Trip C-12

GROUNDWATER CONTAMINATION FROM A SANITARY LANDFILL: INVESTIGATIONS, REMEDIAL ACTION AND ENERGY RECOVERY AS A POSSIBLE SOLUTION

Kenneth Goldstein
Env/Water Resource Planner
Oneida County Planning and Environmental Management Council
Utica, New York

Purpose

The purpose of this field trip is to view the adverse impacts resulting from the improper disposal of solid and hazardous wastes. A tour of the Rome Sanitary Landfill will reveal the impacts on the environment resulting from hazardous waste landfill leachate. Leachate can be seen at the landfill and in nearby streams. The participants will be able to view the remedial measures being conducted at the site, including, the construction of a barrier cap, gas vents and monitoring wells. A discussion on the elements of the site investigation and remedial actions utilized will be conducted while touring the facility. Questions are encouraged! Later in the day the participants will tour the Oneida County Energy Recovery Facility in Rome, N.Y. This facility, which will not be operational at the time of the field trip, is one of Oneida County's solutions to the land burial of industrial and municipal solid waste. Although the facility will not be operational, all equipment will be on-line and will be reviewed.

INTRODUCTION

According to USEPA estimates (1979) over one million tons of municipal and industrial solid wastes is generated and disposed of daily. The disposal of these wastes is becoming an increasing problem. As new materials are developed and marketed yearly, the safe handling and disposing of them is an ever increasing dilemma.

Improper disposal of industrial and municipal wastes has led to numerous pollution problems. In the past, much attention has been focused upon the visible consequences of the dump, the destruction of natural resources and wildlife habitats, or the contamination of air and surface water. Only recently has much attention been focused on the seriousness of groundwater contamination resulting from improper landfilling.

Dealing with the problem of safely transporting and disposing of massive quantities of solid waste is a large task. This problem has received much attention at all levels of government within the last decade.

Solid waste and hazardous waste issues are a high priority for the Oneida County Department of Planning and Environmental Management Council (EMC). The EMC staff has devoted much time and effort to the problems and possible solutions to the solid waste problem in Oneida County. The Council has reviewed conditions at landfills in the County. Staff has reviewed both in-house and DEC files on selected landfills in the County. At times, staff conducted site investigations, and provided technical assistance to DOH, DEC, and local bodies of government.

This report presents the results of a detailed hydrogeologic and water quality investigation of a sanitary landfill in Rome, New York.

In July of 1979, Dunn Geoscience Corp. entered into a contract with the NYS Dept. of Environmental Conservation (DEC) Division of Solid Waste, to determine what impacts, if any, selected municipal landfills across New York State were having on groundwater. This is a report on the elements of a site investigation and remedial actions utilized at the Rome SLF. This hydrogeologic investigation is typical of investigations being carried out at numerous selected landfills located throughout New York State.

Site Description

The landfill is located on Tannery Road just north of Route 49 (figure 1) in the City of Rome, Oneida County, N.Y. This landfill is located within a swampy area contained within a region known as the Rome Sand Plains. Several sand dunes which are characteristic of the topography of the Sand Plains are located at the landfill. The land surrounding the landfill is a rural residential area.

Elements of a Site Investigation

Investigative techniques utilized in this hydrogeologic study are typical of investigations conducted at landfill sites throughout New York State. These work items include the following:

A) Background Investigation: Review of file data and published information;
B) Non-Drilling Activities: Initial site inspection, existing on-site and off-site sampling, geophysical surveys, and remote sensing;
C) Drilling/Sampling: Monitor well installation, soil borings, water level measurements, and groundwater sample collection and analysis;
D) Site mapping;
E) Interpretation and evaluation of data;
F) Conclusions and report preparation; and
G) Site remedial actions.

I. Review of Site File Data and Published Information

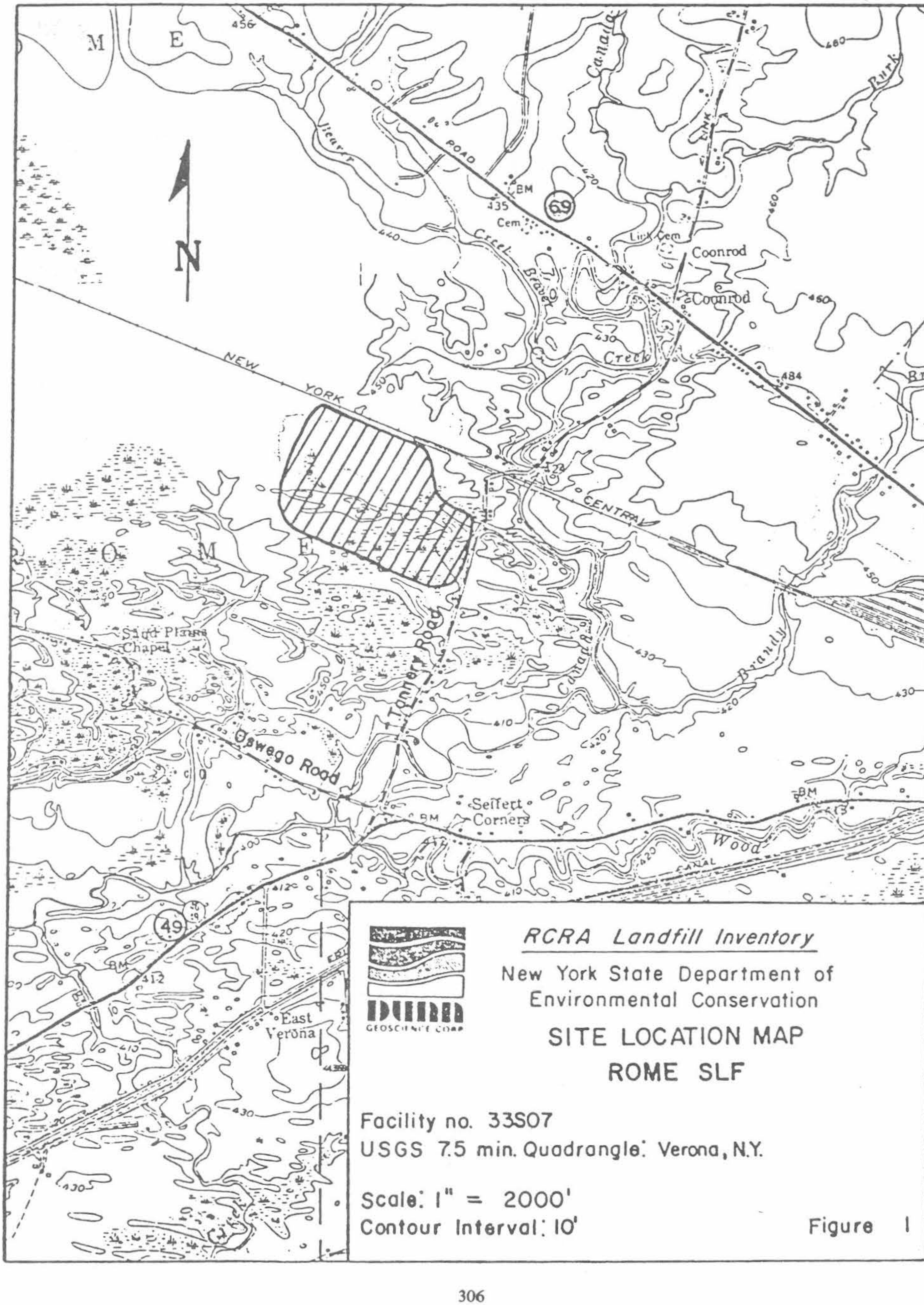
This included an examination of Department of Environmental Conservation (DEC) files and any published information on the Rome SLF and the surrounding area. These sources were examined in order to provide information on past waste disposal practices at the site, and types of wastes received. Published information on geology of the area was examined, where possible, in order to aid in the interpretation of site hydrology and geology.

II. Results of Non-drilling Activities

A. Site Geology

Bedrock:

The bedrock underlying the Rome SLF is the Ordovicean Utica shale. The bedrock is generally flat lying.



RCRA Landfill Inventory

New York State Department of Environmental Conservation

SITE LOCATION MAP
ROME SLF

Facility no. 33S07
USGS 7.5 min. Quadrangle: Verona, N.Y.

Scale: 1" = 2000'
Contour Interval: 10'

Figure 1

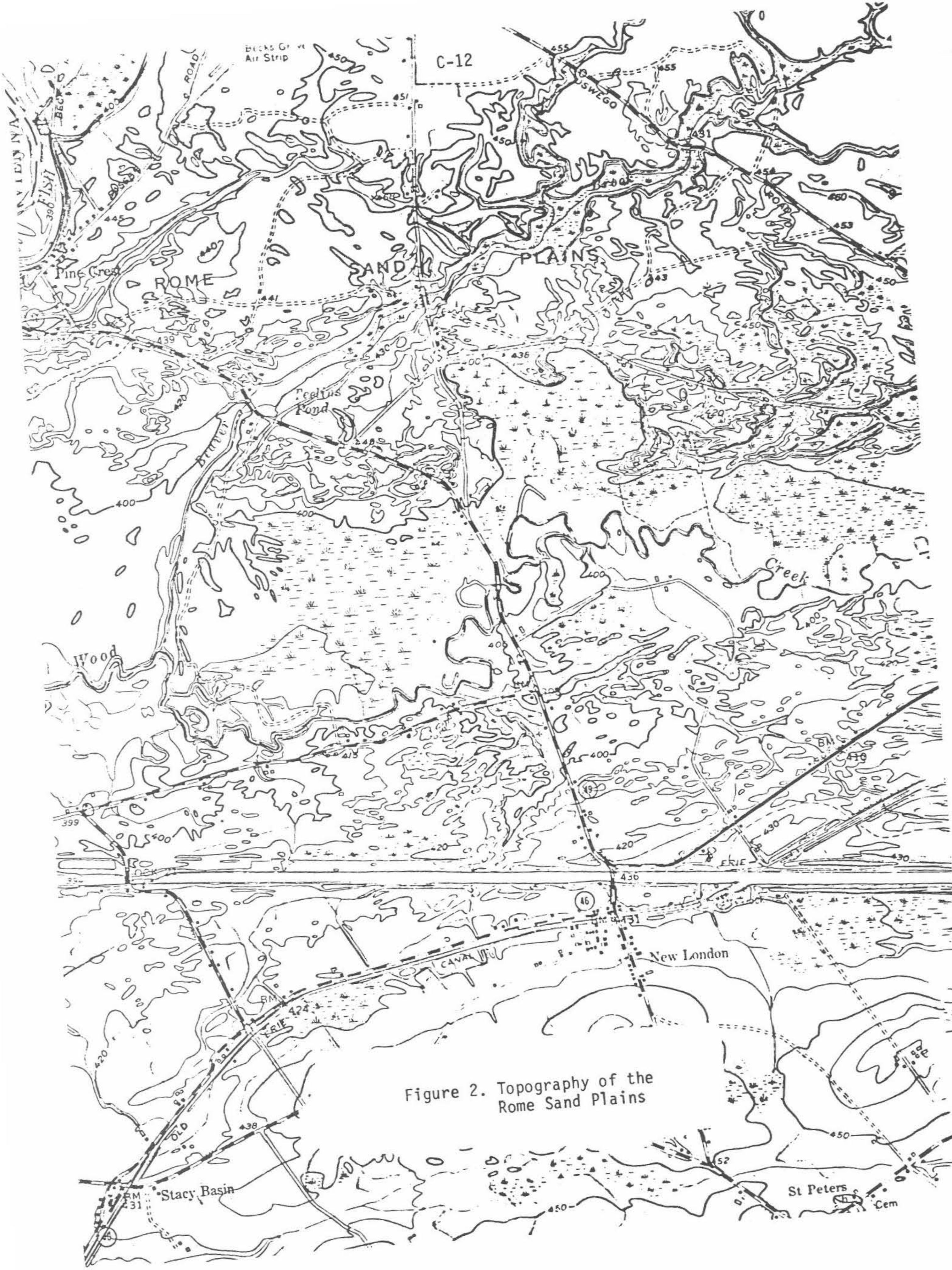


Figure 2. Topography of the Rome Sand Plains

Surficial Geology:

Overlying the bedrock is a series of glacial sediments of late Pleistocene age. The first unconsolidated unit to be deposited was a thin layer of glacial till which mantles the bedrock. Overlying the glacial till is a layer of lacustrine sand and clay which was deposited in glacial Lake Iroquois (fig. 2). When the lake drained, it left large sand deposits which were wind-blown into large crescent shaped dunes. Depressions on the leeward side of the dunes accumulated water and wetlands were formed.

Hydrology

Surface Water:

The regional surface drainage patterns are not well defined due to the override of the last major glacier. Due to the presence of very porous sandy soil at the surface, precipatation infiltrates the ground rapidly resulting in minimum run-off.

Canada Creek is located adjacent to the site. The Creek flows north to south in close proximity to the east boundary at the site. To the south, the Canada Creek joins Wood Creek before the Creek enters Oneida Lake at Sylvan Beach.

Groundwater:

The regional groundwater flow pattern parallels the general flow direction of surface drainage. Groundwater flow is controlled both regionally and locally by the existing topography and the distribution of the unconsolidated aquifer deposits.

Underlying the site area is an aquifer comprised of lacustrine sands. The lacustrine sand can produce fair quantities of groundwater whenever the sands are below the water table. Due to the presence of fine grained sands, the transmissibility of the aquifer is limited.

Little is known about the shale aquifer in the area. The groundwater flow within the shale is controlled by fractures and joints and yields are very low. An analysis of the well logs indicates that the bedrock aquifer is not influenced by the landfill because two aquicludes of lacustrine clay and till are present between the landfill and the bedrock.

Site Groundwater Hydrology

The groundwater flow direction is a radial pattern from the landfill with flow towards the Canada Creek and towards the south and west (figure 3).

The groundwater gradient is gentle approximately one foot drop per 250 feet horizontal distance. This gradient is due, in part, to the flat terraine and the presence of the underlying clay aquiclude.

Determination of the groundwater gradient and construction of the water table contour map were based upon the evaluation of water levels measured in the monitoring/observation wells, and results of the resistivity survey.

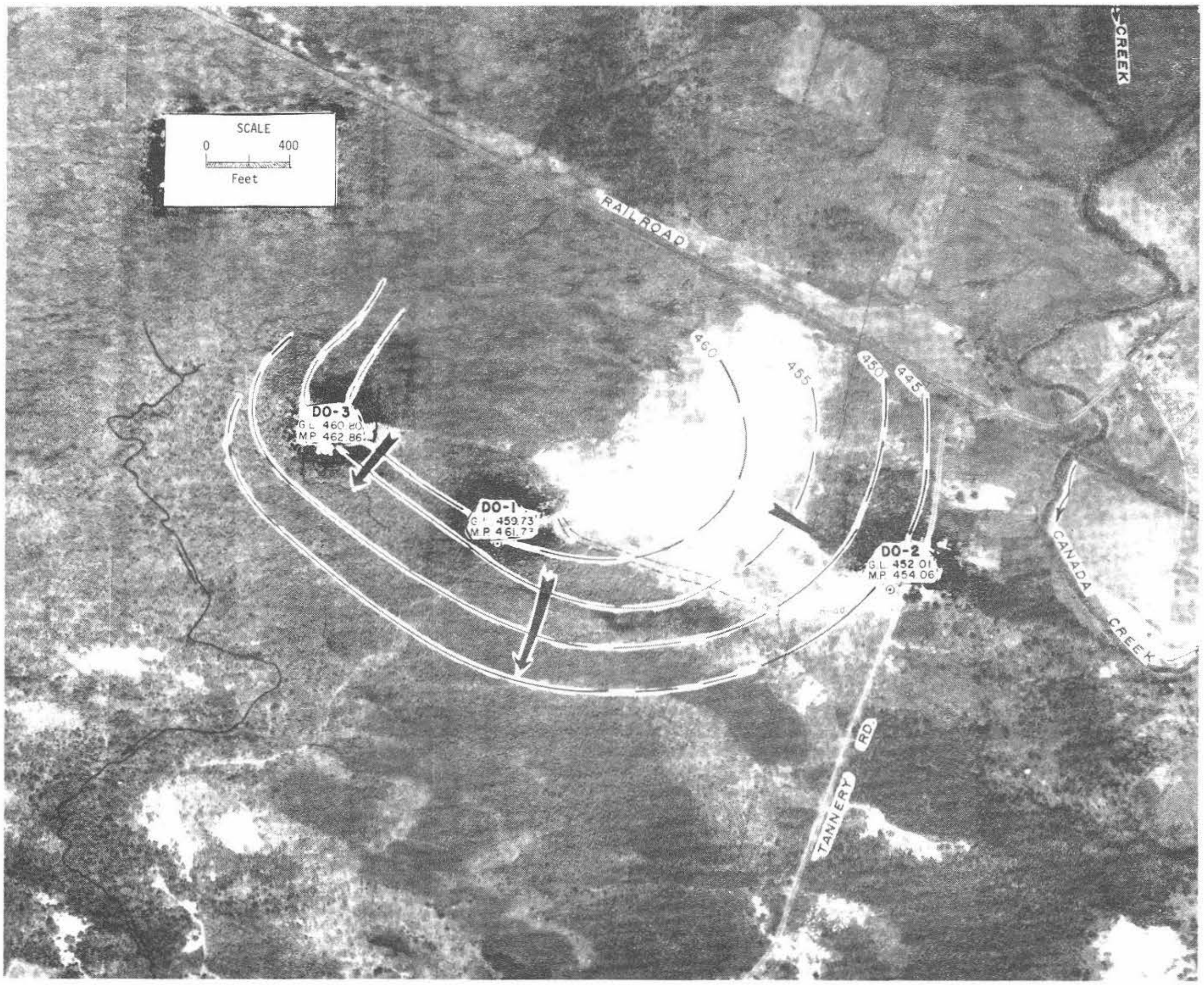


Figure 3. Water table contour map, Landfill Facility No. 33S07, Rome SLF. (Numbered lines give elevation of water table in feet; heavy arrows show direction of groundwater flow;circled dots show positions of monitoring wells) Map by Dunn Geoscience Corp, June 1980.

The actual design and construction of the wells will be reviewed under section heading Drilling/Sampling Program.

Geophysical Resistivity Survey:
An electrical earth resistivity survey (EERS) of the immediate area surrounding the landfill was conducted to determine if there were any areas of leachate contamination of groundwater. Landfill leachate increases the conductance of groundwater and, hence, lowers the bulk resistivity of the aquifer in a contaminated zone. Electrical earth resistivity surveys can also provide a good indication of water table elevation.

Results of the resistivity survey indicated that the groundwater is contaminated. Downgradient well samples had a conductivity that indicated groundwater contamination from landfill leachate. In addition, a small stream that runs adjacent to the landfill appeared to be contaminated by leachate.

III. Drilling/Sampling Program

A.) Monitoring Well Installation:
Based upon the results of the site inspection and resistivity survey, it was determined that three monitoring wells would be needed (1 upgradient, 3 downgradient) around the landfill.

Three monitoring wells were installed by a private drilling outfit (subcontracted by Dunn Geoscience). Figure 4, A, B, C, shows the construction details, depth, screen position, and major subsurface units. A rotary drilling rig was mobilized at the site in order to obtain soil borings (samples of subsurface materials). The subsurface materials were sampled by a split-spoon sampler two out of every five feet according to ASTM standard sampling procedures. All samples were logged (fig. 5) as to sample interval, blow counts, and material type.

When the bottom of the boring was reached, the hole was cleaned out with clean drilling water, removing any excess material. It was then converted to a monitoring well by installing a two-inch OD PVC pipe and well screen in the water-producing zone. Figure 6 shows the construction of a typical well.

The monitoring wells provide a means for measuring the groundwater level at each of the well sites. An electric tape is utilized to measure water levels to an accuracy of 0.01 feet. These level readings provide the basis for the evaluation and determination of groundwater conditions over the site. They were used to construct the groundwater table contour map and to determine the direction of groundwater flow and the groundwater gradient (see figure 3).

B.) Groundwater Sample Collection and Analysis:
Sample withdrawal, transportation, preservation, and analysis must be conducted with extreme care in order to maintain sample integrity. Groundwater sample collection must be in accordance with the standard procedures of the United States Environmental Protection Agency and the American Public Health Association.

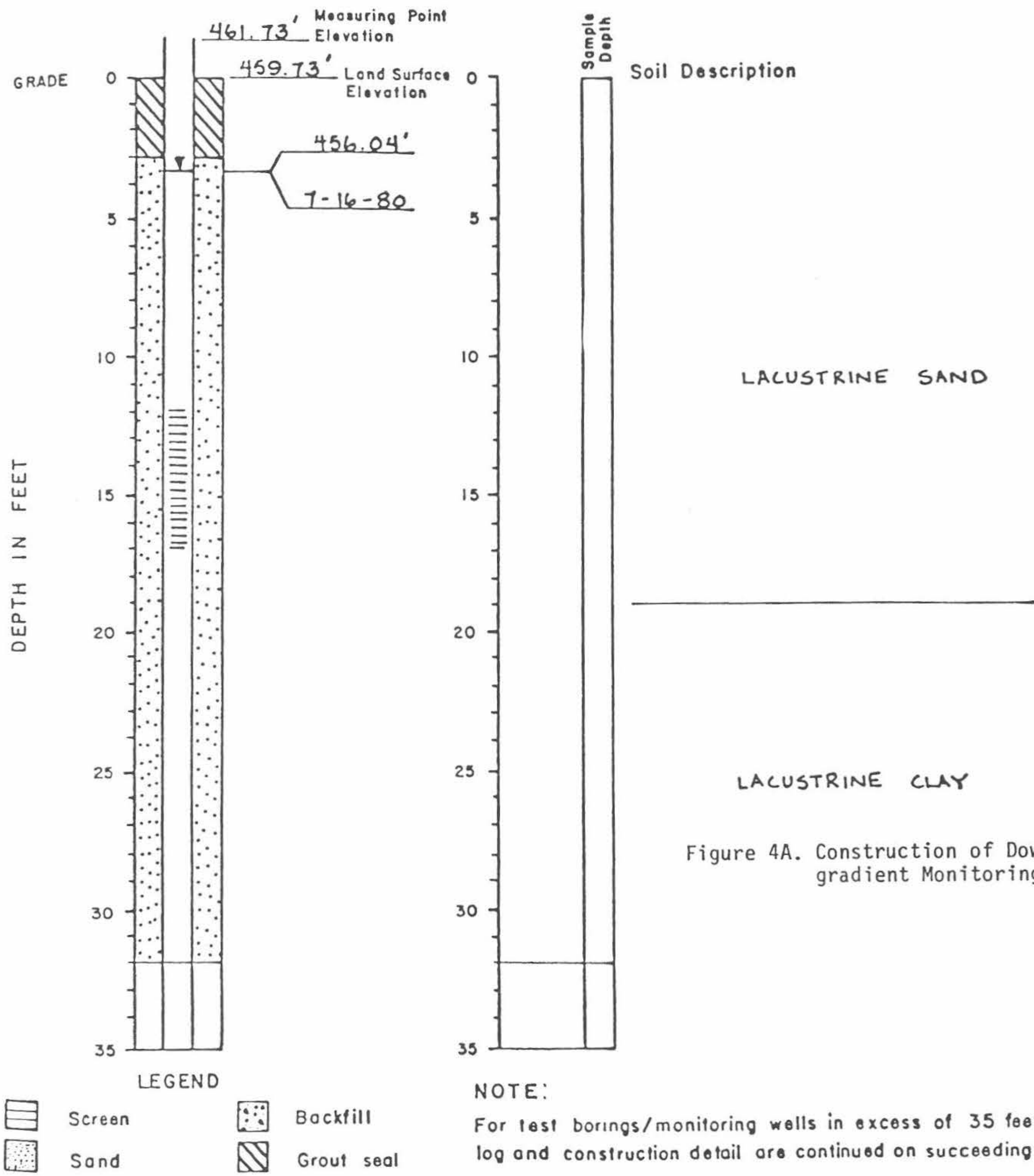


Figure 4A. Construction of Down-gradient Monitoring well.

NOTE:

For test borings/monitoring wells in excess of 35 feet, the log and construction detail are continued on succeeding page

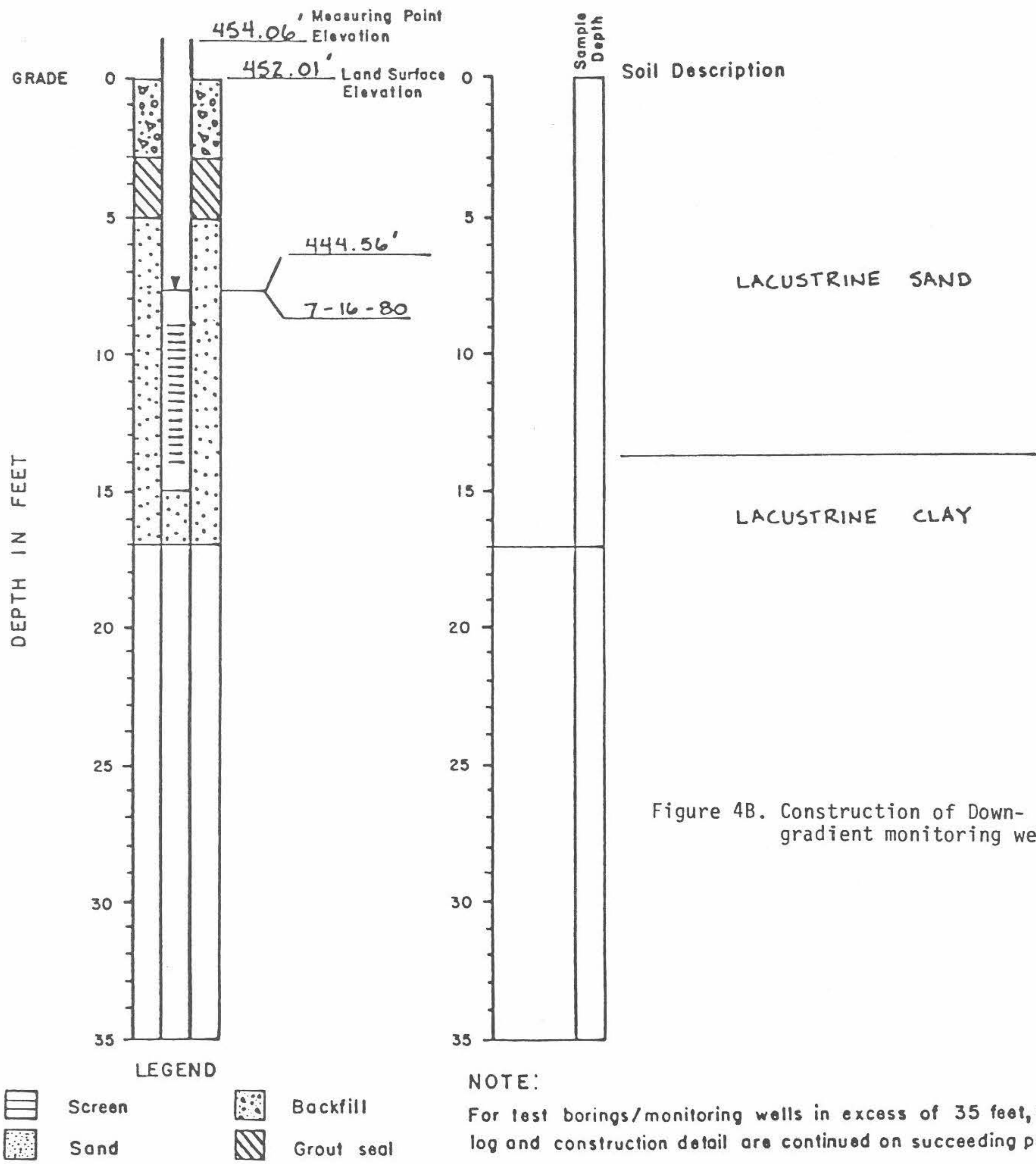


Figure 4B. Construction of Down-gradient monitoring well.

NOTE:
For test borings/monitoring wells in excess of 35 feet, the log and construction detail are continued on succeeding pages.

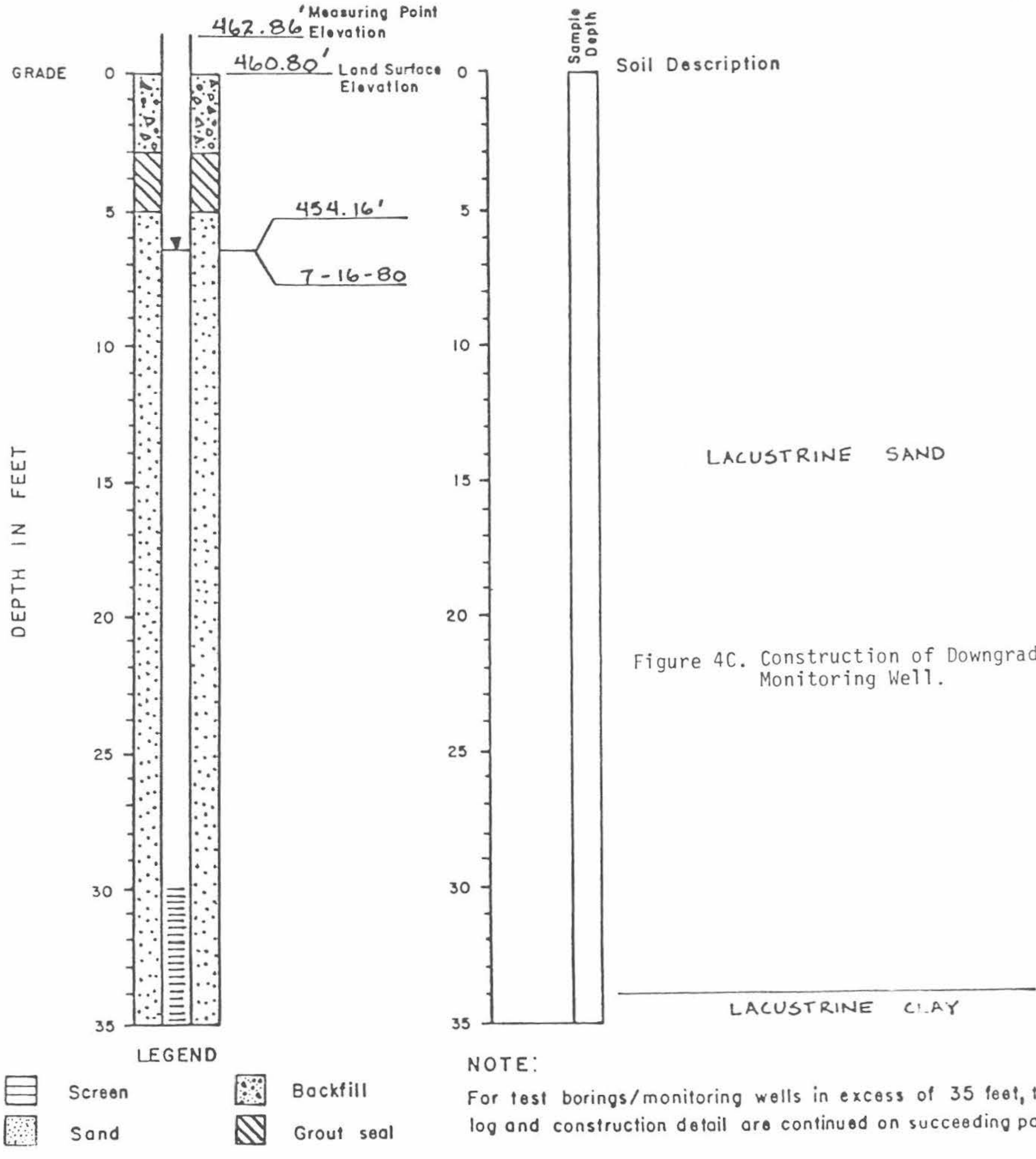


Figure 4C. Construction of Downgradient Monitoring Well.

NOTE:

For test borings/monitoring wells in excess of 35 feet, the log and construction detail are continued on succeeding pages

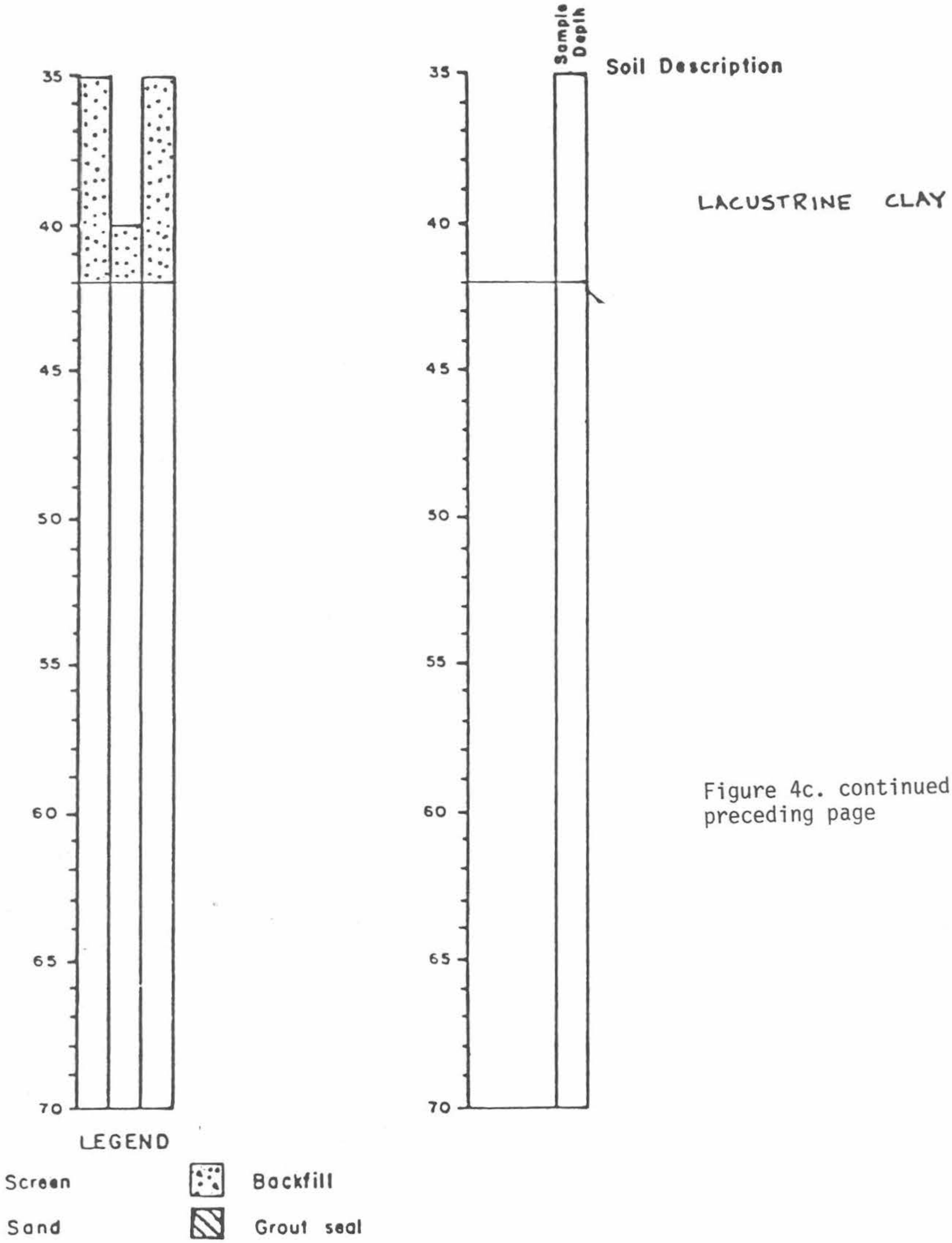


Figure 4c. continued from preceding page

Sheet 1 of 1

INSPECTOR Chisick	SURFACE ELEV.		SAMPLING		WATER LEVEL OBSERVATION
DRILLER Rappold	BORING STARTED	5/6/80	ST SIZE 1 3/8" ID 2" OD		WL: ____ WS CR WD
HELPER Lodge - George	BORING COMPLETED	5/6	HAMMER 140	DROP: 30"	WL: ____ BCR ____ ACR
RIG NO. J-2	STATION	On	ST SIZE ____	ST SIZE ____	WL: ____ AB ____ Hr. AB
	OFF SET		CASING USED 17.0'	SIZE 4"	WL: ____ 24 Hr. AB

JOB NO. 72040 F BORING NO. RA-1 CLIENT Dunn Geo. WEATHER Rain Cloudy TEMP. 60

PENETRATION RECORD

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	Hydraulic Pressure PSI: Time Sec. Hour	Pressure While Sampling	Pressure While Coring	Split Spoon Blows 6"	6"	6"	6"	Casing Blows Per Foot	R Length Recovered in Feet	Q_p Penetrometer Test in TSF	Boring Location: Rome N.Y. landfill — Sample Description
1	0.0	2.0	SS				2	5	9	11		1.5		Brown, fine sand
	2.0	5.0	SS											Wet @ 4.5'
2	5.0	7.0	SS				18	19	20	22		1.7		Brown, fine sand (wet)
	0.0	12.0	RB				Casing to 10.0'							
3	10.0	12.0	SS				11	15	11	11		1.2		Brown, fine sand (wet)
	10.0	15.0	RB				Casing to 15.0							
4	15.0	17.0	SS				8	14	27	31		1.6		Brown,fine sand (wet) change @ 16' to
4A							Casing to 17.0							Grey clayey silt
	15.0	20.0	RB											
5	20.0	22.0	SS				19	15	17	22		1.5		Grey clay, sile silt
	20.0	25.0	RB											
6	25.0	27.0	SS				4	7	9	10		1.7		Grey clay, some silt
	25.0	30.0	RB											
	30.0	32.0	SS				2	5	7	7		1.7		Grey clay, some silt

End of boring 32.0'

Monitoring well - set with tip @ 32' B.G.

Wellscreen from 12' - 17' B.G. Silica sand

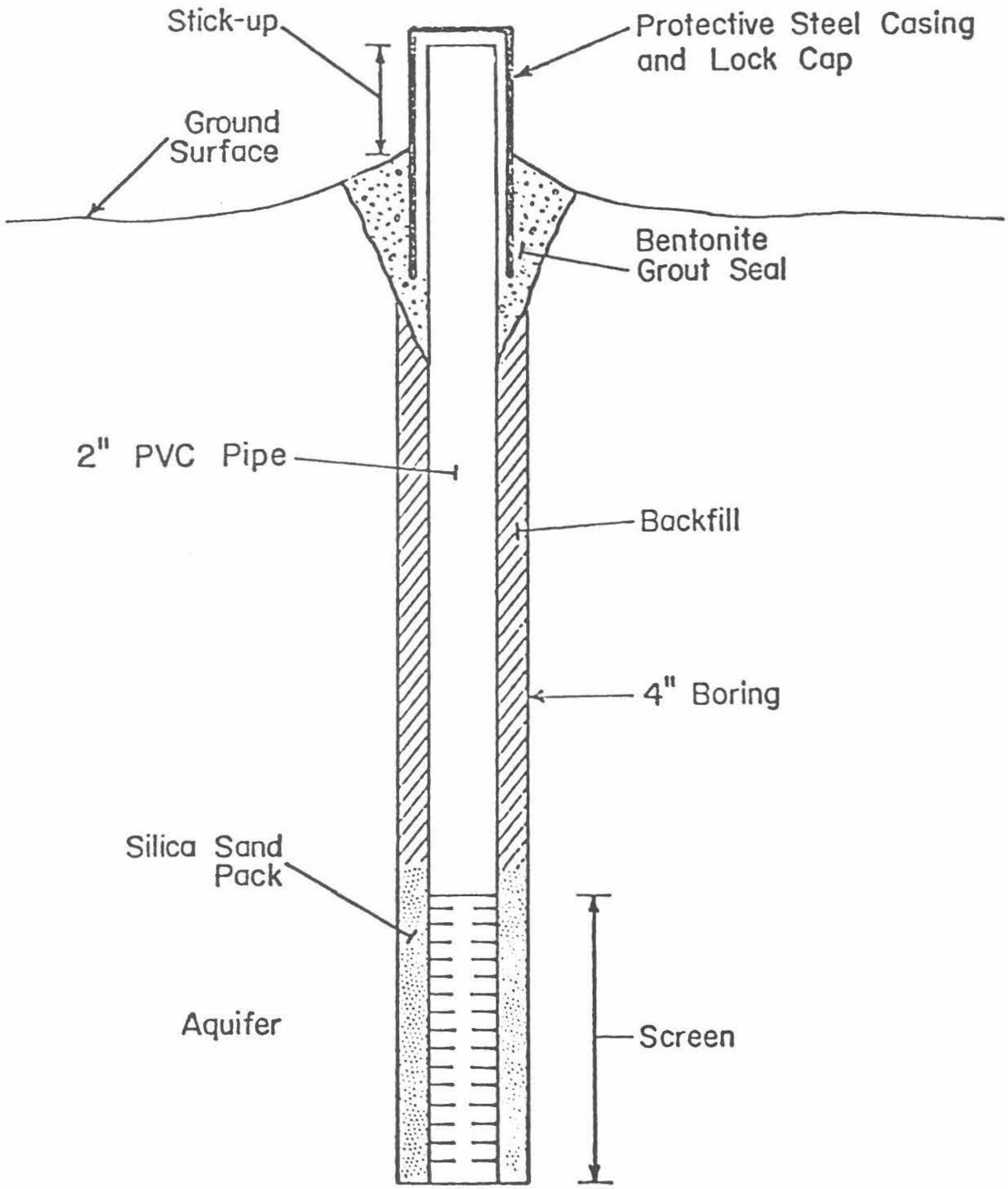
backfill with steel casing grouted @ surface

ABBREVIATIONS
- F.T. - Fish Tail
- W.O. - Wash Out
- S.S. - Split Spoon
- D.B. - Diamond Bit
- P.A. - Power Auger
- R.B. - Rock Bit
- W.S. - While Sampling
- W.D. - While Drilling
- B.C.R. - Before Casing Removal
- A.C.R. - After Casing Removal
- A.B. - After Boring

Figure 5. Typical Drillers Log.

Figure 6.

TYPICAL MONITORING WELL CONSTRUCTION



In order to insure that the samples being withdrawn are uncontaminated from equipment use or from other unsuspected materials, all the wells are bailed, at least one column of water, with stainless steel bailers. To avoid cross-contamination, a different stainless steel bailer is used for each well.

C.) Sampling Protocol

The sampling protocol required an indicator scan of 8 parameters and a baseline scan of 23 parameters. The indicator scan included the following 8 parameters: Conductivity, Eh, PH, Temperature, Chloride (Cl), Iron (Fc), Total Dissolved Solids (TDS), and Total Organic Carbon (TOC). Baseline scan included the eight indicator parameters plus Cadmium, Chromium, Lead, Selenium, Mercury, Copper, Zinc, Aluminum, Manganese, Sulfate, Nitrate, Color, Odor, Hardness, Alkalinity, and Phenols.

The baseline series was run in order to determine if the groundwater had been contaminated by leachate. Baseline scans, in general, are conducted when the results of the indicator parameters suggest groundwater contamination. In this investigation the indicator parameters as well as DEC data on the landfill revealed the potential for contamination.

TOC, nitrate, and phenols are indicators of organic contamination. The analysis indicated that TOC and phenols are elevated in 2 downgradient monitoring wells. Thus, there is evidence of some organic contamination.

IV. Interpretation and Evaluation of Data

Analysis of resistivity data, well logs and water quality analyses indicates that there are zones of low, medium and high quality groundwater around the landfill. These zones are representative of varying degrees of leachate contaminated groundwater. The data suggests some organic contamination and that the leachate is "weak."

Based on the results of this study, the landfill complied with the RCRA, Part 257, Groundwater Quality Criteria at this time. However, these data suggest that leachate from the landfill is entering the groundwater system.

V. A.) Site Remediation

After the site investigation is completed, and the analysis of the data indicates potential pollution of surface water, groundwater, air and/or all three major environmental pathways, it is necessary to select the proper site remediation necessary to maintain a level of control which would prevent further environmental degradation. The necessary site remediation chosen will depend on such factors as: 1) economic feasibility; 2) nature of contamination; 3) specific site conditions; and 4) level of environmental risk.

There are a myriad of existing remediation techniques available to abate environmental degradation from landfill leachates. The major remedial categories include: 1) surface controls; 2) groundwater controls; 3) leachate collection and treatment; 4) gas control systems; and 5) direct waste treatment.

A discussion of all the major remedial categories would be exhaustive and lengthy. In addition, it is not the intent of this report to discuss in detail the various remedial actions. Therefore, a list of the major remedial actions is provided in Appendix A. Illustrative diagrams are also provided in Appendix A for several of the major control techniques.

B.) Remedial Action at the Rome SLF

The remedial action utilized at the Rome SLF was specified by the NYSDEC. On June 2, 1982, the Mayor of the City of Rome signed a Department of Environmental Conservation Consent Order, thereby agreeing to upgrade the Rome Landfill according to a specified schedule of remedial action.

The Consent Order requires the site be capped in three stages in compliance with 6NYCRR Part 360 (Solid Waste Management Facilities) which specifies the minimum requirements for a landfill cap (see fig. 1, appendix A). Construction of the cap will be from off-site materials placed in layers and compacted to predetermined densities and permeabilities (coefficient of permeability of 1 x 10 -5 cm/sec).

When the barrier layer has been constructed and its permeability certified, a one-foot minimum layer of sandy material will be placed on top of the barrier cap. Overlying the sandy layer will be a layer of topsoil which will be seeded.

Landfill gas vents are installed on a 200-foot grid around the landfill. Water samples will be taken quarterly from the three on-site monitoring wells, and any other wells DEC indicates.

Parameters to be measured for include: Chlorides, Specific Conductivity, Total Organic Carbon, PH, Total Iron, Total Dissolved Solids.

Closure plans do not require the construction and placement of a leachate collection system, liners, or subsurface drainage ditches.

Oneida County Energy Recovery Facility An Alternative to the Land Disposal of Solid Wastes

I. INTRODUCTION

BACKGROUND

Landfill disposal in Oneida County has and currently is a responsibility of the towns, cities and villages. In the late 1960's Oneida County recognized the growing solid waste disposal problem was an intermunicipal problem and together with Herkimer County retained a consulting firm to prepare a comprehensive solid waste plan. That plan, completed in 1969, called for the creation of two regional landfills to serve Oneida County; one in Rome and one north of Utica in Trenton. The plan met with vocal opposition from those opposed to the philosophy of burying garbage (wasting a natural resource); those from Rome and Trenton who didn't want waste from "the outside" brought into their community; and those individuals living near the selected landfill site.

As a result of the opposition, the County created the Solid Waste Agency and asked this group of citizens to study resource recovery as an alternative to landfill. The Agency's studies led them to pursue energy recovery from municipal waste as the most appropriate technology for Oneida County. Talks began with Griffiss AFB in 1973 following the fuel shortage of that year and developed over the years to full fledged contract negotiations during 1978-79. The negotiations culminated on December 13, 1979 when Griffiss forwarded steam purchase and waste disposal contracts to the County for signature.

Prior to County authorization each participating municipality signed contracts during February and March 1980 to insure a waste supply. In May, the County Board of Legislators authorized the County Executive to sign the Air Force and municipal contracts, which he did in June. In July, the Board approved the necessary bonding resolution to finance the project.

II. PROJECT DESCRIPTION

The facility will have a design capacity of 200 tons of waste per day using four Modular Incineration Units (MCU) with waste heat recovery. Waste will be accepted from the City of Rome, Town of Floyd, Griffiss Air Force Base, and from NOCO and SWOCO landfill service areas. The steam produced by the plant will be purchased by Griffiss Air Force Base year round. Access to the plant will be directly off State Route 365 (River Road). The plant will have a baghouse on the stacks to clean air emissions. A steam condenser will allow the facility to incinerate waste and pass the cooled exhaust gases through the baghouses when the steam demand is lower than the steam production during the summer months. Wastewater generated at the facility will be treated at the Rome sewage treatment plant. The ash residue will be milled to reduce the metal content and leaching potential prior to burial.

PLANT SITE

The plant will be located (Appendix B, figure 1) on a parcel of land containing approximately 75 acres. The property adjoins Griffiss AFB next to the B-52 bomber alert area. The energy recovery plant will be located about 1,500 feet from the B-52 bombers, about 1,600 feet west of Rickmeyer Road and 2,000 feet north of State Route 365 (River Road).

HAZARDOUS WASTE

Hazardous waste will not be accepted at the plant. Waste coming into the plant will be screened while it is dumped on the tipping floor and when the incinerator hopper is being charged. Any waste that is hazardous or in some way might cause damage will be rejected and removed from the incinerator waste stream. This can be easily accomplished with the relatively small handling equipment (skid steer loader) and the ability of the operator to view the waste being placed into the charging hopper.

The EPA maintains a list of hazardous substances which if generated with other listed hazardous wastes in excess of 2,200 pounds per month must be reported to EPA. This number invokes the EPA hazardous waste manifest (cradle to grave) reporting system. Those handling any mixture of hazardous wastes comprising the minimum 2,200 pounds or more are required to have a manifest accompany it at all times. The New York State Department of Environmental Conservation has proposed reducing that reporting threshold to 220 pounds per month in 1981 for New York State generators of a hazardous waste.

Generators and disposers of hazardous waste who violate the manifest system or improperly dispose of hazardous waste are subject to both civil and criminal penalities. The manifest system is designed to direct hazardous wastes to facilities that are licensed to accept and dispose of such wastes. The Oneida County facility will not accept such hazardous wastes, nor should any such wastes be accepted at the landfills operating in Oneida County.

Most of the substances on the EPA hazardous waste list are liquids or gases and as such would not be accepted at the energy recovery facility in any event. Before the plant is operational, a survey of industries in the area to be serviced by the energy recovery facility will be made. This "one to one" meeting with local industry will identify wastes which are considered to be unacceptable (i.e. hazardous) or incompatible with the incineration equipment.

SOLID AND HAZARDOUS WASTE PROBLEMS AND RECOMMENDED SOLUTIONS

The Oneida County EMC has devoted much time and effort to the problem and possible solutions to the solid waste problem in Oneida County. In August of 1983, staff drafted a statement presented to the NYS Assembly Standing Committee on Environmental Conservation. This statement outlined a basic philosophy that efforts should be made both to remove existing impediments to reducing reliance on landfilling and to increase utilization of proven solid waste management technologies. This effort was accomplished by EMC staff working with the Solid Waste Agency (subcommittee of the EMC), the County Planning Department, and the Department of Public Works Division of Solid Waste. It was pointed out that a direct result of lack of enforcement of the Part 360 Regulations (Solid Waste Management Facilities) could be threats to public health and the environment from waste leachate. In the absence of equal treatment and enforcement by the State, the economic advantage weighs heavily in favor of existing facilities often run in violation of Part 360. The EMC has made specific recommendations to improve solid waste management at the State level as follows:

1. There should be full and equal enforcement of Part 360 NYCRR for all solid waste facilities, either existing or proposed.
2. There should be a clear and consistent state policy on solid waste which emphasizes resource recovery, source separation and recycling and discourages new and continued landfilling. This policy should be translated into positive identifiable actions which promote new technologies instead of stifling such advancement.

3. There should be technical assistance available to evaluate appropriate solid waste technology and assist local governments with its implementation.
4. There should be direct financial aid to solid waste facilities which employ systems that alleviate dependence on landfills.
5. There should be a coordinated review within a pre-set time for new solid waste facility proposals to promote their development.

Appendix A

List of Major Remedial Actions and Representitive Diagrams

I. Surface Controls

a. Caps (see figure 1 appendix A)

1. Purpose

2. Types of materials

a. clay

b. clay, sand, and gravel

c. clay and mix (bentonite, lime, etc.)

d. sprayed bituminous membranes

e. synthetic membrances

f. industrial residues (flyash, slag)

b. Run-on/run-off Controls

1. Berms

2. Ditches

3. Benches

4. Basins/lagoons

II. Groundwater Controls

a. Impermeable Barriers

1. Slurry walls (see figure 2 appendix A)

a. bentonite

b. cement-bentonite

c. vibrated beam

2. Grout curtains

a. suspension (bentonite, cement)

b. chemical (silicates, lignochrome, acrylamide)

3. Sheet piles (various arrangements)

b. Permeable treatment beds

1. Limestone

2. Activated carbon

3. Ion exchange (zeolites, synthetic)

c. Pumping

1. To lower water table (see figure 3 appendix A)
2. To prevent underlying aquifer contamination (see figure 4 appendix A)
3. To contain plume (see figure 5 appendix A)
    a. extraction
    b. injection

d. Treatment

1. Air stripping of VOC packed tower
2. Carbon adsorption
3. Ion exchange
4. Pretreatment requirements

e. Alternate water supply

1. Local household treatment
2. New wells
3. Extension of municipal service
4. Well-head treatment
5. Blending
6. Capital improvements

III. Leachate Collection and Treatment

a. Drains

1. Subsurface
2. Ditches

b. Liners, as

1. Collection aids
2. Interceptors

c. Treatment

1. Activated sludge
2. Activated carbon
3. Air stripping
4. Physical/chemical

IV. Gas Control Systems

a. Pipe vents

1. Atmospheric
2. Forced ventilation

- b. Barriers
- c. Collection - Recovery
- d. Treatment
    - 1. Carbon adsorption
    - 2. Burn-off

V Direct Waste Treatment

- a. Siting
    - 1. Secure landfill
    - 2. Incorporate into site closure
- b. Excavation
    - 1. Equipment
        - a. drag line
        - b. clam-shell
        - c. backhoe
    - 2. Waste inventory - segregation
    - 3. Handling
        - a. safety
        - b. drums
        - c. over-pack drums
- c. Dredging
    - 1. Hydraulic
        - a. cutter head
        - b. mud cat
    - 2. Pneumatic dredge
    - 3. Mechanical dredge
- d. In-site treatment
    - 1. Solidification
    - 2. Encapsulation
    - 3. Neutralization
    - 4. Microbial degradation
- e. Incineration
    - 1. Applicability
    - 2. Mobile units

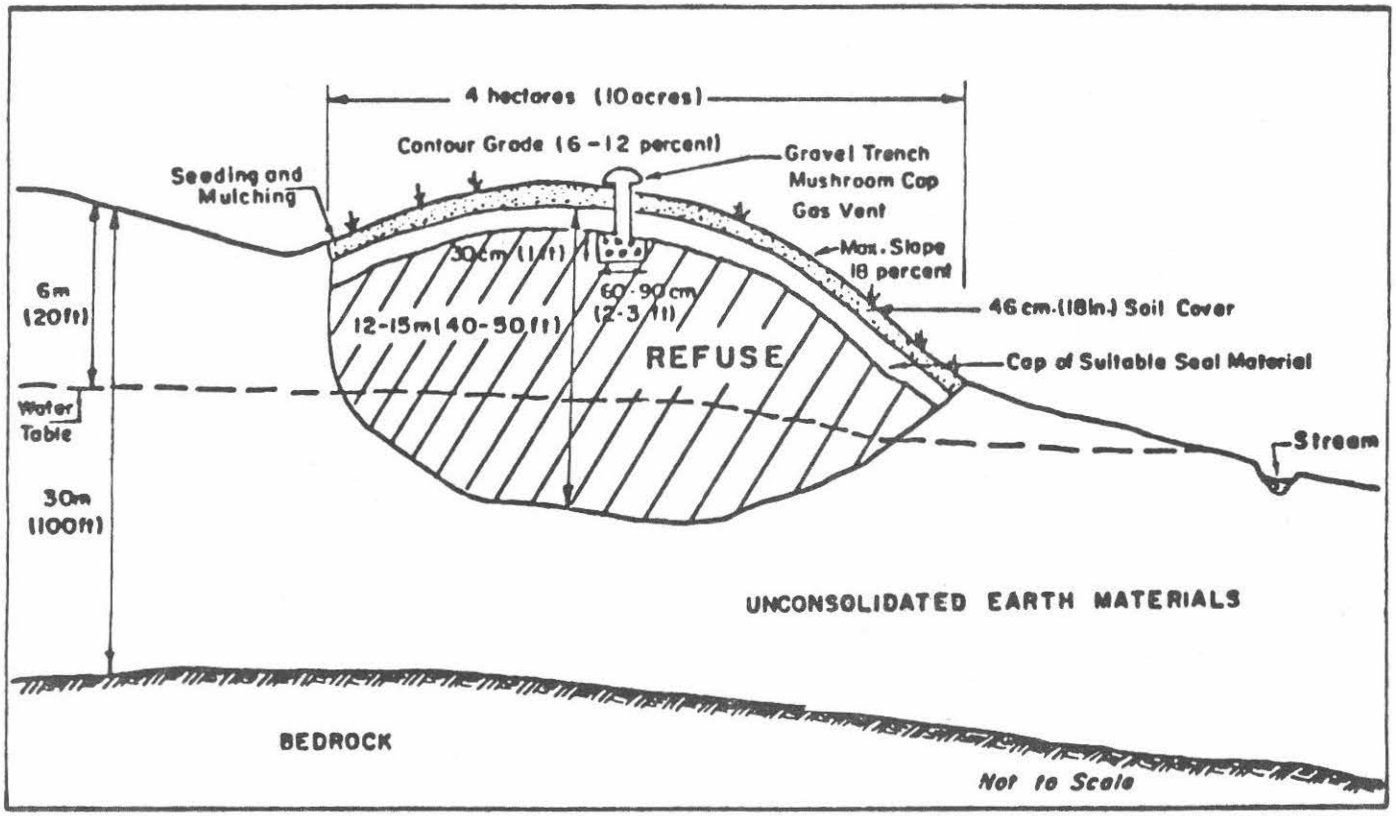
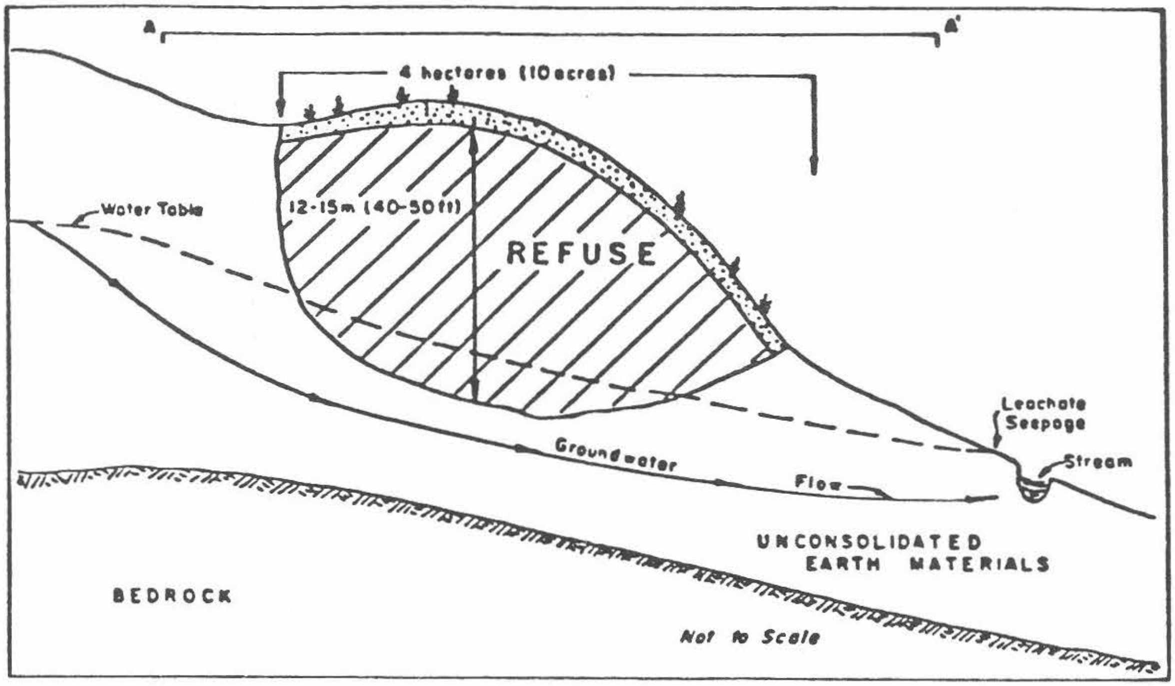
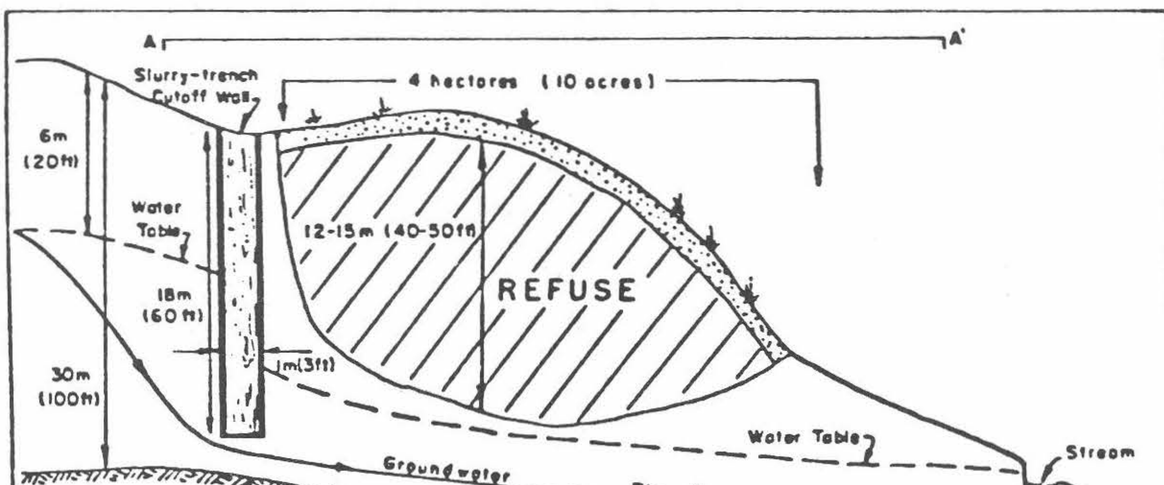


Figure 1. Cross section of capped landfill.

CUT-OFF WALL EFFECTS ON THE WATER TABLE



(a)



(b)

Figure 2. Cross section of landfill before (a) and after (b) slurry-trench cutoff wall installation.

EPA-600/2-78-142

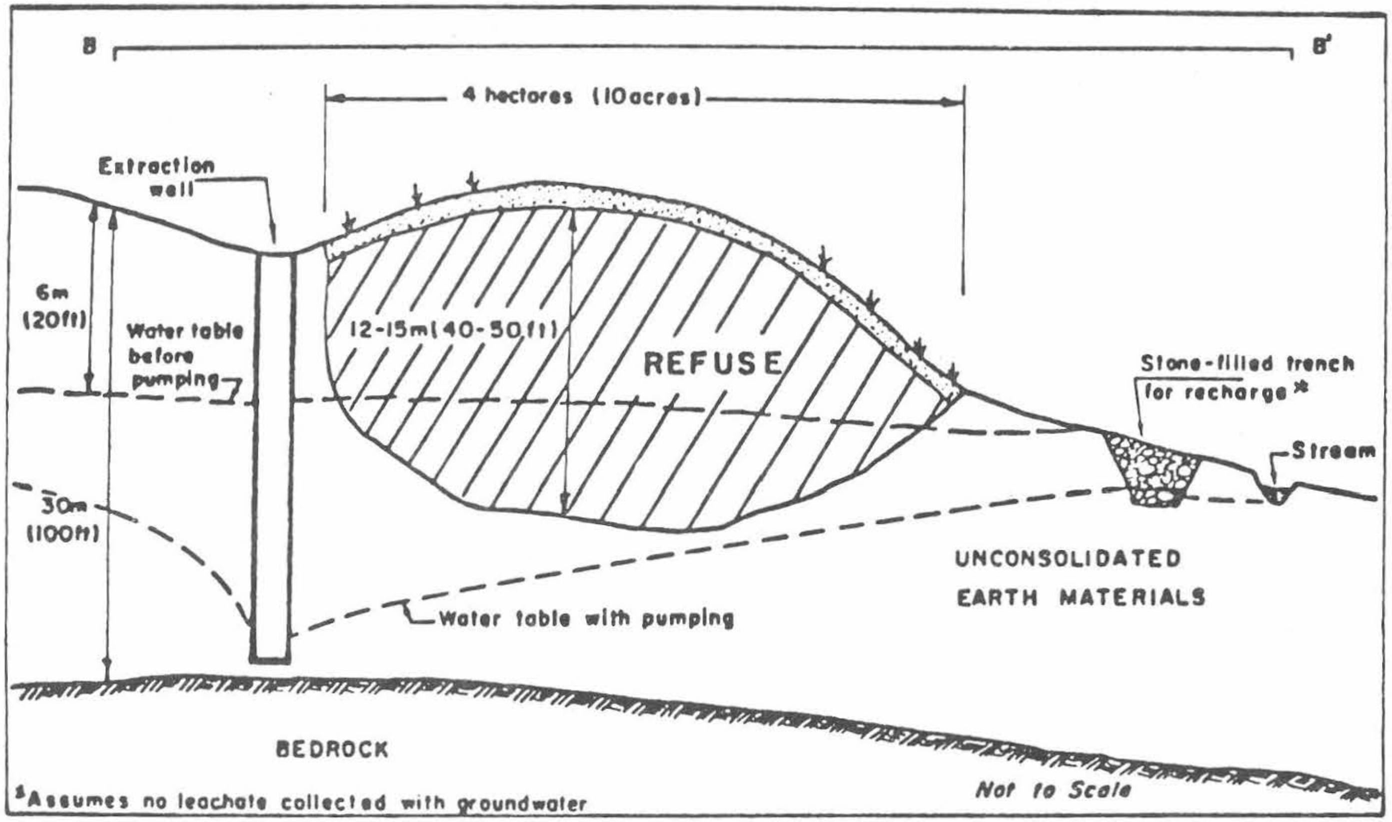


Figure 3. Cross section of extraction well at landfill.

PREVENT UNDERLYING AQUIFER CONTAMINATION

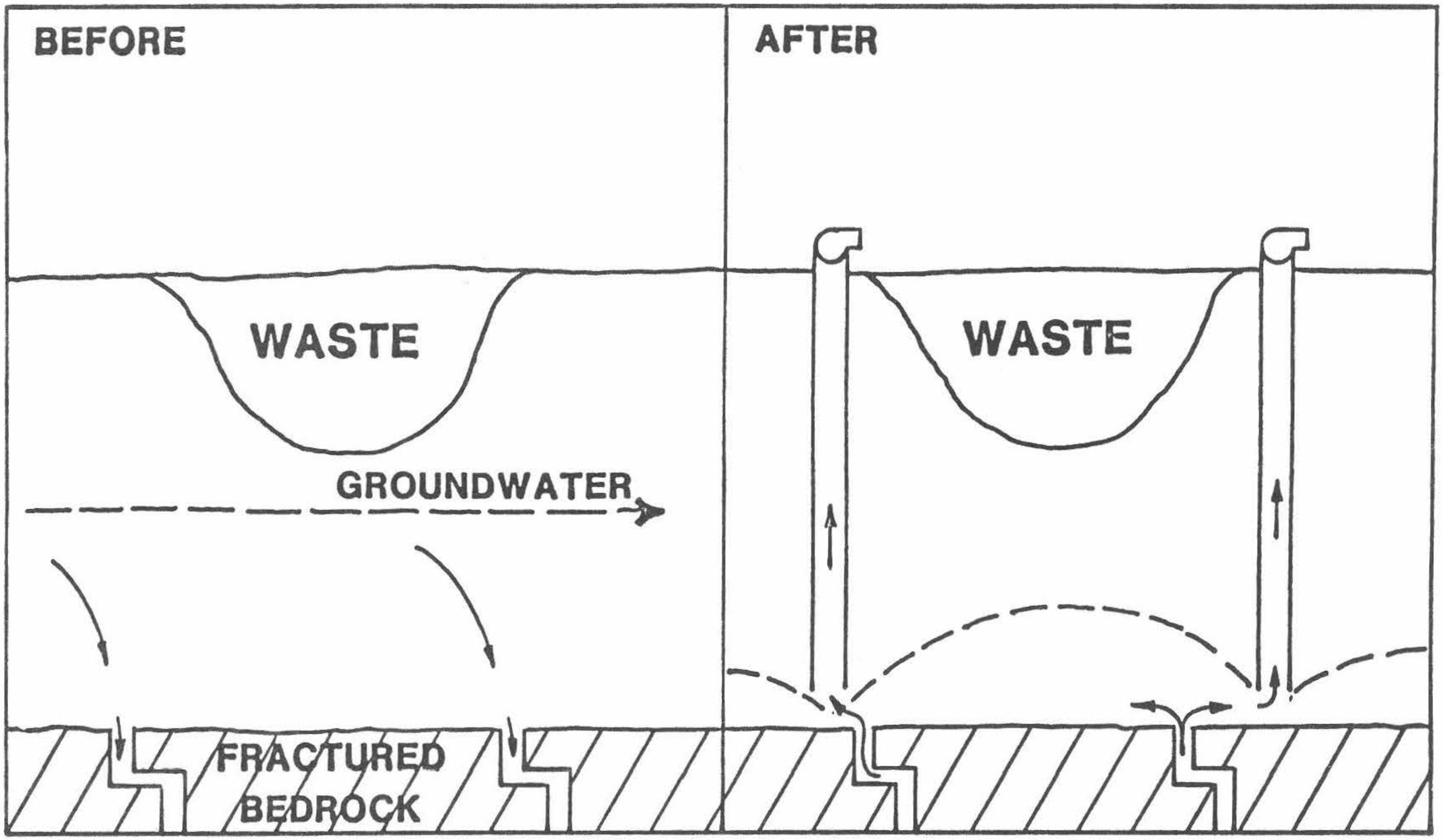


Figure 4.

CONTAIN PLUME

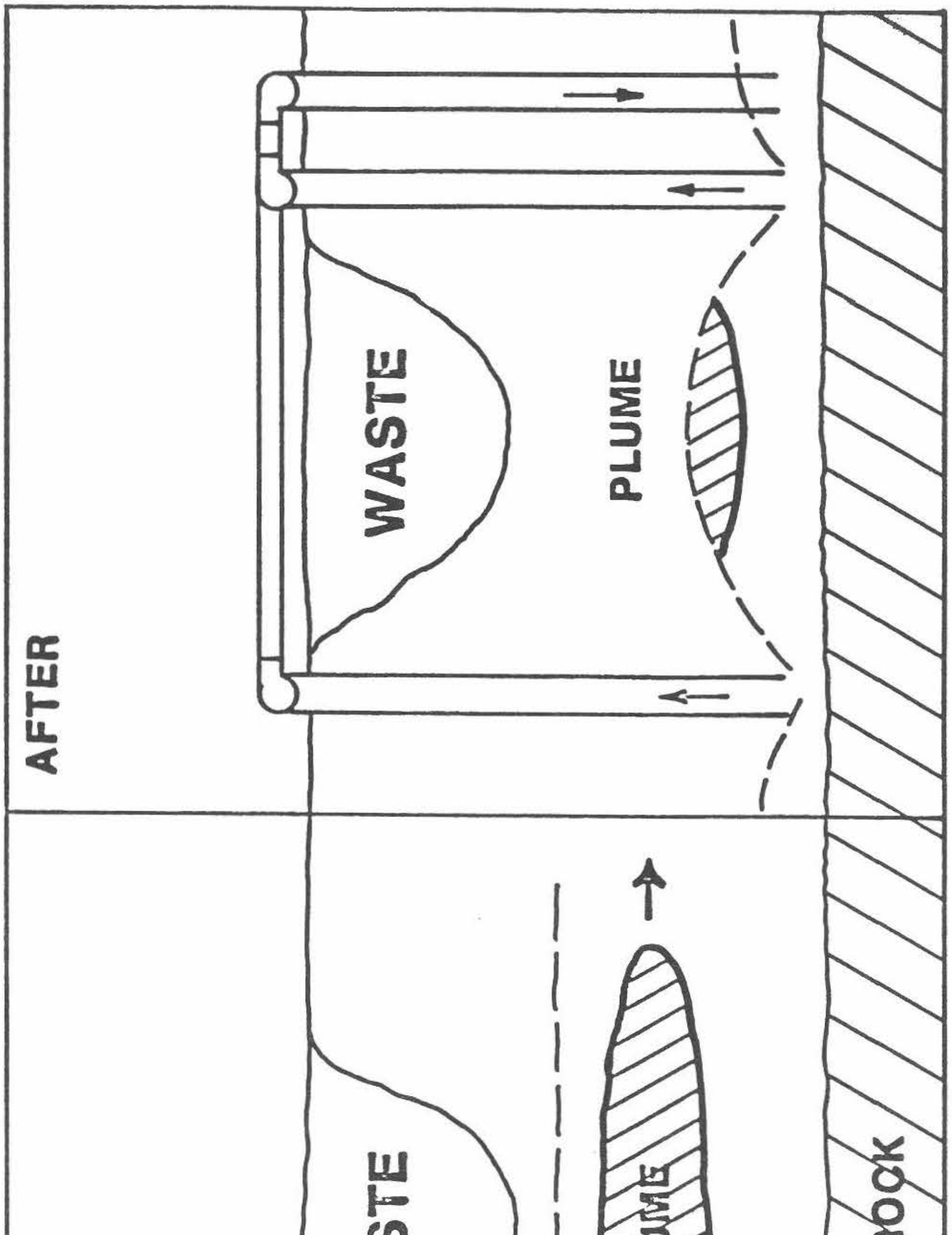
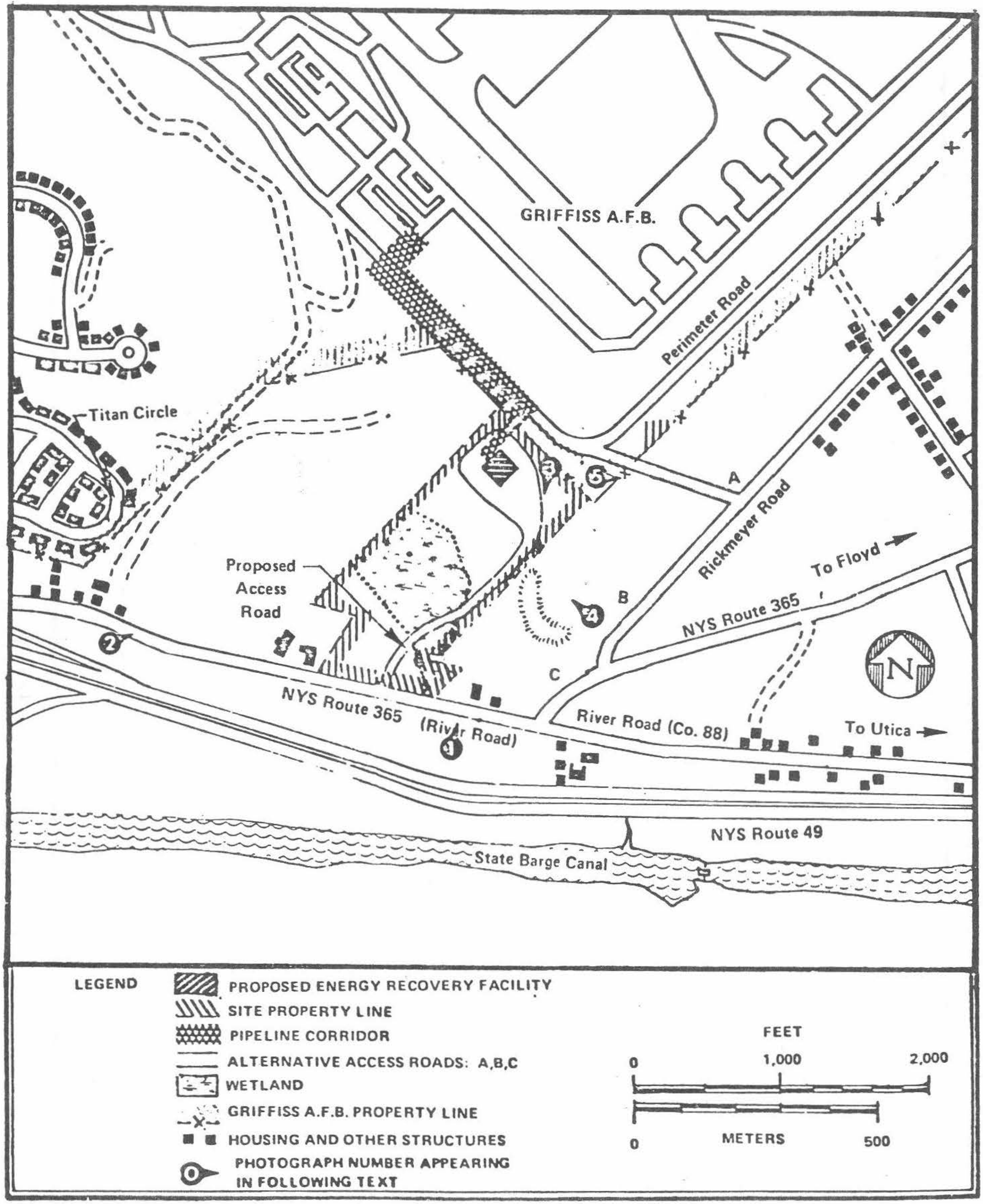


Figure 5.

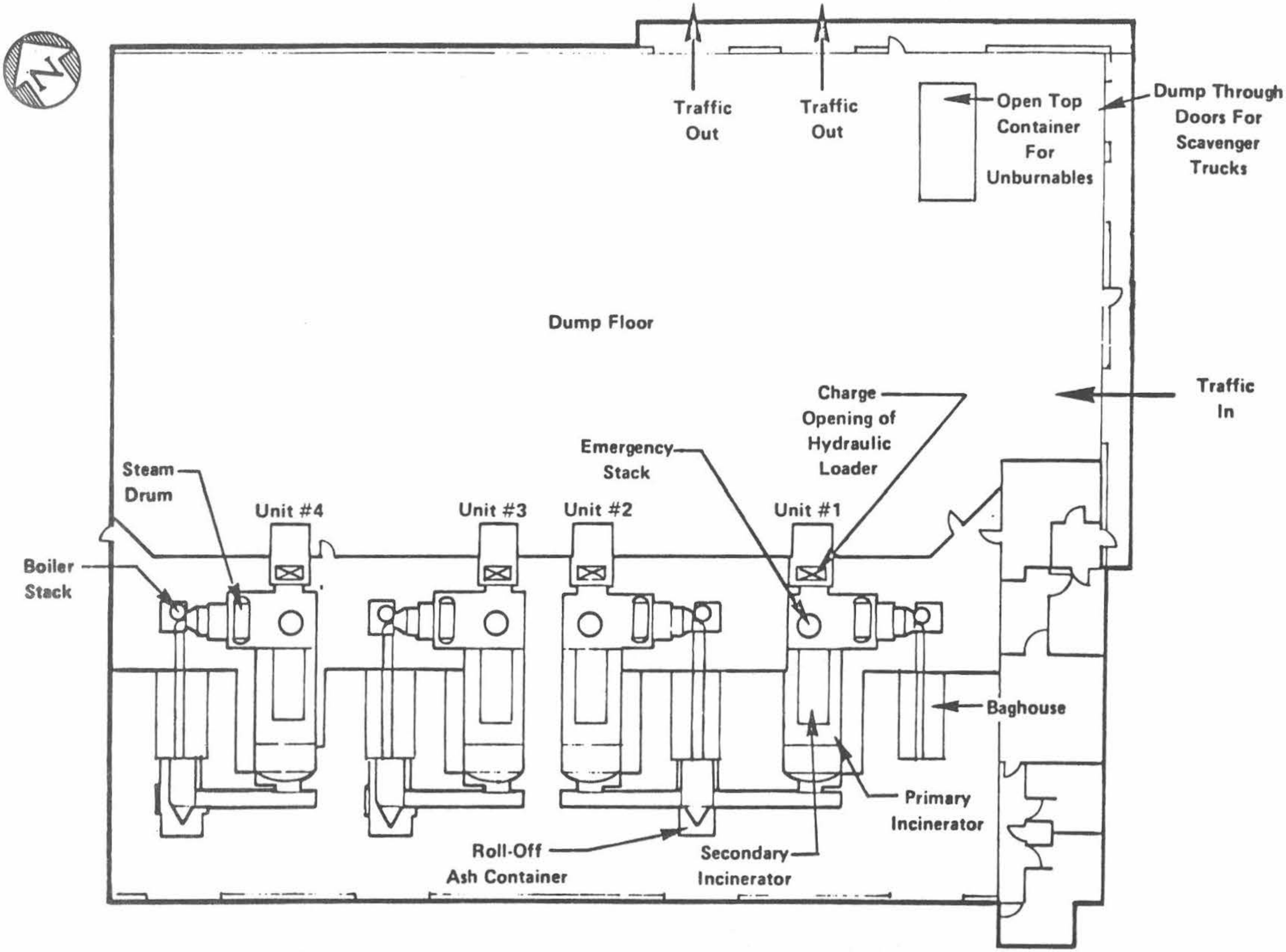
Appendix B

Energy Recovery Facility



SOURCE: BATTELLE, COMPILED FROM OCSWA, 1981; BARTON AND LOGUIDICE, 1981a; 1981b.

FIGURE 1. SITE LOCATION MAP



SOURCE: BARTON AND LOGUIDICE, 1981b; 1982a.

PLAN VIEW OF PROPOSED BUILDING AND EQUIPMENT