STATE OF SOUTH DAKOTA
Richard Kneip, Governor

DEPARTMENT OF NATURAL RESOURCE DEVELOPMENT
Vern W. Butler, Secretary

GEOLOGICAL SURVEY
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Special Report 59

GROUND-WATER INVESTIGATION FOR THE CITY OF PEEVER, SOUTH DAKOTA

by

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Science Center
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Vermillion, South Dakota
1974

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INTRODUCTION

Present Investigation

This report contains the results of a special investigation conducted by the South Dakota Geological Survey from June 6 to June 23, and from July 11 to July 13, 1973, in and around the city of Peever, Roberts County, South Dakota. It is the 59th in a continuing series of investigations to assist the cities in South Dakota in locating future water supplies.

Peever now obtains water from two wells within the city limits. These wells yield water from a fine glacial sand deposit.

Included in the survey of the Peever area were: (1) geologic mapping of the area, (2) drilling of 12 auger holes and 8 rotary test holes, (3) a well inventory, and (4) collection and analyses of 12 water samples.

As a result of this study, a sand and gravel deposit was discovered at a depth of approximately 70 feet below the land surface. This sand and gravel deposit which measures more than 17 feet in thickness is located less than one-half mile from the city. A pump test (aquifer test) is recommended before construction of a permanent well.

The cooperation of the residents of Peever, especially Mayor Harold Hortness and the city councilmen, is appreciated. Field work and compilation of data were performed with the assistance of David Buehrer, summer employee of the South Dakota Geological Survey. The project was financed by the city of Peever and the South Dakota Geological Survey.

Location and Extent of Area

Peever is located in northeast South Dakota in Roberts County in the Minnesota Valley division of the Central Lowland Physiographic province (fig. 1). The Peever study area as used in this report includes a region that measures 2 miles north-south by 2 miles east-west.

GENERAL GEOLOGY

Surficial Deposits

Surficial deposits of the Peever area include alluvium along the present streams and glacial deposits (fig. 2). Alluvium consisting of sand and silt is present along Jorgenson River.

The glacial deposits in this area were formed during the last part of the Pleistocene Epoch of geologic time. These deposits can be divided into two basic groups, "till" and "outwash." Till is deposited directly from the glacial ice and it consists of sand, pebbles, and boulders randomly distributed in a matrix of clay. It is commonly called "boulder clay," "blue clay," or "gumbo." Outwash is a more homogeneous deposit consisting primarily of sand and gravel with only minor amounts of silt and clay. It was deposited by streams flowing out from the melting glacial ice. Till and outwash are collectively known as glacial drift. Figure 2 is a generalized geologic map which shows the distribution of these deposits in the Peever area.

Subsurface Bedrock

No bedrock is exposed in the study area but available data from Roberts and adjacent counties reveal stratified (layered) sedimentary rocks which formed during the period of geologic time known as the Cretaceous underlie approximately 130 feet of glacial drift. Each distinct layer or group of layers (called a formation) has been given a name. The sedimentary rock formations in the Peever area in descending order are the Pierre Shale, Niobrara Marl, Carlile Shale, Greenhorn Limestone, Graneros Shale, and the Dakota Formation.

Pierre Shale was penetrated by some of the test holes in the area. This formation, consisting of light- to dark-gray shale, is very thin in the area. Beneath the Pierre Shale is the Niobrara Marl which consists of a light- to medium blue-gray calcareous shale. Carlile Shale consisting of medium- to dark-gray bentonitic shale with layers of sand and siltstone directly underlies the Niobrara Marl. The total thicknesses of the Pierre Shale, Niobrara Marl, and Carlile Shale is approximately 200 feet.

Greenhorn Limestone is composed of approximately 10 feet of hard, light-colored limestone that is underlain by light- to dark-gray shale. Beneath the Greenhorn is approximately 200 feet of dark-gray Graneros Shale.

The Dakota Formation, approximately 200 feet thick, is a sequence of alternating sand, sandstone, and shale beds located at a depth of approximately 700 feet below the land surface.

Beneath the Dakota Formation at a depth of approximately 850 feet below the land surface lies the Precambrian rocks (probably granite).

OCCURRENCE OF GROUND WATER

Principles of Occurrence

Ground water is defined as water contained in the voids or open spaces within rocks or sediments below the water table. Practically all open spaces in the rocks that lie below the water table are filled with water. This is called the zone of saturation. The water

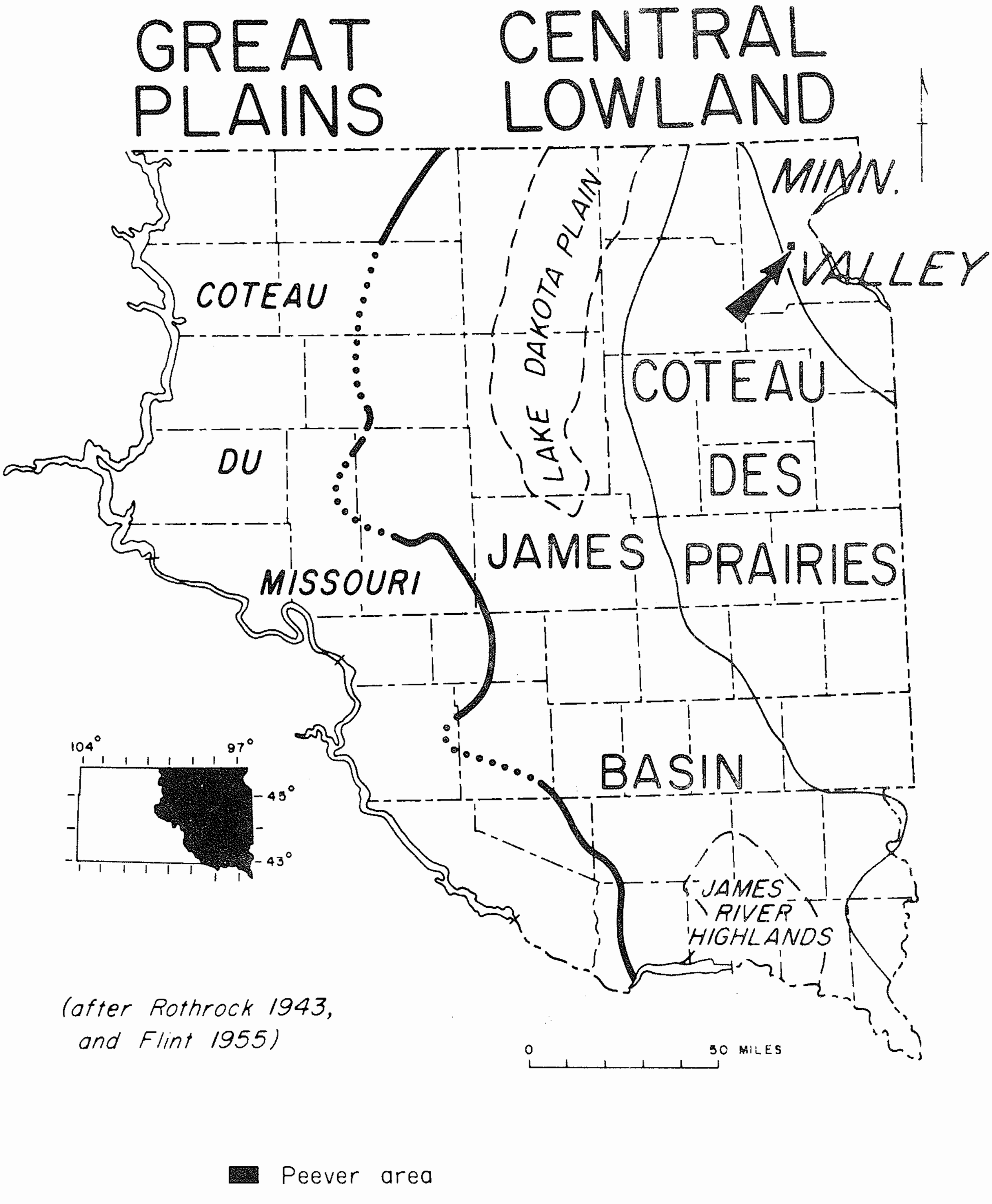


Figure 1. Map of eastern South Dakota showing the major physiographic divisions and location of the Peever area.

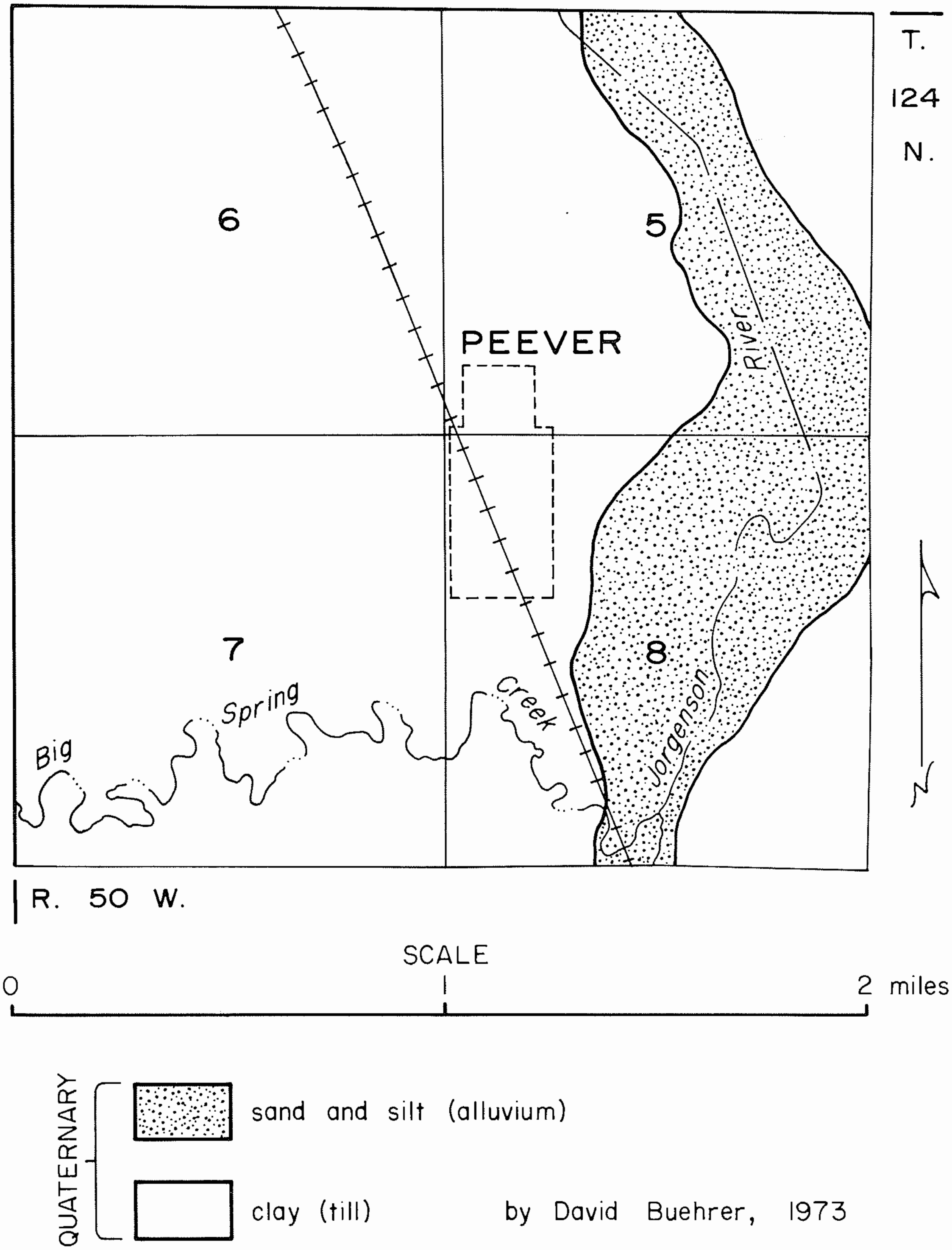


Figure 2. Generalized geologic map of the Peever area.

table is the upper surface of the zone of saturation and is under atmospheric pressure. Rocks (including the soil) that lie above the water table are in the zone of aeration because only some of the open spaces in this zone are filled with water; the remaining portion contains air. This water is either held by molecular attraction, or is moving downward toward the zone of saturation. Water within the ground above the saturated zone moves downward under the influence of gravity, whereas in the saturated zone, it moves in a direction determined by the hydraulic gradient.

Contrary to popular belief, ground water does not occur in "veins" that crisscross the land at random. Instead it can be shown that water is found nearly everywhere beneath the surface, but at varying depths.

Nearly all ground water is derived from precipitation in the form of rain, snow, or ice. This water either evaporates, percolates directly downward to the water table and becomes ground water, or drains off as surface water. Surface water either evaporates, escapes to the ocean by streams, or percolates downward into the rocks.

An aquifer is any deposit (soil or rock) below the water table which has a structure that will permit an appreciable amount of water to move through it, under ordinary field conditions. An area where water is being added to an aquifer is called a recharge area; an area where the water is being removed from an aquifer is called a discharge area. Recharge to an aquifer is accomplished in four general ways: (1) by downward percolation of precipitation from the ground surface, (2) by downward percolation from surface bodies of water, (3) by lateral movement of ground water into the area, and (4) by artificial recharge, which takes place from excess irrigation, seepage from canals, and water purposely applied to augment ground-water supplies.

Discharge of ground water from an aquifer is accomplished in four ways: (1) by evaporation and transpiration by plants, (2) by seepage upward or laterally into surface bodies of water, (3) by lateral movement of ground water out of the area, and (4) by pumping from wells, which constitutes the major artificial discharge of ground water.

The porosity of a rock or soil is a measure of the open pore spaces it contains and is expressed as the percentage of the volume of void spaces to the total volume of the rock. Porosity of a sedimentary deposit depends chiefly on (1) the shape and arrangement of the particles that make it up, (2) the degree of sorting of its particles, (3) the cementation and compaction to which it has been subjected since its deposition, (4) the removal of mineral matter through solution by percolating waters, and (5) the fracturing of the rocks, resulting in joints and other openings. Thus, the size of the material has little or no effect on porosity if all other factors are equal.

The permeability of a rock is its capacity for transmitting a fluid. Water will pass through a material with interconnected pores, but will not pass through material with unconnected pores, even if the latter material has a higher porosity than the former. Therefore, permeability and porosity are not synonymous terms.

Ground Water in Glacial Deposits

It was stated earlier that glacial deposits are divided into till and outwash. Till does not yield water readily because of its highly unsorted nature and the predominance of silt and clay. Locally there may occur some lenses of sand and gravel within the till which provide an adequate supply of water for a farm well, but till as a unit cannot function as a source of water for municipalities. Outwash, usually a highly permeable deposit, may constitute an aquifer if it is extensive and located below the water table.

The results of test holes drilled in the Peever area (see fig. 3 and app. A) indicate that an outwash deposit is located less than one-half mile east of the city. This outwash is more than 17 feet thick and is located approximately 70 feet below the land surface in the vicinity of test hole 16 (see fig. 3, fig. 4, and app. A). Drilling was halted due to caving of gravel in this hole. Test hole 15 located one-eighth of a mile west of test hole 16 shows three layers of sand and gravel. Sand and gravel layers were located from 60 to 65 feet, from 80 to 88 feet, and from 93 to 116 feet below the land surface. Test hole 17 located one-eighth of a mile south of test hole 15 penetrated 32 feet of sand and gravel from 62 feet to 94 feet below the land surface.

Ground Water in Bedrock

The Dakota Formation will also produce significant amounts of water in the Peever area. It was mentioned previously that the Dakota Formation is approximately 700 feet below the land surface. Appendix B is a compilation of well records from the Peever area showing the wells producing water from different formations.

Quality of Ground Water

Ground water always contains dissolved chemicals. Contained chemicals are derived from (1) the atmosphere as water vapor condenses and falls, (2) the soil and underlying deposits as the water moves downward to the water table, and (3) the rocks below the water table. In general, the more chemical substances that a water contains, the poorer its quality.

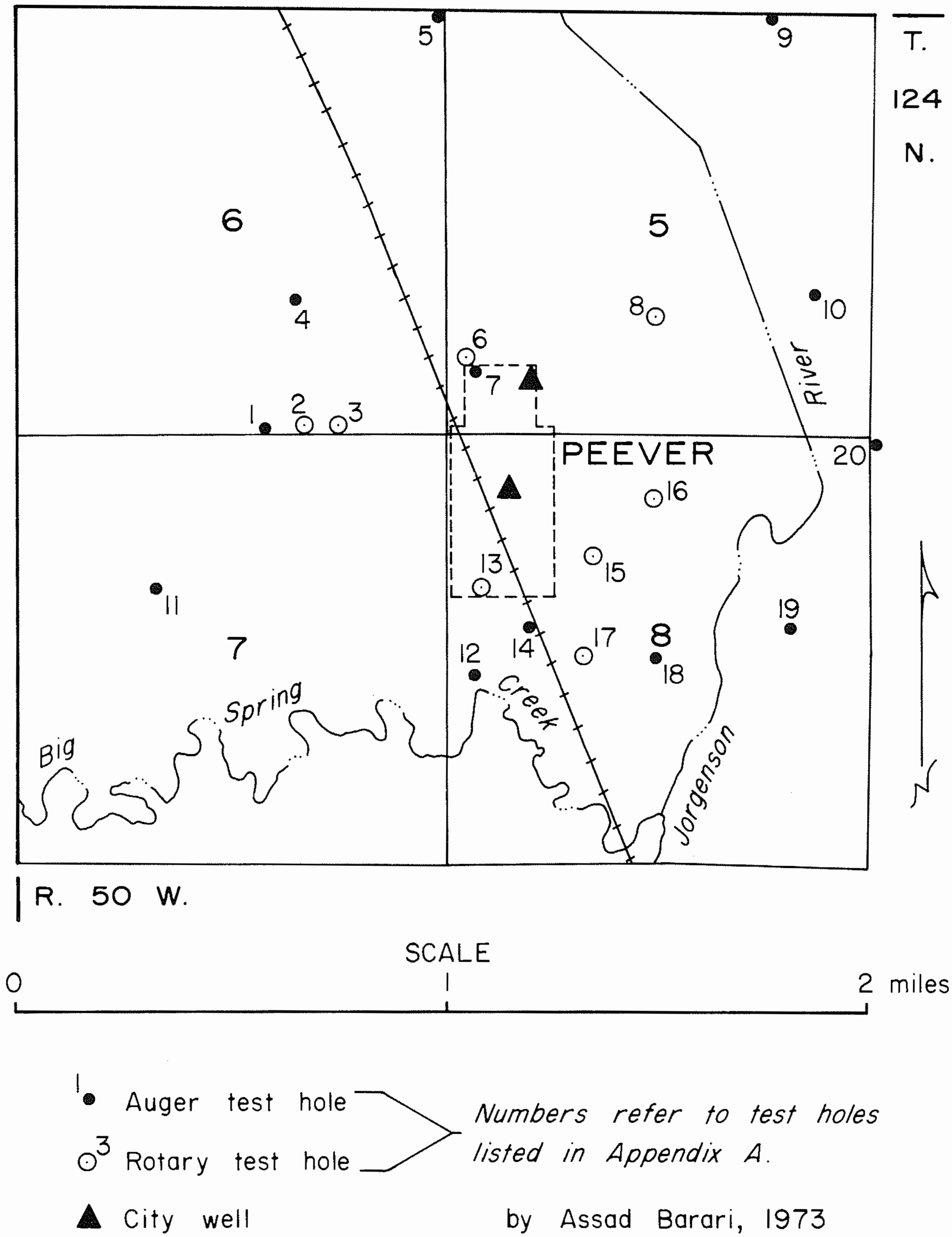
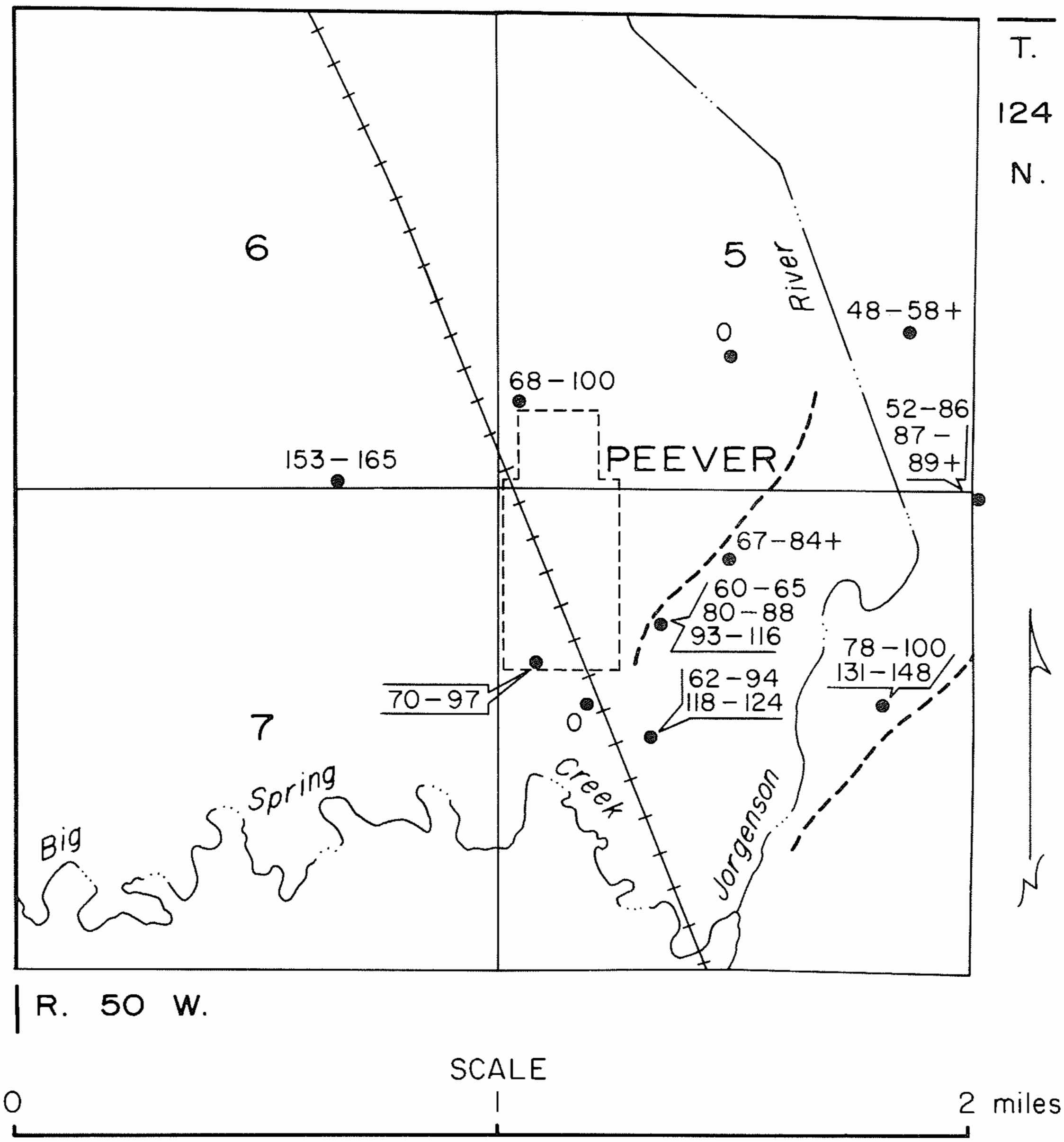


Figure 3. Map showing location of auger and rotary test holes in the Peever area.



48-58+ Test hole, numbers indicate depth(s) at which sand and gravel was found. A plus (+) indicates that the total thickness of the sand was not penetrated.

Lines showing area of the significant part of the buried outwash (coarser and thicker sand and gravel).

Figure 4. Map showing thickness of major glacial buried sand and gravel in the Peever area.

Table 1 shows the chemical quality of water samples collected in the Peever area (for map location, see fig. 5). Except for W-6, the source of which is the Dakota Formation, all samples are collected from wells producing water from the glacial sand and gravel or outwash deposits. Sample W-1 was collected from the city tap water collected from the I. H. Dealer Shop, and sample W-8 was collected from the city well located in the Jail. These two samples have higher sulfate and total solids than the recommended limits set by the South Dakota Department of Health. Sample W-1 has higher manganese and sample W-8 has lower fluoride than the recommended limits.

Samples W-2, W-3, W-4, W-7, W-9, W-10, and W-11 were collected from wells yielding water from glacial sand and gravel. The chemicals in these water samples are comparable to the samples collected from the city wells. They all contain higher total solids and sulfate than the recommended limits set by the South Dakota Department of Health. Sample W-4 has higher iron and samples W-7, W-9, W-10, and W-11 have higher manganese than the recommended limits. The fluoride in the samples analyzed for this chemical is also lower than the limits set by the Department of Health.

Samples W-5 and W-12 are also from wells producing water from the buried glacial sand and gravel. The total solids, sulfate, and hardness of samples W-5 and W-12 are higher than samples from all other wells except W-6. Also, iron content of sample W-12 is higher than the recommended limits and fluoride content is lower than the State limits.

Water sample W-6 is collected from a well 700 feet deep that bottomed in the Dakota Formation. The total solids of this sample are higher than any of the other samples collected in the area during the study. The hardness of sample W-6 is lower than any of the other samples. Sample W-6 has higher sulfate, fluoride, and chloride than the recommended limits.

Table 2 shows the significance of some of the physical and chemical properties of drinking water.

CONCLUSIONS AND RECOMMENDATIONS

It was stated earlier that a buried outwash is located in the study area. This outwash is significant because of its thicker sands and gravel and is suggested as an interval for further investigation (see fig. 4). Test hole 16 located less than one-half mile east of Peever (see fig. 3, fig. 4, and app. A) shows that more than 17 feet of coarse gravel was penetrated at a depth of approximately 70 feet below the land surface. Also, test hole 17 penetrated a sand and gravel layer at a depth of 118 to 124 feet. These sand and gravel layers are probably connected to the fine sand which yields water to the present city wells.

The water in the buried outwash is under pressure and yields water to artesian wells. Artesian wells which have higher hydraulic head than the ground surface produce flowing wells in the area. Samples W-9 and W-10 were collected from flowing wells. Also, water flowed from test hole 10 for a period of time before it was purposely plugged.

The chemical quality of water sampled from the city wells (W-1 and W-8, table 1) is comparable to water sampled from the outwash (W-3, W-9, and W-10). All of these waters have higher total solids and sulfate than the recommended limits set by the South Dakota Department of Health. Also, sample W-1 from the city water, W-9, and W-10 have higher manganese than the recommended limits.

It is recommended that the city test for an additional water supply in the area outlined in figure 4, where the thickness of sand and gravel is significant. If the city should decide to drill a well or wells in this area, it is recommended that an engineering firm licensed in South Dakota be hired to coordinate drilling of the test holes. A test well (preferably in the vicinity of test hole 16 or 17) would be desirable. A pump test should be conducted for approximately 24 hours before completion of the well. Water samples should be collected and chemically analyzed. The South Dakota Geological Survey will provide technical assistance and supervise the conducting of the pump test. Recommendations of future well spacing will be based on the results of the pump test.

Dissolved chemicals are generally high in the Peever area. It is recommended that the city of Peever consult an engineering firm and the South Dakota Environmental Protection Agency with regard to cost of water treatment to remove some of these chemicals.

The Dakota Formation which is located at a depth of approximately 700 feet below the land surface is another potential source of water for the city. Water sample W-6 is collected from a well producing water from this source (see table 1). This sample has less hardness than wells in the glacial deposits, but the total solids, sulfate, chloride, and fluoride content of this sample are higher than those samples taken from glacial aquifers.

Before a permanent well is drilled, the city officials should contact the Division of Water Rights, Department of Natural Resource Development, to obtain water rights and a permit to drill a municipal well, and the South Dakota Environmental Protection Agency to determine the biological and chemical suitability of the water.

TABLE 1. Chemical Analyses of Water Samples From The Peever Area

Sample	Depth of well in feet	Parts Per Million											
		Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	pH	Hardness $CaCO_3$	Total Solids
A		----	----		250	500[1]	0.3	0.05	10.0	0.9-1.7[2]	----	----	1000[1]
W- 1	105/175?	100		70	65	870		0.25	4		7.5	525	1880
W- 8		96	494	55	52	828	1.5		5.2	0.4		466	1988
W- 2		106	423	54	46	960			3.4	0.6		488	1996
W- 3	58	115		58	55	875	0.0	0.0				525	1760
W- 4	90	109	400	34	58	740	1.4		4.3	0.4		410	1744
W- 5	100	211	160	109	20	1166			4.5	0.4		1225	2202
W- 7	100	160		75	60	880		0.3	0.0		7.6	700	1840
W- 9		95	454	47	44	954		0.9	2.6	0.4		431	1954
W-10		85		63	56	975	0.1	0.5	1.5		7.7	470	1880
W-11	60	125		50	75	750	0.02	0.25	1.0		7.6	525	1680
W-12	75	230	229	118	45	1012	0.6	0.0	2.5			1058	2172
W- 6	700	6	517	10	394	1116			2.0	7.5		56	2968

A – Drinking water standards, U.S. Public Health Service (1962).

Samples W-1, W-3, W-7, W-10, and W-11 were analyzed by the South Dakota Geological Survey. All other samples were analyzed by the South Dakota State Chemical Laboratory.

[1] Modified for South Dakota by the Department of Health (written communication, Water Sanitation Section, September 24, 1968).

[2] 1.2 is optimum for South Dakota.

Source of all water samples is glacial sand and gravel or outwash, except W-6 which is from the Dakota Formation.

Location of Water Samples

(For map location, see fig. 5)

W- 1 SW¼SW¼SW¼ sec. 5, T. 124 N., R. 50 W., City tap water, collected from the I. H. Dealer

W- 2 SW¼SW¼SE¼SW¼ sec. 5, T. 124 N., R. 50 W., C. Oletzke

W- 3 NW¼SE¼SE¼SW¼ sec. 5, T. 124 N., R. 50 W., Test hole 10, flowing well

W- 4 SE¼SE¼NE¼SE¼ sec. 5, T. 124 N., R. 50 W., F. Young

W- 5 NW¼NW¼SE¼NW¼ sec. 4, T. 124 N., R. 50 W., R. Herniman

W- 6 NE¼NE¼SE¼NW¼ sec. 4, T. 124 N., R. 50 W., N. Hansen

W- 7 NW¼SW¼SW¼NW¼ sec. 8, T. 124 N., R. 50 W., T Barry, 209 feet to water

W- 8 SW¼NE¼NW¼NW¼ sec. 8, T. 124 N., R. 50 W., City well (Jail well)

W- 9 NE¼NW¼SE¼NW¼ sec. 8, T. 124 N., R. 50 W., Flowing well

W-10 NW¼SW¼NW¼NE¼ sec. 8, T. 124 N., R. 50 W., Flowing well

W-11 SW¼NE¼SE¼NW¼ sec. 8, T. 124 N., R. 50 W., R. Thiele, 10 feet to water

W-12 NW¼SW¼NE¼SW¼ sec. 9, T. 124 N., R. 50 W., M. Herniman, 40 feet to water

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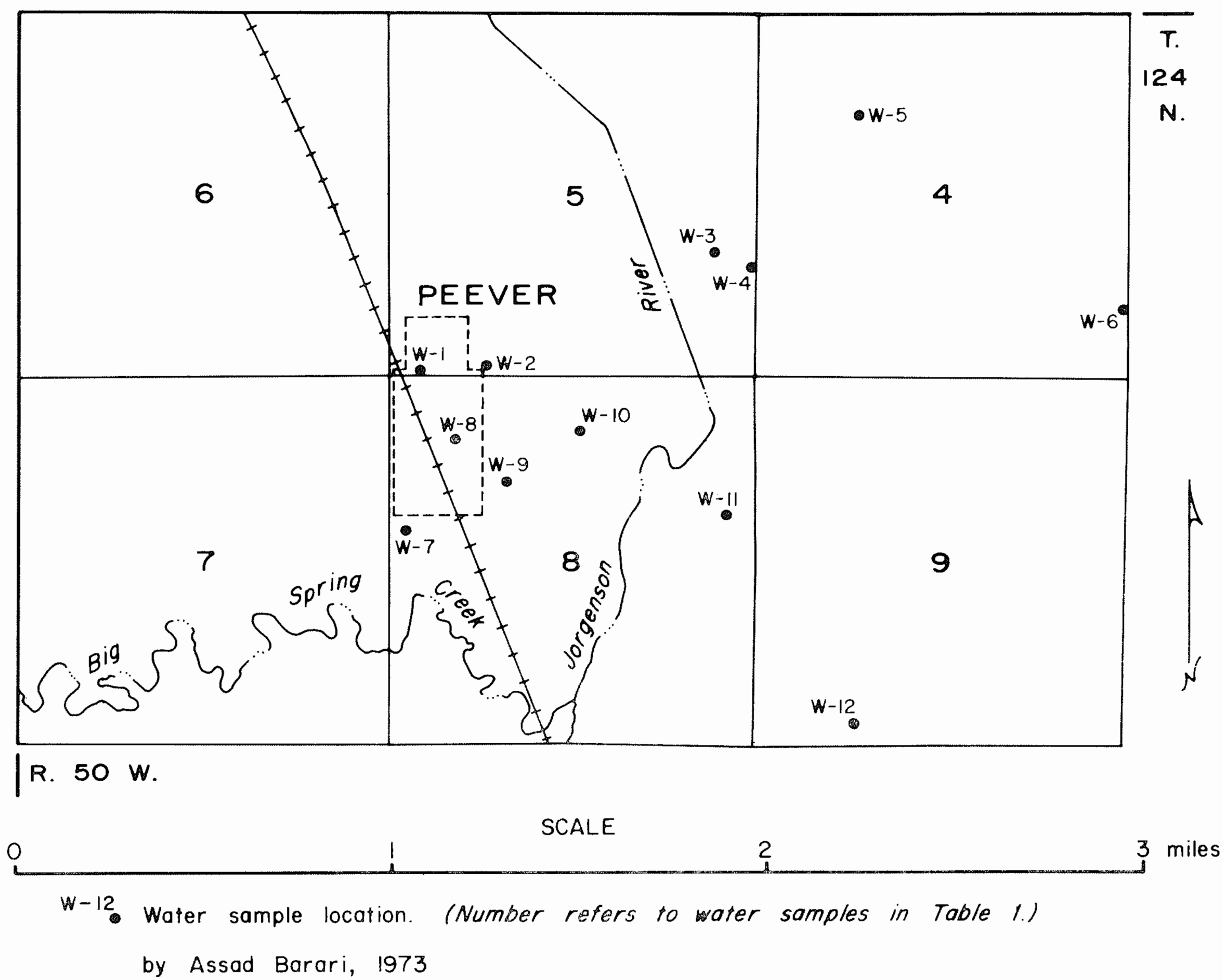

Figure 5. Map showing location of water samples collected in the Peever area.

Table 2.--Significance of some chemical and physical properties of drinking water.

Chemical Constituents	Significance	Recommended Limits (ppm)[1]
Calcium (Ca) and Magnesium (Mg)	Cause most of the carbonate hardness and scale-forming properties of water by combining with carbonate and bicarbonate present in the water. Seldom can be tasted except in extreme concentrations.	Ca—None Mg—None
Sodium (Na)	Large amounts in combination with chloride will give water a salty taste. Large amounts will limit water for irrigation and industrial use.	None
Chloride (Cl)	Large amounts in combination with sodium give water a salty taste. Large quantities will also increase corrosiveness of water.	250
Sulfate (SO_4)	Large amounts of sulfate in combination with other ions give a bitter taste to water and may act as a laxative to those not used to drinking it. Sulfates of calcium and magnesium will form hard scale. U. S. Public Health Service recommends 250 ppm maximum concentration.	500[2]
Iron (Fe) and Manganese (Mn)	In excess will stain fabrics, utensils, and fixtures and produce objectionable coloration in the water. Both constituents in excess are particularly objectionable.	Fe—0.3 Mn—0.05
Nitrate Nitrogen (N)	In excess may be injurious when used in infant feeding. The U. S. Public Health Service regards 45 ppm as the safe limit of nitrate (NO_3) or 10 ppm nitrate nitrogen (N).	10
Fluoride (F)	Reduces incidence of tooth decay when optimum fluoride content is present in water consumed by children during period of tooth calcification. Excessive fluoride in water may cause mottling of enamel.	0.9-1.7[3]
pH	A measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values lower than 7.0 indicate acidity, pH values higher than 7.0 indicate alkalinity. Alkalinity tends to aid encrustation and acidity tends to aid corrosion.	None
Hardness	Hardness equivalent to carbonate and bicarbonate is called carbonate hardness. Hardness in excess of this amount is noncarbonate hardness. Hardness in water consumes soap and forms soap curd. Will also cause scale in boilers, water heaters, and pipes. Water containing 0-60 ppm hardness considered soft; 61-120 ppm moderately hard; 121-180 ppm hard, and more than 180 ppm very hard. Good drinking water can be very hard.	None
Total Solids	Total of all dissolved constituents. U. S. Public Health Department recommends 500 ppm maximum concentration. Water containing more than 1000 ppm dissolved solids may have a noticeable taste; it may also be unsuitable for irrigation and certain industrial uses.	1000[2]

Modified from Jorgensen (1966).
[1] (ppm) parts per million.
[2] Modified for South Dakota by the South Dakota Department of Health (written communication, Water Sanitation Section, September 24, 1968).
[3] 1.2 is optimum for South Dakota.

APPENDIX A

Logs of Test Holes in the Peever Area
(For map location, see fig. 3)

Test Hole 1
Location: SE¼SW¼SW¼SE¼ sec. 6, T. 124 N., R. 50 W.
Surface Elevation: 1210 feet
Depth to water: 12(?) feet

0- 1	Soil, dark gray
1- 8	Clay, brown, pebbly
8-12	Clay, gray, pebbly
12-23	Sand, fine to medium
23-44	Clay, gray, (till)

* * * *

Test Hole 2 (Rotary Hole)
Location: SW¼SE¼SW¼SE¼ sec. 6, T. 124 N., R. 50 W.
Surface Elevation: 1205 feet
Depth to water: not measured

0- 4	Soil, dark gray
4- 14	Clay, yellowish-brown
14- 21	Clay, gray
21- 24	Sand and gravel
24-153	Clay, gray, (till)
153-165	Gravel and sand
165-180	Clay, gray, sandy, (till)
180-185	Niobrara Marl(?)

* * * *

Test Hole 3 (Rotary Hole)
Location: SE¼SE¼SW¼SE¼ sec. 6, T. 124 N., R. 50 W.
Surface Elevation: 1205 feet
Depth to water: not measured

0- 5	Soil, dark gray
5-17	Clay, yellowish-brown
17-19	Clay, gray
19-50	Sand, fine

* * * *

Test Hole 4
Location: NW¼SE¼NW¼SE¼ sec. 6, T. 124 N., R. 50 W.
Surface Elevation: 1195 feet
Depth to water: 13(?) feet

0- 2	Soil, dark gray
2- 13	Clay, brown, pebbly
13- 27	Sand, gray, fine
27- 32	Sand, gray, medium
32- 40	Sand, gray, very coarse
40- 51	Sand, fine, some clay
51- 81	Clay, gravelly, (till)
81- 85	Sand, some gravel
85-106	Clay, gray
106-107	Sand
107-133	Clay, gravelly, (till)

* * * *

Test Hole 5
Location: NE¼NE¼NE¼NE¼ sec. 6, T. 124 N., R. 50 W.
Surface Elevation: 1188 feet
Depth to water: 7 feet

0- 3	Soil, dark gray
3- 8	Clay, sandy
8-48	Clay, gray, (till)

* * * *

Test Hole 6 (Rotary Hole)
Location: SW¼NW¼SW¼SW¼ sec. 5, T. 124 N., R. 50 W.
Surface Elevation: 1200 feet
Depth to water: not measured

0- 3	Soil, dark gray
3- 13	Clay, yellow, pebbly
13- 68	Clay, gray, pebbly
68-100	Sand, medium to coarse, some gravel, some coal, some clay
100-130	Clay, gray
130-140	Clay, dark gray, (shale)

* * * *

Test Hole 7
Location: SW¼NW¼SW¼SW¼ sec. 5, T. 124 N., R. 50 W.
Surface Elevation: 1200 feet
Depth to water: 10 feet

0- 3	Soil, dark gray
3- 8	Clay, pebbly, (till)
8-11	Clay, brown
11-55	Clay, gray, pebbly
55-58	Gravel, medium to coarse
58-64	Clay, gray, pebbly, (till)

* * * *

Test Hole 8 (Rotary Hole)
Location: SE¼SE¼NE¼SW¼ sec. 5, T. 124 N., R. 50 W.
Surface Elevation: 1185 feet
Depth to water: not measured

0- 4	Soil, dark gray
4- 13	Clay, yellowish-brown
13-126	Clay, gray, (till)
126-140	Clay, dark gray, (shale)

* * * *

Test Hole 9
Location: NW¼NW¼NE¼NE¼ sec. 5, T. 124 N., R. 50 W.
Surface Elevation: 1210 feet
Depth to water: 7 feet

0- 3	Soil, dark gray
3-35	Clay, pebbly, (till)
35-48	Sand
48-55	Clay, light gray

* * * *

Test Hole 10
Location: NW¼SE¼NE¼SE¼ sec. 5, T. 124 N., R. 50 W.
Surface Elevation: 1185 feet
Depth to water: flowing

0- 3	Soil, gray

Test Hole 10 -- continued.

3-20	Clay, light brown
20-48	Clay, gray, pebbly
48-53	Gravel, fine to coarse
53-58	Gravel, medium to coarse

* * * *

Test Hole 11
Location: SE¼NW¼SE¼NW¼ sec. 7, T. 124 N., R. 50 W.
Surface Elevation: 1225 feet
Depth to water: 2 feet

0- 3	Soil, dark gray
3-10	Sand, brown
10-60	Clay, light gray, (till)

* * * *

Test Hole 12
Location: NE¼NW¼NW¼SW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1190 feet
Depth to water: not measured

0- 2	Soil, dark gray
2-14	Clay, brown
14-58	Clay, gray, pebbly, (till)

* * * *

Test Hole 13 (Rotary Hole)
Location: SE¼NW¼SW¼NW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1200 feet
Depth to water: not measured

0- 1	Soil, dark gray
1- 13	Clay, brownish-gray
13- 20	Clay, gray
20- 47	Clay, dark gray
47- 69	Clay, light gray
69- 70	Rock
70- 97	Gravel, sand, some clay
97-110	Clay, dark gray, (shale)

* * * *

Test Hole 14
Location: SE¼SE¼SW¼NW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1205 feet
Depth to water: 14 feet

0- 1	Soil, dark gray
1- 7	Clay, brownish-yellow
7- 97	Clay, gray, (till)
97-100	Boulders
100-118	Clay, bluish-gray, pebbly, (till)

* * * *

Test Hole 15 (Rotary Hole)
Location: NE¼NW¼SE¼NW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1190 feet
Depth to water: not measured

0- 2	Soil, gray
2- 8	Clay, yellow, pebbly, (till)
8- 26	Clay, gray, (till)
26- 32	Clay, yellow, pebbly, (till)
32- 60	Clay, gray, pebbly
60- 65	Gravel, very coarse
65- 80	Clay, gray, (till)
80- 88	Sand and gravel
88- 93	Clay, gray, pebbly, (till)
93-116	Sand and gravel
116-140	Clay, dark gray, (till)

* * * *

Test Hole 16 (Rotary Hole)
Location: NE¼SE¼NE¼NW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1185 feet
Depth to water: not measured

0- 2	Soil, dark gray
2-11	Clay, yellowish-brown, pebbly, (till)
11-67	Clay, gray, pebbly, (till)
67-84	Gravel, coarse, caving
84-85	Gravel(?)

* * * *

Test Hole 17 (Rotary Hole)
Location: NE¼NW¼NE¼SW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1190 feet
Depth to water: not measured

0- 1	Soil, dark gray
1- 12	Clay, yellowish-brown
12- 62	Clay, dark gray
62- 94	Gravel, medium to coarse
94-118	Clay, light gray
118-124	Gravel, medium to coarse
124-140	Clay, dark gray, (shale)

* * * *

Test Hole 18
Location: NE¼NW¼NE¼NW¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1180 feet
Depth to water: not measured

0- 1	Soil, dark gray
1-18	Clay, brown
18-33	Clay, gray, (till)
33-34	Rock(?)

* * * *

Test Hole 19
Location: SE¼SW¼SE¼NE¼ sec. 8, T. 124 N., R. 50 W.
Surface Elevation: 1185 feet
Depth to water: flowing

0- 1	Soil, dark gray
1- 8	Clay, brown, pebbly
8- 11	Gravel
11- 20	Sand, silty
20- 23	Sand
23- 61	Clay, gray, pebbly
61- 63	Sand
63- 66	Gravel
66- 78	Clay, bluish-gray, pebbly, (till)
78-100	Gravel, some coarse sand
100-117	Sand(?)
117-131	Clay, gray, pebbly
131-148	Gravel

* * * *

Test Hole 20
Location: NW¼NW¼NW¼NW¼ sec. 9, T. 124 N., R. 50 W.
Surface Elevation: 1185 feet
Depth to water: flowing

0- 1	Soil, dark gray, sandy
1- 6	Clay, dark gray, pebbly
6-15	Sand, brown, clayey
15-16	Gravel

Test Hole 20 -- continued.

16-35	Clay, gravelly
35-47	Gravel, coarse
47-52	Clay, gray
52-86	Gravel, some sand
86-87	Clay, gravelly
87-89	Gravel, some sand

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APPENDIX B

Well Records in the Peever Area

Use: D, domestic; S, stock

Source: SD, glacial sand; GVL, glacial gravel; DF, Dakota Formation

Depth to water: F, flowing well

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Neilsen, W.	NW¼SE¼SE¼SW¼ sec. 1, T. 125 N., R. 51 W.	30			D,S
Knudtson, L.	SW¼NE¼SW¼SE¼ sec. 15, T. 125 N., R. 51 W.	33	5	GVL	D,S
Knudtson, L.	SW¼NE¼SW¼SE¼ sec. 15, T. 125 N., R. 51 W.	20		GVL	D,S
Hawk, R.	NW¼NW¼NW¼SE¼ sec. 15, T. 125 N., R. 51 W.	12	8	SD	D,S
Valnes, E.	NE¼NW¼NW¼SW¼ sec. 22, T. 125 N., R. 51 W.	18	F	GVL	D,S
Weinkauf, A.	NW¼NW¼SW¼NW¼ sec. 22, T. 125 N., R. 51 W.	30	6	SD	D,S
Solberg, W.	NE¼SE¼SE¼SE¼ sec. 23, T. 125 N., R. 51 W.	63	20	SD	D,S
Sandbakken, S.	NW¼NE¼NE¼SE¼ sec. 26, T. 125 N., R. 51 W.	840		DF	
Gill, M.	NE¼SW¼SW¼SW¼ sec. 26, T. 125 N., R. 51 W.	35		GVL	D,S
Carlson, C.	SE¼SW¼SW¼NW¼ sec. 26, T. 125 N., R. 51 W.	12	2	SD	D,S
Knudtson, O.	SE¼SW¼SW¼NW¼ sec. 27, T. 125 N., R. 51 W.	90	70	SD	D,S
Knudtson	SE¼SE¼SE¼SE¼ sec. 28, T. 125 N., R. 51 W.			GVL	D,S
Carl, D.	NE¼SW¼SE¼SW¼ sec. 28, T. 125 N., R. 51 W.				D,S
Vogel	NE¼SW¼SW¼SW¼ sec. 34, T. 125 N., R. 51 W.	10	F	GVL	D,S
Bucklin, E.	SW¼SW¼NW¼NE¼ sec. 34, T. 125 N., R. 51 W.	5	F	SD	D,S
Hutchins	NE¼NE¼NW¼ sec. 13, T. 125 N., R. 50 W.	60			D,S
Pahne, H.	SE¼NW¼NE¼NE¼ sec. 14, T. 125 N., R. 50 W.	20		SD	D,S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Zimmerman, F.	NW¼NE¼NE¼ sec. 16, T. 125 N., R. 50 W.	60		SD	D,S
Fonder, A. D.	SE¼NE¼NW¼NE¼ sec. 17, T. 125 N., R. 50 W.	712		DF	D,S
Philen, R.	SW¼NE¼NW¼SE¼ sec. 20, T. 125 N., R. 50 W.	450	70		D,S
Despiegler, A.	SW¼NE¼NE¼NE¼ sec. 23, T. 125 N., R. 50 W.	500		DF ?	D
Nigg, B.	SW¼SE¼NE¼NE¼ sec. 27, T. 125 N., R. 50 W.	100		SD	D,S
Nigg, D.	NE¼SW¼SW¼SE¼ sec. 28, T. 125 N., R. 50 W.	600		DF ?	D,S
Nielsen, C.	NW¼SE¼NE¼NE¼ sec. 29, T. 125 N., R. 50 W.	25	20	SD	D,S
Nielsen, K.	SW¼SE¼NE¼SE¼ sec. 29, T. 125 N., R. 50 W.	700		DF	D,S
Hanssen, L.	NW¼SW¼SE¼SW¼ sec. 33, T. 125 N., R. 50 W.	100			D,S
Ortley, S.	SE¼NW¼SW¼SW¼ sec. 35, T. 125 N., R. 50 W.	117			D,S
Kurrasch	NE¼SE¼NE¼ sec. 1, T. 124 N., R. 51 W.	726		DF	D,S
Westby, R.	NE¼SW¼NE¼SE¼ sec. 2, T. 124 N., R. 51 W.	24	19	GVL	D,S
Currence, K.	SW¼NW¼NE¼NE¼ sec. 2, T. 124 N., R. 51 W.	700		DF	D,S
Karst, J.	NE¼NE¼SE¼NE¼ sec. 2, T. 124 N., R. 51 W.	28	20	SD	D,S
Howell, A.	SE¼SW¼NE¼SE¼ sec. 8, T. 124 N., R. 51 W.	100		GVL	D,S
Kitto, N.	NE¼SW¼SW¼NW¼ sec. 9, T. 124 N., R. 51 W.	85		SD	D,S
Jones, N. D.	NW¼SW¼NW¼ sec. 9, T. 124 N., R. 51 W.	80			D,S
Leiseth, M.	NW¼SE¼SE¼NW¼ sec. 10, T. 124 N., R. 51 W.	12		SD	D,S
Leiseth, M.	NW¼SE¼SE¼NW¼ sec. 10 T. 124 N., R. 51 W.	20	10	GVL	D,S
Red Earth, E.	SE¼SW¼SE¼NE¼ sec. 10, T. 124 N., R. 51 W.	16		GVL	D,S
Necklace	NW¼NE¼ sec. 10, T. 124 N., R. 51 W.	60	45	GVL	D,S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Chapin, H.	NW¼NW¼SW¼NE¼ sec. 10, T. 124 N., R. 51 W.	13			D,S
Kempton, O.	SE¼NE¼NW¼NW¼ sec. 12, T. 124 N., R. 51 W.	210	6	SD	S
Kempton, O.	SE¼NE¼NW¼NW¼ sec. 12, T. 124 N., R. 51 W.	18	10	SD	D
Kempton, O.	SE¼NE¼NW¼NW¼ sec. 12, T. 124 N., R. 51 W.	24	6	SD	S
Kivley, L.	SW¼SW¼NW¼ sec. 13, T. 124 N., R. 51 W.	70	25	GVL	D,S
Eby, G.	NW¼SW¼NE¼NE¼ sec. 13, T. 124 N., R. 51 W.	100			D,S
Brookens, V.	NE¼SE¼SE¼SE¼ sec. 13, T. 124 N., R. 51 W.	125	13	SD	D,S
Schloe, H.	SW¼NE¼SE¼SW¼ sec. 15, T. 124 N., R. 51 W.	10		SD	D
Schloe, H.	SW¼NW¼SE¼SW¼ sec. 15, T. 124 N., R. 51 W.	14		SD	S
Renville, C.	SE¼NW¼NE¼NE¼ sec. 16, T. 124 N., R. 51 W.		15		D,S
Renville, M.	NW¼SE¼NE¼NE¼ sec. 22, T. 124 N., R. 51 W.	210	150	SD	D,S
German, E.	NE¼NW¼SW¼NW¼ sec. 27, T. 124 N., R. 51 W.	68		GVL	D,S
Davis, A.	SE¼NE¼NE¼ sec. 28, T. 124 N., R. 51 W.	20			D,S
Phillips, G.	NE¼NW¼NW¼SW¼ sec. 35, T. 124 N., R. 51 W.	46	19	SD	D,S
Rodeen, R.	NE¼NE¼SW¼NW¼ sec. 36, T. 124 N., R. 51 W.	25	17	SD	D,S
Roerig, A.	NE¼ sec. 1, T. 124 N., R. 50 W.	517		DF ?	D,S
Serocki, B.	NE¼NE¼SE¼NE¼ sec. 2, T. 124 N., R. 50 W.				D,S
Ziemer, W.	SE¼SE¼SE¼SE¼ sec. 3, T. 124 N., R. 50 W.	80		GVL	D,S
Hansen, N.	NE¼NE¼SE¼SE¼ sec. 4, T. 124 N., R. 50 W.	700	F	DF	S
Herniman, R.	NW¼NW¼SE¼NW¼ sec. 4, T. 124 N., R. 50 W.	100		GVL	D,S
Young, F.	SE¼SE¼NE¼SE¼ sec. 5, T. 124 N., R. 50 W.	90?			D,S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Oletzke, C.	SW¼SW¼SE¼SW¼ sec. 5, T. 124 N., R. 50 W.			SD	D,S
Hortness, D.	SE¼SW¼ sec. 7, T. 124 N., R. 50 W.	118	18	SD	D,S
Barry, T.	NW¼SW¼SW¼NW¼ sec. 8, T. 124 N., R. 50 W.	90	20		D,S
Thiele, R.	SW¼NE¼SE¼NE¼ sec. 8, T. 124 N., R. 50 W.	60	10	SD	D,S
Thiele, R.	SW¼NE¼SE¼NE¼ sec. 8, T. 124 N., R. 50 W.	22		SD	S
Hansen, R.	NE¼NW¼SW¼SW¼ sec. 8, T. 124 N., R. 50 W.	10	2	GVL	S
Herniman, M.	NW¼SW¼SE¼SW¼ sec. 9, T. 124 N., R. 50 W.	75	37	SD	D,S
Robbins, V.	SW¼NE¼NE¼NW¼ sec. 10, T. 124 N., R. 50 W.	85		SD	D,S
Lotz, W.	NE¼SW¼SW¼SE¼ sec. 10, T. 124 N., R. 50 W.	12	6	GVL	D,S
Weeks, W.	NW¼SE¼SE¼SW¼ sec. 12, T. 124 N., R. 50 W.	563		DF ?	D,S
Sykora, C.	NW¼NE¼NE¼SW¼ sec. 13, T. 124 N., R. 50 W.	80		SD	D,S
Hein, F.	NE¼NE¼SE¼NE¼ sec. 13, T. 124 N., R. 50 W.	50	30		D,S
Faith, A.	SE¼SW¼NE¼NE¼ sec. 15, T. 124 N., R. 50 W.	30	SD	S	
Faith, A.	SE¼SW¼NE¼NE¼ sec. 15, T. 124 N., R. 50 W.	60	50	SD	D,S
Neilsen, C.	SW¼NE¼NE¼SE¼ sec. 16, T. 124 N., R. 50 W.		F	SD	D,S
Owen, E. P.	NE¼NW¼SW¼SW¼ sec. 16, T. 124 N., R. 50 W.	80			D,S
Karst, B.	SE¼SW¼NW¼ sec. 17, T. 124 N., R. 50 W.	97	F	GVL	D,S
Ramynke, C.	NE¼SW¼SW¼SE¼ sec. 18, T. 124 N., R. 50 W.	98	F		D,S
Ziemer, W.	SW¼SW¼SW¼ sec. 18, T. 124 N., R. 50 W.	80	68	GVL	D,S
Gerber, D.	SW¼NE¼SE¼SE¼ sec. 20, T. 124 N., R. 50 W.	32			D,S
Foell, D.	SW¼NE¼SE¼SE¼ sec. 20 T. 124 N., R. 50 W.	25		SD	D,S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Gerber, D.	SW¼NE¼SE¼SE¼ sec. 20 T. 124 N., R. 50 W.	36			D,S
Lawrence, F.	SW¼SW¼SE¼NE¼ sec. 21, T. 124 N., R. 50 W.	75		SD	D,S
Lawrence, F.	NW¼NW¼SW¼ sec. 22, T. 124 N., R. 50 W.	90			D,S
Appl, A.	NW¼SE¼NE¼SE¼ sec. 24, T. 124 N., R. 50 W.	90			D,S
Archut, A.	NE¼ sec. 24, T. 124 N., R. 50 W.	65	20	GVL	D,S
Ward, L.	SW¼SE¼NE¼SE¼ sec. 25, T. 124 N., R. 50 W.			SD	D,S
Hageh, V. F.	SE¼SW¼SW¼NW¼ sec. 28, T. 124 N., R. 50 W.	125		SD	D,S
Thiele, K.	SW¼SE¼NE¼NE¼ sec. 29, T. 124 N., R. 50 W.	56		SD	D,S
Gardner, K.	SE¼SE¼SW¼NE¼ sec. 30, T. 124 N., R. 50 W.	20			D,S
Jacobson, C.	NW¼SW¼NW¼NW¼ sec. 30, T. 124 N., R. 50 W.	100			D,S
Flute, J.	NW¼NE¼ sec. 32, T. 124 N., R. 50 W.			SD	S
Sorenson, H.	NW¼SW¼SE¼SW¼ sec. 35, T. 124 N., R. 50 W.	50		SD	D,S
Schaeffer, F.	SE¼SE¼NW¼SW¼ sec. 36, T. 124 N., R. 50 W.	60	35	SD	D,S
Sykora, L.	NE¼SW¼NW¼SW¼ sec. 7, T. 124 N., R. 49 W.				D,S
Greiner, B.	SE¼SE¼SE¼SE¼ sec. 1, T. 123 N., R. 50 W.	65		GVL	S
Dirks, H.	SW¼SW¼SW¼SW¼ sec. 1, T. 123 N., R. 50 W.	32	6	SD	D,S
Greiner, B.	SE¼SE¼SE¼SE¼ sec. 1, T. 123 N., R. 50 W.	85		SD	D,S
Smith, D.	NE¼SW¼SW¼SW¼ sec. 2, T. 123 N., R. 50 W.	24	20	GVL	D,S
Vreim, O.	SE¼SE¼SE¼ sec. 3, T. 123 N., R. 50 W.	27		SD	D,S
Madsen, E.	SE¼NW¼NW¼SW¼ sec. 11, T. 123 N., R. 50 W.				D,S
Greiner, L.	NW¼NE¼SE¼NE¼ sec. 11, T. 123 N., R. 50 W.	30	7	SD	D,S