Site Suitability Review of the Casselton Sanitation Landfill

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

ND Landfill Site Investigation No. 15

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OF THE
CASSELTON LANDFILL

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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 municipal 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. The Casselton municipal solid waste landfill is one of the landfills being evaluated.

Results of the water-quality analyses are based on a one-time sampling event. Additional studies may be necessary to meet the requirements of the NDSDHCL for continued operation of municipal solid waste landfills.

Location of the Casselton Landfill

The Casselton solid waste landfill is located one half mile east of the City of Casselton in Township 140 North, Range 52 West, SW 1/4 of Section 36 (Fig. 1). The landfill site, which

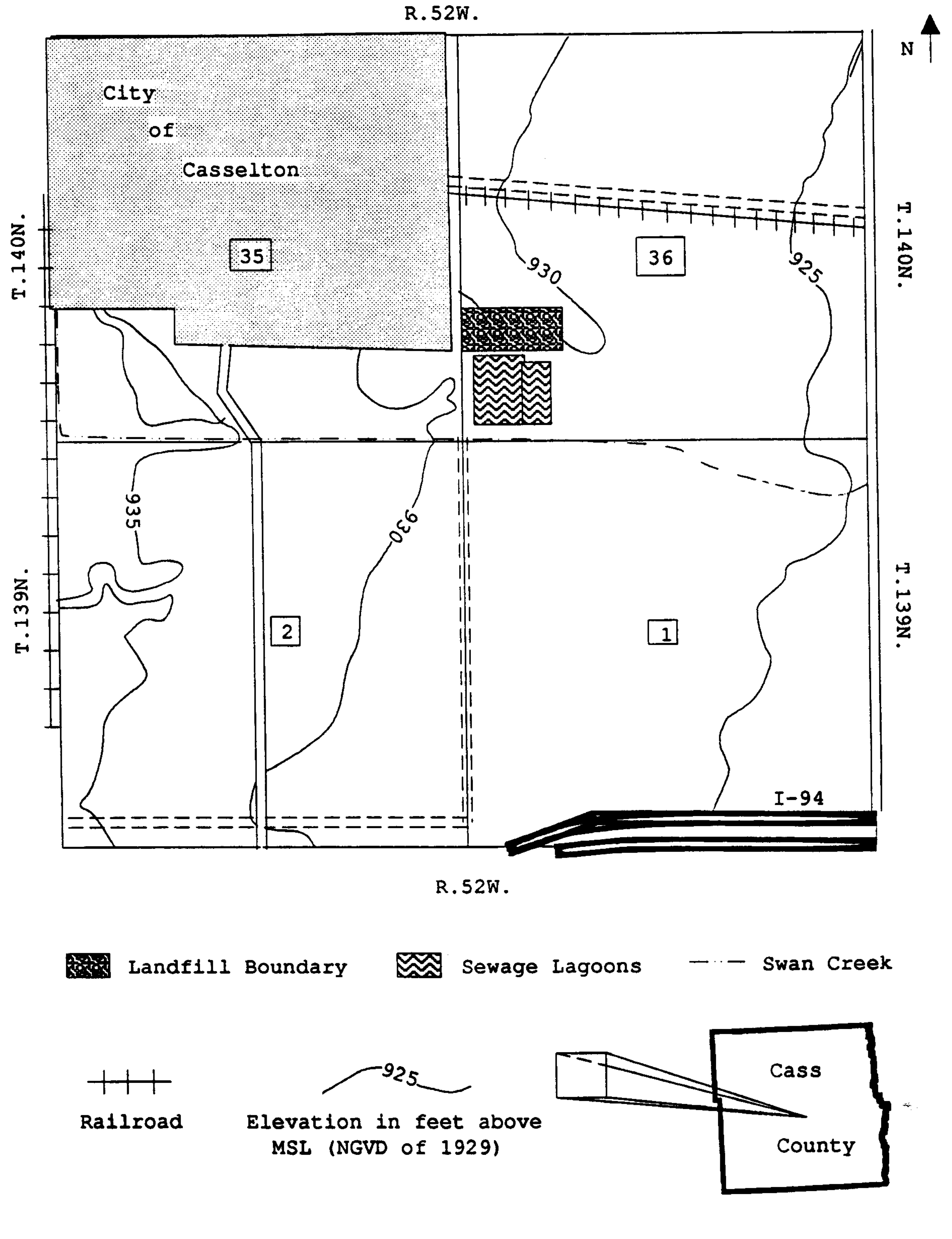

Figure 1. Location of the Casselton landfill in the southwest quarter of section 36, T.140N., R.52W.

encompasses approximately 20 acres, is immediately north of the city sewage lagoons.

Previous Site Investigations

The City of Casselton drilled a soil boring at the landfill in 1984. The drill cuttings from the boring were composed of sandy, clayey silt from 1 1/2 to 5 1/2 feet; silty clay with layers of silt from 5 1/2 to 16 feet; and clay from 16 to 51 feet. The depth of the water table was not determined from this boring.

Methods of Investigation

The Casselton study was accomplished by means of: 1) test drilling; 2) construction and development of monitoring wells; 3) collecting and analyzing water samples; and 4) measuring water levels.

Test Drilling Procedure

The drilling method at the Casselton landfill was based on the site's geology and depth to ground water, as determined by the preliminary evaluation. A hollow-stem auger was used at the Casselton landfill because the sediments were poorly consolidated and the depth to ground water was expected to be less than 70 feet. The lithologic descriptions were determined from the drilling returns.

Monitoring Well Construction and Development

Seven test holes were drilled at the Casselton landfill with monitoring wells installed in each of the test holes. The number of wells installed was based on the geologic and topographic characteristics of the site. The wells were located near the active area of the landfill. 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 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.

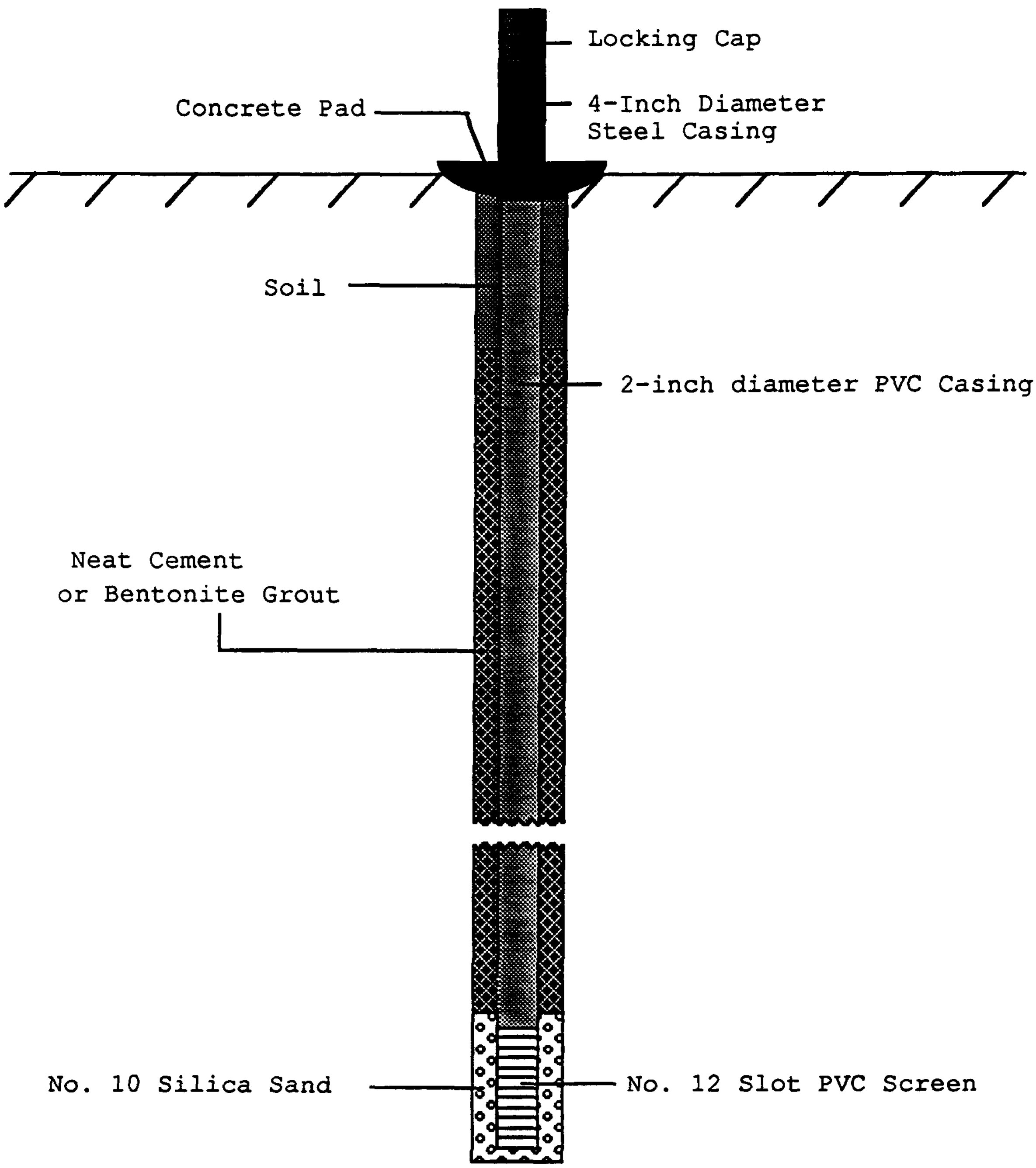

Figure 2. Construction design used for monitoring wells installed at the Casselton landfill.

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 or Secondary Contaminant Levels (MCL, SMCL). MCLs are enforcable drinking water standards and represent the maximum permissible level of a contaminant as stipulated by the U.S. Environmental Protection Agency (EPA). SMCLs are not enforcable contaminant levels.

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.

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.

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

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 section (40-acre tract), and quarter-quarter-quarter section (10-acre tract). Therefore, a well denoted by 140-052-36CDB would be located in the NW1/4, SE1/4, SW1/4, Section 36, Township 140 North, Range 52 West. Consecutive numbers are added following the three letters if more than one well is located in a 10-acre tract, e.g. 140-052-36CDB1 and 140-052-36CDB2.

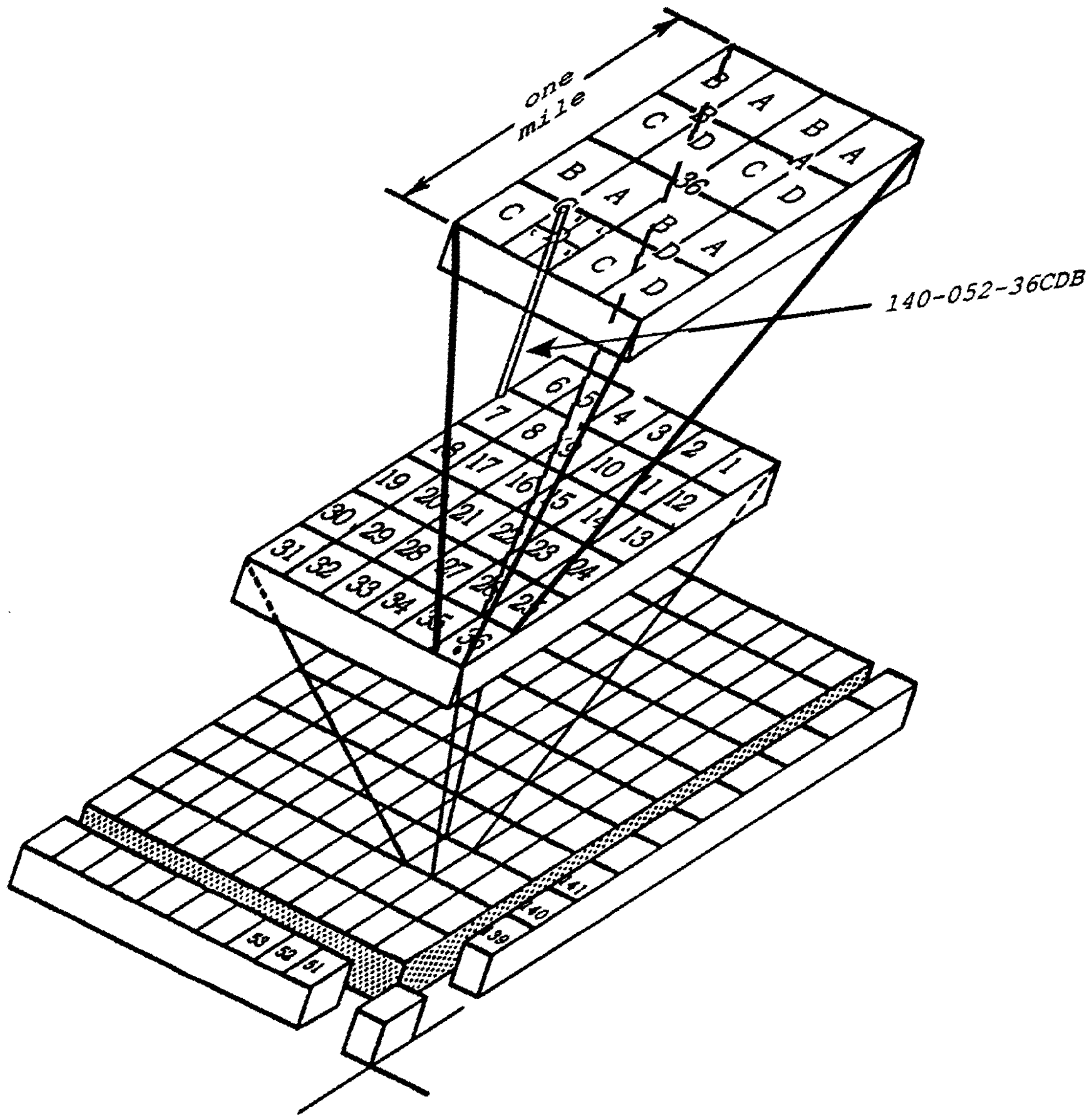

Figure 3. Location-numbering system for the Casselton landfill.

GEOLOGY

The Casselton landfill is located on the glacial Lake Agassiz plain and is underlain by offshore lake deposits. These deposits are composed mainly of clay and silt and average about 50 feet thick in the Casselton area, according to published drill-hole data (Klausing, 1966). The lake deposits are underlain by 150 to 300 feet of till and associated outwash deposits. Bedrock in the area consists of Cretaceous shales and the Dakota Sandstone. A few feet of alluvial and slough sediments occur at the surface in areas near Swan Creek.

Test holes drilled at the landfill for this study encountered clay, silt, and sandy silt. A layer of sandy silt is present on the south side of the site from near the surface to a depth of 10 or 15 feet (Fig. 5). At the southwest corner of the site a sandy, silty clay occurs at the same interval (test hole 140-52-36CCB1, lithologic logs in Appendix C). The silt and sand were not found on the north side of the landfill.

HYDROLOGY

Surface-Water Hydrology

The Casselton landfill is located within the old Swan Creek stream bed. Swan Creek was diverted in man-made canals around the City of Casselton. Swan Creek returns to its

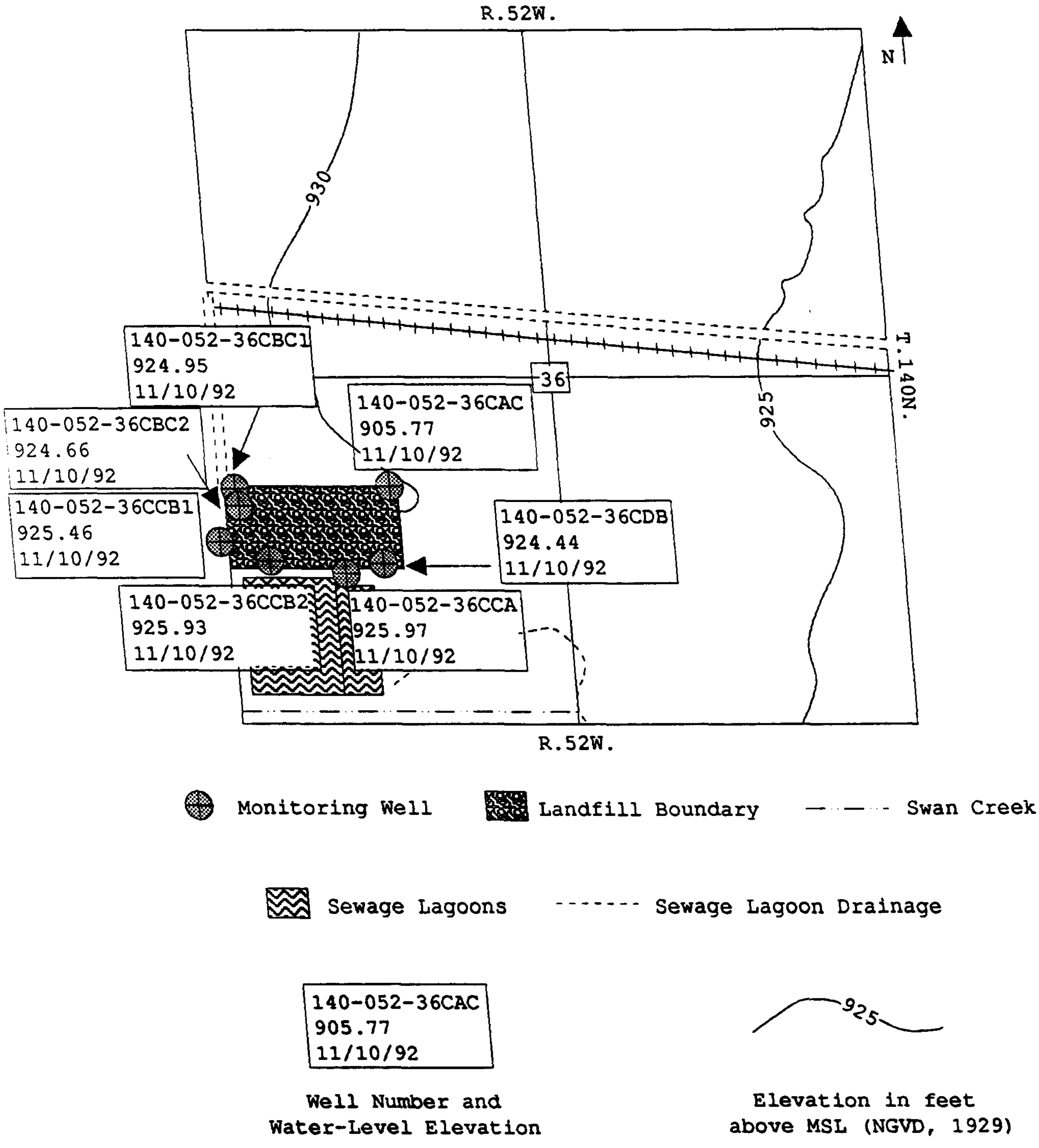

Figure 4. Location of monitoring wells at the Casselton landfill.

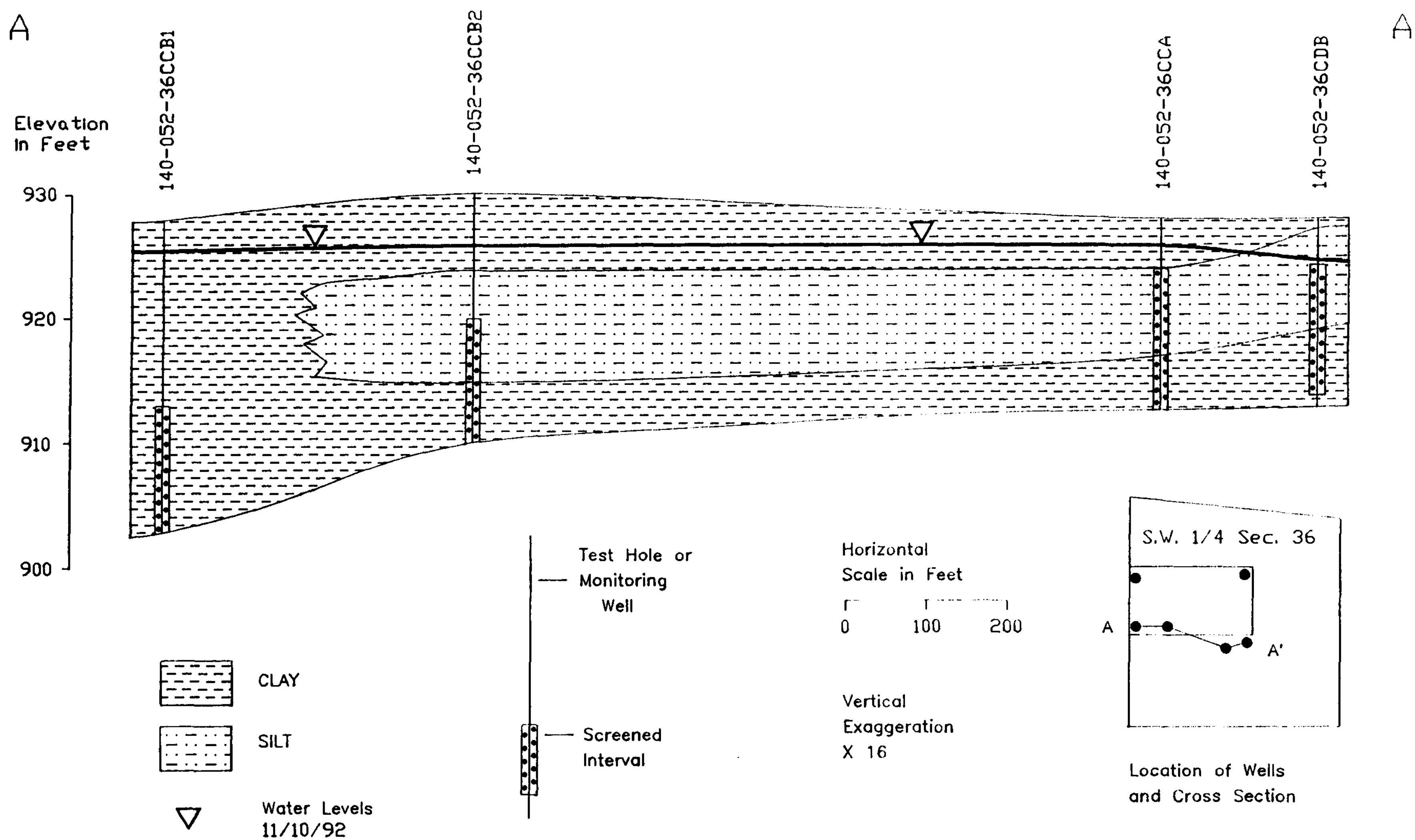

Figure 5. Geohydrologic section A–A' in the Casselton landfill.

original stream bed about a quarter-mile southeast of the landfill. A wetland is located within the old Swan Creek stream bed adjacent to the west side of the landfill boundary.

Three sewage lagoons are located about 100 to 200 feet south of the south side of the landfill boundary. These lagoons are not susceptible to leachate migration from the landfill because water levels associated with the lagoons probably are higher in elevation than the water levels within the landfill.

Regional Ground-Water Hydrology

Regional aquifers near the City of Casselton occur mainly in the Dakota Sandstone. The Dakota aquifer is located about 300 feet below land surface (Dennis, 1949) and is overlain by mostly lacustrine clay and glacial till. This aquifer should not be affected by leachate migration from the landfill because the lacustrine clay is thick and assumed to be characterized by a relatively small hydraulic conductivity.

Undifferentiated sand and gravel aquifers are found throughout the region. These aquifers are not extensive and as a result yield small quantities of water. There are no major glacial aquifers in the area of the Casselton landfill.

Local Ground-Water Hydrology

Seven test holes were drilled at the Casselton landfill with monitoring wells installed in all of them (Fig. 4). The well screens were placed near the top of the water table beneath the landfill. Five water-level measurements were taken over an eight-week period (Appendix D). The water level in well 140-052-36CAC is about 15 feet lower than the other six wells. The lower water level in this well may be, in part due to the fact that the top of the screen is about 15 to 20 feet lower in elevation than the other six wells.

The water table at the landfill is located within the sandy-clay and sandy-silt units at a depth of two to four feet below land surface. The depth to ground water appears to be influenced by ground-water mounding associated with the city's sewage lagoons. The sewage lagoons may provide recharge to the refuse cells.

The direction of ground-water flow in and around the landfill is effected by discharge from the sewage lagoons. The direction of ground-water flow is north-northwest along the south boundary of the landfill. The ground-water flow along the north boundary is to the south- southeast (Fig. 4). The regional direction of flow appears to follow the old Swan Creek stream bed to the south-southeast. The direction of ground-water flow may result in leachate migration into Swan Creek.

WATER QUALITY

Chemical analyses of water samples are shown in Appendix E. Wells 140-052-36CBC1 and 140-052-36CBC2 were used as up-gradient wells. These wells are located in the northwest corner of the landfill site and are not adjacent to the buried refuse or the sewage lagoons (Fig. 4). Water in these two wells is characterized by a calcium-sulfate type. These wells also indicated high concentrations of magnesium, manganese, sodium, and total dissolved solids.

Wells 140-052-36CCA, 140-052-36CCB2, and 140-052-36CDB are located between the landfill and the sewage lagoons (Fig. 4). The water in these wells is characterized as a magnesium-sodium-sulfate type. The increase in magnesium and sodium appears to be attributed to the proximity of the wells to the sewage lagoons and the landfill. Well 140-052-36CDB, which is located near the southeast corner of the landfill site and about 200 feet north of the eastern-most sewage lagoon pond, indicated concentrations of sulfate (2,900 mg/L), sodium (560 mg/L), magnesium (790 mg/L), chloride (301 mg/L), and total dissolved solids (6,330 mg/L) above the maximum (MCL) and secondary (SMCL) contamination levels (Appendix A). This well also detected a selenium concentration of 8 µg/L which is close to the MCL of 10 µg/L. It appears that the ground-water quality at this well may be influenced by contamination migration from the lagoons and/or the landfill. This study did not determine the exact source of contamination. The other six wells did not indicate elevated selenium concentrations. Well 140-052-36CAC, located at the northeast corner of the landfill, detected 190 µg/L of molybdenum which is twice the MCL of 100 µg/L. The source of this molybdenum was not determined in this study but does not appear to originate from the landfill.

A VOC analysis from well 140-052-36CDB, is shown in Appendix F. This analysis did not detect any VOC compounds.

CONCLUSIONS

The Casselton landfill is located in the old Swan Creek stream bed. Swan Creek has been diverted through canals around the City of Casselton, returning to its original stream bed about a quarter of a mile southeast of the landfill. The city sewage lagoons are located about 100 to 200 feet south of the landfill.

The geologic materials at the landfill originated as offshore lake sediments and consist of clay, silt, and sandy silt. The lake deposits are about 50 feet thick. They are underlain by a thick unit of till and outwash, which in turn is underlain by Cretaceous shale and sandstone. The Dakota Sandstone occurs about 300 feet below the surface and is the main aquifer in the region.

The water table at the landfill occurs at a shallow depth. Water levels in six of the monitoring wells ranged from 2 to 4 feet below the land surface. In the seventh well the water level was about 20 feet below the surface. The highest water levels were measured in the wells near the sewage lagoons, suggesting ground-water mounding beneath the lagoons. Local ground-water flow is to the north-northwest because of the effects of discharge from the sewage lagoons. Regional ground-water flow is toward the south-southeast and appears to follow the Swan Creek stream bed.

The up-gradient monitoring wells at the northwest corner of the landfill are characterized by a calcium-sulfate type water with relatively high concentrations of several other major ions. The wells on the south side of the landfill (and near the sewage lagoons) are characterized by a magnesium-sodium-sulfate type water. Samples from one of these wells, 140-052-36CDB, had concentrations of sulfate, sodium, magnesium, chloride, and total dissolved solids which exceeded the MCL or SMCL for these chemicals. This well also indicated an increase in selenium concentration. The increased concentrations of the major ions suggest that the shallow ground water at this well has been affected by contaminant migration originating from either the sewage lagoons or the landfill. The VOC analysis from well 140-052-36CDB showed no detections of volatile organic compounds.

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Dennis, P.E., Akin, P.D., and Worts, G.F., Jr., 1949, Geology and ground-water resources of parts of Cass and Clay Counties, North Dakota and Minnesota: North Dakota State Water Comm. Ground Water Studies No. 10, 177 p.

Hem, J.D., 1989, Study and interpretation of the chemical characteristics of natural water: United States Geological Survey Water-Supply Paper 2254, 263 p.

Klausing, R.L., 1966, Geology and ground-water resources of Cass County, North Dakota: North Dakota Geological Survey, Bulletin 47, North Dakota State Water Commission, County Ground-Water Studies 8, Part II, 158 p.

North Dakota Department of Health, 1986, Water well construction and well pump installation: Article 33-18 of the North Dakota Administrative Code.

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 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. Scew 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

140-052-36CAC

NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	40	Source of Data:	
Screened Interval (ft):	30-40	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	927.67
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
GRAVEL	Fill.	0-1
CLAY	Grayish black N2 (stream and lake deposits).	1-2
CLAY	Moderate yellowish brown 10YR5/4, calcite.	2-6
CLAY	Moderate yellowish brown 10YR5/4..	6-16
CLAY	Pale yellowish brown 10YR6/2.	16-27
CLAY	Olive gray 5Y4/1.	27-40

140-052-36CBC1

NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	15	Source of Data:	
Screened Interval (ft):	5-15	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	928.97
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
CLAY	Trace of sand and gravel, brownish gray 5YR4/1 (stream and lake deposits).	1-3
CLAY	Silty, grayish black N2.	3-9
CLAY	Moderate yellowish brown 10YR5/4.	9-15

140-052-36CBC2

NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	30	Source of Data:	
Screened Interval (ft):	25-30	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	928.69
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
CLAY	Trace of sand and gravel, brownish gray 10YR4/1 (stream and lake deposits).	1-3
CLAY	Silty, grayish black N2.	3-8
CLAY	Moderate yellowish brown 10YR5/4.	8-22
CLAY	Silty, olive gray 5Y4/1.	22-30

140-052-36CCA

NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	15	Source of Data:	
Screened Interval (ft):	5-15	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	928.3
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
CLAY	Organic material, grayish black N2 (stream and lake deposits).	1-4
SILT	With very fine sand, moderate yellowish brown 10YR5/4.	4-11
CLAY	Silty with a trace of very fine sand, moderate yellowish brown 10YR5/4.	11-15

140-052-36CCB1
NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	25	Source of Data:	
Screened Interval (ft):	15-25	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	928.1
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
CLAY	High organic material, dusky brown 5YR2/2 (stream and lake deposits).	2-6
CLAY	Very fine sand, moderate yellowish brown 10YR5/4.	6-16
CLAY	Silty, interbedded with medium grained sand, moderate yellowish brown to dark yellowish orange.	16-22
CLAY	Medium gray N5.	22-25

140-052-36CCB2

NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	20	Source of Data:	
Screened Interval (ft):	10-20	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	929.67
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-2
CLAY	Silty, with calcite, moderate yellowish brown 10YR5/4 (stream and lake deposits).	2-6
SILT	with very fine sand, moderate yellowish brown 10YR5/4.	6-15
CLAY	Silty, moderate yellowish brown 10YR5/4.	15-20

140-052-36CDB

NDSWC

Date Completed:	9/17/92	Well Type:	P2
Depth Drilled (ft):	15	Source of Data:	
Screened Interval (ft):	4-14	Principal Aquifer :	Undefined
Casing size (in) & Type:		L.S. Elevation (ft)	927.66
Owner: Casselton			

Lithologic Log

Unit	Description	Depth (ft)
TOPSOIL		0-1
SILT	With very fine sand, moderate yellowish brown 10YR5/4 (stream and lake deposits).	1-9
CLAY	With calcite, moderate yellowish brown 10YR5/4.	9-11
CLAY	Moderate yellowish brown 10YR5/4.	11-15

APPENDIX D

WATER-LEVEL TABLES

Casselton Landfill Water Levels

140-052-36CAC LS Elev (msl,ft)=927.67

Undefined Aquifer SI (ft.)=30-40

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	4.21	923.46	11/10/92	21.90	905.77
10/07/92	28.42	899.25	11/19/92	18.74	908.93
10/20/92	30.78	896.89			

140-052-36CBC1 LS Elev (msl,ft)=928.97

Undefined Aquifer SI (ft.)=5-15

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	3.91	925.06	11/10/92	4.02	924.95
10/07/92	4.30	924.67	11/19/92	3.99	924.98
10/20/92	6.41	922.56			

140-052-36CBC2 LS Elev (msl,ft)=928.69

Undefined Aquifer SI (ft.)=25-30

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	3.90	924.79	11/10/92	4.03	924.66
10/07/92	4.51	924.18	11/19/92	3.88	924.81
10/20/92	4.86	923.83			

140-052-36CCA LS Elev (msl,ft)=928.3

Undefined Aquifer SI (ft.)=5-15

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	2.55	925.75	11/10/92	2.33	925.97
10/07/92	2.78	925.52	11/19/92	2.43	925.87
10/20/92	2.77	925.53			

140-052-36CCB1 LS Elev (msl,ft)=928.1

Undefined Aquifer SI (ft.)=15-25

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	2.88	925.22	11/10/92	2.64	925.46
10/07/92	3.00	925.10	11/19/92	2.72	925.38
10/20/92	2.94	925.16			

140-052-36CCB2 LS Elev (msl,ft)=929.67

Undefined Aquifer SI (ft.)=10-20

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	3.27	926.40	11/10/92	3.74	925.93
10/07/92	4.48	925.19	11/19/92	2.52	927.15
10/20/92	4.50	925.17			

140-052-36CDB LS Elev (msl,ft)=927.66

Undefined Aquifer SI (ft.)=4-14

Date	Depth to Water (ft)	WL Elev (msl, ft)	Date	Depth to Water (ft)	WL Elev (msl, ft)
09/23/92	3.26	924.40	11/10/92	3.22	924.44
10/07/92	3.82	923.84	11/19/92	3.29	924.37
10/20/92	3.95	923.71			

APPENDIX E

MAJOR ION AND TRACE-ELEMENT CONCENTRATIONS

CASSELTON WATER QUALITY
Major Ions

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 as $CaCO_3$	Hardness as NCH	% Na	SAR	Spec Cond (µmho)	Temp (°C)	pH
			(milligrams per liter)																					
140-052-36CAC	30-40	10/07/92	19	0.07	0.01	150	20	120	88	60	0	690	24	0.3	0.8	0.16	1140	460	410	31	2.4	1590	9	9.58
140-052-36CBC1	5-15	10/07/92	31	0.07	7.4	620	260	200	26	985	0	1700	220	0.2	2.1	0.36	3550	2600	1800	14	1.7	4240	10	7.34
140-052-36CBC2	25-30	10/07/92	22	0.05	1.3	390	150	140	28	543	0	1200	130	0.2	2.1	0.3	2330	1600	1100	16	1.5	2940	10	8.25
140-052-36CCA	5-15	10/07/92	28	0.27	1.3	93	220	290	5.8	862	0	690	340	0.5	0.2	0.7	2090	1100	430	36	3.8	3060	16	8.03
140-052-36CCB1	15-25	10/07/92	24	0.04	0.22	150	81	190	14	439	0	450	230	0.2	3	0.26	1360	710	350	36	3.1	2090	10	7.88
140-052-36CCB2	10-20	10/07/92	29	0.18	0.68	160	160	210	9.4	665	0	670	220	0.5	6.5	0.35	1790	1100	510	30	2.8	2590	11	7.99
140-052-36CDB	4-14	10/07/92	30	0.14	0.5	260	790	560	23	939	0	3900	301	0.3	2.3	0.32	6330	3900	3100	24	3.9	6520	17	8.01

Trace Element Analyses

Location	Date Sampled	Selenium	Lead	Cadmium	Mercury	Arsenic	Molybdenum	Strontium
		(micrograms per liter)						
140-052-36CAC	10/07/92	2	0	0	0	4	190	1100
140-05236CBC1	10/07/92	3	0	1	0	4	9	1400
140-05236CBC2	10/07/92	3	0	0	0	3	6	1300
140-052-36CCA	10/07/92	2	0	0	0	3	11	710
140-052-36CCB1	10/07/92	3	0	0	0	3	83	730
140-052-36CCB2	10/07/92	2	0	0	0.1	3	79	1100
140-052-36CDB	10/07/92	8	0	0	0	5	16	1400

APPENDIX F

VOLATILE ORGANIC COMPOUNDS
FOR WELL 140-052-36CDB

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-Dichlorethane	<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
Carbondisufide	<5
Ether	<5

* Constituent Detection