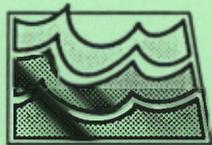


Site Suitability Review of the McDaniel Landfill

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



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

ND Landfill Site Investigation No. 34

SITE SUITABILITY REVIEW
OF THE
MCDANIEL LANDFILL

By Jeffrey M. Olson, North Dakota State Water Commission,
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North Dakota Landfill Site Investigation 34

Prepared by the NORTH DAKOTA STATE WATER COMMISSION
and the NORTH DAKOTA GEOLOGICAL SURVEY

Bismarck, North Dakota
1994

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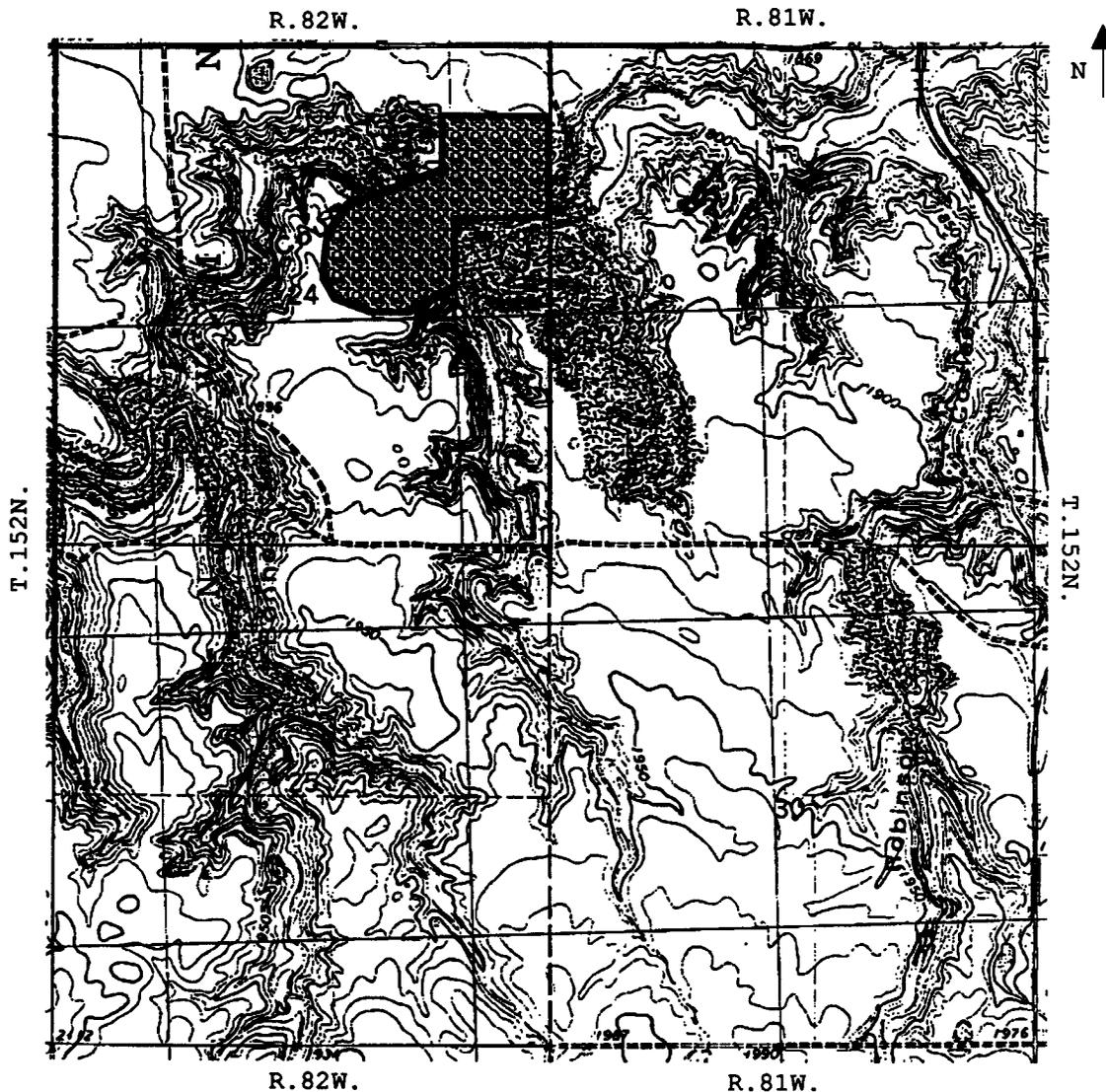
INTRODUCTION

Purpose

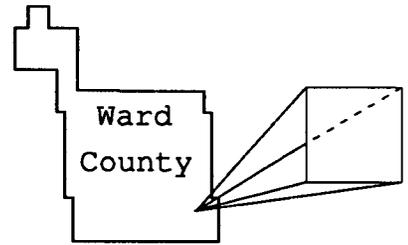
The North Dakota State Engineer and the North Dakota State Geologist were instructed by the 52nd State Legislative Assembly to conduct site-suitability reviews of the solid waste landfills in the state of North Dakota. These reviews are to be completed by July 1, 1995 (North Dakota Century Code 23-29-07.7). 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 (NDS DHCL) 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 NDS DHCL for continued operation of solid waste landfills. The McDaniel solid waste landfill is one of the landfills being evaluated.

Location of the McDaniel Landfill

The McDaniel municipal solid waste landfill is located about eight miles south of the City of Sawyer in Township 152 North, Range 82 West, NE 1/4 Section 24 (Fig. 1). The landfill site encompasses approximately 20 acres.



 Landfill Boundary



1950
Elevation in feet above
MSL (NGVD, 1929)

Figure 1. Location of the McDaniel Sanitation landfill in the NE 1/4 of section 24, T152N, R82W.

Previous Site Investigations

A hydrogeological investigation was completed by Foth and Van Dyke in October, 1990 on the present landfill site. The report concluded the direction of local ground-water flow is towards Bonnes Coulee. Bonnes Coulee flows through the landfill site to the northeast and discharges in the Souris River. The geologic material consists of mine spoils and is underlain by the Bullion Creek Formation. Water quality analyses indicated a mixed calcium, sodium-sulfate, bicarbonate type water. There were no indications of contaminant migration from the present landfill. This study was concluded before the operation of the present site started.

Methods of Investigation

The McDaniel 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 at the McDaniel landfill was based on the site's geology and depth to ground water, as determined by the preliminary evaluation. A forward-rotary drill rig was used at the McDaniel landfill because the

sediments were consolidated and because the depth to the water table was expected to be greater than 70 feet. The lithologic descriptions were determined from the drill cuttings.

Monitoring Well Construction and Development

Six test holes were drilled at the McDaniel landfill, and monitoring wells were installed in all of them. Seven existing wells from Foth and Van Dyke (1990) were also used to evaluate this site. The number of wells installed at the McDaniel landfill was based on the geologic and topographic characteristics of the site. The depth and intake interval of each well was selected to monitor the water level at the top of the uppermost aquifer. The six locations of the new monitoring wells were selected to evaluate the older portion of the landfill. The wells were located within boundaries of the landfill.

Wells were constructed following a standard design (Fig. 2) intended to comply with the construction regulations of the NDS DHCL 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

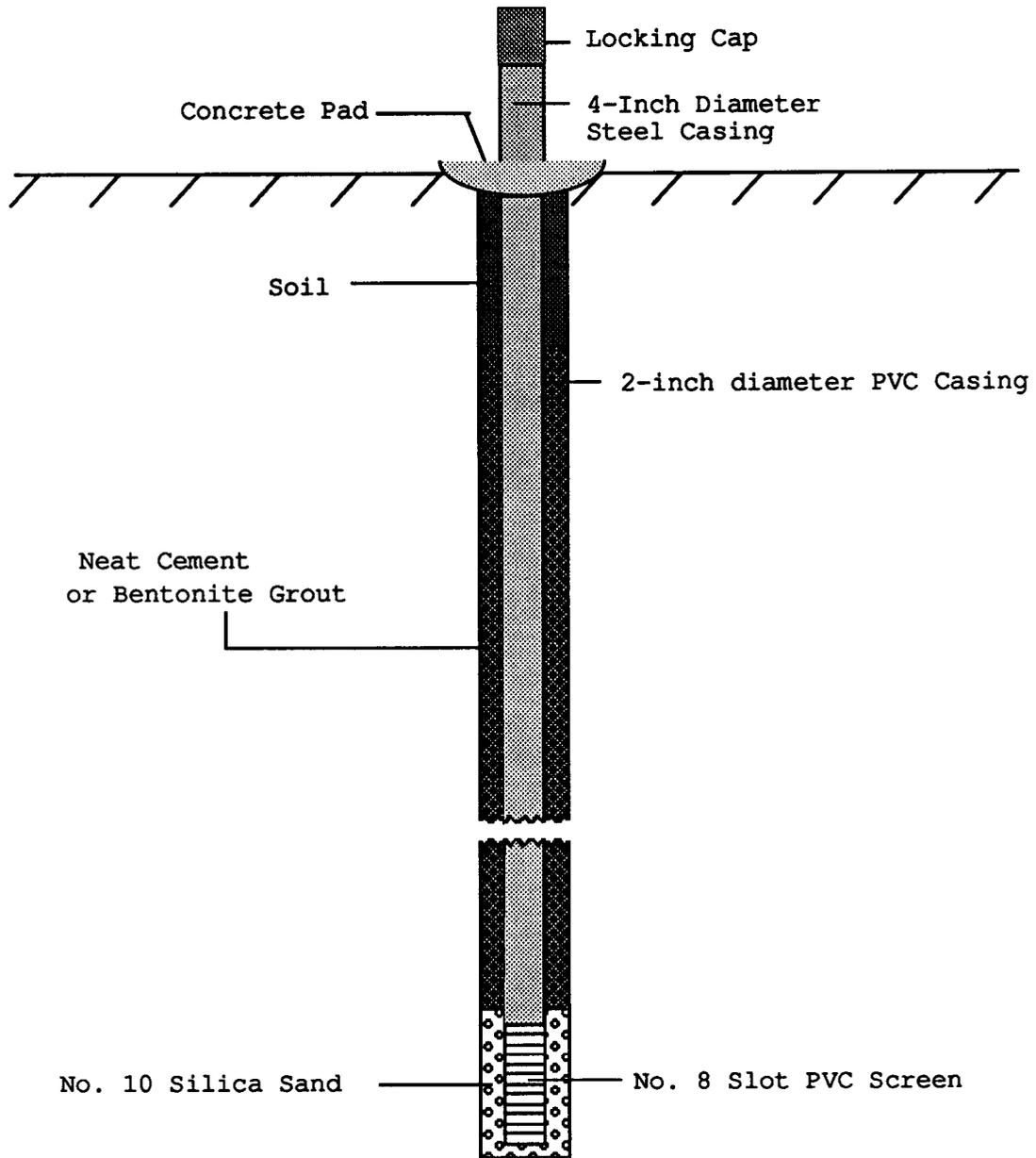


Figure 2. Construction design used for monitoring wells installed at the McDaniel landfill.

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. High-solids bentonite grout and/or neat cement was placed above the silica sand 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, field 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.

One well was sampled for Volatile Organic Compounds (VOC) analysis. This sample was collected at a different

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

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 NDS DHCL.

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, respectively, the northeast, northwest, southwest, and southeast quarter section (160-acre tract), quarter-quarter

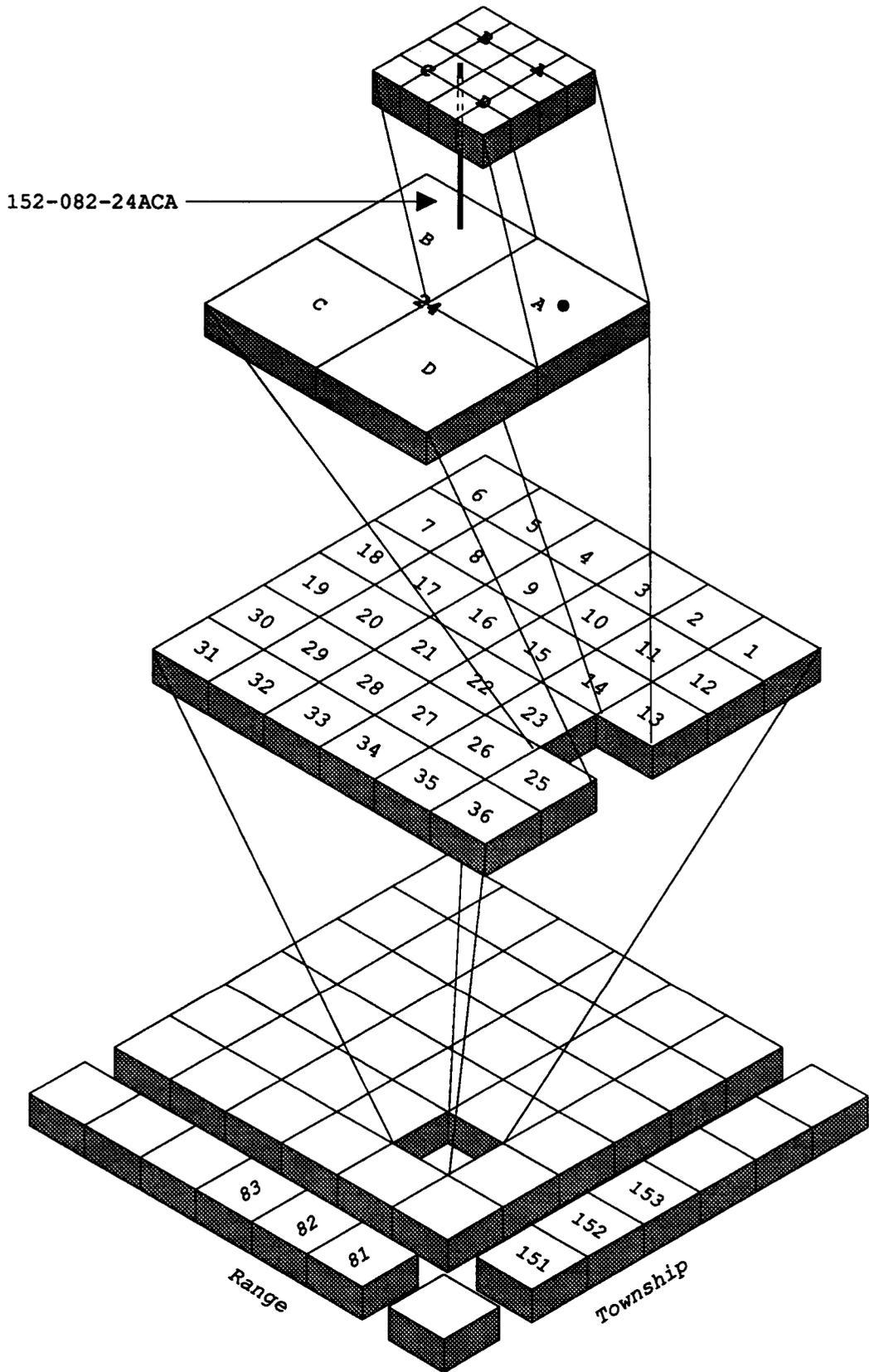


Figure 3. Location-numbering system for the McDaniel landfill.

section (40-acre tract), and quarter-quarter-quarter section (10-acre tract). Therefore, a well denoted by 152-082-24ACA would be located in the NE1/4, SW1/4, NE1/4, Section 24, Township 152 North, Range 82 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 152-082-24ACA1 and 152-082-24ACA2.

GEOLOGY

Regional Geology

The McDaniel landfill is situated near the base of the Missouri escarpment, a steep slope which rises 200 to 300 feet to the southwest. At the base of the escarpment a pediment surface slopes gently to the northeast. The pediment surface is dissected by channels of northeast-flowing intermittent streams.

The region is covered with glacial sediments except for small exposures of the Bullion Creek Formation. The bedrock exposures occur mainly along stream channels where erosion has removed the glacial sediments. Glacial sediments in the region range from 0 to 200 feet thick (Bluemle, 1989, Fig. 4).

In the area of the landfill the glacial sediments are underlain by clay, silt, sand, sandstone, and lignite of the Bullion Creek Formation (Paleocene). Prior to 1986 several

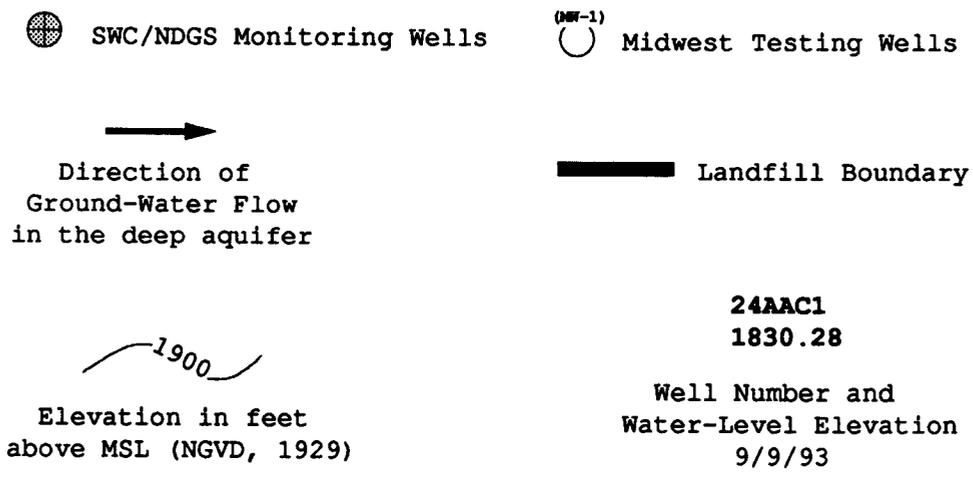


Figure 4. Location of monitoring wells and the direction of ground-water flow.

lignite strip mines operated along the Missouri escarpment where the Bullion Creek Formation is relatively close to the surface. The lignite was mined from the Coteau lignite bed (Bluemle, 1989).

Local Geology

The McDaniel landfill is located near Bonnes Coulee which has eroded approximately 80 feet through the glacial sediments and into the Bullion Creek Formation. Two separate disposal areas occupy distinct topographic and geologic settings. The old area is located in an old lignite mine north of Bonnes Coulee (Fig. 4). It is not known if the Coteau lignite bed was lined with spoil material before waste disposal. This area was closed and capped in 1993.

The new disposal area is located south of Bonnes Coulee in another abandoned lignite pit. Here the refuse is underlain by spoil material and by clay, silt, and lignite of the Bullion Creek Formation (Fig. 5). The lignite pit is surrounded by mine spoil material. The spoil material is a mixture of clay, silt, and sand with a trace of pebbles and lignite fragments (test holes 152-082-24ADCB and ADCC, lithologic logs in Appendix C). Some of the spoil material has also been pushed into Bonnes Coulee.

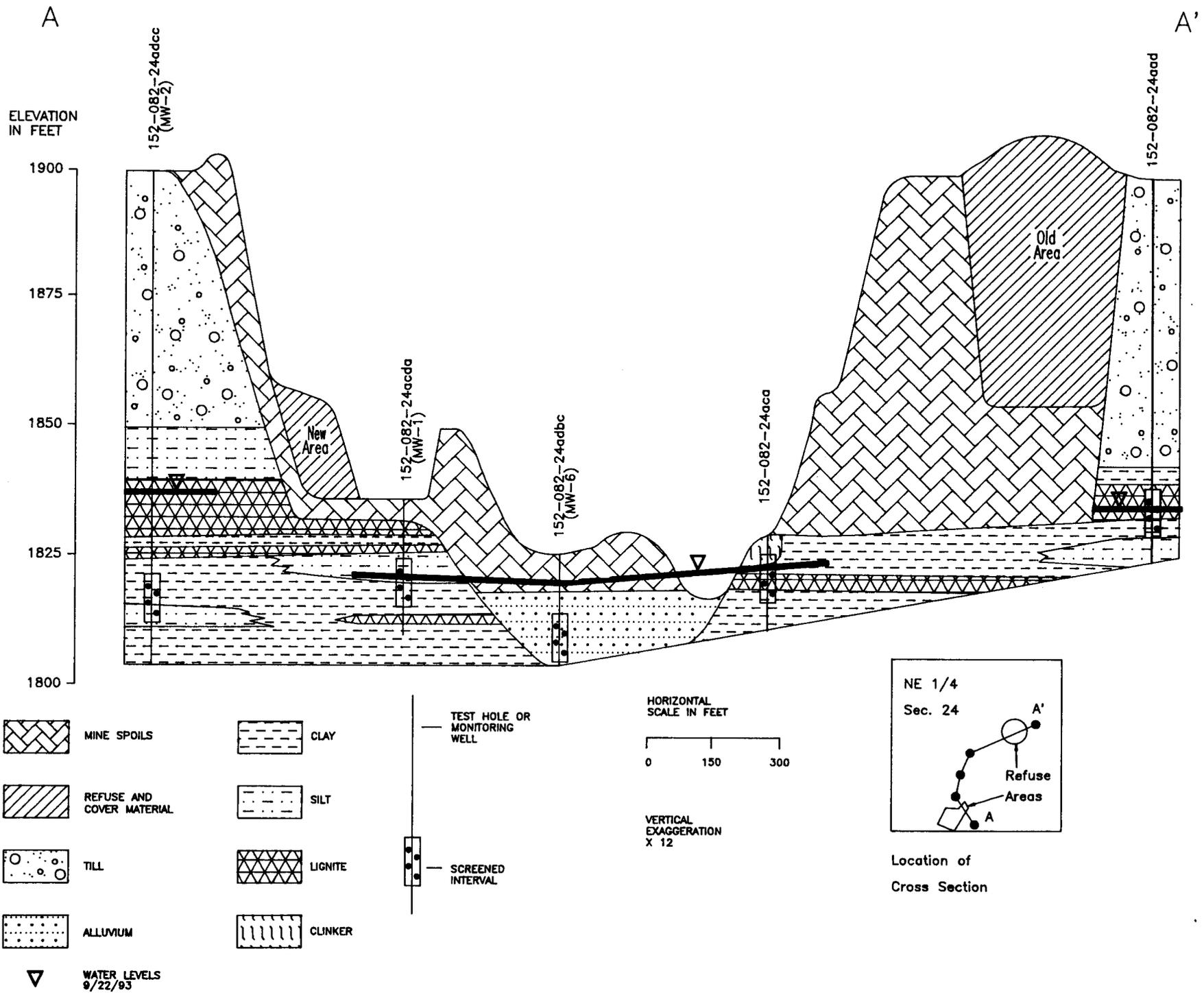


Figure 5. Geohydrologic section A-A' in the McDaniel landfill.

HYDROLOGY

Surface-Water Hydrology

Bonnes Coulee flows through the landfill site to the north-northeast and discharges into the Souris River (Fig. 1). This coulee appears to originate in a wetland area about 4 miles south of the landfill. Bonnes Coulee may be susceptible to contaminant migration from surface runoff from the landfill if the runoff is not contained.

Robinson Coulee is located about one mile east of the McDaniel landfill. This coulee discharges into Bonnes Coulee one mile east of the landfill entrance. Robinson Coulee should not be affected by contaminant migration from the McDaniel landfill due to its distance from the landfill.

Several wetlands occur in the landfill study area. These wetlands are located within valleys created by the piling of mine spoils. One wetland is located near well 24ACA. This wetland may be susceptible to contaminant migration from the old portion of the landfill that has been closed. Contaminant migration may move through the mine spoils or through thin lignite beds that were undisturbed.

A narrow, underground cavern was also intersected during the drilling at the old portion of the landfill. This cavern varied in thickness from 2 to 10 feet and may also act as a rapid transmission conduit for contaminants originating from the buried refuse. The origin of this cavern may be due to underground lignite mining.

Regional Ground-Water Hydrology

About fifty percent of the water used in Ward county is obtained from bedrock aquifers (Pettyjohn and Hutchinson, 1971). These aquifers occur in the Dakota Group, Fox Hills Formation, Hell Creek Formation, Bullion Creek Formation, and the Sentinel Butte Formation. In the study area, the Dakota Formation is located about 3,000 feet below land surface. The Dakota aquifer is characterized by a sodium-chloride type water. This aquifer should not be susceptible to contaminant migration from the landfill due to its depth and the intervening low hydraulic conductivity clay and shale of the Pierre Formation.

The Fox Hills-Hell Creek aquifer overlies the Pierre Formation. This aquifer is comprised of sandstone at a depth of about 900 feet (Pettyjohn and Hutchinson, 1971). The Fox Hills-Hell Creek aquifer is characterized by a sodium-bicarbonate type water. This aquifer should not be susceptible to contaminant migration from the landfill due to its depth and the intervening low hydraulic conductivity clay and shale.

The Bullion Creek Formation overlies the Fox Hills Formation and is the uppermost bedrock aquifer. This aquifer is comprised of sandstone and fractured lignite. Recharge to this aquifer is generally from precipitation and from lateral flow from adjacent undifferentiated glacial and bedrock aquifers. The Bullion Creek aquifer is characterized by a

sodium-sulfate type water (Pettyjohn and Hutchinson, 1971). There are no known major glacial aquifers within a five-mile radius of the landfill.

Local Ground-Water Hydrology

Figure 4 shows the location of five monitoring wells installed at the old McDaniel landfill site (Appendix C). In addition, seven existing monitoring wells that surround the present landfill site were also used for this investigation (Appendix D). At least four water-level measurements were taken over about a five-week period (Appendix E). Except for monitoring wells 24AAC1 and 24ACA, all monitoring wells installed around the old landfill site were screened in the Coteau lignite bed of the Bullion Creek Formation. The Coteau bed has been removed at the present landfill site and replaced with mine spoils. Water-level measurements indicate that the local ground-water flow is towards Bonnes Creek (Fig. 4) from both the old and present landfill sites.

Water Quality

Chemical analyses of water samples are shown in Appendix F. Mobilization of major ions and trace elements from the mine tailings may effectively mask input of major ions and trace elements from the landfill. The major ion analyses detected an anomalous nitrate concentration of 780 mg/L in

well 24ACCB. This concentration exceeds the SMCL of 50 mg/L set by the Environmental Protection Agency. The source of this concentration was not determined but does not appear to originate from the landfill because the well is located up-gradient from the landfill.

About one-half of the water samples detected an elevated iron concentration that exceeded the SMCL of 0.3 mg/L. These concentrations may be due to weathering of the mine tailings.

The trace element analyses indicated a selenium concentration of 106 µg/L in well 24ACCB which exceeds the MCL of 10 µg/L. This well is located up-gradient of the new disposal cell.

The VOC analyses, from wells 152-082-24ACA and 24ACC3, are shown in Appendices G and H. The analysis from well 24ACC3 detected the compound acetone (77.8 µg/L). Acetone is a compound found in most glues, degreasers, and solvents. The source of the acetone may be due to contaminant migration or from well construction. There were no VOC compounds detected in well 24ACA.

CONCLUSIONS

The McDaniel landfill is situated near the base of the Missouri escarpment. The land surface near the landfill is dissected by northeast-flowing stream channels. The region is covered with glacial till except for some small areas

where the Bullion Creek Formation is exposed along stream channels. Several lignite mines occur along the Missouri escarpment where the Bullion Creek Formation is relatively close to the surface.

Two separate disposal cells occur in the landfill study area. The old disposal area is located on the north side of Bonnes Coulee and occupies an old lignite-strip mine. It is not known if the Coteau lignite bed was lined with spoil material before waste disposal. The present disposal area is located south of Bonnes Coulee and also occupies an old lignite-strip mine. The base of this site consists of spoil material.

Bonnes Coulee flows northeast through the landfill site and discharges into the Souris River. Several wetlands are also located throughout the area. The wetlands occupy valleys created by the piling of mine spoils. Bonnes Coulee may be susceptible to contamination from refuse runoff.

The Bullion Creek aquifer is the uppermost bedrock aquifer and is comprised of sandstone and fractured lignite. This aquifer may be susceptible to contaminant migration from the landfill due to the presence of fractured lignite beds. There are no known major glacial aquifers within a five-mile radius of the landfill. The direction of the local groundwater flow in the Bullion Creek aquifer is towards Bonnes Coulee at both the old and present sites.

Mobilization of major ions and trace elements from the mine tailings may effectively mask input of major ions and

trace elements from the landfill. Water quality analyses indicated an anomalously high nitrate concentration in well 24ACCB which is about 15 times higher than the MCL. The source of the nitrates does not appear to be from the landfill because the well is located up-gradient from the landfill. About half of the wells detected iron concentrations that exceeded the SMCL. These concentrations may be due to the weathering of the mine spoils. The trace element analyses indicated a selenium concentration 10 times higher than the MCL in well 24ACCB. This well is located up-gradient of the new disposal cell therefore, the selenium concentration does not originate from the landfill..

The VOC analyses detected the compound acetone in well 24ACC3. This compound is found in various glues, degreasers, and solvents. The source of this compound may be from the landfill or from well construction.

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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	-----

<u>Constituent</u>	<u>MCL (µg/L)</u>
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).

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

	<u>Recommended Concentration Limits (mg/L)</u>
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 Consolidated Laboratories

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

152-082-24AAC1

NDSWC 13276

Date Completed: 8/11/93
 L.S. Elevation (ft): 1896.69
 Depth Drilled (ft): 101
 Screened Interval (ft): 91-101

Purpose:
 Well Type:
 Aquifer:
 Source:
 Owner:

Observation Well
 2" PVC
 UND
 McDANIEL LANDFILL

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
CLAY	TRACE OF SAND, OLIVE GRAY, TILL	1-20
LIGNITE		20-21
CLAY	TRACE OF SAND, OLIVE GRAY, TILL	21-54
LIGNITE	FRACTURED, COTEAU BED	54-67
CLAY	SILTY, MEDIUM GRAY, BEDROCK	67-70
LIGNITE		70-72
CLAY	BROWNISH	72-73
CLAY	TRACE OF SILT, MEDIUM GRAY	73-75
CLAY	SILTY, LIGHT GRAY, BEDROCK	75-80
LOST CIRCULATION	LOST CIRCULATION IN LIGNITE OR CLAY	80-100

152-082-24AAC2

NDSWC 13277

Date Completed: 8/12/93
L.S. Elevation (ft): 1896
Depth Drilled (ft): 78
Screened Interval (ft): 63-73

Purpose:
Well Type:
Aquifer:
Source:
Owner:

Observation Well
2" PVC
UND
McDANIEL LANDFILL

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
CLAY	VERY FINE SANDY, YELLOWISH BROWN, TILL	1-46
LIGNITE		46-47
CLAY	SANDY, YELLOWISH-BROWN, TILL	47-54
LIGNITE	FRACTURED, COTEAU BED	54-73
CLAY	BROWNISH-BLACK	73-78

152-082-24AAC3

NDSWC

Date Completed:	8/23/93	Purpose:	Observation Well
L.S. Elevation (ft):	1896.85	Well Type:	2" PVC
Depth Drilled (ft):	78	Aquifer:	Undefined
Screened Interval (ft):	67-77	Source:	
		Owner:	McDaniel

Lithologic Log

Unit	Description	Depth (ft)
CLAY	TRACE OF SAND AND GRAVEL, MODERATE YELLOWISH-BROWN, 10YR5/4 (TILL).	0-3
CLAY	TRACE OF SAND, GRAYISH-BLACK, N2 (TILL).	3-5
CLAY	TRACE OF SAND AND GRAVEL, MODERATE YELLOWISH-BROWN, 10YR5/4 (TILL).	5-26
CLAY	TRACE OF SAND AND GRAVEL, DARK YELLOWISH-BROWN, 10YR4/2 (TILL).	26-39
CLAY	TRACE OF SAND AND GRAVEL, OLIVE GRAY, 5Y4/1, (TILL).	39-54
LIGNITE	7 FOOT CAVERN FROM 58 TO 65 FEET.	54-65
LIGNITE	WITH SAND AND CLAY, SOFT.	65-69
LIGNITE		69-73
CLAY	MEDIUM LIGHT GRAY, N6.	73-78

152-082-24AAD

NDSWC 13279

Date Completed: 8/12/93
L.S. Elevation (ft): 1898.82
Depth Drilled (ft): 73
Screened Interval (ft): 60-70

Purpose:
Well Type:
Aquifer:
Source:
Owner:

Observation Well
2" PVC
UND
McDANIEL LANDFILL

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
CLAY	SANDY, YELLOWISH-BROWN, TILL, LIGNITE CHIPS STARTING AT 56 FEET	2-58
CLAY	BROWNISH, BEDROCK	58-60
LIGNITE		60-65
CLAY	LIGHT GRAY, INTERBEDDED WITH BROWN CLAY	65-68
SILT	CLAYEY, BLUEISH GRAY	68-73

152-082-24ACA

NDSWC

Date Completed: 8/24/93
L.S. Elevation (ft): 1830.56
Depth Drilled (ft): 13
Screened Interval (ft): 7-12

Purpose:
Well Type:
Aquifer:
Source:
Owner:

Observation Well
2" PVC
Undefined
McDaniel

Lithologic Log

Unit	Description	Depth (ft)
FILL	MINE SPOILS.	0-2
CLINKER		2-6
SAND	MEDIUM GRAINED, MODERATE BROWN, 5YR4/4.	6-7
CLAY	STIFF, GREENISH-GRAY, 5GY6/1.	7-9
LIGNITE		9-11
CLAY	BROWNISH-GRAY, 5YR4/1.	11-13

152-082-24ADA

NDSWC 13278

Date Completed: 8/12/93
 L.S. Elevation (ft): 1899.65
 Depth Drilled (ft): 80
 Screened Interval (ft): 67-77

Purpose:
 Well Type:
 Aquifer:
 Source:
 Owner:

Observation Well
 2" PVC
 UND
 McDANIEL LANDFILL

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-4
CLAY	SANDY, YELLOWISH-BROWN, TILL	4-32
ROCK		32-32.5
CLAY	SANDY, YELLOWISH-BROWN, TILL	32.5-34
SAND	MEDIUM TO COARSE GRAIN WITH GRAVEL, YELLOWISH-BROWN	34-36
CLAY	SANDY, YELLOWISH-BROWN, TILL	36-47
SAND	GRAVEL, CLAY INTERBEDDED, YELLOWISH-BROWN, MEDIUM TO COARSE GRAIN	47-52
CLAY	TRACE OF SAND, YELLOWISH-BROWN WITH YELLOWISH-ORANGE MOTTLES, TILL	52-57
LIGNITE	FRACTURED, COTEAU BED	57-77
CLAY	BROWNISH, BEDDROCK	77-80

APPENDIX D

Previous Well Logs

LOG OF TEST BORING NO.: MW-1

CLIENT: Hjalmer Carlson
 PROJECT: McDaniel Landfill
 PROJECT NUMBER: 88H11
 LOCATION: Sawyer, ND

SURFACE ELEVATION: 1837.2

BORING DEPTH: 26.0

DATE: 04/17/89

MSL ELEV	DEPTH FND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
1837.2	--0	0-1.5	SS	1	18	0.1	Dark brn/blk stained sand w/ clay, traces of red siltstone/sandstone, FILL.	SC		
							Top .4' is a soft, silty COAL.	COAL		
1832.2	--5	4.5-6	SS	2	21	1.2	Bottom .8' is grey/green SILT w/ coal laminations, dry.	ML		
							COAL, brittle, soft, partial consolidated, dry.	COAL		
1827.2	--10	9.5-11	SS	3	60	1.3				
							Grey to green SILTSTONE with some sand sized grains, traces of clay.	Siltst		
1822.2	--15	14.5-16	SS	4	45	1.5				
							Grey, fat CLAY, traces of silt.	CH		
1817.2	--20	19.5-21	SS	5	75	1.5				
							COAL, fractured, brittle, wet. Bottom 0.1' of split spoon sample is a grey, fat CLAY.	COAL CH		
1812.2	--25	24.5-26	SS	6	99	1.5				
							End of Boring at 26.0 feet			
1807.2	--30									
1802.2	--35									
1797.2	--40									
1792.2	--45									
1787.2	--50									
1782.2	--55									

DRILLING DATA

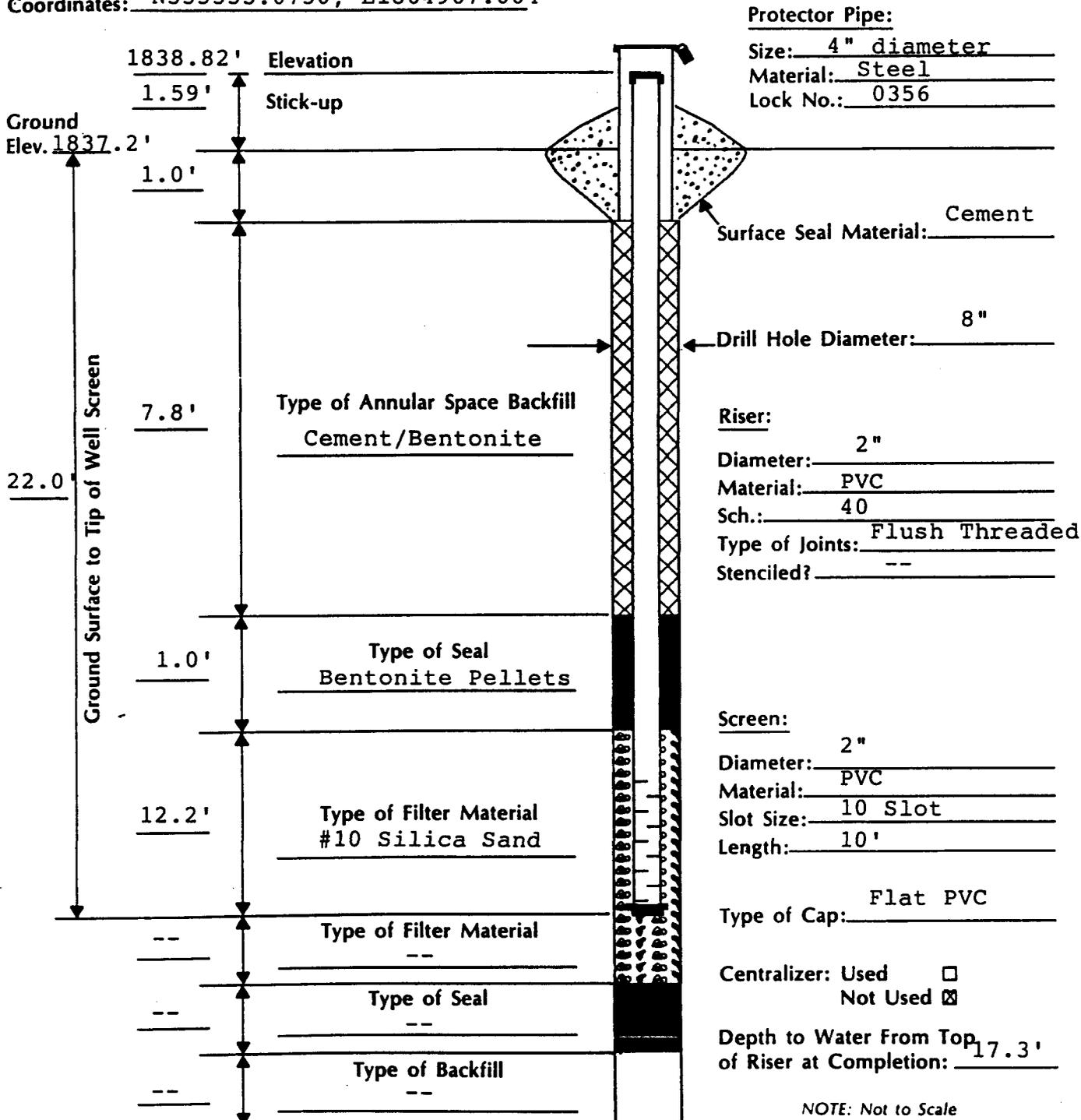
START DATE: 4/17/89
 COMPLETION DATE: 4/17/89
 LOGGED BY: KAD
 DRILLING METHOD: Hollow Stem Auger
 DRILLING CONTRACTOR: Midwest Testing

WATER LEVEL INFORMATION

DEPTH AT COMPLETION: 17.3' from TOC
 LATER TIME/DEPTH: NA
 LATER TIME/DEPTH: NA
 CAVE IN DEPTH: NA
 DRILLING LOSSES: NA

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Well No: MW-1
 Drilling Method: Hollow Stem Auger Date Installed: 4/17/89
 Coordinates: N355553.0750, E1864967.004



Foth & Van Dyke & Associates, Inc.

LOG OF TEST BORING NO.: MW-2

CLIENT: Hjalmer Carlson
 PROJECT: McDaniel Landfill
 PROJECT NUMBER: 88H11
 LOCATION: Sawyer, North Dakota

SURFACE ELEVATION: 1900.8

BORING DEPTH: 96.0

DATE: 04/17/89

MSL ELEV	DEPTH FR: LND SURF	SAMP DEPTH: INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
1900.8	--0	0-1.5	SS	1	35	1.0	Tan/brn, silty, fgr-mgr SAND, tr of roots and organics, tr of clay, dry, topsoil.	SP		
1895.8	--5	4.5-6	SS	2	34	0.7				
1890.8	--10	9.5-11	SS	3	34	0.8				
1885.8	--15	14.5-16.0	SS	4	21	0.7	Tan/brn, silty CLAY w/ fgr-mgr sand; dense, dry, some coal frags, some fgr gravel.	CL		
1880.8	--20	19.5-21	SS	5	24	1.0				
1875.8	--25	24.5-26	SS	6	27	1.0				
1870.8	--30	29.5-31	SS	7	28	1.2				
1865.8	--35	34.5-36	SS	8	27	1.4				
1860.8	--40	39.5-41	SS	9	30	1.4	Same as above. Bottom of sample slightly to very damp.			
1855.8	--45	44.5-46	SS	10	22	0.8	Same as above. Split spoon samples are slightly to very damp.			
1850.8	--50	49.5-51	SS	11	26	0.8	Grey green fgr SAND/SILT w/ clay, damp, dense	SP-ML		
1845.8	--55	54.5-56	SS	12	41	1.3				

DRILLING DATA

START DATE: 4/18/89
 COMPLETION DATE: 4/18/89
 LOGGED BY: KAD
 DRILLING METHOD: Hollow Stem Auger
 DRILLING CONTRACTOR: Midwest Testing

WATER LEVEL INFORMATION

DEPTH AT COMPLETION: 82.19 from TOC
 LATER TIME/DEPTH: NA
 LATER TIME/DEPTH: NA
 CAVE IN DEPTH: NA
 DRILLING LOSSES: NA

Foth & Van Dyke & Associates, Inc.

LOG OF TEST BORING NO.: MW-2

CLIENT: Hjalmer Carlson
 PROJECT: McDaniel Landfill
 PROJECT NUMBER: 88H11
 LOCATION: Sawyer, North Dakota

SURFACE ELEVATION: 1900.8

BORING DEPTH: 96.0

DATE: 04/17/89

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
1845.8	--55.0	54.5-56	SS	12	41	1.3	Grey/green, fgr SAND/SILT w/ clay, damp, dense.	SC-ML		
1840.8	--60.0	59.5-61	SS	13	78	1.3				
1835.8	--65.0	64.5-66	SS	14	100	0.3	soft COAL, dry, "siltlike", weathered, fractures into layers.	COAL		
1830.8	--70.0	69.5-71	SS	15	100	1.2				
							SILT or CLAY ???			between 72' + 74' drilling became much easier as if a clay or silt.
1825.8	--75.0	74.5-76	SS	16	100	1.0	COAL, dry, "siltlike", weathered, fractures into layers	COAL		at 77' hit softer drilling again.
1820.8	--80.0	79.5-81	SS	17	100	1.0	Grey, fat CLAY, hard, conchoidal fracture, some silt, dry.	CH		
1815.8	--85.0	84.5-86	SS	18	100	1.5	Grey SILT w/ clay, organic patches damp.	ML		
1810.8	--90.0	89.5-91	SS	19	100	1.5	Grey, clay, traces of silt, hard, conchoidal fracture, slightly plastic.	CL		
1805.8	--95.0	94.5-96	SS	20	52	1.5	Grey/green fgr sandy SILT, wet.	ML		
							End of Boring at 96.0 feet			
1800.8	--100.0									
1795.8	--105.0									
1790.8	--110.0									

DRILLING DATA

START DATE: 4/18/89
 COMPLETION DATE: 4/18/89
 LOGGED BY: KAD
 DRILLING METHOD: Hollow Stem Auger
 DRILLING CONTRACTOR: Midwest Testing

WATER LEVEL INFORMATION

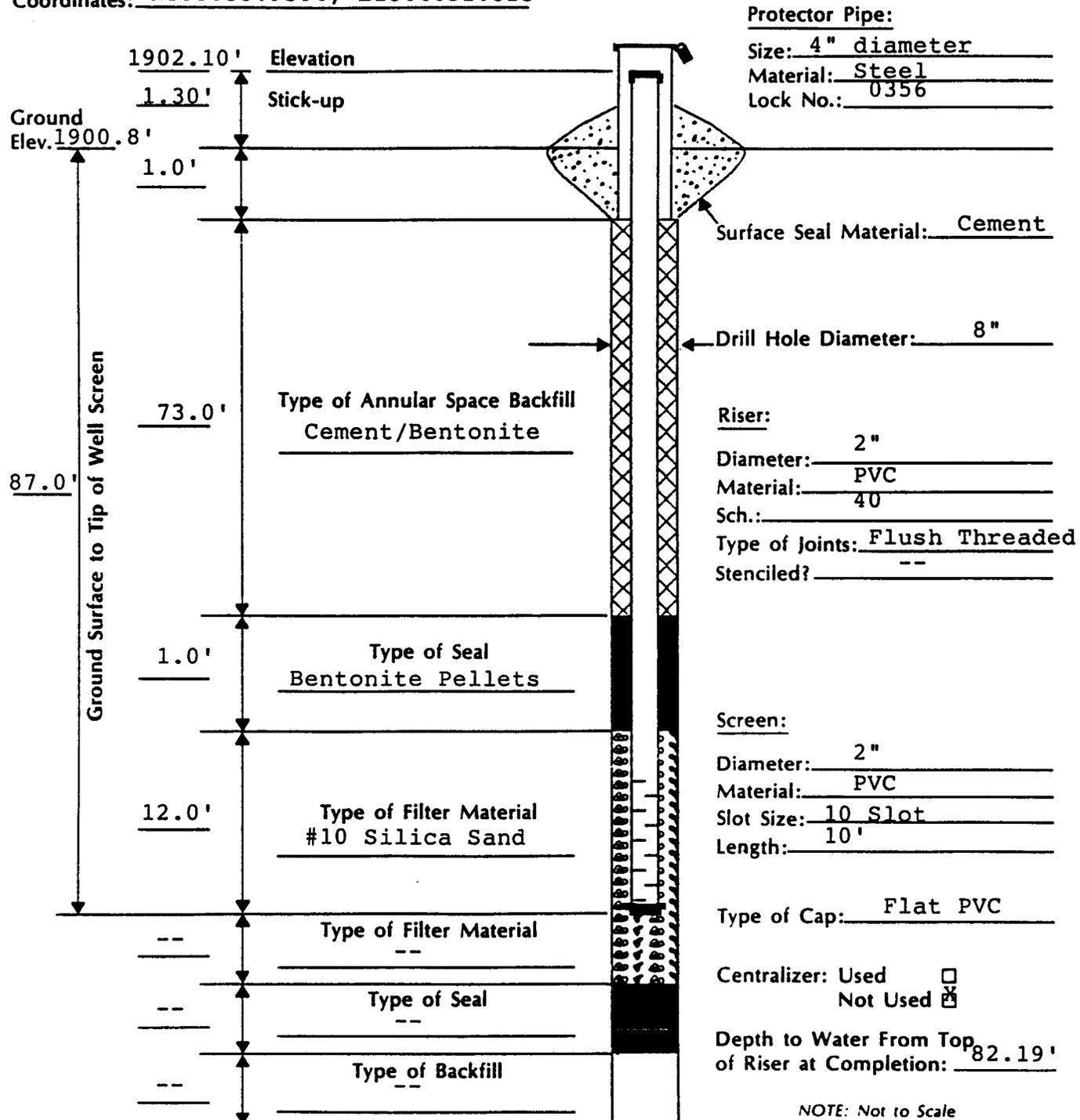
DEPTH AT COMPLETION: 82.19' from TOC
 LATER TIME/DEPTH: NA
 LATER TIME/DEPTH: NA
 CAVE IN DEPTH: NA
 DRILLING LOSSES: NA

Foth & Van Dyke

Client: Hjalmer Carlson Scope I.D.: 88H11
Project: McDaniel Landfill Page: 1 of 1
Prepared by: KAD Date: 10/10/89
Checked by: KAD Date: 10/26/89

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Well No: MW-2
Drilling Method: Hollow Stem Auger Date Installed: 4/17/89
Coordinates: N355035.9304, E1864652.823



Foth & Van Dyke & Associates, Inc.

LOG OF TEST BORING NO.: MW-3

CLIENT: Hjalmer Carlson
 PROJECT: McDaniel Landfill
 PROJECT NUMBER: 88H11
 LOCATION: Sawyer, North Dakota

SURFACE ELEVATION: 1917.7

BORING DEPTH: 100.0

DATE: 04/17/89

MSL ELEV	DEPTH FR: LND SURF	SAMP DEPTH: INTERVAL	TYPE	#	N	REC: (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
1917.7	--0	0-1.5	SS	1	5	0.4	Brn, sandy, lean CLAY w/ silt.	CL		
1912.7	--5	4.5-6	SS	2	33	1.0	Brn/tan and green mottled, fgr sandy CLAY, some silts, organic rich.	CL		
1907.7	--10	9.5-11	SS	3	37	1.0	Brn/orange, fgr sandy SILT, traces of clay, FE stained, med dense, some coal frags and fgr gravel, dry.	ML		
1902.7	--15	14.5-16	SS	4	20	1.5	Olive green and orange-brn mottled CLAY w/ silt, soft, plastic, some coal frags and fgr gravel, damp.	CL		
1897.7	--20	19.5-21	SS	5	23	1.5				
1892.7	--25	24.5-26	SS	6	23	1.5				
1887.7	--30	29.5-31	SS	7	37	1.5				
1882.7	--35	34.5-36	SS	8	32	1.5				
1877.7	--40	39.5-41	SS	9	38	1.5				
1872.7	--45	44.5-46	SS	10	30	1.5				
1867.7	--50	49.5-51	SS	11	27	1.5				
1862.7	--55	54.5-56	SS	12	34	1.5	Description on following page.			

DRILLING DATA

START DATE: 4/19/89
 COMPLETION DATE: 4/19/89
 LOGGED BY: KAD
 DRILLING METHOD: Hollow Stem Auger
 DRILLING CONTRACTOR: Midwest Testing

WATER LEVEL INFORMATION

DEPTH AT COMPLETION: 94.47' from TOC
 LATER TIME/DEPTH: NA
 LATER TIME/DEPTH: NA
 CAVE IN DEPTH: NA
 DRILLING LOSSES: NA

LOG OF TEST BORING NO.: MW-3

CLIENT: Hjalmer Carlson
 PROJECT: McDaniel Landfill
 PROJECT NUMBER: 88H11
 LOCATION: Sawyer, North Dakota

SURFACE ELEVATION: 1837.2

BORING DEPTH: 100.0

DATE: 04/17/89

MSL ELEV	DEPTH LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
1782.2	--55.0	54.5-56	SS	12	34	1.5				
1777.2	--60.0	59.5-61	SS	13	29	1.5	Olive green and orange-brn mottled CLAY w/ silt, soft, plastic, some coal frags and fgr gravel, damp.	CL		clay is wet on outside but dry to damp when broken apart.
1772.2	--65.0	64.5-66	SS	14	31	1.5				
1767.2	--70.0	69.5-71	SS	15	28	1.5	Dark grey, fat clay, damp, conchoidal fracture.	CH		
1762.2	--75.0	74.5-76	SS	16	61	1.5	Blue/grey, silty fgr SAND, traces of clay and coal frags, dry to damp.	SP/NL		
1757.2	--80.0	79.5-81	SS	17	100	0.1	Lt blue/grey SILTSTONE, partially consolidated, brittle, dry.	siltst		
1752.2	--85.0	84.5-86	SS	18	60	1.4				
1747.2	--90.0	89.5-91	SS	19	54	1.4	Same as above except top 0.5' of split spoon sample is a dk grey/blue, fat CLAY.	CH/NL		
1742.2	--95.0	94.5-96	SS	20	75	1.5	Dk grey/blue, fat CLAY, traces of silt, conchoidal fracture, hard, dry to slightly damp.	CH		
1737.2	--100.0	99.5-101	SS	21	100	0.3	COAL, hard, layered, and saturated.	COAL		
							End of Boring at 100 feet			
1732.2	--105.0									
1727.2	--110.0									

DRILLING DATA

START DATE: 4/19/89
 COMPLETION DATE: 4/19/89
 LOGGED BY: KAD
 DRILLING METHOD: Hollow Stem Auger
 DRILLING CONTRACTOR: Midwest Testing

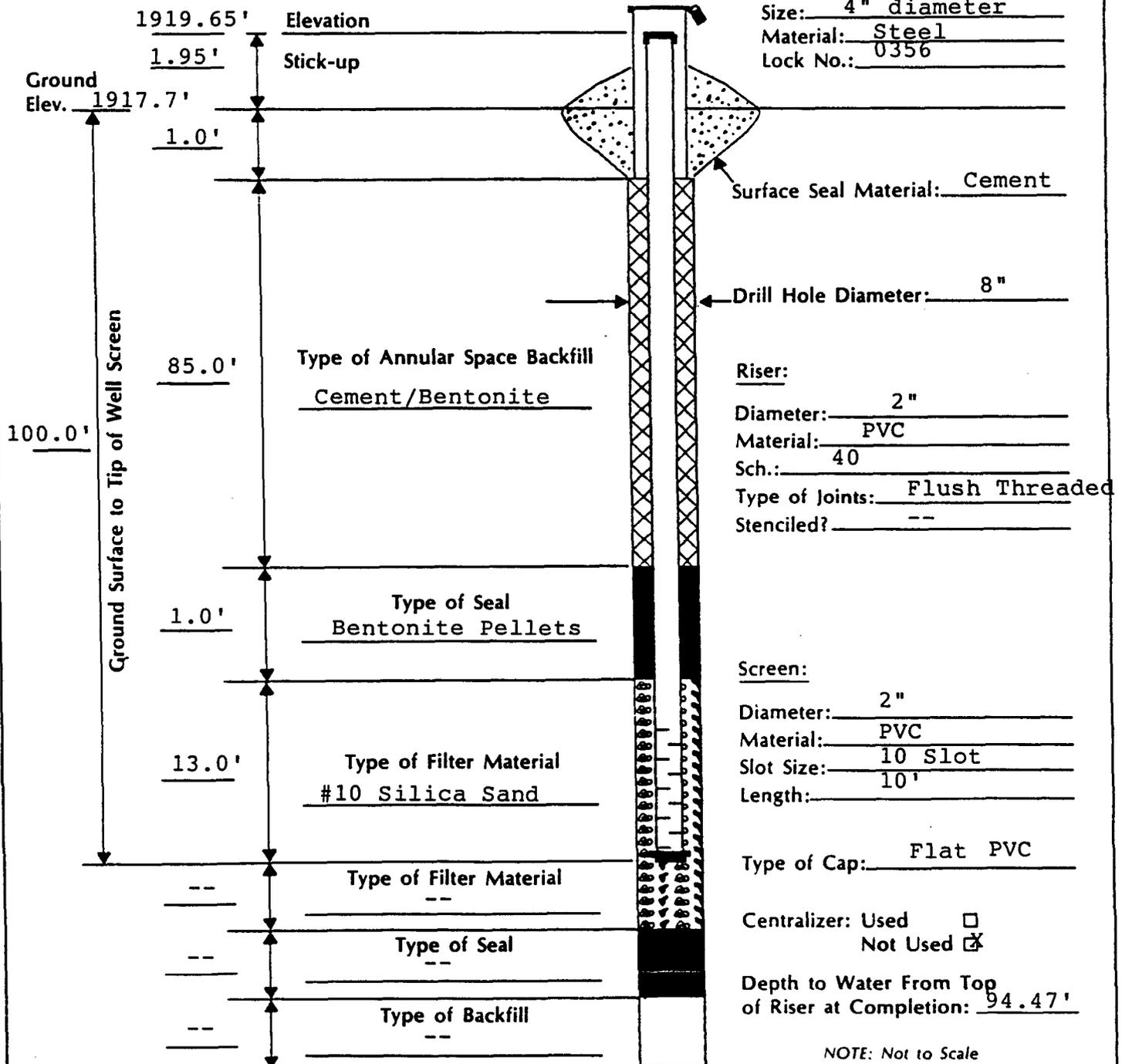
WATER LEVEL INFORMATION

DEPTH AT COMPLETION: 94.47' from TOC
 LATER TIME/DEPTH: NA
 LATER TIME/DEPTH: NA
 CAVE IN DEPTH: NA
 DRILLING LOSSES: NA

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Well No: MW-3
 Drilling Method: Hollow Stem Auger Date Installed: 4/17/89
 Coordinates: N355174.9704, E1865756.995

Protector Pipe:
 Size: 4" diameter
 Material: Steel
 Lock No.: 0356



NOTE: Not to Scale

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: *CVH*

Scope I.D.: 90C18
 Page: 1 of 2
 Date: 05/18/90
 Date: 9-25-90

REPORT - LOG OF TEST BORING

Start Date: 05/03/90
 Completion Date: 05/03/90
 Logged by: CVH

Test Boring No.: MW-5
 Location:
 Boring Depth: 70.0
 Surface Elevation: 1910

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
0.00	--0.0	0.0-1.5	SS	1.0	8	0.5	Black (10 yr 2/1) sandy SILT (topsoil) with organic matter, moist to 2.5' (0.0-2.5')	ML/SM		
-5.00	--5.0	5.0-6.0	SS	2.0	39	0.7	Grayish brown (2.5 Y 5/2) LEAN CLAY w/ snd (till) w/ some clay, coal fragments, mottling, pebbles, dense, dry			
-10.00	--10.0	10.0-11.0	SS	3.0	27	1.1	Olive brown (2.5 Y 4/4) LEAN CLAY with sand (till), coal fragments, mottling, iron stains, cobble, weathered pebbles, moist			
-15.00	--15.0	15.0-16.0	SS	4.0	23	1.5	Dark grayish brown (2.5 Y 4/2) LEAN CLAY w/ snd (till) and some coal fragments, less mottling and iron staining, cobbles, moist			
-20.00	--20.0	20.0-21.0	SS	5.0	23	1.6	Very dark grayish brown (2.5 Y 3/2)			
-25.00	--25.0	25.0-26.0	SS	6.0	29	1.5	Same as above	CL		
-30.00	--30.0	30.0-31.0	SS	7.0	29	1.5	Same as above			
-35.00	--35.0	35.0-36.0	SS	8.0	39	1.6	Same as above except jointed with iron staining and clean, fine sand, weathered cobble			
-40.00	--40.0	40.0-41.0	SS	9.0	37	1.6	Same as above without clean, fine sand			
		42.5-43.5	SS	10	27	1.5	Same as above			
-45.00	--45.0	45.0-46.0	SS	11	32	1.7	Same as above			
		47.5-48.5	SS	12	25	1.5	Same as above with mottling, iron staining, weathered cobbles			
-50.00	--50.0	50.0-51.0	SS	13	31	1.7	Same as above			
		52.5-53.5	SS	14	35	2.0	Very dark gray (10 YR 3/1)			
-55.00	--55.0	55.0-56.0					Information on next page			

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

DEPTH TO WATER -
 AT COMPLETION: 60'
 LATER TIME/DEPTH:

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: *BJ*

Scope I.D.: 90C18
 Page: 2 of 2
 Date: 05/18/90
 Date: 7/25/90

REPORT - LOG OF TEST BORING

Start Date: 05/03/90
 Completion Date: 05/03/90
 Logged by: CVH

Test Boring No.: MW-5
 Location:
 Boring Depth: 70.0
 Surface Elevation: 1910

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
-55.00	--55.0	55.0-56.0	SS	15	29	1.6	Very dark grayish brown (2.5 Y 3/2)			
		57.5-58.5		16	23	1.9	Same as above with fine sand seam (0.12") at 58' which is moist	CL		
-60.00	--60.0	60.0-61.0	SS	17	24	1.6	Very dark gray (10 YR 3/1) with no mottling or iron staining			
		62.5-63.5		18	33	1.6	Very dark grayish brown(2.5Y3/2)			
		63.5-65.0		19	77	1.5	Brown (10YR4/3) poorly graded SAND w/ gravel, wet (63.0-64.5')	SP		
-65.00	--65.0	65.0-66.0	SS	20	51	1.5	Olive brown (2.5 Y 4/4) silty SAND, fine, mottling, pebbles, dense (64.5-65.5')	ML/SM		
							Very dark grayish brown (2.5Y3/2) silty SAND, fine (65.5-66.0')	SM		
-70.00	--70.0	69.0-70.0	SS	21	39	1.2	Very dark grayish brown (2.5Y3/2) fine sandy SILT with mottling, coal fragments (66.0-67.5')	ML/SM		
							Gray (7.5 Y N5) silty fine sandstone, well-graded (67.5-70')	SM		
-75.00	--75.0						End of boring at 70'			
-80.00	--80.0									
-85.00	--85.0									
-90.00	--90.0									
-95.00	--95.0									
-100.00	--100.0									
-105.00	--105.0									
-110.00	--110.0									

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

DEPTH TO WATER -
 AT COMPLETION: 60'
 LATER TIME/DEPTH:

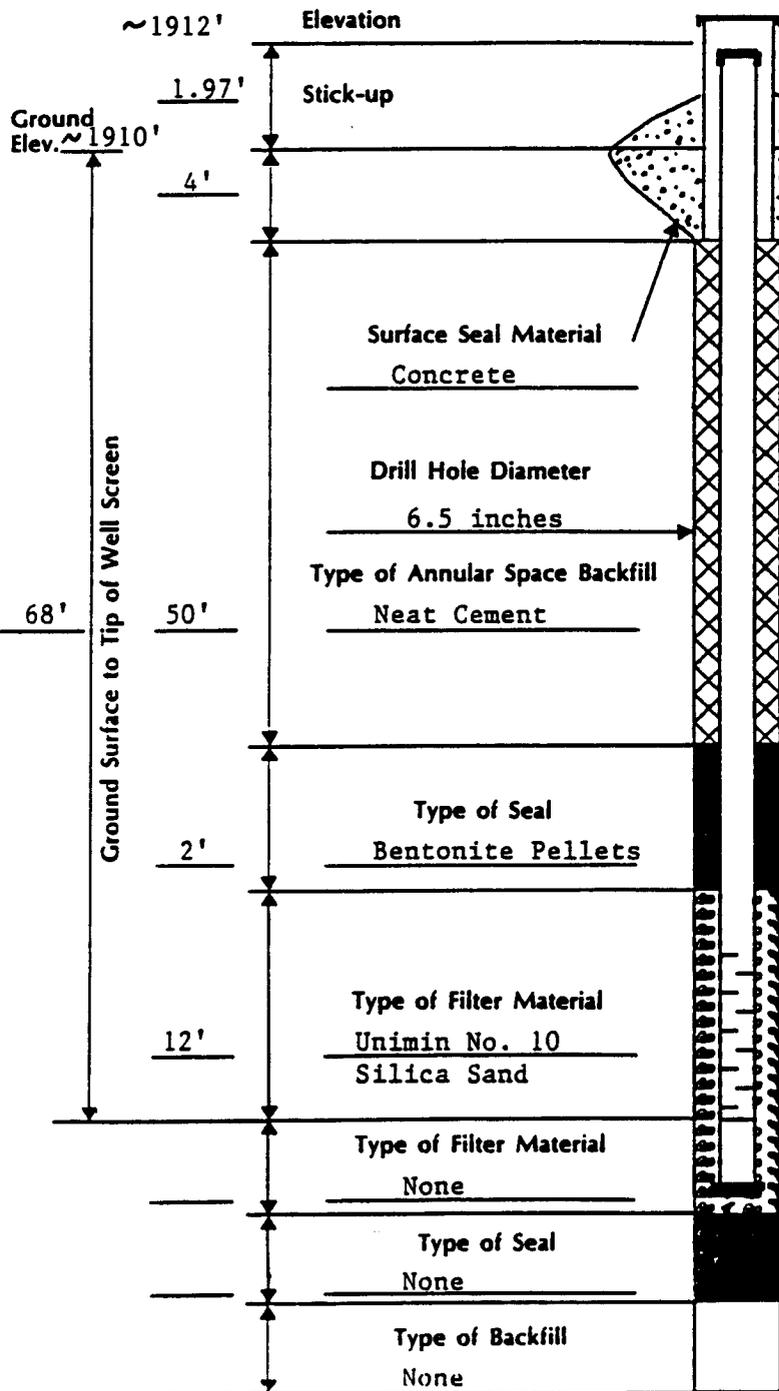
Client: H. Carlson - McDaniel SLF Scope I.D.: 90C18
 Project: Monitoring Wells 5-8, Soil Borings Page: 1 of 1
 Prepared by: CVH Date: 5/3/90
 Checked by: SSS Date: 9-19-90

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Laboratory, Bismarck, ND Well No.: MW-5
 Drilling Method: Hollow Stem Auger Date Installed: 5/3/90

Coordinates: 5522.53N 5745.08E

Protector Pipe:
 Size: 4 inch diameter
 Material: Steel
 Lock No.: Master Lock 3945



Riser:
 Diameter: 2 inch
 Material: PVC
 Sch.: 40
 Type of Joints: Flush-threaded
 Stenciled? No

Screen:
 Diameter: 2 inch
 Material: PVC
 Slot Size: 10-slot
 Length: 10 feet
Sump:
 Length: None
 Type of Cap: PVC

Centralizer: Used Not Used

Depth to Water From Top of Riser at Completion: 63.52 (Protective Pipe)

NOTE: Not to Scale

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: *RJS*

Scope I.D.: 90C18
 Page: 1 of 1
 Date: 05/21/90
 Date: *7/25/90*

REPORT - LOG OF TEST BORING

Start Date: 05/02/90
 Completion Date: 05/02/90
 Logged by: CVH

Test Boring No.: MW-6
 Location:
 Boring Depth: 20.0
 Surface Elevation: 1826.1

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
0.00	--0.0	0.0-1.5	SS	1.0	15	0.7	Dark olive gray (5 Y 3/2) sandy SILT	ML		
-5.00	--5.0	5.0-6.0	SS	2.0	13	1.0	Dark grayish brown (2.5 Y 4/2) fine sandy SILT with mottling, coal fragments, organic matter, moist			
-10.00	--10.0	10.0-11.0	SS	3.0	12	1.3	Same as above with sand lense, wet	SM/ML		
-15.00	--15.0	15.0-16.0	SS	4.0	9	2.0	Olive gray (5 Y 4/2) sandy SILT with mottling, coal fragments, organic matter, pebbles, cobbles			
-20.00	--20.0	20.0-21.0	SS	5.0	26	0.8	Dark olive gray (5 Y 3/2) silty SAND, coarse, w/ gravel, wet (18.5-20.5')	SM		
							Very dark gray (5 Y 3/1) sandy LEAN CLAY, wet (20.5' -)	CL		
							End of boring at 20'			
-25.00	--25.0									
-30.00	--30.0									
-35.00	--35.0									
-40.00	--40.0									
-45.00	--45.0									
-50.00	--50.0									
-55.00	--55.0									

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

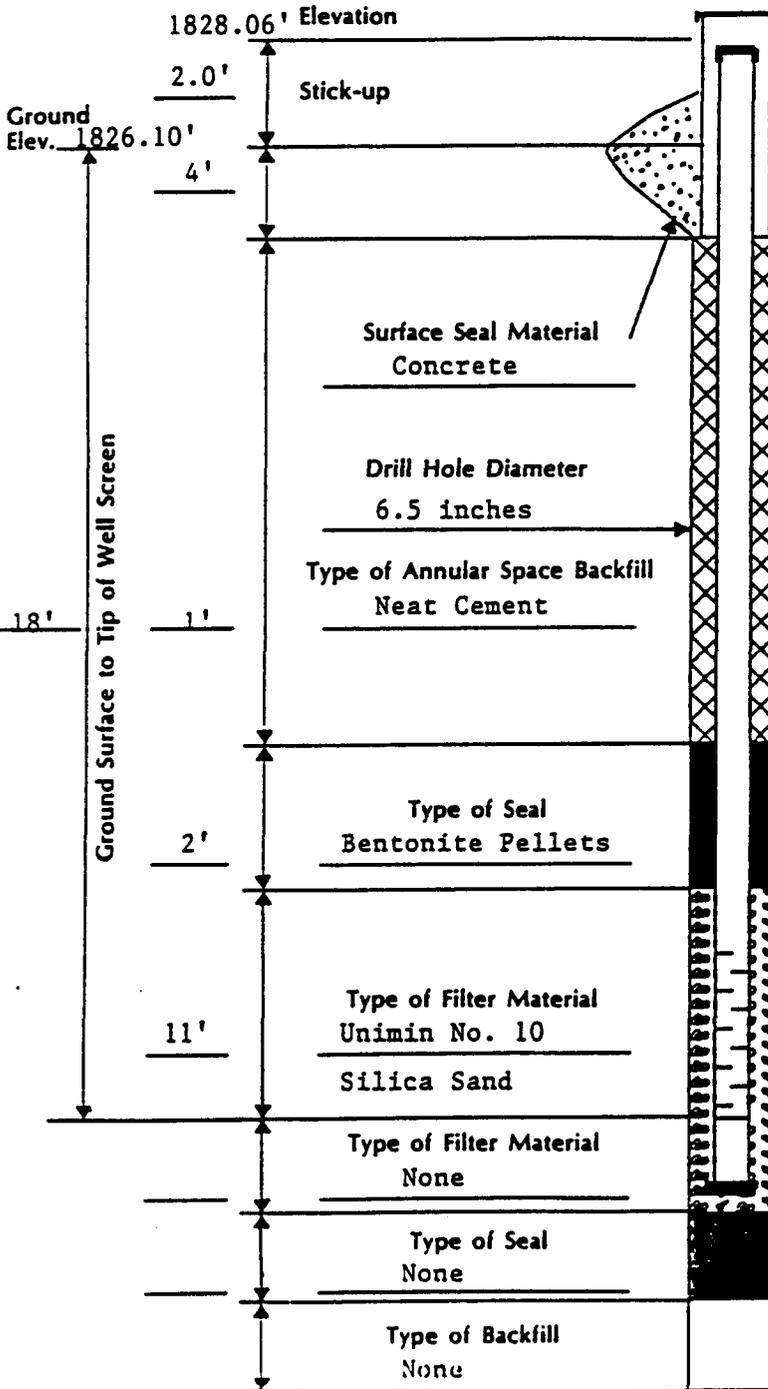
DEPTH TO WATER -
 AT COMPLETION: 10'
 LATER TIME/DEPTH:

Client: H. Carlson - McDaniel SLF Scope I.D.: 90C18
 Project: Monitoring Wells 5-8, Soil Borings Page: 1 of 1
 Prepared by: CVH Date: 5/2/90
 Checked by: BIS Date: 9-19-90

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Laboratory, Bismarck, ND Well No.: MW-6
 Drilling Method: Hollow Stem Auger Date Installed: 5/2/90

Coordinates: 5857.02N 4946.65E



Protector Pipe:
 Size: 4 inch diameter
 Material: Steel
 Lock No.: Master Lock 3945

Riser:
 Diameter: 2 inch
 Material: PVC
 Sch.: 40
 Type of Joints: Flush-threaded
 Stenciled?: No

Screen:
 Diameter: 2 inch
 Material: PVC
 Slot Size: 10-slot
 Length: 10 feet
Sump:
 Length: None
 Type of Cap: PVC Point

Centralizer: Used
 Not Used

Depth to Water From Top of Riser at Completion: 11.52
 (Protective Pipe)

NOTE: Not to Scale

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: *BJS*

Scope I.D.: 90C18
 Page: 1 of 2
 Date: 05/21/90
 Date: *9/25/90*

REPORT - LOG OF TEST BORING

Start Date: 04/30/90
 Completion Date: 05/01/90
 Logged by: CVH

Test Boring No.: MW-7
 Location:
 Boring Depth: 65.0
 Surface Elevation: 1875.6

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
0.00	--0.0	0.0-1.5	SS	1.0	26	0.8	Dark grayish brown (10 YR 4/2) silty SAND, fine, with mottling (spoil)			
-5.00	--5.0	5.0-6.0	SS	2.0	22	1.3	Olive gray (5 Y 5/2) silty SAND, fine, with mottling, coal fragments, cobble (spoil)			
-10.00	--10.0	10.0-11.0	SS	3.0	22	1.0	Same as above	SM		
-15.00	--15.0	15.0-16.0	SS	4.0	9	1.0	Olive gray (5 Y 5/2) silty SAND, fine, with a little clay, mottling, coal fragments, cobble (spoil)			
-20.00	--20.0	20.0-21.0	SS	5.0	17	0.8	Olive gray (5 Y 5/2) silty SAND, fine, with some clay, mottling, coal fragments, cobble (spoil)			
-25.00	--25.0	25.0-26.0	SS	6.0	13	0.9	Dark olive gray (5 Y 3/2) LEAN CLAY w/ snd (till) with coal fragments, pebbles, cobbles (spoil)			
-30.00	--30.0	30.0-31.0	SS	7.0	16	1.2	Dark olive gray (5 Y 3/2) and olive gray (5 Y 5/2) mottled LEAN CLAY w/ snd, coal fragments (spoil)			
-35.00	--35.0	35.0-36.0	SS	8.0	21	1.2	Dark olive gray (5 Y 3/2) LEAN CLAY w/ snd and pebbles (spoil)	CL		
-40.00	--40.0	40.0-41.0	SS	9.0	19	1.0	Very dark grayish brown (2.5 Y 3/2)			
-45.00	--45.0	45.0-46.0	SS	10	19	1.2	Same as above with olive (5 Y 5/3) silty sand, fine, lense at 45'-46'			
-50.00	--50.0	50.0-51.0	SS	11	55	1.5	Black (7.5 YR N2) sandy SILT (topsoil) with organic matter	ML		
-55.00	--55.0	55.0-56.0					Information on next page			

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

DEPTH TO WATER -
 AT COMPLETION: 59'
 LATER TIME/DEPTH:

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: **BB**

Scope I.D.: 90C18
 Page: 2 of 2
 Date: 05/21/90
 Date: 9/25/90

REPORT - LOG OF TEST BORING

Start Date: 04/30/90
 Completion Date: 05/01/90
 Logged by: CVH

Test Boring No.: MW-7
 Location:
 Boring Depth: 65.0
 Surface Elevation: 1875.6

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
-55.00	--55.0	55.0-56.0	SS	12	31	1.2	Light gray (5 Y 6/1) to light olive gray (5 Y 6/2) mottled SILT	ML		
-60.00	--60.0	60.0-61.0	SS	13	44	1.0	Black silty coal, fractured, wet (60-62.5')	COAL		
							Gray (5 Y 5/1) LEAN CLAY, wet (62.5-65')	CL		
-65.00	--65.0	65.0-66.0	SS	14	52	1.5	Olive brown (2.5 Y 4/4) silty SAND, fine, wet	SM		
							End of boring at 65'			
-70.00	--70.0									
-75.00	--75.0									
-80.00	--80.0									
-85.00	--85.0									
-90.00	--90.0									
-95.00	--95.0									
-100.00	--100.0									
-105.00	--105.0									
-110.00	--110.0									

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

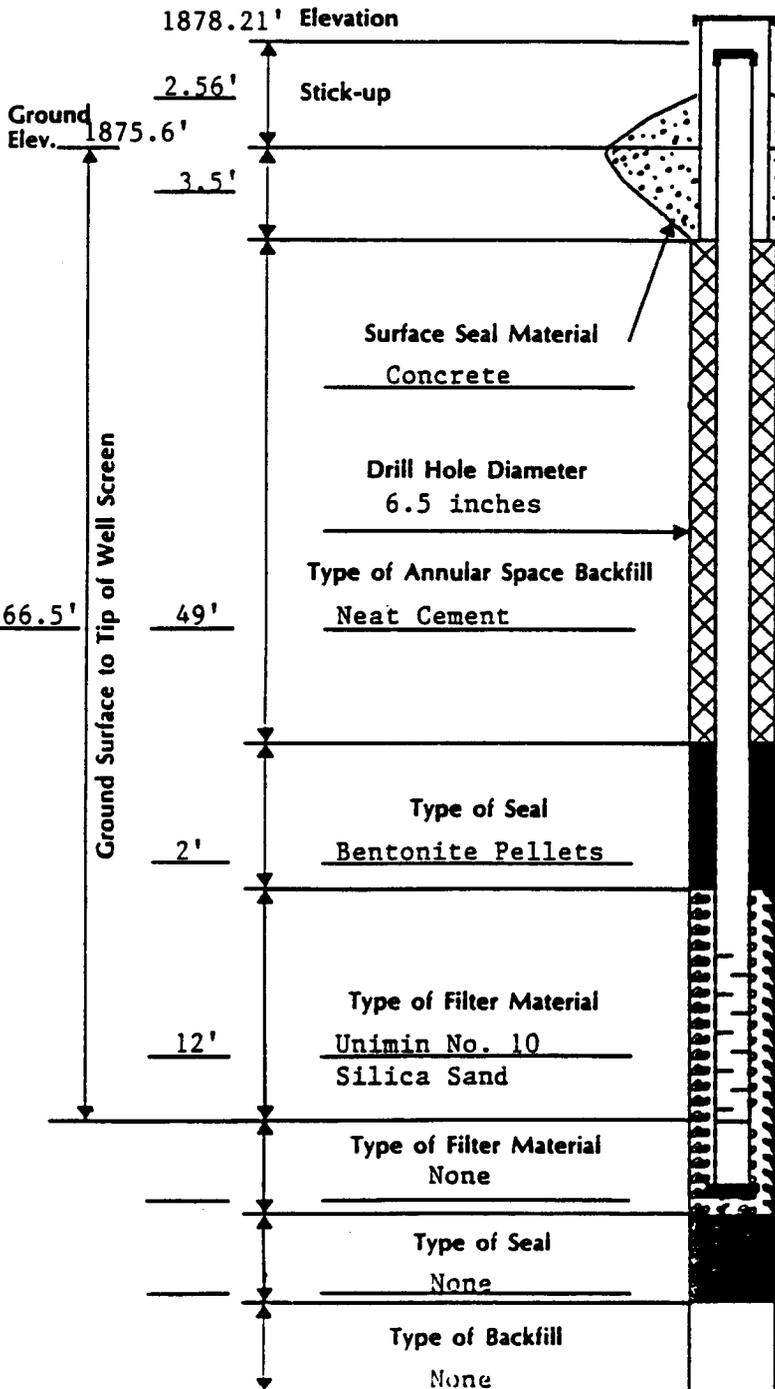
DEPTH TO WATER -
 AT COMPLETION: 59'
 LATER TIME/DEPTH:

Client: H. Carlson - McDaniel SLF Scope I.D.: 90C18
 Project: Monitoring Wells 5-8, soil borings Page: 1 of 1
 Prepared by: CVH Date: 5/1/90
 Checked by: BJS Date: 9-14-90

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Laboratory, Bismarck, ND Well No.: MW-7
 Drilling Method: Hollow Stem Auger Date Installed: 5/1/90

Coordinates: 5674.48N 4835.49E



Protector Pipe:
 Size: 4 inch diameter
 Material: Steel
 Lock No.: Master Lock 3945

Riser:
 Diameter: 2 inch
 Material: PVC
 Sch.: 40
 Type of Joints: Flush-threaded
 Stenciled? No

Screen:
 Diameter: 2 inch
 Material: PVC
 Slot Size: 10-slot
 Length: 10 feet
Sump:
 Length: None
 Type of Cap: PVC Point

Centralizer: Used Not Used
 Depth to Water From Top of Riser at Completion: 60.13
 (Protective Pipe)
 NOTE: Not to Scale

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: *BJS*

Scope I.D.: 90C18
 Page: 1 of 2
 Date: 05/21/90
 Date: *9/25/90*

REPORT - LOG OF TEST BORING

Start Date: 05/01/90
 Completion Date: 05/02/90
 Logged by: CVH

Test Boring No.: MW-8
 Location:
 Boring Depth: 75.0
 Surface Elevation: 1883.9

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
0.00	--0.0	0.0-1.5	SS	1.0	30	1.0	Dark grayish brown (2.5 Y 4/2) silty SAND, fine, to sandy SILT with organic matter, dry (spoil)			
-5.00	--5.0	5.0-6.0	SS	2.0	27	0.9	Light olive gray (5 Y 6/2) and light olive brown (2.5 Y 5/2) mottled silty SAND with organic matter, dry (spoil)	SM		
-10.00	--10.0	10.0-11.0	SS	3.0	18	0.6	Dark grayish brown (2.5 Y 4/2) silty SAND, fine, with mottling, coal fragments (spoil)			
-15.00	--15.0	15.0-16.0	SS	4.0	9	0.8	Dark grayish brown (2.5 Y 4/2) LEAN CLAY w/ snd, fn, and mottling, coal fragments, pebbles, dry (spoil)			
-20.00	--20.0	20.0-21.0	SS	5.0	12	1.0	Same as above			
-25.00	--25.0	25.0-26.0	SS	6.0	22	1.0	Same as above	CL		
-30.00	--30.0	30.0-31.0	SS	7.0	23	1.5	Same as above with cobbles			
-35.00	--35.0	35.0-36.0	SS	8.0	27	1.5	Dark grayish brown (2.5 Y 4/2) LEAN CLAY w/ sand, fine, with mottling, coal fragments (spoil)			
-40.00	--40.0	40.0-41.0	SS	9.0	65	1.5	Olive (5 Y 5/3), yellowish brown (10 YR 4/6) and dark yellowish brown (10 YR 5/5) silty SAND, fine, dry	SM		
-45.00	--45.0	45.0-46.0	SS	10	10	0.5	Black silty coal, fractured, soft from 45-47', hard from 47-55', dry	COAL		
-50.00	--50.0	50.0-51.0	SS	11	14	0.8	Same as above			
-55.00	--55.0	55.0-56.0								

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

DEPTH TO WATER -
 AT COMPLETION: 66'
 LATER TIME/DEPTH:

FOTH & VAN DYKE

Client: Hjalmer Carlson
 Project: McDaniel Landfill, North Dakota
 Prepared by: CVH
 Checked by: BJS

Scope I.D.: 90C18
 Page: 2 of 2
 Date: 05/21/90
 Date: 7/25/90

REPORT - LOG OF TEST BORING

Start Date: 05/01/90
 Completion Date: 05/02/90
 Logged by: CVH

Test Boring No.: MW-8
 Location:
 Boring Depth: 75.0
 Surface Elevation: 1883.9

MSL ELEV	DEPTH FR LND SURF	SAMP DEPTH INTERVAL	TYPE	#	N	REC (ft)	DESCRIPTION OF MATERIAL	CLASS	LABORATORY TESTS	DRILLING AND SAMPLING NOTES
-55.00	--55.0	55.0-56.0	SS	12	100	1.0	Dark gray (5 Y 4/1) silty SAND, very fine (55.0-56.0')	SM		
							Dark gray (5 Y 4/1) silty SAND fine, moist (56.0-58.0')	COAL		
							Black coal (58.0-59.0')			
-60.00	--60.0	60.0-61.0	SS	13	100	1.3	Dark gray (10 YR 4/1) and black (10 YR 2/1) clayey SILT with coal fragments, dense, dry			
-65.00	--65.0	65.0-66.0	SS	14	92	1.5	Gray (5 Y 5/1) clayey SILT with organic fragments, dense	ML		
-70.00	--70.0	70.0-71.0	SS	15	100	2.0	Same as above, outside of sample is wet			
-75.00	--75.0	75.0-76.0	SS	16	100	0.5	Black coal, highly jointed, wet (73.5-74.5')	COAL		
							Black (5 Y 2.5/1) silty CLAY, dense (74.5' -)	CL/ML		
							End of boring at 75'			
-80.00	--80.0									
-85.00	--85.0									
-90.00	--90.0									
-95.00	--95.0									
-100.00	--100.0									
-105.00	--105.0									
-110.00	--110.0									

DRILLING METHOD: Hollow stem auger, 3.5 inch diameter
 DRILLING CONTRACTOR: Midwest Testing Laboratory, Inc.

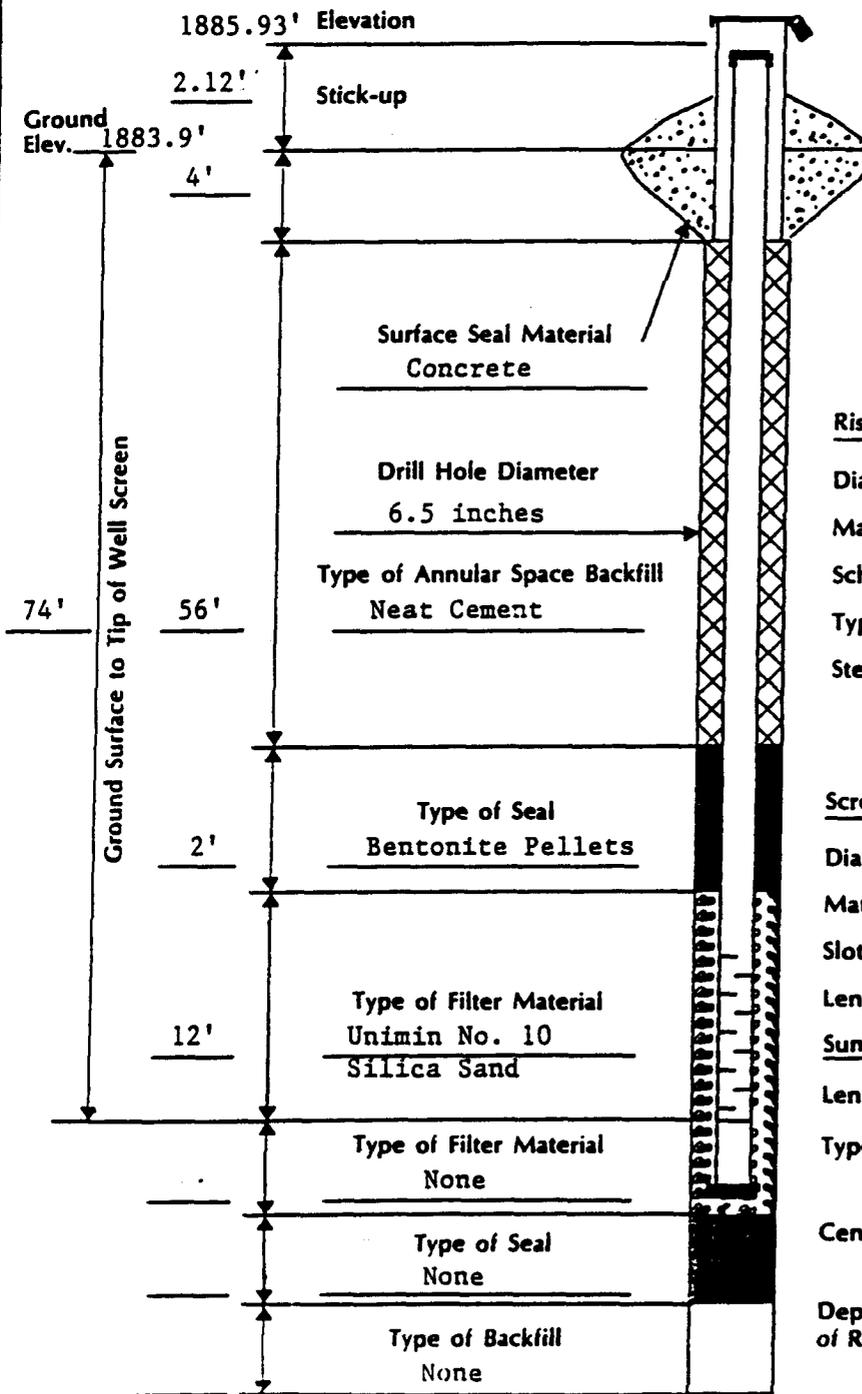
DEPTH TO WATER -
 AT COMPLETION: 66'
 LATER TIME/DEPTH:

MONITORING WELL CONSTRUCTION DIAGRAM

Driller: Midwest Testing Laboratory, Bismarck, ND Well No.: MW-8
 Drilling Method: Hollow Stem Auger Date Installed: 5/2/90

Coordinates: 5407.77N 4668.12E

Protector Pipe:
 Size: 4 inch diameter
 Material: Steel
 Lock No.: Master Lock 3945



Riser:
 Diameter: 2 inch
 Material: PVC
 Sch.: 40
 Type of Joints: Flush-threaded
 Stenciled? No

Screen:
 Diameter: 2 inch
 Material: PVC
 Slot Size: 10-slot
 Length: 10 feet
Sump:
 Length: None
 Type of Cap: PVC Point

Centralizer: Used
 Not Used

Depth to Water From Top of Riser at Completion: 67.30
 (Protective Pipe)

NOTE: Not to Scale

APPENDIX E

WATER-LEVEL TABLES

McDaniel Landfill Water Level
8/16/93 to 9/22/93

152-082-24AAC1 LS Elev (msl, ft)=1896.69
 UNDEF Aquifer SI (ft.)=91-101

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/16/93	64.02	1832.67	09/09/93	66.41	1830.28
08/17/93	67.05	1829.64	09/22/93	66.23	1830.46
08/24/93	66.94	1829.75			

152-082-24AAC3 LS Elev (msl, ft)=1896.85
 Undefined Aquifer SI (ft.)=67-77

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/24/93	63.05	1833.80	09/09/93	63.14	1833.71
08/25/93	63.10	1833.75	09/22/93	63.17	1833.68

152-082-24AAD LS Elev (msl, ft)=1898.82
 UNDEF Aquifer SI (ft.)=60-70

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/16/93	61.40	1837.42	09/09/93	64.84	1833.98
08/17/93	65.13	1833.69	09/22/93	65.09	1833.73
08/25/93	63.54	1835.28			

152-082-24ACA LS Elev (msl, ft)=1830.56
 Undefined Aquifer SI (ft.)=7-12

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/24/93	6.30	1824.26	09/09/93	6.83	1823.73
08/25/93	6.33	1824.23	09/22/93	6.21	1824.35
08/26/93	6.38	1824.18			

152-082-24ACCB (MW-5) LS Elev (msl, ft)=1910.41
 Undefined Aquifer SI (ft.)=58-68

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/25/93	61.46	1848.95	09/22/93	61.60	1848.81
09/09/93	61.51	1848.90			

152-082-24ACCC (MW-3) LS Elev (msl, ft)=1917.92
 Undefined Aquifer SI (ft.)=90-100

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/25/93	92.33	1825.59	09/22/93	92.54	1825.38
09/09/93	92.44	1825.48			

152-082-24ACDA (MW-1) LS Elev (msl,ft)=1837.71
Undefined Aquifer SI (ft.)=12-22

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/25/93	16.36	1821.35	09/22/93	16.83	1820.88
09/09/93	16.08	1821.63			

152-082-24ADA LS Elev (msl,ft)=1899.65
UND Aquifer SI (ft.)=67-77

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/16/93	64.50	1835.15	09/09/93	64.55	1835.10
08/17/93	64.51	1835.14	09/22/93	64.58	1835.07
08/25/93	64.53	1835.12			

152-082-24ADBC (MW-6) LS Elev (msl,ft)=1826.46
Undefined Aquifer SI (ft.)=8-18

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/26/93	7.02	1819.44	09/22/93	6.28	1820.18
09/09/93	7.14	1819.32			

152-082-24ADCB (MW-7) LS Elev (msl,ft)=1875.78
Undefined Aquifer SI (ft.)=56.5-66.5

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/26/93	54.51	1821.27	09/22/93	54.86	1820.92
09/09/93	54.63	1821.15			

152-082-24ADCC (MW-2) LS Elev (msl,ft)=1900.86
Undefined Aquifer SI (ft.)=77-87

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/26/93	78.49	1822.37	09/22/93	78.56	1822.30
09/09/93	78.48	1822.38			

152-082-24ADCC2 (MW-8) LS Elev (msl,ft)=1883.85
Undefined Aquifer SI (ft.)=64-74

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
08/26/93	61.83	1822.02	09/22/93	62.24	1821.61
09/09/93	61.95	1821.90			

APPENDIX F

MAJOR ION AND TRACE-ELEMENT
CONCENTRATIONS

McDaniel Solid Waste Landfill Water Quality
Major Ions

Location	Screened Interval (ft)	Date Sampled	(milligrams per liter)																	Spec				
			SiO ₂	Fe	Mn	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS	Hardness as CaCO ₃	as NCH	% Na	SAR	Cond (µmho)	Temp (°C)	pH
152-082-24AAC1	91-101	08/24/93	8.6	0.47	0.15	38	15	1200	11	2140	0	1000	24	0.5	26	0.47	3380	160	0	94	41	4510	10	7.3
152-082-24AAC3	67-77	08/25/93	70	0.07	0.05	130	48	840	61	819	0	1600	44	0.4	13	1.6	3210	520	0	75	16	4180	12	8.43
152-082-24AAD	60-70	08/25/93	33	0.85	2.3	430	140	1500	25	1140	0	3200	65	0.4	54	4.3	6020	1700	720	66	16	6820	9	6.39
152-082-24ACA	7-12	08/26/93	10	0.09	0.15	230	100	420	9.3	949	0	1100	18	0.2	4.1	0.55	2360	990	210	48	5.8	3000	11	6.63
152-082-24ACCB	58-68	08/25/93	21	0.09	0.65	480	340	1200	32	1170	0	3600	55	0.2	780	0.14	7090	2600	1600	50	10	7170	8	6.42
152-082-24ACCC	90-100	08/25/93	17	0.53	0.43	84	40	330	9.2	674	0	570	7.3	0.2	0	0.56	1390	370	0	65	7.5	1920	9	6.27
152-082-24ACDA	12-22	08/25/93	10	0.27	0.07	210	100	300	7.6	839	0	950	9.6	0.4	11	0.46	2010	940	250	41	4.3	2540	9	6.42
152-082-24ADA	67-77	08/25/93	26	0.08	0.96	330	140	680	20	798	0	2000	90	0.3	5.3	1.8	3690	1400	750	51	7.9	4440	15	6.25
152-082-24ADBC	8-18	08/26/93	32	3.2	2	130	92	330	2.7	1330	0	350	16	0.4	2.6	0.37	1620	700	0	50	5.4		6	6.61
152-082-24ADCB	55.5-65.5	08/26/93	23	0.79	0.97	170	100	450	4.6	1650	0	540	9.3	0.4	7	0.41	2120	840	0	54	6.8	2860	9	6.68
152-082-24ADCC	77-87	08/26/93	7.3	0.03	0.07	16	7	670	7.3	1370	0	400	6.7	0.6	20	0.4	1810	69	21	95	35	2630	8	7.45
152-082-24ADCC2	64-74	08/26/93	10	0.31	0.09	34	12	590	6.4	1310	0	360	5.3	0.3	5.3	0.5	1670	130	19	90	22	2420	8	6.78

Water Quality Analyses (cont.)

Trace Element Analyses

Location	Date Sampled	Selenium	Lead	Cadmium (micrograms per liter)	Mercury	Arsenic	Molybdenum	Strontium
152-082-24AAC1	8/26/93	0	4	0	0	3	7	950
152-082-24AAC3	8/26/93	2	0	0	0	2	77	1800
152-082-24AAD	8/26/93	3	4	0	0	1	3	5900
152-082-24ACA	8/26/93	0	0	0	0.1	0	0	4800
152-082-24ACCB	8/26/93	106	0	0	0	0	1	5000
152-082-24ACCC	8/26/93	1	0	0	0.1	0	1	1900
152-082-24ACDA	8/26/93	1	0	0	0	0	1	3400
152-082-24ADA	8/26/93	0	1	0	0	16	0	6100
152-082-24ADBC	8/26/93	0	0	0	0	5	1	1100
152-082-24ADCB	8/26/93	0	0	0	0	13	3	1900
152-082-24ADCC	8/26/93	0	0	0	0	1	7	390
152-082-24ADCC2	8/26/93	0	0	0	0	0	0	790

APPENDIX G

VOLATILE ORGANIC COMPOUNDS
FOR WELL 152-082-24ACA

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	<2
Vinyl Chloride	<1
Carbon Tetrachloride	<2
1,2-Dichloroethane	<2
Trichloroethylene	<2
1,1-Dichloroethylene	<2
1,1,1-Trichloroethane	<2
para-Dichlorobenzene	<2
Acetone	<50
2-Butanone (MEK)	<50
2-Hexanone	<50
4-Methyl-2-pentanone	<50
Chloroform	<5
Bromodichloromethane	<5
Chlorodibromomethane	<5
Bromoform	<5
trans1,2-Dichloroethylene	<2
Chlorobenzene	<2
m-Dichlorobenzene	<5
Dichloromethane	<5
cis-1,2-Dichloroethylene	<2
o-Dichlorobenzene	<2
Dibromomethane	<5
1,1-Dichloropropene	<5
Tetrachlorethylene	<2
Toluene	<2
Xylene (s)	<2
1,1-Dichloroethane	<5
1,2-Dichloropropane	<2
1,1,2,2-Tetrachloroethane	<5
Ethyl Benzene	<2
1,3-Dichloropropane	<5
Styrene	<2
Chloromethane	<5
Bromomethane	<5
1,2,3-Trichloropropane	<5
1,1,1,2-Tetrachloroethane	<5
Chloroethane	<5
1,1,2-Trichloroethane	<5

* Constituent Detection

VOC Constituents cont.

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

* Constituent Detection

APPENDIX H

VOLATILE ORGANIC COMPOUNDS
FOR WELL 152-082-24ACC3

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	<2
Vinyl Chloride	<1
Carbon Tetrachloride	<2
1,2-Dichloroethane	<2
Trichloroethylene	<2
1,1-Dichloroethylene	<2
1,1,1-Trichloroethane	<2
para-Dichlorobenzene	<2
Acetone	77.8*
2-Butanone (MEK)	<50
2-Hexanone	<50
4-Methyl-2-pentanone	<50
Chloroform	<5
Bromodichloromethane	<5
Chlorodibromomethane	<5
Bromoform	<5
trans1,2-Dichloroethylene	<2
Chlorobenzene	<2
m-Dichlorobenzene	<5
Dichloromethane	<5
cis-1,2-Dichloroethylene	<2
o-Dichlorobenzene	<2
Dibromomethane	<5
1,1-Dichloropropene	<5
Tetrachlorethylene	<2
Toluene	<2
Xylene (s)	<2
1,1-Dichloroethane	<5
1,2-Dichloropropane	<2
1,1,2,2-Tetrachloroethane	<5
Ethyl Benzene	<2
1,3-Dichloropropane	<5
Styrene	<2
Chloromethane	<5
Bromomethane	<5
1,2,3-Trichloropropane	<5
1,1,1,2-Tetrachloroethane	<5
Chloroethane	<5
1,1,2-Trichloroethane	<5

* Constituent Detection

VOC Constituents cont.

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

* Constituent Detection