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OPEN-FILE REPORT 80-UR - NO. 20: RAPID CITY

STATEWIDE LANDFILL STUDY:

RAPID CITY LANDFILL SITE CHARACTERISTICS

by

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CONTENTS

FIGURES

Page

TABLES

APPENDIX

INTRODUCTION

Purpose and Scope

The purpose of this report is to summarize the geologic data, hydrologic data, and other site characteristics of the Rapid City landfill. This information was compiled as a part of the Statewide Landfill Study.

In 1984, the state of South Dakota had 38 permitted solid waste landfills, both private and public, that accepted waste other than ordinary household waste. A study was undertaken in an effort to evaluate selected landfills in South Dakota and identify those that may be best suited for the disposal of these special wastes.

This study was conducted by the South Dakota Geological Survey and the Office of Air Quality and Solid Waste of the Department of Water and Natural Resources, now known as the Department of Environment and Natural Resources. The Office of Air Quality and Solid Waste contracted with the South Dakota Geological Survey for certain geological services. The South Dakota Geological Survey contribution to this study was three-fold. First, available geologic and hydrologic data from landfills in South Dakota were reviewed and evaluated. Second, monitoring well systems were designed and installed at four landfills which were selected by the Office of Air Quality and Solid Waste. Finally, the geology was evaluated in more detail at these four landfills.

Selection of Sites

Existing information concerning 38 permitted and 2 proposed landfill sites was reviewed by the Office of Air Quality and Solid Waste in order to prioritize the sites. The Office of Air Quality and Solid Waste used this preliminary screening to reduce the number of potential sites from 40 to 26 (table 1 and fig. 1).

TABLE 1. List of sites considered for further evaluation

1. Belle Fourche City
2. Brookings City - Proposed
3. Brown County
4. Brule County
5. Byre (Private)
6. Davison County
7. De Smet City
8. Gregory County
9. Haarstad (Private)
10. Huron City
11. John Clements (Private)
12. Kadoka City
13. Marshall County
14. Miedema City
15. Milbank City
16. Miller City
17. Pierre City - Proposed
18. Pierre City - Old Site
19. Ralph Dawson (Private)
20. Rapid City
21. Sioux Falls (Runge) City
22. Vermillion City
23. Walworth County
24. Watertown City
25. Winner City
26. Yankton County

Subsequently, the South Dakota Geological Survey evaluated these 26 sites and prepared a draft report describing each site. No field checking was done. Topics such as topography, drainage, climate, soils, geology, hydrology, water quality, adjacent land use, hazardous waste records, and operational practices were addressed. These reports included copies of available maps, lithologic logs, and water quality analyses. Draft copies of these unpublished reports are on file at the Department of Environment and Natural Resources in Pierre and the South Dakota Geological Survey in Vermillion.

After the initial assessment of the 26 sites, the Office of Air Quality and Solid Waste established criteria for further prioritizing the sites. Four sites were selected for the installation of monitoring wells. The South Dakota Geological Survey conducted detailed investigations at the Brown County, Watertown City, Yankton County, and Rapid City landfills (fig. 1). A draft copy of the unpublished summary report is on file at the Department of Environment and Natural Resources in Pierre and the South Dakota Geological Survey in Vermillion.

The following information was available regarding the Rapid City landfill in 1986. This report is a primarily a compilation of the preliminary report on the Rapid City landfill and the detailed investigation at the Rapid City landfill.

RAPID CITY LANDFILL

Location

The Rapid City landfill is located 1 mile south of Rapid City in Pennington County. Its legal location includes TRACT 1: SE¼ sec. 19, T. 1 N., R. 8 E. and TRACT 2: E½ SW¼ sec. 19, T. 1 N., R. 8 E. (fig. 2).

Topography, Drainage, and Climate

The information on topography and drainage was taken from the Rapid City East Quadrangle (United States Geological Survey, 1953). According to records from the Office of Air Quality and Solid Waste, much of the original surface has been altered and rearranged by landfill operations.

The topography at the Rapid City landfill consists of rolling hills (fig. 2). TRACT 1: The elevation ranges from 3,250 to 3,410 feet, for a maximum relief of 160 feet at the site. TRACT 2: The elevation ranges from 3,310 to 3,440 feet, for a maximum relief of 130 feet at the site.

Surface drainage is controlled by Rapid Creek which is approximately 2 to 3 miles east of the site. An intermittent stream originates in the middle of Tract 2 and it cuts diagonally across the northwest corner of Tract 1. A second intermittent stream cuts diagonally across the southeastern corner of Tract 1. These intermittent streams join and become an unnamed tributary to Rapid Creek.

The average annual temperature in Pennington County is 46 degrees Fahrenheit. Precipitation averages 18 inches per year. The average annual class A pan evaporation is 58 inches. Climatological data are from Spuhler and others (1971).

Method of Investigation

In general, the plan for the detailed investigation was to determine the lithologies present and to install 16 nested sets of monitoring wells at the landfill. Nested wells are individual wells installed at various depths at roughly the same location. This plan was selected to allow for the determination of:

1. lithologic variations with depth,

2. the vertical distribution of hydraulic head, and

3. vertical distribution of water quality.

Modifications concerning the number, arrangement, depth, and design of wells were made based on local hydrogeology and financial considerations. No holes or wells were drilled or constructed in refuse. At localities exhibiting more than one lithology, the well depths were determined after the contact between the differing lithologies had been established. Field work was conducted at the Rapid City landfill during June 1986.

The drilling of test holes and installation of wells were accomplished using two types of drilling rigs. These included a Parmanco F-86-B rig with 4-inch outside diameter flight auger and a Mobile B-61XD rig with 4-inch inside diameter hollow-stem auger. The geology was described from flight-auger cuttings, selected 1.5-inch diameter cored samples, and some 3-inch diameter cored sediment samples.

Two types of wells were constructed. Screened wells were designed to be used primarily for measuring water levels (the shallowest water level). Cored-intake wells were designed to be used primarily for water sampling at a given depth. Both well installation methods are outlined below. In order to prevent organic contamination, no glue or lubricant was used on the polyvinyl chloride casing or in the drilling process.

1. Screened wells (fig. 3) were installed using the method outlined below:

   a. auger 4-inch or 10.75-inch diameter hole

   b. insert 2-inch diameter, schedule 80, polyvinyl chloride casing with slotted screen on bottom

   c. add filter pack to approximately 1 foot above the screen

   d. add granular bentonite and/or bentonite slurry to 1 to 2 feet below the ground surface

   e. cement the upper 1 to 2 feet of borehole to stabilize the casing approximately 6 inches above the ground surface

   f. protect with steel fence posts and/or fence

2. Cored-intake wells (fig. 4) were installed using the method outlined below:

   a. auger 4-inch or 10.75-inch diameter hole

b. insert 2-inch diameter, schedule 80, polyvinyl chloride casing sealed on the bottom by using electrical tape to attach a thin plastic cap over the end of the casing

c. press casing through the thin plastic cap to approximately 6 inches below bottom of the auger hole into undisturbed sediment creating a seal with the outside of the casing and the surrounding sediment

d. insert 1.5-inch diameter shelby tube into casing, core an additional 6 to 12 inches beyond the end of the casing

e. add bentonite slurry between casing and borehole wall to 1 to 2 feet below the ground surface

f. cement the upper 1 to 2 feet of borehole to stabilize casing approximately 6 inches above the ground surface

g. protect with steel posts and/or fence

Several continuous cores were collected from the landfill. At the drill site, these cores were temporarily wrapped and stored in plastic bags. Subsequently, in October and November 1986, they were sealed in clear plastic wrap, placed in boxes, and permanently stored at the South Dakota Geological Survey core repository.

Geology

The Rapid City landfill is located on the east flank of the Black Hills uplift. Cattermole (1972) mapped the geology of the Rapid City East Quadrangle, which included the landfill area (fig. 5).

The Rapid City landfill is constructed on Belle Fourche Shale and Mowry Shale. Topsoil generally less than 1 foot thick overlies weathered shale. Coarse gravel and small boulders are also present at the surface, primarily in the western third of the landfill. Quaternary gravel deposits lie unconformably on Cretaceous units (i.e., all units with a "K" identifier on fig. 5). Quaternary alluvium and gravel deposits are present outside of and directly downslope of the landfill site.

Near the landfill, the strata dip to the east at approximately 8 degrees (Cattermole, 1972). The Belle Fourche Shale overlies the Mowry Shale which overlies the Newcastle Sandstone. The Belle Fourche Shale is a dark-gray clayey shale with bentonite partings 5 inches to 2 feet thick. This unit is approximately 240 feet thick and iron-manganese concretions as much as 2 feet thick and 6 feet long are present in the lower 50 feet of the formation. The Mowry Shale is a dark-gray fissile shale up to 125 feet thick. Bentonite partings up to 1 foot thick are present. Some beds are sandy or silty. Locally, the contact between the Mowry Shale and the Newcastle Sandstone is located in a valley which roughly parallels the western boundary of the landfill (figs. 4 and 5). The Newcastle Sandstone is a sandstone, siltstone, and shale unit 25 to 45 feet thick. Cattermole (1972) states that from Rapid Creek south to the landfill (sec. 19, T. 1 N., R. 8 E.), the sandstone grades laterally into siltstone and shale. Sandstone outcrops were observed near the western boundary of the landfill (Martin Jarrett, South Dakota Geological Survey, personal communication, 1986). The Newcastle Sandstone is defined as an aquifer, equivalent to the lower part of the Dakota Formation in eastern South Dakota. Prior to the South Dakota Geological Survey investigation in 1985, no lithologic logs were available for the Rapid City landfill.

In June 1986, 16 test holes were drilled at the Rapid City landfill and 15 were completed as wells. Well depths ranged between 18 and 50 feet. The locations of test holes and wells are plotted on

figure 6 (app. A). Continuous cores were collected from test holes R20-86-21, R20-86-22, R20-86-23, and R20-86-24.

Shale was observed in all test holes to a maximum depth of 50 feet. Drilling was more difficult in the western third of the landfill because the shale was harder, confirming the presence of the siliceous Mowry Shale. Bentonite layers 1 foot thick were observed in several of the test holes. Concretions were found throughout the shale in the eastern part of the landfill confirming the presence of the Belle Fourche Shale. Several test holes were completed at shallower depths than had been planned because the drilling rigs could not penetrate some of the hard concretions. No sand was observed in the shale.

Gravel was also observed at the landfill as a thin veneer of gravel and small boulders covering the surface along the western side of the landfill. This gravel is Quaternary gravel and Recent alluvium flanking an unnamed tributary in Rapid Creek. During drilling, gravel was also encountered in the top 3 feet of test holes R20-86-23 and R20-86-24 which are located in the northwestern corner of the site. In these two test holes, the gravel probably represents road fill. The only other gravel interval encountered was in test hole R20-86-22 from a depth of 11 to 14 feet. This gravel is probably associated with the intermittent stream located in the southeast corner of the site.

Hydrology

The clay material at the base of the landfill consists primarily of shale (Office of Air Quality and Solid Waste records). This was confirmed by observations made during drilling. The permeability of this material is not known but can be discussed in qualitative terms. In general, the permeability of shale is less than that of sand and gravel. No site specific permeability data are available.

Prior to the June 1985 South Dakota Geological Survey investigation, no monitoring wells were present within 1 mile of the site. Without the presence of adequately constructed monitoring wells (a minimum of three) in the proper locations and at the proper depths, the lateral hydraulic gradient and direction of potential ground water movement could not be estimated for the landfill area.

The nearest ground water supply (aquifer) is unknown. In general, "the Belle Fourche, Mowry, Newcastle, and Skull Creek shale formations in this area offer 250 to 400 feet of impervious layer over any potential aquifer," such as the Fall River and Lakota Formations (Office of Air Quality and Solid Waste records, Mickelson report, October 15, 1985). At the landfill, however, the Newcastle Formation consisted of sandstone rather than shale. Sandstone is generally much more permeable than shale. Surficial Quaternary and Recent alluvium and gravel deposits may provide easy subsurface ground water flow in the area.

Project plans called for the Office of Air Quality and Solid Waste to collect water level data from the wells that were installed for this project. No data are available in the Office of Air Quality and Solid Waste files for this project, but information may be available in records postdating 1986.

Water Quality

Although water quality data were available, the legal locations and/or well depths were not known for wells within the landfill or within 1 mile of the landfill boundaries. Only data meeting the South Dakota Geological Survey criteria were used in this study.

Water quality analyses were utilized if the legal locations were known to four quarter sections (2.5 acres) and if they were located within the landfill or within 1 mile of the site boundaries. Only wells with recorded depths less than 100 feet and with corresponding lithologic logs have been considered. This limit of 100 feet was arbitrarily chosen. Any major changes in water quality would probably be detected within this 100-foot depth limit because of the relatively low permeability of the underlying shale. Also, the analytical laboratory that produced a water quality analysis must have been known or the analysis was not utilized.

Project plans called for the Office of Air Quality and Solid Waste to collect water quality data from the wells that were installed for this project. No data are available in the Office of Air Quality and Solid Waste files for this project, but information may be available in records postdating 1986.

Adjacent Land Use and Features

Information about adjacent land use and features was taken from the Rapid City East Quadrangle (United States Geological Survey, 1953) and the General Highway Map - West Half - Pennington County (South Dakota Department of Transportation, 1964).

* There are several small ponds within 1 mile of the site.

* State Highway 79 lies along the east boundary of the site.

* A racetrack and the Chicago and Northwestern Railroad tracks are located three-quarters of a mile east of the site.

* A radio station (KOTA) broadcasting facility is located approximately a quarter of a mile northeast of the site.

Operational and Siting Criteria – Summary from the Office of Air Quality and Solid Waste Records

The most common responses found on the Office of Air Quality and Solid Waste site inspection reports prior to 1986 are given in this section. Copies of the microfiche data are available from the Department of Environment and Natural Resources in Pierre.

1. Site: Rapid City

2. Population served: 70,000

3. Method of disposal: Trench, open pit, hillside

4. Estimated amount of waste received per unit time: 75,000 tons/year

5. Access to site:
   * Fenced: _X_ Yes ___ No Lockable gate: _X_ Yes ___ No
   * Litter fences present: _X_ Yes ___ No
   * All weather access road to site: _X_ Yes ___ No

6. List industry present: Ellsworth Air Force Base, Magnetic Peripherals

7. Land Use:

   * Preoperational land use: Grazing
   * Proposed post-operational land use: Park, Golf course
   * Current land use within a quarter of a mile radial area: Grazing

SUMMARY

* Intermittent streams on site may provide natural pathways to Rapid Creek, 2 to 3 miles east of the site.

* The geology at this site generally consists of weathered (oxidized) shale overlying unoxidized shale. Topsoil is present at some locations. Coarse gravel and small boulders are present at the surface, primarily in the western third of the site.

* Sixteen test hole logs were available for this site.

* Fifteen monitoring wells were present at this site.

* No reliable water quality data were available near this site.

* No water level data were available near this site.

REFERENCES CITED

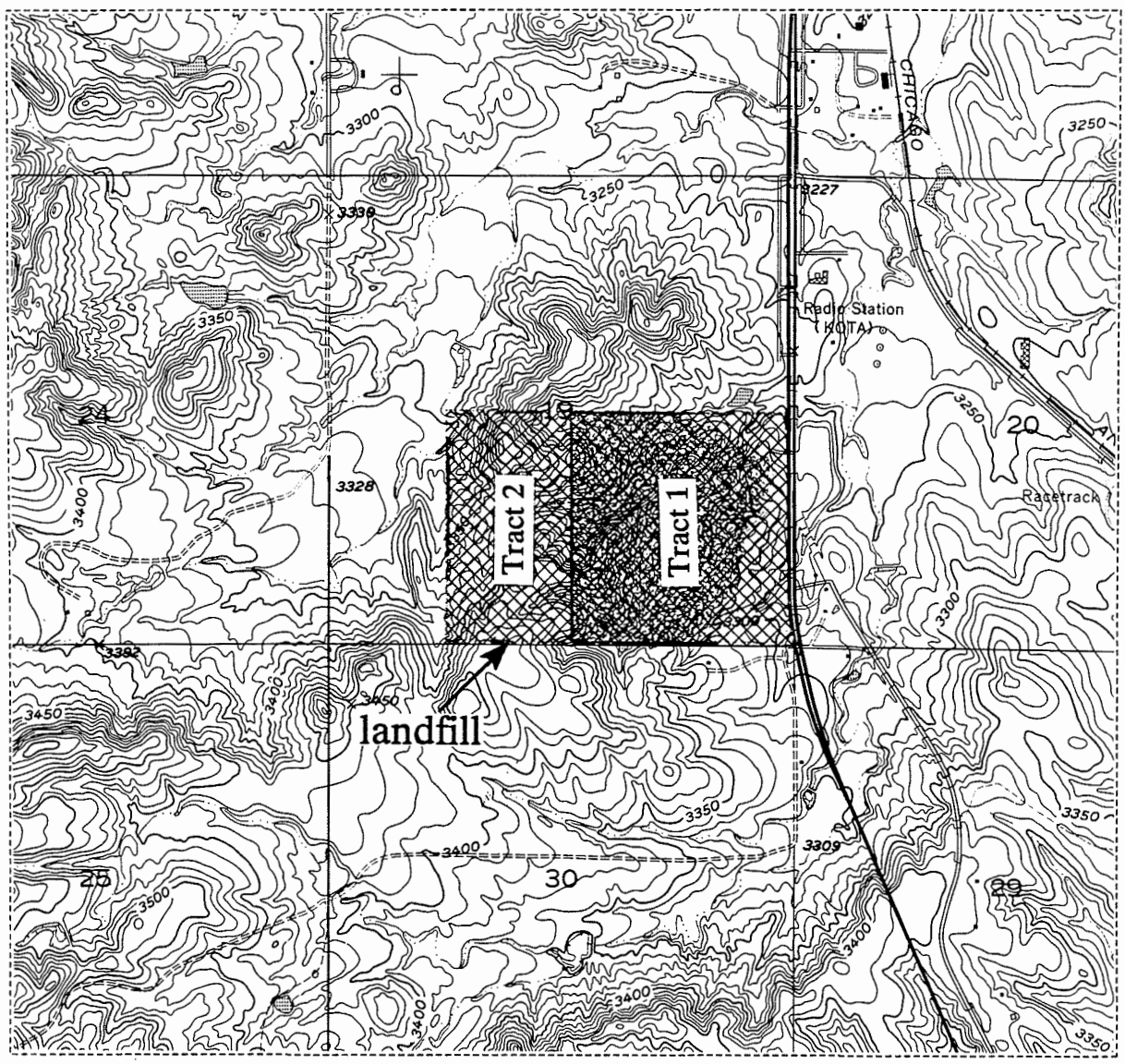
Cattermole, J.M., 1972, Geologic map of the Rapid City East quadrangle, Pennington County, South Dakota (GQ-986): Washington, D.C., United States Geological Survey, Geologic Quadrangle Maps of the United States.

South Dakota Department of Transportation, 1964, General Highway Map - West Half - Pennington County, South Dakota: South Dakota Department of Transportation in cooperation with the United States Department of Transportation, (revisions as of April 30, 1971).

Spuhler, W., Lytle, W.F., and Moe, D., 1971, Climate of South Dakota: Brookings, South Dakota, South Dakota Agricultural Experiment Station Bulletin 582, 30 p.

United States Geological Survey, 1953, Rapid City East quadrangle, South Dakota-Pennington County: 7.5 minute series (topographic), scale 1:24,000, (photorevised in 1978).

Figure 1. Sites considered for further evaluation.



Landfill location: SE¼ sec. 19, T. 1 N., R. 8 E. and
E½ SW¼ sec. 19, T. 1 N., R. 8 E.
Pennington County

Adapted from United States
Geological Survey (1953)

Figure 2. Location of the Rapid City landfill.

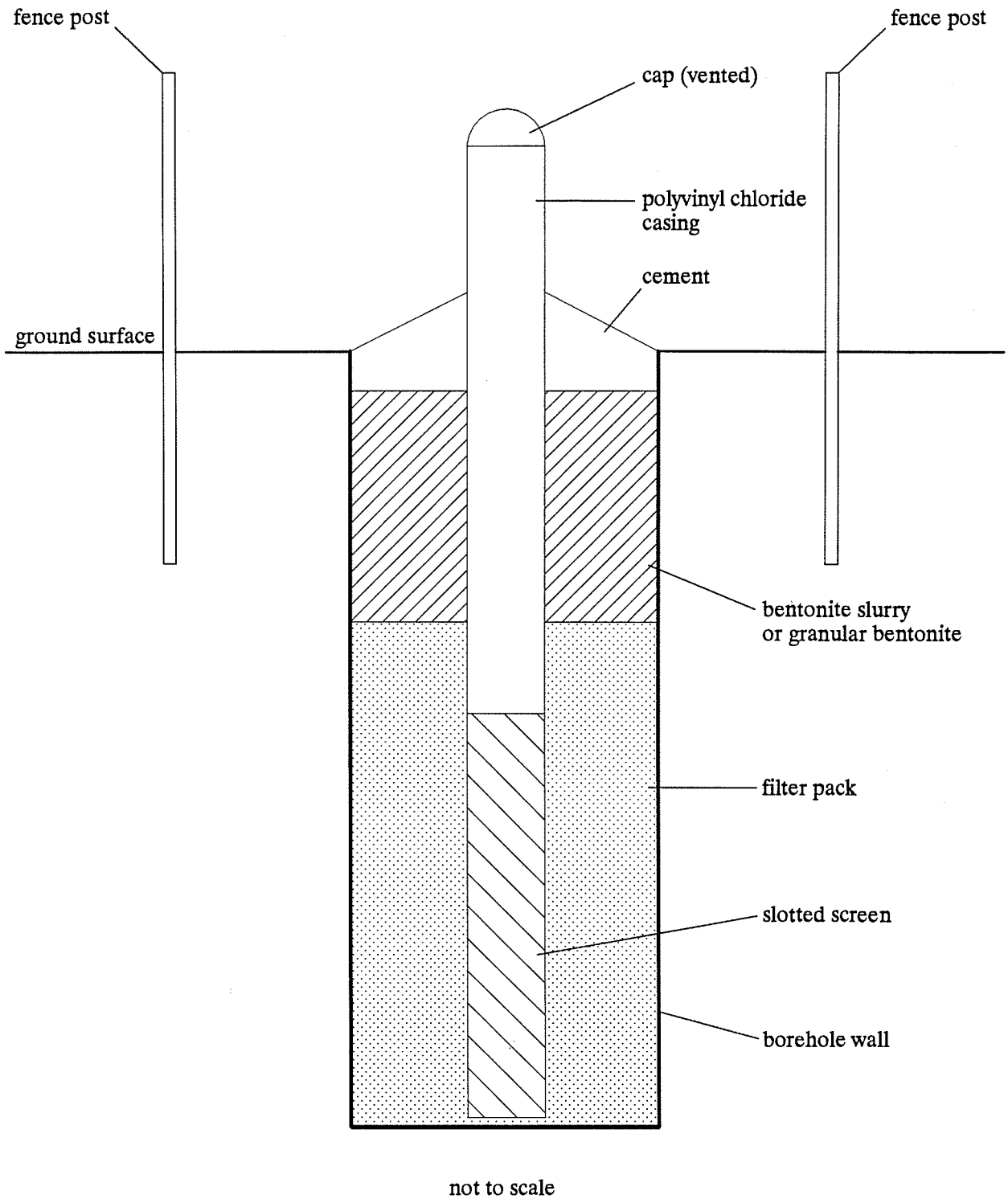


Figure 3. Generalized construction of a screened well.

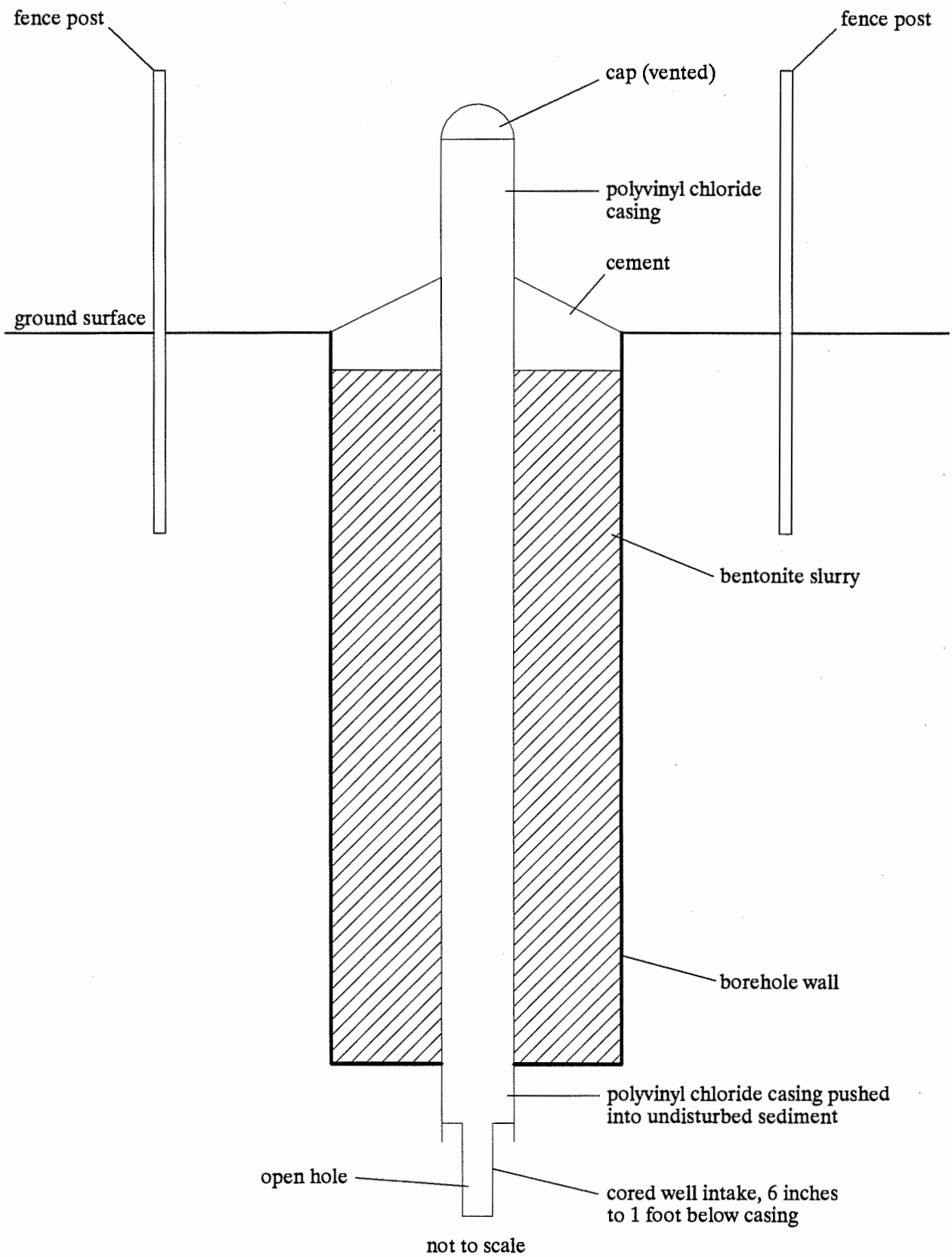
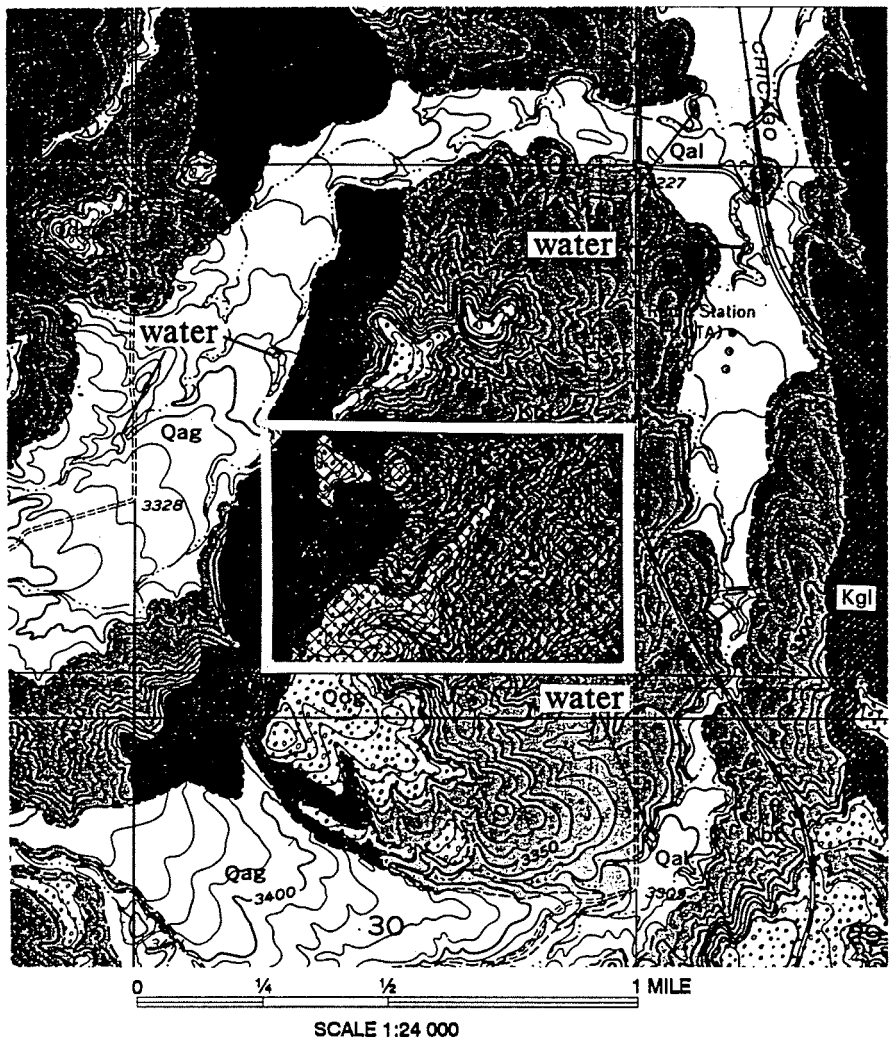


Figure 4. Generalized construction of a cored-intake well.



Qal..... Alluvium

Qag..... Alluvium and gravel

Qdg..... Gravel deposits

Kgl..... Greenhorn Formation

Kbf..... Belle Fourche Shale

Km..... Mowry Shale

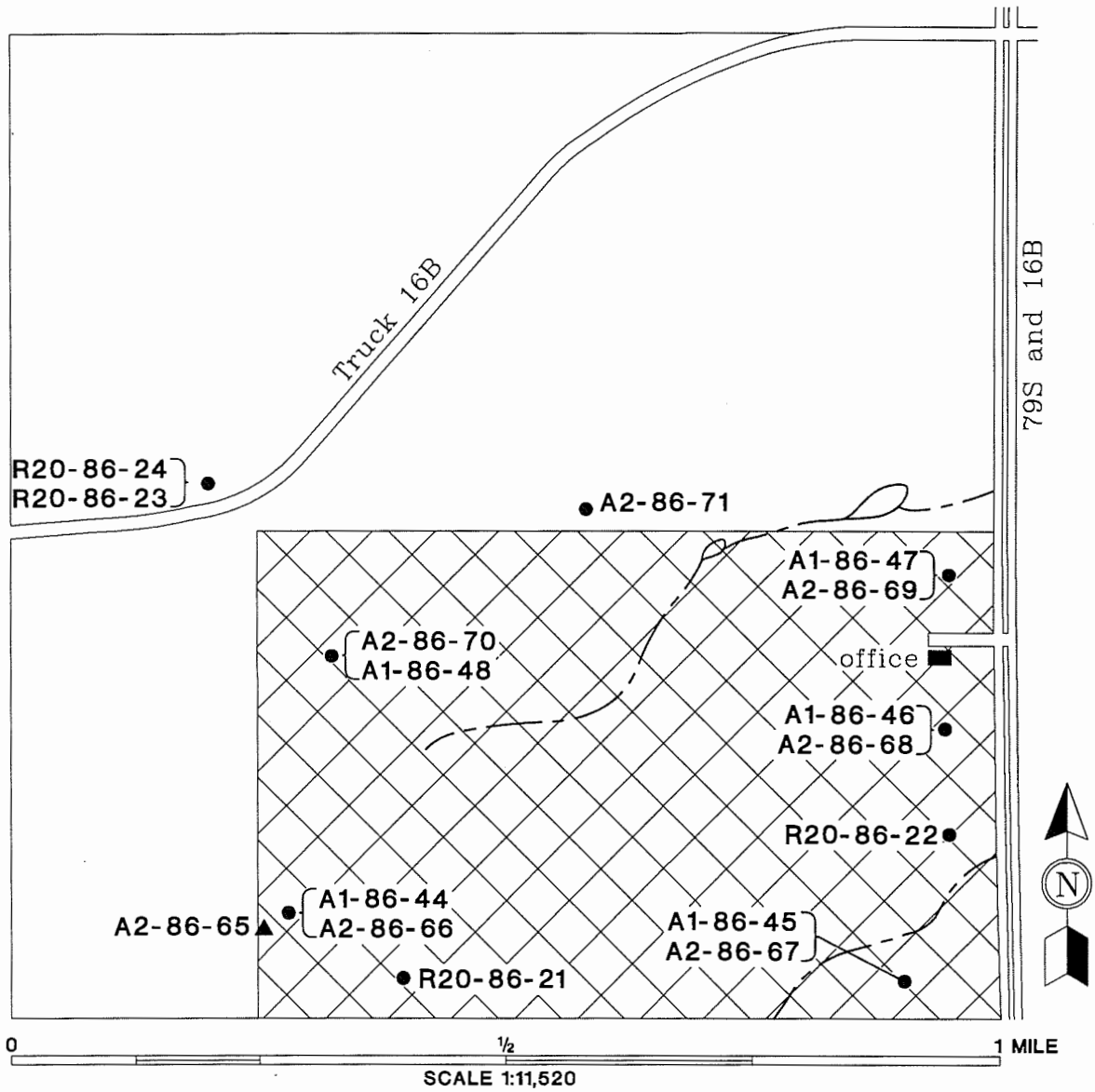
Knc..... Newcastle Sandstone

Ks..... Skull Creek Shale

Landfill

Adapted from Cattermole (1972)

Figure 5. Geology near the Rapid City landfill.



A1-86-46 / A2-86-68 ● Well or nested well set. Letter and numbers are the individual well names.

A2-86-65▲ Test hole. Letter and numbers are the test hole identifier.

Landfill. Landfill location: SE¼ sec. 19, T. 1 N., R. 8 E., and E½ SW¼ sec. 19, T. 1 N., R. 8 E.

Intermittent stream

Figure 6. Locations of test holes and wells at the Rapid City landfill.

APPENDIX A

Legal locations of Rapid City landfill area logs of test holes, 1985

Listed below are the legal locations of the test holes and wells cited in this report. Please contact the South Dakota Geological Survey if a copy of a lithologic log is needed. If a legal location is duplicated, that means more than one test hole or well has been drilled or installed at that location.

SE SE SW NW sec. 19, T. 1 N., R. 8 E.
SE SE SW NW sec. 19, T. 1 N., R. 8 E.
NW SW NE SW sec. 19, T. 1 N., R. 8 E.
NW SW NE SW sec. 19, T. 1 N., R. 8 E.

NW SW SE SW sec. 19, T. 1 N., R. 8 E.
NW SW SE SW sec. 19, T. 1 N., R. 8 E.
NW SW SE SW sec. 19, T. 1 N., R. 8 E.
SW SE SE SW sec. 19, T. 1 N., R. 8 E.

NE NE NE SE sec. 19, T. 1 N., R. 8 E.
NE NE NE SE sec. 19, T. 1 N., R. 8 E.
SE SE NE SE sec. 19, T. 1 N., R. 8 E.
SE SE NE SE sec. 19, T. 1 N., R. 8 E.

NE NW NW SE sec. 19, T. 1 N., R. 8 E.
SE NE SE SE sec. 19, T. 1 N., R. 8 E.
SW SE SE SE sec. 19, T. 1 N., R. 8 E.
SW SE SE SE sec. 19, T. 1 N., R. 8 E.