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GROUND-WATER STUDY FOR THE CITY OF MURDO

by

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GROUND-WATER STUDY FOR THE CITY OF MURDO

This report contains the results of a special ground-water investigation conducted by the South Dakota Geological Survey along the White River floodplain in Jones County, South Dakota. Field work was conducted from June 16 to June 23, 1977. The investigation involved: (1) a review of the unpublished Little White River study (A. Barari, 1970); (2) the drilling of 23 auger test holes; and (3) the collection and analysis of 12 water samples.

The project was financed by the South Dakota Geological Survey, the West River Conservancy Sub-District, and the city of Murdo. The cooperation of the residents in and around Murdo was appreciated.

Alluvial deposits along the White River (fig. 1) consist of fine to medium sand and fine to coarse gravel with clay. The thickness of these deposits vary from less than 1 foot (test hole 16, app. A) to 25 feet (test hole 6, app. A). For location of test holes, see figure 2.

The most promising area, considering the thickness, grain size, and the areal extent of sand and gravel is outlined in figure 2.

Table 1 shows the chemical analysis of water samples collected from the area of study in 1977. Except for samples WS2, WS9, and WS12, all water samples in table 1 were collected from the alluvium along the White River. The total solids in the water samples from the alluvium vary from 288 to 1030 parts per million. The total solids in the vicinity of the recommended area (fig. 2) vary from 288 to 420 parts per million. Overall the water in the area outlined in figure 2 is of good quality.

Another source of water in the area was located along the Little White River during the 1969 study (see fig. 3). The Little White River has deposited alluvial sediments in the valley which varies from less than 1 foot to 21 feet thick (test hole 5, app. B). These sediments consist of sand ranging in size from fine to coarse and in some locations clay and sand are mixed together. The thickest alluvial deposit is at the junction of the Little White River and the White

River. These deposits are mostly coarse to very coarse sand and approximately 15 feet of these deposits are water saturated. Twenty-three feet of alluvium ranging in size from medium sand to gravel was penetrated in test hole 3 (app. B). The water saturated thickness of the material was 16 feet in this hole.

Table 2 shows the chemical analysis of water samples and figure 3 shows the location of samples. The total solids in samples W2 and W3 in the area outlined in figure 3 varies from 418 to 268 parts per million.

Sources of water in the alluvial deposits in these valleys are from local precipitation and from the streams that are hydraulically connected with the aquifers. The water in the White River has higher dissolved chemicals than the Little White River (see WS2 and WS12, table 1). Extensive ground-water pumping would induce water from these surface streams into the alluvial deposits. Consequently, water from the White River probably will deteriorate the quality of water in the area outlined in figure 2. In addition, the silt content of the White River is much higher than the Little White River. The high silt content of the White River could reduce the permeability of the aquifer outlined in figure 2 and consequently, could reduce the production of the wells. For this reason the area outlined in figure 3 is preferred over the area outlined in figure 2.

If the city of Murdo should decide to develop a well field in one or both of the recommended areas, a pump test should be conducted before the construction of a permanent well field in order to determine the quantity and quality of water, the optimum pumping rate, and the well spacing. An engineering firm licensed in South Dakota should be consulted with regard to the pump test(s). The South Dakota Geological Survey is available to supervise such a pump test(s). The city should also consult the Division of Water Rights, Department of Natural Resource Development, to obtain water rights and the Environmental Protection Agency to determine the biological and chemical suitability of the water.

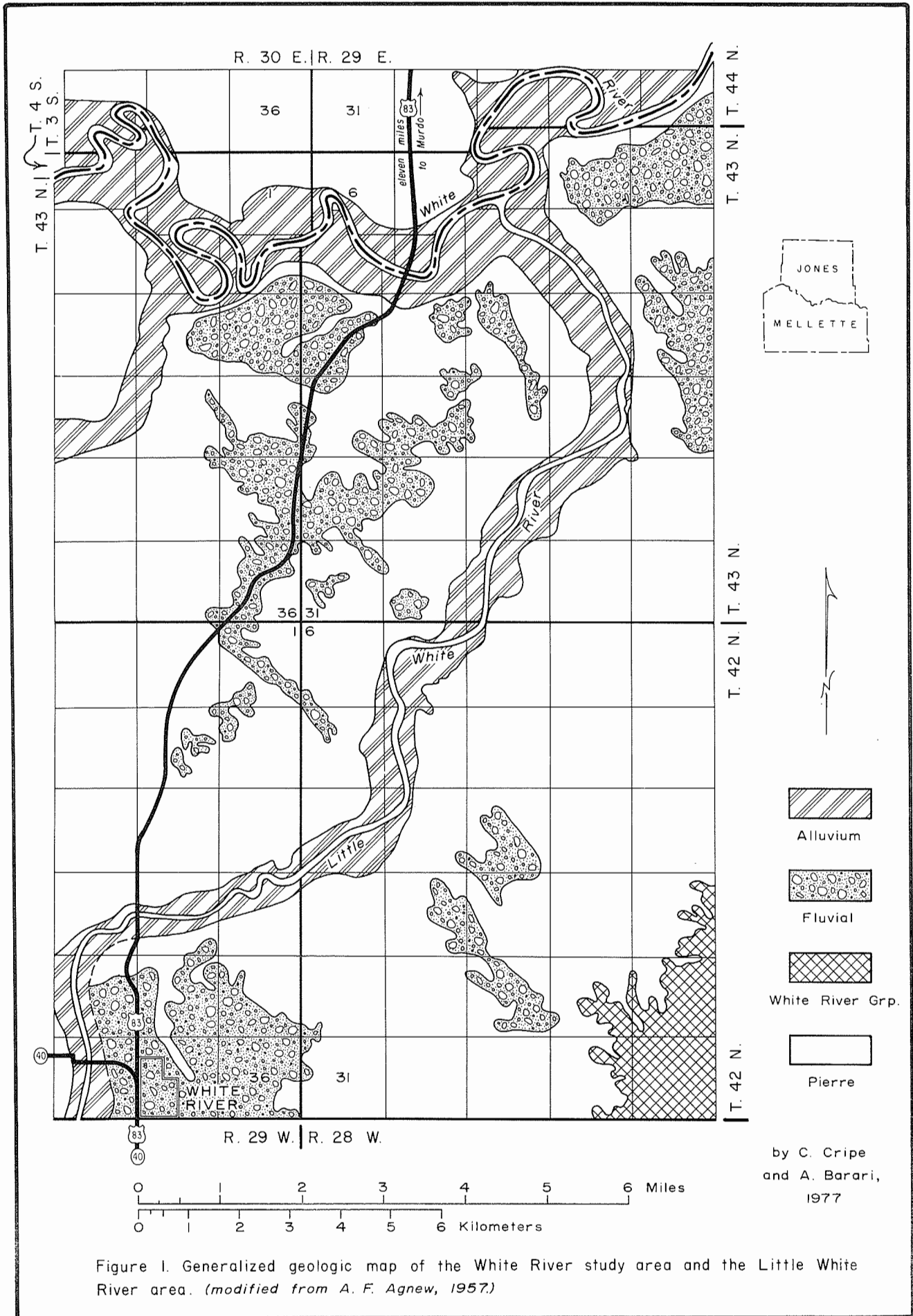


Figure 1. Generalized geologic map of the White River study area and the Little White River area. (modified from A. F. Agnew, 1957.)

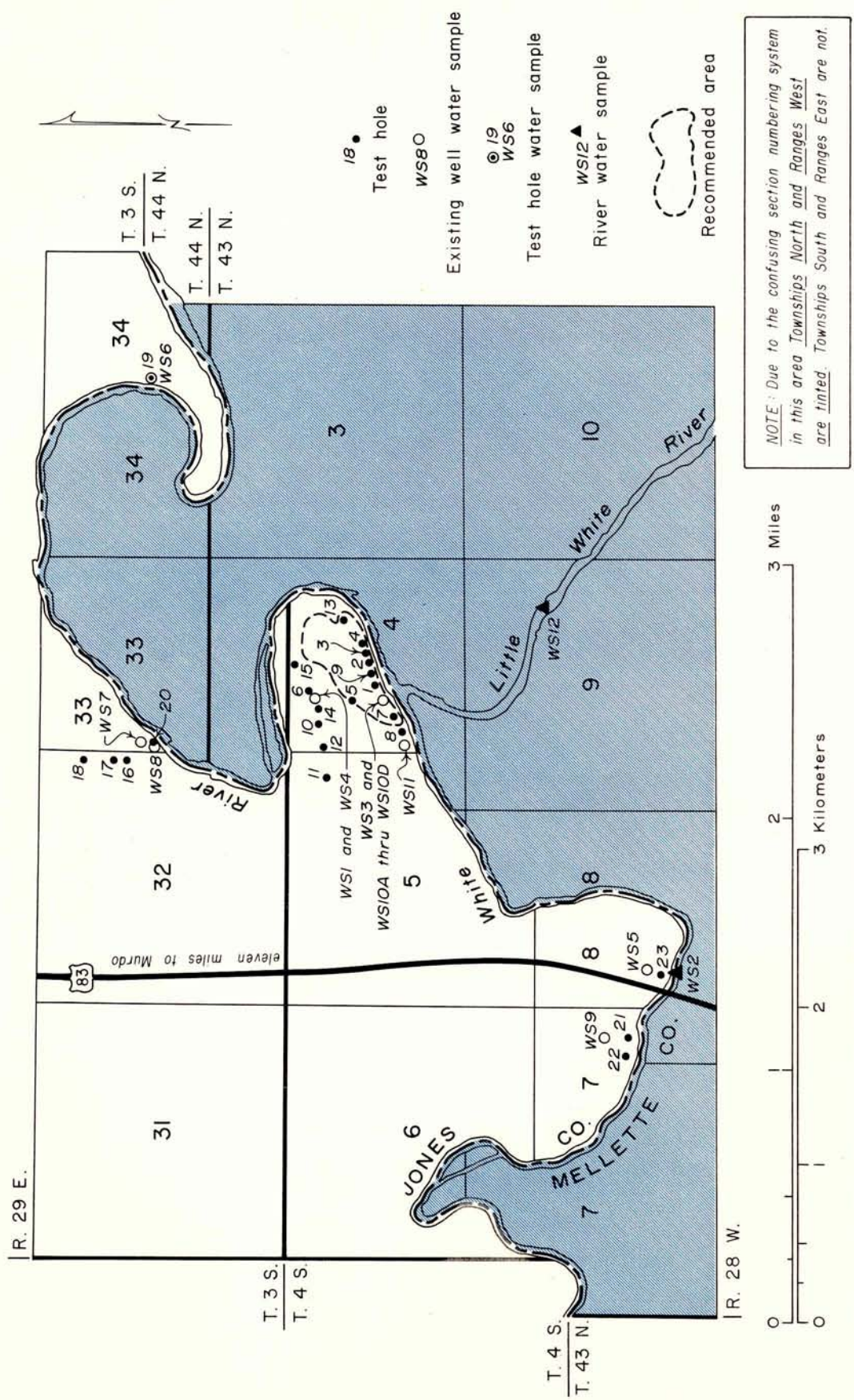


Figure 2. Data map of the White River study area.

by C. Cripe and A. Barari, 1977

TABLE 1. Chemical analyses of water samples from the Murdo area
(see fig. 2 for water sample locations)

Sample	Source	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
WS 1	WA	45	110	100	6	140	0.4	1.4	<0.5	-----	---	-----	-----
WS 2	R	390	170	52	<5	41	6.9	52	1.5	-----	---	-----	1100+
WS 3	WA	12	75	11	<5	23	0.1	1.0	<0.5	-----	---	-----	288
WS 4	WA	10	95	10	<5	34	0.3	0.6	<0.5	-----	---	-----	420
WS 5	WA	45	160	13	5	150	0.5	1.1	0.8	-----	---	-----	712
WS 6	TA	12	90	11	<5	32	3.9	0.9	<0.5	-----	---	-----	320
WS 7	WA	12	105	11	<5	51	0.3	0.5	<0.5	-----	---	-----	396
WS 8	WA	17	115	11	<5	38	0.4	0.6	<0.8	-----	---	-----	516
WS 9	WP	165	425	27	36	1000	1.8	2.6	<0.5	-----	---	-----	1884
WS10A	WA	9.5	50	3.7	1.4	65	0.2	0.8	<0.5	-----	---	-----	380
WS10B	WA	10	51	3.7	1.4	54	0.1	0.8	<0.5	-----	---	-----	400
WS10C	WA	10	50	3.7	1.6	62	0.1	0.8	<0.5	-----	---	-----	360
WS10D	WA	9.5	50	3.7	1.6	64	0.1	0.8	<0.5	-----	---	-----	390
WS11	WA	14.5	240	10	14	330	0.5	0.5	<0.5	-----	---	-----	1030
WS12	LR	40	45	12	<5	20	1.9	0.2	<0.5	-----	---	-----	250

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

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: WA, existing well in alluvium; TA, test hole in alluvium; R, White River; LR, Little White River; WP, existing well in Pierre Shale

Samples were analyzed by the South Dakota Geological Survey.

Location of water samples from the Murdo area
(for map location, see fig. 2)

- WS 1 Sec. 4, T. 4 S., R. 29 E., W. Sanderson.
- WS 2 Sec. 8, T. 4 S., R. 29 E., White River sample.
- WS 3 Sec. 4, T. 4 S., R. 29 E., W. Sanderson, well system in dugout.
- WS 4 Sec. 4, T. 4 S., R. 29 E., W. Sanderson.
- WS 5 Sec. 8, T. 4 S., R. 29 E., Road Side Park well.
- WS 6 Sec. 34, T. 3 S., R. 29 E., D. Height, test hole 19.
- WS 7 Sec. 33, T. 3 S., R. 29 E., P. Thomas, old well.
- WS 8 Sec. 33, T. 3 S., R. 29 E., Ardith Eggleston.
- WS 9 Sec. 7, T. 4 S., R. 29 E., P. Thomas.
- WS10A Sec. 4, T. 4 S., R. 29 E., W. Sanderson, well system in dugout.
- WS10B Sec. 4, T. 4 S., R. 29 E., W. Sanderson, well system in dugout.
- WS10C Sec. 4, T. 4 S., R. 29 E., W. Sanderson, well system in dugout.
- WS10D Sec. 4, T. 4 S., R. 29 E., W. Sanderson, well system in dugout.
- WS11 Sec. 4, T. 4 S., R. 29 E., W. Sanderson, stock well.
- WS12 Sec. 9, T. 43 N., R. 28 W., Little White River.

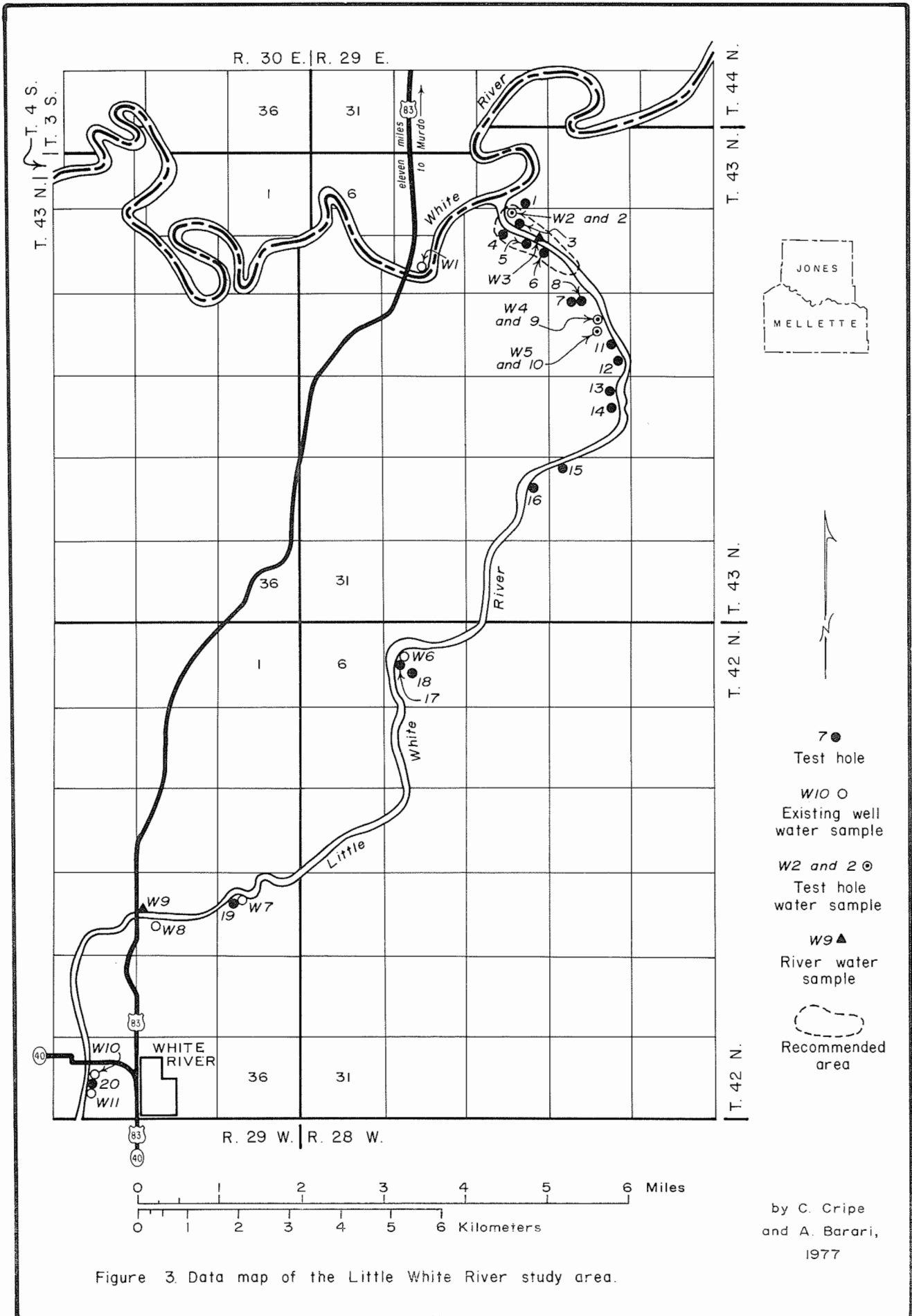


Figure 3. Data map of the Little White River study area.

TABLE 2. Chemical analyses of water from the Little White River study area
(see fig. 3 for water sample locations)

Sample	Source	Parts Per Million											Total Solids
		Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate	Fluoride	pH	Hardness CaCO ₃	
A		----	----	----	250	500 ¹	0.3	0.05 ¹	10.0	0.9-1.7 ²	---	----	1000 ¹
W 1	WA	80	215	18	16	404	0.4	1.2	1.0	0.4	---	274	900
W 2	TA	72	35	19	1	132	2	4.4	-----	4.0	---	259	418
W 3	R	29	22	14	0.4	56	2.6	0	0.4	0.6	---	128	268
W 4	TA	58	41	17	8	50	3.2	1.8	1.2	0.6	---	217	416
W 5	TA	59	80	21	5	126	2.2	1.2	0.4	0.8	---	233	524
W 6	WP	321	156	26	321	736	-----	0.2	40.0	0.6	---	910	1800
W 7	WP	103	200	22	28	460	-----	-----	0.7	0.4	---	346	1014
W 8	WP	582	440	65	32	2358	-----	-----	3.5	1.2	---	1718	3948
W 9	R	18	19	20	0.4	32	-----	-----	0.6	0.4	---	206	270
W10	WA	36	16	13	0	24	1	1.8	1	0.6	---	142	256
W11	WA	27	23	14	0	36	0.3	-----	-----	0.6	---	123	226

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

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: WA, existing well in alluvium; TA, test hole in alluvium; R, Little White River; WP, existing well in Pierre Shale.

Samples were analyzed by the South Dakota Chemical Laboratory.

Location of water samples
(for map location, see fig. 3)

- W 1. SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 8, T. 4 S., R. 29 E., Road Side Park well.
- W 2. NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 9, T. 43 N., R. 28 W., test hole 2, water was collected from depth of 14 feet.
- W 3. SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 9, T. 43 N., R. 28 W., water from Little White River.
- W 4. SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T. 43 N., R. 28 W., test hole 9.
- W 5. SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T. 43 N., R. 28 W., test hole 10.
- W 6. SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 42 N., R. 28 W., Larry Hutchinson well.
- W 7. SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 24, T. 42 N., R. 29 W., Knife well, 47 feet deep.
- W 8. SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 42 N., R. 29 W., Joseph Larvie well, 48 feet deep.
- W 9. SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 42 N., R. 29 W., Little White River water.
- W10. NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 42 N., R. 29 W., White River City well no. 2
- W11. SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 42 N., R. 29 W., White River City well no. 1.

APPENDIX A

Logs of test holes in the White River area (For location, see fig. 2)

NOTE: Elevations for the test holes are taken from U.S. Geological Survey 7½ minute, 10 foot contour interval map and should not be considered as an exact elevation of the test hole location.

Test Hole 1

Location: SW¼SW¼NE¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 4	Silt, medium-tan; dry
4- 7	Silt, clayey(?); moist
7-11	Sand, dark-brown, very fine to fine, clayey; moist
11-13	Sand, medium to coarse; saturated
13-24	Sand, coarse, rounded, some elongated pebbles
24-33	Shale, gray

* * * * *

Test Hole 2

Location: NW¼SE¼NE¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1772 feet

0- 4	Silt, light-tan, clayey; dry
4- 8	Sand, medium to coarse, pebbly (grading to a medium sand)
8-23	Sand, coarse, some pebbles; clean
23-24	Sand, coarse, elongated pebbles, some gravel
24-28	Shale

* * * * *

Test Hole 3

Location: SE¼SE¼NE¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 3	Silt, light-tan
3- 7	Sand, light-brown, medium, rounded
7-14	Sand, gray-brown, fine to very fine, clayey
14-21	Sand, medium to coarse, rounded
21-24	Sand, medium to coarse, pebbly
24-30	Shale

* * * * *

Test Hole 4

Location: NE¼SW¼NW¼SE¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 3	Silt, light-tan
3- 7	Sand, fine to medium, rounded
7-10	Sand, gray, medium; moist
10-18	Sand, medium to coarse, pebbly
18-22	Sand, coarse, pebbles
22-25	Shale

* * * * *

Test Hole 5

Location: NW¼SE¼NW¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1776 feet

0- 3	Silt, light tan
3- 8	Sand, brown, medium to fine, clayey
8-16	Sand, medium to fine, rounded
16-20	Sand, dark-gray, medium, silty
20-27	Sand, dark-gray, coarse, silty
27-35	Shale

* * * * *

Test Hole 6

Location: SW¼NW¼SE¼NW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 6	Sand, yellow-brown, fine, medium to fine, rounded
6-20	Sand, light-brown, medium, rounded, clean
20-23	Sand, gray, medium to fine, silty
23-25	Sand, dark-gray, very fine, clayey
25-30	Shale, soft, some sand and pebbles
30-35	Shale

* * * * *

Test Hole 7

Location: NE¼NE¼SW¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0 - 4	Silt, medium-tan; dry
4 -10	Silt, light-brown, clayey; moist
10 -17	Sand, fine to medium; saturated
17 -20.5	Sand, medium to coarse, rounded
20.5-24	Some small pebbles
24 -28	Sand, coarse to very coarse, pebbles
28 -30	Sand, very coarse, pebbles

* * * * *

Test Hole 8

Location: NE¼NW¼SW¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 3	Silt, medium-tan; dry
3-10	Silt, light-brown, clayey
10-13	Clay, medium-brown, sandy, soft
13-21	Sand, fine to medium, rounded, brown
21-22	Clay
22-24	Sand, coarse, rounded, clayey; some pebbles 3 to 8 cm
24-28	Sand, coarse, pebbles
28-30	Shale

* * * * *

Test Hole 9

Location: NW¼SW¼NE¼SW¼ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 4	Silt, medium-tan; dry
4- 8	Sand, fine to medium, clayey
8-15	Sand, brown, medium
15-22	Sand, coarse, pebbles, platy

Test Hole 9 -- continued.

22-24 Sand, coarse, pebbly, clean
24-30 Shale

* * * *

Test Hole 10

Location: NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 3 Silt, light-brown; dry
3- 9 Sand, brown, fine to medium, clayey;
moist
9-15 Sand, gray-brown, medium to coarse,
clayey
15-21 Sand, coarse, well-rounded; clean
21-23 Sand, coarse, some flat, smooth pebbles
23-27 Shale

* * * *

Test Hole 11

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 5, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0 - 4 Sand, fine, silty
4 - 7 Sand, light-brown, medium to coarse,
clean
7 -14 Sand, light-brown, medium to coarse,
silty
14 -15.5 Gravel, coarse
15.5-20 Shale, hard

* * * *

Test Hole 12

Location: NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 5 Silt, light-brown
5- 9 Silt, light-brown; moist
9-22 Sand, light-brown to light-gray,
fine to coarse, silty
22-25 Shale, hard

* * * *

Test Hole 13

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1772 feet

0-13 Sand, fine; dry
13-20 Sand, light-brown, medium to coarse;
saturated
20-27 Shale, dark-gray, hard

* * * *

Test Hole 14

Location: NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 8 Sand, light-brown, fine; dry
8-11 Sand, fine to medium; moist
11-15 Sand, light-brown, fine to coarse

Test Hole 14 -- continued.

15-19 Gravel, gray, medium, rounded, silty
19-25 Shale, gray, reworked

* * * *

Test Hole 15

Location: SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 4 S., R. 29 E.
Surface elevation: 1775 feet

0- 5 Silt, light-brown
5- 8 Silt, very fine sand; moist
8-19 Sand, light-brown to light-gray,
medium to coarse
19-26 Shale, reworked, gray, hard

* * * *

Test Hole 16

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 3 S., R. 29 E.
Surface elevation: 1799 feet

0-12 Silt, light-brown; dry
12-19 Silt, light-brown, clayey, shaley;
saturated
19-25 Shale, dark-gray, hard

* * * *

Test Hole 17

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 3 S., R. 29 E.
Surface elevation: 1795 feet

0- 2 Clay, medium-brown; dry
2-12 Clay, brown to gray; dry
12-24 Clay, shaley; dry
24-29 Sand, brown, fine, clayey; dry
29-31 Sand, light-brown, medium; saturated
31-35 Shale, soft

* * * *

Test Hole 18

Location: NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 3 S., R. 29 E.
Surface elevation: 1785 feet

0-11 Shale, weathered
11-17 Silt, light to dark-brown, clayey;
moist
17-29 Silt, light-brown, clayey and slightly
sandy, fine; moist
29-35 Shale, hard

* * * *

Test Hole 19

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 34, T. 3 S., R. 29 E.
Surface elevation: 1765 feet

0-10 Sand, light-brown, fine
10-21 Sand, medium to coarse
21-32 Shale

* * * *

Test Hole 20

Location: NW¼SW¼NW¼SW¼ sec. 33, T. 3 S., R. 29 E.
Surface elevation: 1770 feet

0- 2	Topsoil
2- 6	Sand, light-brown, very fine; dry
6-12	Silt, light-brown, clayey
12-20	Sand, dark-gray, coarse, shaley, clayey; saturated at 12 feet
20-27	Shale, dark-gray, hard

* * * *

Test Hole 21

Location: SE¼SE¼SW¼SW¼ sec. 8, T. 4 S., R. 29 E.
Surface elevation: 1782 feet

0- 5	Sand, light-brown, fine; dry
5-10	Sand, light-brown, fine to medium
10-16	Sand, light-brown to light-gray, medium to coarse, silty
16-21	Gravel, coarse, silt and pebbles
21-27	Shale, dark-gray, hard

* * * *

Test Hole 22

Location: NW¼NW¼NW¼SW¼ sec. 8, T. 4 S., R. 29 E.
Surface elevation: 1782 feet

0- 8	Sand, fine; dry
8-18	Sand, light-brown, very coarse to gravel, medium, silty; saturated
18-27	Shale, dark-gray, hard

* * * *

Test Hole 23

Location: SW¼SW¼NE¼SW¼ sec. 8, T. 4 S., R. 29 E.
Surface elevation: 1782 feet

0- 6	Sand, light-brown, fine, silty; dry
6-14	Sand as above; moist
14-21	Sand, coarse to very coarse, silty, shaley, some fine gravel
21-26	Shale, gray, hard

* * * *

APPENDIX B

Logs of test holes in the Little White River area (For location, see fig. 3)

NOTE: Elevations for the test holes are taken from U.S. Geological Survey 7½ minute, 10 foot contour interval map and should not be considered as an exact elevation of the test hole location.

Test Hole 1

Location: SE¼SE¼SW¼SE¼ sec. 4, T. 43 N., R. 28 W.
Surface elevation: 1785 feet
Depth to water: 10 feet

0- 1	Topsoil
1-12	Clay, yellowish-brown
12-20	Clay and gravel
20-25	Gravel
25-28	Shale, dark-gray

* * * *

Test Hole 2

Location: NW¼NW¼NW¼NE¼ sec. 9, T. 43 N., R. 28 W.
Surface elevation: 1782 feet
Depth to water: 6 feet

0- 1	Topsoil
1- 4	Sand, light-brown, medium
4-20	Sand, coarse to very coarse
20-26	Sand and gravel
26-28	Clay

* * * *

Test Hole 3

Location: SW¼SE¼NW¼NE¼ sec. 9, T. 43 N., R. 28 W.
Surface elevation: 1782 feet
Depth to water: 7 feet

0- 1	Topsoil
1- 7	Sand, medium
7-14	Sand, medium to coarse
14-23	Sand and gravel
23-24	Shale, gray

* * * *

Test Hole 4

Location: NE¼NE¼SE¼NW¼ sec. 9, T. 43 N., R. 28 W.
Surface elevation: 1783 feet
Depth to water: 7 feet

0- 4	Clay
4- 8	Sand, gray, medium-fine
8-18	Sand, medium
18-21	Sand, coarse, some pebbles
21-25	Shale, gray

* * * *

Test Hole 5

Location: SE¼NE¼SW¼NE¼ sec. 9, T. 43 N., R. 28 W.
Surface elevation: 1791 feet
Depth to water: 6 feet

Test Hole 5 -- continued.

0- 8	Sand, light-brown, grading to gray, coarse, well-sorted
8-18	Sand, coarse
18-21	Sand, coarse to very coarse, some clay
21-26	Clay, gray

* * * *

Test Hole 6

Location: SE¼SE¼SE¼NE¼ sec. 9, T. 43 N., R. 28 W.
Surface elevation: 1799 feet
Depth to water: 6 feet

0- 1	Topsoil
1- 5	Sand, medium
5-18	Sand, gray, medium, some clay
18-23	Shale

* * * *

Test Hole 7

Location: NW¼NE¼NW¼NW¼ sec. 15, T. 43 N., R. 28 W.
Surface elevation: 1794 feet
Depth to water: 4 feet

0- 2	Topsoil
2- 4	Sand, fine, silty
4- 9	Sand, brown, medium to coarse
9-27	Clay, dark-gray (shale)

* * * *

Test Hole 8

Location: SW¼NE¼NE¼NW¼ sec. 15, T. 43 W., R. 28 W.
Surface elevation: 1794 feet
Depth to water: 4 feet

0- 2	Topsoil
2- 4	Sand, brown, fine to medium
4-12	Sand, brown changing to gray, medium
12-18	Clay, dark-gray (shale)

* * * *

Test Hole 9

Location: SE¼NW¼SW¼NE¼ sec. 15, T. 43 N., R. 28 W.
Surface elevation: 1795 feet
Depth to water: 4 feet

0- 2	Topsoil
2- 7	Sand, fine, some clay
7-15	Sand, gray, medium to coarse
15-23	Clay, gray

* * * *

Test Hole 10

Location: SE¼SW¼SW¼NE¼ sec. 15, T. 43 N., R. 28 W.
Surface elevation: 1798 feet
Depth to water: 6 feet

0- 1	Topsoil
1- 7	Sand, some clay
7-15	Sand, medium to coarse, well sorted
15-17	Clay, gray

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Test Hole 11

Location: SE¼NE¼NW¼SE¼ sec. 15, T. 43 N., R. 28 W.
Surface elevation: 1802 feet
Depth to water: 6 feet

0- 1 Topsoil
1- 5 Sand, brown, medium to coarse
5-17 Sand, gray, some pebbles
17-18 Shale

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Test Hole 12

Location: SW¼NW¼SE¼SE¼ sec. 15, T. 43 N., R. 28 W.
Surface elevation: 1805 feet
Depth to water: 7 feet

0 - 1 Topsoil
1 - 4 Sand, brown, fine
4 - 8 Sand, medium
8 -17½ Sand, medium, some clay
17½-23 Clay, dark-gray (shale)

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Test Hole 13

Location: SE¼SE¼NW¼NE¼ sec. 22, T. 43 N., R. 28 W.
Surface elevation: 1813 feet
Depth to water: 8 feet

0 - 1 Topsoil
1 - 7 Sand, brown, fine
7 - 8 Sand, medium
8 -19½ Clay, gray, soft drilling
19½-21 Shale

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Test Hole 14

Location: NE¼SE¼NW¼NE¼ sec. 22, T. 43 N., R. 28 W.
Surface elevation: 1814 feet
Depth to water: 7 feet

0- 1 Topsoil
1- 4 Sand, brown, fine
4- 6 Sand, medium, some clay
6-12 Sand, medium to coarse
12-15 Sand, some clay
15-18 Clay, gray (shale)

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Test Hole 15

Location: SW¼NE¼NW¼NW¼ sec. 27, T. 43 N., R. 28 W.
Surface elevation: 1822 feet
Depth to water: 5 feet

0- 1 Topsoil
1- 4 Sand, fine, some clay
4-13 Sand, medium to coarse
13-16 Clay, dark-gray

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Test Hole 16

Location: SW¼NW¼SE¼NE¼ sec. 28, T. 43 N., R. 28 W.
Surface elevation: 1823 feet
Depth to water: 8 feet

0- 1 Topsoil
1- 5 Sand, fine
5- 8 Sand, medium
8-12 Sand, coarse
12-13 Clay, gray
13-19 Sand and gravel
19-21 Shale

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Test Hole 17

Location: SW¼SE¼SW¼NW¼ sec. 5, T. 42 N., R. 28 W.
Surface elevation: 1862 feet
Depth to water: 3 feet

0- 2 Sand, brown, medium
2- 5 Sand, coarse
5- 9 Sand, gray, some pebbles
9-12 Shale

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Test Hole 18

Location: NE¼SW¼NE¼SW¼ sec. 5, T. 42 N., R. 28 W.
Surface elevation: 1875 feet
Depth to water: dry hole

0- 1 Topsoil
1- 4 Clay, brown
4- 8 Shale, gray

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Test Hole 19

Location: SE¼NE¼SW¼NW¼ sec. 24, T. 42 N., R. 29 W.
Surface elevation: not measured
Depth to water: 7 feet

0- 9 Sand, tan, medium to coarse
9-11 Shale, gray

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Test Hole 20

Location: NE¼NE¼NE¼SW¼ sec. 34, T. 42 N., R. 29 W.
Surface elevation: not measured
Depth to water: 9 feet

0- 5 Clay and sand (built up area)
5-20 Sand, coarse
20-23 Shale, gray

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