

5-24-1955

# Hydrologic Data Collection Program for New Mexico

Ralph L. Strother

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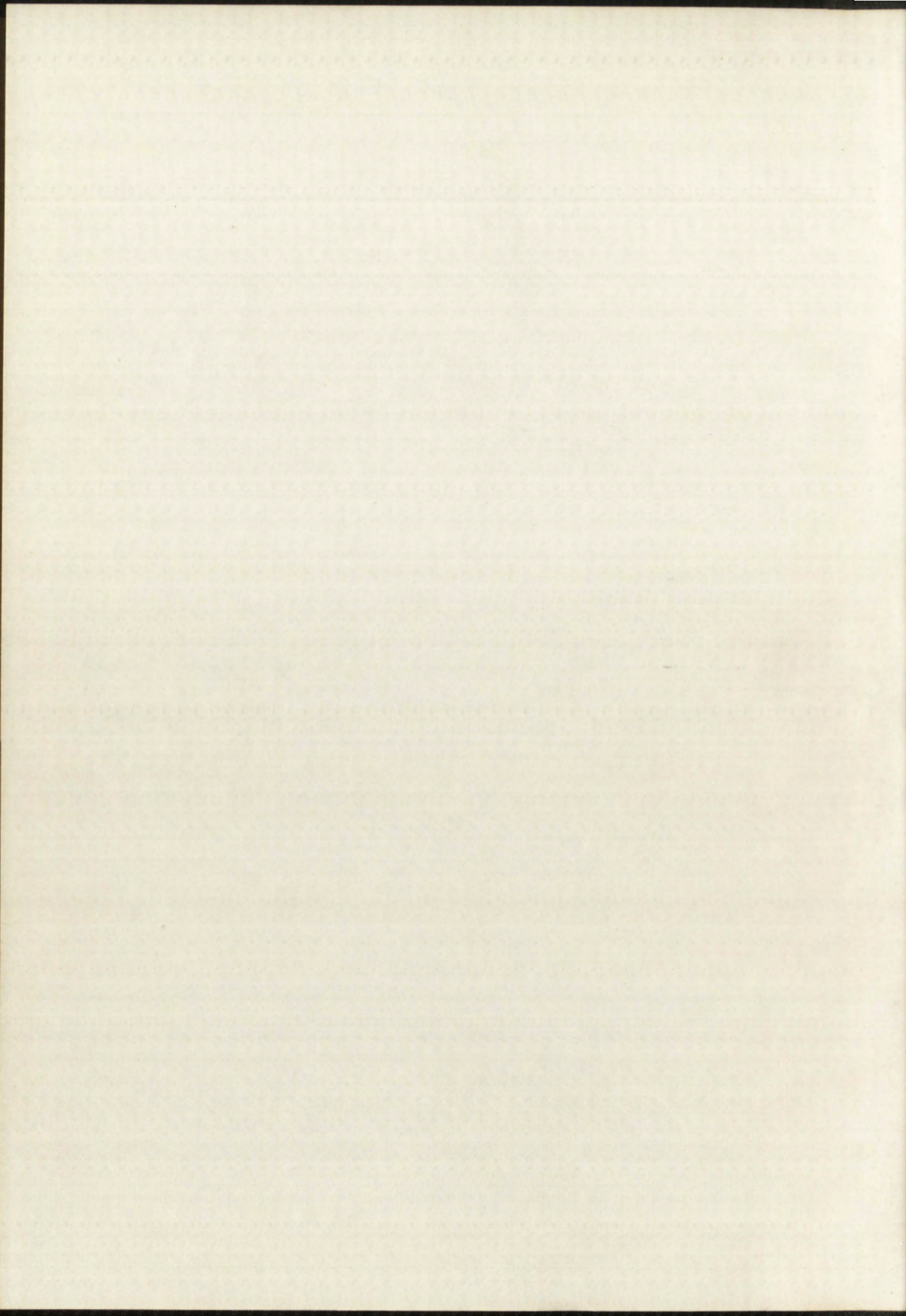
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HYDROLOGIC DATA COLLECTION PROGRAM  
FOR NEW MEXICO

By

Ralph L. Strother



EFFICIENCY  
ERASE BOND  
PAG CONTENT

A Thesis  
In partial fulfillment of the  
Requirements for the Degree of  
Master of Science in Civil Engineering

The University of New Mexico

1955



HYDROLOGIC DATA COLLECTION PROGRAM

FOR NEW MEXICO



By

Alphonse J. Sproston

EFFICIENCY

BASE

BASE

A Thesis

In partial fulfillment of the

requirements for the degree of

Master of Science in Civil Engineering

The University of New Mexico

1953



This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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5/24/1955

DATE

HYDROLOGIC DATA COLLECTION PROGRAM

FOR NEW MEXICO

By

Ralph L. Strother

Thesis committee

J. E. Martinez  
CHAIRMAN  
R. G. Hayes  
W. C. Wagner



The first thing I did was to go to the bank and  
get some money. I then went to the office and  
found that the machine was not working. I  
tried to fix it but I was not successful.  
I then called the repairman and he came  
to the office. He fixed the machine and  
I was able to use it again.

*[Handwritten signature]*

8/24/1905

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FOR THE DEAF  
WASHINGTON, D. C.

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#### ACKNOWLEDGEMENT

Special acknowledgement is made to the Office of the New Mexico State Engineer for furnishing illustrations from its Water Resources Report which has not been published at this time. These illustrations were the basis for the plates and the background for the recommendations presented.

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ACCOMPLISHMENT

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END

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## INTRODUCTION

Hydrology provides the engineer with basic data and methods required to solve engineering problems relating to the regulation, control and utilization of water. In a broad and literal sense the science of hydrology encompasses the behavior of water as it occurs in the atmosphere, on the surface of the ground and underground. Although extensive research has been conducted and enormous amounts of literature have been published on the subject, it cannot as yet be called an exact science. Due to variations in its functioning because of the innumerable combinations of hydrologic phenomena and physical conditions which may occur in nature, the science of hydrology has not yet progressed to the stage where any one exact scientific disposition of water can be expressed to the exclusion of all other possibilities.

Stereotyped procedures and criteria for hydrologic studies have never been developed. The variety of problems involved from place to place and from time to time, the variability and wide range of available data and the lack of positive progress in definitive research have all served to deter their development. Until relatively recent times this field of science has been almost completely dependent upon empirical relationships between various hydrologic



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factors. Research and progressive improvement of methods are continuously adding new concepts and opening new avenues of approach. That some of the newly developed concepts and methods may be at variance with others already in use is only to be expected. Until there has been opportunity to thoroughly establish or refute new concepts and methods on the basis of fact, conflict and lack of agreement on new concepts are certain to exist.

Federal and state agencies responsible for planning of water use and control projects have developed, over the years, practices and procedures and have adopted criteria for hydrologic studies peculiar to their own needs. These are usually referred to as established agency procedures and criteria. However, even within the same agency they are not stereotyped. Instead of hard and fast rules of procedures and criteria, the general rule is that for any project or program the particular procedures and criteria used in the hydrologic analysis are determined by the type and extent of basic data available, the objective of the study and the training and past experience of the individual or individuals conducting the study. Foremost in any hydrologic analysis is basic hydrologic data. Basin- or state-wide planning of this all-important item should be initiated and followed through.



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in any hydrologic analysis is basic hydrologic data. Service  
or state-wide planning of this all-important item should be  
initiated and followed closely.



## CHAPTER I

### OBJECTIVE AND SCOPE

The objective of this thesis is to present a program for the collection of basic hydrologic data for the state of New Mexico. It is an expansion of the existing program which currently becomes more inadequate with the progressively extensive use of the water resources of the state. The need for hydrologic data for planning and operation of water use and control structures far exceeds that obtained by the existing program.

Types of data reported upon are climatological, stream flow, ground water, quality of water, suspended sediment, snow cover and reservoir, valley and channel sedimentation. For the purposes presented herein the individual programs are listed by the five larger drainage basins within the state. These are the Rio Grande, the Pecos, the Canadian, the Gila and the San Juan rivers. Brief descriptions of these drainage basins follow.

Rio Grande Basin. The Rio Grande rises in the Rocky Mountains on the Continental Divide in southern Colorado and flows 182 miles in a southeasterly direction through Colorado, then 465 miles southward across New Mexico to Texas and continues in a southeasterly direction to the



OBJECTIVE AND SCOPE

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Rio Grande Basin. The Rio Grande rises in the Rocky Mountains on the Continental Divide in southern Colorado and flows 182 miles in a southeasterly direction through Colorado, then 162 miles southeast across New Mexico to Texas and continues in a southeasterly direction to the



Gulf of Mexico, forming the international boundary between the United States and Mexico. Its major tributary, the Pecos River, rises in Mora County, north-central New Mexico, and flows also in a general southeasterly direction through the state and on through western Texas to its confluence with the Rio Grande near Langtry, Texas. The Rio Grande and the Pecos River watersheds together drain an area in New Mexico of almost 57,000 square miles or nearly half the area of the state. The terrain varies from rugged mountains to low-lying desert plains and mesa lands. Elevations range from more than 13,000 feet above sea level in the Sangre de Cristo Mountains north of Santa Fe to about 2,800 feet at the southern border.

The Rio Grande drainage area above the New Mexico-Texas state line is about 38,960 square miles, of which about 31,480 square miles lie in New Mexico. The principal tributaries of the Rio Grande, lying wholly within New Mexico, are the Rio Chama, Rio Galisteo, Jemez Creek, Rio Puerco and Rio Salado. The main stem and tributaries of the Rio Grande in New Mexico are entrenched in deep canyons or are confined to alluvial valleys that vary in width from one-fourth to four miles and in length from a few miles to more than 100 miles. There are three notable valleys along the main stem: Espanola (upper) Valley, about 30 miles long;



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Rio Grande and the Pecos River watershed together drain  
an area in New Mexico of about 57,000 square miles or  
nearly half the area of the state. The terrain varies  
from rugged mountains to low-lying desert plains and  
lands. Elevations range from more than 10,000 feet above  
sea level in the Sierra de Gila Mountains north of Santa  
Fe to about 2,500 feet at the southern border.  
The Rio Grande drainage area above the New Mexico-  
Texas state line is about 15,000 square miles, of which  
about 11,000 square miles is in New Mexico. The principal  
tributaries of the Rio Grande, from north to south, are  
Mexico, are the Rio Chama, Rio Salinas, Texas Creek, Rio  
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the main stem: (upper) Valley of the Rio Grande, about 30 miles long;



Middle Valley, about 165 miles long; and Lower Valley, some 110 miles in length. Within these valleys are some of the state's most densely populated areas, including Albuquerque, Belen, Socorro, Truth or Consequences and Las Cruces. Industries, transportation and communication facilities and highly developed agricultural areas are also concentrated along the Rio Grande.

Over the past years, deposition of large quantities of sediment brought down by floods has caused a gradual building-up of the Rio Grande channel through the valley reaches. At the present time in the Espanola and Middle Valleys the stream bed is as high as, and in many localities higher than, the adjacent valley floor. As a result, the developed areas in the valleys are subject to damage from major floods of the Rio Grande. In addition large areas of valuable agricultural land are becoming nonproductive as a result of the rising water table. Also the accumulation of sediment in the stream bed has encouraged and promoted the growth of native vegetation which pirates vast quantities of water.

Pecos River Basin. The Pecos River watershed in New Mexico drains an area of about 25,470 square miles. The principal tributaries of the Pecos River in New Mexico are Salt Creek, Rio Hondo, Rio Felix and Rio Penasco. The



Middle Valley, about 100 miles long; and lower valley, some 100 miles in length. Within these valleys are some of the state's most densely populated areas, including Albuquerque, Bernalillo, Socorro, Santa Fe, and Las Alamos. Industries, transportation and communication facilities and highly developed agricultural areas are also concentrated along the Rio Grande.

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Leona River Basin. The Leona River watershed in

New Mexico drains an area of about 25,000 square miles. The principal tributaries of the Leona River in New Mexico are Salt Creek, the Hambo, the Holin and the Leona. The



larger towns in the watershed, Las Vegas, Santa Rosa, Fort Sumner, Roswell, Artesia and Carlsbad, are located in the valleys of either the main stem or its tributaries.

There are many diversion and storage dams on the Pecos River and its tributaries constructed for the purpose of regulating and utilizing stream flow to provide water for irrigation. However, the supply, generally insufficient except in time of floods, is a limiting factor in the development of the watershed. The use of water and water rights have been the subject of litigation for years, and until recently basin-wide development of the resource was hampered by the lack of agreement between the states on the division and use of waters of the Pecos River and its tributaries. In 1949 a compact which provides for apportionment of Pecos River waters and contains provisions to permit and facilitate full development of the river became effective.

Canadian Basin. In northeastern New Mexico an area of approximately 16,910 square miles drains to the Mississippi River as a part of the Arkansas River system. The Canadian River, the North Canadian River and the Cimarron River are the principal streams in the area. The latter two are locally known as Corrupa Creek and the Dry Cimarron River, respectively. Each of these streams is



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 Sumner, Howell, Arzola and Carlsbad, are located in the  
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Ganadian Basin. In northeastern New Mexico an area  
 of approximately 16,910 square miles drains to the  
 Mississippi River as a part of the Arkansas River system.  
 The Canadian River, the North Canadian River and the  
 Cimarron River are the principal streams in the area. The  
 latter two are locally known as Cimarron Creek and the Dry  
 Cimarron River, respectively. Each of these streams is



locally important and each increases in size and importance as it flows eastward. The Cimarron and North Canadian Rivers rise in foothill areas. In New Mexico they are not dependable sources of water; development along them is comparatively minor and improved areas are widely scattered. The principal towns are Clayton, Folsom and Des Moines. The Canadian River rises in the lofty Sangre de Cristo Range of the Rocky Mountains near Raton Pass at the northern boundary of New Mexico. From its source at about 8,000 feet elevation it flows southward through an ever-widening valley for about 64 miles where it enters a deep, narrow canyon. Except for a short reach where the canyon floor is relatively broad, the river continues southward, confined between canyon walls, for nearly 100 miles to its confluence with the Conchas River. From this point the river flows eastward in a deep canyon for a little more than 100 miles to the eastern boundary of the state. Major tributaries which enter the Canadian River in New Mexico are the Cimarron (not the Dry Cimarron mentioned above), Mora and Conchas Rivers and Ute Creek. Principal towns are Raton, Springer, Tucumcari and Cimarron.

San Juan Basin. The San Juan River, a tributary to the Colorado River, drains the northwest part of the state west of the Continental Divide. Major tributaries



locally important and each increases in size and importance as it flows eastward. The Cimarron and North Canadian rivers rise in foothill areas. In New Mexico they are not dependable sources of water; development along them is comparatively minor and improved areas are widely scattered. The principal towns are Cimarron, Tolson and Las

Meinas. The Canadian River rises in the Jolly Range of the Gila Range of the Rocky Mountains near Laramie Pass at the northern boundary of New Mexico. From its source at about

5,000 feet elevation it flows eastward through an over-arching valley for about 60 miles where it enters a deep, narrow canyon. Except for a short reach above the canyon floor is relatively high. The river continues eastward, confined between canyon walls, for nearly 100 miles to its confluence with the Conchos River. From this point the river flows eastward in a deep canyon for a little more than 100 miles to the eastern boundary of the state.

Major tributaries which enter the Canadian River in New Mexico are the Cimarron (see the very detailed conditions above), Mora and Conchos Rivers and the Great. Principal towns are Hinton, Springer, Tucuman and Cimarron.

San Juan Basin. The San Juan River, a tributary to the Colorado River, drains the northwest part of the state west of the Continental Divide. Major tributaries



which enter the San Juan River in New Mexico are Los Pinos, Animas and Chaco Rivers. The principal towns are Farmington and Shiprock.

Gila Basin. The Gila River, also a tributary to the Colorado River, drains the southwest part of the state. Major tributaries which enter the Gila River in New Mexico are the Diamond, Sapillo, Duck, Mangas and Blue Creeks. Principal towns are Lordsburg and Red Rock. Also included is the closed basin of the Mimbres River in south-central New Mexico, with the principal towns of Silver City and Deming.

#### PROCEDURES

Procedures followed in selecting the recommended program for each type of data were as follows:

A list of all existing and proposed water resource projects within the state was obtained from the Soil Conservation Service, Bureau of Reclamation, Corps of Engineers and the Office of the State Engineer. These projects are located on a map of the state designated as Plate 1, and are listed in Table 1 on pages 15 to 17. Existing collection points for each type of data were located on overlays of Plate 1. These overlays were placed over Plate 1 to determine the adequacy of the



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Pecos, Armas and Grand Rivers. The principal towns are  
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existing programs to supply the required data. When an existing program appeared inadequate, recommended additions or modifications were made. No statistical criteria or techniques were used to develop the patterns or densities of the station programs required for the basic data hydrologic program herein recommended. All recommendations were based on individual judgement in determining the additional stations, instrumentations and modifications necessary to provide a rather uniform distribution capable of producing a fair sampling of the various types of data that are basic to general hydrologic studies and research over the state. It was intended that recommendations be limited to a program both technically plausible and economically feasible. In no area was it deemed desirable to provide for an instrumentation which was sufficiently dense to produce all the data needed for special studies or detailed investigations. In general, the recommended program is meant to be a reasonable compromise for meeting the general needs of federal and state agencies within New Mexico.



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 state agencies within New Mexico.



TABLE 1  
WATER RESOURCES DEVELOPMENTS IN NEW MEXICO

Basin	Development No.	Development	Status	Purpose
<u>Canadian</u>	1	Baker Reservoir	Proposed	Irrigation
	2	Honey Reservoir	"	"
	3	Bueyeros Reservoir	"	"
	4	Guadalupita Reservoir	"	"
	5	Conchas Reservoir	Existing	Flood Control and Irrigation
<u>Rio Grande</u>	6	El Vado Reservoir	Existing	Irrigation
	7	Abiquiu Reservoir	Proposed	Flood Control
	8	Chamita Reservoir	"	" "
	9	Jemez Reservoir	Existing	Flood and Sediment Control
	10	Bernalillo Arroyo Control	Proposed	Watershed Improvement
	11	Bluewater Reservoir	Existing	Irrigation

(Cont'd)



TABLE I  
WATER RESOURCES INVESTMENTS IN NEW MEXICO

Basin	Develop- ment No.	Development	Status	Purpose
<u>Canadian</u>	1	Haber Reservoir	Proposed	Irrigation
	2	Honey Reservoir	"	"
	3	Boyer Reservoir	"	"
	4	Quadrada Reservoir	"	"
	5	Concha Reservoir	Existing	Flood Control and Irrigation
<u>Rio Grande</u>	6	El Vado Reservoir	Existing	Irrigation
	7	Alamo Reservoir	Proposed	Flood Control
	8	Quadrada Reservoir	"	"
	9	Jetta Reservoir	Existing	Flood and Sediment Control
	10	Barnhill Reservoir	Proposed	Watered Irrigation
	11	Brewster Reservoir	Existing	Irrigation
		(Cont'd)		



Basin	Development No.	Development	Status	Purpose
<u>Rio Grande</u> (Cont'd)	12	Rio Puerco Reservoir	Proposed	Irrigation, Flood and Sediment Control
	13	Elephant Butte Reservoir	Existing	Irrigation, Power
	14	Caballo Reservoir	Existing	Irrigation
	15	Hatch Valley Arroyos	Proposed	Watershed Improvement
	16	Dona Ana Arroyo	"	" " "
	<u>Pecos</u>	17	Los Esteros Reservoir	Proposed
18		Alamogordo Reservoir	Existing	Irrigation
19		Upper Rio Hondo	Proposed	Watershed Improvement
20		Two Rivers Reservoir	"	Flood Control
21		Upper Penasco	"	Watershed Improvement
22		McMillan Reservoir	Existing	Irrigation
23		Auelon Reservoir	"	"
<u>San Juan</u>		24	Navajo Reservoir (Cont'd)	Proposed







Basin	Develop- ment No.	Development	Status	Purpose
<u>Gila</u>	25	Hooker Reservoir	Proposed	Irrigation

NOTE: Diversion structures and irrigation projects are not listed.

Developments are located on Plate 1.



Basin	Development	State	Development	Basin

NOTE: Diversion structures and irrigation projects are not listed.  
 Developments are located on Plate 1.



## CHAPTER II

### DESCRIPTION OF THE PROBLEM

Need for hydrologic data. Optimum development of the water resources of the state is an ultimate objective of comprehensive long-range planning in New Mexico. Knowledge of the quantity, quality and mode of occurrence of this important resource is essential if projects and programs for its control and utilization are to be well planned and efficiently operated. The foundation for this knowledge is basic hydrologic data.

To be most useful the collection of hydrologic data should precede project planning by a considerable number of years. Unfortunately, it is now too late to do anything about the deficiencies of past hydrologic collection programs. It must be appreciated, however, that full development of the water resources of the state can be accomplished only over a period of many years. Hydrologic data collection programs should be adjusted and expanded as soon as possible to anticipate needs for data for future planning, design and construction, for the refinement of development plans now in preliminary stages, and for the more efficient operation of current projects and programs.

During the last two decades good progress has been made in expanding data collection programs in New Mexico,



DESCRIPTION OF THE PROGRAM

used for hydrologic data. System development of the water resources of the state is an ultimate objective of comprehensive long-range planning in the state. Knowledge of the quantity, quality and rate of occurrence of this important resource is essential to progress and programs for its control and utilization are to be planned and effectively executed. The foundation for this knowledge is basic hydrologic data. To be most useful, the collection of hydrologic data should precede project planning by a considerable number of years. Unfortunately, it is now too late to do anything about the deficiencies of past hydrologic collection programs. It must be appreciated, however, that the development of the water resources of the state can be accomplished only over a period of many years. Hydrologic data collection programs should be adjusted and expanded as soon as possible to anticipate needs for data for future planning, design and construction, for the refinement of development plans now in preliminary stages, and for the more efficient operation of current projects and programs. During the last two decades good progress has been made in expanding data collection programs in the state.



but a great deal of additional information is needed. Frequent inadequacy and occasional complete absence of data regarding water supply in some places is a recognized barrier to solution of problems faced by individuals working with hydrologic data of New Mexico. Currently available hydrologic data are insufficient to answer all the problems encountered in a broad interrelated program for use and control of the state's water resources.



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RESEARCH  
 DIVISION  
 STATE DEPARTMENT OF  
 WATER RESOURCES



## CHAPTER III

### HYDROCLIMATIC DATA PROGRAM

Weather stations. Precipitation in all its various forms constitutes the gross water supply upon the land. Accurate knowledge of the precipitation regime of an area is important in the planning and operation of water utilization projects and programs. Information on other meteorological data such as pan evaporation, temperature, humidity, sunshine and wind velocity are also important to planning and operation.

Records of precipitation and other meteorological data in New Mexico are generally more extensive and of longer history than other types of hydrologic data. The earliest records of weather were collected by the Army Signal Corps at the forts and outposts which were located in the state over a hundred years ago. At a few of these original locations records have been collected continuously for approximately 100 years. Following creation of the Weather Bureau in 1870 a systematic collection of climatological data was established. Throughout the years, gradually and with the assistance of a large number of public-spirited voluntary observers, the network of climatic observations was expanded.



## HYDROLOGICAL DATA PROGRAM

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Currently, the hydroclimatic network for the state consists of 315 stations which is equivalent to an average density of one station for each 387 square miles. This average density, if uniformly distributed, with proper instrumentation would be more than adequate for the definition of general climate characteristics. However, there are many areas where a more uniformly distributed grid is desirable to provide adequate areal coverage over small areas. The Department of Agriculture, the Corps of Engineers and the Weather Bureau established in 1939 a hydroclimatic network to supplement the Weather Bureau network of meteorological and climatological stations. This program has been continued to date and has resulted in a greatly improved coverage for this essential type of data. The locations of the stations comprising the existing program are shown on the map of Precipitation Stations, Plate 2.

In hydrologic studies meteorological data, because of extensive coverage and long history, are most valuable as a basis for extrapolation of other types of hydrologic data, both for areal coverage and for historical time coverage. There are, however, many deficiencies in available information. Like all hydrologic phenomena, meteorological factors vary continually from time to time and place to place. The existing meteorological network of stations



Currently, the hydrologic network for the state consists of 115 stations which is equivalent to an average density of one station for each 307 square miles. This average density, if uniformly distributed, with proper instrumentation would be more than adequate for the definition of general climate characteristics. However, there are many areas where a more uniformly distributed grid is desirable to provide adequate areal coverage over small areas. The Department of Agriculture, the Corps of Engineers and the Weather Bureau established in 1939 a hydrologic network to supplement the Weather Bureau network of meteorological and climatological stations. This program has been continued to date and has resulted in a greatly improved coverage for this essential type of data. The locations of the stations comprising the existing program are shown on the map of Prediction Stations,

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does not provide sufficient information to define accurately the extent of these fluctuations. In the field of precipitation there are pronounced deficiencies of data on rainfall quantities and intensities as related to complex thunderstorms. More continuous recording precipitation stations are needed in the basins and in small watersheds.

Evaporation and transpiration processes in nature are subjects which require much additional observational data before their probable effects can be accurately predetermined or extrapolated to unsampled areas. Additional information is therefore needed on pan evaporation, temperature, wind movement and solar radiation. As many of these meteorological factors are more uniform over large areas than rainfall, fewer observations are required to define averages and ranges in fluctuation. Table 2, Pages 26 to 34, lists the individual stations which comprise the existing hydroclimatic program. The areal distribution of the recommended program is shown on the map on Plate 2 with the existing program.

Distribution of the recommended program by river basins is shown in the following tabulation:



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Distribution of the recommended program by river basin is shown in the following tabulation:



Distribution of Recommended Hydroclimatic  
Program by River Basins

<u>Status</u>	<u>Rio Grande</u>	<u>Pecos</u>	<u>Canadian</u>	<u>Gila</u>	<u>San Juan</u>	<u>Total</u>
Existing	105	89	57	39	25	315
Additional	27	19	5	3	8	62
Modifica- tions*	6	5	6	6	4	27

\*Modifications to existing installations.

New techniques. The development of new techniques in the meteorological field may have considerable effect in the future on the collection of hydroclimatic data. Radar-meteorology promises much assistance to the hydrologist in overcoming rainfall data deficiencies. At the present time use of this facility is in its infancy, and the recommended data observations will assist in its development.

Improvements in long-range weather forecasting are being sought constantly, and experiments are being made currently on the latest ideas in numerical forecasting by means of electronic computers.

It cannot be stated positively at this time what may develop with regard to the controversial question of weather modification by artificial means. At present, so far as is known, most of the experimental work along this line has been concentrated on cloud-seeding with dry ice or silver iodide in an attempt to increase rainfall at times and places



Distribution of Recommended Hydrological  
Program by River Basin

Status	No Grande	Pecos	Canadian	El Rio	San Juan	Total
Existing	105	82	27	37	22	273
Additional	27	19	2	3	8	59
Modifications	8	2	8	5	4	27

Modifications to existing installations.

New facilities. The development of new facilities in the meteorological field may have considerable effect in the future on the collection of hydrological data. Radar meteorology promises much assistance to the hydrologist in overcoming rainfall data deficiencies. At the present time use of this facility is in its infancy, and the recommended data observations will assist in its development.

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where precipitation is likely to occur.

Snow surveys. Irrigation projects on streams draining the high mountain areas of New Mexico are largely dependent upon runoff from snow melt in the spring or early summer seasons. The efficient operation of such projects depends in large measure on advance knowledge of the water supply that will be available each year. Thus the forecasting of water supplies from stored snow is extremely important to the water users of New Mexico. Sudden melting of the snow pack can create local flood problems, and advance warning of a flood potential will be useful in planning remedial action.

The collection of data on distribution, amounts and water content of the snow received comparatively little attention until about the middle 1930's. In 1935 Congress designated the Division of Irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture, to coordinate and expand the existing program of snow surveys for water supply forecasting in all of the western states. These responsibilities were later transferred to the Soil Conservation Service. This program has developed as a cooperative undertaking between the states, private concerns and federal agencies acting under the general leadership of the Soil Conservation Service.



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Snow surveys in New Mexico are conducted through cooperative agreement between the Office of the State Engineer and the Department of Agriculture, Soil Conservation Service. These surveys, upon which water supply forecasts are based, were initiated in 1937. As of September, 1954, twenty-two snow courses were in operation in the various basins of New Mexico. These were distributed as follows: Rio Grande 14, Pecos 1, Canadian 1, Gila 6. Depth of snow and water content measurements are made on a regular schedule within four days of the first day of February, March and April of each year. Occasional measurements are made during the month of May. In addition to the New Mexico courses in the Rio Grande Basin there are 20 snow courses in Colorado which furnish pertinent data for that basin.

To serve adequately the immediate needs of the state it is recommended that nine additional courses be established. The present program of snow surveying is tabulated in Table III, page 35 and the present locations and recommended locations for additional snow courses are plotted on Plate 3.



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TABLE II  
HYDROCLIMATIC STATIONS IN NEW MEXICO

CANADIAN BASIN						
Station Number	Station	Instrumentation				
		Precipitation	NC	C	Temperature	Evaporation
1	Rutledge Ranch	x	x			
2	Long Canyon	x	x			
3	Lake Maloya	x	x		x	
4	Raton Filter Plant	x	x	x	x	
5	Dawson	x	x			
6	Philmont Ranch	x	x	x	x	
7	Eagle Nest	x	x	x	x	x
8	Cimarron	x	x		x	
9	Cimarron	x	x			
10	Maxwell	x	x		x	
11	Cunico Ranch	x	x			
12	Capulin 6 SSE	x	x		x	
13	Des Moines	x	x		x	
14	Grenville	x	x		x	
15	Clayton WB AP	Complete Meteorological NC & C				
16	Clayton 9 SE	x	x		x	
17	Sedan 7 NW	x	x	x		
18	Hayden 6 NE	x	x			
19	Pennington	x	x			
20	Pasamonte	x	x	x	x	
21	Gladstone	x	x			
22	Yates 6 S	x	x			
23	Ojo Rico Ranch	x	x			
24	Levy	x	x		x	
25	Abbott	x	x			
26	Springer	x	x	x	x	
27	Miami	x	x		x	
28	Aurora	x	x	x		
29	Black Lake	x			Storage	
30	Chacon	x			Storage	
35	Gascon	x	x			x

(Cont'd)



HYDROCLIMATIC STATIONS IN NEW MEXICO

Station Number	Station Name	Instrumentation	
		Precipitation	NO 5 Tempers- ture
1	Buffedge Ranch	X	X
2	Long Canyon	X	X
3	Lake Pajaro	X	X
4	Anton Piller	X	X
5	Ylams	X	X
6	Lewson	X	X
7	William's Ranch	X	X
8	Magie West	X	X
9	Gimerton	X	X
10	Gimerton	X	X
11	Marcelli	X	X
12	Quinto Ranch	X	X
13	Geoffin & Son	X	X
14	Los Hornos	X	X
15	Grenville	X	X
16	Guyton No 1	X	X
17	Guyton No 2	X	X
18	Redan No 1	X	X
19	Hyden & Son	X	X
20	Pennington	X	X
21	Lawrence	X	X
22	Clabson	X	X
23	Yates & Son	X	X
24	Ojo Alco Ranch	X	X
25	Levy	X	X
26	Abbott	X	X
27	Springer	X	X
28	Miami	X	X
29	Autona	X	X
30	Black Lake	X	X
31	Green	X	X
32	Green	X	X

(Cont'd)



## CANADIAN BASIN (Cont'd)

Station Number	Station	Instrumentation				
		Precipita- tion	NC	C	Tempera- ture	Evapora- tion
41	Valmora	x	x		x	
42	Optimo	x	x			
43	Roy	x	x	x	x	
44	Solano	x	x			
45	Mosquero	x	x		x	
46	Bueyeros	x	x			
47	Amistad	x	x		x	
48	Ione	x	x	x		
50	Naravisa	x	x			
51	Obar	x	x		x	
52	Logan	x	x		x	
53	Tucumcari	x	x	x	x	x
54	Tucumcari CAA AP		Complete Meteorological NC			
55	Tucumcari	x	x			
56	Montoya	x	x			
57	San Jon	x	x		x	
58	Porter	x	x			
59	Endee 5 SSE	x	x			
60	Cameron	x	x		x	
63	Quay 2 S	x	x			
70	Newkirk	x	x			
71	Variadero	x	x			
72	Conchas Dam	x	x	x	x	x
73	Bell Ranch	x	x		x	
74	Sanchez	x	x			
75	Trujillo	x	x			

## PECOS BASIN

31	Cowles	x	x		x	
32	Cowles 1 SE	x			Storage	
33	Holy Ghost Canyon	x	x			
34	Tererro	x	x	x	x	
36	Harveys Upper Ranch	x			Storage	
37	Elk Cabin	x			Storage	
38	Pecos RS	x	x		x	
39	Las Vegas	x	x		x	

(Cont'd)



CAWAGUA BASIN (Cont'd)

Station Number	Station	Production	No. of Wells	Production
11	Valmore	X	X	X
12	Opitao	X	X	X
13	Boy	X	X	X
14	Solano	X	X	X
15	Kapuro	X	X	X
16	Pugeton	X	X	X
17	Amsted	X	X	X
18	Lemo	X	X	X
19	Karavisa	X	X	X
20	Opax	X	X	X
21	Logan	X	X	X
22	Fontenot	X	X	X
23	Fontenot 2nd	X	X	X
24	Fontenot 3rd	X	X	X
25	Fontenot 4th	X	X	X
26	Fontenot 5th	X	X	X
27	Fontenot 6th	X	X	X
28	Fontenot 7th	X	X	X
29	Fontenot 8th	X	X	X
30	Fontenot 9th	X	X	X
31	Fontenot 10th	X	X	X
32	Fontenot 11th	X	X	X
33	Fontenot 12th	X	X	X
34	Fontenot 13th	X	X	X
35	Fontenot 14th	X	X	X
36	Fontenot 15th	X	X	X
37	Fontenot 16th	X	X	X
38	Fontenot 17th	X	X	X
39	Fontenot 18th	X	X	X
40	Fontenot 19th	X	X	X
41	Fontenot 20th	X	X	X
42	Fontenot 21st	X	X	X
43	Fontenot 22nd	X	X	X
44	Fontenot 23rd	X	X	X
45	Fontenot 24th	X	X	X
46	Fontenot 25th	X	X	X
47	Fontenot 26th	X	X	X
48	Fontenot 27th	X	X	X
49	Fontenot 28th	X	X	X
50	Fontenot 29th	X	X	X
51	Fontenot 30th	X	X	X
52	Fontenot 31st	X	X	X
53	Fontenot 32nd	X	X	X
54	Fontenot 33rd	X	X	X
55	Fontenot 34th	X	X	X
56	Fontenot 35th	X	X	X
57	Fontenot 36th	X	X	X
58	Fontenot 37th	X	X	X
59	Fontenot 38th	X	X	X
60	Fontenot 39th	X	X	X
61	Fontenot 40th	X	X	X
62	Fontenot 41st	X	X	X
63	Fontenot 42nd	X	X	X
64	Fontenot 43rd	X	X	X
65	Fontenot 44th	X	X	X
66	Fontenot 45th	X	X	X
67	Fontenot 46th	X	X	X
68	Fontenot 47th	X	X	X
69	Fontenot 48th	X	X	X
70	Fontenot 49th	X	X	X
71	Fontenot 50th	X	X	X
72	Fontenot 51st	X	X	X
73	Fontenot 52nd	X	X	X
74	Fontenot 53rd	X	X	X
75	Fontenot 54th	X	X	X
76	Fontenot 55th	X	X	X
77	Fontenot 56th	X	X	X
78	Fontenot 57th	X	X	X
79	Fontenot 58th	X	X	X
80	Fontenot 59th	X	X	X
81	Fontenot 60th	X	X	X
82	Fontenot 61st	X	X	X
83	Fontenot 62nd	X	X	X
84	Fontenot 63rd	X	X	X
85	Fontenot 64th	X	X	X
86	Fontenot 65th	X	X	X
87	Fontenot 66th	X	X	X
88	Fontenot 67th	X	X	X
89	Fontenot 68th	X	X	X
90	Fontenot 69th	X	X	X
91	Fontenot 70th	X	X	X
92	Fontenot 71st	X	X	X
93	Fontenot 72nd	X	X	X
94	Fontenot 73rd	X	X	X
95	Fontenot 74th	X	X	X
96	Fontenot 75th	X	X	X
97	Fontenot 76th	X	X	X
98	Fontenot 77th	X	X	X
99	Fontenot 78th	X	X	X
100	Fontenot 79th	X	X	X
101	Fontenot 80th	X	X	X
102	Fontenot 81st	X	X	X
103	Fontenot 82nd	X	X	X
104	Fontenot 83rd	X	X	X
105	Fontenot 84th	X	X	X
106	Fontenot 85th	X	X	X
107	Fontenot 86th	X	X	X
108	Fontenot 87th	X	X	X
109	Fontenot 88th	X	X	X
110	Fontenot 89th	X	X	X
111	Fontenot 90th	X	X	X
112	Fontenot 91st	X	X	X
113	Fontenot 92nd	X	X	X
114	Fontenot 93rd	X	X	X
115	Fontenot 94th	X	X	X
116	Fontenot 95th	X	X	X
117	Fontenot 96th	X	X	X
118	Fontenot 97th	X	X	X
119	Fontenot 98th	X	X	X
120	Fontenot 99th	X	X	X
121	Fontenot 100th	X	X	X

PROGS BASIN

21	Govles	X	X	X
22	Govles 1 2nd	X	X	X
23	Govles 1 3rd	X	X	X
24	Govles 1 4th	X	X	X
25	Govles 1 5th	X	X	X
26	Govles 1 6th	X	X	X
27	Govles 1 7th	X	X	X
28	Govles 1 8th	X	X	X
29	Govles 1 9th	X	X	X
30	Govles 1 10th	X	X	X
31	Govles 1 11th	X	X	X
32	Govles 1 12th	X	X	X
33	Govles 1 13th	X	X	X
34	Govles 1 14th	X	X	X
35	Govles 1 15th	X	X	X
36	Govles 1 16th	X	X	X
37	Govles 1 17th	X	X	X
38	Govles 1 18th	X	X	X
39	Govles 1 19th	X	X	X
40	Govles 1 20th	X	X	X
41	Govles 1 21st	X	X	X
42	Govles 1 22nd	X	X	X
43	Govles 1 23rd	X	X	X
44	Govles 1 24th	X	X	X
45	Govles 1 25th	X	X	X
46	Govles 1 26th	X	X	X
47	Govles 1 27th	X	X	X
48	Govles 1 28th	X	X	X
49	Govles 1 29th	X	X	X
50	Govles 1 30th	X	X	X
51	Govles 1 31st	X	X	X
52	Govles 1 32nd	X	X	X
53	Govles 1 33rd	X	X	X
54	Govles 1 34th	X	X	X
55	Govles 1 35th	X	X	X
56	Govles 1 36th	X	X	X
57	Govles 1 37th	X	X	X
58	Govles 1 38th	X	X	X
59	Govles 1 39th	X	X	X
60	Govles 1 40th	X	X	X
61	Govles 1 41st	X	X	X
62	Govles 1 42nd	X	X	X
63	Govles 1 43rd	X	X	X
64	Govles 1 44th	X	X	X
65	Govles 1 45th	X	X	X
66	Govles 1 46th	X	X	X
67	Govles 1 47th	X	X	X
68	Govles 1 48th	X	X	X
69	Govles 1 49th	X	X	X
70	Govles 1 50th	X	X	X
71	Govles 1 51st	X	X	X
72	Govles 1 52nd	X	X	X
73	Govles 1 53rd	X	X	X
74	Govles 1 54th	X	X	X
75	Govles 1 55th	X	X	X
76	Govles 1 56th	X	X	X
77	Govles 1 57th	X	X	X
78	Govles 1 58th	X	X	X
79	Govles 1 59th	X	X	X
80	Govles 1 60th	X	X	X
81	Govles 1 61st	X	X	X
82	Govles 1 62nd	X	X	X
83	Govles 1 63rd	X	X	X
84	Govles 1 64th	X	X	X
85	Govles 1 65th	X	X	X
86	Govles 1 66th	X	X	X
87	Govles 1 67th	X	X	X
88	Govles 1 68th	X	X	X
89	Govles 1 69th	X	X	X
90	Govles 1 70th	X	X	X
91	Govles 1 71st	X	X	X
92	Govles 1 72nd	X	X	X
93	Govles 1 73rd	X	X	X
94	Govles 1 74th	X	X	X
95	Govles 1 75th	X	X	X
96	Govles 1 76th	X	X	X
97	Govles 1 77th	X	X	X
98	Govles 1 78th	X	X	X
99	Govles 1 79th	X	X	X
100	Govles 1 80th	X	X	X
101	Govles 1 81st	X	X	X
102	Govles 1 82nd	X	X	X
103	Govles 1 83rd	X	X	X
104	Govles 1 84th	X	X	X
105	Govles 1 85th	X	X	X
106	Govles 1 86th	X	X	X
107	Govles 1 87th	X	X	X
108	Govles 1 88th	X	X	X
109	Govles 1 89th	X	X	X
110	Govles 1 90th	X	X	X
111	Govles 1 91st	X	X	X
112	Govles 1 92nd	X	X	X
113	Govles 1 93rd	X	X	X
114	Govles 1 94th	X	X	X
115	Govles 1 95th	X	X	X
116	Govles 1 96th	X	X	X
117	Govles 1 97th	X	X	X
118	Govles 1 98th	X	X	X
119	Govles 1 99th	X	X	X
120	Govles 1 100th	X	X	X

(Cont'd)



## PECOS BASIN (Cont'd)

Station Number	Station	Instrumentation					
		Precipitation	NC	C	Temperature	Evaporation	
40	Las Vegas CAA AP		Complete Meteorological NC & C				
61	Forrest	X	X				
62	Ragland	X	X				
64	House	X	X				
65	Hassell	X	X				
66	Alamogordo Dam	X	X	X	X	X	
67	Powell Ranch	X	X				
68	Pastura	X	X		X		
69	Santa Rosa	X	X		X		
76	Dilia	X	X	X	X		
77	Villanueva	X	X				
78	Ribera	X	X				
79	Rencona	X	X		X		
80	Palma	X	X				
81	Pedernal	X	X				
82	Duran	X		X			
83	Vaughn	X	X		X		
84	Corona	X	X		X		
85	Ancho	X	X				
86	Carrizozo	X	X	X	X		
87	Bonita Dam	X		X			
88	Monjeau Lookout	X			Storage		
89	Cedar Creek Ski Club	X			Storage		
90	Ruidoso	X	X	X	X		
91	Nogal Lake	X		X			
92	Capitan	X	X				
93	Ft. Stanton	X	X		X		
94	White Tail	X	X				
95	Picacho	X	X		X		
96	Hondo	X	X				
97	Capitan Crest	X			Storage		
98	Farnsworth Ranch	X	X	X			
99	Dunlap	X	X	X	X		
100	Yeso Overton Ranch	X	X		X		
101	Yeso 2 S	X	X				
102	Canton	X	X				
103	Ft. Sumner 5 S	X	X				
104	Ft. Sumner	X	X		X		
105	Taiban	X	X				
106	Melrose	X	X		X		

(Cont'd)



Station Number	Section	Interpretation	Remarks
106	Helipad		
105	Taliban		
104	Ft. Sumner		
103	Ft. Sumner		
102	Canton		
101	Yaso 2 W		
100	Yaso Overton Swamp		
99	Dunlop		
98	Farne Orth Range		
97	Capitan Creek		
96	Hondo		
95	Piñacho		
94	White Hill		
93	Ft. Stanton		
92	Capitan		
91	Yogal Lains		
90	Rudoso		
89	Center Creek SW of Yaso		
88	Mountain Lookout		
87	Honita Dam		
86	Garriposo		
85	Archo		
84	Corona		
83	Van Horn		
82	Burns		
81	Pedernal		
80	Palma		
79	Roncos		
78	Ribera		
77	Villanueva		
76	Dilla		
69	Santa Rosa		
68	Pantura		
67	Powell Ranch		
66	Almondo's Dam		
65	Hassell		
64	Houss		
63	Rayland		
61	Forrest		
60	Las Vegas SW of Y		

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## PEGOS BASIN (Cont'd)

Station Number	Station	Instrumentation				
		Precipitation	NC	C	Temperature	Evaporation
107	Clovis 13 N	x	x	x	x	x
108	Frio Draw	x	x			
109	Clovis	x	x	x	x	
110	Portales 7 WNW	x	x		x	x
111	Floyd	x	x			
112	Portales	x	x		x	
113	Elida	x	x		x	
114	Union Valley	x	x			
115	Milnesand	x	x			
116	Crossroads 1 NNE	x	x			
117	Bitter Lakes Wild Life Refuge	x	x		x	x
118	Roswell WB AP	Complete Meteorological NC & C				
119	Hagerman	x	x		x	
120	Caprock 4 SE	x		x		
121	Tatum	x	x		x	
122	Lovington 1 NW	x	x		x	
123	Maljamar	x	x	x	x	
124	Artesia	x	x	x	x	
125	Pearl	x	x	x	x	
126	Hobbs CAA AP	Complete Meteorological NC & C				
127	Hobbs	x	x		x	
128	Jal	x	x		x	
129	Ochoa	x	x			
129A	Carlsbad Caverns	x	x		x	
130	Carlsbad CAA AP	Complete Meteorological NC				
131	Carlsbad	x	x	x	x	
132	Lake Avalon	x	x		x	x
133	Felix	x	x			
134	Elk	x	x		x	
135	Mayhill RS	x	x		x	
136	Sacramento	x		x		
137	Carissa Lookout	x			Storage	
138	Lulu	x	x			
139	Alamogordo	x	x		x	
140	Mountain Park	x	x		x	
141	Cloudercrott 2	x			Storage	
142	Cloudercrott 1	x	x		x	
143	Mescalero	x	x		x	
144	Tularosa	x	x		x	

(Cont'd)



Station Number	Station	Births	Deaths	Marriages	Divorces
107	Clayton				
108	Clayton				
109	Clayton				
110	Clayton				
111	Clayton				
112	Clayton				
113	Clayton				
114	Clayton				
115	Clayton				
116	Clayton				
117	Clayton				
118	Clayton				
119	Clayton				
120	Clayton				
121	Clayton				
122	Clayton				
123	Clayton				
124	Clayton				
125	Clayton				
126	Clayton				
127	Clayton				
128	Clayton				
129	Clayton				
130	Clayton				
131	Clayton				
132	Clayton				
133	Clayton				
134	Clayton				
135	Clayton				
136	Clayton				
137	Clayton				
138	Clayton				
139	Clayton				
140	Clayton				
141	Clayton				
142	Clayton				
143	Clayton				
144	Clayton				



## PEGOS BASIN (Cont'd)

Station Number	Station	Instrumentation				
		Precipitation	NC	C	Temperature	Evaporation
145	White Sands Nat.M.	x	x	x	x	
146	Orogrande	x	x	x	x	

## RIO GRANDE BASIN

147	Afton 5 ESE	x	x			
148	Agric College	x	x	x	x	x
149	Las Cruces	x	x		x	
150	Florida	x	x	x	x	x
151	Jornada Exp. RS	x	x	x	x	x
152	Hatch	x	x		x	
153	Parks Ranch	x	x			
154	Wedgewood Place	x	x			
155	Hillsboro 1 SSE	x	x	x	x	
156	Caballo Dam	x	x	x	x	x
157	Aleman Ranch	x	x			
158	Engle	x	x			
159	Elephant Butte Dam	x	x		x	x
160	Truth or Consequences 2 NE	x	x	x	x	
161	Truth or C. CAA AP	Complete Meteorological				NC
162	Narrows	x		x		x
163	Pankey Ranch	x	x			
164	Winston	x	x		x	
165	Rienhardt Ranch	x	x	x		
166	Bosque de Apache	x	x	x	x	x
167	Bingham	x	x		x	
168	Socorro	Complete Meteorological				NC & C
169	Kelly Ranch	x	x			
170	Magdalena	x	x		x	
171	Boys Ranch	x	x		x	
172	Gran Quivira Nat. M.	x	x		x	
173	Progreso	x	x	x		
174	Mountainair	x	x		x	
175	Bfeister Ranch	x	x			
176	Capillo Peak	x			Storage	
177	Estancia	x	x		x	
178	Tajique	x	x		x	
179	McIntosh	x	x		x	

(Cont'd)



REGOS BARRIO (Cont'd)

Station Number	Station Name	1	2	3	4	5	6	7	8	9	10
145	White Sands Nat. M.	X									
146	Graysburg	X	X	X	X	X	X	X	X	X	X
RIO GRANDE BARRIO											
147	Alden F. Hill	X									
148	Agua College	X									
149	Las Grutas	X									
150	Florida	X									
151	Florida Exp. St.	X	X	X	X	X	X	X	X	X	X
152	Lucas	X									
153	Lucas Ranch	X									
154	Wedwood Park	X									
155	Hillborye I. Hill	X									
156	Garfield Dam	X									
157	Alfama Ranch	X									
158	Lucas	X									
159	Elephant Ranch Dam	X									
160	Truth or	X									
161	Concepcion F. Hill	X									
162	Truth or G. Hill	X									
163	Harrison	X									
164	Rancho Rancho	X									
165	Winston	X									
166	Blanchard Ranch	X									
167	Boque de Apache	X									
168	Bingham	X									
169	Boocro	X									
170	Kelly Ranch	X									
171	Hagdale	X									
172	Boys Ranch	X									
173	San Quivira Nat. M.	X									
174	Progreso	X									
175	Montclair	X									
176	Blanchard Ranch	X									
177	Galileo Peak	X									
178	Sanchez	X									
179	Patino	X									
180	McIntosh	X									



## RIO GRANDE BASIN (Cont'd)

Station Number	Station	Instrumentation				
		Precipitation	NC	C	Temperature	Evaporation
180	Los Lunas	x	x		x	
181	Belen	x	x		x	
182	Harrington Ranch	x	x			
183	Laguna	x	x	x	x	
184	Marquez	x	x			
185	Montano Grant	x		x		
186	Experiment Farm	x	x		x	
187	Albuquerque WBAP	Complete Meteorological				NC & C
188	Netherwood Park	x	x		x	
189	Sandia Crest	x	x	x	x	
190	Sandia Ski Course	x			Storage	
191	Sandia Park	x	x		x	
192	Tijeras RS	x	x		x	
193	Edgewood	x	x			
194	Otto CAA AP	Complete Meteorological				NC & C
195	Golden	x	x			
196	Hagan	x	x			
197	Bernalillo INNE	x	x	x	x	
198	Jemez Dam	x	x	x	x	x
199	Cabezon 5 SW	x		x		
200	Espiritu Santo Grant	x	x			
201	Jemez Springs	x	x		x	
202	Vallecitos	x	x			
203	Turquoise	x	x			
204	Santa Fe CAA AP	Complete Meteorological				NC & C
205	Glorieta	x	x			
206	Santa Fe	x	x	x	x	x
207	Elk Cabin	x			Storage	
208	Big Tesuque Ski Club	x			Storage	
209	Santa Fe Lake	x			Storage	
210	Bandelier Nat. M.	x	x		x	
211	Los Alamos	x	x		x	
212	Star Lake	x	x		x	
213	Penistaja	x	x		x	
214	Johnson Ranch	x	x			
215	Cuba	x	x		x	
216	Wolf Canyon	x			Storage	
217	Espanola	x	x		x	
218	Nambe l	x	x			
219	Truchas	x			Storage	

(Cont'd)



Station Number	Station Name	Section	Area	Remarks
180	Los Lunas	X		
181	Belan	X		
182	Lanston Ranch	X		
183	Laguna	X		
184	Harros	X		
185	Montano Grant	X		
186	Experiment Farm	X		
187	Albuquerque West	X		
188	Northwood Farm	X		
189	Sanita Grant	X		
190	Sanita 2nd Course	X		
191	Sanita Farm	X		
192	El James	X		
193	Elwood	X		
194	Sanita 3rd Course	X		
195	Golden	X		
196	Harros	X		
197	Sanita 1st Course	X		
198	Sanita Farm	X		
199	Sanita 2nd	X		
200	Sanita 3rd Course	X		
201	Sanita 4th	X		
202	Sanita 5th	X		
203	Sanita 6th	X		
204	Sanita 7th	X		
205	Sanita 8th	X		
206	Sanita 9th	X		
207	Sanita 10th	X		
208	Sanita 11th	X		
209	Sanita 12th	X		
210	Sanita 13th	X		
211	Sanita 14th	X		
212	Sanita 15th	X		
213	Sanita 16th	X		
214	Sanita 17th	X		
215	Sanita 18th	X		
216	Sanita 19th	X		
217	Sanita 20th	X		
218	Sanita 21st	X		
219	Sanita 22nd	X		



## RIO GRANDE BASIN (Cont'd)

Station Number	Station	Instrumentation				
		Precipitation	NC	C	Temperature	Evaporation
220	Alcalde	x	x		x	
221	Penasco RS	x	x			
222	Agua Piedra Lodge	x			Storage	
223	Taos Canyon	x			Storage	
224	Taos	x	x			x
225	Ojo Caliente	x	x			
226	El Rito	x	x			
227	Ghost Ranch	x	x			
228	Regina	x	x	x		x
229	Gavilan	x	x			x
230	Canjilon RS	x	x			
231	EL Vado Dam	x	x			x
232	Bateman Ranch	x			Storage	
233	Aspen Grove Ranch	x			Storage	
234	Tres Piedras	x			Storage	
235	San Cristobal	x	x			x
236	Lobo Peak	x			Storage	
237	Red River	x			Storage	
238	Cerro	x	x			x
239	Skarda	x	x			
240	Chama	x			Storage	
241	El Vado Dam	x	x	x		x
242	Stinking Lake	x	x			
243	Wirt	x			Storage	
267	Thoreau 6 ENE	x	x			
268	Bluewater	x	x			x
269	Grants	x	x			x
270	San Mateo	x		x		
271	La Mosca Peak	x			Storage	
272	San Fidel 3 E	x	x	x		x
273	Grants CAA AP		Complete Meteorological			NC
278	Hickman	x	x			

## SAN JUAN BASIN

244	Dulce	x	x			x
245	Vaqueros	x			Storage	
246	Gobernador	x	x			x

(Cont'd)



RIO GRANDE MAIN (Cont'd)

Station Number	Station	Station	Station	Station	Station
250	Alicha				
251	Panaceo Rd				
252	Agua Fiebra Lodge				
253	Laos Canyon				
254	Taos				
255	Ojo Galiente				
256	El Alto				
257	Ghost Ranch				
258	Recluse				
259	Gavilan				
260	Gentian Rd				
261	El Vado Dam				
262	Hesperia Ranch				
263	Agua Grove Ranch				
264	Tree Ridge				
265	San Cristobal				
266	Lobo Lake				
267	Red River				
268	Cerro				
269	Shosh				
270	Chama				
271	El Vado Dam				
272	Stinking Lava				
273	Wirt				
274	Thoresen & Sons				
275	Huerfano				
276	Grange				
277	San Mateo				
278	La Hoya Park				
279	San Fidel 3rd				
280	Grange 6th St				
281	Richton				

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Rio Grande Main  
 Rio Grande  
 Rio Grande  
 Rio Grande

(Cont'd)



## SAN JUAN BASIN (Cont'd)

Station Number	Station	Instrumentation				
		Precipita- tion	NC	C	Tempera- ture	Evapora- tion
247	Bloomfield	X	X		X	
248	Aztec Ruins Nat. M.	X	X		X	
249	Farmington 3 NE	X	X	X	X	X
250	Farmington CAA AP	Complete Meteorological NC				
251	Fruitland	X	X		X	
252	Shiprock 2 NW	X	X		X	X
253	Newcomb	X	X		X	
254	Cottonwood Pass	X			Storage	
255	Chaco Canyon Nat. M.	X	X		X	
256	Lybrook	X	X		X	
257	Otero	X	X			
258	Pitt Ranch	X	X			
259	Crownpoint	X	X	X	X	
260	Tohatchi Peak	X			Storage	
261	Tohatchi	X	X		X	
262	Mexican Springs	X	X			
263	Gallup KGAK	X	X		X	
264	Sheep Lab.	X	X			
265	Fort Wingate	X	X		X	
266	McGaffey	X	X		X	
274	El Morro Nat. M.	X	X		X	
275	Zuni CAA AP	Complete Meteorological NC & C				

## GILA BASIN

276	Salt Lake 4 NE	X	X			
277	Quemado	X	X		X	
279	Augustine 7 SW	X	X	X	X	
280	Horse Mountain	X	X		X	
281	Jewett RS	X	X		X	
282	Luna RS	X	X	X	X	
283	Reserve RS	X	X		X	
284	Birmingham Ranch	X	X		X	
285	Adobe Ranch	X			Storage	
286	Inman Ranch	X			Storage	
287	Beaverhead RS	X	X	X	X	
288	Hedrick Ranch	X	X			
289	Willow Creek RS	X			Storage	

(Cont'd)



Station Number	Station	Instrumentation
217	Blountfield	X
218	Aspen Basin	X
219	Lawrence	X
220	Parliament	X
221	Paul Island	X
222	Shirley	X
223	Lawson	X
224	Cottonwood Park	X
225	Chaco Canyon	X
226	Lynch	X
227	Cave	X
228	High Ranch	X
229	Ormeau	X
230	Robertson	X
231	Robertson	X
232	Highway 200	X
233	Highway 200	X
234	Highway 200	X
235	Highway 200	X
236	Highway 200	X
237	Highway 200	X
238	Highway 200	X
239	Highway 200	X
240	Highway 200	X
241	Highway 200	X
242	Highway 200	X
243	Highway 200	X
244	Highway 200	X
245	Highway 200	X
246	Highway 200	X
247	Highway 200	X
248	Highway 200	X
249	Highway 200	X
250	Highway 200	X
251	Highway 200	X
252	Highway 200	X
253	Highway 200	X
254	Highway 200	X
255	Highway 200	X
256	Highway 200	X
257	Highway 200	X
258	Highway 200	X
259	Highway 200	X
260	Highway 200	X
261	Highway 200	X
262	Highway 200	X
263	Highway 200	X
264	Highway 200	X
265	Highway 200	X
266	Highway 200	X
267	Highway 200	X
268	Highway 200	X
269	Highway 200	X
270	Highway 200	X
271	Highway 200	X
272	Highway 200	X
273	Highway 200	X
274	Highway 200	X
275	Highway 200	X

GILA BASIN

276	Ball Lake	X
277	Grass	X
278	Augustine	X
279	Horse Mountain	X
280	Lowell	X
281	Lowell	X
282	Lowell	X
283	Lowell	X
284	Lowell	X
285	Lowell	X
286	Lowell	X
287	Lowell	X
288	Lowell	X
289	Lowell	X
290	Lowell	X
291	Lowell	X
292	Lowell	X
293	Lowell	X
294	Lowell	X
295	Lowell	X
296	Lowell	X
297	Lowell	X
298	Lowell	X
299	Lowell	X
300	Lowell	X
301	Lowell	X
302	Lowell	X
303	Lowell	X
304	Lowell	X
305	Lowell	X
306	Lowell	X
307	Lowell	X
308	Lowell	X
309	Lowell	X
310	Lowell	X
311	Lowell	X
312	Lowell	X
313	Lowell	X
314	Lowell	X
315	Lowell	X
316	Lowell	X
317	Lowell	X
318	Lowell	X
319	Lowell	X
320	Lowell	X
321	Lowell	X
322	Lowell	X
323	Lowell	X
324	Lowell	X
325	Lowell	X
326	Lowell	X
327	Lowell	X
328	Lowell	X
329	Lowell	X
330	Lowell	X
331	Lowell	X
332	Lowell	X
333	Lowell	X
334	Lowell	X
335	Lowell	X
336	Lowell	X
337	Lowell	X
338	Lowell	X
339	Lowell	X
340	Lowell	X
341	Lowell	X
342	Lowell	X
343	Lowell	X
344	Lowell	X
345	Lowell	X
346	Lowell	X
347	Lowell	X
348	Lowell	X
349	Lowell	X
350	Lowell	X
351	Lowell	X
352	Lowell	X
353	Lowell	X
354	Lowell	X
355	Lowell	X
356	Lowell	X
357	Lowell	X
358	Lowell	X
359	Lowell	X
360	Lowell	X
361	Lowell	X
362	Lowell	X
363	Lowell	X
364	Lowell	X
365	Lowell	X
366	Lowell	X
367	Lowell	X
368	Lowell	X
369	Lowell	X
370	Lowell	X
371	Lowell	X
372	Lowell	X
373	Lowell	X
374	Lowell	X
375	Lowell	X
376	Lowell	X
377	Lowell	X
378	Lowell	X
379	Lowell	X
380	Lowell	X
381	Lowell	X
382	Lowell	X
383	Lowell	X
384	Lowell	X
385	Lowell	X
386	Lowell	X
387	Lowell	X
388	Lowell	X
389	Lowell	X
390	Lowell	X
391	Lowell	X
392	Lowell	X
393	Lowell	X
394	Lowell	X
395	Lowell	X
396	Lowell	X
397	Lowell	X
398	Lowell	X
399	Lowell	X
400	Lowell	X



## GILA BASIN (Cont'd)

Station Number	Station	Instrumentation			
		Precipitation	NC	G	Temperature Evaporation
290	Fanny Ranch	x			Storage
291	Mogollon	x			x
292	Glenwood				Complete Meteorological NC
293	Buckhorn	x	x		
294	Cliff 10 SE	x	x		x
295	Bear Creek Ranch	x	x		
296	Mimbres RS	x	x	x	
297	Pinos Altos	x	x		
298	Ft. Bayard	x	x		x
299	Silver City	x	x		x
300	Redrock	x	x		
301	Virden	x	x		
302	Cureton Ranch	x	x		
303	White Signal	x	x		
304	Whitewater	x	x		
305	Faywood	x	x		
306	Deming	x	x		
307	Gage	x	x		x
308	Lordsburg	x	x		x
309	Road Forks	x	x		
310	Rodeo	x	x	x	x
311	Animas	x	x		x
312	Hatchita	x	x		x
313	Hermanas	x	x		
314	Columbus CAA AP				Complete Meteorological NE & G
315	Eicks Ranch	x	x	x	x

NOTE: NC represents Non-recording Precipitation Gauge.  
G represents Recording Precipitation Gauge.

Stations are located on Plate 2.



WATER BASIN (Cont'd)

Station Number	Station Name	Location	Remarks
290	Ferry Ranch		
291	Hogdon		
292	Glennwood		
293	Buckhorn		
294	Critt 10 22		
295	Bear Creek Ranch		
296	Minnes RA		
297	Bliss A100		
298	Ft. Payne		
299	Silver City		
300	Hedrick		
301	Widener		
302	Quinton Ranch		
303	White Signal		
304	White Signal		
305	Paywood		
306	Danville		
307	Gay		
308	Lordsburg		
309	Hend Forks		
310	Hodes		
311	Antman		
312	Wichita		
313	Hermann		
314	Colman CA 42		
315	Stick Ranch		

NOTE: 295 represents non-researching weather station.  
 2 represents Researching Weather Station.

Stations are located on map.



TABLE III  
SNOW COURSES IN NEW MEXICO

Basin	Course Number	Course
<u>Canadian</u>	1	Hematite Park
<u>Pecos</u>	2	Panchuela
<u>Rio Grande</u>	3	Red River
	4	Taos Canyon
	5	Aspen Grove
	6	Tres Ritos
	7	Pay Roll
	8	Chama Divide
	9	Chamita
	10	Cordova
	11	Big Tesuque
	12	Elk Cabin
	13	Rio En Medio
	14	Quemazon
	15	Bateman
	16	Fenton Hill
<u>Gila</u>	17	Frisco Divide
	18	State Line
	19	Taylor Creek
	20	Inman
	21	Black Canyon
	22	Mogollon

NOTE: Courses are located on Plate 3.







## CHAPTER IV

### STREAM FLOW DATA

History of investigations. The first sytematic measurements of stream flow in New Mexico were initiated in the Rio Grande Basin in the late 1880's and early 1890's. The records for one of these stations, Rio Grande at San Marcial, have been continued from 1895 to date and constitute the longest continuous discharge record in the state. The primary interest in stream flow in these earlier years was in connection with irrigation developments in the arid and semi-arid regions. Quite substantial stream-gauging programs were initiated throughout the state late in the nineteenth and early in the twentieth centuries. Unfortunately, most of the gauging stations were generally operated for only short periods and these earlier records were fragmentary and incomplete.

As interest in the flow of streams broadened in connection with problems other than irrigation, such as flood control, navigation and hydroelectric power, the need for records of stream flow became increasingly apparent and various states began to supplement the federal stream-gauging program. In 1929 Congress adopted the policy of dollar-for-dollar cooperation with the



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states in connection with the stream-gauging program of the U.S. Geological Survey. At about the same time the Corps of Engineers was engaged in nation-wide investigations of water resource developments as directed by the Rivers and Harbors Act of 1927 which resulted in the series of "308 Reports." The lack of adequate stream flow data greatly handicapped the Corps of Engineers in the prosecution of these studies, and one of their first steps in carrying out this broad directive was to expand the network of stream-gauging stations, largely in cooperation with the U.S. Geological Survey.

The widespread droughts of the '30's, interspersed with damaging floods, gave impetus to public demands for better utilization and control of our streams. All of these factors contributed to the realization of the need for more information on the flow of streams, and systematic programs for the gauging of the most important streams began to take shape throughout the nation. Marked expansion in these programs in New Mexico began about 1938. During the period of 1938 to 1945 the number of gauging stations was about trebled, but only moderate expansion has taken place since then.

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Current Program. The existing program, as of September, 1954, for the collection of stream flow data



consists of 165 stations for the determination of daily discharge or reservoir contents and various other stations where discharge and/or stage records are collected intermittently for periods of less than a month to several months. A listing of the existing gauging stations for which daily discharges and reservoir contents are being collected is shown on Table IV, Pages 60 to 71. Locations of these stations are shown on Plate 4.

The existing network of gauging stations furnishes fairly adequate information on the flows of major streams, although the length of many of the records is too short to delineate long-term trends in runoff. The smaller streams, in general, have less adequate coverage both in respect to areal extent and length of record.

Basic considerations in developing a comprehensive program for stream flow records. A comprehensive program for stream flow measurements in New Mexico should consider stations of the following general classifications: (1) a hydrologic network of primary or base gauging stations; (2) a supplementary network of secondary or short-term hydrologic stations; and (3) project or special purpose stations. The objective of primary and secondary hydrologic stations is to furnish the background of basic data for the development of surface water resources,



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while the project or special project station serves the present; the hydrologic network, although of value for present needs, looks primarily to the future. Together they provide the facts needed for sound water management.

Primary hydrologic stations are stations which should be operated on a long-term continuing basis. The network coverage of these stations should be sufficiently intensive to represent in a general way the widely variable runoff characteristics of all parts of the region, to serve as base "correlation" stations and to be the basis for the definition of long-term trends in runoff. To be included in this group of stations are key stations at strategic points on major streams, stations at or near state boundaries on important streams, and stations in each major geologic and climatological province for small, medium and large streams. All such stations together serve to determine the net effects of development on long-term water supply.

It is not considered economically justifiable or practicable to operate long-term gauging stations on every minor stream or at every major stream site that may be subject to development or use at some time in the future. Instead, secondary or short-term stations may be established on these streams and correlated with the base



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"correlation" stations in the primary network. Secondary stations are to be operated only for periods sufficient to develop adequate correlation with longer-term record stations. The short-term records may then be extended satisfactorily to cover known periods of critical flows.

Project stations are those gauging stations required for some specific purpose. Examples of needs for the records of such stations include the operation of various types of control works, administrative and legal problems related to stream discharge, the planning of water utilization or control works and information for research in hydrology and hydraulics. Project stations for operational, administrative and legal purposes will need to be operated for an indefinite period, but those for design of specific projects or research ordinarily would be established for a definite term.

Development of primary hydrologic network. In classifying stations for the primary hydrologic network the following criteria were generally observed: (1) The area gauged should be relatively homogeneous from a hydrologic standpoint and, where possible, be representative of a fairly large area; (2) the flow at the site should not be affected generally by regulation or diversion, but when so affected, adequate adjustments



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for flow modification should be introduced; (3) records of an acceptable degree of accuracy should be obtainable at reasonable cost.

Observing these general criteria, the selection of primary stations was based on the estimated degree of correlation to be expected and the density of streams in each area on which water use or control developments might reasonably be expected in the future. Thus, primary stations are more closely spaced in areas of many perennial streams than in areas where streams are dry most of the time.

For the perennial streams throughout the state it was found that the need for primary network stations was quite well satisfied under the current program. Almost all of the stations listed in Table IV and located on Plate 4 were considered to be within the primary network. The major exceptions are reservoir stations and the canal stations which are considered as project stations.

Recommendations. With the perennial streams throughout the state being adequately gauged, it is not economically justified to recommend additional network stations for the intermittent streams even though some need for stream flow data would prove invaluable in the future. The probability of usage would not warrant investment even for secondary network stations.



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Modifications to several existing stations are recommended, however, and will be discussed in Chapters V and VI.

The systematic collection of certain supplemental information in addition to that collected at regular gauging stations is recommended for inclusion in the program. Items suggested for inclusion are as follows:

- (1) a network of crest-stage gauges for use in developing flood-frequency curves for all portions of the state;
- (2) the determination of peak discharges for unusual floods at points other than at regular gauging stations;
- (3) the recording and preservation of high-water marks for outstanding floods along all important streams;
- (4) occasional or periodic measurement of ungauged streams, particularly those draining areas of large ground water discharge, for correlation with ground water investigations, and those in areas of existing or potential pollution problems for correlation with chemical and biological analysis of the waters.

Needs for other supplemental information, not presently urgent, will no doubt develop as the economy of the state expands. For example, as optimum utilization of the water resources approaches, a comprehensive and continuing inventory of water use from all sources will be desirable.



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## CHAPTER V

### QUALITY OF WATER DATA

Chemical quality. Water undergoes continuing alteration in chemical content as it progresses through the hydrologic cycle. The type of material with which water has been in contact as well as the length of contact period governs the degree of mineralization and ultimately the utility of the water. The quality of stream waters fluctuates quite widely both with time and location, primarily because of differences in climate and in solubility of rock materials. Evaporation from free water surfaces and transpiration by plants tend to increase quantities of dissolved minerals in stream water. Irrigation return waters, mine drainage, oil field waste waters, municipal sewage and industrial process wastes alter the chemical quality of water in streams.

In the New Mexico basins surface water of excellent quality is generally available in the high mountains. Quality of the stream water in the valley sections deteriorates generally from north to south, but there are so many special conditions that it is not feasible to predict what quality of water can be developed from a particular stream without systematic sampling.



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In the New Mexico basin surface water of excellent quality is generally available in the high mountains. Quality of the stream water in the valley sections deteriorates generally from north to south, but there are so many special conditions that it is not feasible to predict what quality of water can be developed from a particular stream without systematic sampling.



The chemical quality of ground water also varies noticeably from place to place and with depth. Ordinarily the quality of water produced from a particular well is fairly consistent, but heavy pumping may result in introduction of water from adjacent areas and cause change in quality. Polluted waters from other sources may also enter the aquifer and impair the quality.

The chemical composition of available water determines in many ways the use to which the water may be put. In such uses as development of hydro-power and navigation, chemical quality is unimportant. But for other uses such as irrigation or municipal and industrial water supply there are definite limitations on the concentrations of minerals that can be tolerated. The demand of many industrial processes for water of high purity is increasing, and these more exacting needs are causing a continual search for water of better quality. Most uses of water cause some deterioration in quality, and the continual use and reuse of water can render it unfit for many purposes.

The collection of data on chemical quality of surface waters for the most part has lagged behind the collection programs for the other types of hydrologic data. Scattered samples have been collected over a



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period of many years, but no continuous or systematic program of sampling has been carried on until comparatively recent years. Current programs vary widely from basin to basin and for many areas are seriously deficient.

Considerable data on the chemical quality of ground water in the state has been collected as part of ground water investigations, but in many areas where ground water investigations have not been made chemical quality data on the ground water resource are very deficient. However, much miscellaneous information is available from analyses of many municipal and some industrial supplies from ground water sources.

In the formulation of a program for the collection of data on the chemical quality of surface waters to supplement the existing program two types of network stations were considered: primary, those to be maintained on a permanent or continuing basis; and secondary, those to be maintained for a relatively short period of one to three years. Primary stations are useful in evaluating normal fluctuations, long-term trends or changes due to changing water or land uses. Secondary stations are generally designed to meet the planning requirements of a specific project or to extend general coverage. The frequency of sampling for all stations in the recommended program is to be adequate for the



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determination of daily values. The concentration of dissolved minerals usually varies widely with rates of stream discharge, therefore, in order to obtain weighted average concentration, it is desirable that sampling stations be established at sites where stream flow records are being obtained or can be closely estimated. Programs for obtaining discharge and quality-of-water data are thus mutually interrelated.

Chemical quality determinations to be made under the proposed program should include: total hardness, non-carbonate hardness, specific conductance, silica, calcium, magnesium, chloride, sodium, potassium, carbonate, bicarbonate, sulfate, nitrate, boron, dissolved solids and pH. In addition iron, fluoride, and manganese will be determined where local conditions indicate they will be problems in the use of water.

The collection of chemical quality data on ground water is included in most detailed ground water investigations. It is recommended that this practice be continued in all future ground water investigations on a systematic basis. Therefore, no specific program is being presented herein.

Temperature of water in both surface and sub-surface locations has become an item of increasing interest in recent years. This is particularly so in connection with



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industrial uses, air conditioning and fish and wildlife problems. It is recommended that the collection of water temperatures be integrated into quality of both surface-water and ground water programs.

The program for chemical quality stations as developed indicates ten sites at which stations should be established for the collection of chemical quality data adequate for the determination of daily values. These are in addition to the 16 stations in operation as of September, 1954, where data adequate for determination of daily values were being collected. Of the 26 indicated chemical quality stations all would be considered primary stations. The list of existing chemical quality stations is shown in Table IV, Pages 60 to 71, and their locations along with the recommended stations are shown on Plate 4. A comparison between existing and recommended programs by major drainage basins is as follows:

#### Chemical Quality

<u>Status</u>	<u>Rio Grande</u>	<u>Pecos</u>	<u>Canadian</u>	<u>Gila</u>	<u>San Juan</u>	<u>Total</u>
Existing	4	10	0	0	2	16
Recommended	3	1	2	3	1	10

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The program for chemical quality stations as developed indicates ten sites at which stations should be established for the collection of chemical quality data adequate for the determination of daily values. These are in addition to the 13 stations in operation as of September, 1954, where data adequate for determination of daily values were being collected. Of the 23 indicated chemical quality stations all would be considered primary stations. The list of existing chemical quality stations is shown in Table IV, pages 60 to 61, and their locations along with the recommended stations are shown on Table V. A comparison between existing and recommended programs by major drainage basin is as follows:

Chemical Quality

Station	Also Grande Paces Canadian City San Juan Total
Existing	10
Recommended	13
	3
	1
	2
	0
	0
	5
	10

Biological quality. The chemical and physical properties of natural waters exert a great influence on the plant and animal life therein. Numerous kinds of



aquatic animals and plants live in natural waters and are affected by its chemical and physical characteristics. Pollution of water with accompanying changes in chemical or physical water quality characteristics usually reduces the number of kinds of organisms in a stream, although the total number of organisms may increase. Living organisms may alter the quality of water. For example, nitrogen, phosphorous, carbon, potassium, sulfur, iron and other elements are taken up by aquatic plants and used in building plant cells. During photosynthesis the amount of dissolved oxygen, carbon dioxide, bicarbonate and other constituents in the water may be greatly altered. Certain types of algae may create problems of taste and odor or produce toxic substances. Rapid die-off of algae may result in oxygen-depleted water. Bacteria improve water quality by converting organic materials into stable inorganic compounds.

A healthy stream from a biological viewpoint is one which contains physical, chemical and environmental characteristics that will allow the development of a varied number of kinds of aquatic organisms, each of which competes for the available food. The distribution of aquatic life in a stream contributes a good index for determining the degree of past pollution. It may be used as a supplement to the usual chemical and physical



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analyses. In addition, analyses for dissolved oxygen and bio-chemical oxygen demand and bacteria determinations are frequently employed as indices of biological quality. This information may be collected on a short-term or long-term basis.

Biological studies are sometimes performed as brief survey studies to show existing biological conditions. Other studies are conducted over a long period in order to show minor variations or to detect sudden and drastic changes in stream conditions. These studies may be undertaken by federal or state agencies, by municipalities or by industry. A particularly useful and frequently applied use of biological studies is practiced by many industries which initiate studies prior to and following the establishment of an industrial plant to determine the changes brought about by the discharge of the industrial effluent. Ordinarily these studies are the property of the sponsoring industry and are not generally available. Biological studies conducted by state or federal agencies are generally available as special reports or as a part of specific project reports.

Biological studies are vitally important for an understanding of many pollution problems. Although sampling procedures and methods of evaluating data are not well defined, and biological habitats and factors are



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Biological studies are vitally important for an understanding of many pollution problems. Although sampling procedures and methods of evaluating data are not well defined, and biological habits and factors



which affect them are complex, careful interpretations of biological studies are required. A study of the living organisms in the bottom of a stream, for instance, can yield useful information on the condition of a stream. A healthy stream will contain a variety of different kinds of aquatic life which will readily consume moderate quantities of organic pollution and maintain or restore good water quality. Toxic materials, even though occurring in relatively small quantities, may not alter the appearance of water but may render it useless as a habitat for aquatic life and seriously interfere with the recovery capacity of a stream.

No specific program of data collection or studies is proposed herein. It is anticipated, however, that special studies will be needed from time to time to provide data defining biological quality.



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## CHAPTER VI

### SEDIMENT DATA

General. As movement and deposition of sediment is detrimental in almost all instances to the economic development of water resources, all agencies responsible for the conservation and development of land and water resources are concerned with the availability of sediment records. Adequate planning for prevention and relief from sediment damages requires definite knowledge of sediment production, movement and deposition in all its phases.

The sediment loads carried by streams are the result of either erosion of the soil mantle from farm, forest and range lands or of modification of stream channels due to movement of bank and bed materials. To supply data on sediment loads carried by streams sampling stations to measure suspended sediment concentrations and bed load are required.

A part of the sediment in transport in a stream may be temporarily or semi-permanently deposited in a downstream reach of the stream channel. A part of the sediment in transport also may have been derived by scour of the stream bed and bank at some upstream place. This process of aggradation and degradation of stream channels presents a continuing problem to those interested in the



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utilization of the channels. Accumulation of sediment in water courses reduces their carrying capacity, causing increase in overbank flooding. Sediment carried by floods may damage crops, and its deposition on the flood plain may ruin productive bottom land. Data for this phase of sedimentation may be obtained by periodic surveys of selected reaches of stream channels and valleys.

A part or all of the sediment transported by streams entering a lake or reservoir, depending on the trap efficiency of the impoundment, will be deposited in the lake or reservoir. In the case of reservoirs, the reduction in capacity by deposition of fluvial sediments may create additional maintenance expense and result in a lowering of income or degree of protection derived from the project. Unless adequate provision has been made in the reservoir design for this reduction in storage space the ability of the structure to fulfill its purpose will be impaired. Up-to-date information on the extent of reduction due to sediment deposition in the water-storing capacity of constructed reservoirs is necessary in connection with reservoir operations. It is therefore imperative that designing and operating engineers have adequate knowledge of reservoir sedimentation rates and extent of sedimentation. Data for this phase of sedimentation may be obtained by periodic reservoir surveys.



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sedimentation may be obtained by periodic reservoir survey.



As the various phases of sedimentation are related, so are the several programs for collection of sedimentation data closely related. The programs for measurement of accumulated deposits in stream channels on flood plains and in impoundments and the measurement of suspended sediment and bed load sampling programs are complementary or, in some cases, alternate methods for supplying data on sediment yields, transport rates and other sediment characteristics. Each program has its limitations and area of usefulness, but all are essential to supply data needed in resolving the many problems in water resource planning and utilization, including the evaluation of improvements having sediment reduction effects.

Suspended sediment and bedload. Sediment is the insoluble material transported by streams either in suspension or bed load. The sediment particles which move with only occasional contact with the channel bed or banks are termed suspended sediment and consist chiefly of fine sands, silts and clays. Sediment which rolls or bounces along the bottom is termed bed load and consists primarily of gravel and coarse sand. Until very recently, because of difficulty in measuring the movement of bed load, the sediment transport data program was almost entirely limited to suspended sediment sampling.



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Only meager data are available on the magnitude and distribution of suspended sediment loads carried by the streams in the state. Random and intermittent measurements of the suspended loads carried by the streams have been made in the past 50 years. During the past 15 years, however, progress has been made toward more adequate programs for the collection of this type of hydrologic data.

Suspended sediment concentrations usually vary widely from time to time, especially during periods of flood flows, and in order to make reliable computations of loads transported frequency of sampling should be sufficient for determination of daily values. This may require daily or more frequent sampling in some cases, particularly during flood flows. In developing the program for additional suspended sediment sampling, first consideration was given to stations requiring frequency of sampling adequate for determination of daily loads. Stream discharges are necessary in conjunction with sediment concentration determinations to compute the sediment loads. All such sediment sampling stations, therefore, must be confined to sites of existing or proposed stream flow stations.

The suspended sediment measuring stations may be placed in two classifications, depending upon the



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The suspended sediment measuring stations may be placed in two classifications, depending upon the



objective for which the data are to be used. The first deals with the collection of data over a long period of years in order to determine annual variations and long-term trends or to serve as a basis for evaluating the effectiveness of control works and programs for the reduction of sediment yields. These form a primary network and should be continued for an indefinite period.

The second type of station is to be operated for a shorter period, generally three to four years, depending upon the range in flows experienced. This type is intended to furnish data in connection with specific projects or problems and forms a secondary network of stations needed to give areal coverage to the recommended program. If long-term discharge records are available at the sites of secondary sediment stations it will be possible, by the use of correlation techniques, to estimate the sediment record for the longer period.

The program as developed proposes the collection of suspended sediment data at 17 sites in addition to the 26 sediment sampling stations now in operation. The following table summarizes the existing and additional program as developed for such stations by river basins:

#### Suspended Sediment

<u>Status</u>	<u>Rio Grande</u>	<u>Pecos</u>	<u>Canadian</u>	<u>San Juan</u>	<u>Gila</u>	<u>Total</u>
Existing	19	4	0	3	0	26
Recommended	4	4	6	0	3	17



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Suspended Sediment

Status	No Grande	Peace	Canadian	San Juan	Other Total
Existing	19	4	0	3	26
Recommended	1	4	0	2	17



The specific sites of the existing sediment sampling stations are shown in Table IV, Pages 60 to 71. The locations of these sites are shown on Plate 4. Of the 17 additional stations all are classed in the primary network, as are those of the 26 existing stations.

Recent developments in total sediment load (suspended sediment and bed load) studies have provided feasible methods of computing total sediment discharge in alluvial streams. Additional data for determination of bed loads consist of the collection of bed samples, vertical velocity distribution at the same points and particle size analysis of suspended load and bed load materials. As the additional data and analysis of data are not a large item, it should be combined with the suspended sediment sampling program at least at a number of locations where bed-load movement is of importance. Since this method of determination of bed load is relatively new, details for a definite program have not been worked out. However, there probably will be many specific locations within the state where the determination of bed load movement is of primary importance, and it is estimated that bed load determinations will be needed at approximately one-fourth of the existing and recommended suspended sediment sample stations.



The specific sites of the existing sediment sampling stations are shown in Table IV, pages 60 to 71. The locations of these sites are shown on Plate II. Of the 17 additional stations all are classed in the primary network, as are those of the 25 existing stations. Recent developments in total sediment load (suspended sediment and bed load) studies have provided feasible methods of computing total sediment discharge in alluvial streams. Additional data for determination of bed loads consist of the collection of bed samples, vertical velocity distribution at the same points and particle size analysis of suspended load and bed load materials. As the additional data and analysis of data are not a large item, it should be combined with the suspended sediment sampling program at least at a number of locations where bed-load movement is of importance. Since this method of determination of bed load is relatively new, details for a definite program have not been worked out. However, there probably will be many specific locations within the state where the determination of bed load movement is of primary importance, and it is estimated that bed load determinations will be needed at approximately one-fourth of the existing and recommended suspended sediment sampling stations.



The overall program should also include the systematic collection over the state of periodic sediment discharge measurements. Such a program will assist in locating the more important areas of sediment contribution and in selecting locations for more intensive study. In streams where suspended sediment is not a serious problem adequate information may be obtained from sediment measurements obtained at periodic intervals.

Reservoir sedimentation surveys. The measurement of trapped sediment in reservoirs may be used as a basis for estimating the probable sedimentation rates in proposed reservoirs, for evaluation of the net effect of changes in land use practices upon sediment yield rates, and for estimation of the effect of channel stabilization and other upstream sediment control measures. It should be kept in mind that such data should be used with caution and properly evaluated. Such factors as stream channel above the reservoir and the "trap efficiency" of the reservoir should be considered in the analysis of reservoir data.

To obtain the maximum amount of information concerning sedimentation it is essential that reservoir sedimentation surveys be coordinated with other basic data programs and that the reservoir sedimentation survey program be of a continuing nature with a definite



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To obtain the maximum amount of information concerning sedimentation it is essential that reservoir sedimentation surveys be coordinated with other basic data programs and that the reservoir sedimentation survey program be of a continuing nature with a definite



program of surveys scheduled at periodic intervals.

In the past 15 years a number of sedimentation surveys of reservoirs, stock water tanks and farm ponds have been made. For the most part the program has been random, and much of the data are incomplete, especially with respect to correlation with suspended sediment sampling and reservoir inflow and outflow. Also, many of these surveys were made according to reconnaissance standards, and most of the results obtained can be considered only as indicative. Most of the surveys, in addition, have been made without any study of the watershed conditions which are one of the primary casual factors in determining the rate of sedimentation.

Present programs of the Bureau of Reclamation and Corps of Engineers provide for periodic sedimentation surveys of constructed reservoirs in connection with normal maintenance and operations. No program for additional reservoir sedimentation surveys is presented herein. However, it can be assumed that the present programs will be continued.

Valley and channel sedimentation surveys. Present programs of the Corps of Engineers and Bureau of Reclamation in connection with operation and maintenance of constructed projects provide for channel sedimentation



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surveys of reservoirs, flood water tanks and farm ponds  
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with respect to corrosion with sedimentation  
sampling and reservoir failure and erosion. Thus, many of  
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standards, and most of the results obtained can be  
considered only as qualitative. Most of the surveys  
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watered conditions which are one of the primary causal  
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Corps of Engineers provide for periodic sedimentation  
surveys of constructed reservoirs in connection with  
normal maintenance and operation. In the future  
additional reservoir sedimentation surveys are proposed  
herein. However, it can be assumed that the present  
program will be continued.

Vegetation and channel sedimentation surveys.  
Programs of the Corps of Engineers and Bureau of  
Reclamation in connection with operation and maintenance  
of constructed projects provide for channel sedimentation



surveys in streams where problems of channel aggradation or degradation are related to their projects. Channel sedimentation surveys are also occasionally made in connection with authorized or proposed projects.

Data collected in connection with these programs are principally limited to downstream reaches along major streams. Only a limited amount of sedimentation data are available on upper reaches of stream channels and in small valleys along tributary streams.

No program for additional valley and channel sedimentation surveys is outlined. The existing programs of the Corps of Engineers and Bureau of Reclamation appear to be adequate to meet the needs for such surveys on main stem streams, and will no doubt be continued. A program for additional sedimentation surveys for small valleys along tributary streams is not believed justifiable.



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TABLE IV  
RIVER AND RESERVOIR STATIONS IN NEW MEXICO

## CANADIAN BASIN

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem. Qual.	Temp.	Sed.	Res.St. & Cont.
1	Cimarron River nr Guy, N.M.	x				
2	Canadian River nr Hebron, N.M.	x				
3	Vermejo River nr Dawson, N.M.	x				
4	Eagle Nest Reservoir					x
5	Cimarron River below Eagle Nest Dam	x				
6	Cimarron River nr Cimarron, N.M.	x				
7	Ponil Creek nr Cimarron, N.M.	x				
8	Rayado River at Sauble Ranch nr Cimarron, N.M.	x				
9	Rayado River nr Miami, N.M.	x				
10	Cimarron River at Springer, N.M.	x				
11	Canadian River nr Taylor Springs, N.M.	x				
12	Canadian River nr Roy, N.M.	x				
13	Mora River nr Holman, N.M.	x				

(Cont'd)



TABLE IV  
RIVER AND RESERVOIR STATIONS IN NEW MEXICO

Sta- tion No.	Station	Instrumentation	
		Stage Gage, S. G., & Qual.	Temp., Sed., Diss. Sol., & Cond.
1	Garrison River nr Guy, N.M.	x	
2	Canadian River nr Hebron, N.M.	x	
3	Verdejo River nr Lawson, N.M.	x	
4	Bagle Reservoir		x
5	Garrison River below Bagle Res Dam	x	
6	Garrison River nr Garrison, N.M.	x	
7	Lonli Creek nr Garrison, N.M.	x	
8	Verdejo River at Sandie Ranch nr Garrison, N.M.	x	
9	Verdejo River nr Miami, N.M.	x	
10	Garrison River at Springer, N.M.	x	
11	Canadian River nr Taylor Springs, N.M.	x	
12	Canadian River nr Roy, N.M.	x	
13	Mora River nr Holman, N.M.	x	

(Cont'd)



## CANADIAN BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res.St.
14	Mora River at La Cueva, N.M.	x				
15	Mora River nr Golondrinas, N.M.	x				
16	Coyote Creek nr Holman, N.M.	x				
17	Coyote Creek nr Golondrinas, N.M.	x				
18	Mora River nr Shoemaker, N.M.	x				
19	Canadian River nr Sanchez, N.M.	x				
20	Conchas River at Variadero, N.M.	x				
21	Conchas Reservoir at Conchas Dam, N.M.					x
22	Bell Ranch Canal nr Conchas Dam, N.M.	x				
23	Conchas Canal below Conchas Dam, N.M.	x				
24	Canadian River below Conchas Dam, N.M.	x				
25	Ute Creek nr Bueyeros, N.M.	x				
26	Ute Creek nr Logan, N.M.	x				
27	Canadian River at Logan, N.M.					x

(Cont'd)



CANADIAN BASIN (Cont'd)

Station No.	Station Name	Instrumentation
14	Mora River at La Grava, N.M.	x
15	Mora River nr. Colandrea, N.M.	x
16	Coyote Creek nr. Holman, N.M.	x
17	Coyote Creek nr. Colandrea, N.M.	x
18	Mora River nr. Shoemaker, N.M.	x
19	Canadian River nr. Sanchez, N.M.	x
20	Concha River at Valadero, N.M.	x
21	Concha Reservoir at Concha Dam, N.M.	
22	Self Health Canal nr. Concha Dam, N.M.	x
23	Concha Canal below Concha Dam, N.M.	x
24	Canadian River below Concha Dam, N.M.	x
25	Ute Creek nr. Inyoro, N.M.	x
26	Ute Creek nr. Logan, N.M.	x
27	Canadian River at Logan, N.M.	x

(Cont'd)



## RIO GRANDE BASIN

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem. Qual.	Temp.	Sed.	Res. St. & Cont.
28	Costilla Creek below Costilla Dam, N.M.	x				
29	Costilla Creek nr Costilla, N.M.	x				
30	Costilla Creek nr Garcia, Colo.	x				
31	Costilla Creek nr Jaroso, Colo.	x				
32	Latir Creek nr Cerro, N.M.	x				
33	Rio Grande nr Cerro, N.M.	x				
34	Red River nr Red River, N.M.	x				
35	Red River nr Questa, N.M.	x				
36	Cabresto Creek nr Questa, N.M.	x				
37	Red River nr mouth nr Questa, N.M.	x				
38	Rio Hondo nr Valdez, N.M.	x				
39	Rio Hondo at Arroyo Hondo, N.M.	x				
40	Rio Taos nr Ranchos de Taos, N.M.	x				
41	Rio Taos at Los Cordovas, N.M.	x				
42	Rio Grande below Taos Junction Br.	x				

(Cont'd)



RIO GRANDE BASIN

Station No.	Station	Instrumentation
28	Castilla Creek below Castilla Dam, N.M.	x
29	Castilla Creek nr Castilla, N.M.	x
30	Castilla Creek nr Garcia, Colo.	x
31	Castilla Creek nr Jaroso, Colo.	x
32	Little Creek nr Jaroso, N.M.	x
33	Rio Grande nr Jaroso, N.M.	x
34	Red River nr Red River, N.M.	x
35	Red River nr Arroyo, N.M.	x
36	Castro Creek nr Castro, N.M.	x
37	Red River nr Castro, N.M.	x
38	Rio Grande nr Valderrama, N.M.	x
39	Rio Grande at Arroyo Grande, N.M.	x
40	Rio Grande nr Rancho de las Cabezas, N.M.	x
41	Rio Grande at Los Hornos, N.M.	x
42	Rio Grande below Face Junction nr Face Junction, N.M.	x

(Cont'd)



## RIO GRANDE BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem. Qual.	Temp.	Sed.	Res.St. & Cont.
43	Carson Reservoir nr Carson, N.M.					x
44	Embudo Creek nr LLano, N.M.	x				
45	Embudo Creek at Dixon, N.M.	x				
46	Rio Grande at Embudo, N.M.	x		x	x	
47	Rio Chama at Park View, N.M.	x				
48	El Vado Reservoir					x
49	Rio Chama below El Vado Dam, N.M.	x				
50	Rio Chama nr Abiquiu, N.M.	x			x	
51	Rio Ojo Caliente at La Madera, N.M.	x				
52	Rio Chama nr Chemita	x		x	x	
53	Rio Santa Cruz at Cundiyo, N.M.	x				
54	Rio Grande at Otowi Bridge, N.M.	x	x	x	x	
55	Sili Main Canal Heading	x				
56	Cochiti East Side Main Canal Heading	x				
57	Rio Grande at Cochiti, N.M.	x				
58	McClure Reservoir					x
59	Santa Fe Creek nr Santa Fe, N.M.	x				

(Cont'd)



RIO GRANDE BASIN (Cont'd)

Station No.	Location	Stage Chem. Temp. Sed. Res. S. C. Cont.	Investigation
43	Garson Reservoir nr Garson, N.M.	x	
44	Embudo Creek nr Llano, N.M.	x	
45	Embudo Creek at Dixon, N.M.	x	
46	Rio Grande at Embudo, N.M.	x	
47	Rio Grande at Park View, N.M.	x	
48	El Vado Reservoir		
49	Rio Grande below El Vado Dam, N.M.	x	
50	Rio Grande nr Adiquia, N.M.	x	
51	Rio Ojo Caliente at La Habera, N.M.	x	
52	Rio Grande nr Questa	x x	
53	Rio Santa Cruz at Gumbly, N.M.	x	
54	Rio Grande at Snow Bridge, N.M.	x x x	
55	Bill Main Canal Heading	x	
56	Cochiti West Side Main Canal Heading	x	
57	Rio Grande at Cochiti, N.M.	x	
58	McIntire Reservoir	x	
59	Santa Fe Creek nr Santa Fe, N.M.	x	

(Cont'd)



## RIO GRANDE BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res, St. & Cont.
60	Nichols Reservoir					x
61	Galisteo Creek at Domingo, N.M.	x		x	x	
62	Rio Grande at San Felipe, N.M.	x				
63	Albuquerque Main Canal at Algodones, N.M.	x				
64	Jemez River nr Bernalillo, N.M.	x				
65	Jemez Reservoir					x
66	Jemez River below Jemez Reservoir	x		x	x	
67	Rio Grande nr Bernalillo, N.M.	x		x	x	
68	Arenal Main Canal at Albuquerque, N.M.	x				
69	Rio Grande at Albuquerque, N.M.	x				
70	Barr Canal at Albuquerque, N.M.	x				
71	Barr Canal at End, nr Isleta, N.M.	x				
72	Chical Lateral at Head at Isleta, N.M.	x				
73	Peralta Main Canal nr Isleta, N.M.	x				

(Cont'd)



RIO GRANDE BASIN (Cont'd)

Station No.	Station	Instrumentation	Stage Chem. Temp. Sed. Res. St.
60	Nichols Reservoir		
61	Gelisco Creek at Domingo, N.M.	x	x
62	Rio Grande at San Felipe, N.M.	x	
63	Albuquerque Main Canal at Algodones, N.M.	x	
64	James River at Bernillo, N.M.	x	
65	James Reservoir		x
66	James River below James Reservoir	x	x
67	Rio Grande at Bernillo, N.M.	x	x
68	Arenal Main Canal at Albuquerque, N.M.	x	
69	Rio Grande at Albuquerque, N.M.	x	
70	Barr Canal at Albuquerque, N.M.	x	
71	Barr Canal at Sand, near Laleta, N.M.	x	
72	Ortiz Lateral at Head at Laleta, N.M.	x	
73	Peters Main Canal at Laleta, N.M.	x	

(Cont'd)



## RIO GRANDE BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res.St. & Cont.
74	Chical Acequia at Head at Isleta, N.M.	x				
75	Cacique Acequia at Head at Isleta, N.M.	x				
76	Belen High-line Canal nr Isleta, N.M.	x				
77	Rio Grande nr Belen, N.M.	x				
78	San Juan Canal nr Bosque, N.M.	x				
79	Rio Grande nr Bernardo, N.M.	x			x	
80	San Juan Canal nr Bernardo, N.M.	x				
81	Rio Puerco above Chico Arroyo nr Guadalupe, N.M.	x		x		x
82	Chico Arroyo nr Guadalupe, N.M.	x		x		x
83	Bluewater Creek below Bluewater Dam, N.M.	x				
84	Bluewater Creek nr Bluewater, N.M.	x				
85	Bluewater Creek at Grants, N.M.	x				
86	San Jose River nr Grants, N.M.	x				
87	San Jose River at Correo, N.M.	x		x		x

(Cont'd)



RIO GRANDE BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation
74	Chical Acuña at Head of Lafeta, N.M.	x
75	Cadizo Acuña at Head of Lafeta, N.M.	x
76	Belen High-Line Canal nr Lafeta, N.M.	x
77	Rio Grande nr Belen, N.M.	x
78	San Juan Canal nr Bosque, N.M.	x
79	Rio Grande nr Bernardo, N.M.	x
80	San Juan Canal nr Bernardo, N.M.	x
81	Rio Tuques above Chico Arroyo nr Gadsbidge, N.M.	x x
82	Chico Arroyo nr Gadsbidge, N.M.	x x
83	Bluewater Creek below Bluewater Dam, N.M.	x
84	Bluewater Creek nr Bluewater, N.M.	x
85	Bluewater Creek at Grants, N.M.	x
86	San Jose River nr Grants, N.M.	x
87	San Jose River at Correo, N.M.	x x

(Cont'd)

Stage Chan. Equip. Fed. Res. St.  
S. Cont.



## RIO GRANDE BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res. St. & Cont.
88	Rio Puerco at Rio Puerco, N.M.	x		x	x	
89	Rio Puerco nr Bernardo, N.M.	x		x	x	
90	Rio Salado nr San Acacia, N.M.	x		x	x	
91	Socorro Main Canal at San Acacia, N.M.	x				
92	Rio Grande at San Acacia, N.M.	x	x	x	x	
93	Rio Grande at San Antonio, N.M.	x		x	x	
94	Socorro Main Canal nr San Antonio, N.M.	x				
95	San Antonio Riverside drain nr San Antonio, N.M.	x				
96	Elmendorff Interior Drain nr San Antonio, N.M.	x				
97	San Antonio Riverside drain nr San Marcial, N.M.	x				
98	Rio Grande above San Marcial, N.M.	x	x	x	x	
99	Rio Grande (Tiffany Channel) San Marcial, N.M.	x		x	x	
100	Rio Grande Headwaters Elephant Butte Res.	x				

(Cont'd)



RIO GRANDE BASIN (Cont'd)

Station No.	Location	Gravel	Sand	Silt	Clay	Shale	Coal	Other
88	Rio Puerco at Rio Puerco, N.M.	x	x	x				
89	Rio Puerco nr Bernardo, N.M.	x	x	x				
90	Rio Salado nr San Acacia, N.M.	x	x	x				
91	Soconito Main Canal nr San Acacia, N.M.	x						
92	Rio Grande nr San Acacia, N.M.	x	x	x				
93	Rio Grande nr San Antonio, N.M.	x	x					
94	Soconito Main Canal nr San Antonio, N.M.	x						
95	San Antonio River side drain nr San Antonio, N.M.	x						
96	Elmendorf Interior Drain nr San Antonio, N.M.	x						
97	San Antonio River side drain nr San Marcial, N.M.	x						
98	Rio Grande above San Marcial, N.M.	x	x	x				
99	Rio Grande (Tiffany Channel) San Marcial, N.M.	x	x					
100	Rio Grande Headwaters Stephens Lake Res.	x						

(Cont'd)



## RIO GRANDE BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res. St. & Cont.
101	Rio Grande (Main Channel) San Marcial, N.M.	x	x	x	x	
102	Rio Grande at the Narrows, Elephant Butte Res.	x				
103	Elephant Butte Reservoir					x
104	Rio Grande below Elephant Butte Dam, N.M.	x				
105	Caballo Reservoir					x
106	Rio Grande below Caballo Dam, N.M.	x				

## PECOS BASIN

107	Pecos River nr Pecos, N.M.	x				
108	Pecos River nr Anton Chico, N.M.	x				
109	Gallinas River nr Montezuma, N.M.	x				
110	Gallinas River at Montezuma, N.M.	x				
111	Gallinas River nr Lourdes, N.M.	x				
112	Gallinas River nr Colonias, N.M.	x				
113	Pecos River at Santa Rosa, N.M.	x				
114	Pecos River nr Puerto de Luna, N.M.	x	x	x	x	

(Cont'd)



Station No.	Station	Instrumentation
101	Rio Grande (Main Channel) San Marcel, N.M.	x x x x
102	Rio Grande at the Narrows, Elephant Butte Res.	x
103	Elephant Butte Reservoir	
104	Rio Grande below Elephant Butte Dam, N.M.	x
105	Gabillo Reservoir	
106	Rio Grande below Gabillo Dam, N.M.	

PECOS BASIN

107	Pecos River nr Pecos, N.M.	x
108	Pecos River nr Anton Chico, N.M.	x
109	Gallinas River nr Montezuma, N.M.	x
110	Gallinas River at Montezuma, N.M.	x
111	Gallinas River nr Lordsburg, N.M.	x
112	Gallinas River nr Gloria, N.M.	x
113	Pecos River at Santa Rosa, N.M.	x
114	Pecos River nr Puerto de Luna, N.M.	x x x x



## PECOS BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation			
		Stage & Q.	Chem.	Temp.	Sed. Res.St. & Cont.
115	Alamogordo Reservoir				x
116	Pecos River below Alamogordo Dam, N.M.	x	x		
117	Pecos River nr Fort Sumner, N.M.	x			
118	Pecos River nr Acme, N.M.	x	x	x	
119	Rio Ruidoso at Hollywood, N.M.	x			
120	Rio Ruidoso at Hondo, N.M.	x			
121	Rio Bonita at Hondo, N.M.	x			
122	Rio Hondo at Diamond A Ranch nr Roswell, N.M.	x		x	x
123	Rio Felix nr Hagerman, N.M.	x			
124	Pecos River nr Lake Arthur, N.M.	x			
125	Cottonwood Creek nr Lake Arthur, N.M.	x			
126	Pecos River nr Artesia, N.M.	x	x	x	x
127	Rio Penasco nr Daton, N.M.	x		x	x
128	Kaiser Lake-McMillan Channel nr Lakewood, N.M.	x			
129	Pecos River at Lake McMillan, N.M.	x			
130	McMillan Reservoir				x

(Cont'd)



PECOS BASIN (Cont'd)

Station No.	Station	Instrumentation
115	Alamogordo Reservoir	x
116	Pecos River below Alamogordo Dam, N.M.	x x
117	Pecos River nr Fort Sumner, N.M.	x
118	Pecos River nr Azusa, N.M.	x x
119	Rio Hondo at Hollywood, N.M.	x
120	Rio Hondo at Honda, N.M.	x
121	Rio Bonita at Honda, N.M.	x
122	Rio Hondo at Diamond A Ranch nr Hoyal, N.M.	x x
123	Rio Felix nr Hagerman, N.M.	x
124	Pecos River nr Lake Arthur, N.M.	x
125	Gottwood Creek nr Lake Arthur, N.M.	x
126	Pecos River nr Arcoata, N.M.	x x x
127	Rio Pecos nr Dalton, N.M.	x x
128	Kaiser Lake-Mellian Channel nr Lakewood, N.M.	x
129	Pecos River at Lake Mellian, N.M.	x
130	Mellian Reservoir	x

EFFICIENCY  
 BASED  
 ACCOUNT

(Cont'd)



## PEGOS BASIN (Cont'd)

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res.St. & Cont.
131	Pecos River below McMillan Dam, N.M.	x				
132	Pecos River at Dam Site 3 NR Carlsbad, N.M.	x	x			
133	Avalon Reservoir					x
134	Pecos River below Avalon Dam, N.M.	x	x			
135	East Canal at Head	x				
136	East Canal at Carlsbad, N.M.	x				
137	Carlsbad Main Canal at Head	x				
138	Pecos River at Carlsbad, N.M.	x	x	x		
139	Black River above Malaga, N.M.	x				
140	Pecos River nr Malaga, N.M.	x	x			
141	Pecos River at Pierce Canyon Crossing nr Malaga, N.M.	x	x	x		
142	Pecos River at Red Bluff, N.M.	x	x	x		
143	Delaware River nr Red Bluff, N.M.	x				
148	Rio Tularosa nr Bent, N.M. (Cont'd)	x				



Station No.	Location	Station	Instrumentation
131	Pecos River below McMillan Dam, N.M.	X	X
132	Pecos River at Dam Site & RR Carlsbad, N.M.	X	X
133	Avalon Reservoir		X
134	Pecos River below Avalon Dam, N.M.	X	X
135	East Canal at Head	X	
136	East Canal at Carlsbad, N.M.	X	
137	Carlsbad Main Canal at Head	X	
138	Pecos River at Carlsbad, N.M.	X	X
139	Black River above Malaga, N.M.	X	
140	Pecos River nr Malaga, N.M.	X	X
141	Pecos River at Pecos Canyon Crossing nr Malaga, N.M.	X	X
142	Pecos River at Red Bluff, N.M.	X	X
143	Lalawne River nr Red Bluff, N.M.	X	
144	Rio Tularosa nr Bent W.M.	X	



## SAN JUAN BASIN

Sta- tion No.	Station	Instrumentation			
		Stage & Q.	Chem.	Temp.	Sed. Res. St.
149	San Juan River at Rosa, N.M.	x			
150	Los Pinos at La Boca, Colo.	x			
151	Spring Creek at La Boca, Colo.	x			
152	Citizens Ditch nr Turley, N.M.	x			
153	San Juan River nr Blanco, N.M.	x	x	x	x
154	Animas River nr Cedar Hill, N.M.	x			
155	Animas River at Farmington, N.M.	x	x	x	x
156	San Juan River at Farmington, N.M.	x			
157	La Plata River at Colo.-N.M. State Line	x			
158	La Plata River nr Farmington, N.M.	x			
159	San Juan River at Shiprock, N.M.	x		x	x

## GILA BASIN

144	Bear Canyon nr Mimbres, N.M.	x			
145	Mimbres River nr Mimbres, N.M.	x			
146	Mimbres River nr Faywood, N.M.	x			

(Cont'd)



SAN JUAN BASIN

Sta-Station	Location	Remarks
149	San Juan River at Hose, N.M.	x
150	Los Hornos at La Posa, Colo.	x
151	Spring Creek at La Posa, Colo.	x
152	Gilman's Ranch at Tulay, N.M.	x
153	San Juan River at Blanco, N.M.	x x x x
154	Animas River at Gedar Hill, N.M.	x
155	Animas River at Farmington, N.M.	x x x x
156	San Juan River at Farmington, N.M.	x
157	La Plata River at Colo.-N.M. State line	x
158	La Plata River at Farmington, N.M.	x
159	San Juan River at Sipwood, N.M.	x x x

GILA BASIN

144	Beck Canyon at Blanco, N.M.	x
145	Animas River at Blanco, N.M.	x
146	Animas River at Raywood, N.M.	x

(Cont'd)



## GILA BASIN

Sta- tion No.	Station	Instrumentation				
		Stage & Q.	Chem.	Temp.	Sed.	Res. St. & Cont.
147	Mimbres Draw nr Silver City, N.M.	x				
160	Gila River nr Gila, N.M.	x				
161	Gila River nr Red Rock, N.M.	x				
162	Gila River below Blue Creek nr Virden, N.M.	x				
163	Sunset Canal nr Virden, N.M.	x				
164	New Model Canal nr Virden, N.M.	x				
165	San Francisco River nr Glenwood, N.M.	x				







## CHAPTER VII

### GROUND WATER INVESTIGATIONS

In water-resource development planning if the available water resource is to be utilized to the optimum extent it is necessary to have factual knowledge of ground water, its availability and quality, and to know its relation to surface supplies. Ground water investigations have been made for a relatively large part of the state. Most of these investigations have been made systematically by counties or other convenient units, but some have been confined to trouble areas in which difficulties from failing ground water resources already may have developed.

In large sections of the state ground water is the only practicable source of supply for essential needs. In other areas there will be alternatives between the development of either surface or ground water supplies to serve specific needs. The best plan of development can be determined only from detailed studies of both sources of supply. These studies would require detailed information on the occurrence, availability, quantity and quality of the ground waters as well as surface waters. In view of certain general advantages of ground water, particularly with regard to uniformity of quality and



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temperature, it is probable that in areas of intensive development good ground water reservoirs eventually will be developed to their optimum capacities.

The program of underground water investigations in New Mexico is conducted in cooperation with the Geological Survey, Water Resources Division, Ground Water Branch. The studies are generally of two principal types: (1) quantitative studies covering the areas of underground water irrigation; and, (2) studies which are generally reconnaissance in nature, covering broader areas. The quantitative studies provide the basic data needed by the State Engineer in administering underground water laws and by the public for information concerning underground water resources. The studies covering the broader areas give general information regarding the occurrence of underground water and provide the basis for determining areas of potential water supplies for stock, domestic and municipal use in addition to irrigation.

The investigations are basically aimed toward determining the quantity and chemical quality of the underground water available, its source and movement, the character, thickness, areal extent and depth below the surface of the water-bearing formations and the relation of underground water to stream flow. The scope and needs of the investigations are such that appreciable



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time is required for the collection and analysis of data and compilation of reports.

One important phase of the program is that involving the annual measurement of water levels in approximately 1,500 wells and bi-monthly measurements in a smaller number of wells, primarily in areas of heavy withdrawal. These data, together with information on pumpage and a knowledge of the characteristics of each basin, indicate the part played by pumpage and recharge in the general year-to-year change in water level, and assist in pointing out areas of over-development or areas where additional development might be permitted.

Plate 5, showing the areas within the state covered by ground water investigations, indicates that a large portion of New Mexico has been investigated for the type of hydrologic data covered in this chapter. Additional programs will be initiated by the Office of the State Engineer in cooperation with the U.S. Geological Survey as needs are anticipated or as finances warrant. Continuing evaluation of ground water supplies and records of water levels and pumpage will expand with the economic development of the state.



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Continuing evaluation of ground water supplies and records of water levels and pumps will expand with the economic development of the state.



## CHAPTER VIII

### CONCLUSIONS

It is generally recognized that the level of economic development of New Mexico will depend directly on the availability of adequate water. Furthermore, a static level of development may soon be attained unless additional conservation facilities are provided. The solution to this problem will involve the understanding and support by the general public along with those specific agencies dedicated to that purpose. Direct contact with this problem by most of the citizens of the state tends to inspire an individual alertness which is warranted in view of the possibility of water limitation. The continued threatened shortage of water for municipal and domestic use could drastically affect the economic condition of the state by a curtailment of industrial expansion and severe limitation of farming and ranching. The first step toward guarding against this crisis would be to know the water resources and potentialities which can only be derived from hydrologic data.

The basic data program as developed herein could be used to initiate a coordinated hydrologic collection program for New Mexico. This program could be circulated to all interested federal and state agencies for the



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The basic data program as developed herein could be used to initiate a coordinated hydrologic collection program for New Mexico. This program could be circulated to all interested federal and state agencies for the



addition of stations which they felt were needed, indication of purpose that each proposed record would serve, and indication of urgency of need. The follow-up should include numerical values, based on relative agency interest and urgency of need for each item. After each agency has had an opportunity to review the program thoroughly the final program to be recommended would probably be decided at the conference table with representatives from all agencies present.

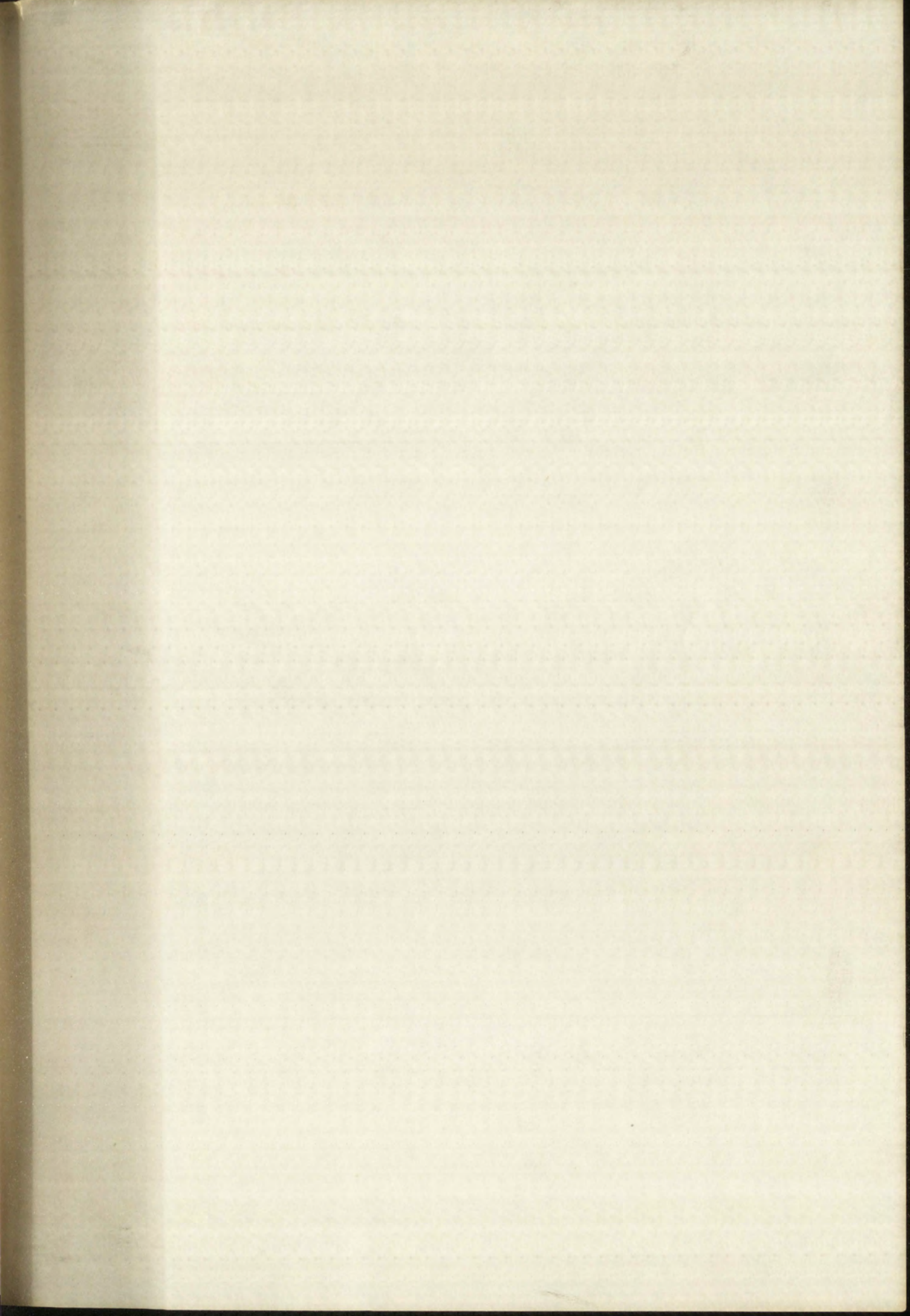
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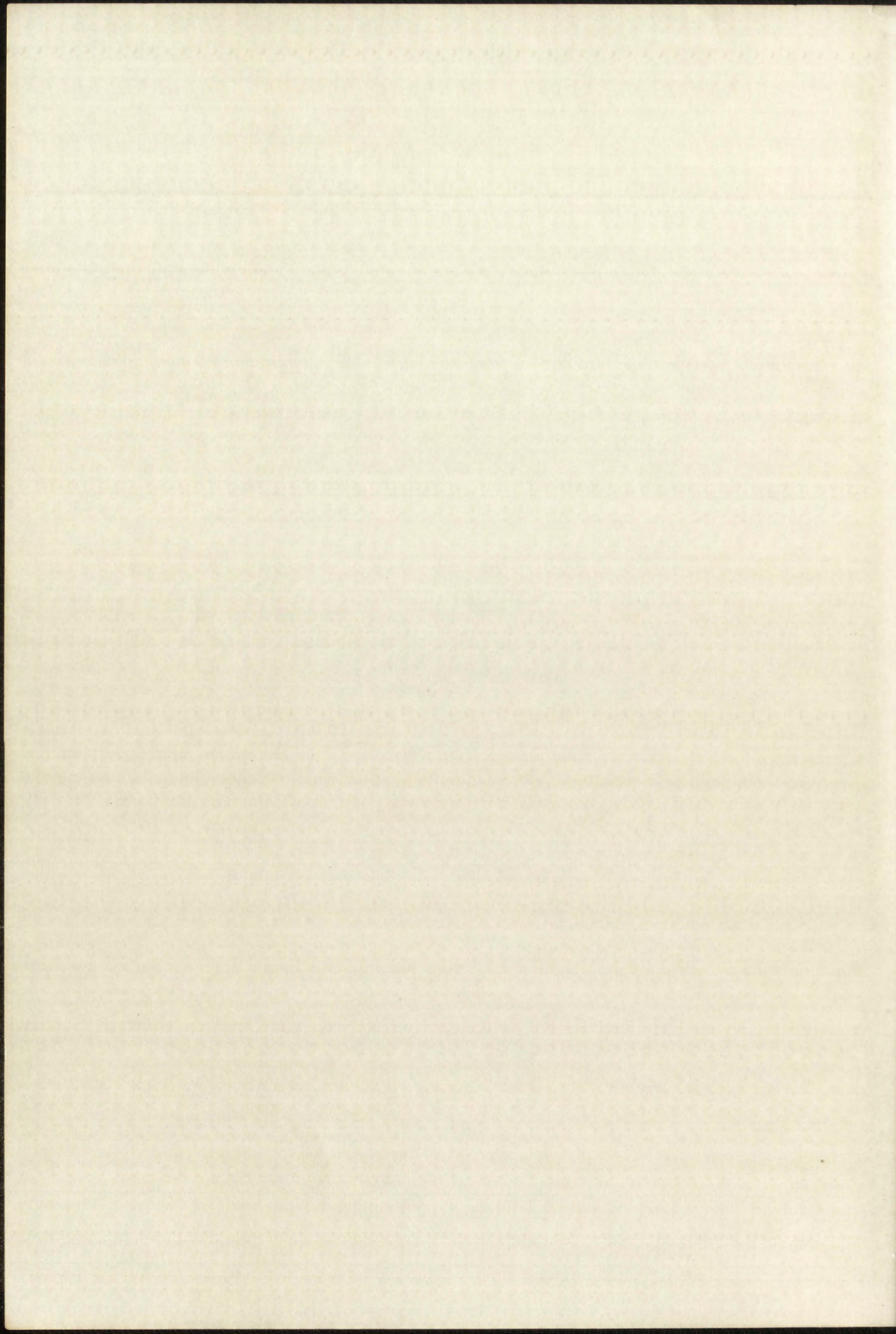
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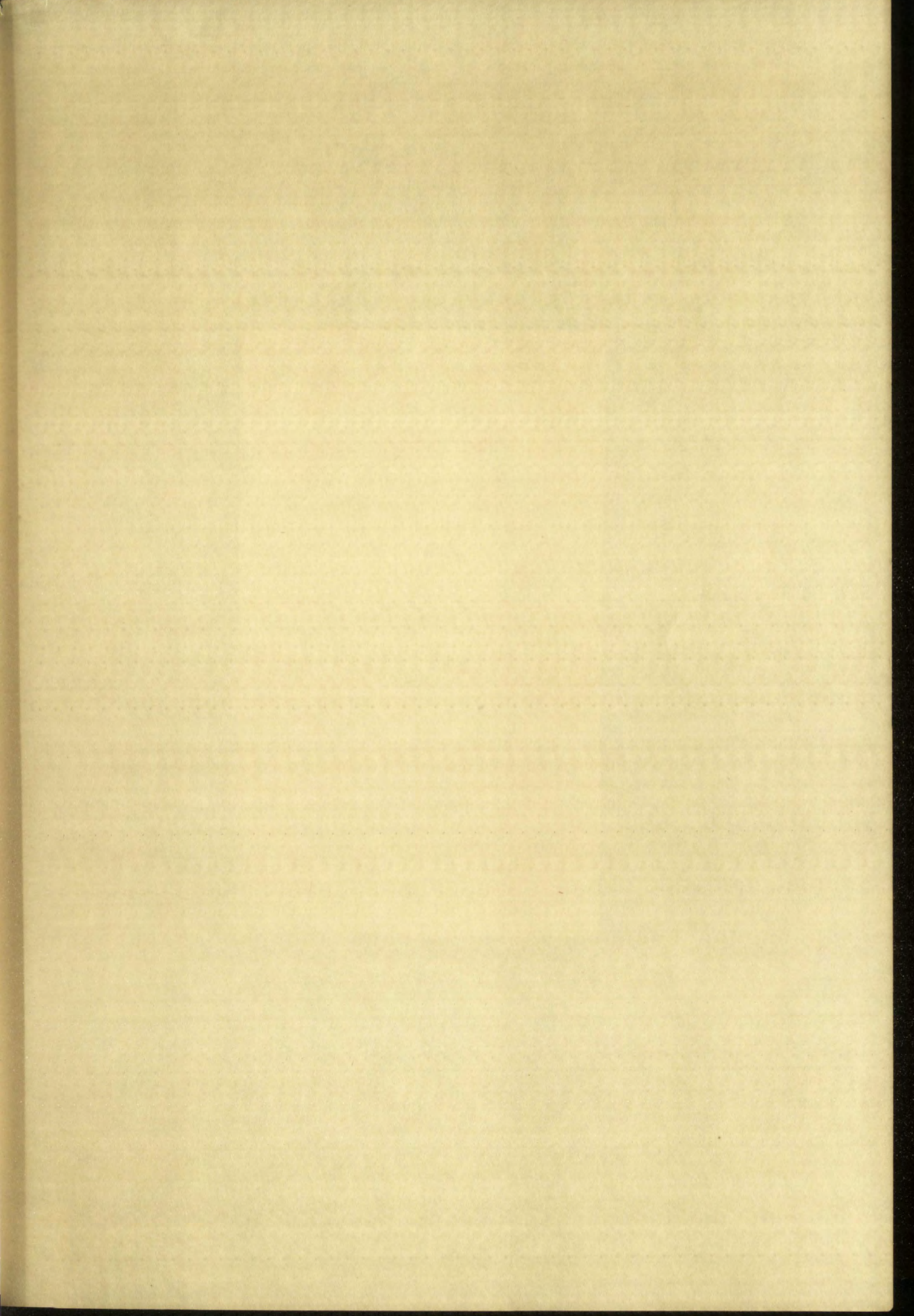


















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