CIRCULAR 3.

NORTH DAKOTA GEOLOGICAL SURVEY

FRANK C. FOLEY, DIRECTOR

MAPS AND GRAPHS PREPARED FOR THE WATER RESOURCES COMMITTEE NORTH DAKOTA STATE PLANNING BOARD

BY
W.P.A. PROJECT 65-73-215
FREDERIC W. VOEDISCH, SUPERVISOR

GRAND FORKS, N. DAK.

FOREWORD

The collection of miscellaneous maps and graphs included in Circular 3, here compiled for convenient reference, was prepared on F.E.R.A. and W.P.A. projects for the Water Resources Committee of the North Dakota State Planning Board under W.P.A. Project 65-73-215, which was sponsored by the North Dakota Geological Survey.

Frederic W. Voedisch
Supervisor of Projects
North Dakota Geological Survey

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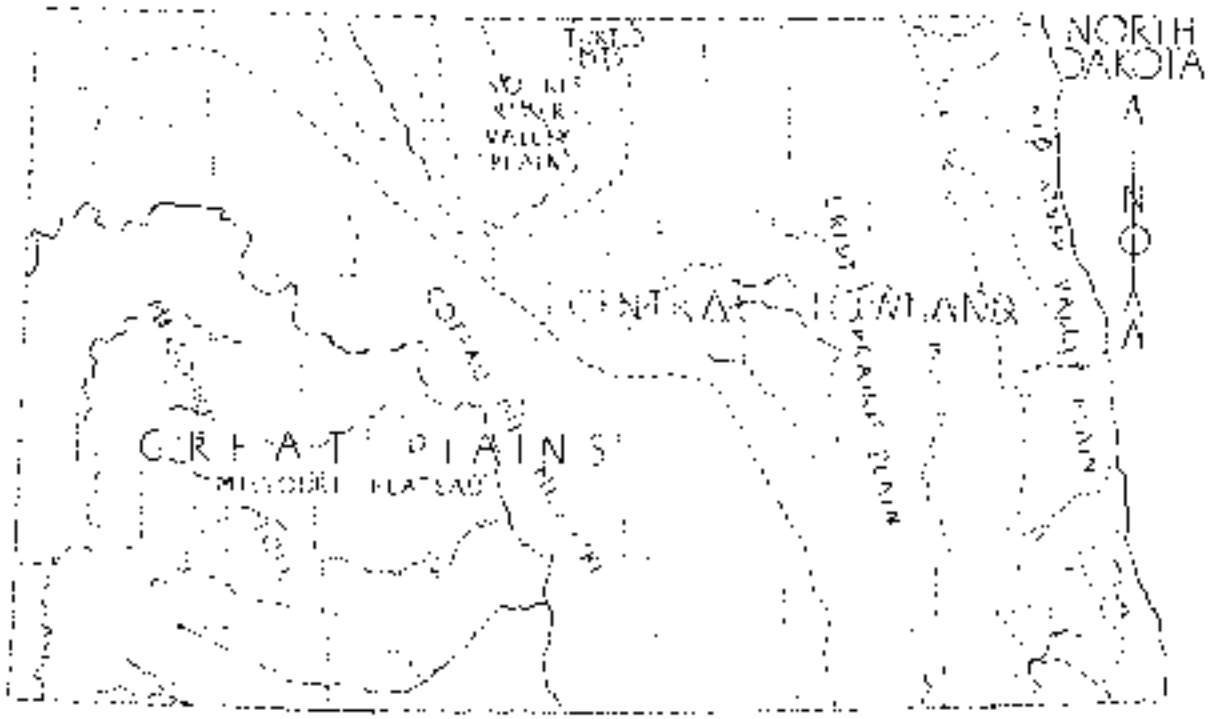
PHYSIOGRAPHY

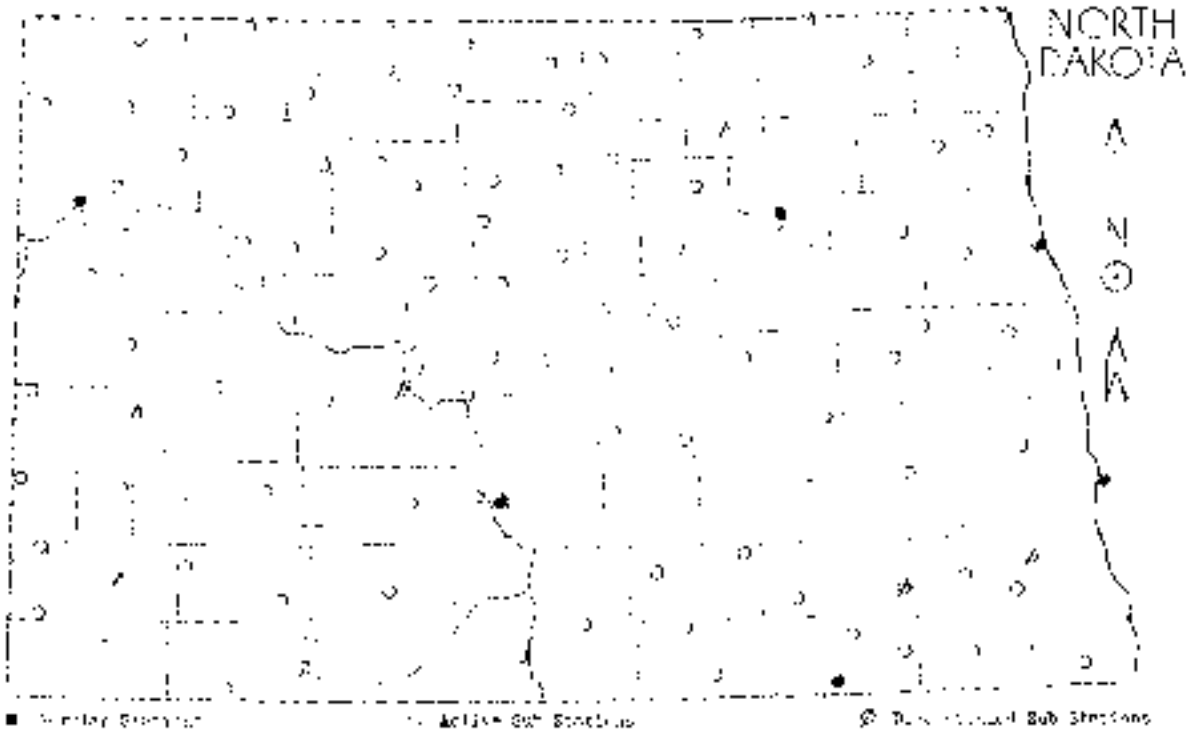
The map below shows the division of North Dakota into two main physiographic regions: the Central Lowland in the north and east portion, and the Great Plains in the south and west. The dividing line between the two areas is the Missouri Escarpment, which runs diagonally across the state from the northwest corner to the south central border. The Central Lowland is sub-divided into two minor regions: the Red River Valley and the Drift Prairie Plains. On the western margin of the Red River Valley are the deltas of three rivers that flowed into glacial Lake Agassiz: the Pembina River, the Elk River, and the Sheyenne River. The Souris River Valley Plain and the Turtle Mountains are found in the north central part of North Dakota. The Missouri Plateau is sub-divided into two minor regions: (1) the Coteau du Missouri, lying north and east of the Missouri River, and (2) the Missouri Slope, lying south and west of the Missouri River.



PHYSOGRAPHY

METEOROLOGICAL OBSERVATION STATIONS OF NORTH DAKOTA

The map below shows the distribution of the regular and co-operative stations from whose observations the climatic conditions of North Dakota are determined. The map indicates the four regular stations which are located at Bismarck, Williston, Devils Lake, and Ellendale. The station at Grand Forks is a special station having the facilities of a regular station. It can be seen from the map that every county in North Dakota except two, Eddy and Oliver, has at least one station, and that McLean County has seven stations.

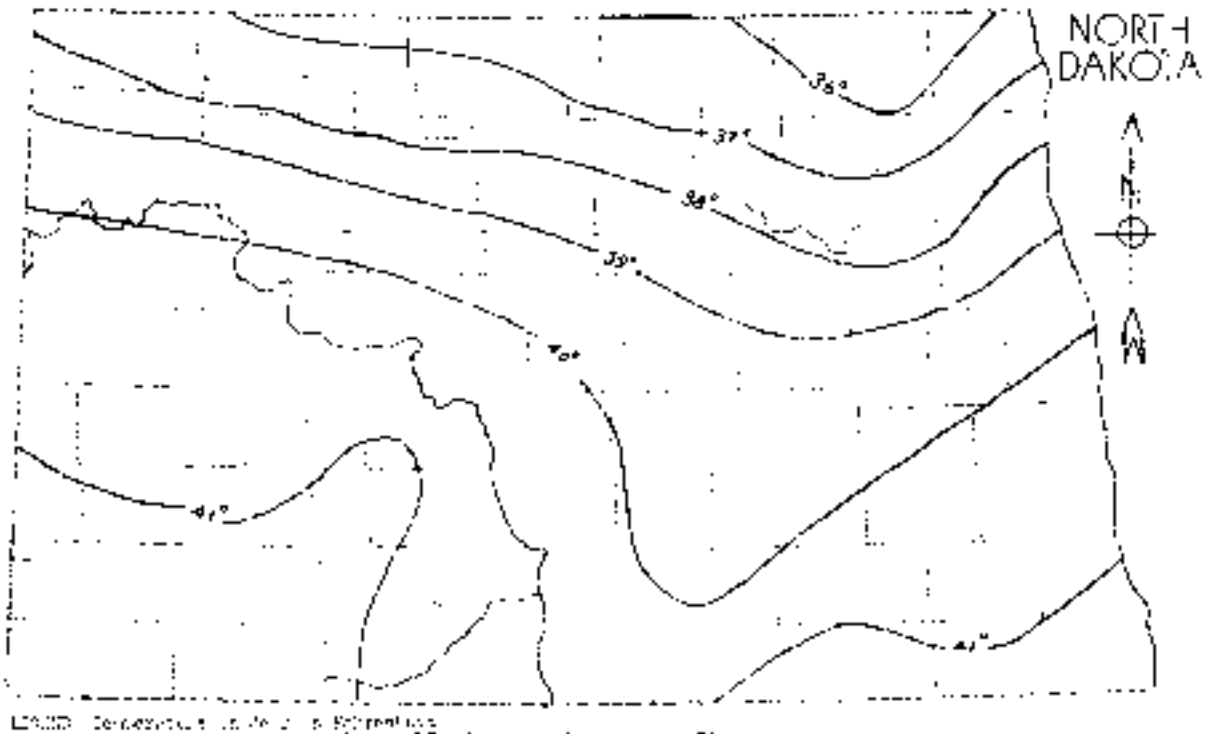


METEOROLOGICAL OBSERVATION STATIONS
OF NORTH DAKOTA

W.P.A. Project 8656

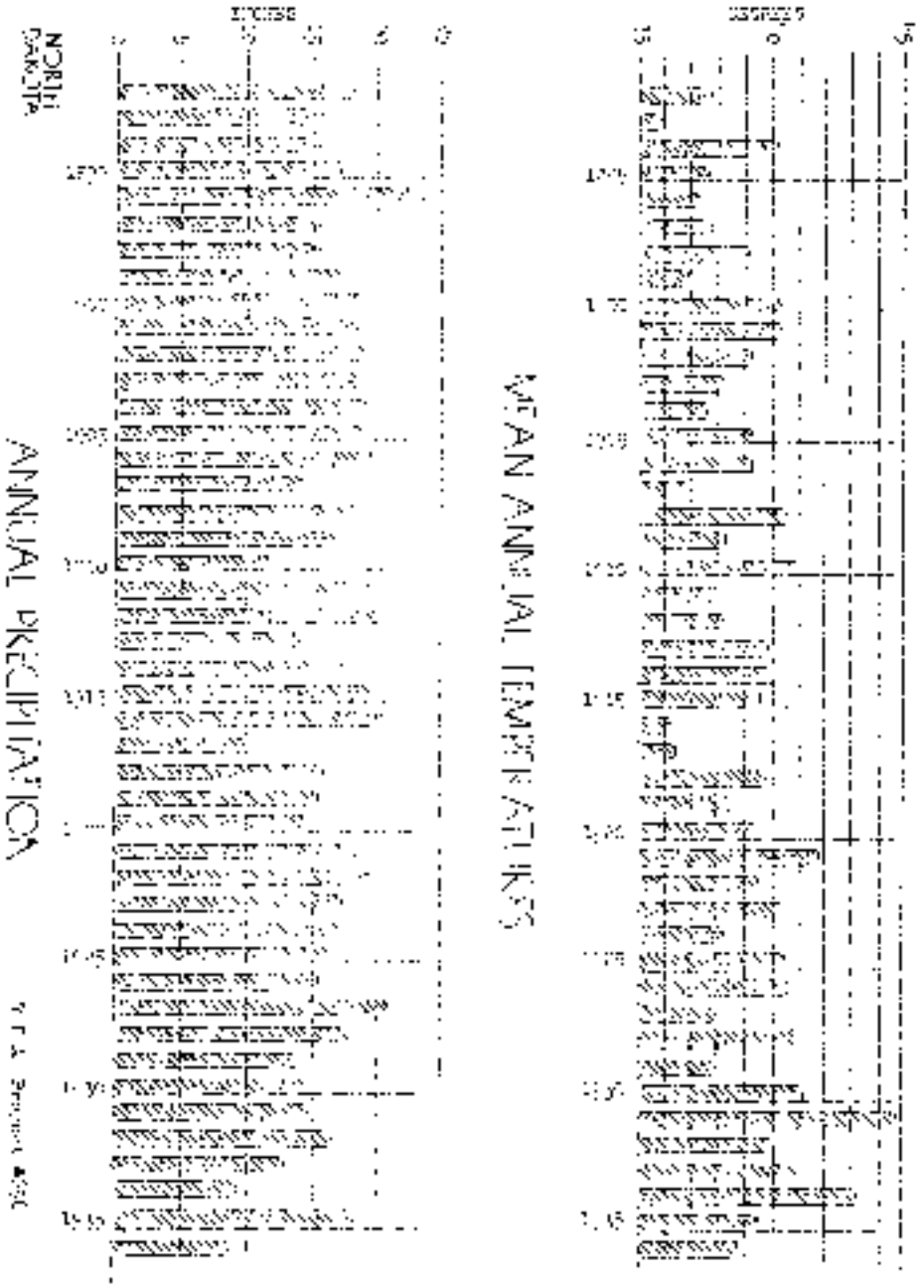
AVERAGE ANNUAL TEMPERATURE
(For period 1898 - 1932 inclusive)

The map below shows the average annual temperature by isotherms. The average annual temperature varies from 36°F (in the northeastern part) to 41°F (in the southwestern and southeastern parts of North Dakota). The average annual temperature for North Dakota is about 39°F.



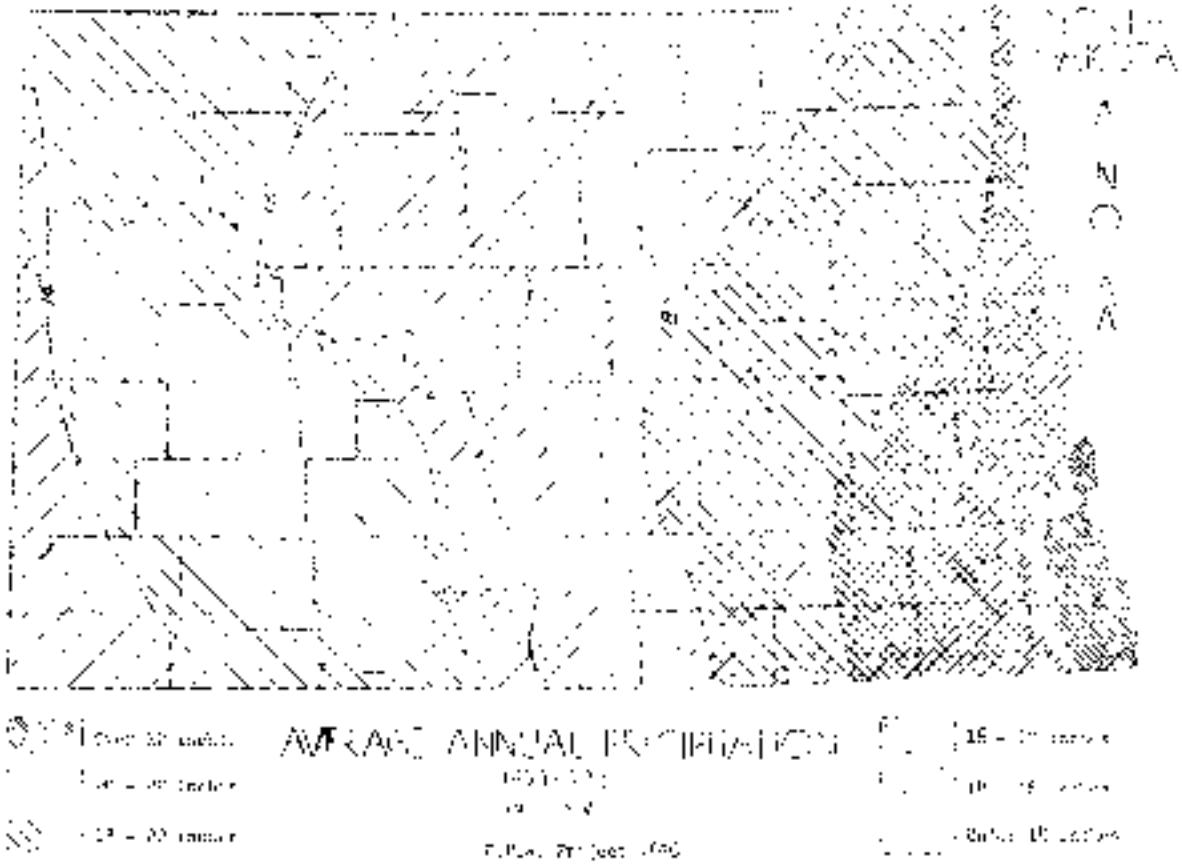
MEAN ANNUAL TEMPERATURE AND ANNUAL PRECIPITATION

The first graph below shows the mean annual temperature from 1892 to 1934 inclusive, with extremes from slightly less than 36°F in 1893 to approximately 45°F in 1931. The annual mean temperature for all of North Dakota during this period is 39.3°F. The second graph below shows the annual precipitation of North Dakota for the same period. The maximum was 24 inches in 1896, and the minimum was 9 inches in 1934.



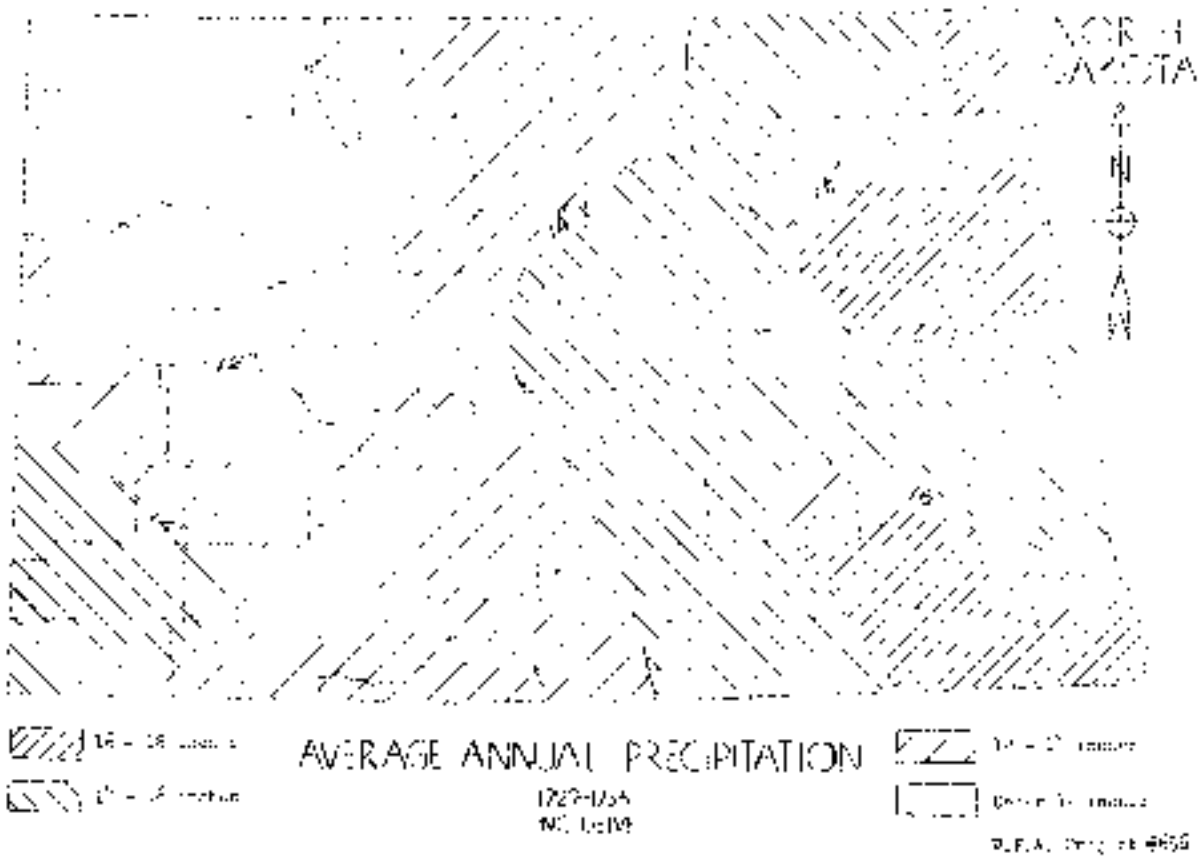
AVERAGE ANNUAL PRECIPITATION
(1898 - 1928 inclusive)

The map below shows the average annual precipitation for the 31 year period prior to 1929. The average annual precipitation during the period ranged from more than 22 inches in the southeastern corner of North Dakota to less than 14 inches along the western border, the average precipitation for a11 of North Dakota being slightly more than 17 inches.



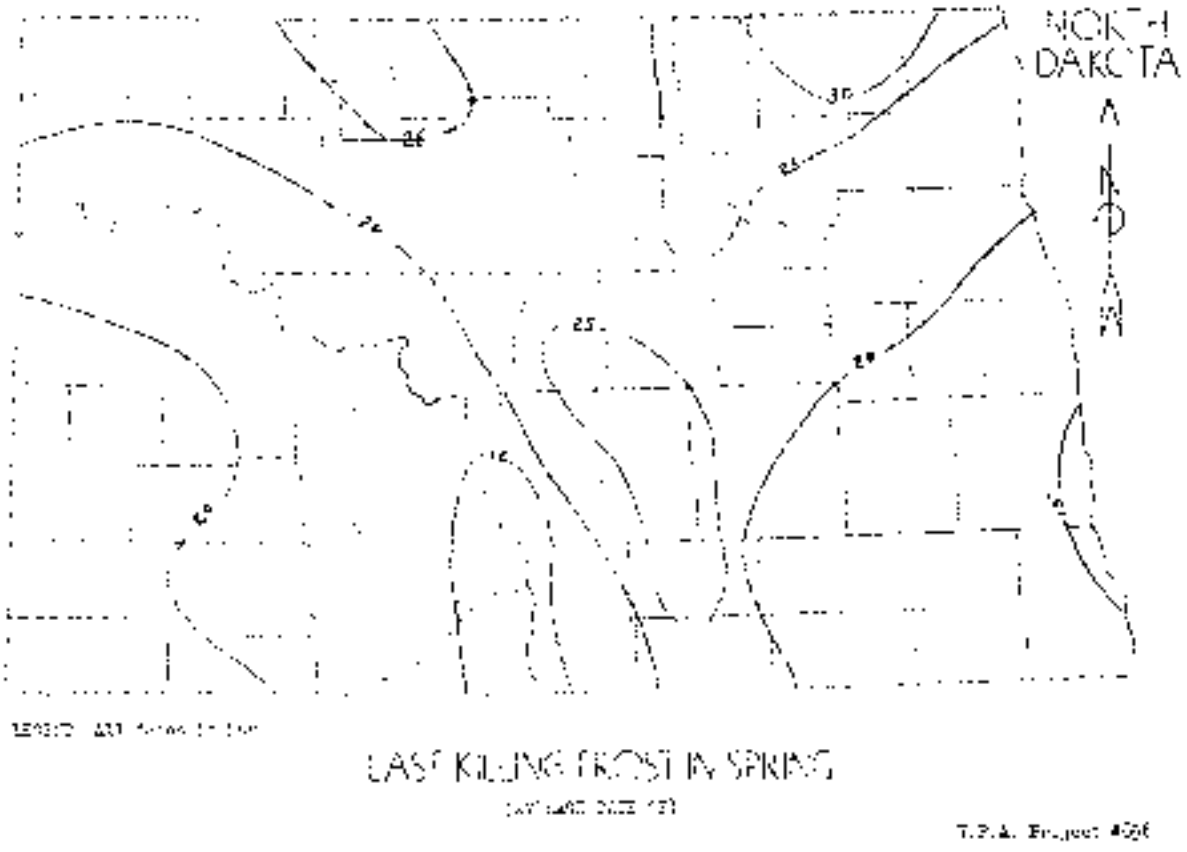
AVERAGE ANNUAL PRECIPITATION
(1929 - 1936 inclusive)

The map below shows that for a six year period (1929 to 1934 inclusive) even the wettest parts of North Dakota received less than the average rainfall, the amount decreasing progressively to the westward. Along the Canadian border an extensive area in the northwestern part of North Dakota received an average of less than 10 inches of rainfall annually.



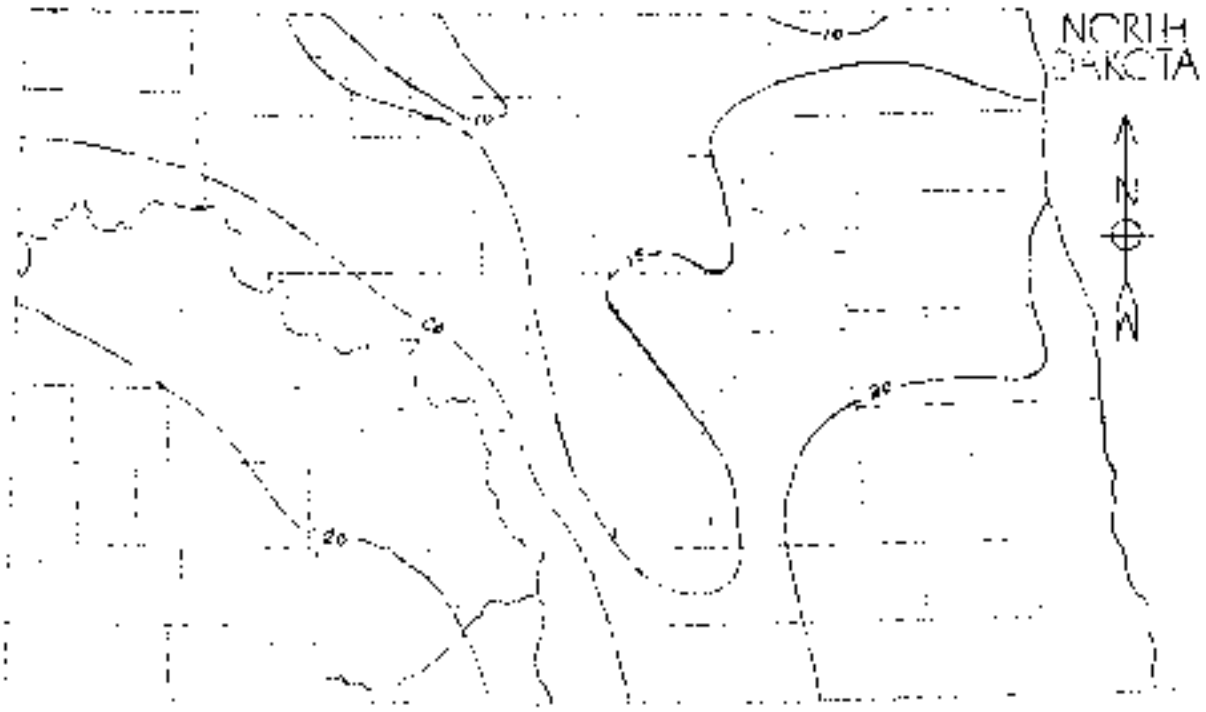
LAST KILLING FROST IN SPRING

The map below shows that the average date of the last killing frost in the spring is May 15 in the lower Missouri River Valley and in the southeastern part of North Dakota, and May 30 in Cavalier County and in the northeastern part of North Dakota. As indicated the dates are based on the average date for the period of record, including 1934.



FIRST KILLING FROST IN AUTUMN

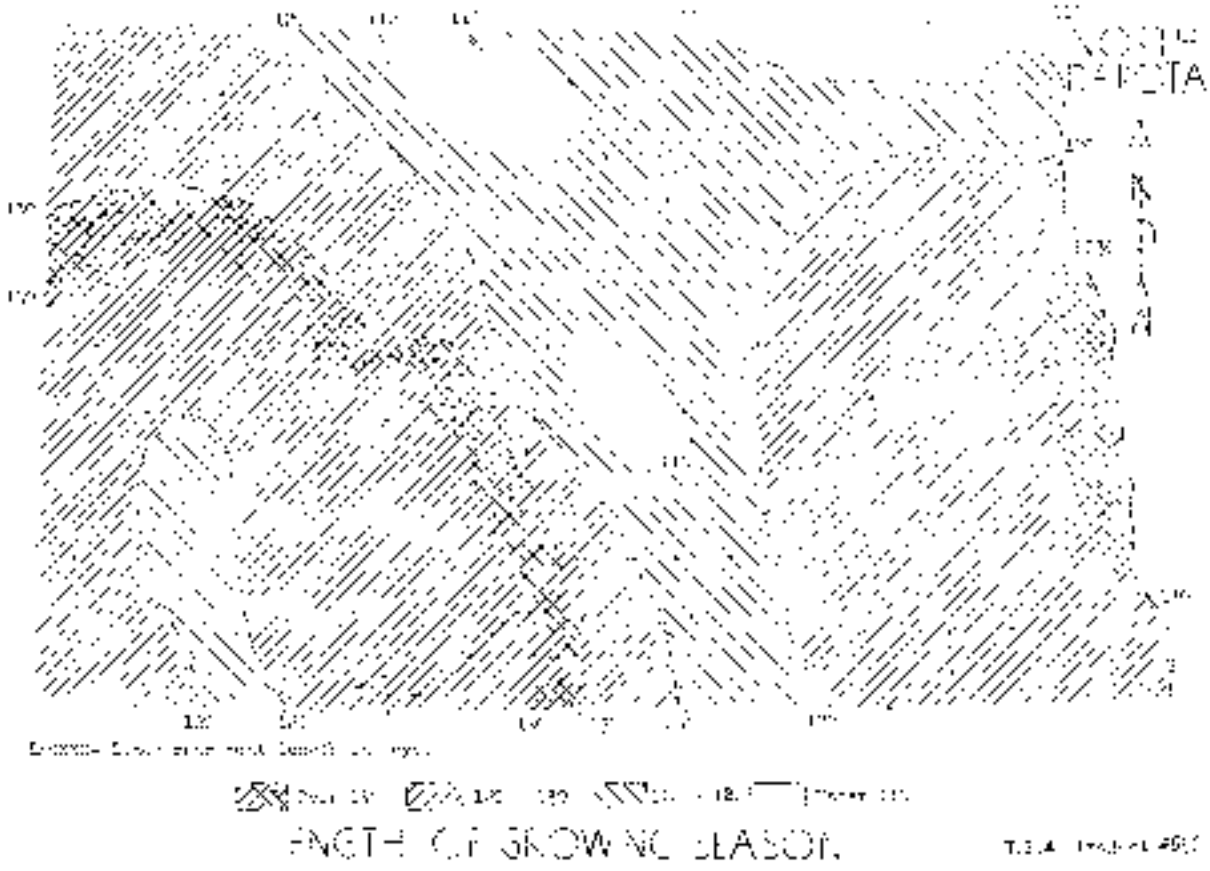
The map below shows that the average date of the first killing frost in autumn is September 10 along the northern boundary, and September 20 in the region along the Missouri River Valley and in the southeastern corner of North Dakota. As indicated, the dates are based on the average date for the period of record, including 1934.



FIRST KILLING FROST IN AUTUMN

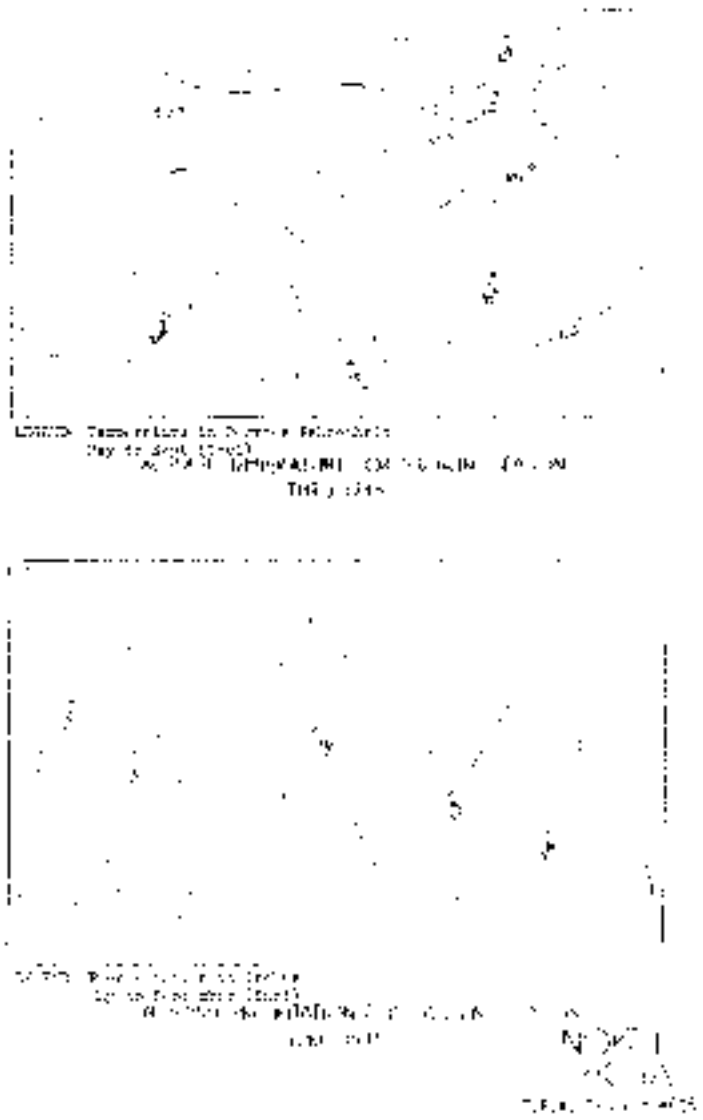
LENGTH OF GROWING SEASON

The map below shows the average period between killing frosts for all stations in North Dakota over the period of record, including 1934. The shortest growing season, 110 days or less, is found along the Canadian border and in an area in the central part of North Dakota; the longest period, 130 days or over, is found in the Missouri River Valley and in an area along the Red River between Grand Forks and Wahpeton.



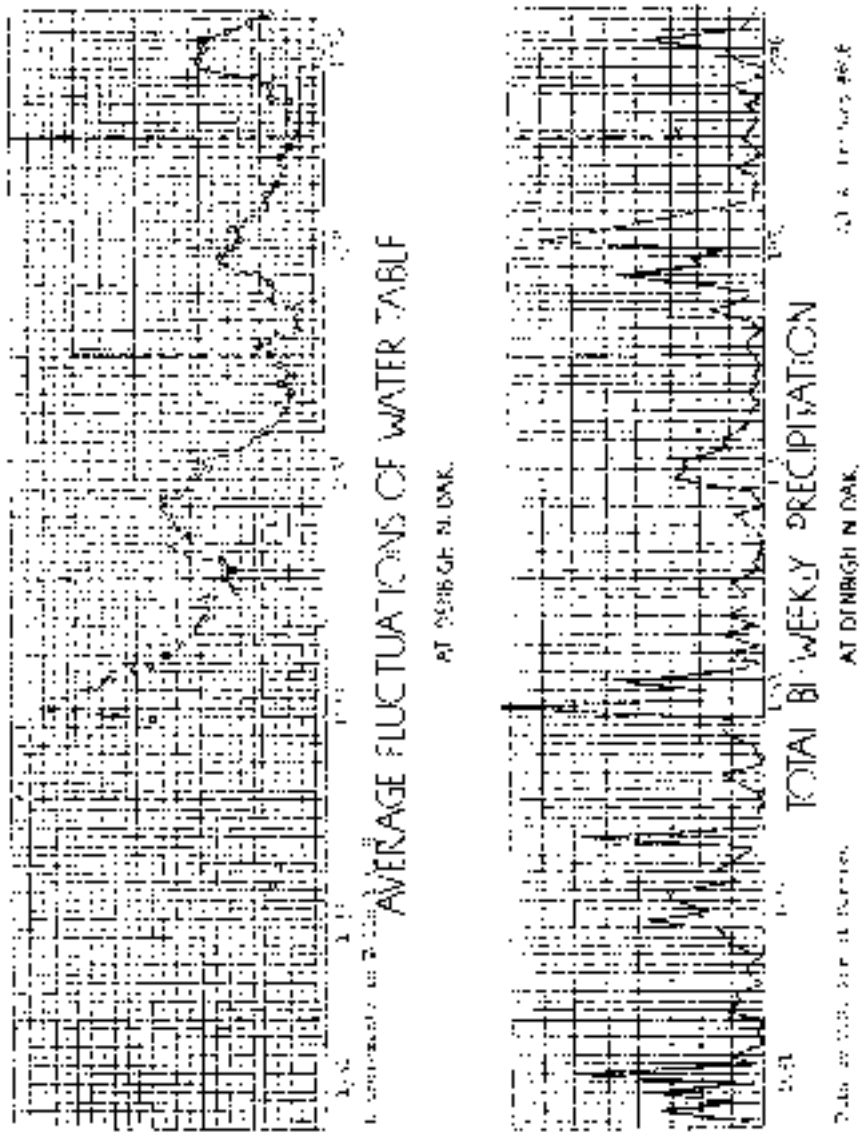
TEMPERATURE AND PRECIPITATION DURING GROWING SEASON

The first map below shows that the average temperature during the growing season ranges from 59°F along the Canadian border (in Cavalier, Towner, and Rolette counties) to 63°F or over in the southeastern corner of North Dakota. The average temperature for most of the state is between 60°F and 62°F. The second map below shows the normal precipitation during the growing season. It ranges from less than 11 inches in the western and northwestern part of North Dakota to more than 14 inches in the southeastern corner. By far the greater part of the precipitation in North Dakota falls during the growing season.



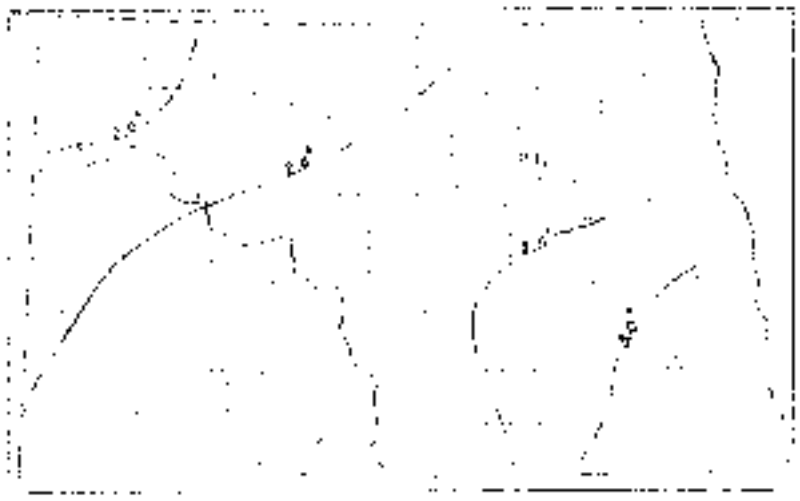
AVERAGE FLUCTUATIONS OF WATER TABLE AND TOTAL BI-WEEKLY PRECIPITATION AT DENBIGH, N. D.

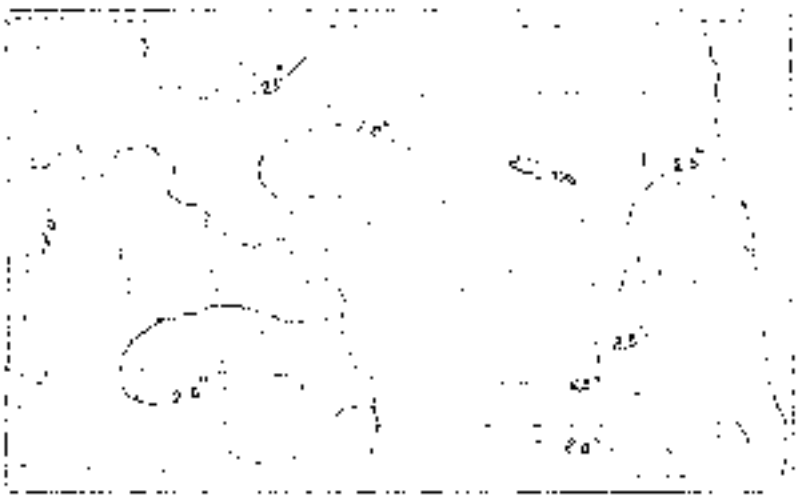
The graph below shows the relationship between the amount of precipitation and the average depth to the ground water tables in five wells. From a high on May 31, 1933, when almost three inches of rain fell, the ground water level has fallen to a low of more than 7.7 feet below the surface, during the two week period ending February 15, 1935; the precipitation has fallen to a low of about 0.10 inches for the same period. It is also apparent that, despite the low rainfall during the first five months of 1934, the water level raised from 7.2 feet to almost 6.7 feet below the surface.



MAY PRECIPITATION

The two maps below show the normal precipitation in May for the period 1898 to 1928 inclusive, and the average precipitation for May for the period 1949 to 1936 inclusive. These two maps show a marked decrease in the amount of precipitation which fell during the month of May during the drought years.

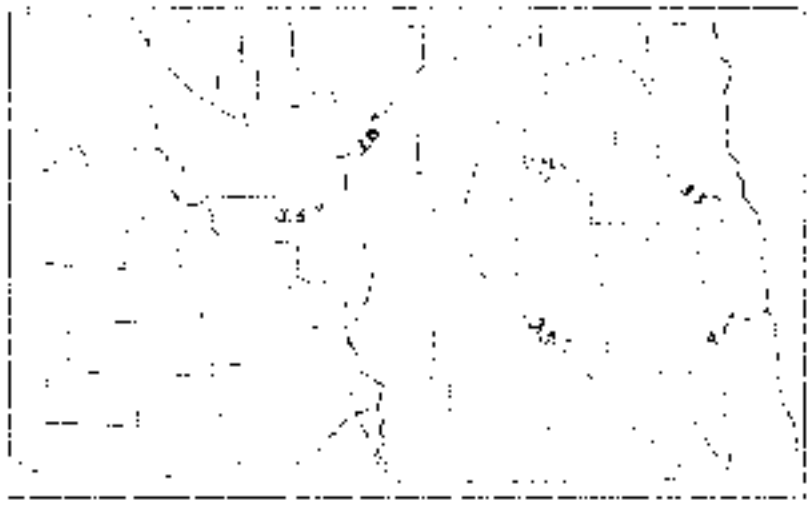


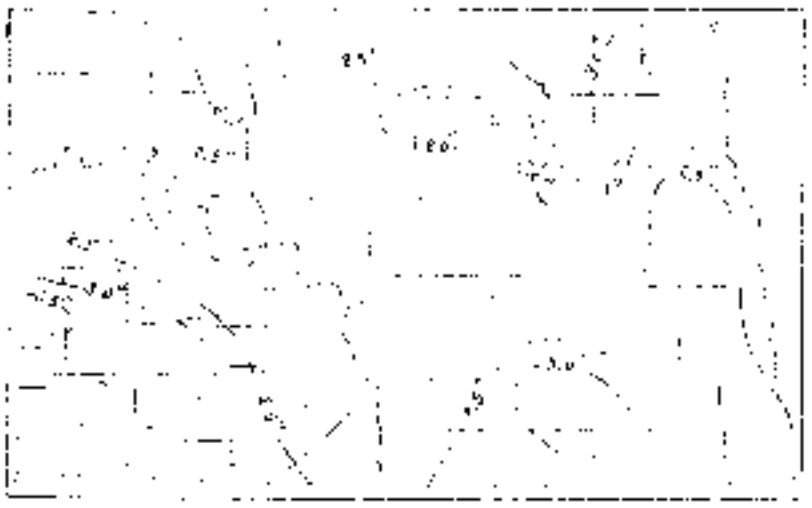


NORTH
DAKOTA

JUNE PRECIPITATION

The two maps below show the normal precipitation in June for the period 1898 to 1928 inclusive, and the average precipitation for June for the period 1929 to 1936 inclusive. These two maps show a marked decrease in the amount of precipitation which fell during the month of June during the drought years.

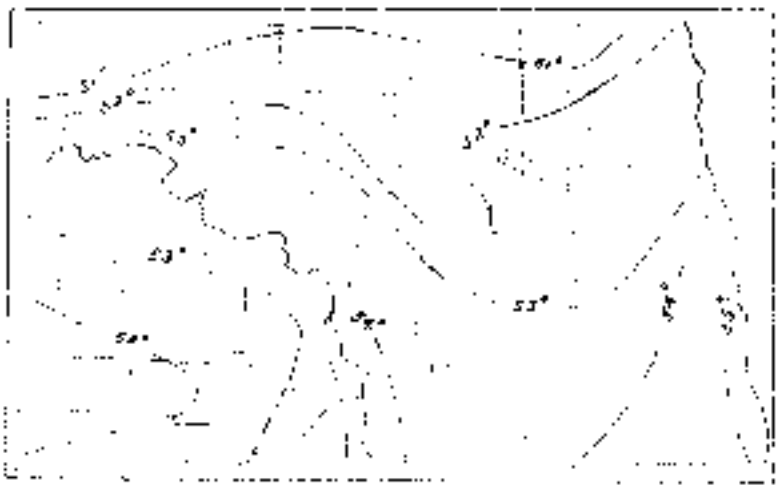


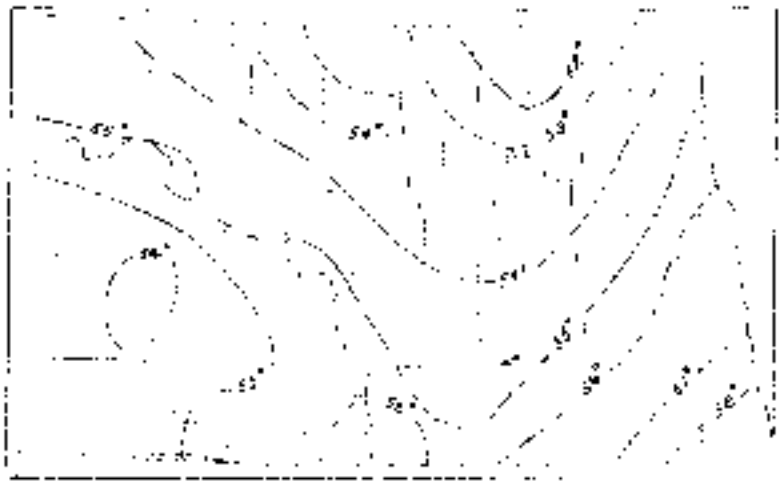


NORTH DAKOTA

MAY TEMPERATURE

The two maps below show the normal temperature for May during the period 1898 to 1928, and the average temperature for May for the period 1929 to 1936 inclusive. These two maps show a marked increase in the average temperature for the month of May during the drought years, indicating that high temperature aggravated drought conditions brought about by a deficiency in rainfall.

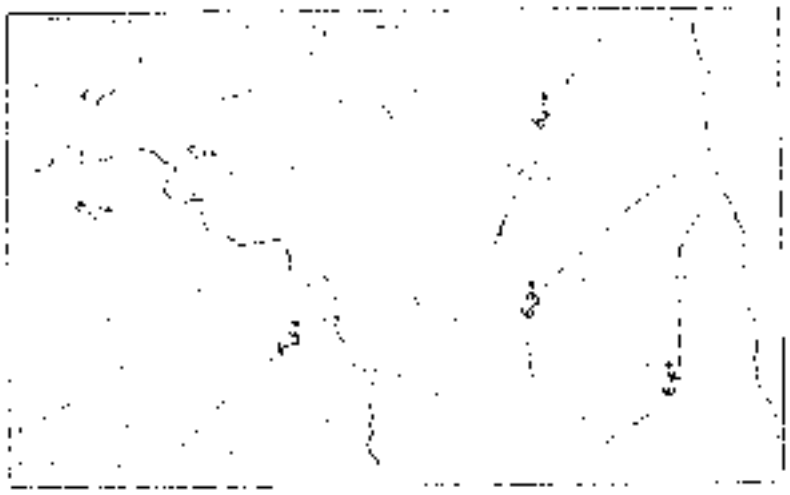




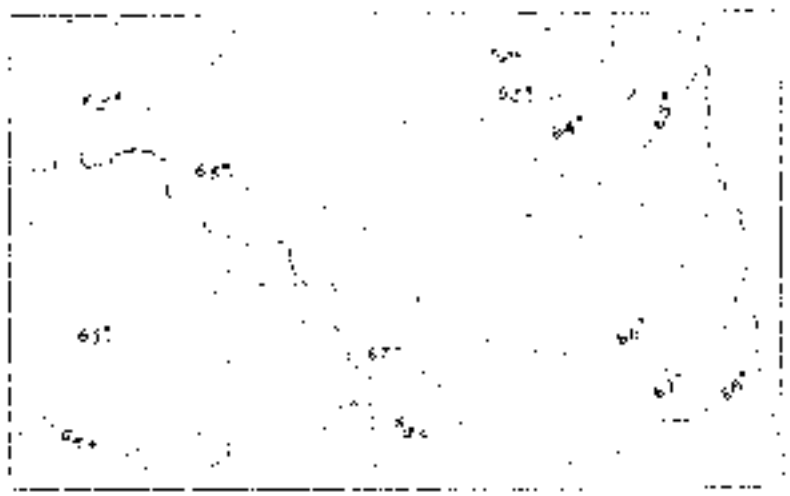
DAKOTA

JUNE TEMPERATURE

The two maps below show the normal temperature for June during the period 1898 to 1928 inclusive, and the average temperature for June for the period 1929 to 1936 inclusive. These two maps show a very marked increase in the average temperature for the month of June during the drought years, indicating that high temperature aggravated drought conditions brought about by a deficiency in rainfall.



NORMAL TEMPERATURE FOR JUNE 1898-1928



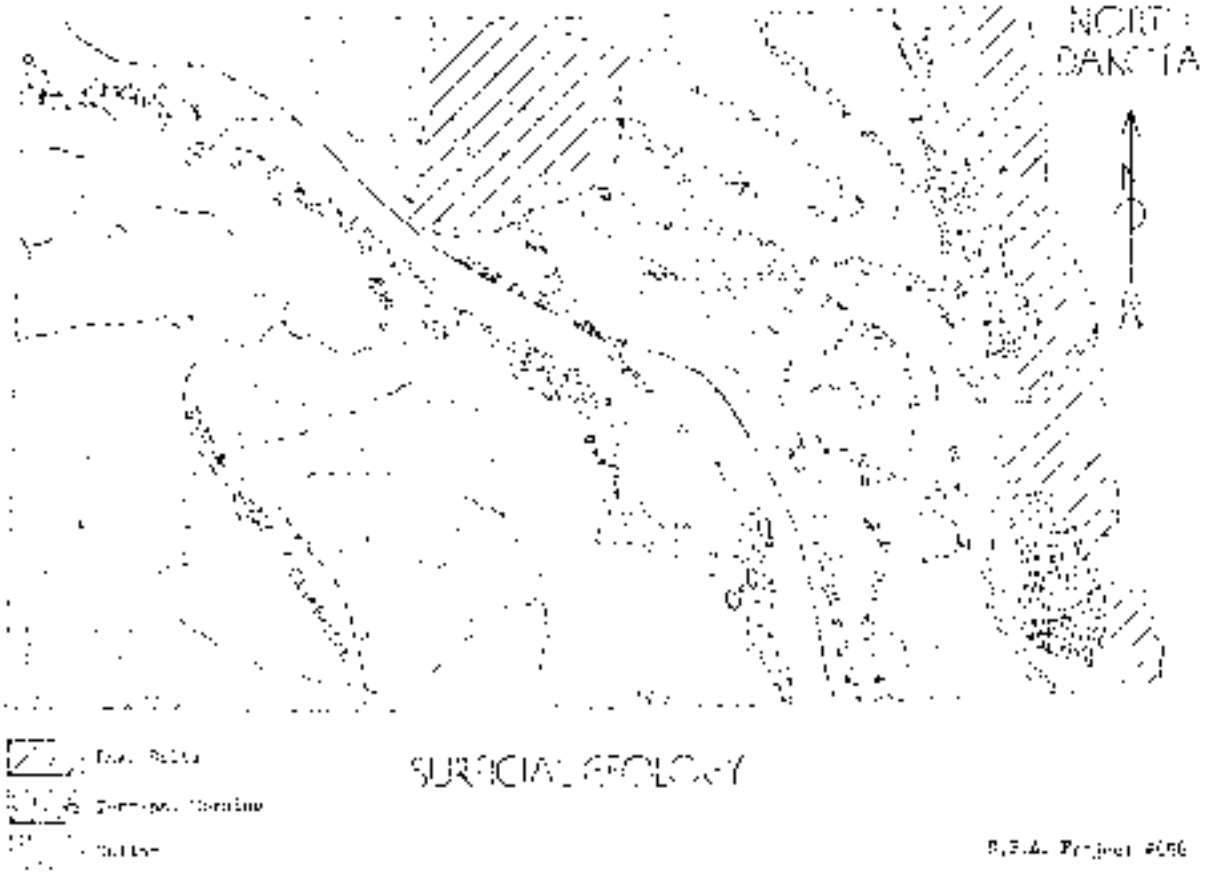
AVERAGE TEMPERATURE FOR JUNE 1929-1936

NORTH DAKOTA

W.P.A. Project 4996

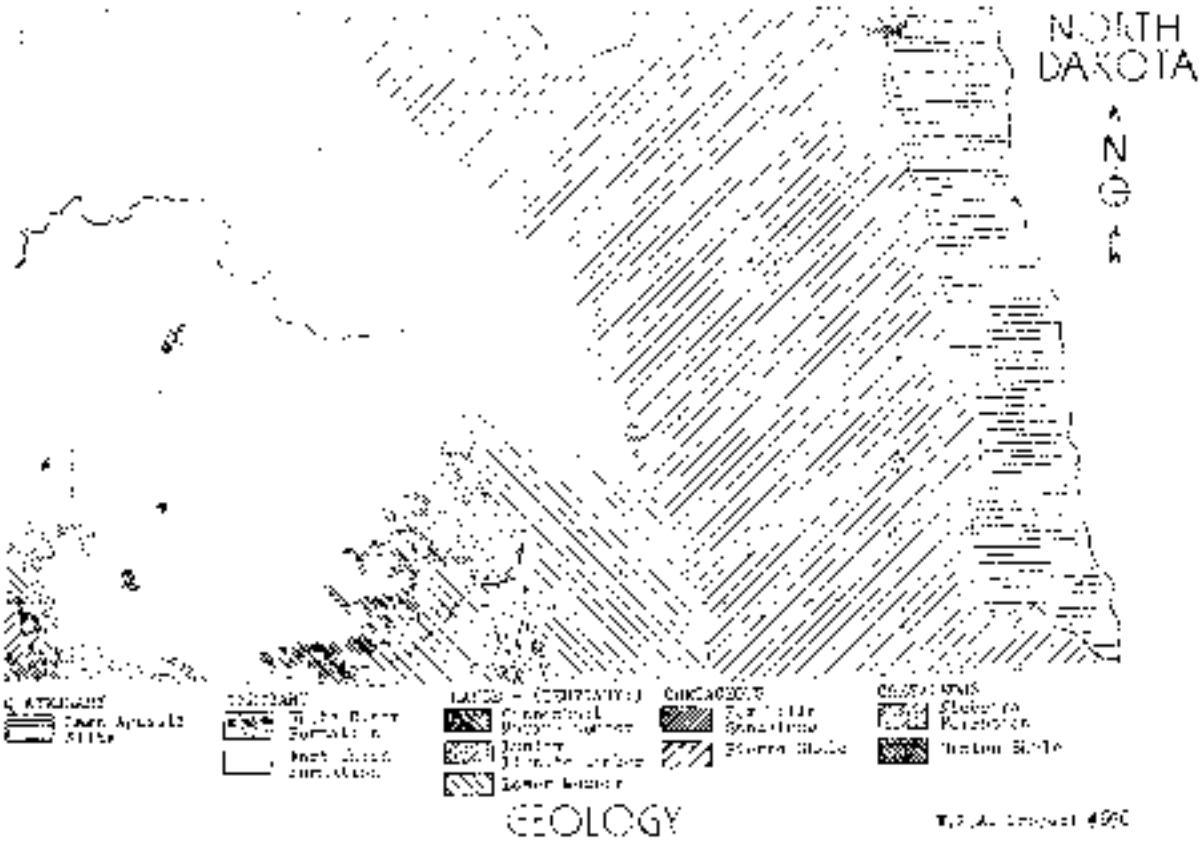
SURFICIAL GEOLOGY

The map below shows the location and extent of North Dakota's various surficial deposits such as the lake silts of the Red River and Souris River plains, the deltas on the western edge of the Red River Valley, and the numerous terminal moraines scattered from the Red River Valley to the Missouri River. Southwest of the Missouri River is a line indicating the extreme limit of glaciation in North Dakota.



GEOLOGY

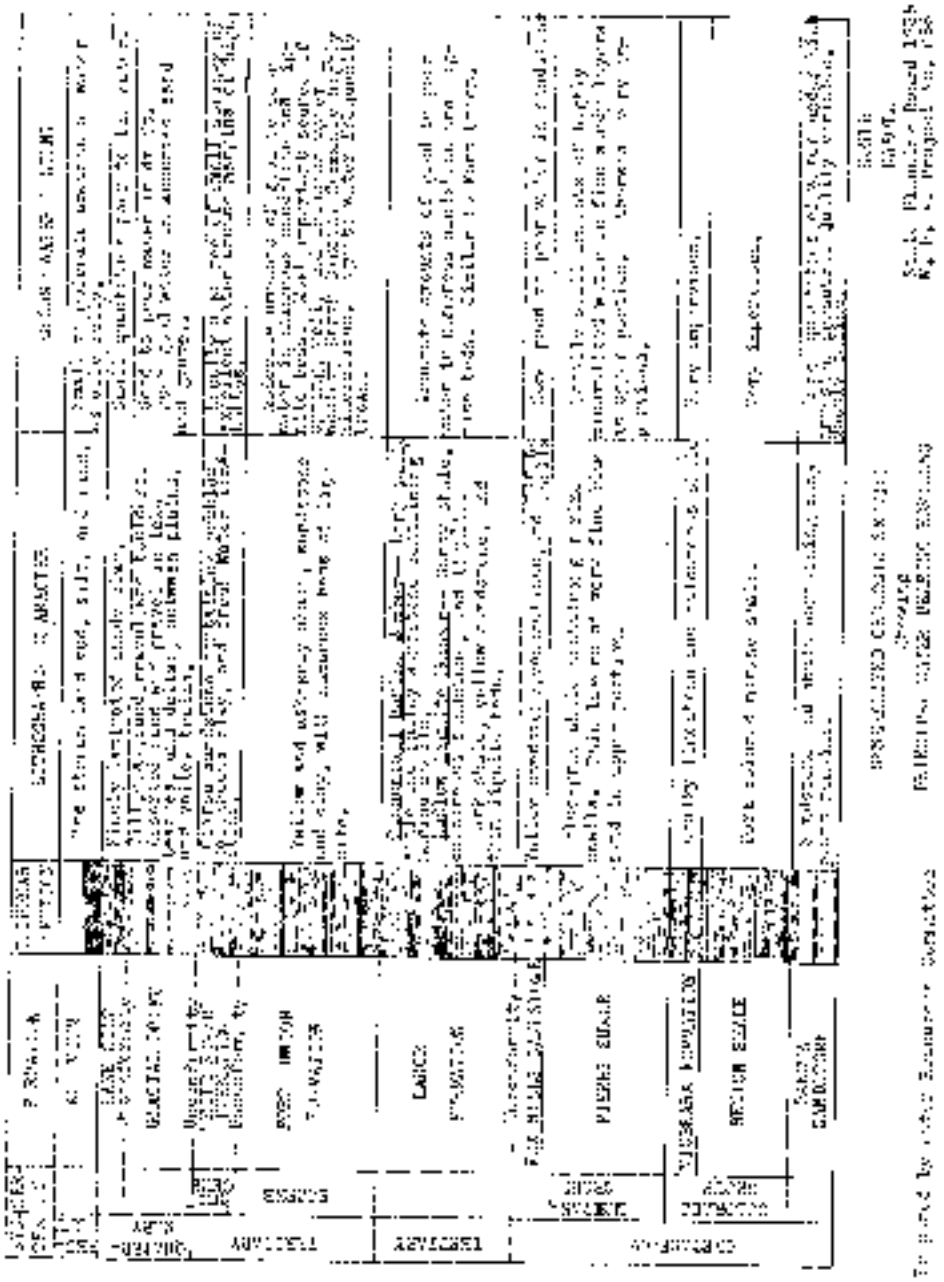
The map below shows the distribution and extent of the outcrops of various bedrock formations which immediately underlie the surficial deposits. The isolated Ft. Union Formation in the Turtle Mountains and the several small outcrops of the White River Formation southwest of the Missouri River stand out as prominent features. The two major bedrock formations, from the standpoint of area and importance, are the Pierre Shale of the east central portion, and the Ft. Union, the important coal-bearing formation, of the western half of North Dakota.



GENERAL GEOLOGIC SECTION SHOWING WATER-BEARING HORIZONS

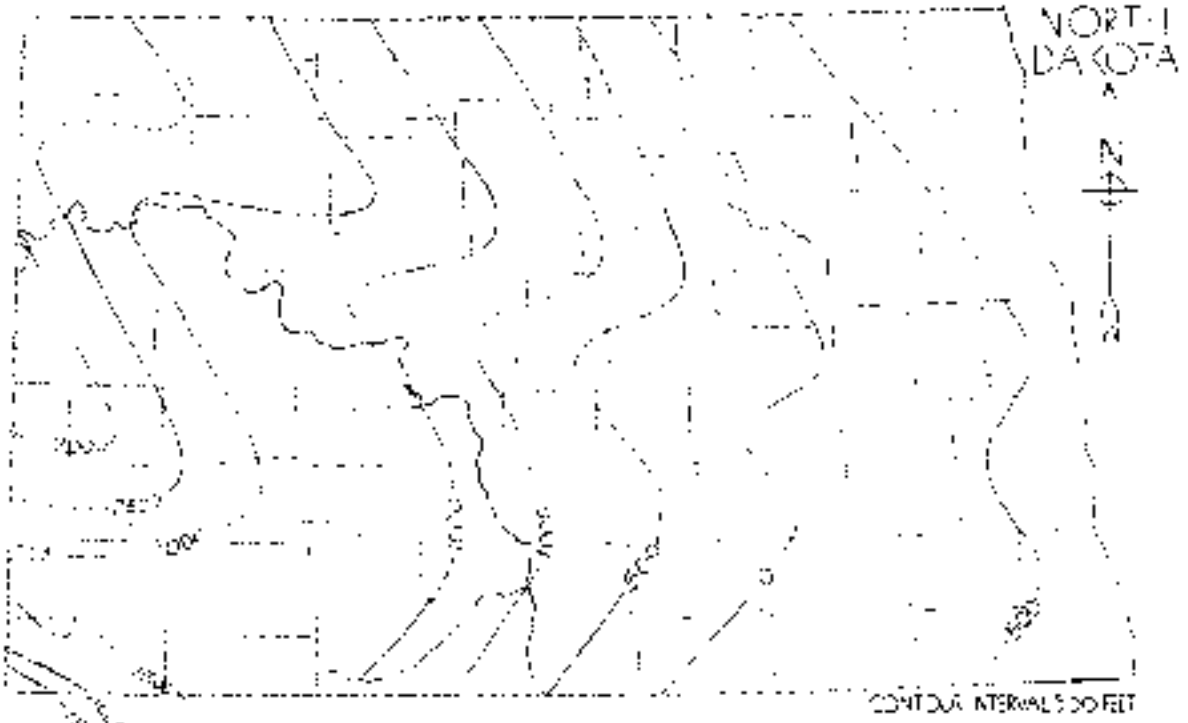
The chart below shows, in a general way, the order of the geologic formations in a columnar section, their lithographic character, and the amount and character of the ground water found in each formation. From this it will be seen that the three most important water-bearing formations are the Dakota Sandstone, the sand and gravel of the glacial drift, and the sandstone and lignite beds of the Fort Union Formation.

ORIGINAL AREAS OF ARTESIAN FLOW



CONTOURS ON TOP DAKOTA SANDSTONE

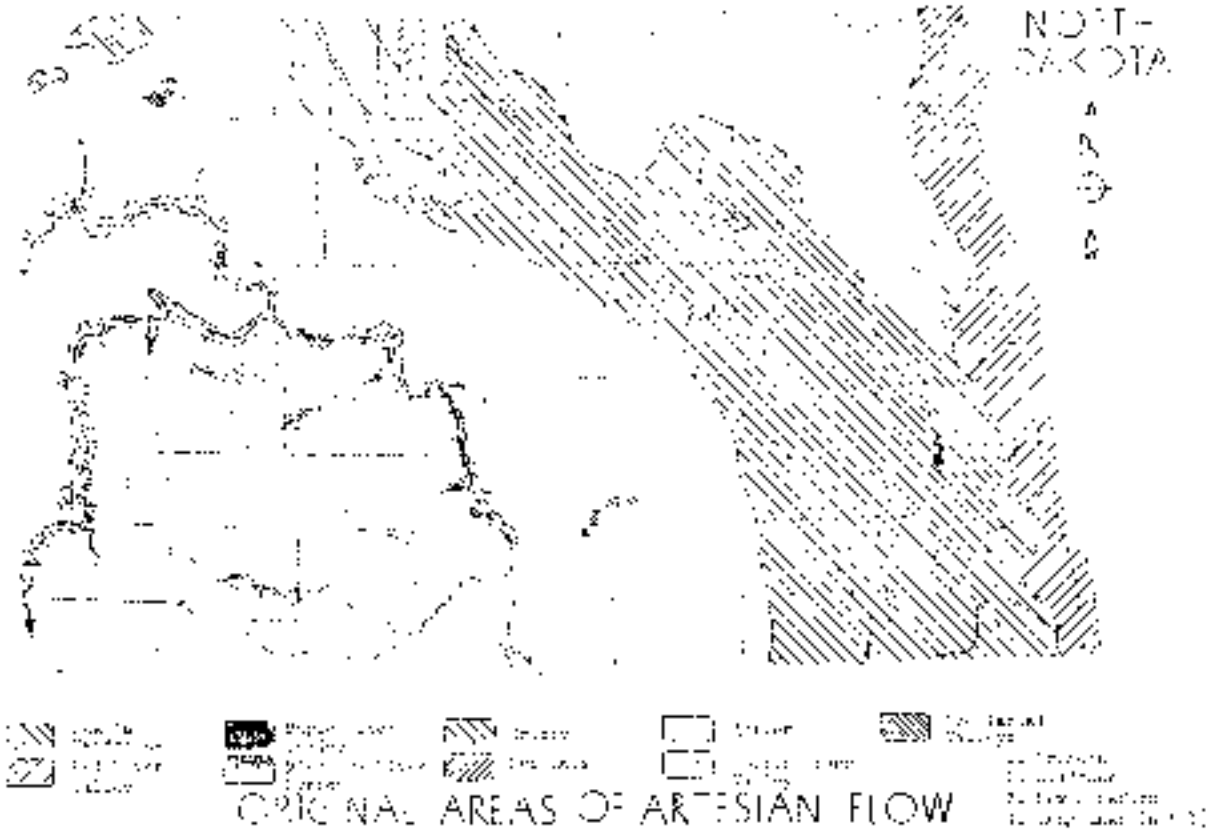
A map showing by means of subsurface contours the elevation above sea level of the top of the Dakota Sandstone formation. The large contour interval (500 feet) does not show minor variations in elevation, but the Cedar Creek anticline in Bowman County and the Nesson Anticline in Williams County are well marked and indicate the two most favorable areas for oil prospecting.



MAP SHOWING
CONTOURS ON TOP DAKOTA SANDSTONE
BY
VIRGINIA AUGUSTINE

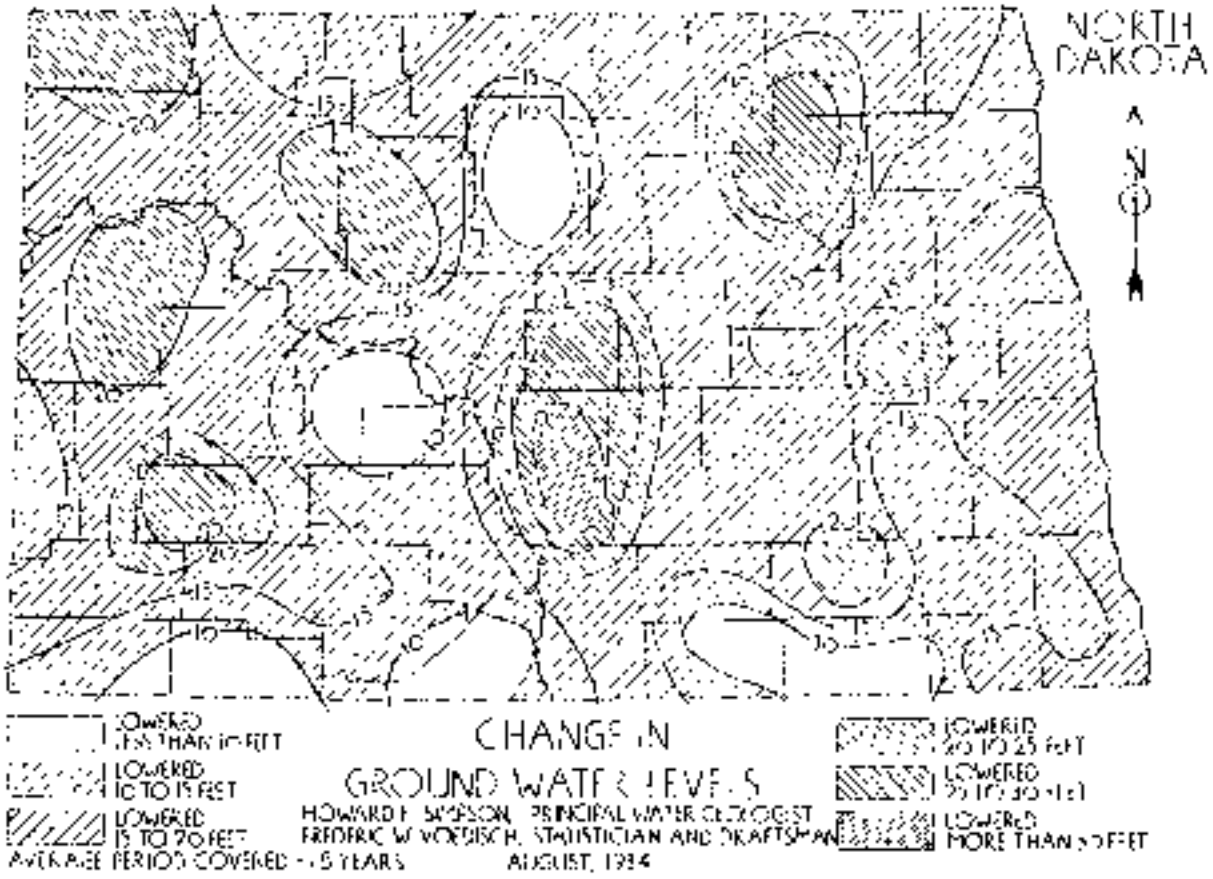
ORIGINAL AREAS OF ARTESIAN FLOW

The map below shows the eight major artesian well areas and four minor areas identified with preglacial valleys. The two largest artesian well areas are located in the eastern half of North Dakota: the Red River Valley and the Dakota Artesian Area.



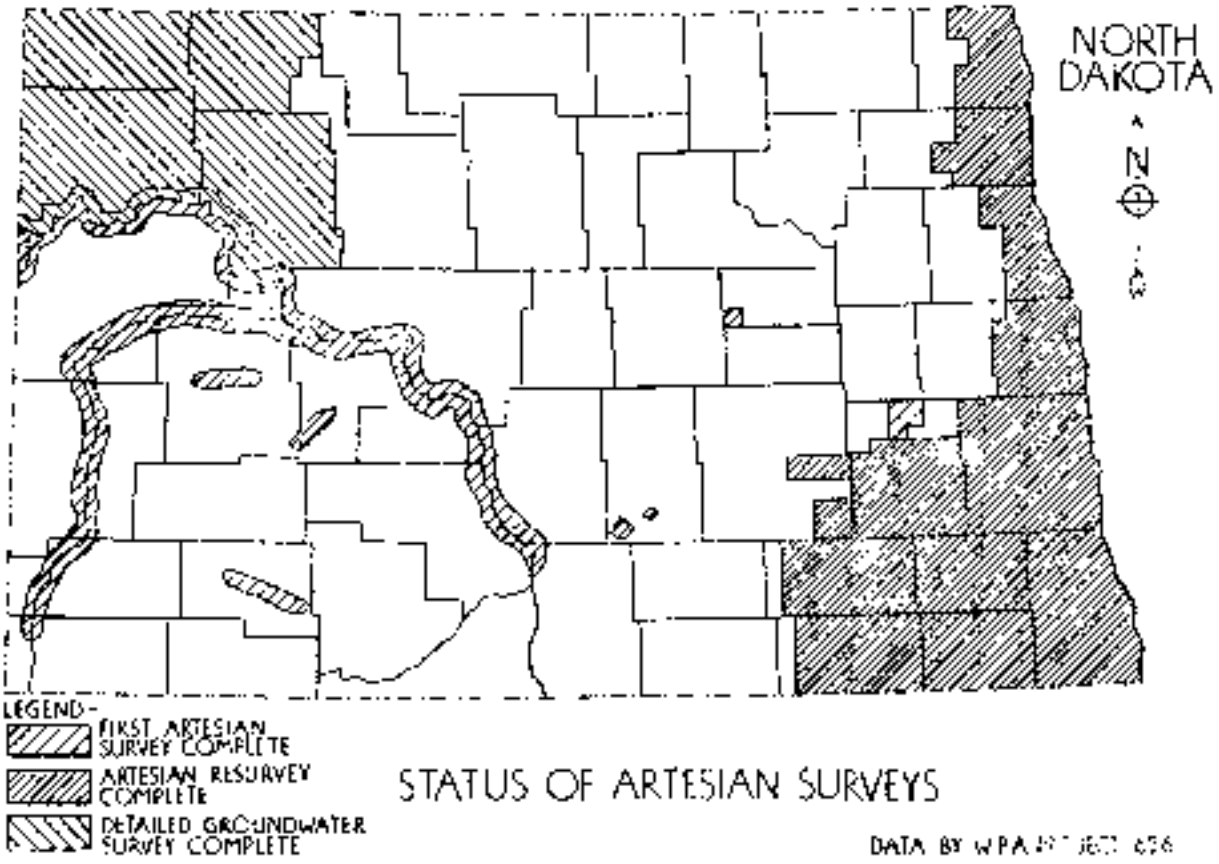
CHANGE IN GROUND WATER LEVELS

The map below shows the average decrease in ground water levels over a period of seventeen years. The greatest decrease occurred in the central and northeastern parts of North Dakota. The range of decrease was from less than ten feet along the southern border to over thirty feet in Burleigh County. The average decrease for all of North Dakota was between fifteen and twenty feet.



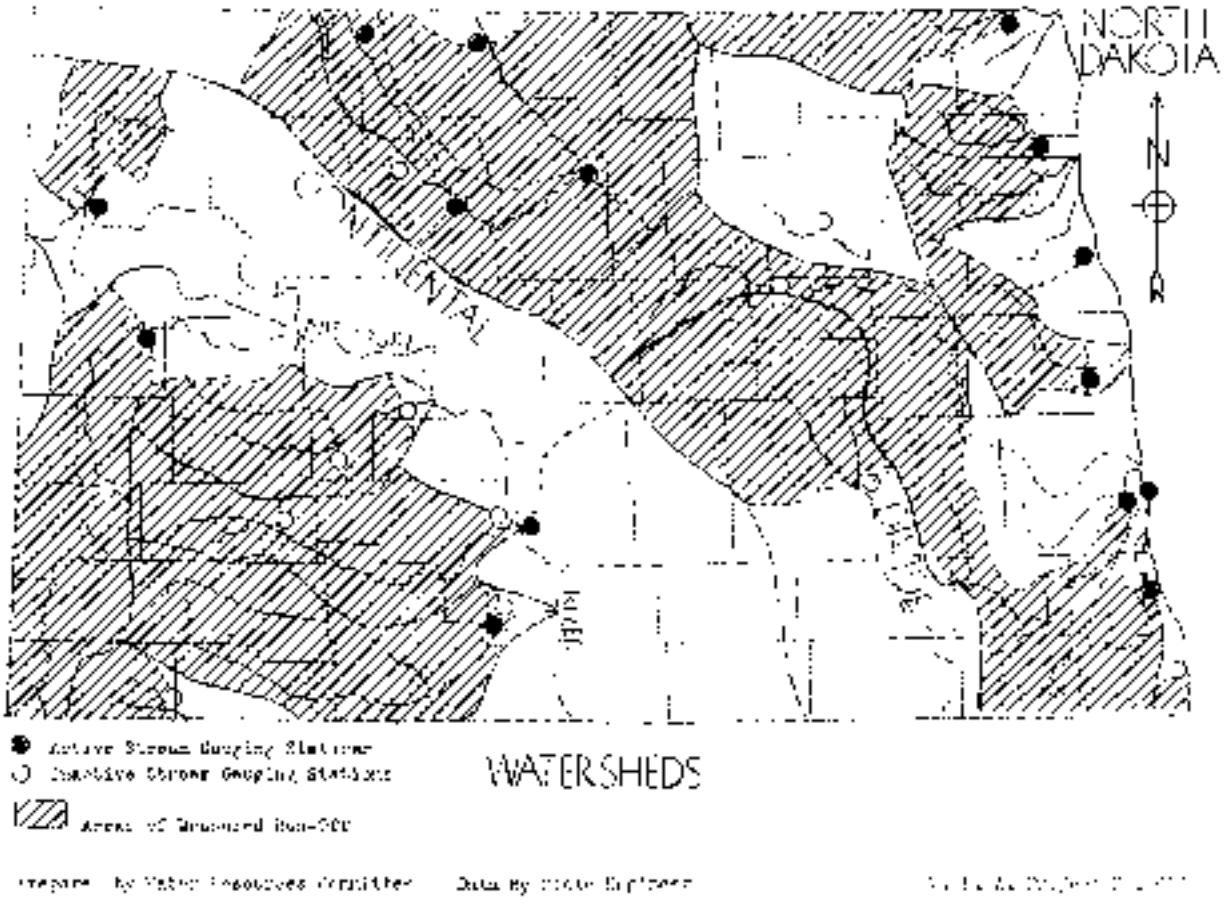
STATUS OF ARTESIAN WELL INSPECTION

The map below shows the portions of North Dakota in which the North Dakota Geological Survey has inspected all artesian wells, recommending reduction of flows where necessary, and suggesting repairs and improvements where needed. The map also shows the portions of North Dakota in which the North Dakota Geological Survey has reinspected flowing wells to check on original data collected, and to see how thoroughly the recommendations made in the previous surveys have been carried out by well owners.



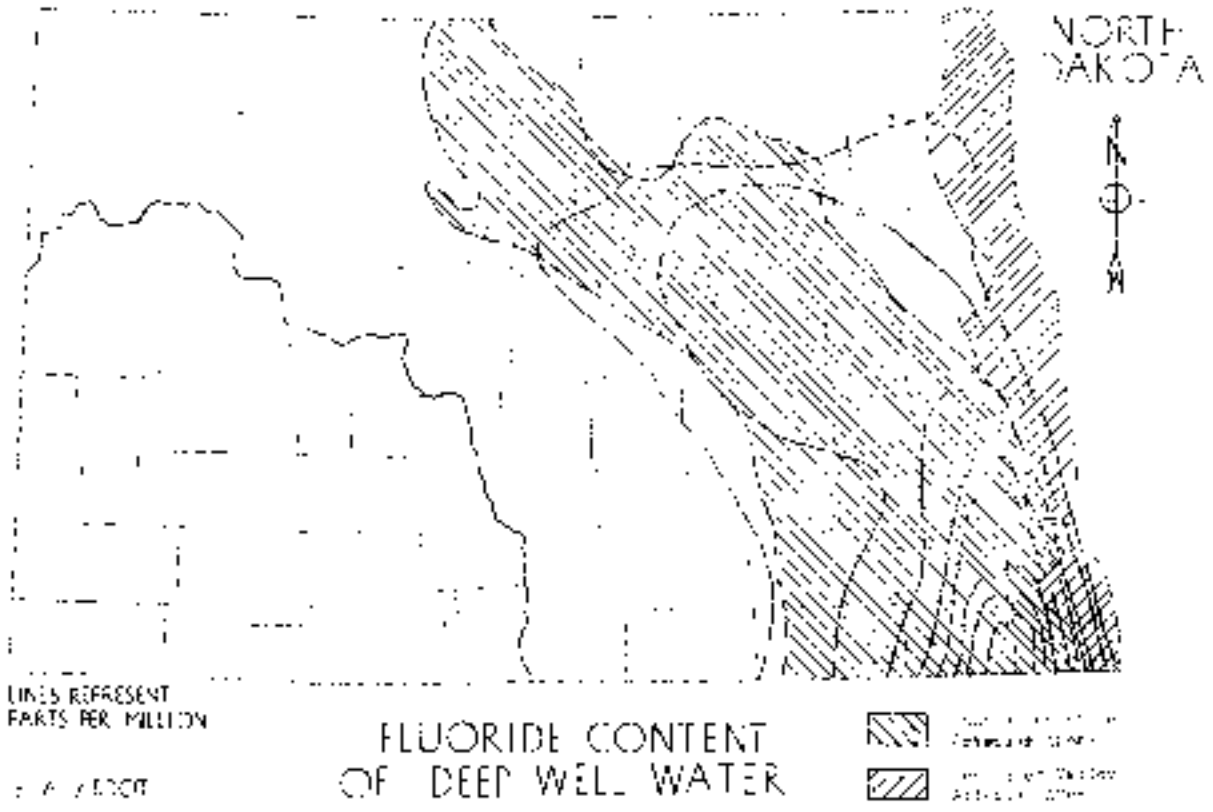
WATERSHEDS

The map below shows the limits of the watershed areas of the several drainage basins in North Dakota, together with the locations of stream gauging stations and the areas of the watersheds from which the run-off has been measured. Most of the individual areas of each of the principal drainage basins lying wholly within North Dakota have been measured in the past. There are several gauging stations for streams running through and outside the boundaries of North Dakota.



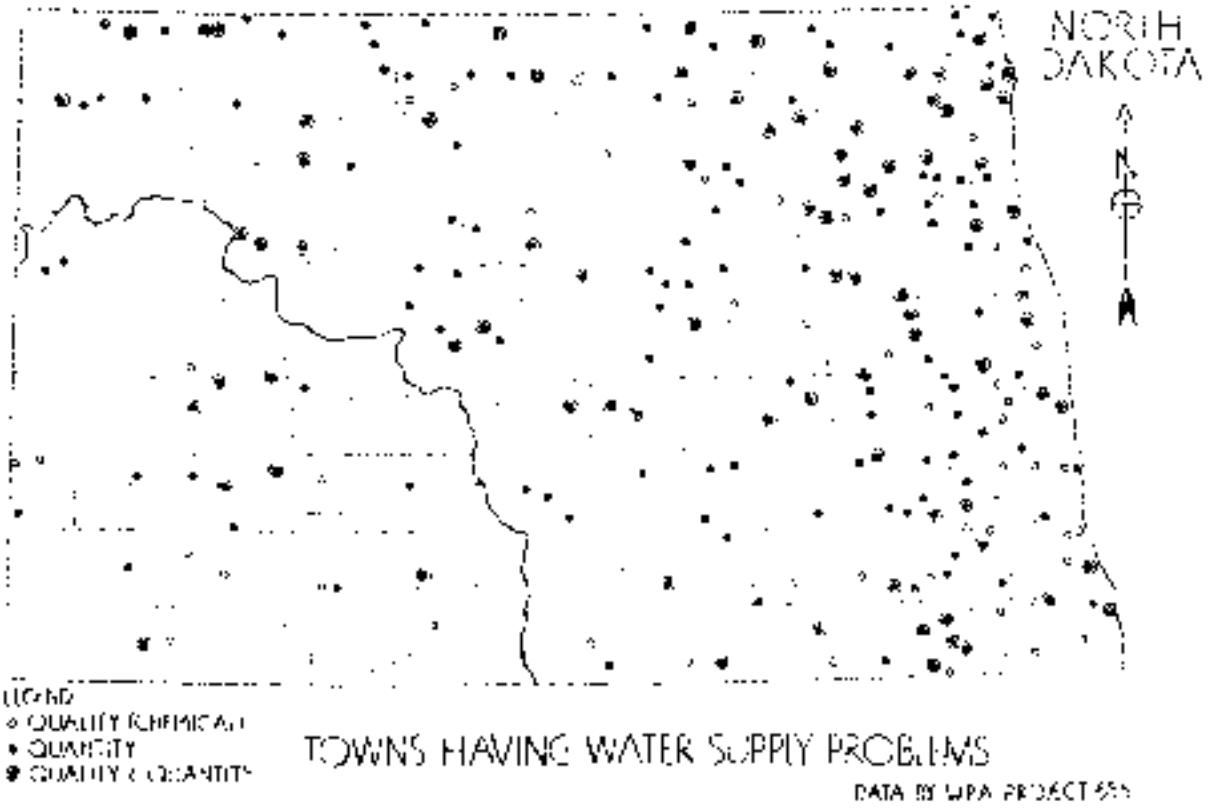
FLUORIDE CONTENT OF DEEP WELL WATER

The map below shows the high concentration of fluorides in waters from deep wells in the Dakota Sandstone and Red River Valley artesian areas. All of the flowing artesian wells in those two artesian areas provide water containing fluorinc in quantities ranging from three parts per million along the margin of flow to ten parts per million in Sargent and Richland counties in the vicinity of Forman and Lidgerwood. Deep wells in other parts of the state may contain fluorides in harmful amounts, usually less than three parts per million. The vital significance of this high concentration of fluoride is apparent when it is considered that one part of fluoride per million parts of water is sufficient to cause the mottling of the enamel of children's teeth.



TOWNS HAVING WATER SUPPLY PROBLEMS

The map below shows municipalities having unsatisfactory water supply. There is a concentration of towns in the east central portion of North Dakota, whose water problem is predominantly that of poor quality; for, during the drought period of the past few years, the shallow ground water supply has become inadequate, and the deeper ground waters are usually too highly mineralized for domestic use, although the supply may be of sufficient quantity.



STATUS OF TOPOGRAPHIC MAPPING

The map below shows the areas of North Dakota for which topographic maps have been published by the United States Geological Survey. On this map are also shown the areas which are at present being surveyed, but for which topographic maps have not been published, as well as those areas which as yet have not been studied.