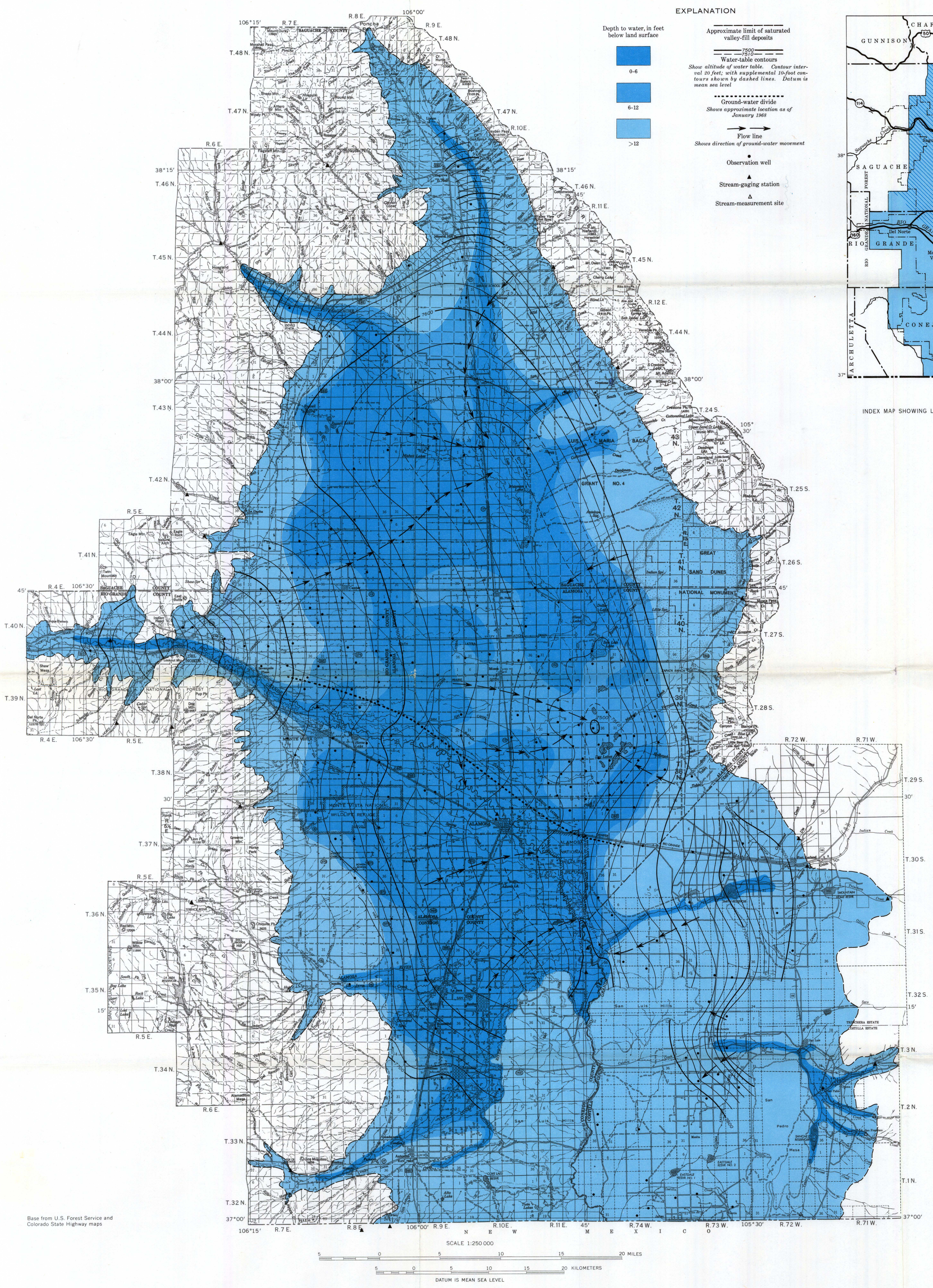
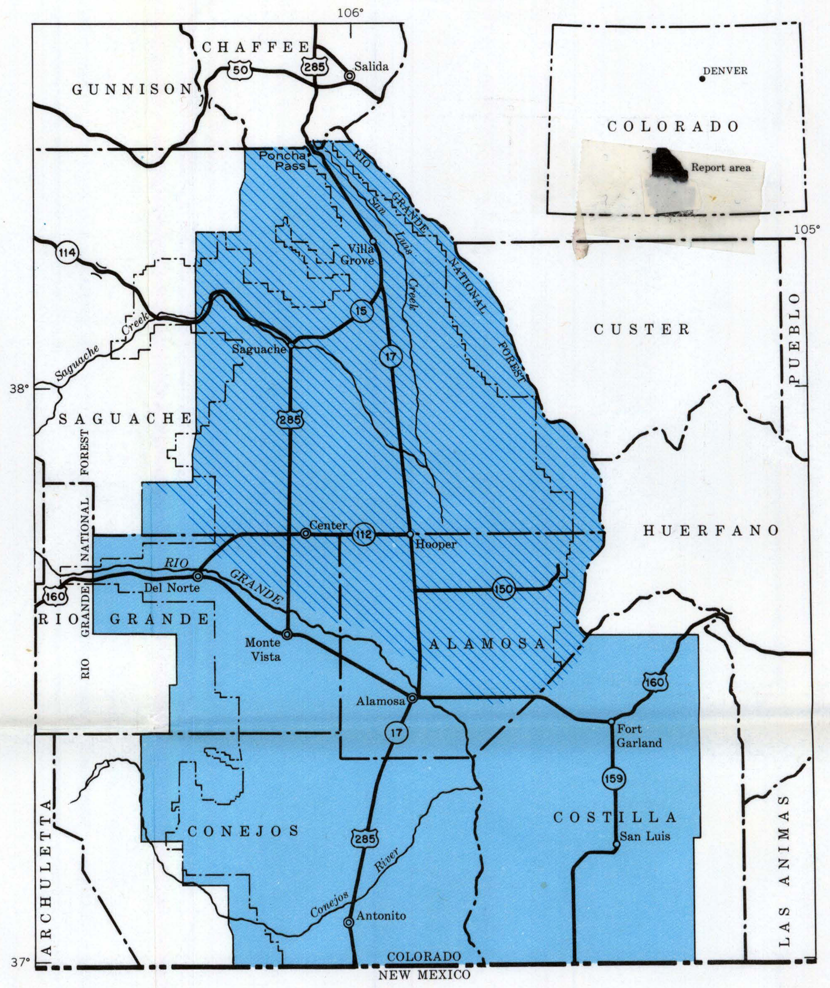
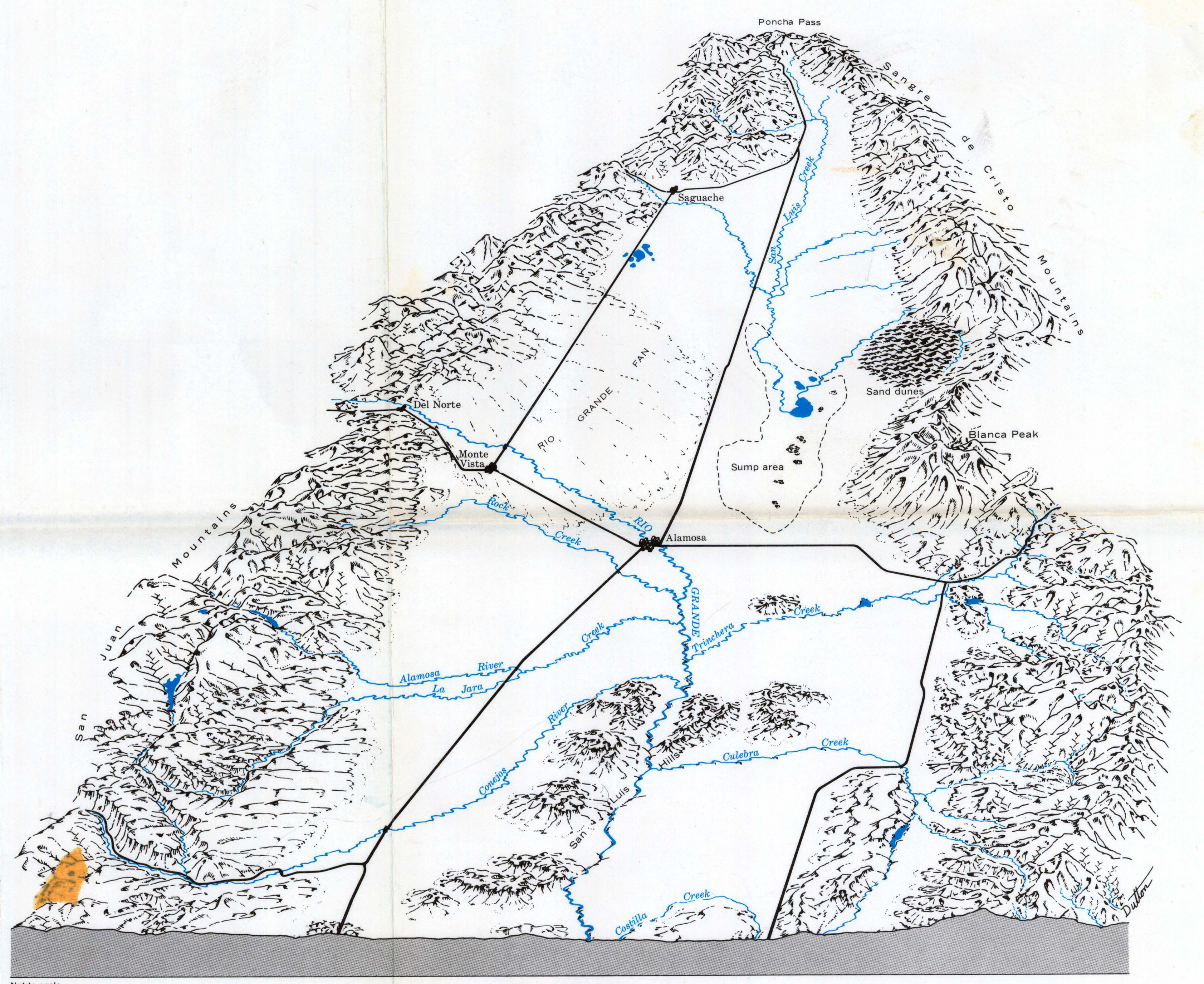
PREPARED IN COOPERATION WITH THE
COLORADO WATER CONSERVATION BOARD
FELIX L. SPARKS, DIRECTOR



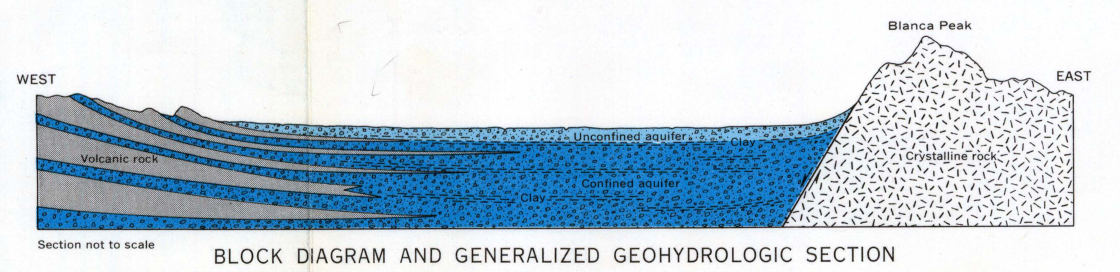
MAP SHOWING CONFIGURATION OF WATER TABLE AND DEPTH TO WATER, JANUARY 1968



INDEX MAP SHOWING LOCATION OF REPORT AREA (SHADED) AND EXTENT OF CLOSED BASIN (RULED PATTERN)



VIEW LOOKING NORTH



BLOCK DIAGRAM AND GENERALIZED GEOHYDROLOGIC SECTION

INTRODUCTION

An investigation of the water resources of the Colorado part of the San Luis Valley was begun in 1966 (see index map) by the U.S. Geological Survey, in cooperation with the Colorado Water Conservation Board. The purpose of the investigation is to provide information for planning and implementing improved water-development and management practices. The major water problems in the San Luis Valley include (1) waterlogging, (2) waste of water by nonbeneficial evapotranspiration, (3) deterioration of ground-water chemical quality, and (4) failure of Colorado to deliver water to New Mexico and Texas in accordance with the Rio Grande Compact.

This atlas describes the hydrologic environment, extent of water-resource development, and some of the problems related to that development. Information presented is based on data collected from 1966 to 1968 and on previous studies. Subsequent reports are planned as the investigation progresses.

The San Luis Valley extends about 100 miles from Poncha Pass near the northeast corner of Saguache County, Colo., to a point about 16 miles south of the Colorado-New Mexico State line. The total area is 3,125 square miles, of which about 3,000 are in Colorado. The valley is nearly flat except for the San Luis Hills and a few other small areas. The Colorado part of the San Luis Valley, which is described in this report, has an average altitude of about 7,700 feet. Bounding the valley on the west are the San Juan Mountains and on the east the Sangre de Cristo Mountains. Most of the valley floor is bordered by alluvial fans deposited by streams originating in the mountains, the most extensive being the Rio Grande fan (see block diagram).

Most of the streamflow is derived from snowmelt from 4,700 square miles of watershed in the surrounding mountains. The northern half of the San Luis Valley is internally drained and is referred to as the closed basin. The lowest part of this area is known locally as the "sump". The remainder of the valley is drained by the Rio Grande and its tributaries.

The climate of the San Luis Valley is arid and a successful agricultural economy would not be possible without irrigation. It is characterized by cold winters, moderate summers, and much sunshine. The average annual precipitation on the valley floor ranges from 7 to 10 inches. More than half the precipitation occurs from July to September. Moisture deficiency in the valley is shown by the graph comparing pan evaporation and precipitation. For the years 1961–67 average pan evaporation for the period April through September was 52.25 inches, but average precipitation for the period was only 5.02 inches. Average annual precipitation was 7.8 inches. Owing to the short growing season (90–120 days), crops are restricted mainly to barley, oats, potatoes, and other vegetables.

HYDROGEOLOGY

The San Luis Valley is a large north-trending structural depression that is downfaulted on the eastern border and hinged on the western side (see generalized geohydrologic section). The valley is underlain with as much as 30,000 feet (Gaca and Karig, 1966, p. 1) of alluvium, volcanic debris, and interbedded volcanic flows and tuffs of Oligocene to Holocene age. Although Siebenthal (1910, p. 39–47) subdivided the deposits into the Santa Fe and Alamosa Formations, later information indicates that it is impossible to differentiate the formations except very locally. In this report, all deposits above the Precambrian crystalline rocks are referred to as valley fill (see table).

The Sangre de Cristo Mountains are composed of igneous, metamorphic, and sedimentary rocks, whereas the San Juan Mountains are composed mainly of volcanic flows, tuffs, and breccias (Larsen and Cross, 1956, p. 62). Many of the lava flows and tuffs from the San Juans dip eastward under the valley floor, and in the southwestern part of the valley, restrict the vertical movement of ground water. Geophysical and drillers' logs indicate that a "clay series" 10 to 80 feet thick occurs throughout much of the central and northern parts of the valley at depths ranging from 50 to 130 feet below land surface. The clay beds also restrict the vertical movement of ground water.

Total annual water supply to the San Luis Valley averages about 2,500,000 acre-feet. About 1,500,000 acre-feet is streamflow derived chiefly from snowmelt in the surrounding mountains and 1,000,000 acre-feet is from precipitation on the valley floor. The streamflow stations shown on the water-table map measure runoff from 80 percent of the drainage area. Runoff from the remainder of the area is estimated by correlation with these stations. Discharge of water from the valley averages about 2,000,000 acre-feet per year by evapotranspiration and about 500,000 acre-feet per year as flow across the State line. The streamflow at the State line averages 445,000 acre-feet and ground-water underflow accounts for a small amount currently estimated as 55,000 acre-feet. About half of the evapotranspiration is nonbeneficial; that is, it does not contribute to the growth of plants having economic value. Much of the nonbeneficial consumption is by phreatophytes in areas where the depth to water is less than 12 feet. The curve on the evapotranspiration graph shows an estimate of the relation of depth to water to annual evapotranspiration from the water table in these areas.

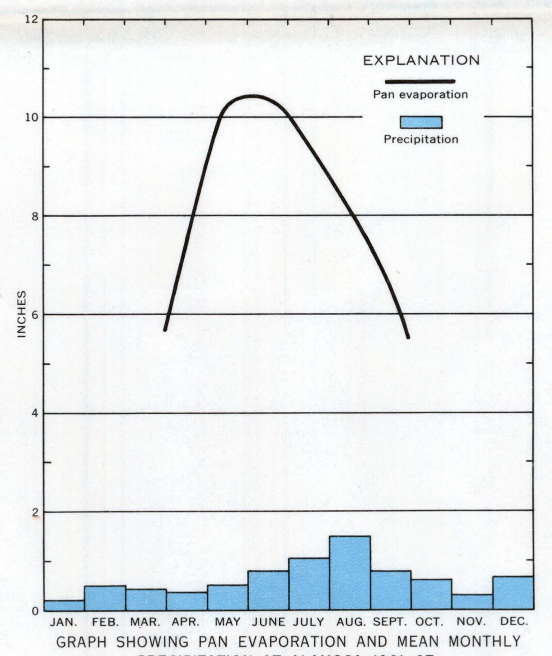
Ground water in the San Luis Valley is obtained from unconfined and confined aquifers. These aquifers contain at least 2 billion acre-feet of water in storage. They are separated by a "clay series" or by a layer of volcanic rocks. These confining beds are discontinuous and lenticular so it is difficult to differentiate between unconfined and confined aquifers except locally. This discontinuity in the "clay series" causes varying degrees of hydraulic connection between the aquifers.

Shallow unconfined ground water occurs almost everywhere in the valley and extends 50 to 200 feet beneath the land surface. The depth to water in the valley is less than 12 feet except along the edges and in most of Costilla County (see depth-to-water map).

Recharge to the unconfined aquifer is mainly by infiltration of applied irrigation water and leakage from canals and ditches. Some water percolates from the many streams flanking the valley and precipitation on the valley floor also recharges the unconfined aquifer. Discharge from this aquifer is by evapotranspiration and seepage to streams. Flow lines show the direction of ground-water movement in the unconfined aquifer in several areas (see water-table map). A slight flexure of the water-table contours shows a ground-water divide north of and parallel to the Rio Grande. The divide, which is marked on the map, is caused by recharge from canal leakage and applied irrigation water. The flow lines show that ground water south of the divide moves toward the Rio Grande and that ground water north of the divide moves into the closed basin where it is discharged by evapotranspiration.

The principal source of recharge to the confined aquifer is seepage from mountain streams that flow across the alluvial fans flanking the valley floor. At the edge of the valley the clay series is absent permitting recharge to beds that constitute the confined aquifer in the main part of the valley. The mountain streams show significant losses as they cross the porous surface of the fans. For example, seepage measurements made July 6, 1967, on Deadman Creek south of Crestone (northeast part of valley) showed that the 7 cfs (cubic feet per second) measured at the canyon mouth was completely dissipated within about 8 miles; all but 1 cfs was lost in the first 3.7 miles. The confined aquifer underlies most of the valley and the water has sufficient head to flow at the land surface. The major discharge from the confined aquifer is by wells, springs, and upward leakage through the confining beds into the unconfined aquifer. A small amount may discharge as underflow into New Mexico.

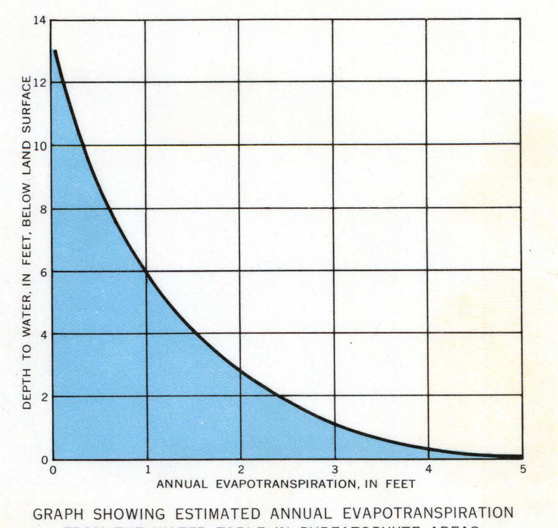
The quality of water in the confined aquifer generally is better than that in the unconfined aquifer according to Powell (1958). The concentration of dissolved solids in 41 samples from the confined aquifer ranged from 70 to 437 mg/l (milligrams per liter) and in 271 samples from the unconfined aquifer ranged from 52 to 13,800 mg/l. The least mineralized water in the unconfined aquifer occurs on the west side of the valley. The mineral concentration increases toward the sump area of the closed basin probably because of solution from the rocks and by concentration by evapotranspiration in areas having a shallow water table.



GRAPH SHOWING PAN EVAPORATION AND MEAN MONTHLY PRECIPITATION AT ALAMOSA, 1961–67

Summary of geologic units and their hydrologic character

System or series	Geologic unit	Hydrologic unit	Thickness (feet)	Physical character	Hydrologic character	Water supply
Holocene to Oligocene	Valley fill	Unconfined aquifer	0-200	Unconsolidated clay, silt, sand, and gravel.	Transmissivity ranges from 1,000 to 250,000 gallons per day per foot. Specific yield is estimated to be 0.20.	Yields as much as 3,000 gallons per minute.
		Confined aquifer	50-30,000	Unconsolidated clay, silt, sand, and gravel interbedded with volcanic flows and tuffs.	Transmissivity ranges from 4,000 to 300,000 gallons per day per foot in zone tapped by existing wells. Storage coefficient is estimated to be 0.0001. Water is under artesian pressure.	Yields as much as 4,000 gallons per minute.
Precambrian	Crystalline rocks			Granite, gneiss, and schist.	Not water bearing.	None.



GRAPH SHOWING ESTIMATED ANNUAL EVAPOTRANSPIRATION FROM THE WATER TABLE IN PHREATOPHYTE AREAS

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1971—W70065

HYDROLOGY OF THE SAN LUIS VALLEY, SOUTH-CENTRAL COLORADO

By
P. A. Emery, A. J. Boettcher, R. J. Snipes, and H. J. McIntyre, Jr.

1971

For sale by U.S. Geological Survey, price $1.00 per set