DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

M.F. Hult

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1157
PLATE 6

EXPLANATION

900 — Water-table contour
Shows altitude of water table. Contour interval 20 feet except where indicated, dashed where approximate. National Geodetic Vertical Datum of 1929

○ Observation well
Source of periodic water-level measurements

• Data point
Source of reported water level from well or boring

Area where water table is in bedrock

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

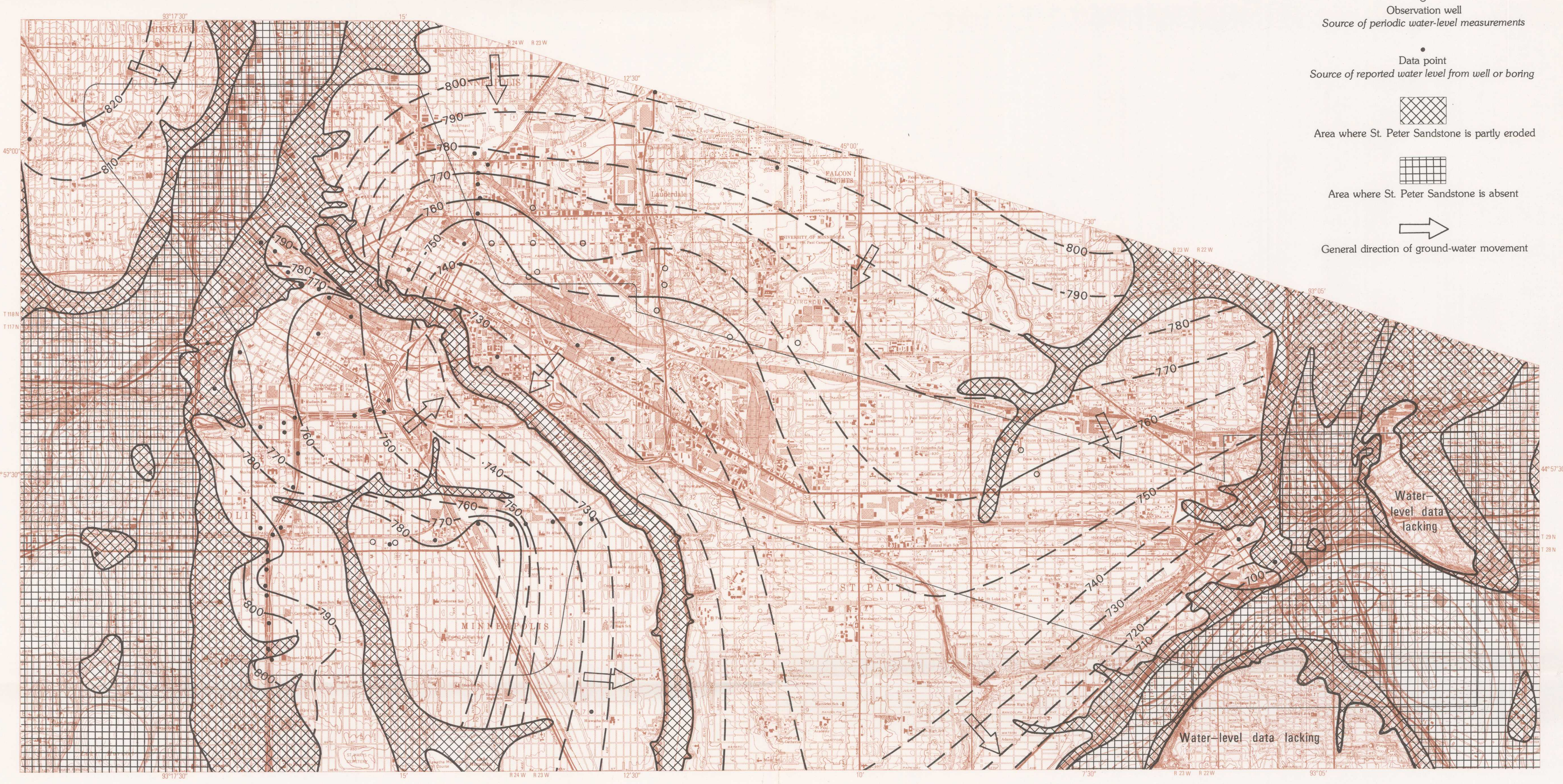
SCALE 1:48 000
1 0 1 2 3 MILES
1 0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

FIGURE 2.—CONFIGURATION OF THE WATER TABLE IN SURFICIAL DEPOSITS

Lines of equal water-level altitude in the surficial deposits (drift) are shown on the water-table contour map (fig. 2). Approximate thickness of unsaturated materials along proposed tunnel routes can be determined by superpositioning a surface-topography map over the water-table map and subtracting the altitude of a water-table contour from the altitude of the overlying topographic contour. Interpolation of values must be made for points between contours.

Most tunnels in the Twin Cities area below the water table would encounter saturated rocks, except in those unsaturated parts of the St. Peter Sandstone below a perched water table. The perched water rests on a confining bed, generally the Decorah Shale but in places the underlying Platteville Formation and Glenwood Shale.

The water-table configuration shown on the map is approximate; it is estimated to be accurate to within 20 feet in the uplands and 10 feet in the river valleys. The control points, mostly wells, represent water levels recorded at intervals over many seasons and many years. Hydrographic features also are used for control; for example, places where land-surface contours intersect streams and lakes. Where control is least reliable, the contour lines are dashed. Data are lacking to extend the water-table contours into the bedrock.



EXPLANATION

800 — Potentiometric contour
Shows altitude of water level in wells completed in the St. Peter Sandstone. Contour interval 10 feet, dashed where approximate. National Geodetic Vertical Datum of 1929

○ Observation well
Source of periodic water-level measurements

• Data point
Source of reported water level from well or boring

Area where St. Peter Sandstone is partly eroded

Area where St. Peter Sandstone is absent

General direction of ground-water movement

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 1:48 000
1 0 1 2 3 MILES
1 0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

FIGURE 3.—POTENTIOMETRIC SURFACE OF WATER IN THE ST. PETER AQUIFER

The potentiometric surface of the St. Peter aquifer is defined by the levels (altitudes) to which water will rise in tightly cased wells completed in fully saturated parts of the St. Peter Sandstone. Where water levels vary appreciably with depth, the potentiometric surface is meaningful only if it describes static water levels along a specified stratum or datum. Because areally extensive silty zones having relatively low permeability occur at different depths within the otherwise uniformly graded sandstone, several potentiometric surfaces may occur. The data points used to draw the map are mostly wells completed in the upper half of the sandstone. Thus the particular potentiometric surface drawn is that for the upper part of the aquifer, the part most likely to be excavated for rapid-transit tunnels.

The configuration of the potentiometric surface shown on the map is approximate, for wells in St. Peter Sandstone are few and the water-levels used as control represent data from different seasonal periods in different years. To map a surface precisely many more control points are needed and the water-level data should be collected in as short a time span as possible.

Because both artesian and water-table conditions occur in the St. Peter aquifer, the contours represent a composite artesian and water-table surface. The condition prevailing at any given place is indicated on the head-relationship map shown in figure 5.

EXPLANATION

760 — Structure contour
Shows altitude of top of St. Peter Sandstone, drawn only where entire formation is present. Contour interval is 10 feet. National Geodetic Vertical Datum of 1929

Area where St. Peter Sandstone is partly eroded

Area where St. Peter Sandstone is absent

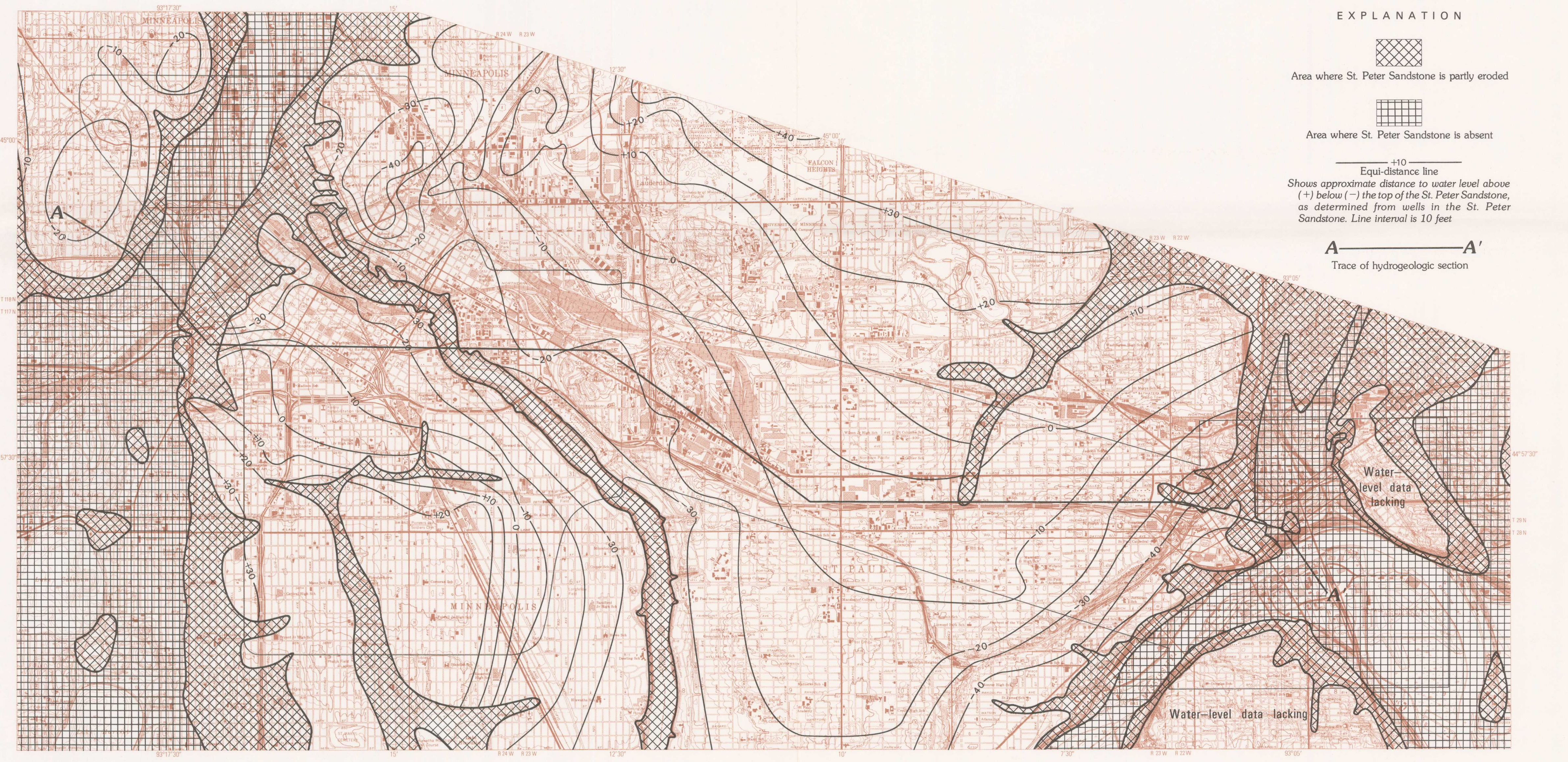
Base from U.S. Geological Survey, Minneapolis North, Minneapolis South, New Brighton, St. Paul East and St. Paul West 1:24,000, 1967
Photorevision as of 1972

SCALE 1:48 000
1 0 1 2 3 MILES
1 0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

FIGURE 4.—STRUCTURE CONTOURS ON THE TOP OF THE ST. PETER SANDSTONE

Configuration of the upper surface of the St. Peter Sandstone is shown on the structure-contour map (fig. 4). Contours are drawn only where the entire thickness (about 150 feet) of the formation is present. In the contoured area, the sandstone is overlain by Glenwood Shale and, at least in part, by Platteville Formation. Where the Platteville does not crop out at the surface, it is overlain by Decorah Shale or surficial deposits. Patterned areas indicate where the sandstone is either partly or entirely eroded. Here the sandstone or underlying rock surface (Prairie du Chien Group or Jordan Sandstone) is overlain by drift. (Sufficient data were not available to draw structure contours on the sandstone surface in the partly eroded areas.)

This map will be useful in selecting tunnel alignments and grades in the St. Peter Sandstone that will encounter minimal areas of other rocks and surficial deposits. The presence of such other rocks presumably would necessitate changes in tunneling methods that could slow progress and increase project costs.



EXPLANATION

Area where St. Peter Sandstone is partly eroded

Area where St. Peter Sandstone is absent

+10 — Equi-distance line
Shows approximate distance to water level above (+) below (−) the top of the St. Peter Sandstone, as determined from wells in the St. Peter Sandstone. Line interval is 10 feet

A——A′ Trace of hydrogeologic section

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 1:48 000
1 0 1 2 3 MILES
1 0 1 2 3 4 5 KILOMETERS
CONTOUR INTERVAL 10 FEET
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FIGURE 5.—HYDROSTATIC HEAD IN RELATION TO THE TOP OF THE ST. PETER SANDSTONE

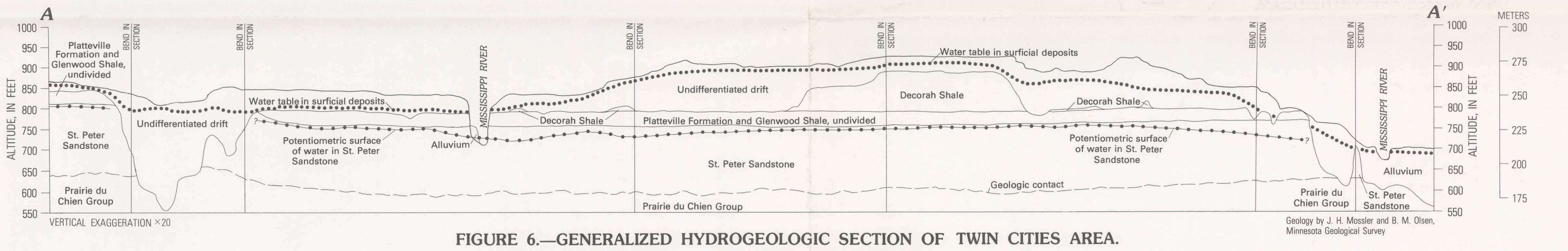

FIGURE 6.—GENERALIZED HYDROGEOLOGIC SECTION OF TWIN CITIES AREA.

The head-relationship map (fig. 5) shows where the St. Peter Sandstone is either unsaturated or saturated. The map is derived by overlaying the potentiometric-surface map (fig. 3) on the structure-contour map (fig. 4) and computing differences in altitude values at respective contour-line crossings. The resultant values are then contoured. Where the values are negative (−), the sandstone is unsaturated to the depths indicated and the water is under unconfined conditions. Where values are positive (+) or zero (0), the sandstone is fully saturated and the contained water is under confined conditions. That is, water in a tightly cased well completed in the sandstone will rise above the top of the sandstone to the heights indicated.

Section A–A′ shows geologic and hydrologic conditions along a hypothetical tunnel route. Based on recommendations made by Nelson and Yardley (1973), transit tunnels in this area should be constructed in the St. Peter Sandstone, immediately below the Platteville Formation. Any number of routes could be selected for consideration by planners through use of figures 4, 5, and 8 (plate 7). Figure 4 enables selection of altitudes and alignments such that all or most of a tunnel can be completed in St. Peter Sandstone. Figure 5 enables selection of routes where dewatering problems may be minimal; and figure 8 shows places where selected routes may expect to encounter existing major tunnels.

HYDROGEOLOGIC SETTING

By
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1979

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