Ground-Water Resources Near Max, McLean and Ward Counties, North Dakota

By
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Geological Survey
United States Department of the Interior

NORTH DAKOTA GROUND-WATER STUDIES NO. 45

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North Dakota State Water Commission and the
North Dakota Geological Survey

Published by
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1301 State Capitol, Bismarck, North Dakota

1963
NORTH DAKOTA STATE WATER CONSERVATION COMMISSION

WATER RESOURCES DEVELOPMENT PLAN

LANDS UNDER IRRIGATION
AREAS CONSIDERED IRRIGABLE
AREAS BEING INVESTIGATED
PROPOSED FOR INVESTIGATION

EXISTING
DAM & RESERVOIR SITES
UNDER CONSTRUCTION OR PROPOSED
PROPOSED CANALS
GARRISON DIVERSION CONSERVANCY
DISTRICT BOUNDARY
GROUNDWATER AQUIFERS

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WILLIAM W. CORWIN
EINAR H. DAHL
HENRY J. STEINBERGER
Areas from which groundwater developments might be made in the Max vicinity are indicated in a report released today by the State Water Commission. Samples of the water located in the aquifers tested show the water to be of inferior quality. Chemical analyses in the report indicate the water is hard and has a relatively high concentration of iron, bicarbonate, and sulfate.

Locations and logs of the 11 test holes drilled, well inventory, quality analyses, along with a map of the area are included in the report. The study area includes 64 square miles primarily in McLean County. Max is 26 miles south of Minot.

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LETTER OF TRANSMITTAL

RE: Groundwater Study Reports

We are enclosing a copy of a groundwater study report published by the State Water Conservation Commission because of your interest in such reports released by this office.

Should you desire further information regarding this report, feel free to contact the State Water Conservation Commission office in Bismarck.

Sincerely yours,

Milo W. Hoisveen
Engineer-Secretary

MWH:hs

Mimeo #160
GROUND-WATER RESOURCES NEAR MAX, McLEAN
AND WARD COUNTIES, NORTH DAKOTA

By
C. A. Armstrong
Geological Survey
United States Department of the Interior

North Dakota Ground-Water Studies No. 45
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GROUND WATER RESOURCES NEAR MAX, McLEAN

AND WARD COUNTIES, NORTH DAKOTA

By

C. A. Armstrong

Introduction

Part of the ground-water investigation program in North Dakota consists of the study of ground-water resources available for municipal development. Ground-water investigations are made of small areas surrounding towns that have requested aid from either the North Dakota State Water Conservation Commission or the North Dakota Geological Survey.

The city council of Max requested the North Dakota State Water Conservation Commission to help locate additional water. As a result of this request an investigation of the geologic and hydrologic conditions of the area surrounding Max was made in the summer of 1958. Max, which is near the Ward County line in the north-central part of McLean County (fig. 1) has a population of about 400 (410 in the 1960 census). It is approximately 26 miles south of Minot, the principal commercial center in the northwestern part of N. Dak.

The city of Max has 3 wells -- a large-diameter dug well 20 feet deep and 2 drilled wells 130 feet deep. The quantity and quality of the ground water from the wells is unsatisfactory for the city's municipal supply.
FIGURE 1--MAP SHOWING PHYSIOGRAPHIC PROVINCES IN NORTH DAKOTA AND LOCATION OF THE MAX AREA.
The area investigated includes 64 square miles of which the larger part is in McLean County and the remainder in Ward County. Max is near the center of the area. The field work for the investigation included a geologic reconnaissance of the area, test drilling, well inventory (table 1), and collection of water samples for chemical analysis. The results of the chemical analyses are shown in table 2.

The average annual precipitation recorded by the United States Weather Bureau (1962, p. 190) for the 33-year period ending December 1961 was 16.79 inches. Most of the precipitation falls as rain during the growing season. The mean annual temperature for the period was 39°F.

Well-Numbering System

The well-numbering system used in this report is illustrated in figure 2 and is based on the location of the well in the federal system of rectangular surveys of the public lands. The first numeral denotes the township north of the base line, the second numeral denotes the range west of the fifth principal meridian, and the third numeral denotes the section in which the well is located. The letters a, b, c, and d designate respectively, the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tract) as shown in figure 2. Thus well 150-83-15daa is in the NE 1/4 NE 1/4 SE 1/4 sec. 15 T. 150 N., R. 83 W.
FIGURE 2--SYSTEM OF NUMBERING WELLS AND TEST HOLES.
Geology and Ground Water

Glacial Drift

The report area is in the glaciated part of the Missouri Plateau section of the Great Plains Province (fig. 1) and lies in that part known as the Max moraine. This moraine, 15 to 20 miles wide in the Max area, was formed along the northeast side of the Missouri Plateau apparently as a result of retardation of Pleistocene glaciers by the higher elevation of the plateau. This retardation caused material in and on the glaciers to be deposited in a chaotic profusion of hills and undrained depressions. The measured thickness of the glacial drift penetrated by test holes ranges from 74 feet in test hole 1377 (150-83-10aaa) to more than 220 feet in test hole 1369 (150-83-18aaa). (See table 3.)

Most of the drift is composed of till, a relatively impermeable, heterogeneous mixture of clay, silt, sand, gravel, and boulders that yields little or no water to wells. However, some drift consists of stratified sand and gravel deposits buried within the till, and their capacity to yield water depends on their size and on the amount of replenishment or recharge they receive. If a sand and gravel deposit is completely surrounded by till, it receives recharge slowly; consequently it will not yield large quantities of water for sustained periods. Sand and gravel deposits that are only partly surrounded by till or other impermeable materials, on the other hand, may supply usable quantities of ground water indefinitely. The amount of water that such a deposits will yield depends largely upon its permeability and size.
Figure 3 shows the location of wells and test holes in the Max area. The logs of 4 test holes, 1369, 1370, 1379, and 1380, (table 3) show sand and gravel overlain by till and in most cases underlain by till also. The sand and gravel in holes 1369 and 1370 might be capable of yielding enough water for a small municipal water supply. Further testing will be necessary to determine the quantity and quality of water that is available at these locations. The sand in hole 1379 was fine grained and contained clay; it is probably not a source of enough water for a municipal supply. Gravel was penetrated in the basal 11 feet of the drift in hole 1380. The driller reported that the water level in the hole stood at about the top of the gravel. Unless the gravel deposit is relatively extensive, however, it also is probably inadequate as a source of supply for Max.

Other sources of small ground-water supplies are the ice-contact deposits composed of stratified silt, sand, and gravel that are scattered throughout the area. These deposits commonly form low-rounded to irregular-shaped knolls, but can best be identified by the material in them. The quantity of water that can be obtained from a particular deposit depends on its size; on its permeability; on its storage capacity, which is determined by its porosity; and on the amount of local precipitation and runoff that infiltrates into the deposit. None of the ice-contact deposits in or near Max are large enough to be depended upon for the city's water supply during prolonged periods of drouth when recharge is low, but two local ice-contact deposits are used to supplement the present Max water supply. Well 150-83-16baal is 20 feet deep; it was
FIGURE 3--MAP OF MAX AREA SHOWING LOCATIONS OF SELECTED WELLS AND TEST HOLES.
dug in an ice-contact deposit consisting of gravel, and it furnishes a part of the city's water supply. Well 150-83-9daa, which is 12 feet deep, was also dug in gravel. It yields only small quantities of water and is not connected to the municipal supply system, but residents of Max carry water from it for culinary use.

Other possible sources of small ground-water supplies are sand and gravel lenses or stringers at the edges of some kettles, which are depressions in the land surface also known as prairie potholes. The sand and gravel deposits were probably formed by the sorting action of melt water from ice blocks that formerly occupied the kettles. The stringers or lenses are generally located only by digging or drilling; because they are not ordinarily exposed and are only a few yards wide; some may be fairly long. Recharge to these shallow aquifers is from local precipitation and runoff. In some deposits the ground water is maintained by water in an adjacent pothole and in some localities water in the potholes may be in part, at least, maintained by water from the shallow aquifers. Generally the deposits yield only a few gallons per minute for relatively short periods, although some of the larger ones may yield small supplies at a nearly steady rate. Wells in such deposits may yield enough water for domestic or stock purposes.
Bedrock Formations

Rocks of the Fort Union Formation of Tertiary age immediately underlie the glacial drift in the Max area. The uppermost beds of this formation are similar to and equivalent to the Tongue River Member as described by Lemke (1960, p. 34). They are composed of gray sandy clay beds interbedded with lignite. In the report area the beds generally dip at a very low angle from the northeast to the southwest. The lack of altitude control as well as the lack of detailed lithologic descriptions in the logs make it difficult and impractical to correlate individual beds within the Tongue River Member. Reported interference between wells in Max that obtain water from lignite beds in the Tongue River Member, however, shows that a degree of hydraulic connection exists, so there is some lateral continuity in the lignite beds at least. Wells yield small supplies from sand beds in a few other parts of the Max area, but the lignite beds are the major sources of water.

The largest part of the Max water supply comes from two drilled wells that tap one of the lignite beds. One well, 150-83-9dda, yields 18 gpm (gallons per minute), which is the maximum reported yield in the report area, and the other well, 150-83-9dba, yields 7 gpm. The yields cannot be sustained indefinitely with both wells pumping simultaneously. During the peak demand for the summer of 1962, 30,000 gallons per day was the maximum quantity of water available. Reports of abandoned wells within the city indicate that perhaps other small-capacity wells could be developed in the bedrock aquifer to supplement the supply, but wide spacing would be necessary to minimize interference between wells.
In parts of North Dakota the Cannonball Member of the Fort Union Formation underlies the Tongue River Member and contains water-producing sand beds, but it has not been identified in the Max area. Simpson (1929, p. 166) gives the log of the Minneapolis, St. Paul, and Sault Ste. Marie Railway well at Max; the well is 2,500 feet deep. Its log shows that shale is present in that part of the section where the Cannonball Member should be. It is probable, therefore, that the sands of this member were not deposited in the Max area. The only water reported in the deep railway well was a "small vein" at 135 feet and another at 250 feet, both of which are in the Tongue River Member. Formations below the Fort Union are either too deep or too impermeable to be considered as practical sources of ground water.

Recharge to both the glacial drift and bedrock aquifers is probably largely from downward seepage of precipitation and runoff on the moraine northeast of Max. Ground water in the Fort Union Formation percolates generally southwestward down the dip of the beds toward the Missouri River valley. This is shown in part by the discharge from springs at some of the lignite outcrops in the escarpment along the northern side of the Missouri River valley.
Quality of Water

Chemical analyses of water samples from 2 wells in the report area are given in table 2. Water from the shallow well (150-83-16baa1) is of better quality than the water from the Fort Union Formation (well 150-83-9dda). In general, the water is probably hard and has a relatively high concentration of iron, bicarbonate, and sulfate.
Summary of Ground-Water Conditions

Wells in the Max area obtain water from either sand and gravel deposits in the glacial drift or from lignite and sand beds in the Tongue River Member of the Fort Union Formation. They supply small amounts of moderately to highly mineralized water for public supply, domestic, and farm use. Ground water occurs in formations older and deeper than the Fort Union Formation, but the formations are too deep or impermeable to be considered as practical sources.

The most promising area for the development of new ground-water supplies is in the vicinity of test holes 1369 and 1370 where probably moderate yields (enough for a small municipal or commercial water supply) can be obtained. Small additional supplies may also be obtained from lignite beds in the Tongue River Member of the Fort Union Formation underlying Max, but widely-spaced wells would be necessary to minimize interference between wells, and the quality of water is apt to be unsatisfactory. Chemical analyses of two ground-water samples suggest that water from the drift is of better quality than water from the Fort Union Formation.

Recharge to shallow aquifers in the drift is derived from water falling on or passing over the surface of the area. Recharge to the bedrock aquifers probably is derived from water percolating downward through the glacial drift in the moraine northeast of Max. The movement of ground water in the bedrock is southwestward toward the Missouri River.
Depth of well and depth to water: Measured depths are given in feet, tenths, and (or) hundredths; reported depths are given in feet.

Type of well: Dr, drilled; Du, dug.

<table>
<thead>
<tr>
<th>Location No.</th>
<th>Owner or name</th>
<th>Depth of well (feet)</th>
<th>Diameter or size (inches)</th>
<th>Type</th>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6aaa</td>
<td>Matt Semchenko</td>
<td>35</td>
<td>24</td>
<td>Dr</td>
</tr>
<tr>
<td>18cccb</td>
<td>Mrs. D. Flitag</td>
<td>295</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>19bbbbb</td>
<td>Otto Hauf</td>
<td>200+</td>
<td>3</td>
<td>Dr</td>
</tr>
<tr>
<td>30aaa</td>
<td>Mrs. Louis Pede</td>
<td>300+</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>30cdd</td>
<td>Wilson Schmidt</td>
<td>185</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>31aabb</td>
<td>Waldo Schmidt</td>
<td>240</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>31daaa</td>
<td>Herman Lange</td>
<td>285</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>150-83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1aad</td>
<td>Aleck Bauch</td>
<td>20</td>
<td>36</td>
<td>Du</td>
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<tr>
<td>1bac</td>
<td>Sam Devnich</td>
<td>180</td>
<td></td>
<td>Dr</td>
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<td>1csaa</td>
<td>Mike Zaderaka</td>
<td>8</td>
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<td>Dr</td>
</tr>
<tr>
<td>4daa</td>
<td>Test hole 1378</td>
<td>126</td>
<td>5</td>
<td>Dr</td>
</tr>
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<td>5ddc</td>
<td>M. Philipenke</td>
<td>150</td>
<td>6</td>
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</tr>
<tr>
<td>7cbb</td>
<td>Herbert Biese</td>
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<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>9acc</td>
<td>Test hole 1367</td>
<td>136</td>
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<tr>
<td>9dda</td>
<td>John Jungling</td>
<td>120</td>
<td></td>
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<td>Test hole 1380</td>
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<td>9dca</td>
<td>Test hole 1368</td>
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<td>5</td>
<td>Dr</td>
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<td>9dda</td>
<td>Emil Torno</td>
<td>115</td>
<td>24</td>
<td>Dr</td>
</tr>
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<td>9dab</td>
<td>City of Max</td>
<td>12</td>
<td>48</td>
<td>Du</td>
</tr>
<tr>
<td>9dca</td>
<td></td>
<td>130</td>
<td></td>
<td>Dr</td>
</tr>
<tr>
<td>9dcb1</td>
<td>Test hole 1381</td>
<td>94</td>
<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>9dcb2</td>
<td>Municipal test hole</td>
<td>500</td>
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<td>Dr</td>
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<td>Dr</td>
</tr>
<tr>
<td>10aaa</td>
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<td>Dr</td>
</tr>
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<td>10bca</td>
<td>Mrs. Bertha Bevers</td>
<td>125</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>11bca</td>
<td>Rudolph Wagner</td>
<td>122</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>14cca</td>
<td>Andrew Michalenko</td>
<td>102</td>
<td>24</td>
<td>Dr</td>
</tr>
<tr>
<td>15aaa</td>
<td>Test hole 1376</td>
<td>105</td>
<td>5</td>
<td>Dr</td>
</tr>
</tbody>
</table>
of wells and test holes

Use of water: D, domestic; P, public supply; S, stock; N, none; T, test hole.

Remarks: Adequate supply means quantity reported sufficient for use indicated.

<table>
<thead>
<tr>
<th>Date completed</th>
<th>Depth to water below land surface (feet)</th>
<th>Use</th>
<th>Aquifer</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>...</td>
<td>23</td>
<td>D,S</td>
<td>Sand</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>...</td>
<td>285</td>
<td>D,S</td>
<td>......</td>
<td>Adequate supply; alkaline.</td>
</tr>
<tr>
<td>...</td>
<td>150</td>
<td>D,S</td>
<td>......</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>...</td>
<td>150</td>
<td>D,S</td>
<td>......</td>
<td>Do</td>
</tr>
<tr>
<td>1921</td>
<td>210</td>
<td>D,S</td>
<td>&quot;Coal&quot;</td>
<td>Do</td>
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<tr>
<td>1918</td>
<td>255</td>
<td>D,S</td>
<td>Sand</td>
<td>Inadequate supply.</td>
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<td>...</td>
<td>6</td>
<td>D,S</td>
<td>Gravel</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>...</td>
<td>Flow</td>
<td>D,S</td>
<td>Sand</td>
<td>Do</td>
</tr>
<tr>
<td>9-58</td>
<td>T</td>
<td>......</td>
<td>See log.</td>
<td></td>
</tr>
<tr>
<td>1918</td>
<td>130</td>
<td>D,S</td>
<td>&quot;Coal&quot;</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>1930</td>
<td>57</td>
<td>S</td>
<td>do</td>
<td>Do</td>
</tr>
<tr>
<td>8-58</td>
<td>T</td>
<td>......</td>
<td>See log.</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>100</td>
<td>S</td>
<td>......</td>
<td>Adequate supply; oily film.</td>
</tr>
<tr>
<td>9-58</td>
<td>T</td>
<td>......</td>
<td>See log.</td>
<td></td>
</tr>
<tr>
<td>8-58</td>
<td>T</td>
<td>......</td>
<td>Do</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>60</td>
<td>D,S</td>
<td>Sand</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>...</td>
<td>PS</td>
<td>Gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-58</td>
<td>PS</td>
<td>&quot;Coal&quot;</td>
<td></td>
<td>Reported yield 7 gpm.</td>
</tr>
<tr>
<td>1956</td>
<td>T</td>
<td>......</td>
<td>See log.</td>
<td></td>
</tr>
<tr>
<td>1954</td>
<td>60</td>
<td>PS</td>
<td>do</td>
<td>Reported yield 18 gpm; see chemical analysis.</td>
</tr>
<tr>
<td>9-58</td>
<td>T</td>
<td>......</td>
<td>See log.</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>90</td>
<td>N</td>
<td>do</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>112</td>
<td>D,S</td>
<td>Gravel</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>9-58</td>
<td>T</td>
<td>......</td>
<td>See log.</td>
<td></td>
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</tbody>
</table>

10b
TABLE 1.--Records of wells

<table>
<thead>
<tr>
<th>Location No.</th>
<th>Owner or name</th>
<th>Depth of well (feet)</th>
<th>Diameter or size (inches)</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>150-83 (Cont.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15aab</td>
<td>Clem Haettl</td>
<td>260</td>
<td>6</td>
<td>Dr</td>
</tr>
<tr>
<td>16aac</td>
<td>Minneapolis, St. Paul &amp; Sault Ste. Marie Railway</td>
<td>225</td>
<td>..</td>
<td>..</td>
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<tr>
<td>16baa1</td>
<td>City of Max</td>
<td>20</td>
<td>84 x 84</td>
<td>Du</td>
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<tr>
<td>16baa2</td>
<td>Municipal test hole</td>
<td>151</td>
<td>..</td>
<td>Dr</td>
</tr>
<tr>
<td>16ccc</td>
<td>Test hole 1373</td>
<td>115.5</td>
<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>17aa</td>
<td>Aleck Vinarckai</td>
<td>92</td>
<td>24</td>
<td>Dr</td>
</tr>
<tr>
<td>17ccd</td>
<td>Test hole 1372</td>
<td>115.5</td>
<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>17daa</td>
<td>William Lee</td>
<td>75</td>
<td>24</td>
<td>Dr</td>
</tr>
<tr>
<td>18aab</td>
<td>Test hole 1369</td>
<td>220</td>
<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>18bbb</td>
<td>Test hole 1370</td>
<td>146</td>
<td>5</td>
<td>Dr</td>
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<tr>
<td>18daa</td>
<td>John Wenger</td>
<td>140</td>
<td>4</td>
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<td>Alex Henne</td>
<td>190</td>
<td>5</td>
<td>Dr</td>
</tr>
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<td>21cdb</td>
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<td>240</td>
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<td>Dr</td>
</tr>
<tr>
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<td>80</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>23ccd</td>
<td>Albert Anderson</td>
<td>90</td>
<td>6</td>
<td>Dr</td>
</tr>
<tr>
<td>23dab</td>
<td>Lloyd S. Monson</td>
<td>160</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>27bba</td>
<td>Emil Bauer</td>
<td>140</td>
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<td>27cda</td>
<td>Herbert Songsted</td>
<td>151</td>
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</tr>
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<td>29dab1</td>
<td>C. A. Lindquist</td>
<td>48</td>
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<td>56</td>
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<td>30acd</td>
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<td>50</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>30cda</td>
<td>Gust Olson</td>
<td>90</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>31bda</td>
<td>.. do ...</td>
<td>91</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>33abc</td>
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<td>101</td>
<td>4</td>
<td>Dr</td>
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<td>33bba</td>
<td>Test hole 1375</td>
<td>147</td>
<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>33dab</td>
<td>Harry Olson</td>
<td>128</td>
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</tr>
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<td>Tennes Torgerson</td>
<td>112</td>
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<td>Dr</td>
</tr>
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<td>35dbd</td>
<td>Victor Zence</td>
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and test holes -- Continued

<table>
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<th>Date completed</th>
<th>Depth to water below land surface (feet)</th>
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<th>Aquifer</th>
<th>Remarks</th>
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<tr>
<td>1956</td>
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<td>T</td>
<td></td>
<td>.Do....</td>
</tr>
<tr>
<td>8-58</td>
<td>67</td>
<td>D,S</td>
<td>Sand</td>
<td>Inadequate supply.</td>
</tr>
<tr>
<td>1954</td>
<td>200</td>
<td>D,S</td>
<td>&quot;Coal&quot;</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>1935</td>
<td>200</td>
<td>D,S</td>
<td></td>
<td>.Do....</td>
</tr>
<tr>
<td>Flow</td>
<td>150</td>
<td>D,S</td>
<td>Sand</td>
<td>.Do....</td>
</tr>
<tr>
<td>1939</td>
<td>60</td>
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<td></td>
<td>Adequate supply; unfit for drinking.</td>
</tr>
<tr>
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<td></td>
<td>S</td>
<td></td>
<td>Inadequate supply.</td>
</tr>
<tr>
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<td>156</td>
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<td>&quot;Coal&quot;</td>
<td>Adequate supply.</td>
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<tr>
<td>1920</td>
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<td>.Do....</td>
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<td>1918</td>
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<td>S</td>
<td>Sand</td>
<td>.Do....</td>
</tr>
<tr>
<td>8-58</td>
<td></td>
<td>T</td>
<td></td>
<td>See log.</td>
</tr>
<tr>
<td>1939</td>
<td>1½</td>
<td>D,S</td>
<td>Gravel</td>
<td>Adequate supply.</td>
</tr>
<tr>
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<td>S</td>
<td></td>
<td>.Do....</td>
</tr>
<tr>
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<td>25</td>
<td>D,S</td>
<td>Sand</td>
<td>.Do....</td>
</tr>
<tr>
<td>1913</td>
<td>106</td>
<td>D,S</td>
<td>&quot;Coal&quot;</td>
<td>.Do....</td>
</tr>
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<td>9-58</td>
<td>80</td>
<td>D,S</td>
<td>Sand</td>
<td>Adequate supply.</td>
</tr>
<tr>
<td>1930</td>
<td>116</td>
<td>D,S</td>
<td></td>
<td>Inadequate supply.</td>
</tr>
<tr>
<td>1913</td>
<td></td>
<td>D,S</td>
<td></td>
<td>Adequate supply.</td>
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### TABLE 1.--Records of wells

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<tr>
<th>Location No.</th>
<th>Owner or name</th>
<th>Depth of well (feet)</th>
<th>Diameter or size (inches)</th>
<th>Type</th>
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<tbody>
<tr>
<td>150-84</td>
<td></td>
<td></td>
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<tr>
<td>12aa</td>
<td>Jacob Finkheiner</td>
<td>142</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>12ccc</td>
<td>Test hole 1371</td>
<td>105</td>
<td>5</td>
<td>Dr</td>
</tr>
<tr>
<td>13acd</td>
<td>George Day</td>
<td>50</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>13bda</td>
<td>..do...</td>
<td>98</td>
<td>4</td>
<td>Dr</td>
</tr>
<tr>
<td>151-82</td>
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<td>Matt Gruzinsky</td>
<td>60</td>
<td>4</td>
<td>Dr</td>
</tr>
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<td>31add</td>
<td>Jake Van Winkle</td>
<td>290</td>
<td>4</td>
<td>Dr</td>
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<tr>
<td>151-83</td>
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<td></td>
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<td>26ccd</td>
<td>George Fannik</td>
<td>64</td>
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<td>Dr</td>
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<td>Jack Fannik</td>
<td>210</td>
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<td>Dr</td>
</tr>
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<td>Fred Strilcov</td>
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<td>2.5</td>
<td>Dr</td>
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<td>John Kabanuck</td>
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<td>4</td>
<td>Dr</td>
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<td>4</td>
<td>Dr</td>
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<td>Steve Bokovaa</td>
<td>125</td>
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<td>Ervin Batke</td>
<td>40</td>
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<td>Dr</td>
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<td>32db</td>
<td>Arnold Schmidt</td>
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<td>Dr</td>
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</table>
and test holes -- Continued

<table>
<thead>
<tr>
<th>Date completed</th>
<th>Depth to water below landsurface (feet)</th>
<th>Use</th>
<th>Aquifer</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>1940</td>
<td>122</td>
<td>D,S</td>
<td>Sand</td>
<td>Adequate supply.</td>
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<td>40</td>
<td>D,S</td>
<td>.do.</td>
<td>Inadequate supply.</td>
</tr>
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<td></td>
<td>38</td>
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<td>.do.</td>
<td>Adequate supply.</td>
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<td>155</td>
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<td>.Do....</td>
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<td>Dry</td>
<td>D,S</td>
<td>.do.</td>
<td>.Do....</td>
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<td>.do.</td>
<td>.Do....</td>
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<td>.do.</td>
<td>.Do....</td>
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<td>140</td>
<td>D,S</td>
<td>&quot;Coal&quot;</td>
<td>.Do....</td>
</tr>
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<td>1925</td>
<td>135</td>
<td>D,S</td>
<td>Sand</td>
<td>.Do....</td>
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<td>1953</td>
<td>30</td>
<td>D,S</td>
<td>Clay</td>
<td>.Do....</td>
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<td>.Do....</td>
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<td>D,S</td>
<td>Sand</td>
<td>Inadequate supply.</td>
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<td>1900</td>
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<td>D,S</td>
<td>Gravel</td>
<td>Adequate supply.</td>
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<td>D,S</td>
<td>Sand</td>
<td>.Do....</td>
</tr>
<tr>
<td>9-58</td>
<td>...</td>
<td>T</td>
<td>.do.</td>
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<td>1955</td>
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<td>Adequate supply.</td>
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TABLE 2.--Chemical

Geologic source: D, drift; Tft, Tongue River Member of Fort Union Formation.

Results in parts per million except as indicated.

<table>
<thead>
<tr>
<th>Location</th>
<th>Geologic source</th>
<th>Depth of well (feet)</th>
<th>Date of collection</th>
<th>Silica (SiO₂</th>
<th>Iron (Fe)</th>
<th>Calcium (Ca)</th>
<th>Magnesium (Mg)</th>
<th>Sodium (Na)</th>
<th>Potassium (K)</th>
<th>Bicarbonate (HCO₃)</th>
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</thead>
<tbody>
<tr>
<td>150-83</td>
<td>Tft</td>
<td>130</td>
<td>2-5-63</td>
<td>14</td>
<td>2.4</td>
<td>95</td>
<td>119</td>
<td>371</td>
<td>11</td>
<td>940.0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16baal</td>
<td>D</td>
<td>20</td>
<td>2-5-63</td>
<td>17</td>
<td>0.1</td>
<td>89</td>
<td>62</td>
<td>27</td>
<td>11</td>
<td>435</td>
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</tbody>
</table>
analyses of ground water

Analyses by State Laboratories, Bismarck, N. Dak.

<table>
<thead>
<tr>
<th></th>
<th>Carbonate (CO₃$^2$⁻)</th>
<th>Sulfate (SO₄$^{2-}$)</th>
<th>Chloride (Cl⁻)</th>
<th>Fluoride (F⁻)</th>
<th>Nitrate (NO₃⁻)</th>
<th>Boron (B)</th>
<th>Dissolved solids (calculated)</th>
<th>Hardness as CaCO₃</th>
<th>Percent sodium</th>
<th>Specific conductance (microhms at 25°C)</th>
<th>pH</th>
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<td>778</td>
<td>7.8</td>
<td>0.3</td>
<td>0</td>
<td>0.3</td>
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<td>2,008.0</td>
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<td>0.2</td>
<td>0.5</td>
<td>0.28</td>
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<td>748</td>
<td>478</td>
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<td>1,057</td>
<td>7.4</td>
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### TABLE 3.--Logs of test holes

#### Test hole 1378
150-83-4daa

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<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, black</td>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Till; clay, yellow to light brown, a few pebbles</td>
<td></td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td>Till; clay, gray, fine gravel, shale pebbles</td>
<td></td>
<td>69</td>
<td>112</td>
</tr>
<tr>
<td>Gravel, fine to medium</td>
<td></td>
<td>3</td>
<td>115</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay, sandy, gray</td>
<td></td>
<td>11</td>
<td>126</td>
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</table>

#### Test hole 1367
150-83-9acc

<table>
<thead>
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<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, black</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Till; clay, sandy, and pebbly, yellow to brown, oxidized</td>
<td></td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>Till; clay, gray, fine gravel, shale pebbles</td>
<td></td>
<td>69</td>
<td>91</td>
</tr>
<tr>
<td>Gravel, fine to medium</td>
<td></td>
<td>1</td>
<td>92</td>
</tr>
<tr>
<td>Till; clay, gray, fine gravel, shale pebbles</td>
<td></td>
<td>37</td>
<td>129</td>
</tr>
<tr>
<td>Lignite</td>
<td></td>
<td>2</td>
<td>131</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale, gray</td>
<td></td>
<td>5</td>
<td>136</td>
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#### Test hole 1380
150-83-9baa

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<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, black</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gravel, fine</td>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Till, clay, yellow, fine gravel</td>
<td></td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Till; clay, gray, fine to medium gravel, shale pebbles</td>
<td></td>
<td>87</td>
<td>115</td>
</tr>
<tr>
<td>Gravel, fine to medium, slightly indurated</td>
<td></td>
<td>11</td>
<td>115</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay, sandy, gray, lignite</td>
<td></td>
<td>1</td>
<td>115</td>
</tr>
<tr>
<td>Clay, sandy, gray, lignite</td>
<td></td>
<td>11</td>
<td>126</td>
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</table>
TABLE 3.--Logs of test holes -- Continued

Test hole 1368
150-83-9ccc

<table>
<thead>
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<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td>Soil, black------------------------------------</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Till; clay, light-yellow gray, oxidized--------</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Till; clay, grayish-brown, fine to medium gravel, oxidized-----</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine to medium gravel, shale pebbles---------</td>
<td>42</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine gravel, shale pebbles-------------</td>
<td>21</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Till; clay, light-yellowish-gray, fine to medium gravel, shale pebbles, oxidized--------</td>
<td>10</td>
<td>94</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Lignite----------------------------------------</td>
<td>2</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Shale, gray-------------------------------------</td>
<td>9</td>
<td>105</td>
</tr>
</tbody>
</table>

Test hole 1381
150-83-9dcbl

<p>| Glacial drift:     | Soil, black------------------------------------| 3                | 3            |
|                    | Till; clay, light yellowish-gray to yellow, a few coarse sand grains-----------------| 18              | 21           |
|                    | Till; clay, gray, fine gravel, shale pebbles------------------| 35              | 56           |
|                    | Gravel, fine to medium--------------------------| 2                | 58           |
|                    | Till; clay, gray, fine gravel, shale pebbles--------------| 10              | 68           |
|                    | Till; clay, brownish-gray, fine gravel, shale pebbles---------| 18              | 86           |
| Fort Union Formation: | Clay, sandy, gray-------------------------| 8                | 94           |</p>
<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td>Clay, gravelly, yellow and rocks (till)</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Clay, sandy, blue and rocks (till)</td>
<td>39</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Rock</td>
<td>2</td>
<td>89</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Clay or shale, gray with some coal</td>
<td>23</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>Clay, yellow</td>
<td>5</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Clay, gray with coal slack layers</td>
<td>83.5</td>
<td>200.5</td>
</tr>
<tr>
<td></td>
<td>Rock layer, hard</td>
<td>2.5</td>
<td>203</td>
</tr>
<tr>
<td></td>
<td>Shale, slightly sandy, gray</td>
<td>29</td>
<td>232</td>
</tr>
<tr>
<td></td>
<td>Shale, light-gray</td>
<td>9</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td>Shale, brown, hard with coal particles</td>
<td>7</td>
<td>248</td>
</tr>
<tr>
<td></td>
<td>Shale, gray</td>
<td>26</td>
<td>274</td>
</tr>
<tr>
<td></td>
<td>Shale, brown</td>
<td>4</td>
<td>276</td>
</tr>
<tr>
<td></td>
<td>Shale, light-green</td>
<td>4</td>
<td>282</td>
</tr>
<tr>
<td></td>
<td>Shale, slightly sandy, gray</td>
<td>14</td>
<td>296</td>
</tr>
<tr>
<td></td>
<td>Hard layer</td>
<td>1</td>
<td>297</td>
</tr>
<tr>
<td></td>
<td>Shale, gray with coal and hard layers</td>
<td>12</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td>6</td>
<td>315</td>
</tr>
<tr>
<td></td>
<td>Shale, gray with few hard layers</td>
<td>60</td>
<td>375</td>
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<tr>
<td></td>
<td>Coal</td>
<td>3</td>
<td>378</td>
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<tr>
<td></td>
<td>Shale, gray</td>
<td>11</td>
<td>389</td>
</tr>
<tr>
<td></td>
<td>Shale, brown, rather hard</td>
<td>5</td>
<td>394</td>
</tr>
<tr>
<td></td>
<td>Shale, gray</td>
<td>24</td>
<td>418</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td>3</td>
<td>421</td>
</tr>
<tr>
<td></td>
<td>Shale, gray</td>
<td>14</td>
<td>435</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td>6</td>
<td>441</td>
</tr>
<tr>
<td></td>
<td>Shale, gray</td>
<td>13</td>
<td>454</td>
</tr>
<tr>
<td></td>
<td>Shale, slightly sandy, gray</td>
<td>9</td>
<td>463</td>
</tr>
<tr>
<td></td>
<td>Shale, gray</td>
<td>29</td>
<td>492</td>
</tr>
<tr>
<td></td>
<td>Shale, sandy, gray</td>
<td>8</td>
<td>500</td>
</tr>
</tbody>
</table>
TABLE 3.--Logs of test holes -- Continued

Test hole 1377  
150-83-10aaa

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td>Soil, black</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellowish-gray, fine gravel</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Till; clay, dense, gray, fine to medium gravel</td>
<td>24</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Clay, light-gray</td>
<td>9</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine to medium gravel</td>
<td>19</td>
<td>74</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Clay, sandy, gray</td>
<td>10</td>
<td>84</td>
</tr>
</tbody>
</table>

Test hole 1376  
150-83-15aaa

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td>Soil, black</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellowish-gray, fine to medium gravel</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine gravel, shale pebbles</td>
<td>10</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellowish-gray, fine gravel, shale pebbles</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Clay, sandy, light-gray</td>
<td>6</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine gravel to cobbles</td>
<td>44</td>
<td>97</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Clay, sandy, gray</td>
<td>8</td>
<td>105</td>
</tr>
</tbody>
</table>
TABLE 3.--Logs of test holes -- Continued

Municipal test hole  
150-83-16bac2  
(Log furnished by C. A. Simpson and Sons, Bisbee, N. Dak.)

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay, brown--------------</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Clay, gravelly, yellow---</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sand and gravel, clayey-</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Clay, blue, some sandy---</td>
<td>80</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>Clay and boulders--------</td>
<td>2</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Clay, very gravelly------</td>
<td>24</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>Clay, gravelly------------</td>
<td>9</td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale, gray with coal flakes---</td>
<td>25</td>
<td>151</td>
<td></td>
</tr>
</tbody>
</table>

Test hole 1373  
150-83-16ccc

| Glacial drift:               |                                               |                  |              |
| Soil, black-----------------| 1                                             | 1                |
| Till; clay, yellow, slightly oxidized, fine gravel- | 39                                            | 40               |
| Till; clay, brownish-gray, fine gravel, shale pebbles--- | 67                                            | 107              |
| Fort Union Formation:       |                                               |                  |              |
| Clay, sandy, gray------------| 8.5                                           | 115.5            |
TABLE 3.--Logs of test holes -- Continued

Test hole 1372
150-83-17ccd

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
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</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soil, black-----------------------------------</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellowish-gray,</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>fine to coarse gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine to</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>medium gravel</td>
<td>26</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Gravel, coarse</td>
<td>1</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine to</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>medium gravel</td>
<td>56</td>
<td>99</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clay, sandy, gray</td>
<td>16.5</td>
<td>115.5</td>
</tr>
</tbody>
</table>
TABLE 3.--Logs of test holes -- Continued

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Soil, black</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, yellow, medium to coarse sand and a few pebbles, oxidized</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine to medium gravel, shale pebbles, lignite fragments</td>
<td>68</td>
<td>90</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, light-grown, coarse sand and pebbles</td>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Gravel, fine to medium, silty, lignite fragments</td>
<td>6</td>
<td>126</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine gravel, shale pebbles</td>
<td>11</td>
<td>137</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Sand, indurated lenses interbedded with till</td>
<td>8</td>
<td>145</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine gravel, shale pebbles</td>
<td>2</td>
<td>147</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Gravel, fine, large concentration of shale granules, lignite fragments</td>
<td>9</td>
<td>156</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine gravel, shale pebbles, lignite fragments</td>
<td>16</td>
<td>172</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Sand, indurated lens</td>
<td>2</td>
<td>174</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine gravel, shale pebbles and lignite fragments</td>
<td>9</td>
<td>183</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine gravel consisting largely of shale granules, lignite fragments</td>
<td>5</td>
<td>188</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, gray, fine gravel, shale pebbles, and lignite fragments</td>
<td>23</td>
<td>211</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, sandy, fine gravel, shale and lignite fragments</td>
<td>9</td>
<td>220</td>
</tr>
</tbody>
</table>
TABLE 3.--Logs of test holes -- Continued

Test hole 1370
150-83-18bbb

<table>
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<th>Formation</th>
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<th>Thickness</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(feet)</td>
<td>(feet)</td>
</tr>
<tr>
<td></td>
<td>Soil, black-----------------------------</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, yellowish-gray-----------------</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellowish, fine to medium gravel-----------------</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine to coarse gravel-----------------</td>
<td>75</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>Sand, coarse, fine gravel and lignite-----------------</td>
<td>15</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, lignite fragments-----------------</td>
<td>5</td>
<td>128</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Shale, clay, sandy, gray-----------------</td>
<td>8</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>Lignite (core)---------------------------</td>
<td>10</td>
<td>146</td>
</tr>
</tbody>
</table>

Test hole 1374
150-83-28bbb

<table>
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<th>Thickness</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(feet)</td>
<td>(feet)</td>
</tr>
<tr>
<td></td>
<td>Soil, black-----------------------------</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Glacial drift:</td>
<td>Till; clay, yellowish-gray, fine to medium gravel-----------------</td>
<td>41</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine to medium gravel-----------------</td>
<td>40</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Till; clay, brownish-gray, fine to medium gravel-----------------</td>
<td>37</td>
<td>121</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Clay, sandy, gray-----------------------</td>
<td>5</td>
<td>126</td>
</tr>
</tbody>
</table>
TABLE 3.—Logs of test holes -- Continued

Test hole 1375
150-83-33bbb

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
<th>Thickness (feet)</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial drift:</td>
<td>Soil, black</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellowish-gray, fine to medium gravel, slightly oxidized</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Till; clay, yellow, fine to medium gravel, slightly oxidized</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, a little fine to coarse gravel, shale pebbles</td>
<td>62</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Till; clay, light-brown, a little fine to medium gravel, slightly oxidized</td>
<td>18</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>Sand, coarse, and fine gravel, consisting of shale granules</td>
<td>3</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>Till; clay, gray, fine gravel and shale pebbles</td>
<td>32</td>
<td>137</td>
</tr>
<tr>
<td>Fort Union Formation:</td>
<td>Clay, sandy, gray</td>
<td>10</td>
<td>147</td>
</tr>
</tbody>
</table>

Test hole 1371
150-84-12ccc

| Glacial drift: | Soil, black                                                              | 1                | 1            |
|                | Till; clay, gray, small amount of sand                                  | 6                | 7            |
|                | Till; clay, light-yellowish-brown, fine to medium gravel                | 11               | 18           |
|                | Till; clay, gray, fine to medium gravel                                | 67               | 85           |
| Fort Union Formation: | Clay, grayish- to greenish-brown, fine to medium sand                   | 20               | 105          |
### TABLE 3.--Logs of test holes -- Continued

**Test hole 1379**  
151-83-3Wbcr

<table>
<thead>
<tr>
<th>Formation</th>
<th>Material</th>
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<tbody>
<tr>
<td><strong>Glacial drift:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, black</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Till; clay, yellowish-gray and fine to medium gravel</td>
<td></td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Till; clay, gray, and fine gravel</td>
<td></td>
<td>78</td>
<td>94</td>
</tr>
<tr>
<td>Till; sand and clay</td>
<td></td>
<td>11</td>
<td>105</td>
</tr>
<tr>
<td>Sand, fine, and clay</td>
<td></td>
<td>10</td>
<td>115</td>
</tr>
<tr>
<td><strong>Fort Union Formation:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay, sandy, yellowish-gray</td>
<td></td>
<td>53</td>
<td>168</td>
</tr>
</tbody>
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References


