STATE OF SOUTH DAKOTA
Archie Gubbrud, Governor

STATE GEOLOGICAL SURVEY
Allen F. Agnew, State Geologist

SPECIAL REPORT 13

WATER SUPPLY FOR THE CITY OF TYNDALL, SOUTH DAKOTA

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INTRODUCTION

Present Investigation

This report is the result of a special investigation by the South Dakota State Geological Survey during the summer of 1961 in and around the city of Tyndall, Bon Homme County, South Dakota (fig. 1). In the spring of 1961 the Tyndall City Council had requested that a complete survey of the ground water conditions in and around the city be made.

Presently the city's water is supplied by two deep wells (fig. 2) which produce from the artesian sands of the Dakota at a depth of about 800 feet. These two wells supply an adequate quantity of water, but the extremely poor quality of the water has become an increasing problem for the city. Some residents are forced to haul water great distances to supply their household needs while others have had to invest in costly treatment equipment. St. Michaels Hospital reported that the water was adversely affecting the functioning of some hospital equipment.

On June 19, 1961, an investigation of the ground water conditions in an area of 88 square miles around the city was started. This investigation consisted of the geologic mapping of the area, the drilling of 29 shallow test holes with a State Survey jeep-mounted auger drill, the drilling of 3 deep test holes with the State Survey's rotary drill, the inventory of all farm wells in the area, and the collecting and analyzing of 7 water samples.

The field work and preparation of this report were performed under the supervision of Merlin Tipton, geologist in charge of ground water studies for the State Geological Survey. Geologic assistance was given by Robert Schoon, geologist-driller for the State Geological Survey and Jim McMeen, Loren Rukstad, Nat Lufkin, Richard Brown, and Mark McDermott. The writer wishes to thank the residents of the Tyndall area for their cooperation, especially Mayor Leonard Chastka and City Attorney R. James Zieser.

Special thanks are due the doctors and staff of St. Michaels Hospital for their aid to Mr. Lufkin.

The writer also wishes to thank the South Dakota State Chemical Laboratory for reconditioning the field analysis kit and for providing a portable pH meter, and the U. S. Geological Survey for providing the specific conductance meter. These instruments made it possible to obtain quick field chemical analysis of water.

Location and Extent of Area

The city of Tyndall is located in Bon Homme County in southeastern South Dakota, and has a population of 1,262 (1960 census). The area iš in the James Basin of the Central Lowlands physiographic province (fig. 1).

FIGURE I
MAJOR PHYSIOGRAPHIC DIVISIONS OF EASTERN SOUTH DAKOTA

■ TYNDALL AREA

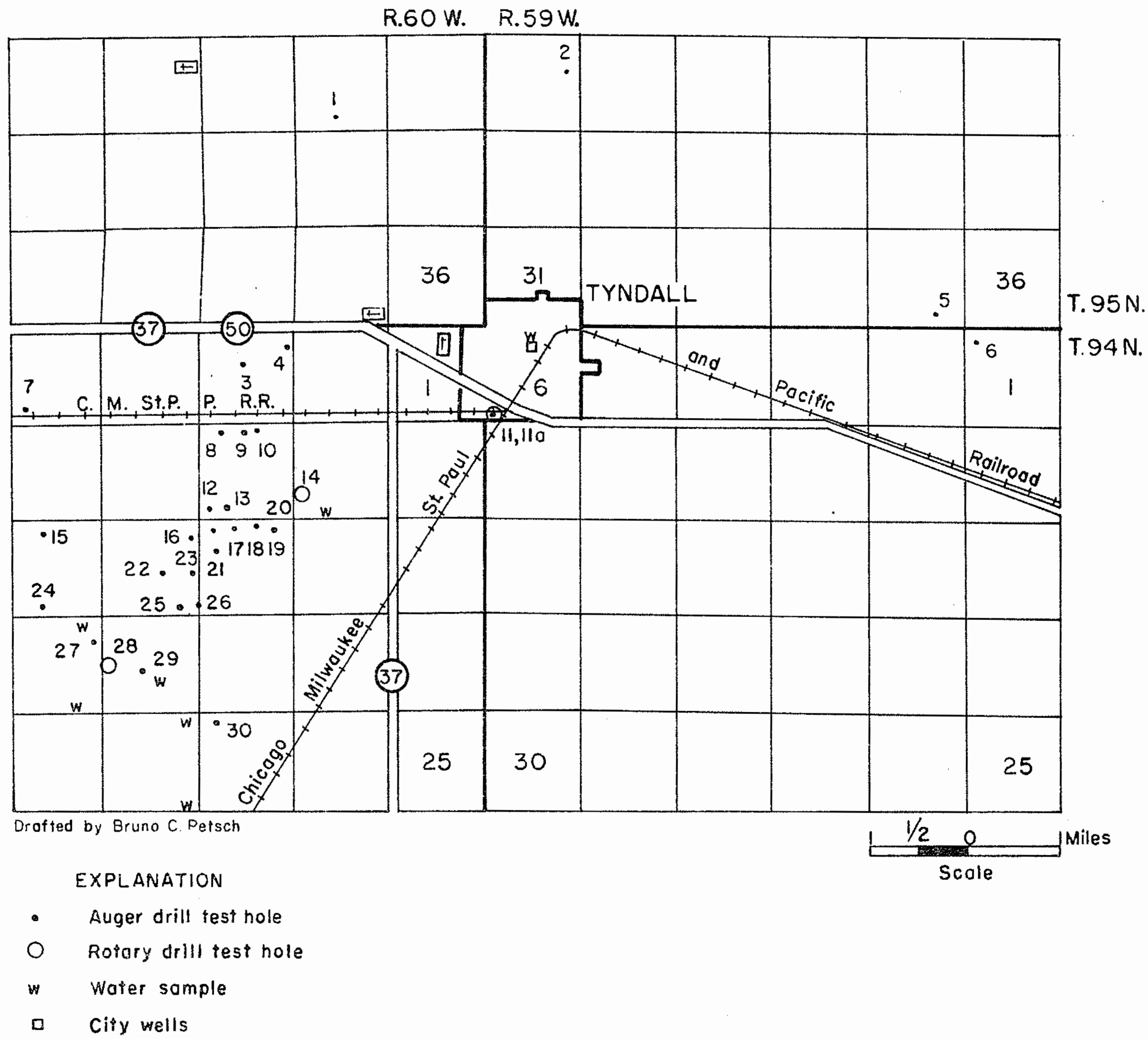

Figure 2. Data Map of Tyndall and Vicinity.
by
R. L. Bruce
1961

Climate

The climate is continental temperate, with large daily fluctuations in temperature. The mean annual temperature is 48.7°F., and the average annual precipitation is 22.34 inches, at the U. S. Weather Bureau Station in Tyndall.

Topography and Drainage

The topography of the area is youthful glacial moraine--rolling hills and valleys with knobs and kettles.

The drainage of the area is controlled by the Missouri River; consequently, all streams flow in a southerly direction. The two most prominent drainages in the immediate area are Emanuel and Snatch Creeks (fig. 3).

GENERAL GEOLOGY

Surficial Deposits

The surficial deposits of the Tyndall area are mostly the result of glaciation during the Pleistocene Epoch. These glacial deposits are collectively called drift and can be divided into till and outwash sediments.

Till consists of clay and silt-size particles mixed randomly with sand, pebbles and boulders, and was deposited by the glacial ice itself. The major surficial deposit in the Tyndall area is till (fig. 3).

Outwash sediments consist chiefly of sand and pebbles with minor amounts of silt and clay, and were deposited by meltwater streams. The only outwash deposits found in the Tyndall area are small terrace remnants along Emanuel Creek and a possible buried outwash in the southwest part of the area mapped (fig. 3).

Alluvium consists of silt and clay-size particles with minor amounts of sand, deposited by recent streams since the retreat of the glaciers. Alluvium occurs along Emanuel and Snatch Creeks (fig. 3).

Subsurface Bedrock

Stratified sedimentary rocks of Cretaceous age lie beneath the surficial deposits in the Tyndall area. The deposits in descending order are the Niobrara, Carlile, Greenhorn, and Graneros Formations, and the Dakota Group.

The Niobrara Formation consists of approximately 65 feet of bluish-gray argillaceous limestone with a high percentage of organic calcium carbonate.

The Carlile Formation consists of medium- to dark-gray bentonitic shale with pyrite concretions. The Codell Sandstone Member of this formation is composed of about 65 feet of fine brown siltstone and fine sand, interbedded with thin silty shale.

The electrical characteristics of the above formations are shown on the electric log (fig. 4) of test hole 11a (fig. 2). This log was run by the State Geological Survey's Widco logger.

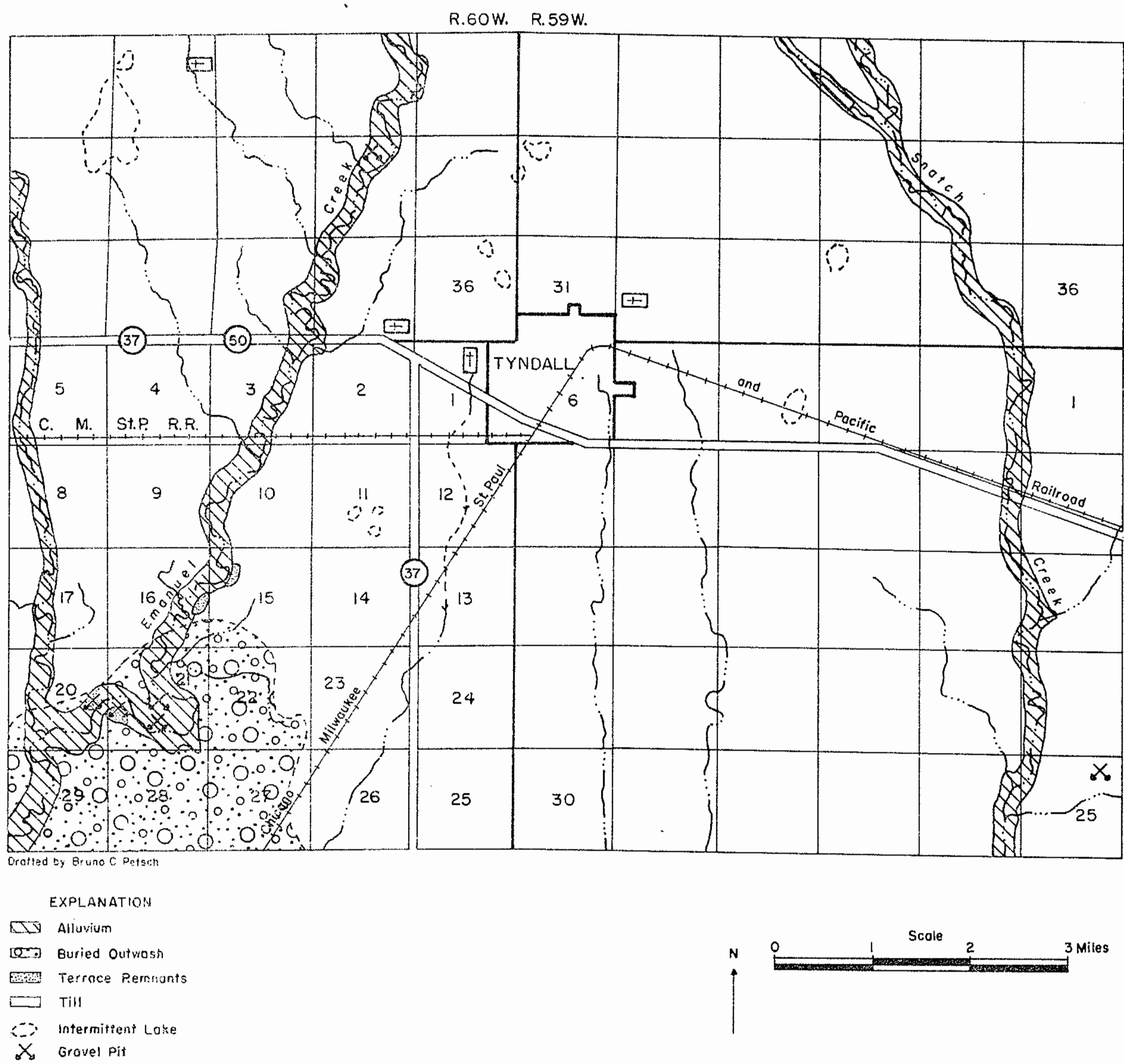

Figure 3. Generalized Geologic Map of Tyndall and Vicinity.
by
R. L. Bruce
1961

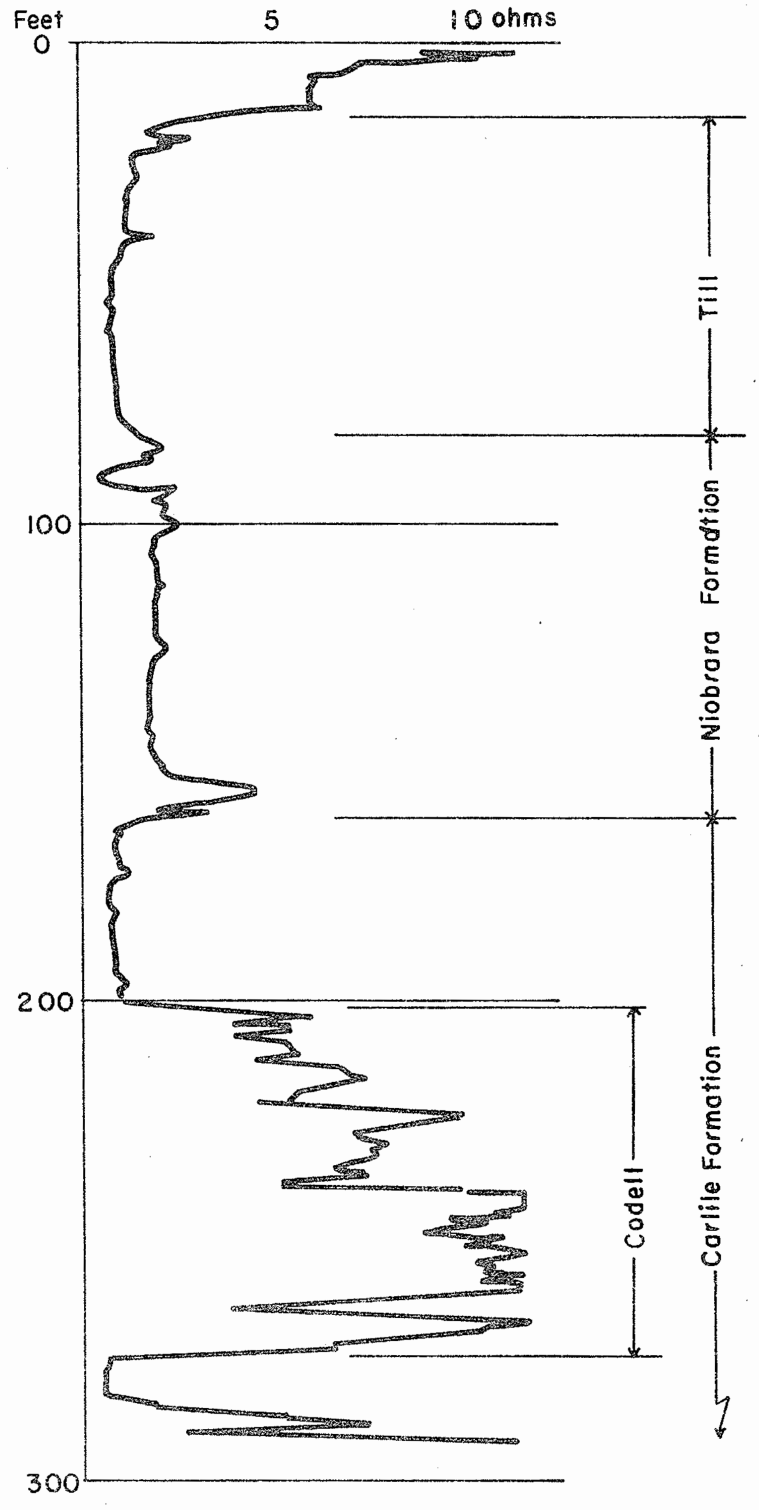

Figure 4. Electric Log of State Geological Survey Test Hole No. 11a (for location see fig. 2)

The Greenhorn Formation consists of a layer of hard cream to white limestone containing numerous fossil clam fragments. This limestone layer is overlain and possibly underlain by a layer of dark-gray shale containing numerous small white calcareous specks.

The Graneros Formation consists of hard, light- to dark-gray siliceous shale.

The top of the Dakota Group is found approximately 600 feet below the surface in the Tyndall area. It consists chiefly of fine to coarse light-colored sandstone interbedded with gray shale. The exact thickness of the Dakota in this area is not known, but it may reach 300 feet.

The sediments of the Dakota Group are probably underlain by the Sioux Quartzite of Precambrian age.

OCCURRENCE OF GROUND WATER

Principles of Occurrence

Ground water may be defined as water contained in the voids or openings of rock or sediments below the water table. Therefore, the water table marks the upper surface of the saturated zone of the water-bearing formation. The common belief that water occurs in "veins" which criss-cross the area in a disconnected maze is not true, as water occurs nearly everywhere below the surface. The existence of a water supply is controlled by the water table; this is not a static level, but fluctuates, and in a general way reflects the surface topography. The water table ranges from a few feet to many tens of feet below the surface; in the Tyndall area it ranges from 3 to 14 feet below the surface.

The amount of water which is contained in the reservoir rock or aquifer is controlled by the porosity and permeability of the rock. Porosity is a measure of the number of voids in a rock and is expressed in the ratio of pore space to the total volume of rock.

Porosity is dependent on (1) the shape and arrangement of individual particles, (2) the degree of sorting of the particles, (3) the degree of cementation and compaction of the particles, and (4) the amount of material which has been removed by percolating ground water. Sands and gravels usually have porosities that range from 20 to 40 percent depending on the above conditions, whereas sandstones have porosities of 15-25 percent. Sandstones have lower porosities owing to their higher degree of compaction and cementation.

Permeability is a measure of the rate at which a fluid will pass through a material. A material that has a high percentage of interconnected pores likewise has a high permeability, whereas a material that is high in porosity but in which the pores are not connected will have low permeability. Therefore, it can be seen that porosity and permeability are not synonymous but are nevertheless related.

Nearly all ground water is derived from precipitation. Rain or melting snow either 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 to the ground water table. In general, ground water moves laterally down the hydraulic gradient, and is said to be in transient storage.

Recharge is the addition of water to an aquifer, and is accomplished in three ways: (1) by downward percolation of precipitation from the ground surface, (2) by downward percolation from surface bodies of water, and (3) by lateral underflow of water in transient storage.

Discharge, or the removal of ground water from an aquifer, is accomplished in four main ways: (1) by evaporation and transpiration by plants, (2) by seepage upward or laterally into surface bodies of water as by springs, (3) by lateral underflow of water in transient storage, and (4) by pumping of wells.

Ground Water in Glacial Deposits

Till does not yield water readily because of its highly unsorted nature and low porosity and permeability. On the other hand, outwash is a favorable source for ground water.

No surface outwash deposits of any extent occur in the Tyndall area, although small terraces occur along Emanuel Creek.

A possible glacial outwash deposit covered by till does occur in the southwestern corner of the mapped area (fig. 3). This deposit is called a buried outwash for the purpose of this report; however, it is possible that it may be a lake, delta or channel deposit. Its origin and exact extent cannot be determined accurately until additional information can be gathered.

State Geological Survey test holes 25, 26, 27, 28, 29, and 30 (fig. 2) penetrated the buried outwash but only Test Hole No. 28 was drilled completely through it. This hole (Appendix A) shows that the deposit consists of 6 feet of gravel resting on 114 feet of saturated sand. This sand and gravel deposit overlies the Niobrara Formation, and is overlain by as much as 63 feet of glacial till except where it has been dissected by Emanuel Creek (fig. 3); here it is overlain by as much as 18 feet of alluvium.

The sand is dark yellowish-orange to moderate yellowish-brown in color. It is well-sorted, as most of its grains lie between one-fourth and one-half mm. in diameter. The sand does, however, have some silt and clay size particles. It is composed chiefly of quartz with minor amounts of feldspar and dark minerals.

The exact extent of this buried outwash deposit is unknown, but geologists of the State Highway Department's Testing Division penetrated 90 feet of this sand while testing bridge foundations along Emanuel Creek 2½ miles south of the area mapped. It is therefore believed to extend farther south than the area shown on Figure 3.

Ground Water in Alluvium

The alluvium below the water table in Snatch and Emanuel Creeks holds a large quantity of ground water but yields this water slowly because of its low permeability. It does, however, supply small domestic needs.

Ground Water in Bedrock

The Codell Sandstone Member of the Carlile Shale is a known water producer in some areas of South Dakota. Some farm wells in the Tyndall area are supplied from this aquifer.

Test hole 11a (fig. 2) was drilled through the Codell, and an electric log of the hole was run to determine the character and thickness of the sand.

The electric log (fig. 4) shows graphically the resistance of the rock strata to the passage of electrical current. Because rocks of different lithologies have different electrical resistances it is possible to differentiate one lithology from another.

In general the resistance of a lithologic type is influenced by its moisture content and therefore by its porosity. Sands, gravels, and sandstones contain more moisture than clays, silts, and shales, and as pure water is a poor conductor of electricity, the resistance of these sediments is higher than the finer, less saturated sediments.

Figure 4 shows the graph from Test Hole No. 11a. At the depth of 200-273 feet a unit was penetrated which had a much higher resistivity than the beds above or below. This is interpreted to be the Codell Sandstone Member of the Carlile Formation.

The jagged edge of the graph shows that the Codell in this area is composed of interbedded shale and sandstone stringers. The driller's log (Appendix A) verifies this observation. Because of the interbedded shales, it is unlikely that this sandstone can produce water of sufficient quantity to supply the city. However, the city may want to drill a test well in this aquifer and run a pump test to determine if sufficient water is available from this sandstone.

The Dakota Group is the only other known bedrock aquifer in this area. The city's present supply comes from this source and, as stated earlier, these sandstones occur approximately 600 feet below the surface in the Tyndall area.

The waters in the Dakota Sandstones are under artesian pressure and some farm wells in this aquifer flow (Appendix B). It is said that the recharge for these sandstones in South Dakota probably comes from the Black Hills or the Rocky Mountains, where they are exposed at much higher elevations than in the Tyndall area; this provides the pressure head necessary for the water to rise nearly to the surface, and locally to flow.

Quality of Ground Water

Precipitated water is nearly pure before it reaches the ground. However, all ground water contains minerals which are obtained: (1) from the atmosphere, (2) from soil and underlying deposits as the water percolates downward to the water table, and (3) from deposits below the water table, in which the water is circulating. In general, the more minerals a water contains, the poorer its quality.

Table 1 shows the chemical properties of various waters in the Tyndall area as compared with the present city water and with the standards for drinking water established by the U. S. Department of Public Health. The city water supply (Sample B) is of extremely poor quality. It tested very high in sulfate, iron, hardness, and total solids. Total solids is a measure of the amount of minerals dissolved in the water.

Samples C and D are from State Geological Survey Test Hole No. 29 in SW$\frac{1}{4}$ sec. 21, T. 94 N., R. 60 W., 4$\frac{1}{2}$ miles southwest of town, from the buried outwash deposit where the overlying till has been removed by Emanuel Creek. This water is exceedingly good in quality for all components except manganese. This ion in combination with iron may

Table 1.--Chemical Analyses of Ground Water in the Tyndall Area

(for locations see fig. 2)

	Parts Per Million										Hard-ness	Total Solids
	Calcium	Sodium	Mag-nesium	Chloride	Sulfate	Iron	Man-ganese	Nitrate	Fluoride	pH	$CaCO_3$	
A	--	--	50	250	500*	0.3	0.05	10*	0.9-1.7**	--	--	1000 *
B	413	129	76	151	1180	3.0	0.2	0.0	3.0	7.3	1350	1529
C	97	8.0	4	None	53	0.1	1.2	1.1	None	--	259	424
D	120		--	8.0	109	0.2				7.7	222	457
E	132	23	20	32	280	1.0	Trace	Trace	None		410	684
F	465		166	28	1064	0.8					1830	
G	199	26	12	11	402	0.1		1.0	None			1010
H	293	21	34	14	692	1.0	0.7	1.4	0.2		872	1474
I	338			16	875	0.3					1370	
J	394	49	22	17	1034	0.7	None	Trace	0.6		1074	2054

A. U. S. Dept. of Public Health Drinking Water Standards (1961)
B. Tyndall City Water
C. State Geological Survey Test Hole No. 29 at 20 feet
D. State Geological Survey Test Hole No. 29 at 70 feet
E. Grimme pasture well, SE$\frac{1}{4}$ sec. 20, T. 94 N., R. 60 W.
F. Lloyd Horack farm, SW$\frac{1}{4}$ sec. 11, T. 94 N., R. 60 W.
G. John Hughes farm, NE$\frac{1}{4}$ sec. 28, T. 94 N., R. 60 W.
H. Walt Kranz farm, NE$\frac{1}{4}$ sec. 20, T. 94 N., R. 60 W.
I. George Ruppelt farm, SE$\frac{1}{4}$ sec. 28, T. 94 N., R. 60 W.
J. Victor Thomas farm, Sec. 33, T. 94 N., R. 60 W.

Sample B was analyzed by U. S. Dept. of Public Health
Samples C, E, G, H, and J were analyzed by State Chemical Laboratory, Vermillion
Samples D, F, and I were analyzed by the author

* modified for South Dakota by the State Dept. of Health (written communication, Feb. 5, 1962)
** optimum

result in the formation of undesirable deposits in the pipes and pumps of the water system. If further testing corroborates this concentration of manganese, it should be removed by treatment.

Samples E, G, H, I, and J are from farm wells believed to be pumping from the buried outwash aquifer, where it is overlain by till. The variation in quality may be attributed primarily to compositional variations in the deposit, or possibly to downward percolation through the overlying till.

Sample F is believed to originate in a local or small isolated outwash lense.

CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the city of Tyndall test for future water supplies in the buried outwash deposit located $2\frac{1}{2}$ miles south and $3\frac{1}{2}$ miles west of town in the SE$\frac{1}{4}$ sec. 21, T. 94 N., R. 60 W., and in the E$\frac{1}{2}$ sec. 20, T. 94 N., R. 60 W. Test holes drilled by the State Geological Survey in the Emanuel Creek valley in this area showed 120 feet of saturated sand and gravel. Farm wells in this sand showed water of good quality, and a sample taken in State Geological Survey Test Hole No. 29 from a depth of 20 feet was of extremely good quality (table 1).

Several test holes should be drilled in this area to determine the extent and thickness of the aquifer. On the basis of these test holes, a location should be picked and a test well put in and test-pumped. This test-pumping should be conducted by licensed engineers and should be run for a minimum of 72 hours.

To avoid a 5-mile pipeline, the city may decide to drill a test well into the Codell Sandstone within the city limits. The Codell is a possible source for water but should be thoroughly tested before a permanent well is installed because of the high clay content of the sandstone.

It is suggested that the city contact a commercial drilling company licensed by the State of South Dakota to test-drill the areas recommended. The city officials should consult the State Water Resources Commission with regard to obtaining a water right and a permit to drill a city well, and the State Department of Health with regard to the biological and chemical suitability of the water. A consulting engineering firm licensed in South Dakota should be hired to design the well and water system.

REFERENCES CITED

U. S. Public Health Service, 1961, Drinking Water Standards: Am. Water Works Assoc. Jour., v. 53, no. 8, p. 935-945.

APPENDIX A

Logs of State Geological Survey Test Holes in the Tyndall Area

(for locations see Figure 2)

Test Hole No. 1
Surface elevation: not measured
Depth to water: not measured

0- 2	topsoil, black
2-29	clay, brown
29-33	clay, blue

* * * * * *

Test Hole No. 2
Surface elevation: not measured
Depth to water: not measured

0- 4	clay, brown, some pebbles
4-14	clay, brown, sandy
14-28	clay, brown, less sand
28-33	clay, brown, wet
33-39	clay, blue
39-44	clay, brown, saturated, trace sand
44-49	clay, blue-gray, saturated, trace sand
49-59	clay, blue-brown, less wet, less sand

* * * * * *

Test Hole No. 3
Surface elevation: not measured
Depth to water: not measured

0- 4	topsoil, black, some brown clay
4- 8	clay, brown, dry
9-14	clay, brown, wet
14-24	clay, brown, saturated, sand 10%, trace pebbles
24-29	clay, blue, silty
29-49	clay, blue, less silt
49-64	clay, blue, poor cuttings

* * * * * *

Test Hole No. 4
Surface elevation: not measured
Depth to water: not measured

0- 4	topsoil, black
4-28	clay, brown, wet
28-30	clay, blue

* * * * * *

Test Hole No. 5
Surface elevation: not measured
Depth to water: 3 feet

0- 4	topsoil, black, some clay, brown
4- 9	clay, brown, wet, trace silt
9-19	silt, brown, saturated, sticky
19-23	clay, blue, very sticky
	hole abandoned at 23 feet because of very sticky nature of clay

* * * * * *

Test Hole No. 6
Surface elevation: not measured
Depth to water: 7 feet

0- 4	sand, coarse, probably road-fill
4-24	alluvium; sand, brown, fine to medium; clay, brown, saturated
24-39	as above, color change to blue-gray

* * * * * *

Test Hole No. 7
Surface elevation: not measured
Depth to water: 5 feet

0- 4	topsoil, black
4-19	clay, brown, silty, sandy, wet
19-23	clay, brown, silty, sandy, saturated
23-24	clay, blue

* * * * * *

Test Hole No. 8
Surface elevation: 1361 feet
Depth to water: 5 feet

0- 4	topsoil, brown
4-14	clay, brown, wet
14-19	silt, brown, sandy, clay, saturated
19-24	silt, blue-gray, clayey, saturated
24-29	as above, some coarse sand

* * * * * *

Test Hole No. 9
Surface elevation: 1358 feet
Depth to water: not measured

0- 4	topsoil, brown to black
4-10	clay, brown, wet
10-19	silt, brown to black
19-30	clay, brown to blue

* * * * * *

Test Hole No. 10
Surface elevation: 1361 feet
Depth to water: 6 feet

0- 4	clay, brown, (slope wash)
4-14	silt, brown, 30% sand, clayey, saturated
14-19	no sample
19-24	clay, blue

* * * * * *

Test Hole No. 11
Surface elevation: not measured
Depth to water: not measured

0- 1	topsoil, black
1-19	clay, brown, silty, some sand, wet
19-24	clay, olive, sand, saturated
24-29	clay, blue, saturated
29-49	clay, olive, saturated

* * * * * *

Test Hole No. 11a (Rotary)
Surface elevation: not measured
Depth to water: not measured

0- 23	clay, brown, boulders, trace sand
23- 95	clay, blue, cobbles, sandy
95-163	Niobrara Limestone
163-198	Carlile Shale
198-273	Codell Sandstone, clay stringers
273-294	Carlile Shale

* * * * * *

Test Hole No. 12
Surface elevation: 1345 feet
Depth to water: not measured

0- 4	topsoil, black
4- 9	clay, brown, 20% sand
9-32	gravel, sand, clayey, saturated
32-39	clay, blue

* * * * * *

Test Hole No. 13
Surface elevation: 1342 feet
Depth to water: 3½ feet

0- 4	topsoil, black
4-15	silt, sandy, saturated
15-29	clay, blue

* * * * * *

Test Hole No. 14 (Rotary)
Surface elevation: not measured
Depth to water: not measured

0-90	clay (glacial till undifferentiated)
90-95	Niobrara Formation

* * * * * *

Test Hole No. 15
Surface elevation: not measured
Depth to water: 8 feet

0- 4	topsoil, black
4- 8	silt, black
8-12	clay, brown
12-14	gravel
14-24	clay, blue

* * * * * *

Test Hole No. 16
Surface elevation: 1340 feet
Depth to water: not measured

0- 2	topsoil, black
2- 5	clay, brown
5- 9	gravel, clayey, saturated
9-19	clay, brown, sandy, saturated
19-24	clay, brown, silty, saturated
24-29	clay, blue

* * * * * *

Test Hole No. 17
Surface elevation: 1344 feet
Depth to water: 8 feet

0- 4	topsoil, black
4-13	silt, gravelly, sandy
13-24	clay, saturated

* * * * * *

Test Hole No. 18
Surface elevation: 1346 feet
Depth to water: not measured

0- 9	clay, dry
9-14	clay, wet
14-24	silt, clayey, saturated
24-29	clay, blue

* * * * * *

Test Hole No. 19
Surface elevation: not measured
Depth to water: 5 feet

0- 1	topsoil, black
1-11	clay, brown
11-24	clay, brown, saturated
24-29	clay, olive
29-34	clay, blue
34-39	clay, olive
39-59	clay, blue

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Test Hole No. 20
Surface elevation: 1393 feet
Depth to water: not measured

0-19	clay, brown
19-29	clay, brown, saturated
29-49	clay, blue

* * * * * *

Test Hole No. 21
Surface elevation: not measured
Depth to water: not measured

0- 4	topsoil, black
4-12	clay, brown-black, sandy
12-19	silt, sandy, clayey, saturated
19-33	clay, blue

* * * * * *

Test Hole No. 22
Surface elevation: 1338 feet
Depth to water: $8\frac{1}{2}$ feet

0- 9	topsoil, black
9-14	silt, black, saturated
14-23	no sample
23-42	clay (?), blue (?)
	hole abandoned at 42 feet because of extreme stickiness of clay

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Test Hole No. 23
Surface elevation: not measured
Depth to water: not measured

0- 2	topsoil, black
2- 3	clay, red

(continued on next page)

Test Hole No. 23--continued

3- 9	gravel, sand (terrace deposit)
9-34	clay, blue-gray
34-54	no sample due to stickiness of clay
54-59	clay, blue

* * * * * *

Test Hole No. 24
Surface elevation: not measured
Depth to water: not measured

0- 4	topsoil
4-14	clay, brown
14-19	clay, blue

* * * * * *

Test Hole No. 25
Surface elevation: 1335 feet
Depth to water: 9 feet

0- 4	topsoil, black
4-16	silt, black, sandy, saturated
16-22	gravel, coarse sand
22-34	silt, black
34-44	sand, brown, fine to medium

* * * * * *

Test Hole No. 26
Surface elevation: not measured
Depth to water: 5 feet

0- 2	topsoil, black
2-16	clay, brown
16-39	clay, brown, saturated
39-52	clay, blue
52-54	clay, olive
54-63	clay, brown
63-74	sand, fine

* * * * * *

Test Hole No. 27
Surface elevation: not measured
Depth to water: not measured

0- 4	soil, road fill
4-29	clay, brown, no sand
29-54	sand, fine, saturated

* * * * * *

Test Hole No. 28(Rotary)
Surface elevation: not measured
Depth to water: not measured

0-18	alluvium, fill
18-24	gravel
24-80	sand, fine
80-138	sand, coarse
138-	Niobrara Formation

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Test Hole No. 29
Surface elevation: not measured
Depth to water: 14 feet

0- 4	topsoil, fill
4- 9	gravel, clayey
9-12	sand, red, medium
12-70	sand, coarse to fine, saturated

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Test Hole No. 30
Surface elevation: not measured
Depth to water: not measured

0- 1	topsoil, black
1-44	clay, brown
44-45	sand, fine

* * * * * *

APPENDIX B

Records of Wells

Well Location: letters stand for quarter-section, first number for section, second for township north, third for range west.
Type of Well: D, drilled; B, bored; Dug
Water-bearing Material: chalk; ss, sandstone; s, sand; g, gravel

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Dia. of Well (inches)	Water-Bearing Material	Depth to Water (feet)
SE-18-95-59	Charles Bambas	D	163	3	chalk	162
-18-95-59	Charles Welfl	D	148	3	ss	18
SW-18-95-59	Jim Hasek	D	276	3		80
NE-19-95-59	Eugene Vavruska	D	187	3		
SE-19-95-59	Wilber Svanda	D	198	3	chalk	190
SW-20-95-59	Ed Kortan	D	180	3	s	60
SE-21-95-59	Charles Mejstrik	D	185	3		
NE-21-95-59	Bob Ruman	D	135	3	chalk	75
SW-21-95-59	Joe Simmek	D	224	3		200
SW-23-95-59	Henry Carda	D	250	3	chalk	100
SW-23-95-59	Ernest Vavruska	D	144	3	chalk	100
SE-27-95-59	Duane Simek	D		3		20
NW-28-95-59	L. G. Hawkey	D	268	3	s	160
SE-28-95-59	Arthur Sip	D	180	4	chalk	25
C-29-95-59	Gordon Hajek	D	230	3	s and g	144
SE-20-95-59	John H. Jochims	D	36	4		8
SW-29-95-59	Bill Pavel	Dug	20	15	s	5

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Dia. of Well (inches)	Water-bearing Material	Depth to Water (feet)
SW-30-95-59	Ralph Stewart	D	180	3	s	
NW-30-95-59	Romane VanWinkle	D	170	3	chalk	160
NW-32-95-59	Joe Obr	D	130	4		125
-32-95-59	Ed Gall	D	263	4	s	
C-34-95-59	Melvin Giedd	D	126	4		
SE-13-95-60	Bill Rada	D	165			
-14-95-60	William Raabe	D	275	3	ss	54
SW-22-95-60	Ruben Hauck	D	250	3		186
W-24-95-60	Willie Kreeger	D	180	3		60
-26-95-60	August Berka	D	220	3	s	100
NW-27-95-60	Ray Hauck	D	126	3		
C-27-95-60	Gottlieb Rueb	Dug	18			10
-31-95-60	Joe A. Plihal	D	286	3	s	126
SE-33-95-60	Wm. Hajek	D	138	4		100+
-34-95-60	Elmer Svanda	D	165	3	s	126
SE-35-95-60	Alb. Wittmeier	D	268		chalk	
SE-36-95-60	Fred Plattner	D	290	3	s	150
SE-36-95-60	Henry Vilhauer	D	248	3		126
NW-3-94-59	Howard Hajek	D	140	3		100+
SE-3-94-59	Frank Schuch	D	224	3	ss	124
NW-4-94-59	Joe Baska	D	691	3	ss	
-4-94-59	Paul Varilek	D	216	3	ss	
SW-4-94-59	Henry Williams	D	244	3	chalk	80
-4-94-59	H. T. Williams	D	160	3	ss	
SW-5-94-59	Laddie Bares	D	204	4		5

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Dia. of Well (inches)	Water-Bearing Material	Depth to Water (feet)
SW-6-94-59	L. F. Chladak	B	35	12	clay	
NE-8-94-59	James Hisek	D	160	4	chalk	144
SW-8-94-59	Howard Burnham	D	133	3	s	100(?)
-9-94-59	Frank E. Soukup	D	248	3	s	80
SE-10-94-59	Joe Humpal	D	230	3	s	
SW-11-94-59	Ronald Potter	B	30	8	s	16
SE-15-94-59	William Holec	B	28	16	s ?	12
NW-16-94-59	Leo Nedred	D	180	4	ss	60
NE-17-94-59	R. E. Colgan	D	650	3	ss	flows
W-17-94-59	Darrel Schuurman	D	110(?)	3	s	15
NW-18-94-59	Wm. Kocourek, Jr.	D	120	3		
SE-18-94-59	Fred Felton	D	475	3	ss	flows
SE-19-94-59	Sam Schuurman	D	154	3	chalk	18
NE-19-94-59	Gerrit Schuurman	D	165	3	chalk	25
NW-19-94-59	Carl Kniffen	D	188	3		
NW-20-94-59	Wm. Svanda	D	696	3	ss	flows
SW-20-94-59	Grace Lubbers	B	160	3	chalk	80
SE-20-94-59	John Lubbers	D	180	3	chalk	60
SW-21-94-59	Wm. Blachnik	D	160	3	chalk	40
NW-22-94-59	Emil M. Kafton	D	160	3	chalk	40
NE-22-94-59	Jim Humpal	D	700	3	ss	flows
NE-22-94-59	Frank Corda	D	232	4	ss	70
NE-29-94-59	Alvis A. Broc	D	550	$1\frac{1}{2}$	ss	flows
SW-30-94-59	Fred Wurtz	D	160	3		20

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Dia. of Well (inches)	Water-Bearing Material	Depth to Water (feet)
-3-94-60	Golf Course well		14	2	s	1
SE-8-94-60	Wm. Minow	D	240	4		
SE-9-94-60	Rudolph Hakal	D	270	3	chalk	9
NW-9-94-60	Emil Kalda	D	195	3	chalk	80
SW-9-94-60	Joe Teply	D	200	3	chalk	
SE-10-94-60	Peter Schuurman	D	220	4	ss	130
SW-10-94-60	Gilbert Colgan	D	216	3	ss	108
SW-11-94-60	Lloyd Horack	D	85	3	s	60
SE-13-94-60	Donald D. Wynia	D	228	3		75
-13-94-60	Joe Hauk	D	126			100
SE-14-94-60	Charles Ferguson	D	100	3		65
NE-14-94-60	C.W. Ferguson	D	247	3	s	140
NW-15-94-60	Fred Weisser	D	150	4		108
	Fred Weisser	D	240	4	s	100
SW-16-94-60	William Turner	D	140	4	chalk	30
-20-94-60	Walt Kranz	D	90	3	s	
SW-20-94-60	Thornton Bochmen	D	217	3	ss	90
SE-21-94-60	Fred Musekamp	D	100+		s	
SE-22-94-60	Irwin Grimme	D	250			
NW-22-94-60	A.G. Serr	D	250	2	chalk	126
NW-23-94-60	George Grimme	D	400	3		
NW-25-94-60	Elvin Grimme	D	126	3	chalk	
-27-94-60	George Nohava	D	180	3		60
-28-94-60	George M. Nohava	D	360	4	ss	90

Well Location	Owner or Tenant	Type of Well	Depth of Well Below Land Surface (feet)	Dia. of Well (inches)	Water-Bearing Material	Depth to Water (feet)
SE-28-94-60	George Ruppelt	D	150	3	s	110
NE-28-94-60	John Hughes	D	100	3	s	55
SW-28-94-60	Rudolph Musekamp	D	240	3	chalk	100+
SE-29-94-60	Joe C. Fryda	D	225	3	ss	106
-29-94-60	Erwin Grimme	D	190	3		140
NE-32-94-60	Sydney Bierema	D	275	3	chalk	130
NE-33-94-60	Wayne Thomas	D	100	6	s	10 (?)
NE-35-94-60	W. R. Slade	D	170	4		
NW-36-94-60	Robert Slade	D	160	3		110
-2-93-60	Cliff Warrington	D	260	3	ss	120