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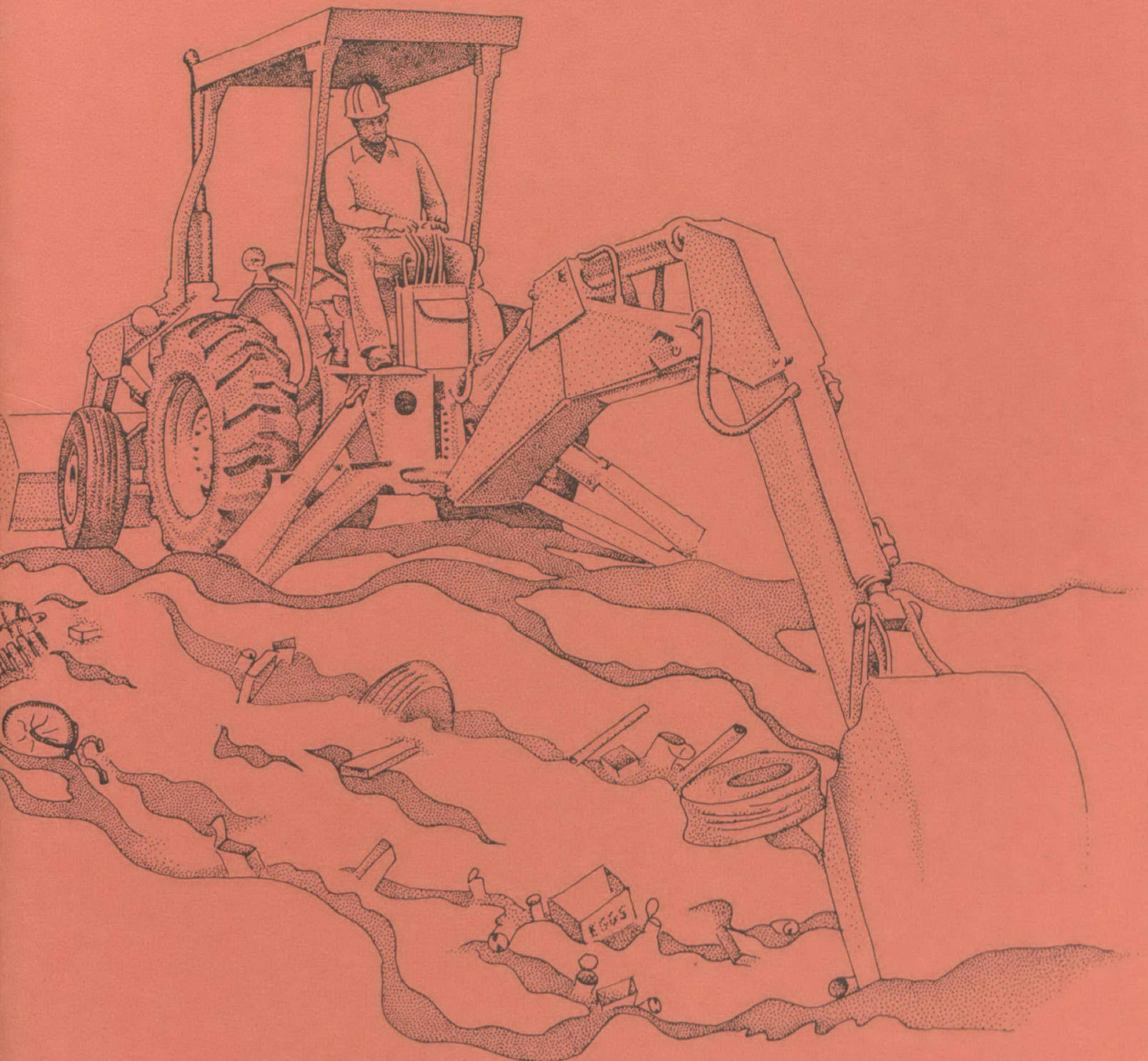
Liners for Sanitary Landfills and Chemical and Hazardous Waste Disposal Sites



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LINERS FOR SANITARY LANDFILLS AND CHEMICAL AND HAZARDOUS WASTE DISPOSAL SITES

by

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Contract No. 68-03-2460-4

Project Officer

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution, and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for preventing, treating and managing wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preserving and treating of public drinking water supplies, and for minimizing the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research--a most vital communications link between the researcher and the user community.

This report lists sanitary landfills and chemical and hazardous waste disposal sites and holding ponds lined with some form of impermeable membrane. Also included is a brief evaluation of three methods for excavating a fill to retreive a small portion of liner for laboratory analysis.

Francis Mayo
Director, Municipal Environmental
Research Laboratory

ABSTRACT

This report lists sanitary landfills and chemical and hazardous waste disposal sites and holding ponds with some form of impermeable lining. Liners included are polyethylene, chlorinated polyethylene, polyvinyl chloride, Hypalon ®, ethylene propylene diene monomer, butyl rubber, conventional paving asphalt, hot sprayed asphalt, asphalt-sealed fabrics, and concrete. Sites lined with treated soils including compacted clay are also listed.

A brief examination is made of three possible methods for excavating a solid waste landfill to remove a small piece of liner for laboratory study. These methods are: use of the dragline, the backhoe, or the caisson. The methods are briefly described and compared as to suitability, and a preliminary cost comparison is given.

This report was submitted in fulfillment of Contract No. 68-03-2460-4 by Ebon Research Systems under the sponsership of the U.S. Environmental Protection Agency. The report covers the period July 1977 to October 1977, and work was completed as of January 1978.

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FIGURES

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METRIC CONVERSION TABLE

English unit		Metric equivalent
1 mil	=	0.0254 mm
1 in.	=	2.54 cm
1 ft	=	0.305 m
1 lb/ft^2	=	4.88 kg/cm^2
1 yd^3	=	0.765 m^3

English units are used in this report, as they are commonly used in the solid waste industry in the United States.

ACKNOWLEDGMENTS

Ebon Research Systems gratefully acknowledges the assistance of our Project Officer, Mr. Robert Landreth, Solid and Hazardous Waste Research Division, U.S Environmental Protection Agency. We would also like to thank Mr. Allan Geswein, Office of Solid Waste Programs, U.S. Environmental Protection Agency. We are also indebted to the many manufacturers, owners, and operators of landfill disposal sites across the country; such a survey would not have been possible without their cooperation.

SECTION 1

INTRODUCTION

Installation of an impermeable liner in a solid waste landfill to prevent leachate from polluting ground and surface waters is a relatively recent development. The use of such liners to contain hazardous materials has a longer history, however. A number of laboratory studies have been conducted simulating field conditions in a solid waste landfill (Haxo, 1976), but little is known of the long-term effects of exposure of liners to the many physical, chemical, and biological processes taking place within the landfill. The Solid and Hazardous Waste Research Division (SHWRD) of the U.S. Environmental Protection Agency has funded studies of several years duration to examine the performance of various lining materials when exposed to either decomposing municipal solid waste (MSW), or to leachate from hazardous sludges. Though much has been learned from lysimeter studies, SHWRD is interested in examining working liners that have been in operation for more than six years to determine how well different liners have withstood actual operating conditions.

Accordingly, the purposes of this report are three-fold:

1. To identify sanitary landfills and chemical and hazardous waste disposal sites and holding ponds with an impermeable lining.

2. To describe these facilities briefly.

3. To provide a cursory technical and economic review of three possible techniques for excavating a fill to remove a small portion of liner for laboratory examination. These techniques are the use of a dragline, backhoe, or caisson.

Throughout this report, the term "liner" is used to describe a variety of materials that can be installed at the base and around the perimeter of a sanitary landfill to prevent leachate from entering ground and surface waters and to impede lateral migration of gases across the fill before venting to the atmosphere. Some of the materials included in this definition are manmade, including: polyethylene (PE), chlorinated polyethylene (CPE), polyvinyl chloride (PVC), Hypalon(R), ethylene propylene diene monomer (EPDM), butyl rubber, conventional paving asphalt, hot sprayed asphalt, asphalt sealed fabric, and concrete.

Various treated and untreated soil mixtures have also been utilized as impermeable linings for sanitary landfills. These mixtures include compacted

clay, pure montmorillonite, montmorillonite mixed with concrete, bentonite with an added polymer, and various other commercially available products. For the purposes of this survey, landfill sites with a clay lining are only included when the clay is installed and compacted at the base or perimeter of the fill. Therefore, this definition excludes in-place clay unless excavated and compacted before construction of the disposal site.

Section 3 lists lined sanitary landfills accepting MSW and Section 4 gives lined sanitary landfills, lagoons, and holding ponds that accept a variety of chemical wastes. Wastes excluded from Section 4 are radioactive wastes, brine, and sewage sludges. Both sections are organized by region and State.

Section 5 contains a brief review of the three possible construction techniques and should be considered a very preliminary examination of a complicated engineering problem.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

Most of the sanitary landfills identified with impermeable liners are of recent construction, a few are 5 years old or more. Liners have proved more popular in some States than others. States with a greater number of lined land disposal sites include Pennsylvania (asphalt, polyvinyl chloride, butyl rubber, and clay); Wisconsin (clay only); Missouri (clay only); and California (clay, polyvinyl chloride, and epoxy cement). The most common liners for containment of chemical wastes were found to be Hypalon®, ethylene propylene diene monomer, and clay.

The dragline is not a very efficient means of excavating a solid waste landfill to retrieve a portion of liner for laboratory study. The dragline is more suitable for loose bulk excavation than for digging narrow trenches or shafts.

At depths of less than 10 ft, manual excavation is most suitable. From 10 to 30 ft, the backhoe with attachments could be used to dig a trench with a comparatively small cross-sectional area. The costs for daily rental and operation of a backhoe are not excessive. A backhoe might be available on-site and could probably be hired for a half day or even on an hourly basis, as needed. The time required for excavation using a backhoe was shown to be generally less than 1 hr.

A caisson would be required for excavations below 30 ft. Minimum rental for moving in the drilling rig, setting it up, and moving it out is high, even without the additional costs for drilling the shaft, inserting and removing the caisson, employing various consulting experts, renting safety equipment, and backfilling the shaft. A 48 in. drilling would give enough working space at the foot of the shaft, especially if it were belled-out manually at the base. For this size drilling, costs increase tremendously for depths greater than 100 ft.

Few sites are deeper than 100 ft, and most fall within the range of 30 to 60 ft. It is thus cost-effective to confine liner sampling to fills in the average depth range. It would also be practical to take samples at varying depths and ages from a fill that has installed liners in a number of cells over a period of several years.

SECTION 3

LINED SANITARY LANDFILLS ACCEPTING MUNICIPAL SOLID WASTE

This section contains a comprehensive list of lined sanitary landfills accepting MSW. A few of these sites also accept hazardous wastes, and this is indicated where applicable. The sites are listed by region and State. Each site is described by essentially the same type of information. In some cases, information requested was not available. The site is initially identified by popular or common name. The address of a site is given where it differs from the address of the owner(s). Several sites have no mailing address. Name and address of the owner(s) are given with a telephone number current as of August/September 1977. Generally, the contact name listed is either the official responsible for operation of the fill for a municipal- or county-owned landfill, or the president of the corporation for a small, privately owned facility. For large corporations, the environmental specialist is given.

The type and thickness of liner is indicated for most of the identified sites. In many cases, portions of liner were installed in individual cells over a period of several years. All of these dates are given where known. If only one date is recorded, it represents the age of the oldest portion of liner installed at a particular site. Liner specifications are usually available from the contact name given. Where other parties may be contacted for liner specifications, names and addresses are given. Several manufacturers were mentioned frequently as suppliers of the various lining materials. Names and addresses of these companies are listed in Appendix A.

The depth of waste as of August 1977 is recorded where possible; otherwise, the depth of the fill is given. These figures should be considered approximate. Where one figure rather than a range is listed, it represents the maximum depth of waste or of the landfill itself. Please note that the depths are given in non-metric units, as is customary use in the United States. A conversion table for all units used in this report appears in the preliminary pages.

Again, construction and engineering plans are usually available from the contact party indicated or from the engineering firm contracted by the owner(s) to assist with construction of the fill. Landfills that accept hazardous wastes are listed again in Section 4 and are identified by an asterisk in both sections. Most of the sites are currently operational. A few sites have been closed for several years, and some have not yet begun to accept waste. Both categories of fill are identified in this list. Sites awaiting State permission to commence operation are also included.

LINED LANDFILL SITES ACCEPTING MUNICIPAL SOLID WASTE

REGION 1

Connecticut

SITE	CITY OF MILFORD SANITARY LANDFILL
Owner(s)	City of Milford
Address	Municipal Sanitation Department #1 Samuel Smith Lane Milford, Connecticut 06460 (203) 873-1731
Contact	Mr. O'Donnell
Type of liner	PVC (20 mil)
Date of installation	1973
Availability of liner specs.	Available, contact Mr. O'Donnell
Availability of construction plans for fill	Available, contact Mr. O'Donnell

Massachusetts

SITE	CLEAN COMMUNITIES' REGIONAL SANITARY LANDFILL
Address	Belcher Street Plainville, Massachusetts
Owner(s)	Clean Communities Corporation
Address	#1 Newbury Street Peabody, Massachusetts 01960 (617) 535-5140
Contact	Joseph Maschio (on site) (617) 695-7155
Type of liner	Clay-like material (18 in.) plus permeable material (18 in.)
Date of installation	September 1975
Depth of waste	50 ft (also depth of fill)
Availability of liner specs.	Available, contact owner
Availability of construction plans for fill	Available, contact owner

New Hampshire

SITE*	WEST ROAD LAGOON
Owner(s)	Town of Merrimac
Address	Town Hall Merrimac, New Hampshire 03054 (603) 883-8196
Contact	Ken Sherwood
Type of liner	PVC (15 mil)
Date of installation	1973
Depth of waste	15 ft (almost full)

Availability of liner specs.	Available, contact owner
Availability of construction plans for site	Available, contact owner
Type of waste	MSW and brewery wastes, other selected industries also accepted

Vermont

SITE	PALISADES SANITARY LANDFILL
Address	Route #2 Moretown, Vermont 05660
Owner(s)	Palisades, Inc.
Address	Box 354 Waterbury, Vermont 05677 (802) 244-8533
Contact	Robert Dowdell
Type of liner	PVC (20 mil)
Date of installation	1973
Availability of liner specs.	Available, contact owner
Availability of construction plans for fill	Available, contact owner

REGION 2

New Jersey

SITE	KRAMER SANITARY LANDFILL
Address	Clarksboro, New Jersey
Owner(s)	Mr. and Mrs. Kramer (609) 468-7911
Contact	Dr. Fungarolli
Address	Applied Geotechnical and Environmental Society (AGES) 215 South Broad Street Suite 902 Philadelphia, Pennsylvania 19107 (215) 545- 5343
Type of liner	CPE (30 mil)
Availablity of liner specs.	Contact engineering firm, AGES, above
Availability of construction plans for fill	Contact engineering firm, AGES, above

SITE	MOUNT HOLLY LANDFILL AND DEVELOPMENT
Address	Route 38 Mount Holly, New Jersey 08060
Owner(s)	SCAS Services
Address	99 High Street Boston, Massachusetts 02110 (617) 423-4100

Operator of fill	Landfill and Development Corp.
Address	208 Patterson Ave. Trenton, New Jersey 08610 (609) 396-2192
Contact	Frank Clowes (609) 267-9585
Type of liner	PVC (9 mil)
Date of installation	April/May 1976
Depth of fill	10-12 ft
Availability of liner specs.	Available, contact manufacturer, Staff Industries
Availability of construction plans for fill	Available, contact Wehran Engineering Corp., E. Main Street Ext., Middleton, New York 10940

New York

SITE	BROOKHAVEN TOWN LANDFILL
Address	Horseblock Road Brookhaven, New York 11719
Owner(s)	Town of Brookhaven
Address	Town Hall S. Ocean Ave. Patchogue, New York 11772
Contact	James Heil, P.E. (516) 286-2828
Type of liner	PVC (20 mil)
Date(s) of installation	1974, 1975, 1976, 1977
Depth of waste	100 ft
Availability of liner specs.	Available, contact James Heil
Availability of construction plans for fill	Available, contact James Heil

SITE	CITY OF BUFFALO
Owner(s)	City of Buffalo
Address	Room 604, City Hall Buffalo, New York 14202
Contact	Charles A. Stutzman (716) 856-4200
Type of liner	Natural clay exposed, backfilled with natural soils and montmorillonite
Date of installation	1973

SITE	MORGAN'S FARM SANITARY LANDFILL
Address	West Point Military Academy West Point, New York 10996
Owner of site	U.S. Government

Contact	John J. O'Connor Chief, Civil Engineering Branch
Address	ϕ 28 Engineers' Detachment - Utilities Bldg. 670 U.S. Military Academy West Point, New York 10996 (914) 938-4130
Type of liner	PVC (30 mil)
Date of installation	June 1974
Depth of fill	30-40 ft
Availability of liner specs.	Available, contact John J. O'Connor
Availability of construction plans for fill	Available, contact John J. O'Connor

SITE	TOWN OF NORTH HEMPSTEAD SOLID WASTE DISPOSAL SITE
Owner(s)	Town of N. Hempstead
Address	102 W. Shore Road Roslyn, New York 11576 (516) 621-0906
Contact	John Murphy William Cook
Type of liner	PVC (20 mil)
Date of installation	1973
Depth of waste	115 ft
Availability of liner specs.	Available, contact engineering firm, L.S. Wegman 100 East 42nd Street New York, New York 10017
Availability of construction plans for fill	Available, contact L.S. Wegman (above)

REGION 3

Maryland

SITE	PARKTON SANITARY LANDFILL
Address	Route 1-83 Parkton, Maryland 21120
Owner(s)	Baltimore County
Address	Bureau of Sanitation 209 Washington Ave. Towson, Maryland 21204 (301) 494-3185
Contact	Charles Farley Steven Lippy
Type of liner	Compacted clay in fill (5 ft), PVC lining in leachate collection system

Date of installation	1977 (first cell)
Depth of fill	10-25 ft
Type of waste	Some commercial waste in addition to MSW, no hazardous waste
Availability of liner specs.	Available, contact County
Availability of construction plans for fill	Available, contact County

Pennsylvania

SITE	COLUMBIA COUNTY SANITARY LANDFILL
Address	R.D. #4 Bloomsburg, Pennsylvania 17815
Owner(s)	Columbia County Solid Waste Authority
Address	Court House Bloomsburg, Pennsylvania 17815 (717) 784-6344
Contact	Pat McKenna
Type of liner	Asphalt concrete sub-base (2 in.)
Date of installation	June 1974
Depth of waste	8- 30 ft
Availability of liner specs.	Available, contact Pat McKenna
Availability of construction plans for fill	Available, contact Pat McKenna

SITE	GRUNDERVILLE LANDFILL
Address	Warren, Pennsylvania 16365
Owner(s)	Warren County Solid Waste Authority
Address	Warren County Courthouse Warren, Pennsylvania 16365 (814) 726-2431
Contact	Walter Sweeney
Type of liner	PVC (20 mil)
Date of installation	Mid-June 1976
Depth of waste	40 ft
Availability of liner specs.	Available, contact Staff Industries
Availability of construction plans for fill	Available, contact Walter Sweeney
Additional notes	Leachate pond is lined with Hypalon ® laminate (20 mil), installed June 1976

SITE	HARRISBURG INCINERATOR RESIDUE DISPOSAL SITE
Address	1670 S. 19th Street Harrisburg, Pennsylvania 17104
Owner(s)	City of Harrisburg
Address	423 Walnut Street Harrisburg, Pennsylvania 17101 (717) 255-6495
Contact	Stanley Brown, Jim Wilt

Type of liner	Butyl rubber
Date of installation	1972
Type of waste	MSW incinerator residue
Availability of liner specs.	Available, contact Stanley Brown or Jim Wilt
Availability of construction plans for fill	Available, contact Stanley Brown or Jim Wilt

SITE	KNICKERBOCKER SANITARY LANDFILL
Owner(s)	Mrs. Robena Samuels
Address	P.O. Box 456 Malbern, Pennsylvania 19355 (215) 644-9736
Contact	Mrs. Robena Samuels
Type of liner	Sprayed asphalt
Date of installation	1972
Availability of liner specs.	Available, contact engineers, Imagineering Associates Ltd. P.O.Box 51 Uwchland Post Office Eagle, Pennsylvania 19480
Availability of construction plans for fill	Available, contact engineers (above)

SITE	LANCHESTER CORPORATION LANDFILL
Owner(s)	Lanchester Corporation
Address	P.O. Box 176 Honeybrook, Pennsylvania 19344 (215) 273-3761
Contact	Lewis Frame, Sr.
Type of liner	Asphalt (4-6 in.)
Date of installation	Fall 1975
Availability of liner specs.	Available, contact Lewis Frame, Sr.
Availability of construction plans for fill	Available, contact Lewis Frame, Sr.

SITE	LYCOMING COUNTY LANDFILL
Address	Allenwood Federal Prison Lycoming County, Pennsylvania
Owner(s)	Lycoming County
Address	Lycoming County Courthouse 48 West 3rd Street Williamsport, Pennsylvania 17701 (717) 323-9811
Contact	David Terrill (717) 547-1870
Type of liner	PVC (20 mil)
Date of installation	September 1977

Depth of waste	Not yet receiving waste
Availability of liner specs.	Available, contact David Terrill
Availability of construction plans for fill	Available, contact David Terrill
SITE	McKEAN COUNTY SOLID WASTE AUTHORITY LANDFILL
Owner(s)	Ness Brothers
Operator(s)	McKean County Authority
Address	Box 448 Mt. Jewett, Pennsylvania 16740 (814) 778-9931
Contact	Raymond Troutman
Type of liner	Clay patching (18 in.)
Date of installation	September 1976
Availability of liner specs.	Available, contact Raymond Troutman
Availability of construction plans for fill	Available, contact Raymond Troutman
Additional notes	County also operates two leachate ponds each with a Hypalon® liner (30 mil), installed September 1976
SITE*	MONTGOMERY COUNTY SOLID WASTE MANAGEMENT SYSTEMS LANDFILL #1
Address	River Road West Conchohawkin, Pennsylvania 19428
Owner(s)	Allentown Portland Cement
Address	Myerstown, Pennsylvania 17067
Operator(s)	Montgomery Co. Solid Waste Authority
Address	West Conchohawkin, Pennsylvania 19428 (215) 275-5000
Contact	Karl Stead Curtis Chapman
Type of liner	Tar-based asphalt (6 in.)
Date of installation	1971
Depth of waste	160 ft
Type of waste	Licensed for some hazardous waste, but acceptance limited
Availability of liner specs.	Available, contact Curtis Chapman
Availability of construction plans for fill	Available, contact Curtis Chapman
Additional notes	First fill constructed in a quarry; a second quarry site is planned
SITE	WARNER COMPANY LANDFILL (GROWS)
Address	Falls Township Bucks County, Pennsylvania
Owner(s)	Warner Company
Type of liner	Asphalt

Date of installation	1970
Availability of liner specs.	Consult engineering firm, Applied Geotechnical and Environmental Society (AGES) 215 S. Broad Street, Suite 902 Philadelphia, Pennsylvania 19107
Availability of construction plans for fill	Consult engineering firm, AGES (above)
SITE	WESTERN BERKS REFUSE AUTHORITY SITE
Owner(s) Address	Western Berks Refuse Authority R.D. #1 Birdsboro, Pennsylvania 19508 (215) 375-1516
Contact	Al Mohn
Type of liner	Asphalt (1/8-1/2 in.)
Date of installation	October 1974, September 1977
Depth of waste	60 ft (closed), second cell- 4 ft
Availability of liner specs.	Available, contact engineering firm, Ed Hollos Gilbert Associates, Inc. P.O. Box 1949 Reading, Pennsylvania 19603
Availability of construction plans for fill	Available, contact Ed Hollos

REGION 4

Florida

SITE	BREVARD COUNTY SOLID WASTE DISPOSAL SYSTEM
Address	Adamson Road West of City of Cocoa, Florida
Owner(s) Address	Brevard County Utilities Division 2575 N. Courtenay Parkway Merritt Island, Florida 32952 (813) 366-2552 X283
Contact	Hoyt Wimberly (813) 632-5040
Type of liner	PVC (10 mil)
Date of installation	October 1976
Depth of fill	Liner on surface, will be 50 ft
Availability of liner specs.	Available, contact County
Availability of construction plans for fill	Available, contact County

SITE	BROWARD COUNTY LANDFILL
Address	SW 142nd Ave. Davie, Florida 33314
Owner(s)	Broward County Authority
Address	Division of Solid Waste Governor's Annex 236 SE 1st Ave. Fort Lauderdale, Florida 33301 (305) 765-5841
Contact	Jerry Peters
Type of liner	Sprayed asphalt
Date of installation	1974
Depth of waste	20 ft above ground
Availability of liner specs.	Available, contact Jerry Peters
Availability of construction plans for fill	Available, contact Jerry Peters

SITE	GULF COAST LANDFILL
Address	Route 82 Fort Myers, Florida 33901 (813) 334-4115
Owner(s)	Waste Management, Inc.
Address	900 Jorie Blvd. Oakbrook, Illinois 60521 (312) 891-1500
Contact	Jerry Gresh (305) 484-5500
Type of liner	PVC (10 mil), periphery only, not typical liner
Date of installation	Spring 1976
Depth of fill	8-10 ft (1/3 full)
Availability of liner specs.	Available, contact Jerry Gresh
Availability of construction plans for fill	Available, contact Jerry Gresh

SITE	TOMAKA FARMS ROAD LANDFILL
Address	Tomaka Farms Road Daytona Beach, Florida
Owner(s)	Rotaler Corporation
Address	170 E. Washington St. Orlando, Florida 32801 (305) 425-2786
Operator(s)	Volusia County
Contact	J.L. Griffin (904) 736-2700
Type of liner	PVC (10 mil)
Date of installation	Installed monthly
Depth of waste	9-10 ft
Availability of liner specs.	Available, contact manufacturer, Staff Industries

Availability of construction plans for fill	Available, contact J.L.Griffin

REGION 5

Illinois

SITE	McHENRY COUNTY SANITARY LANDFILL AND RECYCLING CENTER
Owner(s)	Crystal Lake Disposal, Inc.
Address	6714 Sands Road Crystal Lake, Illinois 60014 (815) 459-3270
Contact	Jim Veugeler
Type of liner	Bentonite (4 in.) with clay (2 ft)
Date of installation	Summer 1972
Availability of liner specs.	Contact Jim Veugeler
Availability of construction plans for fill	Contact S.W. Knetsch & Assoc., Inc. Dekalb, Illinois

SITE	HULCHER QUARRY, INC.
Owner(s)	Norman E. Hulcher
Address	Box 25 Nokomis, Illinois 62075 (217) 563-2531
Contact	Norman E. Hulcher
Type of liner	Clay (2-4 ft)
Date of installation	1972 and as needed
Depth of fill	40 ft
Type of waste	Fly ash from utility companies
Availability of liner specs.	Not known
Availability of construction plans for fill	Not available

SITE*	PAGEL PIT
Owner(s)	Rockford Blacktop
Address	500 Boylston Loves Park, Illinois 61111 (815) 877-9561
Contact	Chuck Howard
Type of liner	Blacktop with coal tar sealer (2 in.)
Date of installation	June 1972
Depth of waste	60 ft
Type of waste	Limited acceptance of hazardous waste
Availability of liner specs.	Available, contact owners
Availability of construction plans for fill	Available, contact owners

Indiana

SITE*	CALDWELL SANITARY LANDFILL
Owner(s)	Caldwell Gravel Sales, Inc.
Address	Rural Route #1 Morristown, Indiana 46161 (317) 763-6258
Contact	Paul Caldwell
Type of liner	Clay (5-12 ft)
Date of installation	1973
Depth of waste	22-25 ft
Type of waste	Also accept some industrial waste
Availability of liner specs.	Not available
Availability of construction plans for fill	Available, contact engineering firm, Technosolve, Inc. (317) 783-9550

Michigan

SITE	CEREAL CITY LANDFILL
Address	64 S. McCamly St. Battle Creek, Michigan 49016
Owner(s)	Waste Management, Inc. 900 Jorie Blvd. Oakbrook, Illinois 60521 (312) 654-8800
Contact	Paul Koruna (at site) (616) 962-4048 Greg Woefel (at Waste Management) (312) 654-8800
Type of liner	PVC (6 mil)
Date of installation	February 1975
Depth of fill	12-50 ft (60% full at present)
Availability of liner specs.	Available, contact Paul Koruna
Availability of construction plans	Available, contact Paul Koruna
Additional notes	Perimeter liner to prevent back migration of gas

SITE	MUSKEGON COUNTY SOLID WASTE MANAGEMENT SYSTEM
Address	9300 Apple Ave. Muskegon, Michigan 49440
Owner(s)	Muskegon County
Address	Department of Public Works County Bldg. 990 Terrace Street Muskegon, Michigan 49440 (616) 724-6411

Contact	Dr. Y.A. Demirijian (616) 853-2291 Ed Peterson (616) 724-6411
Type of liner	Clay (12 in.)
Date of installation	May 1973
Depth of fill	7 ft (now 1/10th full)
Type of waste	Also licensed for industrial waste
Availability of liner specs.	Not available
Availability of construction plans for fill	Available, contact Ed Peterson

SITE Address	PLAINFIELD LANDFILL 2908 Ten Mile Road Rockford, Michigan 49341
Owner(s) Address	Kent City Department of Public Works 1500 Scribner Ave., N.W. Grand Rapids, Michigan 49504 (616) 774-3694
Contact	Robert H. Scott
Type of liner	PVC (20 mil)
Date of installation	On-going
Depth of waste	25 ft
Availability of liner specs.	Available, contact Robert H. Scott
Availability of construction plans for fill	Available, contact Robert H. Scott

SITE Address	S.E. OAKLAND COUNTY INCINERATOR AUTH. 1741 School Road Avon Township Oakland County, Michigan
Owner(s) Address	S.E. Oakland County Incinerator Auth. P.O. Box 1248 Berkeley, Michigan 48072 (313) 288-5150
Contact	Joe Klee or Tom Waffen (313) 651-7840 (fill)
Type of liner	Clay (2 ft on bottom, 15 ft on sides)
Date of installation	1969
Depth of fill	25-80 ft (15 ft to go in center)
Availability of liner specs.	Not available
Availability of construction plans for fill	Available, contact Tom Waffen
Additional notes	Also have a section of fill with a PVC liner (20 mil), installed in 1974 and provided by Staff Industries

Minnesota

SITE	ROCHESTER SANITARY LANDFILL
Address	4 miles north of Rochester, Minnesota
Owner(s)	City of Rochester
Address	1602 4th Street S.E. Rochester, Minnesota 55902 (507) 288-4316
Contact	Harold DeVries (507) 282-4628
Type of liner	Clay (2 ft)
Date of installation	Started 1974
Depth of waste	35-40 ft
Availability of liner specs.	Available, contact Ron Paine Department of Public Services City of Rochester (507) 288-4316
Availability of construction plans for fill	Available, contact Ron Paine

SITE	STEELE COUNTY SANITARY LANDFILL
Address	Section 28 Aurora Township Steele County, Minnesota
Owner(s)	Roger Hagen
Address	408 2nd Avenue S.E. Medford, Minnesota 55049 (507) 451-1981
Contact	Roger Hagen (507) 583-2558
Type of liner	In-place and constructed clay
Date of installation	Continuous from 1974
Depth of waste	16-20 ft
Availability of liner specs.	Not available
Availability of construction plans for fill	Available, contact David Severson Steele County Annex 590 Dunnell Drive Owatonna, Minnesota 55060 (507) 451-4842

Wisconsin

SITE*	BROWN COUNTY EAST LANDFILL
Owner(s)	Brown County
Address	Brown County Courthouse Complex S.W. Systems Green Bay, Wisconsin 54301 (414) 497-3211
Contact	G.R. Rondo
Type of liner	Clay (4-5 ft)

Date of installation	August 1976
Depth of waste	50 ft
Type of waste	Also accept general industrial and demolition waste; hazardous waste accepted only after permission from State Department of Natural Resources
Availability of liner specs.	Available, contact G.R.Rondo
Availability of construction plans for fill	Available, contact G.R.Rondo

SITE	CITY OF PORTAGE LANDFILL
Owner(s)	City of Portage
Address	c/o Portage Municipal Bldg. 115 W. Pleasant Street Portage, Wisconsin 59301 (608) 742-2176
Contact	Fred Herter
Type of liner	Clay (2 ft)
Date of installation	1972
Depth of fill	10 ft (now 3/4 full)
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Not available

SITE	EATON LANDFILL
Address	Eaton Road Green Bay, Wisconsin
Owner(s)	Waste Management of Green Bay (leased)
Address	1745 Morrow Street Green Bay, Wisconsin 54302 (414) 435-1072
Contact	Don Otter (414) 251-1030
Type of liner	Clay
Date of installation	1968
Depth of waste	33 ft
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Available, contact Don Otter

SITE*	GERMANTOWN LANDFILL
Address	12700 County Line Road Germantown, Wisconsin
Owner(s)	Waste Management of Wisconsin 9050 North 124th Street Milwaukee, Wisconsin 53224

Contact	Don Otter (414) 251-1030
Type of liner	Clay (5 ft)
Date of installation	1973
Depth of waste	40 ft
Type of waste	Also accept paint sludges, thinners, neutralized acids
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Available, contact Don Otter

SITE	POLK SANITARY LANDFILL
Address	Highway 175 Polk, Wisconsin
Owner(s)	Waste Management of Wisconsin
Address	9050 North 124th Street Milwaukee, Wisconsin 53224 (414) 251-1030
Contact	Don Otter
Type of liner	Clay (2-5 ft)
Date of installation	1971
Depth of fill	35-40 ft (now half full)
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Available, contact Don Otter

SITE	RECLAMATION, INC. LANDFILL
Address	7 Mile Road and 43rd Street Raymond, Wisconsin
Owner(s)	Waste Management of Wisconsin 9050 North 124th Street Milwaukee, Wisconsin 53224 (414) 251-1030
Contact	Don Otter
Type of liner	Clay (5 ft)
Date of installation	1970-1973
Depth of waste	28 ft (closed)
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Available, contact Don Otter

SITE	SYCAMORE LANDFILL
Owner(s)	City of Madison
Address	Room 115 City Council Bldg. Madison, Wisconsin 53709 (608) 266-4091

Contact	Gary Boley
Type of liner	Clay (18-24 in.)
Date of installation	Summer 1972
Depth of waste	60 ft (closed)
Availability of liner specs.	Available, contact Gary Boley
Availability of construction plans for fill	Available, contact Gary Boley

SITE	GREENTREE LANDFILL
Owner(s)	City of Madison
Address	Room 115 City Council Bldg. Madison, Wisconsin 53709 (608) 266-4091
Contact	Gary Boley
Type of liner	Clay (18-24 in.)
Date of installation	1973
Depth of fill	50 ft (50% full)
Availability of liner specs.	Available, contact Gary Boley
Availability of construction plans for fill	Available, contact Gary Boley

SITE	VALLEY SANITATION LANDFILL
Address	Koshkonong, Wisconsin
Owner(s)	Sanitary Transfer and Landfill
Address	P.O. Box 20 Delafield, Wisconsin 53018 (414) 646-2300
Operator(s)	Valley Sanitation Company Koshkonong, Wisconsin (414) 563-8332
Contact	Joe Tate
Type of liner	Clay (2 ft)
Date of installation	Fall 1976
Depth of fill	32 ft (75% full)
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Available, contact Joe Tate

REGION 7

Iowa

SITE*	JOHN DEERE DUBUQUE WORKS SANITARY LANDFILL
Owner(s)	John Deere Dubuque Works
Address	John Deere Road Dubuque, Iowa 52001 (319) 557-5151, 557-5088
Contact	Richard J. Byrne, P.E.

Type of liner	Thermoplastic rubber, nylon reinforced (30 mil)
Date of installation	November 1974, October 1975, July 1976
Depth of waste	45 ft
Type of waste	Non-hazardous industrial waste-foundry sand, coal ash, and miscellaneous trash
Availability of liner specs.	Available, contact Richard J. Byrne
Availability of construction plans for fill	Available, contact Richard J. Byrne

Missouri

SITE	DALLAS COUNTY SANITARY LANDFILL
Owner(s)	Dallas County
Address	Dallas County Courthouse Buffalo, Missouri 65622 (417) 345-2632
Contact	Clay Young (417) 345-2632
Type of liner	Clay (2 ft)
Date of installation	November 1976 - January 1977
Depth of fill	16-18 ft
Availability of liner specs.	Available, contact Clay Young
Availability of construction plans for fill	Available, contact County Clerk

SITE	CITY OF FESTUS SANITARY LANDFILL
Owner(s)	City of Festus
Address	222-B North Mill Street Festus, Missouri 63028 (314) 937-5221
Contact	Lee R. Luke
Type of liner	Clay (2 ft)
Date of installation	1973
Depth of waste	6 ft
Availability of liner specs.	Available, contact Lee R. Luke
Availability of construction plans for fill	Available, contact Lee R. Luke

SITE	R & E SANITARY LANDFILL
Address	Hoff Road O'Fallon, Missouri 63366
Owner(s)	Ed and Robert Schlaeter
Address	420 Walbush O'Fallon, Missouri 63366 (314) 723-1767
Contact	Ed or Robert Schlaeter
Type of liner	On-site clay patched with compacted clay (1-12 ft)

Date of installation	1975
Depth of fill	50 ft (about to close)
Availability of liner specs.	Available, contact Ed or Robert Schlaeter
Availability of construction plans for fill	Available, contact Ed or Robert Schlaeter
SITE	WEST COUNTY DISPOSAL LTD. SANITARY LANDFILL
Address	Advance Road Sulfur Springs St Louis County, Missouri 63088
Owner(s) Address	West County Disposal Ltd. P.O.Box 428 Valley Park, Missouri 63088 (314) 225-7220
Contact	Jim Baker or Edward Bierman
Type of liner	Clay (3 ft)
Date of installation	1974-1975
Depth of waste	25 ft
Availability of liner specs.	Available, contact Jim Baker
Availability of construction plans for fill	Available, contact Jim Baker
SITE	WEST LAKE LANDFILL, INC. SANITARY LANDFILL
Owner(s) Address	West Lake Landfill, Inc. Box 206, Route #1 Bridgeton, Missouri 63042 (314) 739-1122
Contact	B. Vernon
Type of liner	Clay
Date of installation	1975?
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans	Available, contact State Department of Natural Resources

Nebraska

SITE	CITY OF OMAHA, 2ND AND MARTHA BALEFILL
Owner(s) Address	City of Omaha 6th Floor Omaha Douglas Civic Center 1819 Farnam Street Omaha, Nebraska 68102 (402) 444-5098
Contact	C.A. Geisler (402) 444-5227

Type of liner	Clay (2 ft)
Depth of waste	75-170 ft
Type of waste	MSW baled to density- 60-70 lbs/ft^3
Availability of liner specs.	Available, contact C.A. Geisler
Availability of construction plans for fill	Available, contact C.A. Geisler

REGION 8

Colorado

SITE	PII COLORADO
Address	64th and Huron Denver, Colorado 80221
Owner(s)	PII Colorado
Address	P.O.Box 21186 Denver, Colorado 80221 (303) 429-6411
Contact	Fritz Easterburg
Type of liner	Clay (4 ft at top, 22 ft at bottom)
Date of installation	February 1974
Depth of fill	30 ft (now 9/10ths full)
Availability of liner specs.	Available, contact Fritz Easterburg
Availability of construction plans for fill	Available, contact Fritz Easterburg

Wyoming

SITE	TORRINGTON BALEFILL
Owner(s)	City of Torrington
Address	P.O. Box 250 Torrington, Wyoming 82240 (307) 532-5666
Contact	E.G. Anderson
Type of liner	Clay (4-6 in.)
Date of installation	March 1977
Depth of waste	8 ft
Availability of liner specs.	Available, contact E.G. Anderson
Availability of construction plans for fill	Available, contact engineering firm, K & H Engineering Torrington, Wyoming 82240

REGION 9

California

SITE	GERNEVILLE DISPOSAL SITE
Owner(s)	Sonoma County
Address	Sonoma County Public Works Department Room 117A

	2555 Mendocino Avenue Santa Rosa, California 95401 (707) 527-2231
Contact	John Conoway
Type of liner	Clay (15 ft)
Date of installation	1976
Availability of liner specs.	Available, contact John Conoway
Availability of construction plans for fill	Available, contact John Conoway
SITE	HEALDSBURY DISPOSAL SITE
Owner(s)	Sonoma County
Address	Sonoma County Public Works Department Room 117A 2555 Mendocino Avenue Santa Rosa, California 95401 (707) 527-2231
Contact	John Conoway
Type of liner	Clay (20 ft)
Date of installation	1974
Depth of waste	50% full
Availability of liner specs.	Available, contact John Conoway
Availability of construction plans for fill	Available, contact John Conoway
SITE	MISSION CANYON
Owner(s)	County of Los Angeles
Address	500 North Sepulveda Blvd. West Los Angeles, California 90024 (213) 699-7411
Contact	G. Sturgeon or R. Schwegler
Type of liner	Epoxy cement mixture
Date of installation	1973
Depth of fill	250 ft (now closed)
Availability of liner specs.	Available, contact G. Sturgeon or R. Schwegler
Availability of construction plans for fill	Available, contact G. Sturgeon or R. Schwegler
Additional notes	This is not strictly speaking a liner, a containment wall was built at one toe of the canyon because of the suspected presence of stream.
SITE	MOUNTAIN VIEW LANDFILL
Address	Shoreline Regional Park City of Mountain View
Owner(s)	City of Mountain View

Address	540 Cast Row Street Mountain View, California 94042 (415) 967-7211 x263
Contact	Bob McCafferty
Type of liner	Compacted clay (5 ft around, 12 ft horizontal)
Date of installation	Earliest cells in 1970
Depth of waste	45-50 ft (for filled cells, 25 ft below ground, 20-25 ft above)
Availability of liner specs.	Available, contact Bob McCafferty
Availability of construction plans for site	Available, contact Bob McCafferty
SITE*	JOHN SMITH SOLID WASTE DISPOSAL SITE
Address	John Smith Road Hollister, California 95023
Owner(s)	County of San Benito (land)
Operator(s)	City of Hollister
Address	Municipal Bldg. Hollister, California 95023 (408) 637-4491
Contact	Roger Grimsley
Type of liner	Treated clay (18 in.)
Date of installation	Began 1966, accelerated 1968
Depth of fill	30 ft (3 cells 10 ft each)
Type of waste	California Class II-essentially MSW
Availability of liner specs.	Available, contact Roger Grimsley
Availability of construction plans	Available, contact Roger Grimsley
Additional notes	City also operates two Class I hazardous waste ponds lined with clay, installed January 1977
SITE	SONOMA COUNTY CENTRAL LANDFILL SITE
Owner(s)	Sonoma County
Address	Sonoma County Public Works Department 2555 Mendocino Ave., Room 117A Santa Rosa, California 95401 (707) 527-2231
Contact	John Conoway
Type of liner	Clay (30 ft)
Date of installation	1971
Depth of waste	20% full
Type of waste	California Class 2-1, some chemical toilet wastes accepted
Availability of liner specs.	Available, contact John Conoway
Availability of construction plans for site	Available, contact John Conoway
Additional notes	Vertical barriers for horizontal leachate prevention

SECTION 4

LINED CHEMICAL AND HAZARDOUS WASTE DISPOSAL SITES, LAGOONS, AND HOLDING PONDS

The list presented here is not as complete as that in the previous section. There are probably a number of lined holding ponds for chemical wastes that are not included in this section. Because of the size of the chemical industry and time constraints on the completion of this report, it was not possible to identify and contact all owners of lined holding ponds. Nevertheless, the list shows that, particularly in the last two years, there has been a major effort on the part of chemical manufacturers to build lined facilities for the temporary or permanent storage of chemical wastes.

This section is organized like the previous one. Sites are listed by region and State. Each site is described by the same type of information, including address, ownership, contact name(s), phone numbers, nature of liner date of installation, and depth of fill or pond. Also included for each site is a brief description of the type of chemical waste accepted. Where the type of waste is not given, this information may be available from the company contact directly. Where liner specifications and engineering plans are available, a contact name is given for more information. Facilities that also accept MSW and are thus listed in Section 3 are identified by an asterisk.

As mentioned previously, the categories of chemical waste included in this list are more comprehensive than those wastes typically defined as hazardous. However, sites containing the following wastes are excluded: brine, radioactive wastes, sewage, and activated sludge.

A few of the sites have been closed for several years and some have not yet begun to accept waste. Both categories of facility are identified in this list. Holding ponds are also included where identified, especially those ponds that have been used for many years.

LINED CHEMICAL AND HAZARDOUS WASTE DISPOSAL SITES, LAGOONS AND HOLDING PONDS

REGION 1

Maine

SITE	LINCOLN PULP AND PAPER CO.
Owner(s)	Lincoln Pulp and Paper Co.
Address	Lincoln, Maine 04457
	(207) 794-6721
Contact	L. Orst
Type of liner	Hypalon® (Flexseal®)
Date of installation	May 1977
Depth of pond	21 ft
Type of waste	Paper pulp
Availability of liner specs.	Contact B. F. Goodrich Chemical Co.
Availability of construction plans for pond	Available, contact L. Orst

REGION 2

Delaware

SITE	COKER'S SANITATION SERVICE LANDFILL
Address	Dover, Delaware 19901
Owner(s)	Joseph Kowinski
	(302) 653-5333
Operator(s)	Coker's Sanitation Service
Address	R.D. #4, Box 173A
	Dover, Delaware 19901
	(302) 734-5092
Type of liner	PVC (20 mil)
Date of installation	January 1977
Depth of fill	5-6 ft
Type of waste	Unspecified commercial chemical waste
Availability of liner specs.	Contact Watersaver Co., Inc.
plans for fill	Available, contact Carleton Coker

New Jersey

SITE	BRIDGEPORT
Address	Route 322
	Bridgeport, New Jersey 08014
	(609) 467-3100
Owner(s)	Rollins Environmental Services
Address	One Rollins Plaza
	Wilmington, Delaware 19803
	(302) 658-8541
Contact	William Philipbar
Type of liner(s)	Hypalon®, neoprene, concrete and asphalt, PE

Dates of installation	From 1970 onwards
Depth of holding ponds	Varies, from 5-10 ft
Type of waste	Organic and inorganic chemicals, pharmaceuticals, etc.
Availability of liner specs.	Available, contact William Philipbar
Availability of construction plans for ponds	Available, contact William Philipbar

SITE	B.F. GOODRICH CHEM. CO., PEDRICKTOWN
Owner(s)	B.F. Goodrich Chemical Co.
Address	Pedricktown, New Jersey 08067
	(609) 299-5400
Contact	Jim Kiel
Type of liner	Reinforced Hypalon® (30 mil)
Date of installation	November 1975
Depth of lagoon	6 ft
Type of waste	Sludge from manufacture of PVC resins and latex
Availability of liner specs.	Available, contact Jim Kiel
Availability of construction plans for lagoons	Available, contact Jim Kiel

New York

SITE	NEWCO CHEM WASTE SYSTEMS, INC.
Owner(s)	Niagara Recycling Inc.
Address	4626 Royal Avenue
	Niagara Falls, New York 14303
	(716) 285-6944
Contact	Gary Hall
Type of liner	CPE laminate (30 mil)
Date of installation	1976
Type of waste	Solid and semi-solid chemical residues
Availability of liner specs.	Available, contact Staff Industries
Availability of construction plans for fill	Available, contact Gary Hall

SITE	CHEM-TROL POLLUTION SERVICES, INC.
Address	P.O. Box 200
	Model City, New York 14107
Owner(s)	SCA Services
Address	99 High Street
	Boston, Massachusetts 02110
	(617) 423-4100
Contact	R.W. Rakoczynski
	(716) 754-8231 x53
Type of liner	Hypalon® (30 mil)

Dates of installation	SLF#1 (11-1-1971) SLF#4 (9-10-1974) SLF#2 (2-9-1973) SLF#5 (9-30-1975) SLF#3 (9-1-1973) SLF#6 (11-18-1976)
Depth of waste	20 ft
Type of waste	Hazardous waste from manufacturing and chemical industries
Availability of liner specs.	Available, contact R.W. Rakoczynski
Availability of construction plans	Available, contact R.W. Rakoczynski

REGION 3

Maryland

SITE	AMERICAN RECOVERY CORP.
Owner(s)	American Recovery Corp.
Address	2001 Benhill Avenue Baltimore, Maryland (301) 355-0623
Type of liner	Clay

SITE	CHEMICAL WASTE FACILITY
Owner(s)	Browning Ferris Industries
Address	7300 Ritchie Highway, Suite 902 Glen Burnie, Maryland 21061 (301) 285-7665
Contact	Mel Winstead
Type of liner	Hypalon(R) (10 mil)
Date of installation	1973
Depth of storage lagoon	14.5 ft
Type of waste	Various chemicals, do not accept chlorinated hydrocarbons, cyanides, phenols, arsenic or carcinogens
Availability of liner specs.	Available, contact Mel Winstead
Availability of construction plans for storage ponds	Available, contact Mel Winstead

Pennsylvania

SITE	BAKER AND ADAMSON WORKS
Owner(s)	Allied Chemical Corp.
Address	Wilmington Turnpike Marcus Hook, Pennsylvania 19061 (302) 798-0621 x484
Contact	Leon A. Mattioli
Type of liner	EPDM
Date of installation	1972
Type of waste	Acidic wastes
Availability of liner specs.	Available, contact Leon A. Mattioli
Availability of construction plans for lagoon	Available, contact Leon A. Mattioli

SITE*	MONTGOMERY COUNTY SOLID WASTE MANAGEMENT SYSTEM, LANDFILL #1
Address	River Road West Conchohawkin, Pennsylvania 19428
Owner(s) Address Operator(s)	Allentown Portland Cement Myerstown, Pennsylvania 17067 Montgomery County Solid Waste Management System
Contact	Karl Stead (215) 275-5000
Type of liner Date of installation Depth of fill Type of waste	Tar-based asphalt (6 in.) 1971 180 ft (20 ft till top) Mainly MSW, licensed for some hazardous waste, but acceptance limited
Availability of liner specs. Availability of construction plans for fill	Available, contact Karl Stead Available, contact engineering firm, Imagineering Associates Ltd. P.O. Box 51 Uwchland Post Office Eagle, Pennsylvania 19480 (215) 458-5009
Additional notes	County seeking funding for second quarry site

SITE	INDUSTRIAL WASTE TREATMENT POND
Owner(s) Address	Pennsylvania Power and Light Co. Box 257 Martin's Creek, Pennsylvania 18063 (215) 821-5747
Contact Type of liner Date of installation Depth of pond Type of waste	Wayne Stone Hypalon® 1974 40 ft Did contain all water wastes from two oil-fired units, now contains cooling water, will contain fly ash settling from coal-fired units
Availability of liner specs. Availability of construction plans for pond	Available, contact Wayne Stone Available, contact John Stefanick Engineering Department Pennsylvania Power and Light Co. #2 North 9th Street Allentown, Pennsylvania 18101
Additional notes	Company also has a second pond with a Hypalon® liner, installed Spring 1976. Contains all water wastes from two oil-fired and two coal-fired units

LIBRARY
U.S. Environmental Protection Agency
Corvallis Environmental Research Lab.
200 S.W. 35th Street
Corvallis, Oregon 97330

SITE	TONOLLI CORPORATION SITE
Owner(s)	Tonolli Corporation
Address	R.D. #1, Route 54 Nesquehoning, Pennsylvania 18240 (717) 645-3105
Contact	Nelson Daher
Type of liner	EPDM (1/16 in.)
Date of installation	Winter 1976-1977
Depth of fill	10 ft (now 1/3 full)
Type of waste	Furnace slags, non-ferrous metals
Availability of liner specs.	Available, contact manufacturer, E.I. DuPont de Nemours Co.
Availability of construction plans for fill	Available, contact Nelson Daher

West Virginia

SITE	MOUNDSVILLE NORTH PLANT
Owner(s)	Allied Chemical Corp.
Address	P.O. Box E Moundsville, West Virginia 26041 (304) 845-5670
Contact	Ted Harris or J.V. Murthig
Type of liner	Non-reinforced EPDM (1/16 in.)
Dates of installation	Late 1973 one pond, June 1977 two ponds
Depth of pond	15-16 ft
Type of waste	Oldest pond contains unneutralized organic process waste, other two ponds contain neutralized process waste and settled organic solids
Availability of liner specs.	Available, contact Ted Harris
Availability of construction plans for fill	Available, contact Ted Harris

SITE	MOUNDSVILLE SOUTH PLANT
Owner(s)	Allied Chemical Corp.
Address	P.O. Box D Moundsville, West Virginia 26041 (304) 845-5670
Contact	Mr. Taylor
Type of liner	EPDM (4 ponds), PVC (2 ponds)
Date of installation	1973, 1977
Depth of ponds	Four ponds approximately 12 ft deep Two ponds 20 ft deep
Type of waste	Sludge from mercury cell/chlorine operation in four ponds, two ponds for clarification of spent lime
Availability of liner specs.	Available, contact Mr. Taylor
Availability of construction plans for pond	Available, contact Mr. Taylor

SITE	HUNTINGTON ALLOYS PLANT WASTEWATER
Owner(s)	Huntington Alloys
Address	P.O. Box 1958 Huntington, West Virginia 25720 (304) 696-2150
Contact	Richard Lambiotte
Type of liner	Hypalon®(30 mil)
Date of installation	Fall 1976
Depth of pond	12 ft
Type of waste	Plant wastewater
Availability of liner specs.	Available, contact Richard Lambiotte
Availability of construction plans for pond	Available, contact Richard Lambiotte

REGION 4

Florida

SITE	AMERICAN CYANAMID CO. SANTA ROSA PLANT
Owner(s)	American Cyanamid Company
Address	Santa Rosa Plant Milton, Florida 32570 (904) 994-5311
Contact	Neale Sharitz
Type of liner	Hypalon®(30 mil)
Date of installation	Spring 1975
Depth of waste	18 ft (maximum)
Type of waste	Wastewaters from production of synthetic fibers
Availability of liner specs.	Available, contact Neale Sharitz
Availability of construction plans for pond	Available, contact Neale Sharitz

SITE	EAST LANDFILL, JACKSONVILLE
Address	515 Girbin Road Jacksonville, Florida
Owner(s)	City of Jacksonville
Address	1352 Vega Street Jacksonville, Florida 32205 (904) 633-2434
Contact	Kenneth Powell
Type of liner	Volclay®(approximately 4 in.) + 1 ft of dirt
Date of installation	Currently
Depth of fill	9 ft
Type of waste	Hazardous, industries will be specified in booklet now in production
Availability of liner specs.	Available, contact Kenneth Powell
Availability of construction plans for fill	Available, contact Kenneth Powell

SITE	GENERAL ELECTRIC CO. GAINESVILLE PLANT
Owner(s)	General Electric Company
Address	Battery Business Department P.O. Box 114 Gainesville, Florida 32602 (904) 462-3911
Contact	Ursula Harder
Type of liner	Hypalon®
Date of installation	1974-1975
Type of waste	Highly alkaline wastewaters
Availability of liner specs.	Available, contact Ursula Harder
Availability of construction plans for pond	Available, contact Ursula Harder

Georgia

SITE	AMERICAN CYANAMID CO. SAVANNAH PLANT
Owner(s)	American Cyanamid Co.
Address	P.O. Box 368 Savannah, Georgia 31402 (912) 236-6171
Contact	William E. Trees
Type of liner	Reinforced Hypalon®
Date of installation	1975
Depth of pond	Operating depth 2-3 ft
Type of waste	Waste acid from titanium dioxide/sulfate process, 15-20% free acid, 5-10% ferrous sulfate
Availability of liner specs.	Available, contact B.F. Goodrich, General Products Division
Availability of construction plans for pond	Available, contact William E. Trees

South Carolina

SITE	BISHOPVILLE FINISHING COMPANY
Address	P.O. Box 472 Bishopville, South Carolina 29010
Owner(s)	Reeves Brothers, Inc.
Address	1271 Avenue of the Americas New York, New York 10020 (212) 333-4200
Contact	Roger Hughes
Type of liner	Concrete basin (two basins) (4-5 in.)
Date of installation	First basin in 1972
Depth of basins	30-40 ft
Type of waste	Textile finishing wastes
Availability of liner specs.	Available, contact Roger Hughes
Availability of construction plans for basins	Available, contact Roger Hughes

REGION 5

Indiana

SITE	INDUSTRIAL LIQUID WASTE DISPOSAL CO
Owner(s)	Industrial Liquid Waste Disposal Co.
Address	R.R. #3, Box 156 Columbus, Indiana 47201 (812) 579-5235
Contact	Michael J. Crafton
Type of liner	Clay (30 ft)
Date of installation	1974
Depth of waste	8 ft
Type of waste	Unspecified liquid chemical wastes
Availability of liner specs.	Not available
Availability of construction plans for fill	Not available

Illinois

SITE*	PAGEL PIT
Owner(s)	Rockford Blacktop
Address	500 Boylston Loves Park, Illinois 61111 (815) 877-9561
Contact	Chuck Howard
Type of liner	Blacktop with coal tar sealer (2 in.)
Date of installation	June 1972
Depth of waste	60 ft
Type of waste	MSW and limited acceptance of hazardous waste
Availability of liner specs.	Available, contact Chuck Howard
Availability of construction plans for fill	Available, contact Chuck Howard

Michigan

SITE	CHEM-MET SERVICES
Owner(s)	Chem-Met Services
Address	18550 Allen Road Wyandotte, Michigan 48192 (313) 282-9250
Contact	W.R. Hartman
Type of liner	Clay (minimum of 10 ft)
Date of installation	1966
Type of waste	Acids from steel processing
Availability of liner specs.	Available, contact W.R. Hartman
Availability of construction plans for fill	Available, contact W.R. Hartman

SITE	ENVIRONMENTAL WASTE CONTROL, INC.
Owner(s)	Environmental Waste Control, Inc.
Address	26705 Michigan Avenue Inkster, Michigan 48141
Contact	(313) 357-5680 Carl Horby
Type of liner	(313) 561-1400 Plastic MN-21 (20 mil)
Date of installation	May 1977
Type of waste	Oil and waste water sludges
Availability of liner specs.	Available, contact manufacturer, MISCO-United Supply Inc.
Availability of construction plans for fill	Available, contact Carl Hornby
SITE	MUSKEGON, MICHIGAN
Owner(s)	Systems Technology Corp. 245 N. Valley Road Xenia, Ohio 45385
Contact	(513) 372-8077 Carl Evers
Type of liner	Coal tar epoxy
Date of installation	1975
Depth of site	12 ft
Type of waste	Acid
Availability of liner specs.	Contact Carl Evers
Availability of construction plans for site	Contact Carl Evers

Minnesota

SITE	FEDERAL CARTRIDGE CORPORATION
Owner(s)	Federal Cartridge Corporation
Address	9th and Tyler Anoka, Minnesota 55303
Contact	(612) 421-7100 A. Drury
Type of liner	Clay (1 ft)
Date of installation	Currently
Type of waste	Lime sludge
Availability of liner specs.	Contact A. Drury
Availability of construction plans for site	Contact A. Drury

Ohio

SITE	DUPONT CO., CIRCLEVILLE
Owner(s)	E.I. DuPont de Nemours Co. Circleville Plant P.O. Box 89 Circleville, Ohio 43113

Contact	Jim Parthemore
Type of liner	(614) 474-0111 Reinforced Hypalon®
Date of installation	Late 1960's
Depth of aeration lagoon	12 ft
Type of waste	Low levels of organic fluids, ethylene glycol, some triethylene
Availability of liner specs.	Available, contact Jim Parthemore
Availability of construction plans	Available, contact Jim Parthemore
SITE	FRANKLIN, OHIO
Owner(s)	Systems Technology Corporation
Address	245 North Valley Road Xenia, Ohio 45385 (513) 372-8077
Contact	Carl Evers
Type of liner	Concrete (four in-ground storage tanks 16 above ground)
Date of installation	From 1932
Depth of tanks	Average 8 ft
Type of waste	Oil containing wastes
Availability of liner specs.	Contact Carl Evers
Availability of construction plans for tanks	Contact Carl Evers
SITE	HILYARD, OHIO
Owner(s)	Systems Technology Corporation
Address	245 North Valley Road Xenia, Ohio 45385
Contact	Carl Evers
Type of liner	Hypalon® (four holding ponds above ground, six in-ground, two processing plants)
Date of installation	From 1975
Depth of ponds	Average 9 ft
Type of waste	Acids
Availability of liner specs.	Available, contact Carl Evers
Availability of construction plans for ponds	Available, contact Carl Evers
SITE	RICHENBACHER AIR FORCE BASE
Address	Columbus, Ohio 43217
Owner(s)	U.S. Government
Contact	J. Rasor (614) 492-4458
Type of liner	Hypalon® (35 mil)
Date of installation	August 1975
Depth of pond	10 ft.

Type of waste	Calcium sulfate sludge
Availability of liner specs.	Available, contact J. Rasor
Availability of construction plans for lagoon	Available, contact J. Rasor
SITE	WARREN, OHIO
Owner(s)	Browning Ferris of Ohio
Address	1901 South Pine Street Warren, Ohio 44881 (216) 399-8361
Contact	Michael Heher (216) 792-3852
Type of liner	Hypalon (R)
Date of installation	1973
Type of waste	Acid waste
Availability of liner specs.	Available, contact Michael Heher
Availability of construction plans for ponds	Available, contact Michael Heher

Wisconsin

SITE*	EAST LANDFILL, GREEN BAY
Owner(s)	Brown County
Address	Brown County Court House Complex Solid Waste Systems Green Bay, Wisconsin 54301 (414) 497-3211
Contact	G.R. Rondo
Type of liner	Clay (4 ft, 5 ft below leachate collection pipes)
Date of installation	August 1976
Depth of waste	50 ft
Type of waste	Mainly MSW, some dried sludge and general industrial waste, will accept hazardous waste only after permission from State Department of of Natural Resources
Availability of liner specs.	Available, contact G.R. Rondo
Availability of constructiion plans for fill	Available, contact G.R. Rondo
SITE	EAU CLAIRE, WISCONSIN
Owner(s)	Brown Company-Sterling Operations
Address	1200 Forest Street Eau Claire, Wisconsin 54701 (715) 834-3461
Contact	Tanwir A. Badir
Type of liner	Sludge (3 ft), sand cover (1 ft)
Depth of fill	20 ft
Type of waste	Paper sludge

Availability of liner specs.	Contact Tanwir A. Badir
Availability of construction plans for fill	Contact Tanwir A. Badir
SITE*	GERMANTOWN LANDFILL
Address	1200 County Line Road Germantown, Wisconsin
Owner(s) Address	Waste Management of Wisconsin 9050 North 124th Street Milwaukee, Wisconsin 53224 (414) 251-1030
Contact	Don Otter
Type of liner	Clay (5 ft)
Date of installation	1973
Depth of waste	40 ft
Type of waste	MSW and paint sludges, thinnners, neutralized acids
Availability of liner specs.	Available, contact State Department of Natural Resources
Availability of construction plans for fill	Available, contact Don Otter
SITE	H & R PAPER AND REFUSE SERVICE DISPOSAL FACILITY
Owner(s) Address	H & R Paper and Refuse Service P.O. Box 2381 Green Bay, Wisconsin 54306 (414) 435-2031
Contact	Richard Johnson
Type of liner	Compacted clay (2 ft)
Date of installation	Not specified
Type of waste	Not specified
Availability of liner specs.	Contact Richard Johnson
Availability of construction plans for site	Contact Richard Johnson
SITE	Ash/Bark Site, City of Nekoosa
Owner(s) Address	Nekoosa Paper Company Inc. 100 Wisconsin River Drive Port Edwards, Wisconsin 54469 (715) 887-5680
Contact	John Lacher
Type of liner	Bentonite/sand slurry in trenches secondary trenches with perforated PVC manifold
Date of installation	1977
Depth of trenches	20-25 ft
Type of waste	Bark/ash

Availability of liner specs.	Available, contact John Lacher
Availability of construction plans for trenches	Available, contact John Lacher
SITE	CALCIUM CARBONATE PROCESSING FACILITY
Address	Saratoga, Wood County, Wisconsin
Owner(s)	Nekoosa Paper Company Inc.
Address	100 Wisconsin River Drive Port Edwards, Wisconsin 54469 (715) 887-5680
Contact	John Lacher
Type of liner	Clay (1 ft), four lagoons
Date of installation	1977
Type of waste	Calcium carbonate slurry (can accept slurry for six month period, staggered use permits 18 month holding period in any one lagoon)
Availability of liner specs.	Available, contact John Lacher
Availability of construction plans for lagoons	Available, contact John Lacher
SITE	VAN HANDEL LANDFILL SITE
Owner(s)	Van Handel Company
Address	1719 East Edgewood Drive Appleton, Wisconsin 54911 (414) 734-1272
Contact	Tom or Handel Van Handel
Type of liner	Clay (2 ft)
Date of installation	June 1977
Type of waste	Paper mill sludge
Availability of liner specs.	Available, contact Tom or Handel Van Handel
Availability of construction plans for fill	Available, contact Tom or Handel Van Handel
SITE	WATER QUALITY CENTER
Owner(s)	Consolidated Papers Co.
Address	P.O. Box 50 Wisconsin Rapids, Wisconsin 54494 (715) 422-3111
Contact	S. Martin
Type of liner	Compacted clay to ground level (10 ft) clay berms on top of packed clay
Date of installation	1975
Type of waste	Paper and pulp mill sludge
Availability of liner specs.	Available, contact S. Martin
Availability of construction plans for site	Available, contact S. Martin

REGION 6

Louisiana

SITE	BATON ROUGE PLANT
Address	Scenic Highway Baton Rouge, Louisiana 70807 (504) 778-1234
Owner(s)	Rollins Environmental Services
Address	One Rollins Plaza Wilmington, Delaware 19803 (302) 658-8541
Contact	William Philipbar
Type of liner	Bentonitic clay (50-60 ft)
Date of installation	1971-1972
Depth of fill	15-20 ft
Type of waste	Fixed sludges- petrochemicals
Availability of liner specs.	Available, contact W. Philipbar
Availability of construction plans for fill	Available, contact W. Philipbar

New Mexico

SITE	KERR-McGEE NUCLEAR CORPORATION
Address	Ambrosia Lake Uranium District Grants, New Mexico
Owner(s)	Kerr-McGee Nuclear Corporation
Address	Kerr-McGee Center Oklahoma City, Oklahoma 73125 (405) 236-1313
Contact	Walt Spencer
Type of liner	Pond bottom - PVC (10 mil) Pond sides - CPE (20 mil)
Date of installation	1977
Depth of waste	10 ft
Type of waste	Uranium mill tailings decant solution (acidic)
Availability of liner specs.	Contact Watersaver Co., Inc.
Availability of construction plans for ponds	Available, contact Walt Spencer

SITE	L'EGGS PRODUCTS, INC
Address	P.O. Box 788 Mesilla Park, New Mexico 88047 (505) 524-8541
Owner(s)	Hanes Corporation
Address	P.O.Box 5416 Winston-Salem, North Carolina 27103
Contact	John A. Head, Jr. (505) 524-8541
Type of liner	Asphalt (3/4 in.)

Date of installation	1968
Depth of waste	11 ft
Type of waste	Contact Jesse Lunsford (505) 646-3032
Availability of liner specs.	Available, contact installer, Burn's Construction 2335 E. Lohman Avenue Las Cruces, New Mexico 88001 (505) 526-4421
Availability of construction plans for site	Available, contact John A. Head

Texas

SITE	ALUMINUM CO. OF AMERICA, ROCKDALE WORKS
Owner(s)	Aluminum Co. of America (ALCOA)
Address	P.O. Box 472 Rockdale, Texas 76567
Contact	Brooks Parker (512) 446-5811
Type of liner	PVC (20 mil)
Date of installation	1974-1975, second liner just installed
Depth of pits	20-30 ft (old pit is full, new pit is empty)
Type of waste	Fluoride-contaminated waste
Availability of liner specs.	Contact Brooks Parker
Availability of construction plans for pits	Available, contact Brooks Parker

SITE	BIO-ECOLOGY SYSTEMS, INC.
Owner(s)	Bio-Ecology Systems, Inc.
Address	4100 East Jefferson Grand Prairie, Texas 75051 (214) 264-4281
Contact	Rene Taylor Don Williamson
Type of liner	Hypalon (R)
Date of installation	December 1976
Depth of fill	18 ft
Type of waste	All chemical solvents, acids, no grease trap waste accepted
Availability of liner specs.	Available, contact Don Williamson
Availability of construction plans for fill	Available, contact Don Williamson

SITE	DEER PARK, HOUSTON
Address	Title Road Deer Park, Texas 77536 (713) 474-6001

Owner(s)	Rollins Environmental Services One Rollins Plaza Wilmington, Delaware 19803 (302) 658-8541
Contact	William Philipbar
Type of liner	Bentonitic clay (70 ft) (in-place compacted)
Depth of ponds	25-30 ft (seven or eight ponds)
Type of waste	Fixed sludges- petrochemicals, petroleum
Availability of liner specs.	Available, contact William Philipbar
Availability of construction plans for ponds	Available, contact William Philipbar

REGION 7

Kansas

SITE	KANSAS INDUSTRIAL ENVIRONMENTAL SERVICES, INC.
Address	8808 North 127th Street East Wichita, Kansas
Owner(s)	Kansas Industrial Environmental Services, Inc.
Address	P.O. Box 745 Wichita, Kansas (316) 744-1286
Contact	Lee Deets
Type of liner	Clay (20 ft, in situ clay)
Date of installation	1976
Depth of waste	30 ft
Type of waste	All types of hazardous waste accepted
Availability of liner specs.	Available, contact Lee Deets
Availability of construction plans for fill	Available, contact Lee Deets

Missouri

SITE	EAGLE-PICHER COMPANY SITE
Owner(s)	Eagle-Picher Company
Address	P.O. Box 47 Joplin, Missouri 64801 (417) 623-8000
Contact	Paul Eddy
Type of liner	Hypalon® (30 mil)
Date of installation	1971-1972
Depth of waste	4-5 ft
Type of waste	Battery wastes- any type except acid wastes, special purpose batteries with military and space application
Availability of liner specs.	Available, contact Paul Eddy

Availability of construction plans for site	Available, contact Paul Eddy
SITE	WHEELING DISPOSAL SERVICE CO., INC.
Owner(s)	Wheeling Disposal Service Co., Inc.
Address	1805 South 8th Street St. Joseph's, Missouri 64503 (816) 279-0815
Contact	Clayton Buntrock
Type of liner	Clay
Date of installation	August 1975
Depth of fill	25 ft
Type of waste	Pesticides, pickle liquors, most wastes considered
Availability of liner specs.	Available, contact Clayton Buntrock
Availability of cpnstruction plans for fill	Available, contact Clayton Buntrock
Additional notes	Company also has two evaporation ponds and one solid waste/liquid waste transfer site

REGION 8

Colorado

SITE	EASTMAN KODAK, KODAK COLORADO DIVISION SITE
Owner(s)	Eastman Kodak Company
Address	Windsor, Colorado 80551 (303) 686-7611 x2108
Contact	L. Kent Reitz
Type of liner	EPDM (1/16 in.)
Type of waste	Industrial wastewater treatment facility
Availability of liner specs.	Available, contact L. Kent Reitz
Availability of construction plans for site	Available, contact L. Kent Reitz

Wyoming

SITE	ALLIED CHEMICAL CORP., GREEN RIVER
Owner(s)	Allied Chemical Corp.
Address	P.O. Box 551 Green River, Wyoming 82935 (807) 875-3350
Contact	Bob Teets, Richard Chastain
Type of liner	Hypalon®(30 mil)
Date of installation	Winter 1975-1976
Depth of pond	Maximum 10 ft
Type of waste	Weak sodium carbonate solution

Availability of liner specs.	Available, contact Bob Teets, Richard Chastain
Availability of construction plans for pond	Available, contact Bob Teets, Richard Chastain

REGION 9

California

SITE	IMPERIAL WEST CHEMICAL COMPANY
Owner(s)	Imperial West Chemical Company
Address	1701 Wilbur Avenue Antioch, California (415) 757-8230
Contact	D.A. Huckaboy
Type of liner	Hypalon R (30 mil)
Date of installation	February 1971
Type of waste	Ferrous chloride, pickle liquor
Availability of liner specs.	Available, contact D.A. Huckaboy
Availability of construction plans for fill	Available, contact D.A. Huckaboy

SITE*	JOHN SMITH SOLID WASTE DISPOSAL SITE
Address	John Smith Road Hollister, California 95023
Owner(s)	County of San Benito
Operator(s)	City of Hollister
Address	375 5th Street Hollister, California 95023
Contact	Roger Grimsley
Type of liner	Clay (9 ft) (two ponds)
Date of installation	January 1977
Depth of ponds	24 ft
Type of waste	California Class I, mainly pesticides
Availability of liner specs.	Available, contact Roger Grimsley
Availability of construction plans for ponds	Available, contact Roger Grimsley
Additional notes	City also operates a lined solid waste landfill accepting Class II wastes

SITE	LINDSAY INDUSTRIAL WASTE
Address	R.D. 188 and 137 Lindsay, California
Owner(s)	City of Lindsay
Address	P.O. Box 369 Lindsay, California 93247 (209) 562-2511
Contact	Marvin L. Johnson
Type of liner	Polyethylene (10 mil)

Date of installation	1970-1972
Depth of waste	0-6 ft
Type of waste	Olive brine liquid
Availability of liner specs.	Not available
Availability of construction plans for pond	Available, contact Marvin L. Johnson

SITE	TRI-VALLEY GROWERS- PLANT #8
Address	12806 Road 26N Madera, California 94106 (415) 445-1600
Contact	Bob Parodi (209) 526-4100
Type of liner	Black polyethylene (10 mil)
Date(s) of installation	1967, 1968, 1971, 1973
Depth of waste	10 ft
Type of waste	Olive processing
Availability of liner specs.	Available from manufacturer, contact Bob Parodi
Availability of construction plans for ponds	Available, contact California Regional Water Quality Control Board

SITE	WESTERN FARM SERVICE
Owner(s)	Western Farm Service
Address	24778 Avenue 13 Madera, California 93637 (209) 674-6741
Contact	George Stink
Type of liner	Double liner- Hypalon®(30 mil) and PVC (10 mil)
Date of installation	September/October 1976
Depth of waste	17 ft
Type of waste	Fertilizer waste
Availability of liner specs.	Available, contact Burke Industries
Availability of construction plans for site	Available, contact George Stink

SITE	U.S. BORAX AT BORON, CALIFORNIA
Owner(s)	U.S. Borax and Chemicals
Address	3075 Wilshire Blvd. Los Angeles, California 90010 (213) 381-5811 x 2131
Contact	T. Cromwell Ralph Brown
Type of liner	Tertiary clays (several ponds, various thicknesses of clay)
Date of installation	October 1975, December 1976
Depth of ponds	20 ft

Type of waste	Industrial slurry, underflow from thickeners of borax production
Availability of liner specs.	Available, contact T. Cromwell
Availability of construction plans for site	Available, contact T. Cromwell
SITE	VALLEY NITROGEN PRODUCTS, HELM PLANT
Address	12688 South Colorado Avenue Helm, California 93627
Owner(s)	Valley Nitrogen Products Co-op, Inc.
Address	1221 Van Ness Avenue Fresno, California 93717 (209) 486-0100
Contact	Wade Reynolds
Type of liner	PVC
Date of installation	Summer 1976
Depth of waste	One pond is 6 ft, the other is 2 ft
Type of waste	Processed waste from fertilizer plant
Availability of liner specs.	Available, contact Wade Reynolds
Availability of construction plans for ponds	Available, contact Wade Reynolds

Nevada

SITE	Foote Mineral Company Site
Owner(s)	U.S. Government (own land)
Operator(s)	Foote Mineral Company (lease land)
Address	General Delivery Silver Peake, Nevada 89047 (702) 937-2222
Contact	Tom Cooper
Type of liner	Asphalt membrane on asphalt concrete
Date of installation	1970-1971
Depth of waste	Maximum of 15 ft
Type of waste	Lithium brine
Availability of liner specs.	Available, contact Tom Cooper
Availability of construction plans for pond	Available, contact Tom Cooper

REGION 10

Alaska

SITE	TESORO ALASKAN PETROLEUM CORP. SITE
Owner(s)	Tesoro Alaskan Petroleum Corp.
Address	Nikiski, Alaska (907) 776-8191
Type of liner	Asphalt and polypropylene fiber mat
Date of installation	November 1969
Type of waste	Oil refinery wastewater

Idaho

SITE	WES-CON, INC., TITAN SITE
Owner(s)	Wes-Con, Inc. P.O. Box 564 Twin Falls, Idaho 83301 (208) 734-7711
Contact	Gene Rinebold
Type of liner	Concrete
Date of installation	1964
Depth of site	170 ft
Type of waste	Miscellaneous hazardous waste
Availability of liner specs.	Not available
Availability of construction plans for site	Not available
Additional notes	Chemicals contained in disused silos

Oregon

SITE	OREGON POLLUTION CONTROL CENTER
Address	Star Route Arlington, Oregon 97812
Owner(s)	Chem-Nuclear Systems, Inc.
Address	P.O. Box 1269 Portland, Oregon 97207 (503) 454-2777, (503) 223-1912
Contact	Patrick H. Wicks
Type of liner	Asphalt and gravel composite (2-3 in.) (two trenches)
Date of installation	March/April 1976
Depth of trench	25-30 ft
Type of waste	Miscellaneous hazardous waste
Availability of liner specs.	Contact Patrick H. Wicks
Availability of construction plans for trenches	Contact Patrick H. Wick
Additional notes	Company also has two ponds lined with fiber reinforced PVC (30 mil, and ? mil), installed June 1976, October 1976

SITE	SECONDARY AERATION STABILIZATION BASIN
Owner(s)	Weyerhaeuser Company
Address	P.O. Box 75 Springfield, Oregon 97477 (503) 746-2511
Contact	Wayne Nay
Type of liner	Goodyear vinyl film AV-2537 (10 mil) + clay underneath (18 in.)
Date of installation	1965
Depth of basin	12 ft
Type of waste	Pulp and paper board wastes

Availability of liner specs.	Available, contact Wayne Nay
Availability of construction plans for basin	Available, contact Wayne Nay

Washington

SITE	BOISE CASCADE, VANCOUVER PAPER GROUP
Owner(s)	Boise Cascade, Vancouver Paper Group
Address	907 West 7th Street Vancouver, Washington 98666 (206) 693-2567
Contact	Rick Webber
Type of liner	Hypalon®
Date of installation	1976
Depth of waste	21 ft
Type of waste	Aerated pulp mill wastewater
Availability of liner specs.	Available, contact Rick Webber
Availability of construction plans for pond	Available, contact Rick Webber

SECTION 5

METHODS OF EXCAVATING A FILL TO REMOVE A PORTION OF LINER

The excavation of a sanitary landfill is not a simple matter and must include consideration of many factors unique to each fill, for example:

(a) Density - The density of solid waste in a landfill is extremely variable and depends both on the composition of the waste and degree of compaction achieved. The density may be as great as 1,500 lbs/yd^3, though average values of 800 to 1,000 lb/yd3 are achieved by moderate compaction (Brunner and Keller, 1972). Also, because different wastes decompose at differing rates, there will be variable densities recorded throughout the fill, as daily loads of waste will not have identical composition. Density influences both the rate at which the fill settles, and the bearing capacity of the completed fill.

(b) Settlement - As the fill is constructed, it will settle as a result of decomposition, daily addition of waste, and settling of fine cover material into voids between solid waste matter. Decomposition of the waste is the prime factor in settling and is accelerated by high amounts of water in the fill. Settlement also depends on the composition of the wastes, their degree of compaction and the volume ratio of daily cover to waste material (Brunner and Keller, 1972). A diagram of a sanitary landfill is given in Figure 1.

(c) Bearing capacity - The bearing capacity or integrity of a completed cell is a measure of its ability to support foundations (and heavy equipment). Sowers (1968) reported that the bearing capacity of a completed sanitary landfill was between 500-800 lb/ft^2, though it must be emphasized that this range of values is not predictable.

(d) Decomposition - Most of the materials in a sanitary landfill will decompose though at different rates. As mentioned above, the density of a given fill will vary in spots depending on the decomposition rates of the wastes contained therein. As organic material decomposes under anaerobic conditions prevailing at the base of the site, highly corrosive organic acids are formed, and the explosive and toxic gases, methane and hydrogen sulfide are also produced.

Decomposing landfilled wastes can be and have been successfully excavated for construction purposes. This type of excavation is both expensive and hazardous. It must be emphasized that any workmen involved in such efforts should wear protective clothing and gas masks, and that no open

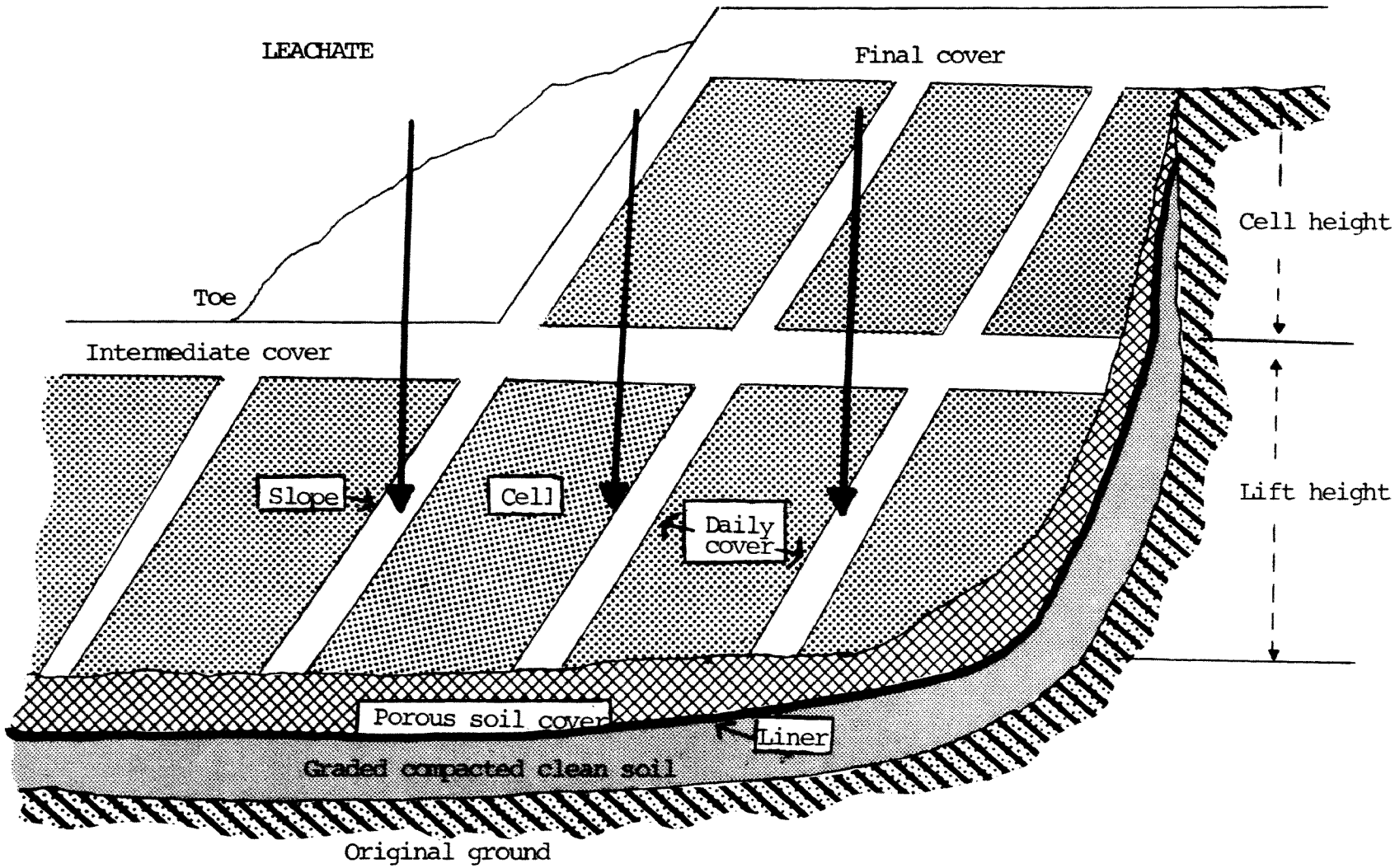

Figure 1. A lined sanitary landfill

flames should be permitted, so as to prevent explosion of the methane generated by the decomposing wastes.

To retrieve a small portion of liner from a fill for subsequent laboratory testing, it is necessary to excavate either a narrow trench, or limited area vertical shaft large enough to allow one man freedom of movement at the base. The excavation would be conducted by machinery to within 6 in. to 12 in. of the liner, while the final liner cover would most safely be removed from the liner by hand. The workman in the trench would manually remove a portion of liner (24 in. x 24 in.), and then patch the hole before ascending to the surface. To determine the most efficient methods of excavation to within inches of the liner, the density, rate of settlement, decomposition and bearing capacity of the fill must be known. As mentioned above, these factors vary depending on the composition and management of each fill, and will even vary within a given fill.

Hence, it is not possible to recommend specific excavation equipment that may be generally applicable to all fills. Each site chosen by the Environmental Protection Agency should be considered a unique engineering problem. Given this qualification, it is possible to describe and compare the three possible methods suggested by the Agency in a very general manner only.

THE DRAGLINE

A dragline excavator is a crane unit with a drag bucket attached by cable to the boom. The lower end of the crane is pivoted from a turntable mounted on either caterpillar treads or wheels (see Figure 2). A hoist cable attached to the drag bucket passes over sheaves at the outer end of the boom, and is anchored to an operating drum in the superstructure. A drag cable from the bucket is attached to a second operating drum in the cab. A third drum may be added to increase the pulling action on the bucket. The bucket is loaded by scraping it along the top layer of soil toward the machine by means of the drag cable. The bucket is lifted by the hoist cable, and the boom is pivoted to above the dumping point. Release of the drag cable will tilt, and hence discharge the bucket. The dragline operates below and beyond the end of the boom. Working dimensions of the dragline for various bucket sizes are summarized in Table 1.

As can be seen from Table 1, the maximum digging depth for a dragline is approximately equal to half the length of the boom, while the digging reach is slightly greater than the length of the boom. The dragline has great flexibility, but is difficult to spot accurately in both the scraping and dumping positions. The digging force of the dragline is less than that of a shovel of the same power, though the force may be improved by attaching the drag chain hitch to a higher point on the bucket. If heavier counterweights and larger crawlers are used to improve the stability of the machine, then for shorter boom lengths, the capacity of the bucket may be larger than the shovel-dipper rating of the machine.

Drag buckets may be of light, medium or heavy weight depending on the type of material to be excavated. Light weight buckets are used for loose

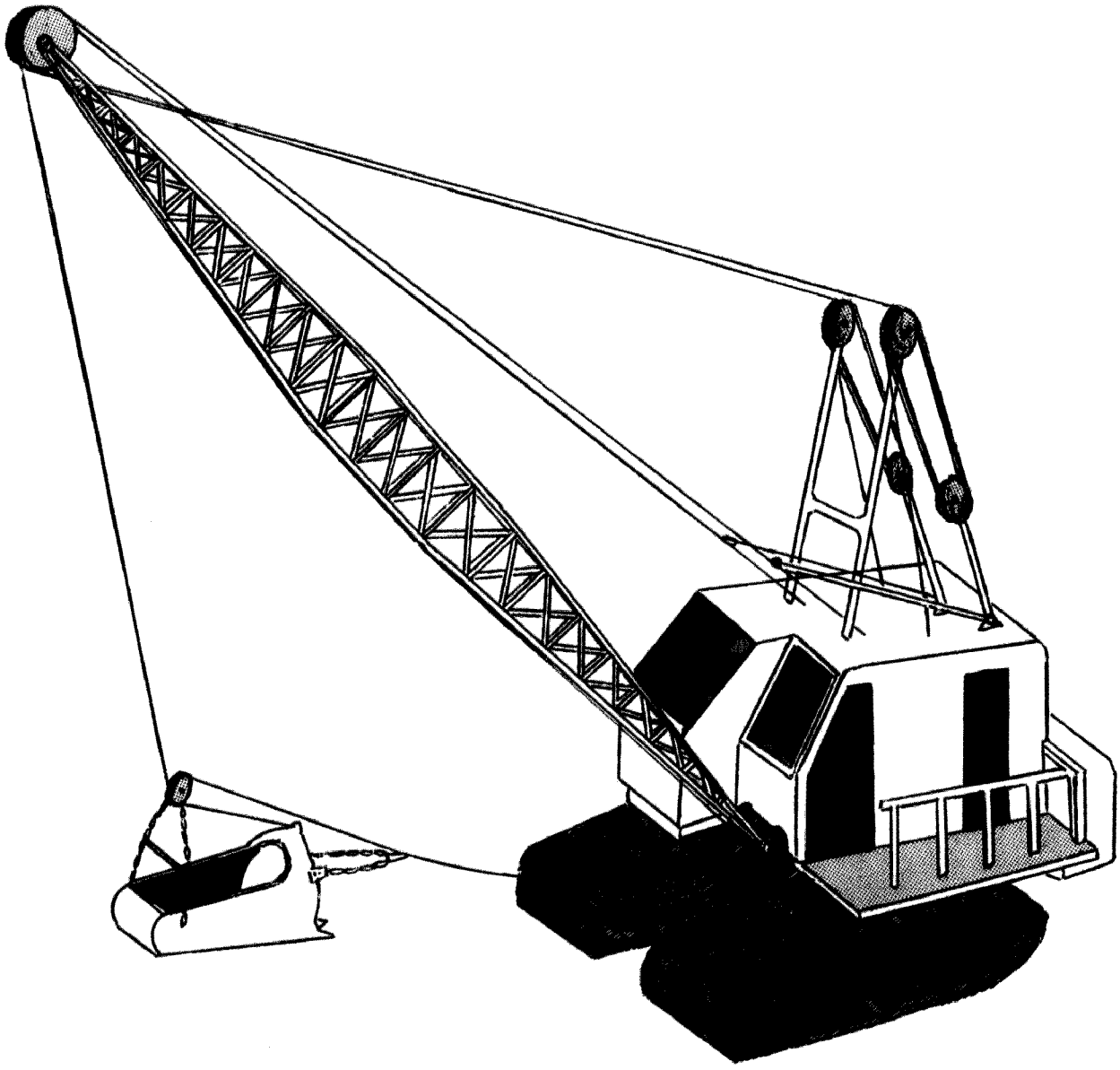

Figure 2. A dragline

TABLE 1

TYPICAL DRAGLINE EXCAVATOR DIMENSIONS
(Day, 1973)

Item	Bucket size in cubic yards (CY)				
	3/4	1	1 1/4	1 3/4	2
Dumping radius, ft	30	35	36	45	53
Dumping height, ft	17	17	17	25	28
Maximum digging depth, ft	12	16	19	24	30
Digging reach, ft	40	45	46	57	68
Boom length, ft	35	40	40	50	60
Bucket length, ft	11.5	14.67	11.83	13.08	14

Note that these values apply to operation of the excavator with its boom at a 40° angle to the horizon.

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clay soil or granular material; heavy duty buckets with reinforced metal plates are used to excavate broken rock or other abrasive material; while medium weight buckets are used for clays, compacted sands and gravels, or any small grained material.

Uses of the dragline are summarized in Table 2. The dragline is considered most ideally suited to loose bulk excavation (Carson, 1961). On a large landfill , a dragline is rated as excellent for excavating large areas of loosely compacted soil for cover material (Brunner and Keller, 1972). It may be used to spread cover material, but is only fair in performance. The dragline is not considered suitable for spreading or compacting solid waste.

Figure 3 shows the maximum practical digging depths for various lengths of boom. As can be seen from the diagram, the maximum digging angle at the landfill is about 45° using a dragline excavator. It is obvious that for digging a trench of any depth, a very wide area must be excavated. Given the performance limitations of the dragline excavator, and the variable and often high density of material within the fill, it does not appear that the dragline is a suitable piece of equipment for excavating a narrow but possibly deep shaft in a solid waste fill.

Table 3 below gives the theoretical hourly production in cubic yards (CY) for a dragline operating in different types of soil with variously sized buckets. The figures in parenthesis refer to the optimum depth in feet to which the excavation may be cut in that soil for the given size bucket. These figures assume 83% job efficiency, 100% operator efficiency, 90° swing of boom and 50 minute hours. The hauling units are considered to be of correct sizing for the excavation conditions, but no allowance has been made for difficult digging or loading conditions (Godfrey, 1975). Actual hourly pro-

TABLE 2
SEVERAL COMPARATIVE PERFORMANCE CHARACTERISTICS OF THE DRAGLINE AND THE BACKHOE

Characteristic	Dragline	Backhoe
Flexibility	Greater reach and dumping height for same size excavator, reach may be extended by using a longer boom.	Reach and dumping height dimensions approximately 50% less than a dragline of same size, but better control of width and depth of trench, especially digging non-homogeneous material.
Depth of operation	Depth approximately 50% of boom length- up to maximum of 30 ft, in practice optimum depth for digging in landfill probably less than 14 ft. Scraping rather than digging action, not considered ideal for vertical excavation, digging force may be improved by attaching drag chain hitch to a higher point on bucket.	More powerful digging action than dragline, crane mounted units operate from 12 to just over 30 ft deep, largest Gradall will dig 25 ft straight down. Optimum depth of 6-14 ft for hard, sticky material.
Stability	Safe load capacity is 65% of tipping load- extra stability by using 36 in. tracks rather than 30 in, also may extend tracks outward at 90° to increase stability.	Basic feature of most backhoes are outrigger stabilizing feet at 90°to trench line, feet may be retracted as hoe moves backward.
Uses	Digging of loose bulk material- including dry sands and gravels, loose and wet clays and silts, soil completely saturated and below water surface, e.g. sand and gravel pit production, strip mining, dredging, irrigation and drainage chanels.	Most useful for excavation of hard rock or consolidated material, may remove sections of hard rock with or without blasting. Hydraulic hoes and the Gradall may be combined with front end loader or dozer blade, can then backfill and grade own trenches. Especially used for trenching

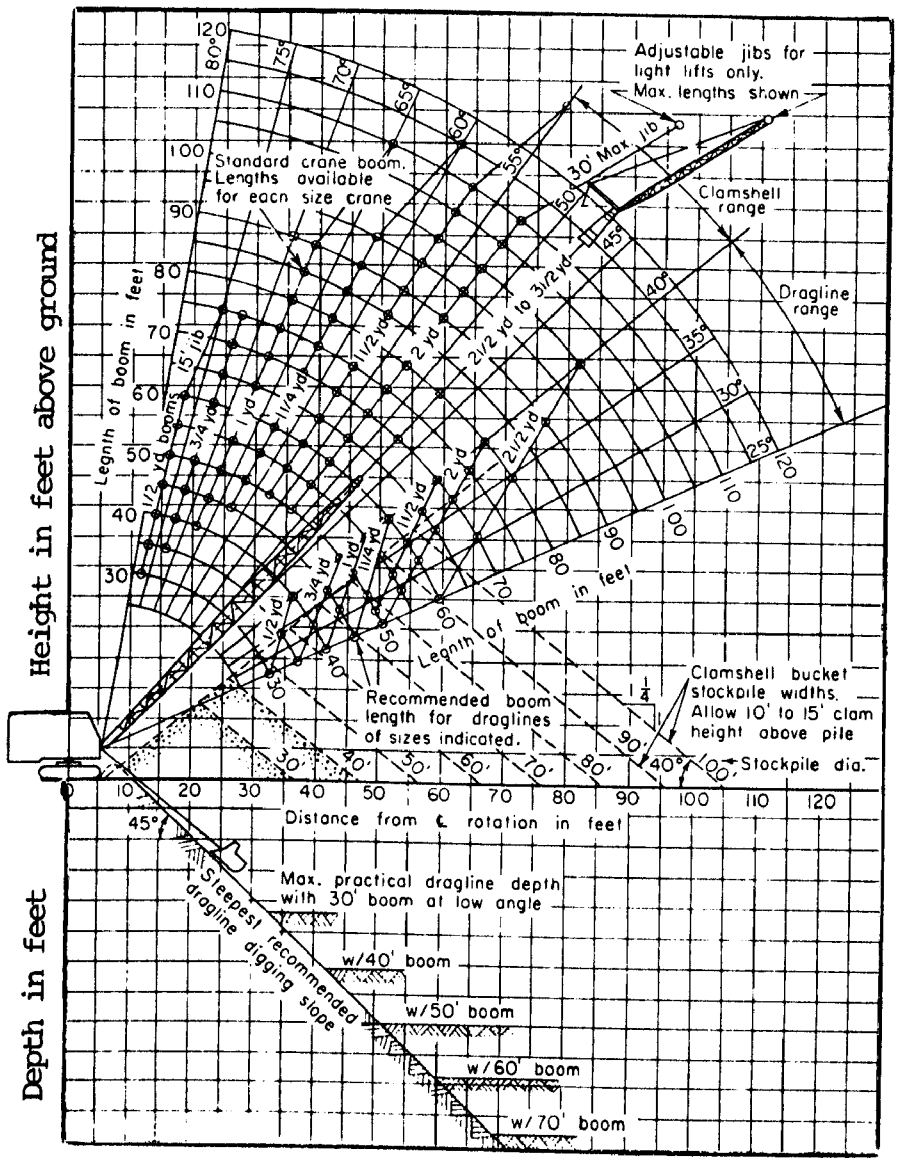

Figure 3. Typical working ranges for cranes and draglines

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duction rates are probably about 50% of these theoretical values. As can be seen from Table 3, optimum depths for the given soils are less than 14 ft. The cost figures calculated for use of the dragline are based on much lower hourly rates of production (see below).

TABLE 3

THEORETICAL HOURLY PRODUCTION OF A DRAGLINE EXCAVATOR
(Godfrey, 1975)

Type of soil	Bucket size (CY)						
	1	1 1/2	2	2 1/2	3	3 1/2	4
Moist loam, sandy clay	130 (6.6)	180 (7.4)	220 (8.0)	250 (8.5)	290 (9.0)	325 (9.5)	385 (10.0)
Sand and gravel	130 (6.6)	175 (7.4)	210 (8.0)	245 (8.5)	280 (9.0)	315 (9.5)	375 (10.0)
Common earth	110 (8.0)	160 (9.0)	190 (9.9)	220 (10.5)	250 (11.0)	280 (11.5)	310 (13.0)
Clay, hard dense	90 (9.3)	130 (10.7)	160 (11.8)	190 (12.3)	225 (12.8)	250 (13.3)	280 (12.0)

From Means Building Construction Cost Data, 1976 edited by R.S. Godfrey. Copyright ©1975 by R.S.Means Co., Inc. Used with permission of R.S. Means Co., Inc.

Cost of Dragline Operation

The following costs are based upon Means cost catalogue (Godfrey, 1975). These figures are average values for 30 major cities of the United States; actual costs may be more or less depending on location, availability of equipment, labor efficiency, local union restrictions, weather, season of the year and any of a number of other variables. Labor rates are usually given as the billing rate which includes fringe benefits, insurance, taxes and contractor's overhead and profit. Equipment costs include equipment, rental and operating costs. Where the equipment costs include payment of the operator(s) this is so indicated.

The shortest period of time for which men and machinery may be engaged for the excavation is considered to be an eight hour work day. Hence, the minimum cost for an excavation which may take less than eight hours is still the cost of renting the equipment for one day plus a day's wages for the operator(s). This figure is quoted even if the digging of one hole takes only minutes. It might be possible to hire men and machinery for periods of less than a day, especially if equipment is already available at the fill. These figures are not given. If the time of excavation for retrieving one sample

at a particular depth is very short, then obviously several samples can be taken. If the time of excavation is greater than eight hours, then only one sample is retrieved in order to minimize costs.

Once the minimum number of days required to complete the excavation was calculated, an additional $200/day was added to cover the expenses of a consultant expert to remove and patch the liner. This figure was based on discussions with manufacturers of lining materials. An additional one-time cost of $200 was included to cover rental of safety equipment, hand digging tools, geographical variations, and increase in wages and/or equipment hire since the original figures were published. It was decided not to use a standard index to upgrade costs for inflation for several reasons: in some areas labor costs have remained steady or even decreased over the past few years; rental costs may not have risen as much as the standardized inflation factor would suggest, because of competition between sub-contractors in a particular locale. Also, it must be remembered that the prices quoted from Godfrey are averages for the country, and will originally have been both lower and higher than the given values.

Godfrey (1975) recommends a 5 to 20% contingency mark-up to allow for unforseen construction difficulties. As there are so many unforseen problems which might arise when retrieving a portion of liner from a solid waste landfill, it was decided to use the 20% contingency factor.

Calculations:

For a 3/4 CY bucket,
Daily output = 280 CY
Equipment cost = $0.58/CY
Hence, equipment cost = $0.58 x 280/day
= $163/day (rounded up to nearest $)
Wages for one equipment operator (med.) = $110/day
Wages for one building laborer = $85.20/day
Total wages = $195.20/day

Therefore,
minimum cost for labor and equipment = $358/day (to nearest dollar)

According to Day (1973), daily rate for rental is usually 1/3 of weekly rate. Therefore, weekly rental of equipment costs the daily rate x 3, i.e. $489/week

Basic weekly cost = $1,465
(equipment + labor)

For a 1 1/2 CY bucket,
Daily output = 520 CY
Equipment cost = $0.50/CY
Hence, equipment cost = $0.50 x 520/day
= $260

Wages for two operators as 3/4 bucket = $195.20

Therefore,
minimum cost for labor and equipment = $455/day (to nearest $)

TABLE 4

MINIMUM NUMBER OF DAYS REQUIRED FOR 3/4 CY BUCKET,
90° SWING, RATING OF 35 CY/HR

Depth dug (ft)	Boom length (ft)	Vol. of excav. (CY)	Approx. time for one excav. (hrs)	Minimum no. of days
10	30	9.3	0.26	1
15	30	31.3	0.90	1
20	30	74.1	2.12	1
30	40	250.0	7.14	1
40	50	593.0	16.93	3
50	60	1188.0	33.93	5

Note that the volume of excavation is an approximate figure based on the solid geometry of the excavation by the dragline. Also note that for depths of excavation less than 20 ft, it is possible to take several samples in one day. For depths of 1 to 5 ft plus, it is more economical to employ hand labor.

TABLE 5

MINIMUM COSTS OF DRAGLINE OPERATION
3/4 CY BUCKET, 90° SWING, RATING OF 35 CY/HR

Depth (ft)	Cost of labor + equipment ($'s)	Costs + $400 as described above ($'s)	Costs + 20% contingency ($'s)
10	358	758	910
15	358	758	910
20	358	758	910
30	358	758	910
40	358x3 = 1074	1474	1770
50	1465*	1865	2238

* Note that weekly rate is used here.

Note that the costs above do not include scaffolding if needed, nor do they include the cost of filling the excavation. Since there is a possibility that a shallow excavation will maintain its integrity, these figures are not included in Table 5. Costs of scaffolding if required are found in Table 8 below. Since the dragline cannot be used to backfill any excavation in the solid waste, a separate table is given for daily hire of dozer to backfill (see Table 9).

TABLE 6

MINIMUM NUMBER OF DAYS REQUIRED FOR A 1 1/2 CY BUCKET
90° SWING, RATING OF 65 CY/HR

Depth dug (ft)	Boom length (ft)	Vol. of excav. (CY)	Approx. time for one excav. (hrs)	Minimum no. of days
10	30	9.3	0.14	1
15	30	31.3	0.48	1
20	30	74.1	1.14	1
30	40	250.0	3.85	1
40	50	593.0	9.12	2
50	60	1188.0	18.28	3

TABLE 7

MINIMUM COSTS OF DRAGLINE OPERATION
1 1/2 CY BUCKET, 90° SWING, RATING OF 65 CY/HR

Depth (ft)	Cost of labor + equipment ($'s)	Costs + $400 as described above ($'s)	Costs + 20% contingency ($'s)
10	455	855	1026
15	455	855	1026
20	455	855	1026
30	455	855	1026
40	455x2 = 910	1310	1572
50	455x3 = 1365	1765	2118

As can be seen from comparing Tables 5 and 7, nominally it is cheaper to rent the smaller capacity machine for depths of less than 30 ft. Actually, with the larger machine at the lower depths, it is possible to dig approximately twice as many samples per day. Of course, if men and machinery can be hired on an hourly basis, then the larger capacity machine becomes more economical.

TABLE 8

OPTIONAL COST OF SCAFFOLDING
(Godfrey, 1975)

Depth of excav. (ft)	Cost/ft2 ($'s)	Cost of scaffolding ($'s)
10	2.55	255
15	3.50	787
20	3.85	1540
30	"	3465
40	"	6160
50	"	9625

The scaffolding is wood solid sheeting, without piles, but including bracing, pull and salvage valve.

TABLE 9

DAILY RENTAL OF DIESEL TRACTOR, DOZER, CRAWLER
(Godfrey, 1975)

Power (HP)	Rental* ($'s)
65	240
105	275
140	350
180	400
270	550
385	770

*includes operator

Tables 8 and 9 from Means Building Construction Cost Data, 1976 edited by R.S. Godfrey. Copyright ©1975 by R.S. Means Co., Inc. Data used with permission.

There is every possibility that there would be a dozer available at the landfill site. It may be therefore possible to hire dozer and operator for hourly periods as required.

Summary

The dragline form of excavation would remove a larger area of the fill than really required. For depths of less than 10 ft, it would be more economical to employ hand labor. For depths requiring wooden shoring to maintain the integrity of the steep slope of the cut, the costs become unreasonable. It would also be necessary to rent a dozer to backfill the excavation.

THE BACKHOE

The backhoe or pull shovel is considered the most versatile piece of equipment used for digging trenches. The backhoe unit may be mounted on either a crane-type or tractor equipment and supported on wheels or crawler tracks. The hoe has a boom, and a dipper stick with the hoe dipper attached to the outer end. It may be controlled by either cables or hydraulic cylinders. Figure 4 shows the comparative functional design elements of the backhoe and the dragline.

Like the dragline, the backhoe operates by pulling its load toward the source of power. Unlike the dragline, it is easy to position and control the bucket, and hence control the depth and width of the trench more precisely (Carson, 1961). Basic characteristics of the backhoe and the dragline are compared in Table 2.

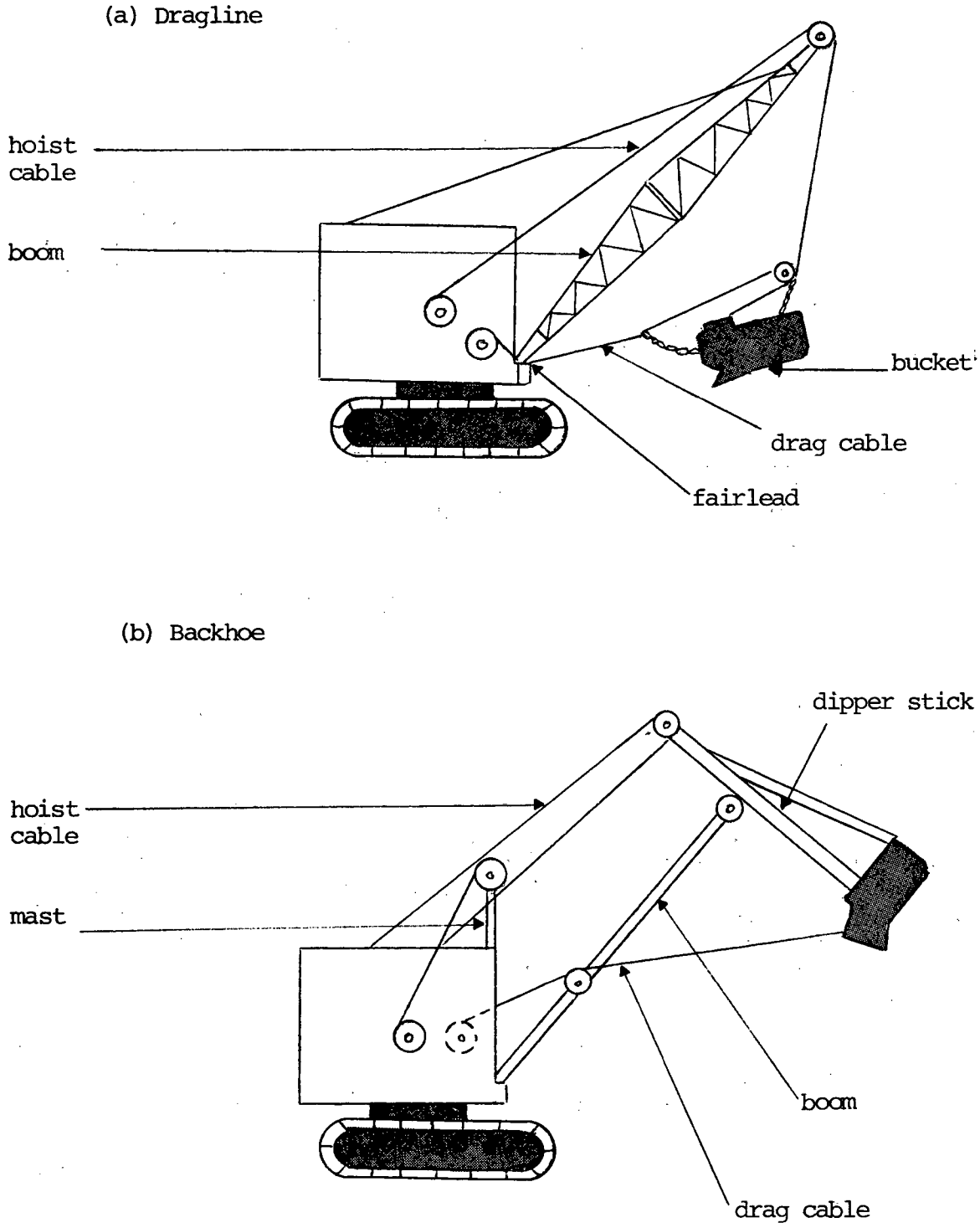

Figure 4. Comparative functional design elements of the dragline and the backhoe

From Standard Handbook for Civil Engineering by F.S. Merritt. Copyright © 1971 by McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.

The boom swings both horizontally and vertically from the support equipment, while the dipper stick pivots about the outer end of the boom in the vertical plane only. The dipper bucket may be pivoted for digging. The bucket is emptied by raising the boom to clear the trench, pivoting the boom horizontally by rotating the turntable, and then opening the bucket. Stabilizing feet at 90° to the body of the equipment may be retracted as the hoe moves backward.

The hoe dipper has a cutting tooth and side-cutters of variable size. The capacity of bucket and size of side-cutters are chosen depending on the type of material to be excavated. A narrow bucket with minimum flaring side-cutters is preferred for highly compacted and non-homogenous digging such as might be expected in a sanitary landfill. The narrower bucket exerts a greater digging force per inch on contact with the soil (Carson, 1961). If the trench required must be wider than the bucket, then two short parallel cuts could be made in the fill.

Hydraulic controls are less rugged than the cable-operated mechanism, but are more precise (Day, 1973). The hydraulic backhoe often has a front-end loader or bulldozer attachment so that the machine can backfill and grade its own trenches.

The Gradall is a type of hydraulic backhoe with an extensible boom that will permit excavation, backfill and grading. It is available both on a crawler mounting and rubber tired truck chassis. The boom is designed in several sections which can be extended up to 100 ft if required, or retracted for close work. The front digging edge of the Gradall bucket may be turned at a 45° angle to the backhoe's center line, and hence can slope the trench sides to any angle depending on the position of the equipment.

Figure 5 shows the range of depth, reach, and dumping height for the more commonly available size of hoe. The largest backhoes will dig to a depth of 30 ft. The depth achieved can be extended by attaching long arms to one piece booms, or by adjusting the foreboom angle on two piece booms (Anon, 1976). The attachment of a clamshell bucket rather than the standard dipper bucket will also extend the depth of a given backhoe. Side digging can be eliminated by fitting a clam rotator between the clam and its extension (Anon, 1976). The clamshell bucket is shown in Figure 6 below.

A dipper tooth may be mounted to the bucket to make it easier to excavate very hard material. Also, the shorter the boom, the greater the digging action. A backhoe with a two-piece boom is useful in that the arm may be shortened at the landfill site if necessary, simply by changing the pin connection at the boom-forearm joint (Anon, 1976).

The backhoe can also be used to compact trench beds and steep slopes by bolting a sheepsfoot roller to the back of the dipper bucket. Some models may apparently be clamped directly onto the bucket in less than one minute (Anon, 1976).

Table 10 gives the theoretical hourly production of a hydraulic backhoe for a 15 ft deep cut in different types of soil for the given size of buck-

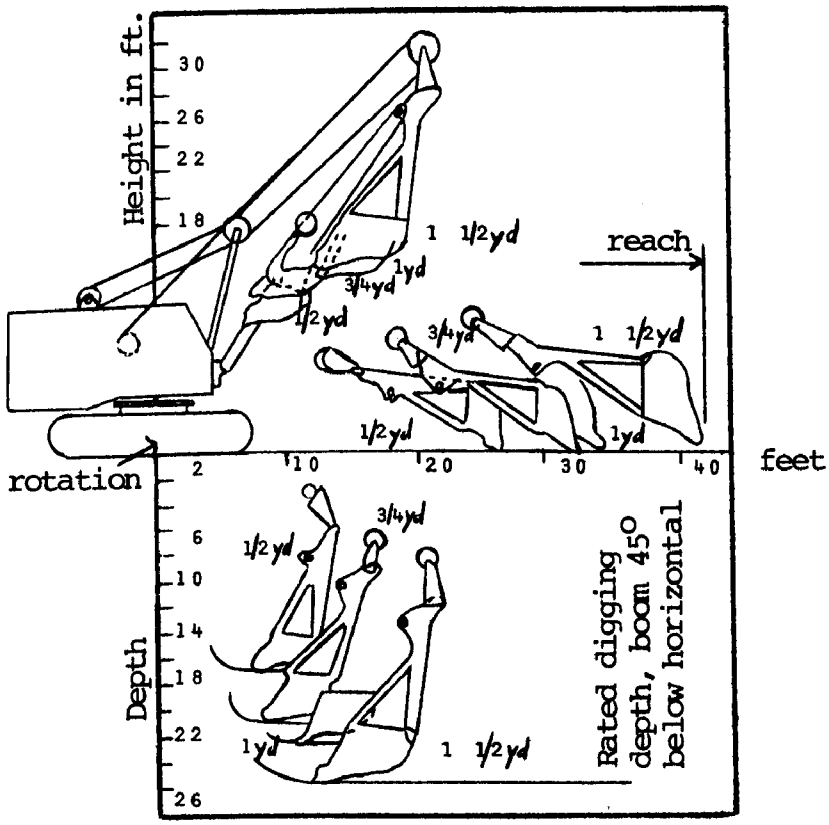

Figure 5. Hoe digging ranges

From Handbook of Heavy Construction by F.W. Stubbs. Copyright © 1959 by McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.

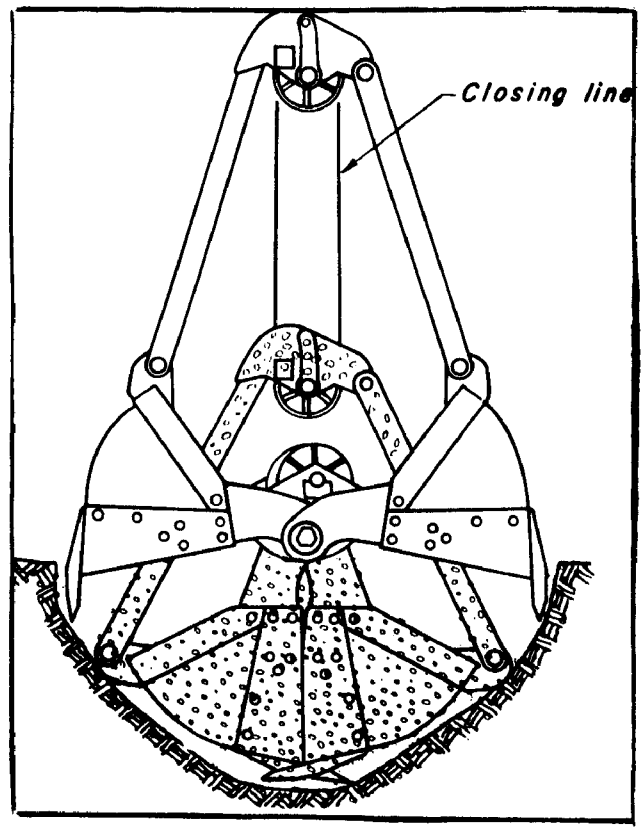

Figure 6. The clamshell bucket

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et. This table may be compared with Table 3 which presents equivalent data for the dragline. The same assumptions apply to both sets of figures.

TABLE 10

THEORETICAL HOURLY PRODUCTION OF A HYDRAULIC BACKHOE
(Godfrey, 1975)

Type of soil	Bucket size (CY)						
	1	1 1/2	2	2 1/2	3	3 1/2	4
Moist loam, sandy clay	85	125	175	220	275	330	380
Sand and gravel	80	120	160	205	260	310	365
Common earth	70	105	150	190	240	280	330
Clay, hard dense	65	100	130	170	210	255	300

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Cost of Backhoe Operation

All calculations below are for a diesel hydraulic backhoe, crawler mounted, maximum digging angle of 45°, and different hoe capacities as indicated. The previous discussion on costing for the dragline also applies to the backhoe.

TABLE 11

RENTAL FEES FOR THE BACKHOE
(Godfrey, 1975)

Capacity (CY)	Rent/day* ($'s)	Rent/week ($'s)	Rent/day + $400	Rent/day + 20% contingency
1	380	950	780	936
1 1/2	560	1300	960	1152
2	700	1500	1100	1320
3 1/2	1100	2900	1500	1800

* Daily rental includes operators, weekly rental does not

Raw data from Means Building Construction Cost Data, 1976 edited by R.S. Godfrey. Copyright ©1975 by R.S. Means Co., Inc. Used with permission of R.S. Means Co., Inc.

TABLE 12

MAXIMUM REACH AND DEPTH FOR VARIOUSLY SIZED HOES
(maximum digging angle of 45°)

Hoe size (CY)	Max. reach of boom (ft)	Max. depth excav. (ft)
1	35	22
1 1/2	42	25
2	49	30
3 1/2	70	45

TABLE 13

MINIMUM NUMBER OF DAYS FOR EXCAVATION USING A BACKHOE

Hoe size (CY)	Depth dug (ft)	Vol.*of excav. (CY)	Capacity (CY/hr)	Approx. time for one excav. (hrs)	Minimum no. of days
1	10	4.63	45	0.10	1
	15	15.60		0.35	1
	20	37.00		0.82	1
	22	49.29		1.10	1
1 1/2	10	4.63	60	0.08	1
	15	15.60		0.26	1
	20	37.00		0.62	1
	25	72.33		1.21	1
2	10	4.63	75	0.06	1
	15	15.60		0.21	1
	20	37.00		0.49	1
	25	72.33		0.96	1
	30	125.00		1.67	1
3 1/2	10	4.63	150	0.03	1
	15	15.60		0.10	1
	20	37.00		0.25	1
	30	125.00		0.83	1
	40	296.30		1.98	1

* The volume excavated is based upon the maximum digging angle of 45°, and the solid geometry of the trench dug at the given depths. Hence, it is only an approximation, and could have a very different value.

It is clear from examination of Table 13, that even for the smallest capacity hoe given, it takes less than an hour (and in some cases only minutes) to dig the required excavation. Hence, it is possible to take several samples/day, the number taken depending on depth of liner, size of hoe and time taken to move equipment to new sites at the fill. Once again, if a minimum number of samples are required, then if possible the equipment should be rented by the hour, or for half a day only.

If equipment is to be rented on a daily basis, then for intermediate depths (10-25 ft), it is cost effective to rent a machine with a lower capacity (45 or 60 CY/hr, hoe size of 1 or 1 1/2 CY).

For all samples as described above, the minimum cost becomes the daily cost plus $400 with 20% mark-up for contingencies. The $400 covers $200/day for the consultant expert to remove and patch the liner, and a one-time cost of $200 for rental of safety equipment, hand digging tools, inflation, geographical variations in cost, etc. The cost of scaffolding if needed would be less than that required when using a dragline (see Table 8) because the area of the excavation is much smaller with the backhoe. Rates for wooden scaffolding per square foot are given in Table 8. If the backhoe comes with a dozer attachment, it would not be necessary to rent a dozer to backfill.

Summary

For depths of 10 to 30 ft, a backhoe would be more efficient and more economical than the dragline. For shallower depths, manual digging is preferred. A backhoe with a dozer attachment eliminates the necessity of hiring additional equipment. The backhoe is not suitable for excavations much deeper than 35 ft.

CAISSON EXCAVATION

A caisson or pier foundation is a vertical shaft excavated either by hand or machine, lined with a box-like structure made of wood, concrete or steel and filled with concrete. The box-like structure used to support the shaft prior to pouring the concrete is termed a caisson.

The simplest shaft is dug manually in the open air at normal atmospheric pressure by a workman operating in an area of 4 ft minimum diameter. Equipment required includes a tripod on which to load the waste, a hoist apparatus to remove debris from the shaft, and possibly a pump.

A rotary drill rig is used to dig shafts from 20 to 100 ft. A drill shaft termed a Kelly bar is suspended from the outer end of a standard crawler, crane, or similar hoisting unit. At the lower end of the Kelly bar, a large horizontal gear on a horizontal supporting table (Kelly yoke) rotates the Kelly bar for drilling. The gear is driven by chain from a powered drum attached to the front of the control cabin. The boom raises and lowers the Kelly bar which has a bucket attached to the lower end.

The digging is actually done by the bucket which has a cutting edge similar to a post-hole augur. Soil enters the bottom of the bucket as it rot-

ates. As the bucket is withdrawn from the soil, the crane swings away from the hole and the hinged bucket is opened to dump its contents. There are several designs of bucket possible, but usually the maximum diameter of the bucket is 4 ft. The casing may be placed during or after excavation of the hole.

Such equipment can dig a 100 ft shaft, 6 to 7 ft in diameter in 12 hours and is most useful for cohesive soils where water is not a problem (Stubbs, 1959). This method of excavation is sometimes known as the dry process (see Figure 7).

Figure 8 shows a wet-process excavator. Here, a mud slurry is driven into the shaft to help prevent cave-in prior to insertion of the casing. During the entire drilling process the shaft remains full of slurry. The pressure of the slurry in the shaft should overbalance the hydrostatic pressure in the surrounding ground so that the active hydrostatic pressure in the shaft is directed radially outward against the walls. The slurry circulates back up the shaft between the drill and the caisson sides carrying loose cut material upwards. Water overflows into the sump and can be pumped back into the caisson.

The wet process would not be suitable for excavation of hazardous wastes as the circulating water would be impregnated with toxic, inflammable or explosive wastes, endangering all workers on the site.

The shaft may be lined in a number of ways depending on the nature of the soil excavated. Telescoping removable steel cylinders may be inserted in the hole as it is dug. These cylinders are typically 1/4 in. plate and 8 to 16 ft long. The largest diameter cylinder is first inserted in the pit extending approximately 1 ft above ground level to prevent water (leachate, rain, drainage) from seeping into the hole. The second cylinder inserted is about 2 in. less in diameter, and laps the outer end of the first. The space between the two cylinders may be pumped out and caulked. Each cylinder is pushed or driven into the shaft.

Alternatively, the telescoping caisson may be made of a series of concrete cylinders inserted in a similar fashion to the steel lining. The caisson may be inserted during or after excavation of the shaft and may be driven into the ground or sink under its own weight.

Pre-cast concrete cylinders with a cutting edge on the bottom cylinder may be forced into the earth by hammer or dead weight, and then dredged using a clamshell or orange peel bucket.

The "Chicago method" of lining a shaft refers to the placement of wooden lagging around the shaft in four to five foot sections. The lagging is made of boards 2 in. x 6 in. or 3 in. x 6 in. in dimensions, bevelled at the edges and grooved so as to hug the sides of the shaft. Horizontal steel rings hold the boards in place against the walls of the shaft rather like hoops holding together the staves of a barrel.

For building of a foundation, the casing may either be retracted slowly

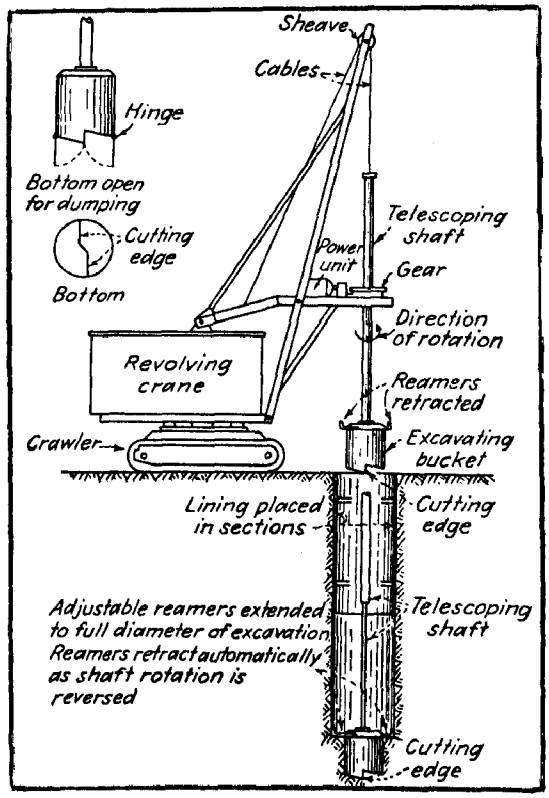

Figure 7. Caisson excavation - the dry process

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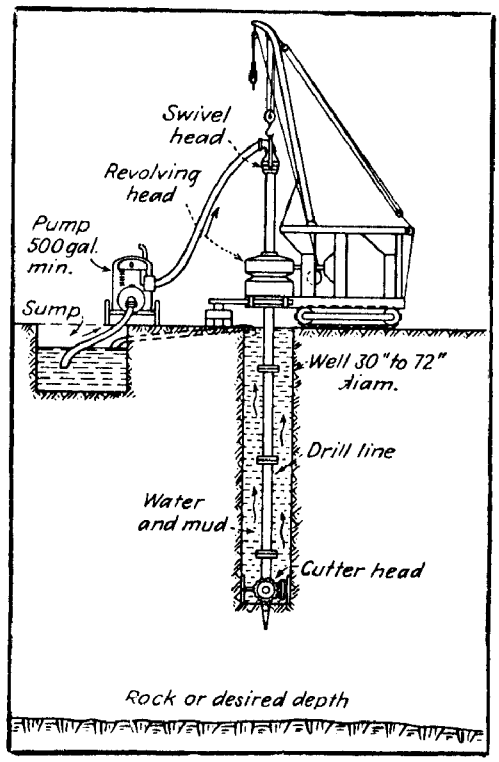

Figure 8. Caisson excavation - the wet process

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while the concrete is poured, or for an additional cost be left in place. When used to support a deep vertical shaft in a landfill, the caisson would be left in place until the expert had descended into the shaft, removed a portion of liner, patched the hole, and been hoisted to the surface. The shaft could be belled-out at the foot by manual excavation to enlarge the working area for the expert (see Figure 9).

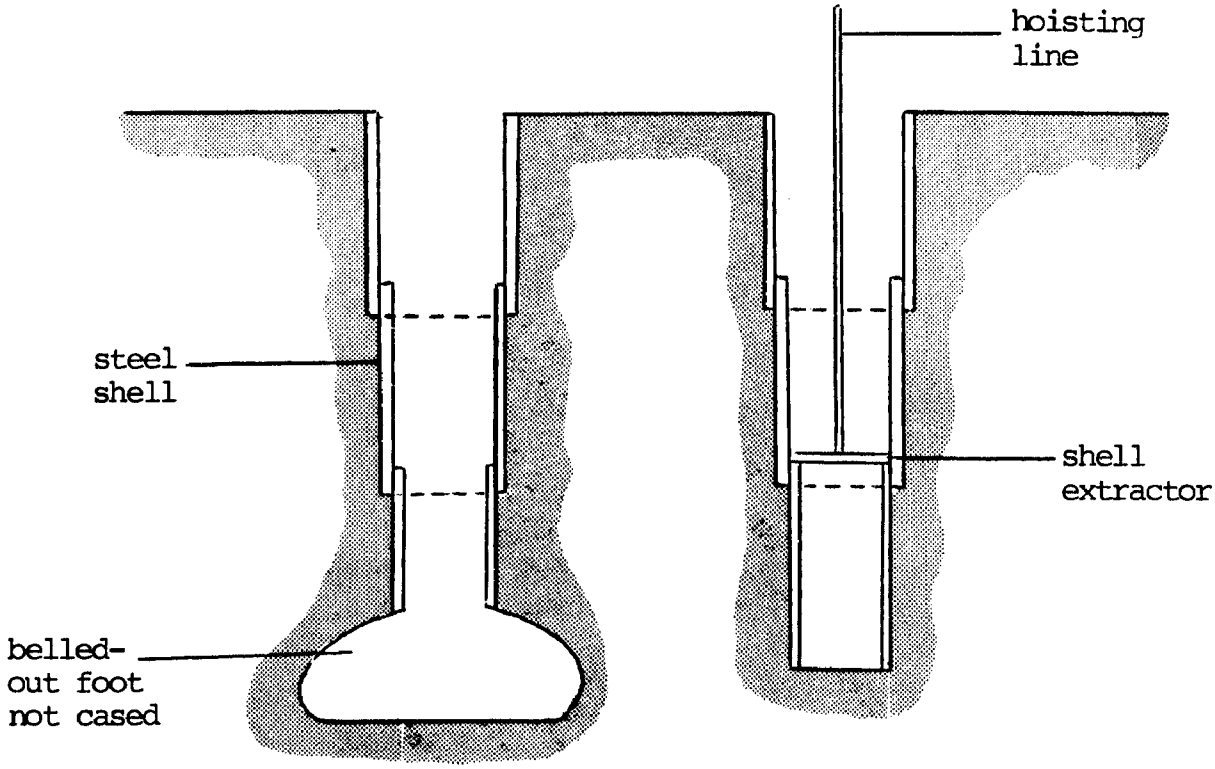

Figure 9. Straight and belled-out shafts for casing

Cost of Caisson Excavation

According to the 1976 Dodge Handbook, it costs a minimum lump sum of $3,047 to move in the drilling rig, set it up and move it out. This cost does not include drilling the hole, inserting the casing, removing the casing nor backfilling the shaft. Job costs given in the Dodge Handbook for caisson excavation include the cost of filling the shaft with concrete, i.e. the entire cost of building a pier foundation. No estimates were found for simply drilling the required size of shaft, inserting the caisson and then removing it after the liner sample(s) were taken.

It was decided that in order to give some idea of the relationship between cost, cross-sectional area and depth of shaft drilled, that the figures for building a concrete foundation, with removal of casing would be quoted. The cost of concrete per cubic yard varies depending on the type of reinforcement used. Given a range of about $35 to $60 per cubic yard, it is possible to remove the costs of the concrete (though not costs of pouring the concrete) from the figures given by Dodge (1975).

The costs given are therefore not accurate, but do indicate that the caisson method of excavation would be very expensive. These costs do not

include the additional $200/day previously mentioned for the services of an expert to remove and reseal the liner; nor the one-time cost of $200 to allow for inflation, geographical variation in cost, hire of safety equipment and hand digging tools, etc.; nor the 20% contingency mark-up.

TABLE 14

COST OF CAISSON OPERATION/LINEAR FOOT - CONCRETE POURED, CASING REMOVED
(Dodge Handbook, 1975)

Diameter	$ Cost/ft
48 in.	16.92
60	43.07

From the Dodge Manual for Building Construction Pricing and Scheduling. Copyright c McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.

The costs of filling the shaft with the excavated solid waste would also have to be added to these figures.

TABLE 15

AN INDICATION OF VARIATION IN COSTS FOR DRILLING A 48 IN. DIAMETER SHAFT TO VARIOUS DEPTHS, CONCRETE AT $35 to $60/CY*

Depth of shaft (ft)	Volume of shaft (CY)	Cost with concrete, casing removed ($'s)	Cost minus cost of concrete ($'s)
20	4.64	339	59 - 176
30	6.86	508	96 - 268
50	11.60	846	150 - 440
100	23.20	1692	300 - 880
150	34,80	2538	450 - 1320
200	46.40	3384	600 - 1760

* This range in cost was taken because the actual cost of the concrete was not indicated in the original figures, and this range is typical.

TABLE 16

AN INDICATION OF VARIATION IN COSTS FOR DRILLING A 60 IN. DIAMETER SHAFT TO VARIOUS DEPTHS, CONCRETE AT $35 to $60/CY*

Depth of shaft (ft)	Volume of shaft (CY)	Cost with concrete, casing removed ($'s)	Cost minus cost of concrete ($'s)
20	5.82	862	513 - 658
30	8.73	1295	771 - 989
50	14.55	2153	1280 - 1644
100	29.10	4307	2561 - 3288
150	43.65	6461	3842 - 4933
200	58.20	8614	5122 - 6577

* This range of cost was taken because the actual cost of the concrete was not indicated in the original figures, and this range is typical.

Summary

The use of the dry method of caisson construction would probably be applicable to the excavation of a shaft in a sanitary landfill at depths greater than 30 ft. At intermediate depths, the backhoe would be the preferred type of equipment.

Though the use of a caisson is possible to depths much greater than 100 ft, in practice the cost becomes prohibitive at the greater depths. The 48 in. diameter shaft is much less expensive than the 60 in. diameter drilling, and is large enough to permit a man to operate at its foot. If more working space is required, the base of the shaft may be belled-out by manual digging.

SAFETY CONSIDERATIONS

As previously mentioned, excavation of a sanitary landfill should be considered as extremely hazardous. Possible hazards include:

* entering the excavated shaft or trench;
* caving or collapse of the excavation;
* fall-in from the top;
* "bad" air, toxic or explosive gases at the of the excavation.

Safety precautions should therefore be extremely stringent at all times. A safety harness and line should be worn on every descent, even for shallow excavations, so that an unconscious man may quickly be removed from the area. An air tank and mask should be strapped to the descending worker for ready use if required. An above-ground observer should be assigned the duty of constantly communicating with the below-ground worker; for very deep holes

they should be in wired contact. The no smoking rule should be operational at all times. For trenches of less than 20 ft in depth, the worker may descend by ladder, though hoisting equipment should still be on-hand for emergencies. For greater depths, a hand-operated windlass with a ratchet to prevent accidental release should be attached to a tripod above the shaft. Fresh air may be introduced to a deep, narrow excavation by means of an air hose. Water seepage may be controlled by use of a pump.

LINER SAMPLING

When the excavating equipment is close to the liner, the final cover should be excavated by hand to prevent wholesale ripping of the liner by the machinery. Before removing a sample, the expert should be aware of the nature of the material used, actual placement technique, the expected lifetime of the liner and its general specifications.

Once the sample has been taken, the liner must be replaced by techniques suitable for that particular type of material. For polymeric liners, for example, the proper adhesive should be used to join old liner to patch. The sampler should note the material coupons and their locations from installation drawings.

The actual sample analysis should note the volume swell, any change in modulus of elasticity, elongation and tensile strength, and any other physical changes. In addition, chemical changes as a function of time, material, plasticizer percentage in the case of plastics, and temperature should be noted. Hazardous material might accelerate the migration of plasticizer in the PVC lining, causing embrittlement and cracking. If the seam strength is declining, adhesive specialists need to be consulted to suggest solutions to the problem.

OTHER CONSIDERATIONS

It must be emphasized that prior to any excavation, an engineering consultant, familiar with the design and maintenance of that particular site, must be engaged to provide expert direction to the entire operation. Consultant fees for the engineer are not included in the above cost comparisons and are likely to be in the order of $200/day. One major problem requiring expert advice is likely to be locating the liner, given settlement of the fill over a number of years.

CONCLUSION

The three processes discussed are compared in Table 17. As can be seen from this Table, for intermediate depths of 5 to 30 ft, the backhoe is the least expensive of the three options. However, the backhoe is not technologically suitable for greater depths. Caisson excavation is suitable for exacavation of a deep shaft, but is very expensive.

TABLE 17

A COMPARISON OF THE THREE METHODS OF EXCAVATING

Item	Dragline	Backhoe	Caisson
Cost	* $1026/day includes labor & equipment, does not include backfilling nor scaffolding. Cost for 1 1/2 CY bucket.	*$1152/day includes labor, equipment and backfilling, does not include scaffolding. Cost for 1 1/2 CY bucket.	$3,047 rental alone, does not include cost of digging nor backfilling.
Depth of Operation	Up to 30 ft (14 ft optimum).	Up to 30 ft (6-14 ft optimum).	Depths in excess of 30 ft, not cost effective for shallower shafts.
Advantages	Might be available on-site.	Easy to position and control the bucket & hence control width & depth of trench. More powerful digging action than dragline. May be used to backfill & grade. Can excavate hard, compacted material.	Can be used for depths in excess of 30 ft. Designed to drill a narrow vertical shaft. Caisson provides safety.
Disadvantages	Not easy to spot bucket for scraping & dumping. Excavates large area. Cannot backfill or compact.	Cannot be used satisfactorily for excavations deeper than 30 ft.	Most expensive of the three, would not be used for depths less than 30 ft.

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APPENDICES

APPENDIX A. MANUFACTURERS, FABRICATORS, SUPPLIERS, AND INSTALLERS OF LINERS

1. Hodgman Division
   Plymouth Rubber Co. Inc.
   104 Revene Street
   Canton, MA 02021
   Contact: Charles Nees
   Kevin Doolin
   Phone: (617) 828-0220
   (212) 594- 0240

2. Unit Liner Company
   Box 789
   Shawnee, OK 74884
   Contact: J.A.Hendershot
   Phone: (405) 275-4600

3. Watersaver Company, Inc.
   3560 Wynkoop Street
   Denver, CO 80216
   Contact: C.J.Gerker
   W. Slifer
   Phone: (303) 623-4111

4. Goodyear Tire and Rubber Co.
   1210 Massillon Road
   Akron, OH 44306
   Contact: Duane Herchler
   Phone: (216) 794-4002

5. Carlisle Tire and Rubber Co.
   Carlisle, PA 17013
   Contact: Hugh C. Kenny
   Ray Jumper
   Phone: (717) 249-1000

6. Staff Industries, Inc.
   78 Dryden Road
   Upper Montclair, N.J. 07043
   Contact: Dr. Charles Staff
   Phone: (201) 744-5367

7. Fabrico Manufacturing Corp.
   1300 West Exchange Ave.
   Chicago, IL 60609
   Phone: (312) 254-4211

8. Burke Rubber Company
   2250 South 10th Street
   San Jose, CA 95112
   Phone: (408) 297-3500

9. Reeves Brothers, Inc.
   P.O. Box 431
   Rutherfordton, N.C. 28139
   Contact: Roger Hughes
   Phone: (803) 576-1210

10. Dow Chemical Co.
    Park 80 Plaza East
    Saddle Brook, N.J. 07662
    Contact: Robert Wood
    Phone: (201) 845-5000

11. B.F. Goodrich
500 South Main Street
Akron, OH 44318
Contact: F. Long
Phone: (216) 379-3565

12. E.I. DuPont de Nemours Co.
3707 Chevy Chase
Louisville, KY 40218
Contact: Gerry Fisher
Phone: (502) 459-8752

13. Dowell
Division of Dow Chemical Co.
140 Concord Street
Indiana, PA 15701
Contact: Thomas A. Sutton
Phone: (412) 837-8550

14. Key Enterprises
Odessa, TX
Contact: Kenneth Stewart
Phone: (915) 582-0101

15. St. Clair Rubber Co.
1765 Michigan Avenue
Marysville, MI 48040
Contact: Pat Keeting
Phone: (313) 364-7424 x219

16. Gulf States Asphalt Co.
610 Jefferson Street
Houston, TX 77002
Contact: John Saenz
Phone: (713) 651-1507

17. Misco United Supply Co.
257 N. Broadway
Wichita, KS 67202
Contact: John Owen
Phone: (316) 265-6641

18. Chemprene
Beacon, N.Y.
Contact: Mr. Spicer
Phone: (914) 831-2800

19. Plasti-Steel, Inc.
Vickers KSB and T Bldg.
Wichita, KS 67202
Phone: (316) 262-6361

20. Liberty Vinyl Corp.
3380 Edward Avenue
Santa Clara, CA 95050
Contact: Roy Lambert
Phone: (408) 249-1234

21. Revere Plastics, Inc.
Little Ferry, N.J.
Phone: (201) 641-0777

22. Hovater-Way Engineers, Inc.
1833 East 17th Street
Santa Ana, CA 92701
Phone: (714) 835-8124

23. Hartwell Company
740 Albert Avenue
Lakewood, N.J. 08701
Contact: Jack Hartwell
Phone: (201) 364-7509

24. American Colloid Company
5100 Suffield Court
Skokie, IL 60076
Contact: Mr. Grody
Phone: (312) 966-5720

APPENDIX B. U.S. ENVIRONMENTAL PROTECTION AGENCY REGIONAL OFFICES

Regional Offices	Address	Telephone Contact
Region I Maine, New Hampshire, Vermont, Conn., Mass., Rhode Island	Administrator John F. Kennedy Bldg. Boston, MA 02203	Head, Solid Waste Prgm. Air & Haz. Mtls. Div. (617) 223- 5186
Region II New York, New Jersey, Puerto Rico	Administrator 26 Federal Plaza New York, N.Y. 10007	Head, Solid Waste Mgmt. Branch, Environmental Programs Division (212) 264-2301
Region III Pa., Md., Va., W.Va., D.C., Del.	Administrator 6th & Walnut Streets Philadelphia, PA 19106	Solid Waste Mgmt. Rep. Air & Haz. Mtls. Div. (215) 597-8131
Region IV Ala., Miss., Ga., N.C., S.C., Tenn., Ky., Fla.	Administrator 345 Courtland St., N.E. Atlanta, Georgia 30308	Head, Solid Waste Mgmt. Section, Air & Haz. Mtls. Branch (404) 285-3454
Region V Minn., Wis., Ill., Ind., Ohio, Michigan	Administrator 230 South Dearborn St. Chicago, Illinois 60604	Chief, Solid Waste Air & Haz. Mtls. Div. (312) 353-5248
Region VI Tex., Arkansas, N.M., La., Oklahoma	Administrator 1201 Elm Street First International Bldg. Dallas, Texas 75201	Chief, Haz. Waste Mgmt. Sec. Air & Haz. Mtls. Div. (214) 749-1121
Region VII Kansas, Nebraska, Missouri, Iowa	Administrator 1735 Baltimore Ave. Kanasa City, MO 64108	Chief, Waste Mgmt. Sec. Air & Haz. Mtls. Div. (816) 374-3307
Region VIII Col., Utah, N.D., S.D., Montana, Wyoming	Administrator 1860 Lincoln Street Denver, Colorado 80203	Chief, Waste Mgmt. Air & Haz. Mtls. Div. (303) 327-2407
Region IX California, Arizona, Nevada, Hawaii	Administrator 100 California Street San Francisco, CA 94111	Head, Solid Waste Mgmt. Program, Air & Haz. Materials Div. (415) 556-4606

Regional Offices	Address	Telephone Contact
Region X Oregon, Washington, Idaho, Alaska	Administrator 1200 6th Avenue Seattle, WA 98108	Chief, Solid Waste Prgm. Air & Haz. Mtls. Div. (206) 399-1236

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16. ABSTRACT

This report lists sanitary landfills and chemical and hazardous waste disposal sites and holding ponds with some form of impermeable lining. Liners included are polyethylene, polyvinyl chloride, Hypalon R, ethylene propylene diene monomer, butyl rubber, conventional paving asphalt, hot sprayed asphalt, asphalt-sealed fabrics, and concrete. Sites lined with treated soils including compacted clay, are also included in the list. Most of the sanitary landfills identified with impermeable liners are of recent construction, a few are 5 years old or more.

A brief examination is also made of three possible methods for excavating a solid waste landfill to remove a small piece of liner for laboratory study. These methods are the use of the dragline, the backhoe, or the caisson. The methods are briefly described and compared as to suitability, and a preliminary cost comparison is given.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Linings, Hazardous materials, Disposal, Soils, Polymeric films	Sanitary landfill, Solid waste management, Chemical waste, Hazardous waste, Land disposal, Holding ponds, Treated soils, Impermeable linings	13B

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