Site Suitability Review of the Consolidated Landfill LTD

by
Phillip L. Greer
North Dakota Geological Survey
and
Jeffrey Olson
North Dakota State Water Commission

Prepared by the
North Dakota Geological Survey
and the
North Dakota State Water Commission

ND Landfill Site Investigation No. 44

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Bismarck, North Dakota
1994

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INTRODUCTION

Purpose

The North Dakota State Engineer and the North Dakota State Geologist were instructed by the 52nd State Legislative Assembly to conduct site-suitability reviews of the solid waste landfills in the state of North Dakota. These reviews are to be completed by July 1, 1995 (North Dakota Century Code 23-29-07.7). The purpose of this program is to evaluate site suitability of each landfill for disposal of solid waste based on geologic and hydrologic characteristics. Reports will be provided to the North Dakota State Department of Health and Consolidated Laboratories (NDSDHCL) for use in site improvement, site remediation, or landfill closure. A one-time ground-water sampling event was performed at each site, and additional studies may be necessary to meet the requirements of the NDSDHCL for continued operation of solid-waste landfills. The Consolidated Landfill LTD is one of the landfills being evaluated.

Location of the Consolidated Landfill LTD

The Consolidated solid-waste landfill is located 5 1/2 miles north of the City of Park River in the SW 1/4, NW 1/4, Section 27, Township 158 North, Range 55 West. The landfill encompasses approximately 30 acres.

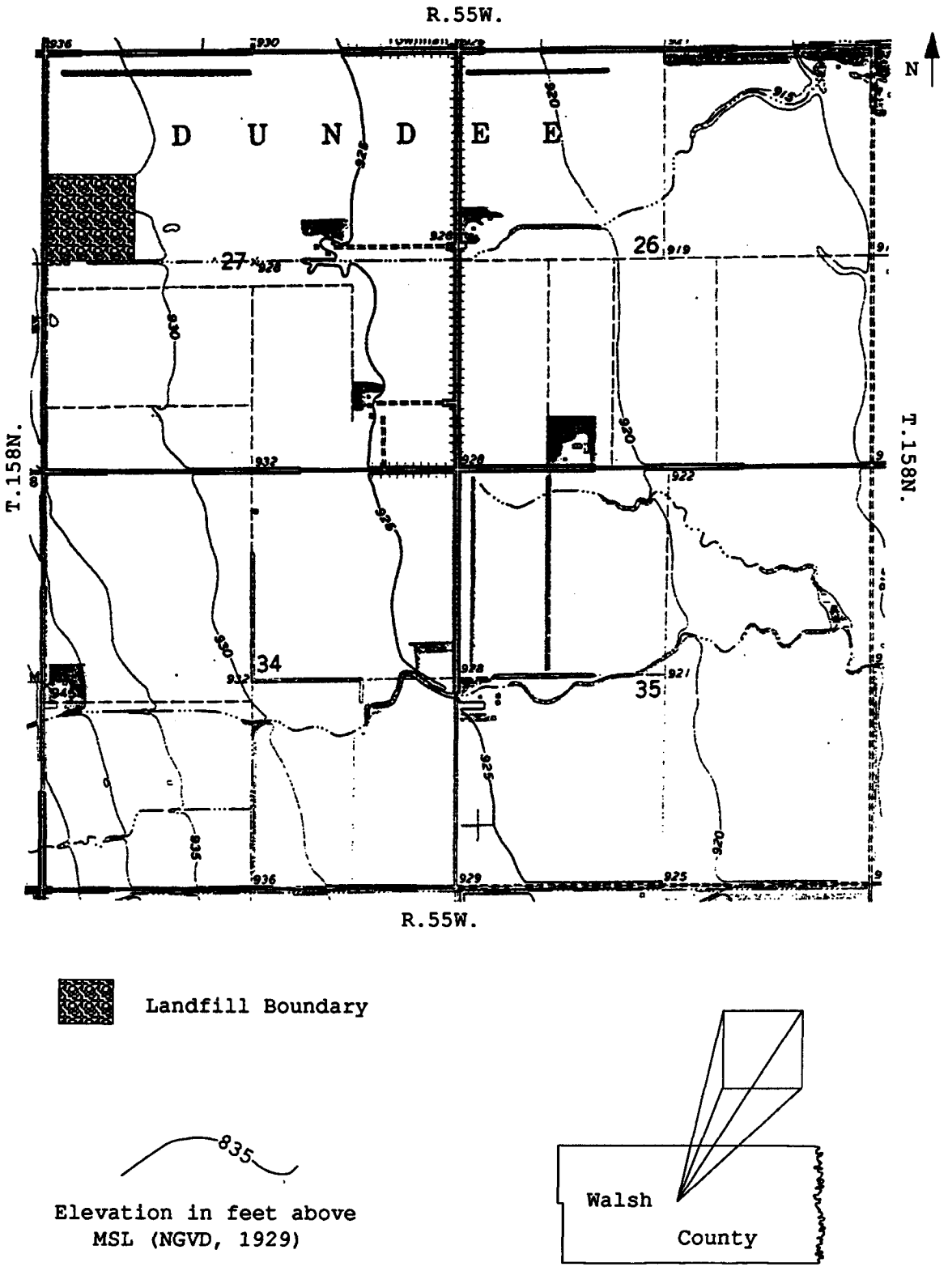

Figure 1. Location of the Consolidated landfill in the SW 1/4, NW 1/4, Section 27, T.158N., R.55W.

Previous Site Investigations

In 1987 Ecology & Environment, Inc. performed an assessment of the landfill under a contract from the Environmental Protection Agency. The landfill was considered a potentially hazardous site because several hundred pesticide containers were buried on the site. Five monitoring wells were used in this investigation: two existing wells and three additional wells drilled by Twin City Testing. Ground water, surface water, and soil samples were collected and tested for pesticides and other hazardous chemicals. Ecology and Environment found no evidence of contaminant release at the site.

Methods of Investigation

The Consolidated Landfill LTD study was accomplished by means of: 1) drilling test holes; 2) constructing and developing monitoring wells; 3) collecting and analyzing water samples; and 4) measuring water levels.

Test-Drilling Procedure

The drilling method was based on the site's geology and depth to ground water, as determined by the preliminary site evaluation. A hollow-stem auger was used at the Consolidated

landfill because the ground water was known to be shallow at the site. The lithologic descriptions were determined from the drill cuttings. The water used with the rig was obtained from municipal water supplies.

Monitoring Well Construction and Development

Four test holes were drilled at the Consolidated landfill, and three of them were completed as monitoring wells. Two existing wells from the Ecology and Environment project were also used in the study. Three other existing monitoring wells had broken casings and as a result were not used to collect water samples for chemical analyses. The north side and northeast corner of the landfill were inaccessible because of farming activities and wet conditions. The depth and intake interval of each well was selected to monitor the water level at the top of the uppermost aquifer.

Wells were constructed following a standard design (Fig. 2) intended to comply with the construction regulations of the NDSDHCL and the North Dakota Board of Water Well Contractors (North Dakota Department of Health, 1986). The wells were constructed using a 2-inch diameter, SDR21, polyvinyl chloride (PVC) well casing and a PVC screen, either 5 or 10 feet long, with a slot-opening size of 0.012 or 0.013 inches. The screen was fastened to the casing with stainless

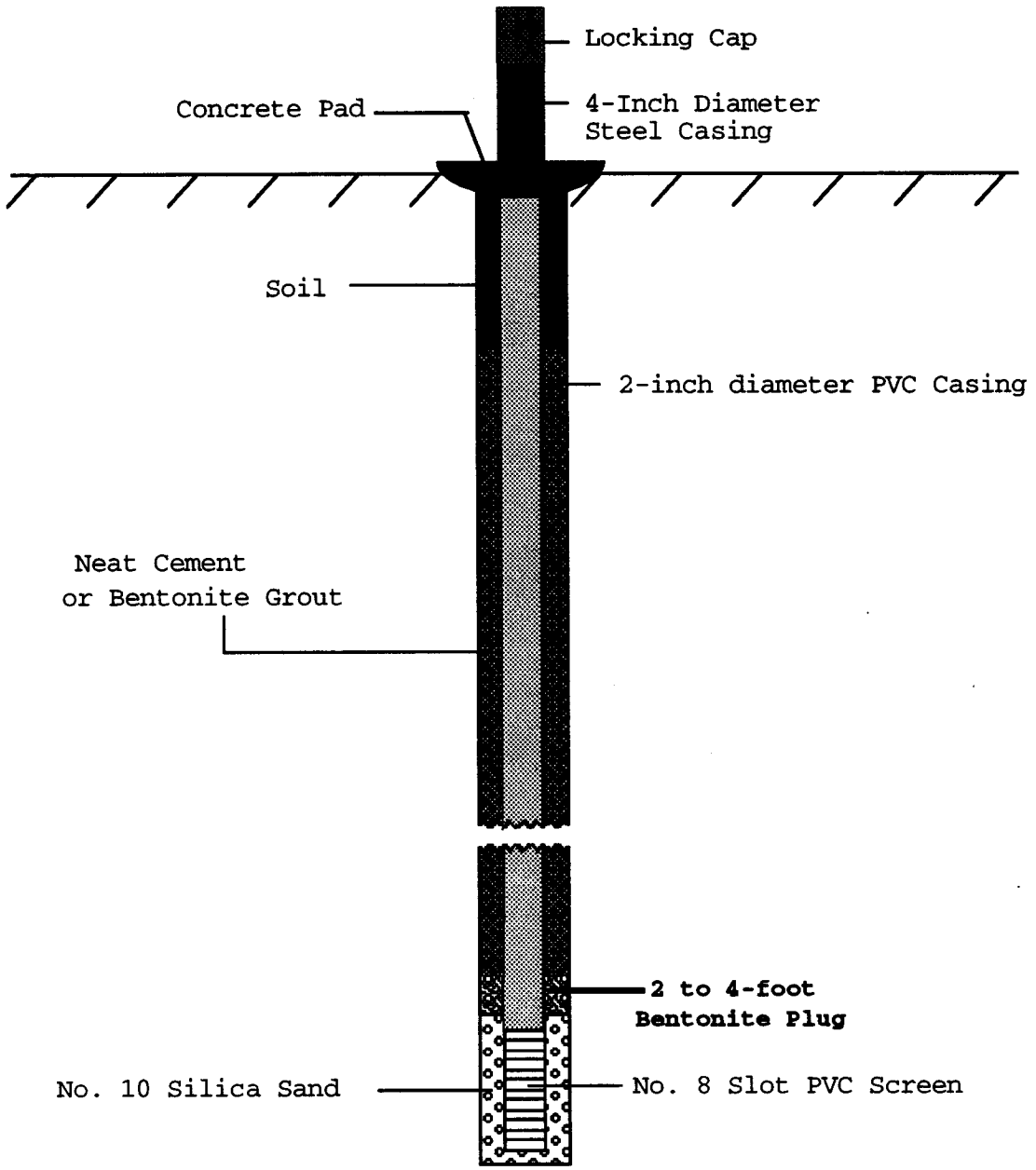

Figure 2. Construction design used for monitoring wells installed at the Consolidated Landfill LTD.

steel screws (no solvent weld cement was used). After the casing and screen were installed into the drill hole, the annulus around the screen was filled with No. 10 (grain-size diameter) silica sand to a height of two feet above the top of the screen. A two to three-foot bentonite plug was placed above the sand pack using medium-size bentonite chips. High-solids bentonite grout and/or neat cement was placed above the bentonite plug to seal the annulus to approximately five feet below land surface. The remaining annulus was filled with drill cuttings. The permanent wells were secured with a protective steel casing and a locking cover protected by a two-foot-square concrete pad.

All monitoring wells were developed using a stainless steel bladder pump or a teflon bailer. Any drilling fluid and fine materials present near the well were removed to insure movement of formation water through the screen.

The Mean Sea Level (MSL) elevation was established for each well by differential leveling to Third Order accuracy. The surveys established the MSL elevation at the top of the casing and the elevation of the land surface next to each well.

Collecting and Analyzing Water Samples

Water-quality analyses were used to determine if leachate is migrating from the landfill into the underlying ground-water system. Selected field parameters, major ions,

and trace elements were measured for each water sample. These field parameters and analytes are listed in Appendix A with their Maximum Contaminant Levels (MCL). MCLs are enforceable drinking water standards that represent the maximum permissible level of a contaminant as stipulated by the U.S. Environmental Protection Agency (EPA).

Water samples were collected using a bladder pump constructed of stainless steel with a teflon bladder. A teflon bailer was used in monitoring wells with limited transmitting capacity. Before sample collection, three to four well volumes were extracted to insure that unadulterated formation water was sampled. Four samples from each well were collected in high-density polyethylene plastic bottles as follows:

1) Raw (500 ml)
2) Filtered (500 ml)
3) Filtered and acidified (500 ml)
4) Filtered and double acidified (500 ml)

The following parameters were determined for each sample: specific conductance, pH, bicarbonate, and carbonate were analyzed using the raw sample. Sulfate, chloride, nitrate*, and dissolved solids were analyzed using the filtered sample. Calcium, magnesium, sodium, potassium, iron, and manganese were analyzed from the filtered, acidified sample. Cadmium, lead, arsenic, and mercury were analyzed using the filtered double-acidified samples.

* No special preservative techniques were applied to nitrate samples and as a result reported nitrate concentrations may be lower than actual.

One well was sampled for Volatile Organic Compounds (VOC) analysis. This sample was collected at a different time than the standard water-quality sample. The procedure used for collecting the VOC sample is described in Appendix B. Each sample was collected with a plastic throw-away bailer and kept chilled. These samples were analyzed within the permitted 14-day holding period. The standard water-quality analyses were performed at the North Dakota State Water Commission (NDSWC) Laboratory and VOC analyses were performed by the NDSDHCL.

Water-Level Measurements

Water-level measurements were taken at least three times at a minimum of two-week intervals. The measurements were taken using a chalked-steel tape or an electronic (Solnist 10078) water-level indicator. These measurements were used to determine the shape and configuration of the water table.

Location-Numbering System

The system for denoting the location of a test hole or observation well is based on the federal system of rectangular surveys of public land. The first and second numbers indicate Township north and Range west of the 5th Principle Meridian and baseline (Fig. 3). The third number indicates the section. The letters A, B, C, and D designate,

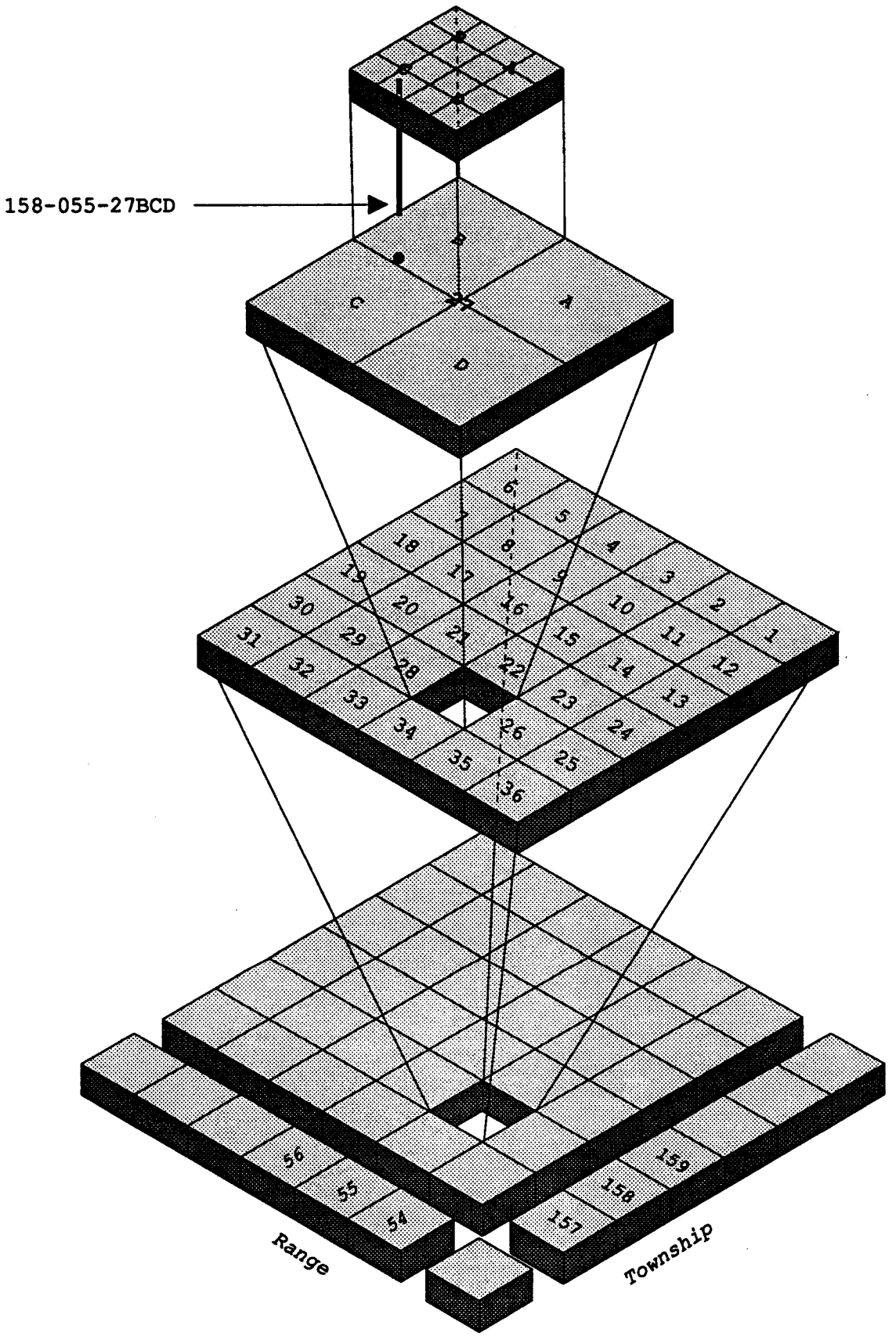

Figure 3. Location-numbering system.

respectively, the northeast, northwest, southwest, and southeast quarter section (160-acre tract), quarter-quarter section (40-acre tract), and quarter-quarter-quarter section (10-acre tract). Therefore, a well denoted by 158-055-27BCD would be located in the SE1/4, SW1/4, NW1/4, Section 27, Township 158 North, Range 55 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 158-055-27BCD1 and 158-055-27BCD2.

GEOLOGY

Regional Geology

The Consolidated landfill lies within the Red River Valley physiographic region, about nine miles east of the Pembina Escarpment. The landfill is in a flat area about one-quarter mile east of the Blanchard beach ridge complex. A variety of sediments occur near the landfill, including beach deposits, near-shore and offshore lake deposits, glacial till, wind-blown deposits, and alluvium (Bluemle, 1973).

Deep test holes that were drilled in 1969 for the county ground water study indicate that the area typically contains a few feet or tens of feet of beach or lake deposits overlying 100 or more feet of till. Bedrock in the form of Cretaceous gray shale occurs at an average depth of about 200

feet (Downey, 1971, test holes 157-55-5BBB, 158-54-18DDD, and 158-55-19AAA). Alluvium occurs near the Park River and its tributaries.

Local Geology

The landfill is located near two intermittent streams (Fig. 4) which flow into the Middle Branch Park River. The streams have been diverted into drainage ditches along section lines and half section lines.

Test holes drilled at the landfill penetrated a variety of generally poorly-sorted sediments, including silty and sandy clay, clayey silt, sandy silt, sand, fine gravel, and till. The top few feet of clay and silt are probably modern alluvium. A zone of sand and sandy silt underlies the surficial clay across the south end of the landfill. This zone ranges in thickness from 7 feet in test hole 27CBA2 to 17 feet in test hole 28ADD (Fig. 5, lithologic logs in Appendix C). The zone is thicker and coarser grained at the southeast corner of the site where lenses of fine gravel are interbedded with the sand (158-055-28ADD and 27CBB). The sand, sandy silt, and fine gravel may be near-shore lake deposits.

Till was encountered in test holes 158-055-27CBA1, 27CBA2, and 27BCB. The till occurs at a shallow depth at the north end of the landfill. Test hole 27BCB penetrated till from 5 to 20 feet, and a landfill trench inspected by the

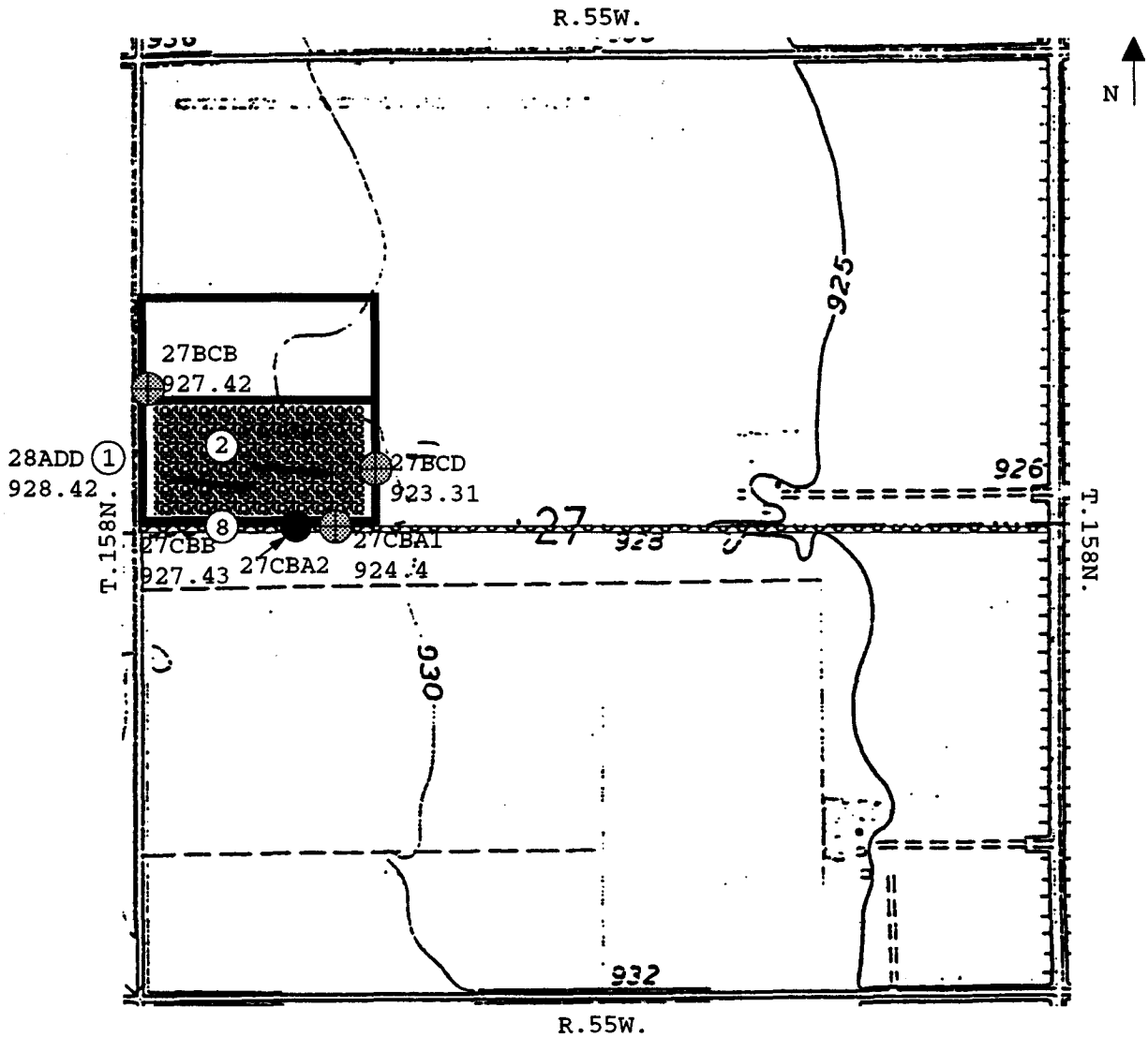

Figure 4. Location of monitoring wells and the direction of ground-water flow.

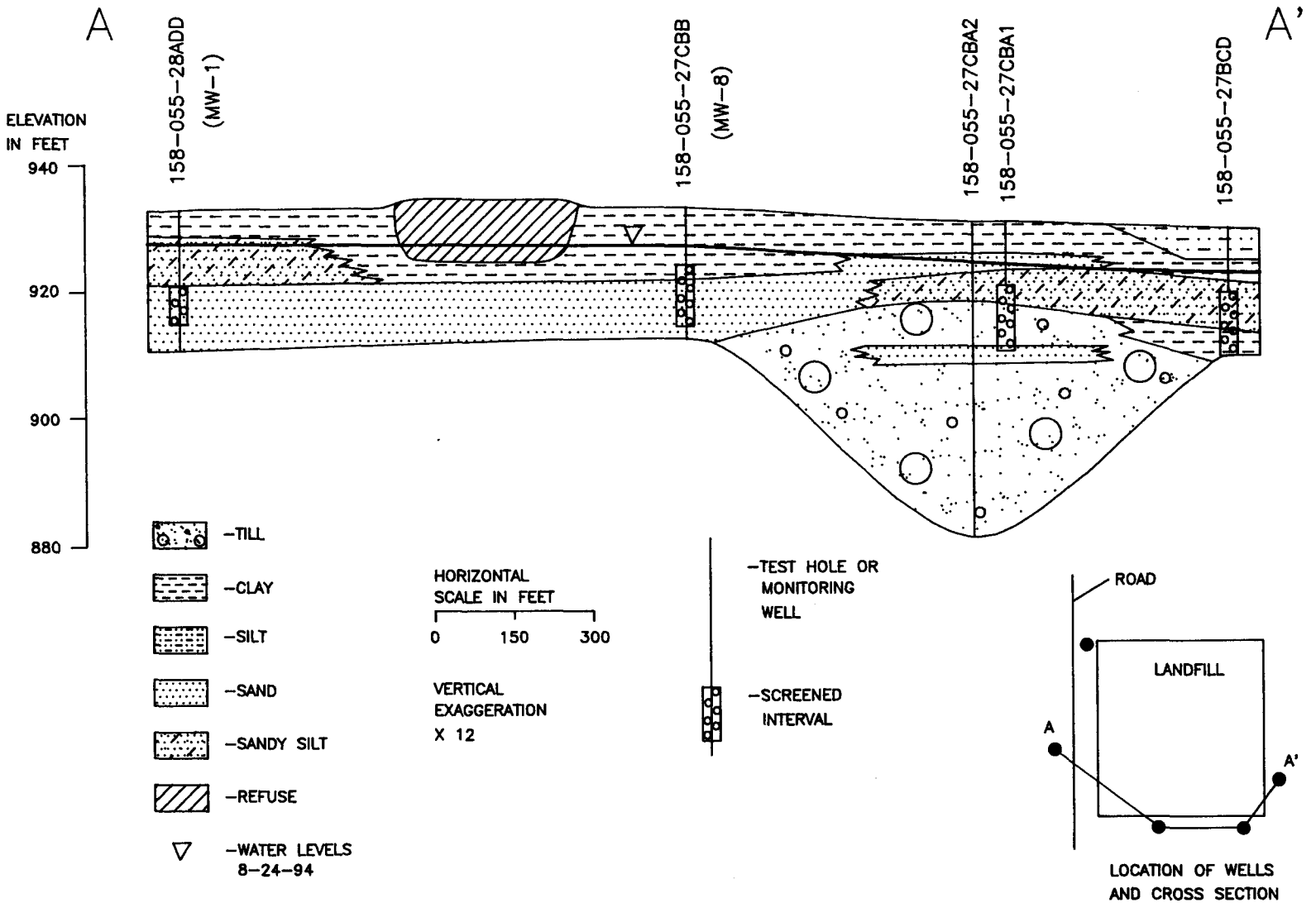

Figure 5. Geohydrologic section A–A' in the Consolidated landfill.

North Dakota Geological Survey in 1977 contained till from 3 feet to the bottom of the trench (Kehew, 1977).

HYDROLOGY

Surface-Water Hydrology

An intermittent stream is located at the southern boundary of the Consolidated landfill. The course of this intermittent stream has been altered to increase surface water drainage. This stream flows east and discharges into the North Branch of the Park River. The base of the stream appears to regulate the depth of the shallow water table. This stream may be susceptible to contaminant migration from the landfill because it is located close to the landfill.

Regional Ground-Water Hydrology

Regional aquifers in the area of the Consolidated landfill consist of bedrock and glacial lithologies. The lower bedrock aquifers may be found in the Ordovician-age formations. These include the Winnipeg, Red River, and Stony Mountain Formations (Downey, 1973). The top of the Ordovician formations is located about 350 feet below land surface in Walsh County. There is little information on the hydrology of these formations but is assumed they contain small quantities of water (Downey, 1973). The aquifers in

these formations are characterized by a sodium-chloride brine type water. These aquifers should not be affected by contaminant migration from the landfill due to their depths and the occurrence of intervening clay and till lithologies.

The Dakota Group overlies the Ordovician formations at a depth of about 200 feet below land surface near the Consolidated landfill (Downey, 1973). The Dakota aquifer may flow in wells below an elevation of about 900 feet MSL (Downey, 1973). The Dakota aquifer is characterized by a sodium-chloride type water. This aquifer should not be susceptible to contaminant migration due to its depth and the occurrence of intervening clay and till lithologies.

The glacial aquifers near the Consolidated landfill consist of undifferentiated sand and gravel deposits (Downey, 1973). These aquifers are usually not very extensive and contain only small quantities of water. There may be an undifferentiated glacial aquifer about 0.75 miles west of the Consolidated landfill. This aquifer should not be affected by contaminant migration from the landfill due to its up-gradient location. It is not known if any other undifferentiated aquifers exist near the landfill.

Local Ground-Water Hydrology

Four test holes were drilled at the Consolidated landfill with monitoring wells installed in three of them. Two additional wells from a previous investigation were also

used in this study. Monitoring well 158-055-28ADD is located up-gradient of the landfill and was used for water-quality comparison. Four water-level measurements were taken over an eight week period (Appendix D). The undifferentiated aquifer beneath the landfill is comprised of sand to silty sand. The local direction of ground-water flow in this aquifer is to the east.

Water Quality

Chemical analyses of water samples are shown in Appendix E. The major ion analyses detected an anomalously high sulfate concentration (3,900 mg/L) in well 27BCB which exceeds the SMCL of 1000 mg/L. The source of the high sulfate concentration was not determined. The major ion analyses detected a chloride concentration of 260 mg/L in well 27BCD. This concentration exceeds the SMCL of 250 mg/L set by the Environmental Protection Agency (EPA). This well is located directly down-gradient of the buried refuse. It is inconclusive whether the elevated chloride concentration may be the result of upward ground-water movement from the underlying bedrock aquifer or contaminant migration from the landfill. No other major ions were detected above their established SMCL.

The trace element analyses detected concentrations of molybdenum (149 µg/L) and selenium (56 µg/L) in well 27BCB. These concentrations exceed their MCL's of 100 µg/L and 10

µg/L repectively. Well 27BCB is located in the northwest corner of the landfill adjacent to the buried refuse. The elevated molybdenum and selenium concentrations may be attributed to contaminant migration from the buried refuse. No other trace elements were detected above their established MCL.

The results of the VOC analysis, from well 158-055-27CBA, are located in Appendix F. The VOC analyses detected a concentration of dichloromethane (1.96 µg/L). It is inconclusive whether the source of the VOC compound is the result of laboratory contamination† or migration from the landfill.

CONCLUSIONS

The Consolidated landfill is located in a relatively flat area east of the Blanchard beach ridge complex. Two intermittent streams near the landfill have been diverted into drainage ditches, one of which extends along the south side of the landfill.

The sediments at the landfill include alluvium, nearshore lake deposits, and glacial till. On the south side of the landfill a 7- to 17-foot-thick layer of sand and sandy silt with lenses of fine gravel forms a small, shallow

† Beginning in September, 1994 the NDSDHCL changed their analytical procedures that lowered detection limits for VOC concentrations by one to two orders of magnitude.

aquifer. The aquifer is not present on the north side of the landfill. In this area a surficial layer of alluvium is directly underlain by till. The direction of ground-water flow in the shallow sand aquifer is toward the east.

No major glacial aquifers are known to occur near the landfill. Bedrock aquifers occur at depths greater than 200 feet and should not be affected by the landfill because of their depths and intervening clay and till lithologies.

Chemical analyses of water samples detected an elevated sulfate concentration in well 27BCB and an elevated chloride concentration in well 158-055-27BCD. The source of the sulfate was not determined. It is inconclusive whether the elevated chloride concentration may be the result of upward ground-water movement from the underlying bedrock aquifers or contaminant migration from the landfill. The trace element analyses revealed molybdenum and selenium concentrations exceeding the MCL's in well 27BCB. This well is located adjacent to the buried refuse and the elevated molybdenum and selenium concentrations may be attributed to contaminant migration from the landfill.

The VOC analysis, from well 27CBA, detected dichloromethane. It is inconclusive whether the source of the VOC compound is the result of laboratory contamination or migration from the landfill.

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APPENDIX A

WATER QUALITY STANDARDS
AND
CONTAMINANT LEVELS

Water Quality Standards and Contaminant Levels

Field Parameters	
appearance	color/odor
pH	6-9 (optimum)
specific conductance	-----
temperature	-----

Constituent	**MCL (µg/L)**
Arsenic	50
Cadmium	10
Lead	50
Molybdenum	100
Mercury	2
Selenium	10
Strontium	*

*EPA has not set an MCL for strontium. The median concentration for most U.S. water supplies is 100 µg/L (Hem, 1989).

	SMCL (mg/L)
Chloride	250
Iron	>0.3
Nitrate	50
Sodium	20-170
Sulfate	300-1000
Total Dissolved Solids	>1000

	Recommended Concentration Limits (mg/L)
Bicarbonate	150-200
Calcium	25-50
Carbonate	150-200
Magnesium	25-50
Hardness	>121 (hard to very hard)

APPENDIX B

SAMPLING PROCEDURE FOR VOLATILE ORGANIC COMPOUNDS

SAMPLING PROCEDURE FOR 40ML AMBER BOTTLES

Sample Collection for Volatile Organic Compounds

by
North Dakota Department of Health
and ConsolidatedLaboratories

1. Three samples must be collected in the 40ml bottles that are provided by the lab. One is the sample and the others are duplicates.

2. A blank will be sent along. Do Not open this blank and turn it in with the other three samples.

3. Adjust the flow so that no air bubbles pass through the sample as the bottle is being filled. No air should be trapped in the sample when the bottle is sealed. Make sure that you do not wash the ascorbic acid out of the bottle when taking the sample.

4. The meniscus of the water is the curved upper surface of the liquid. The meniscus should be convex (as shown) so that when the cover to the bottle is put on, no air bubbles will be allowed in the sample.

convex meniscus

5. Add the small vial of concentrated HCL to the bottle.

6. Screw the cover on with the white Teflon side down. Shake vigorously, turn the bottle upside down, and tap gently to check if air bubbles are in the sample.

7. If air bubbles are present, take the cover off the bottle and add more water. Continue this process until there are no air bubbles in the sample.

8. The sample must be iced after collection and delivered to the laboratory as soon as possible.

9. The 40 ml bottles contain ascorbic acid as a preservative and care must be taken not to wash it out of the bottles. The concentrated acid must be added after collection as an additional preservative.

APPENDIX C

LITHOLOGIC LOGS OF WELLS AND TEST HOLES

158-055-27BCB
NDSWC

Date Completed:	7/12/94	Purpose:	Observation Well
L.S. Elevation (ft):	931.9	Well Type:	2" PVC
Depth Drilled (ft):	20	Aquifer:	Undefined
Screened Interval (ft):	10-20	Source:	
		Owner:	Consolidated landfill

Lithologic Log

Unit	Description	Depth (ft)
Silt	Trace of fine to coarse sand, yellowish-brown, till.	2-5
Clay	Trace of sand and gravel, yellowish-brown, lenses of sand and fine gravel.	5-16
Clay	Trace of gravel, pale yellowish-brown with moderately red mottles.	16-20
Topsoil		0-2

158-055-27BCD
NDSWC

Date Completed:	7/11/94	Purpose:	Observation Well
L.S. Elevation (ft):	930.4	Well Type:	2" PVC
Depth Drilled (ft):	20	Aquifer:	Undefined
Screened Interval (ft):	10-20	Source:	
		Owner:	Consolidated Landfill

Lithologic Log

Unit	Description	Depth (ft)
Topsoil		0-2
Silt	Clayey, yellowish-brown, till.	2-5
Clay	With very fine grained sand and a trace of silt, yellowish-brown.	5-8
Silt	With very fine grained sand, yellowish-brown.	8-17
Clay	Silty, with very fine grained sand, medium gray.	17-20

158-055-27CBA1
NDSWC

Date Completed:	7/11/94	Purpose:	Observation Well
L.S. Elevation (ft):	931.1	Well Type:	2" PVC
Depth Drilled (ft):	20	Aquifer:	Undefined
Screened Interval (ft):	10-20	Source:	
		Owner:	Consolidated Landfill

Lithologic Log

Unit	Description	Depth (ft)
Topsoil		0-2
Clay	Silty with a trace of very fine sand, yellowish-brown, till.	2-7
Sand	Clayey, trace of silt, yellowish-brown.	7-11
Clay	Sandy, silty, yellowish-brown.	11-15
Silt	Sandy, clayey, trace of fine gravel, medium gray.	15-18
Clay	Silty, trace of fine sand, medium gray.	18-20

158-055-27CBA2
NDSWC

Date Completed:	7/12/94	Purpose:	Test Hole
L.S. Elevation (ft):	931.73	Well Type:	
Depth Drilled (ft):	50		
		Source:	
		Owner:	Consolidated Landfill

Lithologic Log

Unit	Description	Depth (ft)
Topsoil		0-2
Clay	Silty, trace fine sand, yellowish-brown, till.	2-6
Sand	Fine grained, silty, trace of clay, yellowish-brown.	6-9
Silt	Sandy, clayey, yellowish-brown.	9-13
Clay	Silty, trace of sand and small pebbles, medium gray.	13-21
Sand	Silty, and fine gravel, medium gray.	21-23
Clay	Sandy with a trace of gravel, lenses of fine to coarse sand, medium gray.	23-42
Clay	Trace of sand and gravel, medium gray.	42-50

DRILL LOG

PROJECT CONCORD AREA LANDFILL TDD NO. F03-8704-14 DATE 8-14-87

WELL/BORING GL-MW-1 LOCATION 250' West of landfill, LOGGER M. Gleason

DRILL METHOD HSA west of County Rd. 12 PAGE 1 OF 1

WATER LEVEL FIRST ENCOUNTERED 11.4 FINAL 4.2 ELEV.

DEPTH IN FEET	LITH COL	SAMPLE TYPE IDENT.	MOISTURE CONTENT WATER LEVEL	LITHOLOGIC DESCRIPTION	NOTES
				Top soil black sandy clay with organic material (0-0.4')	
			Final ▽	Clay, high plasticity, sandy, soft moist, brown (CL)	SS blow count 1-1-2
5				Silt, sandy, fine to coarse grained, loose to med. dense moist, dark brown (SM) Scattered lenses of sandy clay	Recov. 88%
10			Initial ▽	Interbedded fine grained sand, silty, and clay, silty, low plasticity, loose to med dense moist to wet, gray (SM/CL)	SS 10-14-21 Recov 94%
15				Scattered lenses of fine gravel	SS 7-7-17 Recovery: 98%
20					SS 60 pr 6"
21					Recov 100%
				TD 21.0'	HNu: 0 ppm above background at Split Spoon and hole's mouth

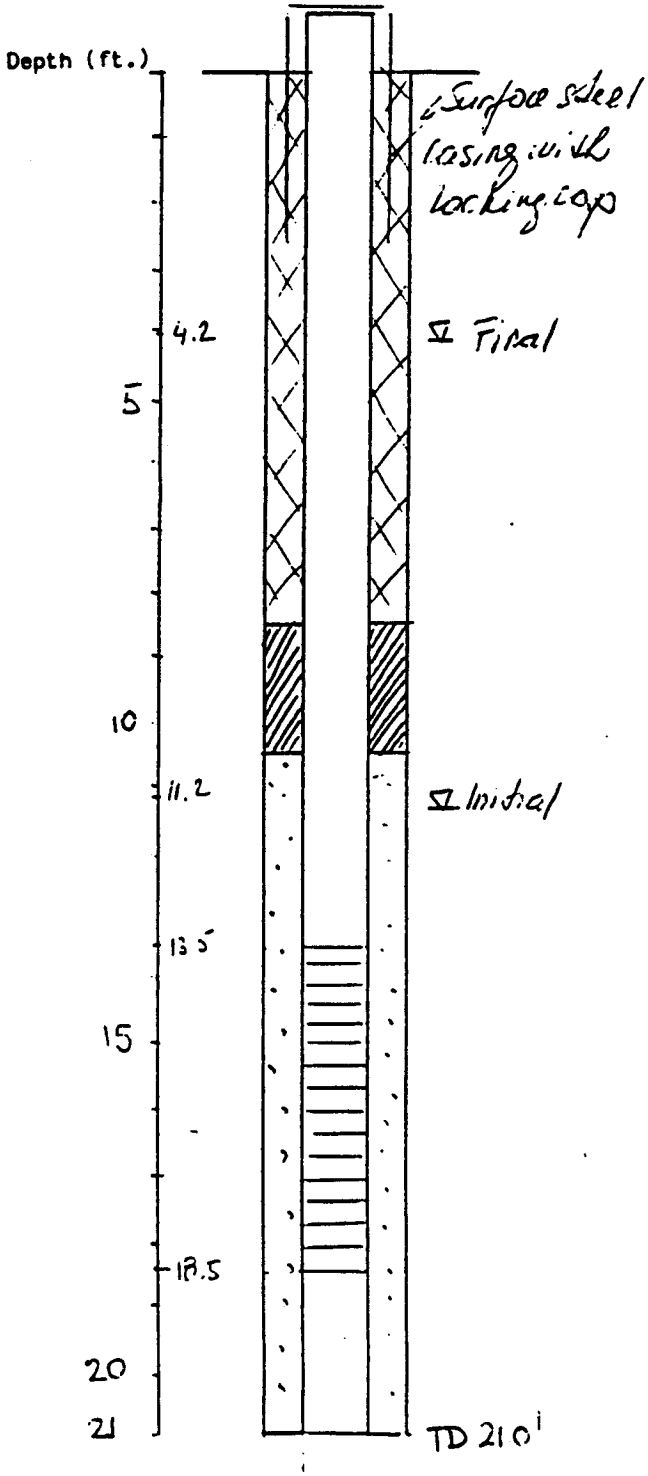
WELL/PIEZOMETER COMPLETION DIAGRAM

Project Consolidated Landfill — TDD No. F08-8707-14

Location West of the County Rd. 12 — Well Number CL-MW-1

Geologist H. Peceny — Date(s) of Installation 10-14-87

Depth to Water 4.2 feet (G.L.) — Elevation from Measuring Point



DRILLING SUMMARY:

Driller H. Jacobson TWIN CITY TESTING

Rig Type CME 75

Drilling Method HSA

Bit(s) Tooth type

Drilling Fluid None

Surface Casing Steel

Hollow Stem/Drive Casing I.D. (in.) 6 1/4"

Total Depth of Boring (ft.) 21.0'

Borehole Diameter (in.) 7 7/8"

WELL DESIGN:

Completion Basis: Above Grade ✓ Below Grade ____ Geological Log ✓ Geophysical Log ____ Type ____

Total Depth of Well (ft.) 21.0

Casing String(s): C=casing S=screen

C 21 - 18.5 | S 18.5 - 13.5

C 13.5 - 0 | ____

Casing: 2" SCH Schedule PVC

Screen: 2" SCH Schedule PVC .010 Slots

Centralizers None

Gravel/Sand Pack 21 to 10.5 feet — Silica Sand 12-30

Bentonite Seal(s) 10.5 to 8.5 feet

to ____ feet

Bentonite (type) 1/2" Pellets

Backfill (cuttings) / to / feet

Cement Seal(s) 8.5 to 0 feet

to ____ feet

Cement Composition 90% Portland Cement + 10% Bentonite (Super Gel)

Protective Casing +2.5 to +2.5 feet

Protective Casing Type 4" Steel w. H locking cap

Other ____

WELL DEVELOPMENT:

Method Stainless Steel Bailer

Duration 3 hrs Estimated production 0.2 gpm

Water Appearance cloudy

Remarks: ____

DRILL LOG

JECT CONSOLIDATED LANDFILL TDD NO. F08-8702-14 DATE 10-14-87

L/BORING A-MW-8 LOCATION Southern Landfill LOGGER M. Secrest

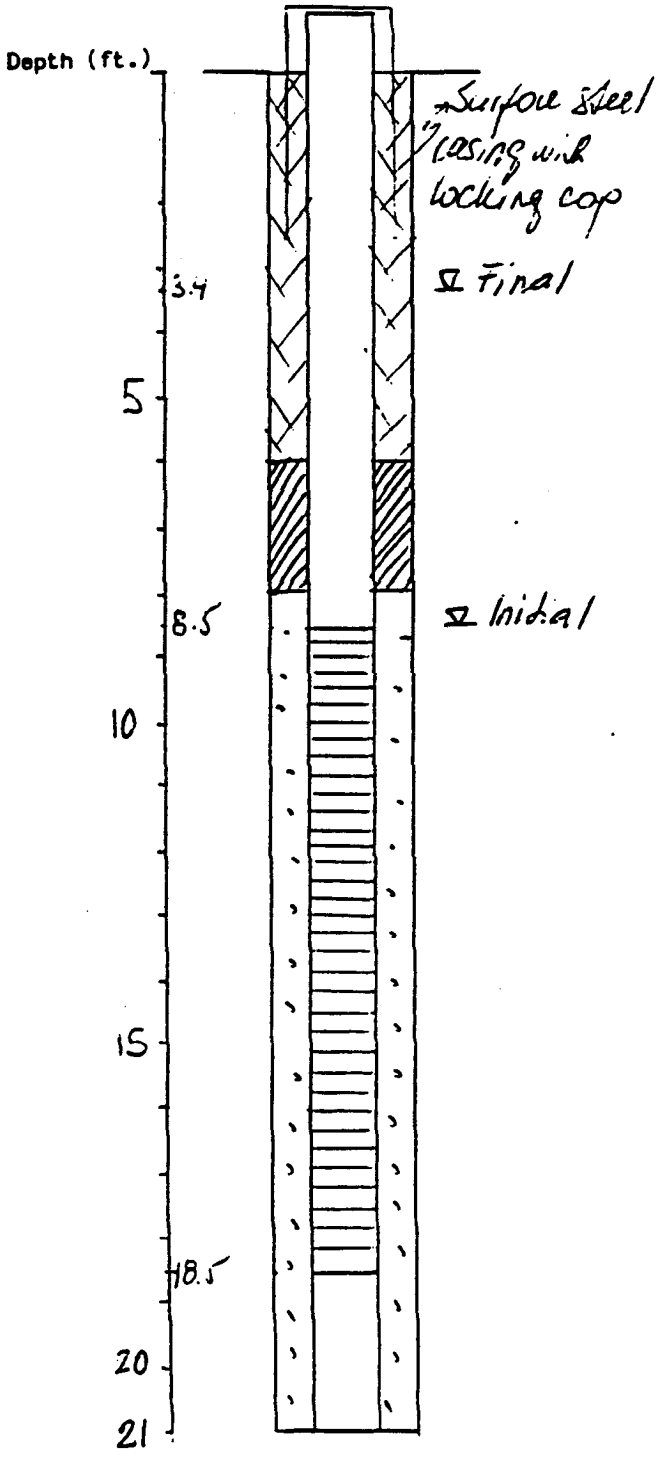
LL METHOD HSA boundary PAGE 1 OF 1

IER LEVEL FIRST ENCOUNTERED 85 FINAL 3.4 ELEV.

EPTH IN EET	LITH COL	SAMPLE TYPE IDENT.	MOISTURE CONTENT WATER LEVEL	LITHOLOGIC DESCRIPTION	NOTES
				Top Soil - black clay w/ organic mat.	
			Final ▽	Clay, high plasticity, sandy to slightly sandy, very soft, moist brown (CL)	
5					
			Initial ▽		SS Blow count 1-1-1
					HNu: 0 ppm above background
10					Recovery: 85%
				Sand, fine to coarse, loose to medium dense, moist to wet, brown interbedded w/ sandy clay (SM/SC)	SS Blow count 12-30-30
15					HNu: 0.6 - 0.8 ppm above background
					Recovery: 90%
				Sand, fine grained, silty, dense to med. dense, moist to wet, gray (SM), scattered fine gravel	SS Blow count 15-30
20					HNu: 0.6 ppm above background
21					Recovery: 95%
	T.D.	21.0			

WELL/PIEZOMETER COMPLETION DIAGRAM

Project Consolidated Landfill
TDD No. F08-8707-14
Location Southern L.F boundary
Well Number CL-MW 8
Geologist M. Pacany
Date(s) of Installation 10-14-87
Depth to Water 3.4 feet (G.L.)
Elevation from Measuring Point



DRILLING SUMMARY:

Driller H. Jacobson TWIN CITY TESTING
Rig Type CME 75
Drilling Method HSA
Bit(s) Tooth type
Drilling Fluid None
Surface Casing Steel
Hollow Stem/Drive Casing I.D. (in.) 6 1/4"
Total Depth of Boring (ft.) 21.0
Borehole Diameter (in.) 7 3/8"

WELL DESIGN:

Completion Basis: Above Grade ✓ Below Grade
Geological Log ✓ Geophysical Log Type
Total Depth of Well (ft.) 21.0
Casing String(s): C=casing S=screen
C 21 - 18.5 | S 18.5 - 8.5
C 8.5 - 0 |
Casing: 2" 80 Schedule PVC
Screen: 2" 80 Schedule PVC .010 slots
Centralizers None
Gravel/Sand Pack 21 to 8 feet
Silica Sand 12-30
Bentonite Seal(s) 8 to 6 feet
to feet
Bentonite (type) 1/2" Pellets
Backfill (cuttings) ~ to ~ feet
Cement Seal(s) 6 to 0 feet
to feet
Cement Composition 50% Portland Cement
50% Bentonite (Super Gel)
Protective Casing -2.5 to +2.5-0 feet
Protective Casing Type 4" Steel with locking cap
Other

WELL DEVELOPMENT:

Method Stainless Steel Bailer
Duration 2.25 hrs Estimated production 0.1 gpm
Water Appearance Slightly cloudy
Remarks:

APPENDIX D

WATER-LEVEL TABLES

Consolidated Landfill Water Levels
7/26/94 to 9/8/94

158-055-27BCB — MP Elev (msl,ft)=933.28
Undefined Aquifer — SI (ft.)=10-20

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/26/94	5.91	927.37	08/24/94	5.86	927.42
08/11/94	6.47	926.81	09/08/94	6.62	926.66

158-055-27BCD — MP Elev (msl,ft)=931.95
Undefined Aquifer — SI (ft.)=10-20

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/26/94	7.79	924.16	08/24/94	8.64	923.31
08/11/94	8.75	923.20	09/08/94	8.76	923.19

158-055-27CBA1 — MP Elev (msl,ft)=933.26
Undefined Aquifer — SI (ft.)=10-20

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/26/94	7.15	926.11	08/24/94	8.86	924.40
08/11/94	8.51	924.75	09/08/94	9.32	923.94

158-055-27CBB — MP Elev (msl,ft)=936.2
Undefined Aquifer — SI (ft.)=8.5-18.5

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/29/94	7.94	928.26	08/24/94	8.77	927.43
08/11/94	8.92	927.28	09/08/94	9.44	926.76

158-055-28ADD — MP Elev (msl,ft)=934.48
Undefined Aquifer — SI (ft.)=13.5-18.5

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
07/26/94	5.38	929.10	08/24/94	6.06	928.42
08/11/94	6.24	928.24	09/08/94	6.87	927.61

APPENDIX E

MAJOR ION AND TRACE-ELEMENT CONCENTRATIONS

Consolidated Landfill Water Quality
Major Ions Analyses

Location	Screened Interval (ft)	Date Sampled	SiO_2	Fe	Mn	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl	F	NO_3	B	TDS	Hardness $CaCO_3$	as NCH	% Na	SAR	Spec Cond (µmho)	Temp (°C)	Lab pH
			←(milligrams per liter)→																					
158-055-27BCB	10-20	07/25/94	28	0.08	0.02	410	310	850	33	179	0	3900	36	0.2	1.3	0.11	5660	2300	2200	44	7.7	7410	10	8.07
158-055-27BCD	10-20	07/19/94	28	0.05	0.18	380	200	140	20	1010	0	910	260	0.3	2.4	0.11	2440	1800	940	14	1.4	3790	10	7.14
158-055-27CBA1	10-20	07/21/94	29	0.21	0.16	190	63	74	10	259	0	640	67	0.4	0	0.07	1200	730	520	18	1.2	2860	8	7.68
158-055-27CBB	8.5-18.5	07/19/94	27	0.3	0.43	500	100	76	6.3	453	0	1400	110	0.6	1.6	0.18	2450	1700	1300	9	0.8	3450	11	7.15
158-055-28ADD	13.5-18.5	07/21/94	27	0.06	0.19	110	150	170	7.3	528	0	780	37	0.4	0	0.19	1540	890	460	29	2.5	3160	10	7.76

Trace Element Analyses

Location	Date Sampled	Selenium	Lead	Cadmium	Mercury	Arsenic	Molybdenum	Strontium
		(micrograms per liter)						
158-055-27BCB	07/25/94	56	0	0	0	0	149	1300
158-055-27BCD	07/25/94	5	0	0	0	2	3	610
158-055-27CBA1	07/25/94	4	0	0	0	2	57	280
158-055-27CBB	07/25/94	4	0	0	0	2	1	570
158-055-28ADD	07/25/94	3	0	0	0	2	1	190

APPENDIX F

VOLATILE ORGANIC COMPOUNDS
FOR WELL 158-055-27CBA

Volatile Organic Compounds
and
Minimum Concentrations

Concentrations are based only on detection limits. Anything over the detection limit indicates possible contamination.

Constituent	Chemical Analysis µg/L
Benzene	<0.5
Vinyl Chloride	<0.5
Carbon Tetrachloride	<0.5
1,2-Dichlorethane	<0.5
Trichloroethylene	<0.5
1,1-Dichloroethylene	<0.5
1,1,1-Trichloroethane	<0.5
para-Dichlorobenzene	<0.5
Acetone	<50
2-Butanone (MEK)	<50
2-Hexanone	<50
4-Methyl-2-pentanone	<50
Chloroform	<0.5
Bromodichloromethane	<0.5
Chlorodibromomethane	<0.5
Bromoform	<0.5
trans1,2-Dichloroethylene	<0.5
Chlorobenzene	<0.5
m-Dichlorobenzene	<0.5
Dichloromethane	1.96*
cis-1,2-Dichloroethylene	<0.5
o-Dichlorobenzene	<0.5
Dibromomethane	<0.5
1,1-Dichloropropene	<0.5
Tetrachlorethylene	<0.5
Toluene	<0.5
Xylene(s)	<0.5
1,1-Dichloroethane	<0.5
1,2-Dichloropropane	<0.5
1,1,2,2-Tetrachloroethane	<0.5
Ethyl Benzene	<0.5
1,3-Dichloropropane	<0.5
Styrene	<0.5
Chloromethane	<0.5
Bromomethane	<0.5
1,2,3-Trichloropropane	<0.5
1,1,1,2-Tetrachloroethane	<0.5
Chloroethane	<0.5
1,1,2-Trichloroethane	<0.5

* Constituent Detection

VOC Constituents cont.

2,2-Dichloropropane	<0.5
o-Chloroluene	<0.5
p-Chlorotoluene	<0.5
Bromobenzene	<0.5
1,3-Dichloropropene	<0.5
1,2,4-Trimethylbenzene	<0.5
1,2,4-Trichlorobenzene	<0.5
1,2,3-Trichlorobenzene	<0.5
n-Propylbenzene	<0.5
n-Butylbenzene	<0.5
Naphthalene	<0.5
Hexachlorobutadiene	<0.5
1,3,5-Trimethylbenzene	<0.5
p-Isopropyltoluene	<0.5
Isopropylbenzene	<0.5
Tert-butylbenzene	<0.5
Sec-butylbenzene	<0.5
Fluorotrichloromethane	<0.5
Dichlorodifluoromethane	<5
Bromochloromethane	<0.5
Allylchloride	<5
2,3-Dichloro-1-propane	<5
Tetrahydrofuran	<50
Pentachloroethane	<5
Trichlorotrifluoroethane	<5
Carbondisufide	<5
Ether	<5
trans-1,3-Dichloropropene	<0.5

* Constituent Detection