter monitoring will be used to identify the long-duration air sample to be analyzed by TEM as well as to indicate the potential short-term impact of Remedial Construction on the surrounding environment.

Personal air monitoring will also be conducted during the initial phases of Remedial Construction work, as presented in Appendix G-C of the Health and Safety Plan.

2.0 SELECTION OF SAMPLING LOCATIONS, NUMBER, FREQUENCY, TIMES AND VOLUME

2.1 Sampling Location and Number

Selection of sampling locations for long-duration perimeter monitoring as well as short-duration concurrent perimeter monitoring will be dependent upon the prevailing wind direction on each work day. Depending upon the observed and forecasted wind direction, sampling locations upwind and downwind of the Construction Area will be chosen. Also, meteorological measurements will be made by a portable, battery-operated recording anemometer placed at a suitable location in the vicinity of the Remedial Construction Area. The anemometer will be

positioned at a height equivalent to the top of the Disposal Area so as to monitor local wind conditions. Wind speed and direction will be routinely decoded in order to select samples for analyses during the program. Wind velocity and direction measurements at each of the sampling locations, twice per day, may be used instead of the recorded data collection at one location. Three perimeter sampling locations will be chosen each workday, depending upon the heavy construction area and prevailing winds, for long-duration perimeter monitoring activities. Of these three sampling locations, two locations representing conditions downwind of the heavy construction area will be chosen for short-duration concurrent perimeter monitoring.

The three perimeter sampling locations will be chosen from several available perimeter sites, shown in Figure C3-B-1.

Long-duration perimeter monitoring during initial phases of Remedial Construction will involve sampling for a 24-hour duration each work day at each of the three sites. Short-duration, concurrent perimeter monitoring will involve sampling for a 4-8 hour duration each work day.

2.2 Sampling Frequency, Times and Volumes:

The long-duration and short-duration perimeter air monitoring will be conducted before and during initial phases of Remedial Construction.

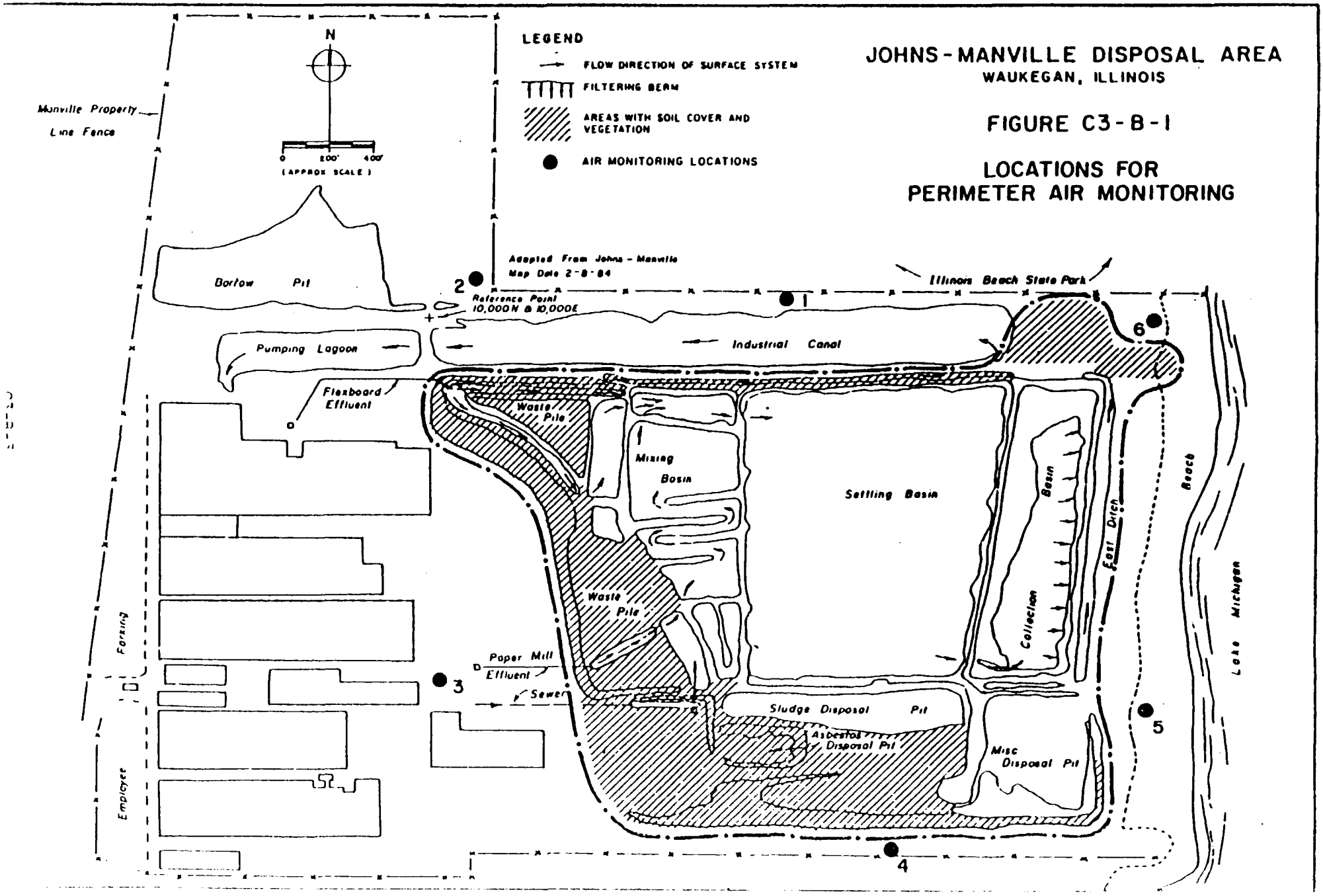
Twenty-four (24±1) hours sample will be collected each work day during long-duration perimeter air sampling. Calibrated Nutech- or equivalent samplers with preloaded cassette carrying MCE filter (25 mm or 37 mm diameter, 0.45 micron pore size) or polycarbonate filter (37 mm diameter, 0.40 micron pore size) will be used. A nominal, air sample total volume of 1200 to 1800 liters for a 25 mm filter or 2600 to 4000 liters for a 37 mm filter will be used.

Four to eight (4-8) hour samples will be collected each work day during short-duration concurrent perimeter air monitoring. Portable samplers with precalibrated pumps and filter cassettes (preloaded with 25 or 37 mm MCE filters or 37 mm polycarbonate filters) will be used to sample approximately 1200 to 1800 liters (for a 25 mm filter) or 2600 to 4000 liters (for a 37 mm filter) of air.

3.0 EQUIPMENT AND SAMPLER SETUP

A schematic diagram of a Nutech sampler is presented in figure C3-B-2. This sampler or an equivalent sampler setup will use a preloaded 25 mm or 37 mm filter cassette.

The short-duration concurrent perimeter sampler will utilize a mixed cellulose ester filter preloaded in a filter cassette.


JOHNS-MANVILLE DISPOSAL AREA
WAUKEGAN, ILLINOIS
FIGURE C3-B-1
LOCATIONS FOR PERIMETER AIR MONITORING
LEGEND
FLOW DIRECTION OF SURFACE SYSTEM
FILTERING BERM
AREAS WITH SOIL COVER AND VEGETATION
AIR MONITORING LOCATIONS
N
0 200' 400'
(APPROX SCALE)
Adapted From Johns-Manville Map Date 2-8-84
Manville Property Line Fence
Borlow Pit
Reference Point 10,000N & 10,000E
Pumping Lagoon
Flexboard Effluent
Industrial Canal
Illinois Beach State Park
Waste Pile
Mixing Basin
Settling Basin
Collection Basin
East Ditch
Beach
Lake Michigan
Waste Pile
Paper Mill Effluent
Sewer
Sludge Disposal Pit
Asbestos Disposal Pit
Misc Disposal Pit
Parking
Employee
1
2
3
4
5
6

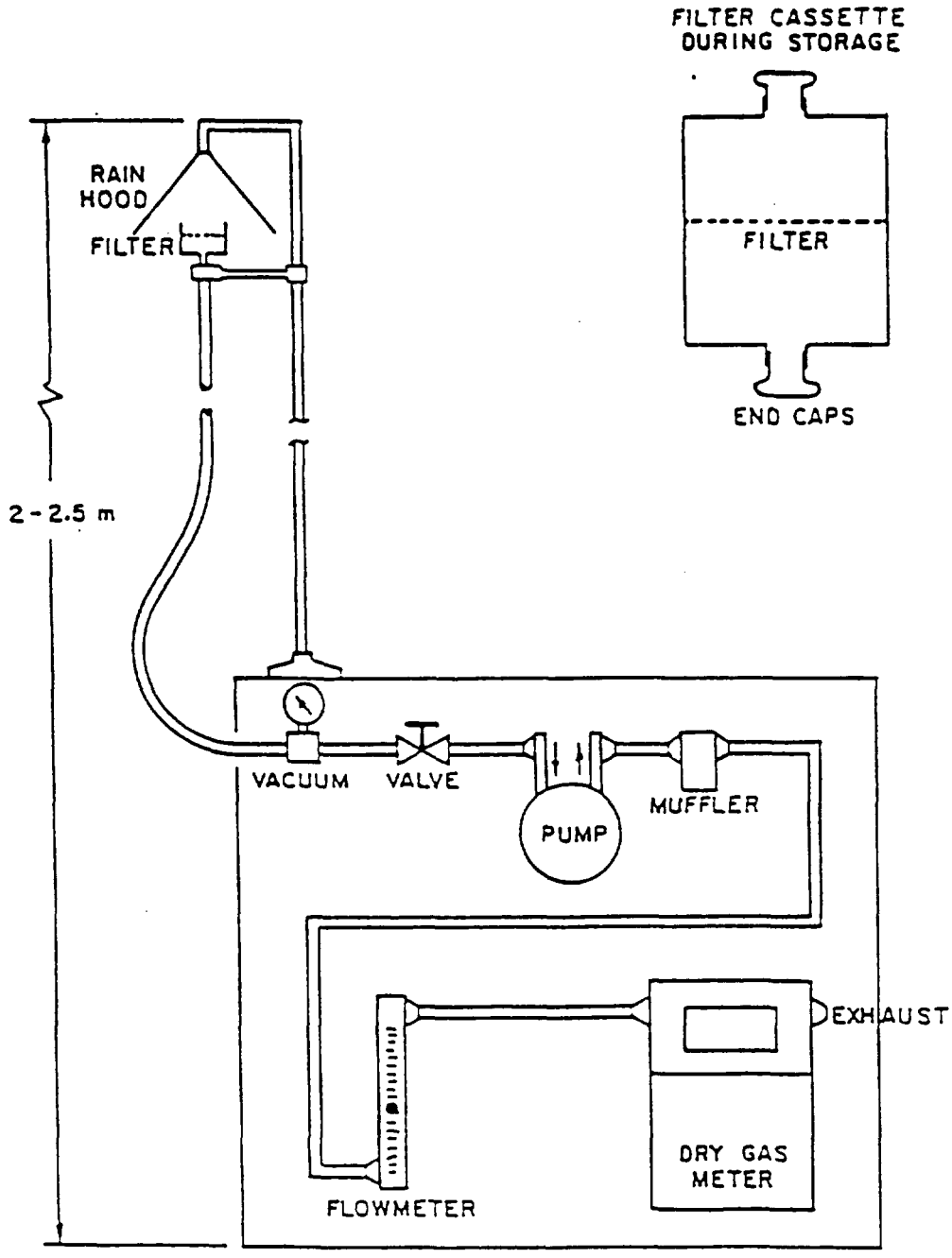


Fig. C3-8-2 SCHEMATIC OF AMBIENT AIR NUTECH SAMPLER

4.0 SAMPLING PROCEDURE

4.1 Sampling Protocol

Manufacturer's and U.S. EPA's published standard sampling techniques will be used.

4.2 Field Blanks

Field Blanks will be encoded and handled according to the same protocol as the test filters .

5.0 SAMPLE ANALYSIS

The total number of samples, field duplicates, lab duplicates and lab replicates to be collected and analyzed during short-duration and long-duration perimeter air sampling to be conducted during the initial phases of Remedial Construction are presented below:

	Filter Blanks		Test Samples		Lab Duplicates		Lab Replicates	
	A	B	A	B	A	B	A	B
Filters to be collected in field	2 per week	2 per week	3 per workday	3 per workday	-	-	-	-
Filters to be Analyzed	1 for every ten samples analyz.	1 for every ten samples analyz.	1 per week	3 per day	1 for every ten samples analyz.	1 for every ten samples analyz.	1 for every ten samples analyz.	1 for every ten samples analyz.

A = Long-duration air monitoring (By TEM)
B = Short-duration air monitoring (By PCM)

Also, during the first week of Remedial Construction, heavy construction work is anticipated. During this week and a week prior to the start of Remedial work, one long-duration perimeter air sample per day will be selected from downwind samples and analyzed by TEM. Hence, five long-duration perimeter monitoring air samples will be analyzed for the one week prior to beginning Remedial Construction and five samples will be analyzed for the first week of heavy construction (total = 10). One field blank, one lab duplicate and one lab replicate will be analyzed in addition to the five samples selected during each of the two weeks.

6.0 PERSONAL PROTECTIVE EQUIPMENT AND DECONTAMINATION

Modified Level D personnel protection will be utilized, including:

- Disposable Tyvek coveralls,
- Dust mask,
- Outer gloves,
- Steel-toed boots;

unless the Site Safety officer determines that greater protection is warranted.

Personnel decontamination will be conducted as described in the Health and Safety Plan (Attachment G) of the Work Plan. Outer gloves will be decontaminated at the end of each sampling period. Wash and rinse solutions can be disposed of on-site.

7.0 SAMPLE DOCUMENTATION

An important part of any field program are the observations and accurate records of the field team. As a minimum, logbook entries shall include:

- Name of field oerator
- Date of record
- Number and location of site
- Position of sampler within site
- Brief site description (sketch)
- Filter cassette number
- Identification number of pump and timer
- Sample flow rate at start of sampling period
- Start time
- Stop time
- Sample flow rate at end of sampling period
- Description of meteorological conditions
- Comments

8.0 SAMPLE PRESERVATION, PACKAGING AND SHIPPING

Throughout the sampling activities both Nuclepore and cellulose ester filters will be loaded in individual filter cassettes in a clean room.

After the pump has been stopped, filter will be handled in accordance with the following steps:

- Remove the filter cassette.

- Cap the cassette and place in a cassette holder.

- Using a rigid shipping container, pack the holder upright in a non-contaminating, non-fibrous medium such as "bubble pack". Expanded polystyrene will not be used because of its static charge potential.

- Include a traceability slip (chain-of-custody) detailing number of samples, their descriptions and all identifying numbers or marks, sampling data, shipper's name, etc.

- Pack and transport or hand carry the samples in a container to the laboratories for analyses.

- Handle the container in a way that will keep the holders and the filter cassettes in a horizontal (flat) position at all times (Handling, transport and storage).