

*New Mexico State Engineer  
Santa Fe, New Mexico*

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# GROUND - WATER RESOURCES

## of the

# MORA RIVER DRAINAGE BASIN,

## western Mora County, New Mexico

by J. W. MERCER  
E. G. LAPPALA



PREPARED IN COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY, THE UNITED STATES SOIL CONSERVATION SERVICE, AND THE FOUR CORNERS REGIONAL COMMISSION



TECHNICAL REPORT 37

*New Mexico State Engineer  
Santa Fe, New Mexico*

**GROUND - WATER RESOURCES**  
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**MORA RIVER DRAINAGE BASIN,**  
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*E. G. LAPPALA*

*United States Geological Survey*

**1972**



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GROUND-WATER RESOURCES OF THE MORA RIVER DRAINAGE BASIN,  
WESTERN MORA COUNTY, NEW MEXICO

By

J. W. Mercer and E. G. Lappala

ABSTRACT

Shortages of surface water for irrigation during the latter part of the growing season have limited agricultural development in western Mora County in northwestern New Mexico. This report describes the possibilities for developing ground water for supplementary use.

The rocks that underlie western Mora County range in age from Precambrian to Holocene. Rocks of Precambrian age, mostly middle-grade metamorphics and granite intrusives, crop out in the western part of the area. Shales, sandstones, and interbedded limestones of Paleozoic and Mesozoic age crop out over large parts of the remainder of the area. These rocks contain only small localized supplies of ground water. In the north-central and eastern sections of the project area the sedimentary rocks are overlain locally by basalts of Tertiary to Quaternary age.

In nearly all of the Mora River drainage, unconsolidated Quaternary deposits of alluvial, colluvial, lacustrine, and glacial(?) origin fill the stream valleys and contain ground water. Thicknesses of these deposits range from a few feet in tributary valleys to more than 300 feet in the Mora Valley in western Mora County. This thickness in Mora Valley seems to be the result of late Cenozoic downwarping and/or faulting with concurrent river deposition by a south-flowing river during Pleistocene time.

Test drilling, driller's logs, and aquifer tests

indicate that unconsolidated materials filling the valleys above Watrous are heterogeneous and anisotropic. Maximum transmissivity and storage coefficient values for these areas are 40 ft<sup>2</sup>/day (square feet per day) and 0.05, respectively. Although the total storage of ground water in the upper valleys (exclusive of Mora Valley) is about 12,700 acre-feet, it is doubtful if adequate irrigation supplies could be maintained because the saturated thickness of the aquifers is generally not sufficient to permit wells to be pumped at rates practical for irrigation. A limited potential for irrigation exists in Mora Valley because of local saturated thicknesses of as much as 200 feet; however, verification of potential awaits drilling of test holes and substantial testing of the aquifer by pumping.

Ground-water development appears to be feasible in the alluvial valley near Watrous. Unconsolidated deposits in this area are relatively homogeneous and isotropic. Transmissivity values range from 3,400 to 20,000 ft<sup>2</sup>/day, and the assumed maximum storage coefficient value is 0.2. The amount of ground water in storage is about 4,000 acre-feet. Annual withdrawals taken from aquifer storage by pumpage would be substantially replaced by recharge from the river and by return flow from irrigation water. However, should more development of ground water occur, it would eventually deplete streamflow by an amount equal to the increased consumptive use less the amount of water which might be salvaged.

The movement of ground water in the alluvial deposits is generally towards the surface-drainage system. In the upper alluvial valleys rates of movement range from 0.03 to 0.1 foot per day. In the Watrous area rates of movement range from 1 to 10 feet per day.

The chemical quality of both surface and ground water throughout the alluvial valleys of western Mora County meets the established criteria for irrigation use.

## INTRODUCTION

This report presents the results of an investigation of the ground-water resources of the Mora River drainage in western Mora County, New Mexico. The investigation was endorsed by the Steering Committee of the Adelante Resource Conservation and Development Project, an organization

formed by the people in the area to encourage development of the resources of Mora County. The investigation is a cooperative effort of the U.S. Geological Survey, the U.S. Soil Conservation Service, the New Mexico State Engineer Office, and the Four Corners Regional Commission.

### Purpose and Scope of the Investigation

The upper part of the Mora River drainage basin has a history of shortages of surface water for irrigation during the latter part of the growing season. This shortage is one of several factors which tends to limit agricultural products to marginal cash crops such as alfalfa, small grains, and corn. If additional irrigation water was available during critical periods the crop pattern could be shifted to the growing of higher value crops such as fruits and vegetables. Such crops would yield greater returns per acre, thus permitting achievement of increased economic stability. One possibility of alleviating irrigation-water shortages would be the use of wells to supplement surface-water supplies during periods of low streamflow.

Preliminary investigation determined that alluvial deposits in the stream valleys were the most likely source of additional water for irrigation needs. It is the primary purpose of this study to determine if and where ground water is present in alluvial deposits in sufficient quantity and of suitable quality to enable the development of supplemental irrigation wells.

The study has, as a secondary objective, the determination of principal factors affecting ground-water irrigation and development, surface water availability, consumptive-use requirements of different crop types, and present and potential drainage problems in irrigated areas.

Field investigations were begun by Geological Survey personnel in November 1968 and completed in October 1969. Records of wells and springs were collected, water levels in wells were measured, water samples were collected for chemical analysis, aquifer tests were made, surface-water records were obtained, alluvial deposits were mapped, and seismic-refraction studies were made to obtain the thickness of the alluvial deposits. Surface geology was compiled from existing maps and photogeologic mapping was done where needed. A network of 44 observation wells was estab-

lished in the area of study. These wells were measured monthly to determine changes in water levels between the irrigation and nonirrigation seasons.

Basic data for wells and springs in the study area were collected by E. F. Rush and J. L. Hughes, U.S. Geological Survey, Carson City, Nevada, and W. D. Purtymun. The remainder of the field work (including the seismic refraction study), interpretation of data, and compiling of the report was done by J. W. Mercer and E. G. Lappala.

The results of the seismic refraction studies, contained in a separate report by Mercer and Lappala (1970), are used freely in this report.

### Location and Extent of the Area

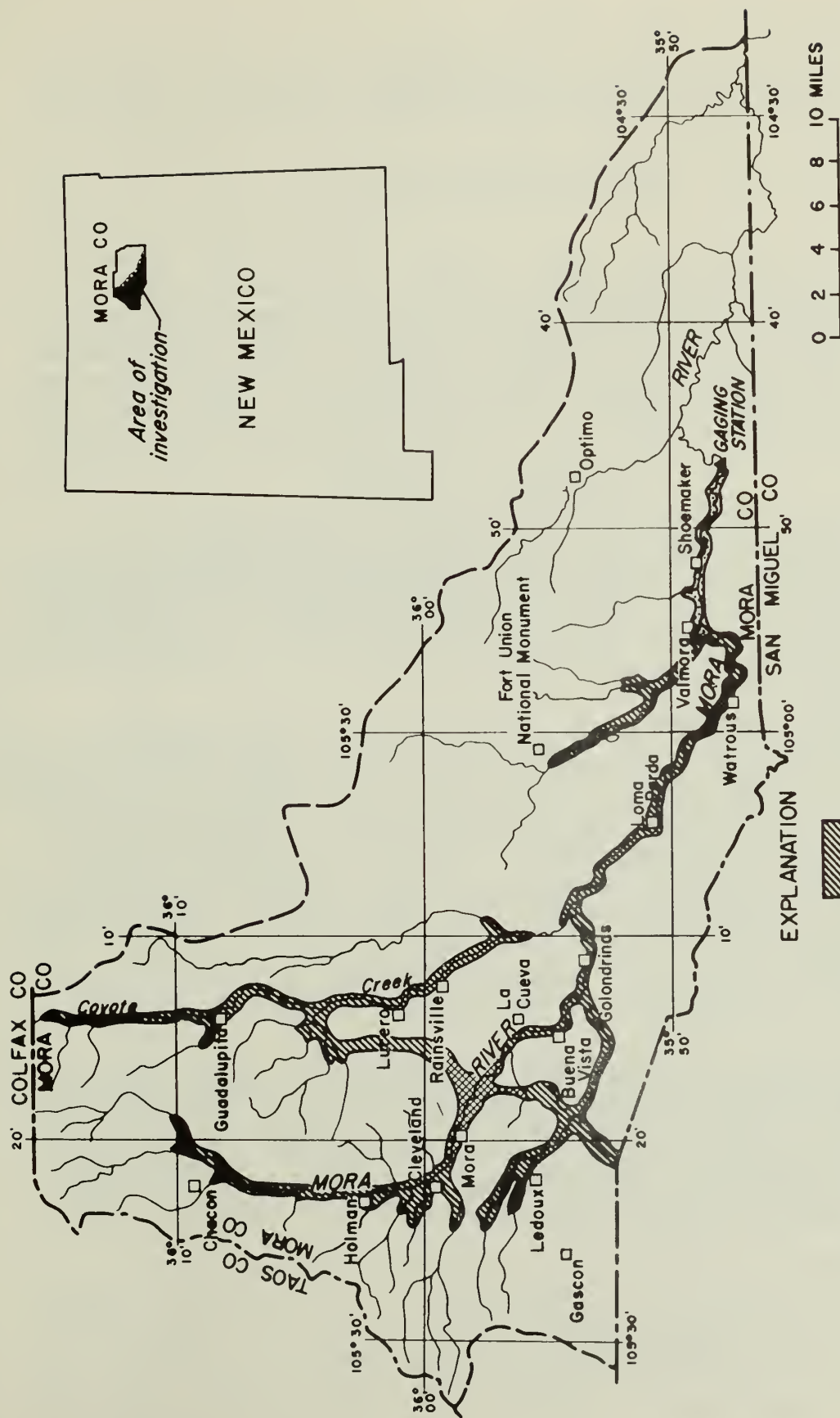
Mora County is in the northeast quarter of New Mexico. The alluvial valleys described in this report are the valleys occupied by the Mora River and its tributaries in the western part of the county upstream from the U. S. Geological Survey gaging station on the Mora River which is 4.5 miles east of the community of Shoemaker (fig. 1).

The Mora River and its tributaries head in the Sangre de Cristo Mountains, which form the western boundary of the basin, and drain approximately 900 square miles in the project area. The Mora River joins the Canadian River 23 miles downstream from the gaging station east of Shoemaker. Altitudes range from more than 12,000 feet at the headwaters to 6,170 feet at the gaging station.

The principal communities in western Mora County are along the main stem of the Mora River and include Chacon, Cleveland, Holman, Mora (the county seat), and Watrous.

### Acknowledgments

The authors express their appreciation to W. L. Shaffer of the Geological Survey for his assistance in data reduction and analysis of seismic data, and to R. T. Zbur of the U.S. Air Force Weapons Laboratory, Kirtland Air Force Base, for the use of equipment and for technical assistance. J. C. Yates, P. D. Akin, Zane Spiegel, and R. L. Borton of the New Mexico State Engineer Office are thanked for tech-



Alluvial deposits in upper valleys, exclusive of Mora Valley.

Alluvial deposits in the Mora Valley.

Alluvial deposits from Valmora to gaging station.

FIGURE 1.--Index map.

nical review of this report.

We also thank the people of Mora County for granting access to their property during the field investigation.

### Previous Investigations

The earliest geologic reports of the area, Stevenson (1881), Lindgren and others (1910), and Darton (1928), were of a general nature and discussed the southern Sangre de Cristo Mountains. Northrop and others (1946) and Bachman (1953) included parts of the area in large scale geologic mapping for oil and gas. Zeller and Baltz (1954) described the sedimentary copper and uranium deposits in the Coyote district along Coyote Creek, a tributary of the Mora River.

Baltz and Bachman (1956) mention the geology in the Mora River drainage in a discussion of the Sangre de Cristo Mountains for the seventh field conference of the New Mexico Geological Society. Baltz (1965) discussed in detail the stratigraphy of the upper Mora drainage in a summary article on the geology of the Raton Basin.

The first report concerned with the water resources was a reconnaissance study made by the U.S. Bureau of Agricultural Economy in 1941. Their concern was with rehabilitation of the water-conveyance system and with the possibilities of building dams for supplemental storage. The U.S. Bureau of Reclamation (1955) compiled a summary of the work previously done and included the feasibility and economic justification for rehabilitating the existing irrigation facilities. A hydrology supplement to previous reports on the Mora drainage basin was compiled in 1966 by the Bureau of Reclamation.

The first investigation concerned with ground-water resources was by Spiegel (1955), New Mexico State Engineer Office, who made a study concerned with water supplies for the communities of Holman and South Holman. A study was made by Winograd (1956) to locate a water supply for Fort Union National Monument near Watrous.

## GEOGRAPHY

### Physiography and Drainage

The study area is characterized by broad, elevated,

north-trending belts of Precambrian crystalline rocks generally flanked by steeply dipping sedimentary rocks. The Sangre de Cristo Mountains are the predominant feature of this part of New Mexico. The topography of the eastern part of the study area is characterized by high mesas, extensive dissected plateaus, and volcanic mountains and flows of various ages.

The area of study lies entirely within the watershed of the Mora River. The Mora and its major tributaries, Coyote Creek, Rito Cebolla, and Rio la Casa are normally perennial streams. The Mora River drains eastward to the Canadian River, a tributary of the Arkansas River.

### Economic Development

The following statistics (written commun., Four Corners Regional Commission, 1968) for Mora County are representative of the economy of the western part of the county.

| <u>Category</u>               | <u>Period</u> | <u>Trend in percent</u> |
|-------------------------------|---------------|-------------------------|
| Population change             | 1960-64       | + 3.3                   |
| Total employed                | 1960-64       | -17.1                   |
| Agriculture                   | 1960-64       | -24.2                   |
| Non-agriculture               | 1960-64       | - 6.7                   |
| Farm income                   | 1960-64       | -17.3                   |
| Acreage devoted to farming    | 1940-64       | No significant change   |
| Acreage devoted to cash crops | 1960-64       | -35.0                   |

The economy is primarily one of subsistence-level farming based on surface-water irrigation which has been practiced for many years. Crops raised are mostly alfalfa, corn, and hay with large areas devoted to vega or natural pasture on which livestock are grazed. Some small scale logging operations provide sawlogs for local mills.

Studies in the southwest (U.S. Bureau of Reclamation, 1966, and Houk, 1951) have shown the consumptive-use requirements (amount of water consumed by crops) (table 1) are generally less for truck crops in the irrigated areas than for forage crops, small grains, and corn.

TABLE 1.--Ranges in consumptive-use requirements for truck, forage, and small grain crops in the Mora River drainage, western Mora County, N. Mex.

| <u>Crop</u>  | Range in<br>consumptive-<br>use require-<br>ments <sub>1</sub> /<br>(acre-feet<br>per acre) | <u>Crop</u>            | Range in<br>consumptive-<br>use require-<br>ments <sub>2</sub> /<br>(acre-feet<br>per acre) |
|--------------|---------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------|
| Beans, snap  | 0.83-1.44                                                                                   | Alfalfa                | 1.74-2.22                                                                                   |
| Beets, table | 0.87-1.37                                                                                   | Small grains           | 1.15-1.18                                                                                   |
| Cabbage      | 0.94-1.49                                                                                   | Corn                   | 1.36-1.80                                                                                   |
| Carrots      | 1.27-1.60                                                                                   | Grass, hay,<br>pasture | 1.56-1.98                                                                                   |
| Cauliflower  | 1.43-1.77                                                                                   | Vega                   | 1.56-1.98                                                                                   |
| Lettuce      | 0.72-1.35                                                                                   | ---                    | ---                                                                                         |
| Onions       | 0.73-1.52                                                                                   | ---                    | ---                                                                                         |
| Peas         | 1.21-1.56                                                                                   | ---                    | ---                                                                                         |
| Spinach      | 0.80-1.07                                                                                   | ---                    | ---                                                                                         |
| Tomatoes     | 0.95-1.42                                                                                   | ---                    | ---                                                                                         |

---

1/ Houk (1951, p. 357)

2/ U. S. Dept. of the Interior (1966)

### Climate

The following climatological data are taken from "Climatological Summary of New Mexico" published annually by the U.S. Weather Bureau. Records of six weather stations in western Mora County and one at Black Lake, Colfax County, have been included (fig. 2).

The climate of western Mora County is semi-arid, typical of high mountain valleys within northern New Mexico.

EXPLANATION

- $\odot^2$

Precipitation station,  
storage gage

  - 1 - Black Lake
  - 2 - Chacon
- $\Delta^5$

Precipitation and temperature  
station, nonrecording

  - 3 - Gascon
  - 5 - Ft. Union
  - 6 - Valmora
- $\odot^7$

Precipitation station,  
nonrecording

  - 4 - La Cueva
  - 7 - Optimo
- $\Delta^8$

Existing gaging station

  - 1 - Mora River near Holman
  - 4 - Rio la Casa near Cleveland
  - 5 - Mora River at La Cueva
  - 7 - Mora River near Golondrinas
  - 8 - Coyote Creek above Guadalupita
  - 10 - Coyote Creek near Golondrinas
  - 12 - Mora River near Shoemaker
- $\Delta^6$

Discontinued gaging stations

  - 2 - Vigil Canyon near Holman
  - 3 - Agua Fria Creek near Holman
  - 6 - Cebolla River (Rio Cebolla) near Golondrinas
  - 9 - Coyote Creek at Guadalupita
  - 11 - Mora River near Watrous
  - 13 - Mora River near Cleveland
- Note: D beside precipitation symbol  
indicates discontinued station

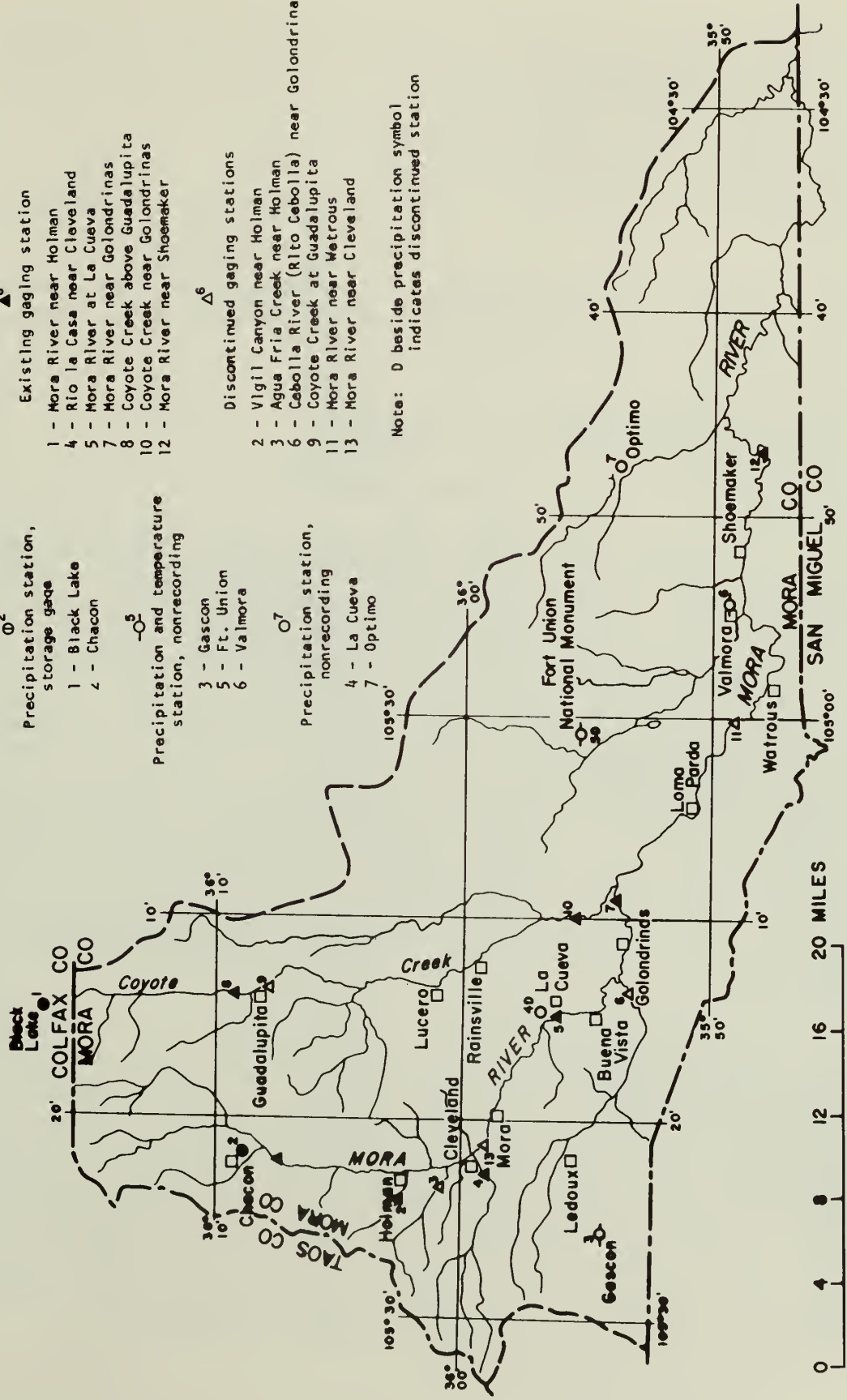


FIGURE 2.--Location of meteorological and stream-gaging stations.

Average annual precipitation varies from 15.5 inches at Optimo to greater than 22 inches in the mountains along the western boundary of the county. Commonly 30 to 40 percent of the average annual precipitation occurs in July and August from convectional summer storms (fig. 3). The occurrence of these storms varies greatly, resulting in a large variation in areal distribution of late-summer precipitation.

Summers are cool and winters mild. The warmest months are July and August; December and January are the coldest (fig. 4).

## GEOLOGY

### Stratigraphy

The rocks that underlie western Mora County range in age from Precambrian to Holocene. Basement rocks of Precambrian age crop out in the western part of the area where they consist of middle-grade metamorphics and granite intrusives. Rocks of Paleozoic and Mesozoic age, Devonian through Cretaceous, crop out over large parts of the remaining area and consist of shales, sandstones, and some interbedded limestones. These deposits generally constitute the bedrock of the area. The sedimentary rocks in the north-central and eastern sections of the Mora River drainage are locally overlain by basalt flows of probable late Tertiary to Quaternary age. Unconsolidated sedimentary deposits of Cenozoic age, mostly Holocene, fill the stream valleys and locally form veneers on low terraces. A thicker deposit of Pleistocene age occurs in the valley trending northeastward from Mora.

The thickness, lithologic character, and water-bearing properties of the rocks that crop out in the Mora River drainage are given in the generalized geologic section (table 2). Three bedrock formations--sandstones in the Sandia Formation of Pennsylvanian age, the Santa Rosa Sandstone of Triassic age, and the Dakota Sandstone of Cretaceous age--furnish small amounts of water to wells. Most of the unconsolidated deposits of Quaternary age are water bearing; the areal extent of the unconsolidated deposits and bedrock formations adjacent to them are shown in plate 1.

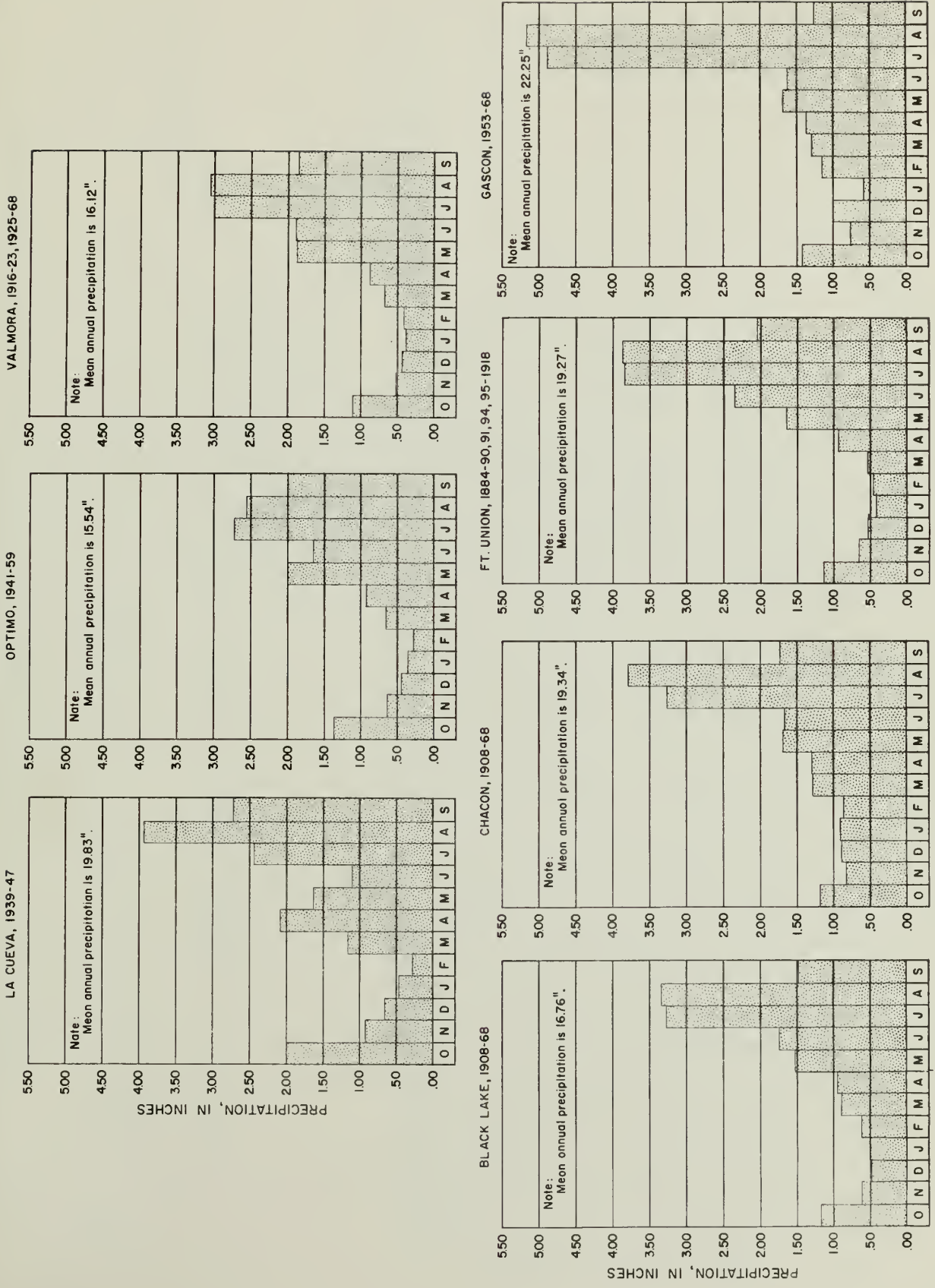


FIGURE 3.--Mean monthly precipitation for stations in the Moud River drainage.

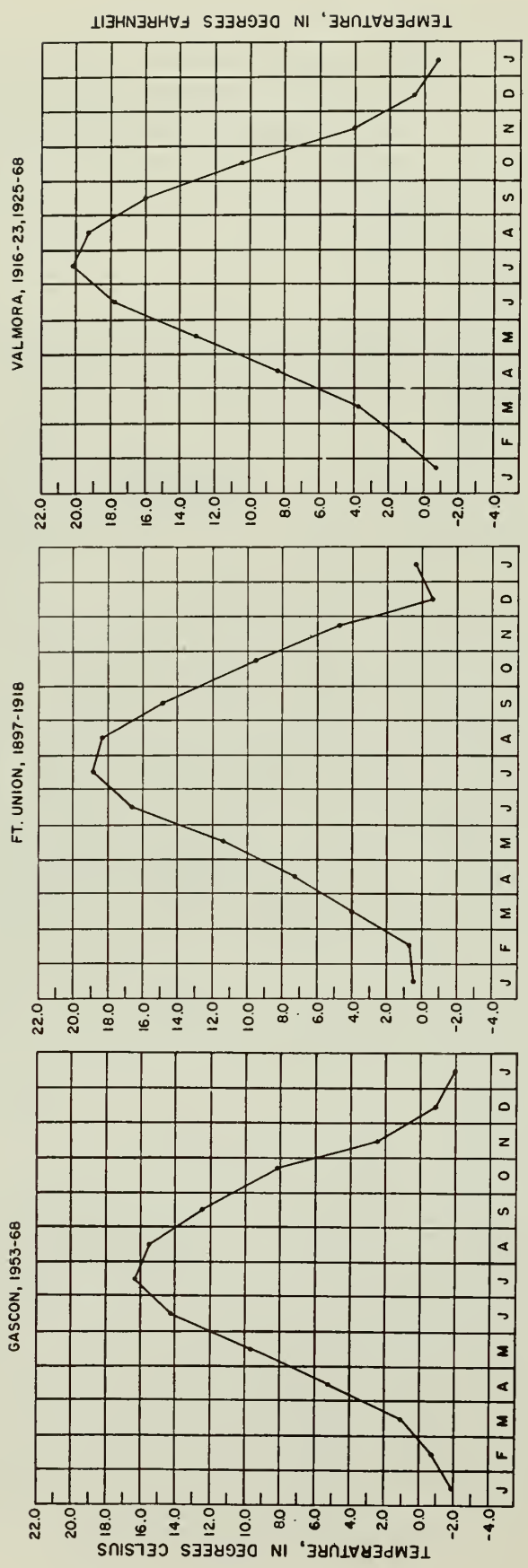


FIGURE 4.--Mean monthly temperature for periods of record shown at Gascon, Ft. Union, and Valmora.

TABLE 2.--Summary of stratigraphic units and their water-bearing properties in the Mora River drainage, western Mora County, N. Mex.

| SYSTEM     | SERIES      | GROUP  | STRATIGRAPHIC UNIT   | THICKNESS<br>(in feet) | LITHOLOGY                                                                                                                                                                  | WATER-BEARING CHARACTER                                                                                                           |
|------------|-------------|--------|----------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Quaternary | Holocene    |        | Alluvium             | 0-50                   | Unconsolidated deposits of valley fill. Chiefly gravel, sand, silt, and clay.                                                                                              | Generally yields small amounts of water for stock and domestic use. Near Watrous yields water sufficient for irrigation purposes. |
|            |             |        | Boulder deposits     | --                     | Deposits of quartzite boulders. Fan built at mouth of Rio la Casa is comprised of these boulders. Boulders are, in part, of glacial origin.                                | Unknown                                                                                                                           |
|            | Pleistocene |        | Pediment gravels     | --                     | Veneer of unconsolidated gravel and sand deposited on stream-cut terrace surfaces.                                                                                         | Not known to yield water.                                                                                                         |
|            |             |        | Valley fill          | 0-322+                 | Sand, gravel, and silt.                                                                                                                                                    | Generally yields small amounts of water for stock and domestic use. Irrigation potential questionable.                            |
| Tertiary   |             |        | Basalt               | --                     | Gray, vesicular, olivine basalt.                                                                                                                                           | Unknown                                                                                                                           |
| Cretaceous | Upper       |        | Greenhorn Limestone  | 0-50                   | Dark-gray, finely crystalline limestone and interbedded dark-gray shale.                                                                                                   | A few wells outside the project area produce water from the limestone.                                                            |
|            | Lower       |        | Graneros Shale       | 250+                   | Consists of dark- to medium-gray shale. Thin beds of argillaceous limestone are common.                                                                                    | Generally not water bearing.                                                                                                      |
| Jurassic   | Upper       |        | Dakota Sandstone     | 100-200                | Consists of two sandstone beds separated by a shale unit. The sandstone beds are gray to tan and composed chiefly of quartz. Shale is dark-gray to black and carbonaceous. | Sandstone yields moderate supplies of water to domestic and stock wells.                                                          |
|            |             |        | Morrison Formation   | 150-400                | Consists of varied proportions of red, gray, and brown sandstone and conglomerate; interbedded red, gray, and green shale; and thin local limestone beds.                  | Generally not water bearing.                                                                                                      |
|            |             |        | Entrada Sandstone    | 20-120                 | White to pink and red, fine- to coarse-grained, moderately well-sorted sandstone.                                                                                          | Yields water to a few stock wells.                                                                                                |
| Triassic   | Upper       | Dockum | Chinle Formation     | 600-900                | Predominately red, purple, and greenish shale and siltstone with interbedded red, brown, and gray sandstone.                                                               | Sandstone yields small amounts of water. Generally highly mineralized.                                                            |
|            |             |        | Santa Rosa Sandstone | 250-450                | Consists of thin to thick layers of brown, gray, and red sandstone and interbedded thin to thick red shale. Sandstone is very lenticular.                                  | Yields moderate amounts of water. Generally under artesian pressure.                                                              |

TABLE 2.--Summary of stratigraphic units and their water-bearing properties in the Mora River drainage, western Mora County, N. Mex.  
Concluded

| SYSTEM        | SERIES           | GROUP     | STRATIGRAPHIC UNIT         | THICKNESS<br>(in feet) | LITHOLOGY                                                                                                                                                                                                                                                                         | WATER-BEARING CHARACTER                                                                                   |
|---------------|------------------|-----------|----------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Permian       | Upper and Lower  |           | Bernal Formation           | 50-100                 | Pink, orange, and red siltstone; shale; fine- to coarse-grained sandstone, and some thin beds of limestone and gypsum.                                                                                                                                                            | Generally not water bearing.                                                                              |
|               | Lower            |           | Glorieta Sandstone         | 275+<br>—              | Gray, fine- to medium-grained, well-sorted, well-cemented, marine sandstone.                                                                                                                                                                                                      | A few wells to the south of the study area yield small amounts of water to wells in the Mora drainage.    |
|               |                  |           | Yeso Formation             | 0-400                  | Orange to brick-red siltstone and shale with interbedded fine-grained sandstone. Locally contains dolomite and gypsum.                                                                                                                                                            | Generally not water bearing.                                                                              |
|               |                  |           | Sangre de Cristo Formation | 700-4,000+             | Red and green shale with interbedded arkose and conglomerate and a few thin beds of limestone.                                                                                                                                                                                    | Data on water-bearing characteristics are sparse.                                                         |
| Pennsylvanian | Upper            |           |                            |                        |                                                                                                                                                                                                                                                                                   |                                                                                                           |
|               | Upper and Middle | Magdalena | Madera Limestone           | 300-3,000(?)           | Consists of two units: a lower gray limestone member composed of interbedded crystalline fossiliferous limestone, dark-gray shale and sandstone; an upper arkosic limestone member comprised of clastic limestone, red, green, and gray shale and conglomerate arkosic sandstone. | Generally not water bearing.                                                                              |
|               | Lower            |           | Sandia Formation           | 300-4,000              | Composed of cyclic variations of gray to black, thin- to thick-bedded limestone; gray to black calcareous and bituminous shales; impure coal; gray, red, and green siltstone; white to gray, brown sandstone, and gray conglomerate.                                              | Sandstone beds contain small amounts of water. Water is generally mineralized and has an unpleasant odor. |
| Mississippian |                  |           | Tererro Formation          | 0-130                  | Limestone breccia, marine conglomerate, clastic and crystalline limestone, and siltstone.                                                                                                                                                                                         | Generally not water bearing.                                                                              |
| Devonian(?)   |                  |           | Espiritu Santo Formation   | 0-80                   | Thin dark-gray limestone, dolomitic limestone, sandy limestone, and a thin basal sandstone.                                                                                                                                                                                       | Generally not water bearing.                                                                              |
| Precambrian   |                  |           |                            |                        | Metamorphic rocks intruded by pegmatites and granitic intrusions.                                                                                                                                                                                                                 | Generally not water bearing.                                                                              |

## Structure

Structural features were developed by folding and thrusting in Late Cretaceous-Early Eocene time during the main Laramide disturbance, which was followed by Miocene and Pliocene high-angle faulting and later epeirongenic uplift (Gabelman, 1956). Structural activity during Miocene and Pliocene time resulted in the present form of the Sangre de Cristo Mountains.

Structural features have greatly controlled development of the present drainage. The river valleys, where Holocene alluvial deposits are concentrated, have formed in the less resistant rocks such as shales; bordering ridges have developed on the more resistant rocks such as sandstones and limestones.

The prominent valley trending northeastward from Mora was formed by block-faulting or by downwarping, which has preserved the present thick section (at least 322 feet) of alluvial deposits.

## HYDROLOGY

The earth's water moves in a continuous system commonly called the hydrologic cycle--from the atmosphere to the earth's surface and back to the atmosphere (fig. 5). There are many short cuts and detours in the hydrologic cycle. Some precipitation evaporates before it reaches the earth, thus bypassing the surface and returning directly to the atmosphere. Some precipitation soaks into the soil zone and is utilized by plants. Some becomes runoff in streams and rivers, flowing to the oceans or to lakes and reservoirs. Some precipitation moves down into the earth, below the soil and root zone, to become ground water--a detour that may delay it for long periods of time before it returns again to the earth's surface. This report is concerned primarily with water in the ground-water phase of the hydrologic cycle, and secondarily with water in the runoff and plant-utilization phases.

### Surface Water

The Mora River and its tributaries (Rio la Casa, Rito Cebolla and Coyote Creek) drain approximately 900 square miles within the project area. Thirteen U.S. Geological Survey gaging stations have been in operation intermittently in western Mora County since 1905 (figs. 2 and 6). Figure 7 shows the streamflow in the Mora River to be typical of streams in high mountain valleys of northern New Mexico, having a runoff peak in late May due to snowmelt and another peak in August due to summer convectional storms.

Base flow of the streams is sustained primarily by natural ground-water inflow and by return seepage and overland flow from surface irrigation.

The natural flow regimen in the basin has been altered considerably by numerous small diversions to the present surface-water irrigation system. Natural streamflow is augmented by two transmountain diversions for irrigation: Rito de la Presa to Agua Fria Creek and Alamitos Creek to Vigil Canyon, which together add about 5,000 acre-feet per year to the flow in the Mora River. Water-use malpractices such as failure to close headgates during the nonirrigation season and water loss through delivery systems result in reducing the flow of the streams.

With the exception of La Cueva and Red Lakes on the Salman Ranch, surface storage within the basin is limited to

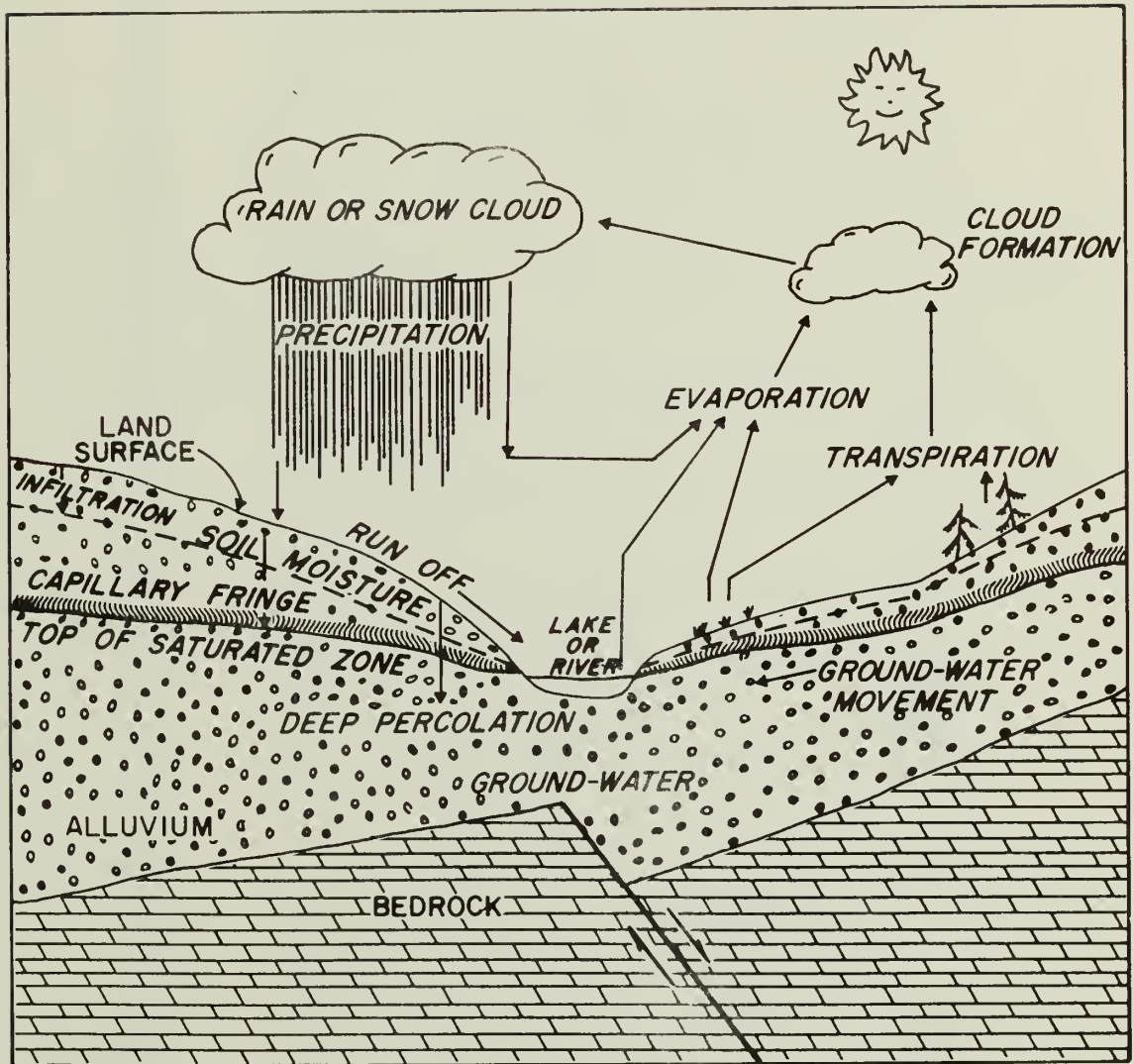
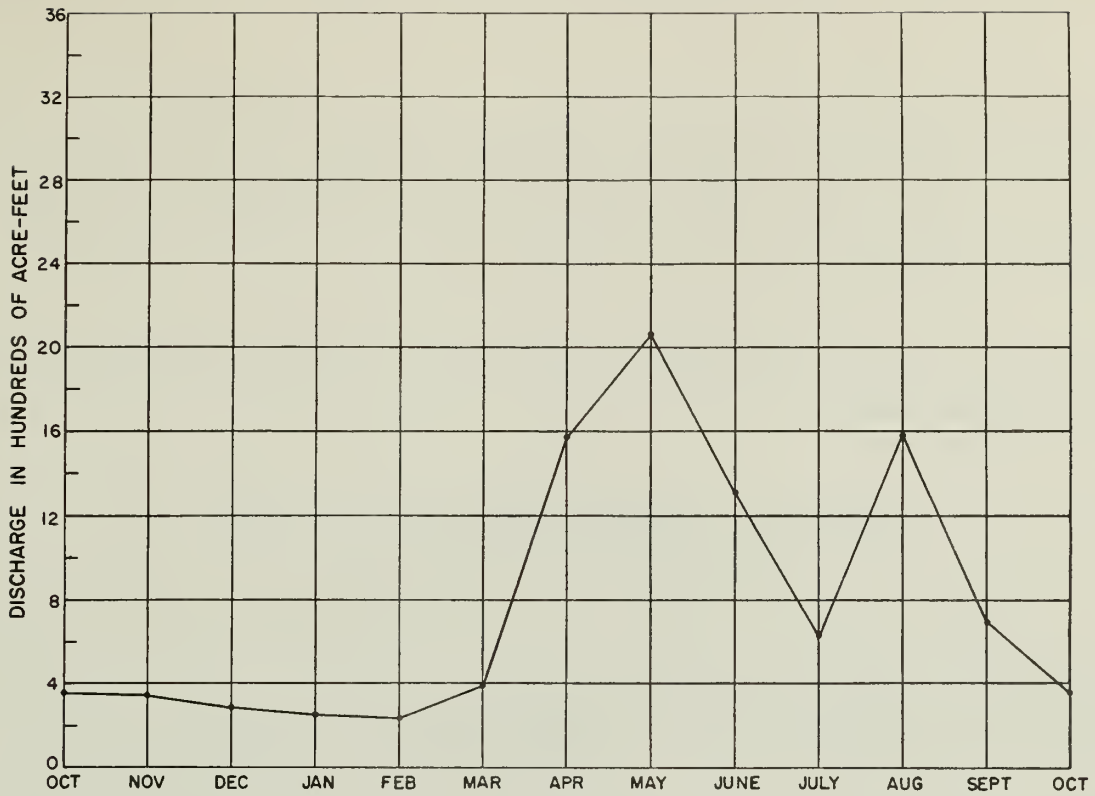


FIGURE 5.--Schematic representation of the hydrologic cycle.

| STATION                        | DRAINAGE<br>AREA<br>(sq. mi.) | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | MEAN ANNUAL DISCHARGE<br>(acre-feet) |
|--------------------------------|-------------------------------|------|------|------|------|------|------|------|------|--------------------------------------|
| Mora River near Holman         | 57                            |      |      |      |      |      |      | —    |      | 9,773                                |
| Vigil Canyon near Holman       | 2.8                           |      |      |      |      |      |      | —    |      | 1,262                                |
| Agua Fria Creek near Holman    | 9.2                           |      |      |      |      |      |      | —    |      | 3,930                                |
| Rio la Casa near Cleveland     | 23                            |      |      |      |      |      |      | —    |      | 10,068                               |
| Mora River near Cleveland      | 165                           |      |      | —    |      |      |      |      |      | 23,092                               |
| Mora River at La Cueva         | 173                           | —    |      | —    | —    | —    | —    | —    |      | 21,313                               |
| Mora River near Golondrinas    | 267                           |      |      | —    | —    | —    | —    | —    |      | 25,231                               |
| Cebolla River near Golondrinas | 64                            |      |      |      |      |      |      | —    |      | 4,053                                |
| Mora River near Watrous        | 521                           |      |      |      |      |      |      | —    |      | 38,943                               |
| Coyote Creek above Guadalupe   | 71                            |      |      |      |      |      |      | —    |      | 7,525                                |
| Coyote Creek at Guadalupe      | 89                            |      |      | —    |      |      |      |      |      | 8,644                                |
| Coyote Creek near Golondrinas  | 215                           |      |      |      | —    | —    | —    | —    |      | 9,790                                |
| Mora River near Shoemaker      | 1104                          |      | —    | —    | —    | —    | —    | —    |      | 45,626                               |

FIGURE 6.--Periods of record and mean annual discharge for U.S. Geological Survey gaging stations in the Mora River drainage, western Mora County.

## MORA RIVER NEAR HOLMAN, 1953-67



## MORA RIVER NEAR SHOEMAKER, 1914-68

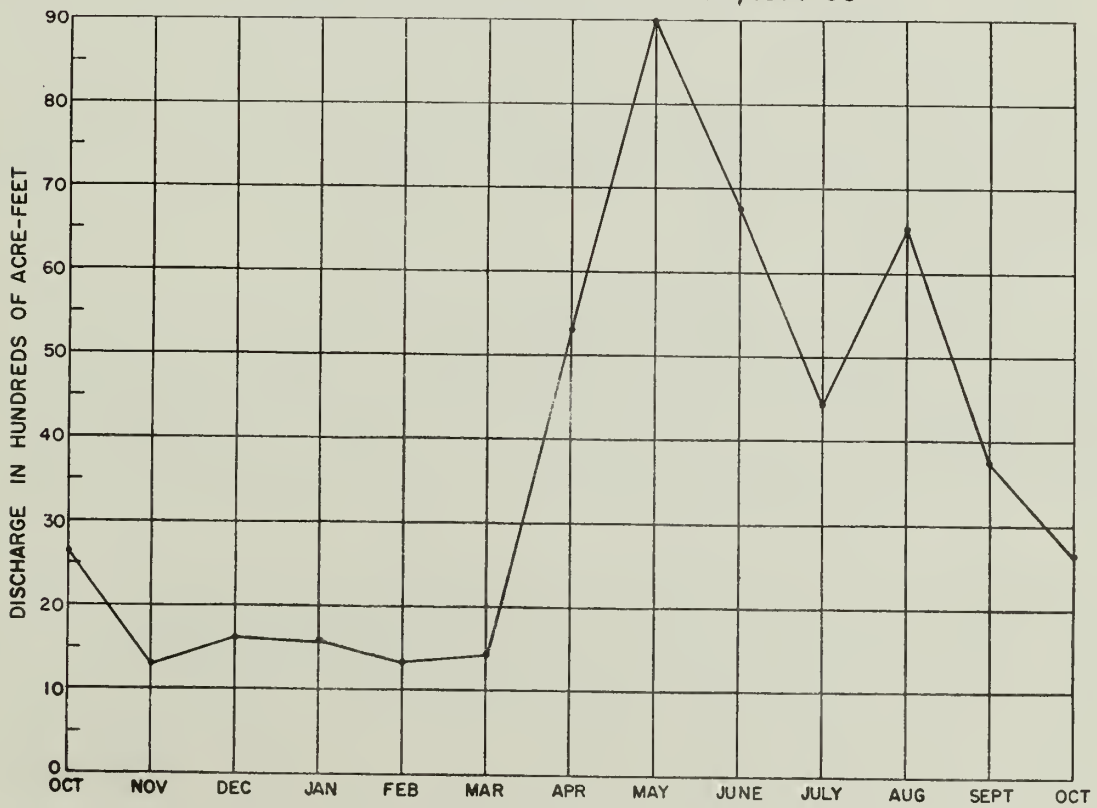


FIGURE 7.--Mean monthly discharge for periods of record, Mora River near Holman and Mora River near Shoemaker.

small earthen irrigation tanks, stock ponds, and sumps. The present maximum volume in surface storage is approximately 57,000 acre-feet. This estimate was made using the total area covered by surface storage and assuming an average depth of 5 feet.

An extensive study of the surface-water regimen in the study area was conducted by the U.S. Bureau of Reclamation (1955 and 1966).

### Ground Water

#### Principles of Occurrence

The principles of occurrence of ground water are discussed in detail by Meinzer (1923a, 1923b). Only a few general statements are made here for the purpose of the discussion that follows.

The source of all ground water in the project area is precipitation. Water that reaches the land surface as precipitation either evaporates, runs off as streamflow, or infiltrates downward into the earth where some of it may reach the saturated zone and becomes ground water (fig. 8). Rocks or unconsolidated materials that yield water to wells are called aquifers, and may consist of one or more geologic formations.

Water in an aquifer may be under confined or semiconfined (artesian) or unconfined (water-table) conditions. Confined or semiconfined conditions can occur when water in a permeable bed, such as sand, is overlain and underlain by less permeable confining beds such as silt, clay, or shale. Confined or semiconfined water is under hydrostatic pressure. If a well penetrates a confined or semiconfined bed the water will rise in the borehole; if it flows at the surface it is called a flowing artesian well; if the water rises in the borehole but does not flow it is called a nonflowing artesian well. The imaginary surface to which water rises in an artesian well is called the potentiometric surface. A good example of a nonflowing artesian well is the New Mexico State Highway Department well (well 73) near La Cueva. The well encountered water-yielding sandstones below 300 feet. In 1969 the water level in the well was 88 feet below the land surface.

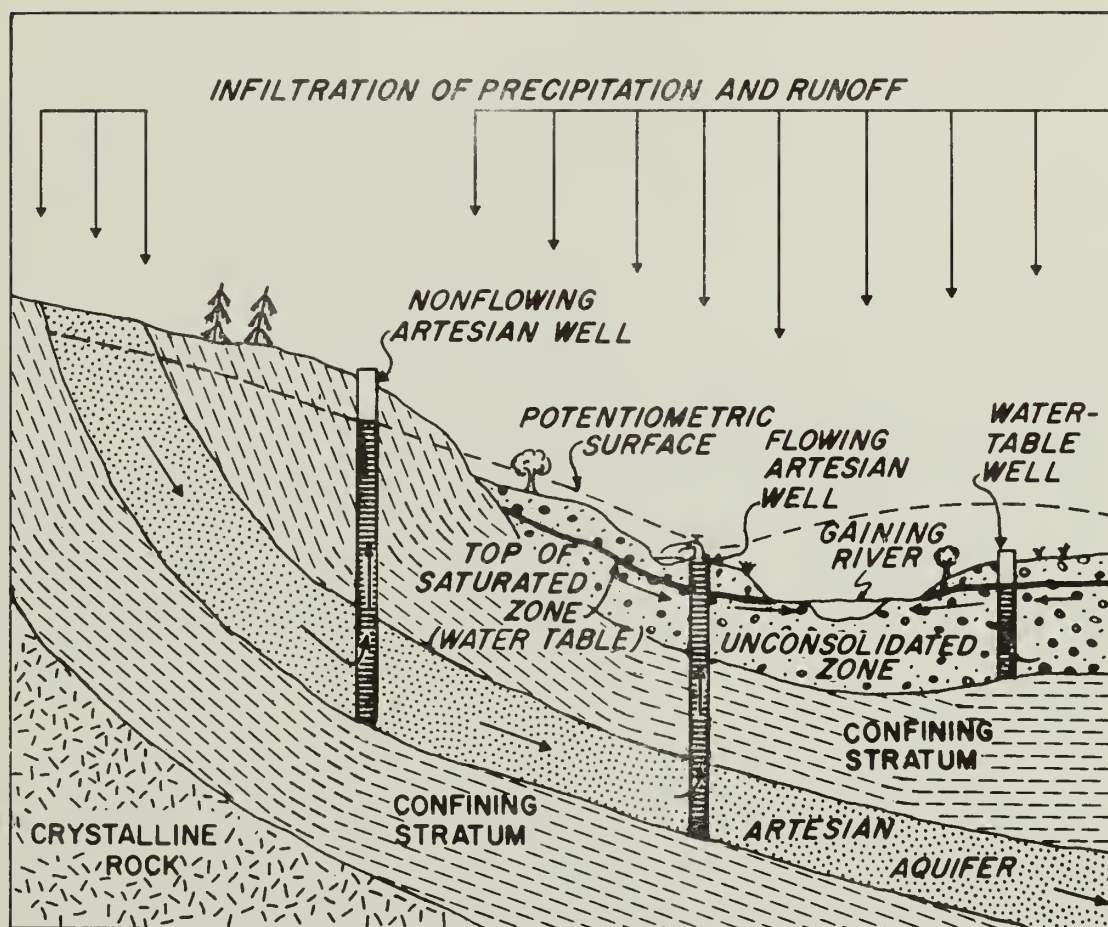


FIGURE 8.--Schematic diagram of the ground-water phase of the hydrologic cycle showing the occurrence of semiconfined and unconfined water.

If water is unconfined, the upper boundary separating the unsaturated zone from the saturated zone is called the water table. At this "surface" (water table) the hydrostatic pressure in the ground water is atmospheric. Most of the domestic and stock wells in western Mora County are completed in unconfined aquifers.

Both confined and unconfined ground water generally moves slowly toward points of discharge, either rivers, springs, or an overlying formation by way of fractures in confining beds. The infiltration, movement and discharge is characteristic of the ground-water phase of the hydrologic cycle (fig. 8). The natural discharge of aquifers provides nearly all of the base flow of the perennial streams of the western Mora County area.

### Bedrock Aquifers

The ability of the bedrock aquifers in western Mora County to yield water to irrigation wells is limited. Bedrock formations (table 2) that are saturated are either too deep to be economically developed, have low yields, or commonly contain water of a quality undesirable for irrigation use. For example, the Sandia Formation of Pennsylvanian age which crops out in extreme western Mora County yields 4 gpm (gallons per minute) to well 11, south of Chacon. The water has a conductance of 1,500 micromhos per centimeter. East of La Cueva the Sandia Formation lies at depths in excess of 3,300 feet.

The Santa Rosa Sandstone of Triassic age and the Dakota Sandstone of Cretaceous age are shallower in depth, but generally are tightly cemented and yields are not commensurate with irrigation requirements. Well 142 north of Loma Parda taps the Dakota Sandstone and yields 16 gpm.

The bedrock aquifers are recharged by precipitation in outcrop areas and by infiltration from ephemeral and intermittent streams where the aquifers immediately underlie the stream channel. The ground water is discharged through wells, springs, and to the perennial reaches of streams (Appendixes A and B). Ground water in bedrock aquifers occurs under both water-table and artesian conditions.

### Unconsolidated Aquifers

The majority of the wells in the project area tap aquifers in unconsolidated deposits (Appendixes A, C, and D)

in the stream valleys. These deposits are of Quaternary age and consist mostly of boulders, cobbles, gravel, sand, silt, and clay. They contain the only appreciable volume of economically recoverable ground water in the Mora River drainage system in western Mora County. The deposits range in thickness from a few feet in tributary valleys and canyons to more than 300 feet in the Mora Valley (figs. 9 and 10) (Mercer and Lappala, 1970). The thickness of these materials is generally the result of erosional and depositional processes related to climatic and structural changes in late Cenozoic time.

With one major exception, the depositional pattern has followed the present east-southeastward-trending drainage system. The exception is a major deposit of alluvium with associated terraces which occurs in a broad north-trending valley extending from north of Black Lake in Colfax County southward through Las Quebraditas Valley. The depositional agent appears to have been a large river that existed in Pleistocene time and is believed to have drained the entire eastern slope of the Sangre de Cristo Mountains. The course of the river was controlled locally by Cenozoic fault zones. Its flow was disrupted by headward erosion and stream capture by eastward-flowing streams such as the Mora River. Baltz and Read (1956, p. 71) refer to this river as the ancestral Coyote River, named for Coyote Creek which, in its upper reaches, flows in what is believed to be the ancestral channel.

A probable sequence of events leading to the present drainage system is shown in figure 11, which is a sketch of the ancestral Coyote River drainage system showing lateral attack and subsequent capture by the Mora River. A steeper gradient on the Mora created by erosion of the softer sedimentary rocks east of the ancestral Coyote probably accelerated headward cutting and contributed to the forming of the present drainage system.

The largest concentration of unconsolidated deposits in the project area occurs in the Mora Valley near Mora and appears to have resulted from alternating lake and river channel deposition. The predominance of dark blue to black, organic, varved clay found in test holes M-3, M-3a, and M-5 (Appendix D) in this area indicates a swampy to lacustrine environment. The existence of sand and gravel lenses in the clay indicates intermittent periods of river channel deposition. The most probable sequence of events explaining

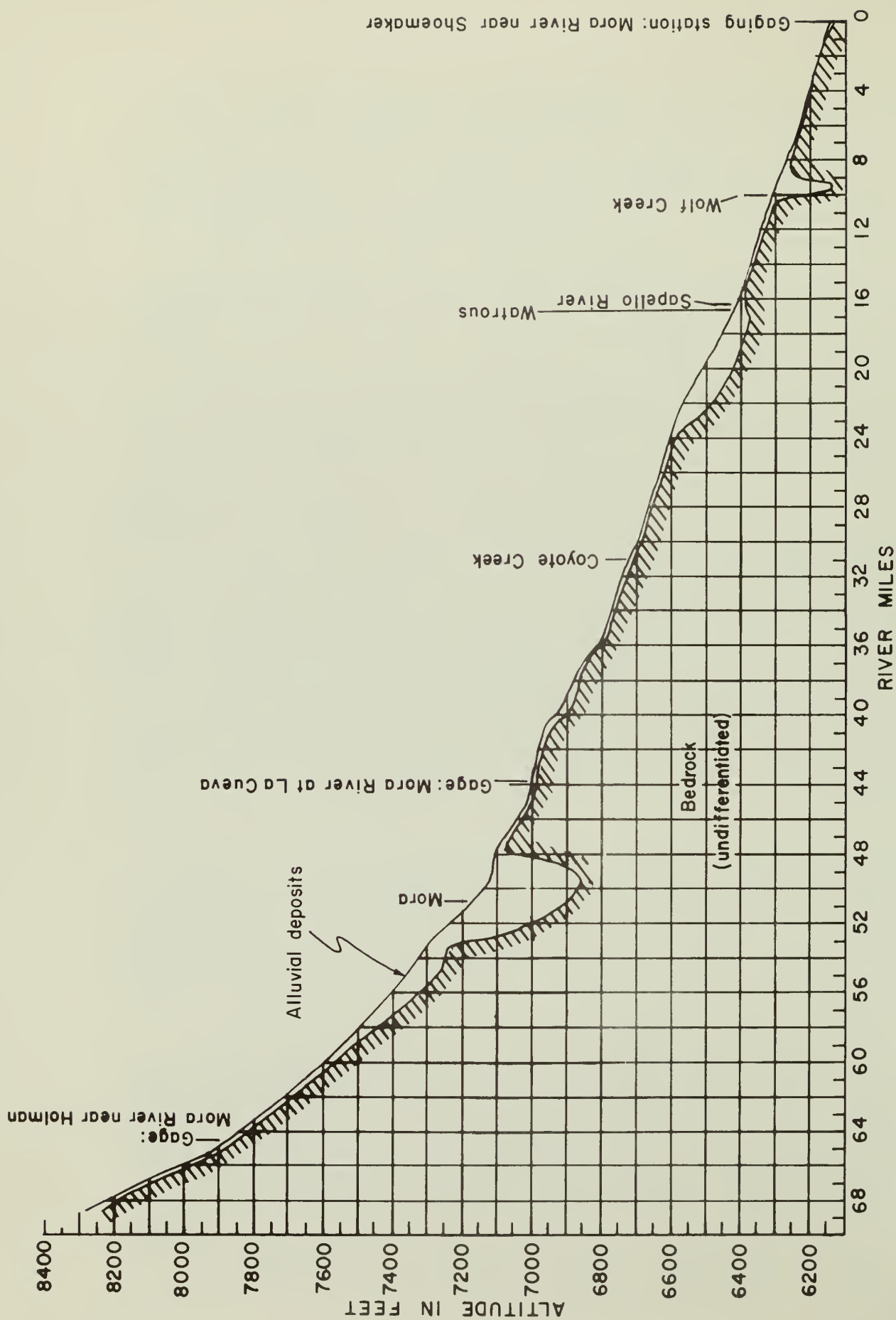


FIGURE 9.--Generalized longitudinal profile along the Mora River showing the thickness of alluvial deposits.

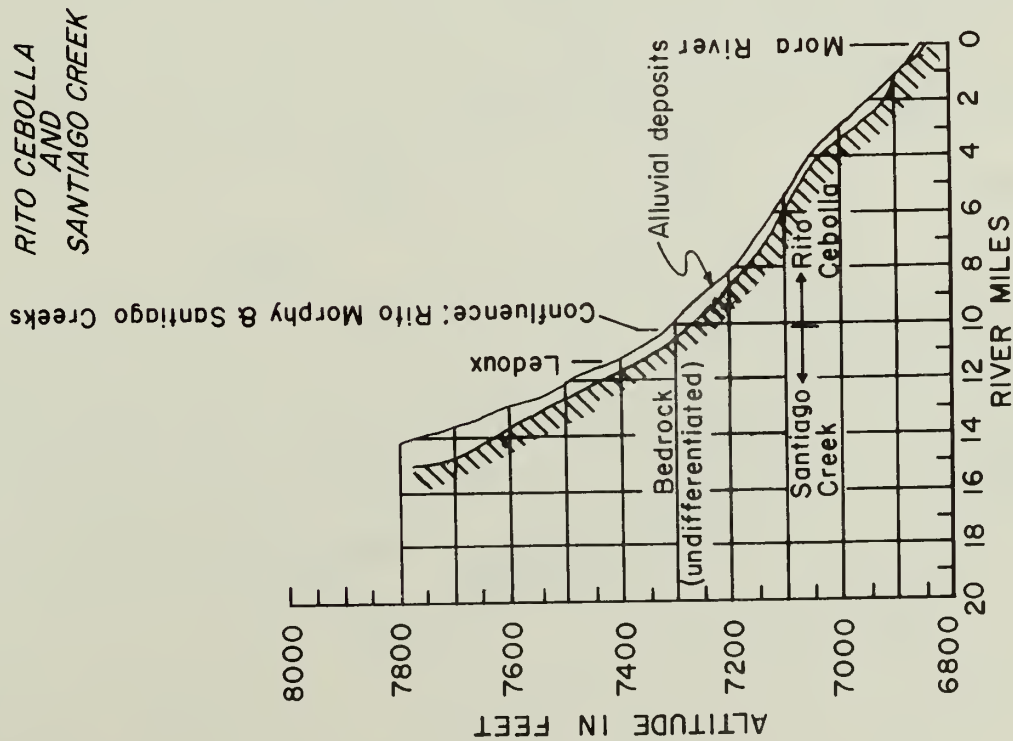
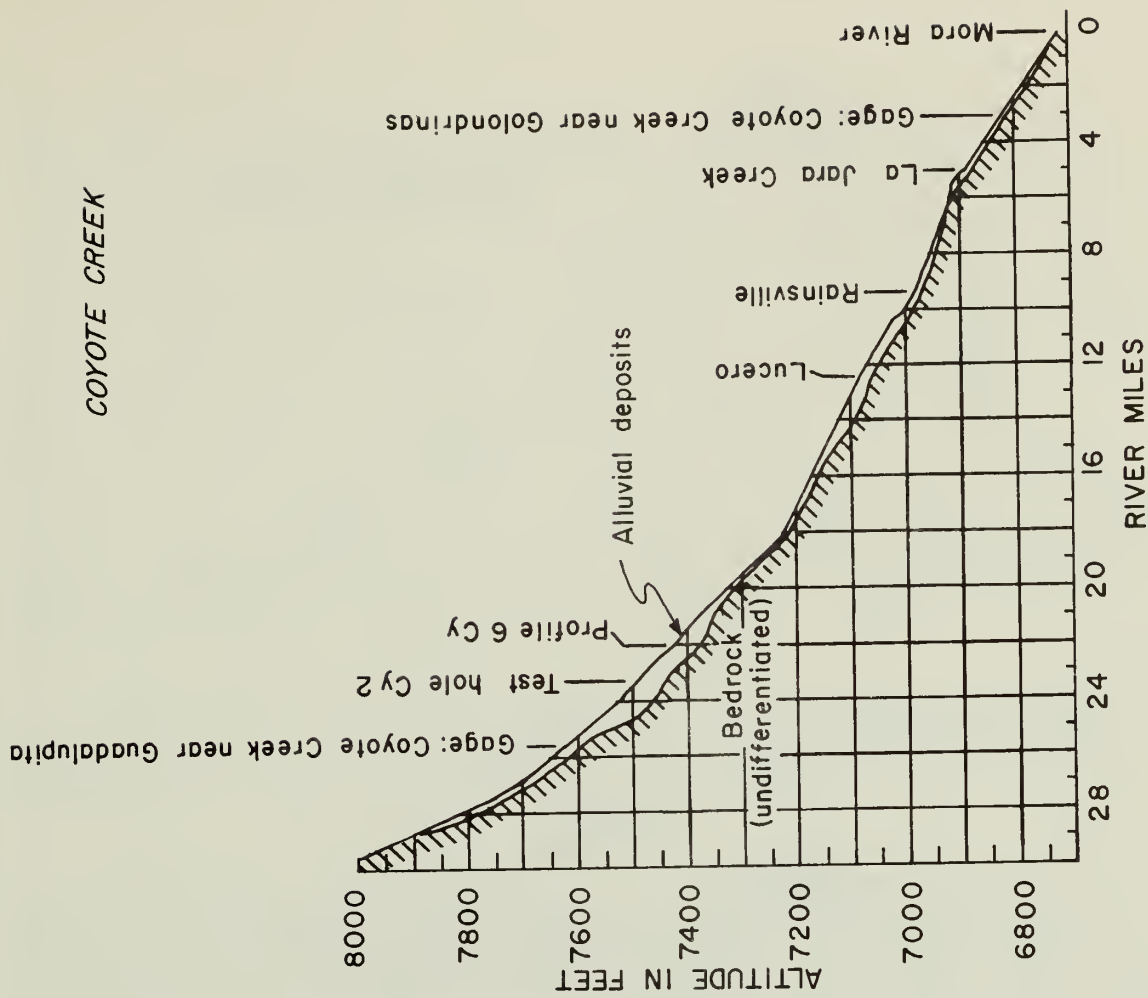


FIGURE 10.--Generalized longitudinal profiles along Rito Cebolla-Santiago Creek and Coyote Creek showing the thickness of alluvial deposits.

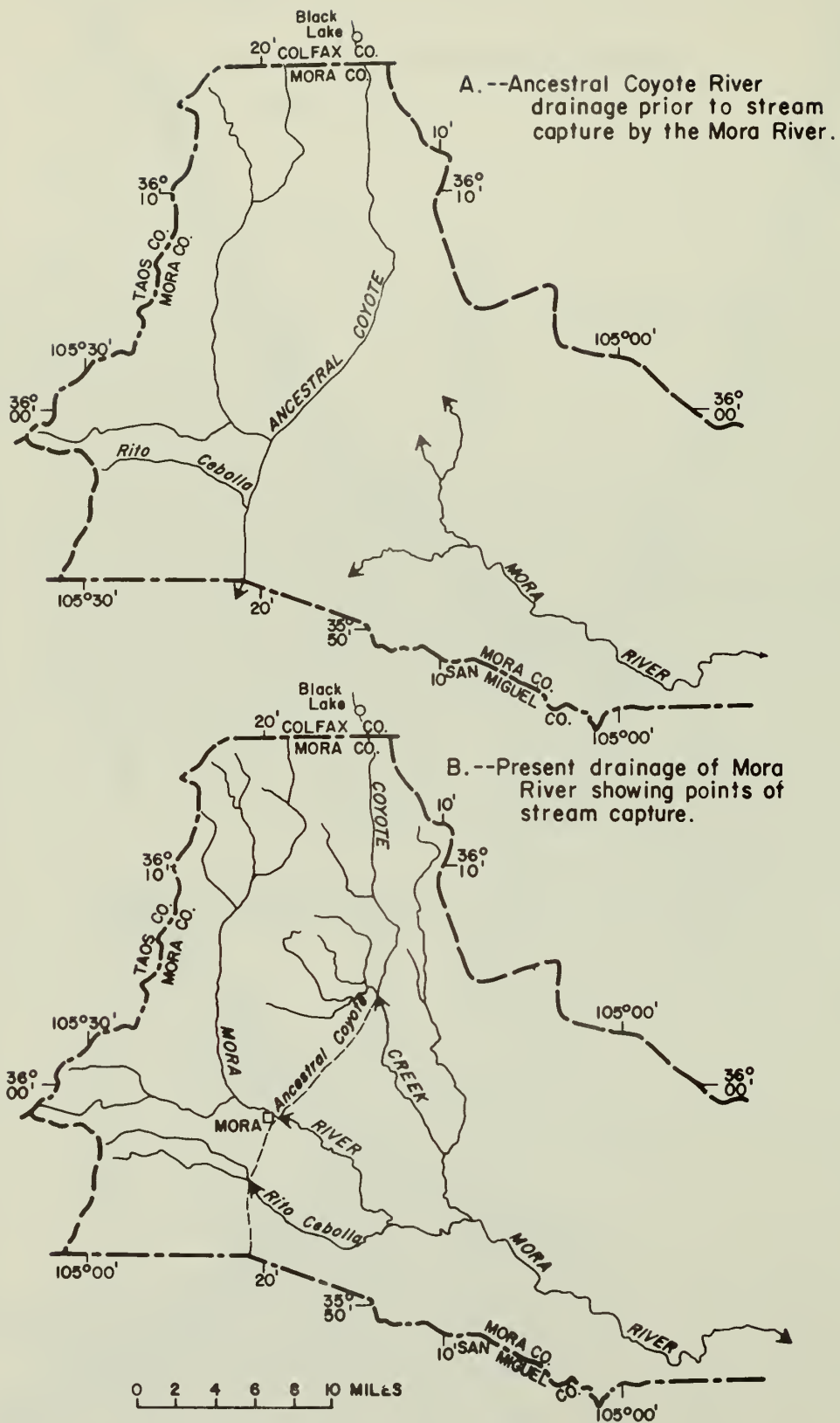


FIGURE 11.--Probable development of the present drainage system in the Mora Valley.

these phenomena is the following: The ancestral Coyote followed a southward course, and tributaries followed the channels shown in figure 11. The area presently known as the Mora Valley was a depression formed by downwarping and/or faulting. Evidence for faulting was found in the subsurface during the seismic investigation (Mercer and Lappala, 1970). This depression represented a low-gradient reach of the ancestral Coyote, most probably a meander valley, which, when downwarping exceeded deposition, was occupied by a lake. During this cycle the valley filled with organic material interbedded with meander-type river deposits thereby creating a poorly sorted mixture of organic and inorganic clays, sands, and gravels with the clay fraction predominating. Results of test drilling indicate small lenses of sand and gravel, alternating with clays.

Cenozoic faulting has also preserved alluvial deposits in local areas. For example, this is the reason for the thick section of alluvium above Watrous (pl. 1 and fig. 9).

Alluvial fan deposits are also present locally in canyons tributary to the main drainage system. An example of this type of deposit is located north of Guadalupita, directly west of Coyote State Park. A water well (well 303A) drilled near the edge of this fan penetrated approximately 200 feet of unconsolidated material (Appendix C). The small recharge areas of these fans preclude the presence of large supplies of ground water, however. The yield of the well 303A was less than 2 gpm.

#### Hydraulic Properties of Aquifers

Water that is pumped from wells moves to the well through open spaces or pores in the rocks or unconsolidated material. If the pores are large, numerous, and interconnected much water can be pumped from a well; if the pores are small, widely spaced, and poorly connected little water can be recovered by pumping. The specific yield of a rock is a measure of the ability of the pore space to yield water to drainage by gravity. It is defined as the amount of water yielded from storage per unit area of unconfined aquifer that occurs as the result of a unit change in head. The specific yield is equivalent to the storage coefficient in unconfined aquifers. Generally, a specific yield of more than 20 percent is considered high and a specific yield of less than 5 percent is considered low.

Though a rock may have a large amount of pore space, it will not yield water to a well unless the water can readily move through the rock; if water can move, the rock is said to be permeable. A rock can be porous, but not permeable; it cannot be permeable without having interconnected porosity. Clay is one of the most porous of earth materials, but water cannot move through it easily because the water is bound tightly to the clay particles by forces of adhesion; the clay, therefore, is porous but only slightly permeable. The permeability of a rock is thus a measure of its capacity to transmit water.

A rock formation must have both porosity and permeability to be an aquifer, and the degree to which it has these properties determines in part whether or not it is a good aquifer. Also important is its areal extent and saturated thickness. For purposes of making mathematical analyses of the effects of pumping, the porosity and permeability of an aquifer must be quantitatively defined. Special terms have been given to these principal hydraulic properties. The term "transmissivity" refers to the ability of an aquifer to transmit water; the ability of an aquifer to store water is indicated by "storage coefficient." The storage coefficient and transmissivity can be used to determine the rate, magnitude, and extent of the lowering of the water level in an aquifer caused by a discharging well.

The storage coefficient ( $S$ ) of an aquifer is defined as the volume of water which the aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in component head normal to that surface.

Transmissivity ( $T$ ) is the flow of water in cubic feet per day, at prevailing water temperature, through a vertical strip of aquifer one foot wide extending the full saturated height of the aquifer under a hydraulic gradient of 100 percent. Transmissivity is the product of the hydraulic conductivity and the saturated thickness of the aquifer, where hydraulic conductivity (measure of the material's capacity to transmit water) is defined as rate of flow of water at the prevailing kinematic viscosity through a cross section of 1 square foot (measured normal to the direction of flow) under a hydraulic gradient of 1 foot per foot, expressed in units of feet per day.

The specific capacity of a well is an important hydraulic property and is defined as the unit yield per unit of

drawdown of the water level in a well. It is usually expressed as gallons per minute per foot of drawdown during a given time interval of pumping. For example, if the water level draws down 5 feet at a pumping rate of 10 gpm, the well has a specific capacity of 2. The specific capacity is not constant and commonly changes with changes in pumping rates. The specific capacity will decrease with time if steady pumping results in a continuing decline of the pumping water level.

### Field Tests of Aquifers

Two approaches were used to determine aquifer properties in the project area: 1) drilling, logging, and pumping of test holes, and 2) pumping of existing wells. Thirteen test holes were drilled in the alluvial deposits (Appendix D); samples from eight test holes were analyzed for size composition (Appendix E).

The transmissivity and storage coefficients of the alluvium were obtained in various sections of the drainage basin by aquifer tests. Pumping water from a well develops a depression in the water table around the pumped well. This depression gradually expands as pumping continues unless withdrawal rates are balanced by either a decrease in the natural discharge and/or an increase in recharge to the aquifer. The difference between the pumping water level and the water level before pumping is defined as the drawdown. The drawdown in the well depends upon the pumping rate, the time since pumping began, the transmissivity and storage properties of the aquifer, and the well construction. The area affected by pumping (area of influence) depends upon the pumping rate, the time since pumping began, and the transmissivity and storage properties of the aquifer. After pumping is stopped, the water level in the well will eventually return almost to its original position. By pumping a well at a known constant rate for a measured time, and by recording drawdown during pumping and recovery after pumping, enough data usually can be collected to compute the hydraulic properties of the aquifer which, in conjunction with other hydrogeologic data, can be used to predict long-term pumping effects.

Pumping tests to determine aquifer characteristics were conducted on all test holes except M-4, and on three existing irrigation wells in the Watrous area. Also used in analyses were data from pumping tests made by Turney and

Associates of Santa Fe (written commun.).

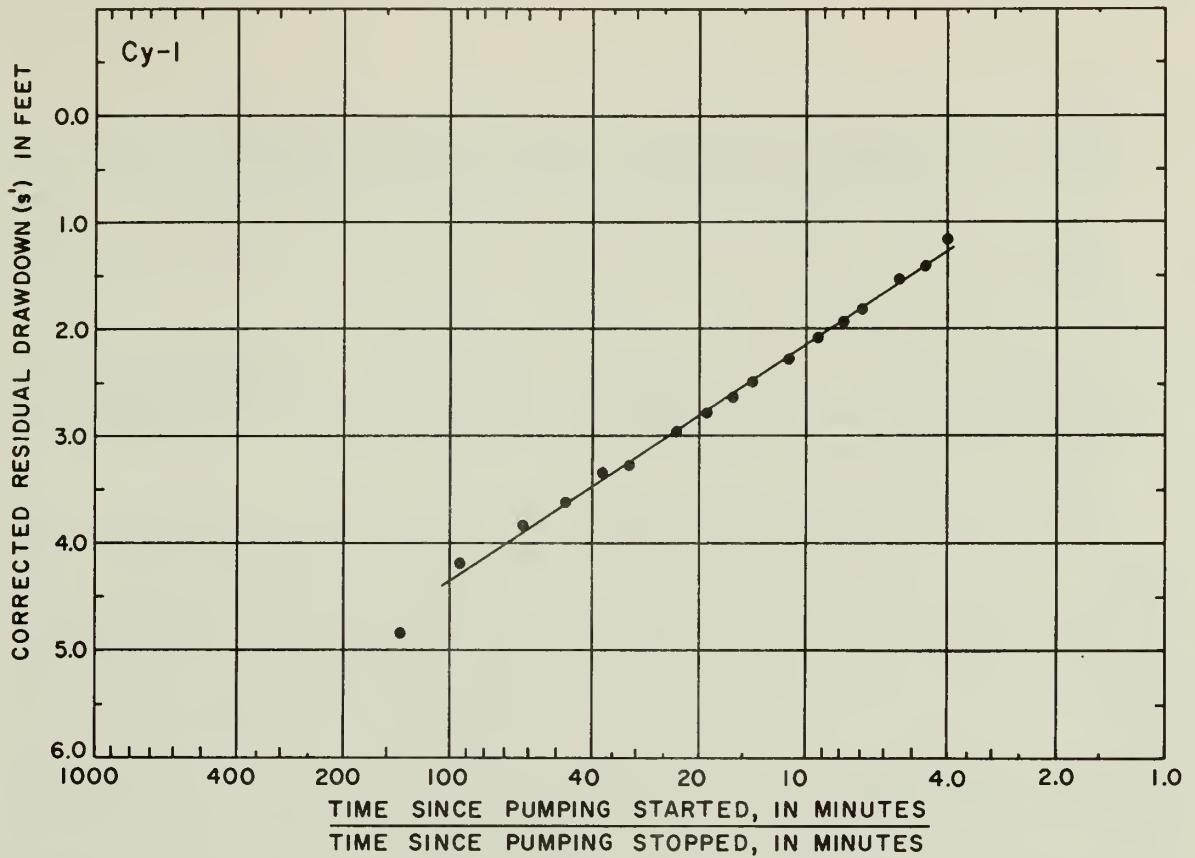
Attempts were made to determine drawdown rates when test holes M-1 and M-1a; M-3 and M-3a; M-5 and M-5a; and Cy-1 and Cy-1a were pumped; however, only tests on Cy-1 and Cy-1a yielded meaningful results. During the pumping period of test hole Cy-1, measurements of drawdown were made in test hole Cy-1a (observation well) and were plotted and analyzed by the Theis nonequilibrium method (fig. 12) as modified and applied by Ferris and others (1962, p. 92-93), to compute transmissivity and storage coefficient. Recovery measurements were made in test hole Cy-1 and plotted against the log of the ratio of time since pumping started to the time pumping stopped as shown in figure 12. The transmissivity values computed for this test are given in table 3. Well locations are shown on plate 2.

Pumping tests were made on three existing wells in the Watrous area (Appendix F, numbers 99, 100, and 102). Transmissivity was determined from these tests by the modified nonequilibrium method of Cooper and Jacob (1946, p. 526-534). An observation well (well 100) was available for use during the test of well 99; however, the storage coefficient could not be determined because the small changes in water level in the observation well were erratic and believed to have been caused primarily by evapotranspiration stresses rather than pumping. No observation wells were available for the tests of well 100 and 102, and consequently no storage coefficient could be computed from these tests. However, based upon examination of similar aquifer materials present in gravel pits in the Watrous area, a value of 0.2 is assumed to be a probable maximum value of the storage coefficient. Data plots for wells 99 and 102 are given in figures 13 and 14.

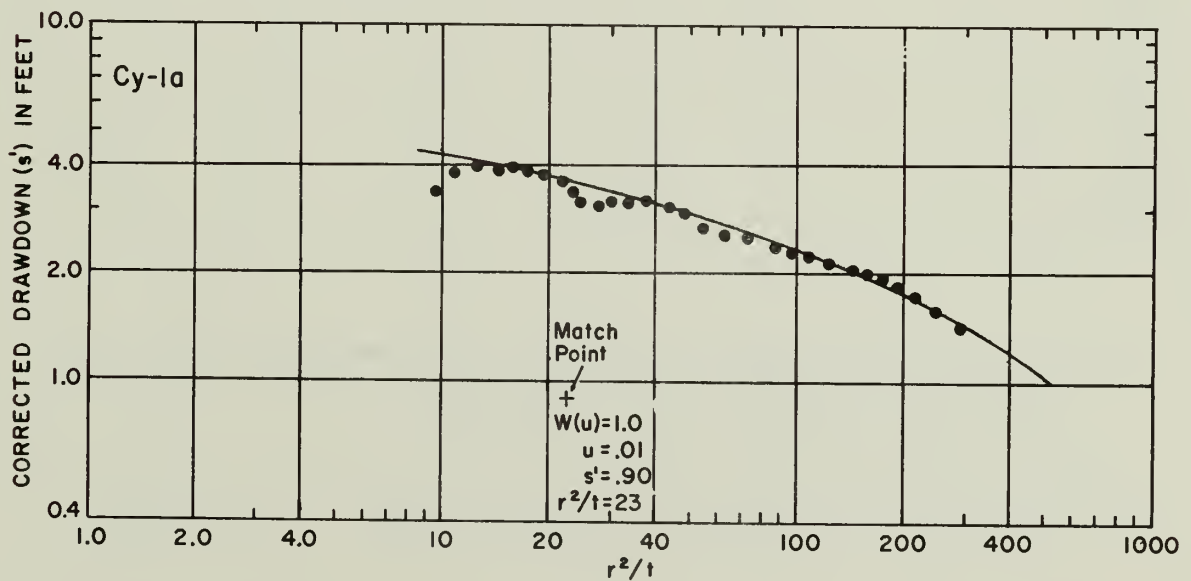
Data from pumping tests made by Turney and Associates of Santa Fe for the New Mexico Health and Social Services Department were used to compute transmissivity values for aquifers at four community supply wells in the upper reaches of the alluvial valleys (table 3).

#### Movement of Ground Water

Ground water is seldom stationary but moves under the force of gravity toward lower altitudes or toward a position of lower hydraulic head. Direction of movement down the hydraulic gradient is along paths that commonly are normal



A.--Corrected residual drawdown of water level in test hole Cy-1 during recovery after pumping stopped.



B.--Corrected drawdown of water level in test hole Cy-1a during pumping cycle of test hole Cy-1.

FIGURE 12.--Corrected drawdown curves of water level in test holes Cy-1 and Cy-1a. (Drawdowns corrected for saturated thickness by:  $s' = s - s^2/2m$  where  $s$  = actual drawdown;  $s'$  = corrected drawdown; and  $m$  = standard thickness.)

TABLE 3.--Summary of aquifer properties determined from pumping tests on wells and test holes in the Mora River drainage, western Mora County, N. Mex.

| Well or test hole<br>number, and<br>general location | Yield<br>(gpm) | Specific<br>capacity<br>(gpm/ft) | Transmissivity<br>(ft <sup>2</sup> /day) |
|------------------------------------------------------|----------------|----------------------------------|------------------------------------------|
| Watrous area                                         |                |                                  |                                          |
| 99                                                   | 940            | 61.0                             | 20,000                                   |
| 100                                                  | 450            | 33.7                             | 3,900                                    |
| 102                                                  | 220            | 25.7                             | 3,400                                    |
| Upper alluvial<br>valleys                            |                |                                  |                                          |
| Cy-1 and Cy-1a                                       | 2              | 0.36                             | 40                                       |
| 151 <sup>1/</sup>                                    | 20             | .30                              | 13                                       |
| 152 <sup>1/</sup>                                    | 10             | .56                              | 20                                       |
| 211 <sup>1/</sup>                                    | 15             | .10                              | 13 <sup>2/</sup>                         |
| 393 <sup>1/</sup>                                    | 25             | .26                              | 20                                       |

<sup>1/</sup> Pumping tests made by Turney and Associates for New Mexico Health and Social Services Department. Exact locations of wells are not known.

<sup>2/</sup> Transmissivities estimated from specific capacities by method described in Bentall (1963, p. 336-340).

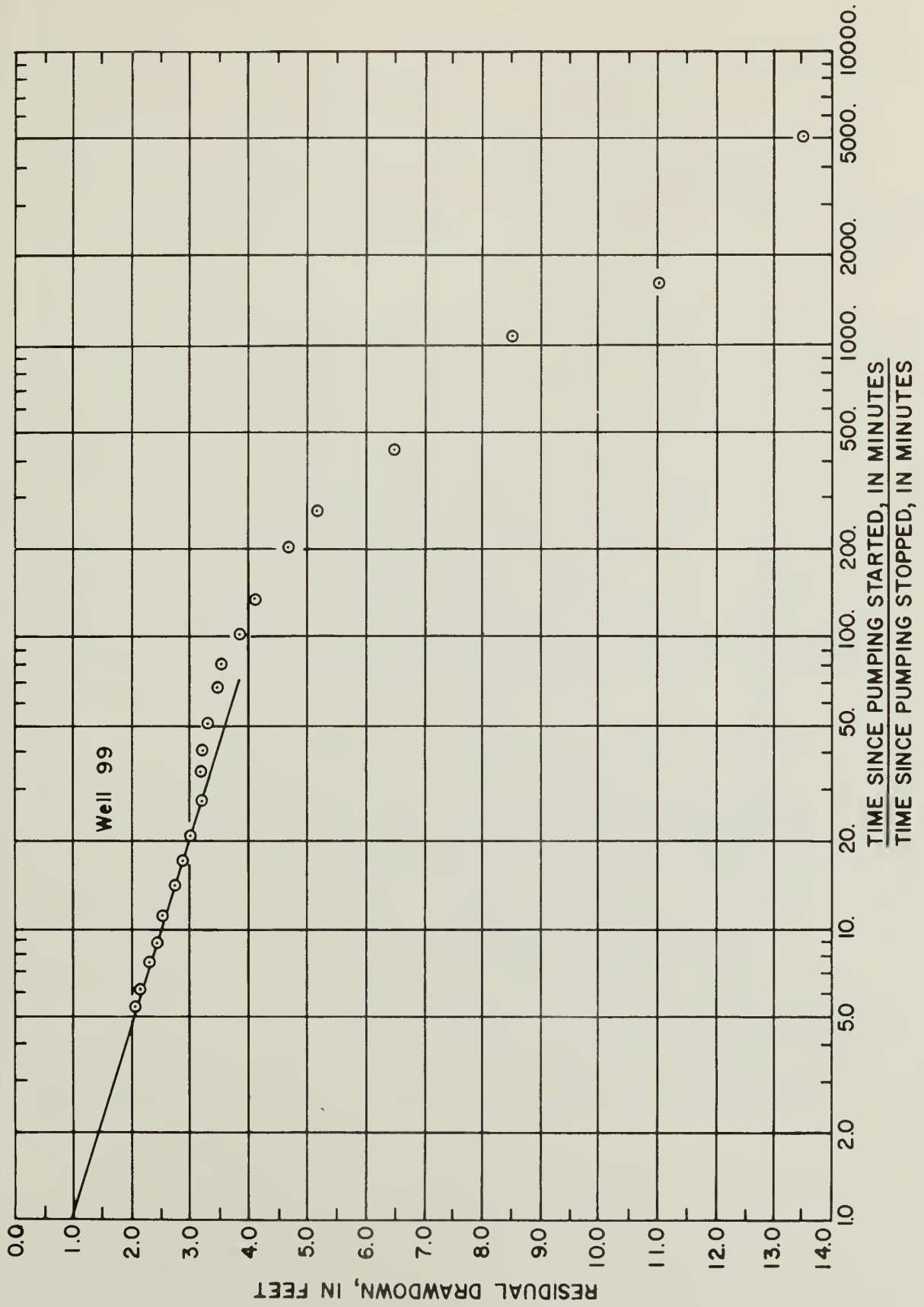


FIGURE 13.--Residual drawdown of water level in well 99 during recovery.

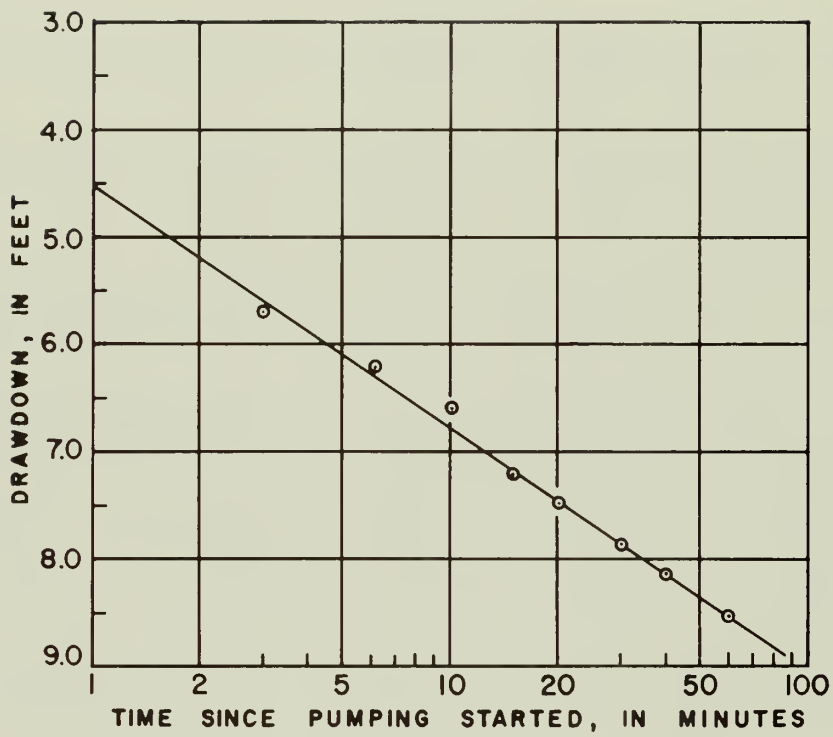


FIGURE 14.--Drawdown of water level  
in well 102 during pumping.

to equipotential lines (contours on top of the saturated zone or the water table). The rates of ground-water movement generally are slow and usually range from a few inches to a few feet per day. Two factors determine the rate of movement: 1) the hydraulic gradient, or slope of the top of the zone of saturation (water table or potentiometric surface) of the aquifer, and 2) the hydraulic conductivity of the water-bearing materials. The quantity of water moving through the aquifer depends upon these factors and upon the cross-sectional area of the aquifer.

The slope of the water table and direction of movement of ground water in the alluvial aquifers were determined from a water-table contour map based on water-level measurements during the winter of 1968-69 in approximately 150 wells (pl. 2). Because many of the wells are in a narrow belt along the Mora River and its tributaries, much of the detail of the shape and slope of the water table could not be shown even in the contoured areas. The map showing contours on top of the saturated zone indicates that ground-water movement is generally toward the surface-drainage system. In the upper alluvial valleys of the project area, the slope of the water table is approximately 100 feet per mile; in the lower valleys it averages about 50 feet per mile.

Actual rates of movement are difficult to determine in most of the project area above Watrous because of the heterogeneity and anisotropy of the alluvial deposits. An estimated velocity based on limited data was calculated for the upper area. The hydrogeologic map (pl. 2) shows an average hydraulic gradient of about 100 feet per mile. Saturated thickness of the alluvium, exclusive of the Mora Valley near Mora, averages about 30 feet (Mercer and Lappala, 1970) and transmissivity determined from pumping tests ranges from 13 to 40 ft<sup>2</sup>/day. Hydraulic conductivity is equal to transmissivity divided by saturated thickness. The estimated rate of movement calculated from the above figures and assuming an average porosity of 30 percent ranges from 0.03 to 0.1 ft/day.

In the vicinity of Watrous the deposits are relatively homogeneous and isotropic, making estimates of rates of movement more feasible. The water-level contours of wells in the area show that the hydraulic gradient ranges from 36 to 60 feet per mile. Saturated thickness of the alluvium ranges from 30 to 50 feet (Mercer and Lappala, 1970) and

transmissivities determined from pumping tests on wells 99, 100, and 102 (table 3) range from 3,400 ft<sup>2</sup>/day to 20,000 ft<sup>2</sup>/day. The probable rate of movement for this area calculated from the above figures and assuming a porosity of 35 percent ranges from 1 to 10 ft/day.

The rates of water movement can be used to compute travel times for contaminants entering the ground-water reservoir; however, actual migration of pollutants also depends upon factors other than the rate of water movement. Among these are the relationship between pore size in the aquifer and particle size of suspended solids, and the absorption characteristics of dissolved materials.

Volumes of ground water moving in the direction of the hydraulic gradient (underflow) were computed for the upper valleys, including the Mora Valley, and for the Watrous area. Underflow rates in the upper valleys average 60 ft<sup>3</sup>/day. This is based on a transmissivity of 30 ft<sup>2</sup>/day, a hydraulic gradient of 100 feet per mile, and an average cross sectional width of the valleys of 100 feet. For the Watrous area, the underflow is about 90,000 ft<sup>3</sup>/day. This is based upon a transmissivity of 10,000 ft<sup>2</sup>/day, a hydraulic gradient of 45 feet per mile, and an average cross-sectional width of the valley at the mouth of the canyon below Watrous of 1,000 feet.

#### Water-Level Fluctuation

The water table or potentiometric surface in an aquifer is not stationary but fluctuates in response to external changes. The amount and rate of the fluctuation is dependent on the rate of loss (discharge) or rate of replenishment (recharge) of water to ground-water storage. In this report, discharge means all outflows from the ground-water system, natural and artificial; recharge means all inflow to the ground-water system. Discharge of ground water from a discrete or local area of an aquifer will cause a lowering of the water level in that area unless it is equaled or exceeded by concurrent recharge. Discharge from the discrete area may result simply by water moving laterally into adjacent parts of the aquifer, by extraction of water by wells located in the particular area being considered, by evapotranspiration if water levels are near the land surface, by vertical leakage into higher or lower aquifers, or by outflow to artificial drains or streams that may cross the area under consideration. Recharge results from water moving

into the area laterally from adjacent areas or vertically from higher or lower aquifers, from downward percolation of precipitation or irrigation return flows that may occur in the area considered, or infiltration of water from streams and ditches which may cross the area. Water levels may rise in some parts of an aquifer owing to the recharge-discharge storage relationship and concurrently lower in other parts of the same aquifer.

A record of periodic water-level fluctuations in an aquifer furnishes valuable information about discharge, recharge, and storage relationships of an aquifer. Monthly fluctuations of water levels in the project area were measured in 44 wells starting in March 1969 and continued until November 1969 (Appendix G). Although measurements were not extensive enough to establish long-term trends, they do indicate seasonal fluctuations that probably are representative of the area.

In the areas heavily irrigated with surface water the water levels in the alluvium generally rose throughout the irrigation season (June-September). For example, water levels in test holes 131 and 135 (Appendix G) show a rise of 1 and 2 feet, respectively. It should be pointed out that in this particular area the only withdrawal from wells is for domestic and stock use.

In the Watrous area some water is pumped from wells for irrigation, but the discharge of these wells is exceeded by recharge from surface irrigation resulting in a rise in water levels during the irrigation season. For example, well 90 (Appendix G) on the Phoenix Ranch near Watrous shows a 3.3-foot rise during the irrigation season.

In the areas with less intensive irrigation, water levels in the alluvial aquifers change very little, or show a slight decline during the summer months. The water level in well 11, near Chacon in the upper valleys, fluctuated very little over the summer, and the water level in well 15, in the same area, declined less than 2 feet (see Appendix G).

## AREAS HAVING A POTENTIAL FOR GROUND-WATER DEVELOPMENT FOR IRRIGATION

Aquifers in areas considered for ground-water development for irrigation must be evaluated to determine if an adequate supply of water can be obtained and maintained. Criteria used in this evaluation are the following:

1. The saturated thickness of the aquifer must be sufficient to permit wells to be pumped at rates practical to supply water for the intended purpose.
2. The aquifer must be of large enough areal extent and have enough inflow to the area considered for ground-water development to sustain planned withdrawal rates over a long enough period of time to justify the development of the area.
3. If the first two criteria are met, spacing and location of wells must be such that:
  - a. Interference between wells should be minimized within economic considerations.
  - b. Optimum use be made of water from the entire stream-aquifer system.

The volume of ground water in storage in an alluvial aquifer can be estimated if the areal extent, the saturated thickness, and the average storage coefficient of the water-bearing alluvium are known. The average saturated thickness and areal extent of the aquifer in the project area were determined from seismic investigations (Mercer and Lappala, 1970). Estimates of the amount of ground water in storage in the alluvial aquifer in western Mora County are given in table 4.

### Upper Alluvial Valleys

The ground water in storage in the principal upper tributary valleys of the Mora (Coyote Creek and Rito Cebolla) and in the main stem of the Mora River above Valmora (exclusive of Mora Valley) is estimated to be about 12,700 acre-feet (table 4).

TABLE 4.--Estimated amount of ground water in storage in the alluvial aquifer, western Mora County, N. Mex.

| Area or tributary <u>1/</u>                                  | Average saturated thickness (feet) <u>2/</u> | Average storage coefficient | Approximate area of aquifer (acres) | Estimated storage (acre-feet) |
|--------------------------------------------------------------|----------------------------------------------|-----------------------------|-------------------------------------|-------------------------------|
| Coyote Creek                                                 | 35                                           | 0.05                        | 3,000                               | 5,200                         |
| Cebolla River<br>(Rito Cebolla)                              | 25                                           | .05                         | 2,100                               | 2,600                         |
| Mora River above<br>Valmora (Mora<br>Valley not<br>included) | 30                                           | .05                         | 3,000                               | <u>4,900</u>                  |
| Subtotal                                                     |                                              |                             |                                     | 12,700                        |
| Mora Valley                                                  | 200                                          | .05                         | 1,200                               | 12,000                        |
| Near Watrous                                                 | 40                                           | .20                         | 500                                 | 4,000                         |
| Valmora to Shoemaker<br>Gage                                 | 35                                           | .20                         | 1,000                               | <u>7,000</u>                  |
| Subtotal                                                     |                                              |                             |                                     | 23,000                        |
| Total                                                        |                                              |                             |                                     | 35,700                        |

1/ See figure 1.

2/ Determined primarily from seismic investigation (Mercer and Lappala, 1970).

Figure 15 shows predicted drawdowns of water level that would occur in wells tapping alluvial aquifers in the upper valleys of the Mora River and its tributaries, and in the Watrous area. The predicted drawdowns were computed assuming a transmissivity of  $40 \text{ ft}^2/\text{day}$  and a storage coefficient of 0.05 for the upper valleys and a transmissivity of  $4,000 \text{ ft}^2/\text{day}$  and a storage coefficient of 0.20 for the Watrous area as determined from pumping tests (table 3).

The alluvial aquifers in the upper reaches of the Mora River drainage above Watrous fail to meet the criteria for ground-water development for irrigation mentioned previously. With the exception of the Mora Valley, average saturated thickness in the valleys is not over 35 feet which, considering the low transmissivity, is not sufficient to sustain well yields adequate for irrigation purposes or the excessive drawdowns expected to result from pumping for irrigation purposes.

The saturated alluvium in Mora Valley is known to average 200 feet in thickness and to exceed 300 feet in some places. It is possible that large yields of water could be obtained from wells in this area. If the deeper deposits have a high transmissivity and if adequate vertical leakage exists between upper beds and streams, a minimum of 12,000 acre-feet of water would be recoverable for development. Verification of this possibility must await drilling of a test well that full penetrates the alluvium.

Alluvial aquifers in the upper valleys are recharged primarily by perched streams, precipitation, seepage from surface irrigation canals, and seepage from poorly constructed drainage systems. The U.S. Bureau of Reclamation (1966, p. 56) estimates canal loss in the upper valleys to range between 30 and 37 percent of the total diverted flow.

In Mora Valley, at the mouth of Rio la Casa, a boulder fan of Quaternary age (table 1) is hydraulically connected to permeable deeply buried deposits that extend eastward at depths greater than 100 feet. Water from the Mora River, Rio la Casa, Canoncito, and Encinal Creeks recharges these deposits through the boulder fan. The following data support this conclusion:

- 1) Seepage investigations by the U.S. Geological Survey (1956, 1957, and 1961) show a significant reduction in flow from the Mora River as it crosses the boulder fan.

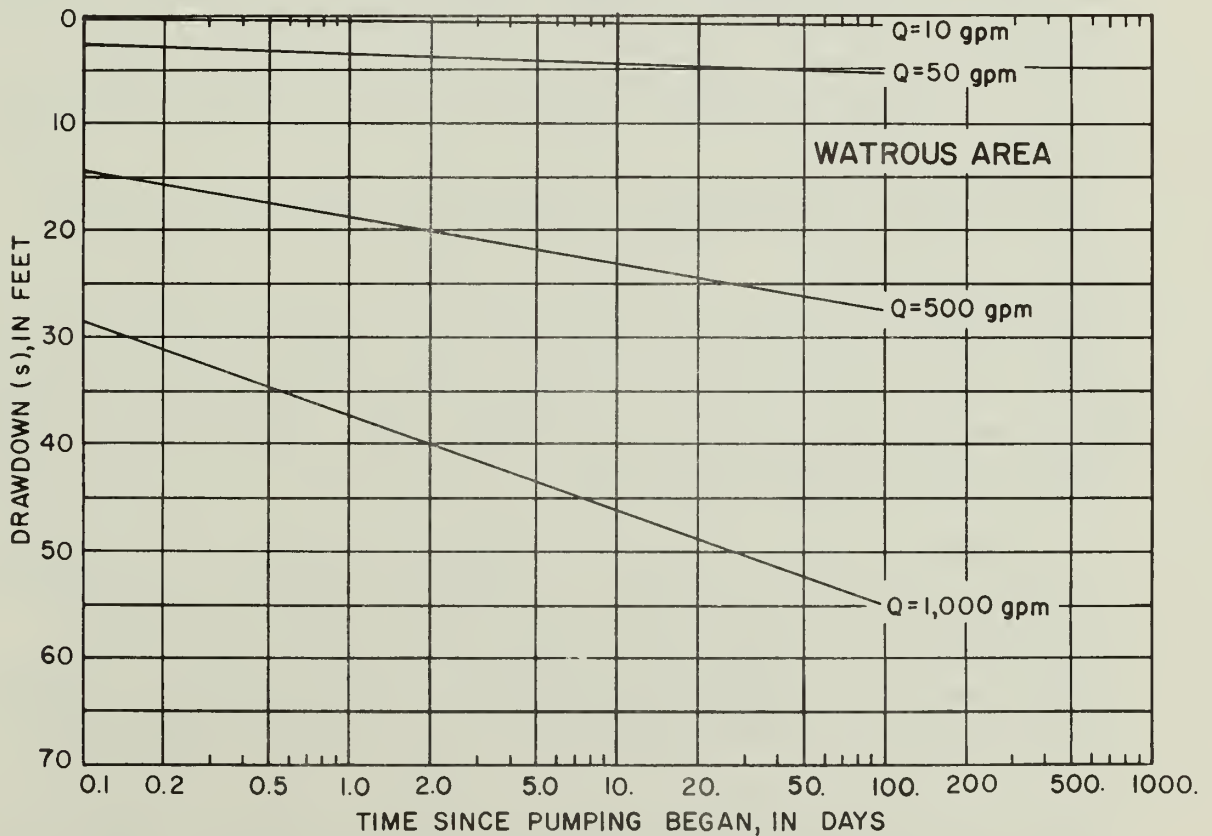
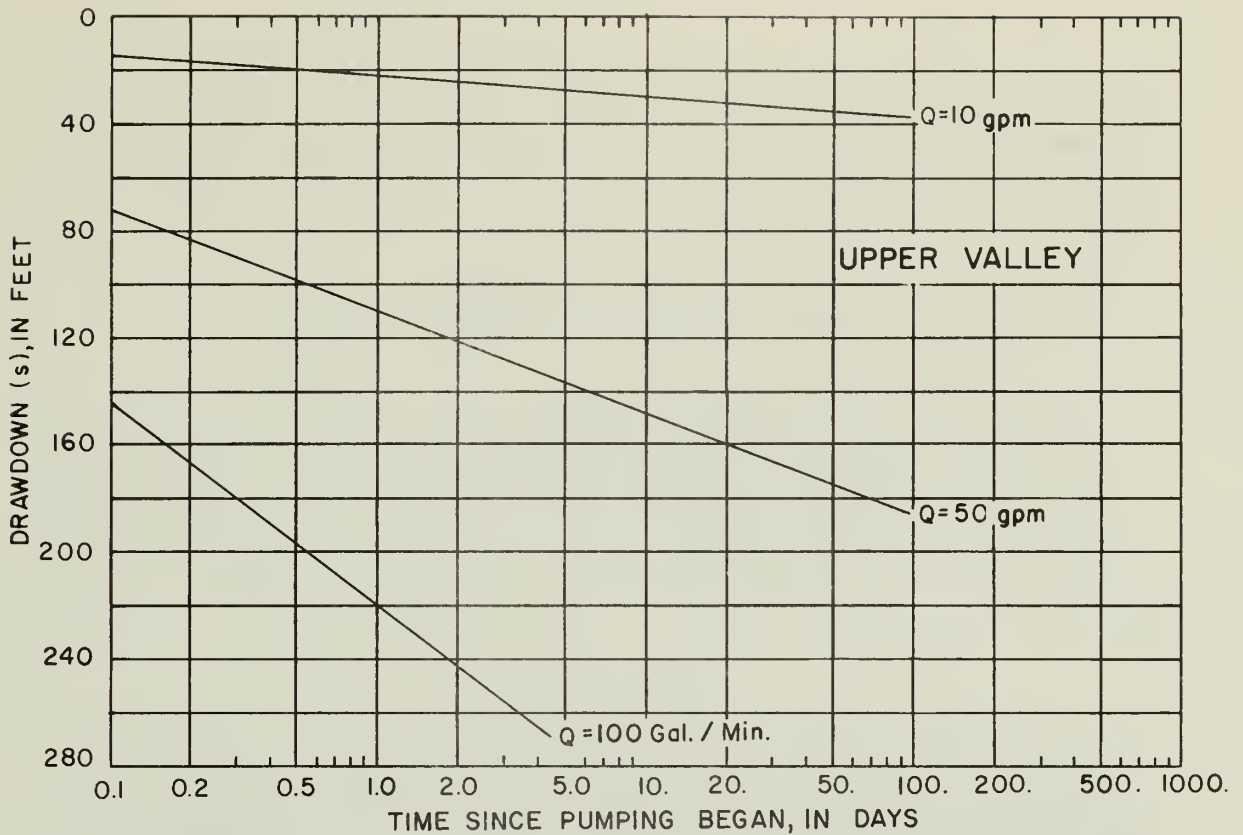


FIGURE 15.--Predicted drawdown of water levels in hypothetical wells tapping alluvial aquifers in the upper valleys of the Mora River and its tributaries, and in the Watrous area, computed for different pumping rates (Q).

2) Sands and gravels are reported to depths of 100 feet in the Mora Community well (Appendix C, well 42). These deposits are reported to have yielded as much as 125 gpm with "no drawdown." No test of their full capacity is known to have been made.

3) Water-level contours suggest continuity between the deeply buried deposits and the boulder fan.

Terrace and pediment deposits in the upper valleys are dependent upon precipitation and ephemeral streamflow for recharge. Some shallow dug wells in the Rainsville area, where these deposits may be less than 20 feet thick, are reported to go dry during years of below-average precipitation.

#### Watrous Area

Alluvial aquifers near Watrous generally meet the criteria for ground-water development for irrigation. Saturated thicknesses (as much as 60 feet) are great enough, when coupled with high transmissivities, to accommodate expected drawdowns during pumping at irrigation rates. Figure 15 shows drawdowns computed using a transmissivity of  $4,000 \text{ ft}^2/\text{day}$ , and a storage coefficient of 0.2. These figures are average values based upon three pumping tests (table 3) and examination of aquifer materials in gravel pits near Watrous. The higher storage coefficient of the aquifer in this area reflects well-sorted alluvial materials that originated in the drainage of the Sapello River, which joins the Mora River at Watrous. The higher carrying capacity of the Mora River below the confluence of the Sapello caused fine materials to be carried downstream, leaving the present coarse, well-sorted deposits.

Based on an average saturated thickness of 40 feet (Mercer and Lappala, 1970), a storage coefficient of 0.2, and an aquifer area of 500 acres, the volume of ground water in storage near Watrous would be about 4,000 acre-feet (table 4). Because the alluvial materials are coarse and well-sorted, more water per unit volume of aquifer material could be obtained from them than from alluvial material in the upper valleys. Data from aquifer tests on wells 99, 100, and 102 indicate that a potential exists for ground-water irrigation near Watrous. Although the alluvial aquifer meets the criteria for development, it is emphasized that careful consideration should be given to the location,

spacing, and construction of wells.

Alluvial deposits similar to those near Watrous are present between Valmora and the gaging station below Shoemaker. The alluvium near Watrous fills a broad valley, but between Valmora and the gaging station the alluvium occurs in a narrow valley of the Mora River. The alluvial aquifer in the valley has an average saturated thickness of 35 feet (Mercer and Lappala, 1970), a storage coefficient of 0.2, and an aquifer area of 1,000 acres. The estimated volume of ground water in storage between Watrous and the gaging station is about 7,000 acre-feet. However, development of large supplies of ground water from wells in the narrow valley may not be feasible as the cone of water-level depression caused by pumping would soon reach impermeable boundaries in the narrow valley which would cause a decrease in the yield of wells.

Recharge to the alluvial aquifers in the Watrous area is derived from precipitation inflow from perched streams, return flow and tail-water losses from surface irrigation, seepage from diversion canals and drainage ditches, and outflow from bedrock aquifers. The U.S. Bureau of Reclamation (1966, p. 56) estimates an average of 42 percent of the diverted flow is lost through canal seepage.

#### WATERLOGGED LANDS AND RELATED PROBLEMS OF DRAINAGE

Land is said to be waterlogged if the moisture content in the root zone is so great that it adversely affects crop growth. Waterlogging results in accumulation of salts and decreases aeration and workability of the soil; in addition, waterlogged soils tend to warm more slowly during the spring, retarding early germination of seed. This is an important factor in western Mora County where the length of the growing season generally is less than 160 days (U.S. Bureau of Reclamation, 1967, p. 39-46).

The primary area of waterlogged land is in the Mora Valley near Mora. Here, rising water levels have rendered the land useless for all crops except natural grasses and alfalfa.

Factors contributing to waterlogging of soils in the Mora Valley are the excessive use of surface water for irrigation by upstream users and the textural and hydrologic character of the material above the water table. Where

soils are tightly packed and composed of fine-grained material, such as clay, the capillary fringe (zone in which ground water is held by capillary forces) extends higher above the water table than in areas where soils are looser and contain coarser grained material. The clay soils also have lower transmissive characteristics, which result in inadequate subsurface drainage. Poor drainage coupled with the high rate of recharge from excess irrigation or underflow from upland areas has caused a rise in water levels throughout the area and waterlogging of the land.

Methods that could be used in the Mora watershed to reduce or eliminate waterlogging include: canal and ditch lining, modification and control of irrigation practices, and construction of deep drains for lowering the water table.

Canal or ditch seepage causes the principal loss of water between the source and the delivery point of the water. this not only reduces the volume of water available for irrigation, but may also cause damage to land adjacent to the canal or ditch. Delivery losses would be minimized by lining the canals.

Perhaps the foremost cause of waterlogging is excessive use of water. Because surface water is plentiful during winter months and early in the irrigation season, it is wasted through uncontrolled flooding, continuous irrigation, and excessively long irrigation runs which contribute greatly to waterlogging.

In parts of the area where waterlogged conditions are caused by inadequate subsurface drainage, deep drains will be required. Deep drains undoubtedly would be the most effective corrective measure near Mora. Common methods for achieving deep drainage are pumped wells, open ditches, and buried-tile drains. Of the three, the buried-tile method would probably be most feasible for use near Mora. Pumping from wells is not recommended because of the hydrologic characteristics of the soil and because a large number of pumping plants would be required. Although initial cost would be lowest, open ditches would not be suitable because their construction would reduce the available agricultural land and their maintenance would require continual attention.

If deep drains were installed it would not only make more tillable land available but might also increase the amount of water available for irrigation. For example, if

the waterlogged land near Mora were drained to a depth of 3 feet the estimated volume of water initially salvaged would be 90 acre-feet. This value is based on 600 acres of waterlogged land, an assumed storage coefficient of 0.05, and a decrease in saturated thickness of 3 feet.

## QUALITY OF WATER

Although terms used in this report are common ones, some have limited usage and others may convey a variety of meanings. To aid in clarity, some of the terms used are defined below:

### Definition of terms

milligrams per liter (mg/l) - A unit expressing the concentration of chemical constituents as the weight of solute in milligrams per liter of solution. In water of low mineral concentration, milligrams per liter is approximately equal to grams of constituent per million grams of solution, commonly reported as parts per million (ppm)

specific conductance - A measure of the ability of water to conduct an electric current; expressed in micromhos per centimeter at 25°C. Because specific conductance is dependent upon the concentration of ions in solution, it can be used as an approximate measure of the degree of mineralization of water.

sodium-absorption-ratio (SAR) - A measure of the quality of irrigation water related to the absorption of sodium by soil from applied water. The ratio is determined by dividing the concentration of sodium by the square root of one-half the concentration of calcium plus magnesium, all concentrations expressed as milliequivalents per liter. In reported ratios, the higher the figure, the poorer the quality of water for irrigation.

hardness - A property of water that results in the formation of soap scum. Several chemical constituents cause hardness, but the degree of hardness for most water can be estimated from the concentration of alkaline earths, such as calcium and magnesium. The U.S. Geological Survey uses adjective ratings to

describe hardness attributed to  $\text{CaCO}_3$ . Thus, soft water contains 0-60 mg/l; moderately hard, 61-120 mg/l; hard, 121-180 mg/l; and very hard, more than 180 mg/l.

### Significance of Chemical Constituents

Water samples from surface and ground-water sources in western Mora County were analyzed to determine the concentration of chemical constituents that affect the usability of the water. The results of these analyses are compared with recommended limits for selected uses, and the derivation and significance of constituents or properties of the water are summarized in table 5. Characteristics of the water such as pH and specific conductance were also determined. Derivation, significance, and recommended limits are those recommended by the California State Water Pollution Control Board (1957).

One of the factors that determines the success or failure of an irrigation project is the quality of the water applied. The suitability of water for irrigation is determined by the total salt concentration, the concentration ratios of different salts, the increase of salt concentration and chemical reactions in the soil after water application, and the concentration of trace elements such as boron. Irrigation practices also are important. Application of water that is rated as good may, with poor irrigation practices such as inadequate provision for drainage, cause deterioration and eventual destruction of the productive capacity of the soil.

Boron, sodium, and salinity are the principal hazards related to the chemical character of irrigation water. Boron is necessary in very small quantities for normal growth of all plants, but in larger concentrations it is toxic. Quantities needed vary with the crop type; sensitive crops require minimum amounts and tolerant crops will not be affected by several times these concentrations. Among the plants most sensitive are citrus fruit and walnut trees; truck garden crops such as carrots, lettuce, and cabbage are among the most tolerant.

When the sodium concentration in applied water is high compared to calcium and magnesium, sodium replaces calcium and magnesium in the soil and a sodium (alkali) soil develops. Sodium soils may be improved by adding conditioners

TABLE 5.--Common chemical constituents, characteristics of water, and summary of analyses of water, western Mora County, N. Mex.

| Constituent or property                                          | Derivation                                                                                                                                          | Significance                                                                                                                                                                                                                                                             | Recommended limits for selected users                                                                                                                                         | Range in concentration for samples analyzed (mg/l) |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Silica (SiO <sub>2</sub> )                                       | Siliceous materials present in virtually all rocks.                                                                                                 | Forms hard scale in boilers and pipes. Inhibits deterioration of zeolite-type water softeners. May prevent corrosion in pipes by forming a protective coating.                                                                                                           | 1 mg/l for high-pressure-boiler feed. 10 to 50 mg/l for other industrial processes.                                                                                           | 2.8- 56                                            |
| Iron (Fe)                                                        | Iron-bearing minerals present in most rocks. Iron may be added to water in contact with iron objects such as well casing, pipes, and storage tanks. | Oxidizes to a reddish-brown precipitate. More than about 0.3 mg/l stains laundry and utensils. Objectionable for many industrial, food processing, and beverage uses. Supports growth of certain bacteria. Imparts objectionable taste when greater than about 1.0 mg/l. | Less than 1.0 mg/l for most industrial use. 0.3 mg/l for the sum of iron and manganese in domestic supplies.                                                                  | 0 - 1.8                                            |
| Calcium (Ca)                                                     | Limestone, dolomite, gypsum or gypsiferous shale, sewage, and industrial waste.                                                                     | With magnesium causes most of the hardness and scale-forming properties of water. Beneficial in irrigation water where unfavorable sodium ratio exists in soil.                                                                                                          | 5 mg/l for boiler feed.                                                                                                                                                       | 4.6- 461                                           |
| Magnesium (Mg)                                                   | Dolomite and most igneous rocks.                                                                                                                    | Similar to calcium in flocculating soil colloids, imparting the property of hardness, and forming scale. Salts of magnesium act as cathartics.                                                                                                                           | 125 mg/l for drinking and culinary waters.                                                                                                                                    | 0.2- 53                                            |
| Sodium (Na) plus potassium (K)                                   | Feldspars, salt beds, other common minerals, sewage, and industrial wastes.                                                                         | Causes foaming in boilers when concentration of sodium plus potassium exceeds 50 mg/l. High concentrations are toxic to plants, harmful to soil, and will act as cathartic. High ratio of sodium to calcium plus magnesium is harmful to soil structure.                 | 50 mg/l of sodium plus potassium for boiler water. 115 mg/l sodium maximum for domestic use.                                                                                  | 10.6- 181.6                                        |
| Bicarbonate (HCO <sub>3</sub> ) and carbonate (CO <sub>3</sub> ) | Carbonate rocks and calcareous materials.                                                                                                           | In combination with calcium and magnesium forms scale and releases corrosive carbon dioxide gas. A high ratio of carbonate and bicarbonate to alkaline earths may cause the water to be unsuitable for irrigation.                                                       | 100 mg/l for boiler use.                                                                                                                                                      | 87 - 596                                           |
| Boron                                                            | Granitic rocks and permatites                                                                                                                       | Boron is necessary in small quantities for normal growth of plants, but very detrimental in large quantities.                                                                                                                                                            | Above 0.5 mg/l citrus fruits affected. If over 2.0 mg/l, most crops injured.                                                                                                  | .01 .53                                            |
| Sulfate (SO <sub>4</sub> )                                       | Gypsum, anhydrite, pyrite, and oxidized organic matter in the sulfur cycle.                                                                         | In combination with calcium and magnesium forms hard scale. As magnesium or sodium sulfate acts as a cathartic. High concentrations may be toxic to plants.                                                                                                              | 250 mg/l for domestic use. 250 mg/l in carbonated beverages.                                                                                                                  | 6.4-1,080                                          |
| Chloride (Cl)                                                    | Most rocks and soils, sewage, and industrial effluents.                                                                                             | High concentrations of chloride salts impart salty taste. May be toxic to plants. May accelerate corrosion in pipes.                                                                                                                                                     | 250 mg/l for domestic use. 200 mg/l for kraft paper pulp.                                                                                                                     | 0.6- 83                                            |
| Fluoride (F)                                                     | Fluorite, apatite, and hydrothermal solutions.                                                                                                      | Reduces incidence of tooth decay in children when concentration is 0.5 to 1.5 mg/l; more than about 1.5 mg/l causes mottling of tooth enamel in children. Concentrations of more than 5 mg/l may cause fluorosis.                                                        | 1.5 mg/l for domestic use. 1.0 mg/l for food canning.                                                                                                                         | 0.2- 17                                            |
| Nitrate (NO <sub>3</sub> )                                       | Decayed organic matter, sewage, nitrate fertilizers, and nitrates in the soil.                                                                      | Values higher than 5 to 10 mg/l may suggest pollution. More than about 44 mg/l may cause methemoglobinemia (infant cyanosis). Generally nitrate in water used for irrigation is desirable for its fertilizing value.                                                     | 44 mg/l for domestic use.                                                                                                                                                     | 0 - 119                                            |
| Dissolved solids                                                 | Rocks, soils, industrial and sewage effluents.                                                                                                      | High concentrations are harmful to plant and animal life and can cause foaming in boilers.                                                                                                                                                                               | 1,000 mg/l for domestic use, although more saline waters are used by some communities without harmful effects. 1,000 mg/l for most industrial uses.                           | 121 -1,810                                         |
| Hardness (as CaCO <sub>3</sub> )                                 | Mainly calcium and magnesium in solution; certain other cations cause hardness but are ordinarily present in small amounts.                         | Hard water causes excessive soap consumption, scale in boilers and pipes, toughening of cooked vegetables. Tends to prevent corrosion of metals. Produces finer grained structure in baking. Very hard water retards fermentation.                                       | Water having a hardness of more than 121 mg/l generally considered to be hard. 0 to 50 mg/l for laundering. 80 mg/l for boiler feed water at 0 to 150 pounds per square inch. | 22 -2,194                                          |
| Specific conductance (micromhos at 25°C)                         | Ion concentration in water.                                                                                                                         | An increase in value indicates an increase in dissolved solids.                                                                                                                                                                                                          | More than 1,500 generally exceeds standards for domestic water. More than 3,000 unsuitable for irrigation under most conditions.                                              | 180 -2,090                                         |
| pH (hydrogen-ion concentration expressed as pH)                  | Hydrogen-ion concentration.                                                                                                                         | Values from 1 to 7 indicate decreasing acidity; of more than 7 indicate increasing alkalinity. Affects taste, corrosivity, and treatment processes such as coagulation. Low value desirable where irrigation water applied to alkaline soils.                            | 7.5 for food canning and freezing. More than 9.0 unsuitable for irrigation use.                                                                                               | 6.8 8.8                                            |

such as gypsum, which replenish calcium and magnesium.

Salinity (dissolved solids) increases the osmotic pressure in the soil solution, and when salinity is high, plant growth is retarded. Because the salinity of water is closely related to the specific conductance of water, specific conductance may be used as a measure of the salinity hazard of water.

### Water Quality in the Mora River Drainage

Chemical analyses of 24 samples of water from wells, 2 samples from springs, and 4 samples of surface water are given in Appendix H. Specific conductance values of water from many wells are also given in Appendix A.

The analyses show only the chemical characteristics of the water. Because the analyses do not include any determination of the biological material contained in the water, they do not indicate sanitary conditions.

### Ground Water

Most of the analyses of ground water are of water samples collected from wells and springs that produce from the alluvium. The dissolved-solids concentration of the 19 samples ranged from 121 to 537 mg/l. Ground water in the alluvium is generally hard to very hard and, based on a percentage composition, may be roughly classed as a calcium sodium sulfate bicarbonate type water.

Water from the bedrock aquifers generally contains more dissolved solids than water from the alluvium. Dissolved-solids concentrations range from 329 to 1,810 mg/l in the seven samples analyzed.

Concentrations of some constituents in water from several wells tapping the alluvium exceed the U.S. Public Health Service (1962) standards. Anomalous high values of fluorides were found in wells 11, 54A, 57, and 212. The concentration of fluoride in well 57 near El Alto was 17 mg/l, the highest recorded in the area and about 11 times the maximum recommended (table 5). Nitrate concentrations are under the recommended limits in all alluvial wells; however, it is extremely high, 119 mg/l, in well 220 which taps both the alluvium and the Sandia Formation of Pennsyl-

vanian age. This high value indicates probable contamination from some outside source. High iron content (1.8 mg/l) was found only in well 11. Sulfate is above recommended limits in 20 of the 26 samples collected from wells and springs.

Ground water in western Mora County appears to be well suited for irrigation. The salinity and sodium hazard, plotted as open circles in figure 16, ranges from a low- to medium-sodium hazard to a low- to high-salinity hazard.

### Surface Water

The chemical quality of surface water based on water analyses made for this study is generally acceptable for all uses and meets the U.S. Public Health (1962) standards. The biological quality was not measured and its suitability for human use was not evaluated.

River water is uniform in chemical character throughout the study area. It is generally of the bicarbonate type, and is very hard with dissolved-solids concentrations ranging from 244 to 296 mg/l. The surface water is suitable for irrigation; as indicated by figure 16, it falls in the medium-salinity and low-sodium hazard category.

### SUMMARY

Preliminary reconnaissance indicated that unconsolidated deposits were the most likely source of sufficient ground water to supplement surface-water supplies during low-flow periods. Deposits of alluvial, colluvial, lacustrine, and glacial(?) origin contain ground water in the valleys of nearly all of the Mora River drainage within western Mora County, New Mexico. Exceptions are isolated terrace and pediment deposits in the Rainsville area.

Thicknesses of unconsolidated deposits (determined by seismic refraction) are generally the result of climatic and structural changes in late Cenozoic time and range from a few feet in tributary valleys to more than 300 feet in the Mora Valley.

Results of test drilling, examination of driller's logs, and pumping tests showed that the unconsolidated boulders, cobbles, gravel, sand, silt, and clay filling the valleys above Watrous are very heterogeneous and aniso-

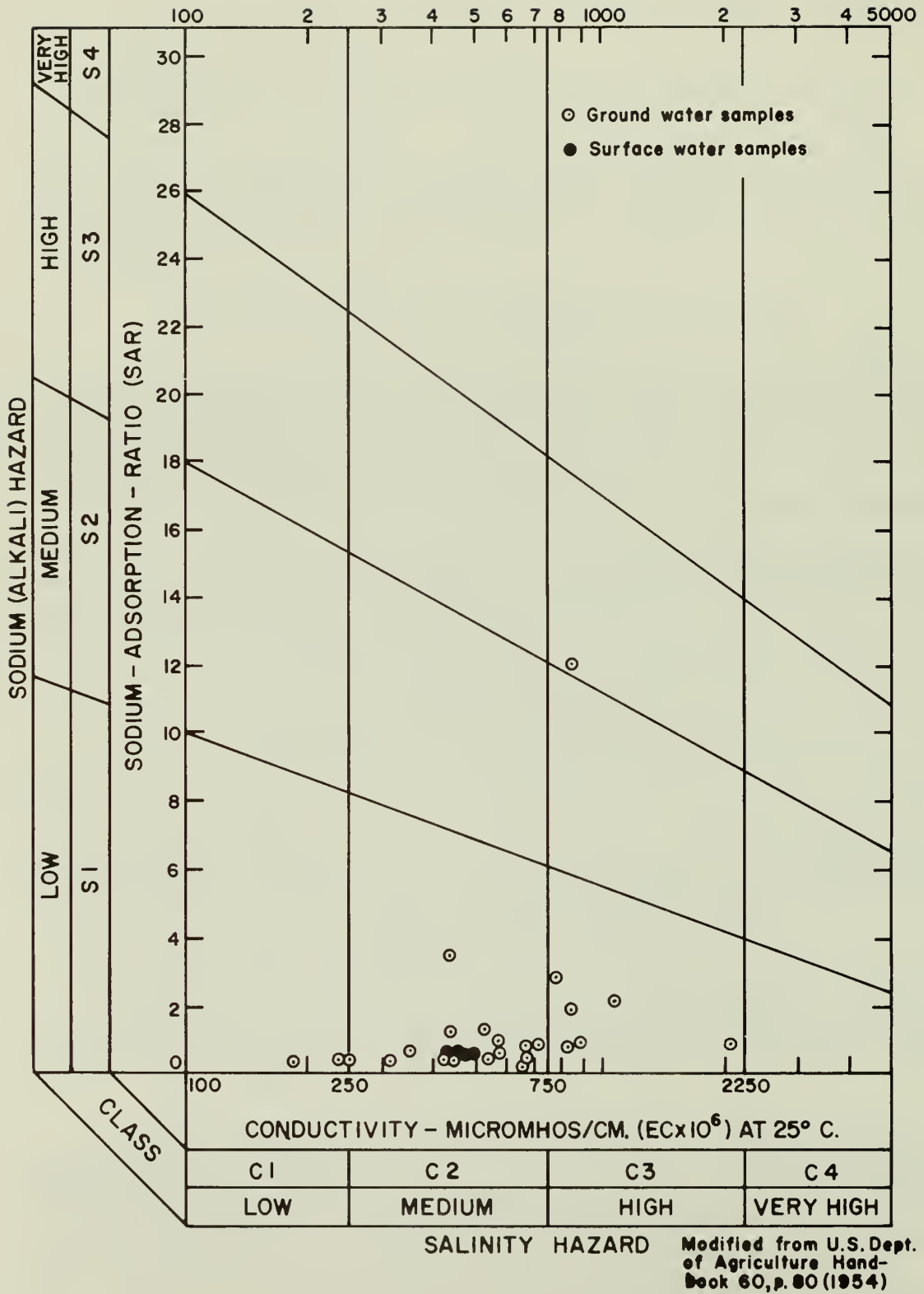


FIGURE 16.--Sodium-salinity hazard for samples of ground and surface water in the Mora River drainage basin.

tropic. Aquifer tests indicate that the maximum transmissivity and storage coefficient for these areas are  $40 \text{ ft}^2/\text{day}$  and 0.05, respectively; however, the reported performance of some existing wells suggests transmissivity may be higher locally. Even though the total storage of ground water in the upper valleys (exclusive of Mora Valley) is about 12,700 acre-feet it is doubtful if an adequate supply could be maintained at pumping rates sufficient to supply supplemental irrigation wells.

Potential aquifers in the alluvial deposits in Mora Valley have been explored only to a depth of about 100 feet. If the deeper deposits could yield adequate supplies for irrigation there would be a minimum of 12,000 acre-feet of water than could be developed for irrigation. Ability of the deeper deposits to yield large quantities of water could be determined by drilling and pumping a test well that fully penetrates the alluvial aquifer.

Additional ground-water development appears to be feasible in the alluvial valley near Watrous. Results of test drilling, examination of gravel pits, and pumping tests in this area showed that unconsolidated deposits are relatively homogeneous and isotropic. Transmissivities range from 3,400 to  $20,000 \text{ ft}^2/\text{day}$ , and the assumed maximum storage coefficient is 0.20. The amount of ground water in storage is about 4,000 acre-feet. This, in conjunction with the high transmissivity, indicates that at pumping rates normally associated with irrigation wells, the supply would be sustained.

The quality of both ground-water and surface-water supplies throughout the project area meets established criteria for irrigation use.

In general, the possibilities for additional ground-water development to supplement present surface-water supplies for irrigation is limited.

The basic cause of present shortages appears to be inefficient use of surface supplies and delivery systems. If shortages still exist after surface supplies have been utilized to their maximum efficiency, and a decision to reclaim waterlogged lands has been made, the development of additional water supplies would require studies to: 1) determine water-bearing and transmissive properties of alluvial deposits at depths greater than 100 feet in the

Mora Valley by test drilling and pumping tests, 2) determine the degree of hydraulic continuity between boulder fan materials at the mouth of Rio la Casa and materials deeper than 100 feet in the Mora Valley, and determine whether the boulder fan could be utilized as a recharge area, 3) determine the full extent of the saturated material in the valley near Watrous by intensive seismic refraction studies, and 4) examine the bedrock aquifers, primarily the Santa Rosa Sandstone of Triassic age and the Dakota Sandstone of Cretaceous age, as possible supplemental sources of irrigation-water supplies.

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## APPENDIXES



# Appendix A.--Records of selected wells in the Mora River drainage, western Mora County, N. Mex.

## EXPLANATION:

Well No.: Wells numbered 1 through 199 are located in the drainage of the main stem of the Mora River; wells numbered 200 through 299 are located in the drainage of Rito Gebolla; wells numbered 300 through 399 are located in the drainage of Coyote Creek; wells numbered 400 through 499 are located in the drainage of the Sapello River.

Latitude and longitude: Interpolated from 7½-minute USGS topographic quadrangle maps.

Owner or name: MDWCA; Mutual Domestic Water Consumers Association.

Depth: R, reported; otherwise measured.

Diameter: Diameter of casing or diameter of hole, if uncased.

Altitude: Altitude of land surface at well. Interpolated from 7½-minute USGS topographic quadrangle maps.

Depth to water: Measured depths given to nearest one-tenth foot; reported depths given to nearest foot.

Principal aquifer: Qal, alluvium; QTB, basalt; ~~Wsr~~, Santa Rosa Sandstone; ~~PU~~, Pennsylvanian rocks, undivided.

Use: D, domestic; I, industrial; Irr, irrigation; O, observation; PS, public supply; S, stock; U, unused.

Specific conductance: Field measurements with portable meter. Asterisk (\*) indicates chemical analysis in Appendix H.

Log: X indicates driller's log listed in Appendix C.

Yield: All yields are those determined by bailing unless otherwise indicated; e indicates estimated yield; sc indicates specific capacity, in gpm/ft.

| Well No. | Latitude-Longitude | Date completed | Owner or name  | Depth (feet) | Diameter (inches) | Altitude (feet) | Water level           |          |                 | Principal aquifer | Use      | Specific conductance (micromhos at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|--------------------|----------------|----------------|--------------|-------------------|-----------------|-----------------------|----------|-----------------|-------------------|----------|------------------------------------------|-----|------------------|-------------|
|          |                    |                |                |              |                   |                 | Depth to water (feet) | Date     | Altitude (feet) |                   |          |                                          |     |                  |             |
| 1        | 36°11'35"          | 1968           | --             | 27R          | 8                 | 8,540           | --                    | --       | --              | Qal               | D        | 580                                      | --  | 9                | --          |
| 2        | 36°09'19"          | --             | --             | --           | 36                | 8,180           | 7.3                   | 11-12-68 | 8,173           | Qal               | D        | --                                       | --  | --               | --          |
| 3        | 36°09'15"          | 1965           | F. Vasquez     | 65R          | --                | 8,260           | --                    | --       | --              | --                | --       | --                                       | --  | --               | 4           |
| 4        | 36°08'38"          | --             | Old School     | 35           | 72                | 8,140           | 25.4                  | 11-12-68 | 8,115           | Qal               | PS, O, U | --                                       | --  | --               | --          |
| 5        | 36°08'29"          | 1967           | S. Maestas     | 125R         | 6                 | 8,150           | --                    | --       | --              | --                | D        | --                                       | X   | --               | 6           |
| 6        | 36°08'34"          | 1967           | J. Bernal      | 120R         | 6                 | 8,120           | 7.0                   | 1-30-67  | 8,113           | Qal (?)           | D        | --                                       | X   | --               | 20          |
| 7        | 36°07'58"          | 1964           | E. L. Duran    | 180R         | --                | 8,020           | --                    | --       | --              | --                | D        | --                                       | X   | --               | 10          |
| 8        | 36°07'54"          | 1962           | L. Ortega Jr.  | 90R          | --                | 8,010           | --                    | --       | --              | --                | D        | --                                       | X   | --               | 3           |
| 9        | 36°07'44"          | 1962           | P. Abeyta      | 126R         | 6                 | 7,990           | 18.6                  | 11-12-68 | 7,971           | --                | D        | --                                       | X   | --               | --          |
| 10       | 36°08'52"          | 1961           | D. Martinez    | 116R         | 6                 | 8,340           | --                    | --       | --              | --                | D        | --                                       | X   | --               | 40          |
| 11       | 36°06'58"          | 1968           | W. Romero      | 50           | 6                 | 7,900           | 7.0                   | 11-12-68 | 7,893           | PU                | D, U, O  | 1,500*                                   | --  | --               | 4           |
| 12       | 36°06'53"          | 1961           | J. Trujillo    | 50R          | 6                 | 7,890           | --                    | --       | --              | Qal (?)           | D        | --                                       | X   | --               | 7           |
| 13       | 36°06'49"          | --             | --             | 10           | 36                | 7,870           | 4.6                   | 11-12-68 | 7,865           | Qal               | D        | 900                                      | --  | 10               | --          |
| 14       | 36°05'09"          | 1967           | E. Lovato      | 76R          | 8                 | 7,760           | 20                    | 5-18-67  | 7,740           | --                | D        | --                                       | X   | --               | 60+         |
| 15       | 36°05'05"          | --             | do.            | 23           | 24                | 7,750           | 13.3                  | 11-12-68 | 7,737           | Qal               | D, O     | 780*                                     | --  | 12               | --          |
| 16       | 36°04'21"          | 1964           | N. Armiño      | 125R         | 6                 | 7,690           | 30.8                  | 11-12-68 | 7,659           | --                | D        | 1,500                                    | X   | 9                | --          |
| 17       | 36°03'37"          | --             | E. Cruz        | 40R          | 36                | 7,660           | 19.0                  | 11-12-68 | 7,641           | Qal               | D        | 1,000                                    | --  | 10               | --          |
| 18       | 36°02'48"          | 1964           | C. A. Grandorf | 105R         | 6                 | 7,630           | --                    | --       | --              | --                | D        | --                                       | X   | --               | 16          |
| 19       | 36°02'48"          | --             | P. Romero      | --           | 6                 | 7,610           | 36.4                  | 11-12-68 | 7,574           | Qal               | D        | 760                                      | --  | 11               | --          |
| 20       | 36°02'37"          | 1957           | R. R. Valdez   | 50R          | 6.8               | 7,580           | --                    | --       | --              | Qal               | D        | --                                       | X   | --               | 25          |

Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Continued

| Well No. | Latitude  | Longitude  | Date completed | Owner or name               | Depth (feet) | Diameter (inches) | Altitude (feet) | Water level           |                 | Principal aquifer | Use   | Specific conductance (microhmhos at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|-----------|------------|----------------|-----------------------------|--------------|-------------------|-----------------|-----------------------|-----------------|-------------------|-------|-------------------------------------------|-----|------------------|-------------|
|          |           |            |                |                             |              |                   |                 | Depth to water (feet) | Altitude (feet) |                   |       |                                           |     |                  |             |
| 21       | 36°02'13" | 105°22'53" | --             | F. A. Duran                 | 37R          | 30                | 7,530           | 30.7                  | 7,499           | Qal               | D     | 720                                       | --  | 12               | --          |
| 22       | 36°01'59" | 105°22'33" | 1965           | A. Sanchez                  | 100R         | 6                 | 7,520           | --                    | --              | --                | D     | --                                        | X   | --               | 3           |
| 23       | 36°01'52" | 105°22'40" | 1954           | E. Hurtado                  | 50R          | 6                 | 7,490           | 29.0                  | 7,471           | Qal               | D     | 610                                       | X   | 16               | 20          |
| 24       | 36°01'39" | 105°22'57" | 1956           | N. Mex. Dept. Public Health | 150R         | 6,10              | 7,520           | --                    | --              | --                | D     | --                                        | X   | --               | 25          |
| 25       | 36°01'17" | 105°22'52" | 1967           | W. Garcia                   | 144R         | 6                 | 7,550           | 90                    | 7,460           | --                | D     | --                                        | X   | --               | 12.5        |
| 26       | 36°01'05" | 105°22'50" | 1964           | E. Chacon                   | 62R          | 6                 | 7,490           | --                    | --              | --                | D     | --                                        | X   | --               | 25          |
| 27       | 36°00'58" | 105°23'21" | 1957           | J. or Romero                | 82R          | 5                 | 7,560           | --                    | --              | --                | D     | --                                        | X   | --               | 20          |
| 28       | 36°00'42" | 105°23'25" | 1964           | S. Romero                   | 90R          | --                | 7,530           | --                    | --              | --                | D     | --                                        | X   | --               | 6           |
| 29       | 36°00'22" | 105°23'37" | --             | J. Bonney                   | 55R          | 6                 | 7,500           | 26.9                  | 7,473           | --                | D     | 610                                       | --  | 13               | --          |
| 30       | 36°00'07" | 105°23'30" | --             | --                          | --           | 48                | 7,540           | 45.4                  | 7,495           | Qal               | D     | 900                                       | --  | 10               | --          |
| 31       | 36°00'06" | 105°23'31" | 1957           | T. Pando                    | 45R          | 6                 | 7,550           | --                    | --              | --                | D     | --                                        | X   | --               | 11          |
| 32       | 36°00'04" | 105°23'14" | 1957           | L. Trujillo                 | 120R         | 6                 | 7,480           | --                    | --              | --                | D     | --                                        | X   | --               | --          |
| 33       | 36°00'24" | 105°22'41" | --             | F. Herrera                  | --           | 36                | 7,420           | 22.8                  | 7,397           | Qal               | D     | 500                                       | --  | --               | --          |
| 34       | 36°00'13" | 105°22'32" | 1964           | Mora Valley Medical Clinic  | 45R          | --                | 7,410           | --                    | --              | Qal(?)            | D     | --                                        | X   | 13               | --          |
| 35       | 36°00'11" | 105°22'35" | 1967           | E. Chacon                   | 53R          | --                | 7,400           | --                    | --              | Qal(?)            | D     | --                                        | X   | --               | 60+         |
| 36       | 36°01'26" | 105°22'22" | --             | --                          | --           | 6                 | 7,470           | 49.2                  | 7,421           | --                | D     | --                                        | --  | --               | --          |
| 37       | 36°01'27" | 105°22'15" | 1967           | O. Medina                   | 83R          | --                | 7,530           | --                    | --              | --                | D     | --                                        | X   | --               | 20          |
| 38       | 36°01'19" | 105°21'57" | 1957           | B. Lujan                    | 131R         | 6                 | 7,540           | --                    | --              | --                | D     | --                                        | X   | --               | 5           |
| 39       | 36°01'05" | 105°22'17" | --             | A. D. Maes                  | 77           | 36                | 7,470           | 54.3                  | 7,416           | Qal               | D, O  | 650*                                      | --  | 13               | --          |
| 40       | 36°01'06" | 105°22'16" | 1957           | C. Pais                     | 105R         | 6                 | 7,470           | --                    | --              | Qal(?)            | D     | --                                        | X   | --               | 5           |
| 41       | 36°01'04" | 105°22'18" | --             | No. Cleveland NWCA          | --           | 6                 | 7,470           | 50                    | 7,420           | Qal(?)            | PS, U | 650                                       | --  | 13               | --          |
| 42       | 36°00'11" | 105°22'10" | --             | P. Lujan                    | 37R          | 24                | 7,400           | 18.1                  | 7,382           | --                | D     | 680                                       | --  | 13               | --          |
| 43       | 35°59'09" | 105°25'24" | 1959           | H. O. Grace                 | 52R          | 6,5               | 8,060           | --                    | --              | --                | D     | --                                        | X   | --               | 12          |
| 44       | 35°59'38" | 105°22'17" | --             | C. D. Romero                | 20           | 36                | 7,380           | 14.5                  | 7,366           | Qal               | D     | 320                                       | --  | 12               | --          |
| 46       | 35°59'13" | 105°21'39" | --             | J. Karavus                  | 16.5         | --                | 7,350           | 14.1                  | 7,336           | Qal               | D     | 650                                       | --  | 10               | --          |
| 47       | 35°50'02" | 105°21'42" | 1962           | Pendleton Oil & Gas Co.     | 50R          | 6                 | 7,330           | 23.7                  | 7,306           | Qal               | D, O  | 205*                                      | X   | --               | 25          |
| 48       | 35°58'52" | 105°21'39" | 1960           | I. Mestas                   | 61R          | 6                 | 7,315           | --                    | --              | Qal               | D     | --                                        | X   | --               | 40          |
| 49       | 35°58'48" | 105°21'26" | --             | --                          | 20           | 30                | 7,300           | 15.9                  | 7,284           | Qal               | D     | 220                                       | --  | 10               | --          |
| 50       | 35°58'38" | 105°20'47" | --             | --                          | 46           | 5                 | 7,250           | 41.3                  | 7,209           | Qal               | D     | --                                        | --  | --               | --          |
| 51       | 35°58'27" | 105°19'54" | --             | --                          | 22           | 36                | 7,190           | 15.8                  | 7,174           | Qal               | O     | 440                                       | --  | 13               | --          |

Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Continued

| Well No. | Latitude  | Longitude  | Date completed | Owner or name      | Depth (feet) | Diameter (inches) | Altitude (feet) | Depth to water (feet) | Water level |                 | Principal aquifer | Use   | Specific conductance (microhmhos at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|-----------|------------|----------------|--------------------|--------------|-------------------|-----------------|-----------------------|-------------|-----------------|-------------------|-------|-------------------------------------------|-----|------------------|-------------|
|          |           |            |                |                    |              |                   |                 |                       | Date        | Altitude (feet) |                   |       |                                           |     |                  |             |
| 52       | 35°58'16" | 105°19'46" | 1950           | Mora MDMCA         | 170R         | 10                | 7,180           | --                    | --          | --              | Qa1               | PS    | 329                                       | X   | --               | 125         |
| 53       | 35°58'05" | 105°19'42" | --             | --                 | --           | 40                | 7,170           | 3.2                   | 11-14-68    | 7,167           | Qa1               | D,O   | 440                                       | --  | 12               | --          |
| 54       | 35°57'46" | 105°19'06" | --             | S. Muniz           | 35           | --                | 7,180           | 25.4                  | 3-27-69     | 7,155           | Qa1(?)            | D,O   | 290                                       | --  | 12               | --          |
| 54A      | 35°57'47" | 105°19'07" | --             | do.                | 28.5         | --                | 7,180           | 27.9                  | 3-27-69     | 7,152           | Qa1(?)            | D     | 466*                                      | --  | --               | --          |
| 55       | 35°58'12" | 105°19'06" | --             | E. Herrera         | --           | --                | 7,140           | .6                    | 11-14-68    | 7,139           | Qa1               | D     | 410                                       | --  | 11               | --          |
| 56       | 35°58'05" | 105°18'29" | --             | J. P. Bert         | 14           | 48                | 7,110           | 3.5                   | 11-14-68    | 7,106           | Qa1               | D,I,O | 390*                                      | --  | 13               | --          |
| 57       | 35°58'39" | 105°18'17" | --             | --                 | 18           | 40                | 7,150           | 12.6                  | 11-14-68    | 7,137           | Qa1               | D,O   | 800*                                      | --  | 18               | --          |
| 58       | 35°59'02" | 105°18'50" | --             | --                 | 29           | 6                 | 7,155           | 5.6                   | 11-14-68    | 7,149           | Qa1               | D,O   | 360                                       | --  | 13               | --          |
| 59       | 35°59'18" | 105°19'29" | --             | M. Rudolph         | --           | 48                | 7,175           | 5.0                   | 11-14-68    | 7,170           | Qa1               | D,O   | --                                        | --  | --               | --          |
| 60       | 35°59'19" | 105°19'29" | --             | do.                | 420R         | 6                 | 7,180           | --                    | --          | --              | --                | D     | 360                                       | --  | --               | 30          |
| 61       | 36°00'01" | 105°18'05" | --             | Mora Rodeo Grounds | 182          | 6                 | 7,310           | 144                   | 11-14-68    | 7,166           | --                | S,PS  | 240                                       | --  | 11               | 11          |
| 62       | 36°00'48" | 105°16'20" | --             | T. Martinez        | 52R          | 40                | 7,470           | 38.0                  | 11-15-68    | 7,432           | Qa1               | D,S   | 900                                       | --  | 9                | --          |
| 63       | 36°01'00" | 105°16'20" | --             | A. Martinez        | 18R          | 40                | 7,450           | 5.7                   | 11-15-68    | 7,444           | Qa1               | D     | 1,130                                     | --  | 7                | --          |
| 64       | 36°01'14" | 105°16'21" | --             | do.                | 6.7          | 36                | 7,445           | 4.1                   | 11-15-68    | 7,441           | Qa1               | S     | 220                                       | --  | 7                | --          |
| 65       | 36°01'49" | 105°16'18" | --             | --                 | 27R          | 60                | 7,475           | 21.0                  | 11-15-68    | 7,454           | Qa1               | D,S   | 510                                       | --  | 6                | --          |
| 66       | 35°57'17" | 105°18'10" | --             | P. Montano         | 75R          | 6                 | 7,235           | 25                    | 11-14-68    | 7,210           | Qa1               | D     | 250                                       | --  | 10               | --          |
| 67       | 35°55'56" | 105°17'36" | --             | --                 | 23           | 80                | 7,310           | 16.4                  | 11-14-68    | 7,294           | Qa1               | D     | 280                                       | --  | 10               | --          |
| 68       | 35°55'34" | 105°17'41" | --             | A. Trujillo        | 22           | 36                | 7,320           | 17.7                  | 11-14-68    | 7,302           | Qa1               | D,S   | 840                                       | --  | 10               | --          |
| 69       | 35°55'01" | 105°17'59" | --             | D. Chavez          | 81           | 5                 | 7,370           | 60                    | 11-14-68    | 7,310           | --                | D,S,O | 300*                                      | --  | 13               | 20          |
| 70       | 35°57'24" | 105°16'50" | 1964           | M. Tafaya          | 100R         | --                | 7,110           | --                    | --          | --              | --                | D     | --                                        | X   | --               | 2           |
| 71       | 35°56'59" | 105°15'57" | 1957           | L. Alcone          | 50R          | 6                 | 7,070           | --                    | --          | --              | --                | D     | 420                                       | X   | 13               | --          |
| 72       | 35°57'34" | 105°16'58" | --             | --                 | --           | 6                 | 7,100           | --                    | --          | --              | Qa1(?)            | D,U   | 380                                       | --  | --               | --          |
| 72A      | 35°56'38" | 105°15'30" | --             | E. Eaabla          | 50R          | --                | 7,050           | --                    | --          | --              | Qa1               | D,O   | 460                                       | --  | 11               | --          |
| 73       | 35°56'02" | 105°15'10" | 1965(?)        | N. Mex. Hwy. Dept. | 403R         | 6                 | 7,100           | 88.0                  | 6- 3-69     | 7,012           | --                | D,I,O | 650                                       | X   | 16               | --          |
| 74       | 35°54'33" | 105°15'09" | --             | Buena Vista MDMCA  | 150R         | 6                 | 7,050           | 82.0                  | 6- 3-69     | 6,968           | --                | PS    | 650*                                      | --  | --               | --          |
| 75       | 35°54'19" | 105°15'00" | --             | J. Floris          | 80+          | 8                 | 7,010           | 42.1                  | 11-19-68    | 6,968           | --                | D     | --                                        | --  | --               | --          |
| 76       | 35°54'00" | 105°15'09" | --             | L. Shock           | 200R         | 6                 | 7,080           | --                    | --          | --              | --                | S     | --                                        | X   | --               | 30          |
| 77       | 35°56'54" | 105°14'49" | --             | --                 | 100+         | 6                 | 7,080           | 82.7                  | 11-19-68    | 6,997           | --                | S     | 620                                       | --  | 6                | --          |
| 78       | 35°56'30" | 105°14'53" | --             | W. Salaman         | 200R         | 6                 | 7,020           | --                    | --          | --              | --                | D     | 950                                       | --  | 10               | --          |
| 79       | 35°56'07" | 105°14'59" | --             | F. Igo             | 12           | 48                | 7,020           | 8.6                   | 11-19-68    | 7,011           | Qa1               | D     | 1,000                                     | --  | 11               | --          |
| 80       | 35°55'15" | 105°14'58" | --             | --                 | 35           | 60                | 6,995           | 20.9                  | 11-19-68    | 6,975           | Qa1(?)            | D     | 900                                       | --  | 12               | --          |
| 81       | 35°54'15" | 105°14'43" | --             | L. Shock           | 103R         | 5                 | 6,980           | --                    | --          | --              | --                | D     | --                                        | X   | --               | 20          |

Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Continued

| Well No. | Latitude  | Longitude  | Date completed | Owner or name     | Depth (feet) | Diameter (inches) | Altitude (feet) | Depth to water (feet) | Water level     |       | Principal aquifer | Use    | Specific conductance (micromhos at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|-----------|------------|----------------|-------------------|--------------|-------------------|-----------------|-----------------------|-----------------|-------|-------------------|--------|------------------------------------------|-----|------------------|-------------|
|          |           |            |                |                   |              |                   |                 |                       | Altitude (feet) | Date  |                   |        |                                          |     |                  |             |
| 82       | 35°53'55" | 105°13'56" | --             | 69 Ranch          | 80R          | 5                 | 6,940           | --                    | --              | --    | --                | D, U   | --                                       | --  | --               | --          |
| 83       | 35°53'35" | 105°11'07" | 1959           | F. C. Stover      | 202R         | 6                 | 6,865           | 59.8                  | 11-19-68        | 6,805 | --                | S      | 360                                      | X   | --               | --          |
| 84       | 35°53'27" | 105°11'05" | 1960           | do.               | 50R          | --                | 6,830           | --                    | --              | --    | --                | --     | --                                       | X   | --               | 25          |
| 85       | 35°53'22" | 105°11'02" | --             | C. H. Penland     | 200R         | 8                 | 6,815           | 11.7                  | 11-19-68        | 6,803 | Qal               | U, O   | --                                       | --  | --               | --          |
| 86       | 35°53'18" | 105°11'02" | --             | do.               | 12R          | --                | 6,800           | --                    | --              | --    | Qal               | D      | 2,300*                                   | --  | 18               | --          |
| 87       | 35°53'40" | 105°10'35" | 1957           | F. C. Stover      | 70R          | 6                 | 6,850           | --                    | --              | --    | --                | --     | --                                       | X   | --               | 12          |
| 88       | 35°53'30" | 105°10'53" | --             | --                | 110R         | 6                 | 6,830           | --                    | --              | --    | --                | --     | --                                       | --  | --               | 10          |
| 89       | 35°49'18" | 105°00'58" | --             | --                | 24           | --                | 6,490           | 20.4                  | 11-19-68        | 6,470 | Qal               | D      | --                                       | --  | --               | --          |
| 90       | 35°48'54" | 105°00'02" | 1946           | Phoenix Ranch     | 327          | 10                | 6,475           | 11.9                  | 6-4-69          | 6,463 | Qal(?)            | U, O   | --                                       | --  | --               | --          |
| 91       | 35°48'28" | 105°00'25" | --             | V. Boney          | 108R         | 8                 | 6,475           | --                    | --              | --    | Qal(?)            | D      | 650                                      | --  | 16               | --          |
| 99       | 35°48'16" | 104°58'56" | 1967           | W. Shoemaker      | 100R         | 14                | 6,425           | 5.2                   | 11-21-68        | 6,420 | Qal               | Irr, O | 850                                      | X   | 11               | 1,110       |
| 100      | 35°48'19" | 104°59'04" | 1954(?)        | do.               | 100R         | 12                | 6,425           | 6.2                   | 11-15-68        | --    | Qal               | Irr    | --*                                      | --  | --               | 490         |
| 101      | 35°48'24" | 104°59'04" | --             | Sellman Bros.     | 50R          | 6                 | 6,430           | --                    | --              | --    | Qal               | D      | 700*                                     | --  | --               | --          |
| 102      | 35°48'40" | 104°59'03" | 1967           | do.               | 110R         | 12                | 6,460           | 20.5                  | 11-19-68        | 6,440 | Qal               | Irr    | 650                                      | --  | 14               | 270         |
| 103      | 35°48'57" | 104°59'45" | 1947           | G. Mitchell       | 210R         | 12                | 6,460           | 20.0                  | 11-21-68        | 6,440 | Qal               | S, Irr | --                                       | --  | --               | --          |
| 104      | 35°49'11" | 104°59'50" | --             | --                | 38           | 36                | 6,465           | 16.2                  | 11-21-68        | 6,449 | Qal               | D      | 750                                      | --  | 6                | --          |
| 105      | 35°47'31" | 104°55'57" | --             | --                | 29           | 8                 | 6,350           | 22.0                  | 11-21-68        | 6,328 | Qal(?)            | D      | --                                       | --  | --               | --          |
| 106      | 35°47'22" | 104°55'30" | --             | M. Sellman        | 44           | 8(?)              | 6,330           | 10                    | 11-21-68        | 6,320 | Qal(?)            | D      | 800                                      | --  | --               | --          |
| 107      | 35°47'45" | 104°59'35" | --             | Phoenix Ranch     | 302R         | --                | 6,440           | --                    | --              | --    | Qal(?)            | D, Irr | 600                                      | --  | --               | --          |
| 130      | 36°02'15" | 105°22'55" | --             | Maestas           | 16           | 30                | 7,540           | 15.3                  | 4-9-69          | 7,525 | Qal               | D, O   | --                                       | --  | --               | 25          |
| 131      | 35°58'30" | 105°18'30" | 1968           | U.S. Geol. Survey | --           | 2                 | 7,135           | 4.9                   | 6-3-69          | 7,130 | Qal               | O      | --                                       | --  | --               | --          |
| 132      | 35°58'11" | 105°19'07" | 1968           | do.               | --           | 3                 | 7,140           | .1                    | 6-3-69          | 7,140 | Qal               | O      | --                                       | --  | --               | --          |
| 133      | 35°50'46" | 105°04'30" | --             | --                | --           | --                | 6,590           | 19.8                  | 6-4-69          | 6,570 | Qal               | U, O   | --                                       | --  | --               | --          |
| 134      | 35°55'39" | 105°17'33" | --             | M. Valdez         | 23           | 36                | 7,320           | 19.3                  | 4-9-69          | 7,301 | Qal               | D, O   | --                                       | --  | --               | --          |
| 135      | 35°58'16" | 105°19'44" | 1968           | U.S. Geol. Survey | --           | 3                 | 7,180           | 2.7                   | 6-3-69          | 7,177 | Qal               | O      | --                                       | --  | --               | --          |
| 136      | 35°48'51" | 104°52'31" | --             | --                | 28           | 8                 | 6,270           | 10.2                  | 6-4-69          | 6,260 | Qal               | U, O   | --                                       | --  | --               | --          |
| 140      | 35°57'54" | 105°19'49" | 1968           | U.S. Geol. Survey | 20           | 2½                | 7,220           | 14.3                  | 10-2-69         | 7,206 | Qal               | O      | --                                       | --  | --               | --          |
| 142      | 35°55'32" | 105°02'59" | --             | A. Marshall       | 280          | 8                 | 7,000           | 150.8                 | 7-26-56         | 6,849 | --                | S      | 525                                      | --  | 16               | --          |
| 143      | 35°56'44" | 104°59'12" | 1954           | do.               | 425R         | 7                 | 7,100           | 108.0                 | 7-25-56         | 6,992 | --                | S      | 490                                      | --  | 16               | --          |
| 144      | 35°55'24" | 105°09'40" | --             | do.               | 270          | 6                 | 6,920           | 64.8                  | 7-25-56         | 6,865 | --                | S      | 500                                      | --  | 21               | --          |
| 145      | 35°53'58" | 105°00'46" | 1957           | Nat. Park Service | 325          | 8                 | 6,720           | 85                    | 8-21-57         | 6,635 | --                | --     | --                                       | --  | --               | 50          |
| 146      | 36°00'32" | 105°17'13" | 1969           | E. Hanks          | 150          | 6                 | 7,390           | 73                    | 7-31-69         | 7,317 | Qal               | U      | 220                                      | --  | 14               | 12-15       |
| 150      | 35°12'47" | 105°12'29" | --             | --                | 160R         | --                | 7,025           | --                    | --              | --    | --                | S      | 1,000                                    | --  | 4                | --          |
| 151      | 36°02'30" | 105°22'30" | 1955           | Holman NDHCA      | 154R         | 10                | --              | 59                    | 11-29-55        | --    | Qal, Pu           | PS     | --                                       | --  | --               | 15          |
| 152      | 36°02'00" | 105°22'30" | 1956           | So. Holman NDHCA  | 95R          | 6                 | --              | 56                    | 2-3-56          | --    | Qal               | PS     | --                                       | --  | --               | 10-20       |
| 201      | 35°57'17" | 105°25'57" | 1961           | W. Sawyer         | 150R         | 6                 | 8,500           | --                    | --              | --    | --                | D      | --                                       | X   | --               | 1-2         |

**Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Continued**

| Well No. | Latitude  | Longitude  | Date completed | Owner or name   | Depth (feet) | Diameter (inches) | Altitude (feet) | Water level           |                 | Principal aquifer | Use     | Specific conductance (microhms at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|-----------|------------|----------------|-----------------|--------------|-------------------|-----------------|-----------------------|-----------------|-------------------|---------|-----------------------------------------|-----|------------------|-------------|
|          |           |            |                |                 |              |                   |                 | Depth to water (feet) | Altitude (feet) |                   |         |                                         |     |                  |             |
| 201A     | 35°57'13" | 105°26'02" | 1959           | W. Sawyer       | 300R         | 6                 | 8,500           | --                    | --              | --                | --      | --                                      | X   | --               | 0.5         |
| 202      | 35°57'31" | 105°25'42" | 1958           | R. C. Kay       | 40R          | 72                | 8,300           | 26.8                  | 8,273           | --                | S       | 240                                     | --  | 12               | --          |
| 203      | 35°56'54" | 105°23'06" | 1963           | L. J. Chamberd  | 70R          | --                | 7,680           | --                    | --              | Qal(?)            | --      | --                                      | X   | --               | --          |
| 204      | 35°57'47" | 105°22'57" | 1954           | La Cañada MDMCA | 150R         | 6                 | 7,800           | 80                    | 7,720           | --                | PS      | 520                                     | --  | 10               | --          |
| 205      | 35°56'39" | 105°21'42" | 1955           | R. Romero       | 150R         | 6                 | 7,570           | 74.0                  | 7,496           | --                | D       | 480                                     | --  | 12               | --          |
| 206      | 35°56'52" | 105°20'56" | --             | S. Regenber     | 110R         | 6                 | 7,570           | --                    | --              | --                | D       | 420                                     | --  | 13               | --          |
| 207      | 35°56'57" | 105°20'43" | --             | --              | 9            | 36                | 7,560           | 2.5                   | 7,558           | Qal               | U       | 102                                     | --  | 18               | --          |
| 208      | 35°55'58" | 105°21'46" | 1957           | S. Quintana     | 60R          | 6                 | 7,480           | 30.0                  | 7,450           | --                | D       | 795                                     | --  | 12               | --          |
| 209      | 35°55'51" | 105°22'22" | 1956           | J. Romero       | 17           | 48                | 7,520           | 6.6                   | 7,513           | Qal               | D       | 240                                     | --  | 12               | --          |
| 210      | 35°55'36" | 105°21'52" | 1962           | T. Abeyta       | 18           | 72                | 7,480           | 10.0                  | 7,470           | Qal               | U       | --                                      | --  | --               | --          |
| 211      | 35°55'12" | 105°21'25" | 1954           | Ledoux MDMCA    | 150R         | 6                 | 7,440           | 43.4                  | 7,397           | --                | PS, O   | 510*                                    | --  | 11               | --          |
| 212      | 35°55'17" | 105°21'44" | --             | A. Garcia       | 13           | 54                | 7,340           | 7.8                   | 7,332           | Qal               | --      | 820*                                    | --  | 10               | --          |
| 212A     | 35°56'43" | 105°20'43" | 1961           | do.             | 125R         | 6                 | 7,540           | --                    | --              | --                | D       | --                                      | X   | --               | 1           |
| 213      | 35°55'08" | 105°20'40" | --             | --              | 10           | 36                | 7,310           | 7.2                   | 7,303           | Qal               | U       | --                                      | --  | --               | --          |
| 214      | 35°54'29" | 105°20'44" | --             | --              | 66           | 72                | 7,365           | 54.0                  | 7,306           | Qal               | D       | --                                      | *   | --               | --          |
| 215      | 35°54'04" | 105°20'32" | 1965           | B. Abeyta       | 100R         | 6                 | 7,360           | 55.0                  | 7,305           | Qal(?)            | --      | 168                                     | --  | 13               | --          |
| 216      | 35°54'19" | 105°19'34" | --             | P. Aragon       | 12           | 48                | 7,240           | 6.0                   | 7,236           | Qal               | D       | 240*                                    | --  | 10               | --          |
| 217      | 35°54'20" | 105°18'48" | 1904           | E. Martinez     | 39           | 60                | 7,245           | 29.4                  | 7,216           | Qal               | D       | --                                      | --  | --               | --          |
| 218      | 35°54'17" | 105°17'59" | 1953           | A. Nolan        | 51           | 48                | 7,310           | 32.1                  | 7,278           | Qal               | D, O    | --                                      | --  | --               | 2e          |
| 219      | 35°53'31" | 105°18'55" | --             | --              | 25           | 48                | 7,205           | 23.4                  | 7,182           | Qal               | U, O    | --                                      | --  | --               | --          |
| 220      | 35°52'36" | 105°16'10" | 1968           | T. Ansley       | 76           | 6                 | 7,115           | 50.8                  | 7,064           | --                | D, O    | 820*                                    | --  | --               | --          |
| 223      | 35°52'13" | 105°20'48" | 1965           | M. Garcia       | 60R          | 6                 | 7,375           | 18.0                  | 7,357           | Qal               | D       | --                                      | --  | --               | --          |
| 224      | 35°52'12" | 105°20'45" | 1958           | do.             | 14           | 42                | 7,360           | 8.3                   | 7,352           | Qal               | D       | 360                                     | --  | 9                | 2e          |
| 225      | 35°52'52" | 105°19'40" | --             | G. Marujo       | 19.5         | 36                | 7,280           | 6.2                   | 7,274           | Qal               | D       | 580                                     | --  | 10               | --          |
| 226      | 35°53'08" | 105°20'15" | 1966           | D. Chavez       | 100R         | 6                 | 7,385           | 25.6                  | 7,359           | --                | --      | 180                                     | --  | 11               | 24e         |
| 227      | 35°53'04" | 105°19'29" | --             | --              | --           | 36                | 7,280           | 17.8                  | 7,262           | Qal               | O       | --                                      | --  | --               | --          |
| 228      | 35°57'11" | 105°23'29" | --             | --              | 3.5          | 24                | 7,100           | 3.0                   | 7,090           | Qal               | D, U, O | --                                      | --  | --               | --          |
| 229      | 35°52'43" | 105°22'00" | 1965           | P. Serna        | 85R          | 6                 | 7,590           | 65.5                  | 7,524           | --                | D       | --                                      | --  | --               | --          |
| 230      | 35°56'41" | 105°22'46" | 1968           | Cherry          | 64R          | 6                 | 7,620           | 17.5                  | 7,602           | Qal(?)            | D, O    | 240*                                    | --  | --               | --          |
| 231      | 35°53'56" | 105°20'18" | --             | D. Trujillo     | 41           | 36                | 7,340           | 37.8                  | 7,302           | Qal               | D, O    | --                                      | --  | --               | --          |
| 232      | 35°52'58" | 105°16'43" | --             | --              | 22           | 36                | 7,100           | 16.9                  | 7,083           | Qal               | U, O    | --                                      | --  | --               | --          |
| 233      | 35°55'53" | 105°16'46" | --             | --              | 18.5         | 48                | 7,110           | 9.0                   | 7,101           | Qal               | U, O    | --                                      | --  | --               | --          |
| 303      | 36°11'21" | 105°14'00" | 1955           | Romano          | 12           | 24                | 7,765           | 9.5                   | 7,755           | Qal               | D, O    | 120                                     | --  | 9                | 3e          |

Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Continued

| Well No. | Latitude  | Longitude  | Date completed | Owner or name     | Depth (feet) | Diameter (inches) | Altitude (feet) | Water level           |          |                 | Principal aquifer | Use | Specific conductance (micromhos at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|-----------|------------|----------------|-------------------|--------------|-------------------|-----------------|-----------------------|----------|-----------------|-------------------|-----|------------------------------------------|-----|------------------|-------------|
|          |           |            |                |                   |              |                   |                 | Depth to water (feet) | Date     | Altitude (feet) |                   |     |                                          |     |                  |             |
| 303A     | 36°10'39" | 105°14'00" | 1971           | Guadalupita Corp. | 205          | 6                 | 7,800           | 28.1                  | 5-27-71  | --              | Qa1               | U   | --                                       | X   | --               | 1.5         |
| 304      | 36°09'27" | 105°13'51" | --             | --                | 20           | 24                | 7,590           | 13.5                  | 11-13-68 | 7,576           | Qa1               | D   | --                                       | --  | --               | --          |
| 305      | 36°09'16" | 105°14'03" | --             | --                | 20R          | 36                | 7,585           | 14.3                  | 11-13-68 | 7,571           | Qa1               | D   | 260                                      | --  | 12               | --          |
| 306      | 36°09'00" | 105°14'26" | 1964           | B. Ortega         | 61R          | 6                 | 7,620           | 35.7                  | 11-13-68 | 7,584           | Qa1               | D,U | --                                       | X   | --               | --          |
| 307      | 36°09'00" | 105°14'36" | 1964           | do.               | 63R          | 6                 | 7,615           | --                    | --       | --              | Qa1               | D   | --                                       | X   | --               | 1.0ac       |
| 308      | 36°08'54" | 105°14'27" | 1920           | M. Torres         | 8R           | 36                | 7,590           | 5.0                   | 11-13-68 | 7,585           | Qa1               | D,S | 355                                      | --  | 9                | --          |
| 309      | 36°08'55" | 105°14'34" | --             | --                | 10R          | 48                | 7,605           | 5.0                   | 11-13-68 | 7,600           | Qa1               | D   | 210                                      | --  | 6                | --          |
| 310      | 36°08'36" | 105°14'27" | --             | --                | 30R          | 6                 | 7,590           | --                    | --       | --              | Qa1(?)            | D   | --                                       | --  | --               | --          |
| 311      | 36°08'41" | 105°14'51" | --             | Fedel             | 25R          | 36                | 7,660           | 12.0                  | 11-13-68 | 7,648           | Qa1               | D,S | 400                                      | --  | 10               | 2           |
| 312      | 36°08'14" | 105°14'20" | 1960           | A. Pacheco        | 180R         | 6                 | 7,575           | --                    | --       | --              | --                | D   | --                                       | X   | --               | --          |
| 313      | 36°08'13" | 105°14'18" | --             | Damacio           | 37R          | 36                | 7,560           | 32.0                  | 11-13-68 | 7,528           | Qa1               | U   | 160                                      | --  | 13               | 0.5ac       |
| 314      | 36°08'16" | 105°14'06" | 1930           | S. Romero         | 10.4         | 36                | 7,510           | 6.2                   | 11-13-68 | 7,504           | Qa1               | D,O | 655*                                     | --  | 10               | 20          |
| 315      | 36°06'53" | 105°12'48" | 1968           | Serne             | 51R          | 6                 | 7,415           | 8.9                   | 11-13-68 | 7,406           | Qa1               | D   | 430                                      | --  | 9                | 0.5ac       |
| 316      | 36°01'00" | 105°13'41" | 1938           | Nontoya           | 75R          | 6                 | 7,120           | --                    | --       | --              | Qa1(?)            | D   | 950                                      | --  | 11               | --          |
| 317      | 36°00'57" | 105°13'37" | --             | M. Racl           | 25R          | 36                | 7,110           | 21.0                  | 11-13-68 | 7,089           | Qa1               | U   | 870                                      | --  | 11               | --          |
| 318      | 36°00'57" | 105°13'37" | 1968           | do.               | 56R          | 6                 | 7,110           | 20.0                  | 11-13-68 | 7,090           | Qa1               | D   | 870                                      | --  | 11               | --          |
| 319      | 36°07'35" | 105°14'20" | 1965           | A. Griego         | 47           | 6                 | 7,520           | 26.0                  | 11-14-68 | 7,494           | --                | D   | 340                                      | --  | 5                | --          |
| 320      | 36°07'12" | 105°14'16" | --             | Griego            | 70R          | 6                 | 7,550           | 67.5                  | 11-14-68 | 7,482           | --                | D   | 420                                      | --  | 8                | --          |
| 321      | 36°06'39" | 105°14'23" | --             | M. Herrera        | --           | 40                | 7,505           | --                    | --       | --              | --                | --  | 210                                      | --  | 12               | --          |
| 322      | 36°06'30" | 105°14'22" | --             | A. Griego         | 80R          | 72                | 7,485           | 44.9                  | 11-14-68 | 7,440           | --                | D,S | 230                                      | --  | 7                | --          |
| 323      | 36°06'18" | 105°14'36" | 1960           | J. C. Sandoval    | 160R         | 6.5               | 7,475           | --                    | --       | --              | --                | D   | 530                                      | X   | 9                | 8           |
| 324      | 36°06'07" | 105°14'37" | 1966           | E. Torres         | 65R          | 6                 | 7,460           | --                    | --       | --              | --                | D,S | 530                                      | --  | 8                | 0.4ac       |
| 325      | 36°05'00" | 105°15'04" | --             | --                | 12           | 3                 | 7,360           | 9.6                   | 11-14-68 | 7,360           | Qa1               | D,I | --                                       | --  | --               | --          |
| 326      | 36°04'46" | 105°15'06" | --             | --                | 23           | 60                | 7,360           | 18.6                  | 11-14-68 | 7,341           | Qa1               | D   | 730                                      | --  | 5                | --          |
| 327      | 36°04'43" | 105°15'24" | --             | --                | 14.5         | 48                | 7,385           | 8.5                   | 11-14-68 | 7,377           | Qa1               | U   | --                                       | --  | --               | --          |
| 329      | 36°04'02" | 105°15'29" | 1948           | E. Torres         | 21           | 48                | 7,345           | 12.0                  | 11-14-68 | 7,333           | Qa1               | D,S | 860                                      | --  | 16               | 5e          |
| 330      | 36°04'05" | 105°16'06" | 1968           | S. Romero         | 110R         | 6                 | 7,440           | --                    | --       | --              | --                | --  | 850                                      | --  | 8                | --          |
| 331      | 36°04'04" | 105°16'05" | --             | do.               | 36           | 48                | 7,430           | 23.5                  | 11-14-68 | 7,406           | Qa1               | D,O | 555                                      | --  | 8                | --          |
| 332      | 36°03'54" | 105°15'41" | --             | --                | 16           | 60                | 7,360           | 5.6                   | 11-14-68 | 7,354           | Qa1               | D,S | 445                                      | --  | 11               | --          |
| 333      | 36°03'49" | 105°16'53" | --             | --                | 64           | 40                | 7,470           | 21.5                  | 11-14-68 | 7,448           | Qa1               | U   | 365                                      | --  | 11               | --          |
| 334      | 36°04'24" | 105°17'02" | --             | --                | 52R          | 40                | 7,540           | 19.0                  | 11- 4-68 | 7,521           | Qa1               | D   | 435                                      | --  | 11               | --          |
| 335      | 36°04'37" | 105°17'14" | --             | --                | 14.9         | 70                | 7,589           | 9.8                   | 11-14-68 | 7,570           | Qa1               | U   | --                                       | --  | --               | --          |

Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Continued

| Well No. | Latitude  | Longitude  | Date completed | Owner or name    | Depth (feet) | Diameter (inches) | Altitude (feet) | Depth to water (feet) | Water level     |       | Principal aquifer | Use   | Specific conductance (microhmhos at 25°C) | Log | Temperature (°C) | Yield (gpm) |
|----------|-----------|------------|----------------|------------------|--------------|-------------------|-----------------|-----------------------|-----------------|-------|-------------------|-------|-------------------------------------------|-----|------------------|-------------|
|          |           |            |                |                  |              |                   |                 |                       | Altitude (feet) | Date  |                   |       |                                           |     |                  |             |
| 336      | 36°03'12" | 105°16'05" | --             | --               | 10.5         | 36                | 7,410           | 9.8                   | 11-14-68        | 7,400 | Qal               | S     | 175                                       | --  | 8                | --          |
| 337      | 36°02'58" | 105°16'41" | --             | --               | 31           | 36                | 7,440           | 19.5                  | 11-14-68        | 7,420 | Qal               | S     | --                                        | --  | --               | --          |
| 338      | 36°02'15" | 105°16'23" | --             | --               | 30           | 36                | 7,470           | 25.4                  | 11-14-68        | 7,445 | Qal               | U     | --                                        | --  | --               | --          |
| 344      | 36°03'15" | 105°16'51" | --             | W. Rossitter     | 125R         | 6                 | 7,475           | 32.0                  | 11-15-68        | 7,543 | Qal               | S     | 240                                       | --  | 7                | --          |
| 345      | 36°03'10" | 105°17'16" | 1961           | do.              | 165R         | 6                 | 7,530           | --                    | --              | --    | Qal(?)            | D     | --                                        | --  | --               | --          |
| 346      | 36°02'58" | 105°10'58" | 1952           | T. M. Rivera     | 300R         | 6                 | 7,338           | --                    | --              | --    | --                | D     | 460                                       | --  | 12               | --          |
| 347      | 36°02'51" | 105°12'38" | 1951           | R. Andersen      | 340R         | 6                 | 7,293           | 8.0                   | 11-20-68        | 7,285 | --                | S     | --                                        | --  | --               | --          |
| 348      | 36°02'29" | 105°10'01" | 1948           | do.              | 130R         | 6                 | 7,306           | 98.0                  | 11-20-68        | 7,208 | --                | S,O   | 300                                       | --  | 6                | --          |
| 349      | 36°02'58" | 105°08'23" | 1950           | W. Salman        | 244R         | 6                 | 7,520           | 190.5                 | 6- 4-69         | 7,330 | --                | D,S,O | 430*                                      | --  | 10               | --          |
| 350      | 36°03'32" | 105°08'16" | 1939           | F. Vigil         | 25R          | 40                | 7,550           | 14.1                  | 11-20-68        | 7,536 | Qal               | D,S   | 340                                       | --  | 10               | --          |
| 352      | 35°59'45" | 105°12'06" | 1956           | --               | 70R          | 6                 | 7,060           | 13.1                  | 11-20-68        | 7,047 | --                | S     | --                                        | --  | --               | --          |
| 353      | 35°59'31" | 105°11'39" | 1967           | H. Caseus        | 100R         | 6                 | 7,042           | 33.0                  | 11-20-68        | 7,009 | Qal               | D,S   | --                                        | --  | 10               | --          |
| 354      | 35°59'31" | 105°11'40" | 1940           | do.              | 35           | 65                | 7,045           | 29.5                  | 11-20-68        | 7,015 | Qal               | D,O   | 600*                                      | --  | 10               | --          |
| 355      | 35°59'26" | 105°10'51" | 1968           | T. Rivera        | 90R          | 6                 | 7,055           | 56.4                  | 11-20-68        | 6,999 | --                | D,S   | 800                                       | --  | 11               | --          |
| 356      | 35°59'29" | 105°11'20" | 1958           | M. Rivera        | 87R          | 6                 | 7,030           | 41.0                  | 11-20-68        | 6,989 | --                | D     | 820                                       | X   | 15               | --          |
| 357      | 35°59'06" | 105°11'20" | 1952           | R. Lambach       | --           | 6                 | 7,005           | 21.3                  | 11-20-68        | 6,984 | --                | D     | 710                                       | --  | 12               | --          |
| 358      | 36°03'30" | 105°07'04" | --             | Ojo Feliz NDWCA  | 7.0          | 48                | 7,535           | 2.5                   | 11-21-68        | 7,533 | Qal               | PS    | 1,010                                     | --  | 9                | --          |
| 359      | 36°04'16" | 105°06'31" | --             | R. Anderson      | 47R          | 6                 | 7,650           | 39.0                  | 11-21-68        | 7,621 | --                | S     | 540                                       | --  | 7                | --          |
| 363      | 36°03'06" | 105°06'53" | --             | --               | 17.8         | 60                | 7,495           | 15.6                  | 11-21-68        | 7,479 | Qal               | U     | 1,100                                     | --  | 9                | --          |
| 364      | 36°02'22" | 105°06'32" | 1955           | J. Vigil         | 411R         | 6                 | 7,435           | 36                    | 11-21-68        | 7,399 | QTB(?)            | D     | 560                                       | --  | 9                | --          |
| 365      | 35°59'56" | 105°12'53" | 1960           | M. Cruz          | 100R         | 6                 | 7,080           | 51.2                  | 11-21-68        | 7,029 | --                | D,S   | 470                                       | X   | 15               | --          |
| 366      | 35°59'33" | 105°12'57" | --             | A. Duran         | 160R         | 6                 | 7,075           | --                    | --              | --    | --                | D     | 500                                       | --  | 11               | --          |
| 367      | 35°58'22" | 105°12'27" | 1960           | S. Lucero        | 135R         | 6                 | 7,040           | --                    | --              | --    | --                | D     | 640                                       | X   | 10               | --          |
| 368      | 35°58'45" | 105°12'31" | 1943           | C. Barela        | 20.5         | 36                | 7,042           | 18.5                  | 11-21-68        | --    | Qal               | --    | 460                                       | --  | 11               | --          |
| 369      | 35°58'52" | 105°11'44" | --             | --               | 11.0         | 40                | 6,987           | 5.1                   | 11-21-68        | 6,982 | Qal               | U     | 700                                       | --  | 11               | --          |
| 370      | 35°58'19" | 105°12'18" | 1932           | P. O. Raineville | 61.3         | 42                | 7,038           | 26.6                  | 11-21-68        | 7,013 | Qal               | D     | 490                                       | --  | 11               | --          |
| 371      | 35°58'47" | 105°10'10" | --             | W. Salman        | --           | 6                 | 7,056           | 24.7                  | 11-21-68        | 7,031 | --                | S     | 500                                       | --  | 11               | --          |
| 372      | 35°56'30" | 105°14'05" | 1960           | do.              | 450R         | 6                 | 7,028           | --                    | --              | --    | Per               | D     | 1,200*                                    | --  | 16               | --          |
| 373      | 35°56'55" | 105°12'28" | --             | do.              | --           | 6                 | 7,010           | --                    | --              | --    | --                | D     | 690                                       | --  | 11               | --          |
| 374      | 35°56'33" | 105°11'39" | --             | do.              | --           | 6                 | 6,990           | --                    | --              | --    | --                | D     | 650                                       | --  | 11               | --          |
| 375      | 35°56'12" | 105°11'00" | 1957           | do.              | 18.1         | 24                | 6,920           | 12.0                  | 11-21-68        | 6,908 | Qal               | U     | 1,000                                     | --  | 11               | --          |
| 376      | 35°58'03" | 105°08'08" | --             | do.              | 130R         | 6                 | 7,014           | 98.0                  | 11-21-68        | 6,916 | --                | S     | --                                        | --  | --               | --          |

Appendix A.--Records of selected wells in the Mora River drainage,  
western Mora County, N. Mex. - Concluded

| Well<br>No. | Latitude  | Longitude  | Date<br>completed | Owner or name         | Depth<br>(feet) | Diam-<br>eter<br>(inches) | Altitude<br>(feet) | Water level                    |          |                    | Principal<br>aquifer | Use | Specific<br>conductance<br>(micromhos<br>at 25°C) | Log | Tem-<br>per-<br>ature<br>(°C) | Yield<br>(gpm) |
|-------------|-----------|------------|-------------------|-----------------------|-----------------|---------------------------|--------------------|--------------------------------|----------|--------------------|----------------------|-----|---------------------------------------------------|-----|-------------------------------|----------------|
|             |           |            |                   |                       |                 |                           |                    | Depth<br>to<br>water<br>(feet) | Date     | Altitude<br>(feet) |                      |     |                                                   |     |                               |                |
| 377         | 35°59'03" | 105°07'33" | --                | W. Salman             | --              | 6                         | 7,042              | 126                            | 11-21-68 | 6,916              | --                   | S   | 560                                               | --  | 16                            | --             |
| 379         | 35°57'49" | 105°09'40" | --                | do.                   | --              | 6                         | 6,988              | --                             | --       | --                 | --                   | S   | 502                                               | --  | 11                            | --             |
| 381         | 35°57'04" | 105°10'19" | --                | do.                   | --              | 6                         | 6,890              | 31.2                           | 11-22-68 | 6,859              | --                   | D,O | 510*                                              | --  | 14                            | --             |
| 390         | 36°08'54" | 105°15'24" | --                | --                    | 22.3            | 72                        | 7,790              | 7.0                            | 6- 4-69  | 7,783              | Qal                  | U,O | --                                                | --  | --                            | --             |
| 392         | 36°01'23" | 105°13'39" | --                | --                    | 12.3            | 24                        | 7,140              | 8.8                            | 6- 4-69  | 7,131              | Qal                  | S   | --                                                | --  | --                            | --             |
| 393         | 36°08'00" | 105°19'00" | 1957              | Guadalupita NDWCA     | 122R            | 11                        | --                 | --                             | --       | --                 | --                   | PS  | --                                                | --  | --                            | 25             |
| 492         | 35°46'43" | 105°00'09" | --                | Stage station         | 31              | 6                         | 6,475              | 28.8                           | 11-21-68 | 6,446              | Qal                  | PS  | --                                                | --  | --                            | --             |
| 494         | 35°46'54" | 105°59'17" | --                | Watrous Trailer Court | --              | 8                         | 6,425              | 15.2                           | 11-21-68 | 6,410              | Qal                  | PS  | --                                                | --  | --                            | --             |
| 495         | 35°47'29" | 104°58'57" | --                | Watrous NDWCA         | 220R            | 8                         | 6,425              | 11.9                           | 3-25-69  | 6,413              | Qal                  | PS  | 830*                                              | --  | --                            | --             |
| 496         | 35°07'29" | 104°50'55" | --                | Emberg                | 170R            | 12                        | 6,410              | --                             | --       | --                 | Qal(?)               | PS  | 540                                               | --  | 9                             | --             |

## Appendix B.--Records of selected springs in the Mora River drainage, western Mora County, N. Mex.

**EXPLANATION:**

Latitude and longitude: Interpolated from 7½-minute USGS topographic quadrangle maps.

Principal aquifer: Qal, alluvium; QTb, basalt; Kd, Dakota Sandstone; Jm, Morrison Formation; Pu, Permian rocks, undivided; IPu, Pennsylvanian rocks, undivided; pEu, Precambrian rocks, undivided.

Specific conductance: Field measurements with portable meter. Asterisk (\*) indicates chemical analysis in Appendix H.

| Spring letter | Latitude  | Longitude  | Topographic situation | Altitude (feet) | Estimated discharge (gpm) | Principal aquifer | Specific conductance (micromhos at 25°C) |
|---------------|-----------|------------|-----------------------|-----------------|---------------------------|-------------------|------------------------------------------|
| A             | 36°11'36" | 105°21'02" | Valley side           | 8,640           | 15                        | Pu                | 580                                      |
| B             | 35°57'29" | 105°23'37" | Valley floor          | 7,805           | 1                         | Qal               | 105                                      |
| C             | 35°56'48" | 105°22'43" | do.                   | 7,615           | -                         | Qal               | 180*                                     |
| D             | 35°36'40" | 105°20'35" | Arroyo                | 7,530           | -                         | Qal               | -                                        |
| E             | 35°55'27" | 105°20'29" | Edge of valley        | 7,400           | 1-2                       | Qal               | 100                                      |
| F             | 35°53'53" | 105°20'22" | Arroyo                | 7,315           | -                         | Qal               | -                                        |
| G             | 35°53'02" | 105°19'37" | do.                   | 7,245           | -                         | Qal               | -                                        |
| H             | 35°52'13" | 105°20'36" | Valley floor          | 7,340           | -                         | Qal               | 360                                      |
| I             | 35°53'30" | 105°20'14" | Edge of valley        | 7,140           | 220                       | Pu                | 460                                      |
| K             | 36°08'46" | 105°15'16" | Pediment              | 7,750           | 20                        | pEu               | 280                                      |
| L             | 35°54'21" | 105°01'13" | Arroyo                | 6,725           | .5                        | Qal-Jm            | 550                                      |
| M             | 35°53'58" | 105°01'08" | Valley                | 6,715           | 6                         | QTb-Jm            | -                                        |
| N             | 35°56'02" | 105°04'32" | Canyon                | -               | .5                        | -                 | -                                        |
| O             | 35°49'00" | 104°55'25" | Base of cliff         | 6,360           | -                         | Base of Kd        | 520*                                     |
| P             | 35°55'36" | 105°02'59" | do.                   | 6,850           | 4                         | Kd(?)             | -                                        |
| R             | 36°09'06" | 105°24'47" | Edge of valley        | 9,560           | 26                        | IPu               | 400                                      |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.

| <u>Stratigraphic unit and material</u>         | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|------------------------------------------------|-----------------------------|-------------------------|
| Well 5                                         |                             |                         |
| Quaternary System:                             |                             |                         |
| Alluvium:                                      |                             |                         |
| Topsoil .....                                  | 2                           | 2                       |
| Clay, yellow; and gravel .....                 | 17                          | 19                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale, black .....                             | 6                           | 25                      |
| Shale, black; with lime streaks .              | 13                          | 38                      |
| Shale and clay, black .....                    | 4                           | 42                      |
| Sand, brown .....                              | 43                          | 85                      |
| Shale, black; with lime streaks .              | 40                          | 125                     |
| Well 6                                         |                             |                         |
| Old well .....                                 |                             | 82                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale and clay, black .....                    | 38                          | 120                     |
| Well 7                                         |                             |                         |
| Topsoil .....                                  | 1                           | 1                       |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale, black .....                             | 179                         | 180                     |
| Well 8                                         |                             |                         |
| Quaternary System:                             |                             |                         |
| Alluvium:                                      |                             |                         |
| Topsoil .....                                  | 10                          | 10                      |
| Boulders and soil; shale, black .              | 20                          | 30                      |
| Gravel .....                                   | 6                           | 36                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale, black .....                             | 54                          | 90                      |
| Well 9                                         |                             |                         |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale, yellow .....                            | 18                          | 18                      |
| Shale, black; with hard and soft streaks ..... | 108                         | 126                     |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex. - Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 10                                |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Clay, yellow .....                     | 24                          | 25                      |
| Shale, black; with blue streaks .      | 55                          | 80                      |
| Shale, black; rotten .....             | 36                          | 116                     |
| Well 12                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 15                          | 15                      |
| Gravel .....                           | 5                           | 20                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 30                          | 50                      |
| Well 14                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Sandy clay and gravel .....            | 20                          | 22                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 54                          | 76                      |
| Well 16                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Sand and gravel .....                  | 34                          | 36                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 16                          | 52                      |
| Shale, black; hard .....               | 27                          | 79                      |
| Shale, gray; soft .....                | 16                          | 95                      |
| Shale, black .....                     | 30                          | 125                     |

Appendix C.--Driller's logs of selected wells in the Mora  
River drainage, western Mora County, N. Mex. -  
 Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 18                                |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Clay and shale, yellow .....           | 9                           | 10                      |
| Shale, black .....                     | 4                           | 14                      |
| Shale, yellow .....                    | 23                          | 37                      |
| Shale, black .....                     | 23                          | 60                      |
| Shale, blue; and sandstone, white      | 9                           | 69                      |
| Shale, black; and sandstone .....      | 6                           | 75                      |
| Sandstone, white .....                 | 30                          | 105                     |
| Well 20                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Sand .....                             | 8                           | 10                      |
| Sand and boulders .....                | 30                          | 40                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Yellow clay .....                      | 10                          | 50                      |
| Well 22                                |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black; hard .....               | 26                          | 27                      |
| Clay, yellow; and gravel .....         | 5                           | 32                      |
| Shale, black; hard .....               | 36                          | 68                      |
| Sandstone, white .....                 | 32                          | 100                     |

Appendix C.--Driller's logs of selected wells in the Mora  
River drainage, western Mora County, N. Mex.--  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 23                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, red .....                        | 6                           | 8                       |
| Sand and boulders .....                | 40                          | 48                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 2                           | 50                      |
| Well 24                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil, black .....                   | 8                           | 8                       |
| Soil, black; and gravel .....          | 30                          | 38                      |
| Sandy gravel .....                     | 11                          | 49                      |
| Gravel, hard, cemented .....           | 6                           | 55                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation and Madera Limestone: |                             |                         |
| Clay, yellow .....                     | 3                           | 58                      |
| Limestone .....                        | 4                           | 62                      |
| Gravel and boulders .....              | 18                          | 80                      |
| Limestone, hard, sandy .....           | 5                           | 85                      |
| Shale, gray .....                      | 6                           | 91                      |
| Limestone, hard, sandy.....            | 19                          | 110                     |
| Shale, black .....                     | 37                          | 147                     |
| Limestone .....                        | 3                           | 150                     |
| Well 25                                |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, gray .....                      | 19                          | 20                      |
| Shale and clay, black .....            | 62                          | 82                      |
| Sandy clay, gray .....                 | 2                           | 84                      |
| Sandstone, yellow .....                | 21                          | 105                     |
| Shale, black .....                     | 10                          | 115                     |
| Sandstone, gray .....                  | 15                          | 130                     |
| Sandstone, yellow .....                | 10                          | 140                     |
| Shale, black .....                     | 4                           | 144                     |

Appendix C.--Driller's logs of selected wells in the Mora  
River drainage, western Mora County, N. Mex.-  
Continued.

| <u>Stratigraphic unit and material</u>         | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|------------------------------------------------|-----------------------------|-------------------------|
| Well 26                                        |                             |                         |
| Quaternary System:                             |                             |                         |
| Alluvium:                                      |                             |                         |
| Topsoil .....                                  | 3                           | 3                       |
| Clay, gray; and gravel .....                   | 22                          | 25                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Sandstone, gray; with streaks of<br>clay ..... | 37                          | 62                      |
| Well 27                                        |                             |                         |
| Quaternary System:                             |                             |                         |
| Alluvium:                                      |                             |                         |
| Clay, red .....                                | 18                          | 18                      |
| Sandstone and boulders .....                   | 6                           | 24                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale, black .....                             | 58                          | 82                      |
| Well 28                                        |                             |                         |
| Quaternary System:                             |                             |                         |
| Alluvium:                                      |                             |                         |
| Topsoil .....                                  | 2                           | 2                       |
| Sandy clay, brown .....                        | 10                          | 12                      |
| Gravel .....                                   | 23                          | 35                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Clay, black .....                              | 18                          | 53                      |
| Shale, black; hard .....                       | 37                          | 90                      |
| Well 31                                        |                             |                         |
| Quaternary System:                             |                             |                         |
| Alluvium:                                      |                             |                         |
| Clay, yellow .....                             | 30                          | 30                      |
| Pennsylvanian System:                          |                             |                         |
| Sandia Formation:                              |                             |                         |
| Shale, black .....                             | 15                          | 45                      |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.--  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 32                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Clay, red .....                        | 8                           | 8                       |
| Clay, yellow .....                     | 29                          | 37                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation and Madera Limestone: |                             |                         |
| Shale, black .....                     | 20                          | 57                      |
| Sandstone and shale .....              | 5                           | 62                      |
| Sandstone, white .....                 | 13                          | 75                      |
| Shale, black .....                     | 20                          | 95                      |
| Sandstone, white .....                 | 1                           | 96                      |
| Shale, black .....                     | 9                           | 105                     |
| Sandstone, white .....                 | 9                           | 114                     |
| Shale, pink .....                      | 6                           | 120                     |
| Well 34                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, brown; and gravel.....           | 22                          | 24                      |
| Gravel .....                           | 18                          | 42                      |
| Clay and sand, red .....               | 3                           | 45                      |
| Well 35                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, sandy .....                      | 16                          | 18                      |
| Clay and gravel .....                  | 7                           | 25                      |
| Clay, sandy .....                      | 10                          | 35                      |
| Clay and gravel .....                  | 18                          | 53                      |
| Well 37                                |                             |                         |
| Old well .....                         | 76                          | 76                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Sandstone, yellow and white .....      | 7                           | 83                      |

Appendix C.--Driller's logs of selected wells in the Mora  
River drainage, western Mora County, N. Mex.-  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 38                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Clay and sand .....                    | 30                          | 30                      |
| Permian and Pennsylvanian Systems:     |                             |                         |
| Sangre de Cristo Formation:            |                             |                         |
| Clay, red and yellow .....             | 58                          | 88                      |
| Sandstone, broken .....                | 4                           | 92                      |
| Shale, red and blue .....              | 28                          | 120                     |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 11                          | 131                     |
| Well 40                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, red .....                        | 4                           | 6                       |
| Sand and boulders .....                | 24                          | 30                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 75                          | 105                     |
| Well 43                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Boulders .....                         | 12                          | 13                      |
| Clay, black .....                      | 2                           | 15                      |
| Sand and gravel .....                  | 15                          | 30                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, yellow .....                    | 5                           | 35                      |
| Granite, decomposed .....              | 12                          | 47                      |
| Shale, black .....                     | 5                           | 52                      |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.--  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 47                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Gravel and boulders .....              | 48                          | 50                      |
| Well 48                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Boulders .....                         | 38                          | 40                      |
| Sand and gravel .....                  | 21                          | 61                      |
| Well 52                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Soil, black loam .....                 | 6                           | 6                       |
| Sand and gravel .....                  | 6                           | 12                      |
| Boulder, large .....                   | 68                          | 80                      |
| Gravel, fine .....                     | 10                          | 90                      |
| Gravel, blue .....                     | 10                          | 100                     |
| Pennsylvanian System:                  |                             |                         |
| Sandia(?) Formation:                   |                             |                         |
| Limestone, black .....                 | 20                          | 120                     |
| Limestone, brown .....                 | 30                          | 150                     |
| Granite .....                          | 10                          | 160                     |
| Clay, yellow .....                     | 5                           | 165                     |
| Lime shell .....                       | 5                           | 170                     |
| Well 70                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 4                           | 4                       |
| Clay, gray; and gravel .....           | 26                          | 30                      |
| Gravel .....                           | 2                           | 32                      |
| Sand .....                             | 10                          | 42                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia(?) Formation:                   |                             |                         |
| Shale, black .....                     | 40                          | 82                      |
| Sandstone, white .....                 | 18                          | 100                     |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.-  
Continued.

| <u>Stratigraphic unit and material</u>                                               | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|--------------------------------------------------------------------------------------|-----------------------------|-------------------------|
| Well 71                                                                              |                             |                         |
| Permian and Pennsylvanian Systems:                                                   |                             |                         |
| Sangre de Cristo Formation:                                                          |                             |                         |
| Clay, red .....                                                                      | 8                           | 8                       |
| Sandstone, red; soft .....                                                           | 12                          | 20                      |
| Shale, red .....                                                                     | 5                           | 25                      |
| Sandstone, red; soft .....                                                           | 25                          | 50                      |
| Well 73                                                                              |                             |                         |
| Quaternary System:                                                                   |                             |                         |
| Alluvium:                                                                            |                             |                         |
| Clay, gummy and sticky .....                                                         | 4                           | 4                       |
| Sandy clay, brown with broken sandstone and occasional small gravel                  | 6                           | 10                      |
| Triassic System:                                                                     |                             |                         |
| Santa Rosa Sandstone:                                                                |                             |                         |
| Shale, red, firm .....                                                               | 27                          | 37                      |
| Sandstone, yellow, occasional seams of blue and red shale .....                      | 17                          | 54                      |
| Sandstone, gray and blue, very hard                                                  | 6                           | 60                      |
| Sandstone, tan, hard, with traces of red shale .....                                 | 15                          | 75                      |
| Sandstone, blue, very hard and fine grained; occasional seam of shale                | 26                          | 101                     |
| Sandstone, gray and yellow, hard and fine grained; seams of blue and red shale ..... | 7                           | 108                     |
| Sand, brown, tight, with clay seams                                                  | 7                           | 115                     |
| Sandstone, brown and yellow, hard                                                    | 11                          | 126                     |
| Sandstone, very hard, traces of blue and gray shale .....                            | 7                           | 133                     |
| Shale, soft .....                                                                    | 32                          | 165                     |
| Shale, varicolored, hard .....                                                       | 66                          | 231                     |
| Sandstone, gray, very hard .....                                                     | 11                          | 242                     |
| Shale, varicolored, hard, seams of sandstone and clay .....                          | 32                          | 274                     |
| Sandstone and shale, hard .....                                                      | 11                          | 285                     |
| Sandstone, soft .....                                                                | 5                           | 290                     |
| Sandstone and shale seams, alternating hard and soft .....                           | 53                          | 343                     |

Appendix C.--Driller's logs of selected wells in the Mora  
River drainage, western Mora County, N. Mex.-  
 Continued.

| <u>Stratigraphic unit and material</u>                              | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|---------------------------------------------------------------------|-----------------------------|-------------------------|
| Well 73 - Concluded                                                 |                             |                         |
| Sandstone and shale layers, soft,<br>occasional seams of hard shale | 27                          | 370                     |
| Sandstone and shale, hard, fractured                                | 27                          | 397                     |
| Sandstone, porous, and hard shale                                   | 6                           | 403                     |
| Well 76                                                             |                             |                         |
| Topsoil .....                                                       | 2                           | 2                       |
| Triassic System:                                                    |                             |                         |
| Chinle Formation:                                                   |                             |                         |
| Sandstone .....                                                     | 10                          | 12                      |
| Shale and clay, gray .....                                          | 38                          | 50                      |
| Sandstone, yellow .....                                             | 60                          | 110                     |
| Shale, gray and red .....                                           | 5                           | 115                     |
| Sandstone, yellow .....                                             | 20                          | 135                     |
| Sandstone, white .....                                              | 5                           | 140                     |
| Sandstone, yellow .....                                             | 40                          | 180                     |
| Sandstone, dark white .....                                         | 5                           | 185                     |
| Lime, blue .....                                                    | 5                           | 190                     |
| Shale, red .....                                                    | 10                          | 200                     |
| Well 81                                                             |                             |                         |
| Old well .....                                                      | 65                          | 65                      |
| Jurassic System:                                                    |                             |                         |
| Morrison(?) Formation:                                              |                             |                         |
| Sandstone, red .....                                                | 15                          | 80                      |
| Sandstone, white .....                                              | 13                          | 93                      |
| Clay, red .....                                                     | 10                          | 103                     |
| Well 83                                                             |                             |                         |
| Cretaceous System:                                                  |                             |                         |
| Graneros Shale and Greenhorn Limestone:                             |                             |                         |
| Limestone and streaks of gray shale                                 | 50                          | 50                      |
| Slate, blue .....                                                   | 50                          | 100                     |
| Shale, blue; rotten .....                                           | 75                          | 175                     |
| Limestone streaks and shale .....                                   | 27                          | 202                     |

Appendix C.--Driller's logs of selected wells in the Mora  
River drainage, western Mora County, N. Mex.-  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 84                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Clay, black .....                      | 9                           | 10                      |
| Clay, yellow .....                     | 5                           | 15                      |
| Boulders and gravel .....              | 10                          | 25                      |
| Cretaceous System:                     |                             |                         |
| Graneros Shale:                        |                             |                         |
| Shale, black; hard .....               | 25                          | 50                      |
| Well 87                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 5                           | 5                       |
| Clay, black .....                      | 3                           | 8                       |
| Clay, red .....                        | 24                          | 32                      |
| Cretaceous System:                     |                             |                         |
| Graneros Shale:                        |                             |                         |
| Shale, black .....                     | 38                          | 70                      |
| Well 99                                |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 30                          | 30                      |
| Sand and gravel .....                  | 30                          | 60                      |
| Cretaceous System:                     |                             |                         |
| Graneros Shale:                        |                             |                         |
| Clay and shale, blue .....             | 40                          | 100                     |
| Well 201                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Landslide deposits:                    |                             |                         |
| Granite boulders, blue .....           | 7                           | 7                       |
| Clay, blue .....                       | 10                          | 17                      |
| Pennsylvanian System:                  |                             |                         |
| Madera Limestone and Sandia Formation: |                             |                         |
| Limestone, blue .....                  | 33                          | 50                      |
| Sandstone, yellow .....                | 20                          | 70                      |
| Limestone, blue .....                  | 15                          | 85                      |
| Shale, blue .....                      | 70                          | 150                     |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.--  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 201A                              |                             |                         |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Sandstone, coarse .....                | 27                          | 27                      |
| Shale, black .....                     | 24                          | 51                      |
| Sandrock, white; hard .....            | 41                          | 92                      |
| Shale, black .....                     | 20                          | 112                     |
| Sandrock .....                         | 73                          | 185                     |
| Shale, black .....                     | 115                         | 300                     |
| Well 203                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 4                           | 4                       |
| Sand and gravel, coarse .....          | 31                          | 35                      |
| Clay and gravel .....                  | 6                           | 41                      |
| Clay and large boulders .....          | 19                          | 60                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Sandstone .....                        | 10                          | 70                      |
| Well 212A                              |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, yellow .....                     | 23                          | 25                      |
| Precambrian:                           |                             |                         |
| Mica(?) .....                          | 100                         | 125                     |
| Well 303A                              |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Boulders .....                         | 87                          | 88                      |
| Sand and gravel .....                  | 56                          | 144                     |
| Yellow clay .....                      | 4                           | 148                     |
| Boulders and sand .....                | 14                          | 162                     |
| Yellow sandstone .....                 | 28                          | 190                     |
| Pretty clean sand .....                | 12                          | 202                     |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.--  
Continued.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 306                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 1                           | 1                       |
| Clay and boulders .....                | 9                           | 10                      |
| Precambrian:                           |                             |                         |
| Mica .....                             | 51                          | 61                      |
| Well 307                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 3                           | 3                       |
| Gravel and boulders .....              | 30                          | 33                      |
| Sand and gravel .....                  | 28                          | 61                      |
| Precambrian:                           |                             |                         |
| Mica .....                             | 2                           | 63                      |
| Well 312                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Clay, brown .....                      | 10                          | 10                      |
| Clay and gravel .....                  | 20                          | 30                      |
| Pennsylvanian System:                  |                             |                         |
| Sandia Formation:                      |                             |                         |
| Shale, black .....                     | 30                          | 60                      |
| Shale, white .....                     | 10                          | 70                      |
| Shale, black .....                     | 110                         | 180                     |
| Well 323                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Clay, yellow; and gravel .....         | 65                          | 65                      |
| Sandstone and gravel .....             | 95                          | 160                     |

Appendix C.--Driller's logs of selected wells in the Mora River drainage, western Mora County, N. Mex.--  
Concluded.

| <u>Stratigraphic unit and material</u> | <u>Thickness<br/>(feet)</u> | <u>Depth<br/>(feet)</u> |
|----------------------------------------|-----------------------------|-------------------------|
| Well 356                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Clay, red .....                        | 25                          | 25                      |
| Gravel .....                           | 4                           | 29                      |
| Triassic System:                       |                             |                         |
| Chinle Formation:                      |                             |                         |
| Clay, red; and gravel .....            | 58                          | 87                      |
| Well 365                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, yellow .....                     | 8                           | 10                      |
| Sand, gravel, and boulders .....       | 15                          | 25                      |
| Sandstone, red .....                   | 60                          | 25                      |
| Clay, red .....                        | 15                          | 100                     |
| Well 367                               |                             |                         |
| Quaternary System:                     |                             |                         |
| Alluvium:                              |                             |                         |
| Topsoil .....                          | 2                           | 2                       |
| Clay, yellow .....                     | 8                           | 10                      |
| Sand and boulders .....                | 15                          | 25                      |
| Triassic System:                       |                             |                         |
| Chinle(?) Formation:                   |                             |                         |
| Sandstone, red .....                   | 60                          | 85                      |
| Shale .....                            | 15                          | 100                     |
| Clay .....                             | 35                          | 135                     |

Appendix D.--Records of test holes drilled in the Mora River drainage, western Mora County, N. Mex.

EXPLANATION:

Formation at total depth: Qal, alluvium; Kgr, Graneros Shale; IPu, Pennsylvanian rocks, undivided; pCu, Precambrian rocks

| Test hole number | Latitude  | Longitude  | Total depth (feet) | Casing diameter (inches) | Water level        |                         | Formation at total depth | Yield (gpm) | Remarks                                                                                                         |
|------------------|-----------|------------|--------------------|--------------------------|--------------------|-------------------------|--------------------------|-------------|-----------------------------------------------------------------------------------------------------------------|
|                  |           |            |                    |                          | above (+) or below | (-) land surface (feet) |                          |             |                                                                                                                 |
| M -1             | 36°00'20" | 105°22'59" | 40                 | 1½                       |                    | -11                     | IPu                      | 12-14       | --                                                                                                              |
| M -1a            | 36°00'20" | 105°22'59" | 22                 | 2                        |                    | - 7                     | IPu                      | -           | --                                                                                                              |
| M -2             | 35°53'04" | 105°11'02" | 25                 | 1½                       |                    | -15                     | Kgr                      | 1.5         | Yield estimated                                                                                                 |
| M -2a            | 35°53'15" | 105°10'59" | 15                 | 1½                       |                    | -10                     | Kgr                      | 1.5         | Do.                                                                                                             |
| M -3             | 35°58'48" | 105°19'32" | 35                 | 1½                       |                    | Flowing                 | Qal                      | -           | --                                                                                                              |
| M -3a            | 35°58'48" | 105°19'32" | 30                 | 2                        |                    | Do.                     | Qal                      | 2.6         | --                                                                                                              |
| M -4             | 35°59'57" | 105°18'09" | 61                 | None                     |                    | Dry                     | pCu                      | Dry         | --                                                                                                              |
| M -5             | 35°58'37" | 105°18'44" | 65                 | 1½                       |                    | Flowing                 | Qal                      | .5          | Two casing strings in hole; one set at 65 ft. and one at 15 ft. No yield was obtained from casing set at 15 ft. |

Appendix D.--Records of test holes drilled in the Mora River drainage, western Mora  
County, N. Mex. - Concluded

| Test<br>hole<br>number | Latitude  | Longitude  | Total<br>depth<br>(feet) | Casing<br>diameter<br>(inches) | Water<br>level<br>above (+)<br>or below<br>(-) land<br>surface<br>(feet) | Formation<br>at total<br>depth | Yield<br>(gpm) | Remarks |
|------------------------|-----------|------------|--------------------------|--------------------------------|--------------------------------------------------------------------------|--------------------------------|----------------|---------|
| C -1                   | 35°55'35" | 105°21'28" | 8                        | None                           | - 6                                                                      | Qal                            | -              | --      |
| C -2                   | 36°56'14" | 105°21'11" | 15                       | do.                            | - 5                                                                      | Qal                            | -              | --      |
| Cy-1                   | 36°07'56" | 105°13'59" | 20                       | 2                              | + .20                                                                    | p <u>eu</u>                    | 1.9            | --      |
| Cy-1a                  | 36°07'56" | 105°13'59" | 20                       | 2                              | + .20                                                                    | p <u>eu</u>                    | 1.9            | --      |
| Cy-2                   | 36°04'49" | 105°14'50" | 50                       | 4                              | - 8                                                                      | p <u>eu</u>                    | -              | --      |

Appendix E.--Size analyses of samples from test holes in  
the Mora River drainage, western Mora County,  
N. Mex.

| Depth of sample<br>(feet) | Gravel %<br>(>2.0 mm) | Sand %<br>(0.065-2.0 mm) | Silt-clay %<br>(<0.0625 mm) |
|---------------------------|-----------------------|--------------------------|-----------------------------|
| Test hole M-1             |                       |                          |                             |
| 0- 5                      | 5.25                  | 38.98                    | 55.77                       |
| 5-10                      | 11.77                 | 35.71                    | 52.52                       |
| 10-15                     | 37.90                 | 33.35                    | 28.75                       |
| 15-35                     | No sample             |                          |                             |
| 35-40                     | 68.47                 | 19.95                    | 11.58                       |
| Test hole M-2             |                       |                          |                             |
| 0- 5                      | 75.09                 | 19.48                    | 5.43                        |
| 5-10                      | No sample             |                          |                             |
| 10-15                     | 3.57                  | 20.22                    | 76.21                       |
| 15-20                     | 9.58                  | 22.06                    | 68.36                       |
| 20-25                     | No sample             |                          |                             |
| Test hole M-2a            |                       |                          |                             |
| 0- 5                      | 42.86                 | 40.84                    | 16.30                       |
| 5-10                      | 39.79                 | 46.54                    | 13.67                       |
| 10-15                     | 11.63                 | 31.88                    | 56.49                       |
| Test hole M-3             |                       |                          |                             |
| 0- 5                      | 0.33                  | 38.91                    | 60.76                       |
| 5-10                      | .58                   | 31.31                    | 68.11                       |
| 10-35                     | No sample             |                          |                             |
| Test hole M-4             |                       |                          |                             |
| 0- 5                      | 2.54                  | 51.81                    | 45.65                       |
| 5-10                      | No sample             |                          |                             |
| 10-15                     | 4.26                  | 48.53                    | 47.21                       |
| 15-20                     | 40.65                 | 31.63                    | 27.72                       |
| 20-25                     | 14.01                 | 51.35                    | 34.64                       |
| 25-30                     | 17.23                 | 46.26                    | 36.51                       |
| 30-45                     | 9.45                  | 52.87                    | 38.68                       |
| 45-55                     | No sample             |                          |                             |
| 55-61                     | 38.83                 | 32.43                    | 29.74                       |
| Test hole M-5             |                       |                          |                             |
| 0- 5                      | 6.70                  | 59.94                    | 33.36                       |
| 5-10                      | 17.19                 | 39.68                    | 43.13                       |
| 10-65                     | No sample             |                          |                             |
| Test hole Cy-1            |                       |                          |                             |
| 0- 5                      | 9.07                  | 42.10                    | 38.83                       |
| 5-10                      | 31.45                 | 37.19                    | 32.36                       |
| 10-20                     | No sample             |                          |                             |

Appendix E.--Size analyses of samples from test holes in  
the Mora River drainage, western Mora County,  
N. Mex. - Concluded

| Depth of sample<br>(feet) | Gravel %<br>(>2.0 mm) | Sand %<br>(0.065-2.0 mm) | Silt-clay%<br>(<0.0625 mm) |
|---------------------------|-----------------------|--------------------------|----------------------------|
| Test hole Cy-2            |                       |                          |                            |
| 0- 5                      | 6.05                  | 59.62                    | 34.33                      |
| 5-10                      | 7.27                  | 52.50                    | 40.23                      |
| 10-15                     | 5.25                  | 55.75                    | 39.00                      |
| 15-20                     | 17.97                 | 56.72                    | 25.31                      |
| 20-25                     | 2.61                  | 45.37                    | 52.02                      |
| 25-30                     | 4.16                  | 58.04                    | 37.80                      |
| 30-35                     | .98                   | 29.15                    | 69.87                      |
| 35-40                     | 3.56                  | 48.77                    | 47.67                      |
| 40-50                     | No sample             |                          |                            |

Appendix F.--Records of pumping tests made on wells and  
test holes in the Mora River drainage,  
western Mora County, N. Mex.

Well 99

Owner: J. W. Shoemaker  
 Date of test: September 25, 1969  
 Method of discharge measurement: Free fall jet; checked by  
 propeller-type meter  
 Measuring point: Hole in pump base 1 foot above  
 land-surface datum.  
 Saturated thickness at beginning of test: 55 feet

Pumping period

| Time since<br>pumping started<br>(minutes) | Depth to water<br>below measuring<br>point<br>(feet) | Drawdown<br>(feet) | Discharge<br>(by free fall)<br>(gpm) |
|--------------------------------------------|------------------------------------------------------|--------------------|--------------------------------------|
| 0                                          | 6.45                                                 | 0                  | -                                    |
| .3                                         | 23.15                                                | 16.70              | -                                    |
| 1                                          | 20.95                                                | 14.50              | -                                    |
| 2                                          | 21.55                                                | 15.10              | -                                    |
| 3                                          | 21.93                                                | 15.48              | -                                    |
| 4.5                                        | 21.72                                                | 15.27              | -                                    |
| 6                                          | 21.65                                                | 15.20              | 1,060                                |
| 8                                          | 21.29                                                | 14.84              | -                                    |
| 10                                         | 21.65                                                | 15.20              | -                                    |
| 14                                         | 21.62                                                | 15.17              | -                                    |
| 22                                         | 21.85                                                | 15.40              | -                                    |
| 26                                         | 21.82                                                | 15.37              | -                                    |
| 30                                         | 21.58                                                | 15.13              | -                                    |
| 35                                         | 21.60                                                | 15.15              | -                                    |
| 40                                         | 21.45                                                | 15.00              | 910                                  |
| 50                                         | 21.81                                                | 15.36              | -                                    |
| 60                                         | 21.55                                                | 15.10              | -                                    |
| 70                                         | 21.71                                                | 15.26              | 950                                  |
| 85                                         | 21.50                                                | 15.05              | -                                    |
| 102                                        | 21.55                                                | 15.10              | -                                    |
| 115                                        | 21.57                                                | 15.12              | -                                    |
| 130                                        | 21.65                                                | 15.20              | 920                                  |
| 145                                        | 21.67                                                | 15.22              | -                                    |
| 160                                        | 21.30                                                | 14.85              | 870                                  |
| 175                                        | 21.30                                                | 14.85              | 890                                  |
| 190                                        | 21.46                                                | 15.01              | -                                    |
| 205                                        | 21.67                                                | 15.22              | 870                                  |
| 220                                        | 21.80                                                | 15.35              | -                                    |
| 235                                        | 21.85                                                | 15.40              | -                                    |

Discharge check with meter averaged 1,100 gpm.

Appendix F.--Records of pumping tests made on wells and test holes in the Mora River drainage, western Mora County, N. Mex. - Continued

Well 99 - Concluded

Recovery period

| Time since<br>pumping stopped<br>(minutes) | Time since<br><u>pumping started</u><br>Time since<br>pumping stopped<br>(minutes) | Depth to water<br>below measuring<br>point<br>(feet) | Residual<br>drawdown<br>(feet) |
|--------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------|
| 0                                          | --                                                                                 | 21.85                                                | 15.40                          |
| .117                                       | 5,002                                                                              | 20.00                                                | 13.55                          |
| .250                                       | 1,608                                                                              | 17.50                                                | 11.05                          |
| .383                                       | 1,060                                                                              | 15.00                                                | 8.55                           |
| .917                                       | 438                                                                                | 13.00                                                | 6.55                           |
| 1.50                                       | 269                                                                                | 11.65                                                | 5.20                           |
| 2                                          | 202                                                                                | 11.17                                                | 4.72                           |
| 3                                          | 135                                                                                | 10.55                                                | 4.10                           |
| 4                                          | 101.5                                                                              | 10.28                                                | 3.83                           |
| 5                                          | 81.4                                                                               | 10.00                                                | 3.55                           |
| 6                                          | 68.0                                                                               | 9.95                                                 | 3.50                           |
| 8                                          | 51.2                                                                               | 9.77                                                 | 3.32                           |
| 10                                         | 41.2                                                                               | 9.70                                                 | 3.25                           |
| 12                                         | 34.5                                                                               | 9.67                                                 | 3.22                           |
| 15                                         | 27.8                                                                               | 9.66                                                 | 3.21                           |
| 20                                         | 21.1                                                                               | 9.45                                                 | 3.00                           |
| 25                                         | 17.1                                                                               | 9.30                                                 | 2.85                           |
| 30                                         | 14.4                                                                               | 9.21                                                 | 2.76                           |
| 40                                         | 11.1                                                                               | 8.98                                                 | 2.53                           |
| 50                                         | 9.04                                                                               | 8.90                                                 | 2.45                           |
| 60                                         | 7.70                                                                               | 8.77                                                 | 2.32                           |
| 75                                         | 6.35                                                                               | 8.60                                                 | 2.15                           |
| 90                                         | 5.47                                                                               | 8.50                                                 | 2.05                           |

Well 100

Measurements in observation well 100  
when pumping well 99

Distance from pumped well: 300 feet

Measuring point: Top of casing 0.8 feet  
above land-surface datum

| Time since<br>pumping started<br>(minutes) | Depth to water<br>below measuring<br>point<br>(feet) | Drawdown<br>(feet) |
|--------------------------------------------|------------------------------------------------------|--------------------|
| 22                                         | 6.70                                                 | 0                  |
| 24                                         | 6.69                                                 | + .01              |
| 37                                         | 6.69                                                 | + .01              |
| 57                                         | 6.57                                                 | + .13              |

Appendix F.--Records of pumping tests made on wells and test holes in the Mora River drainage, western Mora County, N. Mex. - Continued

Well 100 - Continued

| Time since<br>pumping started<br>(minutes) | Depth to water<br>below measuring<br>point<br>(feet) | Drawdown<br>(feet) |
|--------------------------------------------|------------------------------------------------------|--------------------|
| 71                                         | 6.70                                                 | + .05              |
| 132                                        | 6.71                                                 | .01                |
| 146                                        | 6.75                                                 | .05                |
| 163                                        | 6.77                                                 | .07                |
| 176                                        | 6.79                                                 | .09                |
| 191                                        | 6.77                                                 | .07                |
| 206                                        | 6.79                                                 | .09                |
| 221                                        | 6.84                                                 | .14                |
| 236                                        | 6.83                                                 | .13                |

Well 100 - Concluded

Owner: J. W. Shoemaker  
 Date of test: November 15, 1968  
 Method of discharge measurement: Free fall jet; checked by propeller-type meter  
 Measuring point: Top of casing 0.8 foot above land-surface datum

Pumping period

| Time since<br>pumping started<br>(minutes) | Depth to water<br>below measuring<br>point<br>(feet) | Drawdown<br>(feet) | Discharge<br>(gpm) |
|--------------------------------------------|------------------------------------------------------|--------------------|--------------------|
| 0                                          | 7.00                                                 | 0                  | 450                |
| 14                                         | 17.40                                                | 10.40              | 450                |
| 16                                         | 18.00                                                | 11.00              | 450                |
| 18                                         | 18.50                                                | 11.50              | 450                |
| 20                                         | 18.70                                                | 11.70              | 450                |
| 25                                         | 20.50                                                | 13.50              | 450                |
| 32                                         | 18.60                                                | 11.60              | fluctuating        |
| 38                                         | 19.80                                                | 12.80              | Do.                |
| 45                                         | 20.25                                                | 13.25              | Do.                |
| 55                                         | 20.35                                                | 13.35              | Do.                |

Discharge check with meter averaged 490 gpm.

Appendix F.--Records of pumping tests made on wells and test holes in the Mora River drainage, western Mora County, N. Mex. - Continued

Well 102

Owner: Sellman Brothers  
 Date of test: November 15, 1968  
 Method of discharge measurement: Free fall jet; checked by propeller-type meter  
 Measuring point: Top of casing 1 foot above land-surface datum

Pumping period

| Time since pumping started (minutes) | Depth to water below measuring point (feet) | Drawdown (feet) | Discharge (by free fall) (gpm) |
|--------------------------------------|---------------------------------------------|-----------------|--------------------------------|
| 0                                    | 22.07                                       | 0               | 220                            |
| 1                                    | 27.00                                       | 4.93            | 220                            |
| 3                                    | 27.80                                       | 5.70            | 220                            |
| 6                                    | 28.30                                       | 6.20            | 220                            |
| 10                                   | 28.70                                       | 6.60            | 220                            |
| 15                                   | 29.28                                       | 7.21            | 220                            |
| 20                                   | 29.53                                       | 7.46            | 220                            |
| 30                                   | 29.90                                       | 7.83            | 220                            |
| 40                                   | 30.25                                       | 8.18            | 220                            |
| 60                                   | 30.60                                       | 8.53            | 220                            |

Note: Discharge by propeller-type meter averaged 270 gpm.

Test hole Cy-1 and observation well Cy-1a

Date of test: October 3, 1969  
 Method of discharge measurement: Volumetric  
 Observation well (Cy-1a) 29.5 ft. from pumped well (Cy-1)  
 Saturated thickness in both wells at start of test: 20 ft.

Pumping period

| Time since pumping started in test hole Cy-1 (minutes) | Depth to water above (+) or below land surface in observation well Cy-1a (feet) | $r^2/t$ | Drawdown in observation well Cy-1a (feet) | Discharge from test hole Cy-1 (gpm) |
|--------------------------------------------------------|---------------------------------------------------------------------------------|---------|-------------------------------------------|-------------------------------------|
| 0                                                      | +0.58                                                                           | 0       | 0                                         | 0                                   |
| 3                                                      | 2.08                                                                            | 290     | 1.50                                      | 2                                   |
| 3.5                                                    | 2.22                                                                            | 249     | 1.64                                      | 2                                   |
| 4                                                      | 2.40                                                                            | 218     | 1.82                                      | 2                                   |
| 4.5                                                    | 2.51                                                                            | 193     | 1.93                                      | 2                                   |

Appendix F.--Records of pumping tests made on wells and test holes in the Mora River drainage, western Mora County, N. Mex. - Continued

Test hole Cy-1 and observation well Cy-1a - Continued

Pumping period - Concluded

| Time since pumping<br>started in test<br>hole Cy-1<br>(minutes) | Depth to water above<br>(+) or below land<br>surface in observation<br>well Cy-1a<br>(feet) | $r^2/t$ | Drawdown<br>in obser-<br>vation well<br>Cy-1a<br>(feet) | Discharge<br>from test<br>hole Cy-1<br>(gpm) |
|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------|---------------------------------------------------------|----------------------------------------------|
| 5                                                               | 2.62                                                                                        | 174     | 2.04                                                    | 2                                            |
| 5.5                                                             | 2.69                                                                                        | 158     | 2.11                                                    | 2                                            |
| 6                                                               | 2.76                                                                                        | 145     | 2.18                                                    | 2                                            |
| 7                                                               | 2.86                                                                                        | 124     | 2.28                                                    | 2                                            |
| 8                                                               | 2.97                                                                                        | 109     | 2.39                                                    | 2                                            |
| 9                                                               | 3.05                                                                                        | 96.7    | 2.47                                                    | 2                                            |
| 10                                                              | 3.13                                                                                        | 87.0    | 2.55                                                    | 2                                            |
| 12                                                              | 3.28                                                                                        | 72.5    | 2.70                                                    | 2                                            |
| 14                                                              | 3.35                                                                                        | 62.2    | 2.77                                                    | 2                                            |
| 16                                                              | 3.48                                                                                        | 54.4    | 2.90                                                    | 1.8                                          |
| 18                                                              | 3.75                                                                                        | 48.3    | 3.17                                                    | 1.82                                         |
| 20                                                              | 3.93                                                                                        | 43.5    | 3.35                                                    | 1.82                                         |
| 23                                                              | 4.07                                                                                        | 37.8    | 4.39                                                    | 1.82                                         |
| 26                                                              | 4.02                                                                                        | 33.5    | 3.44                                                    | 1.82                                         |
| 29                                                              | 4.02                                                                                        | 30.0    | 3.44                                                    | 1.82                                         |
| 32                                                              | 3.95                                                                                        | 27.2    | 3.37                                                    | 1.82                                         |
| 35                                                              | 3.87                                                                                        | 24.9    | 3.29                                                    | 1.82                                         |
| 37                                                              | 4.28                                                                                        | 23.5    | 3.70                                                    | 2.22                                         |
| 40                                                              | 4.57                                                                                        | 21.8    | 3.99                                                    | 2.22                                         |
| 45                                                              | 4.81                                                                                        | 19.3    | 4.23                                                    | 2.22                                         |
| 50                                                              | 4.88                                                                                        | 17.4    | 4.30                                                    | 2.35                                         |
| 55                                                              | 5.00                                                                                        | 15.8    | 4.42                                                    | 2.35                                         |
| 60                                                              | 4.91                                                                                        | 14.5    | 4.33                                                    | 2.35                                         |
| 70                                                              | 5.01                                                                                        | 12.4    | 4.43                                                    | 2.35                                         |
| 80                                                              | 4.85                                                                                        | 10.9    | 4.27                                                    | 2.35                                         |
| 90                                                              | 4.32                                                                                        | 9.67    | 3.74                                                    | 2.35                                         |

Appendix F.--Records of pumping tests made on wells and test holes in the Mora River drainage, western Mora County, N. Mex. - Concluded

Test hole Cy-1 and observation well Cy-1a - Concluded

Measuring point: Top of casing 4 feet above land-surface datum

Recovery period, pumped well (Cy-1)

| Time since<br>pumping stopped<br>(minutes) | Time since<br><u>pumping started</u><br>Time since<br>pumping stopped<br>(minutes) | Depth to water<br>below measuring<br>point<br>(feet) | Residual<br>drawdown<br>(feet) |
|--------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------|
| 0.67                                       | 135.5                                                                              | 9.40                                                 | 5.60                           |
| 1                                          | 91                                                                                 | 8.55                                                 | 4.75                           |
| 1.5                                        | 61                                                                                 | 8.12                                                 | 4.32                           |
| 2                                          | 46                                                                                 | 7.85                                                 | 4.05                           |
| 2.5                                        | 37                                                                                 | 7.47                                                 | 3.67                           |
| 3                                          | 31                                                                                 | 7.40                                                 | 3.60                           |
| 4                                          | 23.5                                                                               | 7.02                                                 | 3.22                           |
| 5                                          | 19                                                                                 | 6.81                                                 | 3.01                           |
| 6                                          | 16                                                                                 | 6.65                                                 | 2.85                           |
| 7                                          | 13.85                                                                              | 6.48                                                 | 2.68                           |
| 9                                          | 12.4                                                                               | 6.24                                                 | 2.44                           |
| 11                                         | 11.2                                                                               | 6.00                                                 | 2.20                           |
| 13                                         | 10.3                                                                               | 5.83                                                 | 2.03                           |
| 15                                         | 7                                                                                  | 5.70                                                 | 1.90                           |
| 20                                         | 5.5                                                                                | 5.40                                                 | 1.60                           |
| 25                                         | 4.6                                                                                | 5.25                                                 | 1.45                           |
| 30                                         | 4                                                                                  | 5.00                                                 | 1.20                           |

Note: Static water level: 3.80 feet below measuring point.

Appendix G.--Records of water levels in observation wells  
in the Mora River drainage, western Mora County, N. Mex.

| Well<br>No. | Owner or name              | Date<br>(1969) | Depth<br>to<br>water<br>(feet) | Date<br>(1969) | Depth<br>to<br>water<br>(feet) | Date<br>(1969) | Depth<br>to<br>water<br>(feet) | Date<br>(1969)     | Depth<br>to<br>water<br>(feet) | Date<br>(1969) | Depth<br>to<br>water<br>(feet) | Date<br>(1969)                | Depth<br>to<br>water<br>(feet) | Date<br>(1969) | Depth<br>to<br>water<br>(feet) |
|-------------|----------------------------|----------------|--------------------------------|----------------|--------------------------------|----------------|--------------------------------|--------------------|--------------------------------|----------------|--------------------------------|-------------------------------|--------------------------------|----------------|--------------------------------|
| 4           | Old School                 | 4- 9           | 24.9                           | 6- 3           | 23.7                           | 7- 9           | 29.1                           | 7-31               | 24.5                           | 9- 4           | 22.8                           | 10- 2                         | 24.5                           | 11- 6          | 30.5                           |
| 11          | W. Romero                  | 4- 2           | 6.6                            | 6- 3           | 6.8                            | 7- 9           | 6.7                            | 7-31               | 6.8                            | 9- 4           | 6.0                            | 1- 2                          | 6.4                            | 11- 6          | 5.6                            |
| 15          | N. Lovato                  | 4- 9           | 16.4                           | 6- 3           | 17.2                           | 7- 9           | 17.2                           | 7-31               | 18.4                           | 9- 4           | 12.6                           | 10- 2                         | 18.9                           | 11- 6          | 18.5                           |
| 39          | A. D. Maes                 | 4- 9           | 63.4                           | 6- 3           | 46.8                           | 7- 9           | 38.7                           | Replaced by No. 41 |                                | -              | -                              | -                             | -                              | -              | -                              |
| 41          | No. Cleveland MDWCA        | -              | -                              | -              | -                              | -              | -                              | 8- 1               | 48.1                           | 9- 4           | 51.1                           | -                             | -                              | -              | -                              |
| 47          | Pendleton Oil &<br>Gas Co. | 3-27           | 23.7                           | 6- 3           | 19.2                           | 7- 9           | 22.5                           | 8- 1               | 21.8                           | 9- 4           | 23.3                           | 10- 2                         | 24.8                           | 11- 7          | 21.9                           |
| 51          | -                          | 3-27           | 14.9                           | 6- 3           | 12.4                           | 7- 9           | 7.5                            | 8- 1               | 8.9                            | 9- 4           | 11.7                           | 10- 2                         | 13.3                           | 11- 7          | 13.7                           |
| 53          | -                          | 3-27           | 3.4                            | 6- 3           | .9                             | 7- 9           | .4                             | 8- 1               | .4                             | 9- 4           | 2.5                            | 10- 2                         | 1.6                            | 11. 7          | 2.2                            |
| 54          | S. Muniz                   | 3-27           | 25.4                           | 6- 3           | 25.0                           | 7- 9           | 22.4                           | 8- 1               | 20.7                           | 9- 4           | 20.6                           | 10- 2                         | 14.0                           | 11- 6          | 18.1                           |
| 56          | J. P. Bert                 | 3-27           | 3.8                            | 6- 3           | 3.9                            | 7- 9           | 3.5                            | 8- 1               | 3.5                            | 9- 4           | 2.7                            | 10- 2                         | 3.8                            | 11- 6          | 3.5                            |
| 57          | -                          | 3-27           | 13.9                           | 6- 3           | 12.7                           | 7- 9           | 12.6                           | 8- 1               | 12.6                           | 9- 4           | 12.9                           | 10- 2                         | 12.7                           | 11- 6          | 12.8                           |
| 58          | -                          | 3-27           | 4.4                            | 6- 3           | 5.2                            | 7- 9           | 5.1                            | 8- 1               | 5.1                            | 9- 4           | 5.3                            | 10- 2                         | 5.3                            | 11- 6          | 4.7                            |
| 69          | D. Chavez                  | 4- 9           | 25.4                           | 6- 3           | 25.8                           | 7- 9           | 26.2                           | 8- 1               | 26.2                           | 9- 4           | 24.2                           | 10- 2                         | 26.4                           | 11- 6          | 25.2                           |
| 73          | N. Mex. Hwy. Dept.         | 4- 9           | 88.0                           | 6- 3           | 88.0                           | -              | -                              | -                  | -                              | -              | -                              | -                             | -                              | -              | -                              |
| 74          | Buena Vista MDWCA          | 3-27           | 85.2                           | 6- 3           | 82.0                           | 7- 8           | 90.0                           | 7-31               | 83.5                           | -              | -                              | 10- 2                         | 82.6                           | -              | -                              |
| 85          | C. H. Penland              | 3-25           | 12.4                           | 6- 4           | 11.6                           | 7- 8           | 10.8                           | 7-30               | 11.5                           | 9- 4           | 11.6                           | 10- 2                         | 12.1                           | -              | -                              |
| 90          | Phoenix Ranch              | 3-25           | 14.9                           | 6- 4           | 11.9                           | 7- 8           | 11.6                           | 7-30               | 11.0                           | -              | -                              | 10- 2                         | 11.6                           | -              | -                              |
| 99          | J. Shoemaker               | 3-25           | 4.4                            | 6- 4           | 4.4                            | 7- 8           | 5.5                            | 7-30               | 5.0                            | 9- 4           | 5.1                            | 10- 2                         | 5.3                            | 11- 6          | 5.4                            |
| 130         | Maestas                    | 4- 9           | 15.3                           | 6- 3           | 12.6                           | 7- 9           | 11.1                           | 8- 1               | 10.2                           | 9- 4           | 10.6                           | 10- 2                         | 12.3                           | 11- 6          | 9.3                            |
| 131         | USGS                       | 3-28           | 5.9                            | 6- 3           | 4.9                            | 7- 9           | 4.4                            | 8- 1               | 4.2                            | 9- 4           | 3.9                            | 10- 2                         | 4.6                            | 11- 6          | 3.3                            |
| 132         | do.                        | -              | -                              | 6- 3           | .1                             | 7- 9           | .2                             | 8- 1               | Flow                           | 9- 4           | -                              | 10- 2                         | Flow                           | 11- 6          | Flow                           |
| 134         | M. Valdez                  | 4- 9           | 19.3                           | 6- 3           | 20.5                           | 7- 9           | 19.8                           | 8- 1               | 20.6                           | 9- 4           | 19.5                           | 10- 2                         | 19.2                           | 11- 6          | 18.5                           |
| 135         | USGS                       | -              | -                              | 6- 3           | 2.7                            | 7- 9           | 1.0                            | 8- 1               | 1.6                            | 9- 4           | 1.5                            | 10- 2                         | 4.1                            | 11- 6          | 4.9                            |
| 136         | -                          | -              | -                              | 6- 4           | 10.2                           | -              | -                              | 7-30               | 10.3                           | 9- 4           | 9.4                            | 10- 2                         | 11.9                           | 11- 6          | 12.0                           |
| 140         | USGS                       | -              | -                              | -              | -                              | -              | -                              | 8- 1               | 10.5                           | 9- 4           | 12.7                           | 10- 2                         | 14.3                           | 11- 6          | 15.6                           |
| 211         | Ledoux MDWCA               | 4-22           | 49.2                           | 6- 3           | 40.6*                          | 7- 9           | 39.0                           | 8- 1               | *                              | 9- 5           | 35.8                           | 10- 1                         | 40.4                           | 11- 6          | 37.7                           |
| 218         | A. Nolan                   | 4-22           | 58.8                           | 6- 3           | 51.0                           | 7- 9           | 38.2                           | 8- 1               | 31.9                           | 9- 5           | 29.6                           | -                             | -                              | 11- 6          | 32.4                           |
| 219         | -                          | 4-22           | 24.0                           | 6- 3           | 20.3                           | 7- 9           | 22.1                           | 8- 1               | 24.7                           | 9- 5           | 24.7                           | 10- 1                         | 24.4                           | 11- 6          | 20.0                           |
| 220         | T. Ansley                  | 4-22           | 52.7                           | 6- 3           | 49.0                           | 7- 9           | 48.8                           | 8- 1               | 47.6                           | -              | -                              | 10- 1                         | 49.4                           | 11- 6          | 45.3                           |
| 227         | -                          | 4-22           | 17.8                           | 6- 3           | 15.9                           | 7- 9           | 17.2                           | 8- 1               | 20.2                           | 9- 5           | 17.6                           | 10- 1                         | 17.5                           | 11- 6          | 16.4                           |
| 228         | -                          | 4-22           | 3.0                            | 6- 3           | 3.6                            | 7- 9           | Dry                            | -                  | -                              | -              | -                              | -                             | -                              | -              | -                              |
| 230         | Cherry                     | 4-22           | 17.5                           | 6- 3           | 8.3                            | 7- 9           | 2.2                            | 8- 1               | 1.7                            | 9- 5           | .6                             | 10- 1                         | 4.7                            | -              | -                              |
| 231         | D. Trujillo                | 4-22           | 37.8                           | 6- 3           | 25.9                           | 7- 9           | 20.0                           | 8- 1               | 17.4                           | 9- 5           | 17.2                           | 10- 1                         | 21.9                           | 11- 6          | 23.3                           |
| 232         | -                          | 4-22           | 19.9                           | 6- 3           | 10.6                           | 7- 9           | 10.4                           | 8- 1               | 10.7                           | -              | -                              | 10- 1                         | 10.8                           | -              | -                              |
| 303         | Romano                     | 3-27           | 12.4                           | 6- 4           | 12.3                           | 7- 9           | 12.6                           | 7-31               | 11.8                           | 9- 5           | 12.7                           | No measurement,<br>redrilling |                                | 11- 7          | 10.5                           |
| 314         | S. Romero                  | 4- 9           | 6.1                            | 6- 4           | 7.5                            | 7- 9           | 8.1                            | 7-31               | 7.7                            | 9- 5           | 6.9                            | 10- 3                         | 8.3                            | 11- 7          | 7.1                            |
| 331         | do.                        | 3-25           | 33.1                           | 6- 4           | 32.1                           | 7- 8           | 32.0                           | 7-31               | 32.0                           | 9- 5           | 26.3                           | 10- 1                         | 27.5                           | 11- 7          | 27.5                           |
| 338         | -                          | 4- 9           | 30.6                           | 6- 4           | 28.0                           | 7- 8           | 26.8                           | 7-31               | 26.1                           | 9- 5           | 21.6                           | 10- 1                         | 23.5                           | 11- 6          | 19.3                           |
| 348         | R. Anderson                | 4- 9           | 97.6                           | 6- 4           | 99.0                           | 7- 8           | 98.6                           | -                  | -                              | 9- 5           | 97.1                           | 10- 1                         | *                              | 11- 6          | *                              |
| 349         | W. Salman                  | 4- 9           | 157.0                          | 6- 4           | 190.5                          | 7- 8           | 190.3                          | 7-30               | 180.6                          | 9- 5           | 179.6                          | 10- 1                         | *                              | 11- 6          | *                              |
| 354         | H. Caseus                  | 3-25           | 35.3                           | 6- 4           | 32.6                           | 7- 8           | 28.2                           | 7-30               | 34.4                           | 9- 5           | 35.2                           | 10- 1                         | 35.3                           | -              | -                              |
| 381         | W. Salman                  | 4- 9           | 30.7                           | 6- 4           | 26.8                           | 7- 8           | 21.5                           | -                  | -                              | -              | -                              | -                             | -                              | -              | -                              |
| 390         | do.                        | -              | -                              | 6- 4           | 7.0                            | 7- 9           | 8.9                            | 7-31               | 6.9                            | -              | -                              | 10- 1                         | 13.7                           | 11- 7          | 15.3                           |
| 495         | Watrous MDWCA              | 3-25           | 11.9                           | 6- 4           | 30.7*                          | 7- 8           | 8.4                            | 7-31               | 11.2                           | 9- 4           | 7.2                            | 10- 2                         | 11.8                           | 11- 6          | 8.2                            |

\*Pumping water level, or no measurement due to pumping.

# Appendix H.--Chemical analyses of water samples from wells, streams, and springs in the Mora River drainage, western Mora County, N. Mex. (Chemical constituents are in milligrams per liter)

EXPLANATION:

Source of sample: Number of wells and letters of springs correspond to those in Appendixes A and B, and on figure 14.

Principal aquifer: Qal, alluvium; Kgr, Graneros Shale; Kd, Dakota Sandstone; Rr, Chinle Formation; Rr, Santa Rosa Sandstone; Pu, Pennsylvanian rocks, undivided.

| Source of sample             | Date of collection | Temp-<br>erature<br>°C | Silica<br>(SiO <sub>2</sub> ) | Iron<br>(Fe) | Cal-<br>cium<br>(Ca) | Magne-<br>sium<br>(Mg) | Sodium<br>(Na) | Potas-<br>sium<br>(K) | 8icar-<br>bonate<br>(HCO <sub>3</sub> ) | Car-<br>bonate<br>(CO <sub>3</sub> ) | Sulfate<br>(SO <sub>4</sub> ) | Chlo-<br>ride<br>(Cl) | Fluo-<br>ride<br>(F) | Ni-<br>trate<br>(NO <sub>3</sub> ) | Dis-<br>solved<br>solids | Hardness<br>as CaCO <sub>3</sub> |                        | Per-<br>cent<br>Sod-<br>ium | Sodium<br>adsorp-<br>tion<br>ratio<br>(SAR) | Specific<br>conduct-<br>ance<br>(micro-<br>mhos at<br>25°C) | pH    | Principal<br>aquifer |            |
|------------------------------|--------------------|------------------------|-------------------------------|--------------|----------------------|------------------------|----------------|-----------------------|-----------------------------------------|--------------------------------------|-------------------------------|-----------------------|----------------------|------------------------------------|--------------------------|----------------------------------|------------------------|-----------------------------|---------------------------------------------|-------------------------------------------------------------|-------|----------------------|------------|
|                              |                    |                        |                               |              |                      |                        |                |                       |                                         |                                      |                               |                       |                      |                                    |                          | Calcium<br>solids                | Non-<br>carbon-<br>ate |                             |                                             |                                                             |       |                      |            |
| Well 11                      | 7-31-69            | 18                     | 16                            | 1.80         | 4.6                  | 2.6                    | 394            |                       | 0.53                                    | 596                                  | 4.3                           | 282                   | 9.6                  | 3.9                                | 0.1                      | 1,050                            | 22                     | 0                           | 97                                          | 36                                                          | 1,380 | 8.8                  | Pu         |
| Well 15                      | 1-31-69            | 12                     | 15                            | -            | 95                   | 26                     | 23             |                       | .08                                     | 288                                  | 0                             | 141                   | 2.8                  | .4                                 | 4.2                      | 449                              | 342                    | 106                         | 13                                          | .5                                                          | 689   | 7.6                  | Qal        |
| Well 39                      | 8-1-69             | 14                     | 16                            | -            | 128                  | 6.0                    | 0              |                       | .05                                     | 310                                  | 0                             | 68                    | 3.6                  | .4                                 | 16                       | 390                              | 344                    | 90                          | 0                                           | 0                                                           | 662   | 7.4                  | Qal        |
| Well 47                      | 8-1-69             | 17                     | 16                            | -            | 34                   | .2                     | 6              |                       | .01                                     | 100                                  | 0                             | 15                    | .6                   | .2                                 | 0                        | 121                              | 86                     | 4                           | 13                                          | .3                                                          | 180   | 7.2                  | Qal        |
| Well 54A                     | 8-1-69             | 12                     | 30                            | -            | 55                   | 7.1                    | 33             |                       | .06                                     | 172                                  | 0                             | 34                    | 15                   | 2.1                                | 44                       | 305                              | 166                    | 25                          | 30                                          | 1.1                                                         | 458   | 7.3                  | Qal        |
| Well 56                      | 8-1-69             | 16                     | 12                            | -            | 100                  | .6                     | 20             |                       | .04                                     | 224                                  | 0                             | 73                    | 18                   | .7                                 | 9.8                      | 344                              | 252                    | 68                          | 15                                          | .5                                                          | 546   | 7.9                  | Qal        |
| Well 57                      | 11-27-68           | 17                     | 56                            | .04          | 9.5                  | 4.5                    | 177            | 4.6                   | .36                                     | 212                                  | 0                             | 80                    | 83                   | 17                                 | .9                       | 537                              | 42                     | 0                           | 89                                          | 12                                                          | 843   | 7.4                  | Qal        |
| Well 69                      | 8-1-69             | 18                     | 21                            | -            | 44                   | 6.3                    | 14             |                       | .02                                     | 180                                  | 0                             | 10                    | 4.6                  | .7                                 | .3                       | 190                              | 136                    | 0                           | 18                                          | .5                                                          | 302   | 8.0                  | Qal        |
| Well 74                      | 7-31-69            | 19                     | 17                            | -            | 102                  | 11                     | 32             |                       | .05                                     | 310                                  | 0                             | 75                    | 13                   | .7                                 | 21                       | 424                              | 300                    | 46                          | 19                                          | .8                                                          | 671   | 7.4                  | Rc(?)      |
| Well 86                      | 7-30-69            | 19                     | 13                            | .07          | 461                  | 53                     | 83             |                       | .14                                     | 300                                  | 0                             | 1,080                 | 8.4                  | .4                                 | 20                       | 1,810                            | 1,220                  | 974                         | 13                                          | 1.0                                                         | 2,090 | 7.7                  | Qal & Kgr  |
| Well 100                     | 10-9-69            | 12                     | 18                            | -            | 104                  | 25                     | 30             |                       | .11                                     | 360                                  | 0                             | 104                   | 9.2                  | .6                                 | 6.2                      | 477                              | 362                    | 62                          | 15                                          | .7                                                          | 803   | 7.6                  | Qal        |
| Well 101                     | 11-27-68           | 11                     | 16                            | .00          | 98                   | 17                     | 32             | 1.1                   | .11                                     | 319                                  | 0                             | 109                   | 6.7                  | .4                                 | 2.8                      | 440                              | 316                    | 54                          | 18                                          | .8                                                          | 701   | 7.5                  | Qal        |
| Well 211                     | 8-1-69             | 13                     | 21                            | -            | 85                   | 3.4                    | 15             |                       | .02                                     | 292                                  | 0                             | 9.6                   | 2.8                  | .8                                 | 4.2                      | 286                              | 226                    | 0                           | 13                                          | .4                                                          | 462   | 7.8                  | Qal        |
| Well 212                     | 11-27-68           | 10                     | 17                            | .00          | 61                   | 12                     | 87             | 1.2                   | .11                                     | 194                                  | 0                             | 156                   | 30                   | 2.2                                | 37                       | 499                              | 202                    | 43                          | 48                                          | 2.7                                                         | 755   | 7.5                  | Qal        |
| Well 214                     | 11-27-68           | 11                     | 17                            | .00          | 62                   | 4.3                    | 7.2            | 3.0                   | .11                                     | 210                                  | 0                             | 19                    | 1.8                  | .7                                 | 1.9                      | 220                              | 172                    | 0                           | 8                                           | .2                                                          | 361   | 7.5                  | Qal        |
| Well 216                     | 11-27-68           | 8                      | 27                            | .00          | 37                   | 7.7                    | 14             | 2.7                   | .10                                     | 87                                   | 0                             | 32                    | 13                   | .5                                 | 45                       | 222                              | 124                    | 52                          | 19                                          | .5                                                          | 335   | 7.1                  | Qal        |
| Well 220                     | 8-1-69             | 23                     | 15                            | .08          | 152                  | 6.1                    | 35             |                       | .05                                     | 302                                  | 0                             | 80                    | 37                   | .3                                 | 119                      | 593                              | 404                    | 156                         | 16                                          | .8                                                          | 870   | 7.6                  | Qal & Pu   |
| Well 230                     | 8-1-69             | 15                     | 14                            | -            | 40                   | 2.4                    | 8.3            |                       | .01                                     | 142                                  | 0                             | 6.4                   | 2.0                  | .3                                 | 1.3                      | 145                              | 110                    | 0                           | 14                                          | .3                                                          | 238   | 6.8                  | Qal(?)     |
| Well 314                     | 11-27-68           | -                      | 11                            | .40          | 24                   | 4.9                    | 73             | 3.4                   | .14                                     | 247                                  | 0                             | 18                    | 4.1                  | .4                                 | 17                       | 277                              | 80                     | 0                           | 65                                          | 3.6                                                         | 450   | 7.7                  | Qal        |
| Well 349                     | 7-30-69            | 17                     | 26                            | .05          | 62                   | 12                     | 19             |                       | .03                                     | 256                                  | 0                             | 22                    | 5.4                  | .4                                 | 5.4                      | 278                              | 204                    | 0                           | 17                                          | .6                                                          | 435   | 7.9                  | Rsr        |
| Well 354                     | 7-30-69            | 12                     | 20                            | .05          | 72                   | 19                     | 31             |                       | .05                                     | 316                                  | 0                             | 27                    | 9.0                  | .4                                 | 29                       | 362                              | 256                    | 0                           | 21                                          | .9                                                          | 576   | 8.2                  | Qal        |
| Well 372                     | 11-27-68           | -                      | 14                            | .00          | 130                  | 40                     | 105            | 3.3                   | .21                                     | 412                                  | 0                             | 288                   | 41                   | .5                                 | 1.5                      | 827                              | 490                    | 152                         | 32                                          | 2.1                                                         | 1,210 | 7.7                  | Rc & Rsr   |
| Well 381                     | 7-30-69            | 16                     | 19                            | -            | 60                   | 15                     | 42             |                       | .07                                     | 288                                  | 0                             | 46                    | 7.6                  | .6                                 | 10                       | 342                              | 212                    | 0                           | 30                                          | 1.3                                                         | 524   | 7.9                  | Qal        |
| Well 495                     | 7-30-69            | -                      | 15                            | -            | 80                   | 22                     | 75             |                       | .13                                     | 308                                  | 0                             | 170                   | 15                   | 1.0                                | .4                       | 530                              | 290                    | 38                          | 36                                          | 1.9                                                         | 829   | 7.9                  | Qal        |
| Spring C                     | 11-27-68           | 4                      | 2.8                           | .06          | 32                   | 7.8                    | 7.6            | 3.0                   | .09                                     | 130                                  | 0                             | 14                    | 5.0                  | .4                                 | 1.1                      | 138                              | 112                    | 6                           | 12                                          | .3                                                          | 249   | 7.1                  | Qal        |
| Spring Q                     | 7-30-69            | -                      | 25                            | -            | 85                   | 5.8                    | 24             |                       | .06                                     | 276                                  | 0                             | 32                    | 46                   | .9                                 | 4.4                      | 329                              | 236                    | 10                          | 18                                          | .7                                                          | 570   | 8.0                  | Base of Kd |
| Rito Cebolla at State Hwy. 3 | 11-27-68           | 3                      | 21                            | .00          | 62                   | 15                     | 18             | 1.8                   | .13                                     | 244                                  | 0                             | 47                    | 6.6                  | .4                                 | .2                       | 292                              | 216                    | 16                          | 15                                          | .5                                                          | 477   | 7.9                  | -          |
| Rito Cebolla near Well 212   | 11-27-68           | 9                      | 13                            | .25          | 60                   | 9.8                    | 16             | 1.3                   | .11                                     | 250                                  | 0                             | 16                    | 3.5                  | .6                                 | 0                        | 244                              | 190                    | 0                           | 15                                          | .5                                                          | 415   | 7.9                  | -          |
| Luna Cr. at Hwy. 121         | 10-10-69           | 7                      | 7.6                           | -            | 68                   | 13                     | 13             |                       | .06                                     | 207                                  | 7                             | 64                    | 1.0                  | .2                                 | .1                       | 276                              | 222                    | 52                          | 11                                          | .4                                                          | 428   | 8.4                  | -          |
| Mora River at Hwy. 38        | 10-10-69           | 11                     | 8.5                           | -            | 68                   | 17                     | 13             |                       | .06                                     | 224                                  | 0                             | 77                    | 1.6                  | .2                                 | .7                       | 296                              | 239                    | 56                          | 10                                          | .4                                                          | 483   | 8.2                  | -          |





