GL01531 - DOC #1

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1033-F

EXPLANATION

Dissolved-solids concentrations of water in streams, lakes, and reservoirs are in the ranges specified most of the time. Discharge-weighted average concentrations of dissolved solids and dissolved-solids concentrations of water in streams during periods of direct snowmelt and storm runoff may be less than specified.

Dissolved solids, in milligrams per liter

100-250 | 250-500 | 500-1000 | 1000-3000 | 3000-10,000

100-500 | 250-1000 | 500-3000

Area of Lake Powell at maximum lake stage

Major drainage divide

INTRODUCTION

This is one of a series of maps that describes the geology and related natural resources of the Kaiparowits coal-basin area, Utah. Published sources of water-quality data used in the preparation of this map included Iorns, Hembree, Phoenix, and Oakland (1964), Goode (1966, 1969), U.S. Bureau of Land Management (1976), and U.S. Geological Survey (1961-75). Sources of unpublished data included the U.S. Bureau of Reclamation and the Southeastern Utah Association of Governments. Some of the unpublished data was provided by Vaughn Hansen Associates of Salt Lake City, Utah, whose assistance is gratefully acknowledged.

RUNOFF

As noted by Price (1978), runoff in the Kaiparowits coal-basin area—except parts of the Escalante River basin—is intermittent or ephemeral. Shown on this map are the ranges of dissolved-solids concentrations that can be expected most of the time in runoff (including streams, small lakes, and reservoirs) when present. Dissolved-solids concentrations in direct storm and snowmelt runoff generally are lower than the ranges shown here, as are the discharge-weighted average dissolved-solids concentrations in runoff from the area (Price and Waddell, 1973, sheet 2). The ranges shown here are based chiefly on (1) chemical analyses of about 130 water samples collected at about 40 sites throughout the area—mostly during low runoff periods from 1972 to 1975—and (2) the local geology (Hackman and Wyant, 1973) and general chemical quality of ground water (Price, 1977)—both of which significantly influence the chemical quality of runoff. Other factors taken into consideration while compiling the map included mean altitudes of individual drainage basins, normal annual precipitation, mean annual runoff, surface-water uses, and evapotranspiration along water courses. Of the surface-water sites sampled, 12 are along the main stem and headwater tributaries of the Escalante River; 14 are in the Wahweap, Warm, and Last Chance Creek drainage basins; 5 are in the Paria River drainage area; and 1 is in the East Fork Sevier River. The rest are in miscellaneous streams, most of which drain directly into Lake Powell. The expanded ranges of dissolved-solids concentration (100-500, 250-1000, and 500-3000) shown on this map are for those areas where there were insufficient data for better definition of the surface-water quality.

Runoff in the Kaiparowits coal-basin area generally ranges from fresh to moderately saline according to the following classification commonly used by the U.S. Geological Survey. (See Hem, 1970, p. 219.)

Class	Dissolved-solids concentration (milligrams per liter)
Fresh	Less than 1,000
Slightly saline	1,000 to 3,000
Moderately saline	3,000 to 10,000
Very saline	10,000 to 35,000
Briny	More than 35,000

The maximum concentration of dissolved solids recommended by the U.S. Public Health Service (1962, p. 7) for drinking water is 500 mg/L. However, waters containing more than 1,000 mg/L are used for this purpose in some areas where fresher water is unavailable.

Runoff is freshest in the headwaters of the Escalante River, which have dissolved-solids concentrations of generally less than 250 mg/L even during low-flow periods; runoff is most saline along the lower reaches of Wahweap, Warm, and Last Chance Creeks, which have dissolved-solids concentrations of generally more than 3,000 mg/L. Although not shown on the map, there may be local pools of very saline to briny water in these and other lower stream reaches, owing to concentration of dissolved solids by evapotranspiration.

The principal factors contributing to the salinity of the runoff in the Kaiparowits coal-basin area are irrigation return flows (to the Paria and Escalante Rivers), seepage of saline ground water to streams (especially in or downstream from outcrops of the Mancos and Tropic Shale), and evapotranspiration along water courses. Saltcedar, a phreatophyte that can consume more than 7 feet (2 m) of water per year under 100 percent volume density and ideal growing conditions (Robinson, 1958, p. 75), is well established along the Paria River, lower Wahweap Creek, Alvey Wash, and other streams in the area. Consumptive use of streamflow by these plants significantly concentrates the salts in the remaining flows. During periods of very low runoff, salt deposits are left on the beds and banks of such streams as the Paria River and Wahweap, Warm, and Last Chance Creeks by depleted streamflow and effluent ground water. These salts are readily redissolved in the initial surges of subsequent periods of runoff and increase the salinity of that runoff.

Runoff in the headwaters of the Escalante River and most other areas where dissolved-solids concentrations are generally less than 500 mg/L is of a calcium bicarbonate type. Runoff from other areas is generally of a calcium sulfate or sodium sulfate type.

LAKE POWELL

Although considerable quality-of-water data have been collected in Lake Powell since it began filling in 1963, only general information about the chemical quality of the water in the lake is given herein. The reader is referred to Blim, Stewart, and Wilkes (1973), Standiford, Potter, and Kidd (1973), and Reynolds and Johnson (1974) for more detailed information about the chemical quality and major-element geochemistry of the lake.

As shown on this map, dissolved-solids concentrations of the lake water are in the range of from 500 to 1,000 mg/L (1976 salinity level). During 1965-70 the U.S. Bureau of Reclamation collected and analyzed 54 near-surface and 54 near-bottom samples from the lake at a site in the Wahweap Creek bay. Dissolved-solids concentrations of the near-surface samples ranged from 291 to 759 mg/L and averaged 554 mg/L; dissolved-solids concentrations of the near-bottom samples ranged from 417 to 973 mg/L and averaged 815 mg/L. According to Reynolds and Johnson (1974), Lake Powell has an overall average salinity of about 500 mg/L. The lake water has a mixed chemical character with calcium and sodium the dominant cations and sulfate the dominant anion.

Although Wahweap, Warm, and Last Chance Creeks discharge moderately saline water into Lake Powell, the total annual salt load contributed to the lake by those streams is relatively small. For example, the total annual salt discharged by those streams into Lake Powell is about 24,500 tons (22,225 t), assuming the streams have a total mean annual runoff of 6,000 acre-feet (7.4 hm^3) (U.S. Bureau of Land Management, 1976, p. II-156-II-157) and a discharge-weighted average dissolved-solids concentration of 3,000 mg/L. This is only 0.3 percent of the total estimated salt load added to the lake by the Colorado and San Juan Rivers under 1974 conditions (modified) (U.S. Dept. Interior, 1977, p. 65).

REFERENCES CITED

Blim, D., Stewart, A., and Wilkes, S., 1973, The limnology of Wahweap and Warm Creek bays of Lake Powell, in Environmental impact studies of the Navajo and Kaiparowits powerplants: Northern Arizona Univ., 2d annual rept., p. 199-215.

Goode, H. D., 1966, Second reconnaissance of the water resources in western Kane County, Utah: Utah Geol. and Mineralog. Survey Water-Resources Bull. 8, 44 p.

_____ 1969, Reconnaissance appraisal of the water resources near Escalante, Garfield County, Utah: Utah Geol. and Mineralog. Survey Water-Resources Bull. 11, 38 p.

Heckman, R. J., and Wyant, D. G., 1973, Geology, structure, and uranium deposits of the Escalante quadrangle, Utah and Arizona: U.S. Geol. Survey Misc. Geol. Inv. Map I-744, scale 1:250,000.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water (2d ed.): U.S. Geol. Survey Water-Supply Paper 1473, 363 p.

Iorns, W. V., Hembree, C. H., Phoenix, D. A., and Oakland, G. L., 1964, Water resources of the Upper Colorado River Basin—Basic data: U.S. Geol. Survey Prof. Paper 442, 1036 p.

Price, Don, 1977, Map showing general chemical quality of ground water in the Kaiparowits coal-basin area, Utah: U.S. Geol. Survey Misc. Geol. Inv. Map I-1033-A, scale 1:125,000.

_____ 1978, Map showing principal drainage basins, principal runoff-producing areas, and selected streamflow data: U.S. Geol. Survey Misc. Geol. Inv. Map I-1033-E, scale 1:125,000.

Price, Don, and Waddell, K. M., 1973, Selected hydrologic data in the Upper Colorado River Basin: U.S. Geol. Survey Hydrol. Inv. Atlas HA-477, scale 1:2,500,000.

Reynolds, R. C., Jr., and Johnson, N. M., 1974, Major element geochemistry of Lake Powell: Lake Powell Research Proj. Bull. 5, 13 p.

Robinson, T. W., 1958, Phreatophytes: U.S. Geol. Survey Water-Supply Paper 1423, 84 p.

Standiford, D. R., Potter, L. D., and Kidd, D. E., 1973, Mercury in the Lake Powell ecosystem: Lake Powell Research Proj. Bull. 1, 21 p.

U.S. Bureau of Land Management, 1976, Final environmental impact statement, Kaiparowits Power Project, Chapter II, Description of the environment: U.S. Bur. Land Management rept., p. II-135-II-160.

U.S. Department of the Interior, 1977, Quality of water, Colorado River basin: U.S. Dept. Interior Progress Rept. 8, 195 p.

U.S. Geological Survey, 1961-75, Water resources data for Utah, Part 2, Water quality records: U.S. Geol. Survey annual series.

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

Base from U.S. Geological Survey 1:250,000 Series
Escalante, 1956 (1970 revision)

SCALE 1:125 000
2 1 0 2 4 6 8 10 MILES
2 1 0 2 4 6 8 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION
NATIONAL GEODETIC VERTICAL DATUM OF 1929

APPROXIMATE MEAN DECLINATION, 1979

MAP SHOWING GENERAL CHEMICAL QUALITY OF SURFACE WATER IN THE KAIPAROWITS COAL-BASIN AREA, UTAH

By
Don Price
1979

For sale by Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225

Interior—Geological Survey, Reston, Va.—1979—G78018