DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

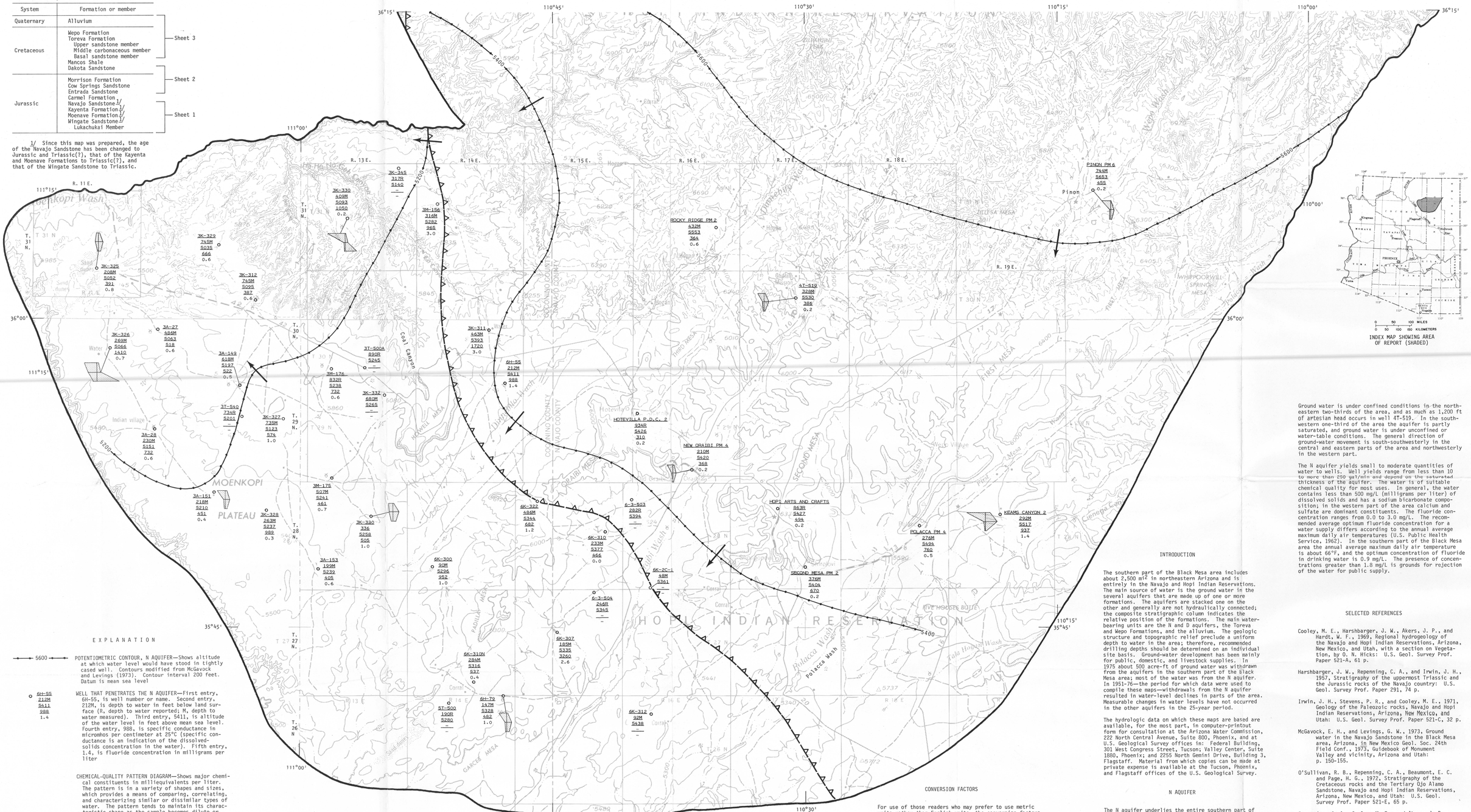
PREPARED IN COOPERATION WITH THE
ARIZONA WATER COMMISSION

WATER-RESOURCES INVESTIGATIONS 77-41
OPEN-FILE REPORT (SHEET 1 OF 3)

Composite stratigraphic column for the southern part of the Black Mesa area

System	Formation or member	
Quaternary	Alluvium	
Cretaceous	Wepo Formation Toreva Formation Upper sandstone member Middle carbonaceous member Basal sandstone member Mancos Shale Dakota Sandstone	Sheet 3
Jurassic	Morrison Formation Cow Springs Sandstone Entrada Sandstone Carmel Formation	Sheet 2
Jurassic	Navajo Sandstone 1/ Kayenta Formation 1/ Moenave Formation 1/ Wingate Sandstone 1/ Lukachukai Member	Sheet 1

1/ Since this map was prepared, the age of the Navajo Sandstone has been changed to Jurassic and Triassic(?), that of the Kayenta and Moenave Formations to Triassic(?), and that of the Wingate Sandstone to Triassic.



INDEX MAP SHOWING AREA OF REPORT (SHADED)

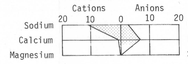
EXPLANATION

5600 — POTENTIOMETRIC CONTOUR, N AQUIFER—Shows altitude at which water level would have stood in tightly cased well. Contours modified from McGavock and Levings (1973). Contour interval 200 feet. Datum is mean sea level

6H-55 212M 5411 988 1.4 — WELL THAT PENETRATES THE N AQUIFER—First entry, 6H-55, is well number or name. Second entry, 212M, is depth to water in feet below land surface (R, depth to water reported; M, depth to water measured). Third entry, 5411, is altitude of the water level in feet above mean sea level. Fourth entry, 988, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in the water). Fifth entry, 1.4, is fluoride concentration in milligrams per liter

CHEMICAL-QUALITY PATTERN DIAGRAM—Shows major chemical constituents in milliequivalents per liter. The pattern is in a variety of shapes and sizes, which provides a means of comparing, correlating, and characterizing similar or dissimilar types of water. The pattern tends to maintain its characteristic shape as the sample becomes dilute or concentrated, and the pattern size varies in proportion to the variation in dissolved solids

Milliequivalents per liter



CONFINED / UNCONFINED — APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS IN THE N AQUIFER

GENERALIZED DIRECTION OF GROUND-WATER FLOW

ARBITRARY BOUNDARY OF GROUND-WATER AREA

Ground water is under confined conditions in the northeastern two-thirds of the area, and as much as 1,200 ft of artesian head occurs in well 4T-519. In the southwestern one-third of the area the aquifer is partly saturated, and ground water is under unconfined or water-table conditions. The general direction of ground-water movement is south-southwesterly in the central and eastern parts of the area and northwesterly in the western part.

The N aquifer yields small to moderate quantities of water to wells. Well yields range from less than 10 to more than 250 gal/min and depend on the saturated thickness of the aquifer. The water is of suitable chemical quality for most uses. In general, the water contains less than 500 mg/L (milligrams per liter) of dissolved solids and has a sodium bicarbonate composition; in the western part of the area calcium and sulfate are dominant constituents. The fluoride concentration ranges from 0.0 to 3.0 mg/L. The recommended average optimum fluoride concentration for a water supply differs according to the annual average maximum daily air temperatures (U.S. Public Health Service, 1962). In the southern part of the Black Mesa area the annual average maximum daily air temperature is about 66°F, and the optimum concentration of fluoride in drinking water is 0.9 mg/L. The presence of concentrations greater than 1.8 mg/L is grounds for rejection of the water for public supply.

INTRODUCTION

The southern part of the Black Mesa area includes about 2,500 mi² in northeastern Arizona and is entirely in the Navajo and Hopi Indian Reservations. The main source of water is the ground water in the several aquifers that are made up of one or more formations. The aquifers are stacked one on the other and generally are not hydraulically connected; the composite stratigraphic column indicates the relative position of the formations. The main water-bearing units are the N and D aquifers, the Toreva and Wepo Formations, and the alluvium. The geologic structure and topographic relief preclude a uniform depth to water in the area; therefore, recommended drilling depths should be determined on an individual site basis. Ground-water development has been mainly for public, domestic, and livestock supplies. In 1975 about 500 acre-ft of ground water was withdrawn from the aquifers in the southern part of the Black Mesa area; most of the water was from the N aquifer. In 1951-76—the period for which data were used to compile these maps—withdrawals from the N aquifer resulted in water-level declines in parts of the area. Measurable changes in water levels have not occurred in the other aquifers in the 25-year period.

The hydrologic data on which these maps are based are available, for the most part, in computer-printout form for consultation at the Arizona Water Commission, 222 North Central Avenue, Suite 800, Phoenix, and at U.S. Geological Survey offices in: Federal Building, 301 West Congress Street, Tucson; Valley Center, Suite 1880, Phoenix; and 2255 North Gemini Drive, Building 3, Flagstaff. Material from which copies can be made at private expense is available at the Tucson, Phoenix, and Flagstaff offices of the U.S. Geological Survey.

N AQUIFER

The N aquifer underlies the entire southern part of the Black Mesa area. The N aquifer consists of the Navajo Sandstone, the Kayenta Formation, the Moenave Formation, and the Lukachukai Member of the Wingate Sandstone. The aquifer is composed of an alternating sequence of fine-grained sandstone and siltstone. The aquifer thins eastward and is 1,300 ft thick near the Moenkopi Plateau near the west boundary of the area and 800 ft thick in the northeast corner (Harshbarger and others, 1957, pl. 2).

CONVERSION FACTORS

For use of those readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below:

Multiply English unit	By	To obtain metric unit
feet (ft)	0.3048	meters (m)
square miles (mi²)	2.590	square kilometers (km²)
acre-feet (acre-ft)	.001233	cubic hectometers (hm³)
gallons per minute (gal/min)	.06309	liters per second (L/s)

SELECTED REFERENCES

Cooley, M. E., Harshbarger, J. W., Akers, J. P., and Hardt, W. F., 1969, Regional hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a section on Vegetation, by O. N. Hicks: U.S. Geol. Survey Prof. Paper 521-A, 61 p.

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Irwin, J. H., Stevens, P. R., and Cooley, M. E., 1971, Geology of the Paleozoic rocks, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah: U.S. Geol. Survey Prof. Paper 521-C, 32 p.

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O'Sullivan, R. B., Repenning, C. A., Beaumont, E. C. and Page, H. G., 1972, Stratigraphy of the Cretaceous rocks and the Tertiary Ojo Alamo Sandstone, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah: U.S. Geol. Survey Prof. Paper 521-E, 65 p.

Repenning, C. A., Cooley, M. E., and Akers, J. P., 1969, Stratigraphy of the Chinle and Moenkopi Formations, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah: U.S. Geol. Survey Prof. Paper 521-B, 34 p.

U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

BASE FROM U.S. GEOLOGICAL SURVEY
FLAGSTAFF 1:250,000, 1970,
MARBLE CANYON 1:250,000, 1970,
AND SHIPROCK 1:250,000, 1969

5 0 5 MILES
5 0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
DATUM IS MEAN SEA LEVEL

GROUND-WATER CONDITIONS IN THE N AQUIFER

MAPS SHOWING GROUND-WATER CONDITIONS IN THE SOUTHERN PART OF THE BLACK MESA AREA, NAVAJO, APACHE, AND COCONINO COUNTIES, ARIZONA—1976

By

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