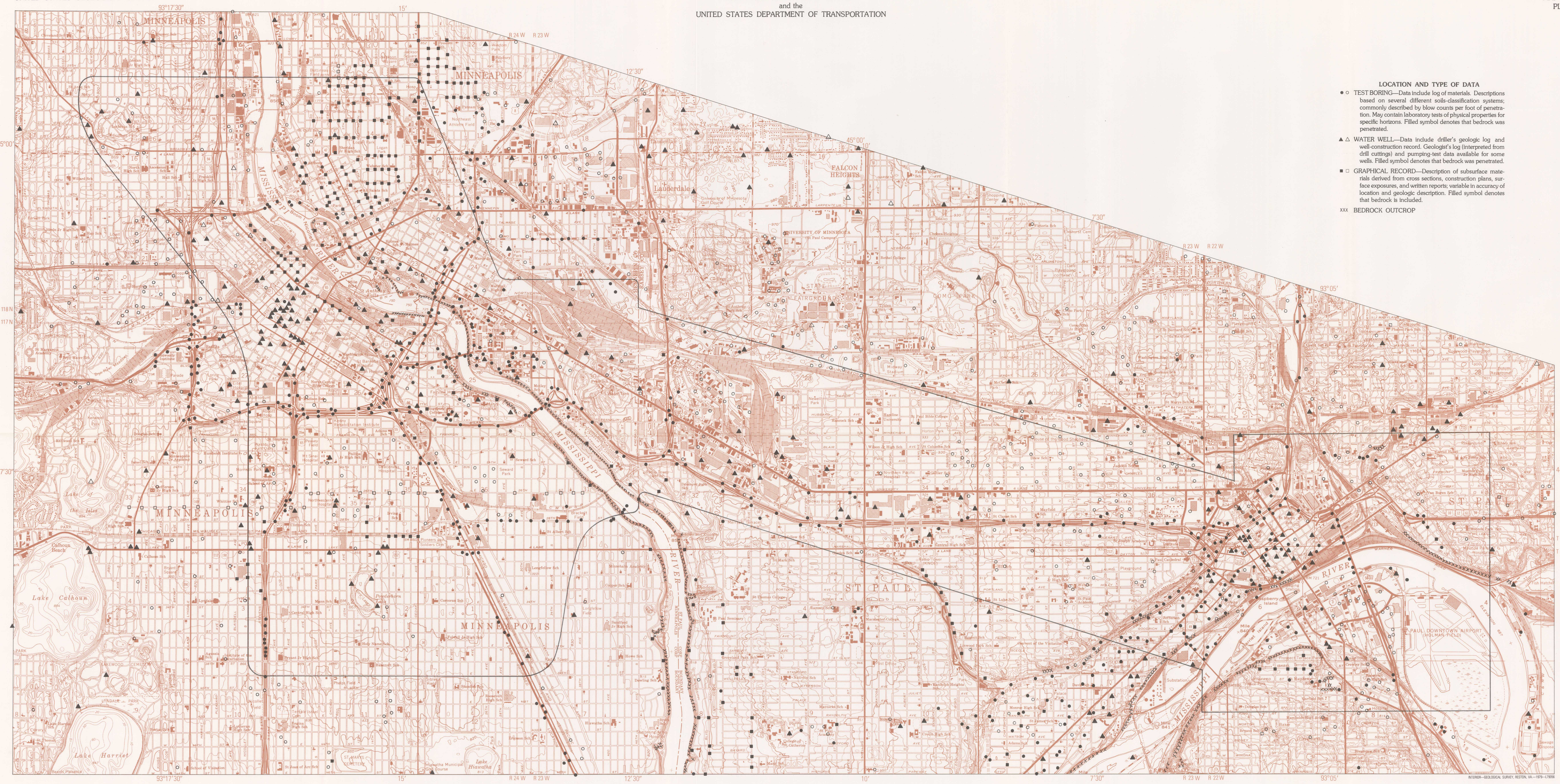
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
MINNESOTA GEOLOGICAL SURVEY
and the
UNITED STATES DEPARTMENT OF TRANSPORTATION

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1157
PLATE 1



LOCATION AND TYPE OF DATA

● ○ TEST BORING—Data include log of materials. Descriptions based on several different soils-classification systems; commonly described by blow counts per foot of penetration. May contain laboratory tests of physical properties for specific horizons. Filled symbol denotes that bedrock was penetrated.

▲ △ WATER WELL—Data include driller's geologic log and well-construction record. Geologist's log (interpreted from drill cuttings) and pumping-test data available for some wells. Filled symbol denotes that bedrock was penetrated.

■ □ GRAPHICAL RECORD—Description of subsurface materials derived from cross sections, construction plans, surface exposures, and written reports; variable in accuracy of location and geologic description. Filled symbol denotes that bedrock is included.

XXX BEDROCK OUTCROP

Base from U.S. Geological Survey, Minneapolis North, Minneapolis South, New Brighton, St. Paul East and St. Paul West 1:24 000, 1967
Photorevision as of 1972

SCALE 1:24 000
1 ½ 0 1 MILE
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTRODUCTION AND DATA BASE

By Bruce A. Bloomgren, Bruce M. Olsen, and James R. Poppe
Minnesota Geological Survey
1979

INTRODUCTION

This report presents the results of a pilot study of geologic and hydrologic aspects of tunneling in part of the Minneapolis–St. Paul (Twin Cities) metropolitan area, Minnesota. The Minnesota Geological Survey collected, compiled and interpreted geologic and engineering-test data and the U.S. Geological Survey compiled and interpreted hydrologic data. The report was prepared on behalf of the U.S. Department of Transportation and funding was provided by that agency. A similar pilot study was recently made in the Los Angeles area, California (Yerkes and others, 1977).

This report, in atlas format, comprises seven plates:

1. Introduction and Data Base
2. Surficial Geology
3. Bedrock Geology
4. Thickness of drift
5. Geologic Sections and Engineering Characteristics of Quaternary Units
6. Hydrogeologic Setting
7. Hydraulic Properties and Tunneling Constraints

Mapping geology and hydrology in urban areas requires use of unconventional methods, because draining and filling of boggy ground, grading, landscaping, building, and mining create an urban mask over the original land surface. Abundant geologic and hydrologic data for urban areas exist as engineering-test borings, well and utility-ditch logs, and miscellaneous construction records (plate 1). These data typically are scattered in the files of many agencies and are difficult to compile.

Subsurface geologic information never fully defines all materials now concealed beneath the man-made surfaces. Therefore geologic maps of urban areas must be regarded as somewhat generalized. Similarly with the hydrology, ground-water levels change seasonally and annually in response to variations in recharge, and also change significantly, both short-term and long-term, in response to pumpage from wells. Thus, hydrologic maps made from historical data also should be considered as generalizations. Though engineering and hydraulic properties of consolidated and unconsolidated rocks are more stable, even they change locally, for example where compaction owing to dewatering of granular materials has occurred. Despite these uncertainties, the geologic, hydrologic and engineering information in this report is far more detailed than any heretofore available and the report provides a modern summary of geologic and hydrologic aspects of tunneling in the Twin Cities area.

The authors are grateful to the Minnesota Department of Transportation (MDOT) and the Departments of Public Works of the cities of St. Paul and Minneapolis for furnishing plans of tunnel alignments and water-level altitudes. C. R. Ford of the MDOT and H. W. Ruthmiller and R. Melcher of Tri-State Drilling and Equipment Company were generous in providing unpublished data on tunneling in the Twin Cities. Officials of Northern States Power Company and Dr. D. H. Yardley of the University of Minnesota also provided valuable information.

Sources of public or non-proprietary engineering, geologic, and hydrologic data used in this study

City of Minneapolis:
- Department of Public Works
  - Sewer Planning and Design
  - Inspection Department

City of St. Paul:
- Department of Community Services
  - Division of Environmental Protection
  - Housing and Building Code Enforcement Division
- Housing and Redevelopment Authority
- Port Authority
- Department of Public Works
  - Engineering Division
- Public School System

Metropolitan Airports Commission
Metropolitan Waste Control Commission
State of Minnesota:
- Administrative Department
  - Architectural and Engineering Division
- Department of Natural Resources
  - Division of Waters
- Department of Transportation
  - Office of Design Services
  - Office of Materials and Research
- Health Department
  - Division of Environmental Health

United States Department of the Interior
- Geological Survey

University of Minnesota
- Minnesota Geological Survey

Water-well Drillers of Minnesota

Area of study

The Twin Cities metropolitan area comprises about 75 mi²; it includes a central area of about 30 mi² consisting of a 1.6-mile wide corridor that connects and expands into the central business districts (CBD) of the two cities. Selection of the central area was made by the Metropolitan Transit Commission of the Twin Cities.

The estimated population of the Twin Cities metropolitan area in 1976 was 1,993,000, thus ranking the cities 14th in population among metropolitan areas in the Nation.

Twin Cities Tunnels

In addition to shallow communications and utility tunnels and a few short traffic tunnels constructed by cut-and-cover methods, there are many miles of deep tunnels, mainly storm drains and collector sewers. The deep tunnels are cut in the St. Peter Sandstone of Ordovician age that is about 150 feet thick.

The St. Peter Sandstone, which underlies much of the study area is easily excavated and lends itself to rapid, low-cost tunneling methods. Where the total thickness of the sandstone is present, it is overlain by the thin Glenwood Shale and above it the Platteville Formation. The latter is predominantly dolomitic limestone that can provide a strong, stable roof for tunnels. The Glenwood Shale is structurally weak and does not provide a stable dependable roof. Where exposed to air it tends to slake gradually and disintegrate. However, this shale is thin (2–5 feet) and can be stripped from the base of the Platteville to provide a strong stable roof for underground openings. Where small tunnels 3 to 5 feet wide are driven the Glenwood can provide an adequate roof but gradual deterioration should be anticipated.

DATA BASE MAP

The map shows the locations of data sites and types of data used to prepare this report. The data were used to describe the physical properties and the hydrologic and engineering characteristics of the surficial deposits and rock formations. To avoid unnecessary redundancy, a goal of about 25 test borings per 10 mi² was established. Where test borings exceeded this density, only those data judged to be most informative were used. In places where subsurface data were scanty or unavailable for desired depths, geologic and hydrologic conditions were extrapolated from nearby points. The distribution of the data points shown on the map provides a means of judging the reliability for the interpretations made.

DATA COLLECTION

The test borings and other subsurface data were generated by publicly funded projects and are non-proprietary. Success of the data-collection program for this study is attributed to the assistance and cooperation of the listed sources.

An inventory (Olsen and others, 1975) made prior to the data-collection program showed that a large amount of engineering-geology data was available in the public domain. To copy and efficiently locate data points, only enough redundancy was allowed to evaluate date variability and precision and to indicate accurately the soil conditions at any specific site. However, the number of records needed to define on-site lithology was usually less than the number needed to define the variability of the engineering characteristics of each rock or soil type identified.

Test borings or test excavations are generally made at construction sites. In order to locate each data point accurately, construction plans with boring locations had to be collected in addition to the geologic logs. Difficulty was experienced in locating data points owing to the nonstandardized methods used to survey boring sites and site altitudes. Furthermore, most data sources tend to file boring records separately from relevant site plans or do not file data geographically. Some potential sources were not used even though they had large volumes of data, simply because their filing systems were too unwieldy for the time constraints of this study. Also, large amounts of data are lost because public agencies periodically decrease their files due to storage limitations.

DATA QUALITY

About 4,000 test-boring logs and construction records were used in this study in addition to more than 900 water-well records on file at the Minnesota Geological Survey. Not all data sites are shown on the base map because some records are redundant, too closely spaced for map scale, or located just outside the study area. Quality of the data is directly dependent upon the methods used to record it. Data for a given boring varies from a detailed description of soil characteristics to sketchy information. Generally, corroborating data from different sources tend to verify the accuracy of the data base at any locality, providing these data are available in sufficient quantity.

Many of the data pertain to geologic and hydrologic conditions within 30 to 35 feet of land surface, with fewer data describing deeper-lying, unconsolidated deposits and bedrock. Laboratory and field tests are more commonly available for unconsolidated deposits than for bedrock. Also, data are sparse in residential parts of the study area.

DATA STORAGE AND RETRIEVAL

Original records obtained for this study were converted to machine-readable data on standard coding forms, keypunched, and placed on magnetic tape for permanent storage. During periods of intensive computer manipulation of data, copies of these files are transferred to on-line disk units. Data can be retrieved and displayed on a point-by-point printout or on maps of various scales using an electrostatic plotter. These maps have a plotting resolution of 0.01 inch and represent geologic data by coded symbols and numeric quantities. Automated contouring of the data is also possible.

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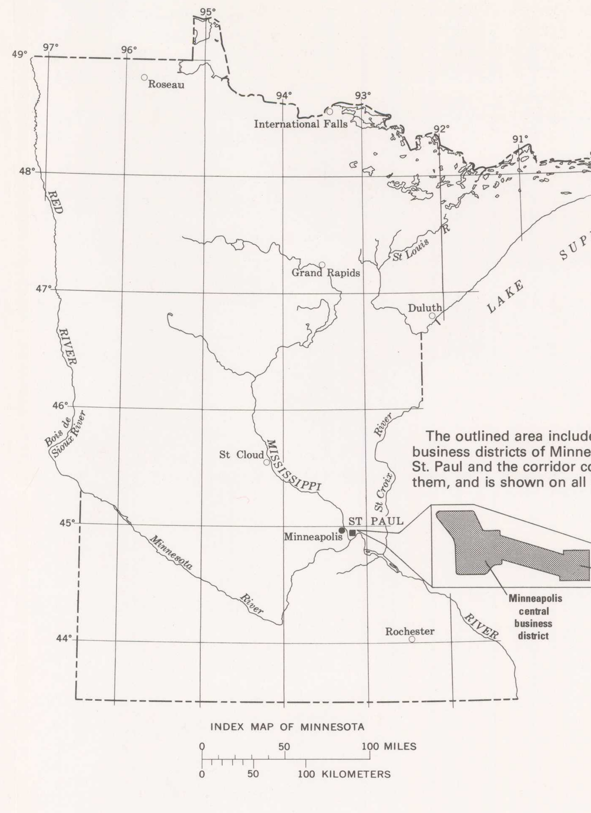

The outlined area includes the central business districts of Minneapolis and St. Paul and the corridor connecting them, and is shown on all maps.

INDEX MAP OF MINNESOTA

M.F. How

MAP I-1157
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC AND HYDROLOGIC ASPECTS OF TUNNELING IN THE TWIN CITIES AREA, MINNESOTA
Edited by Ralph F. Norvitch and Matt S. Walton

Prepared by the
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GEOLOGIC AND HYDROLOGIC ASPECTS OF TUNNELING IN THE TWIN CITIES AREA, MINNESOTA

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