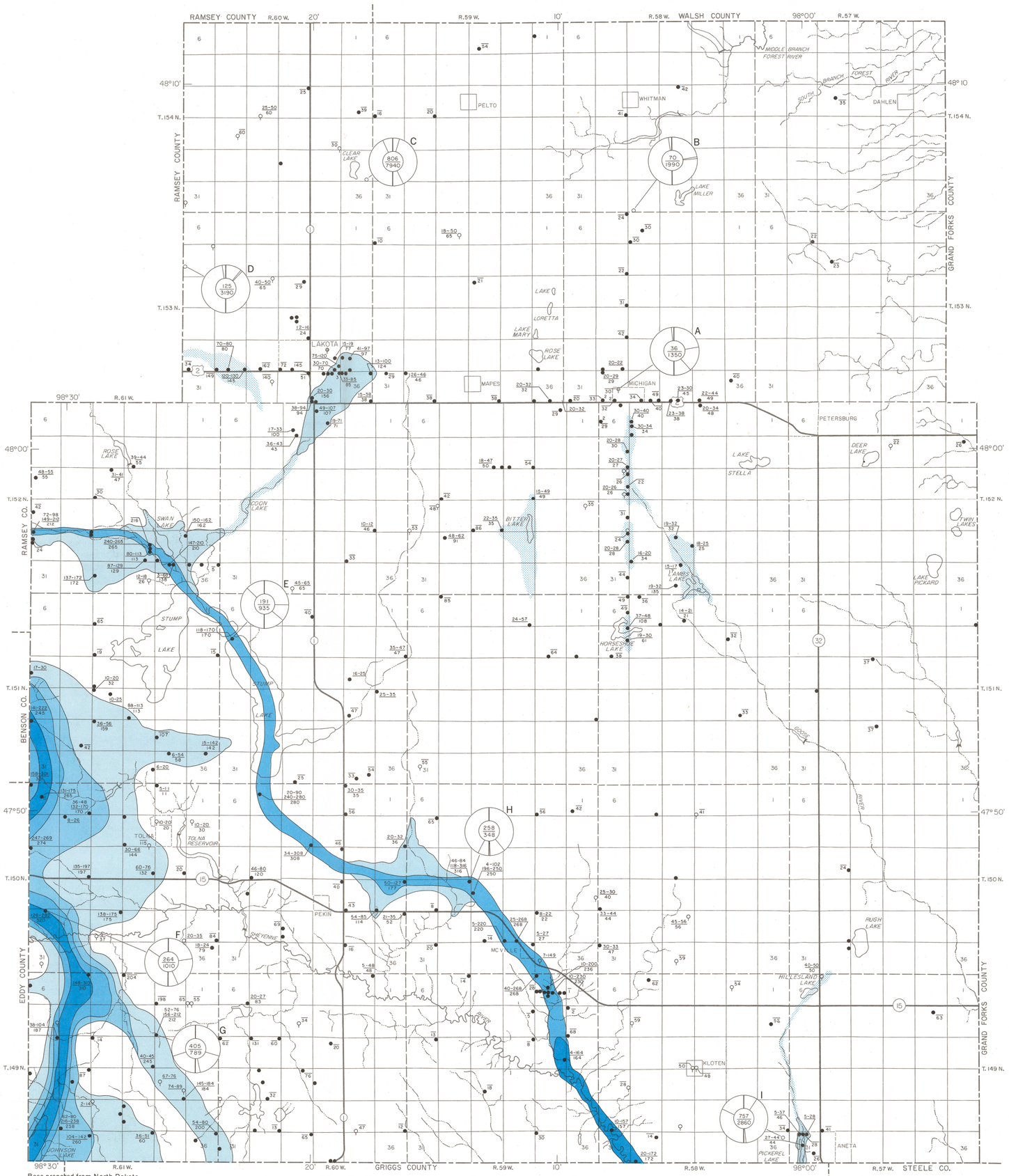
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
NORTH DAKOTA STATE WATER COMMISSION
NORTH DAKOTA GEOLOGICAL SURVEY
NELSON COUNTY WATER MANAGEMENT DISTRICT

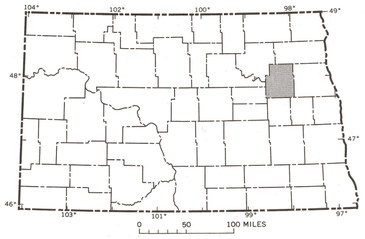
HYDROLOGIC INVESTIGATIONS
ATLAS HA-428



Base prepared from North Dakota Highway Department county highway maps

GROUND-WATER AVAILABILITY MAP

SCALE 1:126 720



LOCATION OF NELSON COUNTY

EXPLANATION

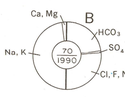
POTENTIAL WELL YIELD, IN GALLONS PER MINUTE

- More than 500
- 250–500
- 50–250
- 10–50
- Glacial spillways and glacial features filled with stratified drift. Potential yields may exceed 10 gallons per minute
- 0–10

SELECTED TEST-HOLE AND WELL DATA

- Test hole
- Private well with log
- 20–30 / 156 — Upper numbers indicate aquifer interval, in feet below land surface. Lower number indicates depth to bedrock, in feet below land surface

CHEMICAL COMPOSITION OF DISSOLVED SOLIDS



Letter above circular diagram refers to analysis listed in table of chemical analyses. Number above line at center of circular diagram is carbonate hardness (calcium magnesium hardness as $CaCO_3$), in milligrams per liter; number below line is dissolved solids, in milligrams per liter. The size of the segments of each semicircle are proportional to the quantity of each group of anions or cations to the total anions or cations present

INTRODUCTION

This investigation is part of a Statewide program to determine the location and extent of the ground-water reservoirs (aquifers); to evaluate the occurrence and movement of ground water within these aquifers, including the sources of recharge and discharge; and to determine the chemical quality of the ground water.

Nelson County covers an area of approximately 1,000 square miles in northeastern North Dakota. The study, which began in July 1967, has been made cooperatively by the U.S. Geological Survey, the North Dakota State Water Commission, the North Dakota Geological Survey, and the Nelson County Water Management District. The final results of the study will be published in three parts by the cooperating State agencies.

SOURCES OF GROUND-WATER DATA

Many sources of data have been utilized in the preparation of the ground-water availability map. A well inventory has provided data on depth, construction, and productivity of the private and public wells in the county. Test drilling, both private and public, has supplied information as to the thickness and extent of the various aquifers. Chemical analyses of water from selected wells have furnished data as to the quality of the water from the aquifers.

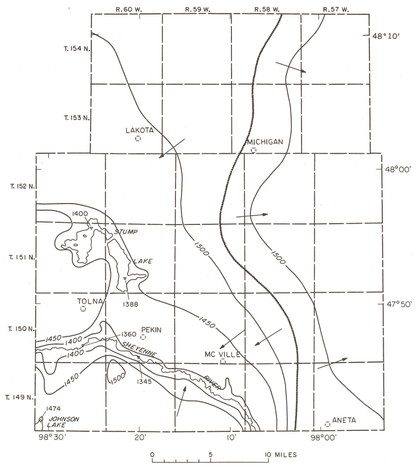
The potential yields shown on the ground-water availability map were estimated from the thickness and permeability[1] of the water-bearing materials. Generally, the greater the permeability and thickness of water-bearing materials, the larger the yields. The test-drilling logs were examined in detail and the materials were assigned permeabilities on the basis of grain size, apparent sorting, and drilling characteristics of the materials. The test holes were drilled by hydraulic-rotary drilling equipment, which on drilling sand or gravel beds commonly produces samples having less silt and clay and a higher degree of sorting than is actually present in the deposit. In assigning permeabilities, allowances were made for this discrepancy. The permeability values were further compared with and adjusted to data obtained from aquifer tests, where available.

OCCURRENCE AND POTENTIAL YIELD OF AQUIFERS

Nelson County is almost entirely covered by glacial drift, which may be subdivided into two distinct types. The most common type is till, a nonsorted mixture of clay, silt, sand, gravel, and pebbles. Till was mainly deposited by active glaciers, has a low permeability, and will normally yield only small quantities of ground water to wells. Glaciofluvial deposits, the least common type, are stratified deposits of sand and gravel that are sorted according to grain size. These materials were deposited by moving water, are normally quite permeable, and form the principal aquifers in Nelson County.

The glacial drift generally ranges in thickness from about 30 feet in the eastern and northern parts of the county to about 250 feet in the southwestern corner. Locally, as along the shore of Stump Lake and along the Sheyenne River, the glacial drift has been removed by erosion and the underlying bedrock is exposed at the surface. Water levels in the glacial drift range from an elevation of about 1,345 feet near the Sheyenne River in the southern part of the county to about 1,530 feet at the ground-water divide near Michigan (see water-table map).

[1] The coefficient of permeability, which is a measure of the capacity of an aquifer to transmit water, may be expressed as the number of gallons of water at 16°C that will pass in 1 day through a section of the aquifer 1 foot high and 1 mile wide under a hydraulic gradient of 1 foot per mile.



EXPLANATION

1500 — Water-table contour. *Shows elevation of water table. Contour interval 50 feet. Datum is mean sea level*

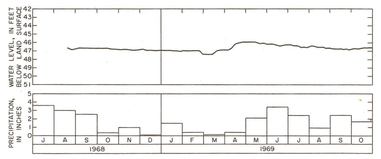
Ground-water divide

Inferred direction of ground-water movement

1360 — Surface-water elevation

Map showing elevation of water table

The aquifer associated with the buried river valley that crossed Nelson County in a southeasterly direction from T. 152 N., R. 61 W., to T. 149 N., R. 58 W., has the greatest potential yield in Nelson County. Yields greater than 500 gpm (gallons per minute) can be developed from this aquifer in the area along the Sheyenne River south of McVille. Water-level fluctuations in this aquifer are shown by the hydrograph for well H.



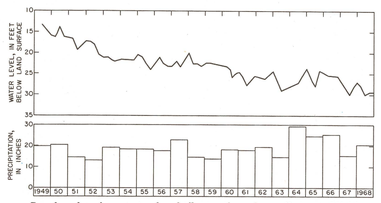
Graphs showing water-level fluctuations in well H near McVille and precipitation at McVille

The largest glacial drift aquifer in Nelson County is located in the southwestern corner of the county in T. 149 N., R. 61 W., and T. 150 N., R. 61 W., and extends across the southern part of T. 151 N., R. 61 W. This aquifer, which covers an area of about 80 square miles in Nelson County and extends into Eddy, Benson, and Griggs Counties, has the second greatest potential for development.

Many small deposits of sand and gravel occur in areas associated with spillways and other glacial features shown on the water-availability map. Test drilling has shown that in many places these deposits contain a thin water-saturated zone near the base, which would supply sufficient water for farm use and domestic supply. Short-term yields from these deposits may be more than 10 gpm; however, long-term yields may be much less.

The bedrock in Nelson County consists of the various members of the Pierre Shale of Late Cretaceous age. Brittle layers in the Pierre have been fractured, apparently by overriding glaciers, and are sources of water for the city of Michigan and many private homes and farms in other parts of Nelson County. The location of fracture zones in the formation is highly variable, in both horizontal and vertical directions, and cannot be accurately predicted. Most of the fractures, however, occur at depths from 30 to about 130 feet below the top of the shale.

The Pierre aquifer will yield no more than 1 to 5 gpm in most areas of the county. Continuous pumping at the higher rate will cause a decline in water levels similar to that shown by the hydrograph for well A at Michigan. This is an observation well that is located about 350 feet west of a public supply well. The public-supply well is reported to be pumped at 6 gpm 12 hours per day.



Graphs showing water-level fluctuations in well A at Michigan and precipitation at McVille

The availability map should be used with the understanding that the estimated yields are for fully penetrating, properly screened and developed wells of adequate diameter. The map is intended as a general guide in the location of major aquifers, not as a map to locate specific wells. Few, if any, aquifers are so uniform in their water-bearing properties that production wells may be drilled in them without preliminary exploratory drilling. If the map is used with this understanding of its limitations, it should serve as a useful tool in the future development of the ground-water resources of Nelson County.

CHEMICAL QUALITY OF WATER

Wells tapping glacial-drift aquifers in Nelson County yield water with a wide range in chemical quality, as shown by the chemical-analysis symbols on the water-availability map and by the table of selected chemical analyses (analyses E through I).

In Nelson County, glacial till (analysis I) normally yields water with greater dissolved solids than water produced from wells tapping glaciofluvial deposits (analyses E through H).

Water quality from the Pierre Shale (analyses A through D) also varies widely within the county, depending upon depth of the well and location. In general, it appears that water from the Pierre Shale in the eastern and central parts of the county is lower in dissolved solids than in the western part. This difference in water quality is due, apparently, to differences in recharge areas and degree of fracturing within the Pierre Shale.

SELECTED REFERENCES

Aronow, Saul, Dennis, P.E., and Akin, P.D., 1953, Geology and ground-water resources of the Michigan City area, Nelson County, North Dakota: North Dakota State Water Comm. Ground-Water Studies, no. 21, 125 p.

Dennis, P.E., 1947, Ground water in the Aneta area, Nelson County, North Dakota: North Dakota State Water Comm. Ground-Water Studies, no. 7, 23 p.

Powell, J.E., and Jones, S.L., 1962, Ground water resources in the Lakota area, Nelson County, North Dakota: North Dakota State Water Comm. Ground-Water Studies, no. 48, 68 p.

CHEMICAL ANALYSES FROM SELECTED WELLS

Aquifer and formation symbols

Symbol	Aquifer
K3PD	Pierre Shale
QG41	Glacial till
QG51	Buried sand and gravel

(Analytical results in milligrams per liter)

Well	Depth	Aquifer	Date of collection	Temperature (°C)	Silica (SiO_2)	Total iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Residue on evaporation at 180°C	Dissolved solids: Sum	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Sodium adsorption (SAR)
A	108	K3PD	9-20-67	11	27	0.12	11	2.1	472	6.3	589	0	347	168	0.7	2.5	3.7	1,350	1,330	36	0	96	2,100	8.2	34
B	125	K3PD	5-10-69	8	27	.0	19	5.5	761	11	965	0	34	666	.3	2.9	3.6	1,990	2,010	70	0	95	3,440	7.9	40
C	110	K3PD	5-10-69	----------	25	.20	210	68	2,260	28	655	0	4,880	213	.2	22	2.9	7,940	8,030	806	268	85	9,530	7.6	35
D	140	K3PD	8- 5-68	----------	23	.26	35	9.1	1,220	16	746	0	64	1,510	.4	1.8	4.0	3,190	3,250	125	0	95	5,710	8.1	47
E	143	QG51	7-24-69	7	28	.76	57	12	250	10	458	0	167	152	.1	2.1	.93	935	906	191	0	73	1,490	7.7	7.9
F	240	QG51	6-19-68	10	30	1.0	75	19	259	9.2	458	0	332	77	.5	7.3	.83	1,010	1,040	264	0	67	1,550	8.0	6.9
G	200	QG51	6-18-69	6	30	1.1	107	33	116	11	499	0	223	33	.2	0	.63	789	801	405	0	38	1,180	8.1	2.5
H	253	QG51	6-28-68	7	14	.44	73	18	14	11	286	0	58	2.6	.5	0	.05	348	333	258	23	10	534	7.6	.4
I	35	QG41	8-22-67	8	25	.56	174	78	615	14	498	0	1,640	38	.2	14	.88	2,860	2,845	757	348	63	3,640	7.9	9.7

GROUND-WATER RESOURCES OF NELSON COUNTY, NORTHEASTERN NORTH DAKOTA

By
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