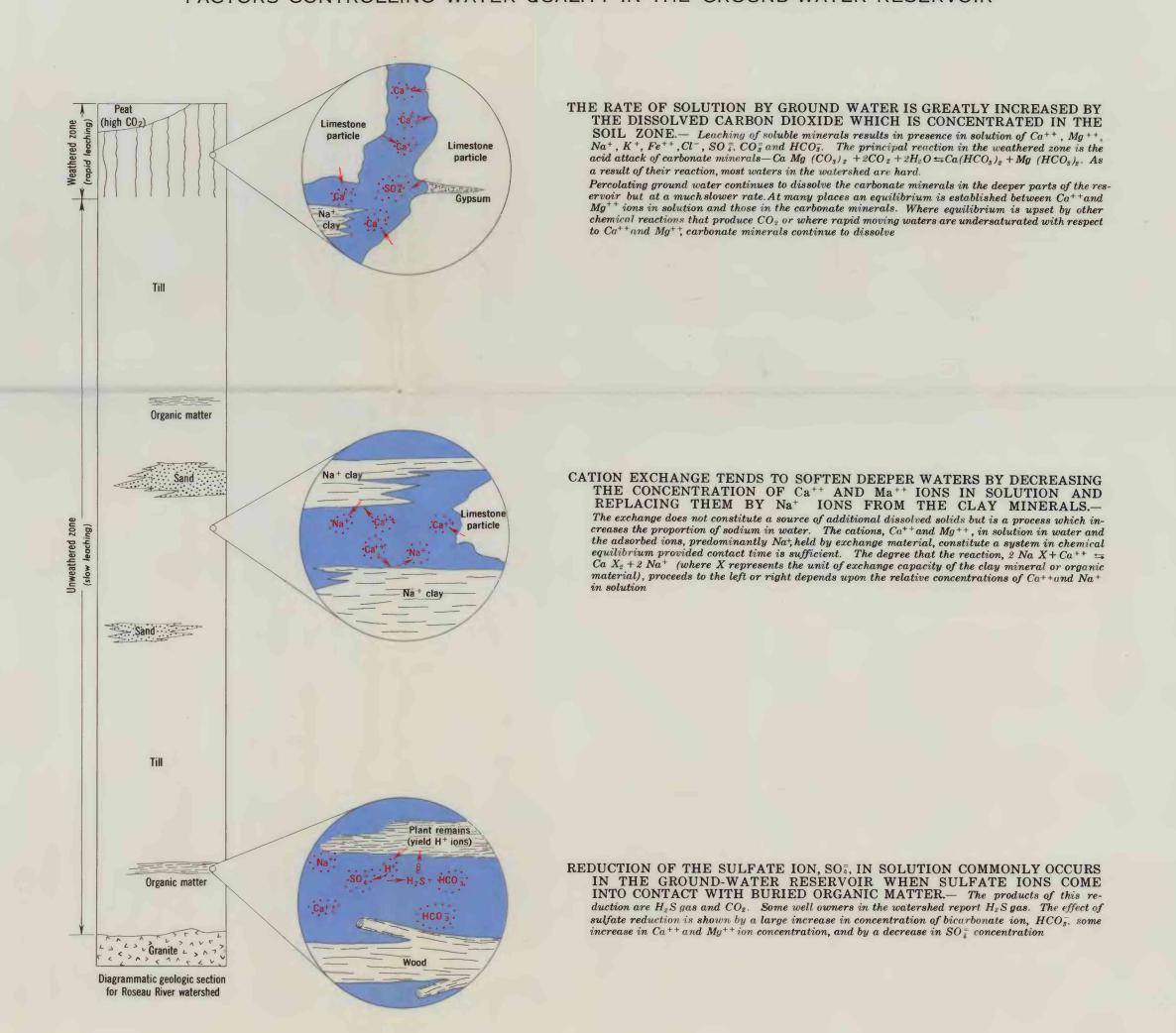
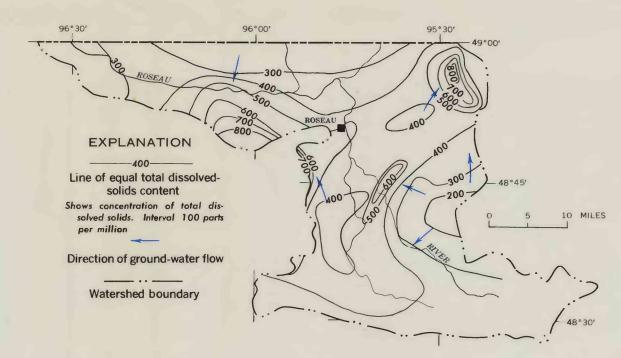


WATER QUALITY

FACTORS CONTROLLING WATER QUALITY IN THE GROUND-WATER RESERVOIR

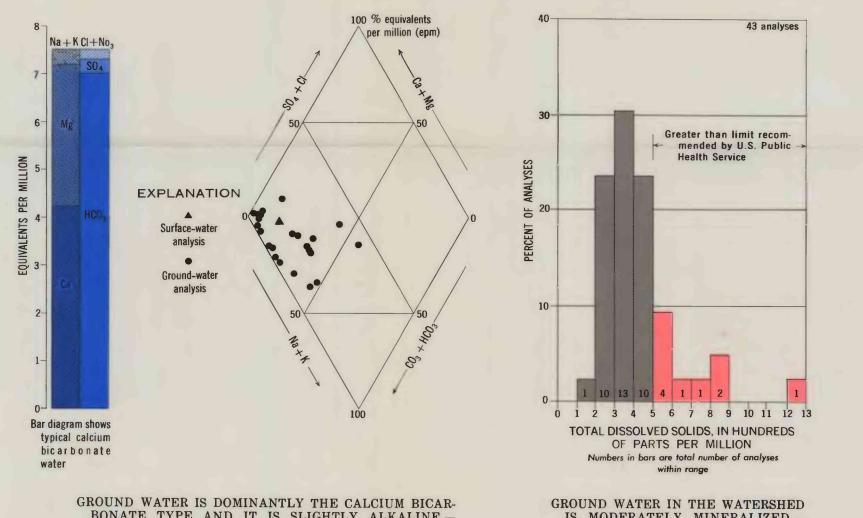




AREAL DIRECTION OF GROUND-WATER MOVEMENT IS REFLECTED BY LATERAL CHANGES IN DISSOLVED-SOLIDS CONTENT.— In general, waters of lowest dissolved solids occur in recharge areas and increase in dissolved solids toward discharge areas. The water-table map and dissolved-solids map are similar in pattern, thus flow lines of water movement can be drawn on the basis of iso-concentration lines. Low values of dissolved solids indicate recharge in the larger sandy areas in the southeastern and southwestern parts of the watershed. Indications are that dissolved-solids content is low in the sandy area of the Pine Creek drainage in Canada, thus indicating recharge here also. Particularly high concentration of dissolved solids in the swampy area of the northeastern part of the watershed may be due to the movement of water for considerable distance, local con-

WATER-QUALITY CHARACTERISTICS

centration by evaporation, or solution due to availabilty of CO2



GROUND WATER IS DOMINANTLY THE CALCIUM BICARBONATE TYPE AND IT IS SLIGHTLY ALKALINE.—
Hydrogen-ion concentration, pH, ranges from 7.4 to 8.3, the mean is 7.7, for the 24 analyses. At this pH nearly all the alkalinity is due to the bicarbonate ion, HCO_3^- . Sulfate ion, SO_4^- , is low and ranges from 1 part per million (ppm) to 134 ppm, and has a mean of 12 ppm. The typical water is low in free carbon dioxide, free from hydrogen sulfide, very hard, low in chloride, and is moderately high in iron. The water is suitable for most municipal and agricultural uses

GROUND WATER IN THE WATERSHED IS MODERATELY MINERALIZED.—
Dissolved-solids content ranges from 192 to 830 ppm, with one exception, and the median is 340 ppm. This is the normal range for waters in the glacial drift in northwestern Minnesota. There is no good correlation between well depth and dissolved-solids content for the water samples that were analyzed. Water samples were obtained from wells vary-

ing in depth from 17 to 175 feet

MOST GROUND WATER IS VERY HARD.—
Hardness is due mainly to the presence of calcium and magnesium compounds, generally bicarbonates and sulfates, which react with soap to form insoluble products. The mineral salts that cause hardness can form incrustation on well screens, in pipes, and in boilers. Total hardness, as expressed in equivalent amount of calcium carbonate, ranges from 142 to 725 ppm and the median is 253 ppm

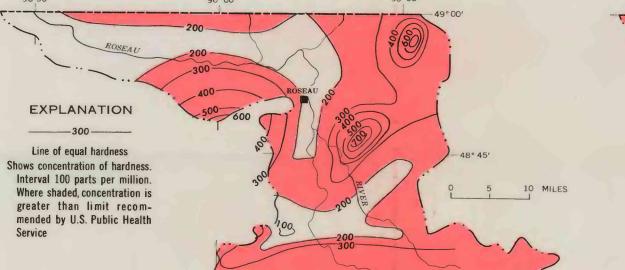
INTERIOR-GEOLOGICAL SURVEY, WASHINGTON, D.C.-1967-W66420

0 60 120 180 240 300 360 420 480 540 600 660 720 780

HARDNESS, IN PARTS PER MILLION

Numbers in bars are total number of analyses

within range



HARDNESS OF GROUND WATER WITHIN THE SHADED AREA CAUSES MOD-ERATE TO SEVERE INCRUSTATIONS OF WELL SCREENS AND PIPES.— Where hardness exceeds 500 ppm, incrustation on domestic well screens may require replacement after several years of use. Maintenance of original yield in the area will require periodic treatment of well screens. By pumping wells at a low rate, the effect of incrustation can be minimized

WATER-QUALITY PROBLEMS

96°30′

96°00′

95°30′

48°45′

Line of equal iron content
Shows concentration of iron. Interval 1.0 part per million
Supplemental contour at 0.3
part per million
Where shaded, concentration is greater than limit recommended by U.S. Public Health Service

AREA CAUSES MOD
CONCENTRATION OF DISSOLVED IRON IN THE SHADED AREA IS SUFFICIENT

TO CAUSE PRECIPITATION OF RELATIVELY INSOLUBLE FERRIC HYDROX-

IDE WHEN WATER IS EXPOSED TO AIR.— Iron also contributes to incrustation of well

screens. Removal of iron is required before using the water for laundering

WATER RESOURCES OF THE ROSEAU RIVER WATERSHED, NORTHWESTERN MINNESOTA