CARBON BACKS

NM 123, Part 9

SOUTHWESTERN CLOSED BASINS - BY GENE DOTY

DETAILED BASIN OUTLINE

Location

_____ basin is outlined on Figs. ____, ____. Sub-basins within this major drainage area are _____, _____, _____. Counties and parts of counties included within the area are _____, _____. The larger cities and villages in the area are _____, _____.

Description

Geography

Drainage areas

Stream systems

_____ river and tributaries

Topography and physiographic provinces

Topographic mapping

Geology

Sedimentary rocks

Igneous rocks

Minerals

Geologic mapping

Soils and vegetation

Soils

Vegetation

Hydrology

General (weather stations, temperature, precipitation)

Surface water

Streamflow measuring network

Water yield, annual runoff

Description

Hydrology (cont'd)

Surface water (cont'd)

Supply

Virgin flow

Regulation (by reservoirs and projects)

Floods — areas subject to flooding

Sedimentation

Monitoring network

Origin and deposition

Chemical Quality

Monitoring network

Quality of water

Ground water

Known and probable reservoirs (alluvial or bedrock)

Stream-connected aquifers

Non-connected aquifers

Supply

Chemical quality

Monitoring network

Quality of water

Ground-water studies

Areas investigated

Water-level measurements

(The above part of report to be written by USGS)

Population and Economy of the Area

Population

Urban

Municipalities

Rural

Industries and commerce

Commercial enterprises

Agriculture

Irrigated

Non-irrigated

Timber

Minerals

Transportation facilities

Roads, railroads, airlines

Power availability

Fish, wildlife and recreation

Cultural resources

(This part of the report to be of a general and somewhat historical nature in order to provide a setting for the next section of the report)

Water Development and Use

Beneficial uses

Municipal, industrial, military, and rural domestic

Power production

Recreation, fish and wildlife

Water Development and Use (cont'd)

Beneficial uses (cont'd)

Agriculture

Non-irrigated

(Items as dry-land, rangeland, livestock, land treatment, erosion control, etc)

Irrigated

(Items as project lands, crops, water requirements, drainage problems, etc.)

Other consumptive uses

Reservoir evaporation

Native vegetation and phreatophytes

Channel losses

Summary Table of water uses Item	Unit of use	Units	Surface water Diver.	C.U.	Ground water Diver.	C.U.	SW and GW Diver.	C.U.
Agriculture								
Municipal and Industrial								
Rural domestic and livestock								
Power production								
Recreation, Fish & Wildlife								

(Note: Under each item discussed, uses of surface water, ground water, and combinations thereof to be discussed and developed as appropriate)

Problems of the Area

Surface water

Available supplies and shortages

Streamflow regulation (conservation storage, sediment, and flood control)

Problems of the Area (cont'd)

Surface water (cont'd)

Competitive demands for water uses

Quality of water

Pollution abatement

Consumptive waste from beneficial uses

M & I

Agriculture

Irrigation practices

Drainage problems

Other consumptive
Non-beneficial losses

Reservoir evaporation

Vegetative losses (native and phreatophytes)

Basic data collection program

Ground water

Availability

Stream-connected aquifers

Non-connected aquifers

Quality of water

Saline encroachment

Other

Basic data collection program

Water Resource Programs and Activities by Governmental Agencies

Local

State

Federal

(Note: The parts "Population and Economy" through above section to be written by personnel of SEO Technical Division)

Water Management and Legal Considerations (by the logical breakdown between surface and ground water, and as applicable in the basin area, the following items are to be discussed)

Water rights acquisition and administration*

Interstate compacts

Declared underground water basins

Court decress and adjudication

Transfer of place and method of use

* Breakdown of claimed rights for use of water will be furnished by Technical Div.

(Note: The above section to be written by legal staff of SEO. Much of the legal regulations, etc. set forth in the state-wide summary will be applicable to all areas of the State and need not be repeated for each basin area. This section is intended to cover only those items directly applicable to the area itself, Example: Rio Grande Compact in the Rio Grande Basin).

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United States
Department of the Interior
Geological Survey
Albuquerque, New Mexico

Southwestern Closed Basins

By

Gene C. Doty

(A contribution for incorporation in a
State Planning Report to be prepared
by the New Mexico State Engineer Office.)

Prepared in cooperation with
the New Mexico State Engineer

December 1964

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Southwestern Closed Basins

By

Gene C. Doty

Description

The Southwestern Closed Basins are outlined on figure 1. Sub-basins

Figure 1.--(caption on next page) belongs near here

within this major drainage area are Mimbres, Animas, Playas, Wamel, San Luis, and Hachita. Counties and parts of counties included within the area are Luna, Hidalgo, Grant, Sierra, and Dona Ana. The larger cities and villages in the area are Deming in Luna County; Lordsburg in Hidalgo County; and Silver City in Grant County.

Figure 1.--Drainage basins of New Mexico

Geography

The Southwestern Closed Basins in New Mexico consist of six drainage areas. The Animas Basin, 9-1 on figure 1, is 2,170 sq. mi. (square miles); the Mimbres Basin, 9-2, is 4,515 sq. mi.; the Playas Basin, 9-3, is 470 sq. mi.; the Wamel Basin, 9-4, is 170 sq. mi.; the San Luis Basin, 9-5, is 165 sq. mi.; and the Hachita Basin, 9-6, is 930 sq. mi.

In most of the basins drainage does not follow a distinct channel. Runoff from precipitation spreads across the lowlands as sheet flow and terminates in shallow playa lakes. In the Animas Basin runoff collects in Animas Creek, in upper Animas Valley, and spreads northward across lower Animas Valley in a wide indistinct channel, which terminates in broad playas at the north end of the valley. The Mimbres River follows a distinct channel, generally southward, across about half the Mimbres Basin. Flood flow in the river usually terminates as sheet flow on the flats about 8 miles east of Deming, although unusually large runoffs may reach as far south as the Mexican border. The Mimbres River and its tributaries form the best defined drainage system in the Southwestern Closed Basins.

The Southwestern Closed Basins are within the Mexican Highland section of the Basin and Range Province and is an area of sharp topographic contrast. Mountain ranges parallel intermontane valleys or bolsons; altitude ranges from about 9,000 feet on the higher peaks in the northern part of the area to about 4,000 feet in the southern part of the Mimbres bolson near the Mexican border.

All of the area within the Southwestern Closed Basins has been topographically mapped on a scale of 1:250,000 (200 foot-contour interval). About half the area has been mapped in detail on $7\frac{1}{2}$ or 15 minute quadrangle maps (fig. 2). Detailed maps are not available

Figure 2.--(caption on next page) belongs near here.

for about 60 percent of Luna County, about 30 percent of Hidalgo County and most of the southern "panhandle" section of Grant County. Topographic mapping is currently under way in all but about 14 percent of the area for which detailed maps are not available.

Figure 2.--Status of topographic mapping in New Mexico

Geology

Rocks that crop out in the Southwestern Closed Basins are of sedimentary, igneous, and metamorphic origin and range in age from Precambrian to Quaternary. No rocks of Triassic or Jurassic age crop out in the area. During late Cretaceous or early Tertiary time, intrusion and extrusion of igneous rocks was associated with early phases of orogenic folding and faulting. During Tertiary time volcanism covered most of the area with great thicknesses of flow rocks and block-faulting uplifted the mountain masses. Uplift of the mountain areas has continued through Recent time. Table 1 is a generalized stratigraphic section in the Southwestern Closed Basins and figure 3 shows

Figure 3.--(caption on next page) belongs near here.

the distribution of the consolidated rocks.

The oldest sedimentary rocks which crop out in the Southwestern Closed Basins consist chiefly of marine limestones and shales and range in age from Cambrian through Cretaceous. The older sedimentary rocks crop out mostly in the mountains. Younger sedimentary rocks within the basin range in age from Tertiary through Quaternary and crop out in the valleys and on fan slopes. The younger sedimentary rocks are unconsolidated to consolidated gravels, sands, and clays, and mixtures of these particle sizes derived from erosion of the older sedimentary and igneous rocks in the mountains.

Figure 3.--Distribution of consolidated rocks in mountain ranges of the Southwestern Closed Basins.

Igneous rocks cap, or comprise entirely, several mountains in the area and range in age and type from Precambrian granite to Quaternary basalt flows. Most of the igneous rocks are of Tertiary age and consist of extrusive and intrusive rocks of andesitic to rhyolitic composition. Quaternary basalt flows cover unconsolidated rocks of Tertiary and Quaternary age in parts of the Animas, Hachita, and Mimbres Basins.

Many mineral deposits are associated with the igneous intrusive rocks of the Southwestern Closed Basins. Base and precious metals, semiprecious gemstone, radioactive and other minerals have been prospected for in the area (Northrop, 1959). Copper was mined by Indians near Santa Rita prior to the Spanish exploration of the New Mexico territory, and today the open-pit copper mine at that locality is one of the larger mines of its type in the United States. Turquoise, also mined by the Indians, was produced from mines in Grant and Hidalgo Counties near the turn of the century, but is not presently mined in quantity. Manganese, tungsten, iron, lead, and zinc as well as gold and silver are now, or have been, mined in the Southwestern Closed Basins. Fluorite has been mined at several localities in the area during war years and some radioactive minerals have been mined in the past decade. About a dozen prospect wells have been drilled in search of petroleum, but no producing wells have been completed in the area.

The geology of the Southwestern Closed Basins has been the subject of numerous mining and general geology investigations. The most recent compilation of geologic mapping is Miscellaneous Geologic Investigations (Dane and Bachman, 1961)
Map I-344 Preliminary geologic map of the southwest part of New Mexico, published by the U.S. Geological Survey. This map also includes a list of the more detailed maps from which it was compiled. The U.S. Geological Survey also published a geologic index map of New Mexico (Boardman and others, 1956) which indicates areas included in available maps and reports. The most recent compilation of geologic information on the Southwestern Closed Basins can be found in the guidebooks of the New Mexico Geological Society and Roswell Geological Society. Information in the Eleventh Field Conference Guidebook of the Roswell Geological Society (1958) and the Fourth Field Conference Guidebook of the New Mexico Geological Society (1953) is pertinent to this area.

Soils and Vegetation

Most of the Southwestern Closed Basins are covered by light- to medium-textured soil, thickest in the bolson plains and thinnest in and near the mountains. The soil is derived from sedimentary and igneous rocks eroded from the mountains and ranges widely in mineral composition. Alkaline minerals have accumulated in the playas and caliche (secondary carbonate) firmly cements soils locally. Wind-blown sand covers some areas. The soils resource map of New Mexico (fig. 4)

Figure 4.--(caption on next page) belongs near here.

indicates the areas covered by general soil types. The lowland area of the Southwestern Closed Basins is semi-desert brush and grassland. Creosote bush, mesquite, yucca, and a variety of grasses cover this area in the lower Sonoran life zone. Woodland vegetation of pinyon, juniper, oak, and forest vegetation, mostly ponderosa pine, grow at the higher elevations in the upper Sonoran and Transition life zones. General areas of native vegetation are shown on the Vegetative type map of New Mexico (fig. 5).

Figure 5.--(caption on next page) belongs near here.

The life zones of New Mexico are shown on figure 6. Most of the

Figure 6.--(caption on next page) belongs near here.

lowland areas are in the lower Sonoran life zone; the mountain slopes and peaks include upper Sonoran and Transition life zones. Most of the arable land in the Southwestern Closed Basin area is in the lower Sonoran life zone.

Figure 4.--Soil resource map of New Mexico

Figure 5.--Vegetative-type map of New Mexico

Figure 6.--[Map showing] the life zones of New Mexico

Hydrology

Climatology

Several weather stations are maintained in the Southwestern Closed Basins; see map of weather stations and climatologic divisions (fig. 7). The growing season in most of the area is from March or

Figure 7.--(caption on next page) belongs near here.

early April through October, although April through September is commonly used for agricultural planting.* (See fig. 8.) The mean monthly

Figure 8.--(caption on next page) belongs near here.

temperature at Silver City, Deming, and Animas is shown by bargraphs on figure 9.

Figure 9.--(caption on next page) belongs near here.

The mean temperature and precipitation by months for ten weather stations is tabulated in table 2; the tabulation also includes average figures for stations in the Southwestern Mountains and Southern Desert Divisions and the evaporation and total wind movement at Florida station. Most of the precipitation is during summer months when evaporation and plant evapotranspiration is high. Data is from records of the U.S. Weather Bureau.

Figure 7.--Weather stations and climatologic divisions in New Mexico.

Figure 8.--Graphs showing average January and July temperatures and average dates of last killing frost in spring and fall.

Figure 9.--Mean monthly temperatures at selected stations.

Table 2.--Mean temperature, precipitation, evaporation, and wind movement at places in the Southwestern Closed Basins
(U.S. Weather Bureau, 1959)

Station		January		February		March		April		May		June		July		August		September		October		November		December		Annual	
		Temp. (°F)	Prec. (inches)	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.
Fort Bayard	Southwestern Mountains Division	37.6	.84	41	0.99	45.5	0.59	53.2	0.43	60.7	0.43	69.8	0.78	72.8	2.71	71.2	3.08	66.5	2.14	57.1	0.87	45.9	0.64	40.4	0.83	55.1	14.38
Mimbres Ranger Station		-	1.20	-	1.17	-	.84	-	.54	-	.49	-	.92	-	2.95	-	3.28	-	2.12	-	1.20	-	.75	-	1.11	-	16.57
Pinos Altos		-	1.26	-	1.76	-	1.13	-	.76	-	.45	-	1.13	-	3.20	-	3.96	-	2.18	-	1.13	-	.73	-	1.32	-	19.01
Silver City		-	1.08	-	1.34	-	.94	-	.55	-	.32	-	.72	-	2.54	-	3.14	-	2.22	-	1.05	-	.71	-	1.13	-	15.74
Animas	Southern Desert Division	-	.59	-	.63	-	.54	-	.26	-	.15	-	.56	-	1.80	-	2.10	-	1.22	-	.64	-	.42	-	.62	-	9.53
Deming		40.4	.44	45.2	.59	51.0	.30	59.3	.30	67.5	.28	76.8	.58	80.3	1.52	78.7	1.61	72.8	1.48	62.1	.78	49.0	.33	42.3	.59	60.5	8.80
Gage		-	.59	-	.80	-	.41	-	.29	-	.20	-	.44	-	1.39	-	1.76	-	1.56	-	.78	-	.42	-	.71	-	9.35
Hachita		40.9	.52	45.2	.70	50.7	.45	58.7	.25	66.6	.17	75.5	.43	78.4	1.74	76.7	2.25	71.5	1.14	61.3	.78	49.2	.37	42.7	.69	59.8	9.49
Hermanas		-	.64	-	.64	-	.38	-	.27	-	.23	-	.61	-	1.83	-	1.98	-	1.67	-	.72	-	.31	-	.74	-	10.02
Lordsburg		-	.77	-	.95	-	.58	-	.37	-	.14	-	.50	-	1.42	-	2.02	-	1.24	-	.69	-	.52	-	.68	-	9.88
Southwestern Mountains Division (Avg.)		-	.80	-	.73	-	.67	-	.56	-	.53	-	.79	-	2.22	-	2.74	-	1.67	-	.80	-	.52	-	.79	-	12.82
Southern Desert Division (Avg.)		-	.69	-	.70	-	.48	-	.35	-	.28	-	.62	-	1.87	-	1.90	-	1.48	-	.81	-	.43	-	.72	-	10.33

Mean Evaporation, in inches, and total wind movement, in miles, 1960
(U.S. Weather Bureau, 1960)

	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind	Evap.	Wind
Florida	2.71	1499	4.34	2619	6.74	2745	9.45	2461	12.44	2455	14.06	1418	12.24	1151	-	-	8.33	1153	6.13	1380	4.38	12.07	3.34	1060	-	-

Surface water

Records of four gaging stations on the Mimbres River drainage are summarized in table 3. Surface water gaging stations are not maintained on the ephemeral streams in the Southwestern Closed Basins. Some measurements of streamflow in the lower reaches of the Mimbres were made by W. N. White about 1930 in connection with seepage run studies (White, 1931) and some older records of streamflow are reported in that publication, but the reliability of these records is doubtful. The total annual runoff in the Southwestern Closed Basins cannot be estimated accurately because drainage is erratic through ephemeral channels. Many canyons and draws have been dammed to store runoff in stock tanks. The annual virgin flow of the Mimbres River near Faywood is estimated to be 12,110 acre feet.

Water is diverted from the Mimbres for surface flooding of fields and pastureland, and a reservoir for storage and recreation has been constructed on Bear Canyon. The streamflow is not otherwise regulated by man-made structures and infrequent freshets spread over the lowlands as sheetflow. Flood damage from the Mimbres River and ephemeral streams in the Southwestern Closed Basins consist mostly of washing out of roads and drowning of crops. Floodwater in draws and arroyos is usually heavily charged with particles ranging in size from clay to boulders; no sediment stations are maintained in the area. The chemical quality of most surface water is good (table 4); only water that stands in the playa lakes dissolve large concentrations of minerals.

1930 1940 1950 1960

Table 3.--Summary of gaging station records in Mimbres River basin

Gaging station	Drainage area (sq mi)	Average annual runoff (ac-ft)	Date	Peak discharge cfs	Peak discharge cfs/sq mi
Bear Canyon near Mimbres	14.5	579	9-29-41	123	8.48
Mimbres River near Mimbres	152	7,310	8- 2-52	1,560	10.3
Mimbres River near Faywood	460	9,480	8- 4-39	20,000	43.5
San Vicente Arroyo at Silver City	26.5	615	8-30-57	+2,920	110

Table 4.--Analysis of water sample from Mimbres River at Faywood gaging station, Luna County, N. Mex.

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

Date of collection	5-24-55					
Silica (SiO_2)	52					
Iron (Fe), dissolved 1/	-					
Iron (Fe), total	-					
Manganese (Mn), dissolved 1/	-					
Manganese (Mn), total	-					
Calcium (Ca)	71					
Magnesium (Mg)	20					
Sodium (Na)	40					
Potassium (K)						
Bicarbonate (HCO_3)	292					
Carbonate (CO_3)	0					
Sulfate (SO_4)	75					
Chloride (Cl)	17					
Fluoride (F)	.8					
Nitrate (NO_3)	4.0					
Dissolved solids						
Sum	424					
Residue on evaporation at 180°C	434					
Hardness as $CaCO_3$	259					
Non-carbonate	20					
Specific conductance (micromhos at 25°C)	631					
pH	7.8					
Color	-					

1/In solution at time of analysis.

Ground water

Most of the usable ground water in the Southwestern Closed Basins is contained in the Tertiary and Quaternary bolson deposits, although a few wells of small to medium yield obtain water from older limestone rocks near Silver City. Stock and domestic wells and springs also derive water from older rocks in the mountainous areas. Large quantities of water for irrigation, municipal, and industrial use are obtained from the bolson deposits. The bolson deposits consist of clay, sand, gravel, and mixtures of these particle sizes in irregular beds and lenses. The bolson deposits also include interbedded volcanic rocks locally. Thickness of the bolson deposits is more than 1,000 feet in places. Figure 10 shows areas in which small, moderate, and large supplies of

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Figure 10 (caption on next page) belongs near here.

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ground water are obtained from wells in New Mexico. The water in the bolson deposits is derived from precipitation on the drainage area; most recharge occurs along permeable stream beds such as the Mimbres River, and on the upland slopes of alluvial fans where coarse particles permit water to infiltrate easily. Runoff that reaches playas penetrates the underlying clay and silt beds very slowly and most of the water is evaporated. Ground water in most of the basins is moving toward a point of discharge, usually springs or seeps along playa lakes, but some ground water in deeply buried rocks may be stagnated.

Figure 10.--General availability of relatively fresh ground water in New Mexico

The amount of water in storage in the bolson deposits cannot be estimated accurately because the thickness of the deposits is not known and the deposits are hetergeneous mixtures of clay, sand, and gravel that range widely in storage capacity. The area of the bolson deposits in the Southwestern Closed Basins is approximately 5,600 square miles or 3,584,000 acres. The volume of water in storage is about 179,200,000 acre feet, if it is assumed that an average of 250 feet of saturated material underlies this area and that the average porosity of the material is 0.2 of the volume. Not all this volume of water, of course, is available to wells. Assuming an average annual precipitation of 10 inches per year, recharge to the ground water supply may be on the order of 1 percent of the precipitation over the total drainage area (8,420 square miles), or about 45,000 acre feet of water per year. The amount of water in storage in the older rocks is not estimated because of lack of information and the relatively small amount of water obtained from them.

Water samples from selected wells in the Mimbres Basin and Animas Basin, are collected annually for chemical analysis. Ground water is of good quality in most of the Southwestern Closed Basins (figs. 11 and 12). Most of the water contains less than 1,000 ppm

Figure 11 (caption on next page) belongs near here.

Figure 12 (caption on next page) belongs near here.

(parts per million) total dissolved solids, but may contain more fluoride than is recommended for domestic use. The general quality of water may be inferred from the maps and the tabulation of chemical analyses. (See table 5.) Water from mines, and from wells near mines, is frequently of poor quality; highly mineralized water has been obtained from a few deep test wells in southeastern Luna County. The quality of water at depth in the bolson deposits may deteriorate to the extent that water quality, not economic pumping lift, will be the limiting factor in utilization of the water resources of the area. Little data is available on the quality of water at depths greater than 1,000 feet in the bolson deposits.

Table 5.--Analyses of water from wells in the

Southwestern Closed Basins

Analyses by Geological Survey, United States Department of the Interior

(parts per million)

Location (Township, Range, Section)	20S., 5W. 31	24S., 7W. 9	24S., 9W. 6	24S., 11W. 12	24S., 17W. 11	24S., 20W. 1
Date of collection	5-9-61	8-12-57	9-12-44	8-9-62	5-20-55	3- -48
Silica (SiO_2)	81	83		22	31	
Iron (Fe), dissolved 1/						
Iron (Fe), total						
Manganese (Mn), dissolved 1/						
Manganese (Mn), total						
Calcium (Ca)	26	14	29	36	30	16
Magnesium (Mg)	6.6	4.3	7.7	6.6	13	4.4
Sodium (Na)	67	115	37	278	45	112
Potassium (K)						
Bicarbonate (HCO_3)	193	246	182	122	179	232
Carbonate (CO_3)	13	0		4	0	0
Sulfate (SO_4)	27	50	19	568	57	86
Chloride (Cl)	12	16	9	15	11	14
Fluoride (F)	1.3	4.4	.6	.8	1.2	-
Nitrate (NO_3)	11	19	2.0	.6	3.1	2.8
Dissolved solids						
Sum	340	427	194	992	279	350
Residue on evaporation at 180°C	376	435		981		
Hardness as $CaCO_3$	92	52	104	117		58
Non-carbonate	0	0	0	10		0
Specific conductance (micromhos at 25°C)	447	577	346	1,430		580
pH	8.6	8.1		8.3		-
Color						-

1/In solution at time of analysis.

Table 5.--Analyses of water from wells in the Southwestern Closed Basins-Continued

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

Location (Township, Range, Section)	24S.,9W. 1	27S.,19W. 19	28S.,7W. 20	30S.,15W. 14	30S.,16W. 14	32S., 16W. 30
Date of collection	7-19-54	5-26-48	7-19-54	12-1-55	9-21-53	11-23-53
Silica (SiO_2)	74	43	63		62	38
Iron (Fe), dissolved 1/						
Iron (Fe), total						
Manganese (Mn), dissolved 1/						
Manganese (Mn), total						
Calcium (Ca)	24	24	3.2		20	41
Magnesium (Mg)	13	5.9	1.0		3.4	6.4
Sodium (Na)	42	57	462	147	114	19
Potassium (K)						
Bicarbonate (HCO_3)	207	168	423	242	282	129
Carbonate (CO_3)	0	0	41	0	0	0
Sulfate (SO_4)	17	55	251	316	49	28
Chloride (Cl)	10	6	220	28	12	21
Fluoride (F)	1.2	.8	11	2.2	3.6	.6
Nitrate (NO_3)	1.3	2.9	1.6	3.2	3.3	5.9
Dissolved solids						
Sum	284	277	1,260	714	406	223
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	114	84	12	255	64	129
Non-carbonate	0	0	0	0	0	24
Specific conductance (micromhos at 25°C)	384	388	1,970	1,060	588	348
pH		7.8		7.4		
Color						

1/ In solution at time of analysis.

Figure 11.--General occurrence of saline ground water in New Mexico

Figure 12.--General quality of shallow ground water in New Mexico

Most of the area of the Southwestern Closed Basins was included in the ground water studies made about 1910 and published as U.S. Geological Survey Water-Supply Paper 422 and Bulletin 618. Reports of more recent investigations include State Engineer Technical Reports 11 (Meeder, 1957) (Animas Basin), 15 (Doty, 1960) (Playas Basin), and 26 (Trauger and Hennick, 1962) (Hachita Basin); studies currently under way by the U.S. Geological Survey, but not yet published, include Grant County and southern Luna County. Figure 13 shows

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Figure 13 (caption on next page) belongs near here.

---

the areas in New Mexico in which ground-water studies have been made.

The areas in which periodic measurements of water levels in observation wells are made are shown on figure 14. The measurements of

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Figure 14 (caption on next page) belongs near here.

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water level are reported in the series "Water levels and artesian pressures in wells in the United States, southwestern states," by the U.S. Geological Survey and in the Technical Report series, through 1960, and unnumbered basic data reports, after 1960, by the New Mexico State Engineer Office.

Figures 15 and 16 show the decline of ground-water levels in the

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Figure 15 (caption on next page) belongs near here.

Figure 16 (caption on next page) belongs near here.

Animas basin for the period 1948-60 and in the Mimbres basin for the period 1940-60, respectively.

Figure 13.--Areas in New Mexico in which ground-water studies have been made.

Figure 14.--Areas of observation of water-level fluctation in New Mexico.

Figure 15.--Decline of ground-water level in the Animas basin, Hidalgo County, New Mexico, for the period 1948-60.

Figure 16.--Decline of ground-water level in the Mimbres basin, Luna County, New Mexico, for the period 1940-60.

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——, 1960, Climatological data, New Mexico: v. 64, no. 13, 1961

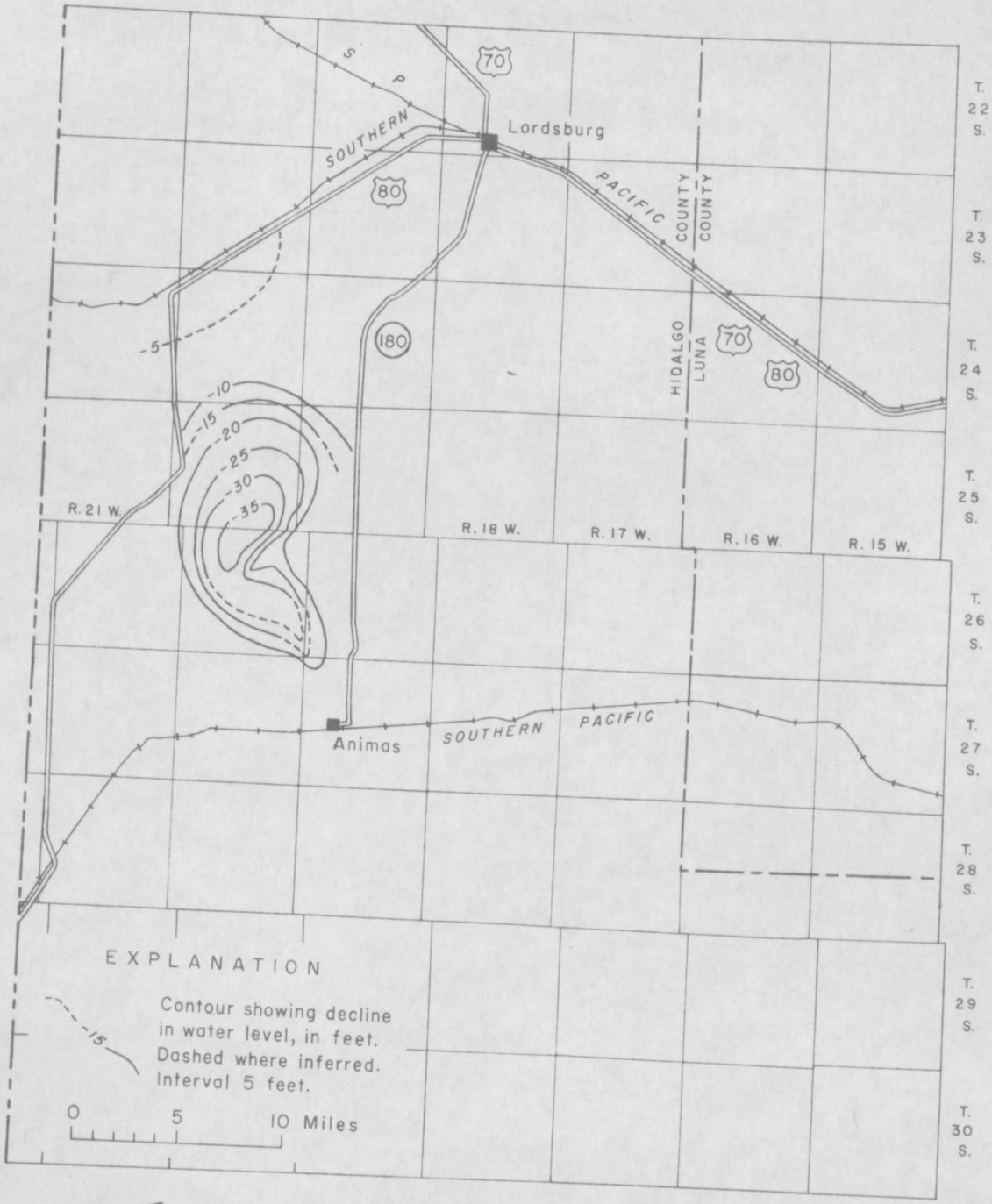

Figure ~~92~~ 15.--Decline of ground-water level in the Animas ~~Valley~~ basin, Hidalgo County, New Mexico, for the period 1948-60.

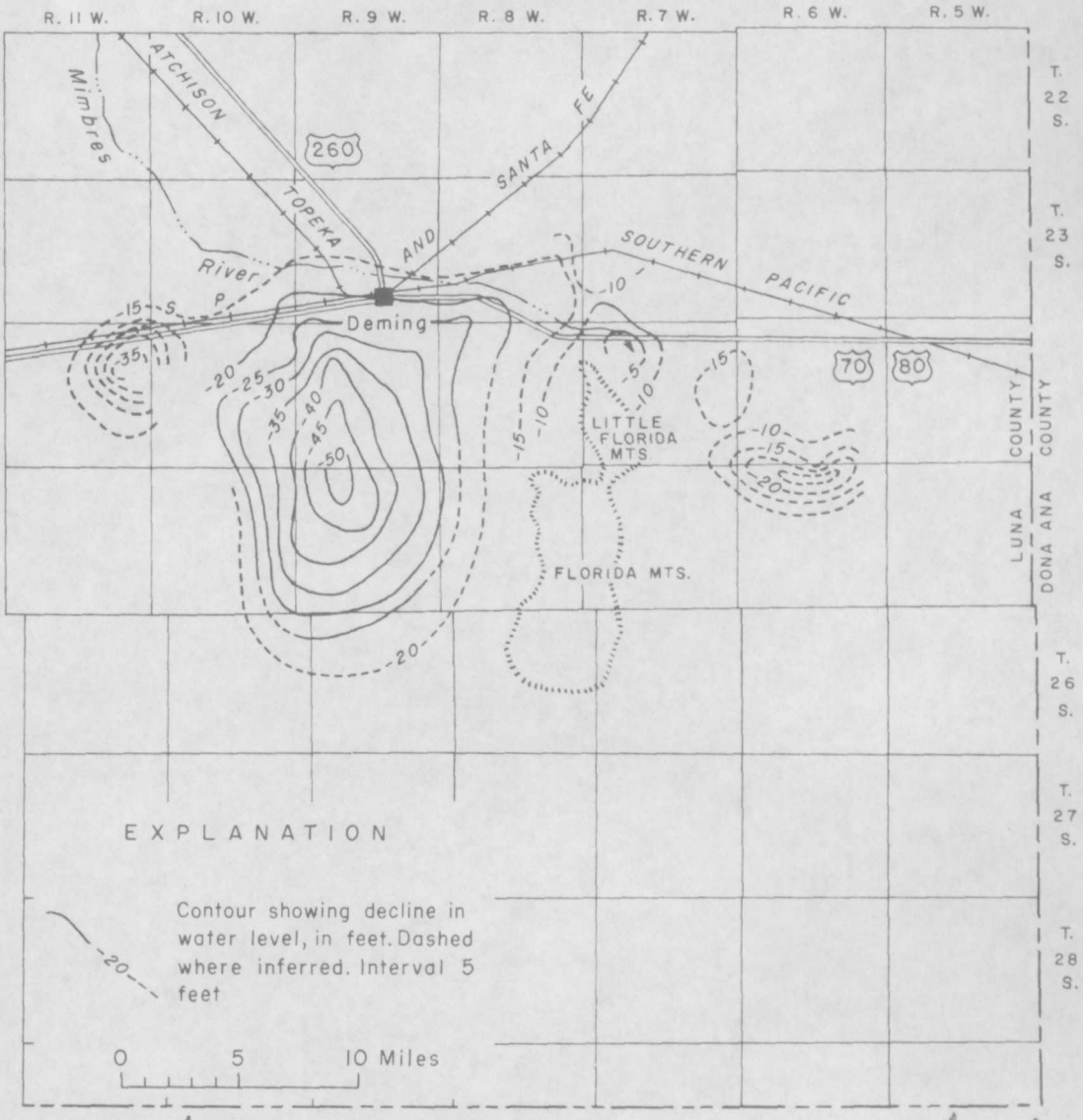

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Figure 91.--Decline of ground-water level in the Mimbres ~~Valley~~ basin, Luna County, New Mexico, for the period 1940-60.

Table 1.-- Generalized stratigraphic section in the Southwestern Closed Basins, New Mexico

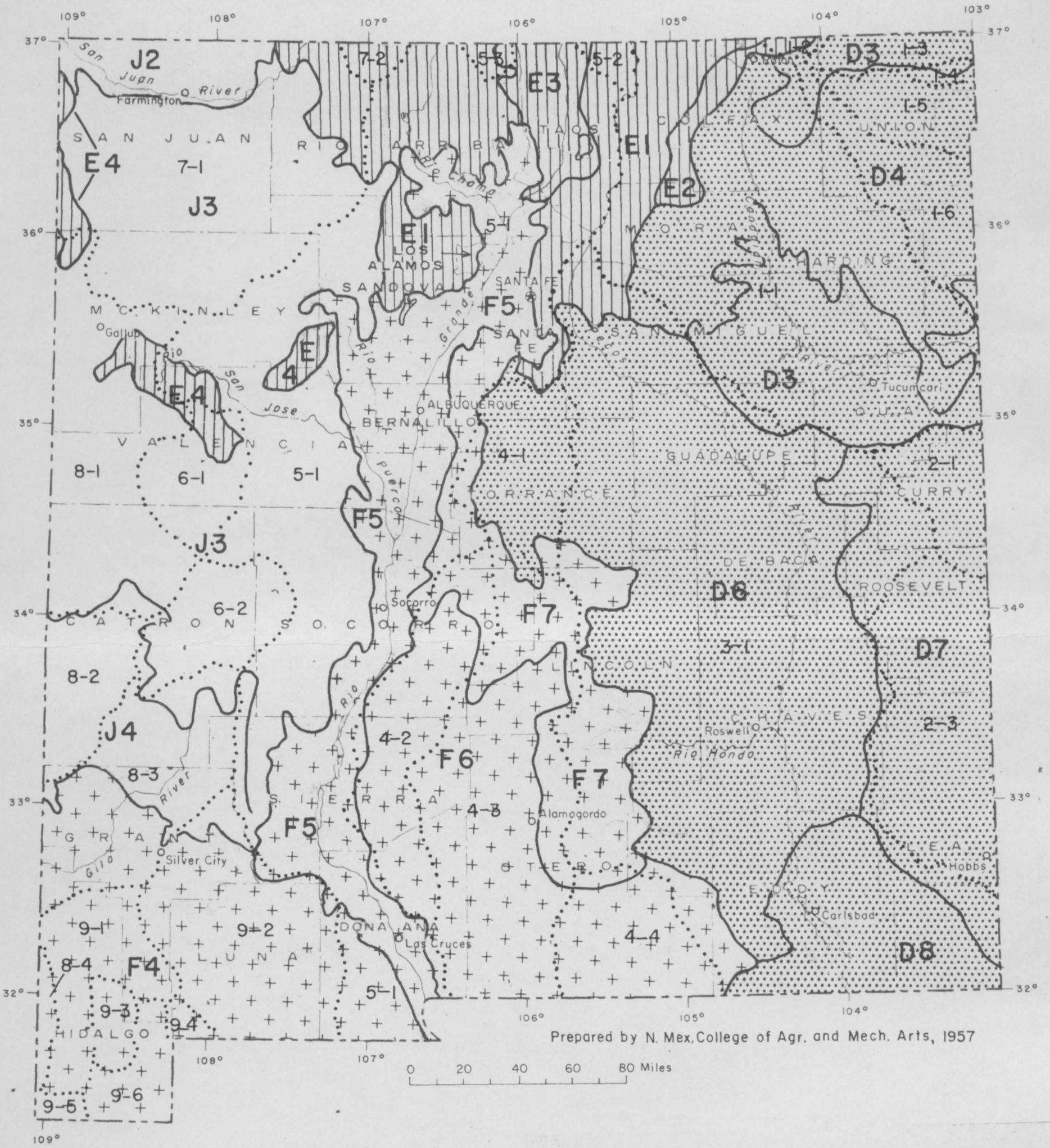
System	Stratigraphic Unit	Thickness (feet)	Distribution	Physical properties	Water-bearing characteristics
Quaternary	Stream channel alluvium and wind-blown deposits.	0 to 100±	In all major valleys and in most minor tributaries.	Unconsolidated clay, silt, sand, and gravel; generally poorly sorted; varied composition.	Poor to excellent, depending on the coarseness and degree of sorting.
	Basalt	0 to 100±	In Animas, Hachita, and Mimbres Valleys and West Potrillo Mountains.	Dense to highly scoriaceous and broken flows of basalt.	Unknown but could produce large quantities of water under favorable circumstances.
Quaternary and Tertiary	Bolson deposits, fan and terrace gravels, older alluvial material, Santa Fe Group, Gila conglomerate and local interbeds of rhyolite and basalt	0 to several thousand	Intermontane basins and fan slopes.	Unconsolidated to locally, well-consolidated beds and lenses of clay, silt, sand, and gravel, and mixtures of these particle sizes.	Poor to excellent; yields range up to 2,000 gpm in some wells in southern Luna County. The bolson deposits are the major aquifer in the Southwestern Closed Basin area.
Tertiary	Igneous rocks, intrusive and extrusive rocks of varied composition including Datil and Rubio Peak Formations	Ranges widely to several thousand. Maximum estimated 8,000 to 10,000	Mountains and hills throughout the area.	Flows and intrusive rocks ranging from basaltic to rhyolitic composition; dense to tuffaceous flow rocks including agglomerates, brecciated pyroclastics, and welded tuffs.	Generally poor; yields small quantities of water to stock wells and springs; fractured flows may transmit large quantities of water under favorable circumstances.

Table 1.--Generalized stratigraphic section in the Southwestern Closed Basins, New Mexico - Continued

System	Stratigraphic Unit	Thickness (feet)	Distribution	Physical properties	Water-bearing characteristics
Tertiary - Continued - - - - - -	Fanglomerate and limestone conglomerate	100±	Mountains and hills in Cooks Range, Florida and Big Hatchet Mountains.	Conglomerates and beds of clay, silt, sand, and gravel commonly well-indurated; may be interbedded with volcanic rocks.	Unknown, but probably poor.
Tertiary-Cretaceous	Igneous rocks, intrusive and extrusive rocks of andesite to rhyolite composition	Ranges widely	Mountains and hills in Pyramid and Little Hatchet Mountains and Coyote Hills.	Syenodiorite, granodiorite and granite sills and laccoliths, andesite-latite-rhyolite flows. Dense to tuffaceous.	Unknown, but probably poor.
Cretaceous	Undifferentiated	Ranges to 15,000±	Cooks Range, Florida, Animas, Peloncillo, Hatchet and Pinos Altos Mountains, Coyote Hills and Sierra Rica.	Sandstone, quartzite, shale, and limestone.	Unknown.
Permian Pennsylvanian Mississippian	Undifferentiated	Ranges to 9,000±	Black Range, Cooks Range, Florida, Tres Hermanas, Cedar, Hatchet, Animas, and Pinos Altos, Peloncillo Mountains, and Sierra Rica.	Limestone, dolomite, shale, and sandstone.	Generally unknown and suspected to be poor; however, limestone near Silver City yields as much as 150 gpm and yields of 500 gpm from fractured limestone may be possible in some areas.
Devonian	Percha Formation	300±	Pinos Altos, Florida, Cedar, Hatchet, and Peloncillo Mountains.	Shale and shaly limestone.	Poor.
Silurian, Ordovician, and Cambrian	Undifferentiated	1,500±	Black Range, Cooks Range, Florida, Pinos Altos, Victorio, Cedar, Hatchet, Animas, and Peloncillo Mountains and Sierra Rica.	Cherty dolomite, dolomitic limestone, massive to thin-bedded limestone, glauconitic and hematitic sandstone and quartzite.	Large yields possible from fractured rocks in some areas; wells near Silver City produce 400 gpm from Paleozoic limestone.

Table 1.--Generalized stratigraphic section in the Southwestern Closed Basins, New Mexico - Concluded

System	Stratigraphic Unit	Thickness (feet)	Distribution	Physical properties	Water-bearing characteristics
Precambrian	Granite, gneiss, schist and quartzite	-	Cooks Range, Florida, Burro, Hatchet, Animas, Peloncillo, and Cobre Mountains.	Mostly dense, hard crystalline rock. Locally weathered, jointed, and fractured.	Poor. Yields generally less than 5 gpm from deeply weathered zones, fractures, and joints.



D_3 Generally shallow soils in steeply rolling and rough broken areas. Moderately deep and deep soils in valley bottoms and alluvial fans.

D_4 Largely moderately deep to deep, medium to heavy-textured soils interspersed with some areas of shallow soils; generally gently rolling topography.

D_6 Dominantly moderately deep to deep, medium-textured soils with rolling topography, interspersed with areas of shallow soils and deep sandy soils with dune-like topography.

D_7 Generally loose sandy soils with dune-like topography east of Pecos river, interspersed with areas of shallow to moderately deep, medium to heavy-textured soils west of Pecos river.

D_8 Similar to D-7, east of Pecos river, interspersed with areas of shallow to moderately deep, medium-textured soils west of Pecos river.

E_1, E_2, E_3, E_4 Largely shallow to moderately deep, light to medium-textured soils with rolling to mountainous topography. Generally shallow soils on escarpments and mountainous areas.

2-1 Outline of river basins

F_4 Generally light to medium-textured, deep and shallow soils with rolling topography, interspersed with low mountains. Dominantly shallow soils and rock outcrops in mountainous areas.

F_5 Large areas of light to medium-textured, shallow to moderately deep soils with gentle to moderate slopes.

F_6 Mesas, benchlands, and mountain slopes. Largely light to medium-textured, shallow to moderately deep soils on mesas and benchlands, and gravelly shallow soils on mountain slopes and foothills.

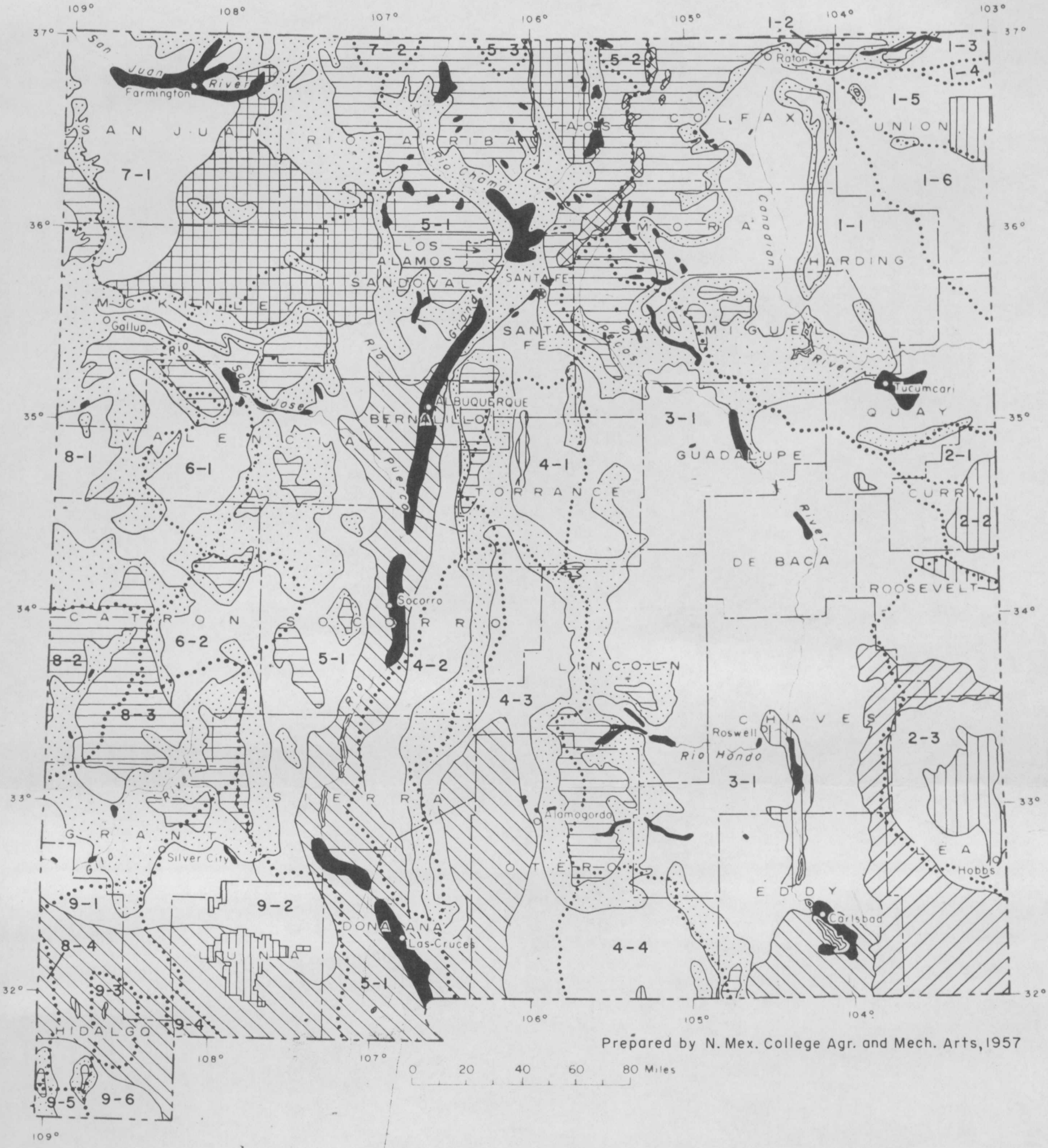
F_7 Largely mountain ranges and foothill slopes. Dominantly medium-textured soils on mountain slopes, and moderately deep to deep soils on foothill slopes.

J_2 Dominantly medium-textured, shallow soils on steep slopes. Medium-textured moderately deep soils on sloping plains, and dissected mesas; and medium to heavy-textured deep soils in valleys.

J_3 Largely medium-textured, moderately deep to shallow soils interspersed with areas of light-textured soils. Generally rolling topography with steep slopes in mountainous areas.

J_4 Generally mountainous shallow soils interspersed with rock outcrops and small areas of moderately deep soils. Generally mountainous topography.

Figure 5. --- Soils resource map of New Mexico



Prepared by N. Mex. College Agr. and Mech. Arts, 1957

EXPLANATION

1 Semi-desert brush

2 Grassland

Shinnery

Big sagebrush

3 Woodland

4 Forest

Tundra

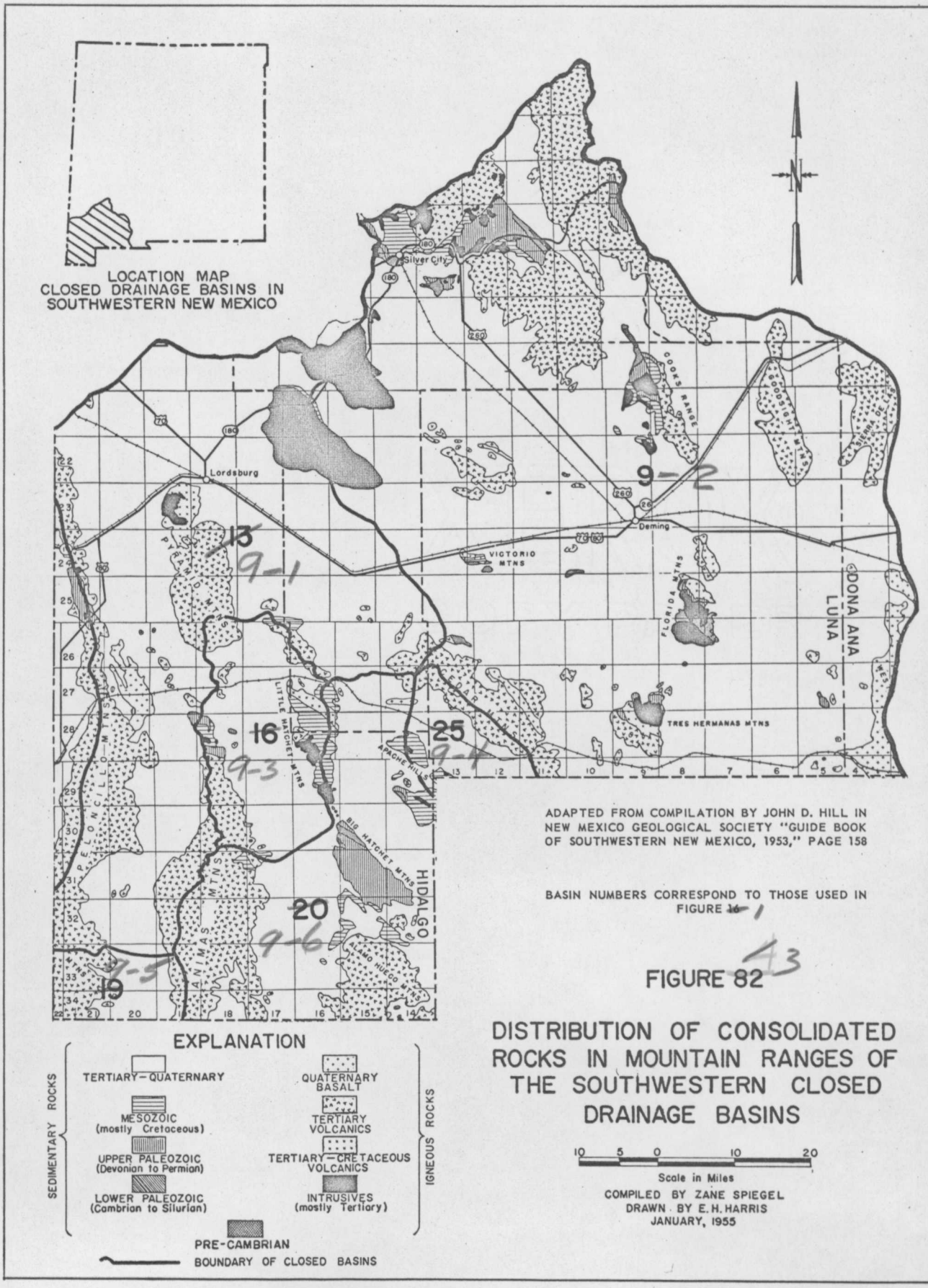
Irrigated lands with water sources from surface water only or from surface water supplemented by pumping of ground water

Irrigated lands with water source entirely from pumped or artesian ground water

Lakes and reservoirs

2-1 Outline of river basins

Figure 5.-- Vegetative type map of New Mexico



ADAPTED FROM COMPILATION BY JOHN D. HILL IN NEW MEXICO GEOLOGICAL SOCIETY "GUIDE BOOK OF SOUTHWESTERN NEW MEXICO, 1953," PAGE 158

BASIN NUMBERS CORRESPOND TO THOSE USED IN FIGURE ~~16~~ 1

FIGURE ~~42~~ 43

DISTRIBUTION OF CONSOLIDATED ROCKS IN MOUNTAIN RANGES OF THE SOUTHWESTERN CLOSED DRAINAGE BASINS

10 5 0 10 20

Scale in Miles

COMPILED BY ZANE SPIEGEL
DRAWN BY E. H. HARRIS
JANUARY, 1955

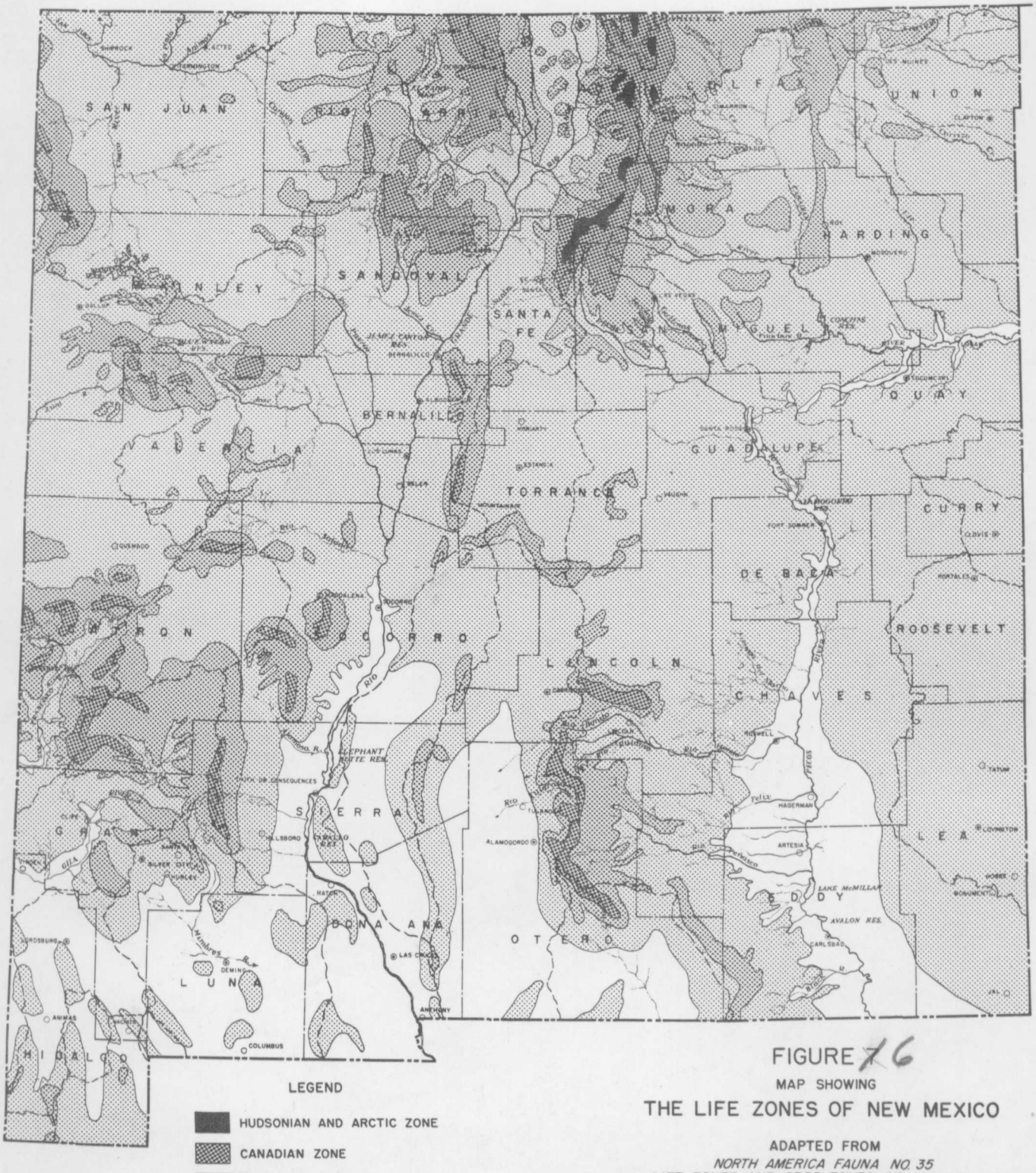


FIGURE 16

MAP SHOWING

THE LIFE ZONES OF NEW MEXICO

ADAPTED FROM

NORTH AMERICA FAUNA NO. 35

LIFE ZONES AND CROP ZONES OF NEW MEXICO

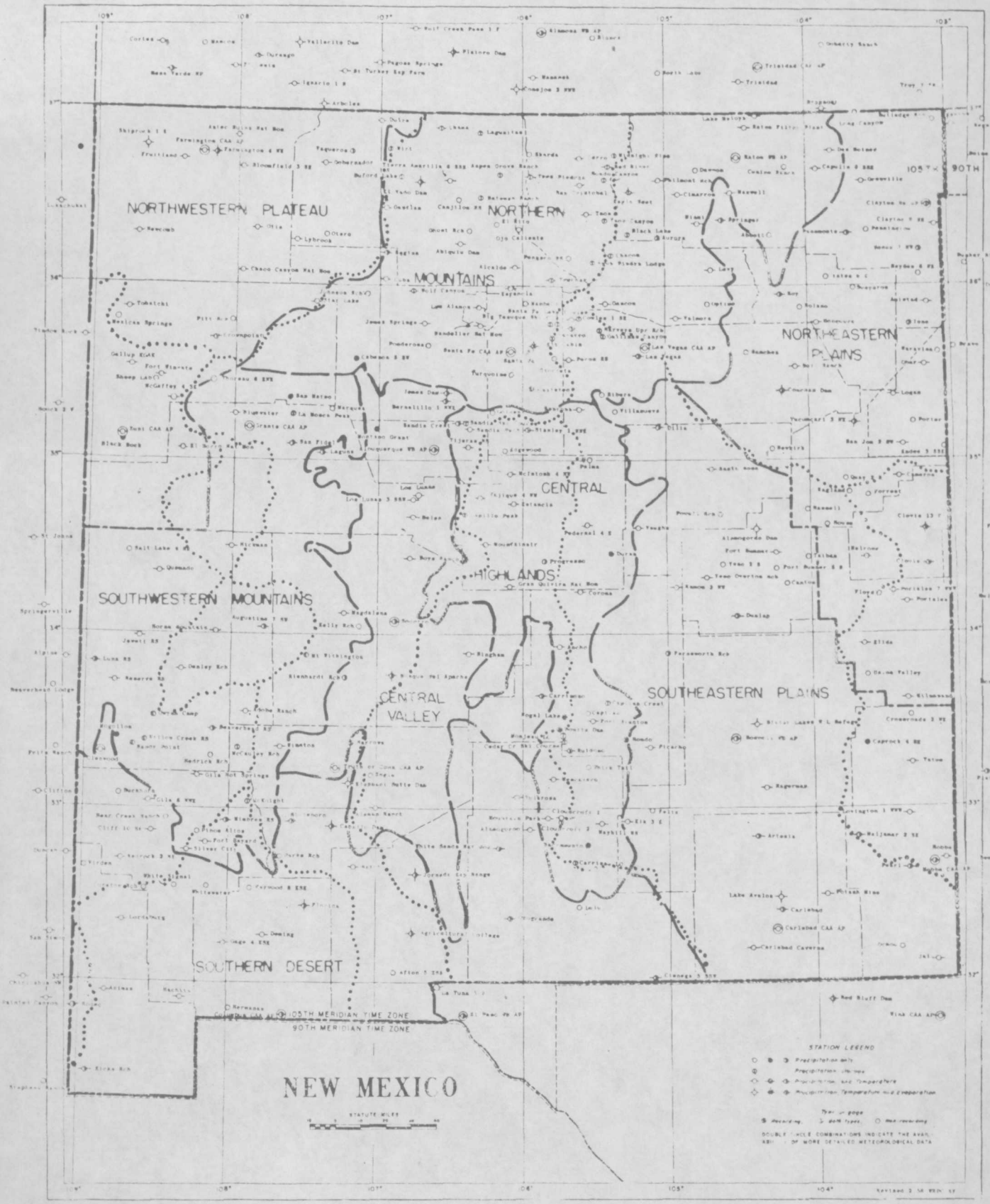
VERNON BAILEY, 1913, U.S. DEPARTMENT OF AGRICULTURE

DRAWN BY M.B. HUEY

JULY 1956

10 0 10 20 30 40 50 60

SCALE IN MILES



U.S. GOVERNMENT PRINTING OFFICE: 1959 O - 533379

Figure 3 Weather stations and Climatologic divisions ~~Meteorological stations~~ in New Mexico

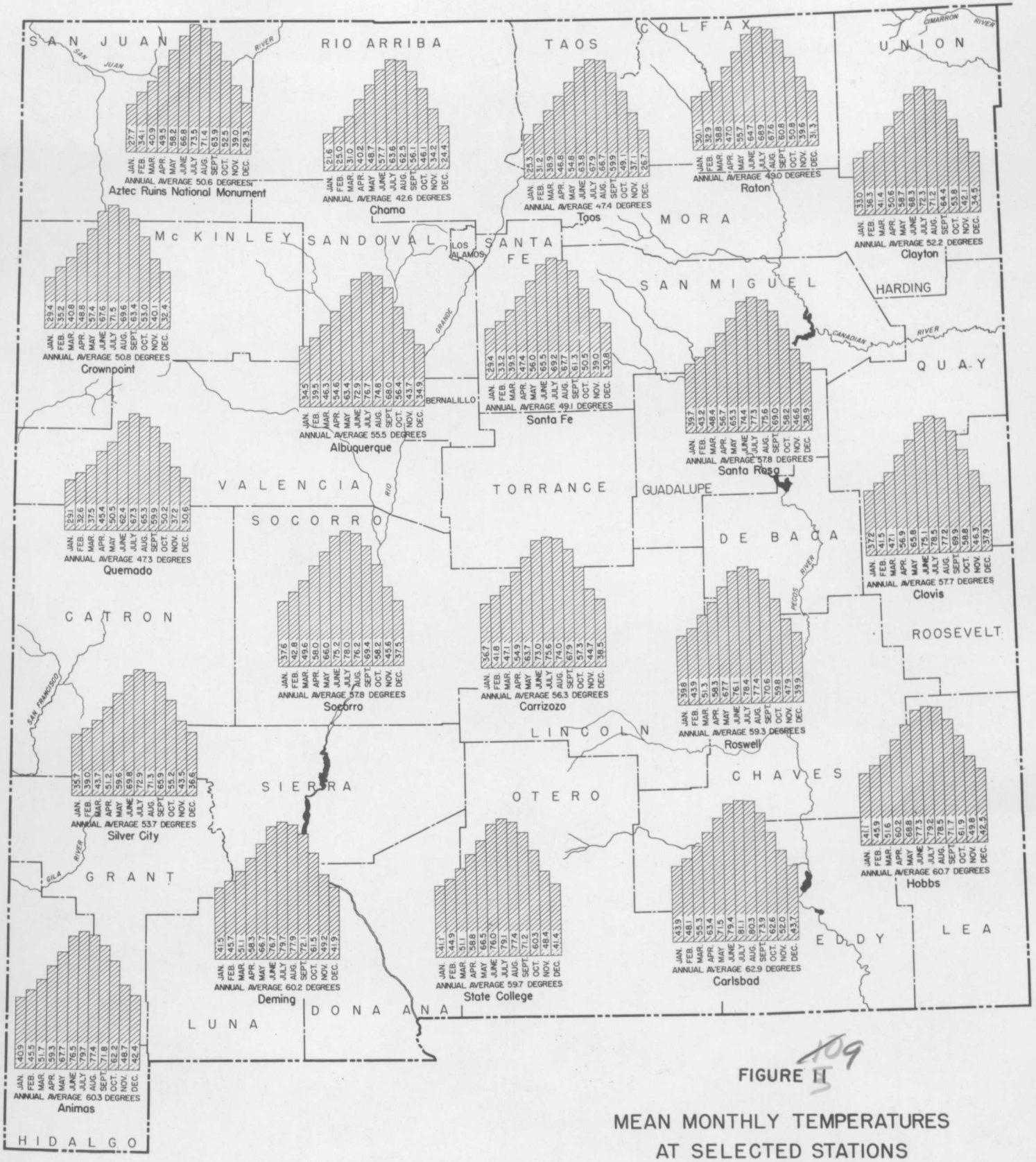


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FIGURE 11

MEAN MONTHLY TEMPERATURES AT SELECTED STATIONS

UNITS = DEGREES FAHRENHEIT

NOTE:
DATA OBTAINED FROM U.S. WEATHER BUREAU RECORDS.

COMPILED BY L.B. SEWARD
DRAWN BY E.H. HARRIS
MAY 1955

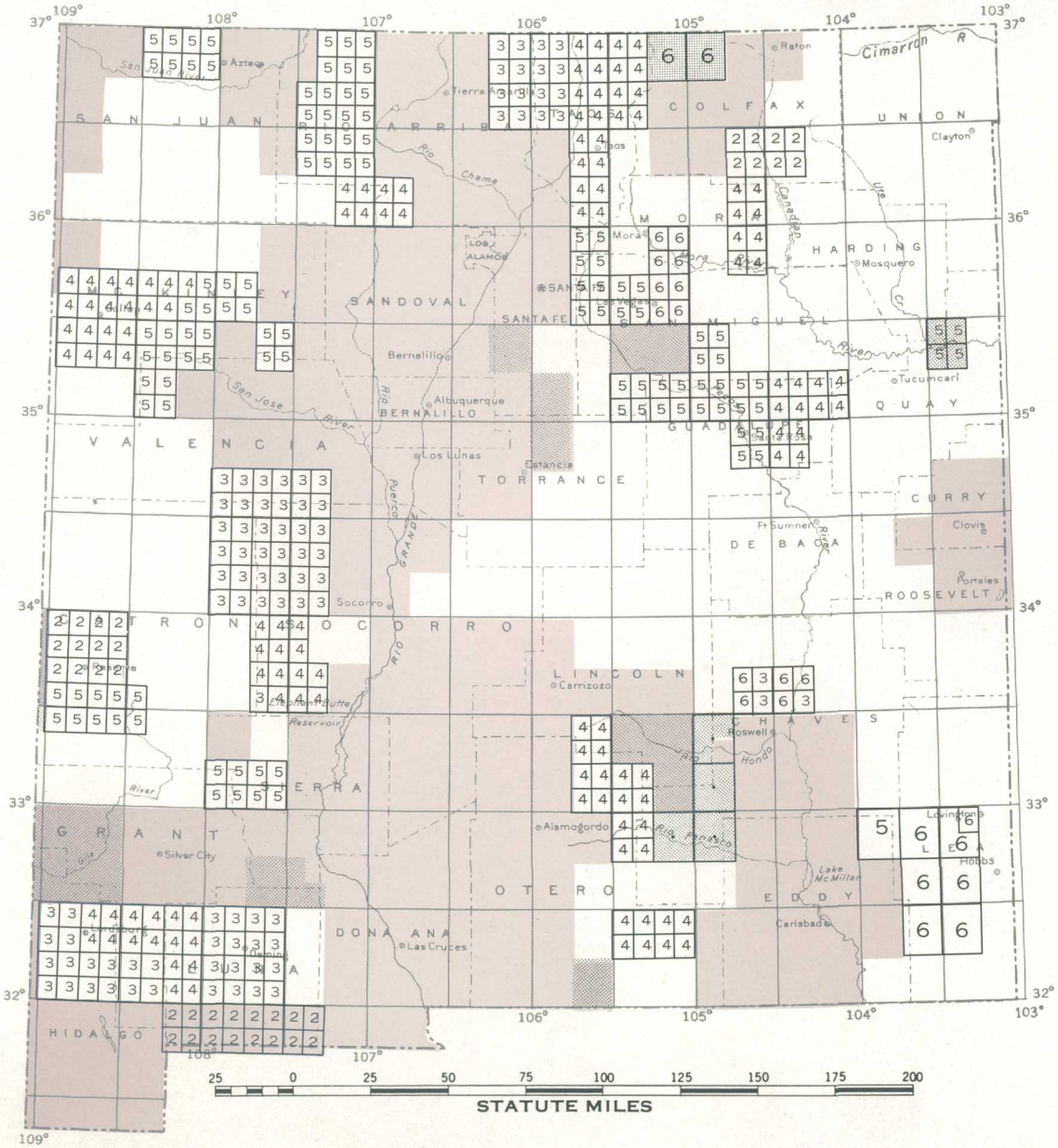
21

10 0 10 20 40 60
SCALE IN MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

NEW MEXICO

TOPOGRAPHIC DIVISON
ROCKY MOUNTAIN AREA
DENVER, COLORADO
OCTOBER 1, 1964



ADVANCE MATERIAL AVAILABLE
FROM CURRENT TOPOGRAPHIC
MAPPING QUARTERLY EDITION

2 Aerial photography completed. Information available from U.S. Geological Survey, Topographic Division, Federal Center, Bldg. 25, Denver, Colorado, 80225, or Map Information Office, U.S. Geological Survey, Washington, D.C., 20242.

3 Basic horizontal and vertical control surveys completed. Descriptions and unadjusted coordinates and/or elevations are available. Price 50 cents for each 15-minute quadrangle horizontal or vertical control list. See notes.

P 4 Prints of manuscripts compiled from aerial photographs are available at 50 cents each. Contours are shown in areas suitable for stereocontouring. Letter "P" indicates quadrangles on which contouring is not complete and which will require fieldwork to complete the contouring. (If shaded, see explanation below.)

5 Field mapping and checking completed. One-color advance prints (without names) available for 50 cents each. (If shaded, see explanation below.)

6 Final drafting completed. Partially-edited one-color advance prints (with names) available for 50 cents each. (If shaded, see explanation below.)

. Maps published since latest edition of Index to Topographic Mapping— May, 1964. See statement below regarding published maps. (If shaded, see explanation below.)

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NOTES

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2. In ordering materials or requesting information, mark the area of interest on this index and forward it with your order. A new copy of the index will be returned to you for future use.

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Published 7½′ or 15′ Quadrangles

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[Fig 27]

Figure 27.--Status of topographic mapping in New Mexico

~~RIO GRANDE BASIN — Continued~~

~~Hydrology — Continued~~

~~Ground waters — Continued~~

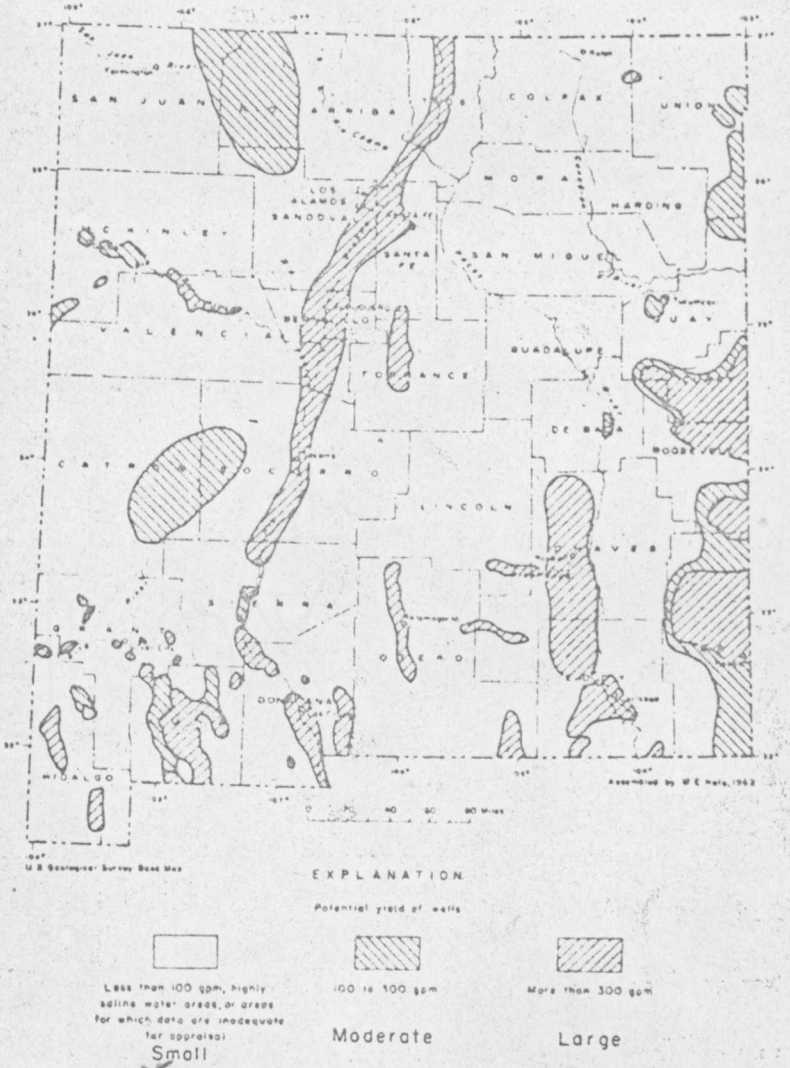


Figure 10.--General availability of relatively fresh ground water in New Mexico

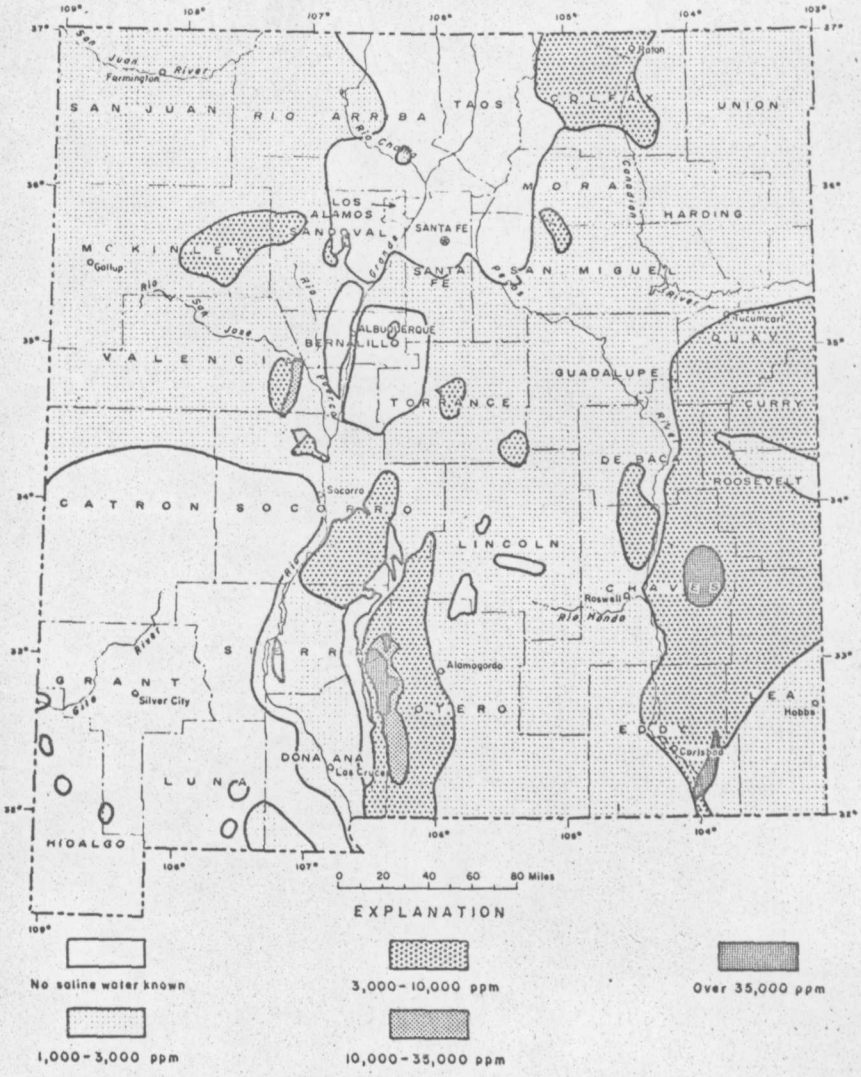


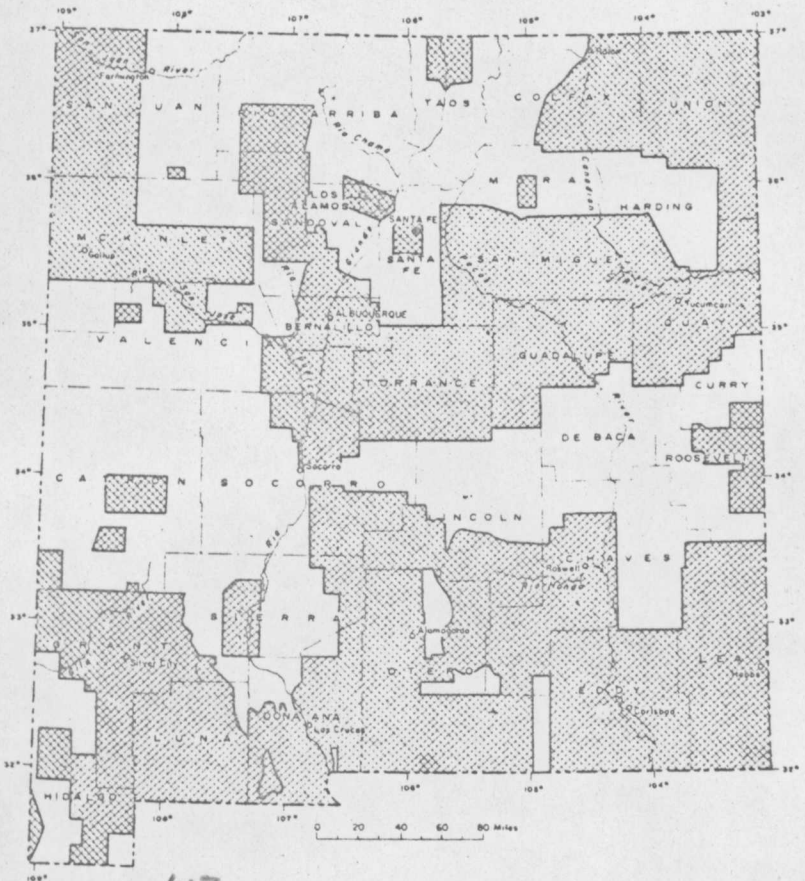
Figure 11.- General occurrence of saline ground water in New Mexico

ister copy.

Hydrology - Continued

Groundwater - Continued

Figure 17.—General quality of shallow ground waters in shallow wells in New Mexico



#13

Figure 11.--Areas in New Mexico in which groundwater studies have been made.

Figure 12.--Areas of observation of water-level fluctuation in New Mexico

Will be revised and checked by J. Rowzee.

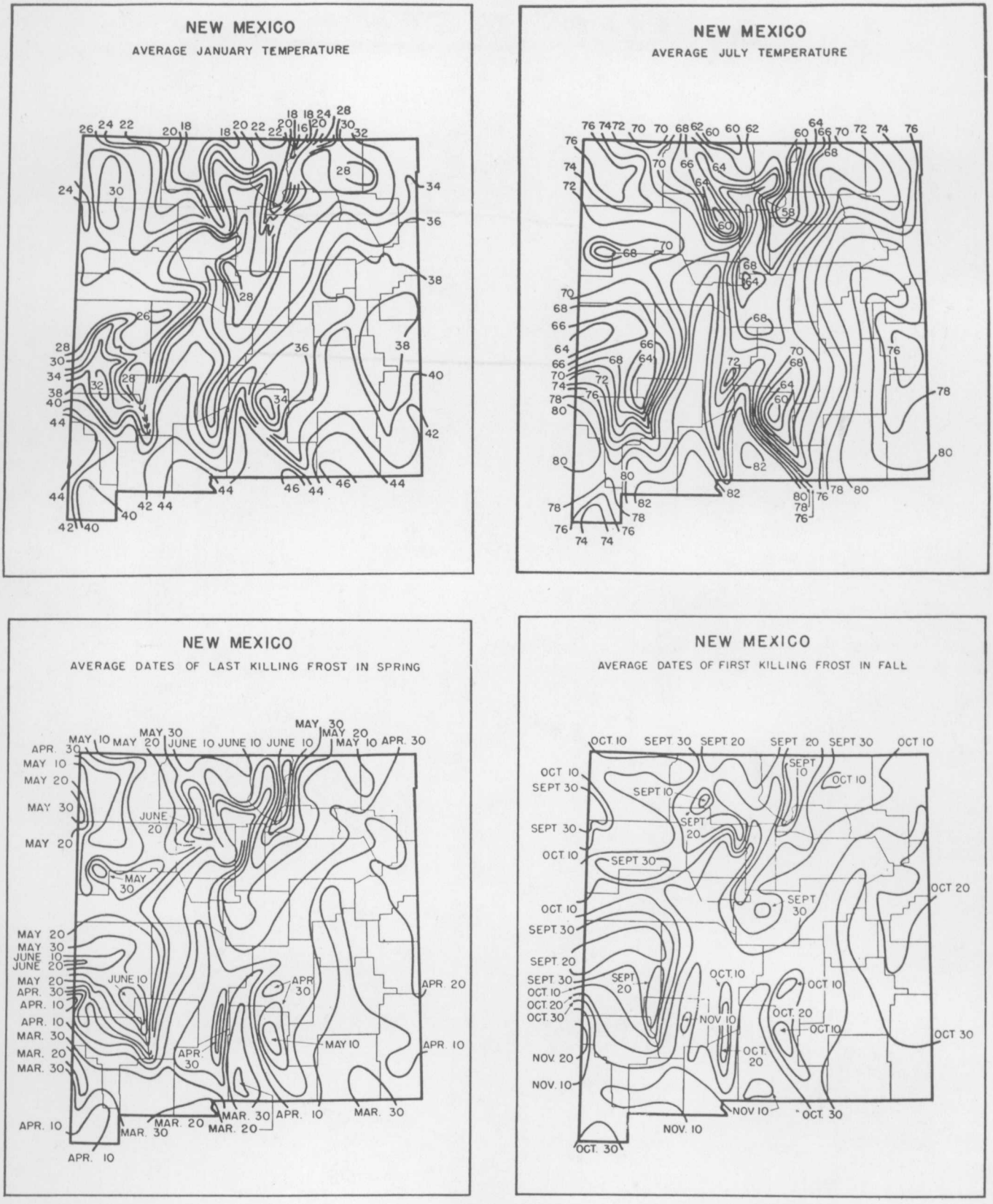
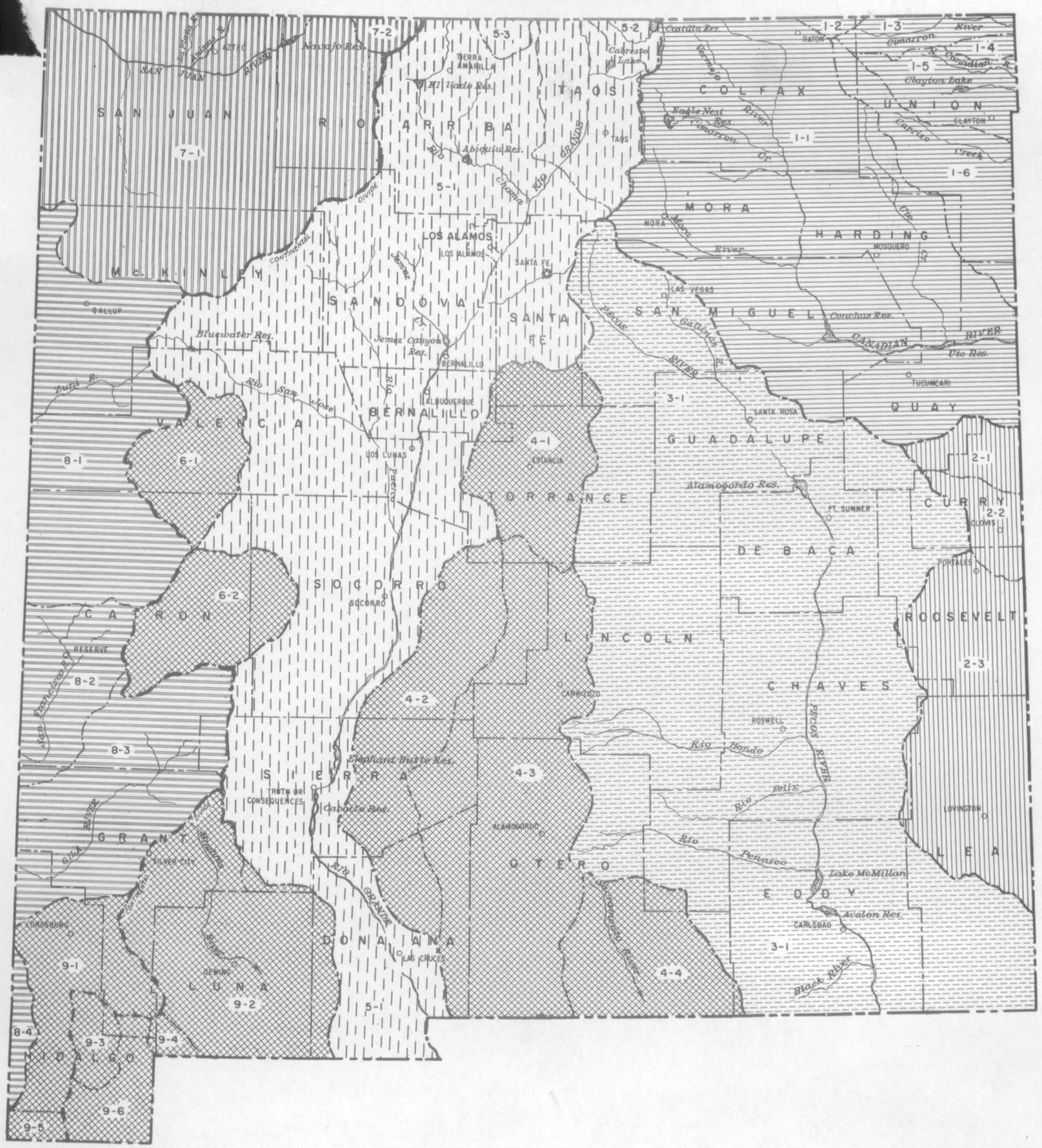


FIGURE 12

GRAPHS SHOWING AVERAGE JANUARY AND JULY TEMPERATURES AND AVERAGE DATES OF LAST KILLING FROST IN SPRING AND FIRST KILLING FROST IN FALL
(From *Climate and Man - Yearbook of Agriculture*, 1941)



BASIN INDEX

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- 1-1, CANADIAN RIVER
- 1-2, PURGATOIRE RIVER
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- 9-2, MIMBRES BASIN
- 9-3, PLAYAS BASIN
- 9-4, WAMEL BASIN
- 9-5, SAN LUIS BASIN
- 9-6, HACHITA BASIN

0 5 10 20 30 40 50 60 70 80 90 100

SCALE IN MILES

FIGURE 1

DRAINAGE BASINS OF NEW MEXICO