Appendix A to the Master Water Control Manual
Rio Grande Basin

WATER CONTROL MANUAL

ABIQUIU DAM

Rio Chama, New Mexico

U.S. Army Corps of Engineers
South Pacific Division
Albuquerque District
Albuquerque, New Mexico

April 2024

ABIQUIU DAM AND RESERVOIR AERIAL IMAGES

RECORD OF CHANGES

Date of Change	Section Number of Change/ Complete Update	Summary of Change
October-1995	Initial version	
April-2024	Complete update	New authorization that requires updating the WCP. Specifically, allowing simultaneous storage of Rio Grande system water and SJ-C project water up to elevation 6,230.0 feet

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this water control manual be published in digital form in the central repository located at the following link:

https://cwbi-int.sec.usace.army.mil/dcp

The water control manual at the central repository will be considered the official manual and will be kept current at all times. Instructions and information to upload or document the review status of the water control manual, as per ER 1110-2-240, in the central repository portal can be found under the help tab in the portal.

It is not unexpected that USACE Corporate Information may move the central repository link to a new location. This information will be shared with all offices if a situation occurs by the HQUSACE.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, communication can be achieved by contacting appropriate water management personnel.

Directory of Regulation Personnel

USACE, Albuquerque District Personnel (Section)	Office Phone	Work Cell	Email Address
[redacted]	[redacted]		[redacted]
[redacted]	[redacted]		[redacted]
[redacted]	[redacted]		[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]

U.S. ARMY CORPS OF ENGINEERS

(ALBUQUERQUE DISTRICT/SOUTH PACIFIC DIVISION)

JANUARY 2024

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VERTICAL DATUM CONVERSION

In this water control manual, elevations for reservoir levels and project drawings are based upon the National Geodetic Vertical Datum of 1929 (NGVD 29) and have not been converted to the North American Vertical Datum of 1988 (NAVD 88) because of the desire to provide elevation data that is consistent with historical events and the original design drawings for the project. Unless otherwise stated, all elevations in this water control manual are provided in NGVD 29. Elevations at Abiquiu Dam and Reservoir should be converted between NGVD 29 and NAVD 88 cautiously. The delta elevations of points Abiquiu 2 and Abiquiu 3 are averaged to establish the conversion factor. Use the following equation to convert between vertical datums at Abiquiu Dam and Reservoir:

NGVD 29+3.33=NAVD 88

Point Name	NAVD 88 Elevation (feet)	NGVD 29 Elevation (feet)	Delta Elevation (feet)	Latitude	Longitude
Abiquiu Primary Datum Point	6,465.67			36.2430307207	-106.4300226261
Abiquiu 2	6,460.48	6,456.84	3.402	36.2413414922	-106.4292518212
Abiquiu 3	6,412.61	6,409.36	3.250	36.2402730540	-106.4262031504

UNIT CONVERSIONS AND UNITS OF MEASURE

English Units	To convert, multiply by:	Metric
in	2.54	cm
ft	0.3048	m
mi	1.609	km
ft^2	0.0929	m^2
ac	4047	m^2
ac	0.4047	ha
mi^2	2.59	km^2
ft^3	0.02832	m^3
ac-ft	0.001233	hm^3
ac-ft	1233	m^3
cfs	0.028317	m^3/s
mgd	0.04381	m^3/s
Slope in ft/mi	0.1894	m/km
ac-ft/mi^2	476.1	m^3/km^2
Temperature °F	(°F-32)×5/9	Celsius °C

DEFINITIONS AND COMMON TERMINOLOGY

Authorized Purpose—A purpose that a reservoir is to serve as given in laws may be grouped into the following categories: (1) laws initially authorizing construction of the project; (2) laws specific to the project passed subsequent to construction; and (3) laws that apply generally to all USACE reservoirs.

The District—The Albuquerque District of the United States Army Corps of Engineers.

Operating Purpose—A reservoir purpose for which water control management decisions are made. Either the volume of water retained in storage, the water surface elevation, or the rate of discharge is regulated to serve the stated purpose.

Operation—The physical manipulation of spillway gates, outlet works, or instrumentation associated with the projects for the adjustment of flow quantity and quality.

Outlet Works—Project outlet works or conduits required for passing flows to meet project functions or controlling reservoir levels (EM 1110-2-3600).

Project—USACE water resource engineering facilities, such as locks, dams, levees, reservoirs, navigation channels, etc. In this manual, “the project” refers to Abiquiu Dam and Reservoir.

Project Staff—Full-time and part-time personnel employed at Abiquiu Dam, including but not limited to Resource Manager, Ranger, Maintenance Mechanic, Student, Temporary, etc.

Regulation—(1) Water control procedures and decisions that normally are determined by regulating engineers (hydrologic or hydraulic) or (2) legal rules, agreements, or contracts (ER 1110-2-8156).

Non-damaging flow—Flow rate that the channel can safely carry with minimal damages to property. Ideally, releases would be made to not exceed channel capacities, but during certain events releases may exceed channel capacity in accordance with the water control plan to ensure the project’s structural integrity. Every effort should be made to prevent encroachments in the channel downstream of dams to achieve optimum flood risk management.

Run-of-River Operation (Hydropower)—The hydroelectric facilities shall be operated in a manner that assures no deviation from requirements dictated by the district for magnitude, frequency, and ramping rates of streamflow, nor adversely impact the district’s management of water quality being discharged from the dam.

Spillways—Gated or ungated structures used to release floodwater which normally cannot be passed by other water passage facilities at the dam; primarily to prevent overtopping of the dam (EM 1110-2-3600).

Water Control Management—The management of water resources and infrastructure by USACE to support authorized project purposes through implementation of the approved water control plan.

Water Control Projects—USACE water control projects include dams, local protection, levee systems, and navigation projects which store, regulate, divert, constrict, or convey surface waters in the United States.

Water Quality—The physical, chemical, biological, and radiological characteristics of surface and ground water affecting abiotic and biotic interrelationships.

Water Quality Benefits—Outcomes resulting from the appropriate management of water resource systems which serve to conserve, enhance, and protect the full spectrum of human and ecosystem needs.

Water Resource Management—Processes which promote the coordinated development and use of water, lands, and related resources in order to sustainably support economic, social, and ecological systems.

LIST OF ACRONYMS AND ABBREVIATIONS

AAR	After Action Report
AEP	Annual Exceedance Probability
AOP	Annual Operating Plan
asl	above sea level
cfs	cubic feet per second
CHAT	Climate Hydrology Assessment Tool
CIO/G6	USACE Information Technology
CMP	corrugated metal pipe
COOP	Continuity of Operations Plan
CWMS	Corps Water Management System
DCP	Drought Contingency Plan
DM	Design Memorandum
DO	dissolved oxygen
DSAP	Dam Safety Assurance Program
DSO	Dam Safety Officer
EA	Environmental Assessment
EAD	expected annual damage
EAP	Emergency Action Plan
EM	Engineering Manual, USACE
ER	Engineering Regulation, USACE
F	Fahrenheit
FCM	flood control mode
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FIRO	Forecast Informed Reservoir Operation
FY	fiscal year
GHCN	Global Historical Climatology Network

GOES	Geostationary Operational Environmental Satellite
H&H	Hydrology and Hydraulics
HDB	Hydrologic Database
HEC	Hydrologic Engineering Center
HEC-DSS	Data Storage System
HEC-FIA	Flood Impact Analysis
HEC-HMS	Hydrologic Modeling System
HEC-RAS	River Analysis System
HEC-ResSim	Reservoir System Simulation
HEC-SSP	Statistical Software Package
HMR	Hydrometeorological Report
hp	horsepower
HQUSACE	Headquarters USACE
IDF	Inflow Design Flood
IRRMP	Interim Risk-Reduction Measures Plan
LAC	Los Alamos County, New Mexico
LAC-CR	LAC powerhouse control room
LAC-DPU	Los Alamos County Department of Public Utilities
LAC-GH	LAC Gate House
LANL	Los Alamos National Laboratory
LiDAR	light detection and ranging
M&I	Municipal and Industrial
MOA	Memorandum of Agreement
mph	miles per hour
MRGCD	Middle Rio Grande Conservancy District
NAVD 88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NGVD 29	National Geodetic Vertical Datum of 1929

NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
NWS-WGRFC	West Gulf River Forecast Center
NWS-WFO	Weather Forecast Office
OPM	Operations Project Manager
PA	Periodic Assessment
PAR	population at risk
PCB	polychlorinated biphenyl
PDF	Project Design Flood
PDSI	Palmer Drought Severity Index
PET	potential evapotranspiration
PGM	power generation mode
PI	Periodic Inspection
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PRV	pressure relief valve
QPE	Quantitative Precipitation Estimate
QPF	Quantitative Precipitation Forecast
RAWS	Remote Automated Weather Station
RCAA	Rio Chama Acequia Association
RDF	Reservoir Design Flood (original project SDF)
RFC	River Forecast Center, NWS
RM	river mile
RPVD	Reclamation Project Vertical Datum

RSI	Reservoir Sedimentation Information
SDF	Spillway Design Flood
SJ-C	San Juan-Chama
SNOTEL	Snow Telemetry
SPA	Albuquerque District, USACE
SPD	South Pacific Division, USACE
SPF	Standard Project Flood
TA3	County Dispatch Center
Tmax	maximum temperature in degrees Fahrenheit
Tmin	minimum temperature in degrees Fahrenheit
TSV	Turbine Shutoff Valves
U.S.	United States
URGWOM	Upper Rio Grande Water Operation Model
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
VoIP	Voice over IP
WCM	Water Control Manual
WCP	Water Control Plan
WGRFC	West Gulf River Forecast Center
WFO	Weather Forecast Office, NWS
WMS	Water Management Section, Albuquerque District, USACE

ABIQUIU DAM AND RESERVOIR PERTINENT DATA (SHEET 1 OF 2)

GENERAL	
Location of Dam	7.8 miles Northwest of Abiquiu, New Mexico
County	Rio Arriba County
River and River Mile	Rio Chama, 32 river miles above the confluence with the Rio Grande
1-inch Runoff Volume above Abiquiu Dam and Reservoir	114,453 acre-feet (2,146 square miles)
DAM	
Type	Rolled earthfill
Crest Elevation	6,381.0 feet
Maximum Base Width	2,000 feet
Crest Width	30 feet
Height above Streambed	341 feet
Crest Length	1,800 feet
Date of Closure	February 1963
SPILLWAY	
Location	4,000 feet north of left abutment
Type	Uncontrolled Spillway
Crest Elevation	6,350.0 feet
Length	2,600 feet
Bottom Width	68 feet
Discharge Capacity at Maximum Water Surface	24,000 cfs at elevation 6,374.0 feet
OUTLET WORKS	
Power Penstocks	126-inch diameter (steel lined)
Location	Left abutment of dam
Rated Capacity (175-foot design head)	1,500 cfs
Intake elevation CL	6,050.0 feet
River Outlets	134-inch diameter (steel lined)
Location	Along the left abutment
Discharge Capacity (Maximum pool)	7,700 cfs at pool elevation 6,374.0 feet
Intake Elevation CL	6,060.0 feet
Turbine Intakes	Two, 76.0-inch diameter; One, 72-inch diameter
Location	Left abutment of dam
Discharge	1,500 cfs at elevation 6,220.0 feet
Intake Elevation CL	6,050.0 feet
POWER PLANT	
Generators	Two, Vertical Shaft at 6,900 kW One, Horizontal Shaft at 3,200 kW
Plant Capacity	17,000 kW
Maximum Head	255 feet

ABIQUIU DAM AND RESERVOIR PERTINENT DATA (SHEET 2 OF 2)

GOVERNMENT-OWNED LAND AND EASEMENTS	Elevation (feet)		Area (acres)
Flood Control Zone	6,060.0–6,293.5		6,133
Land Acquired in Fee	6,215 (taking line)		2,860.4
RESERVOIR USE	**Elevation Limits (feet)**		**Capacity (acre-feet)**
Surcharge Zone	6,350.0–6,374.0		338,048
Induced Surcharge Zone	6,283.5–6,350.0		656,342
Exclusive Flood Control Zone	6,230.0–6,283.5		326,579
Joint Use Flood Control and Conservation Zone	6,060.0–6,230.0		229,199
RESERVOIR POOLS	**Elevation (feet)**	**Gross Area (acres)**	**Gross Storage (acre-feet)**
Top of Dam	6,381.0	16,529	1,662,770
Maximum Pool	6,374.0	15,639	1,550,168
Spillway Crest	6,350.0	12,606	1,212,120
Top of Flood Control Pool	6,283.5	7,656	555,778
Top of Joint Use (Flood Control and Conservation)	6,230.0	4,691	229,199
Zero Storage	6,080.0	0	0
Conduit Invert	6,060.0	0	0
DESIGN FLOODS			
Spillway Design Flood			
Volume and Peak Flow	504,000 acre-feet; 429,000 cfs		
Standard Project Flood			
1941 Volume and Peak	454,250 acre-feet; 6,600 cfs (April through June)		

CHAPTER 1—INTRODUCTION

1-01 AUTHORIZATION

This manual was prepared in compliance with the following authorities and directives:

- Engineering Regulation (ER) 1110-2-240, Water Control Management, 30 May 2016
- ER 1110-2-8156, Preparation of Water Control Manuals, 30 September 2018

Construction of Abiquiu Dam and Reservoir was authorized by the Flood Control Act of 1948, Public Law 80-858, 80th Congress, Chapter 771, 2nd Session and in the Flood Control Act of 1950, Public Law 81-516, 81st Congress, Chapter 188, 2nd Session.

1-02 PURPOSE AND SCOPE

This manual is applicable to the Abiquiu Dam and Reservoir. Water management activities prescribed comply with all applicable federal laws and regulations, including the Flood Control Act of 1944 and the Water Resource Development Acts of various years and those laws listed in Appendices A and B of ER 1110-2-240, Water Control Management.

This manual presents the general plan of regulation for Abiquiu Dam and Reservoir. The manual serves as documentation of the plan for water control and is a reference source for higher authority and for personnel responsible for water control management during the life of the project. Additionally, the manual contains background information pertinent to objectives and applications of water management schedules, as well as results of project operation simulations for specific purposes and conditions.

This water control manual (WCM) includes descriptions of the project's authorized purposes, project features, project history, watershed characteristics, data collection and communication networks, forecast methodology, water control plan (WCP), effect of the WCP, and water control management.

Development of this plan and implementation of regulatory strategies uses a systems approach considering hydrologic and ecological relationships within and among systems, comprehensive scope, multiple users, project purposes, and economic impacts throughout the system. Risk and uncertainty analysis and the need to effectively communicate the concept of risk to the public were considered in the preparation of this manual.

This manual addresses USACE's role as an environmental steward and activities prescribed are guided by the USACE Environmental Principles in accordance with authorized or approved purposes and comply with the National Environmental Policy Act (NEPA) as provided in ER 200-2-2 and other applicable environmental laws, executive orders, and regulations. Policies for project operations support enhanced ecosystem sustainability whenever compatible with other project purposes.

1-03 RELATED MANUALS AND REPORTS

This WCM supersedes the 1995 Abiquiu Dam and Reservoir Water Control Manual, Appendix A to the Master Water Control Manual, Rio Grande Basin. Table 1-1 lists manuals and reports pertinent to Abiquiu Dam and Reservoir (see Supplemental Tables).

1-04 PROJECT OWNER

The United States Government has full title, ownership, and fee control of all U.S. Army Corps of Engineers (USACE) reservoir and lake lands including Abiquiu Dam and Reservoir and operating structures.

1-05 OPERATING AGENCY

Albuquerque District operates Abiquiu Dam and Reservoir. The project office is staffed Monday through Friday from 0730 to 1600 hours local time. The Incorporated County of Los Alamos Department of Public Utilities (LAC-DPU) operates the hydroelectric power plant.

Abiquiu Dam and Reservoir Project Office
4731 State Highway 96
Abiquiu, New Mexico 87510
Office Phone: 505-685-4371
Fax Number: 505-685-4647

1-06 REGULATING AGENCIES

The Albuquerque District is responsible for the regulation of the project (see Chapter 9 for details). The Albuquerque District is responsible for setting the flows to be maintained by the hydroelectric power facility. The LAC-DPU has the direct responsibility to ensure that the power facility operation follows USACE's reservoir regulation schedule.

1-07 VERTICAL DATUM

As part of the Comprehensive Evaluation of Project Datums in 2010, North American Vertical Datum of 1988 (NAVD 88) elevations were established on several benchmarks. The average of two of those points established the conversion factor of -3.33 feet from NAVD 88 to National Geodetic Vertical Datum of 1929. For consistency Abiquiu Dam uses NGVD 29 to provide elevation data that is consistent with historical events and the original design drawings for the project.

CHAPTER 2—DESCRIPTION OF PROJECT

2-01 LOCATION

Abiquiu Dam and Reservoir is located at river mile (RM) 32.0 on the Rio Chama, upstream from its confluence with the Rio Grande which is at RM 1,621 above the mouth of the Rio Grande in the Rio Grande Basin. The dam is approximately 7.8 miles northwest of Abiquiu, New Mexico, in Rio Arriba County (latitude: 36.2380, longitude: -106.4266). Plate 2-1 is a system map illustrating the location of the Abiquiu Dam within the Rio Grande Basin. Plate 2-2 shows the location of the Abiquiu Dam in the Rio Chama Watershed.

2-02 PURPOSE

Abiquiu Dam and Reservoir is operated primarily for flood risk management, sediment control and water supply. Recreation, fish and wildlife conservation, and hydroelectric power generation are incidental benefits. LAC-DPU owns and operates the hydroelectric powerplant. Section 7-01 contains more details on project purposes.

a. Purposes Assigned by Congress

Congress authorized the construction of Abiquiu Dam for Flood Control and Sediment Control purposes with the Flood Control Acts of 1948 (Public Law 80-858) and 1950 (Public Law 81-516).

b. Purposes Subsequently Assigned by Congress

The Flood Control Act of 1960 (Public Law 86-645, Exhibit B) modified flood control operations. Public Law 97-140, Public Law 100-522 and Public Law 116-260 authorized the storing of transmountain and Rio Grande system water for water supply purposes.

c. Purposes Contained in or Derived from Congressional Acts

This project has no purposes contained in or derived from general congressional acts.

d. Incidental Benefits

Recreation and fish and wildlife conservation are incidental benefits of water supply storage in Abiquiu Reservoir. Hydroelectric power generation is also an incidental benefit, which is provided by the hydroelectric powerplant that operates as a run-of-river project. Hydroelectric power generation is authorized by the Federal Power Act, as amended (16 U.S.C. § 791a *et seq.*).

2-03 PHYSICAL COMPONENTS

Plate 2-3 shows the physical components of Abiquiu Dam, and they are described below.

a. Embankment

The embankment is a rolled earthfill structure with a crest length of 1,800 feet and a crest width of 30 feet. The top of the dam is at elevation 6,381.0 feet and is approximately

341 feet above the streambed. The embankment section consists of a centrally located impervious core and cutoff trench through the streambed alluvium. Upstream sections consist of random and waste-fill with a free-draining wedge of pervious-fill in the critical drawdown area. The downstream section of random-fill is enveloped with free draining blankets.

The top 16 feet of the embankment are a dam safety modification consisting of random-fill on the upstream side and impervious-fill on the downstream side. Upstream slope protection from elevation 6,190.0 feet to the crest consists of a 6-foot-thick blanket of dumped sandstone rock placed on the pit-run pervious fill wedge. The exposed 1V:5H slope of waste-fill material below berm elevation 6,190.0 feet, has no formal protection. Downstream slope protection consists of a 2-foot-thick dumped sandstone, placed on a pervious-fill blanket.

The drainage blankets in the downstream section, abutment blankets downstream from the core, inclined chimney, and the streambed blanket all aid in the prevention of saturation of the random-fill section. The downstream berm at elevation 6,060.0 feet is below the maximum tailwater elevation of 6,067.0 feet and is a continuation of the pervious streambed blanket. The downstream rock toe, which is founded on primary formation below the streambed alluvium, provides embankment protection against streambed degradation. The rock toe is an extension of existing protection works constructed downstream and adjacent to the flip bucket. A 48-inch diameter corrugated metal pipe (CMP) toe drain was added in 1979 as a result of continued seepage observed from both abutments and concerns that the horizontal drainage blanket could be overwhelmed and that the rock toe (900 feet downstream of the dam) could be blocked by sediment. Plate 2-4 shows the current embankment plan and section.

b. Spillway

The uncontrolled spillway is through a natural saddle about 4,000 feet north of the left abutment. Excavated spillway material was principally sandstone interbedded with thin layers of shale. The spillway has a bottom width of 68 feet and a total length of about 2,600 feet. The crest elevation is 6,350.0 feet. No provisions were made to further stabilize the spillway section because spillway activation is expected to occur infrequently and there is relatively hard material in the spillway. The computed discharge through the spillway at the maximum water surface elevation of 6,374.0 feet is about 24,000 cfs. Spillway flows will enter the Rio Chama about 1,000 feet below the dam. Plate 2-5 shows the spillway plan, profile, and section.

c. Outlet Works

The outlet works consist of a tunnel, intake structure, gate chamber, closure gate, bypass valves, and flip bucket. The tunnel was bored through shale and sandstone along the left abutment and has a total length of about 2,260 feet. The tunnel upstream of the gate chamber is 12 feet in diameter, about 700 feet long and concrete lined. Downstream of the gate chamber, the tunnel is about 1,400 feet long and consists of a 134-inch diameter steel liner grouted inside of the original concrete lining. The invert elevation at the inlet to the conduit is 6,060.0 feet and at the outlet is 6,050.0 feet. A closure gate, located at the tunnel outlet just upstream of the flip bucket, diverts water to the hydroelectric power facility, which includes two 54-inch fixed cone valves and one 14-inch jet flow valve. Outlet works capacity at maximum water surface elevation of 6,374.0 feet is 7,700 cfs. Plate 2-6 shows the outlet works including the flip bucket.

The intake structure is 136 feet long and consists of a transition section with a maximum width of 30 feet at the upstream end. Trash bars consist of a grillwork of reinforced concrete beams which are grooved for stoplogs. Contiguous to the wing wall on the left side of the intake structure is a gage well with intake pipes at elevations 6,060.5 feet, 6,075.5 feet, 6,090.5 feet, and 6,105.5 feet. The top of the well is at elevation 6,112.0 feet. A manifold system of piping and valves permits entrance of reservoir water to the float well through the intake pipes and provides a means for water to flow to the high-head gage well located in the access shaft of the control chamber. A shelter, located over the gage well, houses a water level recorder for use when pool elevations are below 6,112.0 feet. The intake structure has slots to accommodate bulkhead gates. The bulkhead gates are stored in the maintenance yard and have to be placed utilizing a floating crane and divers.

A gate chamber, 40 feet in diameter, located near the midpoint of the tunnel, houses two 5-foot by 9-foot service slide gates and operating machinery. In 1999, emergency gates were installed upstream from the service gates. Access to the gate chamber is by a 16-foot diameter vertical shaft that extends from ground level down to the gate chamber. Contained in the shaft are an elevator, stairway, vent pipes with butterfly valves, and a gage well for recording pool elevations above 6,078.5 feet. The operations building over the shaft houses an overhead traveling crane and operating machinery, and provides space for a shop, general storage, equipment room, and office. Removal of gates or operating equipment for repairs or replacement will be done with the crane. The elevator is used for transporting personnel, small tools, and equipment. Two 36-inch diameter pipes provide air to the conduit behind the gates to prevent negative pressures.

The conduit transitions to the downstream cut and cover closure section and then terminates to a flip bucket located adjacent to the downstream left abutment and downstream of the embankment toe. The invert at the transition from conduit-to-conduit closure section is at elevation 6,050.26 feet. The invert at the transition from the conduit closure section to the flip bucket is at elevation 6,050.0 feet. The flip bucket is 125 feet long and varies in width from 12 to 33 feet. The lowest elevation of the flip bucket is 6,040.0 feet with an end sill at elevation 6,047.5 feet. The landward side of the flip bucket is parallel to the centerline to deflect flow away from the abutment. The flip bucket walls vary in height from 20 to 21.5 feet and include 6 feet of freeboard. At low flows, the bucket acts as a stilling basin.

d. Hydroelectric Power Facilities

The hydroelectric power plant facility owned and operated by LAC-DPU consists of an outlet tunnel steel liner, plenum chamber and closure gate, penstock, main powerhouse, low flow turbine powerhouse addition, tailrace, switchyard, and transmission line. Refer to Plate 2-7 for hydroelectric plant arrangement.

The outlet tunnel steel liner is approximately 1,400 feet long and consists of a 134-inch inside diameter welded steel liner with varying plate thickness. It extends from the end of the existing steel lining of the USACE service gates transition in the bell chamber to the LAC-

DPU plenum chamber downstream. It is fully grouted in-place inside the existing concrete tunnel.

The plenum chamber and closure gate are located at the outlet works tunnel portal and provide the means to close and seal off the tunnel to convey flows to the powerhouse's penstock. The plenum is a conical welded steel liner, fully encased, and the closure gate is a 14-foot by 14-foot upstream-seal bulkhead gate with hydraulic operator. An operator building provides an enclosure for the gate and mechanical/electrical equipment.

The penstock is a welded pipeline of varying diameter and plate thickness, fully encased, joining the powerhouse to the plenum chamber. It has discharge branches designated for three bypass valves and three turbines.

The original main powerhouse structure houses two turbine-generators and appurtenant mechanical and electrical equipment. Each turbine-generator is rated at 6.9 MW and has a range of flow from 200 cfs to 625 cfs at elevation 6,220.0 feet. In addition, two 54-inch fixed cone bypass valves and one 14-inch jet flow bypass valve are located in the main powerhouse with a total bypass capacity of approximately 4,000 cfs at elevation 6,220.0 feet.

LAC-DPU constructed an addition to the main powerhouse in 2011 that houses a new low-flow turbine-generator unit and all necessary sub-systems. The third unit was installed to take advantage of river flows below the operating minimums of the two larger original units, as well as add to the overall combined total generation capacity. The low-flow unit is rated at 3.2 MW and has a range of flows from 75 cfs to 250 cfs at elevation 6,220.0 feet. The tailrace transition from powerhouse to river channel is constructed immediately downstream. It is about 70 feet wide and about 160 feet long. It transitions from approximately 30 feet deep at the powerhouse's downstream face up to the normal riverbed.

An outdoor step-up transformer at the powerhouse switchyard raises the voltage from 4.16 kV to 69 kV, where it feeds the transmission line. The line is about one mile long and runs in a northerly direction from the powerhouse to the Coyote switching station at U.S. Highway 84/96 junction.

After the additional turbine was installed and commissioned in 2011, the LAC-DPU hydroelectric power plant is capable of releasing water up to approximately 5,500 cfs. At full generation, the power plant is capable of producing 15 MW at approximately 1,500 cfs. Total combined nameplate ratings of 17.0 MW are unachievable due to penstock manifold pressure losses at higher flows. All flows below 75 cfs and above 1,500 cfs are released through a combination of the 3 bypass valves.

e. Water Supply Facilities

Abiquiu Dam does not have separate facilities for water supply releases. See Section 2-03 c, Outlet Works.

f. Reservoir

The reservoir, at maximum water surface elevation of 6,374.0 feet has a capacity of 1,550,168 acre-feet and a surface area of 15,639 acres. Reservoir and shoreline length at this elevation are 15 miles and 147 miles, respectively. Top flood control pool elevation is 6,283.5 feet with a storage capacity of 555,778 acre-feet and a surface area of 7,656 acres. Reservoir and shoreline length at this elevation are 11 miles and 88 miles, respectively. The conservation pool stores San Juan-Chama (SJ-C) project water and Rio Grande system water up to elevation 6,230.0 feet, a volume of 229,199 acre-feet, and a surface area of 4,691 acres. Reservoir and shoreline length at this elevation are 10 miles and 65 miles, respectively. A space of about 77,039 acre-feet was reserved for sediment deposition over the design life of 50 years. The last survey, conducted in April 2021, shows 23,297 acre-feet of sediment have been deposited.

2-04 RELATED CONTROL FACILITIES

Not applicable to this project.

2-05 REAL ESTATE ACQUISITION

Total land acquired for the Abiquiu Dam project is 9,679.9 acres. Land acquired in fee is 2,860.4 acres, which is blocked to a taking line elevation of 6,215.0 feet. Permanent easement land in the reservoir is 6,133.0 acres, which is blocked to elevation 6,293.5 feet. Land acquired for relocation of utilities and roads is 178.7 acres, which has been disposed to the owner. Plate 2-8 shows the Real Estate map.

2-06 PUBLIC FACILITIES

Recreational facilities consist of the Riana Campground containing 50 campsites, 14 tent sites, 1 group camp site, two shower buildings, sanitary dump station, playground, and amphitheater; Cerrito Day Use Area with two boat ramps, two courtesy boat docks, playground, 4 group campsites, 11 day use shelters, 6 vault toilets, and swim beach; Rio Chama Day Use Area with river access, 4 day-use shelters, and vault toilet; and two overlooks with 7 day-use shelters between them. Plate 2-9 shows recreation facility locations on a land use map.

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CHAPTER 3—HISTORY OF PROJECT

3-01 AUTHORIZATION FOR PROJECT

Congressional authority for the construction of Abiquiu Dam is contained in the Flood Control Act of 1948 (Public Law 80-858, 80th Congress, Chapter 771, 2nd Session) and in the Flood Control Act of 1950 (Public Law 81-516, 81st Congress, Chapter 188, 2nd Session). Flood Control Act of 1960 (Public Law 86-645) provided integrated operational procedures for all USACE reservoirs constructed as part of the Middle Rio Grande project (Abiquiu, Cochiti, Galisteo, and Jemez Canyon dams). The Abiquiu Dam project was to operate solely for flood control and sediment retention, with no permanent storage intended.

Public Law 97-140, 29 December 1981, authorized the Secretary of the Army, acting through the Chief of Engineers, to enter into agreements with entities which have contracted with the Secretary of the Interior for water from the SJ-C project. The authorization allowed for 200,000 acre-feet of SJ-C project water to be stored in Abiquiu Reservoir in the flood control space. Public Law 100-522, 24 October 1988, authorized the Secretary of the Army, acting through the Chief of Engineers, to store 200,000 acre-feet of Rio Grande system water at Abiquiu Dam, in lieu of the water storage authorized by Section 5 of Public Law 97-140, to the extent that contracting entities no longer require such storage. Public Law 116-260 (Sec. 337 of Water Resources Development Act of 2020, WRDA 2020) amended Public Law 100-522. The amendment allows for the simultaneous storage of SJ-C project water and Rio Grande system water up to elevation 6,230.0 feet to the extent that the necessary real property interests have been acquired by entities requesting such storage and direct the Secretary of the Army to amend or enter into new storage agreements.

3-02 PLANNING AND DESIGN

The Chamita project, as originally planned, provided for a high dam to be constructed at RM 5 on the Rio Chama. However, during the preconstruction planning stage, a superior plan was developed. This plan comprised of two dams, a low dam located at about the original site and a high dam at the Abiquiu Dam site (about 27 miles above the Chamita site on the Rio Chama). The superior plan was approved by the Senate and House Appropriations Committees during the fiscal year (FY) 1955 hearings. A restudy of the comprehensive plan of improvement for the Rio Grande Basin resulted in the construction of Cochiti Dam and the elimination of the proposed low dam at the Chamita site.

Original design plans of the Abiquiu Dam included uncontrolled flood control tunnel at top of the flood control elevation 6,283.5 feet to allow for uncontrolled releases when water elevation is above top of flood pool. However, this feature was never constructed.

As a result of provisions contained in the Dam Safety Assurance Program (DSAP), Abiquiu Dam was modified in 1985 to conform to updated NWS Probable Maximum Precipitation (PMP). Remedial work consisted of raising the dam by 13 feet to achieve needed freeboard requirements and widening the spillway to 68 feet so that the dam can safely pass the Probable Maximum Flood (PMF).

Los Alamos County (LAC), New Mexico, filed on 30 March 1984 an application with the Federal Energy Regulatory Commission (FERC) for a license under part I of the Federal

Power Act to construct, operate, and maintain the Abiquiu Hydroelectric Project. The LAC was issued a license by FERC on 16 April 1986. The hydroelectrical power facility was designed and built by LAC-DPU and was upgraded in 2011 to include low flow turbine.

3-03 CONSTRUCTION

Construction of Abiquiu Dam began in September 1956 and was completed and placed in operation in February 1963. Table 3-1 lists several modifications and additions to the dam that were constructed at later dates.

Table 3-1. Additions and Modifications to Abiquiu Dam

Year	Construction Description
1966	Addition of horizontal drains into the left abutment; grouting of the outlet works control shaft; adding 560-foot extension of the grout curtain into the left abutment.
1977	Addition of the Bulkhead gates; adding horizontal drains into the right abutment; adding 21 piezometers in the abutment and the embankment.
1978	Slope stabilization at the intake structures; 500-foot extension of the grout curtain into the right abutment; Removal of original rock toe and addition of a 48-inch CMP toe drain.
1985	13-foot embankment raise and 28-foot spillway widening to provide capacity to pass the revised Inflow Design Flood (IDF) and the PMF.
1986	Downstream left abutment slope stabilization (Phase I Bank Stabilization); Addition of 10 abutment and embankment piezometers.
1987	Start construction of the LAC-DPU’s hydroelectric power plant.
1988	Reinforced concrete rock bin constructed along downstream left abutment to protect flip bucket.
1990	Right and left abutment seepage control adits. LAC-DPU’s hydroelectric power plant became operational (owned, designed and built by LAC-DPU)
1999	Emergency gates added
2001	Reinforced concrete rock bin extended and rockfall fence installed along the downstream left abutment to protect flip bucket
2003	Downstream left abutment benches with wire mesh added (Phase II Bank Stabilization)
2009	Downstream left abutment benched, wire-mesh removed, and lower slope buttressed (Phase III Bank Stabilization)
2010	Piezometers automated to collect 15-minute readings and plot daily (midnight) values on intranet-based viewer.
2011	Adding low flow turbine (construction from November 2009 to February 2011)
2017	Butterfly valves installed on the vent pipes

3-04 RELATED PROJECTS

USACE owns and operates Cochiti, Galisteo, and Jemez Canyon dams. Additional data on these flood control structures are available in the Rio Grande Basin Master Water Control

Manual and its appendices. Platoro Reservoir is part of the Rio Grande basin flood control system, but primarily provides flood risk mitigation along the Conejos River in Colorado. Heron and El Vado dams are upstream of Abiquiu Dam. El Vado primarily provides conservation storage. The many features of the SJ-C Project, described in sections 3-04 g, are dedicated to conservation storage of transmountain water and would bypass all flood waters. Plates 2-1 and 2-2 show the location of these projects.

a. Cochiti Dam and Lake

Cochiti Dam is located on the Rio Grande at the upstream end of the Middle Rio Grande Valley where the river emerges from the White Rock Canyon. There are 11,695 square miles of drainage area in the Rio Grande Basin that contribute to the flow above Cochiti Dam. The lake has a storage capacity of 570,192 acre-feet at spillway crest, elevation 5,460.5 feet of which 483,678 acre-feet are used for flood control and 86,514 acre-feet reserved for sediment deposition. At maximum water surface, elevation 5,474.1 feet the capacity is 710,815 acre-feet. With the other existing dams operating (Abiquiu, Galisteo, and Jemez Canyon), floods of record for the period between 1920 to 2023 would be controlled to a maximum of 7,000 cfs at Albuquerque, New Mexico (USGS gage 08330000). Cochiti Dam has a 1,200-acre recreation pool, which is established and maintained using SJ-C project water. The Cochiti Dam Water Control Manual is Appendix C to the Rio Grande Basin Master Water Control Manual.

b. Galisteo Dam and Reservoir

Galisteo Dam is located on Galisteo Creek about 12 miles above the mouth of Galisteo Creek. It controls 596 square miles of Galisteo Creek drainage area. Galisteo Dam is ungated with storage capacity of 89,468 acre-feet at spillway crest, elevation 5,608 feet of which 80,148 acre-feet are allocated for flood control and 9,320 acre-feet for sediment deposition. At maximum water surface, elevation 5,633.7 feet the capacity is 153,638 acre-feet. The Galisteo Water Control Manual is Appendix B to the Rio Grande Basin Master Water Control Manual.

c. Jemez Canyon Dam and Reservoir

Jemez Canyon Dam is on the Jemez River, approximately 2 miles above its confluence with the Rio Grande. The drainage area above the dam is 1,034 square miles. The storage capacity of the reservoir at spillway crest, elevation 5,232.0 feet is 99,334 acre-feet, of which 71,849 acre-feet are for flood control and 27,485 acre-feet for sediment deposition. At maximum water surface, elevation 5,271.6 feet the capacity is 259,342 acre-feet. The Jemez Canyon Water Control Manual is Appendix D to the Rio Grande Basin Master Water Control Manual.

d. Platoro Dam and Reservoir

Platoro Dam is on the Conejos River about 1 mile upstream from Platoro, Colorado, and about 80 miles above the confluence with the Rio Grande. The total drainage area above the dam is about 40 square miles. Reservoir storage capacity at spillway crest, elevation 10,034 feet is 59,571 acre-feet. The top 6,000 acre-feet are allocated for flood control and the remaining space is joint use for conservation and flood control. Flood control is achieved by evacuation of conservation storage based on snowmelt runoff forecasts. At maximum water surface, elevation 10,042 feet the capacity is 67,301 acre-feet.

This project was constructed for irrigation and flood control in 1951 by the U.S. Bureau of Reclamation (USBR). Operation and maintenance of Platoro Dam was turned over to the Conejos Water Conservation District in 1993. The authorizing legislation requires that the project be operated in conformance with the Rio Grande Compact (Exhibit C). Under Section 7 of the Flood Control Act of 1944, USACE is responsible for prescribing the flood control operation. The Platoro Reservoir Water Control Manual is Appendix E to the Rio Grande Basin Master Water Control Manual.

e. El Vado Dam

The Middle Rio Grande Conservancy District (MRGCD) built El Vado Dam between 1934 and 1935. The dam is located on the Rio Chama about 160 miles north of Albuquerque, New Mexico, and the USBR rehabilitated it in 1954 through 1955. The USBR built a new outlet works in 1965 to 1966 to accommodate the additional water from the SJ-C Project. The dam embankment is of rolled gravel-fill with a steel membrane on the upstream face. USBR operates and maintains it. The reservoir has a maximum storage capacity of about 214,091 acre-feet. Top of the active conservation storage is at 6,902.0 feet Reclamation Project Vertical Datum (RPVD) with a capacity of 191,050 acre-feet. The dam provides conservation storage for irrigation use on the MRGCD lands along the Rio Grande from Cochiti Dam to below Socorro, New Mexico. The dam provides incidental regulation of flood flow by storage of water for irrigation. The LAC-DPU owns and operates a hydroelectric facility at El Vado Dam. The powerplant has a rated capacity of 8 MW.

f. San Juan Chama Project

The SJ-C Project diverts water from the upper tributaries of the San Juan River, through the Continental Divide, and into the Rio Chama watershed (Plate 2-2). Project facilities include three diversion structures in Colorado, two siphons, two dams (Heron and Nambe Falls dams), and 26 miles of concrete tunnels including Azotea Tunnel. The project was authorized in 1962 and completed in 1971. It is operated and maintained by the USBR. SJ-C project provides water supply for irrigation, municipal and industrial (M&I), and recreation and wildlife in New Mexico. Average annual diversion of about 90,000 acre-feet had been diverted to the Rio Chama basin for the period from 1971 to 2022. The imported, transmountain water (SJ-C project water) is stored in Heron Reservoir until it releases at the request of the SJ-C project contractors.

3-05 DAM SAFETY HISTORY/ISSUES

USACE Dam Safety performs several activities including inspections, routine instrument evaluations, periodic assessments and studies, maintenance activities, training, and risk communication. Routine inspections and instrument evaluations are performed to monitor performance of the project. Maintenance is routinely performed at the project and recent activities include repair of bulkhead gates, replacement of damaged sections of air vent pipes, repair of deteriorated rock protection, and installation of new seepage monitoring instruments.

Comprehensive inspections occur annually, with more detailed Periodic Inspections (PIs) taking place every 5 years. Periodic Assessments (PAs) occur every 10 years to compare original design and construction methods to modern standards. An Issue Evaluation Study was completed in 2019 to assess dam breach risk and included investigation of project features and installation of additional instruments to improve performance monitoring.

The Interim Risk-Reduction Measures Plan (IRRMP) was last updated in July 2015 and the following IRRMs have been implemented for the project: updated Emergency Action Plan (EAP), updated inundation maps, tabletop exercise, risk awareness communication, and stockpiled sand, gravel materials, and sandbags.

3-06 PRINCIPAL REGULATION ISSUES

The design studies for Abiquiu Dam established downstream nondamaging flow at 4,000 cfs for flood control releases. Deterioration of local irrigation diversion structures, channel aggradation caused by arroyo inflow and urbanization encroachments, have reduced non-damaging flow to 1,800 cfs immediately downstream of the dam and 3,000 cfs at Rio Chama confluence with the Rio Grande.

3-07 MODIFICATION TO REGULATIONS

Initial operation for sediment retention was to hold a 24-hour equivalent pool when inflow exceeded 140 cfs. This was effective in trapping sand and larger particles but let clay and most of the silt pass through. Subsequent reworking of material deposited in the reservoir by low flows carried material through the conduit thus reducing the trap efficiency and effectiveness of the project to prevent sediment from building up in the channel downstream. A 2,000 acre-feet pool was established on 6 March 1968 to improve sediment retention. This pool had a marginal effect, so the pool was increased to 4,000 acre-feet in 1974 by a resolution of the Rio Grande Compact Commission.

After 1980, Abiquiu Dam releases were limited to 1800.0 cfs due to problems with the irrigation diversions structures constructed of rock and brush.

Regulation for water supply storage and releases began in 1981 by storing up to 200,000 acre-feet of SJ-C project water for contractors. In 2020, regulation for water supply was modified to include storage of SJ-C project water and Rio Grande system water up to elevation 6,230.0 feet with this current WCP updates. Chapter 7, Table 7-3 provides more details on the current regulations.

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CHAPTER 4—WATERSHED CHARACTERISTICS

4-01 GENERAL CHARACTERISTICS

The Rio Chama watershed is located south of the San Juan Mountains in northern New Mexico (Plate 2-2). The watershed area is about 3,154 square miles, of which 2,146 square miles are above Abiquiu Dam. Pertinent drainage is perennial, rises in the San Juan Mountains in Southern Colorado and flows in a southeasterly direction for about 130 miles to its confluence with the Rio Grande. The principal tributaries above El Vado Dam are the Rio Brazos, with a drainage area of 168 square miles, and Willow Creek, with a drainage area of 193 square miles. Heron Dam is located on Willow Creek just above its confluence with the Rio Chama that stores only transmountain water and bypasses natural runoff of the Willow Creek watershed. From El Vado Dam to Abiquiu Dam, the principal tributaries are the Rio Gallina, with a drainage area of 280 square miles; Rio Puerco, with a drainage area of 210 square miles; and Cañones Creek, with a drainage area of 87 square miles. The streams and creeks within the watershed are snowpack driven and receive bi-modal precipitation in the form of winter storms and summer monsoons. Elevations in the watershed range from about 12,000 feet in the San Juan Mountains to about 5,600 feet at the mouth of the Rio Chama. Stream slopes are steep (300 to 500 feet per mile) near the headwaters and gradually flatten (100 to 25 feet per mile) as the Rio Chama enters El Vado Reservoir. Downstream of El Vado Dam the stream slope continues to flatten from about 25 to 10 feet per mile as flow enters Abiquiu Reservoir. Table 4-1 summarizes pertinent drainage areas within the basin.

The headwaters of the Rio Chama have mountainous terrains that receive the large snow-packs and are covered in forests. Stands of aspen and both spruce-fir and ponderosa pine forests are common. As the Rio Chama flows downhill, the terrains change to less steep, Rocky Mountains and sparser vegetation with a more arid nature. Although these lower elevation lands still receive winter snowstorms, snowpacks are smaller and generally melt earlier than the high mountains of the headwaters. The high elevation forests change to pinon, juniper, and oak brush at the watershed outlet in Espanola, with more short grasses and semi-desert shrubs. Although the vegetation change is distinct from headwaters to outlet, cattle grazing and dry-land farming are common throughout this watershed. In the lower portion of the watershed, irrigation farming is extensive in the valley bottoms.

Table 4-1. Rio Chama Drainage Area Data

Watershed	River Miles to Mouth (confluence with Rio Grande)	Total Area Above Location on Rio Chama (square miles)
Above mouth of Rio Brazos	98.4	225
Near La Puente	91.4	480
Above mouth of Willow Creek	85.7	485
At El Vado Dam	77.7	873
At gage below El Vado Dam (USGS 08285500)	77.2	877
Above mouth of Rio Nutrias	73.4	886
Above mouth of Rio Cebolla	62.7	1,084
Above mouth of Rio Gallina	55.4	1,235
At gage above Abiquiu Reservoir (USGS 08286500)	47.4	1,600
Above mouth of Rio Puerco	40.1	1,624
Above mouth of Canjilon Creek	36.6	1,842
Above mouth of Cañones Creek	32.5	2,059
At Abiquiu Dam	31.8	2,146
At gage below Abiquiu Dam (USGS 08287000)	31.3	2,147
Near Abiquiu, New Mexico	18.2	2,284
Above mouth of El Rito Creek	16.4	2,304
At mouth of Rio Ojo Caliente	6.3	2,554
At gage near Chamita (USGS 08290000)	2.8	3,144
At mouth (Rio Grande)	0.0	3,154

4-02 TOPOGRAPHY

The upper portion of the watershed consists primarily of high plateaus and mountain ranges. The average elevation of the high plateaus, comprising approximately 80 percent of the area, is about 9,000 feet. Steep slopes drop from 12,000 feet in the San Juan Mountains to about 6,740 feet at El Vado Dam. The steeper slopes in many of the sub-watersheds in this region encourage faster runoff and can produce flash floods during summer monsoon storms. Below El Vado Dam, the topography is characterized by lower mountains and more gradual slopes. At the confluence with the Rio Grande the elevation is approximately 5,600 feet NGVD. Plate 4-1 shows the Rio Chama watershed topography.

4-03 GEOLOGY AND SOILS

The Rio Chama Basin is considered a transitional region between the Colorado Plateau and the Rio Grande Rift. Broad folds and gentle regional dips to the north and west characterize the southeastern part of the Rio Chama Basin. Steeply dipping normal faults with a general north to northeast trend are common and often exhibit throws in excess of 200 feet.

The Rio Chama Basin is an elongated, north plunging depression bounded on the west by the structurally uplifted Gallina-Archuleta Arch (San Pedro Mountains), on the northeast by the Brazos Uplift, and on the north and south by the San Juan and Jemez volcanics, respectively. On the east, within 1.5 miles of the dam, the Rio Chama Basin is bounded by the Española Basin which is one of the major basins of the Rio Grande Rift; a structural feature that extends the length of New Mexico. This boundary is marked by northeast trending, high angle normal faulting.

The rocks that surround Abiquiu Reservoir and extend off to the west toward Arroyo del Agua and Gallina are sedimentary rocks of Pennsylvanian, Permian, and Triassic age. These rocks include the Cutler Group (late Pennsylvanian to early Permian) and the overlying Chinle Group (upper Triassic), both of which were formed by rivers flowing during times of semi-arid climate. The Cutler Group consists of reddish-brown, greenish-gray, and pale red siltstone; reddish-brown and yellowish-gray sandstone; and minor conglomerate. The Chinle Group consists of reddish-brown, purplish-red, and light green interbedded sandstone, siltstone, and shale. Both of these rock units are prominent throughout the southwestern United States. These units are known to contain fossils of primitive reptiles and dinosaurs.

4-04 SEDIMENT

El Vado Dam effectively controls the sediment from the upper 768 square miles of the Rio Chama Basin, leaving 1,378 square miles of sediment producing area above Abiquiu Dam. This area contains about fifteen exposed major geologic formations. Surface materials vary from hard volcanic rocks south of the river to soft soapy marls. About one-third of the total area is considered erosion resistant. The remainder has a moderate to high erosion rate. Steep tributary slopes, intense thunderstorm activity, and soft materials traversed by the streams have resulted in deep, steep-sided arroyos and canyons which carry much coarse, as well as fine, material to the Rio Chama.

One of the authorized project purposes of Abiquiu Dam is sediment retention. Historic sediment surveys show an average annual sediment load of approximately 400 acre-feet per year. Abiquiu Dam was constructed with an initial sediment reserve of 77,039 acre-feet in 1963. The sediment space remaining after the sediment survey of 2021 was 53,778 acre-feet. At the current rate of sedimentation, the sediment reserve will be filled in approximately year 2160.

Scouring and sediment deposition have had no significant impacts on the project operation. The constructed portion of the spillway is set in rock and should be relatively slow to erode if significant flows pass through it. The downstream river channel appears to be stable.

4-05 CLIMATE

The Rio Chama Basin has a cool (lower elevations) to cold (higher elevations), semi-arid climate. In the winter half year, the predominant movement of moisture is from the west in the form of frontal systems, which produce generally less precipitation over a broad area in the form of either snow or rain. In the summer, the predominant moisture source is humid air pulled in from the Gulf of Mexico, which, when lifted by fronts or mountains, produces thunderstorms characterized by more intense precipitation over smaller areas (Sheppard et al. 2002). Table 4-2 presents climate normal monthly weather averages for the period between 1991 and 2020. Refer to Tables 4-3 to 4-12 in the Supplemental Tables section for climate data at additional sites throughout the watershed.

Table 4-2. 30-Year Normal Climate Values for Abiquiu Dam (1991–2020)

Month	Average Temperature (°F)	Average Precipitation (inches)	Average Snowfall Depth (inches)
January	29.9	0.41	2.8
February	34.4	0.34	2.0
March	42.3	0.58	1.6
April	49.0	0.79	0.4
May	58.2	0.80	0.0
June	68.5	0.62	0.0
July	72.9	1.65	0.0
August	70.9	1.75	0.0
September	64.1	1.19	0.0
October	52.2	0.89	0.1
November	40.6	0.50	0.6
December	31.2	0.54	3.0
Annual	**51.2**	**10.06**	**10.5**

Source: National Climatic Data Center, U.S. Department of Commerce
Temperature and Precipitation data is at USC00290041 (Abiquiu Dam) station
Snowfall data is from the National Weather Service.

a. Temperature

The high mountain headwaters of the Rio Chama have a cold summer, continental climate as described by the Köppen Climate Classification system (https://insideidaho.org/data/ago/ics/koppen-climate-classification.zip).

The Wolf Canyon Global Historical Climatology Network (GHCN) site (USC00299820, 8,280 feet above sea level (asl), Table 4-11 in the Supplemental Tables section), is typical of this region, located about 27 miles southwest of Abiquiu Dam. It is characterized by cold winters (January daily maximum temperature [Tmax] averages 38.2 °F, and daily minimum temperature [Tmin] averages 9.3 °F) and warm summers (July daily Tmax averages 77.0 °F, daily Tmin averages 43.7 °F). Snow accumulation in the winter months (December through February) averages just above 20 inches (1.67 to 1.90 inches of precipitation). Annual average precipitation is 22.6 inches. Most months have an inch or more of precipitation, with July and August typically averaging 3.35 inches of rain per month. Daily extremes may exceed monthly average precipitation. Monsoon season precipitation (July through September) is 39 percent of the annual total, and is typically in the form of brief, intense thunderstorms.

A cold semi-arid climate is found along the lower reaches of the Rio Chama (Köppen: BSk) in the vicinity of Abiquiu Reservoir. The Abiquiu Dam GHCN site (USC00290041, 6,380.0 feet (asl), Table 4-8 in the Supplemental Tables section) is typical of this climate zone. It is characterized by cool winters (January daily Tmax averages 42.0 °F, daily Tmin averages 17.7 °F) and hot summers (July daily Tmax 87.5 °F, daily Tmin 58.3 °F). Precipitation in the winter half-year year is normally less than 1 inch per month but averages above 1 inch in the summer half year, peaking during the monsoon season (July through September) at 1.19 to 1.75 inches per month (46 percent of annual precipitation). Monsoon season precipitation is typically in the form of brief, intense thunderstorms. Daily extremes may exceed monthly average precipitation.

b. Precipitation

Annual precipitation averages in excess of 35 to 50 inches in the high mountain areas, declines to about 20 inches in the floodplain of the upper watershed in the vicinity of Chama, NM, and drops with distance downstream to approximately 10 inches at Abiquiu Dam and below (Plate 4-2). Snowfall follows a similar decline, with accumulations persisting only at the high mountains.

c. Snow

During the winter months, heavy snowfall occurs in the upper mountainous areas of the watershed, whereas over the lower portion snowfall is light. Snow usually remains in the mountains above elevation 8,000 feet from the beginning of heavy storms in December until early April when snowmelt runoff typically begins. Snow below elevation 8,000 feet seldom stays on the ground more than a few days. During the spring months, the depth and water content is measured at four Snow Telemetry (SNOTEL) stations in the watershed. Table 4-13 shows the average, maximum, and minimum snow-water content for the months of December through May.

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Table 4-13. Active SNOTEL Sites (sheet 1 of 2)

Station	Elevation	DEC. AVE.	DEC. MAX. (Year)	DEC. MIN. (Year)	JAN. AVE.	JAN. MAX. (Year)	JAN. MIN. (Year)	FEB. AVE.	FEB. MAX. (Year)	FEB. MIN. (Year)
Bateman	9,250	2.1	14.5 (1983)	0.1 (2017)	4.6	16.5 (1984)	0.3 (2003)	7.1	18.1 (1984)	0.5 (2014)
Chamita	8,400	1.7	10.6 (1983)	0.0 (2017)	4.0	13.3 (2017)	0.3 (2003)	6.8	19.3 (1989)	0.0 (2002)
Cumbres Trestle	10,000	5.3	23.3 (1983)	0.5 (1989)	10.6	31.9 (2017)	0.7 (1981)	16.2	39.4 (2008)	0.5 (2002)
Hopewell	10,100	3.3	16.6 (1983)	0.2 (2017)	6.9	19.6 (1997)	0.5 (2003)	10.7	25.3 (2008)	0.5 (2002)

Table 4-13. Active SNOTEL Sites (sheet 2 of 2)

Station	Elevation	MAR. AVE.	MAR. MAX. (Year)	MAR. MIN. (Year)	APR. AVE.	APR. MAX. (Year)	APR. MIN. (Year)	MAY AVE.	MAY MAX. (Year)	MAY MIN. (Year)
Bateman	9,250	9.6	21.8 (1980)	0.2 (2008)	10.4	23.1 (1980)	0.1 (2020)	3.0	21.5 (1984)	0.0 (many years)
Chamita	8,400	9.0	24.3 (1980)	0.0 (1997 and 2016)	6.4	25.5 (1980)	0.0 (1989)	0.3	8.3 (1980)	0.0 (2020)
Cumbres Trestle	10,000	21.8	42.3 (2017)	0.6 (1997)	25.7	44.3 (2017)	0.0 (1989)	20.1	43.2 (1985)	0.0 (2004)
Hopewell	10,100	14.6	29.2 (1985)	0.1 (2016)	17.5	30.5 (1995)	0.0 (1992 and 2020)	10.7	29.0 (1995)	0.0 (1996 and 1998)

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d. Evaporation

A Class A Land Pan is used for evaporation measurements at the projects. Pans are placed in operation in the spring when low temperatures exceed 30 °F for several days and are emptied in the fall when the ice cover does not melt off before noon. Consequently, the evaporation record typically covers the period of April through October. April through October pan evaporation in the Rio Chama watershed varies from an estimated 62 inches at Abiquiu Dam to less than 49 inches at the El Vado Dam (Table 4-14). The Abiquiu Dam estimated average monthly rates for October through February are based on available winter pan evaporation data at nearby stations. Monthly pan evaporation for Abiquiu and El Vado dam sites are included in the Supplemental Tables section (Tables 4-15 and 4-16).

Table 4-14. Average Monthly Pan Evaporation for 1975–2022 (inches)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr–Oct
Abiquiu Dam	2.48	3.60	6.12	7.41	9.97	11.70	10.58	9.10	7.36	5.55	3.54	2.44	61.67
El Vado Dam	N/A	N/A	N/A	5.80	7.78	9.40	8.67	7.28	5.80	4.06	N/A	N/A	48.78

e. Wind

Data on wind taken at the Los Alamos Airport (accessed 18 April 2023) for the most recent climate normal (1991 through 2020) shows winds are predominantly out of the south-southwest, and most commonly in the 5 to 14.9 mph range. Highest wind speeds for the period 1984 to 2022 were measured in spring (March through June), with the highest average monthly wind speed of 7.3 miles per hour observed in April. Los Alamos Airport wind data is available at:
https://mesonet.agron.iastate.edu/sites/windrose.phtml?station=LAM&network=NM_ASOS.

f. Climate Change

A qualitative assessment of potential climate change impacts that may be relevant to the Rio Chama watershed was performed using USACE's Climate Hydrology Assessment Tool (CHAT, USACE Climate Preparedness and Resilience), refer to Exhibit D. Current climate and climate change trends including temperature, precipitation, and streamflow were investigated to determine changes in the watershed climatological baseline. Under all climate scenarios, temperature is expected to be warmer, however, precipitation is not expected to change much. Spring runoff may occur earlier based on projected warmer winter and spring temperatures (Exhibit D). Overall, projected climate change is expected to have little to no impact on the existing flood control operations of Abiquiu Dam and Reservoir. The Abiquiu Dam will continue to perform and function, as designed, to provide flood risk management benefits to the Rio Chama and Rio Grande watersheds, and the nearby town of Espanola, New Mexico.

4-06 STORMS AND FLOODS

Floods that occur in the Rio Chama watershed are of two general types. The most frequent type is the spring flood that occurs during the period between April and June as the result of snowmelt. The spring floods are characterized by a gradual rise to a comparatively moderate rate of flow, which is usually maintained for about two months. The other type is the summer flood or flash flood that occurs from June through October as a result of rainfall. This type of flood produces runoff which rises sharply to a peak, recedes rapidly, and is of small volume (a narrow peak hydrograph).

Since the beginning of streamflow records in 1889, the notable spring floods of 1903, 1920, 1941, and 1942 were, in general, caused by snowmelt runoff and were large volume floods of relatively long duration. Three notable summer and fall floods occurred in 1911, 1929, and 1935. These floods were caused by runoff from rainfall and were of smaller volume and shorter duration than the spring floods. Notable floods are discussed further in the following paragraphs.

a. Flood of 1920

The 1920 spring flood was caused primarily by above-normal snowfall in the mountains during the winter months, above-normal temperatures, and precipitation during the spring. The volume of runoff during the April through June period was 574,000 acre-feet at the Chamita gage. Runoff for the same period at the El Vado Dam site was 369,000 acre-feet.

b. Flood of 1929

The August 1929 flood was produced by a general storm over northern New Mexico that was augmented by an established Atlantic high inducing moist Gulf air to flow into New Mexico. Prior to the storm, an anticyclone was moving southeast from Canada. Convergence of the tropical maritime air associated with the frontal trough caused intensification of summer thunderstorms in this region. The storm produced a peak discharge of 10,400 cfs at the Chamita gage on 12 August. Maximum mean daily discharge for the 8 to 15 August period was 8,770 cfs on 11 August. Total volume of flow at the Chamita gage for the 8 to 15 August period was 41,000 acre-feet. During the same period, 10,140 acre-feet passed the Park View gage (USGS 08283500, gage was discontinued in 1955).

c. Flood of 1941

The 1941 spring flood produced the maximum runoff of record and was used as a basis for the design storm for Abiquiu Dam. It was caused by above-normal precipitation and snowfall, and below-normal temperatures that delayed early spring snowmelt. Unusually warm weather during 9 through 16 May and intermittent general rains from 18 May to 11 June served to sustain high flow through the middle of June and produced the maximum instantaneous peak of 9,910 cfs at Chamita. The volume of flow during the months of May and June was 590,000 acre-feet at Chamita.

d. Flood of 1942

The 1942 spring flood was caused by excessive precipitation during April, which was the wettest month of record. Heavy rain in the lower elevations during the 22 through 24 April period produced peak discharges of 8,350 cfs at the Chamita gage and 6,330 cfs at the Abiquiu gage on the 23 April. On 25 April, 3,880 cfs was recorded at the Tierra Amarilla gage. The heavy storms of April included considerable snow in the higher elevations that produced a large volume of runoff during May. May was a dry month with slightly less than normal temperatures, which resulted in normal runoff that prevented more serious flood conditions. The volumes of flow for April and May were 429,000 acre-feet at Chamita, 357,000 acre-feet at Abiquiu and 244,000 acre-feet at Tierra Amarilla. Rio Ojo Caliente at La Madera recorded a peak discharge of 2,980 cfs on 22 May and a volume of 80,000 acre-feet during April and May.

e. Flood of 1958

The 1958 spring flood was caused by above-normal temperature and snowfall preceded by above normal fall precipitation. The above-normal precipitation in the fall of 1957 resulted in high soil moisture content in the mountainous areas. Snowfall was at or near normal during the early part of the winter in most of the watershed. In northern New Mexico and southern Colorado, the snowfall in April was above normal. Temperatures during May and June were above normal. Runoff started late in April and continued through June. The total volume of flow passing the Chamita gage from April through June was 394,000 acre-feet. The flood volume contributed to the Rio Chama during this period by Rio Ojo Caliente was 89,310 acre-feet. Without regulation by El Vado Dam, the volume passing the Chamita gage would have been 526,800 acre-feet.

f. Flood of 1979

The winter of 1978 to 1979 was colder and wetter than normal, which resulted in a near record snowpack over the southern Sangre de Cristo and San Juan Mountains. The first snow came in November, much earlier than usual, and by January snow accumulation was above normal. The snow-water content at most stations had exceeded 200 percent of normal by 1 February, and by 1 May two stations in New Mexico were over 400 percent of normal. All stations exceeded 150 percent of normal, with several exceeding 200 percent. Evaluation of station records shows that the 1979 snowpack is the most uniform in areal distribution during the period of record.

Spring runoff in the Rio Grande Basin in New Mexico began in mid-April. Fluctuating temperatures prevented the Rio Chama from sustaining a large peak flow, instead it had several peaks of various magnitudes, the largest being 4,074 cfs, which occurred on 8 May. Another factor that affected the runoff was that the previous years had been dry. The delaying of runoff by temperature fluctuations resulted in less storage in the reservoir than forecasted for this near-record snowpack. Storage in Abiquiu Reservoir started on 16 April and reached a maximum storage of 146,940 acre-feet on 28 June. The maximum release during the runoff was 1,892 cfs. Flood water was held in storage during the summer months and was released by the end of the year. Plate 4-3A shows the flood operation hydrograph.

The total flow volume that passed the Chamita gage for April through June was 320,850 acre-feet. The flow, if El Vado and Abiquiu dams had not stored, would have been 574,250 acre-feet.

g. Flood of 1980

The snowpack in the Rio Grande Basin during 1980 was well above normal and exceeded the 1979 snowpack in the upper Rio Chama watershed. Spring wind during April and May reduced runoff due to sublimation. Spring runoff in 1980 was about 75 percent of the 1979 runoff. The 1 April NWS forecast for Rio Chama at Chamita was 635,000 acre-feet for the period March through July, the observed flow was 438,000 acre-feet. The flow at Chamita, if El Vado and Abiquiu dams had not stored, would have been 533,000 acre-feet. The Abiquiu Dam peak inflow of 5,308 cfs occurred on 23 May, maximum storage of 198,320 acre-feet occurred on 14 June. The maximum release was 2,218 cfs on 26 June. There was about 90,000 acre-feet of flood water held in storage by early July and was released by the end of the year. Plate 4-3A shows the flood operation hydrograph.

h. Flood of 1985

In January 1985, the forecasted snowmelt runoff in the Rio Grande Basin ranged from 105 to 150 percent of normal. Seasonal precipitation, October through December, over the Rio Grande Basin was well above normal. In October alone, totals were three to four times the monthly average. By February, the snowmelt runoff forecast for the basin ranged from 120 to 140 percent of average. Precipitation during January was near normal and precipitation for the month of February was below normal. At the beginning of March, when normally 80 percent of the total seasonal mountain snowpack would be expected to have accumulated, the snow courses averaged 123 percent in Colorado and 147 percent in New Mexico. Substantial amounts of additional snow accumulated in the mountains in March. Heavy amounts were observed in the Sangre De Cristo mountains of northern New Mexico in March. During the last week in April, significant precipitation was observed at many basin locations pushing the monthly totals above 200 percent of normal throughout the basin. In New Mexico, above average temperatures around the middle of April resulted in melting of a large percentage of the snowpack.

The above average precipitation in 1985 resulted in the snowmelt runoff exceeding 250 percent of normal in many areas of the basin. For the first time in the history of the Albuquerque District the flood control projects of the upper basin (Abiquiu, Cochiti, and Jemez Canyon dams) were used to provide flood protection for the area below Elephant Butte Dam. A 100,000 acre-feet reserve was maintained in Elephant Butte Reservoir during the summer months and a 50,000 acre-feet reserve during the winter months to provide space for a 100-year flood event. The upper basin projects were operated in this manner for the period 16 May through 23 July. Abiquiu Reservoir stored snowmelt runoff beginning 18 April and reached a maximum pool elevation of 6,256.22 feet (382,720 acre-feet) on 10 June. The total volume of flow that passed the Chamita gage for March through July was 407,150 acre-feet. The flow, if El Vado and Abiquiu dams had not stored, would have been 657,150 acre-feet. Plate 4-3A shows the flood operation hydrograph.

i. Flood of 1986

In January 1986, the forecasted water supply for the Rio Grande Basin was for above normal runoff except for a few tributaries in the Sangre De Cristo mountains of northern New Mexico. Fall precipitation was above normal over most of the basin. Two to three times the monthly average precipitation was observed at most basin observation points during October. By February, the snowmelt runoff in the upper Rio Grande was 115 to 125 percent of average along the mainstem and slightly below normal amounts along the eastern San Luis Valley Rio Grande tributaries. On the New Mexico mainstem, amounts were expected to be 100 to 125 percent of average but lesser amounts, 65 to 85 percent of average were forecasted for the Sangre de Cristo Mountain tributaries. Precipitation totals for the month of January were very light. Mountain snowpack in January were near to above normal except for the Sangre De Cristo mountains which were below normal. February precipitation amounts were above normal over most of the basin averaging near 150 percent. Snowfall during the month of February was variable over the basin. Some areas received near twice the normal monthly accumulations, while most of the Sangre De Cristo were well below normal. Overall, the 1 March snowpack was 109 percent of average in Colorado and 69 percent of average in New Mexico. Precipitation totals for the month of March were below normal except for isolated areas in western portions of the basin. Precipitation totals for the month of April were well above normal over a large portion of the basin. Many stations in Colorado and northern New Mexico had 2 to 3 times the average with isolated reports of up to five times the long-term average. Snowpack amounts at the end of April were 124 percent of average in the Colorado portion of the basin. In New Mexico, runoff of 115 to 145 percent of average was forecasted along the mainstem of the Rio Chama, and 50 to 80 percent along the Sangre De Cristo and Jemez tributaries. Warmer than normal temperatures during the latter part of April produced considerable melting of the lower elevation snowpack, particularly in New Mexico where none of the lower elevation snow courses reported any snow remaining.

The final snowmelt runoff in the Rio Grande Basin was about 200 percent of normal. The flood control projects of the upper basin (Abiquiu, Cochiti, and Jemez Canyon dams) were again used to provide flood protection for reaches of the Rio Grande as far down as Fort Quitman, which is below El Paso, Texas. A 50,000-acre-foot reserve was maintained in Elephant Butte Reservoir to provide space to control a 100-year flood event. Abiquiu Reservoir stored snowmelt runoff beginning 2 April and reached a maximum pool elevation of 6,246.74 feet (319,161 acre-feet) on 27 July. The total volume of flow that passed the Chamita gage for March through July was 345,700 acre-feet. The flow at Chamita, if El Vado and Abiquiu dams had not stored, would have been 473,700 acre-feet. Plate 4-3A shows the flood operation hydrograph.

j. Flood of 1987

In January 1987, early season projections were for 110 to 130 percent of normal in the Colorado portion of the basin and 95 to 135 percent of normal in New Mexico. Fall precipitation was above normal over most of the basin. For the month of November, precipitation totals were 2 to 3 times normal monthly totals. Precipitation totals for the month of January were above normal over much of the basin. Strong storm systems during the early and middle portion of the month produced heavy amounts of precipitation resulting in monthly totals 2 to 4 times the long-term January normal amount over all the San Luis Valley in Colorado and the northern Rio Grande valley in New Mexico. The March snowmelt runoff forecast was for above average runoff. The Sangre De Cristo tributaries were expected to produce 120 to 160 percent of average. Precipitation during the month of February was above average over most of the basin with most of the reporting stations receiving 150 to 200 percent of average. Streamflow based on April forecasts were expected to range from 140 to 167 percent average along the mainstem and from 92 to 175 percent of average along the tributaries. March precipitation totals were variable in the basin. Above normal amounts, 150 to 250 percent of average, were recorded in the upper reaches of the basin above Del Norte in Colorado. Farther south, amounts decreased to around 50 to 70 percent in the Colorado/New Mexico border region and only 5 to 20 percent in the Albuquerque, New Mexico, and Santa Fe, New Mexico, areas. The 1 May snowpack showed significant depletion at middle and lower elevations since early April, reflecting above normal temperatures for the last month. In Colorado, the forecast was for 120 percent of average. New Mexico forecasts ranged from 200 to 260 percent on the mainstem and 125 to 175 percent of average along the tributaries. A large percentage of the snowpack melted in April producing above normal runoff and streamflow for the month of April.

The weather system that moved in to produce the 1987 snowmelt runoff in the Rio Grande Basin of about 200 percent of normal as recorded at the Otowi gage was a remarkably persistent split-flow circulation pattern where a polar front jet stream remained in Canada north of its normal position and an active subtropical jet stream, which crossed the southern United States, led to above normal flows in the central one-third of the U.S. High volume discharges in the Rio Grande resulted from fall, winter, and spring precipitation throughout the entire Rio Grande Basin of Colorado and northern New Mexico.

The total volume of flow that passed the Chamita gage for March through July was 348,400 acre-feet. The flow at Chamita, if El Vado and Abiquiu dams had not stored, would have been 488,400 acre-feet. Abiquiu Reservoir began storing snowmelt runoff on 12 April and reached a record pool elevation of 6,261.06 feet (402,258 acre-feet) on 22 June. The maximum release was 1,680 cfs, Plate 4-3B shows the flood operation hydrograph. The magnitude of storage was in part due to Elephant Butte and Caballo reservoirs being full. Due to successive years of a full reservoir at Elephant Butte, a tremendous amount of sediment deposition created a plug at the headwaters, which resulted in high river stage that threatened existing levees that protect the Low Flow Conveyance Channel near San Marcial, New Mexico.

The Rio Grande below El Paso, Texas, had not experienced sustained flood flows since the early 1940s. Therefore, a considerable amount of sediment aggradation had occurred, which severely reduced channel capacities through Fort Quitman. This resulted in numerous levee breaches on the Mexican side of the river and high-water tables in the agricultural areas on the United States side. The lack of channel capacity in these areas delayed the release of flood water from Abiquiu, Cochiti, and Jemez Canyon reservoirs.

k. Flood of 1995

The 1 April water supply forecast for the Rio Chama below El Vado Dam was estimated to be between 170 and 225 percent of normal. Observed flow below the dam during the April to July period was 215 percent of normal. With storage in the reservoir at about 150,000 acre-feet on 1 January, storage of snowmelt runoff began in late March and continued well into August. High levels of storage at Elephant Butte Dam contributed to the long duration of release of stored water. Peak storage of 305,944 acre-feet occurred on 25 June with a maximum pool elevation of 6,244.9 feet NGVD. Maximum release was 1,820 cfs on 8 June.

The total volume of flow that passed the Chamita gage for March through July was 478,600 acre-feet. The flow at Chamita, if El Vado and Abiquiu dams had not stored, would have been 703,600 acre-feet. Plate 4-3B shows the flood operation hydrograph.

l. Flood of 2019

April's streamflow forecast into El Vado Dam was estimated to be between 130 percent and 180 percent of average. A late season storm in 9 to 10 May delivered 10 to 20 inches of snow in the Sangre de Cristo and San Juan Mountains in northern New Mexico and southern Colorado. Observed inflow to the Abiquiu Dam during the March to July period was 341,200 acre-feet, which is about 145 percent of normal. With above average spring runoff on the Rio Chama Basin, flood operations began at Abiquiu Dam on 25 April with releases averaging 1,500 cfs and increasing to 1,793 cfs on 08 May and continuing until late June, when all flood water was evacuated. Storage in Abiquiu Dam began on 19 April continuing until 13 May when pool elevation reached 6,197.29 feet with 106,256 acre-feet in storage. The total volume of flow that passed the Chamita gage for March through July was 404,300 acre-feet. The flow at Chamita, if El Vado and Abiquiu dams had not stored, would have been 489,300 acre-feet. Plate 4-3B shows the flood operation hydrograph.

m. Flood of 2023

April's streamflow forecast into El Vado Dam was estimated to be between 160 percent and 225 percent of median. Observed inflow to the Abiquiu Dam during the March to July period was 386,400 acre-feet, which is about 162 percent of normal. Since El Vado Dam was not storing due to construction rehabilitation, all spring runoff on Rio Chama bypassed down to Abiquiu Dam. Abiquiu Dam began flood operations on 14 April with releases near 1,400 cfs and increased releases by approximately 150 to 200 cfs gradually until making a release of 1,695 cfs on 28 April. As the flow at the Chamita gage approached 3,000 cfs, Abiquiu Dam releases were reduced to 1,500 cfs and as low as 1,300 cfs before increasing to 1,500 cfs and stayed at this level for the remainder of the runoff period. Due to safety issues with the Middle valley levee system, Cochiti Dam releases were restricted to 5,000 cfs, which limited Abiquiu Dam releases from reaching 1,800 cfs. Abiquiu Dam's instantaneous pool elevation peaked at 6,230.72 feet with storage of 232,591 acre-feet on 3 June 2023. There was approximately 120,000 acre-feet of flood water being locked in storage on 1 July, which was evacuated before the end of the year.

The total volume of flow that passed the Chamita gage for March through July was 295,250 acre-feet. The flow at Chamita, if Abiquiu Dam had not stored, would have been 405,000 acre-feet. Plate 4-3B shows the flood operation hydrograph.

4-07 RUNOFF CHARACTERISTICS

The majority of the runoff on the Rio Chama is driven by snowmelt during the spring season (March to May). During the rest of the year, Rio Chama is a perennial stream with low flow that varies from 1 to 100 cfs. Summer and early fall rainstorms could produce high peak flows with generally little runoff volume. The SJ-C project began operations in 1971 moving transmountain water from the San Juan Basin flowing into the Rio Chama Basin, with an annual average between 1971 and 2022 of 90,000 acre-feet. This imported water increased streamflow in the Rio Chama. Table 4-17 displays monthly average streamflow at the gage above Abiquiu Dam for the periods before and after construction of the dam.

Table 4-17. Monthly Average Streamflow above Abiquiu Dam

Month	1942 to 1963 Streamflow (cfs)	1963 to 2022 Streamflow (cfs)
January	49	141
February	219	156
March	319	284
April	623	752
May	1,006	1,389
June	793	759
July	492	443
August	483	449
September	302	377
October	127	211
November	307	210
December	190	248

Inflow frequency volume by month is generated using the computed inflow to Abiquiu Dam (Plate 4-4). Plates 4-5A through 4-5H display observed daily flow hydrographs near the dam site. Plate 4-6 shows duration curves for the gages above and below the Abiquiu Dam. In the Supplemental Tables section, Table 4-18 and Table 4-19 display recorded monthly and annual inflow and outflow, respectively, and are found in the Supplemental Tables section.

4-08 WATER QUALITY

New Mexico Environment Department (NMED) periodically monitors water quality within the state's waterbodies to determine whether attainment of water quality standards and supporting designated uses are occurring. NMED has designated multiple inflows to Abiquiu Dam as impaired for not meeting use-specific water quality criteria (https://www.env.nm.gov/surface-water-quality/303d-305b/). Cañones Creek, which flows in to Abiquiu Reservoir is impaired for E. coli and temperature. The Rio Nutrias, which flows into the Rio Chama in its Wild and Scenic-designated section downstream of El Vado Reservoir, is impaired for E. coli, turbidity, and nutrients (for cold and warm water species). Coyote Creek is impaired for temperature, E. coli and nutrients (for cold water species). Poleo Creek is impaired for sedimentation/siltation and the Rito Encino has impairments for polychlorinated biphenyls (PCBs) and sedimentation/siltation. Coyote Creek, Poleo Creek, and Rito Encino all flow into the Rio Puerco de Chama, which flows into Abiquiu Reservoir.

In 2007, NMED completed three seasonal visits to two lake stations at Abiquiu Dam. All physical and chemical parameters were below levels of concern except for dissolved oxygen (D.O.). Three of five D.O. results were slightly below the 6.0 mg/L criterion for cold water aquatic life. However, D.O. results fully supported the warm water aquatic life (5.0 mg/L) (https://www.env.nm.gov/surface-water-quality/water-quality-monitoring/). The most recent Fish Consumption Advisory (updated November 2022) for Abiquiu Dam identifies mercury as the sole contaminant of concern (https://www.env.nm.gov/surface-water-quality/fish-consumption-advisories/).

4-09 CHANNEL AND FLOODWAY CHARACTERISTICS

The design non-damaging flow for the reach from below Abiquiu Dam to the mouth of Rio Ojo Caliente was 4,000 cfs. By the early 1980s, deterioration of local irrigation diversion structures, channel aggradation caused by arroyo inflow, and urbanization encroachments have reduced non-damaging flow to 1,800 cfs immediately downstream of the dam and 3,000 cfs at Rio Chama confluence with the Rio Grande. Major tributaries that contribute to the Rio Chama flow below Abiquiu Dam are El Rito Creek and Rio Ojo Caliente. Plates 4-7A through 4-7F show Rio Chama channel profiles. The average slope for the reach from the dam to the confluence with the Rio Grande is 0.0026 feet per foot.

a. Damage Centers of Key Control Points

At releases above 1,800 cfs, a few residential encroachments (single-family homes), uncultivated land, and a small amount of cultivated land may experience limited damages. The damage center in the Espanola Valley, along the Rio Grande below the Rio Chama confluence, is principally urban in character such as structural, content, and vehicle damages, but some agricultural damages will occur. Urban property in Espanola, New Mexico, is currently protected from flows up to about 10,000 cfs.

b. Time of Water Travel

Travel times for the Rio Chama and the Rio Grande were developed as part of the Upper Rio Grande Water Operation Model (URGWOM) (https://www.spa.usace.army.mil/Missions/Civil-Works/URGWOM/). Table 4-20 illustrates the travel time for low and high flows for the reaches shown on Plate 4-8.

Table 4-20. Travel Times for the Rio Grande and Rio Chama

Rio Grande Reach	Length (miles)	Slope (feet per foot)	500 cfs	1,000 cfs	3,000 cfs	5,000 cfs	10,000 cfs
1-Lobatos, CO to Embudo, NM	76	0.0026	36 hours	28 hours	19 hours	16 hours	13 hours
2-Embudo to Rio Chama Confluence	13	0.0023	5 hours	4 hours	2 hours	2 hours	1 hours
3-Rio Chama Confluence to Otowi Bridge	14	0.0017	4 hours	3 hours	2 hours	2 hours	1 hours
4-Otowi Bridge to Cochiti	22	0.0018	8 hours	6 hours	4 hours	3 hours	2 hours
Rio Chama Reach	**Length (miles)**	**Slope (feet per foot)**	**100 cfs**	**500 cfs**	**1,000 cfs**	**2,000 cfs**	**6,000 cfs**
5-Below El Vado Dam to above Abiquiu Reservoir	28.8	0.0027	21 hours	9 hours	7 hours	5 hours	3 hours
6-Below Abiquiu Dam to near Chamita	28.5	0.0026	18 hours	10 hours	7 hours	5 hours	4 hours

4-10 UPSTREAM STRUCTURES

This subsection discusses structures upstream of Abiquiu Dam.

a. San Juan-Chama Project

The SJ-C project diverts water from the upper tributaries of the San Juan River, through the Continental Divide, and into the Rio Chama (Plate 2-2). Project facilities include three diversion structures in Colorado, two siphons, and 26 miles of concrete tunnels including Azotea Tunnel. The project was authorized in 1962 and completed in 1971. It is operated and maintained by the USBR. SJ-C project provides water supply for irrigation, M&I, and recreation and wildlife in New Mexico. Average annual diversion of about 90,000 acre-feet had been diverted to the Rio Chama Basin for the period from 1971 to 2022. The imported, transmountain water (SJ-C project water) is stored in Heron Reservoir.

b. Heron Dam and Reservoir

This project is located on Willow Creek just above its confluence with the Rio Chama, which is about five miles above El Vado Dam (Plate 2-2). Its main purpose is to store the imported transmountain water. Heron Dam is not authorized to store Rio Grande system water; therefore, natural inflow is bypassed. Heron Reservoir has a capacity of 400,000 acre-feet at top of the active conservation pool elevation of 7,186.1 feet. The spillway has a maximum capacity of 660 cfs when the water level is at elevation 7,190.8 feet. The USBR owns and operates the project.

c. El Vado Dam and Reservoir

El Vado Dam is on the Rio Chama, 45 miles above Abiquiu Dam, near New Mexico State Highway 112, which crosses the dam crest and spillway. The USBR operates and maintains El Vado Dam. The dam was constructed to provide conservation storage for irrigation use on the MRGCD lands along the Rio Grande from Cochiti Dam to below Socorro, New Mexico. Because El Vado Dam was constructed after 1929, the operation of the reservoir for storage and release of native water is subject to restrictions of the Rio Grande Compact. Water imported into the Rio Grande Basin via the SJ-C project and stored in El Vado Reservoir is not subject to restrictions of the Rio Grande Compact. The reservoir has a maximum storage capacity of about 214,091 acre-feet. Top of the active conservation storage is at 6,902.0 feet RPVD with a capacity of 191,050 acre-feet. The dam also provides incidental regulation of flood flow by storage of water for irrigation. Drainage area above the project is 873 square miles. The LAC-DPU owns and operates a hydroelectric facility at El Vado Dam. The powerplant has a rated capacity of 8 MW.

In 2022, the USBR initiated a significant rehabilitation project to ensure the continued structural stability of the facility. Improvements scheduled to be completed include grouting behind the dams' steel faceplate and installation of a geomembrane over the face of the dam. Additionally, the primary spillway and bridge over the spillway will be replaced.

4-11 DOWNSTREAM STRUCTURES

There are no major water control structures on the Rio Chama below Abiquiu Dam. There are 18 irrigation diversion structures in the Rio Chama from Abiquiu Dam to the confluence of the Rio Grande.

4-12 ECONOMIC DATA

Analysis of population, agriculture, industry, and flood damages is focused on the floodplain below Abiquiu Dam and Reservoir, as well as information relevant to activities occurring within the footprint of the reservoir and watershed upstream of the dam. The floodplain downstream of Abiquiu Dam impacts Rio Arriba County. After the confluence of the Rio Chama and the Rio Grande, operations of Abiquiu Dam impact Santa Fe, and Sandoval counties.

a. Population

The 2023 population of Rio Arriba County, New Mexico, is about 40,399 persons. There are few employment opportunities in the county and many persons with high levels of education migrate to areas where employment possibilities and wages are higher. The unemployment rate in Rio Arriba County is consistently among New Mexico's highest and was 3.0 percent in 2023. Although the unemployment rate is relatively low historically, it may be undercounted since the poverty rate for Rio Arriba County is 22.4 percent. The median household income in 2021 was $46,969. According to the Bureau of Business and Economic Research at the University of New Mexico, there is no major population growth expected in the county in the future. Though the population is expected to increase, employment opportunities are not expected to change and will result in a net outward migration.

Sante Fe County, New Mexico, has a 2023 unemployment rate of 2.7 percent with 12.7 percent of its population living below poverty line. Median household income in 2021 was $67,341.

Rio Arriba County, New Mexico, is 72 percent Hispanic/Latino with 14 percent American Indian. Sante Fe County, New Mexico, is 51 percent Hispanic/Latino with 41 percent White, and only 2 percent American Indian. Table 4-21 provides population data for counties and major towns in the watershed.

Table 4-21. Watershed Population Data

Location/Community	County	Population
Abiquiu	Rio Arriba	231
Espanola/Fairview	Rio Arriba	10,130
El Duende	Rio Arriba	707
Chamita	Rio Arriba	870
Hernandez	Rio Arriba	946
San Jose	Rio Arriba	204
Santa Cruz	Rio Arriba	368
La Mesilla	Rio Arriba	1,772

2023 City-Data.com extrapolated from United States Census Bureau

The population within the floodplain below and surrounding Abiquiu Reservoir reside within the following counties according to the 2020 decennial US Census and updated using City-Data.com estimates (Table 4-22).

Table 4-22. Population and Demographic in and downstream of the Abiquiu Dam Watershed

	Rio Arriba County	Santa Fe County	Sandoval County
Population 2023	40,399	158,018	154,015
Population 2000	41,190	129,292	89,908
Population Growth 2010–2023	0.4%	9.6%	17%
Hispanic/Latino	72%	51%	41%
American Indian	14%	2%	10%
White	11%	41%	41%
Other	1%	1%	0%
Multi-Racial	1%	4%	5%
Asian	1%	1%	1%
Black	1%	1%	1%
Hawaiian/Pacific	0%	0%	0%
Average Income 2021	$46,969	$67,341	$72,151
Median Home Value 2021	$208,210	$362,200	$252,200

Population for 2023 data from Population of Counties in New Mexico 2023 (worldpopulationreview.com)

The population at risk (PAR) is the number of people that are physically located within the area that could experience inundation. This includes everyone within the 0.001 Annual Exceedance Probability (AEP) floodplain. PAR values are calculated from the National Structure Inventory within the floodplain. Within the Abiquiu Dam floodplain, there is a daytime PAR of 2,456 and a nighttime PAR of 2,431. Of the total PAR, 96 percent is in Rio Arriba County, New Mexico. The almost identical daytime and nighttime PAR is indicative of subsistence farming and those working outside their home are still within the floodplain.

b. Agriculture

The Abiquiu Dam downstream floodplain is primarily self-sustaining agriculture for use of on-farm animals. Most of Rio Arriba County, New Mexico is rural with many family farms and small ranches. The Census Bureau indicated in 1960 that 60 percent of the farms contain less than 10 acres of irrigated land and that over 80 percent contain less than 20 acres. In recent years, there has been little development of agriculture land within the floodplain. Most farms and ranches average less than 35 acres.

The average cash receipts for agriculture in 2023 were $10,679 per farm for Rio Arriba County, New Mexico, and $25,615 in Sante Fe County, New Mexico (Table 4-23). The relatively low level of economic contribution is shown when compared to the total 2021 farm receipts of $16.9 million for Rio Arriba County, New Mexico, and $19.9 million for Sante Fe County, New Mexico. Most of the farms are operated and run by their owners who live on the farm or nearby in either county. Many of the commodities do not reach commercial markets. The low level of developed land results in agriculture not being a driving economic factor for the area, and only minor source of consequences of Abiquiu Dam. Most of the agricultural activity takes place along the Rio Chama River upstream of the confluence with the Rio Grande River. Much of the crop raised on these farms feeds animals on the farm with very little exported beyond the region.

About 41,100 acres are currently irrigated. Production of cattle and sheep is the predominant agricultural activity. In the area of Abiquiu Dam and the lower Rio Chama Valley, grazing land and cropland are the principal uses. Lands surrounding the reservoir are classified as rangeland and are used primarily for grazing.

Table 4-23. Counties Downstream from Abiquiu Dam with Agricultural Development within Floodplain

Counties	Farm Size (Acres)	Value of Product Sold	Production Cost	Livestock	Cattle per 100 acres	Vegetable acreage	Orchard acreage	Family Farms
Rio Arriba	1,449	$10,679	$12,438	93%	1.57	156	859	93%
Santa Fe	1,486	$25,615	$30,077	87%	1.6	40	248	93%

https://www.city-data.com/county/Rio_Arriba_County-NM.html, https://www.city-data.com/county/Santa_Fe_County-NM.html

c. Industry

The Carson National Forest occupies 856,700 acres of Rio Arriba County, New Mexico, and the Santa Fe National Forest occupies 531,600 acres. With the exception of lumbering and associated wood products, there is very little industrial development in the county. The southern portion of the county has benefitted from Los Alamos National Laboratories which employs some Rio Arriba County, New Mexico, residents. A source of income in the northern part of the county is tourism and recreation. Fishing and hunting as well as the narrow-gauge railroad at Chama, New Mexico, attract tourists to this part of the state.

The LAC-DPU owns and operates the hydroelectric power facility at Abiquiu Dam and has direct responsibility to ensure that the power facility operation follows the Abiquiu Reservoir regulation schedule. The Utilities Department of the county is responsible for the facility operation.

Land ownership within the watershed consists of various Federal and State entities including the Bureau of Land Management, Bureau of Indian Affairs, United States Forest Service, New Mexico Department of Game and Fish, New Mexico State Parks, and private lands. Privately owned land and ranches are primarily located on land grants in and around the larger New Mexico towns of Chama, Tierra Amarilla, and Abiquiu, as well as points east including El Rito, and Ojo Caliente in Taos County, New Mexico.

d. Flood Damages

Flood damages are calculated using an HEC-FIA model. Water surface profiles were generated for flood events and each event was run as a single event in the HEC-FIA model. The results for each event were then used to build a frequency/probability – damage table. This table was annualized to produce an Expected Annual Damage for with and without project. These calculations model damages to the structure inventory below the dam with and without the dam in place. The difference in damages from the with- and without-dam scenarios is, therefore, the amount of direct economic damages reduced by the presence of the dam. The inventory of structures included all structures within the boundary of the 0.001 AEP floodplain. Unless specifically identified, all values are expressed in FY 2023 levels (Table 4-24).

The National Structure Inventory estimates a total value of $2.2 billion dollars in structure, content, and vehicle values, attributed to 3,962 individual structures, 88 percent of which are residential structures. The inventory includes all structures. The predominant rural residential and small farms have multiple outbuildings including barns, shops, garages, animal/grain buildings. These outbuildings are counted in the structure inventory.

Most of the farms are operated and run by their owners who live on the farm or nearby in the Rio Arriba or Sante Fe counties. Many of the commodities do not reach commercial markets. The low level of developed land results in agriculture not being a driving economic factor for the area, and only minor source of consequences of Abiquiu Dam.

Table 4-24. Floodplain Structure Distribution and Value (2023 price level)

Types of Structures	Number of Structures	Value of Structures ($1,000)	Value of Contents ($1,000)	Value of Vehicles ($1,000)
Commercial	399	$390,504	$399,685	$34,598
Industrial	27	$13,178	$15,391	$881
Public	47	$65,657	$72,937	$3,841
Residential	3,489	$722,798	$361,399	$115,714
Grand Total	3,962	$1,192,137	$849,412	$155,033

Table 4-25 displays the total event-based damages within the floodplain. The most frequent event modeled was the 0.5 AEP event. Analysis of the river channel shows that channel capacity is 1,800 cfs, and the flow for a 2-year event without the dam is 13,283 cfs.

Damages prevented according to the modeled data shows damages occurring at a 0.5 AEP event. Much of the floodplain is enclosed by canyons and a narrow channel. Where the floodplain widens, structures close to the river sustain damage when flows are above 1,800 cfs without the dam.

It is important to note that the damages recorded are solely in reference to Rio Chama River flows coming from releases of Abiquiu Dam, and do not account for flooding that originates from other sources, such as rainfall and urban runoff within the floodplain below the dam. Therefore, these numbers do not exactly represent the amount of damage that the floodplain could experience during similar AEP flood events.

Table 4-25. Direct Economic Damages by Event

AEP Event	Event (years)	Damages Without Dam ($1,000)	Damages With Dam ($1,000)	Damages Prevented ($1,000)
50%	2	$24,243	$0.00	$24,243
20%	5	$55,400	$0.00	$55,400
10%	10	$73,760	$0.00	$73,760
5%	20	$92,717	$0.00	$92,717
2%	50	$115,181	$0.00	$115,181
1%	100	$134,355	$0.00	$134,355
0.5%	200	$157,142	$0.00	$157,142
0.2%	500	$191,573	$0.00	$191,573
0.1%	1,000	$222,498	$0.00	$222,498

For Abiquiu Dam the expected annual damage (EAD) indicates the monetary value of physical loss that can be expected in any given year based on the magnitude and probability of loss from all possible events. Table 4-26 shows the sum of the weighted damage estimates represents the EAD below with and without Abiquiu Dam. The EAD in the floodplain below Abiquiu Dam is estimated to be approximately $28 million without the presence of the dam. Since Abiquiu Dam can capture all flood events, the EAD with the dam is reduced by 100 percent to approximately $0.

Table 4-26. Direct Economic Damages by Event without Dam

Event (Year)	Probability	Incremental Probability	Damages ($1,000)	Average Damage ($1,000)	Expected Annual Damage ($1,000)
		0.001			$0
1000	0.001		$222,498		
		0.001		$207,036	$207
500	0.002		$191,573		
		0.003		$174,358	$523
200	0.005		$157,142		
		0.005		$145,749	$729
100	0.01		$134,355		
		0.01		$124,768	$1,248
50	0.02		$115,181		
		0.03		$103,949	$3,118
20	0.05		$92,717		
		0.05		$83,239	$4,162
10	0.1		$73,760		
		0.1		$64,580	$6,458
5	0.2		$55,400		
		0.3		$39,822	$11,946
2	0.5		$24,243		
Without Project Expected Annual Damages ($1,000)					**$28,391**

Since Abiquiu Dam can contain all flows up to the 0.001 AEP event, the average annual damages prevented is 100 percent of the estimated damages without the project, $28.391 million as shown in Table 4-27.

Table 4-27. Expected Annual Damage Summary

Without Project Expected Annual Damages ($1,000)	$28,391
With Project Expected Annual Damages ($1,000)	$0
Damage Reductions due to Dam ($1,000)	$28,391
Expect Average Annual Damages Reduced due to Dam (%)	100%

CHAPTER 5—DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 HYDROMETEOROLOGICAL STATIONS

The Water Management Section (WMS) of the USACE, Albuquerque District; the National Weather Service (NWS); Natural Resources Conservation Service (NRCS); and the United States Geological Survey (USGS) cooperate to collect hydrometeorological data and maintain a communication network. Plate 5-1 shows the locations of the precipitation, SNOTEL, and stream gages in the Rio Chama watershed.

a. Facilities

Climatological, stream flow, and reservoir water level data are collected and monitored by gages located in the Rio Chama watershed. In the Supplemental Tables section, Table 5-1 lists all active gages (see Supplemental Tables), and Plate 5-1 shows their locations. A Geostationary Observational Environmental Satellite (GOES) data collection platform provides Albuquerque District with near real-time hydrometeorological data. Each GOES data collection platform telemetry station measures and records data every 15 minutes, then transmits the data once an hour. The NRCS owns and has installed and maintains a system of automated snowpack data collection called SNOTEL, which relays snow water content daily from selected snow courses.

There is a weather station located at Abiquiu Dam with data collected manually at 0800 each working day. The following parameters are collected: current, maximum and minimum temperatures, precipitation, and pan evaporation. The evaporation pan is operated during the freeze-free period, which is usually April through October.

b. Reporting

All data collection platforms in the Rio Chama Basin transmit data via GOES satellite to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA). The data is received by a downlink directly into the computer network of the WMS office. Most of these stations are weather, reservoir elevation, and stream flow gages. The WMS generates a daily report, which uses data received with additional data gathered by project personnel. The WMS report includes reservoir elevation, storage, outflow, computed inflow, precipitation, evaporation, temperatures, the percent of cloud cover, and the percent of lake surface covered by ice.

The NWS provides an array of weather data, including observed and short- and long-range forecasts, precipitation totals, watches and warnings, and severe weather statements. Weather information is provided through their website (https://www.weather.gov/).

During flood emergencies, additional real-time precipitation and weather data can be provided through special report request. Further reports can also be obtained from project staff. Reporting criteria and methods are described in Standing Instructions to Project Operator, Exhibit F.

(1) Data Transmitted to National Weather Service

WMS reports planned reservoir releases and manually collected weather data at the project to the NWS.

(2) National Water Management Dissemination

WMS reports reservoir elevation, storage, computed inflow, outflow, precipitation, evaporation and temperatures to the National Water Management database.

c. Maintenance

USGS installs and maintains the gage equipment at the project office and at other real time data gaging stations in the watershed. Four USACE stream and reservoir gages are operated and maintained by the USGS under cooperative stream gaging program (Table 5-1 in the Supplemental Tables section). Personnel from USGS conducts scheduled visits to each gage to insure proper operation.

The USACE OPM is responsible for the operation and maintenance of the weather station at the project and for making weekly checks of the reservoir and downstream gages to assure that the automated readings match the staff gages. NWS personnel visit all precipitation stations periodically to inspect and repair the instruments.

5-02 WATER QUALITY STATIONS

This subsection discusses water quality stations.

a. Facilities

The Albuquerque District collects water quality data upstream, downstream, and within Abiquiu Reservoir. Within the reservoir, project office staff collect monthly vertical profiles (water temperature and dissolved oxygen [DO]), surface measurements (turbidity, pH, and specific conductance), and water transparency (secchi depth) at three locations (i.e., Rio Chama inlet, Cañones inlet, and near the dam). Beginning in 2020, USACE started a 5-year program to collects high-frequency (15-minute intervals) water temperature, specific conductance, DO, turbidity, and pH upstream and downstream of the reservoir (i.e., collocated with USGS streamflow gages).

NMED collects data from the Rio Chama inlet and near the dam on a 10-year rotational schedule. Monitoring occurs in non-winter months from March through November over two years. USGS collects periodic water quality samples in the watershed.

LAC-DPU monitors DO on a continuous basis at the powerhouse tailrace upon immediate release from the outlet works. DO monitoring equipment consists of a configurable dissolved oxygen monitor with digital and analog I/O, a DO sensor probe, chart recorder, 2 redundant large 75 hp motors turning 2 high cfm air blowers. The system monitors DO saturation in the hypolimnetic water being discharged through the 3 turbines 24 hours a day, 7 days a week. The system includes digital and analog input and outputs that automatically start and stop the air blowers and record DO levels on a monthly circle chart recorder. The system is designed to maintain a DO concentration greater than 6.0 ppm in the water being released into the lower Rio Chama corridor below Abiquiu Dam. DO levels are maintained naturally by normal river flow downstream of the tailrace. The two 54-inch cone valves and the 14-inch jet flow valve do not require oxygen injection as these valves are designed to aerate the water during discharge from their respect outlets. Therefore, the hydroelectric power plant monitors and records DO levels 100 percent of the time, but air injection only occurs during turbine/generator unit operation, and then typically only during the warmer summer months.

b. Reporting

Water quality data collected by USACE entered into the Corps Water Quality Enterprise Database and available to the public. NMED reports the monitoring work plans and data are available at: https://www.env.nm.gov/surface-water-quality/. Data collected by USGS are available at their website: https://waterdata.usgs.gov/nwis/qw.

c. Maintenance

The USACE project staff maintain water quality equipment. USGS and NMED maintain their own equipment.

5-03 SEDIMENT STATIONS

This subsection discusses historic sediment data collection, changes over time and current aerial and bathymetric surveys.

a. Facilities

Collection of suspended sediment samples below the dam was discontinued in 1993. Samples below the dam were collected for approximately 28 years. The transport and deposition of sediment, which affects the operation of Abiquiu Dam, are monitored by periodic aerial (light detection and ranging [LiDAR] data) and bathymetric surveys of the reservoir area. Twenty-six transverse reservoir sediment ranges have been established for measuring the rate of depletion of reservoir storage caused by sediment deposition. The locations of these ranges are permanently fixed by survey monuments located at the ends of each range. Eleven degradation ranges were established below the dam and cover a distance of about 15 miles. Plate 5-2 shows sediment and degradation range locations.

b. Reporting

The frequency of sedimentation surveys will depend on hydrologic conditions and the need for determining sediment deposition and storage depletion. Normally, a period of no more than 10 to 15 years would elapse between sedimentation surveys. However, sedimentation surveys are currently done periodically depending on need and funding availability. Resurveys of Abiquiu Reservoir were made in 1963, 1967, 1972, 1973, 1976, 1978, 1984, 1991, 1998, 2013, and 2021. Sedimentation data is entered into the Reservoir Sedimentation Information (RSI) database.

c. Maintenance

The WMS is responsible for the sedimentation and degradation range line monuments with the assistance of the OPM who periodically inspects the monuments.

5-04 RECORDING HYDROLOGIC DATA

Real-time hydrologic data is collected and processed in the Corps Water Management System (CWMS). The CWMS database serves as the data repository for real-time and historical data collected at the Abiquiu Dam. Real-time data is critical for assessing the watershed conditions. It is also used as input for forecasts and decision support models used by the Albuquerque District water managers in anticipating changes to water surface elevation and associated discharge, which are sampled at 15-minute intervals and transmitted hourly. They can be viewed as a plot or in a tabular format via the Albuquerque District Water Management Section website (https://w3.spa.usace.army.mil).

Daily summaries of Abiquiu Dam data including stage, storage, outflow, inflow, precipitation, and evaporation are available from the WMS. Plate 5-3 shows an example of the daily report for Abiquiu Dam. Monthly tabulations of this information are retained indefinitely as the official record of operation. Summary data, monthly data, and annual data are provided to various agencies at their request. USGS records river flow data within the Rio Chama Basin.

5-05 COMMUNICATION NETWORK

Primary communication is by phone and email. USACE Information Technology (CIO/G-6) maintains the Voice over IP (VoIP) phone system. Further detail on the communications network is provided in the EAP for Abiquiu Dam. Backup communication is by Cellular voice and data network.

Albuquerque District's CWMS computer system data is continuously backed up to a CWMS system hosted by the Sacramento District, to ensure continuity of Albuquerque District's water management operations.

5-06 COMMUNICATION WITH PROJECT

This subsection discusses methods of communication among WMS, Project Office and Others.

a. Communication Between Regulating Office and Project Office

The primary mode of communication between the Abiquiu Dam project office and WMS is by telephone, cellular phone, or email. Should communication between the project and the district be disrupted, the OPM would direct regulation of the reservoir on his or her own initiative in accordance with the Emergency Rules and Regulations listed in Section 7-04 and Exhibit F of this manual.

b. Communication Between Regulating/Project Office and Others

This subsection discusses methods of communication WMS and Abiquiu Dam project office with other agencies.

(1) Project Office and Others

The Abiquiu Dam project office personnel have the additional capability to use radio to communicate with local law enforcement and other emergency responders. When flooding from unscheduled releases may occur, the OPM will notify the New Mexico State Police and Rio Arriba County Sheriff. The OPM will follow communication procedures as laid out in the EAP when conditions develop which could lead to a breach of the dam or an uncontrolled release of water.

(2) Water Management Section/Hydraulics and Hydrology Branch and Others

The WMS will maintain liaison and cooperate with federal, state, and county agencies and officials and with local, public and private interests relative to the regulation of the reservoir. Along with telephone, email, and text message communications between WMS and other agencies, the WMS website provides real-time data used to inform current and future project conditions.

Local news media will be notified of unscheduled releases which might cause flooding through a press release(s) by the Albuquerque District Public Affairs Office. Table 5-2 and Table 5-3 in the Supplemental Tables section show officials and agencies to be notified in the event of a flood emergency.

(3) Water Management Section/Project office with Los Alamos County, New Mexico

Operation of the hydroelectric power facility is the responsibility of the LAC-DPU under the direction of the Utilities Department Manager. The WMS under the supervision of the District Engineer, will direct the county regarding the reservoir releases. The Project Office and LAC-DPU will coordinate releases. Exhibit H details the lines of communication and hydroelectric power facility operating procedures.

5-07 PROJECT REPORTING INSTRUCTIONS

Abiquiu Dam project office personnel prepare a daily report on the CWMS system. The reports are prepared each morning between 0730 and 0815. On weekends and/or holidays, reports are prepared on the next workday. The WMS retrieves the daily report(s) from the system each morning between 0830 and 0900. When the Abiquiu Dam project office cannot access the CWMS, project data will be transmitted by telephone or email to the WMS. Project office personnel are responsible for ensuring the data reported is accurate. The minimum requirement is for visual staff readings (not chart readings) of reservoir elevation and downstream gage and gate settings each Monday morning (or the next workday after a holiday). This information is used to check the accuracy of the sensor data. Project office personnel need to alert the WMS when the sensor is off ±0.03 feet or more. The WMS will issue instructions to the project office on whether the sensor needs adjustment or when there is a need for better accuracy than mentioned above. Plate 5-3 shows an example of the daily reservoir report.

The WMS will instruct the project office personnel to make specific gate settings for estimated releases when controlled by the USACE service gates. Project office personnel are required to confirm the change and give a visual staff reading of the downstream gage to the WMS after one hour, when the new flow rate has stabilized. Unanticipated conditions which arise are reported immediately to the WMS and the WMS will issue new instructions. During periods of flooding, the OPM must report reservoir conditions at the end of the day to the WMS. In the event of rainfall exceeding 0.50 inches per 6-hour period at the dam, the OPM will immediately report the information to the WMS. Exhibit F contains the Standing Instructions to the Project Operator, where additional details and more explicit reporting instructions can be found.

During releases through the hydroelectric power facility, the LAC-DPU will, after being instructed by the WMS to modify flow releases, report to the WMS the time at which the flow modification took place. The LAC-DPU will also verify, one hour later, the new discharge rate based on readings taken at the USGS gage. The WMS in turn will notify the Abiquiu Dam project office confirming time and amount of flow change. Exhibit F, Standing Instructions to the Project Operator has additional details about reporting instructions.

5-08 WARNINGS

The WMS will issue the necessary instructions for flood warnings from scheduled releases to the Albuquerque District Public Affairs Office. Local news media will be notified of the scheduled releases which might cause flooding through press releases by the Albuquerque District Public Affairs Office.

CHAPTER 6—HYDROLOGIC FORECASTS

6-01 GENERAL

The NWS is the recognized federal agency responsible to the public for flood forecasts. USACE estimates flows and reservoir levels, which are used to forecast the effects of flood regulation in accordance with the WCP. For these purposes, it is essential that close coordination efforts within the two agencies be maintained. Forecasts of the spring snowmelt runoff volumes are generated by both the NRCS and the NWS at the first of each month from January through June. Rain-flood forecasts are infrequent since general area storms of large magnitude are rare but are available from the NWS. Flood forecasts for high-intensity, localized rainstorm events that develop rapidly may not provide sufficient lead time for project operation.

a. Role of U.S. Army Corps of Engineers

The Albuquerque District WMS is responsible for monitoring the operation of Abiquiu Dam and Reservoir to ensure it complies with its' approved WCP. WMS personnel utilize precipitation and flow data from various sources to prepare forecasts of expected pool elevation and estimated reservoir releases. The forecasts are furnished to project office personnel and other USACE personnel with a need for this information. Planned changes in the release rates are furnished to the National Weather Service–West Gulf River Forecast Center (NWS-WGRFC) in Fort Worth, Texas. The Public Affairs Office is always informed of lake conditions and makes news releases as necessary.

The WMS will maintain the CWMS models and the URGWOM, which was developed using RiverWare software, for use in flood forecasting and reservoir operations. When appropriate, releases from Abiquiu Dam will be coordinated with scheduled releases from other flood control projects operating in the Rio Chama and Rio Grande basins.

b. Role of Other Agencies

The NRCS provides USACE with water supply forecasts with spring runoff volumes for certain forecast periods at numerous locations within the Rio Chama and Rio Grande basins. The NRCS has installed and maintains a system of automated snowpack data collection called SNOTEL, which transmits snow water content daily from selected snow courses. Monthly NRCS forecasts of snowmelt runoff volumes are issued from January through June. NRCS water supply outlook reports are available on NRCS website, https://www.nrcs.usda.gov/resources/data-and-reports/new-mexico-water-supply-outlook-reports.

The NWS-WGRFC and Weather Forecast Office (NWS-WFO) provide information about river flow, spring runoff volumes, and flood forecasts to the WMS. The NWS is responsible for issuing flood forecasts, along with current weather conditions to the public. The WMS uses NWS forecasts of temperature, precipitation, and streamflow as an input to CWMS models.

USGS maintains a series of stream flow gages throughout the Rio Chama Basin used to support the CWMS forecasting model.

6-02 FLOOD CONDITION FORECASTS

This subsection discusses flood condition forecast requirements and methods using both CWMS and URGWOM.

a. Requirements

Flood condition forecasts are required when above normal winter snowpack or when substantial rainfall occurs above and below Abiquiu Dam. The type of forecast varies whether it is spring runoff forecast or summer rainfall forecast.

b. Methods

CWMS is an integrated system of hardware and software used to derive the hydrologic response of watersheds above and below reservoirs. It is a real-time decision support system that expands and enhances the data and information available to the WMS in making decisions about operation of Abiquiu Dam. Data and information made available through CWMS includes precipitation and forecasts as well as data and information about the current state of watersheds. The CWMS software has a mechanism that links the selected analysis software for a forecast, so that the selected software applications are executed in an orchestrated manner. Data and other inputs are passed to each piece of analysis software through the Hydrologic Engineering Center's Data Storage System (HEC-DSS) data exchange software.

The Rio Chama watershed is represented in the CWMS models for the Rio Grande watershed. Models are used to forecast inflows and facilitate reservoir operation decision making using an hourly time step. There are two Hydraulic Modeling System (HEC-HMS) models, and both use the gridded data described in Chapter 5. One of the HEC-HMS models is a snowmelt and rainfall model that includes the headwater of the Rio Grande in Colorado to the New Mexico-Texas state line. The other HEC-HMS model is a rainfall-driven model that includes the whole Rio Grande watershed from its headwater in Colorado to Amistad, Texas. The HEC-HMS models are linked to the Reservoir System Simulation (HEC-ResSim) model, which is used to determine the coordinated operations between Abiquiu Dam and other dams within the Rio Grande Basin. River Analysis System (HEC-RAS) and Flood Impact Analysis (HEC-FIA) models are used to determine inundated areas and consequences, respectively, downstream of the Abiquiu Dam. Section 4-12.d describes an economic analysis development that used HEC-RAS and HEC-FIA models.

The URGWOM is developed through an interagency effort for the purpose of simulating integrated reservoir operations and stream flows on a daily time step. URGWOM covers the Rio Grande Basin from its headwaters in Colorado to Hudspeth County, Texas, and involves the use of complex accounting to track water specifically allocated for different water users. It is a comprehensive decision support tool for water management and water accounting in the Rio Grande Basin and uses Riverware software as its platform. URGWOM is used to track SJ-C project water and prepare annual accounting reports for the Rio Grande Compact Commission. URGWOM is used to forecast flood operation at the Abiquiu Dam based on the NRCS spring runoff volume forecast.

Key streamflow forecast points for Abiquiu Dam are the New Mexico river gages located on the Rio Chama near La Puente, Rio Chama near Chamita, and the Rio Grande at Otowi Bridge. Observed reservoir storage and intervening downstream runoff are used to determine current and future flood control releases in accordance with criteria in paragraph 7-05.

6-03 CONSERVATION PURPOSE FORECASTS

This subsection discusses water supply (conservation) forecast requirements and methods using URGWOM.

a. Requirements

The conservation pool forecast is coordinated with the USBR based on the NRCS spring runoff volume forecast for each month (January to June). Abiquiu Dam and Reservoir is authorized to store transmountain water (SJ-C project water) and Rio Grande system water.

b. Methods

The operation module of URGWOM is used to forecast water supply storage and releases. The accounting module of URGWOM also tracks the type and ownership of water. Conservation storage forecasts are made on a monthly basis or as needed depending on the forecast.

6-04 LONG RANGE FORECASTS

Annual Operating Plans (AOP) are developed using URGWOM with the NRCS and NWS forecasted runoff volumes to forecast operation and resulting flows at several locations in the Rio Grande basin. Long-range weather forecasts are made by the NWS Climate Prediction Center, and available at the Outlooks Index in the website http://www.cpc.ncep.noaa.gov/products/OUTLOOKS_index.shtml. The Outlooks Index contains temperature forecasts and precipitation forecasts for the categories of Monthly to Seasonal and Extended Range. The special products, such as current UV Index forecast, and Soil Moisture Outlooks are also available on this website.

6-05 DROUGHT FORECAST

Appendix F to the Rio Grande Basin Master Water Control Manual, Drought Contingency Plan (DCP), Rio Grande Basin, provides information on historical droughts in the basin and methods used to compute the drought severity of current basin conditions. In general, the three factors used to estimate the potential for drought are the current irrigation water supply available, the volume of spring snowmelt runoff volume forecasted, and an NWS index known as the Palmer Drought Severity Index (PDSI). The PDSI is published monthly by the NWS and provides a measure of current soil conditions.

6-06 WATER QUALITY FORECASTING

Water quality is not an authorized purpose for Abiquiu Dam.

6-07 FORECAST INFORMED RESERVOIR OPERATION

Forecast Informed Reservoir Operation (FIRO) is a proposed management strategy that uses data from watershed monitoring and modern weather and water forecasting to help water managers electively retain or release water from reservoirs in a manner that reflects current and forecast conditions. A FIRO research study, if considered, would take several years to complete, and a recommended FIRO Study alternative could lead to a subsequent update to the WCP and WCM if results of this study show FIRO tools could be viable for implementation.

The Rio Grande Compact (Exhibit C) allocates the water of the Rio Grande Basin, including flood water, between Colorado, New Mexico, and Texas. The Flood Control Act of 1960 (Exhibit B) provides specific rules for storing and releasing flood water for all USACE projects in the Rio Grande Basin. Therefore, it is expected that any forecast-informed operational changes would require legislative authorization and the three states’ agreement.

CHAPTER 7—WATER CONTROL PLAN

7-01 GENERAL OBJECTIVES

Abiquiu Dam and Reservoir is operated primarily for flood control, sediment control, and water supply within the restrictions imposed by the Flood Control Act of 1960 (Exhibit B, Public Law 86-645) and in accordance with the Rio Grande Compact (Exhibit C). USACE considers Abiquiu Dam and Reservoir to be one of the reservoirs of the Middle Rio Grande project as defined in Public Law 86-645. Any deviation of this plan, not deemed an emergency, requires advice and consent (i.e., unanimous consent) of the Rio Grande Compact Commissioners (see paragraph 7-14), if the deviation is a departure from the operation schedule detailed in Public Law 86-645. Flood control releases are contingent on flow in the Rio Grande and inflow to the Rio Chama below Abiquiu Dam. Operation of Abiquiu Dam is integrated with Cochiti, Galisteo, and Jemez Canyon dams for flood control. Transmountain diversion water from the San Juan Basin and Rio Grande system water are stored under the authority contained in Public Laws 97-140 and 100-522, as amended by Public Law 116-260 (Sec. 337 of WRDA 2020). SJ-C project contractors can store SJ-C project water and Rio Grande system water up to elevation 6,230.0 feet in accordance with applicable state and federal laws, including the Rio Grande Compact.

The hydroelectric power facility is a run-of-river plant, with releases based on the water supply and flood control release schedules of Abiquiu Dam.

All elevations referred to in Chapter 7, unless noted otherwise, are in feet using the NGVD 29 datum. The Abiquiu Dam datum conversion from NGVD 29 to NAVD 88 is:

NGVD 29+3.33 feet=NAVD 88.

7-02 CONSTRAINTS

The process to switch between releases going through or bypassing the hydroelectric power facility takes approximately 9 hours. The process requires reduced releases in order to raise the closure gate of the hydroelectric power facility intake, allowing releases to flow through the flip bucket. The USACE service gates will then control of the releases through the outlet works.

Rio Chama Acequia Association (RCAA) has several diversion structures in the Rio Chama reach from Abiquiu Dam to the confluence of the Rio Grande. Most of these structures are of rock construction that may experience minor damages at flows above 1,800 cfs. Bank erosion and sloughing is expected when flows are equal to or greater than 1,800 cfs.

7-03 OVERALL PLAN FOR WATER CONTROL MANAGEMENT

Abiquiu Dam is regulated to control flows on the lower Rio Chama and the Rio Grande to non-damaging flow rates. Abiquiu, Cochiti, and Jemez Canyon dams are all regulated as a system. Water stored in the flood space is evacuated as rapidly as conditions downstream permit. Flood storage can be evacuated after 1 July on the spring flood recession only when the natural flow at the Otowi gage on the Rio Grande is greater than 1,500 cfs. Flood storage that is retained through the summer is released after 31 October and must be fully evacuated by 31 March of the following year.

Water stored for SJ-C project contractors (SJ-C project water and Rio Grande system water) is limited to elevation 6,230.0 feet and released as requested by the storing entities. All other natural Rio Chama flow and releases from upstream reservoirs are passed through Abiquiu Dam with minimum regulation.

Water stored for SJ-C project contractors (SJ-C project water and Rio Grande system water) may be evacuated, as necessary on a forecast basis, to limit flood storage to the top of the flood control pool. See Exhibit I for example of evacuation of conservation storage. Furthermore, contractors stored water could be evacuated to allow maintenance or repair of the dam or appurtenant structures.

Table 7-1. Reservoir Storage Allocations

Reservoir Use	Elevation Limits (feet)	Capacity (acre-feet)
Surcharge Storage	6,350.0–6,374.0	338,048
Induced Surcharge Storage	6,283.5–6,350.0	656,342
Exclusive Flood Control Storage	6,230.0–6,283.5	326,579
Joint Use Flood Control and Conservation	6,060.0–6,230.0	229,199

7-04 STANDING INSTRUCTIONS TO PROJECT OPERATOR

Abiquiu Dam releases could occur through the hydroelectric power facility or through the USACE flip bucket bypassing the hydroelectric power facility. Standing instruction to the Abiquiu Dam project operator will be in accordance with paragraph 7-05 and Exhibit F. The LAC-DPU operates the hydroelectric power facility at the Abiquiu Dam under a Memorandum of Agreement (MOA) with USACE (Exhibit G). The coordinated procedure for operation of the power plant is explained in Exhibit H.

a. Conservation, Normal Flood, and Emergency Regulation

Instructions to the project operator and LAC-DPU for storage and release are issued by the WMS, Hydrology and Hydraulics (H&H) Branch, Engineering and Construction Division, Albuquerque District.

b. Instructions During Loss of Communication for Flood and Non-Flood Conditions

In the event of a communications disruption between the WMS and the Abiquiu Dam project office or LAC-DPU, reservoir regulation will be in accordance with Exhibit F, paragraph 10, Table F-1 of this manual. Communications should be reestablished as rapidly as possible.

7-05 FLOOD RISK MANAGEMENT

Flood risk management (flood control) at Abiquiu Dam begins when control point capacities are exceeded or are forecasted to be exceeded, or when the flood control operation at Cochiti Dam requires storage in Abiquiu Reservoir.

a. Regulation under Normal Conditions

(1) Elevation 6,060.0 feet to 6,283.5 feet

Abiquiu Dam is operated for flood control on the Rio Chama and Rio Grande. Joint use water for conservation storage is stored in the flood control pool below elevation 6,230.0 feet. During non-flood operations, releases are based on upstream irrigation releases and SJ-C contractors requests. Table 7-2 lists control point capacities below Abiquiu Dam.

Table 7-2. Downstream Control Point Capacities

Control Point	Flow (cfs)
Rio Chama below Abiquiu Dam (USGS 0828700)	1,800
Rio Chama near Chamita Gage (USGS 0829000)	3,000
Rio Grande at Otowi Bridge Gage (USGS 08313000)	10,000

The control point capacity below Abiquiu Dam is variable, dependent on sediment accumulations that result from inflow by tributary arroyos. The channel below Abiquiu Dam has a control point capacity of approximately 1,800 cfs for extended periods when conditioned by bringing the flow up gradually from 1,200 cfs up to 1,800 cfs based on channel conditions. Channel control point capacity below the Rio Ojo Caliente confluence is about 3,000 cfs as measured at the Chamita gage. Abiquiu Dam operation will not cause the flows to rise above 10,000 cfs, as measured at the Otowi gage, when possible. When Abiquiu Dam is being operated for flood control, a minimum release rate will be maintained to satisfy the downstream Rio Chama irrigation demand to the extent that such inflow is available. Flood releases should, if possible, also match the flow of the Rio Ojo Caliente to transport sediment down to the Rio Grande.

Flood water stored in the flood space is evacuated as rapidly as conditions downstream permit. When the Rio Grande flow at Otowi gage (excluding any flood releases from upstream storage) falls below 1,500 cfs after 1 July, during the spring flood recession, flood storage that has not been evacuated is retained until after the irrigation season. This storage that is retained through the summer is released after 31 October and before 31 March of the following year. Subsequent flood storage, due to excess rainfall, would be released as rapidly as conditions downstream permit.

(2) Elevation 6,283.5 feet to 6,350.0 feet

Abiquiu Reservoir has sufficient storage capacity equal to 130 percent of the PMF. Operation in the range above the top of the flood control pool (induced surcharge storage), elevation 6,283.5 feet, is to continue operating to the downstream control points until the reservoir elevation reaches 6,350.0 feet, the spillway crest. If pool elevation exceeded 6,350.0 feet and begins to fall, maintain maximum releases reached during the event until the pool falls to the top of flood control elevation (6,283.5 feet).

When the reservoir level rises to elevation 6,300.0 feet, releases will be controlled by the USACE outlet works service gates and bypass the hydroelectric power plant in accordance with procedures explained in Exhibit H.

(3) Above Elevation 6,350.0 feet

When the reservoir elevation rises above 6,350.0 feet (spillway crest), continue to make flood control releases through the outlet works until gates are fully opened. Maintain maximum releases reached during the event until the reservoir elevation falls to 6,283.5 feet.

b. Conservation Storage (Joint Use Space) Evacuation

The authorized flood control storage in Abiquiu Reservoir is 502,000 acre-feet. The storage up to elevation 6,230.0 feet of SJ-C project water and Rio Grande system water in Abiquiu Reservoir was authorized by public laws 97-140 and 100-522, as amended by Public Law 116-260 (Sec. 337 of WRDA 2020). When forecasts indicate that more storage space is needed for flood control, pre-evacuation of conservation storage would begin such that the reservoir elevation would not exceed top of the flood control elevation (6,283.5 feet). The pre-evacuation amount and the time to initiate the release would be dependent upon the runoff forecasts. Exhibit I shows the analysis of the forecasting methodology and example of the pre-evacuation process.

Table 7-3 summarizes the regulations of the Abiquiu Dam.

c. Gate Openings

Exhibit F contains a complete discussion of the decision process used to determine gate opening.

d. Rating Curves and Tables

Elevation-Area-Capacity tables are published to 0.01-foot intervals under separate cover. Copies of the tables are maintained at the Abiquiu Dam project office and the WMS for use in daily operations. In the Supplemental Tables section, Table 7-4 shows the Elevation-Area-Capacity tables in 1-foot increments in the Supplemental Tables section. Plates 7-1A through 7-4 are conduit, tailwater, spillway rating curves, and Elevation-Area-Capacity curves. Plate 7-5 shows Rio Chama rating curves, and Plate 7-6 illustrates the hydropower facility rating curves.

Table 7-3. Regulation of Abiquiu Dam and Reservoir

(A) Non-Flood Operations (6,060.0–6,230.0 feet)	Pass RG inflow and irrigation releases from El Vado Dam. Storage and release of SJ-C project water will be as requested by the water owner. Storage and release of RG system water will be as requested by the water owner and according to the State storage permit conditions.
(B) Flood Risk Management Operations (6,060.0–6,283.5 feet)	Flood control operation at Abiquiu Dam will be to minimize downstream damages and evacuate flood storage as rapidly as downstream conditions permit. Flood control operation will meet the following constraints. 1. Control dam releases as measured at the Rio Chama below Abiquiu Dam gage to 1,200 cfs and increase in about 150–200 cfs increments and monitor downstream channel conditions up to 1,800 cfs. Cease releases of conservation and water supply storage when releases reach 1,500 cfs. 2. Limit flow at Rio Chama at Chamita gage to 3,000 cfs. 3. Limit flow at Rio Grande at Otowi gage to 10,000 cfs. 4. Flood water that could not pass through Cochiti Dam due to Middle Rio Grande valley conditions will be stored at Abiquiu Reservoir. 5. Release of flood storage will not be made after 1 July when the flow at the Otowi gage (excluding any flood releases from upstream storage) is below 1,500 cfs. This locked in flood storage is called carryover water. 6. Flood carryover water during the summer will be released after 31 October and before 31 March of the following year. 7. Change in release rate will be in accordance with paragraph 7-15.
(C) Flood Control Operations (6,283.5–6,350.0 feet)	1. Evacuate flood storage as rapidly as downstream conditions permit (except as noted in D-2 below). 2. When the reservoir elevation rises to elevation 6,300.0 feet releases will be controlled by the USACE service gates and bypass the hydropower facility.
(D) Flood Control Operations (Above 6,350.0 feet)	1. When the reservoir elevation rises to the spillway elevation 6,350.0 feet, the conduit is operated to maintain the reservoir elevation at spillway crest until gates are fully opened. 2. Maintain maximum releases reached during the event until the reservoir elevation falls to the top of flood control elevation (6,283.5 feet).

7-06 RECREATION

A recreation pool is provided by the conservation storage in the joint use pool. There are no specific operations for recreation at Abiquiu Dam.

7-07 WATER QUALITY

Water quality improvement is incidental to the flood and sediment control operations, since water quality control is not an authorized project purpose; however, all federal facilities comply with applicable federal, state, interstate, and local substantive standards (USACE 2018). Operation of any of the hydroelectric power facility's three turbine/generator units may reduce levels of dissolved oxygen in the river immediately downstream of the dam as the result of passing hypolimnetic water off the bottom of the reservoir through the turbines. To assure that water oxygen saturation is maintained to state and federal standards, the power plant facility is equipped with a dissolved oxygen monitoring and air injection system. If the dissolved oxygen level should fall below environmental standards, LAC-DPU's air injection system will automatically introduce additional oxygen at any of the three turbine draft tubes.

7-08 FISH AND WILDLIFE

Fish and wildlife habitat is an incidental benefit of the conservation storage in the joint use pool.

a. Fish

The increased storage of water has replaced the narrow riverine corridor with a larger area of lake habitat in the project area. The lake habitat supports a different fish and aquatic community. Abiquiu Reservoir is currently managed by the New Mexico Department of Game and Fish as a two-story, cold and warm water fishery, and a put-grow-and-take fishery. Sportfish include rainbow trout, brown trout, kokanee salmon, channel catfish, smallmouth bass, and walleye.

b. Wildlife

The wildlife and fish species by taxa that may occur in Rio Arriba County, New Mexico, are mammals (89), birds (251), reptiles (28), amphibians (12), and fish (33). Mammals associated with the upland areas surrounding Abiquiu Dam and Reservoir include mule deer, pronghorn, coyote, desert cottontail, Ord's kangaroo rat, piñon mouse, rock squirrel, and white-throated wood rat. The riparian corridors support beaver, muskrat, raccoon, striped skunk, and Botta's pocket gopher. Bobcat and other large carnivores occur infrequently in the area due to disturbances by humans.

7-09 WATER CONSERVATION/WATER SUPPLY

Water conservation and water supply storage is done under the terms of the storing entities' water supply contracts and storage permits with the New Mexico Office of the State Engineer (NMOSE) and in accordance with applicable state and federal laws, including the Rio Grande Compact. Storage of SJ-C project water and/or Rio Grande system water requires a contract with USACE for designated storage space in Abiquiu Reservoir. Release of stored conservation water is made at the request of the owner.

7-10 HYDROELECTRIC POWER

The hydroelectric power facility is a non-federal facility owned and operated by LAC-DPU with no storage allocation. The facility has a rated capacity of 17.0 MW and is operated in accordance with the normal regulation schedule of the reservoir. The hydroelectric power plant has the capacity to release flows up to 5,500 cfs through a combination of the three turbines and three bypass valves. For reservoir releases above 5,500 cfs, the hydroelectric power facility is shut down, the closure gate is lifted, and all releases are regulated by the USACE service gates. Exhibit H describes USACE coordination with respect to operation of the hydroelectric power facility.

At elevation 6,220.0 feet, a reservoir release of about 75 cfs represents the lower boundary of turbine operation and about 1,500 cfs is the upper boundary with all three turbines operating. The bypass valves have a discharge capacity of 5,500 cfs at elevation 6,220.0 feet.

The turbines are designed to operate between a minimum reservoir elevation of 6,170.0 feet and a maximum reservoir elevation of 6,300.0 feet. If the reservoir level is above or below the turbine operating range, the hydroelectric power facility is shut down and releases are made through the bypass valves, if the conduit remains pressurized, or controlled by the USACE service gates, if the conduit is depressurized.

7-11 NAVIGATION

Navigation is not a project purpose.

7-12 DROUGHT CONTINGENCY PLAN

The purpose of the DCP for the Rio Grande Basin is to provide a basic reference for water management decisions and responses to water shortages induced by climatological droughts. As a water management document, it is limited to those drought concerns relating to water control management actions. Refer to Appendix F of the Rio Grande Basin Master Water Control Manual for more information.

7-13 FLOOD EMERGENCY ACTION PLAN

The WMS manages response to flooding in accordance with the WCP described in this chapter. The EAP is developed through the Dam Safety Program by the Geotechnical Engineering Section. The EAP applies to emergencies that may impact the structural stability or operational adequacy of the project, including increased surveillance during record pool events and spillway activation. Copies of the EAP are located in the WMS, Geotechnical Engineering Section and at the Abiquiu Dam project office. The current EAP was completed in 2018, but a revision is slated to be released in 2024.

7-14 DEVIATION FROM NORMAL REGULATION

There are occasions when it is necessary or desirable to deviate from the WCP for short periods of time. Approval of deviations is required from the USACE South Pacific Division office. The protocol in the South Pacific Division regulation, Guidance on the Preparation of Deviations from Approved Water Control Plans (CESPD-RBT, Regulation No. 10-1-04), dated 18 December 2014, or any updated guidance, shall be followed when requesting deviations (Exhibit J).

The Flood Control Act of 1960 (Public Law 86-645) requires advice and consent of the Rio Grande Compact Commission for any departure from the operation schedule detailed in Public Law 86-645. The upper basin reservoirs (Abiquiu, Cochiti, Galisteo, and Jemez Canyon dams) are operated in accordance with Public Law 86-645 (Exhibit B) which states, in part, that:

> All reservoirs of the Middle Rio Grande project will be operated at all times in the manner described above in conformity with the Rio Grande compact, and no departure from the foregoing operation schedule will be made except with the advice and consent of the Rio Grande compact, and no departure from the foregoing operation schedule will be made except with the advice and consent of the Rio Grande Compact Commission: Provided, That whenever the Corps of Engineers determines that an emergency exists affecting the safety of major structures or endangering life and shall so advise the Rio Grande Compact Commission in writing these rules of operation may be suspended during the period of and to the extent required by such emergency.

7-15 RATE OF RELEASE CHANGE

The allowable rate of release change varies with flow magnitude. Generally, the increase and decrease in stage at the downstream gage should be held to a range of 0.25 to 0.50 feet. The limitation on the increase in stage at the downstream gage is based on public safety concerns. The limitation on the decrease in stage at the downstream gage is based on trying to prevent bank sloughing. Flow changes should not be made in less than one-hour intervals. WMS, or the Abiquiu Operations Project Manager, at their discretion, may exceed the normal rates of change in release in the event of drowning, accidents, failure of operational facilities, severe weather, or other emergencies deemed to require a more rapid rate of increase or decrease in the rate of release. Refer to Exhibit F for more information.

CHAPTER 8—EFFECT OF WATER CONTROL PLAN

8-01 GENERAL

The Abiquiu Dam project provides flood risk management benefits on the Rio Chama and some flood risk management benefits on the Rio Grande below the confluence. Abiquiu, Cochiti, Jemez Canyon, and Galisteo dams are operated to provide flood risk management benefits in the Middle Rio Grande Valley in New Mexico. The Abiquiu Dam project provided water conservation benefits for 19 SJ-C contractors including water supply for two major New Mexico cities (Albuquerque and Santa Fe) and to the MRGCD. In addition, conservation water stored in Abiquiu Reservoir provides recreation, enhances fish and wildlife habitat, and increases the efficiency of sediment retention. Power plant operation will not impact the authorized purpose of Abiquiu Dam.

8-02 FLOOD RISK MANAGEMENT

This subsection discusses the effect of the WCP using design storms and selected historical flood events.

a. Probable Maximum Flood

A PMF based on new rainfall criteria presented in the NWS Hydrometeorological Report No. 55 (HMR 55), Probable Maximum Precipitation Estimates–United States Between Continental Divide and the 103rd Meridian, dated August 1983, was revised in 1985. Unit hydrographs were developed from a regional regression analysis. Adopted loss rates are 0.28 inches per hour above El Vado Dam and 0.15 for areas below the dam. The resultant PMF has a peak inflow of 429,000 cfs and total volume of 504,000 acre-feet. The PMF was routed through the dam using the spillway crest as the starting elevation, 6,350.0 feet (storage of 1,212,120 acre-feet). Routing of the PMF resulted in a maximum water surface elevation of 6,374.0 feet, maximum storage of 1,550,150 acre-feet and peak release of 31,688 cfs (combined spillway and conduit releases). The conduit is operated to maintain the pool at spillway crest as long as possible until it is fully opened. The gates remain fully open until the pool elevation recedes back to the top of the flood pool (6,283.5 feet). Plate 8-1 shows the 1985 PMF routing.

b. Spillway Design Flood

In 1985, the Abiquiu Dam crest was raised by 13 feet and the spillway widened to 68 feet based on a revised PMP from the NWS in 1977. With these dam modifications, the 1981 PMF became the current SDF for Abiquiu Dam and Reservoir. The development of this SDF is documented in Appendix B of the 1981 Reconnaissance Report for Dam Safety Assurance Program. The 1981 SDF peak flow is 451,000 cfs with a volume of 559,800 acre-feet. Plate 8-2 shows the PMF routing from the 1982 Design Memorandum No. 18. Routing of the PMF resulted in a maximum water surface elevation of 6,377.3 feet and a peak release of 39,000 cfs (combined spillway and conduit releases). The conduit is fully opened.

c. Reservoir Design Flood

The original Reservoir Design Flood (RDF) was a combination of the 1941 meteorological conditions (Thermal budget) for May with heavy snowmelt runoff plus maximum precipitation event based on a 21 through 23 November 1931 storm. The inflow hydrograph yielded a peak inflow into the reservoir of 130,000 cfs and a volume of 1,377,000 acre-feet (1 May through 18 May). The RDF was routed through Abiquiu Dam assuming the conservation storage is full, elevation 6,230.0 feet. The routing assumes conduit releases of 1,800 cfs up to pool level of 6,350.0 feet, spillway crest elevation. The conduits were assumed fully opened once the pool level began to exceed the spillway crest elevation. At maximum pool elevation of 6,365.7 feet the peak outflow is 20,112 cfs with a maximum storage of 1,425,372 acre feet. The pool recedes back to the spillway crest approximately 19 days later (Plate 8-3). The RDF exceeds the spillway crest elevation by 15.7 feet. Evacuation of flood water continued to maintain fully opened conduit until reaching top of flood control pool (6,283.5 feet). By end of June, there is about 400,000 acre-feet of flood water in the induced surcharge space (above elevation 6,283.5 feet) and another 325,000 acre-feet in the flood space.

In this scenario, water management will consider pre-evacuation of the conservation storage by early February. Refer to Exhibit I for pre-evacuation details.

d. Other Floods

(1) Standard Project Flood

The standard project flood (SPF) was developed using a hypothetical 1 May snowpack and 1941 weather conditions, except for a transposed precipitation event (based the 21 through 23 November 1931) added for 14 through 16 May 1941. The flood of 1941 was used to determine the project flood control space not the SPF. The original design memorandum routed the 1941 event including limiting flows on the Rio Grande to 5,000 cfs, in so far as possible, resulted in a peak storage requirement of 401,600 acre-feet. This peak storage was increased by 25 percent to compute the design flood control allocation to 502,000 acre-feet.

(2) 1941 Flood

The 1941 event runoff volume was 454,250 acre-feet (1 April to 30 June 1941). Snowmelt runoff began in earnest the second week of May and peaked on 18 May at 6,445 cfs (instantaneous peak of 6,600 cfs). This inflow hydrograph was routed with top of the conservation pool as starting condition. During the actual event in 1941, high Rio Grande flow would constrain the releases from Abiquiu Dam to 100 cfs during the runoff period. Limiting Abiquiu Dam releases resulted in a maximum storage of 686,270 acre-feet occurring on 29 August with a corresponding pool elevation of 6,299.5 feet. Flood water in Abiquiu Reservoir was held in storage and was evacuated at a rate of 1,800 cfs from 1 November through 31 March of the following year in compliance with the WCP. Plate 8-4 illustrates routing of the 1941 spring runoff.

(3) 1979 Flood

The Rio Chama spring runoff began in mid-April and continued through mid-June. The inflow hydrograph peaked at 4,074 cfs on 8 May, with a total volume of 354,000 acre-feet from 1 April to 30 June. This inflow hydrograph is routed with top of the conservation pool as starting condition (elevation 6,230.0 feet) using the current WCP. Maximum storage of 297,808 acre-feet occurred on 2 June with a corresponding elevation of 6,243.6 feet. The release was kept at 1,800 cfs except for a brief period in end of May to account for intervening flows above Chamita gage. The flood water stored in Abiquiu Reservoir would be released from 1 November through 31 March of the following year. Plate 8-4 illustrates routing of the 1979 spring runoff.

(4) 1987 Flood

In 1987, snowmelt runoff in the Rio Grande Basin was about 200 percent of normal as recorded at the Otowi gage. The inflow hydrograph peaked at 4,077 cfs on 20 April with a total volume of 321,500 acre-feet for the period from 1 April to 30 June. This inflow hydrograph is routed with top of the conservation pool as starting condition (elevation 6,230.0 feet) using the current WCP. Maximum storage of 322,029 acre-feet occurred on 21 May with a corresponding elevation of 6,248.0 feet. The release was kept at 1,800 cfs during most of the event. The flood water stored in Abiquiu Reservoir would be released from 1 November through 31 March of the following year. Plate 8-4 illustrates routing of the 1987 spring runoff.

(5) 1995 Flood

The 1 April water supply forecast for the Rio Chama below El Vado Dam was estimated to be between 170 and 225 percent of normal. The inflow hydrograph peaked at 4,580 cfs on 23 May with a total volume of 399,000 acre-feet for the period from 1 April to 30 June. The observed spring runoff inflow hydrograph was routed with starting storage at the top of the conservation elevation 6,230.0 feet. Results indicated peak storage of 342,683 acre-feet occurred on 25 June with maximum pool elevation of 6,251.7 feet. The release was kept at 1,800 cfs during most of the event until end of June. The flood water stored in Abiquiu Reservoir would be released from 1 November through 31 March of the following year. Plate 8-4 illustrates routing of the 1995 spring runoff.

8-03 RECREATION

Annual recreation visitation to Abiquiu Dam and Reservoir was about 128,000 in FY 2022. The significantly popular recreational activities include picnicking, camping, boating, fishing, swimming, and sightseeing. The Rio Chama supports considerable rafting, canoeing, and kayaking, especially in the reach between El Vado Dam and Abiquiu Dam. Plate 2-9 shows recreation areas and other facilities.

8-04 WATER QUALITY

The construction of Heron, El Vado, and Abiquiu dams, and the importation of Colorado River Basin water via the SJ-C project has had numerous effects on water quality in the Rio Chama watershed (Langman and Anderholm 2004). The coordinated storage and releases from the dams and the additional flows from the SJ-C project decreased specific conductance and suspended-sediment concentration and increased pH (Langman and Anderholm 2004). The hypolimnetic release from Abiquiu Dam can also influence the DO regime on the Rio Chama. New Mexico Water Quality Control Commission established water quality standard for DO at 6 mg/l, which was a violation below Abiquiu Dam in 1999 (NMED 2004). Not meeting the standard was attributed to documented summer stratification and formation of anoxic water within the hypolimnion (Davis and Joseph 1999, Davis 2007) that was subsequently released from the reservoir (NMED 2004). The hypolimnetic release, which dampens thermal regime downstream of the dam, may also facilitate elevated DO concentrations due to physical controls on the solubility of oxygen in water (Wetzel 2001).

The current operation of Abiquiu Dam will likely result in continued thermal pollution on the Rio Chama downstream, which act to modify natural temperature cycles with potential impacts to the native fish and aquatic communities. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of additional stressors such as introduced species. Water temperature within the stream substrate can influence the growth of insects, and the toxicity of many chemical contaminants increases with temperature (Caissie, 2006). Hypolimnetic releases may reduce thermal impacts, but would require coordination (e.g., scheduling of water releases to coincide with peak summer temperatures in the Rio Chama).

Climate-mediated disturbances such as wildfire activity, have increased in each of the last two decades in the southwestern U.S. (Westerling et. al. 2006) and impacted water quality of streams and rivers within the Rio Grande Basin (Dahm et al. 2015, Reale et al. 2015, Sherson et al. 2015). Wildfires impact the physical, biological, and chemical processes in lake and flowing water ecosystems (McCullough et al. 2019). However, the hypolimnetic release may dampen the impacts of a wildfire on water quality immediately downstream of the dam (Dahm et al. 2015).

8-05 FISH AND WILDLIFE

This subsection discusses the effect of the WCP on fish and wildlife in and around the reservoir.

a. Fish

The quality and quantity of lake habitat has been significantly increased with the conservation storage. Correspondingly, aquatic and semi aquatic fauna have benefited. Also, stream habitat in the lower Rio Chama has improved from the hypolimnetic discharge of cooler less turbid water. Abiquiu Dam is currently managed by the New Mexico Department of Game and Fish for a put-grow-and- take fishery. The reservoir has a two-story cold and warm water fishery. Common fish species in the Abiquiu Reservoir (Sublette et al. 1990) include rainbow trout (*oncorhynchus mykiss*), brown trout (*salmo trutta*), kokanee salmon (*oncorhynchus nerka*), common carp (*cyprinus carpio*), Rio Grande chub (*gila pandora*), fathead minnow (*pimephales promelas*), flathead chub (*platygobio gracilis*), white sucker (*catostomus commersoni*), channel catfish (*ictalurus punctaus*), green sunfish (*lepomis cyanellus*), bluegill (*lepomis macrochirus*), smallmouth bass (*micropterus dolomieui*), and walleye (*stizostedion vitreum*).

The current operation of Abiquiu Dam will likely result in continued thermal modification on the Rio Chama downstream, which cools and reduces the seasonal and daily magnitude of the natural temperature cycles with potential impacts to the native fish and aquatic communities. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of additional stressors such as introduced species. Water temperature within the stream substrate influences insect growth, and the toxicity of many chemical contaminants increases with temperature (Caissie, 2006). Hypolimnetic releases may reduce thermal impacts, which will generally coincide with M&I releases.

New Mexico Department of Game and Fish, in cooperation with multiple agencies, constructed instream aquatic habitat features on the Rio Chama downstream of Abiquiu Dam. The 2020 project was designed to improve riverine fish habitat in a 3-mile reach downstream of Abiquiu Dam. Habitat features include rock and wood sills, pools, rock grade control structures, rock habitat structures, rock deflectors, and riparian vegetation. Stream habitat and cold-water fish in the lower Rio Chama benefit from the discharge of cooler, less turbid (oligotrophic) water from Abiquiu Reservoir.

b. Wildlife

Wildlife habitat has changed with increased water availability at the reservoir, which has produced a limnetic-terrestrial ecotone. The reservoir has created better habitat for waterfowl, shorebirds, wading birds, and some raptors. Large mammals associated with the upland areas surrounding the reservoir include mule deer, and pronghorn antelope, and coyotes. Small mammals frequently found in the pinon-juniper woodlands of the project lands include desert cottontail, Ord's kangaroo rat, pinion mouse, rock squirrel, and white-throated wood rat. The riparian corridors also support many mammals including beaver, muskrat, raccoon, bobcats, stripped skunk, and Beta's pocket gopher.

8-06 WATER CONSERVATION/WATER SUPPLY

Conservation storage provides water supply for New Mexico cities such as Albuquerque and Santa Fe and irrigation districts such as MRGCD and Pojoaque Valley Irrigation District. Conservation storage started in mid-1980s by storing SJ-C project water up to 200,000 acre-feet. During 2020 Abiquiu Dam was authorized to store Rio Grande system water in addition to SJ-C project water up to elevation 6,230.0 feet. Abiquiu Dam provides the opportunity for SJ-C contractors to carryover their annual allocation. Since the mid-1980s, the average annual conservation storage was about 130,000 acre-feet. Due to increasing demand, it is expected that the use of the conservation storage will increase in the future. In addition, the authorization of storing up to elevation 6,230.0 feet provides more conservation storage.

8-07 HYDROELECTRIC POWER

Construction of the hydroelectric power facility at Abiquiu Dam began in 1987 and began service in April 1990 and the low flow turbine was added in 2011. LAC-DPU operates hydroelectric power plant with a nameplate capacity of 17 MW. The plant uses run-of-river to provide electricity to residents of the City of Los Alamos, New Mexico. The conservation storage at the Abiquiu Dam benefited the reliability of power generation year-round. During FY 2022, LAC-DPU produced 22,090 MW/h with a value of about $1,494,168.

8-08 NAVIGATION

Navigation is not an authorized purpose for Abiquiu Dam.

8-09 DROUGHT CONTINGENCY PLAN

The purpose of the DCP for the Rio Grande Basin is to provide a basic reference for water management decisions and responses to water shortages induced by climatological droughts. As a water management document, it is limited to drought concerns relating to water management actions. The DCP details only a limited number of specific actions that can be carried out related to water supply. The primary value of the DCP is in providing a framework to facilitate coordination and documenting data needed to manage water resources to ensure that they are used in a manner consistent with the needs which may develop during a drought.

8-10 FLOOD EMERGENCY ACTION PLAN

The EAP describes the type of emergencies to be encompassed, notification procedures, and accumulation of data and information needed in a flood emergency. The purpose of the plan is to provide procedures, aids, instructions, and other provisions for interpreting information and data to assess if remedial actions listed in the plan are required to correct an existing or potential emergency. Included are flood inundation maps that show the areas likely to be inundated. The EAP provides technical data required for the development of an evacuation plan for downstream areas which are subject to flooding. Refer to Abiquiu Dam and Reservoir Emergency Action Plan dated August 2018 for additional information.

8-11 FREQUENCIES

This section discusses frequency data for inflow, pool elevation, and at key control points.

a. Inflow Probability

Plate 8-5 shows inflow frequency curves for the gage above Abiquiu Dam. Peak flow data was downloaded from the USGS National Water Information System: Web Interface—annual peak data for Rio Chama Above Abiquiu Reservoir gage (USGS 08286500). Statistical Software Package (HEC-SSP) V2.3 was used to develop the frequencies analysis using Bulletin 17C method, Table 8-1 illustrates these results.

Table 8-1. Annual Chance of Exceedance of Peak Flow at Above Abiquiu Reservoir Gage

AEP (Percent)	Peak Flow (cfs)
0.2	10,021
0.5	8,825
1	7,947
2	7,088
5	5,972
10	5,129
20	4,268
50	3,004
80	2,117
90	1,764
95	1,517
99	1,144

b. Pool Elevation Duration and Frequency

Plates 8-6 and 8-7 show annual peak pool elevation probability and elevation duration curves. Table 8-2, in the Supplemental Tables section, illustrates the annual peak elevations and storage from 1963 to 2022. Plates 8-8A and 8-8B show historic end of month pool elevations hydrographs. Historical maximum elevation of 6,261.06 feet occurred on 22 June 1987.

c. Key Control Points

Three stream gages, Rio Chama below Abiquiu Dam, Rio Chama near Chamita and Rio Grande at Otowi (Plate 2-2), are used as flood control points. The Chamita gage is located on the Rio Chama about 5 miles above its confluence with the Rio Grande. The Otowi gage is on the Rio Grande downstream of the Rio Chama confluence with the Rio Grande. Plate 7-5 shows the USGS gage rating curves. Plate 8-9 shows discharge frequency curves for the Rio Chama near Chamita and Rio Grande at Otowi Bridge.

8-12 OTHER STUDIES

This section mentions other studies related to Abiquiu Dam.

a. National Implementation Program

The CWMS National Implementation Effort is to have all USACE watersheds fully modeled within CWMS. These models will be operated daily to provide decision support and to have results automatically consolidated into standardized briefing tools for executive and public use. The CWMS will be used to develop procedures for the regulation of Abiquiu Dam and Reservoir for predicting flood flows and in developing new and better methods of regulation to obtain optimum flood and sediment control benefits. There were no specific studies conducted in the development of the WCP.

b. Channel and Floodway Improvement

During 2023, WMS developed a two-dimensional (2D) HEC-RAS model to evaluate the channel capacity below the Abiquiu Dam. The model was calibrated against 2019 spring runoff releases (1,800 cfs for about 6 weeks) and was validated during the 2023 spring runoff releases. Results indicate that release of 1,800 cfs is considered non-damaging flow below Abiquiu Dam. This release needs to be practiced every time the water is available to maintain channel capacity below Abiquiu Dam. Currently, there are a few structures that were built close to the channel that could limit dam releases, depending on the channel conditions.

c. Miscellaneous Studies

(1) 2008 Probable Maximum Flood Study

A hydrologic assessment was performed in 2008 and the updated PMP was developed by determining the rainfall intensities as described in HMR-55A (Shoaff, 2008). The 2008 draft hydrology uses the 72-hour precipitation of 8.17 inches distributed over 6-hour increments with the temporal distribution set forth in HMR 51 and a Snyder Unit Hydrograph with similar constant losses. The resulting hydrograph has a peak of 447,039 cfs into the reservoir and a total runoff volume of 449,702 acre-feet. A comparison of both hydrographs indicates that the peak inflow resulting from the 2008 study is 447,039 cfs while the peak inflow of the 1985 PMF 429,000 cfs, a difference of less than 5 percent. The runoff volume for 1985 PMF is 504,000 acre-feet which is greater than the volume of the hydrograph that resulted from the 2008 study by a difference of approximately 12 percent. The 2008 PMF study did not go through the agency technical review process and therefore, it was not adopted.

(2) Water Quality Monitoring

Since 2020, the Albuquerque District increased water quality monitoring by adding high-frequency (15-minute) data collection for water temperature, specific conductance, DO, turbidity, and pH data upstream and downstream of Abiquiu Reservoir. These stations are temporary based on the availability of funds.

CHAPTER 9—WATER CONTROL MANAGEMENT

9-01 RESPONSIBILITIES AND ORGANIZATION

This subsection discusses water control management responsibilities by organization.

a. U.S. Army Corps of Engineers

USACE owns and operates Abiquiu Dam and has direct regulatory responsibility for flood control operations and water supply. The Operations Division of the Albuquerque District is responsible for project operation and maintenance. The Engineering and Construction Division is responsible for prescribing regulations to effect optimum benefits for the purposes which the project was authorized and constructed.

The WMS is responsible for issuing instructions for the regulation of the Abiquiu Dam. The WMS works closely with the H&H section. Both sections are in the H&H Branch of Engineering and Construction Division, Albuquerque District. The function of the WMS is to issue instructions for regulation of the reservoir, maintain a continuous record of pertinent river and reservoir data, maintain contact with the NWS on climatic conditions, and for collecting information for establishing current conditions and using CWMS and other hydrologic modeling tools for forecasting future conditions. During flood conditions, the chief of the WMS is responsible for:

1. Keeping officials informed of current and forecasted flows, storage conditions at the reservoir, weather conditions, and the nature and extent of damages.

2. Providing reservoir and flow data for flood situation reports in accordance with ER 500-1-1 and appendices.

3. Directing activities for gathering and analyzing weather and stream flow data, and for preparing runoff forecasts.

4. Maintaining liaison with other agencies engaged in data collection and/or operation of reservoirs in the basin.

5. Following the WCP.

The Albuquerque District Operations Branch is responsible for the operation and maintenance of the Abiquiu Dam. The OPM and staff maintain the equipment and provide weather data, reservoir data, and flow data as specified in Exhibit F to the WMS. During flood conditions, the OPM is responsible for:

1. Providing project data in a timely manner.

2. Making gate changes.

3. Operating on a 24-hour basis, when required.

4. Assuring project personnel are on duty 24 hours per day, when required.

5. Notifying authorities.

Plate 9-1 shows the district organization chart pertaining to the regulation of Abiquiu Dam. The duties at the project site, related to regulation of flows, are performed either by the OPM or by a designated project operator and are outlined in the Standing Instructions to Project Operator, Exhibit F. The normal tour-of-duty at the dam is eight hours per day (0730 to 1600), five days per week. At other times (nights and weekends) the OPM may be reached by telephone. The principal duties performed by the project operator pertaining to regulation of flow at Abiquiu Dam are outlined as follows:

1. Carry out instructions for operation of the gates as required. Maintain the reservoir elevation gage. Check reservoir automatic stage recorder at least weekly, to assure that it is reporting consistent with the staff gage and note the time and gage readings on the chart.

2. Submit directly to the WMS data from the project gages and the weather station at the dam during the regular reporting period at 0830 each working day and such other times as requested by the WMS.

3. Perform emergency operations during critical flood periods in the event communications with the district office fail.

4. Operate the weather station at Abiquiu Dam.

b. Other Federal Agencies

The USBR operates and maintains the SJ-C transmountain diversion project. Currently there are 19 SJ-C project contractors with either storage accounts or pass through account at Abiquiu Dam. The USBR is responsible in performing the accounting for SJ-C project water at Abiquiu Dam and coordinate with WMS on a regular basis.

The USGS is responsible for the maintenance and operation of all streamflow and reservoir gages throughout the project area. USGS provides stream flow and reservoir data on their public website.

Congress has given the NWS national responsibility for issuing flood warnings to the public. The West Gulf River Forecast Center of the NWS at Fort Worth, Texas, is responsible for forecasting streamflow, runoff, and precipitation throughout the Rio Grande watershed, as explained in Section 6-01.

The NRCS is responsible for providing snow survey data and water supply forecast.

FERC is responsible for the LAC compliance with federal regulation.

c. State and County Agencies

LAC-DPU has the direct responsibility to ensure that the power facility operation follows USACE’s reservoir regulation schedule. The responsibilities and authority of USACE with and LAC-DPU, with respect to the operation of the hydroelectric power facility are outlined more fully in the MOA between USACE and LAC, which is included herein as Exhibit G.

d. Private Organizations

There are no private organizations that have regulatory responsibilities at Abiquiu Dam.

9-02 INTERAGENCY COORDINATION

To ensure that the operation of Abiquiu Dam will be as effective as possible, it is essential that the operating agencies be advised of weather conditions, inflow to the reservoir, flows at key locations in the Rio Grande basin, and potential flood hazards. This requires close communication, on a daily or hourly basis, between USACE, USBR, USGS, NWS, NRCS, and state and local organizations.

a. Local Press and USACE Bulletins

The Albuquerque District Public Affairs Office coordinates with the local press for release of information of public interest. Current reservoir status information is available at: https://w3.spa.usace.army.mil/.

b. National Weather Service

The NWS-WFO at Albuquerque, New Mexico, furnishes meteorological data and forecasts regularly to the WMS. The WGRFC provides 7-day quantitative precipitation forecasts at least twice per day and more frequently, if conditions warrant. If flooding is forecasted, the WGRFC also provides flow forecasts at selected sites. The Abiquiu Dam project office reports climatological and WMS reports on forecasted release data collected at the project to the NWS.

c. U.S. Geological Survey

The USGS operates stream gages on a cooperative basis with state and federal agencies throughout the Rio Grande Basin. They make measurements, provide maintenance service, and publish records from stream gage stations through their web site. If the USGS receives word of flooding or potential flooding, they attempt to do field measurements. WMS reports to the USGS any word of high water.

The Albuquerque District contracts with the USGS for the maintenance and servicing of the reservoir and stream flow gages for the Abiquiu Dam project and for publication of these data.

d. Power Marketing Agency

The hydroelectric power plant at Abiquiu Dam is a non-federal facility, see Section 9-05 for more information.

e. Other Federal, State, or Local Agencies

The NRCS, U.S. Department of Agriculture, operates snow courses in cooperation with state and other federal agencies monthly during the winter and spring seasons.

SJ-C contractors coordinate with WMS on management of their storage account in Abiquiu Reservoir. USACE, the USBR, and the contractors coordinate on the accounting of their water stored in Abiquiu Reservoir.

The LAC-DPU coordinates directly with WMS in the operation of the hydroelectric power facility. Further, the county cooperates with local, state, and federal agencies that have regulatory responsibility in connection with the power facility.

9-03 INTERAGENCY AGREEMENTS

USACE has contract and/or storage agreement with SJ-C contractors to store water in Abiquiu Reservoir. Exhibit E includes a copy of these agreements.

USACE has a MOA with the LAC for operation of the hydroelectric power facility, see Exhibit G.

9-04 COMMISIONS, RIVER AUTHORITIES, COMPACTS AND COMMITTEES

The Abiquiu Dam and Reservoir is operated in accordance with the provisions of the Flood Control Act of 1960 (Public Law 86-645 [Exhibit B]) and in accordance with the articles and resolutions of the Rio Grande Compact (Exhibit C). The Rio Grande Compact Commission is composed of a member from each of the states of Colorado, New Mexico, and Texas, and a representative of the United States.

9-05 NON-FEDERAL HYDROPOWER

The LAC-DPU owns and operates the hydroelectric power facility at Abiquiu Dam and has direct responsibility to ensure that the power facility operation follows the WMS reservoir regulation schedule. The LAC-DPU is responsible for the facility operation and maintenance. The power generated at the hydroelectric power facility is transmitted to the Coyote Substation where it enters the electrical grid, is metered and sold as an asset of the county power pool that serves the residents of LAC as well as the U.S. Department of Energy’s Los Alamos National Laboratory (LANL). The WMS under the supervision of the District Engineer, will direct the LAC-DPU regarding reservoir releases to be maintained. Exhibit H details the lines of communication and hydroelectric power facility operating requirements.

9-06 REPORTS

Five recurring reports are prepared by the WMS. These reports are described below and listed in Table 9-1:

- A daily report of reservoir operations is published on the WMS website by 10:00 hours each weekday (https://w3.spa.usace.army.mil/wc/DailyReports/).

- A monthly reservoir operations report is published on the WMS website by the 10th of the subsequent month (https://w3.spa.usace.army.mil/wc/MonthlyReports/).

- An annual report of Reservoir Operation Activities is prepared for the Division Annual Report.

- An annual flood damages prevented report provides an estimate of the damages prevented by the flood control operations of USACE-owned and Section 7 dams. This report is prepared annually, and the data provided directly uploaded onto a national USACE website for flood damages reduced.

- Flood Emergency Reporting is provided daily during floods by the Albuquerque District WMS, and sometimes more often to the Albuquerque District Emergency Management Office to be incorporated into their situation reports. After Action Report (AAR) is prepared as soon as practicable after major floods.

- The LAC-DPU provides the WMS with an annual summary of hydroelectric generation revenue in tabular form. This report will be for the previous water year and will be submitted to the WMS by 20 October of each year. The county will also provide to Albuquerque District annual DO reports as long as the data is required by FERC or the State of New Mexico. The data will be included in the Annual Water Quality Report to be submitted to the South Pacific Division.

Table 9-1. Reports

Report Name	When Required	Regulation Requiring Report
Daily Reservoir Operation Report	Weekdays by 10 am	EM 1110-2-3600
Monthly Reservoir Operations report	10 of the subsequent Month	EM 1110-2-3600 ER 1110-2-240
Annual Summary Report	Annual	ER 1110-2-240
Flood Damages Prevented Report	Annual	EM 1110-2-3600
Flood Emergency Reporting	Per flood event	ER 500-1-1

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SUPPLEMENTAL TABLES

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Table 1-1. Pertinent Manuals and Reports (sheet 1 of 2)

Abiquiu Project Design Memorandums	Approval Date
DM–1 Hydrology	Jun 1953 (Rev 1954)
DM–2 Site Selection	Sep 1954
DM–3 General Design	Feb 1955
DM–4 Geology, Soils, and Construction Materials	Oct 1955
DM–5 Flood Control Outlet	Nov 1955 (Rev 1956)
DM–7 Embankment and Spillway	May 1958
DM–8 Relocations	Jan 1957
DM–9 Operator's Quarters	Jan 1957 (Rev 1957 and 1959)
DM–10 Rela Estate and Gross Appraisal of Land to be Acquired	Oct 1955 (Rev 1956)
DM–11 Overlook Shelter and Comfort Station	Jul 1959
DM–15 Forest Service Trail	Jan 1960
DM–16 Preliminary Master Plan	Nov 1959
DM–17 Fallout Shelter	May 1962
DM–18 Project Modification for the Dam Safety Assurance Program	Feb 1983
DM–19 Initial Reservoir Filling Plan/Flood Emergency Plan	Feb 1988
DM–20 Seepage Control Adits	Feb 1988
DM–20 Installation of Emergency Gates	May 1991
Water Control Manuals for Related Projects	**Approval Date**
Master Water Control Manual, Rio Grande Basin	Jun 1963 (Rev 1985)
Appendix B, Galisteo Dam and Reservoir	Apr 2001
Appendix C, Cochiti Dam and Reservoir	May 1996
Appendix D, Jemez Canyon Dam and Reservoir	Mar 1994
Appendix E, Platoro Dam and Reservoir	Oct 1998
Appendix F, Rio Grande Basin Drought Contingency Plan	Oct 1991 (Rev 2023)

Table 1-1. Pertinent Manuals and Reports (sheet 2 of 2)

Other Reports Relevant to Abiquiu Dam	Approval Date
Review Survey for Flood Control, Interim Report on Main Stem of the Rio Grande Above Elephant Butte Dam	Dec 1958
Operation and Maintenance Manual	Apr 1961
Environmental Assessment and Draft Rio Chama Management Plan	May 1990
Abiquiu Dam New Mexico, Final Environmental Statement, Operations and Maintenance	1976
Abiquiu Dam New Mexico, Reconnaissance Report for Dam Safety Assurance Program	1981
Abiquiu Dam New Mexico, Final Environmental Impact Statement, Water Supply Storage	1983
Abiquiu Dam Power Project, Design Report (FERC project # 7396)	1987
Reconnaissance Report: Rio Chama, Abiquiu Dam to Espanola, NM	1996
Hydrologic Assessment, Abiquiu Dam in New Mexico, Emergency Action Plan Study	2008

Table 4-3. Climate Data at Site: USC00292608—Dulce, New Mexico
Climate Normal (1991–2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)								Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	43.6	10.2	26.9	67	2015	-32	2011	0.0	1181.0	1.46	0.99	2008	13.4	11.0	2017	42.1	2017	4.1	0.0	2.2	30.9	7.7
2	47.8	15.8	31.8	67	1995	-21	2007	0.0	929.6	1.36	1.24	2019	12.8	9.2	1997	39.0	2019	4.1	0.0	0.6	27.4	2.8
3	56.6	22.3	39.5	77	2004	-8	2012	0.0	792.1	1.14	1.41	2019	6.3	8.5	2003	23.6	2000	3.2	1.4	0.1	29.1	0.4
4	64.1	27.5	45.8	82	2012	7	2013	0.0	576.0	1.16	1.31	2010	2.7	6.0	1999	11.6	1995	3.3	8.1	0.0	24.6	0.0
5	73.6	33.9	53.7	95	2002	15	2008	1.1	349.9	1.09	1.31	2007	0.4	4.5	2014	4.5	2014	3.3	22.3	0.0	14.2	0.0
6	84.2	40.7	62.4	99	2013	24	1999	30.4	106.9	0.66	0.98	2009	0.0	0.0	1991	0.0	1991	1.9	29.3	0.0	3.6	0.0
7	88.2	49.6	68.9	98	2002	29	1997	130.8	10.0	2.08	1.26	2020	0.0	0.0	1991	0.0	1991	5.8	31.0	0.0	0.2	0.0
8	85.4	49.1	67.3	96	2000	31	2009	89.2	19.4	2.41	1.51	1992	0.0	0.5	2008	0.5	2008	6.2	30.7	0.0	0.1	0.0
9	78.9	40.6	59.8	94	2019	20	1999	11.0	168.5	1.72	1.51	1997	0.0	0.0	1991	0.0	1991	4.6	27.5	0.0	5.2	0.0
10	67.6	29.0	48.3	85	2010	0	2019	0.0	517.7	1.48	1.81	1998	1.0	7.1	1991	10.9	1991	4.0	14.3	0.0	23.1	0.0
11	54.1	19.7	36.9	74	1999	-12	2010	0.0	843.0	1.32	1.58	1993	5.7	17.0	1993	20.7	1993	3.7	0.9	0.6	28.0	0.6
12	43.7	11.9	27.8	65	2003	-24	2013	0.0	1153.1	1.49	1.27	2008	13.4	11.5	2008	42.7	2008	4.2	0.0	2.7	30.7	5.9

36.9358 N, -107 W, 6,793 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (http://www.ncei.noaa.gov/products/land-based-station/us-climate-normals accessed) 22 March 2023.

Table 4-4. Climate Data at Site: USC00291664—Chama, New Mexico
Climate Normal (1991–2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Avg.	Daily Extreme Max	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	37.5	7.1	22.3	58	2015	-25	2011	0.0	1323.7	2.04	1.40	1993	22.6	17.0	2000	68.5	2017	4.7	0.0	6.5	30.9	7.9
2	40.8	10.8	25.8	59	2004	-29	2011	0.0	1097.6	1.94	1.72	2019	23.0	24.0	1994	55.5	2008	5.1	0.0	2.9	27.8	4.2
3	48.4	18.3	33.4	69	2012	-14	2002	0.0	981.2	1.45	1.98	1995	13.9	17.0	2015	30.9	1991	4.2	0.0	0.7	30.4	1.2
4	56.2	24.2	40.2	76	2007	0	1997	0.0	744.0	1.51	1.51	1999	5.9	11.0	1999	17.0	2009	4.2	1.5	0.1	27.1	0.0
5	65.5	31.5	48.5	89	2002	10	2008	0.1	511.6	1.59	1.84	2019	1.1	5.0	2019	10.5	2019	4.0	12.8	0.0	18.4	0.0
6	76.8	38.5	57.6	91	1994	21	1999	3.3	223.8	0.80	1.18	2009	0.0	0.0	1991	0.0	1991	2.4	27.2	0.0	5.0	0.0
7	80.4	46.0	63.2	93	2003	22	2007	20.1	76.0	2.32	1.65	2008	0.0	0.0	1991	0.0	1991	6.8	30.4	0.0	0.3	0.0
8	77.8	45.6	61.7	93	2002	29	2009	9.6	111.9	3.02	2.30	2008	0.0	0.0	1991	0.0	1991	7.8	29.6	0.0	0.3	0.0
9	71.5	37.9	54.7	88	1995	13	1996	0.3	309.3	2.32	2.58	2020	0.0	10.0	2020	0.0	1991	6.0	22.2	0.0	6.2	0.0
10	60.6	27.1	43.9	83	2010	-2	1993	0.0	655.6	1.73	1.39	2015	2.1	15.5	1991	21.6	1991	4.7	6.2	0.1	24.2	0.1
11	47.7	16.9	32.3	72	2006	-13	1994	0.0	981.0	1.69	2.40	2002	9.7	14.5	1993	24.5	2000	3.9	0.1	2.1	28.9	1.7
12	37.7	8.2	22.9	64	1998	-25	1996	0.0	1303.5	1.94	1.15	2007	13.6	14.8	2007	75.3	2008	4.7	0.0	7.2	31.0	7.4

36.9178 N, -106.5781 W, 7,850 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (http://www.ncei.noaa.gov/products/land-based-station/us-climate-normals) accessed 22 March 2023.

Table 4-5. Climate Data at Site: USC00292837—El Vado Dam, New Mexico Climate Normal (1991–2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)								Mean Number of Days				
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	39.7	8.6	24.2	60	2000	-25	2013	0.0	1266.3	0.86	0.74	2019	10.4	10	2007	33.5	2005	3.3	0.0	3.6	30.7	7.5
2	43.4	14.3	28.8	65	1995	-20	2004	0.0	1012.2	0.88	1.31	2019	7.3	12	2015	27.7	2008	2.8	0.0	1.6	27.5	3.0
3	52.1	20.5	36.3	77	2004	-7	2012	0.0	889.7	0.80	0.70	2019	2.2	10	2015	10.7	2015	2.4	0.9	0.4	29.1	0.3
4	59.3	25.4	42.4	80	1992	4	2013	0.0	679.5	1.08	1.35	2010	2.2	8	1995	11.0	2016	3.1	5.7	0.0	24.5	0.0
5	69.4	32.6	51.0	93	2002	10	2014	0.6	434.6	1.04	1.49	2019	0.0	4	2011	0.0	1991	2.9	19.4	0.0	14.8	0.0
6	80.4	40.1	60.3	105	2004	20	2018	16.0	158.5	0.70	0.92	2009	0.0	0	1991	0.0	1991	2.2	29.0	0.0	3.3	0.0
7	84.6	48.8	66.7	102	2018	30	1997	78.6	26.0	1.84	1.92	1999	0.0	0	1991	0.0	1991	5.7	30.8	0.0	0.1	0.0
8	81.6	47.9	64.7	95	1996	29	2008	47.6	55.3	2.16	1.67	2007	0.0	0	1991	0.0	1991	6.2	30.5	0.0	0.1	0.0
9	75.5	38.7	57.1	93	2020	20	1999	4.0	241.0	1.67	1.66	2020	0.0	7	2020	0.0	1991	4.5	25.9	0.0	5.5	0.0
10	64.0	27.6	45.8	85	2010	4	2008	0.0	595.2	1.33	1.13	2020	0.7	6	1991	11.0	1991	3.9	11.9	0.0	23.3	0.0
11	50.8	17.9	34.4	75	1999	-5	1994	0.0	919.5	0.83	1.24	2003	3.3	7	2000	9.5	2008	2.9	0.8	0.9	28.1	0.5
12	40.2	10.3	25.3	63	1995	-17	2012	0.0	1232.2	0.94	0.94	2009	9.6	11	2008	54.5	2008	3.0	0.0	4.9	30.7	5.1

36.5928 N, -106.73 W, 6,740 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

*Table 4-6. Climate Data at Site: USC00292820—El Rito, New Mexico
Climate Normal (1991–2020) and Daily Extremes*

Month	Temperature Normal and Extremes (°F)							Degree Day Normal		Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	41.3	17.9	29.6	64	2003	-11	2011	0.0	1097.4	0.65	0.64	2005	6.5	12.0	1997	18.1	1995	2.1	0.0	2.4	30.5	0.6
2	45.8	20.9	33.3	70	2006	-16	2011	0.0	886.1	0.47	2.01	2011	3.6	11.0	2004	16.5	1993	1.7	0.0	1.3	26.5	0.3
3	54.4	26.2	40.3	85	2003	0	2002	0.0	765.7	0.71	0.92	1994	3.6	15.0	1994	22.0	1994	2.3	1.8	0.2	24.8	0.0
4	62.6	31.8	47.2	81	2000	11	2014	0.0	534.0	0.86	2.00	2011	1.1	4.0	1995	8.0	1995	1.9	9.5	0.0	14.7	0.0
5	71.7	40.3	56.0	99	2005	17	2011	7.3	286.4	0.88	2.00	2011	0.0	3.0	2011	3.0	2011	2.7	21.9	0.0	3.7	0.0
6	81.1	47.5	64.3	98	1998	28	1998	52.9	73.9	0.74	1.26	2002	0.0	0.0	1991	0.0	1991	2.3	29.2	0.0	0.3	0.0
7	84.3	54.1	69.2	104	2003	32	2015	136.7	6.6	1.77	5.44	2015	0.0	0.0	1991	0.0	1991	4.8	31.0	0.0	0.0	0.0
8	81.7	53.4	67.6	99	2004	41	2004	95.9	16.9	1.90	2.55	1999	0.0	0.0	1991	0.0	1991	4.7	30.7	0.0	0.0	0.0
9	76.1	46.5	61.3	95	2001	26	1996	18.3	129.4	1.50	2.10	2013	0.0	0.0	1991	0.0	1991	3.8	27.2	0.0	0.6	0.0
10	65.3	35.5	50.4	90	2001	1	1993	0.2	452.8	0.85	1.00	2011	0.9	5.5	1991	5.5	1991	2.8	14.9	0.0	9.6	0.0
11	50.8	25.3	38.0	93	2002	0	2003	0.0	808.5	0.64	1.19	1991	1.5	8.0	1993	8.0	1993	2.3	1.1	0.8	25.8	0.1
12	40.7	18.8	29.7	83	2008	-11	2013	0.0	1092.6	0.77	0.90	2007	6.7	10.0	1992	26.5	1992	1.9	0.0	3.0	30.4	0.9

36.3467 N, -106.1878 W, 6,870 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals) accessed 22 March 2023.

*Table 4-7. Climate Data at Site: USC00294960—Lindrith 1 WSW, New Mexico
Climate Normal (1991–2020) and Daily Extremes*

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	39.5	11.9	25.7	63	2000	-20	2013	0.0	1218.3	1.09	1.10	2017	12.5	10.0	1991	39.5	1995	3.4	0.0	4.5	30.8	3.5
2	43.3	16.1	29.7	65	2017	-19	2011	0.0	988.4	1.15	0.95	1997	9.3	8.4	2019	23.5	2004	3.4	0.0	1.9	27.8	1.3
3	52.2	22.2	37.2	75	2004	-4	2002	0.0	861.8	1.13	1.16	2000	6.6	10.0	2000	18.0	2000	3.5	1.1	0.5	29.1	0.1
4	60.4	27.1	43.8	84	2012	0	1997	0.0	637.5	0.95	1.78	2004	2.9	8.0	2004	11.0	2004	2.6	7.1	0.0	22.2	0.0
5	69.5	36.5	53.0	93	2002	14	2008	3.7	375.7	1.12	1.70	2019	0.1	3.0	2011	2.0	2019	2.3	20.3	0.0	8.2	0.0
6	82.2	46.4	64.3	99	1998	26	1999	63.1	84.1	0.72	1.33	1996	0.0	0.0	1991	0.0	1991	2.0	28.9	0.0	0.6	0.0
7	85.2	52.8	69.0	100	1995	31	1995	135.3	11.3	2.60	1.77	2014	0.0	0.0	1991	0.0	1991	6.8	30.9	0.0	0.0	0.0
8	82.2	50.8	66.5	97	2012	0	1998	77.6	31.1	2.09	1.80	1992	0.0	0.0	1991	0.0	1991	5.9	30.6	0.0	0.0	0.0
9	75.3	42.8	59.0	98	1993	4	1994	11.9	190.4	1.29	2.22	2003	0.0	0.0	1991	0.0	1991	3.8	26.2	0.0	2.0	0.0
10	63.3	30.6	46.9	84	2003	0	1998	0.0	559.5	1.19	2.25	1998	2.3	10.0	1991	21.5	1991	2.9	11.7	0.2	16.9	0.0
11	49.8	20.5	35.1	74	1999	-8	2004	0.0	895.5	0.88	1.20	2020	5.8	10.0	1991	27.0	1991	2.2	0.5	1.2	28.3	0.3
12	39.7	11.9	25.8	65	1995	-18	2007	0.0	1215.1	1.26	1.07	2007	10.9	13.0	2006	39.5	2006	3.3	0.0	5.4	30.6	3.6

36.3042 N, -107.0542 W, 7,220 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

Table 4-8. Climate Data at Site: USC00290041—Abiquiu Dam, New Mexico
Climate Normal (1991–2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	42.0	17.7	29.9	62	2000	-8	1991	0.0	1089.6	0.41	0.68	2005	2.8	7.0	2005	11.0	2005	1.5	0.0	2.7	30.2	1.0
2	47.0	21.8	34.4	69	2016	-17	2011	0.0	856.8	0.34	0.52	2019	2.0	5.0	2018	12.8	2008	1.2	0.0	1.0	27.0	0.2
3	55.9	28.6	42.3	79	2012	5	2007	0.0	705.3	0.58	0.82	1999	1.6	10.0	2010	11.0	2010	1.4	2.2	0.1	22.1	0.0
4	63.3	34.8	49.0	84	2000	13	2013	0.1	478.6	0.79	1.14	2004	0.4	4.5	2004	4.5	2004	2.0	10.0	0.0	8.8	0.0
5	72.8	43.7	58.2	94	2002	24	2014	16.7	225.9	0.80	1.15	1991	0.0	0.0	1991	0.0	1991	2.4	22.9	0.0	1.1	0.0
6	83.8	53.3	68.5	101	2013	31	2013	135.7	29.3	0.62	1.17	1999	0.0	0.0	1991	0.0	1991	2.0	29.4	0.0	0.0	0.0
7	87.5	58.3	72.9	101	2003	41	1993	246.8	1.9	1.65	2.10	2009	0.0	0.0	1991	0.0	1991	4.4	30.9	0.0	0.0	0.0
8	85.1	56.8	70.9	98	2000	43	2013	189.7	5.3	1.75	1.11	2012	0.0	0.0	1991	0.0	1991	5.3	30.8	0.0	0.0	0.0
9	78.7	49.5	64.1	94	1995	33	1995	53.4	80.5	1.19	1.19	2003	0.0	0.0	1991	0.0	1991	3.1	27.5	0.0	0.0	0.0
10	67.0	37.4	52.2	90	2012	10	2019	0.7	397.5	0.89	0.95	2015	0.1	2.5	1991	2.5	1991	2.8	16.1	0.1	4.8	0.0
11	53.9	27.3	40.6	75	1999	10	2006	0.0	732.0	0.50	0.65	1991	0.6	6.2	2000	6.2	2000	1.5	1.3	0.4	22.9	0.0
12	43.3	19.0	31.2	65	1995	-4	2020	0.0	1049.3	0.54	1.04	2006	3.0	12.0	2006	18.0	2006	1.9	0.0	2.6	30.4	0.0

36.2403 N, -106.4278 W, 6,380 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

Table 4-9. Climate Data at Site: USC00290245—Alcalde, New Mexico Climate Normal (1991–2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)							Degree Day Normal		Precipitation Normal and Extremes (inches)								Mean Number of Days				
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	45.1	15.3	30.2	69	2000	-8	2011	0.0	1078.8	0.51	0.67	2002	2.2	8.0	2002	8.0	2002	1.5	0.0	1.4	30.4	0.5
2	51.0	19.6	35.3	87	2001	-12	2011	0.0	831.6	0.39	0.68	2020	1.5	6.0	2020	9.1	1997	1.6	0.2	0.5	27.2	0.2
3	60.0	24.8	42.4	83	2012	7	1998	0.0	700.6	0.69	0.70	1994	1.4	6.5	2005	8.5	2010	2.2	5.9	0.0	27.0	0.0
4	67.4	31.9	49.6	88	1992	12	1997	0.0	460.5	0.70	1.23	2004	0.3	3.5	2004	2.0	2008	2.3	15.9	0.0	16.2	0.0
5	76.2	39.9	58.1	98	2000	23	2010	10.2	225.7	0.78	1.20	1992	0.0	2.5	2011	0.0	1991	2.3	25.1	0.0	3.5	0.0
6	86.0	48.2	67.1	100	1994	32	2007	94.7	31.8	0.78	0.93	2015	0.0	0.0	1991	0.0	1991	2.0	29.8	0.0	0.0	0.0
7	88.1	55.4	71.8	101	2020	32	1994	210.5	1.3	1.65	1.38	2006	0.0	0.0	1991	0.0	1991	4.6	31.0	0.0	0.0	0.0
8	85.6	53.7	69.6	98	1996	34	1992	152.2	8.1	1.75	2.43	2016	0.0	0.0	1991	0.0	1991	4.4	30.8	0.0	0.0	0.0
9	79.8	44.6	62.2	95	1995	28	1999	27.9	111.9	1.25	1.70	2002	0.0	0.0	1991	0.0	1991	2.5	28.4	0.0	1.0	0.0
10	68.7	31.9	50.3	86	1991	9	1996	0.2	455.8	1.14	1.40	2015	0.6	8.0	2020	8.7	2020	2.9	17.3	0.0	17.5	0.0
11	55.4	22.0	38.7	86	1995	1	2004	0.0	789.0	0.73	1.30	1991	1.4	6.8	2002	5.0	2019	2.0	2.2	0.2	28.2	0.0
12	44.5	15.2	29.8	68	1993	-7	1992	0.0	1089.6	0.73	1.22	2007	3.3	9.5	2008	13.3	2008	2.0	0.0	1.8	30.7	0.5

36.0908 N, -106.0567 W, 5,680 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

Table 4-10. Climate Data at Site: USC00292241—CUBA, New Mexico Climate Normal (1991–2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	43.0	13.9	28.4	64	2000	-23	2007	0.0	1133.0	0.77	0.96	1995	7.6	10.0	1995	26.0	1995	1.9	0.0	2.2	30.8	6.7
2	47.0	19.4	33.2	66	1995	-21	1994	0.0	890.3	0.73	0.86	2001	7.0	10.0	2004	31.0	2004	2.5	0.0	0.9	27.2	2.0
3	56.0	24.6	40.3	79	2004	-14	2002	0.0	765.7	0.92	1.12	2000	5.3	10.0	2000	24.0	2000	2.0	1.0	0.2	28.6	0.4
4	64.3	29.2	46.7	84	2020	5	1997	0.0	547.5	0.74	1.13	2004	0.5	12.0	1995	6.5	1997	1.9	8.7	0.0	24.5	0.0
5	73.5	36.0	54.8	96	2002	10	2008	2.6	320.4	0.78	1.04	2019	0.1	2.0	2008	2.0	2008	1.8	23.2	0.0	14.1	0.0
6	84.6	44.8	64.7	98	1998	22	1999	65.3	74.3	0.61	0.90	1991	0.1	1.0	2008	1.0	2008	1.5	29.5	0.0	5.0	0.0
7	86.7	53.7	70.2	100	1995	30	2004	165.9	4.8	2.18	1.58	1998	0.0	0.0	1991	0.0	1991	4.8	30.8	0.0	0.3	0.0
8	84.1	52.5	68.3	95	2019	33	2002	114.1	11.8	2.03	1.42	1994	0.0	0.0	1991	0.0	1991	6.3	30.8	0.0	0.0	0.0
9	78.5	43.7	61.1	94	2019	18	1999	23.6	140.7	1.22	1.43	2003	0.0	0.0	1991	0.0	1991	3.2	27.5	0.0	5.6	0.0
10	66.6	31.4	49.0	82	2020	-2	2019	0.1	496.0	1.22	2.25	1998	1.5	13.2	2020	13.2	2020	2.6	13.3	0.2	21.7	0.0
11	53.7	22.9	38.3	75	1999	-10	2001	0.0	801.0	0.78	0.87	2002	3.5	8.0	1993	11.0	1992	2.3	0.8	0.9	28.6	0.8
12	43.5	15.8	29.7	65	1995	-18	2004	0.0	1095.8	0.82	1.72	2007	8.5	10.0	2006	30.0	2006	2.6	0.0	3.0	30.7	5.0

35.995 N, -106.9703 W, 6,908 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

Table 4-11. Climate Data at Site: USC00299820—Wolf Canyon, New Mexico Climate Normal (1991-2020) and Daily Extremes

Month	Temperature Normal and Extremes (°F)						Degree Day Normal			Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	38.2	9.3	23.7	NA	NA	NA	NA	0.0	1278.7	1.89	NA	NA	22.8	NA	NA	NA	NA	4.8	0.0	8.2	30.9	5.7
2	40.1	12.7	26.4	NA	NA	NA	NA	0.0	1080.8	1.67	NA	NA	20.1	NA	NA	NA	NA	5.0	0.0	6.0	27.9	3.4
3	47.8	18.8	33.3	NA	NA	NA	NA	0.0	982.7	1.66	NA	NA	16.8	NA	NA	NA	NA	4.7	0.0	1.3	30.7	0.8
4	55.8	24.0	39.9	NA	NA	NA	NA	0.0	753.0	1.33	NA	NA	11.9	NA	NA	NA	NA	3.1	0.3	0.3	28.5	0.0
5	64.7	29.9	47.3	NA	NA	NA	NA	0.0	548.7	1.15	NA	NA	2.2	NA	NA	NA	NA	3.1	7.9	0.0	22.5	0.0
6	75.3	36.9	56.1	NA	NA	NA	NA	0.7	267.7	0.90	NA	NA	0.1	NA	NA	NA	NA	2.6	24.1	0.0	6.0	0.0
7	77.0	43.7	60.4	NA	NA	NA	NA	2.1	146.3	3.35	NA	NA	0.0	NA	NA	NA	NA	8.9	27.8	0.0	0.6	0.0
8	74.7	42.9	58.8	NA	NA	NA	NA	0.3	192.5	3.35	NA	NA	0.0	NA	NA	NA	NA	7.8	25.0	0.0	0.2	0.0
9	69.2	36.1	52.6	NA	NA	NA	NA	0.0	370.5	2.12	NA	NA	0.2	NA	NA	NA	NA	5.1	13.9	0.0	9.4	0.0
10	58.8	26.7	42.8	NA	NA	NA	NA	0.0	689.7	1.75	NA	NA	3.5	NA	NA	NA	NA	4.4	1.3	0.2	25.9	0.0
11	46.6	17.6	32.1	NA	NA	NA	NA	0.0	987.0	1.51	NA	NA	11.4	NA	NA	NA	NA	3.8	0.0	2.5	29.4	1.1
12	38.0	10.1	24.1	NA	NA	NA	NA	0.0	1269.4	1.90	NA	NA	22.3	NA	NA	NA	NA	5.0	0.0	8.8	30.9	5.6

35.9478 N, -106.7469 W, 8,221 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

*Table 4-12. Climate Data at Site: USC00295084—Los Alamos, New Mexico
Climate Normal (1991-2020) and Daily Extremes*

Month	Temperature Normal and Extremes (deg F)						Degree Day Normal			Precipitation Normal and Extremes (inches)							Mean Number of Days					
	Monthly Max.	Monthly Min.	Monthly Ave.	Daily Extreme Max.	Year	Daily Extreme Min.	Year	Cooling Degree Days	Heating Degree Days	Monthly Precip.	Daily Extreme Precip.	Year	Monthly Snow Accum.	Daily Snow Extreme	Year	Extreme Monthly Snow Total	Year	Precip >0.1 inches	Tmax >70 °F	Tmax <32 °F	Tmin <32 °F	Tmin <0 °F
1	40.3	20.5	30.4	60	2000	-9	2011	0.0	1072.6	0.90	1.20	1993	9.9	12.6	1995	35.2	2001	2.4	0.0	5.4	30.1	0.4
2	44.5	23.6	34.1	66	2006	-16	2011	0.0	866.6	0.72	0.93	1997	8.8	13.7	2004	37.8	2004	2.8	0.0	2.6	25.6	0.2
3	53.4	29.6	41.5	74	2012	0	2002	0.0	728.5	1.04	0.91	2005	5.9	13.6	2005	22.2	2005	3.3	0.7	0.5	21.6	0.0
4	61.0	35.4	48.2	80	2020	15	1997	0.1	504.1	0.93	1.02	1995	3.3	10.2	1995	20.4	1995	2.4	4.8	0.1	11.6	0.0
5	70.2	44.2	57.2	92	2002	22	2013	14.7	256.4	1.17	1.05	1992	0.1	2.0	1995	2.8	1995	3.3	17.7	0.0	2.0	0.0
6	80.9	53.5	67.2	96	2016	33	2001	110.2	44.3	1.17	1.43	2002	0.0	0.0	1991	0.0	1991	2.9	27.9	0.0	0.0	0.0
7	82.5	56.7	69.6	98	2020	40	1995	151.7	9.1	2.94	1.63	2010	0.0	0.0	1991	0.0	1991	6.7	30.5	0.0	0.0	0.0
8	79.5	55.1	67.3	92	2012	39	2005	93.3	22.0	3.20	2.04	2006	0.0	0.0	1991	0.0	1991	8.0	29.3	0.0	0.0	0.0
9	74.0	49.1	61.5	90	2020	27	1999	27.0	130.5	2.02	3.52	2013	0.0	0.7	2020	0.7	2020	4.5	22.5	0.0	0.5	0.0
10	62.7	38.4	50.6	81	2020	6	1993	0.4	448.3	1.58	1.97	1994	1.7	12.5	1996	21.2	1996	3.6	6.9	0.3	7.0	0.0
11	50.1	28.2	39.1	69	1999	1	2006	0.0	775.5	0.95	1.39	1991	4.4	10.6	2000	16.0	1997	2.4	0.0	1.3	22.0	0.0
12	40.3	20.6	30.5	61	2008	-11	1996	0.0	1071.0	0.87	1.23	2007	8.0	10.3	2008	29.0	2008	2.8	0.0	6.2	29.8	0.4

35.8644 N, -106.3214 W, 7,424 feet (asl).

Data: NCEI Monthly and Daily 30-Year Normal (1991–2020) database (https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals), accessed 22 March 2023.

Table 4-15. Monthly Pan Evaporation in Inches at Abiquiu Dam, 1975–2022 (sheet 1 of 3)

Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	Sum
1975	6.63	9.30	10.89	9.32	10.25	6.24	6.36	58.99
1976	7.44	9.00	13.37	11.34	9.38	6.51	5.50	62.54
1977	6.13	10.38	11.88	10.11	9.24	6.99	5.53	60.26
1978	8.38	8.16	12.18	10.70	10.21	8.48	6.04	64.15
1979	6.23	7.52	10.63	11.49	9.55	8.28	6.50	60.20
1980	5.21	8.85	12.77	11.22	9.82	7.53	5.69	61.09
1981	8.42	9.32	13.04	10.78	8.94	6.17	4.86	61.53
1982	8.17	8.62	11.52	11.48	7.99	6.38	4.73	58.89
1983	7.19	8.54	10.96	11.41	8.11	7.94	4.99	59.14
1984	6.63	11.97	11.06	12.09	9.39	7.44	4.08	62.66
1985	6.50	8.95	11.10	9.29	9.07	6.63	3.10	54.64
1986	6.40	10.44	8.83	8.53	8.75	5.70	3.77	52.42
1987	6.90	8.99	10.54	12.59	8.00	7.39	5.77	60.18
1988	6.39	9.30	9.45	10.27	7.93	6.73	5.02	55.09
1989	10.17	12.36	11.66	11.34	8.86	7.74	5.35	67.48
1990	7.58	10.86	12.56	7.74	8.87	6.75	5.40	59.76
1991	7.82	10.00	9.08	8.96	7.89	5.97	5.78	55.50
1992	7.44	7.82	10.97	11.09	8.33	8.16	5.67	59.48
1993	7.97	8.15	12.04	12.73	7.64	7.51	4.77	60.81
1994	6.55	8.19	12.17	11.92	8.56	6.43	4.89	58.71
1995	6.16	8.42	9.60	11.04	8.44	6.90	6.07	56.63

Table 4-15. Monthly Pan Evaporation in Inches at Abiquiu Dam, 1975–2022 (sheet 2 of 3)

Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	Sum
1996	8.66	13.77	10.90	9.60	9.20	7.11	5.93	65.17
1997	6.48	8.41	9.16	10.18	8.13	6.58	5.62	54.56
1998	6.15	11.07	14.51	9.32	9.41	8.20	4.77	63.43
1999	6.37	8.33	10.74	8.46	6.82	6.10	5.52	52.34
2000	8.18	11.39	10.97	10.75	10.10	9.38	4.95	65.72
2001	7.49	10.77	12.02	9.80	8.52	8.30	5.88	62.78
2002	8.98	12.23	12.49	11.63	11.27	6.97	5.16	68.73
2003	8.22	10.49	12.48	12.85	10.14	8.21	6.16	68.55
2004	7.02	11.99	12.21	10.99	9.92	8.07	5.31	65.51
2005	7.03	9.88	12.23	13.40	9.45	7.97	4.53	64.49
2006	7.92	10.34	10.79	9.48	8.16	7.04	5.60	59.33
2007	7.21	7.97	11.47	10.90	9.76	7.10	6.39	60.80
2008	8.37	10.60	12.85	9.87	9.69	8.10	6.59	66.07
2009	7.41	9.82	8.88	10.59	9.70	6.77	5.91	59.08
2010	8.19	10.78	12.26	10.61	9.24	8.67	6.16	65.91
2011	8.63	11.38	15.22	10.79	9.09	7.22	5.59	67.92
2012	7.56	11.62	13.25	9.59	10.22	7.21	7.57	67.02
2013	7.95	9.78	13.24	10.01	8.82	6.59	5.64	62.03
2014	7.47	9.86	13.08	10.00	8.72	7.86	5.35	62.34
2015	7.73	8.33	10.02	8.59	10.27	7.50	5.43	57.87
2016	6.89	8.99	11.33	13.15	8.53	7.35	6.56	62.80

Table 4-15. Monthly Pan Evaporation in Inches at Abiquiu Dam, 1975–2022 (sheet 3 of 3)

Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	Sum
2017	7.26	9.86	13.31	11.17	9.31	8.19	5.90	65.00
2018	7.97	11.77	13.63	11.74	9.60	8.95	5.83	69.49
2019	7.64	8.32	11.75	11.67	10.11	8.71	6.59	64.79
2020	7.35	12.40	13.07	10.81	10.72	8.70	7.92	70.97
2021	6.86	10.35	12.71	9.50	9.95	7.32	5.51	62.20
2022	8.33	13.02	10.72	7.01	6.64	5.44	3.92	55.08
AVG	7.41	9.97	11.70	10.58	9.10	7.36	5.55	61.67
MAX	10.17	13.77	15.22	13.40	11.27	9.38	7.92	70.97
MIN	5.21	7.52	8.83	7.01	6.64	5.44	3.10	52.34

Table 4-16. Monthly Pan Evaporation in inches at El Vado Dam, 1975–2022 (sheet 1 of 3)

Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	Sum
1975	4.67	7.64	9.39	8.37	7.79	5.49	4.72	48.07
1976	5.50	7.35	10.61	9.04	7.18	4.85	3.59	48.12
1977	5.09	8.69	10.09	8.45	7.50	4.99	3.76	48.57
1978	6.44	7.02	9.00	9.42	7.62	5.55	4.38	49.43
1979	5.06	5.75	7.87	8.32	7.08	6.65	4.88	45.61
1980	4.66	6.84	10.52	9.18	8.01	6.38	4.17	49.76
1981	6.40	7.50	10.22	8.26	6.85	5.29	3.53	48.05
1982	5.92	6.98	7.77	8.34	5.90	3.99	3.37	42.27
1983	5.19	6.92	8.02	7.93	6.10	5.92	3.30	43.38
1984	5.21	9.04	7.94	8.75	7.34	5.69	2.26	46.23
1985	5.08	5.52	8.56	8.15	7.53	5.26	3.47	43.57
1986	4.77	7.21	7.35	6.77	6.74	4.41	2.88	40.13
1987	5.38	5.62	8.77	10.16	7.40	6.00	4.38	47.72
1988	5.36	7.77	8.03	8.26	5.90	5.70	4.33	45.35
1989	7.91	9.48	9.42	8.81	7.01	6.32	4.28	53.23
1990	5.08	8.05	10.36	7.69	6.73	5.66	3.75	47.32
1991	6.12	8.43	7.35	8.01	6.65	5.27	4.63	46.46
1992	6.04	6.16	8.81	8.24	6.68	5.70	4.25	45.88
1993	5.74	6.30	9.25	10.70	6.75	6.14	3.83	48.71
1994	4.34	6.18	8.58	9.24	6.93	5.12	3.08	43.47
1995	4.37	5.72	8.20	8.60	7.75	5.34	4.28	44.26

Table 4-16. Monthly Pan Evaporation in inches at El Vado Dam, 1975–2022 (sheet 2 of 3)

Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	Sum
1996	6.54	10.61	9.16	7.99	7.23	5.57	3.91	51.01
1997	4.73	6.72	7.21	7.87	6.24	4.85	3.51	41.13
1998	4.74	8.32	10.98	8.07	7.05	6.30	4.00	49.46
1999	5.16	6.79	8.62	7.72	5.29	4.48	4.36	42.42
2000	6.46	8.87	9.71	9.52	8.27	7.32	3.76	53.91
2001	5.64	8.31	10.10	9.01	7.27	6.86	5.70	52.89
2002	7.69	10.18	11.55	9.42	8.71	5.72	3.57	56.84
2003	5.92	7.78	9.87	10.55	7.46	6.24	4.16	51.98
2004	5.11	9.66	9.93	9.21	8.46	5.91	3.25	51.53
2005	5.65	7.78	8.76	10.18	7.40	6.26	3.32	49.35
2006	6.06	9.65	10.33	7.82	6.98	5.12	3.74	49.70
2007	5.19	6.11	9.59	8.27	6.49	5.34	4.23	45.22
2008	7.01	8.65	10.45	8.01	7.77	6.35	3.93	52.17
2009	5.94	7.97	7.07	8.80	8.37	5.06	4.17	47.38
2010	5.62	8.87	10.35	8.70	7.33	6.63	4.22	51.72
2011	6.41	8.02	11.32	8.61	8.79	5.72	3.81	52.68
2012	6.21	9.12	11.22	8.20	7.46	6.64	5.64	54.49
2013	6.74	9.04	11.54	8.29	7.44	5.70	4.14	52.89
2014	6.14	8.12	11.46	9.39	8.10	6.87	4.51	54.59
2015	6.52	6.12	7.74	7.65	7.64	6.11	3.75	45.53
2016	5.14	6.85	9.46	9.95	5.89	5.59	4.71	47.59

Table 4-16. Monthly Pan Evaporation in inches at El Vado Dam, 1975–2022 (sheet 3 of 3)

Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	Sum
2017	5.21	7.36	10.41	8.25	6.73	6.34	5.07	49.37
2018	6.74	8.86	10.55	9.14	8.17	6.48	3.76	53.70
2019	5.65	5.64	8.52	8.80	8.10	6.49	5.91	49.11
2020	7.26	9.72	10.52	9.78	9.19	6.13	5.32	57.92
2021	7.91	8.28	9.52	7.89	7.65	6.56	3.18	50.99
2022	6.55	9.78	9.02	8.27	6.52	6.19	4.10	50.43
AVG	5.80	7.78	9.40	8.67	7.28	5.80	4.06	48.78
MAX	7.91	10.61	11.55	10.70	9.19	7.32	5.91	57.92
MIN	4.34	5.52	7.07	6.77	5.29	3.99	2.26	40.13

Table 4-18. Abiquiu Monthly and Annual Computed Inflow in Acre-Feet 1963–2022 (sheet 1 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
1963	4,910	48,600	53,770	11,490	8,370	18,250	46,510	18,130	9,090	8,280	7,130	3,880	238,410
1964	3,030	16,420	2,800	2,620	2,100	5,730	17,220	53,820	12,370	7,960	16,500	10,570	151,140
1965	2,620	17,760	3,360	9,030	11,830	15,100	58,810	80,520	86,280	78,930	75,520	17,390	457,150
1966	9,690	4,880	5,580	6,920	9,320	41,070	59,540	80,040	44,030	8,160	7,400	2,350	278,980
1967	2,160	2,310	7,050	4,580	4,090	12,050	9,830	52,150	25,450	10,130	34,770	10,800	175,370
1968	3,600	26,390	3,150	1,900	5,990	8,650	19,410	107,890	42,380	8,450	36,670	4,080	268,560
1969	3,790	22,990	3,860	9,390	5,330	10,990	81,030	125,500	37,010	15,640	14,150	13,840	343,520
1970	14,790	16,600	22,100	5,740	5,800	6,320	11,740	96,580	24,690	10,370	9,050	13,890	237,670
1971	6,200	25,900	4,730	4,600	5,010	12,550	29,910	37,180	17,120	12,380	6,910	7,970	170,460
1972	9,190	22,860	5,470	4,470	12,110	20,580	21,560	13,880	11,820	10,620	7,450	5,370	145,380
1973	15,640	11,810	6,130	5,820	5,290	9,510	24,790	197,270	74,950	18,240	25,350	31,440	426,240
1974	11,240	4,810	41,820	5,820	4,250	19,320	15,900	35,230	44,870	31,390	35,820	5,670	256,140
1975	5,650	4,170	16,830	2,200	2,570	10,540	61,170	160,330	46,380	28,680	18,090	8,200	364,810
1976	10,650	23,750	79,630	25,230	3,240	10,460	48,250	70,360	11,710	37,270	38,180	48,320	407,050
1977	10,100	3,060	7,400	2,150	3,090	3,180	7,080	27,200	65,760	39,630	26,230	14,480	209,360
1978	12,750	3,560	8,760	2,110	1,900	8,820	23,860	124,350	65,090	22,900	27,770	21,060	322,930
1979	2,900	6,200	12,210	5,090	6,620	30,170	105,840	157,570	93,490	23,750	6,060	30,150	480,050
1980	30,448	5,145	55,448	5,472	13,929	16,426	88,366	213,067	127,121	30,369	26,012	21,782	633,585
1981	15,170	5,580	7,795	10,225	4,293	6,882	18,575	36,501	44,853	31,886	21,091	7,578	210,429
1982	9,054	5,054	7,727	5,135	5,524	20,631	77,071	169,189	78,776	22,797	17,119	21,513	439,590

Table 4-18. Abiquiu Monthly and Annual Computed Inflow in Acre-Feet 1963–2022 (sheet 2 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
1983	10,821	9,487	62,970	6,497	8,057	26,923	64,870	169,267	146,833	31,382	21,226	26,775	585,108
1984	11,554	11,362	20,907	20,068	24,393	42,863	67,182	215,382	82,868	17,124	22,914	23,015	559,632
1985	12,458	17,314	19,822	22,958	27,137	69,107	142,597	236,083	50,609	9,734	10,804	7,836	626,459
1986	20,650	11,340	11,810	11,380	35,960	46,890	126,750	162,700	68,420	22,690	10,090	15,290	543,970
1987	40,630	44,820	31,970	29,170	32,270	46,060	138,060	151,800	31,600	11,560	15,690	23,550	597,180
1988	13,440	13,420	10,790	9,570	10,930	21,320	50,000	73,160	25,200	22,340	23,840	16,540	290,550
1989	6,360	6,470	6,906	7,115	8,181	26,417	99,396	37,295	24,775	37,670	25,040	17,698	303,323
1990	7,740	7,300	7,820	7,890	8,750	9,520	13,095	31,120	27,270	32,990	22,010	25,815	201,320
1991	11,130	8,730	13,520	14,823	15,998	26,393	100,125	154,583	59,732	17,442	23,297	12,760	458,533
1992	11,549	11,482	18,083	15,699	18,026	24,151	103,705	134,506	44,693	51,105	42,585	22,339	497,923
1993	10,428	13,614	14,281	20,625	22,711	37,429	108,989	169,471	92,184	35,142	42,271	18,281	585,426
1994	12,447	12,541	14,000	13,379	13,421	26,441	109,825	155,479	47,943	43,908	40,401	19,572	509,357
1995	13,160	13,110	13,526	13,843	18,701	64,896	75,627	161,051	162,323	44,724	39,758	15,096	635,815
1996	15,304	20,493	16,696	18,204	16,071	15,170	20,935	47,954	47,905	36,014	44,402	26,624	325,772
1997	20,581	12,445	11,914	11,303	11,130	18,011	38,083	113,274	66,267	26,801	31,496	29,132	390,437
1998	41,979	13,157	13,791	13,924	13,507	18,478	41,716	112,099	30,421	36,998	45,743	59,871	441,684
1999	26,864	12,707	11,125	11,388	10,541	12,314	14,560	82,622	36,723	28,441	34,227	12,564	294,076
2000	17,101	8,361	6,900	7,464	8,123	26,583	36,693	42,542	63,858	54,436	45,436	47,511	365,008
2001	21,872	10,664	6,935	7,702	8,515	9,327	15,008	49,184	21,096	15,372	29,021	45,737	240,433
2002	24,365	13,613	13,813	13,451	11,732	13,183	20,098	47,788	55,524	44,722	23,992	10,469	292,750

Table 4-18. Abiquiu Monthly and Annual Computed Inflow in Acre-Feet 1963–2022 (sheet 3 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
2003	6,252	4,723	3,825	3,016	1,800	9,876	27,099	22,443	26,621	66,250	47,485	16,764	236,154
2004	11,642	8,780	12,099	14,704	14,510	17,805	34,519	71,513	18,964	33,024	26,664	17,580	281,804
2005	6,432	6,691	15,236	7,121	12,597	9,058	96,315	142,293	18,431	17,466	30,534	32,419	394,593
2006	8,512	18,088	19,873	14,489	15,771	19,487	33,437	34,444	48,753	31,642	19,684	13,945	278,125
2007	9,544	16,067	13,578	13,048	10,106	11,802	17,386	82,742	30,863	32,860	28,007	25,091	291,094
2008	5,844	4,535	13,795	8,499	19,687	77,594	97,089	85,212	71,186	25,605	36,916	38,619	484,581
2009	22,058	3,998	20,045	10,051	5,943	22,749	47,729	138,682	32,851	43,041	60,241	37,655	445,043
2010	23,838	10,119	12,985	9,401	5,250	10,041	83,394	60,067	28,480	48,577	52,672	50,279	395,103
2011	20,013	7,029	14,528	5,671	4,610	9,109	26,743	41,780	49,649	42,646	54,276	38,402	314,456
2012	11,449	16,112	18,789	4,682	5,330	13,878	31,756	40,452	59,643	46,859	43,424	38,467	330,841
2013	10,656	13,188	22,471	10,136	9,716	9,272	21,254	44,879	45,058	27,645	26,843	20,421	261,539
2014	6,864	10,086	18,095	4,243	3,831	5,120	22,952	33,244	23,217	32,568	29,561	28,129	217,910
2015	7,728	6,830	13,777	7,536	5,174	7,849	16,685	35,794	37,662	23,102	40,426	49,969	252,532
2016	20,643	22,581	47,096	6,344	8,763	7,120	11,169	66,548	43,500	42,356	46,938	32,951	356,009
2017	13,818	12,802	11,211	9,174	8,019	49,280	112,151	107,862	40,845	37,289	24,575	42,967	469,993
2018	29,816	32,676	24,816	8,184	6,743	6,244	28,332	45,306	43,361	44,563	34,163	34,605	338,809
2019	11,606	5,394	3,587	2,552	8,551	23,818	87,807	119,309	77,792	32,479	30,169	40,330	443,394
2020	34,596	56,738	18,407	6,915	7,377	7,531	17,454	32,442	33,142	27,970	38,669	37,753	318,994
2021	7,597	7,014	6,267	7,812	6,444	7,322	35,566	63,455	24,121	18,397	14,734	13,619	212,348

Table 4-18. Abiquiu Monthly and Annual Computed Inflow in Acre-Feet 1963–2022 (sheet 4 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
2022	4,620	12,095	14,830	6,801	6,736	7,613	44,701	61,115	19,405	20,742	29,108	27,866	255,632
Average	13,459	13,764	16,808	9,447	10,196	20,021	51,789	92,228	48,717	29,558	29,443	23,577	359,009
Max	41,979	56,738	79,630	29,170	35,960	77,594	142,597	236,083	162,323	78,930	75,520	59,871	635,815
Min	2,160	2,310	2,800	1,900	1,800	3,180	7,080	13,880	9,090	7,960	6,060	2,350	145,380

1963 to 1991: Monthly values from 1995 WCM/1991 to 2022 from USACE—Albuquerque Abiquiu Monthly Reports

Table 4-19. Abiquiu Monthly and Annual Computed Outflow in Acre-Feet, 1963–2022 (sheet 1 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
1963	4,925	48,446	54,001	11,640	6,810	18,078	45,817	18,664	9,114	7,975	7,648	3,878	236,996
1964	3,026	16,417	2,800	2,624	2,100	5,084	16,811	53,316	12,652	8,460	17,058	10,557	150,905
1965	2,621	17,761	3,360	9,028	10,606	13,941	58,850	71,575	65,322	81,004	14,257	7,887	356,212
1966	7,816	44,024	63,860	8,136	9,316	37,323	60,818	79,734	21,553	7,239	8,035	2,381	350,235
1967	2,121	24,130	8,142	4,578	3,994	11,763	9,656	51,106	25,553	9,940	34,524	10,839	196,346
1968	3,565	27,798	3,146	1,904	5,958	7,976	18,865	58,614	57,385	8,413	51,765	3,900	249,289
1969	3,705	34,734	3,772	9,321	5,327	8,903	62,229	92,612	88,431	13,976	14,824	12,353	350,187
1970	16,608	16,579	22,036	5,811	6,070	6,019	11,480	54,635	65,855	8,875	8,307	15,353	237,628
1971	6,874	26,384	5,122	4,950	5,226	12,820	31,829	38,700	19,018	13,281	7,108	6,545	177,858
1972	11,713	23,790	5,436	4,421	12,563	22,191	23,040	14,849	12,835	12,359	7,870	3,832	154,899
1973	16,509	12,615	6,678	5,989	5,493	11,867	25,581	35,478	48,097	91,494	66,653	30,484	356,937
1974	10,477	19,654	65,115	44,062	6,209	16,964	17,107	33,966	44,265	31,309	36,062	6,212	331,405
1975	5,331	4,320	2,699	2,287	2,499	10,797	59,314	71,818	100,800	67,513	17,985	8,533	353,897
1976	20,580	24,040	80,426	29,047	2,370	5,251	20,404	67,636	10,925	36,690	38,627	46,360	382,354
1977	9,580	3,529	7,231	2,226	2,805	3,222	6,623	26,710	65,276	38,762	25,536	13,781	205,280
1978	15,685	3,642	8,762	2,195	2,110	7,901	21,993	85,406	83,901	31,254	31,685	19,958	314,492
1979	2,761	5,784	11,523	5,042	6,248	29,686	69,739	92,969	59,326	48,421	6,050	26,682	364,231
1980	34,150	70,274	56,815	4,372	12,327	19,596	68,668	102,807	127,398	57,700	26,563	20,684	601,353
1981	14,800	56,934	49,172	9,371	4,071	6,155	18,226	35,724	44,979	31,543	20,217	7,640	298,832
1982	8,756	4,969	8,141	4,655	4,732	20,106	74,023	121,192	123,471	20,924	18,545	21,404	430,917

Table 4-19. Abiquiu Monthly and Annual Computed Outflow in Acre-Feet, 1963–2022 (sheet 2 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
1983	10,668	9,348	12,691	5,817	9,108	26,790	58,058	126,357	105,798	91,186	20,149	26,081	502,052
1984	11,265	11,371	22,634	6,967	5,476	30,904	64,860	113,752	143,881	24,564	26,175	22,731	484,578
1985	12,666	10,860	14,905	13,533	14,651	64,316	112,701	91,740	31,014	20,820	25,849	30,383	443,436
1986	20,113	7,414	15,329	52,867	88,193	71,818	106,512	107,111	21,820	15,876	13,072	13,680	533,806
1987	15,064	28,431	28,610	24,915	94,858	102,561	99,729	35,497	22,844	45,113	62,656	71,345	631,623
1988	77,536	40,070	3,111	3,068	2,744	27,639	49,079	65,300	29,401	19,824	20,531	13,371	351,673
1989	6,186	7,777	3,591	3,333	2,949	33,111	89,078	46,614	25,349	45,439	33,523	16,649	313,598
1990	5,583	2,725	6,561	3,314	2,893	6,327	13,162	30,830	27,997	26,280	26,975	39,189	191,837
1991	9,740	9,312	9,217	6,831	9,752	25,136	54,095	108,649	96,337	30,744	20,070	21,779	401,662
1992	16,694	28,669	25,714	12,150	16,250	36,192	72,893	110,555	84,436	48,292	38,848	46,401	537,093
1993	29,219	5,825	8,608	12,414	12,457	14,431	84,020	101,823	104,906	52,929	36,050	19,523	482,206
1994	23,003	29,704	27,467	10,188	7,809	27,165	96,397	105,021	107,167	47,118	40,975	25,771	547,785
1995	23,863	9,568	9,512	10,625	16,039	37,987	63,015	103,238	105,620	57,811	35,921	31,966	505,165
1996	39,672	36,309	27,891	27,042	23,221	29,545	23,784	54,675	54,768	43,257	46,325	36,625	443,112
1997	18,748	4,445	5,245	5,042	8,481	18,631	26,688	94,568	79,319	30,861	20,506	32,971	345,503
1998	41,018	9,943	11,283	11,984	10,091	16,140	39,195	108,464	50,454	36,431	44,800	57,648	437,452
1999	24,546	4,748	2,988	3,738	3,316	5,079	25,831	75,753	47,252	21,060	23,956	13,656	251,922
2000	15,550	5,587	5,829	5,626	6,068	25,388	33,310	60,080	83,960	77,905	69,788	59,802	448,895
2001	14,204	3,665	3,283	3,302	3,460	3,111	9,955	10,477	12,234	32,859	37,200	50,703	184,455
2002	28,407	2,511	2,693	2,632	1,505	8,467	43,277	66,407	65,098	52,043	51,557	22,034	346,631

Table 4-19. Abiquiu Monthly and Annual Computed Outflow in Acre-Feet, 1963–2022 (sheet 3 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
2003	10,840	2,969	3,013	2,669	2,055	9,014	23,100	20,389	30,002	52,898	41,209	18,232	216,390
2004	8,596	6,700	7,698	2,287	3,129	5,595	13,942	60,750	22,534	29,016	28,764	27,592	216,604
2005	5,331	6,111	16,479	6,641	11,257	7,956	66,228	100,778	73,309	15,064	29,981	31,632	370,769
2006	7,815	6,058	8,196	2,927	1,211	7,538	28,883	39,125	54,785	26,950	14,923	14,983	213,394
2007	9,500	16,643	9,973	3,173	2,744	6,315	14,001	85,037	36,321	35,786	26,692	17,096	263,281
2008	5,331	3,392	12,488	7,723	17,026	72,494	94,136	72,924	80,628	19,129	37,784	37,892	460,947
2009	18,871	4,409	11,959	10,287	7,348	22,566	47,645	102,438	62,420	40,938	54,595	35,137	418,613
2010	21,324	9,116	10,035	9,278	6,265	11,720	61,765	81,471	38,862	45,230	35,251	39,790	370,107
2011	19,221	4,070	12,796	7,182	6,503	11,486	37,214	47,714	54,411	42,611	37,231	19,345	299,783
2012	8,651	13,377	16,866	6,930	7,656	12,962	29,639	43,109	70,691	54,712	41,092	21,059	326,742
2013	11,953	14,251	25,019	4,083	3,093	6,542	35,226	55,284	58,879	12,550	18,871	13,085	258,837
2014	14,191	8,860	6,622	4,501	4,160	4,704	25,373	51,656	30,258	23,193	24,091	26,884	224,492
2015	9,143	5,897	12,384	3,388	2,821	6,671	19,928	37,932	39,255	23,913	38,436	30,121	229,888
2016	13,810	35,137	52,258	4,427	7,852	4,851	10,842	48,495	61,765	51,557	35,632	29,199	355,826
2017	14,087	14,162	12,666	6,302	4,349	49,596	97,944	98,196	37,386	38,165	24,128	40,510	437,492
2018	31,961	42,563	35,054	4,581	2,294	5,583	33,828	51,785	54,762	48,532	41,135	24,486	376,564
2019	18,034	5,224	6,665	7,717	9,103	30,572	70,988	105,451	95,802	33,640	14,628	23,665	421,489
2020	39,180	59,254	13,890	4,667	4,107	3,523	18,190	27,042	48,573	43,373	39,764	25,890	327,455
2021	6,868	4,445	3,468	4,987	1,849	3,247	41,421	65,054	24,623	11,898	11,320	7,509	186,688

Table 4-19. Abiquiu Monthly and Annual Computed Outflow in Acre-Feet, 1963–2022 (sheet 4 of 4)

Water Year	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	Annual
2022	4,563	3,794	20,262	3,325	3,325	5,388	45,032	48,741	20,021	10,721	20,115	9,207	194,494
Average	15,410	17,009	16,886	8,402	9,405	19,578	45,034	67,797	56,352	35,124	29,498	23,748	344,243
Max	77,536	70,274	80,426	52,867	94,858	102,561	112,701	126,357	143,881	91,494	69,788	71,345	631,623
Min	2,121	2,511	2,693	1,904	1,211	3,111	6,623	10,477	9,114	7,239	6,050	2,381	150,905

1963 to 1991: Monthly values from 1995 WCM/1991 to 2022 from USACE—Albuquerque Abiquiu Monthly Reports

Table 5-1. Active Hydrometeorological Gages in Rio Chama Watershed (sheet 1 of 2)

Gage Description	CWMS ID	USGS ID	NWS ID	GOES ID	Elevation (feet)	Latitude	Longitude	Agency	Parameters
Abiquiu Dam Weather Station	Abiquiu		ABIN5		6,404.0	36.2333	-106.4333	USACE	Air Temperature Precipitation Pan Evaporation Snow Depth
Abiquiu Reservoir	Abiquiu	08286900	ABIN5	CE1B1592	6,381.0	36.2400	-106.4283	USACE	Pool Elevation
Rio Chama bl Abiquiu Dam	Abiquiu DS	08287000	AICN5	CE1B2008	6,040.0	36.2372	-106.4174	USACE	Flow
Rio Chama ab Abiquiu Reservoir	Abiquiu US	08286500	RCAN5	CE1B80F0	6,279.9	36.2767	-106.5590	USACE	Flow
Rio Chama nr Chamita	Chamita	08290000	CMTN5	CE19D578	5,653.6	36.0736	-106.1117	USACE	Flow
Azotea Tunnel Outlet nr Chama	Azotea Outlet	08284160	CHUN5	5166817A	7,519.9	36.8506	-106.6717	USBR	Flow
Rio Chama ab Chama	Chama	08281400	RCCN5	168226E8	8,024.0	36.9350	-106.5547	NMISC	Flow
El Vado Lake	El Vado	08285000	ELVN5	3486F724	6,915.8	36.5942	-106.7333	USBR	Pool Elevation
Rio Chama bl El Vado Dam	El Vado DS	08285500	RCEN5	348657DC	6,696.1	36.5804	-106.7248	USBR	Flow
Rio Brazos nr Tierra Amarilla	Fishtail Rd	08282300	RFRN5	16DB748A	7,735.0	36.7381	-106.4708	NMISC	Flow
Heron Reservoir on Willow Creek	Heron	08284510	TRAN5	3486E452	7,199.0	36.6656	-106.7036	USBR	Pool Elevation Release

Table 5-1. Active Hydrometeorological Gages in Rio Chama Watershed (sheet 2 of 2)

Gage Description	CWMS ID	USGS ID	NWS ID	GOES ID	Elevation (feet)	Latitude	Longitude	Agency	Parameters
Rio Ojo Caliente at La Madera	La Madera	08289000	LMDN5	178D1442	6,358.8	36.3497	-106.0442	NMISC	Flow
Rio Chama nr La Puente	La Puente	08284100	RLEN5	348644AA	7,083.0	36.6627	-106.6334	NMISC	Flow
Rio Grande at Otowi Bridge	Otowi	08313000	OTWN5	CE19809E	5,488.5	35.8745	-106.1424	RGCC	Flow
Rio Grande at Embudo	Embudo	08279500	EMBN5	1786D2F4	5,789.1	36.2056	-105.9640	USGS	Flow
Chamita SNOTEL	Chamita SNOTEL		CHAN5		8,400.0	36.9600	-106.6600	NRCS	SNOTEL
Stone Lake RAWS	RawsSTLN5		STLN5	52139286	7,385.0	36.7317	-106.8658	BIA	Weather
Hopewell SNOTEL	Hopewell		HPWN5		10,000.0	36.7200	-106.2600	NRCS	SNOTEL
Deadman Peak RAWS	RawsDPKN5		DPKN5	326EB0CE	8,263.0	36.4228	-106.7719	DAFS	Weather
Coyote RAWS	RawsCOYN5		COYN5	3232D0F6	8,651.0	36.0731	-106.6572	DAFS	Weather
Bateman SNOTEL	Bateman		BAMN5		9,300.0	36.5100	-106.3200	NRCS	SNOTEL
Jarita Mesa RAWS	RawsJARN5		JARN5	32814352	8,803.0	36.5558	-106.1031	DAFS	Weather
Cumbres Trestle SNOTEL	Cumbres Trestle		CUMN5		10,040.0	37.0200	-106.4500	NRCS	SNOTEL

Table 5-2. Water Management Contact List for Abiquiu Dam (sheet 1 of 4)

Name	Agency	Title	Office Number	Work Cell Number
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	

Table 5-2. Water Management Contact List for Abiquiu Dam (sheet 2 of 4)

Name	Agency	Title	Office Number	Work Cell Number
[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 5-2. Water Management Contact List for Abiquiu Dam (sheet 3 of 4)

Name	Agency	Title	Office Number	Work Cell Number
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	

Table 5-2. Water Management Contact List for Abiquiu Dam (sheet 4 of 4)

Name	Agency	Title	Office Number	Work Cell Number
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]	[redacted]	

Table 5-3. Water Management Contact List for Abiquiu Dam—Other Agency/Organization Contacts

Name/Title	Agency	Location	Telephone Number
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 1 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6081	1	0
6082	1	1
6083	4	4
6084	5	8
6085	6	14
6086	8	21
6087	10	30
6088	12	41
6089	14	54
6090	17	69
6091	20	88
6092	23	109
6093	25	133
6094	29	160
6095	35	192
6096	40	230
6097	45	272
6098	53	321
6099	61	378
6100	69	443
6101	76	516
6102	82	595
6103	88	680
6104	94	771
6105	99	867
6106	105	969
6107	111	1,077
6108	116	1,191
6109	122	1,310
6110	130	1,436
6111	139	1,570

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 2 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6112	150	1,715
6113	161	1,870
6114	170	2,036
6115	178	2,210
6116	194	2,395
6117	211	2,598
6118	226	2,816
6119	241	3,050
6120	253	3,297
6121	267	3,557
6122	278	3,829
6123	291	4,114
6124	310	4,414
6125	334	4,736
6126	348	5,077
6127	362	5,432
6128	376	5,801
6129	390	6,184
6130	408	6,583
6131	429	7,002
6132	446	7,439
6133	465	7,895
6134	490	8,372
6135	519	8,876
6136	539	9,405
6137	556	9,953
6138	571	10,516
6139	584	11,094
6140	596	11,684
6141	609	12,286
6142	622	12,902

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 3 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6143	635	13,530
6144	646	14,171
6145	658	14,823
6146	671	15,487
6147	685	16,165
6148	700	16,858
6149	718	17,567
6150	742	18,297
6151	764	19,050
6152	786	19,825
6153	808	20,622
6154	834	21,443
6155	861	22,290
6156	895	23,168
6157	941	24,086
6158	987	25,050
6159	1,034	26,061
6160	1,080	27,117
6161	1,130	28,222
6162	1,174	29,374
6163	1,216	30,569
6164	1,263	31,809
6165	1,313	33,096
6166	1,367	34,436
6167	1,422	35,831
6168	1,474	37,279
6169	1,527	38,779
6170	1,581	40,333
6171	1,631	41,939
6172	1,689	43,599
6173	1,745	45,316

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 4 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6174	1,797	47,087
6175	1,854	48,912
6176	1,916	50,797
6177	1,974	52,742
6178	2,030	54,744
6179	2,085	56,801
6180	2,132	58,910
6181	2,177	61,064
6182	2,224	63,265
6183	2,274	65,514
6184	2,323	67,812
6185	2,371	70,159
6186	2,422	72,556
6187	2,479	75,006
6188	2,535	77,513
6189	2,591	80,076
6190	2,646	82,694
6191	2,698	85,366
6192	2,753	88,092
6193	2,807	90,872
6194	2,858	93,704
6195	2,908	96,587
6196	2,956	99,519
6197	3,002	102,498
6198	3,049	105,524
6199	3,094	108,595
6200	3,136	111,710
6201	3,172	114,864
6202	3,208	118,054
6203	3,268	121,292
6204	3,325	124,589

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 5 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6205	3,389	127,946
6206	3,448	131,364
6207	3,500	134,838
6208	3,549	138,363
6209	3,601	141,938
6210	3,651	145,564
6211	3,700	149,239
6212	3,755	152,967
6213	3,809	156,749
6214	3,861	160,584
6215	3,918	164,473
6216	3,973	168,419
6217	4,030	172,420
6218	4,084	176,477
6219	4,138	180,588
6220	4,191	184,753
6221	4,243	188,970
6222	4,295	193,239
6223	4,347	197,560
6224	4,396	201,931
6225	4,446	206,352
6226	4,495	210,823
6227	4,545	215,343
6228	4,595	219,913
6229	4,643	224,532
6230	4,691	229,199
6231	4,744	233,916
6232	4,795	238,686
6233	4,845	243,506
6234	4,894	248,375
6235	4,943	253,294

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 6 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6236	4,993	258,262
6237	5,043	263,280
6238	5,094	268,348
6239	5,144	273,467
6240	5,195	278,637
6241	5,246	283,857
6242	5,294	289,127
6243	5,343	294,446
6244	5,395	299,815
6245	5,446	305,235
6246	5,496	310,706
6247	5,546	316,227
6248	5,596	321,798
6249	5,646	327,419
6250	5,698	333,091
6251	5,752	338,816
6252	5,805	344,595
6253	5,858	350,426
6254	5,911	356,311
6255	5,964	362,248
6256	6,016	368,238
6257	6,071	374,282
6258	6,127	380,381
6259	6,184	386,536
6260	6,240	392,748
6261	6,294	399,015
6262	6,351	405,338
6263	6,410	411,718
6264	6,468	418,157
6265	6,528	424,655
6266	6,589	431,214

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 7 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6267	6,648	437,832
6268	6,710	444,511
6269	6,769	451,251
6270	6,830	458,050
6271	6,889	464,910
6272	6,949	471,829
6273	7,009	478,808
6274	7,070	485,847
6275	7,131	492,948
6276	7,191	500,109
6277	7,252	507,330
6278	7,314	514,613
6279	7,375	521,958
6280	7,437	529,364
6281	7,500	536,832
6282	7,563	544,364
6283	7,625	551,958
6284	7,686	559,613
6285	7,747	567,330
6286	7,807	575,107
6287	7,868	582,944
6288	7,929	590,843
6289	7,990	598,802
6290	8,049	606,822
6291	8,110	614,901
6292	8,169	623,041
6293	8,228	631,239
6294	8,284	639,495
6295	8,345	647,810
6296	8,404	656,184
6297	8,465	664,619

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 8 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6298	8,526	673,114
6299	8,588	681,671
6300	8,652	690,291
6301	8,714	698,974
6302	8,776	707,719
6303	8,843	716,529
6304	8,912	725,406
6305	8,981	734,353
6306	9,047	743,367
6307	9,114	752,447
6308	9,180	761,594
6309	9,244	770,806
6310	9,307	780,082
6311	9,371	789,421
6312	9,436	798,824
6313	9,501	808,293
6314	9,566	817,826
6315	9,633	827,426
6316	9,701	837,093
6317	9,769	846,828
6318	9,838	856,631
6319	9,906	866,503
6320	9,974	876,443
6321	10,043	886,452
6322	10,111	896,529
6323	10,181	906,675
6324	10,253	916,892
6325	10,327	927,182
6326	10,403	937,547
6327	10,481	947,989
6328	10,560	958,509

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 9 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6329	10,641	969,110
6330	10,720	979,790
6331	10,802	990,551
6332	10,884	1,001,394
6333	10,968	1,012,320
6334	11,053	1,023,331
6335	11,139	1,034,427
6336	11,226	1,045,609
6337	11,315	1,056,880
6338	11,405	1,068,240
6339	11,496	1,079,690
6340	11,590	1,091,233
6341	11,689	1,102,873
6342	11,787	1,114,611
6343	11,887	1,126,448
6344	11,984	1,138,383
6345	12,086	1,150,418
6346	12,185	1,162,554
6347	12,286	1,174,789
6348	12,389	1,187,127
6349	12,496	1,199,569
6350	12,606	1,212,120
6351	12,715	1,224,781
6352	12,823	1,237,550
6353	12,936	1,250,429
6354	13,051	1,263,423
6355	13,169	1,276,533
6356	13,289	1,289,762
6357	13,411	1,303,112
6358	13,537	1,316,586
6359	13,665	1,330,187

Table 7-4. Reservoir Elevation-Area-Capacity Table (sheet 10 of 10)

Elevation (feet)	Surface Area (acres)	Capacity (acre-feet)
6360	13,797	1,343,917
6361	13,930	1,357,781
6362	14,064	1,371,778
6363	14,199	1,385,909
6364	14,344	1,400,181
6365	14,485	1,414,595
6366	14,616	1,429,145
6367	14,744	1,443,825
6368	14,873	1,458,634
6369	15,001	1,473,571
6370	15,129	1,488,636
6371	15,256	1,503,828
6372	15,382	1,519,147
6373	15,510	1,534,593
6374	15,639	1,550,168
6375	15,767	1,565,871
6376	15,896	1,581,702
6377	16,023	1,597,662
6378	16,150	1,613,748
6379	16,278	1,629,962
6380	16,404	1,646,303
6381	16,529	1,662,770

Table 8-2. Maximum Water Year Elevation and Storage 1963–2022 (sheet 1 of 2)

Date	Elevation (feet)	Storage (acre-feet)
04/16/1963	6,089.72*	2110*
11/11/1963	6,090.12	2,407
09/13/1965	6,186.61	99,582
10/29/1965	6,186.41	99,051
10/01/1966	6,141.17	23,253
06/08/1968	6,167.30	54,926
05/25/1969	6,172.20	59,954
05/25/1970	6,167.00	48,737
09/30/1971	6,116.38	4,052
09/21/1972	6,115.13	3,607
06/21/1973	6,219.93	205,320
11/10/1973	6,184.33	85,315
06/02/1975	6,193.86	110,280
05/19/1976	6,161.25	37,310
06/03/1977	6,152.79	26,990
06/01/1978	6,172.91	57,180
06/28/1979	6,205.26	146,940
06/14/1980	6,219.63	198,320
10/01/1980	6,202.30	133,200
06/03/1982	6,185.79	84,515
06/14/1983	6,213.89	175,460
05/29/1984	6,228.09	234,960
06/11/1985	6,256.22	382,720
12/17/1985	6,246.20	325,250
07/27/1986	6,246.74	319,161
06/22/1987	6,261.06	402,258
10/01/1987	6,235.74	262,161
03/13/1989	6,221.69	198,338
07/29/1990	6,216.24	176,095
05/28/1991	6,235.26	256,856
05/31/1992	6,223.12	202,266

*Data started 04 FEB 1963

Table 8-2. Maximum Water Year Elevation and Storage 1963–2022 (sheet 2 of 2)

Date	Elevation (feet)	Storage (acre-feet)
06/07/1993	6,236.81	264,472
05/26/1994	6,232.66	244,441
06/25/1995	6,244.90	305,944
10/01/1995	6,237.35	267,149
06/09/1997	6,221.05	193,634
05/24/1998	6,219.11	185,670
03/29/1999	6,220.45	185,703
03/14/2000	6,219.59	182,234
06/17/2001	6,212.08	153,498
03/19/2002	6,212.88	156,452
08/14/2003	6,186.70	73,064
05/14/2004	6,207.39	136,608
05/21/2005	6,222.32	193,409
04/18/2006	6,217.40	173,587
05/18/2007	6,220.84	187,292
06/05/2008	6,222.51	194,201
05/25/2009	6,228.19	218,576
05/01/2010	6,223.08	196,587
12/30/2010	6,220.05	184,082
12/19/2011	6,220.33	185,216
03/22/2013	6,216.74	171,023
01/03/2014	6,212.41	154,715
09/30/2015	6,208.17	141,580
10/30/2015	6,209.88	147,540
06/06/2017	6,211.94	155,043
10/02/2017	6,208.88	144,029
05/13/2019	6,197.29	106,256
05/13/2020	6,192.55	92,386
03/30/2021	6,186.62	76,818
09/24/2022	6,204.08	124,855

*Data started 04 FEB 1963

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EXHIBIT A

SUPPLEMENTARY PERTINENT DATA
ABIQUIU DAM AND RESERVOIR

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Item	Description or Quantity and Units
General Information	
Other Names of Project	None.
Location	Abiquiu Dam is located in the Rio Grande Basin on the Rio Chama at RM 32 in New Mexico.
Project Type	Dam and Reservoir
Water Management Objectives	Abiquiu Dam is authorized for purposes of flood control, sediment retention, and water supply.
Project Owner	USACE
Operating Logistics	Abiquiu Dam is operated by the Albuquerque District, USACE. The duties related to regulation of flows are performed either by the OPM or by a designated dam operator. The OPM has a normal tour of duty at the dam of 8 hours per day, 5 days per week. At other times during flood emergencies at night or on weekdays, the OPM may be reached at their residence. Personnel will be on duty weekends and holidays and at other normal working hours when necessary for the efficient functioning of the project.
Water Management Agency	The Albuquerque District, USACE is responsible for the regulation of Abiquiu Dam. USACE, NWS, NRCS, and USGS cooperate to collect and disseminate hydrologic data.
Federal Power commission License	The hydroelectric power facility is owned and operated by the Incorporated LAC-DPU under FERC License No. 7396-001, dated 16 April 1986.
Water Supply Agreements	Refer to Exhibit E
Other Formal Agreements	Rio Grande Compact (Exhibit C). MOA between USACE and LAC for Construction, Operation, and Maintenance of Hydroelectric Powerplant (Exhibit G).
Project Cost	$21.3 million (initial, 1963 dollars).
Closure Date	February 1963
Special Project Features	There is induced surcharge storage space (656,342 acre-feet) between top of the flood control pool and the emergency spillway.

Item		Description or Quantity and Units	
Reservoir, Lake, or Pool			
Pool	**Incremental Storage**	**Cumulative Capacity**	**Area**
Top of Dam	112,602	1,662,770	16,529
Maximum Pool	338,048	1,550,168	15,639
Spillway Crest	656,342	1,212,120	12,606
Top Flood Control Pool	326,579	555,778	7,656
Top Joint Use (Flood Control and Conservation)	229,199	229,199	4,691
Zero Storage	0	0	0
Conduit Invert	0	0	0
Real Estate Taking Line for Fee Title		6,215.0 feet	
Real Estate Taking Line for Easement		6,293.5 feet	
Range Clearing		None	
Pool Elevation Corresponding to Discharge Capability of Maximum Non-damaging Flow Rate Downstream		6,070.0 feet	
Reservoir Length at Top of Conservation Pool		10 Miles	
Shoreline Length at Top of Conservation Pool		65 Miles	
Safety Aspects, Possibly Requiring Warning		When unusual increases in reservoir stages are expected, project will notify visitors that are camped close to the water edge. A siren will be sounded to warn visitors below the dam prior to flow changes.	
Emergency Drawdown		The time required to empty all storage below the top of the flood control pool (elevation 6,283.5 feet NGVD) based on 2021 A-C table (555,768 acre-feet) is approximately 45 days. All discharges would be through the conduit and no dead storage would remain.	
Project Facilities in Reservoir Area		Recreation facilities.	
Project Facilities in Downstream Area		Hydroelectrical power facility.	

Item	Description or Quantity and Units
Hydrology	
Drainage Area	Total drainage area is 2,146 square miles.
Probable Maximum, Standard Project Flood	PMF: Max Water Surface Elevation—6,374.0 feet Peak Inflow—429,000 cfs Total Storm Runoff—504,000 acre-feet Total Volume Stored—1,550,150 acre-feet Max Outflow—31,688 cfs Seasonal Distinction—rain flood Standard Project Flood: Flood Control Volume—502,000 acre-feet Seasonal Distinction—Snowmelt and rainstorm.
Climate	The climate of the area varies from semiarid in the lower basin to subalpine in the mountainous headwater area.
Storm Types	Convective and orographic summer thunderstorms; summer-fall transition frontal activity.
Flood Season	April through October
Low Flow Season	July through March
Minimum Daily Flow and Date of Occurrence	Zero on numerous days (1926–2022)
Minimum Monthly Flow and Date	Zero flow during months of October 1928 and August 1934 (1926–2022)
Minimum Annual Flow and Year	98,300 acre-feet in 1934 (1926–2022)
Average Annual Flow	347,550 acre-feet (1926-2022)
Maximum Daily Flow and Date	6,480 cfs on 18 May 1984 (October 1941–2022)
Maximum Monthly Flow and Date	270,100 acre-feet in May 1941 (1926–2022)
Maximum Annual Flow and Year	752,100 acre-feet in 1942 (1926–2022)
Maximum Instantaneous Flow and Date	7,870 cfs on 28 July 1952 (October 1941–2022)
Maximum Flow Volume and Dates	434,900 acre-feet flood of 27 April–03 July 1941
Name and Location of Key Streamflow Stations	Rio Chama above Abiquiu Reservoir at RM 47.4 Rio Chama below Abiquiu Dam at RM 31.3 Rio Chama near Chamita at RM 2.8 Rio Grande at Otowi, RM 1,614.2

Item	Description or Quantity and Units
Type of Meteorological Data Recorded at Dam Site	Precipitation (standard and recording), evaporation, wind movement (total miles past station), temperature (air).
Number of Precipitation Stations Used in Hydrologic Forecasting	Forecasting flows are based on gridded estimated and forecasted precipitation data from NWS (quantitative precipitation estimates and quantitative precipitation forecasts).
Number of SNOTEL Stations	There are 4 SNOTEL sites in the Rio Chama subbasin. Maximum snowpack normally occurs about mid-April.
Number of Snow Courses	None.
Number of Sediment Ranges	26 sediment ranges are located within the reservoir area and 11 degradation ranges are located in the channel below the dam. Reservoir area is resurveyed periodically using combined bathymetric and LiDAR data.
Embankments	
Location	Abiquiu Dam is located on the Rio Chama at RM 32 in New Mexico.
Purpose	Flood risk mitigation and water supply
Type	Rolled earthfill embankment
Type of Fill	Centrally located impervious core and cutoff trench through the streambed alluvium.
Slope Protection	Upstream face consists of 6-foot-thick blanket of dumped sandstone rock. Downstream slope protection consists of a 2-foot thickness of dumped sandstone placed on a pervious fill blanket
Height	341 feet above streambed
Length	1,800 feet
Top Elevation	6,381.0 feet
Percent Exceedance Frequency Flood Which Will Overtop Structure	Beyond 0.00001 percent exceedance.
Design Flood	N/A
Freeboard	residuaN/A

Item	Description or Quantity and Units
Associate Pumping/Siphon Station	N/A
Seepage Rate at Design Pool	N/A
Usage/Access	Yes
Elevation of Toe	6,040.0 feet
Spillway	
Location	The spillway is located off-channel and empties into the Rio Chama from the left bank about 1,000 feet downstream the outlet works.
Type	Rock-cut, uncontrolled.
Crest Elevation	6,350.0 feet
Width	68 feet
Number and Size of Gates	None.
Type of Gates	None.
Top of Gate Elevation	N/A
Induced Surcharge	66.5 Feet
Design Head	24 feet
Maximum Discharge Capacity	35,000 cfs
Bridge Deck Elevation	None
Type Energy Dissipator	None
Automated Gates-Elevation to Initiate Gate Raise	N/A
Automated Gates-Elevation Where Gates are Fully Open	N/A
Automated Gates-Elevation that Causes Gates to Lower	N/A
Time Required to Open/Close All Gates	N/A
Type Emergency Closure/Time Requirement	N/A
Recurrence Interval of Pool Attaining Crest Elevation	In excess of 1,000 years.
Spillway Activation	None.
Outlet Facilities	
Location	The outlet works are located in the left abutment with the conduit passing directly under the project office.

Item	Description or Quantity and Units
Purpose	The outlet works are used to control all releases.
Type Outlet	The outlet works consist of a tunnel, intake structure, gate chamber and flip bucket.
Size of Outlet	The tunnel upstream of the gate chamber is 12 feet in diameter about 700 feet long and concrete lined. Downstream of the gate chamber, the tunnel is about 1,400 feet long and consists of a 134 inches diameter steel liner grouted inside the original concrete lining.
Type of Service Gate or Valve	Hydraulic operated slide gate, 5 feet by 9 feet
Number and Size of Gates and Valves	Two rectangular passages with 5 feet by 9 feet service gates and two emergency gates.
Entrance Invert Elevation	6,060.0 feet
Multilevel Intake Elevations	None.
Discharge at Pertinent Elevations	See Plate 7-1A-C for outlet rating curves
Minimum Pool Elevation when Inoperative	6,060.0 feet
Minimum Time Required to Open/Close Service Gates	20 minutes.
Type Emergency Closure and Time Requirements	The emergency gates have a similar closure time as the service gates. Two bulkhead gates are provided for maintenance closure. However, placing the bulkhead gates is costly and time-consuming requiring barge and experienced divers.
Type of Energy Dissipator	Flip bucket which operates as a stilling basin below 2,500 cfs and flips at flows above 2,500 cfs.
Location	Steel liner, plenum chamber and closure gate located in the downstream section of the outlet tunnel; a penstock and powerhouse located downstream of the toe of the dam in a filled area adjacent to the flip bucket; and a transmission line located from the left abutment to U.S. Highway 84.
Type	Run-of-River power plant generates electricity based on USACE-directed water operations.
Hydroelectric Power Facilities	
Installed Capacity	17.0 megawatts.

Item	Description or Quantity and Units
Number/Type and Capacity of Units	Two 6.9 megawatts vertical Francis turbines direct coupled to synchronous generators. One 3.2 MW horizontal Francis turbine direct coupled to brushless generator.
Power-on-line Data	April 1990 (first two units). March 2011 (3.2 MW unit)
Provision for Future	None
Plant Factor	The plant factor is approximately 0.90, based on normal reservoir regulation.
Load Factor	Normal plan for generation, seasonable if applicable
Number and Size of Penstocks	One main penstock (126-inch diameter) with two 54-inch and one 14-inch diameter branch outlets for the bypass valves and two 76-inch diameter branch outlets for the turbines.
Turbine Discharge	At design head–625 cfs At top of flood control pool–470 cfs At maximum power pool–470 cfs
Design Head	175 feet (reservoir elevation 6,220.0 feet)
Maximum Gross Head for Power	255 feet (reservoir elevation 6,300.0 feet)
Average Net Head	N/A
Minimum Flow Required for Generation	75 cfs
Drawdown	6,170.0 feet
Minimum Head	125 feet (reservoir elevation 6,170.0 feet)
Annual Firm Energy-Critical Drawdown	N/A
Minimum Peaking Capability	N/A
Dependable Capacity	N/A
Average Annual Energy	N/A
Specific Hydroelectric Power Storage or Pondage	None
Comingled, Joint Use, or Seasonal Storage	None
Critical Tailwater Elevation	Above 6,045.0 feet
Discharge at Pertinent Elevations	N/A
Pumpback Capability	None
Type of Emergency Closure and Time Required	None
Type of Energy Dissipator	None
Constraints	None

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EXHIBIT B

PUBLIC LAWS

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Public Law 80-858

(b) The Devils Swamp project at Baton Rouge, Louisiana, at an estimated cost of $2,000,000, authorized by the River and Harbor Act approved July 24, 1946, and the authorization for the Lower Mississippi River project is increased accordingly.

Baton Rouge, La.

60 Stat. 635.

(c) The project for improvement of the L'Anguille River, Arkansas, at an estimated cost of $5,100,000 is hereby approved substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 651, Eightieth Congress, and the authorization for the Lower Mississippi River project is increased by $2,000,000.

L'Anguille River, Ark.

RIO GRANDE BASIN

The comprehensive plan for the Rio Grande Basin as set forth in the report of the Chief of Engineers dated April 5, 1948, and in the report of the Bureau of Reclamation dated November 21, 1947, all in substantial accord with the agreement approved by the Secretary of the Army and the Acting Secretary of the Interior on November 21, 1947, is hereby approved except insofar as the recommendations in those reports are inconsistent with the provisions of this Act and subject to the authorizations and limitations set forth herein.

Approval of plan.

The approval granted above shall be subject to the following conditions and limitations:

Limitations.

(a) Construction of the spillway gate structure at Chamita Dam shall be deferred so long as New Mexico shall have accrued debits as defined by the Rio Grande Compact and until New Mexico shall consistently accrue credits pursuant to the Rio Grande Compact;

Chamita Dam.

46 Stat. 767.

(b) Chiflo Dam and Reservoir on Rio Grande shall be excluded from the Middle Rio Grande project authorized herein without prejudice to subsequent consideration of Chiflo Dam and Reservoir by the Congress;

Chiflo Dam and Reservoir.

(c) The Bureau of Reclamation, in conjunction with other interested Federal agencies, is directed to make studies to determine feasible ways and means of reducing nonbeneficial consumption of water by native vegetation in the flood plain of the Rio Grande and its principal tributaries above Caballa Reservoir; and

Studies by Bureau of Reclamation.

(d) At all times when New Mexico shall have accrued debits as defined by the Rio Grande Compact all reservoirs constructed as a part of the project shall be operated solely for flood control except as otherwise required by the Rio Grande Compact, and at all times all project works shall be operated in conformity with the Rio Grande Compact as it is administered by the Rio Grande Compact Commission.

Operation of reservoirs, etc.

46 Stat. 767.

In carrying out the provisions of this Act, the Secretary of the Interior shall be governed by and have the powers conferred upon him by the Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388), and Acts amendatory thereof or supplementary thereto, except as is otherwise provided in this Act or in the reports referred to above. This Act shall be deemed a supplement to said Federal reclamation laws.

Authority of Secretary of Interior.

43 U. S. C. § 391.

Approval is granted to the Secretary of the Interior subject to the limitations of the authorizations approved from time to time for the prosecution of this plan to acquire in the name of the United States, by purchase or otherwise, any or all of the bonds and other evidences of indebtedness of the Middle Rio Grande Conservancy District outstanding when such authorizations are approved at such prices and on such terms and conditions as he shall deem necessary or proper for the protection of the investment of the United States and to retire those obligations on such terms and conditions as he shall likewise deem proper or necessary.

Acquisition by U. S. of indebtedness of Middle Rio Grande Conservancy District.

The Secretary of the Interior, in entering into a contract or contracts for the repayment of the reimbursable construction costs of the Middle

Repayment of reimbursable construction costs.

Rio Grande project, now estimated at approximately $18,000,000, shall vary that amount to reflect changes in the estimates of those costs occurring prior to the date of the contract or contracts and in so doing may, if need be, extend the repayment period beyond forty years to permit payment of costs in excess of the present estimate.

Acquisition of agricultural lands in New Mexico.

Subject to the limitations of authorizations approved from time to time for prosecution of this plan, approval is granted to the Secretary of the Interior to acquire, on behalf of the United States, by purchase or donation, agricultural lands owned by the State of New Mexico within the Middle Rio Grande project and to develop those lands substantially in the manner outlined in the report of the Bureau of Reclamation referred to above. Lands so acquired shall be resold or leased by the Secretary to actual settlers for agricultural purposes under rules and regulations prescribed by him which rules and regulations shall set out the prices and terms of such sales and leases, the qualifications required of purchasers and lessees, and other matters relating to the disposition and use of these lands, and shall provide a preferred right to purchase or lease any tract of such land to otherwise qualified persons of the following classes in the order here set out, purchasers in any class being preferred to lessees in that or any other class:

Sale or lease of land.

Order of preference in leases or purchases.

(1) The former owner or owners of such tracts, if his or their title thereto was divested by reason of sale for taxes to the State of New Mexico.

(2) Honorably discharged veterans of World War II who are the sons or daughters of the former owner or owners of such tract, if the title of said former owner or owners was divested by reason of sale for taxes to the State of New Mexico.

(3) The sons or daughters of the former owner or owners of such tract other than those referred to in (2) if the title of said former owner or owners was divested by reason of sale for taxes to the State of New Mexico.

(4) Honorably discharged veterans of World War II other than those referred to in (2).

(5) Persons other than those referred to in the clauses above. Any deed executed by the Secretary in favor of any person described under (4) or (5) shall provide that any person described under (1), (2), or (3) shall have the right to purchase any land conveyed by such deed, within a period of ten years after the execution thereof, by (a) paying to the owner the amount or amounts actually paid by him as consideration for such deed and for the actual cost of improvements on such land plus interest at the rate of 6 per centum per annum on such amount or amounts, and (b) assuming any obligations of the owner to the Secretary with respect to such land. Any lease executed by the Secretary under the provisions of this section to any person described under (4) or (5) shall, by its terms, expire not later than five years after the date of its execution. The preferred rights provided for by this section to purchase or lease any land shall continue to be applicable until such land is finally disposed of by the Secretary; but the right of any lessee or purchaser to enter into possession shall be subject to any rights under any prior lease executed by the Secretary. Moneys accruing from the sale or lease of said lands shall be covered into the reclamation fund in the Treasury.

Expiration of lease.

Preferred rights.

Use of water.

In the administration of the provisions of this Act all water in the Middle Rio Grande Valley in New Mexico shall be deemed to be useful primarily for domestic, municipal, and irrigation purposes.

Nothing in this Act shall be construed as affecting or abrogating in any way the laws of the State of New Mexico in which the Middle Rio

Grande Valley lies, relating to the control, appropriation, or distribution of water used in irrigation or for municipal or other uses, or any vested right therein.

Nothing in this Act shall be construed to abrogate or impair existing obligations of the United States or any agency thereof, including obligations to furnish water for irrigation and obligations to any Indian or tribe or band of Indians whether based on treaty, agreement, or Act of Congress. Obligations of U. S.

There is hereby authorized to be appropriated the sum of $3,500,000 to be expended by the Department of the Army for the partial accomplishment of the comprehensive plan for the Rio Grande Basin. Appropriation authorized.

SEC. 204. The Secretary of the Army is hereby authorized and directed to cause preliminary examinations and surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its Territorial possessions, which include the following-named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and water-flow retardation and soil-erosion prevention on such drainage areas, the cost thereof to be paid from appropriations heretofore or hereafter made for such purposes: *Provided*, That after the regular or formal reports made on any examination, survey, project, or work under way or proposed are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to the Congress if such review is required by the national defense or by changed physical or economic conditions: *And provided further*, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law; Preliminary examinations and surveys. Supplemental reports. Adoption of project by law.

Rahway River and its tributaries, New Jersey;

Chowan River and its tributaries, Virginia and North Carolina;

Pantego Creek and Cucklers Creek, North Carolina;

Rice Creek, a tributary of Saint Johns River, Florida;

Streams flowing through the Brazoria-Galveston Soil Conservation District, the Trinity Bay Soil Conservation District, the Coastal Plains Soil Conservation District, and the Matagorda County Soil Conservation District, Texas, with a view to improvement in the interest of navigation, flood control, and related purposes, including channel and major drainage improvements; Texas.

Area at and in the vicinity of Texas City, Texas, with a view to providing for its protection against storms and erosions, including the protection of the instrumentalities and aids to commerce located there; Texas City, Tex.

Au Gres River and tributaries, Michigan;

Area at and in the vicinity of Bellevue, Ohio, and the surrounding area of Seneca, Erie, Huron, and Sandusky Counties, with a view to the control of floods caused by excess underground and surface waters; Bellevue, Ohio.

Harbors and rivers in Alaska, with a view to determining the advisability of improvements in the interest of navigation, flood control, hydroelectric power, and related water uses; Alaska.

Two Mile Creek, Oregon;

Aroostook River and tributaries, Maine;

Beaver Creek, Lincoln County, Oregon;

Skinner Creek, at and in the vicinity of Mannesville, New York;

Steinhatchee and Fenholloway Rivers, Florida;

River Rouge and tributaries, Michigan.

Allotment for small projects.

SEC. 205. That the Secretary of the Army is hereby authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $2,000,000 for any one fiscal year, for the construction of small flood-control projects not specifically authorized by Congress, and not within areas intended to be protected by projects so authorized, which come within the provisions of section 1 of the Flood Control Act of June 22, 1936, when in the opinion of the Chief of Engineers such work is advisable: *Provided*, That not more than $100,000 shall be allotted for this purpose at any single locality from the appropriations for any one fiscal year: *Provided further*, That the provisions of local cooperation specified in section 3 of the Flood Control Act of June 22, 1936, as amended, shall apply: *And provided further*, That the work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submission of preliminary examination and survey reports.

49 Stat. 1570. 33 U. S. C. § 701a. Limitation.

49 Stat. 1571. 33 U. S. C. § 701c.

SEC. 206. That section 5 of the Flood Control Act of August 18, 1941, as amended by section 12 of the Flood Control Act of 1946, is hereby further amended to read as follows:

55 Stat. 650; 60 Stat. 652. 33 U. S. C. § 701n. Allotment for rescue work, etc.

"That the Secretary of the Army is hereby authorized to allot, from any appropriations heretofore or hereafter made for flood control, not to exceed $2,000,000 for any one fiscal year to be expended in rescue work or in the repair, restoration, or maintenance of any flood-control work threatened or destroyed by flood, including the strengthening, raising, extending, or other modification thereof as may be necessary in the discretion of the Chief of Engineers for the adequate functioning of the work for flood control."

Appropriations authorized for improvements and surveys.

SEC. 207. That the sum of $62,000,000 is hereby authorized to be appropriated for carrying out improvements under this title by the Department of the Army, and the sum of $10,000,000 additional is authorized to be appropriated and expended in equal amounts by the Departments of the Army and Agriculture for carrying out any examination or survey provided for in this title and any other Acts of Congress to be prosecuted by said Departments.

Appropriation authorized for emergency fund.

SEC. 208. That the sum of $25,000,000 is hereby authorized to be appropriated as an emergency fund to be expended under the direction of the Secretary of the Army and the supervision of the Chief of Engineers for the repair, restoration, and strengthening of levees and other flood-control works which have been threatened or destroyed by recent floods, or which may be threatened or destroyed by later floods, including the raising, extending, or other modification of such works as may be necessary in the discretion of the Chief of Engineers for the adequate functioning of the works for flood control: *Provided*, That local interests shall provide without cost to the United States all lands, easements, and rights-of-way necessary for the work and shall maintain and operate all the works after completion in a manner satisfactory to the Chief of Engineers: *Provided further*, That pending the appropriation of said sum, the Secretary of the Army may allot from existing flood-control appropriations such sums as may be necessary for the immediate prosecution of the work authorized by this section, such appropriations to be reimbursed from said emergency fund when appropriated: *And provided further*, That funds allotted under this authority shall not be diverted from the unobligated funds from the appropriation "Flood control, general", made available in War Department Civil Functions Appropriation Acts for specific purposes.

Allotments from other appropriations.

Short title.

SEC. 209. Title II may be cited as the "Flood Control Act of 1948".

Approved June 30, 1948.

Sheyenne, Maple, and Rush Rivers in North Dakota, on the Mustinka, Otter Tail, Wild Rice, Marsh, and Sand Hill Rivers in Minnesota, and on the Bois des Sioux and Red Rivers in the vicinity of Wahpeton-Breckenridge to be accomplished by channel improvement, and at Fargo-Moorhead, and at Grand Forks-East Grand Forks by channel improvements, levees, etc., in addition to construction of a multiple-purpose reservoir (Orwell site) on the Otter Tail River to control floods and, in conjunction with previously authorized Federal reservoir projects on Sheyenne River and at Red Lakes, to increase low flow for water supply and pollution abatement. The estimated Federal cost of the comprehensive plan is $9,928,000, of which $2,000,000 were authorized for appropriation by the 1948 Flood Control Act for initiation of the plan. The estimated annual cost of Federal maintenance, is $8,800.

Local cooperation.—In connection with local protection improvements, local interests are required to give the usual assurances covering lands, damages, highway, bridge, and utility changes, maintenance and operation of channel and levee works after completion, and provision of spoil areas. Improvement at any recommended locality may be undertaken independently of the others whenever funds for that purpose are available and prescribed local cooperation has been provided. The estimated cost to local interests is $2,337,000.

Benefits.—The average annual benefits of the authorized comprehensive plan are estimated at $1,025,000. This amount when compared with average annual charges of $546,330 yields a benefit-cost ratio of 1.88 to 1.

Status of comprehensive plan.—Orwell Reservoir on Otter Tail River, and channel improvements on Wild Rice, Marsh, and Sheyenne Rivers, are under construction.

Use of additional monetary authorization.—The estimated total cost of work under way in the comprehensive plan is $2,498,000, compared with present authorization of $2,000,000, leaving a deficit in authorization of $498,000. Authorization needed to initiate and complete remaining projects in the comprehensive plan amounts to $7,430,000. Total additional authorization needed, therefore, is $7,928,000. The proposed authorization for appropriation of $4,000,000 in the bill will permit the completion of work under way and about one-half of the remaining projects in the comprehensive plan.

Remarks.—The Red River of the North drainage basin is subject to destructive floods, and the inadequate natural water supply has restricted its development. The committee is convinced that additional authorization to permit continuation of the comprehensive plan is needed for the economic welfare of the citizens of the area.

RIO GRANDE BASIN

Location.—The Rio Grande rises in the Rocky Mountains on the Continental Divide in southern Colorado, flows 182 miles southeast through Colorado, and 465 miles southward through New Mexico to El Paso, Tex., whence, for 1,241 miles to the Gulf of Mexico, it forms the international boundary between the United States and Mexico. The total drainage area above El Paso is 38,964 square miles, of which 31,476 are in New Mexico. The population of the basin above El Paso was about 272,500 in 1946. Albuquerque is the largest city with a population of 41,000 and Santa Fe, the capital of New Mexico, has a population of 31,000. The major occupations of the basin are large-scale ranching and irrigation farming. Major irrigated crops are alfalfa, native hay, cotton, corn, small grains, vegetables, and fruits.

The largest flood of record occurred during May, June, and July of 1941, and caused damages aggregating over $2,000,000 in three localities alone (Espanola, Middle and Bluewater Valleys). Sixteen major floods occurred during the period 1874 through 1943. Sedimentation of the stream bed has raised ground water levels in the valley and has caused abandonment of large agricultural areas and increased damages from floods.

Existing project.—The Flood Control Act approved June 30, 1948, House Document 243, Eighty-First Congress, approved the general comprehensive plan of improvement for the Rio Grande Basin in accordance with the recommendations of the Chief of Engineers in his report dated April 5, 1948, and in the report of the Bureau of Reclamation dated November 21, 1947, with certain modifications as set forth in the act, and authorized the appropriation of $3,500,000 to be expended by the Department of the Army for the partial accomplishment of the comprehensive plan. The total estimated Federal cost of the comprehensive plan is $69,518,000, of which $41,234,000 is for work by the Department of the Army. The estimated Federal annual maintenance cost is $589,000. The Bureau of Reclamation has completed the Elephant Butte and the Caballo Reservoirs and additional work in the basin, and was authorized by the Interior Appropriation Act of 1941 to construct the San Luis Valley project in Colorado. Other Federal agencies and local interests have completed works for soil conservation, wildlife refuges and irrigation.

Authorized comprehensive plan of improvement

Project	Federal	Non-Federal	Total
Chamita Reservoir	$30,833,000		$30,833,000
James Reservoir	7,201,000		7,201,000
Rio Grande floodway [1]	11,526,000	$181,000	11,707,000
Bluewater floodway	200,000	75,200	275,200
Rehabilitation work [2]	18,233,000		18,233,000
Miscellaneous work [2]	1,525,000		1,525,000
Total	69,518,000	256,200	69,874,200

[1] Authorized for joint construction by Corps of Engineers and Bureau of Reclamation; estimated cost for portion to be constructed by Corps of Engineers is $3,000,000.
[2] Work by Bureau of Reclamation.

Local cooperation.—Local interests are required to give the customary assurances in connection with flood-control projects covering lands, damages, and highway and highway-bridge alterations for channels and levees in addition to maintaining and operating all levees in the Bluewater floodway. They must also contribute in cash $75,000 to the cost of constructing a culvert which is part of the Bluewater floodway project. Total estimated non-Federal cost of the comprehensive plan is $256,200.

Benefits.—The plan will provide for the development of the water resources of the Rio Grande Basin and the flood-control phase of the plan covered in this report will provide improvements essential to the economic welfare of the inhabitants of the basin. The ratio of average annual benefits to average annual costs is 1.2 to 1.

Status of comprehensive plan.—No work has been started on the comprehensive plan.

Use of additional monetary authorization.—Of the total estimated cost of $41,234,000 for work by the Department of the Army, $3,500,000 has been authorized for appropriation, leaving a remainder of $37,734,000 needed to complete the comprehensive plan. The additional monetary authorization proposed in the bill, $34,000,000 will permit substantial completion of the authorized plan.

Remarks.—The plan has been coordinated among the Federal and State agencies concerned and all are in agreement. Construction of the entire plan would be a joint undertaking of the Department of the Army and the Department of the Interior. The committee is of the opinion that flood and sediment control in the Rio Grande Basin is essential for protection of the valley lands. The comprehensive plan worked out by State, Federal, and local officials would reduce flood damages and permit continued use of a large area for agricultural and other purposes. The authorization of $3,500,000 provided by the Congress in the 1948 Flood Control Act, when appropriated, will be sufficient only for the construction of one small unit of the plan and partial accomplishment of one other unit. The committee feels that the recommended additional authorization in the amount of $34,000,000 is essential.

SANTA ANA RIVER AND TRIBUTARIES, CALIF.

(H. Doc. 135, 81st Cong., 1st sess.)

Location.—Santa Ana River rises in San Bernardino Mountains and flows 100 miles to enter the Pacific Ocean near Newport Beach, 30 miles southeast of Los Angeles. The basin has a drainage area of 2,470 square miles. Population of the basin in 1946 was 400,000 of which 55,000 resided in San Bernardino, the largest city. Oil and gas, gems, gold, silver, and sand and gravel are the important natural resources to be found in the basin. The principal occupation in the basin is the growing, packing, and shipping of citrus fruits. United States military installations are at March Field, San Bernardino Army Airfield, and Mira Loma Quartermaster Depot. The area is well served by three main line railroads, by an electric interurban system connecting principal communities in the basin with the Los Angeles metropolitan area, and by a network of Federal, State, and county highways.

Report authorized by.—Flood Control Act approved August 28, 1937.

Existing project.—The Flood Control Acts approved June 22, 1936; June 28, 1938; and December 22, 1944, authorized the construction of three reservoirs and one channel improvement in the Santa Ana River Basin, and six reservoirs in the coastal areas, north and south of the basin. Three of these units have been completed.

The Corps of Engineers constructed a levee for the protection of the Army airfield at San Bernardino which was completed in 1942. The Civilian Conservation Corps and the United States Forest Service completed some soil-conservation and reforestation improvements in

Public Law 86-645

acquisition of water rights), unless the State or one or more other non-Federal entities shall have entered into an agreement in advance to assume at least 20 per centum of the cost (except costs of planning, design, and acquisition of water rights) of the completed project allocated to the production of local flood control benefits, payable either as construction proceeds or pursuant to a contract providing for repayment with interest within 50 years. The actual cost, or fair market value of lands, easements, rights-of-way, and work performed or services rendered prior to completion of construction of the project, which are furnished by a non-Federal entity, shall be included in the share of the cost to be borne by the non-Federal entity.

(d) Garland City, Arkansas: The Secretary of the Army is hereby authorized and directed to cause an immediate study to be made under the direction of the Chief of Engineers of emergency bank protection at Garland City, Arkansas, and the project is hereby authorized as determined to be justified by the Secretary of the Army with the approval of the President, unless within the first period of 60 calendar days of continuous session of the Congress after the date on which the report is submitted to it such report is disapproved by Congress.

WHITE RIVER BASIN

In addition to previous authorizations, there is hereby authorized to be appropriated the sum of $50,000,000, for the prosecution of the comprehensive plan for the White River Basin authorized by the Flood Control Act of June 28, 1938, as amended and supplemented by subsequent Acts of Congress. 52 Stat. 1218.

Modification of the existing flood protection project for Village Creek, White River, and Mayberry Levee Districts, White River, Arkansas, is hereby authorized substantially in accordance with plan I as contained in House Document Numbered 225, Eighty-sixth Congress, at an estimated cost of $294,000: *Provided*, That the Secretary of the Army is hereby authorized and directed to cause a restudy to be made under the direction of the Chief of Engineers of plan III as contained in the House Document Numbered 225, Eighty-sixth Congress, and to report to Congress his findings thereon. Report to Congress.

ARKANSAS RIVER BASIN

The general comprehensive plan for flood control and other purposes for the Arkansas River Basin, approved by the Act of June 28, 1938, as amended, and the multiple-purpose plan for the Arkansas River and tributaries, Arkansas and Oklahoma, approved by the River and Harbor Act of July 24, 1946, as amended, are hereby further amended to provide for the incorporation of the two plans into a single plan of development: *Provided*, That authorizations heretofore, herein and hereafter made available for the Arkansas River Basin shall be applicable to the combined plan of development. 52 Stat. 1218. 60 Stat. 634.

There is hereby authorized to be appropriated the sum of $179,000,000 for prosecution of the combined plan of development for the Arkansas River Basin as herein authorized.

RIO GRANDE BASIN

The project for improvement of the Rio Grande Basin is hereby authorized substantially as recommended by the Chief of Engineers in Senate Document Numbered 94, Eighty-sixth Congress, at an estimated cost of $58,300,000.

Conditions and limitations.

The approval granted above shall be subject to the following conditions and limitations:

Cochiti Reservoir, Galisteo Reservoir, and all other reservoirs constructed by the Corps of Engineers as a part of the Middle Rio Grande project will be operated solely for flood control and sediment control, as described below:

(a) the outflow from Cochiti Reservoir during each spring flood and thereafter will be at the maximum rate of flow that can be carried at the time in the channel of Rio Grande through the middle valley without causing flooding of areas protected by levees or unreasonable damage to channel protective works: *Provided*, That whenever during the months of July, August, September, and October, there is more than two hundred twelve thousand acre-feet of storage available for regulation of summer floods and the inflow to Cochiti Reservoir (exclusive of that portion of the inflow derived from upstream flood-control storage) is less than one thousand five hundred cubic feet per second, no water will be withdrawn from storage in Cochiti Reservoir and the inflow derived from upstream flood-control storage will be retained in Cochiti Reservoir.

(b) Releases of water from Galisteo Reservoir and Jemez Canyon Reservoir during the months of July, August, September, and October, will be limited to the amounts necessary to provide adequate capacity for control of subsequent summer floods; and such releases when made in these months, or thereafter, will be at the maximum rate practicable under the conditions at the time.

(c) Subject to the foregoing, the storage of water in and the release of water from all reservoirs constructed by the Corps of Engineers as part of the Middle Rio Grande project will be done as the interests of flood and sediment control may dictate: *Provided*, That the Corps of Engineers will endeavor to avoid encroachment on the upper two hundred and twelve thousand acre-feet of capacity in Cochiti Reservoir, and all reservoirs will be evacuated completely on or before March 31 of each year: *And provided further*, That when estimates of anticipated streamflow made by appropriate agencies of the Federal Government indicate that the operation of reservoirs constructed as a part of the Middle Rio Grande project may affect the benefits accruing to New Mexico or Colorado, under the provisions of the eighth unnumbered paragraph of article VI of the Rio Grande compact, releases from such reservoirs shall be regulated to produce a flow of ten thousand cubic feet per second at Albuquerque, or such greater or lesser rate as may be determined by the Chief of Engineers at the time to be the maximum safe flow, whenever such operation shall be requested by the Rio Grande compact commissioner for New Mexico or the commissioner for Colorado, or both, in writing prior to commencement of such operation.

(d) All reservoirs of the Middle Rio Grande project will be operated at all times in the manner described above in conformity with the Rio Grande compact, and no departure from the foregoing operation schedule will be made except with the advice and consent of the Rio Grande compact, and no departure from the foregoing operation schedule will be made except with the advice and consent of the Rio Grande Compact Commission: *Provided*, That whenever the Corps of Engineers determines that an emergency exists affecting the safety of major structures or endangering life and shall so advise the Rio Grande Compact Commission in writing these rules of operation may be suspended during the period of and to the extent required by such emergency.

(e) The foregoing regulations shall not apply to storage capacity which may be allocated to permanent pools for recreation and fish and wildlife propagation: *Provided*, That the water required to fill and maintain such pools is obtained from sources entirely outside the drainage basin of the Rio Grande.

UPPER MISSISSIPPI RIVER BASIN

In addition to previous authorizations, there is hereby authorized to be appropriated the sum of $12,000,000 for the prosecution of the comprehensive plan for the Upper Mississippi River Basin, approved in the Act of June 28, 1938, as amended and supplemented by subsequent Acts of Congress. 52 Stat. 1215.

The flood protection project on Redwood River at Marshall, Minnesota, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 417, Eighty-sixth Congress, at an estimated cost of $2,252,000.

The project for the Coralville Reservoir on Iowa River in Iowa, as authorized by the Act of June 28, 1938 (52 Stat. 1215), is hereby modified in order to provide for a highway bridge across Coralville Reservoir at or near the Mehaffy site, such site to be mutually satisfactory to the Secretary of the Army, the chief engineer, Iowa State Highway Commission, and the Board of Supervisors of Johnson County, Iowa, to replace the previously existing bridge crossing of Johnson County on County Road Y. Such bridge shall be constructed under the direction of the Secretary of the Army and the supervision of the Chief of Engineers in accordance with such plans as may be approved by the Chief of Engineers and the chief engineer, Iowa State Highway Commission: *Provided*, That prior to the award of any contract for the construction of the bridge or the approach roads authorized by this paragraph, local interests, acting through the Board of Supervisors of Johnson County, Iowa, shall contribute toward the cost of the construction of such bridge and approach roads such amounts as the Secretary of the Army shall determine to be equitable, and the United States shall pay all other costs of such bridge and approach roads.

MISSOURI RIVER BASIN

In addition to previous authorizations, there is hereby authorized to be appropriated the sum of $207,000,000 for the prosecution of the comprehensive plan for the Missouri River Basin approved in the Act of June 28, 1938, as amended, and supplemented by subsequent Acts of Congress. 52 Stat. 1215.

The report of the Chief of Engineers on Wilson Dam and Reservoir, Saline River, Kansas, submitted in compliance with Public Law 505, Eighty-fourth Congress, published as Senate Document Numbered 96, Eighty-sixth Congress, is hereby approved, and construction of the project as a unit of the comprehensive plan of improvement for the Missouri River Basin authorized by the Flood Control Act approved December 22, 1944, is hereby authorized at an estimated cost of $18,081,000. 70 Stat. 126. 58 Stat. 887.

The project for flood protection in the Gering and Mitchell Valleys, Nebraska, authorized by the Flood Control Act of July 3, 1958 (Public Law 500, Eighty-fifth Congress), in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 139, 84th Congress, is hereby modified to provide for such revisions in project scope and purposes due to changed conditions as may be found necessary by the Chief of Engineers, to provide needed protection in Gering Valley: *Provided*, That construction shall not be initiated until the Chief of Engineers shall submit a feasibility report, which shall be coordinated with the Soil Conservation Service, for the ap- 72 Stat. 312.

Public Law 97-140
97th Congress

An Act

To authorize the Secretary of the Army to contract with the Tarrant County Water Control and Improvement District Numbered 1 and the city of Weatherford, Texas, for the use of water supply storage in Benbrook Lake, and for other purposes.

Dec. 29, 1981
[H.R. 779]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act entitled "An Act to provide for municipal use of storage water in Benbrook Dam, Texas" approved July 24, 1956 (70 Stat. 632) (as amended by section 6 of Public Law 91-282 (84 Stat. 312) and section 9 of Public Law 92-222 (85 Stat. 799)), is amended—

Benbrook Lake, Tex.
Water supply storage.

(1) in the first sentence, by inserting "and with the Tarrant County Water Control and Improvement District Numbered 1, the city of Grandbury, and with the city of Weatherford," after "Benbrook Water and Sewer Authority,";

(2) in the second sentence, by inserting "or the Tarrant County Water Control and Improvement District Numbered 1, the city of Grandbury, or the city of Weatherford" after "Benbrook Water and Sewer Authority"; and

(3) by adding at the end thereof the following new sentence: "To the extent consistent with the authorized purposes of the project, the Secretary of the Army is authorized to contract with the Tarrant County Water Control and Improvement District Numbered 1 to provide for the use by such district of terminal storage in the Benbrook Reservoir for water of such district delivered into the Benbrook Reservoir from other sources.".

SEC. 2. (a) The third sentence of section 205 of the Flood Control Act of 1948 (33 U.S.C. 701s) is amended to read as follows: "Not more than $4,000,000 shall be allotted under this section for a project at any single locality.".

(b) The amendment made by this section shall not apply to any project under contract for construction on the date of enactment of this Act.

33 USC 701s note.

SEC. 3. Section 164 of the Water Resources Development Act of 1976 (Public Law 94-587) is amended by deleting the figure "$21,000,000" and inserting in lieu thereof "$23,200,000".

SEC. 4. The Secretary shall relocate the water supply intake facility on the Missouri River at Springfield, South Dakota, which facility is subject to severe sedimentation, at an estimated cost of $2,190,000.

SEC. 5. (a) The proviso of section 2 of Public Law 84-485 shall not be construed to prohibit the storage of San Juan-Chama project water acquired by contract with the Secretary of the Interior pursuant to Public Law 87-483 in any reservoir, including the storage of water for recreation and other beneficial purposes by any party contracting with the Secretary for project water.

San Juan-Chama water storage project.
43 USC 620a note.

(b) The Secretary of the Army, acting through the Chief of Engineers, is authorized to enter into agreements with entities which have contracted with the Secretary of the Interior for water from the San Juan-Chama project pursuant to Public Law 87-483 for storage of

Abiquiu Reservoir.

a total of two hundred thousand acre-feet of such water in Abiquiu Reservoir. The Secretary of the Interior is hereby authorized to release San Juan-Chama project water to contracting entities for such storage. The agreements to thus store San Juan-Chama project water shall not interfere with the authorized purposes of the Abiquiu Dam and Reservoir project and shall include a requirement that each user of storage space shall pay any increase in operation and maintenance costs attributable to the storage of that user's water.

Elephant Butte Reservoir.

(c) The Secretary of the Interior is authorized to enter into agreements with entities which have contracted with the Secretary of the Interior for water from the San Juan-Chama project pursuant to Public Law 87-483 for storage of such water in Elephant Butte Reservoir. The Secretary of the Interior is hereby authorized to release San Juan-Chama project water to contracting entities for such storage. Any increase in operation and maintenance costs resulting from such storage not offset by increased power revenues resulting from that storage shall be paid proportionately by the entities for which the San Juan-Chama project water is stored.

(d) The amount of evaporation loss and spill chargeable to San Juan-Chama project water stored pursuant to subsections (b) and (c) of this section shall be accounted as required by the Rio Grande compact and the procedures established by the Rio Grande Compact Commission.

16 USC 460d note.

SEC. 6. Notwithstanding any other provision of law, no houseboat, floating cabin, marina (including any with sleeping facilities), or lawfully installed dock or cabin and appurtenant structures shall be required to be removed before December 31, 1989, from any Federal water resources reservoir or lake project administered by the Secretary of the Army, acting through the Chief of Engineers, on which it was located on the date of enactment of this Act, if such property is maintained in usable condition, and, in the judgment of the Chief of Engineers, does not occasion a threat to life or property.

Approved December 29, 1981.

LEGISLATIVE HISTORY—H.R. 779:

HOUSE REPORT No. 97-95 (Comm. on Public Works and Transportation).
CONGRESSIONAL RECORD, Vol. 127 (1981):
June 1, considered and passed House.
Dec. 16, considered and passed Senate, amended; House concurred in Senate amendment.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 17, No. 53 (1981):
Dec. 29, Presidential statement.

Public Law 100–522 100th Congress

An Act

Oct. 24, 1988
[H.R. 5423]

To authorize continued storage of water at Abiquiu Dam in New Mexico.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

43 USC 620a note.

SECTION 1. WATER STORAGE.

Notwithstanding any other provision of law, the Secretary of the Army, acting through the Chief of Engineers, is authorized to store 200,000 acre-feet of Rio Grande system water at Abiquiu Dam, New Mexico, in lieu of the water storage authorized by section 5 of Public Law 97–140, to the extent that contracting entities under section 5 of Public Law 97–140 no longer require such storage. The Secretary is authorized further to acquire lands adjacent to Abiquiu Dam on which the Secretary holds easements as of the date of enactment of this Act if such acquisition is necessary to assure proper recreational access at Abiquiu Dam. The Secretary is further directed to report to Congress as soon as possible with recommendations on additional easements that may be required to assure implementation of this Act.

Reports.

43 USC 620a note.

SEC. 2. LIMITATION.

The authorization to store water and to acquire lands under section 1 is subject to the provisions of the Rio Grande Compact and the resolutions of the Rio Grande Compact Commission.

Approved October 24, 1988.

LEGISLATIVE HISTORY—H.R. 5423:

CONGRESSIONAL RECORD, Vol. 134 (1988):
Oct. 6, considered and passed House.
Oct. 7, considered and passed Senate.

O

Determination.

"(4) JUSTIFICATION.—In determining the economic justification of a sediment management plan under paragraph (2), the Secretary shall—

"(A) measure and include flooding, erosion, and accretion damages both upstream and downstream of the reservoir that are likely to occur as a result of sediment management within the reservoir compared to the damages that are likely to occur if the sediment management plan is not implemented; and

Costs.
Time period.
Analysis.

"(B) include lifecycle costs and a 100-year period of analysis.

"(5) IMPLEMENTATION.—As part of a sediment management plan under paragraph (2), and in accordance with paragraph (10), the Secretary may carry out sediment removal activities at reservoirs owned and operated by the Secretary in the Upper Missouri River Basin, or at reservoirs for which the Secretary has flood control responsibilities under section 7 of the Act of December 22, 1944 (33 U.S.C. 709), in the Upper Missouri River Basin, in accordance with section 602 of the Water Resources Development Act of 1986 (100 Stat. 4148; 110 Stat. 3758; 113 Stat. 295; 121 Stat. 1076) as if those reservoirs were listed in subsection (a) of that section.".

SEC. 335. PORTSMOUTH, NEW HAMPSHIRE.

Massachusetts.

The Secretary shall expedite the activities required to be carried out under section 204 of the Water Resources Development Act of 1992 (33 U.S.C. 2326) regarding the use of improvement dredging of the Portsmouth Federal navigation project in Portsmouth, New Hampshire, carried out pursuant to section 3 of the Act of August 13, 1946 (33 U.S.C. 426g), as a source of clean beach fill material to reinforce the stone revetment at Nantasket Beach, Hull, Massachusetts.

SEC. 336. RAHWAY FLOOD RISK MANAGEMENT FEASIBILITY STUDY, NEW JERSEY.

The Secretary shall—

(1) nullify the determination of the North Atlantic Division of the Corps of Engineers that further activities to carry out the feasibility study for a project for flood risk management, Rahway, New Jersey, authorized by the resolution of the Committee on Transportation and Infrastructure of the House of Representatives adopted on March 24, 1998 (docket number 2548), is not warranted;

(2) identify an acceptable alternative to the project described in paragraph (1) that could receive Federal support; and

(3) carry out, and expedite the completion of, a feasibility study for the acceptable alternative identified under paragraph (2).

SEC. 337. SAN JUAN-CHAMA PROJECT; ABIQUIU DAM, NEW MEXICO.

(a) ABIQUIU RESERVOIR.—Section 5(b) of Public Law 97–140 (43 U.S.C. 620a note) is amended by striking "a total of two hundred thousand acre-feet of".

(b) WATER STORAGE AT ABIQUIU DAM, NEW MEXICO.—Section 1 of Public Law 100–522 (43 U.S.C. 620a note) is amended—

(1) by striking "200,000 acre-feet of";

(2) by inserting "and San Juan-Chama project" after "Rio Grande system"; and

(3) by striking ", in lieu of the water storage authorized by section 5 of Public Law 97–140, to the extent that contracting entities under section 5 of Public Law 97–140 no longer require such storage".

(c) WATER STORAGE.—The Secretary shall—

(1) store up to elevation 6230.00 NGVD29 at Abiquiu Dam, New Mexico, to the extent that the necessary real property interests have been acquired by any entity requesting such storage; and

(2) amend the March 20, 1986, contract between the United States of America and the Albuquerque Bernalillo County Water Utility Authority (assigned by the City of Albuquerque, New Mexico to the Albuquerque Bernalillo County Water Utility Authority) for water storage space in Abiquiu Reservoir to allow for storage by the Albuquerque Bernalillo County Water Utility Authority of San Juan-Chama project water or native Rio Grande system water up to elevation 6230.00 NGVD29.

(d) STORAGE AGREEMENTS WITH USERS OTHER THAN THE ALBUQUERQUE BERNALILLO COUNTY WATER UTILITY AUTHORITY.—The Secretary shall—

(1) retain or enter into new agreements with entities for a proportionate allocation of 29,100 acre-feet of storage space pursuant to section 5 of Public Law 97–140; and

(2) amend or enter into new storage agreements for storage of San Juan-Chama project water or native Rio Grande system water up to the space allocated for each entity's proportionate share of San Juan-Chama water.

(e) OPERATIONS DOCUMENTS.—The Secretary shall amend or revise any existing operations documents, including the Water Control Manual or operations plan for Abiquiu Reservoir, as necessary to meet the requirements of this section.

(f) LIMITATIONS.—In carrying out this section, the following limitations shall apply:

(1) The storage of native Rio Grande system water shall be subject to the provisions of the Rio Grande Compact and the resolutions of the Rio Grande Compact Commission.

(2) The storage of native Rio Grande system water shall only be authorized to the extent that the necessary water ownership and storage rights have been acquired by the entity requesting such storage.

(3) The storage of native Rio Grande system water or San-Juan Chama project water shall not interfere with the authorized purposes of the Abiquiu Dam and Reservoir project.

(4) Each user of storage space, regardless of source of water, shall pay for any increase in costs attributable to storage of that user's water.

SEC. 338. FLUSHING BAY AND CREEK FEDERAL NAVIGATION CHANNEL, NEW YORK.

(a) IN GENERAL.—The portion of the project for navigation, Flushing Bay and Creek, New York, authorized by the first section of the Act of March 3, 1905 (chapter 1482, 33 Stat. 1120; 52 Stat. 803; 76 Stat. 1174), described in subsection (b) is no longer authorized beginning on the date of enactment of this Act. Effective date.

EXHIBIT C

RIO GRANDE COMPACT

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RIO GRANDE COMPACT

The State of Colorado, the State of New Mexico, and the State of Texas, desiring to remove all causes of present and future controversy among these States and between citizens of one of these States and citizens of another State with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and being moved by considerations of interstate comity, and for the purpose of effecting an equitable apportionment of such waters, have resolved to conclude a Compact for the attainment of these purposes, and to that end, through their respective Governors, have named as their respective Commissioners:

For the State of Colorado	M. C. Hinderlider
For the State of New Mexico	Thomas M. McClure
For the State of Texas	Frank B. Clayton

who, after negotiations participated in by S. O. Harper, appointed by the President as the representative of the United States of America, have agreed upon the following articles, to- wit:

ARTICLE I

(a) The State of Colorado, the State of New Mexico, the State of Texas, and the United States of America, are hereinafter designated “Colorado,” “New Mexico,” “Texas,” and the “United States,” respectively.

(b) “The Commission” means the agency created by this Compact for the administration thereof.

(c) The term “Rio Grande Basin” means all of the territory drained by the Rio Grande and its tributaries in Colorado, in New Mexico, and in Texas above Fort Quitman, including the Closed Basin in Colorado.

(d) The “Closed Basin” means that part of the Rio Grande Basin in Colorado where the streams drain into the San Luis Lakes and adjacent territory, and do not normally contribute to the flow of the Rio Grande.

(e) The term “tributary” means any stream which naturally contributes to the flow of the Rio Grande.

(f) “Transmountain Diversion” is water imported into the drainage basin of the Rio Grande from any stream system outside of the Rio Grande Basin, exclusive of the Closed Basin.

(g) “Annual Debits” are the amounts by which actual deliveries in any calendar year fall below scheduled deliveries.

(h) “Annual Credits” are the amounts by which actual deliveries in any calendar year exceed scheduled deliveries.

(i) “Accrued Debits” are the amounts by which the sum of all annual debits exceeds the sum of all annual credits over any common period of time.

(j) “Accrued Credits” are the amounts by which the sum of all annual credits exceeds the sum of all annual debits over any common period of time.

(k) “Project Storage” is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for the storage of usable water below Elephant Butte and above the first diversion to lands of the Rio Grande Project, but not more than a total of 2,638,860 acre feet.

(l) “Usable Water” is all water, exclusive of credit water, which is in project storage and which is available for release in accordance with irrigation demands, including deliveries to Mexico.

(m) “Credit Water” is that amount of water in project storage which is equal to the accrued credit of Colorado, or New Mexico, or both.

(n) “Unfilled Capacity” is the difference between the total physical capacity of project storage and the amount of usable water then in storage.

(o) “Actual Release” is the amount of usable water released in any calendar year from the lowest reservoir comprising project storage.

(p) “Actual Spill” is all water which is actually spilled from Elephant Butte Reservoir, or is released therefrom for flood control, in excess of the current demand on project storage and which does not become usable water by storage in another reservoir; provided, that actual spill of usable water cannot occur until all credit water shall have been spilled.

(q)”Hypothetical Spill” is the time in any year at which usable water would have spilled from project storage if 790,000 acre feet had been released therefrom at rates proportional to the actual release in every year from the starting date to the end of the year in which hypothetical spill occurs; in computing hypothetical spill the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following the effective date of this Compact, and thereafter the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following each actual spill.

ARTICLE II

The Commission shall cause to be maintained and operated a stream gaging station equipped with an automatic water stage recorder at each of the following points, to-wit:

(a) On the Rio Grande near Del Norte above the principal points of diversion to the San Luis Valley;

(b) On the Conejos River near Mogote;

(c) On the Los Pinos River near Ortiz;

(d) On the San Antonio River at Ortiz;

(e) On the Conejos River at its mouths near Los Sauces;

(f) On the Rio Grande near Lobatos;

(g) On the Rio Chama below El Vado Reservoir;

(h) On the Rio Grande at Otowi Bridge near San Ildefonso;

(i) On the Rio Grande near San Acacia;

(j) On the Rio Grande at San Marcial;

(k) On the Rio Grande below Elephant Butte Reservoir;

(l) On the Rio Grande below Caballo Reservoir.

Similar gaging stations shall be maintained and operated below any other reservoir constructed after 1929, and at such other points as may be necessary for the securing of records required for the carrying out of the Compact; and automatic water stage recorders shall be maintained and operated on each of the reservoirs mentioned, and on all others constructed after 1929.

Such gaging stations shall be equipped, maintained and operated by the Commission directly or in cooperation with an appropriate Federal or State agency, and the equipment, method and frequency of measurement at such stations shall be such as to produce reliable records at all times. (Note: See Resolution of Commission printed elsewhere in this report.)

ARTICLE III

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line, measured at or near Lobatos, in each calendar year, shall be ten thousand acre feet less than the sum of those quantities set forth in the two following tabulations of relationship, which correspond to the quantities at the upper index stations:

DISCHARGE OF CONEJOS RIVER

Quantities in thousands of acre feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	45
250	75
300	109
350	147
400	188
450	232
500	278
550	326
600	376
650	426
700	476

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U.S.G.S. gaging station near Mogote during the calendar year, plus the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of San Antonio River at the U.S.G.S. gaging station at Ortiz, both during the months of April to October, inclusive.

(2) Conejos River at Mouths is the combined discharge of branches of this river at the U.S.G.S. gaging stations near Los Sauces during the calendar year.

DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER

Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	60
250	65
300	75
350	86
400	98
450	112
500	127
550	144
600	162

RIO GRANDE COMPACT

DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER--Con.
Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
650	182
700	204
750	229
800	257
850	292
900	335
950	380
1,000	430
1,100	540
1,200	640
1,300	740
1,400	840

Intermediate quantities shall be computed by proportional parts.

(3) Rio Grande at Del Norte is the recorded flow of the Rio Grande at the U.S.G.S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley) corrected for the operation of reservoirs constructed after 1937.

(4) Rio Grande at Lobatos less Conejos at Mouths is the total flow of the Rio Grande at the U.S.G.S. gaging station near Lobatos, less the discharge of Conejos River at its Mouths, during the calendar year.

The application of these schedules shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) any new or increased depletion of the runoff above inflow index gaging stations; and (c) any transmountain diversions into the drainage basin of the Rio Grande above Lobatos.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin, Colorado shall not be credited with the amount of such water delivered, unless the proportion of sodium ions shall be less than forty-five percent of the total positive ions in that water when the total dissolved solids in such water exceeds three hundred fifty parts per million.

ARTICLE IV

The obligation of New Mexico to deliver water in the Rio Grande at San Marcial, during each calendar year, exclusive of the months of July, August, and September, shall be that quantity set forth in the following tabulation of relationship, which corresponds to the quantity at the upper index station:

RIO GRANDE COMPACT

DISCHARGE OF RIO GRANDE AT OTOWI BRIDGE AND AT SAN MARCIAL
EXCLUSIVE OF JULY, AUGUST AND SEPTEMBER
Quantities in thousands of acre feet

Otowi Index Supply (5)	San Marcial Index Supply (6)
100	0
200	65
300	141
400	219
500	300
600	383
700	469
800	557
900	648
1,000	742
1,100	839
1,200	939
1,300	1,042
1,400	1,148
1,500	1,257
1,600	1,370
1,700	1,489
1,800	1,608
1,900	1,730
2,000	1,856
2,100	1,985
2,200	2,117
2,300	2,253

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August and September, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

(6) San Marcial Index Supply is the recorded flow of the Rio Grande at the gaging station at San Marcial during the calendar year exclusive of the flow during the months of July, August and September.

The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico at any time of the year of the natural runoff at Otowi Bridge; (c) depletion of the runoff during July, August and September of tributaries between Otowi Bridge and San Marcial, by works constructed after 1937; and (d) any transmountain diversions into the Rio Grande between Lobatos and San Marcial.

Concurrent records shall be kept of the flow of the Rio Grande at San Marcial, near San Acacia, and of the release from Elephant Butte Reservoir to the end that the records at these three stations may be correlated. (Note: See Resolution of Commission printed elsewhere in this report.)

ARTICLE V

If at any time it should be the unanimous finding and determination of the Commission that because of changed physical conditions, or for any other reason, reliable records are not obtainable, or cannot be obtained, at any of the stream gaging stations herein referred to, such stations may, with the unanimous approval of the Commission, be abandoned, and with such approval another station, or other stations, shall be established and new measurements shall be substituted which, in the unanimous opinion of the Commission, will result in substantially the same results so far as the rights and obligations to deliver water are concerned, as would have existed if such substitution of stations and measurements had not been so made. (Note: See Resolution of Commission printed elsewhere in this report.)

ARTICLE VI

Commencing with the year following the effective date of this Compact, all credits and debits of Colorado and New Mexico shall be computed for each calendar year; provided, that in a year of actual spill no annual credits nor annual debits shall be computed for that year.

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre feet, except as either or both may be caused by holdover storage of water in reservoirs constructed after 1937 in the drainage basin of the Rio Grande above Lobatos. Within the physical limitations of storage capacity in such reservoirs, Colorado shall retain water in storage at all times to the extent of its accrued debit.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre feet at any time, except as such debit may be caused by holdover storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. Within the physical limitations of storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. In computing the magnitude of accrued credits or debits, New Mexico shall not be charged with any greater debit in any one year than the sum of 150,000 acre-feet and all gains in the quantity of water in storage in such year.

The Commission by unanimous action may authorize the release from storage of any amount of water which is then being held in storage by reason of accrued debits of Colorado or New Mexico; provided, that such water shall be replaced at the first opportunity thereafter.

In computing the amount of accrued credits and accrued debits of Colorado or New Mexico, any annual credits in excess of 150,000 acre feet shall be taken as equal to that amount.

In any year in which actual spill occurs, the accrued credits of Colorado, or New Mexico, or both, at the beginning of the year shall be reduced in proportion to their respective credits by the amount of such actual spill; provided that the amount of actual spill shall be deemed to be increased by the aggregate gain in the amount of water in storage, prior to the time of spill, in reservoirs above San Marcial constructed after 1929; provided, further, that if the Commissioners for the States having accrued credits authorize the release of part, or all, of such credits in advance of spill, the amount so released shall be deemed to constitute actual spill.

In any year in which there is actual spill of usable water, or at the time of hypothetical spill thereof, all accrued debits of Colorado, or New Mexico, or both, at the beginning of the year shall be cancelled.

In any year in which the aggregate of accrued debits of Colorado and New Mexico exceeds the minimum unfilled capacity of project storage, such debits shall be reduced proportionally to an aggregate amount equal to such minimum unfilled capacity.

To the extent that accrued credits are impounded in reservoirs between San Marcial and Courchesne, and to the extent that accrued debits are impounded in reservoirs above San Marcial, such credits and debits shall be reduced annually to compensate for evaporation losses in the proportion that such credits or debits bore to the total amount of water in such reservoirs during the year.

ARTICLE VII

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre feet of usable water in project storage; provided, that if the actual releases of usable water from the beginning of the calendar year following the effective date of this Compact, or from the beginning of the calendar year following actual spill, have aggregated more than an average of 790,000 acre feet per annum, the time at which such minimum stage is reached shall be adjusted to compensate for the difference between the total actual release and releases at such average rate; provided, further, that Colorado, or New Mexico, or both, may relinquish accrued credits at any time, and Texas may accept such relinquished water, and in such event the state, or states, so relinquishing shall be entitled to store water in the amount of the water so relinquished.

ARTICLE VIII

During the month of January of any year the Commissioner for Texas may demand of Colorado and New Mexico, and the Commissioner for New Mexico may demand of Colorado, the release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of Colorado and New Mexico, respectively, and such releases shall be made by each at the greatest rate practicable under the conditions then prevailing, and in proportion to the total debit of each, and in amounts, limited by their accrued debits, sufficient to bring the quantity of usable water in project storage to 600,000 acre feet by March first and to maintain this quantity in storage until April thirtieth, to the end that a normal release of 790,000 acre feet may be made from project storage in that year.

ARTICLE IX

Colorado agrees with New Mexico that in event the United States or the State of New Mexico decides to construct the necessary works for diverting the waters of the San Juan River, or any of its tributaries, into the Rio Grande, Colorado hereby consents to the construction of said works and the diversion of waters from the San Juan River, or the tributaries thereof, into the Rio Grande in New Mexico, provided the present and prospective uses of water in Colorado by other diversions from the San Juan River, or its tributaries, are protected.

ARTICLE X

In the event water from another drainage basin shall be imported into the Rio Grande Basin by the United States or Colorado or New Mexico, or any of them jointly, the State having the right to the use of such water shall be given proper credit therefor in the application of the schedules.

ARTICLE XI

New Mexico and Texas agree that upon the effective date of this Compact all controversies between said States relative to the quantity or quality of the water of the Rio Grande are composed and settled; however, nothing herein shall be interpreted to prevent recourse by a signatory state to the Supreme Court of the United States for redress should the character or quality of the water, at the point of delivery, be changed hereafter by one signatory state to the injury of another. Nothing herein shall be construed as an admission by any signatory state that the use of water for irrigation causes increase of salinity for which the user is responsible in law.

ARTICLE XII

To administer the provisions of this Compact there shall be constituted a Commission composed of one representative from each state, to be known as the Rio Grande Compact Commission. The State Engineer of Colorado shall be ex-officio the Rio Grande Compact Commissioner for Colorado. The State Engineer of New Mexico shall be ex-officio the Rio Grande Compact Commissioner for New Mexico. The Rio Grande Compact Commissioner for Texas shall be appointed by the Governor of Texas. The President of the United States shall be requested to designate a representative of the United States to sit with such Commission, and such representative of the United States, if so designated by the President, shall act as Chairman of the Commission without vote.

The salaries and personal expenses of the Rio Grande Compact Commissioners for the three States shall be paid by their respective States, and all other expenses incident to the administration of this Compact, not borne by the United States, shall be borne equally by the three States.

In addition to the powers and duties hereinbefore specifically conferred upon such Commission, and the members thereof, the jurisdiction of such Commission shall extend only to the collection, correlation and presentation of factual data and the maintenance of records having a bearing upon the administration of this Compact, and, by unanimous action, to the making of recommendations to the respective States upon matters connected with the administration of this Compact. In connection therewith, the Commission may employ such engineering and clerical aid as may be reasonably necessary within the limit of funds provided for that purpose by the respective States. Annual reports compiled for each calendar year shall be made by the Commission and transmitted to the Governors of the signatory States on or before March first following the year covered by the report. The Commission may, by unanimous action, adopt rules and regulations consistent with the provisions of this Compact to govern their proceedings.

The findings of the Commission shall not be conclusive in any court or tribunal which may be called upon to interpret or enforce this Compact.

ARTICLE XIII

At the expiration of every five-year period after the effective date of this Compact, the Commission may, by unanimous consent, review any provisions hereof which are not substantive in character and which do not affect the basic principles upon which the Compact is founded, and shall meet for the consideration of such questions on the request of any member of the Commission; provided, however, that the provisions hereof shall remain in full force and effect until changed and amended within the intent of the Compact by unanimous action of the Commissioners, and until any changes in this Compact are ratified by the legislatures of the respective states and consented to by the Congress, in the same manner as this Compact is required to be ratified to become effective.

ARTICLE XIV

The schedules herein contained and the quantities of water herein allocated shall never be increased nor diminished by reason of any increase or diminution in the delivery or loss of water to Mexico.

RIO GRANDE COMPACT

ARTICLE XV

The physical and other conditions characteristic of the Rio Grande and peculiar to the territory drained and served thereby, and to the development thereof, have actuated this Compact and none of the signatory states admits that any provisions herein contained establishes any general principle or precedent applicable to other interstate streams.

ARTICLE XVI

Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes.

ARTICLE XVII

This Compact shall become effective when ratified by the legislatures of each of the signatory states and consented to by the Congress of the United States. Notice of ratification shall be given by the Governor of each state to the Governors of the other states and to the President of the United States, and the President of the United States is requested to give notice to the Governors of each of the signatory states of the consent of the Congress of the United States.

IN WITNESS WHEREOF, the Commissioners have signed this Compact in quadruplicate original, one of which shall be deposited in the archives of the Department of State of the United States of America and shall be deemed the authoritative original, and of which a duly certified copy shall be forwarded to the Governor of each of the signatory States.

Done at the City of Santa Fe, in the State of New Mexico, on the 18th day of March, in the year of our Lord, One Thousand Nine Hundred and Thirty-eight.

(Sgd.) M. C. HINDERLIDER

(Sgd.) THOMAS M. McCLURE

(Sgd.) FRANK B. CLAYTON

APPROVED:

(Sgd.) S. O. HARPER

RATIFIED BY:

Colorado, February 21, 1939
New Mexico, March 1, 1939
Texas, March 1, 1939

Passed Congress as Public Act No. 96, 76th Congress,

Approved by the President May 31, 1939

RESOLUTION ADOPTED BY RIO GRANDE COMPACT COMMISSION
AT THE ANNUAL MEETING HELD AT EL PASO, TEXAS, FEBRUARY 22-24, 1948, CHANGING
GAGING STATIONS AND MEASUREMENTS OF
DELIVERIES BY NEW MEXICO

R E S O L U T I O N

Whereas, at the Annual Meeting of the Rio Grande Compact Commission in the year 1945, the question was raised as to whether or not a schedule for delivery of water by New Mexico during the entire year could be worked out, and

Whereas, at said meeting the question was referred to the Engineering Advisers for their study, recommendations and report, and

Whereas, said Engineering Advisers have met, studied the problems and under date of February 24, 1947, did submit their Report, which said Report contains the findings of said Engineering Advisers and their recommendations, and

Whereas, the Compact Commission has examined said Report and finds that the matters and things therein found and recommended are proper and within the terms of the Rio Grande Compact, and

Whereas, the Commission has considered said Engineering Advisers' Report and all available evidence, information and material and is fully advised:

Now, Therefore, Be it Resolved:

The Commission finds as follows:

(a) That because of change of physical conditions, reliable records of the amount of water passing San Marcial are no longer obtainable at the stream gaging station at San Marcial and that the same should be abandoned for Compact purposes.

(b) That the need for concurrent records at San Marcial and San Acacia no longer exists and that the gaging station at San Acacia should be abandoned for Compact purposes.

(c) That it is desirable and necessary that the obligations of New Mexico under the Compact to deliver water in the months of July, August, September, should be scheduled.

(d) That the change in gaging stations and substitution of the new measurements as hereinafter set forth will result in substantially the same results so far as the rights and obligations to deliver water are concerned, and would have existed if such substitution of stations and measurements had not been so made.

Be it Further Resolved:

That the following measurements and schedule thereof shall be substituted for the measurements and schedule thereof as now set forth in Article IV of the Compact:

"The obligation of New Mexico to deliver water in the Rio Grande into Elephant Butte Reservoir during each calendar year shall be measured by that quantity set forth in the following tabulation of relationship which corresponds to the quantity at the upper index station:

RIO GRANDE COMPACT COMMISSION REPORT

DISCHARGE OF RIO GRANDE AT OTOWI BRIDGE AND ELEPHANT BUTTE EFFECTIVE SUPPLY

Quantities in thousands of acre-feet

Otowi Index Supply (5)	Elephant Butte Effective Index Supply (6)
100	57
200	114
300	171
400	228
500	286
600	345
700	406
800	471
900	542
1,000	621
1,100	707
1,200	800
1,300	897
1,400	996
1,500	1,095
1,600	1,195
1,700	1,295
1,800	1,395
1,900	1,495
2,000	1,595
2,100	1,695
2,200	1,795
2,300	1,895
2,400	1,995
2,500	2,095
2,600	2,195
2,700	2,295
2,800	2,395
2,900	2,495
3,000	2,595

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San ildefonso (formerly station near Buckman) during the calendar year, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

(6) Elephant Butte Effective Index Supply is the recorded flow of the Rio Grande at the gaging station below Elephant Butte Dam during the calendar year plus the net gain in storage in Elephant Butte Reservoir during the same year or minus the net loss in storage in said reservoir, as the case may be.

The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico of the natural runoff at Otowi Bridge; and (c) any transmountain diversions into the Rio Grande between Lobatos and Elephant Butte Reservoir."

Be it Further Resolved:

That the gaging stations at San Acacia and San Marcial be, and the same are hereby abandoned for Compact purposes.

Be it Further Resolved:

That this Resolution has been passed unanimously and shall be effective January 1, 1949, if within 120 days from this date the Commissioner for each State shall have received from the Attorney General of the State represented by him, an opinion approving this Resolution, and shall have so advised the Chairman of the Commission, otherwise, to be of no force and effect.

(Note: The following paragraph appears in the Minutes of the Annual Meeting of the Commission held at Denver, Colorado, February 14-16, 1949.

"The Chairman announced that he had received, pursuant to the Resolution adopted by the Commission at the Ninth Annual Meeting on February 24, 1948, opinions from the Attorneys General of Colorado, New Mexico and Texas that the substitution of stations and measurements of deliveries by New Mexico set forth in said resolution was within the powers of the Commission").

RULES AND REGULATIONS FOR ADMINISTRATION OF THE RIO GRANDE COMPACT

A Compact, known as the Rio Grande Compact, between the States of Colorado, New Mexico and Texas, having become effective on May 31, 1939 by consent of the Congress of the United States, which equitably apportions the waters of the Rio Grande above Fort Quitman and permits each State to develop its water resources at will, subject only to its obligations to deliver water in accordance with the schedules set forth in the Compact, the following Rules and Regulations have been adopted for its administration by the Rio Grande Compact Commission; to be and remain in force and effect only so long as the same may be satisfactory to each and all members of the Commission, and provided always that on the objection of any member of the Commission, in writing, to the remaining two members of the Commission after a period of sixty days from the date of such objection, the sentence, paragraph or any portion or all of these rules to which any such objection shall be made, shall stand abrogated and shall thereafter have no further force and effect; it being the intent and purpose of the Commission to permit these rules to obtain and be effective only so long as the same may be satisfactory to each and all of the Commissioners.

(1) GAGING STATIONS /1, /2

Responsibility for the equipping, maintenance and operation of the stream gaging stations and reservoir gaging stations required by the provisions of Article II of the Compact shall be divided among the signatory States as follows:

(a) Gaging stations on streams and reservoirs in the Rio Grande Basin above the Colorado-New Mexico boundary shall be equipped, maintained, and operated by Colorado in cooperation with the U.S. Geological Survey.

(b) Gaging stations on streams and reservoirs in the Rio Grande Basin below Lobatos and above Caballo Reservoir shall be equipped, maintained and operated by New Mexico in cooperation with the U.S. Geological Survey to the extent that such stations are not maintained and operated by some other Federal agency.

(c) Gaging stations on Elephant Butte Reservoir and on Caballo Reservoir, and the stream gaging station on the Rio Grande below Caballo Reservoir shall be equipped, maintained and operated by or on behalf of Texas through the agency of the U.S. Bureau of Reclamation.

The equipment, method and frequency of measurements at each compact stream gaging station shall be sufficient to obtain stream flow records at least equal in accuracy to those classified as “good” by the U.S. Geological Survey. The stream flow records for each compact stream gaging station shall be reviewed annually by the U.S. Geological Survey to ensure accuracy. Water-stage recorders on the reservoirs specifically named in Article II of the Compact shall have sufficient range below maximum reservoir level to record major fluctuations in storage. Staff gages may be used to determine fluctuations below the range of the water-stage recorders on these and other large reservoirs, and staff gages may be used upon approval of the Commission in lieu of water-stage recorders on small reservoirs, provided that the frequency of observation is sufficient in each case to establish any material changes in water levels in such reservoirs.

/1 Amended at Eleventh Annual Meeting, February 23, 1950.
/2 Amended at Seventy-Seventh Annual Meeting, March 31, 2016.

(2) RESERVOIR CAPACITIES /1

Colorado shall file with the Commission a table of areas and capacities for each reservoir in the Rio Grande Basin above Lobatos constructed after 1937; New Mexico shall file with the Commission a table of areas and capacities for each reservoir in the Rio Grande Basin between Lobatos and San Marcial constructed after 1929; and Texas shall file with the Commission tables of areas and capacities for Elephant Butte Reservoir and for all other reservoirs actually available for the storage of water between Elephant Butte and the first diversion to lands under the Rio Grande Project.

Whenever it shall appear that any table of areas and capacities is in error by more than five per cent, the Commission shall use its best efforts to have a re-survey made and a corrected table of areas and capacities to be substituted as soon as practicable. To the end that the Elephant Butte effective supply may be computed accurately, the Commission shall use its best efforts to have the rate of accumulation and the place of deposition of silt in Elephant Butte Reservoir checked at least every three years.

(3) ACTUAL SPILL /2, /3, /4, /6

(a) Water released from Elephant Butte in excess of Project requirements, which is currently passed through Caballo Reservoir, prior to the time of spill, shall be deemed to have been Usable Water released in anticipation of spill, or Credit Water if such release shall have been authorized.

(b) Excess releases from Elephant Butte Reservoir, as defined in (a) above, shall be added to the quantity of water actually in storage in that reservoir, and Actual Spill shall be deemed to have commenced when this sum equals the total capacity of that reservoir to the level of the uncontrolled spillway less capacity reserved for flood purposes, i.e., 1,999,600 acre-feet in the months of October through March inclusive, and 1,974,600 acre-feet in the months of April through September, inclusive, as determined from the 2009 area-capacity table or successor area-capacity tables and flood control storage reservation of 50,000 acre-feet from April through September and 25,000 acre-feet from October through March.

(c) All water actually spilled at Elephant Butte Reservoir, or released therefrom, in excess of Project requirements, which is currently passed through Caballo Reservoir, after the time of spill, shall be considered as Actual Spill, provided that the total quantity of water then in storage in Elephant Butte Reservoir exceeds the physical capacity of that reservoir at the level of the sill of the spillway gates, i.e. -1,830,000 acre-ft in 1942.

(d) Water released from Caballo Reservoir in excess of Project requirements and in excess of water currently released from Elephant Butte Reservoir, shall be deemed Usable Water released, excepting only flood water entering Caballo Reservoir from tributaries below Elephant Butte Reservoir.

(4) DEPARTURES FROM NORMAL RELEASES /5

For the purpose of computing the time of Hypothetical Spill required by Article VI and for the purpose of the adjustment set forth in Article VII, no allowance shall be made for the difference between Actual and Hypothetical Evaporation, and any under-release of usable water from Project Storage in excess of 150,000 acre-ft in any year shall be taken as equal to that amount.

/1 Amended at Eleventh Annual Meeting, February 23, 1950.
/2 Adopted at Fourth Annual Meeting, February 24, 1943.
/3 Amended September 9, 1998.
/4 Amended March 22, 2001; made effective January 1, 2001.
/5 Adopted June 2, 1959; made effective January 1, 1952.
/6 Adopted March 31, 2009; made effective January 1, 2010.

(5) EVAPORATION LOSSES /6, /7, /8

The Commission shall encourage the equipping, maintenance and operation, in cooperation with the U.S. Weather Bureau or other appropriate agency, of evaporation stations at Elephant Butte Reservoir and at or near each major reservoir in the Rio Grande Basin within Colorado constructed after 1937 and in New Mexico constructed after 1929. The net loss by evaporation from a reservoir surface shall be taken as the difference between the actual evaporation loss and the evapo-transpiration losses which would have occurred naturally, prior to the construction of such reservoir. Changes in evapo-transpiration losses along stream channels below reservoirs may be disregarded.

Net losses by evaporation, as defined above, shall be used in correcting Index Supplies for the operation of reservoirs upstream from Index Gaging Stations as required by the provisions of Article III and Article IV of the Compact.

In the application of the provisions of the last unnumbered paragraph of Article VI of the Compact:

(a) Evaporation losses for which accrued credits shall be reduced shall be taken as the difference between the gross evaporation from the water surface of Elephant Butte Reservoir and rainfall on the same surface.

(b) Evaporation losses for which accrued debits shall be reduced shall be taken as the net loss by evaporation as defined in the first paragraph.

(6) ADJUSTMENT OF RECORDS

The Commission shall keep a record of the location, and description of each gaging station and evaporation station, and, in the event of change in location of any stream gaging station for any reason, it shall ascertain the increment in flow or decrease in flow between such locations for all stages. Wherever practicable, concurrent records shall be obtained for one year before abandonment of the previous station.

(7) NEW OR INCREASED DEPLETIONS

In the event any works are constructed which alter or may be expected to alter the flow at any of the Index Gaging Stations mentioned in the Compact, or which may otherwise necessitate adjustments in the application of the schedules set forth in the Compact, it shall be the duty of the Commissioner specifically concerned to file with the Commission all available information pertaining thereto, and appropriate adjustments shall be made in accordance with the terms of the Compact; provided, however, that any such adjustments shall in no way increase the burden imposed upon Colorado or New Mexico under the schedules of deliveries established by the Compact.

(8) TRANSMOUNTAIN DIVERSIONS

In the event any works are constructed for the delivery of waters into the drainage basin of the Rio Grande from any stream system outside of the Rio Grande Basin, such waters shall be measured at the point of delivery into the Rio Grande Basin and proper allowances shall be made for losses in transit from such points to the Index Gaging Station on the stream with which the imported waters are comingled.

/6 Amended at Tenth Annual Meeting, February 15, 1949.
/7 Amended at Twelfth Annual Meeting, February 24, 1951.
/8 Amended June 2, 1959.

(9) QUALITY OF WATER

In the event that delivery of water is made from the Closed Basin into the Rio Grande, sufficient samples of such water shall be analyzed to ascertain whether the quality thereof is within the limits established by the Compact.

(10) SECRETARY /8, /9, /10

The Commission may, on a yearly basis, employ appropriate entities to render such engineering and clerical aid as may reasonably be necessary for administration of the Compact. The entities may be employed to:

(1) Collect and correlate all factual data and other records having a material bearing on the administration of the Compact and keep each Commissioner advised thereof.

(2) Inspect all gaging stations required for administration of the Compact and make recommendations to the Commission as to any changes or improvements in methods of measurement or facilities for measurement which may be needed to insure that reliable records be obtained.

(3) Report to each Commissioner in writing within thirty days after the end of each quarter a summary of all hydrographic data then available for the current year - on forms prescribed by the Commission - pertaining to:

(a) Deliveries by Colorado
(b) Deliveries by New Mexico
(c) Operation of Project Storage

(4) Make such investigations as may be requested by the Commission in aid of its administration of the Compact.

(5) Act as Secretary to the Commission and submit to the Commission at its regular meeting a report on its activities and a summary of all data needed for determination of debits and credits and other matters pertaining to administration of the Compact.

(11) COSTS /1, /2, /3

At its annual meeting, the Commission shall adopt a budget for the ensuing fiscal year beginning July first.

Such budget shall set forth the total cost of maintenance and operating of gaging stations, of evaporation stations, the cost of engineering and clerical aid, and all other necessary expenses excepting the salaries and personal expenses of the Rio Grande Compact Commissioners.

Contributions made directly by the United States and the cost of services rendered by the United States without cost shall be deducted from the total budget amount; the remainder shall then be allocated equally to Colorado, New Mexico and Texas.

/8 The substitution of this section for the section titled “Reports to Commissioners” was adopted at Ninth Annual Meeting, February 22, 1948.
/9 Amended March 31, 2009.
/10 Amended at Seventy-Seventh Annual Meeting, March 31, 2016.
/1 Amended at Eleventh Annual Meeting, February 23, 1950.
/2 Amended March 31, 2009.
/3 Amended at Seventy-Seventh Annual Meeting, March 31, 2016.

Expenditures made directly by any State for purposes set forth in the budget shall be credited to that State; contributions in cash or in services by any State under a cooperative agreement with any federal agency shall be credited to such State, but the amount of the federal contribution shall not so be credited; in event any State, through contractual relationships, causes work to be done in the interest of the Commission, such State shall be credited with the cost thereof, unless such cost is borne by the United States.

Costs incurred by the Commission under any cooperative agreement between the Commission and any U.S. Government Agency, not borne by the United States, shall be apportioned equally to each State, and each Commissioner shall arrange for the prompt payment of one-third thereof by his State.

The Commissioner of each State shall report at the annual meeting each year the amount of money expended during the year by the State that the Commissioner represents, as well as the portion thereof contributed by all cooperating federal agencies, and the Commission shall arrange for such proper reimbursement in cash or credits between States as may be necessary to equalize the contributions made by each State in the equipment, maintenance and operation of all gaging stations authorized by the Commission and established under the terms of the Compact.

It shall be the duty of each Commissioner to endeavor to secure from the Legislature of the State represented by the Commissioner an appropriation of sufficient funds with which to meet the obligations of that State, as provided by the Compact.

(12) MEETING OF COMMISSION /1, /10, /11

The Commission shall meet each year for the consideration and adoption of the annual report for the calendar year preceding, and for the transaction of any other business consistent with its authority. Other meetings as may be deemed necessary shall be held at any time and place set by mutual agreement, for the consideration of data collected and for the transaction of any business consistent with its authority.

No action of the Commission shall be effective until approved by the Commissioner from each of the three signatory States.

(Signed) M. C. HINDERLIDER

M. C. Hinderlider

Commissioner for Colorado

(Signed) THOMAS M. McCLURE

Thomas M. McClure

Commissioner for New Mexico

(Signed) JULIAN P. HARRISON

Julian P. Harrison

Commissioner for Texas

Adopted December 19, 1939.

/1 Amended at Eleventh Annual Meeting, February 23, 1950.
/10 Amended at Thirteenth Annual Meeting, February 25, 1952.
/11 Amended at Seventy-Seventh Annual Meeting, March 31, 2016.

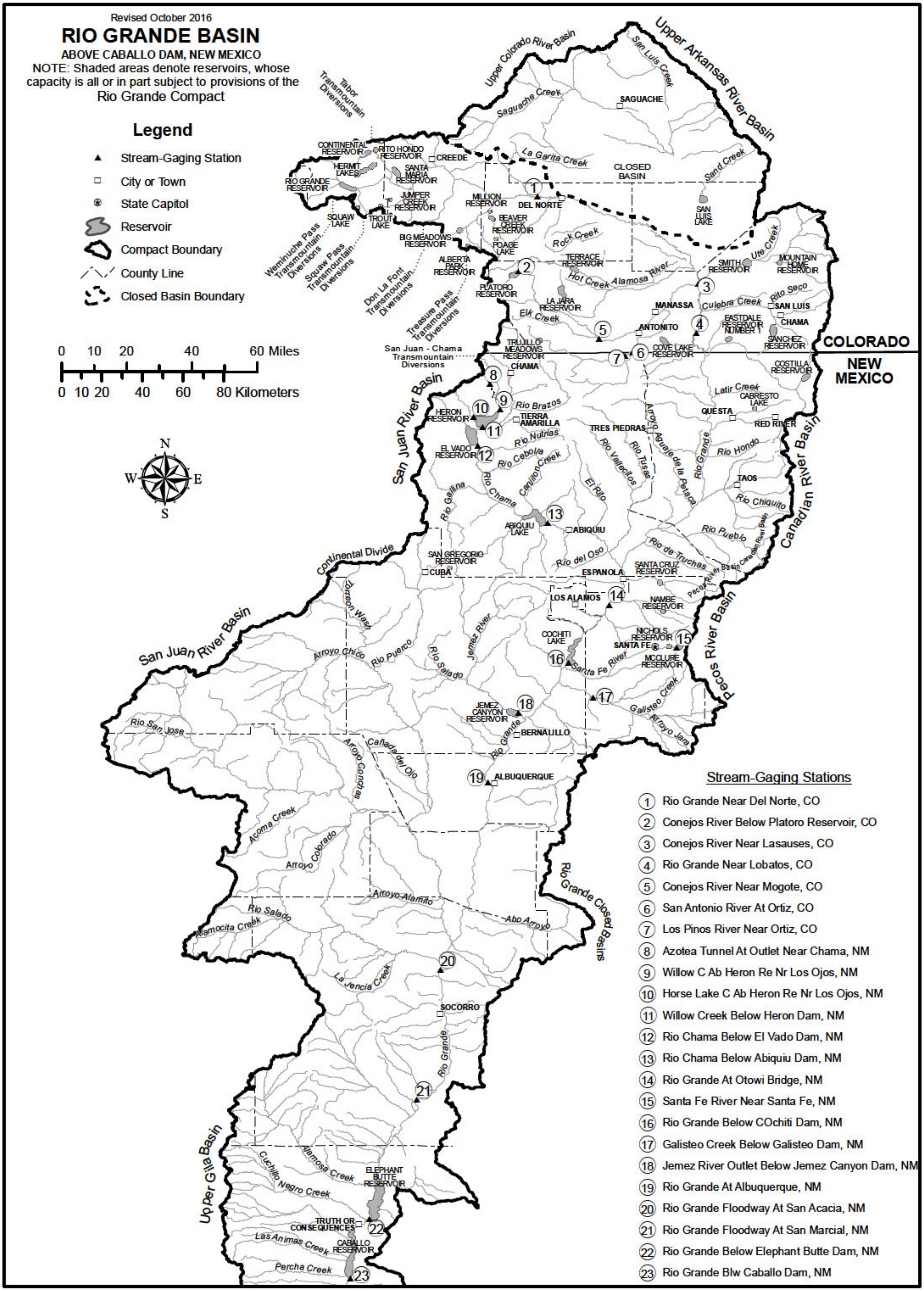
Revised October 2016
RIO GRANDE BASIN
ABOVE CABALLO DAM, NEW MEXICO
NOTE: Shaded areas denote reservoirs, whose capacity is all or in part subject to provisions of the Rio Grande Compact
Legend
Stream-Gaging Station
City or Town
State Capitol
Reservoir
Compact Boundary
County Line
Closed Basin Boundary
0 10 20 40 60 Miles
0 10 20 40 60 80 Kilometers
N
S
E
W
COLORADO
NEW MEXICO
Upper Colorado River Basin
Upper Arkansas River Basin
San Juan River Basin
Canadian River Basin
Pecos River Basin
Rio Grande Closed Basins
Upper Gila Basin
Continental Divide
CLOSED BASIN
Tabor Transmountain Diversions
Weminuche Pass Transmountain Diversions
Squaw Pass Transmountain Diversions
Don La Font Transmountain Diversions
Treasure Pass Transmountain Diversions
San Juan - Chama Transmountain Diversions
SAGUACHE
CREEDE
DEL NORTE
MANASSA
ANTONITO
SAN LUIS
CHAMA
TIERRA AMARILLA
TRES PIEDRAS
QUESTA
RED RIVER
TAOS
ABIQUIU
CUBA
ESPANOLA
LOS ALAMOS
SANTA FE
BERNALILLO
ALBUQUERQUE
SOCORRO
TRUTH OR CONSEQUENCES
CONTINENTAL RESERVOIR
RITO HONDO RESERVOIR
HERMIT LAKES
SANTA MARIA RESERVOIR
RIO GRANDE RESERVOIR
JUMPER CREEK RESERVOIR
SQUAW LAKE
TROUT LAKE
MILLION RESERVOIR
BEAVER CREEK RESERVOIR
BIG MEADOWS RESERVOIR
POAGE LAKE
ALBERTA PARK RESERVOIR
PLATORO RESERVOIR
TERRACE RESERVOIR
LA JARA RESERVOIR
SAN LUIS LAKE
SMITH RESERVOIR
MOUNTAIN HOME RESERVOIR
EASTDALE RESERVOIR NUMBER 1
SANCHEZ RESERVOIR
COVE LAKE RESERVOIR
TRUJILLO MEADOWS RESERVOIR
COSTILLA RESERVOIR
CABRESTO LAKE
HERON RESERVOIR
EL VADO RESERVOIR
ABIQUIU LAKE
SAN GREGORIO RESERVOIR
SANTA CRUZ RESERVOIR
NAMBE RESERVOIR
NICHOLS RESERVOIR
MCCLURE RESERVOIR
COCHITI LAKE
JEMEZ CANYON RESERVOIR
ELEPHANT BUTTE RESERVOIR
CABALLO RESERVOIR
San Luis Creek
Saguache Creek
La Garita Creek
Sand Creek
Rock Creek
Ute Creek
Alamosa River
Hot Creek
Elk Creek
Culebra Creek
Rito Seco
Latir Creek
Rio Brazos
Rio Nutrias
Rio Cebolla
Canjilon Creek
Rio Chama
Rio Gallina
El Rito
Rio Vallecitos
Rio Tusas
Arroyo Aguaje de la Petaca
Rio Grande
Rio Hondo
Rio Chiquito
Rio Pueblo
Rio de Truchas
Rio del Oso
Torreon Wash
Jemez River
Arroyo Chico
Rio Puerco
Rio Salado
Santa Fe River
Galisteo Creek
Arroyo Jara
Rio San Jose
Arroyo Conchas
Cañada del Ojo
Acoma Creek
Arroyo Colorado
Arroyo Alamito
Abo Arroyo
Alamocita Creek
La Jencia Creek
Cuchillo Negro Creek
Alamosa Creek
Las Animas Creek
Percha Creek
Stream-Gaging Stations
1 Rio Grande Near Del Norte, CO
2 Conejos River Below Platoro Reservoir, CO
3 Conejos River Near Lasauses, CO
4 Rio Grande Near Lobatos, CO
5 Conejos River Near Mogote, CO
6 San Antonio River At Ortiz, CO
7 Los Pinos River Near Ortiz, CO
8 Azotea Tunnel At Outlet Near Chama, NM
9 Willow C Ab Heron Re Nr Los Ojos, NM
10 Horse Lake C Ab Heron Re Nr Los Ojos, NM
11 Willow Creek Below Heron Dam, NM
12 Rio Chama Below El Vado Dam, NM
13 Rio Chama Below Abiquiu Dam, NM
14 Rio Grande At Otowi Bridge, NM
15 Santa Fe River Near Santa Fe, NM
16 Rio Grande Below COchiti Dam, NM
17 Galisteo Creek Below Galisteo Dam, NM
18 Jemez River Outlet Below Jemez Canyon Dam, NM
19 Rio Grande At Albuquerque, NM
20 Rio Grande Floodway At San Acacia, NM
21 Rio Grande Floodway At San Marcial, NM
22 Rio Grande Below Elephant Butte Dam, NM
23 Rio Grande Blw Caballo Dam, NM

EXHIBIT D

CLIMATE HYDROLOGY ASSESSMENT

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CLIMATE CHANGE ANALYSIS

For north-central New Mexico, climate change is projected to result in an increase in average annual temperatures of 5.7 °F to 6.0 °F for the period between 2040 and 2069 compared to the average for the period between 1971 and 2000 for the higher emissions scenario[1] (New Mexico Bureau of Geology and Mineral Resources, 2022). Statewide, by the end of the century, under the higher emissions scenario, temperatures are projected to increase as much as 7 °F to 14 °F, and under the lower emissions scenario, from 2.5 °F to 7.5 °F (NOAA 2022). Warmer temperatures are anticipated to drive up potential evapotranspiration (PET) rates in the basin by 7 inches to 9 inches by mid-century (2040 to 2069) compared to 1971 through 2000 (NMBR 2022). The temperature-driven increase in PET will lead to a more arid climate overall, and long-term reductions in soil moisture.

Annual precipitation is not anticipated to change much, although the spring months are anticipated to be both warmer and drier (NMBR 2022, NOAA 2022). Spring precipitation may be reduced from 5 percent to 10 percent (NOAA 2022). Even if winter precipitation remains unchanged or increases slightly, the combination of a drier spring with warmer winter and spring temperatures is projected to result in:

1. A greater share of snowmelt runoff in the winter and early spring, and therefore an advance in timing of peak spring runoff to earlier in the year.

2. Potential increases in snowpack sublimation under warmer air temperatures. This effect may be enhanced if dust-on-snow increases as a result of enhanced dust production due to spring drying in areas to the southwest.

3. More losses to transpiration in the spring as the onset of the growing season occurs earlier in the year.

These changes are likely to lead to reductions in summer base flows in many years compared to present (NMBR 2022, NOAA 2022). For larger rivers in the region (Rio Grande [USBR, USACE and Sandia NL 2013], Pecos [USBR and NMOSE 2021]), the consensus is that changes in snowmelt may decrease annual flows overall by 25 percent to 30 percent, although in the Pecos Basin around Artesia, considerable groundwater contributions to streamflow may serve to buffer some of this variation (USBR and NMOSE 2021).

For the Chama River at Abiquiu Dam, the USACE Climate Hydrology Assessment Tool (USACE 2023) projects statistically significant reductions in annual streamflow volume under the low (p-value<0.05 by two of three measures) and the high (p-value< 0.001, all measures) scenarios for the period 2006 to 2099. Little change occurs in unregulated mean flows at the dam under either the lower or higher emissions scenario (Figure 1). In addition, the projected advance in timing of snowmelt runoff as an increase in winter precipitation, and

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[1] Climate models drive future conditions using greenhouse gas emissions scenarios, which are models for how greenhouse gas emissions respond to human demographic, technological, social, political, and economic decisions. The higher emissions scenario corresponds to a warming of 8.5 Watts m^{-2} (known as relative concentration pathway (RCP) 8.5) and the lower emissions scenario corresponds to a warming of 4.5 Watts m^{-2} (RCP 4.5). A large share of climate model uncertainty results from uncertainty about how human behaviors will change over time.

the subsequent declines in early summer base flows (May, June) are evident in the monthly streamflow data (Figure 2). Similar changes were evident in headwaters stream segments (not shown).

Figure D-1. Projected reductions in annual streamflow volume are projected for the Rio Chama near Abiquiu Dam (HUC 13020102, stream segment 13000506) under both scenarios in the USACE Climate Hydrology Assessment Tool (USACE 2023).

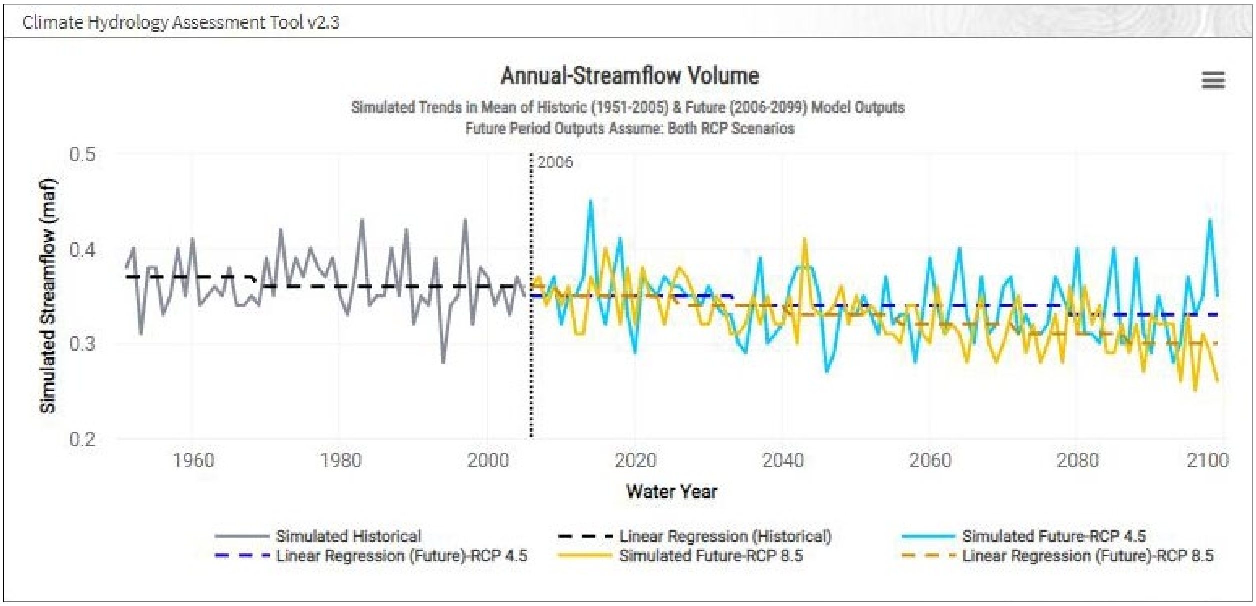
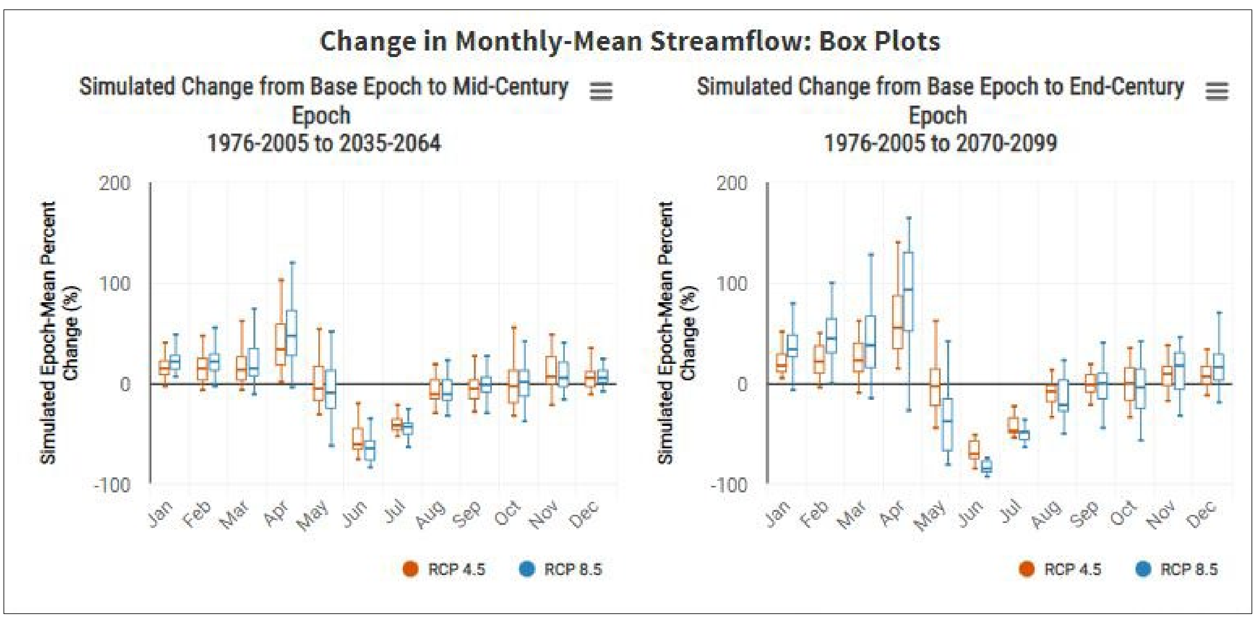
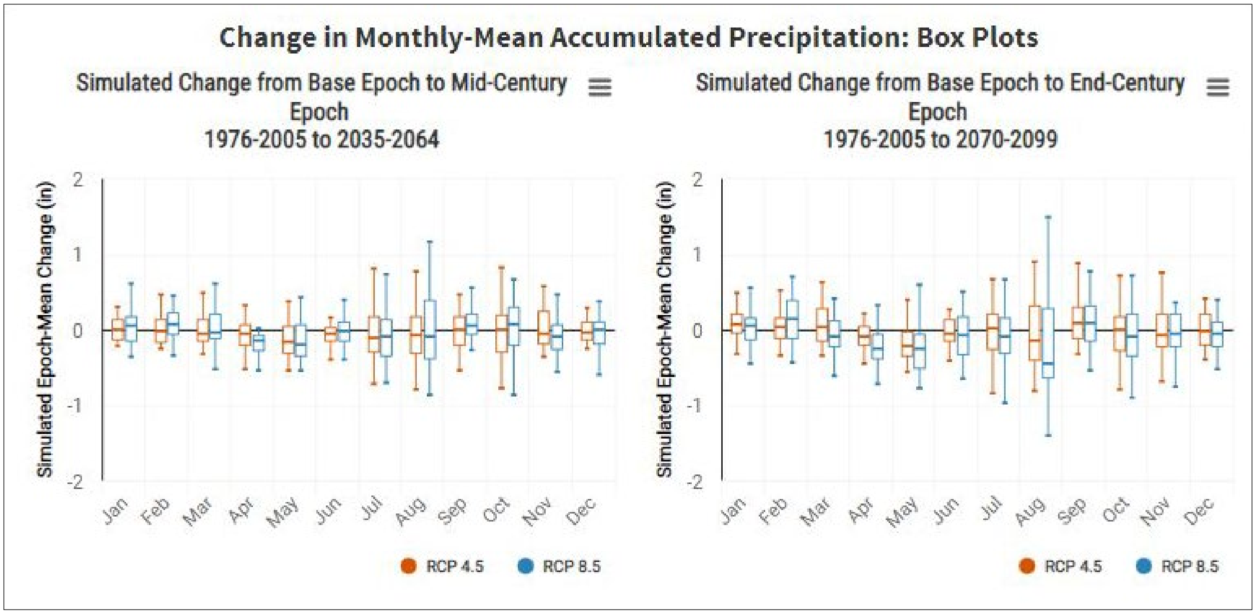


Figure D-2. Projected change in monthly-mean streamflow for the Rio Chama near Abiquiu Dam (HUC 13020102, stream segment 13000506) from the USACE Climate Hydrology Assessment Tool (accessed 29 March 2023).



How hotter and drier summers will affect monsoon precipitation is not resolved in the climate models (NMBR 2022), although there is some evidence that the monsoon timing may gradually shift by up to a month later in the fall (Seager et al. 2007). A later monsoon and an earlier end to snowmelt runoff would suggest a longer, late spring-early summer period of dry weather that exacerbates summer low flows and increases wildfire risk. Boxplots of change in monthly mean accumulated precipitation from the USACE CHAT (Figure 3) detect the projected small reductions in spring precipitation but fail to detect changes in the timing or intensity of monsoonal precipitation.

Figure D-3. Monthly change in mean accumulated precipitation at Abiquiu Dam based on LOCA CMIP5 data for the Rio Chama near Abiquiu Dam (HUC 13020102, stream segment 13000506).



Annual precipitation is anticipated to fall more unevenly: more of that precipitation is likely to fall in fewer, larger storms with more dry days in between. Although extreme precipitation is hard to quantify from climate models, the physics strongly suggest increases in the intensity of one-day precipitation extremes in the Southwest of 10 percent to 12 percent by mid-century and 13 percent to 20 percent by the late-century (NMBR 2022). Episodic heavy rain on a more arid landscape with diminished vegetation has the potential to lead to widespread soil erosion and gully-reactivation. For this watershed, there is a statistically significant but small increase in the annual maximum 1-day precipitation under both the high scenario (0.5 inches, p-value<0.001) and the low scenario (0.4 inches, p-value<0.05) (USACE 2023) over the period between 2006 to 2099). The same findings are reflected in the data in the USACE Screening-Level Climate Change Vulnerability Assessment (USACE n.d.) indicates that increases in flood magnification (the increase in the 10 percent AEP flood relative to historical values) is a key driver of climate exposure in this watershed in the wetter scenario.

Interannual variation in precipitation is also anticipated to continue even as the overall climate becomes more arid. Some years that are wetter than the current average will still occur. However, the evidence suggests that the climate will be varying around a more arid mean state, with more drought years (longer, hotter droughts) than the previous 100 years.

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EXHIBIT E

WATER STORAGE CONTRACTS

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EXHIBIT F

STANDING INSTRUCTION TO PROJECT OPERATOR
ABIQUIU DAM AND RESERVOIR

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F-01 BACKGROUND AND RESPONSIBILITIES

a. General Information

These standing instructions to the project operator for water control are written in compliance with Paragraph 9-2 of EM 1110-2-3600 and with ER 1110-2-240. A copy of these standing instructions must be kept on hand at the project site at all times. Any deviation from the standing instructions will require approval to the district commander.

b. Project Purposes

Abiquiu Dam is operated for flood risk management and water supply. Water control actions are in support of these project purposes and for purposes of the Rio Chama system.

c. Chain of Command

The project will be regulated in accordance with the normal regulations for flood control as directed in Chapter 7 of this WCM. The Albuquerque District WMS will issue instructions for the storage and release of reservoir water. In the event communications with the Albuquerque District office are disrupted; the reservoir will be regulated in accordance with the schedule of regulations described in Section 7-05 of this WCM and this exhibit. In addition, the OPM will immediately make every effort to re-establish communications with the Albuquerque District Office and the WMS.

The standing instructions provide directions for the regulation of reservoir releases under both routine and emergency conditions when communications with the Albuquerque District Office and the WMS personnel are lost. The EAP provides additional information on interagency coordination and public notification procedures required when unusually large or spillway releases are necessary or when emergency conditions exist due to potential or actual dam breach.

d. Structure

Abiquiu Dam is in Rio Arriba County, New Mexico, on the Rio Chama about 32 river miles upstream from its confluence with the Rio Grande. The dam is approximately 115 roadway miles from the Albuquerque District Office. LAC-DPU owns and operates a run-of-river hydropower facility at Abiquiu Dam. Normally, project releases are made through the hydropower facility. LAC-DPU personnel operate their facility remotely, 24 hours per day, from the City of Los Alamos, approximately 60 roadway miles from the project. Most project personnel live in Espanola, New Mexico, which is about 31 miles from the project.

e. Operation and Maintenance

Albuquerque District Operations Division is responsible for the general O&M of Abiquiu Dam. Project personnel that operate and maintain the USACE-owned facilities at Abiquiu Dam are part of the Operations Division. LAC-DPU operates and maintains the hydropower facilities at Abiquiu Dam.

f. Role of the Project Operator(s)

The Abiquiu Dam project operator is responsible for release changes directly when releases are controlled by the USACE service gates. Release changes through the hydropower facilities are made by LAC-DPU personnel. The WMS specifies the timing and quantity of these releases. The WMS will contact both Abiquiu Dam project personnel and LAC-DPU personnel requesting release changes.

1. Normal Conditions.

    a. Accomplishing the physical operation of the reservoir releases in accordance with instructions contained in this manual and under the direction of the WMS.

    b. Abiquiu Dam OPM will advise local interests of unusual releases.

    c. Abiquiu Dam OPM will report to the WMS any unusual conditions in the reservoir or along the downstream channel which might interfere with the regulation of flow from the reservoir.

2. Emergency Conditions (flood, drought, or special conditions).

    All points mentioned under the normal conditions will also apply during emergency conditions. The frequency of release changes and reporting may increase during emergency conditions.

In addition, if prior to, or during flood risk management operation, communications between the WMS and OPM are lost, then the OPM must maintain the last gate operation instructions received from the WMS, and then work to re-establish communications with the WMS. If communications with the WMS cannot be re-established within 2 full hours, then the OPM will follow the No-Communication Regulation Schedule provided on Table F-01. The OPM must continue the effort to re-establish communications with the WMS. The OPM shall also continue with preparing project status reports, at the frequency that the WMS had also last instructed, which must be provided to the WMS after communications has been re-established.

F-02 DATA COLLECTION AND REPORTING

a. General

Daily reservoir data are submitted to the WMS each workday morning. The WMS office is staffed during normal business hours and in the mornings on weekends during the spring and summer seasons (1 March to 31 October). Data are currently reported via web site or other direct entry, but other forms of communication may also be utilized. The project personnel will provide the following reports:

b. Daily Reporting

Daily reservoir data are normally submitted to the WMS by 0900 each morning. The daily data includes the pool elevation, the current releases, any gate changes since the last report, daily precipitation, pan evaporation, air temperature (24-hour high, low, and current),

current ice conditions and current cloud cover. The reports may be provided electronically or by telephone. See Plate F-1 for sample data entry form.

Data for non-working days may be the accumulated values for the entire period, or the values taken from the instruments' memory or recording charts.

c. Flow and Gate Changes

When releases are made through the hydropower facility, the WMS will call LAC-DPU personnel with new flow target. The county will report the date and time of flow change to the WMS upon completion of the flow change. The county will maintain a log change, including date and time and downstream stage and flow.

When releases are controlled by the USACE service gates, the WMS will call Abiquiu Dam project office personnel with new gate settings. The date and time of gate changes are reported by the project upon completion of the gate change. Maintaining a log of gate operations, including gate setting, date and time, reservoir level, and downstream stage and flow.

d. Gage Verification

At least once per week, Abiquiu Dam project office personnel will obtain pool elevation and downstream physical gage readings and compare the manual reading to automated instrumentation values. Physical gage readings may be from staff gage and/or wire-weight gages. Readings will be included in the daily reported data to the WMS. More frequent physical gage readings will be needed when automated instrumentation malfunctions or requires resetting by the USGS.

e. Regional Hydro-meteorological Conditions

The WMS will communicate daily with the Abiquiu Dam project office on prevailing hydro-meteorological conditions and how it may impact reservoir operations. In the event that communications with the WMS is lost and cannot be re-established within 2 hours, the OPMs can then consult the WMS's project websites that provide the latest status for rainfall, streamflow, and reservoir pool elevations (https://w3.spa.usace.army.mil/wc/RealTimeDcp/).

The NWS website reports the latest status for weather in the Rio Arriba County, New Mexico (https://weather.gov/abq).

F-03 WATER CONTROL AND REPORTING

a. Normal Conditions.

All water control decisions for Abiquiu Dam are made by the WMS, following the WCP contained in Chapter 7 of this WCM. The OPMs are provided all instructions by the WMS, from when they must report to the project site, how often the project status reports will need to be prepared. The WMS will issue all specific instructions for releases for both water conservation and flood risk management operations.

The OPM shall always implement gate changes immediately following acknowledgement of instructions from the WMS. Delaying a gate change may have serious impacts on affected activities. If other concurrent activities cause a delay in implementation of a gate change, the OPM must immediately inform the WMS and request guidance. Once a gate change has been completed, the OPM then reports to the WMS the time when the gate change was completed, along with another full project status report.

b. Emergency Conditions (flood and special conditions)

The WMS will also provide all instructions to the OPM for water control during flood runoff events and/or emergency conditions. If there are any observed emergency situations that arise at the dam, the reservoir area, or the downstream channel, the OPMs must notify the WMS as soon as possible with a description of the conditions so that the WMS water control managers can assess and evaluate impacts, if any, to water control decisions required during flood runoff events.

If communications between the WMS and project operators are lost, (i.e., no radio, landline, cell, or satellite phones) then the project operator must maintain the last gate operation instructions received from the WMS, and then work to re-establish communications with the WMS. If communications with the WMS cannot be re-established within 2 full hours, then the project operators will follow the No-Communication Regulation Schedule provided on Table F-01. Even while implementing the No-Communication Regulation Schedule, the project operators must continue the effort to re-establish communications with the WMS. The project operators shall also continue with preparing project status reports, at the frequency that the WMS had also last instructed, which must be provided to the WMS after communications has been re-established.

During emergency situations such as a hazardous chemical spill or potential life loss through drowning, immediate action will be necessary. The OPMs should report the incidence to the WMS immediately, and to receive any required gate operations to assist with the emergency. The WMS will keep the dam operator apprised of regulation objectives and critical regulation constraints whenever possible. In case of threat to public health or safety, the OPM can make the appropriate decision regarding dam releases, then report the action as soon as possible to WMS.

If release changes are required based on Table F-01, or during immediate threat to public health and safety, Abiquiu Dam project personnel will contact the LAC-DPU with the new flow target. If releases are controlled by the USACE service gates, use linear interpolation based on the current gate settings to estimate the new gate openings.

Example: Present flow is 300 cfs and the total gate opening is 0.75 feet, and the desired flow is 350 cfs.

$$\frac{300}{0.75} = \frac{350}{x}\text{, then } x = \frac{(350 \times 0.75)}{300} = 0.87$$

0.87 feet is gate opening for a flow of 350 cfs

One gate will be used to make releases during low flow periods up to about a 1-foot gate opening. Both gates will be used above 1 foot.

c. Inquiries

All significant inquiries received by the project operator from citizens, constituents, or interest groups regarding water control procedures or actions must be referred directly to the WMS, as soon as practicable. The WMS will coordinate responses with Albuquerque District Office of Counsel and Albuquerque District Public Affairs Officer.

d. Water Control Problems

The project operator must immediately notify the WMS, by the most rapid means available, in the event that an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.

Emergency departures from operations instructions provided to OPM by the WMS may at times be required, because of water control equipment failures, accidents, or other emergencies requiring immediate action. Under these situations, the OPMs must immediately contact the WMS for instructions. The OPMs should immediately alert the WMS whenever the requested gate change cannot be fully implemented due to mechanical or physical problems. For example, debris could prevent total gate closure. The WMS will evaluate the problem and provide further instructions to the OPMs.

If communications are broken, or the situation demands immediate action by the OPM, then OPMs may complete the required emergency action and, if applicable, proceed with following the No-Communication Regulation Schedule provided on Table F-02. In addition, during this period of no-communication with the WMS, the OPMs may also be required to make notifications based on the EAP. The OPM shall also continue with preparing project status reports, at the frequency that the WMS had also last instructed, which must be provided to the WMS after communications has been re-established, along with any emergency water control actions taken that is not within the No-Communication Gate Operation Schedule guidance.

e. Potential Spillway Discharge

Coordination and preparations for potential spillway discharge is also under the direction of the WMS. During the significant flood runoff event, constant communication between the WMS and project office is crucial. Uncontrolled spillway flows from the Abiquiu Dam starts when the pool elevation rises to 6,350.0 feet. As the pool elevation rises above the spillway crest elevation, project personnel will increase conduit releases through the outlet works to maintain the pool at elevation 6,350.0 feet until the gates are fully open. The OPM is responsible for collecting and reporting project status reports to the WMS at regular intervals from as frequent as 15 minutes to 1 hour.

If communication is broken between the OPM and the WMS, continue using the outlet works to maintain reservoir elevation to spillway elevation (6,350.0 feet) until gates are fully opened, follow instructions in Table F-01. The OPM shall continue to collect and record project status reports as last instructed by the WMS, and also continue to make every attempt to re-establish communications.

Emergency notifications are normally made by the WMS. However, if the OPM loses communication with the WMS and it becomes necessary to make an emergency notification due to imminent uncontrolled spillway releases, or due to other emergency situation that arises, the OPM must also make the necessary notifications as provided in the EAP.

Upon completing the above notifications, attempt to re-establish communications with the WMS. Document all notifications made during the communication outage.

Table F-1. Loss of Communications Regulation of Abiquiu Dam and Reservoir

(A) Normal Operations (6,060.0–6,230.0 feet)	Continue releases based on last instruction from the WMS.
(B) Flood Control Operations (6,060.0.0–6,283.5 feet)	1. If downstream flows are unknown, continue last release for two hours. Then, if communications cannot be reestablished, reduce release by half every two hours until release is about 100 cfs, which will be maintained until communications have been re-established. 2. If downstream flows are known, continue last release and control dam releases not to exceed 1,800 cfs below Abiquiu Dam and not to exceed 3,000 cfs as measured at the Rio Chama at Chamita gage. 3. Change in release rate will be in accordance with paragraph 7-15, when possible.
(C) Flood Control Operations (6,283.5–6,350.0 feet)	1. If downstream flows are unknown and not D2 situation below, continue last release for two hours. Then, if communications cannot be reestablished, reduce release by half every two hours until release is about 100 cfs, which will be maintained until communications have been re-established. 2. If releases at the time of the communication outage are based on D2 below, continue releases based on last instruction from the WMS. 3. When the pool elevation rises to 6,300.0 feet, releases will be controlled by the USACE service gates and bypass the hydroelectric power facility.
(D) Flood Control Operations (Above 6,350.0 feet)	1. When the pool rises to the spillway elevation 6,350.0 feet, the conduit is operated to maintain the reservoir elevation at spillway crest until gates are fully opened. 2. Maintain maximum releases reached during the event until the pool falls to the top of flood control elevation (6,283.5 feet).

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EXHIBIT G

MEMORANDUM OF AGREEMENT
BETWEEN THE U.S. ARMY CORPS OF ENGINEERS
AND
THE INCORPORATED COUNTY OF LOS ALAMOS, NEW MEXICO
FOR
CONSTRUCTION, OPERATION, AND MAINTENANCE
OF A HYDROELECTRIC POWERPLANT
AT ABIQUIU DAM

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Memorandum of Agreement
Between the U.S. Army Corps of Engineers
And
The Incorporated County of Los Alamos, New Mexico

For The

Construction, Operation, and Maintenance
of A Hydroelectric Powerplant
At Abiquiu Dam
Federal Energy Regulatory Commission License No. 7396

THIS MEMORANDUM OF AGREEMENT, entered into and effective this 30 day of MARCH, 1987, by and between the Incorporated County of Los Alamos, New Mexico (the "County") and the U.S. Army Corps of Engineers, (the "Corps") establishes the responsibilities for the construction, operation and maintenance of the Abiquiu Dam Power Project (the "Project"), as authorized by the Federal Energy Regulatory Commission License No. 7396.

EXPLANATORY RECITAL

WHEREAS, the Senate and House Appropriations Committees in Fiscal Year 1955 hearings approved for construction Abiquiu Dam located on the Chama River, New Mexico, in substitution for Chamita Dam, the latter having been authorized for construction by the U.S. Army Corps of Engineers, Albuquerque District by the Flood Control Act of 1948 (P.L. 858, 80th Congress) for flood and sediment control, and the Corps remains responsible for preservation of the safety of the structure and its operations for authorized project purposes; and

WHEREAS Public Law 97-140 authorized the conservation storage in the flood control space of a maximum of 200,000 acre-feet of San Juan-Chama Project imported water in Abiquiu Reservoir for release upon demand of the owners of such water the Corps is currently storing such water pursuant to agreements with the owners thereof;

WHEREAS the County has received a license from the Federal Energy Regulatory Commission ("FERC") pursuant to the Application for License No. 7396, dated March 30, 1984 (the "FERC License") for construction, operation, and maintenance of hydroelectric power engineering facilities and transmission lines required to utilize the water power potential of the existing Abiquiu Dam (the "Abiquiu Dam Power Project" or the "Project");

WHEREAS the construction, operation, and maintenance of the Project will not be detrimental to the authorized purposes of Abiquiu Dam and Reservoir;

WHEREAS the Corps and the County have determined that this construction, operation, and maintenance agreement is necessary to protect the interest of the United States Government and to ensure the continuity of the operation of Abiquiu Dam and Reservoir; and

WHEREAS, Articles 37 and 40 of the License requires the Licensee to enter into a memorandum of agreement with the Corps, coordinating its plans for access to and site activities on lands and property administered by the Corps, and describing the mode of hydropower operation, design, and construction as acceptable to the Corps;

NOW, THEREFORE, the Corps and the County do mutually agree to the construction, operation, and maintenance of the Abiquiu Dam Power Project, subject to the terms of the FERC License and the conditions hereinafter set forth.

1. License and Agreement

(a) The Corps hereby grants the consents to the County, its contractors, and agents, without warranty of title, an exclusive right, privilege, and license for the period of the FERC license to enter upon, construct, operate, and maintain the Abiquiu Dam Power Project on, under, and across land identified as parcels F and L on Exhibits A and B.

(b) The Corps hereby grants to the County, its contractors and agents, without warranty of title, a temporary, nonexclusive license not to exceed three (3) years for construction purposes on, under, and across land, identified as parcels A, B, C, E, I and K on Exhibits A and B.

(c) The Corps hereby grants to the County, its contractors and agents, without warranty of title, a nonexclusive license for the period of the rights granted under paragraph (a) above to use the existing United States Government roads maintained by the Corps at Abiquiu Dam and Reservoir.

(d) The Corps shall not, while rights granted under paragraph (a) are in existence, grant any license below Abiquiu Dam that may be inconsistent with the hydropower purposes of the County.

(e) The rights granted to the County under this Agreement shall be construed in conjunction with the FERC License to assure fulfillment of the conditions of that License.

(f) Rights conferred to the County by this Agreement shall not be construed as being inclusive of any other licenses or permits required of the County by the laws of the United States or the State of New Mexico. Specifically, this Agreement shall not be considered as a permit required under the Clean Water Act of 1972 as amended.

2. Construction

(a) The County shall construct the Project according to the designs and plans as approved by the Corps and by FERC. The Corps shall make every effort to expedite and complete its review of designs, plans, and specifications submitted by the County as soon as possible and in a time period no more than 60 days after date of their receipt. All design and construction work that will be an integral part of Abiquiu Dam or that could affect the structural integrity or operations of Abiquiu Dam shall be reviewed and approved by the Corps, and the County will reimburse the Corps for all costs in accordance with the terms of Article 8 of this Agreement. Modifications to designs and plans that have been previously approved by the Corps shall be submitted to the Corps for review and approval.

(b) Prior to beginning construction, the County will have Corps approval of construction plans and specifications for those items described in para (a) above, and a detailed construction schedule which will establish the dates on which construction activities on Abiquiu Dam facilities will be undertaken and completed. As the construction schedule changes, updated schedules will be furnished the Corps. During construction, Corps representatives will inspect the quality of construction activities and Project features that are an integral part of or could affect Abiquiu Dam or its operations to ensure compliance with approved plans.

(c) The County shall be responsible for inspecting, during construction, all Project features to ensure conformance with construction contract documents.

(d) The Corps will have the right to direct the County or its designated agent to correct any activity in the construction of the Project which may have an adverse effect on Abiquiu Dam and Reservoir including any activities that may affect the structural integrity of the Dam or the operation of the facility. In correcting such activities, the Corps will have the right to shut down the construction work until corrections are made. The County will reimburse the Corps for all costs associated with its inspection activity in accordance with terms of Article 8 of this Agreement.

(e) Only closely monitored, controlled blasting will be permitted. Monitoring plans and specific blasting procedures and operations will be in accord with EM385-1-1 and shall be approved in advance in writing by the Corps. The County expects that blasting may be necessary for the foundations of the powerhouse, plenum chamber, and penstock and in the excavation of the tailrace.

(f) Any costs associated with the improvement of the powerplant access road shall be the sole responsibility of the County. The County will be responsible for maintaining any existing or new roads (other than State Highway 96) on Corps land in a satisfactory condition during the construction period. Upon completion of construction, the County shall repair any damage to roads occurring as a result of their construction activities and restore the roads to a condition acceptable to the Corps.

(g) Upon completion of construction, the County will remove all construction debris from the site and restore any disturbed areas to its original condition as acceptable to the Corps.

(h) During the construction phase of the Project, the Corps shall not be responsible for loss or damage to property of the County or its contractors or agents (except for the actions of its officers, agents or employees causing loss or damages recoverable under the Federal Tort Claims Act), and the County shall take such security measures as it deems necessary to protect its property and those areas to which it requires access.

(i) The County will provide the Corps full-size reproducible (mylar) record drawings (as-builts) of the Project within 3 months of completion.

(j) The County agrees that all on-site construction will be accomplished in a competent, workmanlike manner in accordance with existing construction safety rules and regulations, including adequate safety precautions, so as to not constitute a hazard to the public or the parties, their respective contractors, or agents or employees.

3. Ownership

(a) The Corps holds sufficient title to Abiquiu Dam and Reservoir, and to the lands associated with the dam and reservoir as is necessary to the construction and operation of the Abiquiu Dam Power Project The title to such works and lands shall remain with the Corps, subject to the rights granted to the County under Section 1 hereof.

(b) The County shall own and be responsible for the operation and maintenance of all facilities, equipment, buildings, and improvements comprising the Project or later provided in connection therewith.

(c) Under this Agreement and the FERC License Agreement, the County has acquired rights and license in the Dam and Reservoir to construct, maintain, and operate all facilities, equipment, and land associated with the Project, including the following: the Project will utilize the existing outlet works. A steel liner will be installed in the tunnel downstream of the existing valve chamber. The existing valve chamber will be modified to reinforce the air vent pipes and supports. The lower end of the tunnel upstream from the existing flip bucket structure will be modified to permit installation of the plenum chamber. The County will construct a hydroelectric powerhouse to house turbines, electric generator, and other plant equipment for the generation of electric power and energy. Access and parking for normal operation will be on the right side and upstream of the powerhouse. A new transmission line will be constructed from the substation to existing transmission facilities.

(d) The Project shall not interfere with existing access by the public to the recreational areas above or below Abiquiu Dam nor shall it interfere with access by the Corps to any of its facilities for operation and maintenance purposes.

4. Operations During Construction

(a) The construction of a steel liner in the outlet tunnel and the plenum chamber requires the Corps' outlet works to be closed during the months of December, January, and February (winter construction period) in two consecutive years. The County, during the winter construction period, will pass no less than the native water inflow up to a maximum of 75 cubic feet per second (cfs). During normal operations, the by-pass flows will be limited to 50 cfs. The County shall develop a water management plan for implementation during the winter construction period, which plan must be approved in writing prior to the winter construction period by the New Mexico State Engineer and the Corps. And, provided the Rio Grande Compact Commission has adopted an appropriate resolution to facilitate the storage and release of native Rio Grande water during the Project construction.

(b) Should hydrologic conditions arise that would require the evacuation of storage in Abiquiu Reservoir during the winter construction period that otherwise could not be completed by March 31, Project construction shall be suspended upon 7 days notice in writing being given to the County by the Corps. Construction shall not be restarted until approved in writing by the Corps.

(c) In the event of a substantial failure of the County's bypass system as required by paragraph 4(a) above, the County has a maximum of eight (8) hours to establish the bypass flow as directed by the Corps. If the County has not established the directed bypass flow by the end of the eight hour period, the Corps may suspend the County's construction activities in the outlet works and immediately reestablish downstream flows through the Corps' outlet works. The Corps will make an effort to restrict such releases in these circumstances to not more than 150 cfs.

5. Operations

(a) The time and quantity of all releases and changes in releases from Abiquiu Dam will be determined and directed by the Corps. The Corps and the County will cooperate in order to ensure that the operation of the Project is consistent with the primary purposes of the Dam and Reservoir. The County will operate its Project facilities, including its outlet works in accordance with the Corps' directions. All releases of water within the range of the design capacities of the Project shall be made through the Project facilities. When Corps directed releases cannot be made through the Project facilities, releases will be made through the Corps' outlet works. The Corps shall have the right to override the County's operation of the outlet works to assure operation of the Dam and Reservoir in accordance with their primary purposes, but such rights shall be exercised only if the County shall have failed to respond to the Corps' direction with respect to the directed release rates.

(b) The powerplant and the Project outlet works will be remotely controlled and operated by the County. Releases by the County will at all items equal the release requirements as directed by the Corps.

(c) The operation and maintenance of Project facilities shall not degrade the quality of raw water made available through the project facilities from standards as determined by the State of New Mexico. The Corps does not warrant the quality of water and is under no obligation to construct or furnish water treatment facilities to maintain or improve the quality of water.

(d) The Project shall be operated in close coordination with the operation of Abiquiu Dam and Reservoir subject to the following restrictions:

(1) The County will provide the Corps with copies of any and all operating manuals for equipment whose operation could have an impact on the operations or structural integrity of Abiquiu Dam.

(2) The Project will not commence normal operations until all Project equipment and facilities are tested and found satisfactory by the County. Corps personnel shall be notified in advance when final testing is scheduled and shall be permitted to attend.

(3) The parties recognize that power may be generated and sold during any test period before commencement of normal operations.

(4) The Project shall use only flows in the amount directed by the Corps.

(5) The County shall notify the Corps of any expected Project outages for scheduled maintenance or repair purposes. Such notice shall be provided at least 48 hours in advance. The rate of release from Abiquiu Dam shall not be interrupted or changed by operation or maintenance of the powerplant except with the Corps' approval.

(6) The County hereby agrees that if the Project interferes with, or threatens to interfere with the rate of release of water required by the Corps, the County shall correct the interference. If the County fails for any reason to correct the interference, the Corps may make the correction at the expense of the County.

(e) The County, in consultation with the Corps, will provide input to an Emergency Action Plan establishing procedures to be followed in case of accident to or failure of the Project.

(f) When possible, the Corps will provide the County reasonable prior notice of any change in the normal annual reservoir release patterns.

(g) Coordinated operation of the Corps' outlet works and Project outlet works shall be undertaken in accordance with procedures to be developed jointly by the County and the Corps. Note: The jointly developed procedures will become Exhibit "H" of the Abiquiu Water Control Manual.

6. Maintenance

(a) The County at its own expense will be responsible for the maintenance of the Project.

(b) The County will accomplish all necessary repairs related to the Project including those items identified by the Corps. Should the County fail to make such repairs to those items identified as causing safety or operational problems in a timely and acceptable manner, the repairs may be made by the Corps and the County will reimburse the Corps for the cost of said repairs.

(c) The County will be responsible to perform the maintenance and to pay the total cost of maintenance of the following:

(d)

(1) The Abiquiu Dam Power Project facilities.

(2) Fenced areas and other security measures for those areas under the control of the County.

7. Inspections

(a) The County shall inspect those Project features requiring complete closure of the Corps outlet works concurrently with the Corps' inspection program as identified in paragraph (b) hereunder.

(b) The Corps shall have the right to conduct inspections of the Project to ensure it is being operated and maintained in a manner which will not endanger the structural integrity or interfere with the Corps' operation of Abiquiu Dam. These inspections of the hydropower facilities shall be integrated into the Corps' inspection program for Abiquiu Dam. Upon request, the County shall reimburse the Corps for the applicable portion of the costs of inspection, reporting and continuing observation and evaluation of the Project. Review of operation and maintenance of the Project shall be conducted concurrently with the Corps' annual inspections of Abiquiu Dam upon prior reasonable notice to the County. Special inspections of the Project called for by the Corps or the County due to a special or unique problem shall be at the County's expense. Copies of any inspection reports shall be provided to the County, FERC, and the Corps.

8. Payment of Corps' Costs

(a) The County agrees to reimburse the Corps for its reasonable costs during the design and construction of the Project.

(b) Charges for the following services rendered by the Corps in connection with the County's activities shall be reimbursable by the County to the Corps.

(1) Review of technical studies to include consultation required relating to Abiquiu Dam Power Project operation, structural integrity of Abiquiu Dam, or any other matter associated with the Project.

(2) Review of engineering reports, technical studies, environmental issues and construction plans and specifications of Project features, safety or operations of Abiquiu dam or reservoir.

(3) Site visits by Corps personnel at the request of the County or as reasonably determined necessary by the Corps.

(4) Providing copies of reports, drawings, and similar data not normally provided at no cost to the public and as requested by the County.

(5) Consultation other than routine telephone conversations with the County which involves more than an incidental amount of Corps personnel time.

(6) Periodic inspections and continuing evaluations as identified in Paragraph 7(b) above.

"Costs" as used herein shall include an hourly charge to include burden and overhead for time reasonable incurred by Corps personnel providing the aforementioned services, travel charges reasonably incurred for site visits and meetings as provided in para. 8(b)(3), mail costs and copying costs; provided however, that no charge shall be assessed for publications, information, technical services or reproductions costs that would normally be provided to the public at no charge.

(c) The County has heretofore advanced to the Corps deposits of $105,000 to cover costs incurred by the Corps for the aforementioned services during the design and construction phase. The County shall advance further deposits to the Corps upon written notification of prospective expenditures which would overdraw such account. A quarterly accounting of costs by the Corps will be provided to the County. Following initial commercial operation of the Project, a fund balance not to exceed $5,000 shall be maintained to cover incidental costs incurred by the Corps during the operation phase.

(d) Following three years of operation of the Abiquiu Dam Power Project, the Corps and the County shall endeavor to negotiate a flat annual fee to be paid by the County to the Corps as reimbursement for the types of Corps costs set forth in this Article 8. If successfully negotiated, said flat annual fee shall replace and supersede the charges provided for in this Article 8.

9. Liability

(a) The County hereby agrees to indemnify and hold harmless the United States Government from any loss or damage and from any liability on account of personal injury, death or property damage of any nature whatsoever and by whomsoever made arising out of the County's activities under this Agreement.

(b) Any damage to the Abiquiu Dam and its appurtenances as result of the County's activities shall be repaired by the Corps at the County's expense. At such time as the Corps furnishes the County with its reasonable cost estimates for such repairs, the County shall advance funds to the Corps for these reimbursable costs under the processes specified in Article 8.

(c) The County hereby agrees to indemnify and hold harmless the United States Government from any liability for damages related to or arising from interference by the Project with the delivery of water, rights to the use of which have vested in accordance with the laws of the United States and the State of New Mexico.

10. <u>Cooperation of Parties Under the FERC License</u>

(a) This Agreement is subject to, but not limited to, the terms and conditions of the License issued by FERC. The Corps will cooperate with the County in implementing the License to the extent it may do so without being inconsistent with the authorized purpose of flood and sediment control, its authorized operating procedures and control so long as the safety and integrity of the structures are not endangered.

(b) Any costs or expenses incurred to maintain the FERC License shall be borne by the County, and the Corps shall not be liable for any costs or expenses of the County under the FERC License, or otherwise in connection with the Project.

(c) This Agreement and the FERC License Agreement define and limit the County's liability to the Corps.

11. <u>Equal Opportunity</u>

During the performance of this Agreement, the County agrees as follows:

(a) The County Shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The County shall take affirmative action to ensure that applicants are employed without discrimination, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The County agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Corps setting forth the provisions of this nondiscrimination clause.

(b) The County shall, in all solicitations or advertisements for employees placed by or on behalf of the County, state that all qualified applicants will receive consideration for employment without discrimination because of race, color, religion, sex, or national origin.

(c) The County shall send to each labor union or representative of workers, with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the Corps, advising the said labor union or workers' representative of the County's commitment under Section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The County shall comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(e) The County shall furnish all information and reports required by said amended Executive Order and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and shall permit access to its books, records, and accounts by the Corps and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(f) In the event of the County's noncompliance with the nondiscrimination clauses of this Agreement or with any of the said rules, regulations, or orders, this Agreement shall be cancelled, terminated, or suspended, in whole or in part, and the County shall be declared ineligible for further Government contracts in accordance with procedures authorized in said amended Executive Order, and such other sanctions may be imposed and remedies invoked as provided in said executive Order or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(g) The County shall include the provisions of paragraphs (a) through (f) in every subcontract or purchase order involving the Project unless exempted by the rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of said amended Executive Order, so that such provisions will be binding upon each subcontractor or vendor. The County shall take such action with respect to any subcontract or purchase as may be directed by the Secretary of Labor as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event the County becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the County may request the Corps to enter into such litigation to protect the interest of the United States.

12. Title VI, Civil Rights Act of 1964

The County agrees that is will comply with Title VI of the Civil Rights Act of July 2, 1964 (78 Stat. 241) and all requirements imposed by or pursuant to the Department of the Army issued pursuant to that title, to the end that, in accordance with Title VI of the Act and the Regulation, no person in the United States shall, on grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any benefits of, or be otherwise subjected to discrimination under any program or activity for which the County received financial assistance from the United States and hereby gives assurance that it will immediately take any measure to effectuate this Agreement.

13. Certification of Nonsegregated Facilities

The County hereby certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at a location, under its control, where segregated facilities are maintained. It certifies further that it will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The County agrees that a breach of this certification is a violation of Title VI, Civil Rights Act of 1964. As used in this certification, the term “segregated facilities,” means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, timeclocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are, in fact, segregated on the basis of race, creed, color, or national origin, because of habit, local custom, or otherwise.

14. Officials Not to Benefit

(a) No member of or delegate to Congress or resident Commissioner shall be admitted to any share or part of this License and Agreement or to any benefit that may arise herefrom, but this restriction shall not be construed to extend to this Agreement if made with a corporation for its general benefit.

(b) No official of the County shall received any benefit that may arise by reason of the execution of the License and Agreement other than as a landowner within the Project and in the same manner as other landowners within the Project.

15. Existing Relationships

This Agreement shall not have any effect on existing agreements, rights, and relationships of the Corps not on the administration of the Rio Grande under the Rio Grande Compact.

16. Future Work

The implementation of this License and Agreement does not in any way restrict the Corps from any future modifications or improvements to the Dam and Reservoir and appurtenant features. Any such modification will be made after full consultation with the County and following an effort to cooperate in the design and construction of such modification.

17. Term of Agreement

(a) This Agreement shall become effective on the day of execution by the Corps and shall terminate upon termination of the FERC license for the Project. This Agreement will be extended for the term of any renewal of the FERC license.

(b) The benefits and obligations of this License and Agreement may be assigned by the County subject to approval by the Corps. Such approval shall not be unreasonably withheld but may require some modification of the operational provisions of this Agreement and the operations procedures developed thereunder. This agreement shall be binding upon any assigns or successors of the County.

18. Disputes (1984 APR) FAR 52.233-1

(a) This Agreement is subject to the Contract Disputes Act of 1978 (41 U.S.C. 601-613) (the Act).

(b) Except as provided in the Act, all disputes arising under or relating to this Agreement shall be resolved under this clause.

(c) “Claim,” as used in this clause, means a written demand or written assertion by one of the contracting parties seeking, as a matter of right, the payment of money in a sum certain, the adjustment or interpretation of terms, or other relief arising under or relating to this Agreement. A claim arising under this Agreement, is a claim relating to that Agreement, in a claim that can be resolved under an agreement clause that provides for the relief sought by the claimant. However, a written demand or written assertion by the Contractor seeking the payment of money exceeding $50,000 is not a claim under the Act until certified as required by subparagraph (d) (2) below. A voucher, invoice, or other routine request for payment that is not in dispute when submitted is not a claim under

the Act. The submission may be converted to a claim under the Act, by complying with the submission and certification requirements of this clause, if it is disputed either as to liability or amount is not acted upon in a reasonable time.

(d) (1) A claim by the County shall be made in writing and submitted to the Contracting Officer for a written decision. A claim by the Government against the County shall be subject to a written decision by the Contracting Officer.

(2) For County claims exceeding $50,000, the County shall submit with the claim a certification that--

(i) The claim is made in good faith;

(ii) Supporting data are accurate and complete to be the best of the County's knowledge and belief; and

(iii) The amount requested accurately reflects the contract adjustment for which the County believes the Government is liable.

(3) The certification shall be executed by--

(i) A senior County official in charge at the County's plant or location involved; or

(ii) An officer of the County having overall responsibility of the conduct of the County's affairs.

(e) For County's claims of $50,000 or less, the Contracting Officer must, if requested in writing by the County, render a decision within 60 days of the request. For County-certified claims over $50,000, the Contracting Officer must, within 60 days, decide the claim or notify the Contractor of the date by which the decision will be made.

(f) The Contracting Officer's decision shall be final unless the County appeals or files a suit as provided in the Act.

(g) The Government shall pay interest on the amount found due and unpaid from (1) the date the Contracting Officer receives the claim (properly certified if required), or (2) the date the payment otherwise would be due, if that date is later, until the date of payment. Simple interest on claims shall be paid at the rate, fixed by the Secretary of the Treasury as provided in the Act, which is applicable to the period during which the Contracting Officer receives the claim and then at the rate applicable for each 6-month period as fixed by the Treasury Secretary during the pendency of the claim.

(h) The County shall proceed diligently with performance of this Agreement, pending final resolution of any request for relief, claim, appeal, or action arising under the Agreement, and comply with any decision of the Contracting Officer.

(i) For purposes of this clause and any actions taken by the Government pursuant thereto, the term "Contracting Officer" shall be deemed to mean the District Engineer, Albuquerque District, U.S. Army Corps of Engineers.

19. Notices

(a) Any notice, demand, or request authorized or required by this License and Agreement shall be deemed to have been given when mailed, postage prepaid, or personally delivered as follows:

(b) If to the Corps, to:

U.S. Army Corps of Engineers
District Engineer

517 Gold S.W.
P.O. Box 1580
Albuquerque, New Mexico 87102

(c) If to the County, to:

Incorporated County of Los Alamos
Post Office Box 30
Attention: Utility Manager
Los Alamos, New Mexico 87544

(d) If to FERC, to:

Regional Engineer
Federal Energy Regulatory Commission
333 Market St., 6th Floor
San Francisco, California 94105

(e) The designation of the addressee or the address may be changed by notice given in the same manner as provided in this article for other notices.

20. Modifications

The provisions of this agreement may be modified or added to by mutual agreement of the parties.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

UNITED STATES DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS SOUTHWESTERN DIVISION

By:______________________________
J.B. Hilmes
Major General, U.S. Army
Division Engineer

COUNTY OF LOS ALAMOS

By:______________________________
Jeanette O. Wallace
Chairman, County Council

By:______________________________
Fred A. Gross, Jr.
Chairman, Board of Public Utilities

STATE OF NEW MEXICO)
COUNTY OF ________________) ss,

The foregoing instrument was acknowledged before me this ______ day of , 1987, by Jeanette O. Wallace, Chairman of the County Council of the Incorporated County of Los Alamos, on behalf of said County.

Commission Expires:

____
Notary Public

____

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EXHIBIT H

COORDINATED PROCEDURES FOR OPERATION OF THE POWER PLANT

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OPERATION OF THE HYDROELECTRIC POWER FACILITY

H-01 GENERAL

The following paragraphs cover project duties which are the responsibility of the District Engineer's duly appointed representatives (the Abiquiu Dam OPM and Supervisor for the Reservoir Control Section), and the county's Director of Electrical Production, in connection with the operation of the hydroelectric power facility. These instructions cover daily routine operation, responsibilities during flood or equipment emergencies, and when communications between the project office and the county are disrupted.

H-02 OPERATION REQUIREMENTS

Operation of the hydroelectric power facility is accomplished by Pan Am (Department of Energy contractor) personnel, located at the County Dispatch Center (TA3), under the direction of the County Director of Electrical Production.

a. All releases of water within the range of the design capacity of the power facility will be made through the power facility power generation mode (PGM). When USACE-directed releases cannot be made through the power facility, releases will be made through the USACE’s outlet works flood control mode (FCM).

b. In the PGM, powerhouse releases are adjusted by TA3 (by remote control) or by the county plant operator (if onsite) whenever necessary to match the required reservoir outflow directed by the WMS. The WMS instructions are transmitted via phone to TA3. If phone communications are disrupted, the county’s back up radio communications system will be activated.

c. The county, and the District Engineer or his duly designated representative, monitors and records river flow at the existing USGS gaging station.

d. The county, and the District Engineer or his duly designated representative, monitors and records the reservoir level using equipment installed at the USACE’s reservoir floatwell.

e. The county monitors and records the plant monthly energy generation. A summary of the energy generation is provided to the WMS on an annual basis, not later than 20 October each year for the water year ending 30 September.

f. A remote monitoring panel is installed in the USACE operations building that has lights indicating the status of the closure gate, unit operation and governor oil pressure.

H-03 TRANSITION FROM FLOOD CONTROL MODE TO POWER GENERATION MODE

When the reservoir releases fall within the range of design capacity of the power facility, the transition to the PGM occurs. The following procedure shall be used to pressurize the conduit at Abiquiu Dam to allow operation of the hydroelectric generating plant.

It should be understood that once the plant is pressurized, LAC-DPU is responsible for the control of the river as directed by the USACE.

A safety meeting including all persons and agencies involved shall be held immediately preceding the execution of this procedure. A roster of attendees shall be kept and signed by each individual attending the safety meeting.

It is important to monitor the rate at which pressurization is accomplished. This means USACE Gate Chamber personnel set inflow using the Service Gates while LAC-DPU Control Room personnel set the outflow using the jet flow valve. Under no circumstances should this differential rate exceed a net differential greater than 100 cfs. To ensure this rate, the Service Gate shall not exceed 0.30 feet.

The following steps should be completed in sequence to pressurize the plant. Each step shall be initiated and the time recorded when completed.

If a water leak develops within the USACE Gate Chamber at any time during this pressurization procedure, the Service Gates shall immediately be fully closed, USACE butterfly valves will be fully opened and downstream LAC-DPU releases will begin. This will help to minimize risk to personnel within the Gate Chamber and allow the system to be dewatered.

Date and time safety meeting held: ________________________

Time Pressurization Procedure started: ________________________

1. Clear hydroelectric plant and site of all personnel except those actively participating in this procedure. Spectators shall be outside the fence boundaries of the project.

   Completed: ______________

2. Key personnel assigned to the following locations:

   a. USACE Gate Chamber (USACE-GC)—Two persons in the USACE gate chamber, one of which shall be a LAC-DPU employee and one USACE employee. Verify elevator is working and secondary communication path to top of gate chamber is working.

      USACE Employee(s): ______________________________

      LAC-DPU Employee(s): ________________________________

b. LAC Gate House (LAC-GH)—Two persons in the LAC-DPU closure gate structure one USACE and one LAC-DPU. Ensure all manway doors are fully propped open, the large roll up hatch door is completely open, and all gate cover hatches are safely stowed out of the way.

USACE Employee(s): ______________________________

LAC-DPU Employee(s): ________________________________

c. LAC powerhouse control room (LAC-CR)—Two persons in the LAC-DPU powerhouse control room, one USACE and one LAC. Open both doors to facilitate movement between areas and aid in hearing the audible indications of the procedure.

USACE Employee(s): ______________________________

LAC-DPU Employee(s): _________________________________

d. One USACE employee at the front desk in Visitor Center as the Communications Operator. Have backup employee nearby to help with normal receptionist duties as needed during procedure.

USACE Employee(s): ______________________________

Completed: ______________

3. Communications Operator verify intercom communications between the USACE gate chamber, closure gate structure, and powerhouse control room are functioning (All).

Completed: ______________ GC______ CR______ GH______

4. In the powerhouse control room, open the jet flow valve 100 percent, (approximately 80 cfs) (LAC-CR).

Flow Set: ________________

Completed: ______________ GC______ CR______ GH______

5. In the powerhouse control room, verify that both PRV's are closed to 0 percent (LAC-CR).

Completed: ______________ GC______ CR______ GH______

6. In the powerhouse control room, verify all 3 turbine generator units are in local control (automatic or manual), in shutdown status with all wicket gates closed, and all 3 turbine shutoff valves (TSV) are closed (LAC-CR).

Completed: ______________ GC______ CR______ GH______

7. At the LAC-DPU closure gate structure verify the 36-inch air vent is open (LAC-GH).

Completed: _______________ GC______ CR______ GH______

8. Verify LAC-DPU closure gate is pre-suspended above water flow ahead of time and locked out and tagged out properly with side screw bolts inserted (LAC-GH).

Completed: _______________ GC______ CR______ GH______

9. In the USACE gate chamber verify 36-inch butterfly valves #1 and #2 controls are operational and working (power on), and the automatic 3-inch inch air relief/vacuum breaker valves are open and free (USACE-GC).

Completed: _______________ GC______ CR______ GH______

10. In the USACE gate chamber set both of the 36-inch butterfly valves to 100 percent open (USACE-GC).

Butterfly Valve #1 Position: ____________________

Butterfly Valve #2 Position: ____________________

Completed: _______________ GC______ CR______ GH______

11. At the LAC-DPU closure gate structure verify operation of the hydraulic power unit (LAC-GH).

    a. Hydraulic system running and tested.

    b. Verify hydraulic system working pressure is approximately 135 bar nominal.

Completed: _______________ GC______ CR______ GH______

12. In the USACE gate chamber verify operation of the hydraulic power unit for service gate operation (USACE-GC).

Completed: _______________ GC______ CR______ GH______

13. USACE personnel establish a minimum water release of 100 CFS (approximately 0.25 feet opening of one service gate, depending on Lake elevation) to a maximum of 150 CFS (approximately 0.32 feet opening of one service gate, depending on Lake elevation) determined by releases at the time this procedure is executed. Record estimated flow and USACE gate positions when flow is set (USACE-GC).

Flow Set: _______________cfs.

Emergency Gate #1 Position: ____________________

Emergency Gate #2 Position: ________________

Service Gate #1 Position: ________________

Service Gate #2 Position: ________________

Completed: _____________ GC______ CR______ GH______

14. Lower LAC-DPU closure gate to restrict one half of flow. This position is determined by water release at the time this procedure is being executed. It is based on a closure gate staff gage reading at full closed of 261 inches on the provided rule (LAC-GH).

    Completed: _____________ GC______ CR______ GH______

15. Verify water flow over the invert as observed through the opening of the 36-inch air vent valve in the LAC-DPU gate house. This can take 15-20 minutes (LAC-GH).

    Completed: _____________ GC______ CR______ GH______

16. Fully close the 36-inch air vent valve in the LAC-DPU gate house once water is over invert and ensure air is still escaping from the 2-inch automatic air relief valve (LAC-GH).

    Completed: _____________ GC______ CR______ GH______

17. Lower LAC-DPU house closure gate to fully closed position (LAC-GH).

    Completed: _____________ GC______ CR______ GH______

18. Monitor penstock pressure gauge in powerhouse control room for rise to approximately 60 psi to 70 psi. This can take from 20 to 30 minutes (LAC-CR).

    Completed: _____________ GC______ CR______ GH______

19. If the pressure stalls have the USACE increase their service gate opening to allow 150 CFS into conduit (USACE-GC).

    Completed: _____________ GC______ CR______ GH______

20. Verify powerhouse penstock pressure reading is at approximately 60 to 70psi (LAC-CR).

    Completed: _____________ GC______ CR______ GH______

21. Monitor water indicator above the open two USACE 36-inch butterfly valves. Once water is noted in air vent pipe and air has stopped exiting vacuum breaker valves, USACE personnel shall fully close both 36-inch butterfly valves (USACE-GC).

    GC______ CR______ GH______

Completed: ______________

22. Open the drain valve of one of USACE air vent pipes that are now partially filled with water and allow it to start draining into sump (This step could take up to 3 hours per vent pipe.). Wait until the first air vent pipe is empty before draining the second one to prevent the sump pump from being overwhelmed. Continue with checklist after opening first drain (USACE-GC).

Completed: ______________

23. Open both USACE Service gates to 100 percent and both USACE Emergency gates to 100 percent (USACE-GC).

Completed: ______________ GC______ CR______ GH______

24. Open desired LAC-DPU pressure relief valves (PRVs) to establish required flow in the river. This is determined by the release required by USACE for the day (LAC-CR).

Flow Set: ________________

PRV #1 Position: __________

PRV #2 Position: __________

Completed: ______________ GC______ CR______ GH______

25. Close the powerhouse jet flow valve to 0 percent (LAC-CR).

Completed: ______________ GC______ CR______ GH______

26. Secure hydraulic controls in closure LAC-DPU gate house (LAC-GH).

Completed: ______________ GC______ CR______ GH______

27. Secure hydraulic controls in the USACE gate chamber (USACE-GC).

Completed: ______________ GC______ CR______ GH______

28. USACE verify water indicator above both 36-inch butterfly valves are dry and automatic air relief valves closed. NOTE: This step MUST be verified complete by the end of the day (USACE-GC).

Completed: ______________ GC______ CR______ GH______

29. Ensure all stations are ok and log time the procedure was completed and signature of person keeping the master log sheet.

Completed: ______________

Signature: ______________________________________

Communications Operator

H-04 TRANSITION FROM POWER GENERATION MODE TO FLOOD CONTROL MODE

The transition to the FCM is made whenever the reservoir releases cannot be made through the power facility, or at the request of the District Engineer or his duly designated representative in accordance with the MOA. The WMS will provide the County Director of Electrical Production with a 24-hour advance notice prior, when possible, to beginning the PGM-to-FCM transition. The following procedure shall be used to depressurize the conduit at Abiquiu Dam to allow inspections of the main USACE penstock and/or the hydroelectric generating plant waterways. This procedure is also used to transfer operational control of water releases from LAC-DPU back to USACE.

It should be understood that once the plant is depressurized, USACE is responsible for the control of the river under their own direction, and LAC-DPU is relieved of control until re-pressurization is performed.

A safety meeting including all persons and agencies involved shall be held immediately preceding the execution of this procedure. A roster of attendees shall be kept and signed by each individual attending the safety meeting.

It is important to monitor the rate at which depressurization is accomplished. This means USACE Gate Chamber personnel stop inflow through the USACE Service Gates while LAC-DPU Control Room personnel set PRV outflow. Under no circumstances shall this differential rate exceed a net differential faster than 30 CFS before USACE butterfly valves are open, or 150 CFS after USACE butterfly valves are open.

The following steps should be completed in sequence to depressurize the plant. Each step shall be initialed, and the time recorded when completed.

In case of EMRGENCY in the USACE Gate Chamber, immediately open both Butterfly Valves, fully close both Service Gates and begin dewatering of the conduit.

Date and time safety meeting held: ______________________

Time Pressurization Procedure started: ______________________

1. Clear hydroelectric plant and site of all personnel except those actively participating in this procedure. Spectators shall be outside the fence boundaries of the project.

   Completed: _____________

2. Key personnel assigned to the following locations:

   a. (USACE-GC)—Two persons in the USACE gate chamber, one of which shall be a LAC-DPU employee and one USACE employee. Verify elevator is working and secondary communication path to top of gate chamber is working.

      USACE Employee(s): ____________________________

      LAC-DPU Employee(s): ______________________________

b. (LAC-GH)—Two persons in the closure gate structure one USACE and one LAC-DPU. Ensure all manway doors are fully propped open, the large roll up hatch door is completely open, and all gate cover hatches are safely stowed out of the way.

USACE Employee(s): ______________________________

LAC-DPU Employee(s): ________________________________

c. (LAC-CR)—Two persons in the powerhouse control room, one USACE and one LAC-DPU. Open both doors to facilitate movement between areas and aid in hearing the audible indications of the procedure.

USACE Employee(s): ______________________________

LAC-DPU Employee(s): ________________________________

d. One USACE employee at the front desk in Visitor Center as the Communications Operator. Have backup employee nearby to help with normal receptionist duties as needed during procedure.

USACE Employee(s): ______________________________

Completed: ______________

3. Communications Operator verify intercom communications between the USACE gate chamber, closure gate structure, and powerhouse control room are functioning (All).

Completed: ___________

4. Verify LAC-DPU closure gate hydraulic gate controls are functional (LAC-GH).

a. Hydraulic system running and tested.

b. Verify hydraulic system working pressure is approximately 135 bar.

Completed: ___________

5. In the USACE gate chamber verify operation of the hydraulic power unit (USACE-GC).

Completed: ___________

6. At the LAC-DPU powerhouse, verify that all gates and valves are closed. Wicket gates, 3-TSVs, 2-PRVs, and jet flow valve (LAC-GH/LAC-CR).

Completed: ___________

7. USACE shall close service and emergency gates and verify their position (USACE-GC).

   Emergency Gate #1 Position: __________________

   Emergency Gate #2 Position: __________________

   Service Gate #1 Position: __________________

   Service Gate #2 Position: __________________

   Completed: ______________

8. In the LAC-DPU powerhouse open the jet flow valve to a setting corresponding to a flow NOT MORE THAN the maximum allowable depressurization flow BEFORE USACE 36-inch butterfly valves are opened (published above, approx. 1 minute opening time) (LAC-CR).

   Flow Set: ________________

   Completed: ______________

9. Verify the automatic air relief/vacuum breaker valves on the two USACE 36-inch air vent valves have opened and are allowing air into the penstock at an acceptable rate (USACE-GC).

   Completed: ___________

10. Ensure power is activated to the butterfly valves. USACE personnel fully open 36-inch butterfly valves #1 and #2 (USACE-GC).

    Completed: __________

11. Open the powerhouse PRV(s) in small increments (approximately 5 percent each, every 3 to 5 minutes) to a setting corresponding to a flow, when combined with the current jet flow valve flow, not more than the maximum allowable depressurization flow after USACE 36-inch butterfly valves are opened (published above). Do this in coordination with the LAC-DPU employee stationed at the closure gate structure and the USACE employee stationed in the gate chamber to assure the system is evacuating water and drawing in air at a suitable rate. Adjust as necessary. This could take 20 to 30 minutes. This step can be considered complete immediately after initial opening to facilitate subsequent steps allowing for adjustments (LAC-CR).

    Completed: ___________

12. Verify the 2-inch automatic air relief breaker valve on the 36-inch air vent valve in the LAC-DPU gate house has opened and is allowing air into the penstock at an acceptable rate (LAC-GH).

Completed: ___________

13. Open the 36-inch air vent valve in the LAC-DPU gate house to fully open position (LAC-GH).

    Completed: ___________

14. Wait for water flow through the powerhouse PRV(s) and jet flow valve to stop (LAC-CR).

    Completed: ___________

15. Using the ruled staff gage on the closure gate frame to measure closure gate opening, raise the gate 6 inches from the normal 261 inches on the provided rule when fully closed to 255 inches and wait 5 minutes (LAC-GH).

    Completed: ___________

16. Repeat Step 14 above and wait another 5 minutes (LAC-GH).

    Completed: ___________

17. Repeat Step 15 until bottom of closure gate is clear of water (LAC-GH).

    Completed: ___________

18. While raising the powerhouse bulkhead gate, operate the gate locking mechanism to the unlock position using the operator lever in the hydraulic cabinet (LAC-GH).

    Completed: ___________

19. Raise the powerhouse bulkhead gate to the top of the cylinder. This could take 15 to 20 minutes. Operate the gate lock lever in the hydraulic cabinet to lock the gate in the up position. Ensure the locking shoe engages the horns of the bulkhead gate shaft (LAC-GH).

    Completed: ___________

20. Operate the lower lever to lower the gates weight onto the locking/shoe (LAC-GH).

    Completed: ___________

21. USACE personnel to set the service gate to the proper stream flow. Verify final gate settings (USACE-GC).

    Service Gate #1 Position: ____________

    Service Gate #2 Position: ____________

Emergency Gate #1 Position: ____________

Emergency Gate #2 Position: ____________

Completed: ______________

22. Secure all powerhouse hydraulic equipment and turn off hydraulic pump (LAC-GH).

    Completed: ______________

23. Secure hydraulic controls in the USACE gate chamber (USACE-GC).

    Completed: ______________

24. Ensure all stations are OK and log time the procedure was completed and signature of person keeping the master log sheet (All).

    Completed: ______________

    Signature: _______________________________________

    Communications Operator

H-05 EMERGENCY OPERATION

A power plant emergency is defined to occur when the county loses its ability to regulate the reservoir discharge in the PGM. This emergency situation is created by a failure of equipment or piping where the control of flow through the facility is lost, as described more fully below:

- Each of the 54-inch bypass valves are operated from the governor oil pressure set of the corresponding turbine and are independent systems. Should the oil piping rupture or the pressure set fail in a system, the 54-inch bypass valve would remain in the position established prior to the failure and the gate position or flow through the valve could not be changed until repairs were made.
- Structural failure of one of the three bypass valves.
- Structural failure of the closure gate.
- Site conditions that would potentially result in an emergency situation are as follows:
- Low governor oil system pressure or volume.
- Failure of any governor oil pressure set component resulting in operation utilizing backup systems.
- Extended loss of station service (electrical) power.
- Significant vibration and/or leakage of bypass valves or closure gate during operation.

The following procedure and sequence shall be used Ito close gates in an emergency when County is generating power.

1. Close both of the USACE gates in the bottom of the gate chamber completely.
2. Place LAC-DPU Power Plant pump out of service switch in number l position (pointing up) on panel board in the closure gate building downstream.
3. In the closure gate building push start button on panel board and hydraulic pump should start operating.
4. Wait until the water stops draining through the power plant.
5. Push pressure oil cylinder lever to the right.
6. Pressure gauge should read about 135 bar.
7. Move closure gate control to raise position. Lift gate only 6 inches and wait 5 minutes.

8. Lift gate 6 inches and wait 5 minutes, continue this until gate clears water. After the gate clears the water, it may be raised all the way.

9. Before the gate reaches the top of the cylinder, operate the gate lock control to the unlock position.

10. Raise the gate to the top of the cylinder.

11. Operate the gate lock control to the lock position.

12. Lower the gate on the lock.

13. Return all hydraulic controls to the center position.

14. Press the stop button on the control panel.

15. Secure closure gate building.

16. Set USACE gates at approved river flow based on existing conditions.

In the event communications are disrupted and an emergency develops, the Abiquiu Dam OPM is authorized to close the USACE's service gates to cause an automatic shutdown of the power plant and begin the transition to the FCM. Tables H-1 and H-2 describe the sequence and timing of transition from PGM to FCM with communications intact and with communications disrupted respectively.

An emergency notification procedure is shown in Table H-2.

H-06 STANDING INSTRUCTIONS DURING FLOOD EMERGENCY

Flood control operation shall be in accordance with instructions from the WMS. If the reservoir releases cannot be made in the PGM, the transition to the FCM will be made. During flood periods, the TA3 and WMS will maintain close contact to enable the transition to the FCM (if needed) with less than 24-hour notice, overriding the provisions of paragraph 4 above.

When lines of communication are disrupted and contact with the County by alternate means is unsuccessful, the Abiquiu Dam OPM is authorized to close the USACE service gates to cause an automatic shutdown of the power plant and begin the transition to the FCM when any of the following conditions are met:

1. The reservoir elevation is forecasted to exceed 6,300.0 feet.

2. The required reservoir release is greater than 5,500 cfs.

3. Other emergencies as deemed appropriate by the Abiquiu Dam Water Manager or the district office.

H-07 INSPECTIONS OR MAINTENANCE

The County Director of Electrical Production will notify the WMS of any expected power facility outages for scheduled inspection, maintenance, or repair purposes that may or may not require transition to FCM. Such notice will be provided at least 48 hours in advance under normal operating conditions. The inspection, maintenance or repair purposes that require complete closure of the USACE's outlet works shall be scheduled concurrently with the USACE O&M periodic inspection program as identified in paragraph 7 of the MOA (Exhibit G).

Table H-1. Abiquiu Dam Power Project Sequence and Timing of Transition Emergency Project Operation at the Direction of USACE

From Power Generation Mode to Flood Control Mode with Communications Intact Transition in Approximately Three Hours	1. USACE alerts county of emergency, operator is dispatched (75 minutes). 2. The powerhouse and bypass valves would begin to shut down (Estimated time 30 minutes). 3. After the power facilities are shut down, the service gates would be closed (Estimated time 10 minutes per gate=20 minutes. Simultaneous operation of both service gates is not permitted per the USACE O&M manual for Abiquiu Dam). Estimated total time for steps 2 and 3 is 50 minutes. 4. The tunnel is depressurized. The closure gate is opened with water ponding in the outlet tunnel and is secured in the up position (30 minutes). 5. The service gates are used to regulate the flow approximately 2 hours and 35 minutes after initiation of the mode transition.

Note: USACE personnel will be trained to cause an automatic shutdown of the turbine-generator units in case of an emergency.

Table H-2. Sequence and Timing of Transition from Power Generation Mode to Flood Control Mode Emergency Project Operations at the Direction of USACE

Communications Disrupted Transition in Approximately One- and One-Half Hours	1. USACE faces an emergency, communications have been disrupted and alternate communications with the county have been unsuccessful, or the county is unable to operate the power plant by remote control and the county's operator is unable to reach Abiquiu Dam power project (Estimated time lapsed 30 minutes). 2. USACE personnel will start automatic sequence of shut down by closing the service gates (Estimated time 20 minutes). 3. As the service gates start to close the unit will detect a change in pressure in the penstock and the power output will decrease until such time as it reaches the lower limit of power production (about 200 kW). At this point the unit will trip, and the flow will be transferred to the bypass valves, which will drain the tunnel without the need of a hand operated procedure (Estimated time about 5 minutes more than the closure time for the service gates). 4. USACE personnel will open closure gate with water ponding in the outlet tunnel and secure the closure gate in the up position (Estimated time 30 minutes). 5. USACE personnel can then start flow regulation through the service gates.

EXHIBIT I

ABIQUIU FORECAST OPERATION FOR CONSERVATION STORAGE EVACUATION

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The flood potential of the Rio Chama results from both snowmelt runoff and rainfall events. However, much of the required flood control storage is for snowmelt runoff. This being the case, it is possible to make dual use of a portion of the snowmelt flood storage. This is possible since snowmelt runoff is predictable, and reasonably accurate forecasts of snowmelt runoff can be made, which would allow for evacuation of conservation water occupying a portion of the flood pool. The remote sensing snow course system, SNOTEL, assists in this type of operation since it allows a real-time assessment of the change in snowpack conditions between snow course measurements and forecasts.

Major flood-producing storms have been experienced primarily during transitional periods between spring and summer, and between summer and fall. During the spring to summer transition period, the winter continental high pressure systems are weakening, thus permitting the Bermuda High and its attendant western lobe to move northward and westward so the western lobe is in position to cause an inflow of moist air from the Gulf of Mexico into New Mexico and Colorado. Rainstorms from such occurrences will occur after the evacuation period. The records demonstrate that precipitation at the high elevations of the Rio Chama prior to mid-April will occur in the form of snow.

The design flood control storage in the Abiquiu Dam project is 502,000 acre-feet. This value was derived by increasing the storage required for the flood of record (1941) by 25 percent. The present sediment reserve is 53,778 acre-feet. Abiquiu Dam is authorized to store SJ-C project water and Rio Grande system water up to elevation 6,230.0 feet for SJ-C contractors. Currently Abiquiu Dam contains 656,342 acre-feet of storage space above the flood control pool for structure protection.

Evacuation of stored conservation water would be required when the snowmelt forecast indicates a need for flood space exceeding available space below elevation 6,283.5 feet. A review of historical streamflow record shows that most years would not require evacuation of conservation water to control the spring runoff. In the 60 years or so of operation of Abiquiu Dam, there has not been a need to pre-evacuate any conservation storage, which further demonstrates that the need for pre-evacuation is a somewhat rare occurrence. The snowmelt runoff forecast point for the Rio Chama is the inflow to El Vado Dam. Adjustments must be made to estimate the inflow into Abiquiu Dam. The adjustments needed are whether El Vado Dam will store any water and addition of intervening flow between El Vado Dam and Abiquiu Dam. A curve was developed from historical data to show the relationship between forecasted snowmelt runoff at El Vado Dam and intervening flow between El Vado Dam and Abiquiu Dam. Figure I-1 shows the relationship, developed using a polynomial best fit curve. Examples of the evacuation of water supply storage were developed using the URGWOM.

A runoff hydrograph similar to the 1942 flood at the Rio Chama near Abiquiu stream gage location (USGS 08287500, 1941 through 1967) was used in the examples. The 1 February forecasted snowmelt runoff volume at El Vado Reservoir for March through July was set at 730,000 acre-feet. The 1990 to 2020 average snowmelt runoff into El

Vado Dam is 186,000 acre-feet, therefore the runoff used in the example is about 392 percent of the 1990 to 2020 normal.

The intervening flow from Figure I-1 for this example is approximately 190,000 acre-feet, making a total of about 920,000 acre-feet of inflow into Abiquiu Dam. It was assumed for this example that El Vado Dam was not storing any water and therefore passing all inflow. Figure I-2 shows the operation of the reservoir without evacuation of conservation storage. Elevation 6,283.5 feet, the top of the flood pool, would have been exceeded; maximum water level is about 6,296.5 feet. Figure I-3 shows the operation of the reservoir with evacuation of conservation starting with the 1 February forecast. The reservoir elevation stays close to the top of the flood pool (6,283.5 feet NGVD29). In both cases, initial reservoir level is 6,230 feet. In each case, operation of Abiquiu Dam from 1 July until 1 November is in accordance with the WCP in Chapter 7.

The basis for evacuation of storage will be made from spring snowmelt runoff forecasts and channel conditions downstream from Abiquiu Dam. Determinations will be made of when and how much evacuation will be required. These forecasts will be supplemented by real-time data from the SNOTEL system to make any adjustments to the evacuation schedule. The accuracy of the forecasts improves with each additional month of data, so the 1 March forecast is better than the 1 February forecast. Adjustments will be made with each new forecast.

Figure I-1. Intervening Runoff on the Rio Chama from El Vado Dam to Abiquiu Reservoir

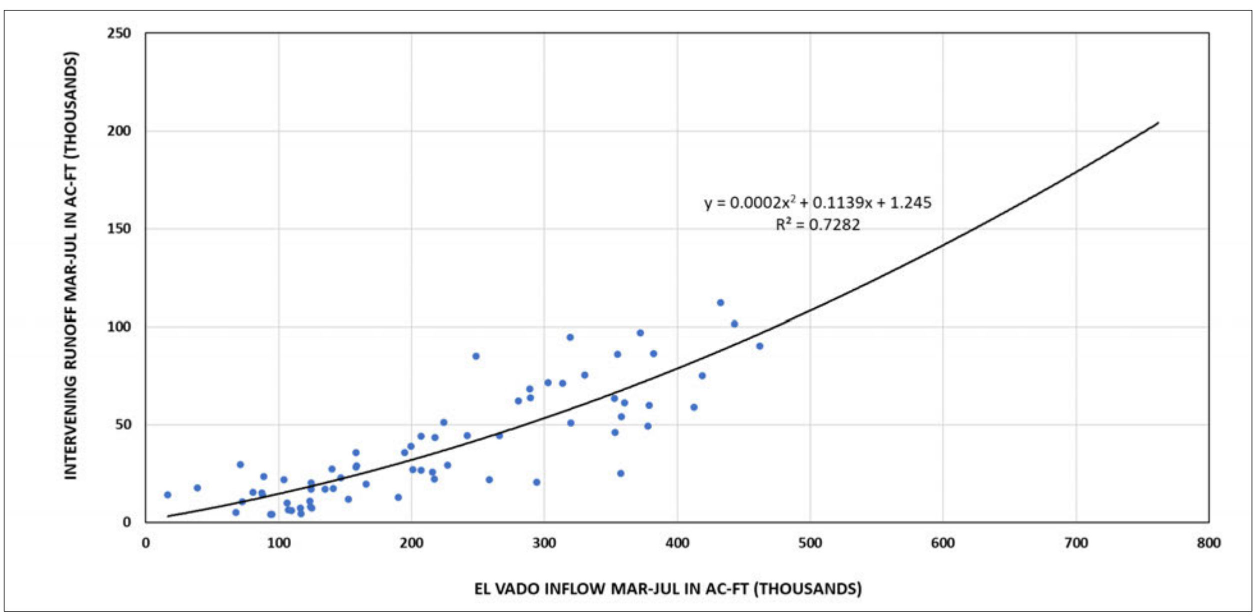


Figure I-2. Abiquiu Dam Operation without Evacuation of Conservation Storage (Inflow 920,000 acre-feet)

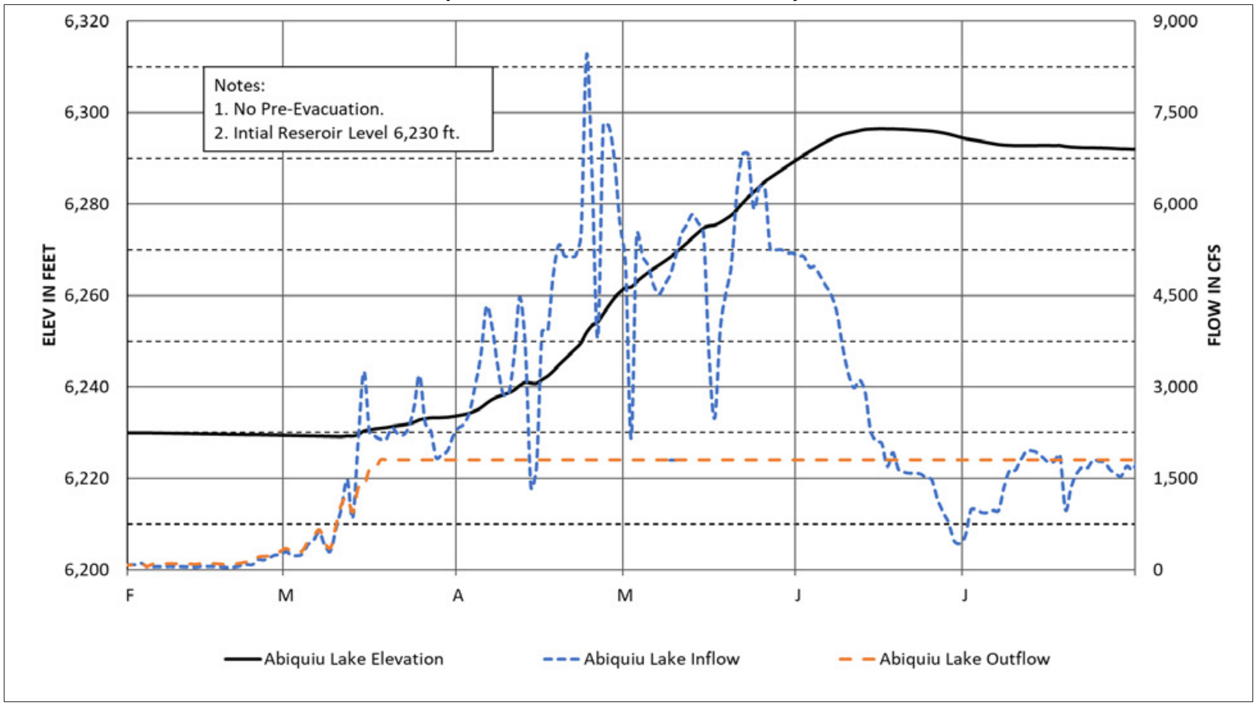
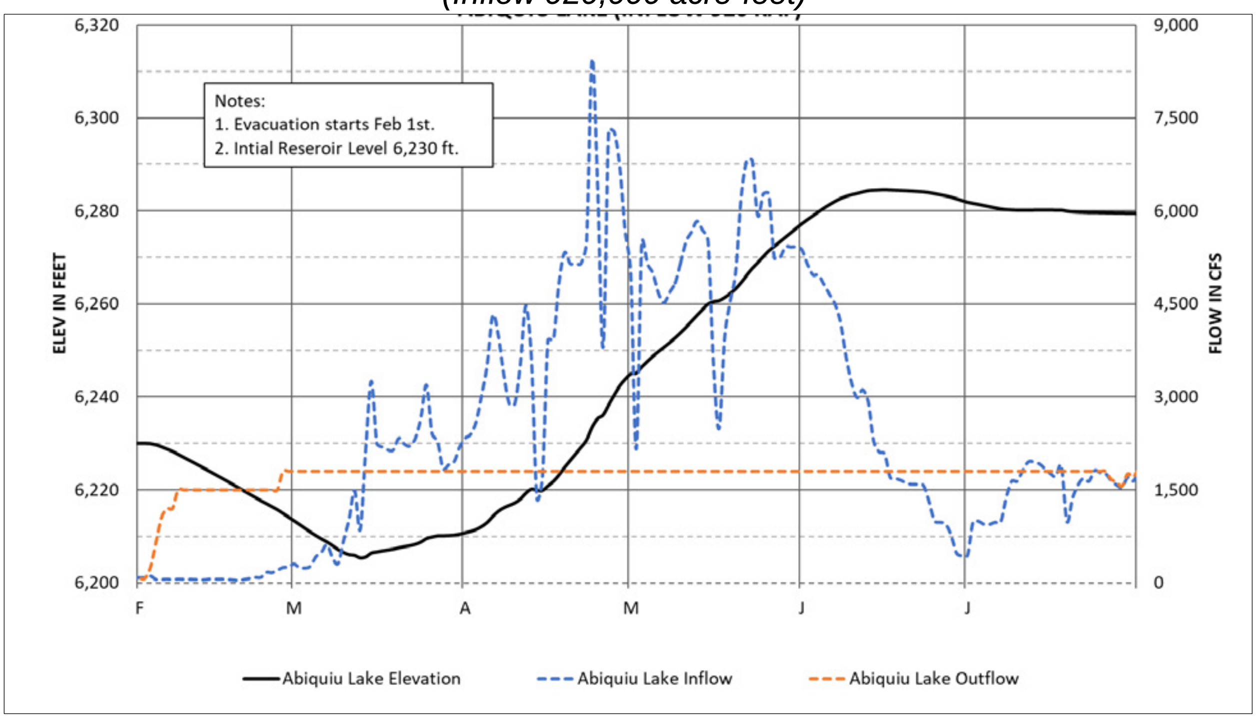


Figure I-3. Abiquiu Dam Operation with Evacuation of Conservation Storage (Inflow 920,000 acre-feet)



Following are more examples of pre-evacuation curves in Abiquiu Dam using a high flow runoff hydrograph similar to the computed inflow into Abiquiu in 1984. The 1990 to 2020 average snowmelt runoff into El Vado Dam is 186,000 acre-feet and 3 flow scenarios (400 percent, 350 percent, and 300 percent of the average flow) are presented in Table I-1.

Table I-1 Three Scenarios of Inflows to Abiquiu Dam

Flow Scenario	El Vado Inflow (acre-feet)	Intervening Flow (acre-feet)	Total Inflow (acre-feet)
Scnario-1: 400% of Average Flow	744,000	196,600	940,600
Scenario-2: 350% of Average Flow	651,000	159,420	810,420
Scenario-3: 300% of Average Flow	558,000	126,720	684,720

Intervening flows in Table I-1 are determined from Figure I-1. This curve that was developed from historical data to show the relationship between forecasted snowmelt runoff at El Vado Dam and intervening flow between El Vado Dam and Abiquiu Dam as described above.

Figure I-4 (A) shows Abiquiu Reservoir water level for the three inflow scenarios (400 percent, 350 percent, and 300 percent of the normal or average water volume in the period March through July). Examples in this figure assume that the evacuation at Abiquiu Dam starts at the beginning of February and the starting water level at the reservoir is 6,230.0 feet. Elevation 6,230.0 feet is the maximum elevation for water supply storage. Figure I-4b shows inflow and outflow hydrographs along with the reservoir water level for inflow 400 percent of the normal flow. Other conditions in Figure I-4b are similar to those in Figure I-4a. Similarly, Figure I-5a shows Abiquiu Dam water level for three different forecasted water volumes (400 percent, 350 percent, and 300 percent) of the normal water volume in the period March through July, where the evacuation of the reservoir starts at the beginning of March. Figure I-5b shows inflow and outflow hydrographs along with the reservoir water level for inflow 400 percent of the normal inflow.

Figure I-4a. Abiquiu Reservoir Elevation for Three Inflow Scenarios (Evacuation Starts on 01 February)

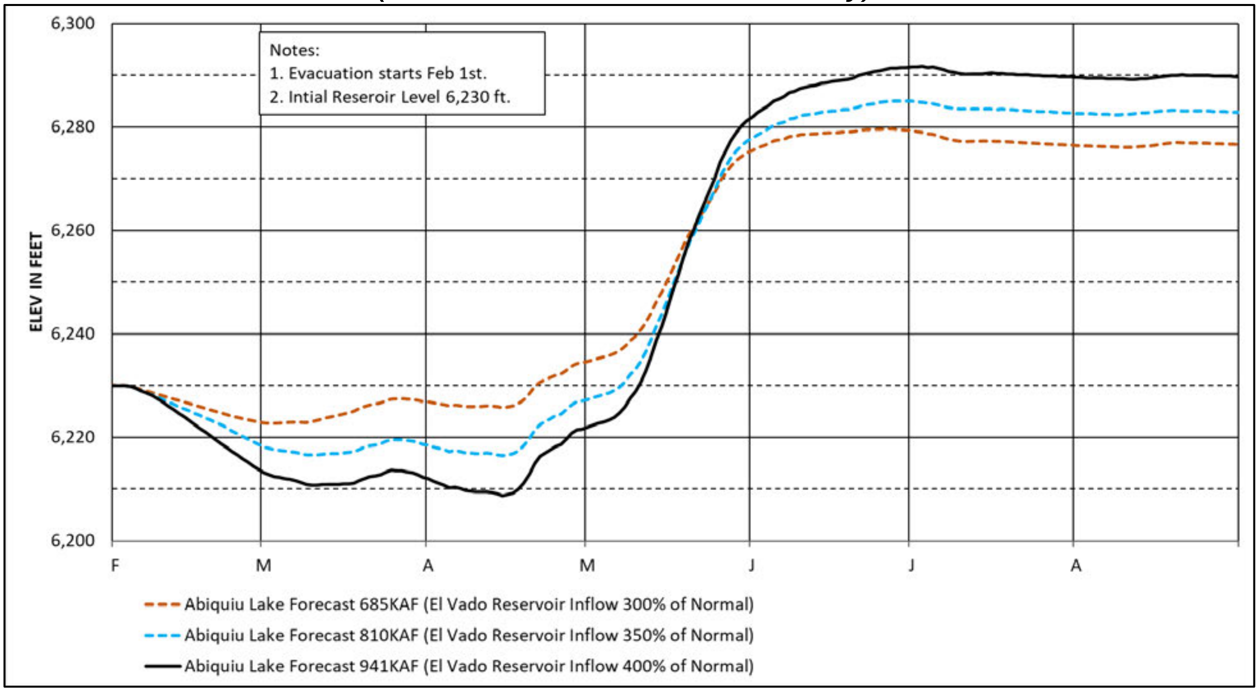


Figure I-4b. Abiquiu Dam Operation for Scenario-1 (940,600 acre-feet) (Evacuation Starts on 01 February)

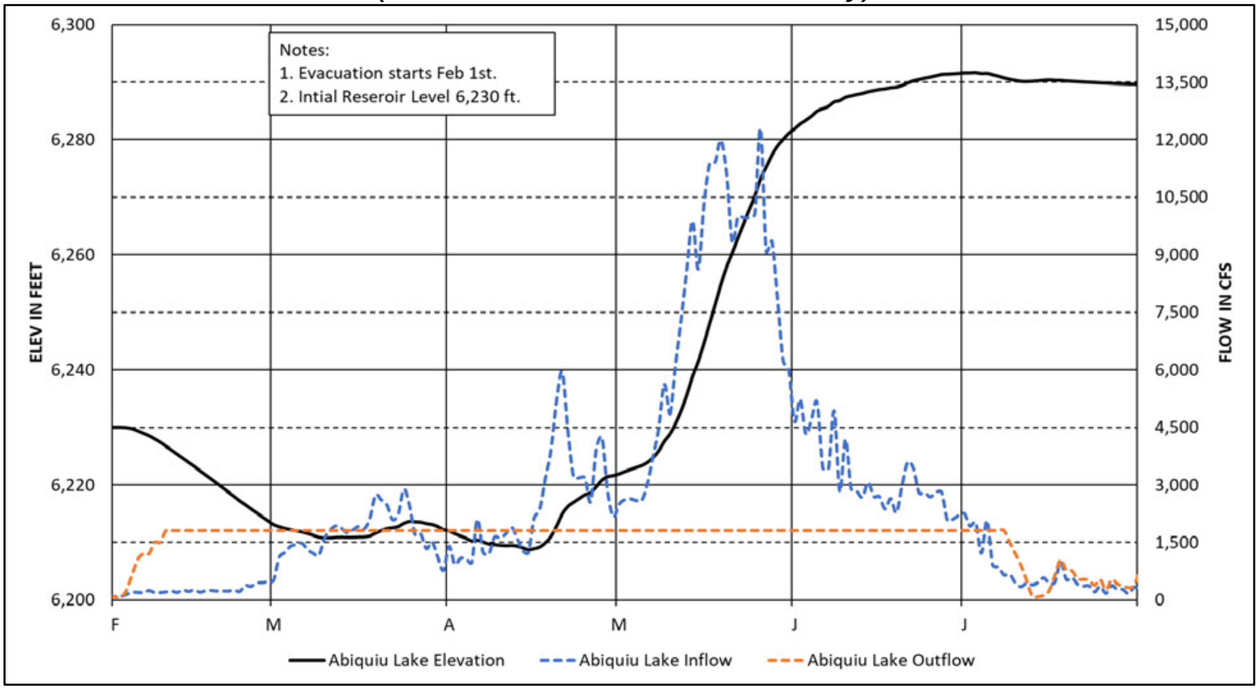


Figure I-5a. Abiquiu Reservoir Elevation for Three Inflow Scenarios (Evacuation Starts on 01 March)

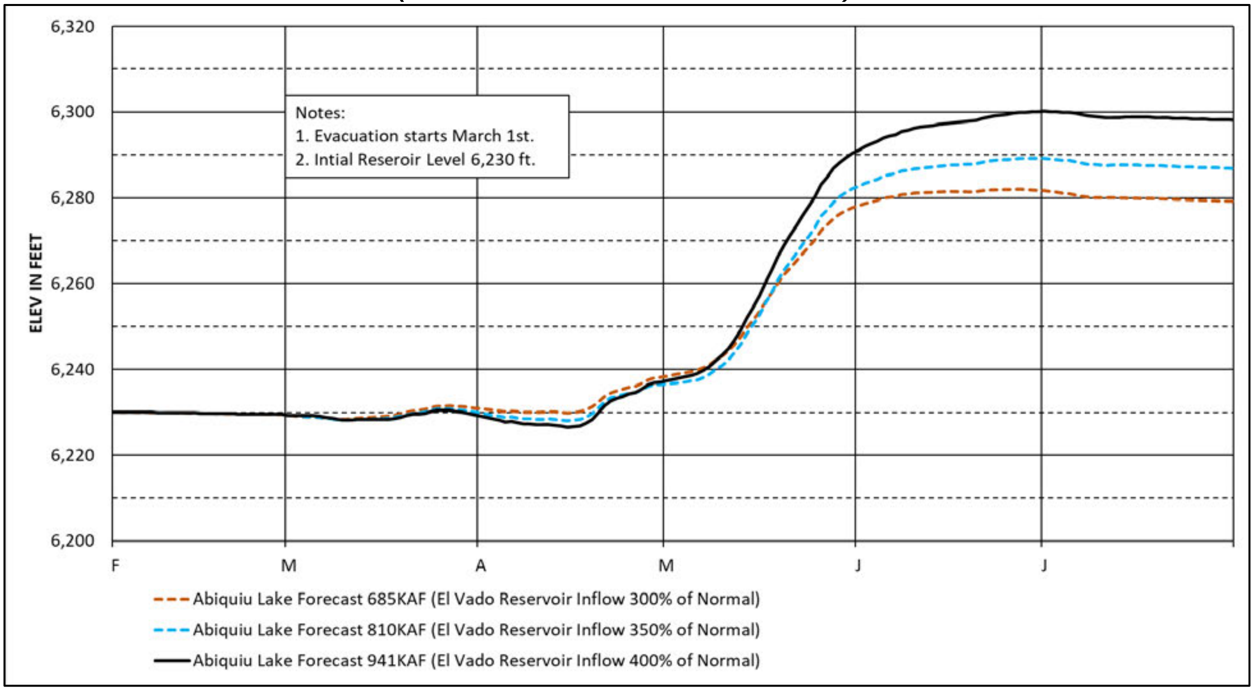


Figure I-5b. Abiquiu Dam Operation for Scenario-1 (940,600 acre-feet) (Evacuation Starts on 01 March)

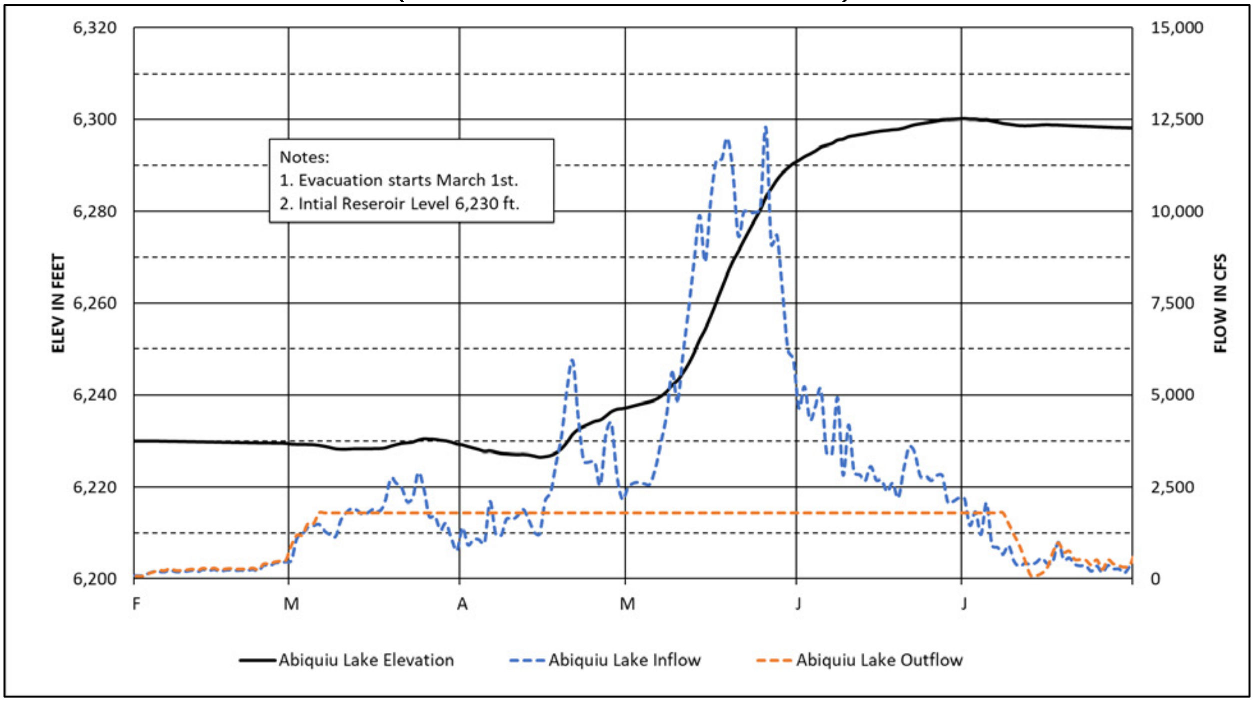


EXHIBIT J

CESPD-RBT
REGULATION NO. 10-1-04

GUIDANCE ON THE PREPARATION OF DEVIATIONS FROM APPROVED WATER CONTROL PLANS

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DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION CORPS OF ENGINEERS
1455 Market Street
San Francisco, California 94105-2195

CESPD-RBT

REGULATION
No. 10-1-04

18 December 2014

Engineering and Design
GUIDANCE ON THE PREPARATION OF DEVIATIONS FROM APPROVED WATER CONTROL PLANS

1. PURPOSE. This document establishes the protocol for reporting deviations from approved Water Control Plans for water control projects within the South Pacific Division (SPD). Each major subordinate command (MSC) is responsible for establishing guidance as outlined in ER 1110-2-1400 with respect to water control management policy including deviation. It defines coordination, review, and approval procedures between SPD and District offices. Approval from SPD must be obtained for deviations.

2. APPLICABILITY. The following is applicable to all South Pacific Division Districts and field-operating activities having civil works responsibilities.

3. REFERENCES. Authority and guidance can be found in Appendix A and B of Draft ER 1110-2-240 (enclosure):

4. OVERVIEW.

a. Water Control Manuals are prepared for USACE-owned reservoir projects. Water Control Manuals are also prepared for non-USACE projects where USACE has flood control or navigation responsibilities. The Water Control Manual provides guidance and instruction for project personnel and serves as a reference for others who may be involved with, responsible for, or affected by project water control regulation. The Water Control Manual includes the Water Control Plan and is compliant with the objectives and provisions of authorizing legislation and applicable USACE project reports. The Water Control Manual generally describes how a reservoir will be regulated, incorporates allowable flexibility for a broad variety of runoff and climatic conditions to achieve authorized project purposes and covers the regulation of the project over the entire regime of pool elevations and conditions.

b. Water Control Plans are developed to ensure that operations of reservoirs, locks and dams, re-regulation, and major control structures and interrelated systems conform to objectives and specific provisions of authorizing legislation and applicable USACE reports, including any applicable authorities established after project completion. Water Control Plans are prepared with appropriate consideration of federal law that relates to the operation of federal facilities, as well as the requirements of Water Control Manuals. Thorough analyses are performed to establish optimal Water Control Plans within prevailing constraints. Formulation of these plans requires a comprehensive knowledge of project purposes, history, authorizing legislation, USACE policies and regulations, system effects, hydrology, meteorology, operations and physical constraints/capabilities of project features. Prior to approval and implementation, the proposed Water Control Plan is released for public review and comment. Generally, this proceeds concurrently with the NEPA public review process.

The Water Control Plan consists of coordinated regulation schedules for project/system regulation, provisions for collection and dissemination of data, guidelines for preparation of detailed operating instructions, guidelines to assure project safety, and actions to fulfill regulatory requirements.

Deviations – Water Control Manuals contain a provision authorizing the operating agency to deviate temporarily from operations prescribed in the project's approved Water Control Plan when necessary to alleviate critical situations or to realize increased benefits during an operation season without significantly affecting the fulfillment of the projects authorized purposes. These deviations are intended to address special and unique circumstances including dam safety issues. The competing goals and complex interactions of interested groups/agencies can cause even seemingly inconsequential deviations from an approved plan to lead to unforeseen life safety and environmental impacts, and legal complications. This regulation serves to assist the District in preparing their deviation requests. It outlines a minimum set of considerations that need to be addressed when making a recommendation to deviate from an approved Water Control Plan.

Deviations generally fall into three categories: emergency, unplanned, and planned deviations. Regardless of the type of deviation, the basic tenets of a deviation must adhere to safe operation to include operational/structural integrity, not endanger the dam, mitigate risk of downstream flooding, not unnecessarily store water in the pool, and not compromising the safety of persons or property downstream. Also any deviation must be consistent with project authorization and within existing authorities.

5. TYPES OF DEVIATIONS.

a. *Emergency Deviations.* An emergency deviation from an approved Water Control Plan is one that is required to mitigate an immediate threat to public health and safety, property, project, or the environment. Each Water Control Manual generally contains provisions for dealing with emergency situations. If the Water Control Manual contains provisions for emergency situations, water control action taken in accordance with those provisions would not be considered a deviation from the Water Control Plan. However, for those situations not covered in the Water Control Manual, these are considered emergency deviations and demand immediate action. Request for and approval of emergency deviation may be transmitted to SPD by telephone or electronic media. Necessary actions may then be immediately taken under emergency conditions with the approval of the District Commander. A written confirmation describing the deviation and the conditions that required the action shall be forwarded to the SPD Commander as soon as practicable.

An emergency situation could include: drowning and other accidents, assistance to local authorities responding to an emergency (e.g. police and fire departments), failure of operations facilities, chemical spills, treatment plant failures, and other temporary pollution or water quality problems. Water control actions necessary to abate the problem are taken immediately unless such action would create equal or worse conditions. Such deviations generally last from a few hours to a few days.

b. Unplanned Deviations. Each Water Control Manual generally contains provision for dealing with a wide range of unplanned occurrences that are not considered emergencies. The need for unplanned deviations can arise due to unforeseen conditions that do not allow sufficient time for a full analysis prior to the deviation. These types of unplanned deviations could arise due to construction, maintenance, inspection or flood control needs. Such deviations generally last from a few hours to a few days. Each request for an unplanned deviation should be analyzed on its own merits, with an evaluation of factors such as impacts to potential failure mode and consequences, upstream watershed conditions, potential flood threat, condition of the lake, possible alternative measures, and potential adverse effects on the overall regulation of the project for the authorized purposes. Requests for and approval of unplanned deviations may be transmitted by telephone or electronic media. Follow-up written documentation explaining the deviation and its cause shall be furnished as soon as practicable to the SPD Senior Regional H&H/Water Control Engineer with notification to (cc'ed) the District and SPD Dam Safety Officers. Unplanned deviation should follow the guidance and process of a planned deviation. It is recognized that unplanned deviation may require expedited review/approval due to the circumstances. Hence, early notification to SPD is of utmost importance.

c. *Planned Deviations*. Planned deviations cover other deviations not addressed by an emergency or unplanned deviation. Planned deviations for Dam Safety Action Classification (DSAC 1-3) dams shall comply with ER 1110-2-1156, chapter 24 – Dam Safety Considerations for Storage Allocation, Reallocation, and related Studies of. A major deviation that would result in increased water storage at a DSAC 1,2, or 3 requires HQ approval. Planned Deviations are categorized into two types – Planned Minor and Planned Major.

1. *Planned Minor*. Minor deviation is limited by i) flood control pool elevation will not vary more than 2 feet from what would have been the water surface elevation under the approved Water Control Plan or ii) storage difference from approved Water Control Manual will not exceed 5% of the total storage. Minor deviation should not last more than 10 days. Longer minor deviation must be coordinated with the SPD Senior Regional H&H/Water Control Engineer.

2. *Planned Major*. All other planned deviations are considered major deviations.

A risk and uncertainty (Section 8.b.3) analysis shall be performed to determine potential consequences of the deviation. Depending on the circumstances and availability of data, this could be qualitative or quantitative. Best effort should be used to attempt a qualitative analysis.

6. OFFICE OF RECORD. The originating District's water control management office will be responsible for maintaining all relevant records documenting the deviation.

7. GENERAL INFORMATION FOR PREPARING DEVIATIONS.

a. Time to Prepare Deviations. District offices should also inform potential agencies/entities that the lead time required to assemble the necessary information required to evaluate a deviation request may be on the order of months (normally due to the required environmental analysis and the public review process). Thus, the request to the District should be made well in advance of the proposed initiation date from the deviation. The requesting agency/entity should also be made aware that approval of the deviation request would depend upon such things as a review of the impacts (e.g., environmental, hydrologic, legal, etc.). The deviation request should also be coordinated with the District Dam Safety Officer.

b. Coordinating with SPD Staff. Preparation of a deviation package is a time consuming and costly undertaking. Incomplete or inadequate package impacts timing for approvals. District personnel are to coordinate any questions or concerns about potential deviations, and discuss any atypical situations with their SPD counterparts early in the process before the package submittal. The necessary technical review will be conducted at the District level with review certification provided to SPD. In an emergency situation, a formal quality certification will most likely not be required. A written confirmation describing the deviation and the conditions that required the action shall be forwarded to the division commander as soon as practicable.

c. Non-Corps Projects. Deviation requests from non-Corps (Section 7 the Flood Control Act of 1944, as amended) projects must be prepared with the approval of the project owner. This is required because project owners are responsible for assuring that the project is operated as prescribed in the Water Control Plan developed in concert with the USACE flood control requirements. The owner is also ultimately responsible for dam safety at the project and for funding of the project.

d. Environmental Requirements. Each deviation request shall include a summary of identified environmental effects of the proposed deviation, and a statement of how the proposal complies with pertinent environmental requirements, including but not limited to the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Clean Water Act (CWA), and the Clean Air Act (CAA). NEPA documentation requirements may be met by preparation of an Environmental Assessment (EA) of the proposed action, concluding with a Finding of No Significant Impact (FONSI). If the EA discloses significant impacts to the human environment that are complex, extensive and/or that cannot be readily avoided, minimized, or mitigated; development and coordination of an Environmental Impact Statement (EIS) is required, concluding with a Record of Decision (ROD). This and related decisions will be coordinated with senior environmental staff in the District's and Division's Planning Divisions, to include senior ecologists. If an existing EIS/ROD or EA/FONSI accurately covers the action, and if there have been no environmental changes since that documentation, there may be reliance and reference to this documentation for purposes of environmental compliance. If those NEPA documents are more than five years old, such reliance is improper. Updated NEPA documentation is required to include full coordination with resource agencies and the public. The scope and type of NEPA documentation will be coordinated with Planning and Office of Counsel. Supporting environmental documents shall be included in the deviation request package when it is submitted. Subject NEPA documents will be accompanied, as applicable, by a Biological Assessment and final Biological Opinion, and a letter from U.S. Fish & Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS) concurring there is not likely to be adverse effect on listed or other significant species. A 404(b)(1) evaluation under the CWA may also be required. In the case of emergency deviations, the emergency provisions and requirements of the various environmental laws shall be followed as practicable. Deferred compliance does not mean compliance is avoided, but rather that it may be delayed or mitigated. Any significant impacts of reoperation, moreover, must be identified, managed and mitigated after the fact regardless of the urgency of such emergency activities. Foresight, planning ahead and timely coordination with resource agencies, therefore, is of utmost importance and priority.

e. *Recurring Deviation.* Recurrent or prolonged planned deviation may indicate the need for a formal change to the water control plan. Deviations that occur in three or more consecutive years, or three or more times within a five-year period, must be fully coordinated with USACE Headquarters.

8. ROLES AND RESPONSIBILITIES

a. SPD DISTRICTS

Preparation of Deviations. Processing of a deviation request as outlined in the approved Water Control Manual and in accordance with this regulation originates at the District Water Control Management office. The District Commander may delegate signature authority for requesting deviations from approved Water Control Plans to the appropriate functional division head or designated representative. Consultation with the District staffs, including engineering, planning, environmental, economics, operations, construction and legal must take place. The following information shall be submitted in written form to the SPD Commander or designee for consideration of the deviation:

(1) Description of the proposed deviation, including purpose, proposed change from the approved water control plan, duration, and other details about the deviation.

(2) The implications of adhering to the water control plan and of employing the proposed deviation.

(3) Alternative deviation plan (or plans) to include the application of risk and uncertainty in the analysis and the consequences of each.

(4) Effects of the proposed deviation on project and system operation, and on other project purposes such as flood control, hydropower, water quality, water supply, navigation, recreation, or fish and wildlife.

(5) Review of the existing Potential Failure Mode Analysis (PFMA) for the dam and an analysis of the effect of the deviation on the probability of failure and consequences associated with the deviation.

(6) The potential flood threat with and without the proposed deviation.

(7) Current and predicted maximum storage, elevation, river stage, and other pertinent information with and without the deviation.

(8) Review of the alternative (or alternatives) under provisions of pertinent laws and regulations, including, but not limited to, the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Clean Water Act (CWA), National Historic Preservation Act (NHPA), Clean Air Act (CAA), etc., when and as applicable.

(9) A description of the coordination that has been done with affected entities, both USACE and non-USACE, and the effect on other local, regional, state, tribal, and federal agencies.

(10) Written comments from agencies, organizations, businesses, and individuals who may be impacted by, or supportive of the proposed change in flows, including federal, state, and local agencies; tribes; industries, organizations, and other stakeholders; and the public.

(11) Discussion of any other relevant issues.

(12) District Commander's, or designee's, recommendation.

In addition, requirements for submission of an exception to ER 1110-2-1156, Chapter 24, if required, shall conform to the submission requirements contained therein. Also, Appendix B.1 - District Engineer Quality Certification must be signed and submitted with the package.

b. SOUTH PACIFIC DIVISION

Approval of Deviations. Approval for deviations must be obtained from the SPD Commander or designee prior to their implementation. Approval for exceptions to Chapter 24 of ER 1110-2-1156 for deviations that increase water storage at DSAC 1, 2, or 3 dams shall be obtained from the HQUSACE Dam Safety Officer. Such request will be submitted through command channels to the SPD USACE Regional Integration Team (RIT) in Washington, DC. As noted in paragraph 5.a, an emergency deviation situation may warrant an immediate action as outlined in the Water Control Manual. Necessary actions under emergency conditions may then be taken immediately upon telephone or electric media notification to SPD and with approval of the District Commander. A written confirmation describing the deviation and conditions that required the action shall be forwarded to the SPD Commander as soon as practicable.

Approval of all unplanned and planned deviation must be obtained prior to implementation of the deviation. Planned deviation must be approved in writing. Unplanned deviations may be approved via telephone, e-mail, fax or other appropriate communication methods with written documentation provided as soon as practicable. Unplanned and Planned major deviation must be approved by the Division Commander or designee (Deputy Commander), hence may require more time and coordination. Approval of planned minor deviation will be given by the SPD Senior Regional H&H/Water Control Engineer or his/her immediate supervisor.

9. PREPARING EMERGENCY DEVIATIONS

a. Emergency deviations are the only type of deviation that do not require prior approval from SPD, and must only be used if events warrant an immediate emergency action, such that time constraints render impractical notification to the SPD. However, even in an emergency situation, the District shall notify the SPD of the action as soon as possible, and shall comply with all applicable requirements.

b. A record of the emergency deviation shall be developed at the district office and transmitted to the SPD office within a day of the action taken.

c. Procedures for emergency deviations: (1)

(1) Take the necessary action.

(2) Contact SPD as soon as possible to describe the action taken and the cause (NOTE: The order of (l) and (2) may be reversed depending on the nature of the emergency). Continuation of the deviation will require SPD approval.

(3) The District shall provide written confirmation to the SPD office within 21 days of the deviation. The correspondence shall include the items outlined section 7.b (as applicable).

(4) The SPD shall respond within 7 days of the District's notification of the emergency deviation.

10. PREPARING PLANNED (UNPLANNED) DEVIATIONS.

a. The District shall inform SPD (Senior Regional H&H/Water Control Engineer) within 2 days of receiving a request for a proposed deviation. If the District is requesting the deviation, notification to SPD should be made as soon as practicable.

b. At least 21 days prior to the proposed action, the District shall transmit a deviation request package to the SPD offices. The deviation request package shall include the items in section 8.a. This package may be initially transmitted electronically.

c. If the District submits a complete quality package with all required documentation, SPD will review the proposal and approve or disapprove the District's deviation request within 7 days. Early, detailed, coordination and transmittal of documents to SPD may expedite the processing time.

d. For unplanned deviation, the District will notify SPD as soon as possible of a request for a proposed deviation. SPD will make an expedited effort to review/approve the deviation based on the project's needs.

MARK TOY, P.E.
BG, USA
Commanding

APP A-District Engineer's Certification for Emergency Deviation
APP B.1 – District Approval Certification for Major Deviation
APP B.2 – Division Approval Certification for Major Deviation
APP C – Division Approval Certification for Minor Deviation

DISTRIBUTION: Electronic
Copy Available

APPENDIX A

DISTRICT ENGINEER'S CERTIFICATION
For Emergency Deviation

COMPLETION OF QUALITY CONTROL ACTIVITIES
The District has completed the review/analysis of the emergency water control deviation from the Approved Water Control Plan for *(Project Name and Location)*. Certification is hereby given that all quality control activities appropriate to the level of risk and complexity inherent in this analysis have been completed. A written confirmation describing the deviation and the conditions that required the action was forwarded to the SPD Commander on (*insert date*).

GENERAL FINDINGS

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, data and the reasonableness of the results. The undersigned recommends certification of the quality control certification for this deviation request.

(Signature) *(Date)*
Chief, District Engineering Division

(Signature) *(Date)*
Chief, District Asset Management (Operation) Division

(Signature) *(Date)*
Chief, District Planning (Environmental) Division

CERTIFICATION OF LEGAL REVIEW*
The request for a water control deviation from the approved Water Control Plan report for *indicate name of project*, has been fully reviewed by the Office of Counsel, and is approved as legally sufficient.

(Signature) *(Date)*
Chief, District Counsel

DISTRICT COMMANDER CERTIFICATION
All issues and concerns resulting from technical review of the water control deviation have been resolved. A written confirmation describing the deviation and the conditions that required the action shall be forward to the Division Commander as soon as practicable. **This deviation is approved.**

(Signature) *(Date)*
District Commander

APPENDIX B.1
(To be completed by District)

DISTRICT APPROVAL CERTIFICATION
For Major Planned (Unplanned) Deviation

COMPLETION OF QUALITY CONTROL ACTIVITIES

The District has completed the review/analysis of the water control deviation from the Approved Water Control Plan for *(Project Name and Location)*. Certification is hereby given that all quality control activities appropriate to the level of risk and complexity inherent in this analysis have been completed.

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, data and the reasonableness of the results. The undersigned recommends certification of the quality control certification for this deviation request.

(Signature) (Date)
Chief, District Engineering Division

(Signature) (Date)
Chief, District Asset Management (Operation) Division

(Signature) (Date)
Chief, District Planning (Environmental) Division

(Signature) (Date)
Chief, District Environmental Resources Branch

CERTIFICATION OF LEGAL REVIEW*

The request for a water control deviation from the approved Water Control Plan report for *indicate name of project*, has been fully reviewed by the Office of Counsel, and is approved as legally sufficient.

(Signature) (Date)
District Counsel

QUALITY CERTIFICATION

All issues and concerns resulting from technical review of the water control deviation have been resolved. This deviation is recommended for approval.

(Signature) (Date)
District Commander

APPENDIX B.2
(To be completed by Division)

DIVISION APPROVAL CERTIFICATION
For Major Planned (Unplanned) Deviation

COMPLETION OF QUALITY ASSURANCE ACTIVITIES

The Division has completed the review/analysis of the water control deviation from the Approved Water Control Plan for *(Project Name and Location)*. Certification is hereby given that all quality assurance activities appropriate to the level of risk and complexity inherent in this analysis have been completed.

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, data and the reasonableness of the results. The undersigned recommends certification of the quality assurance certification for this deviation request.

(Signature) *(Date)*
Chief, SPD Business Technical Division

(Signature) *(Date)*
Chief, SPD Civil Work Integration Division

(Signature) *(Date)*
Chief, SPD Planning (Environmental) Division

CERTIFICATION OF LEGAL REVIEW*

The request for a water control deviation from the approved Water Control Plan report for *indicate name of project*, has been fully reviewed by the Office of Counsel, and is approved as legally sufficient.

(Signature) *(Date)*
Chief, SPD Office of Counsel

DIVISION COMMANDER APPROVAL

(Signature) *(Date)*
Division Commander

APPENDIX C

DIVISION APPROVAL CERTIFICATION
For Minor Planned (Unplanned) Deviation

COMPLETION OF QUALITY CONTROL ACTIVITIES

The District has completed the review/analysis of the water control deviation from the Approved Water Control Plan for *(Project Name and Location)*. Certification is hereby given that all quality control activities appropriate to the level of risk and complexity inherent in this analysis have been completed.

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, data and the reasonableness of the results. The undersigned recommends certification of the quality control certification for this deviation request.

(Signature) *(Date)*
Chief, District Engineering Division

(Signature) *(Date)*
Chief, District Asset Management (Operation) Division

(Signature) *(Date)*
Chief, District Planning (Environmental) Division

(Signature) *(Date)*
Chief, District Environmental Resources Branch

CERTIFICATION OF LEGAL REVIEW*

The request for a water control deviation from the approved Water Control Plan report for *indicate name of project,* has been fully reviewed by the Office of Counsel, and is approved as legally sufficient.

(Signature) *(Date)*
District Counsel

DIVISION APPROVAL

(Signature) *(Date)*
SPD Senior Regional H&H/Water Control Engineer

PLATES

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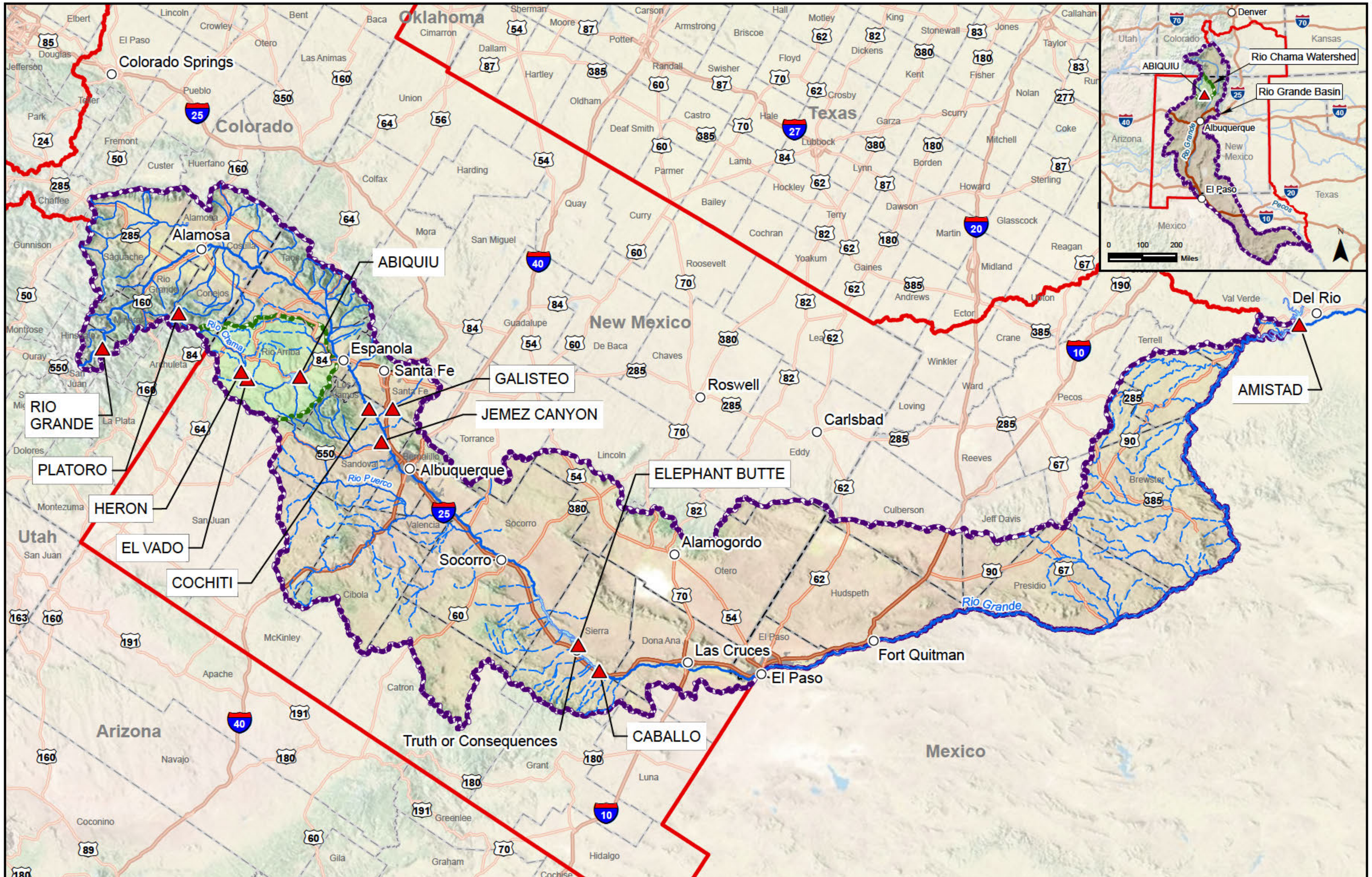


Legend

- City
- Dam
- Ephemeral Stream
- River
- Interstate or Limited Access Highway
- Highway
- Albuquerque District Boundary
- County Boundary
- State Boundary
- Rio Chama Watershed
- Rio Grande Basin
- Water Body
- Urban Area

US Army Corps of Engineers ®
Albuquerque District

0 60 120 180 240 Miles

1:3,801,600

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

LOCATION AND VICINITY MAP

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 2-1

Legend

- City
- Dam
- Stream Gage
- Ephemeral Stream
- River
- San Juan Chama Project Tunnel
- Interstate or Limited Access Highway
- Highway
- Albuquerque District Boundary
- County Boundary
- State Boundary
- Rio Chama Watershed
- Rio Grande Basin
- National Forest
- Tribal Land
- Urban Area
- Water Body

US Army Corps of Engineers ®
Albuquerque District

0 9 18 27 36 Miles

1:570,240

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

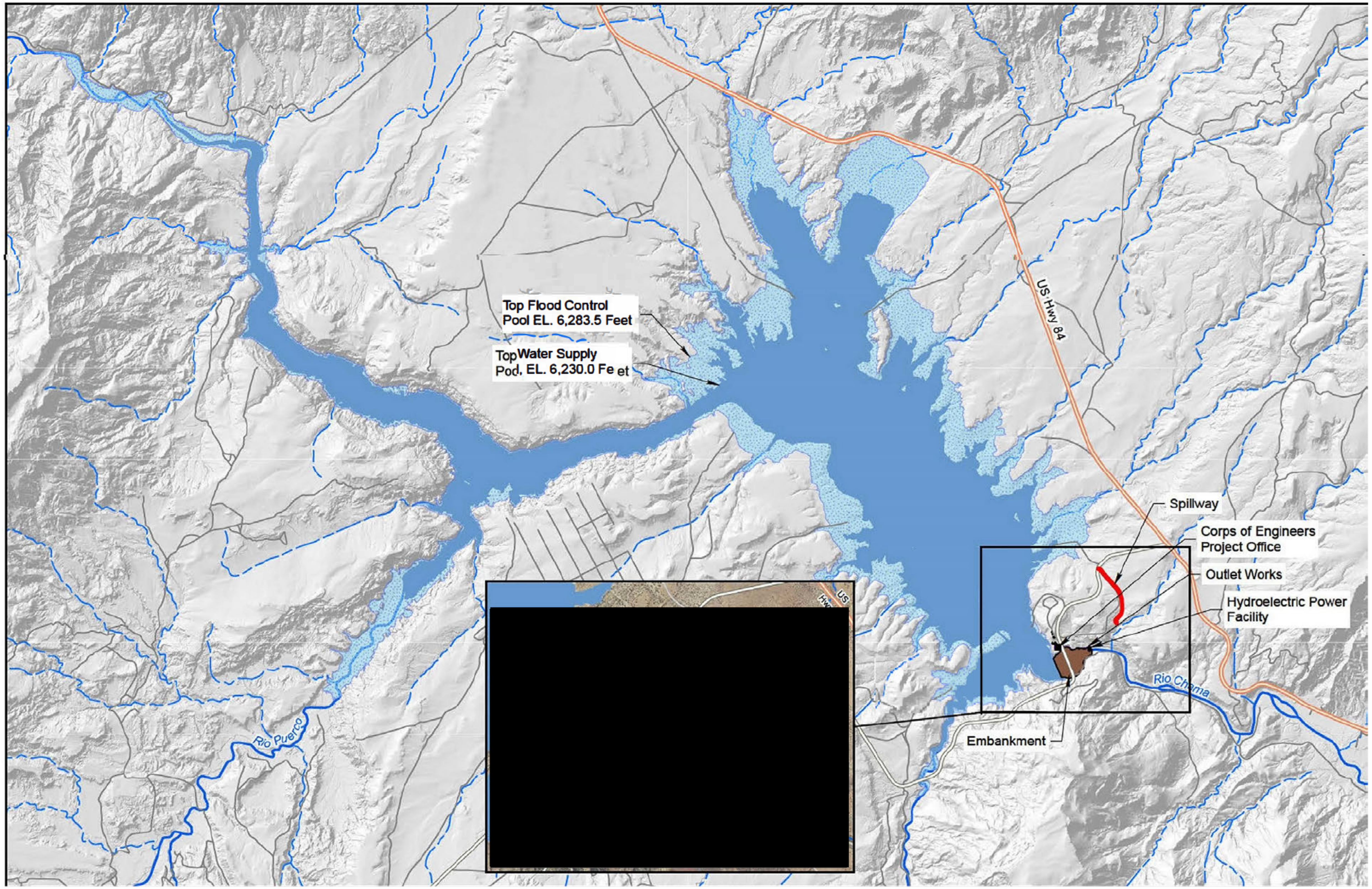
RIO GRANDE BASIN | NEW MEXICO

ABIQUIU DAM

RIO CHAMA WATERSHED MAP

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 2-2



US Army Corps of Engineers ®
Albuquerque District

0 1 2 3 4 Miles

1:63,360

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

PHYSICAL COMPONENTS

TO ACCOMPANY WATER
CONTROL MANUAL
DATED APRIL 2024

Plate 2-3

[redacted]

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

EMBANKMENT PLAN AND SECTION

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 2-4

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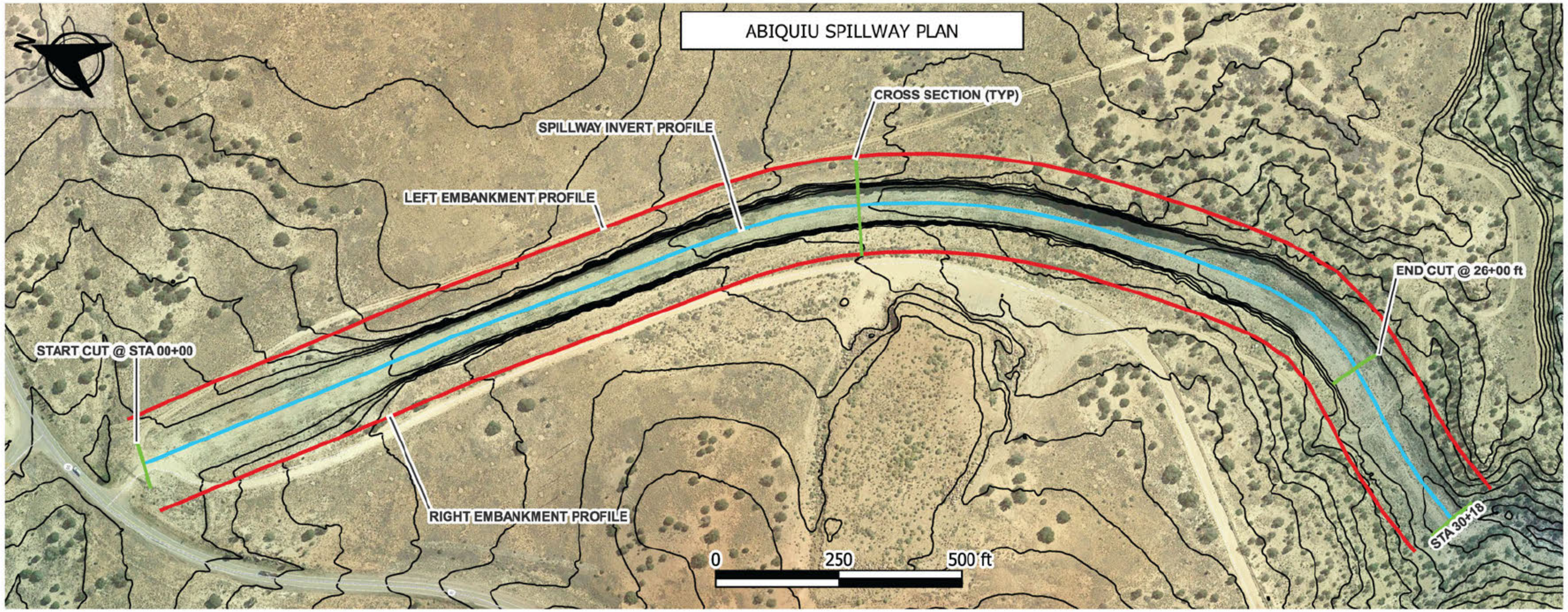
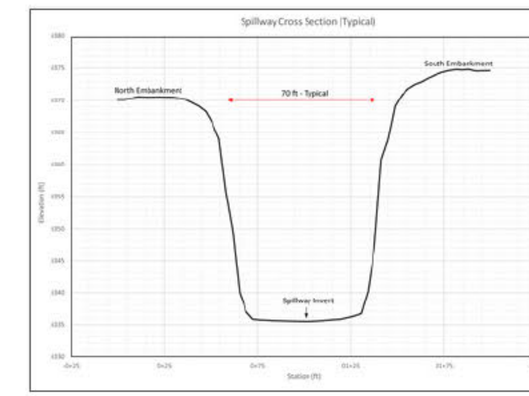
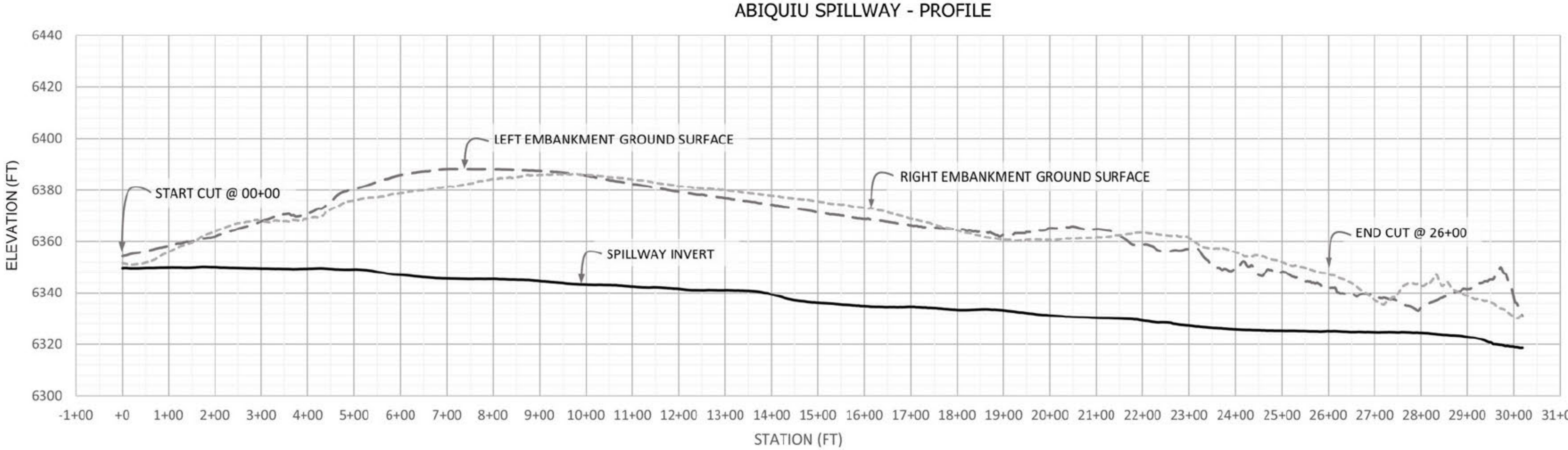
Albuquerque District





ABIQUIU SPILLWAY - PROFILE



Note: 2022 Rio Chama Lidar Flight data with QGIS, NAVD88 (profile converted to NGVD 29)

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

US Army Corps of Engineers ®
Albuquerque District

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
RIO GRANDE BASIN	NEW MEXICO
ABIQUIU DAM **SPILLWAY PLAN, PROFILE AND SECTION**	
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024	**Plate 2-5**

[redacted]

US Army Corps
of Engineers ®
Albuquerque District

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

OUTLET WORKS

TO ACCOMPANY WATER
CONTROL MANUAL
DATED APRIL 2024

Plate 2-6

[redacted]

US Army Corps
of Engineers ®
Albuquerque District

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

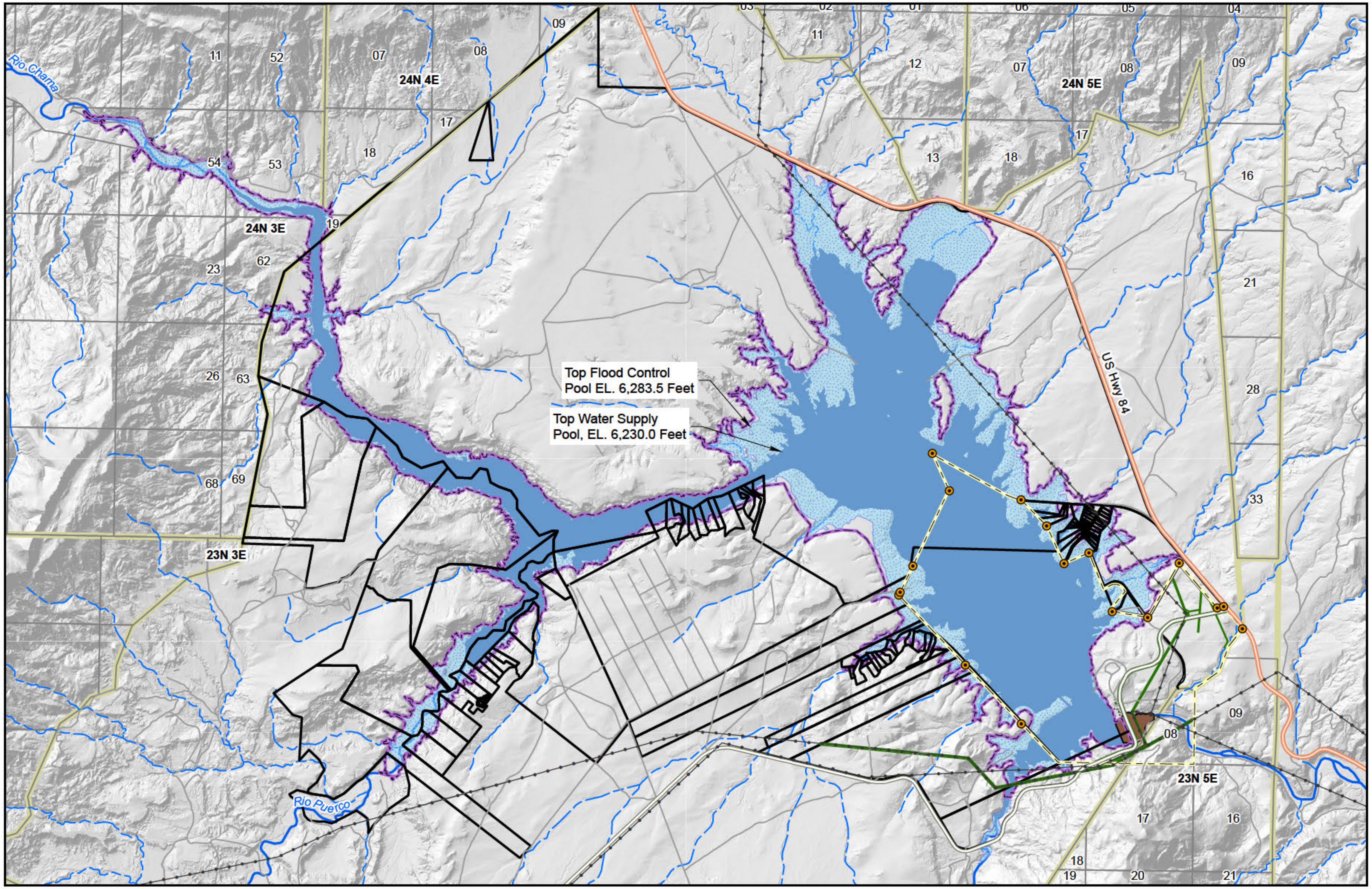
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

HYDROELECTRIC POWER FACILITIES

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 2-7



Legend

- Property Control Monument
- Ephemeral Stream
- River
- Primary Highway
- Major Road
- Local Road
- Power Line
- PLSS Section
- PLSS Township
- Fee Boundary
- Flowage Easement (6,293.5 ft)
- Outgrant Easement
- Real Estate Parcel
- Embankment
- Top Water Supply Pool
- Top Flood Control Pool

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

US Army Corps of Engineers ®
Albuquerque District

0 1 2 3 4 Miles

1:63,360

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

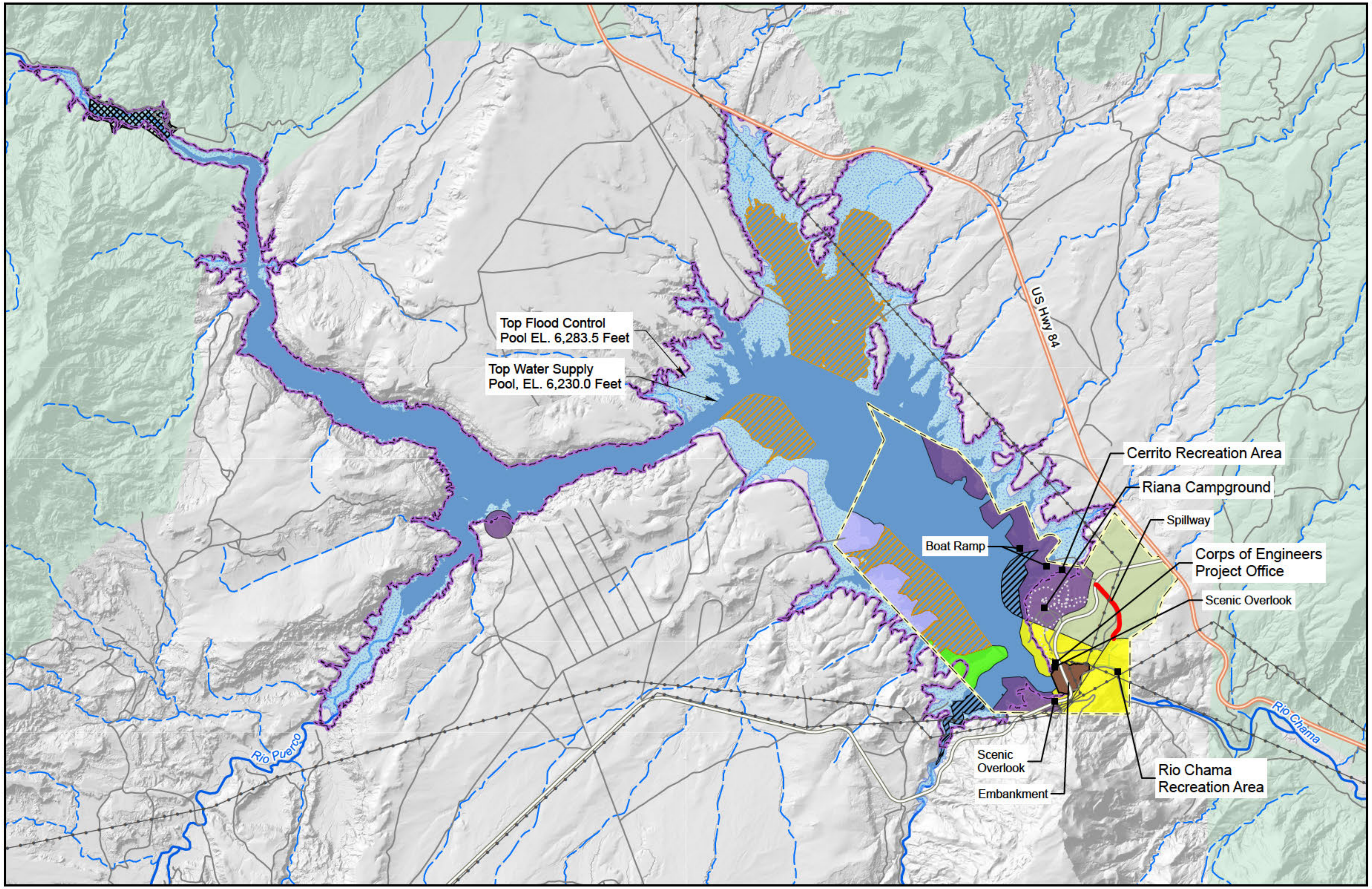
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

REAL ESTATE MAP

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 2-8



Legend
- Ephemeral Stream
- River
- Primary Highway
- Major Road
- Local Road
- Trail
- Power Line
- Santa Fe National Forest
- Fee Boundary
- Flowage Easement
- Spillway Channel
- Embankment
- Project Operations
- Recreation
- Recreation, Veg and Wildlife Management
- Veg and Wildlife Management
- Veg Management
- No Boating (enforced)
- No Wake (enforced)
- Proposed No Wake
- Top Water Supply Pool
- Top Flood Control Pool

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

US Army Corps of Engineers ®
Albuquerque District

0 1 2 3 4 Miles

1:63,360

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

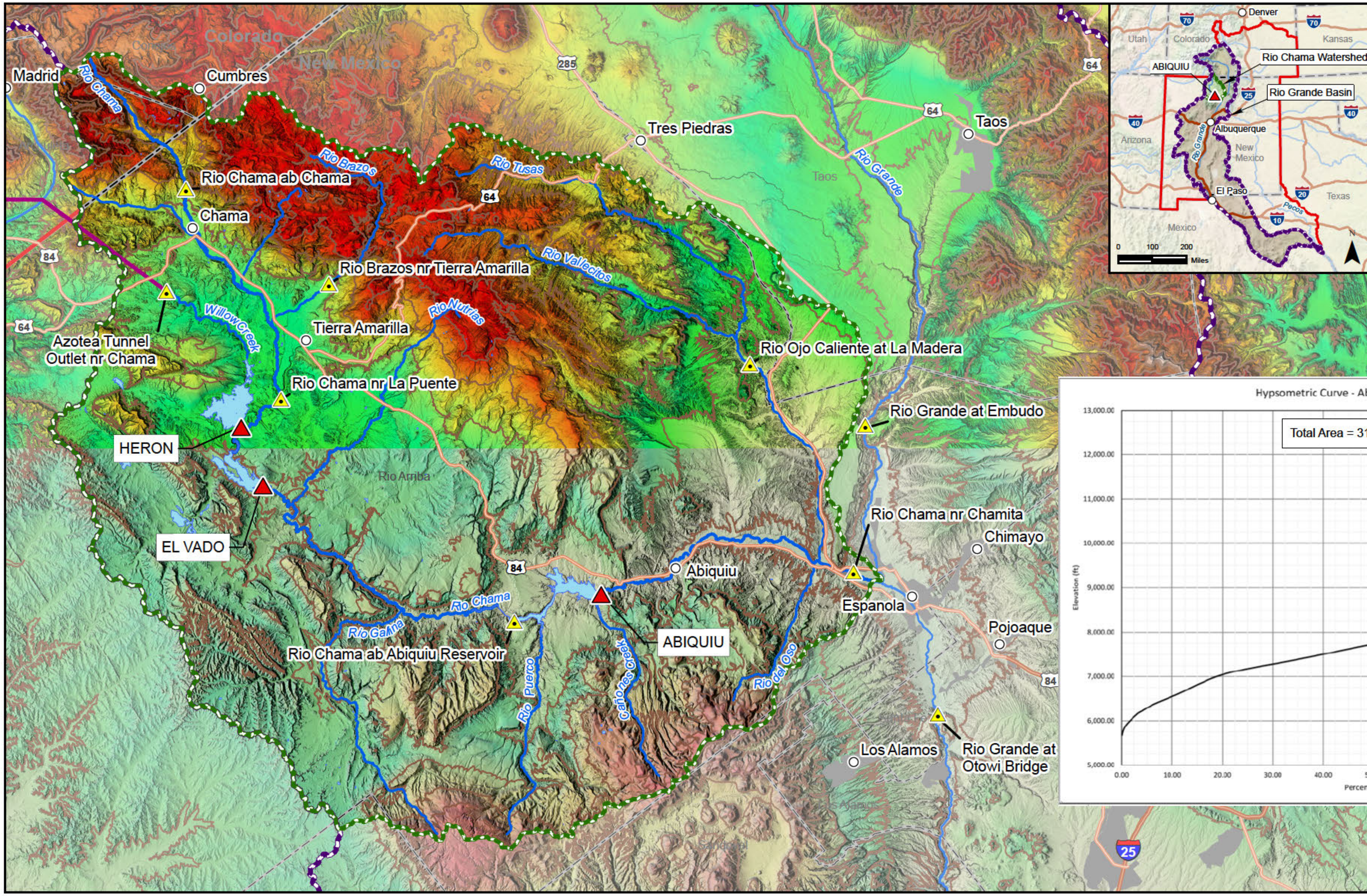
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

LAND USE MAP

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 2-9



Legend

- City
- Dam
- Stream Gage
- Contour, 1,000 feet
- River
- San Juan Chama Project Tunnel
- Interstate or Limited Access Highway
- Highway
- Albuquerque District Boundary
- County Boundary
- State Boundary
- Rio Chama Watershed
- Rio Grande Basin
- Urban Area
- Water Body

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

US Army Corps of Engineers ®
Albuquerque District

0 9 18 27 36 Miles

1:570,240

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

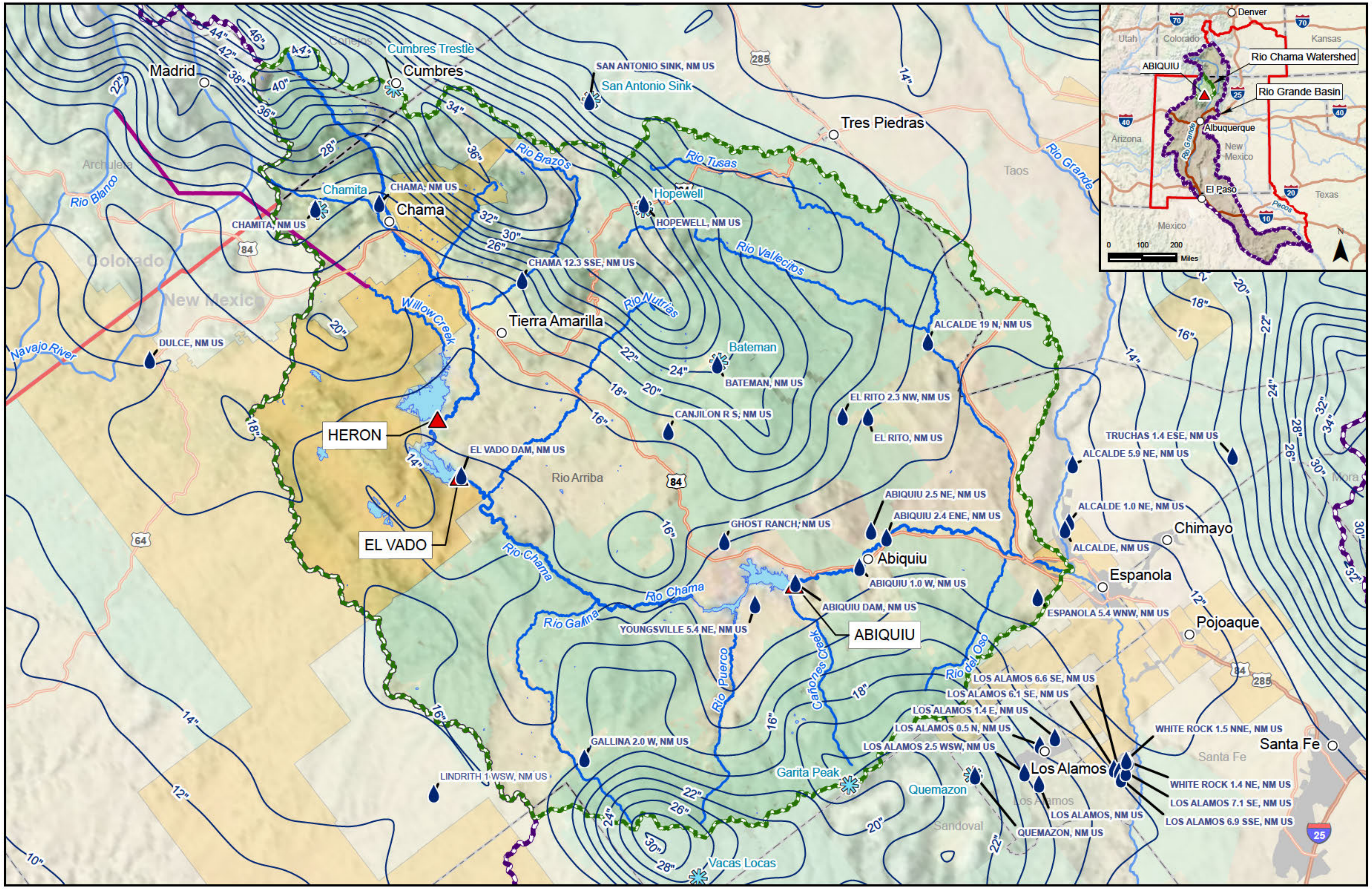
RIO GRANDE BASIN — NEW MEXICO

ABIQUIU DAM

RIO CHAMA WATERSHED TOPOGRAPHY

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-1



Legend

- City
- Dam
- Precipitation Gage
- Snotel Gage
- Average Annual Precipitation 1991-2020
- River
- San Juan Chama Project Tunnel
- Interstate or Limited Access Highway
- Highway
- Albuquerque District Boundary
- County Boundary
- State Boundary
- Rio Chama Watershed
- Rio Grande Basin
- National Forest
- Tribal Land
- Urban Area
- Water Body

US Army Corps of Engineers®
Albuquerque District

0 9 18 27 36 Miles

1:570,240

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

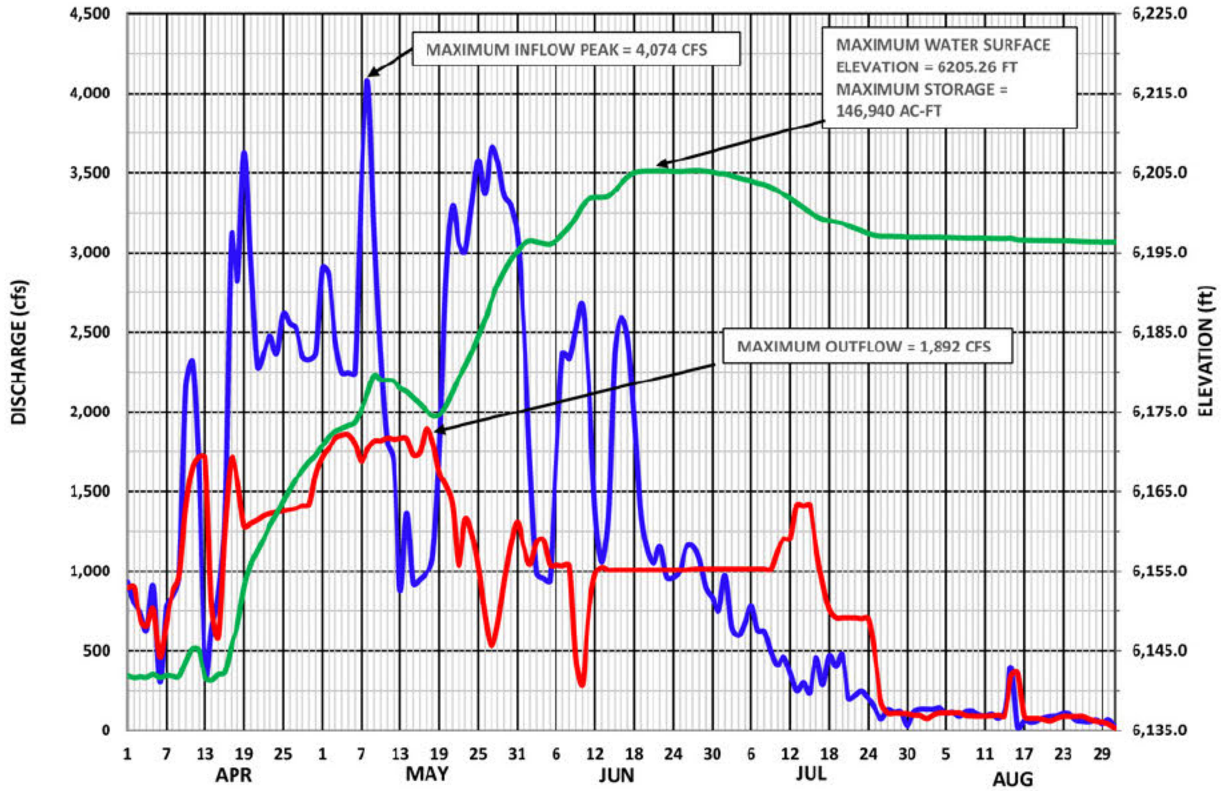
ABIQUIU DAM

AVERAGE ANNUAL PRECIPITATION 1991 - 2020

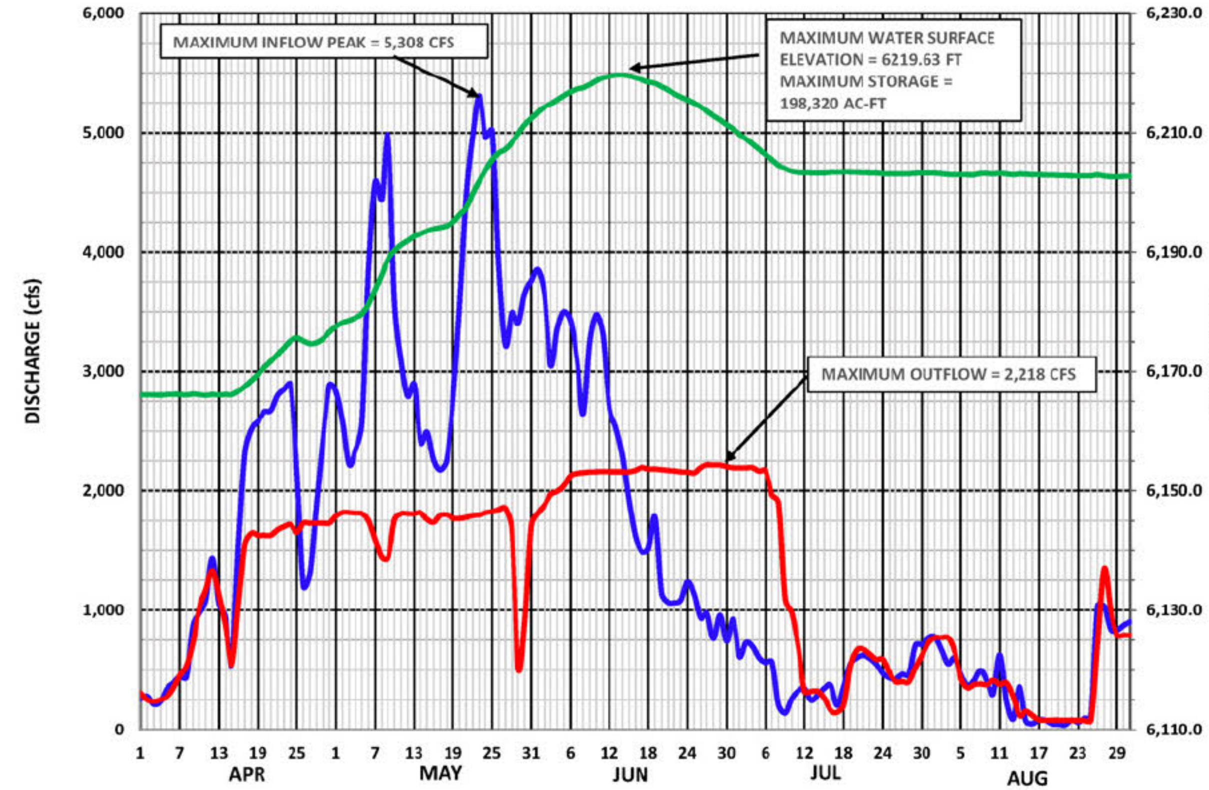
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-2

1979 ABIQUIU RESERVOIR OPERATIONS

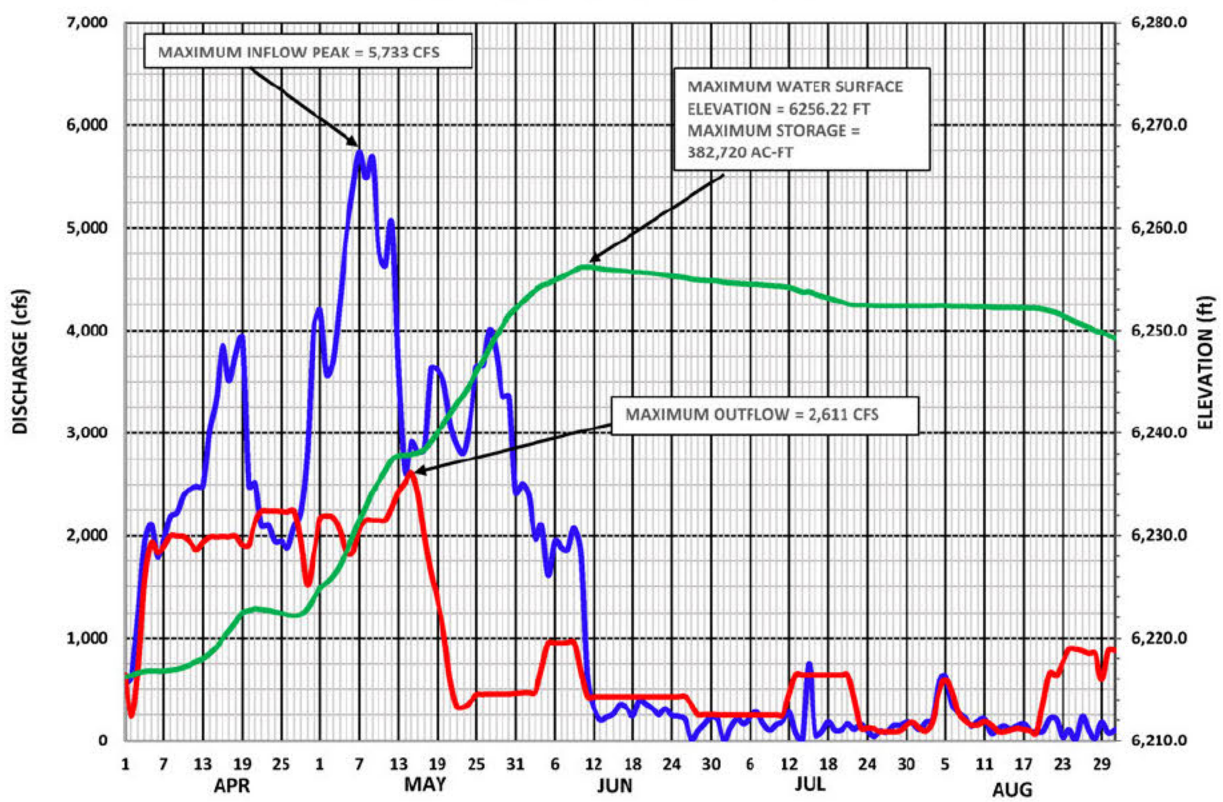


1980 ABIQUIU RESERVOIR OPERATIONS

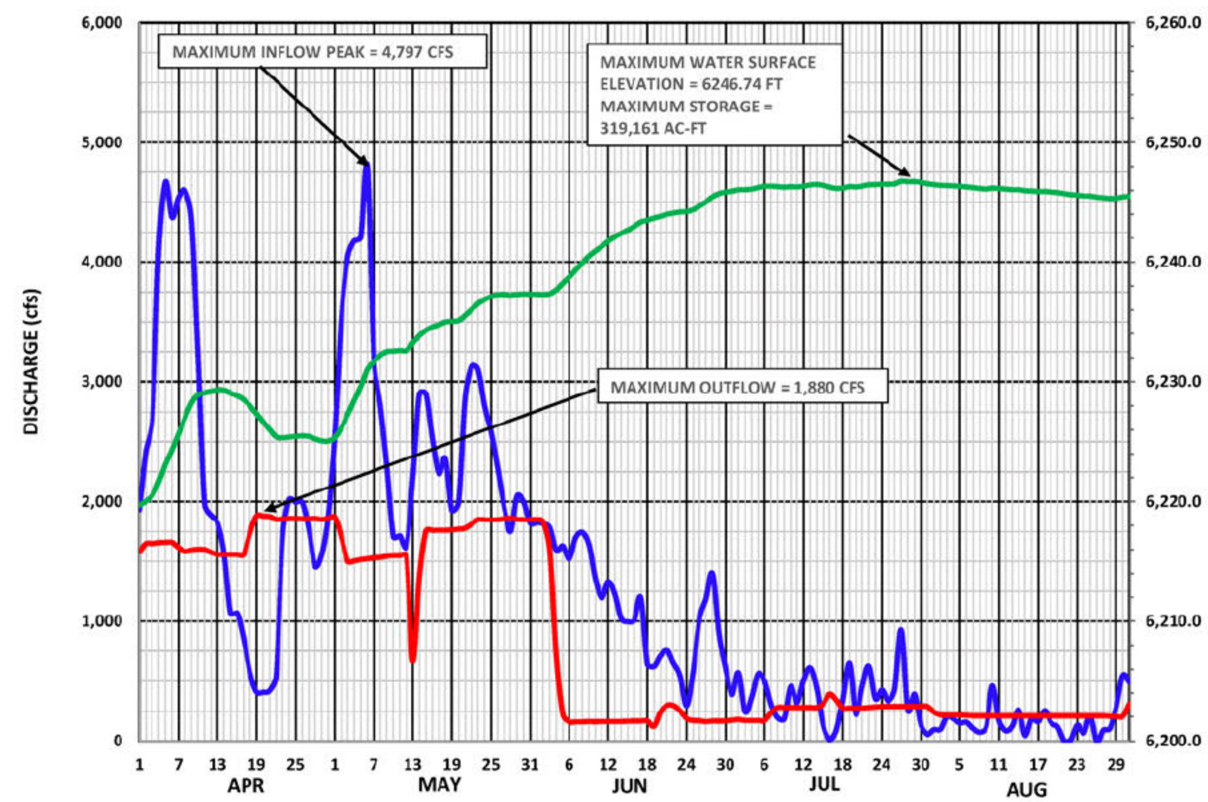


Inflow (CFS)
Outflow (CFS)
Elevation (FT)

1985 ABIQUIU RESERVOIR OPERATIONS



1986 ABIQUIU RESERVOIR OPERATIONS



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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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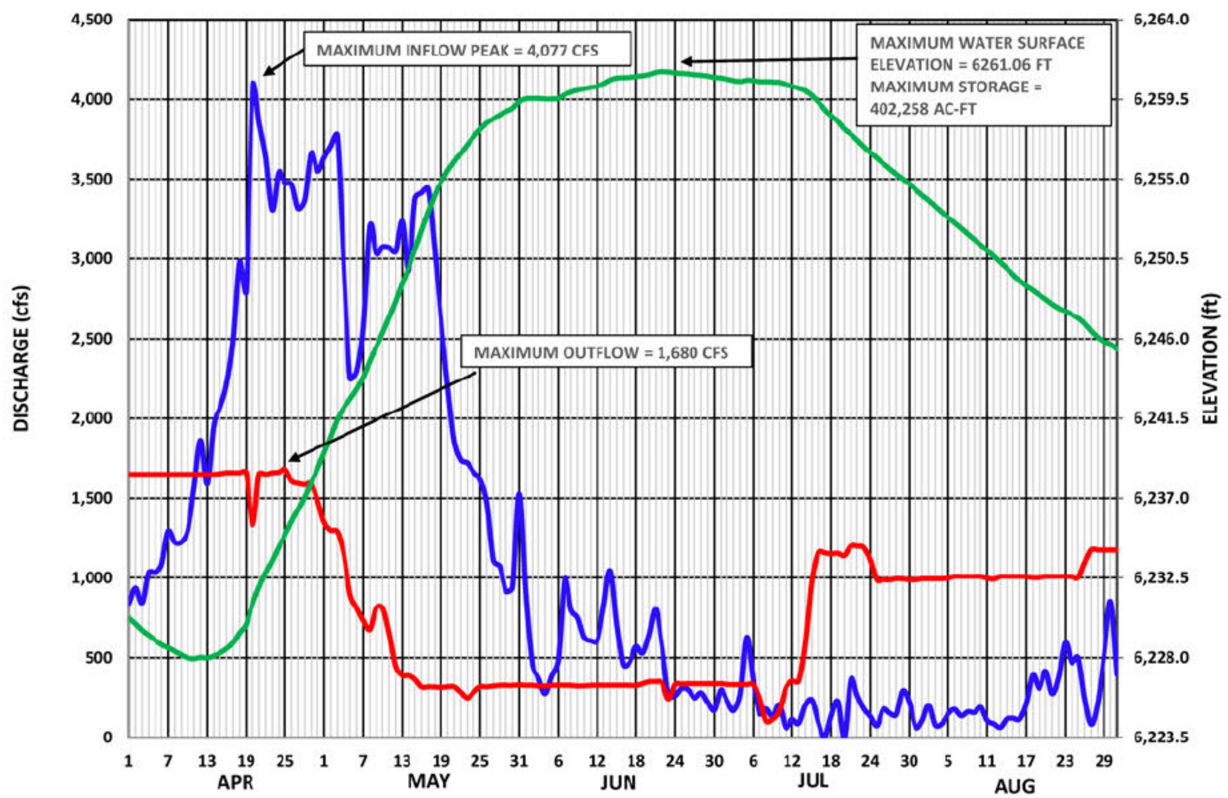
ABIQUIU DAM
HISTORICAL OPERATION FLOODS OF 1979, 1980, 1985 & 1986

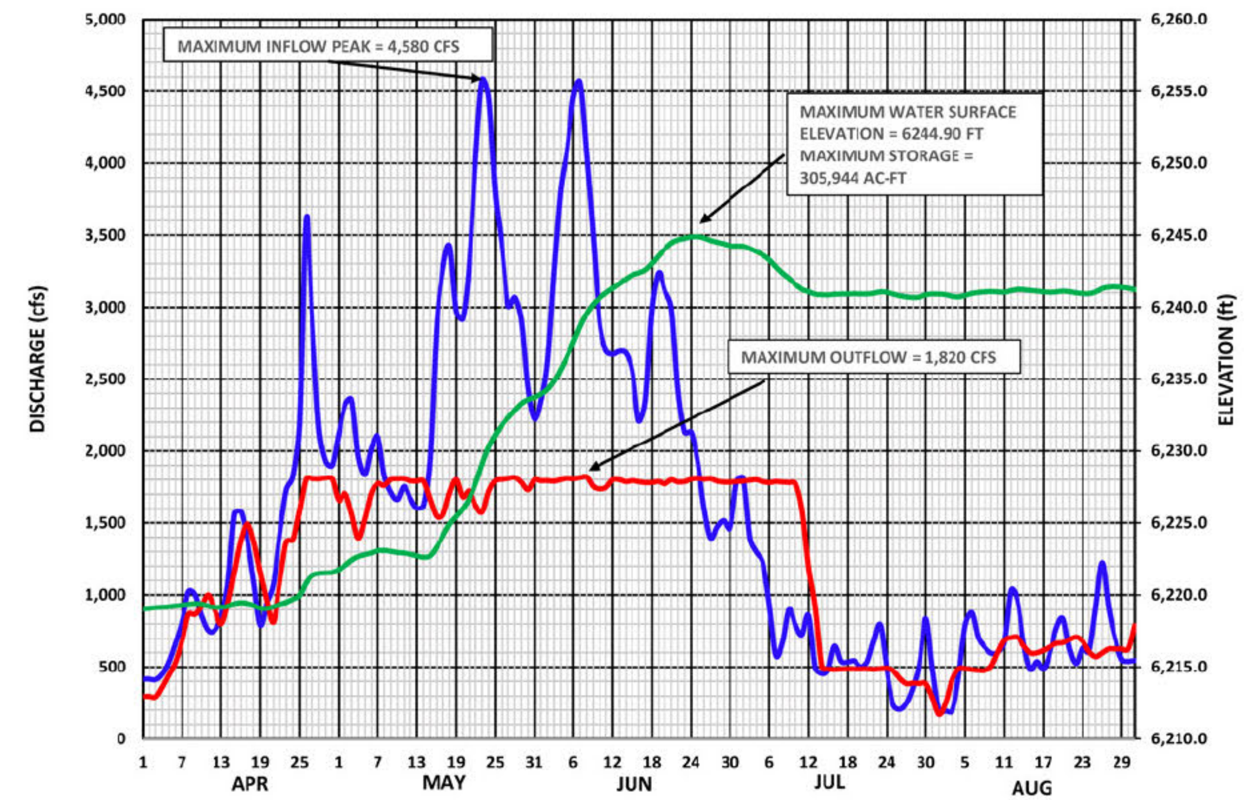
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-3A

1987 ABIQUIU RESERVOIR OPERATIONS

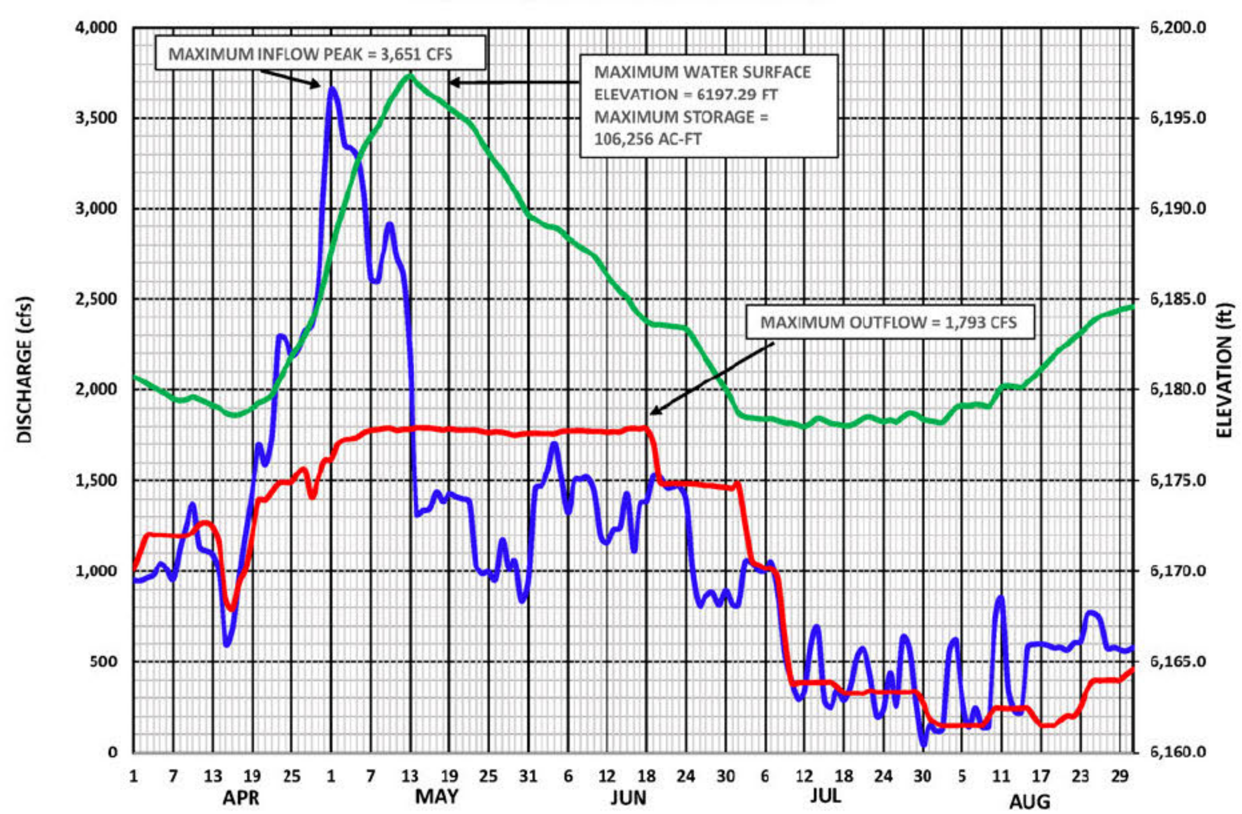


1995 ABIQUIU RESERVOIR OPERATIONS

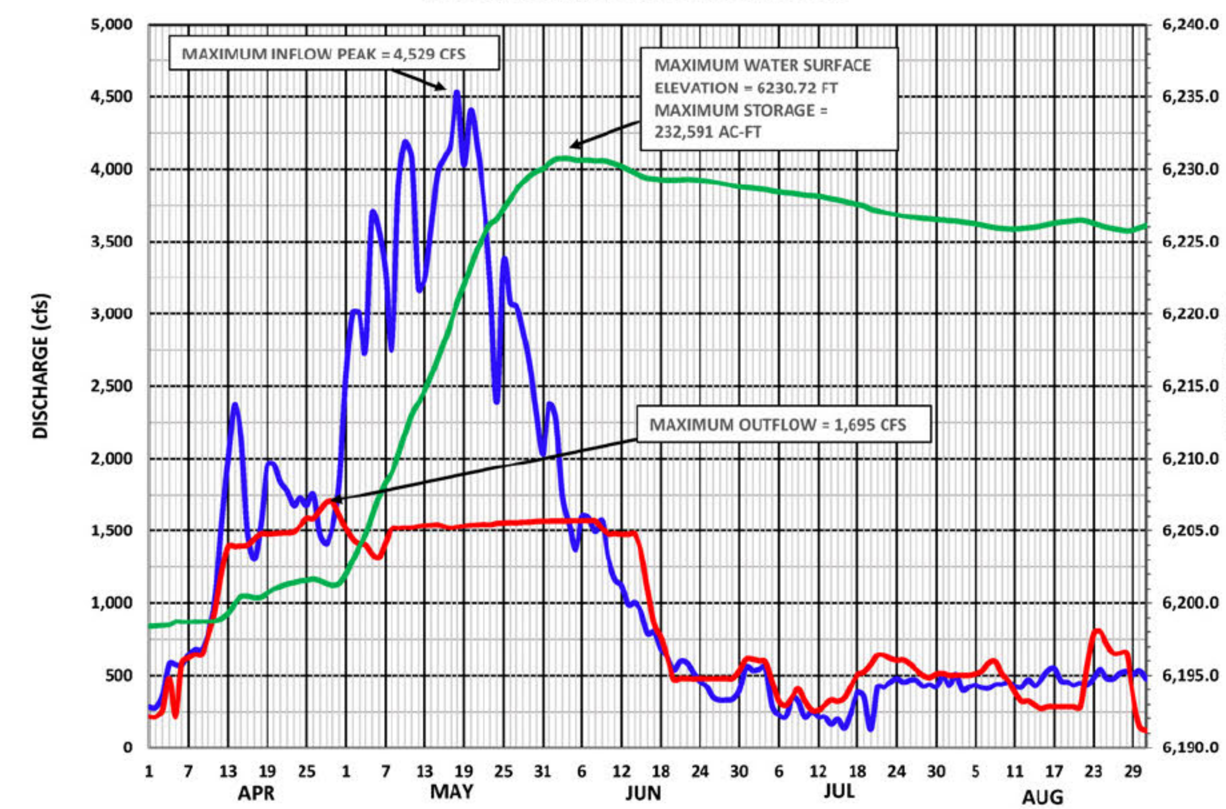


Inflow (CFS)
Outflow (CFS)
Elevation (FT)

2019 ABIQUIU RESERVOIR OPERATIONS



2023 ABIQUIU RESERVOIR OPERATIONS



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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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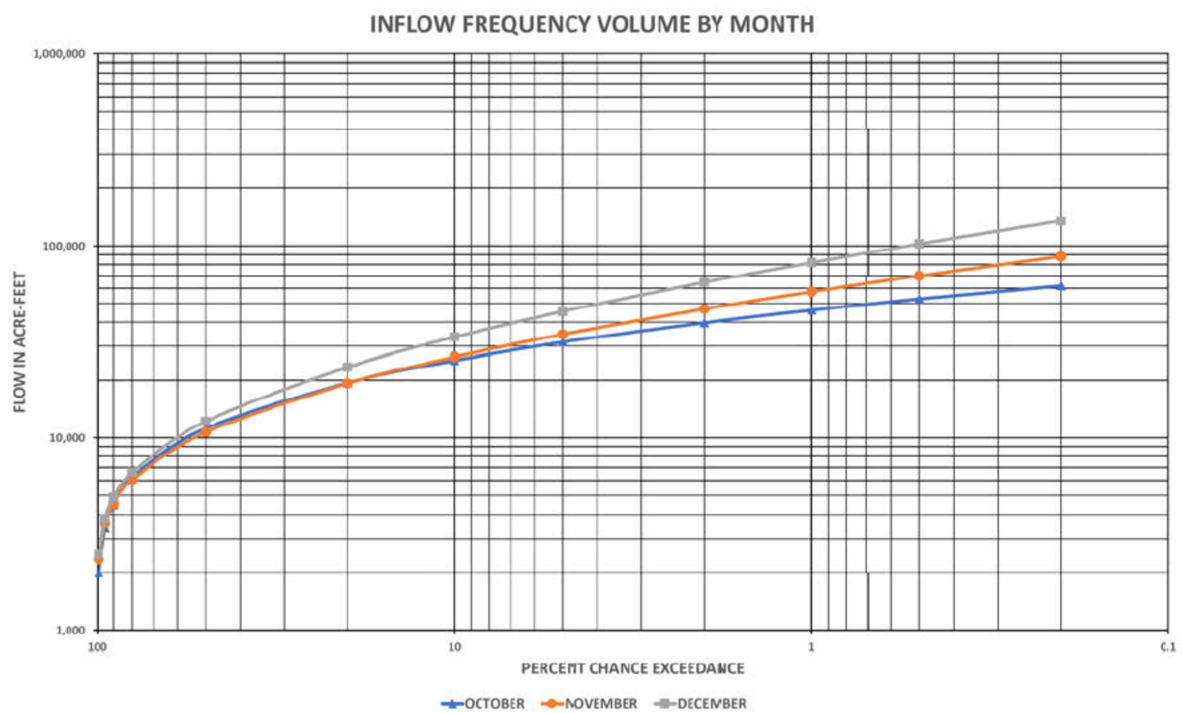
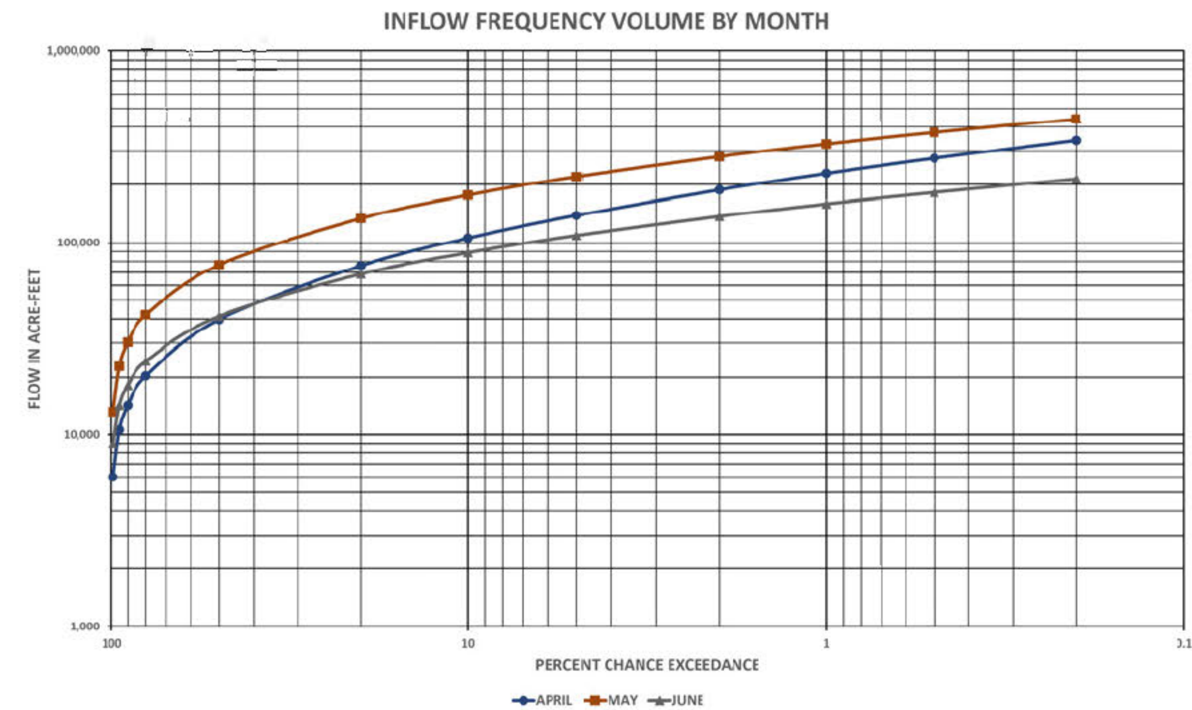
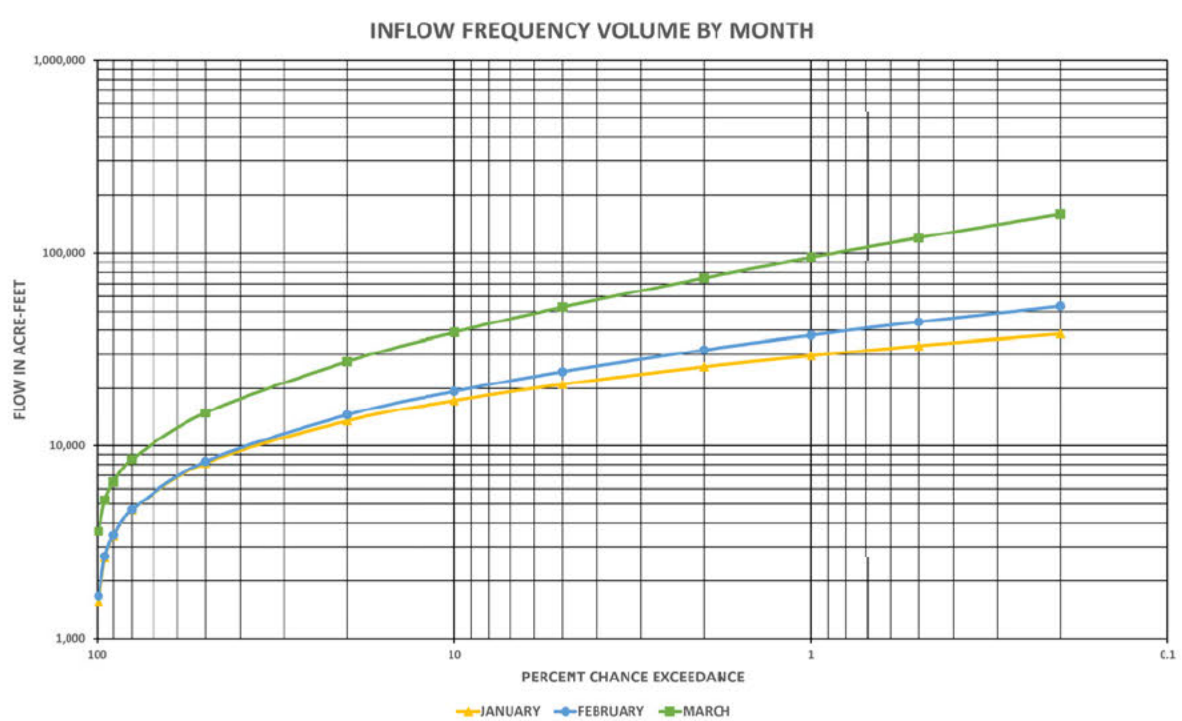
HISTORICAL OPERATION FLOODS OF 1987, 1995, 2019 & 2023

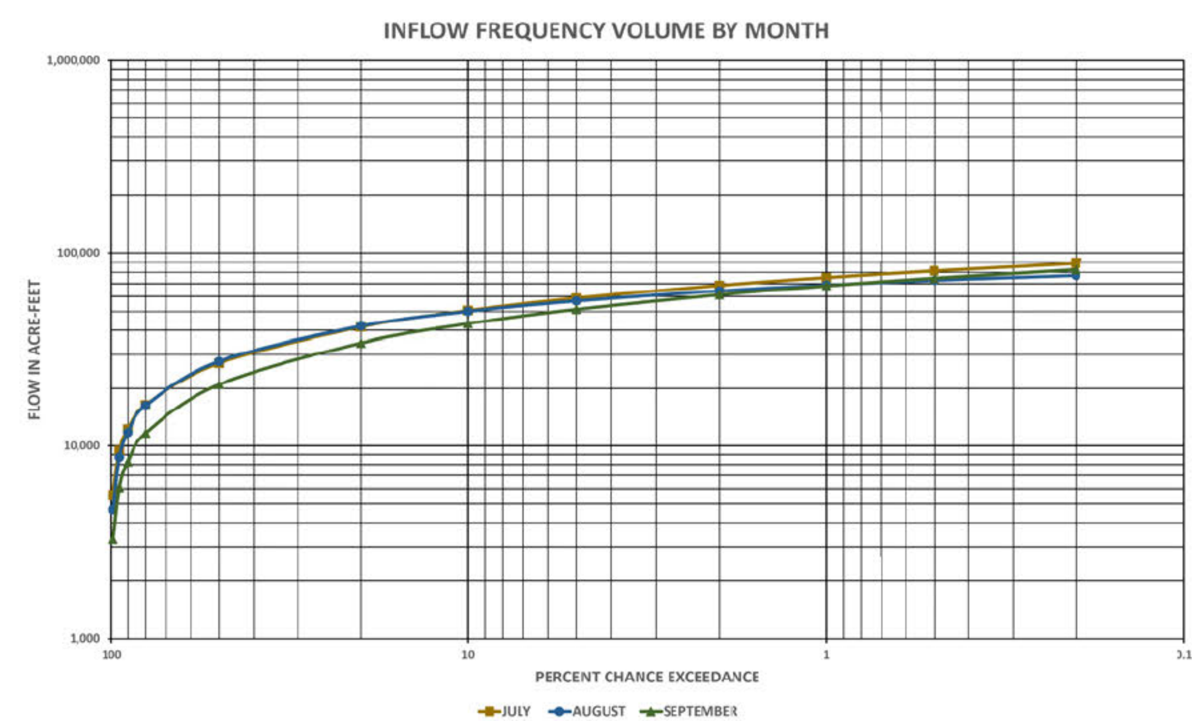
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-3B









NOTE: Frequency Data Computed Using HEC-SSP (VER 2.2)

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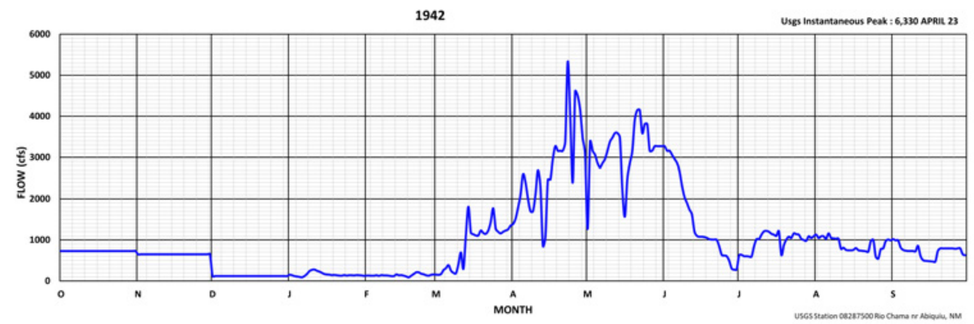
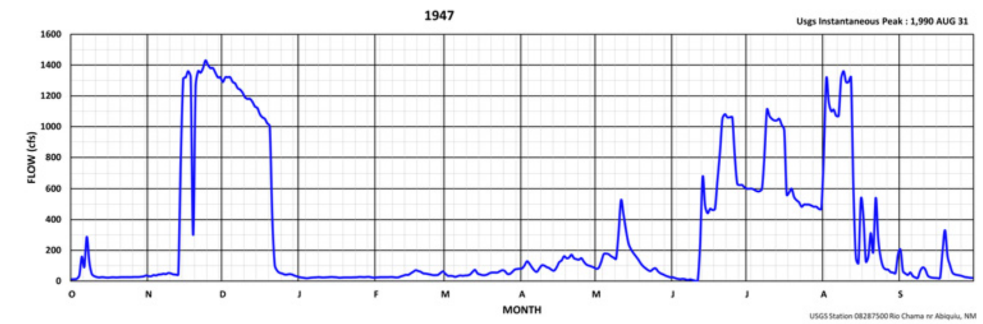
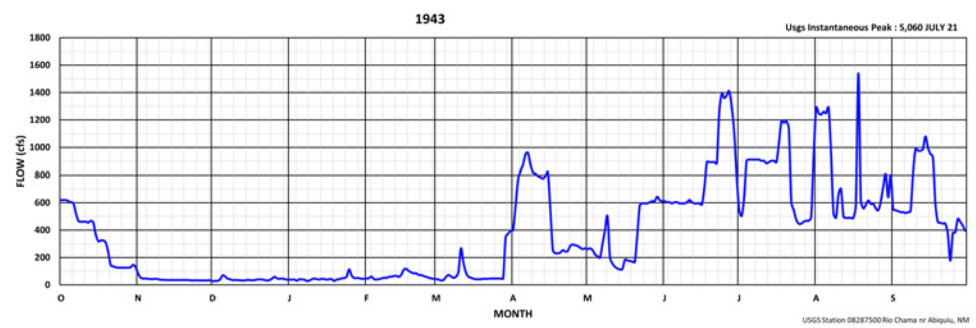
INFLOW FREQUENCY VOLUME BY MONTH

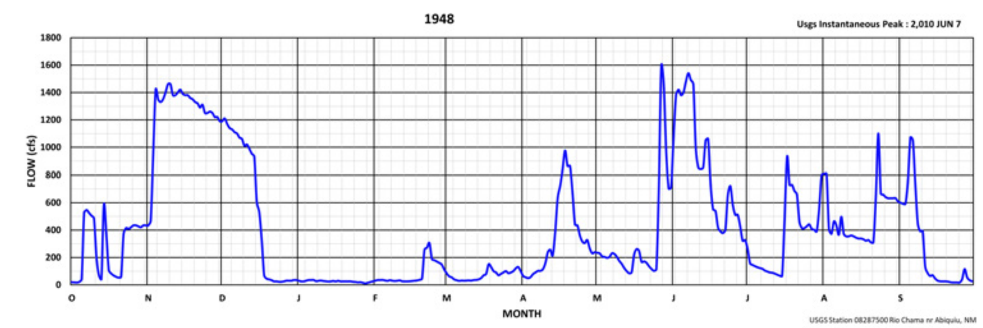
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

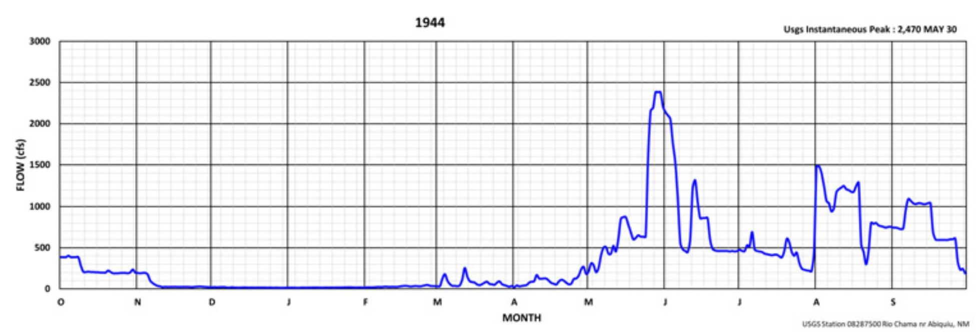
Plate 4-4

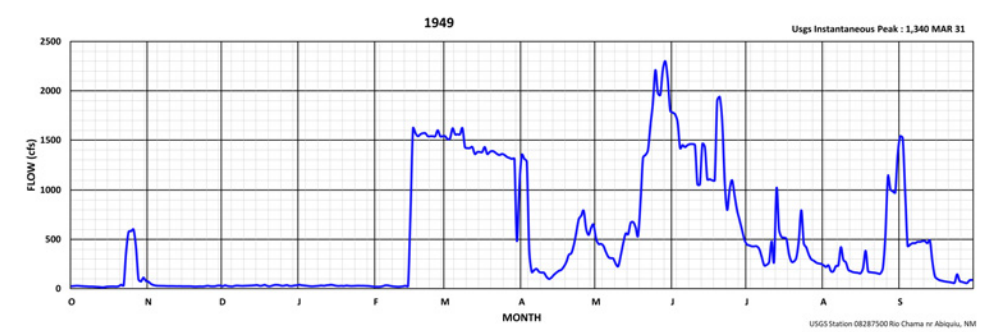


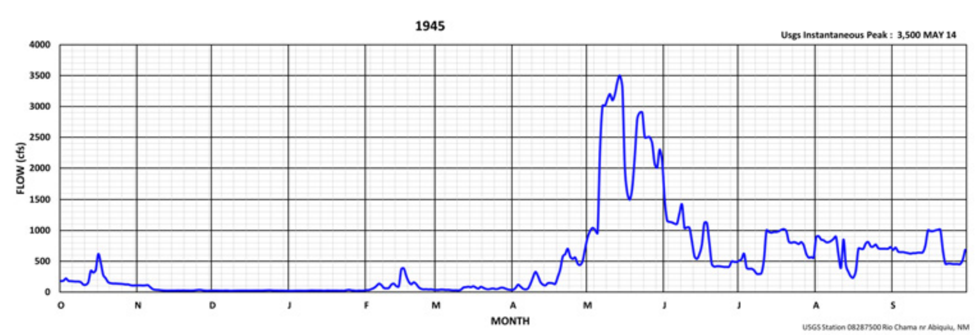


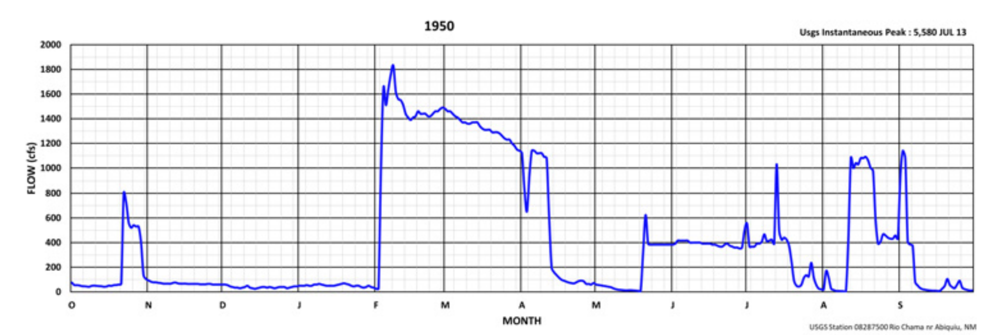


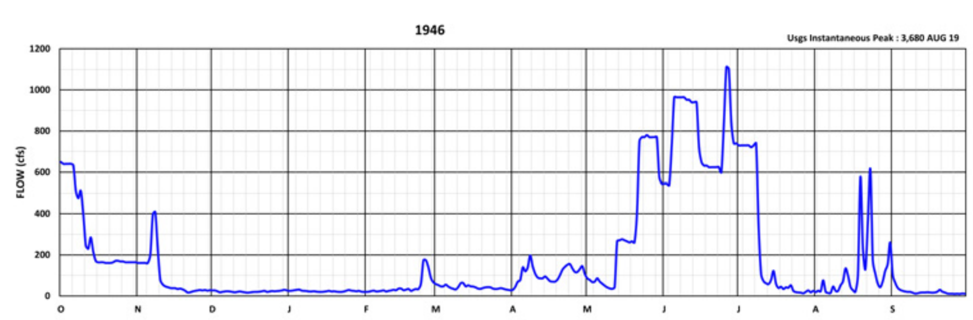


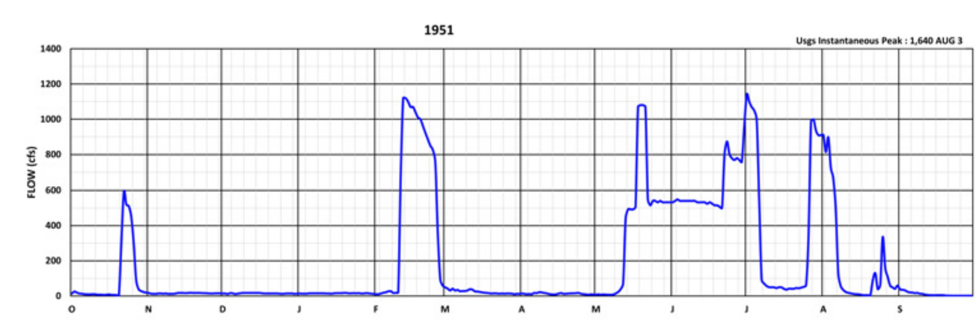












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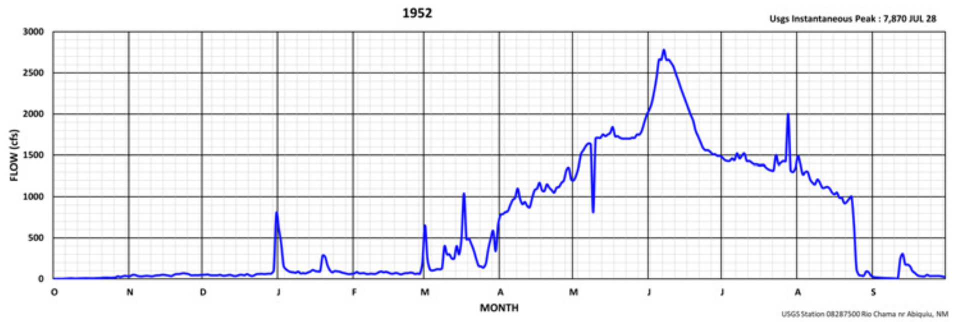
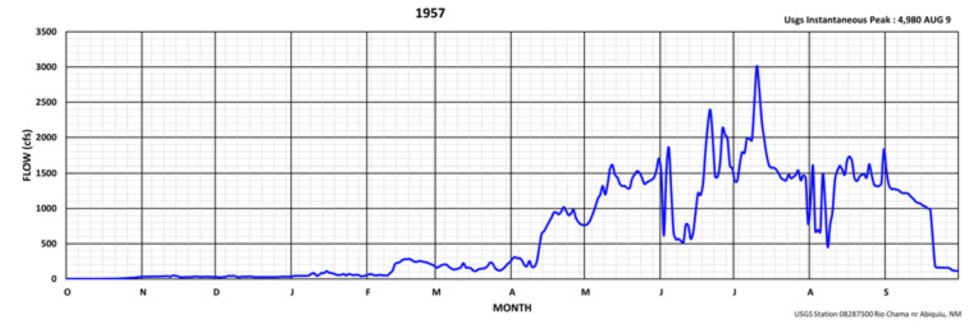
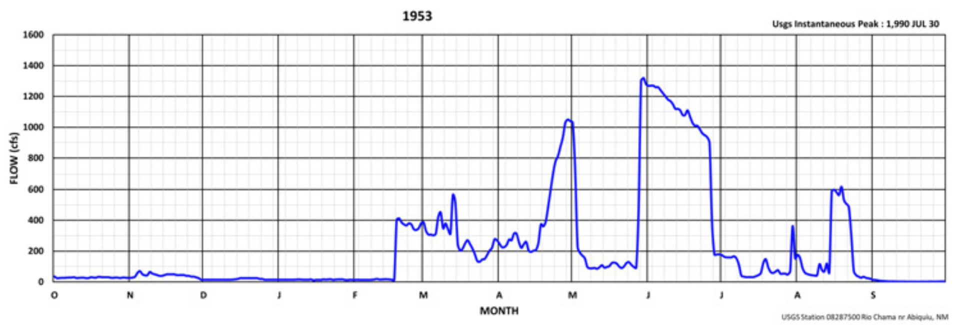
OBSERVED DAILY FLOW HYDROGRAPHS 1942 - 1951

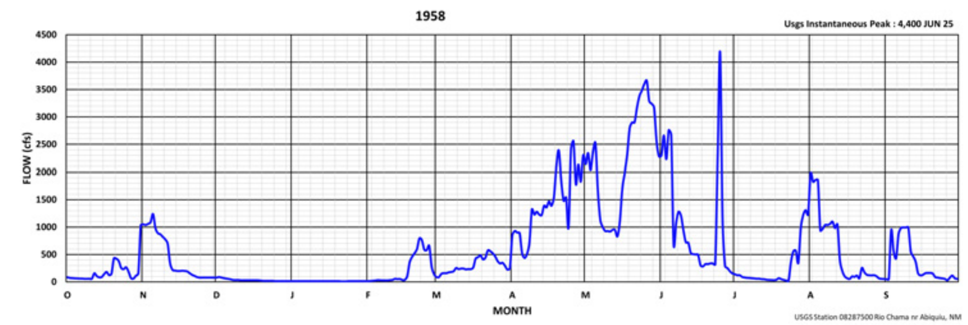
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

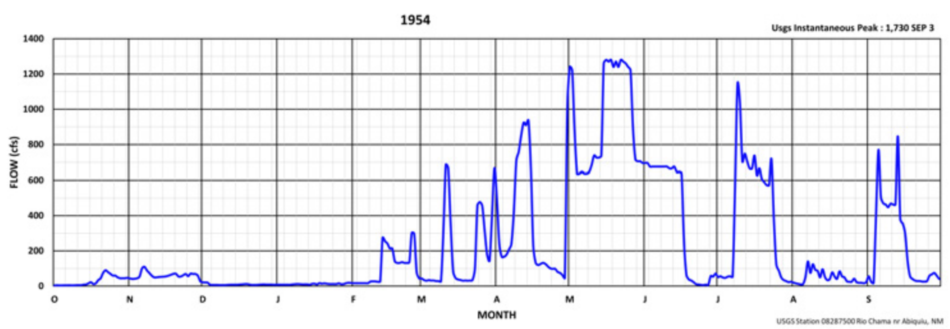
Plate 4-5A

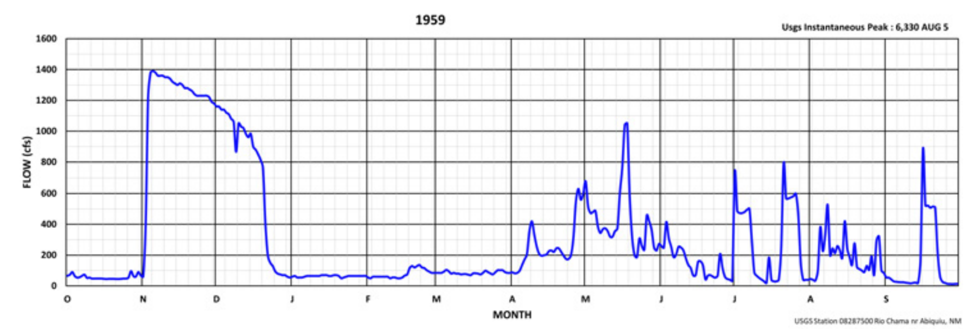


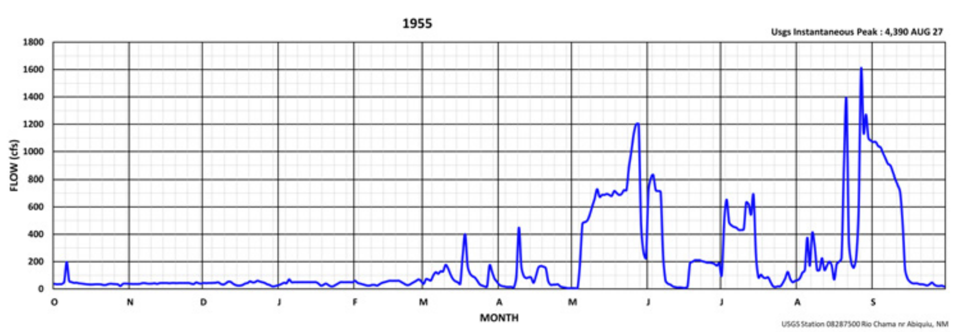


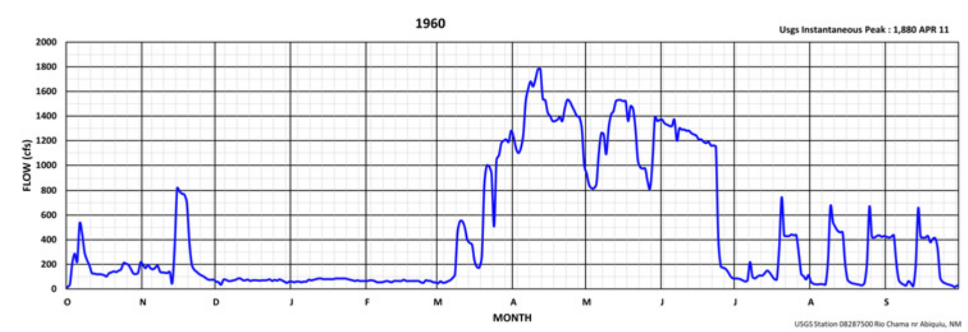


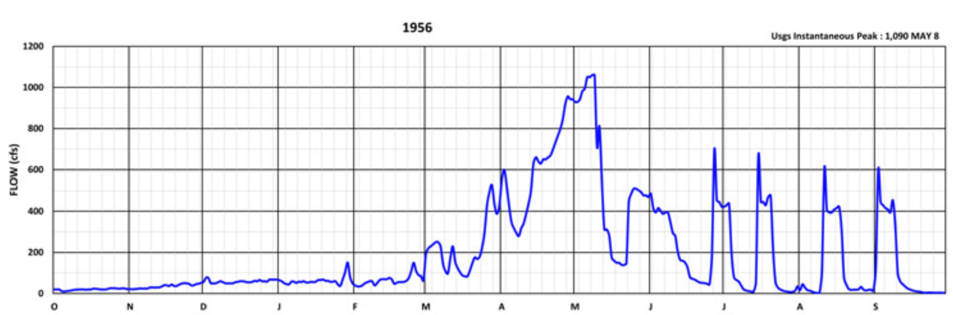


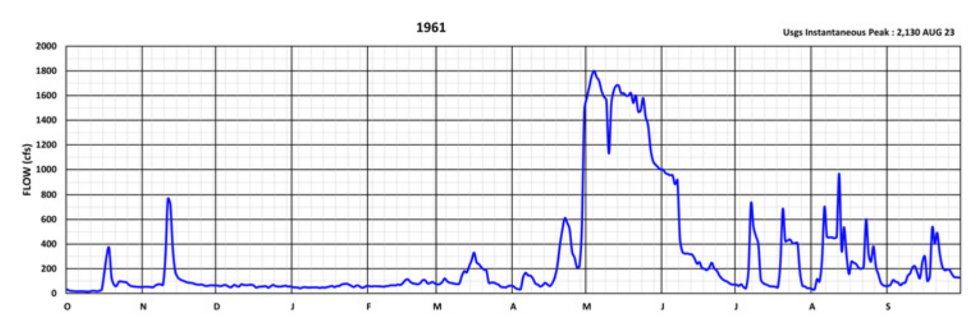












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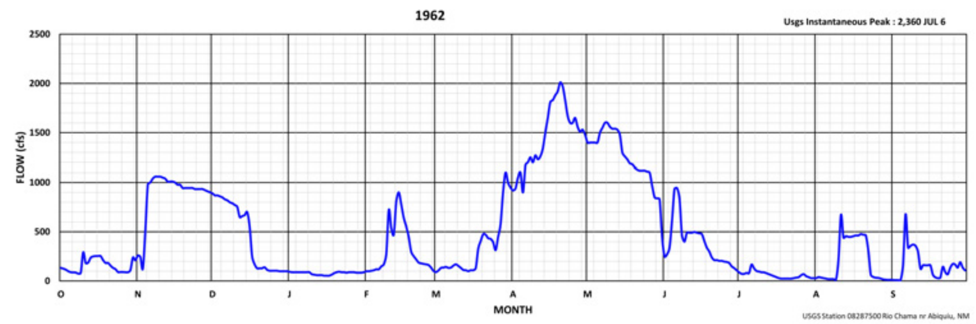
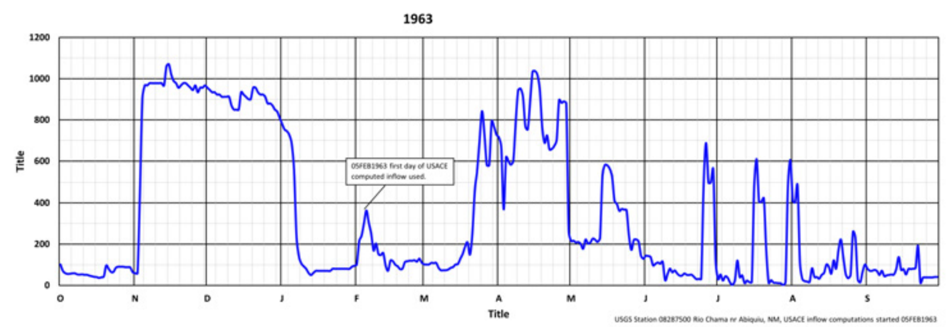
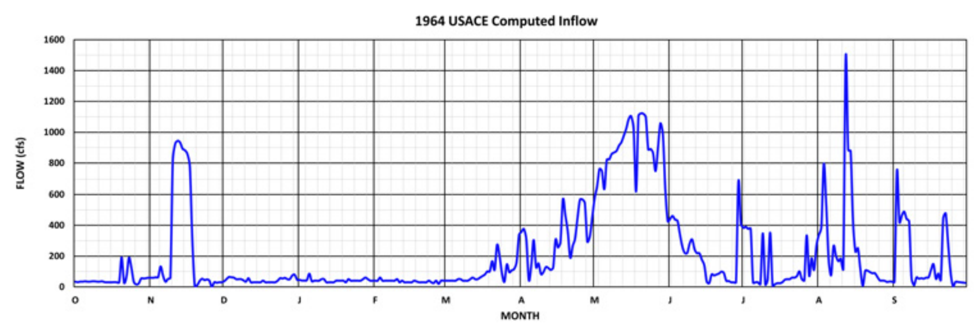
OBSERVED DAILY FLOW HYDROGRAPHS 1952 - 1961

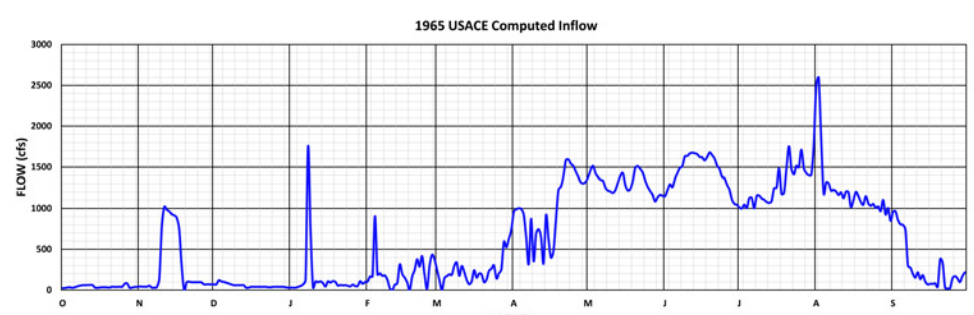
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

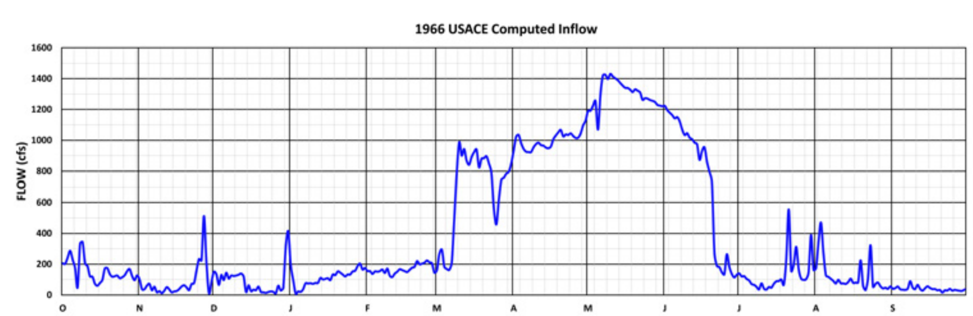
Plate 4-5B

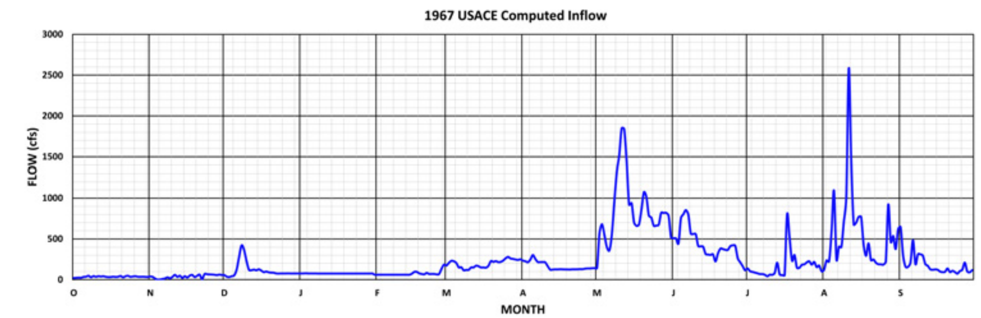


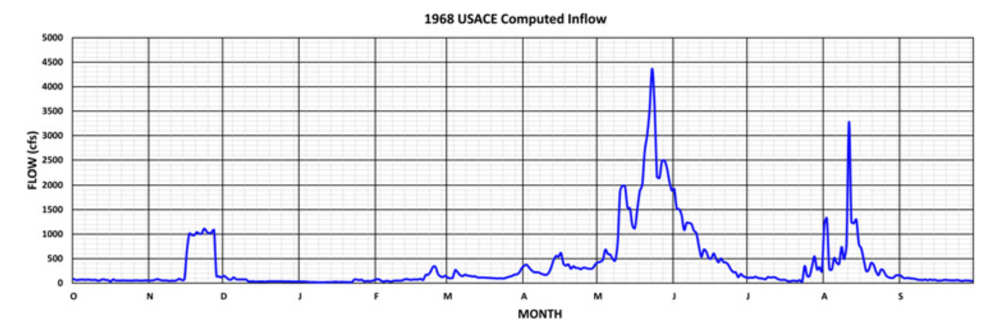


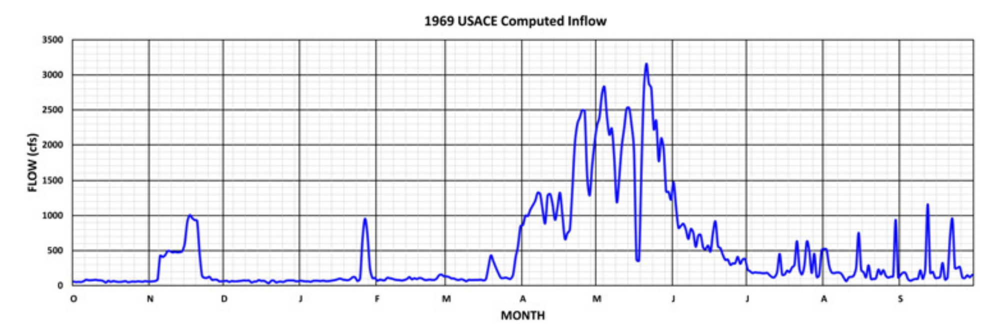


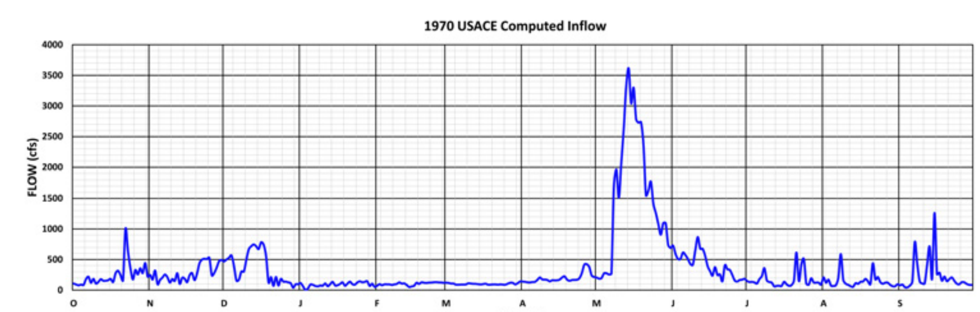


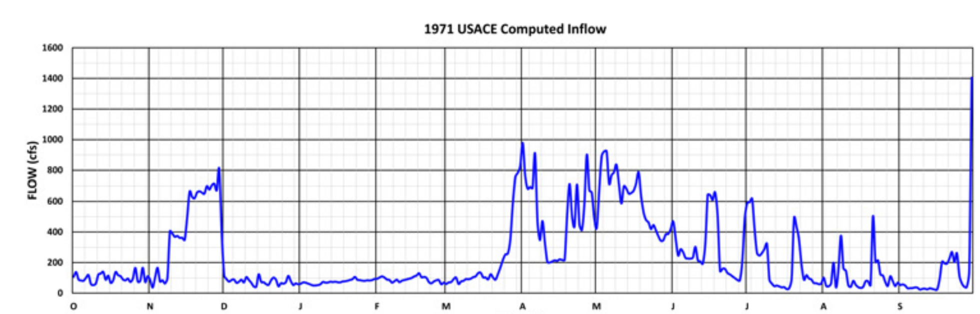












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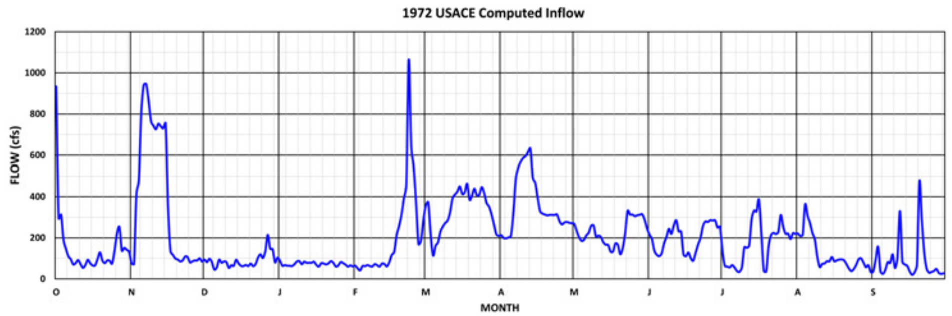
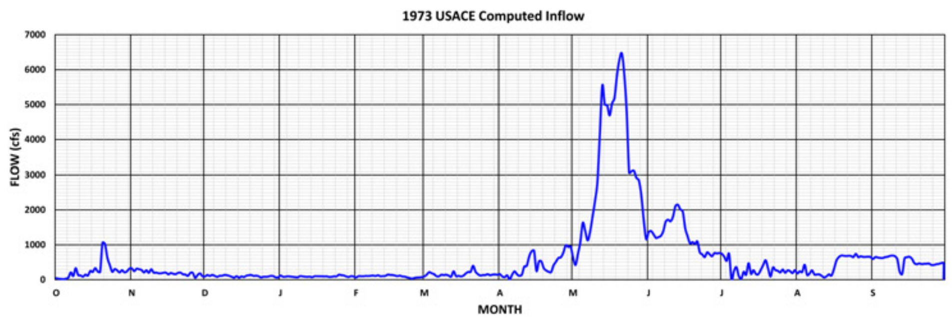
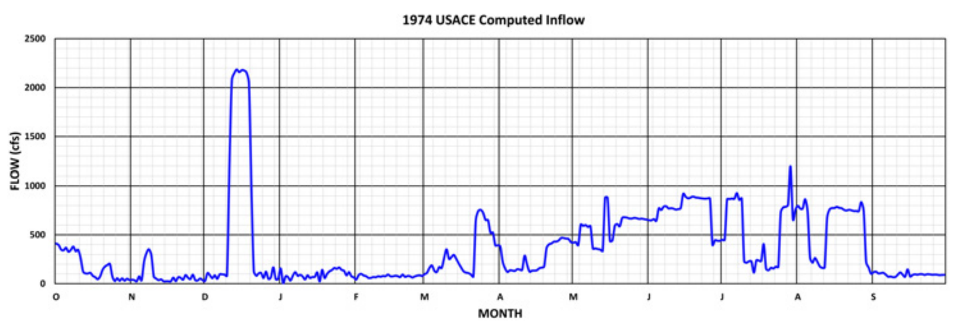
OBSERVED DAILY FLOW HYDROGRAPHS 1962 - 1971

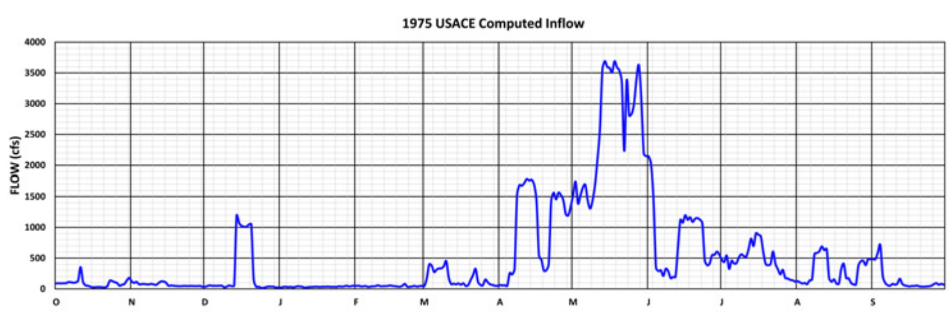
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

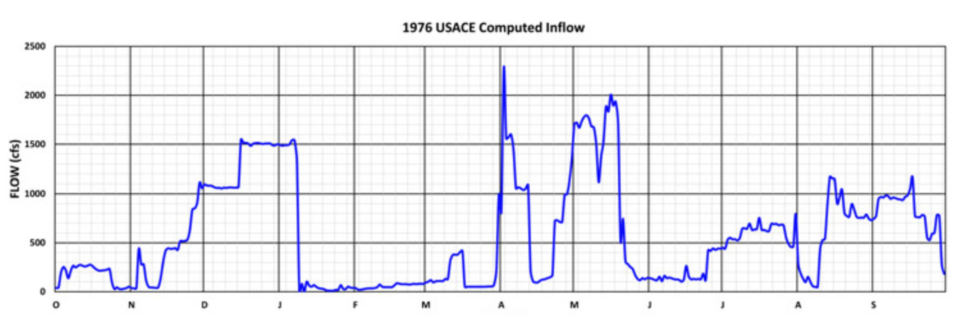
Plate 4-5C

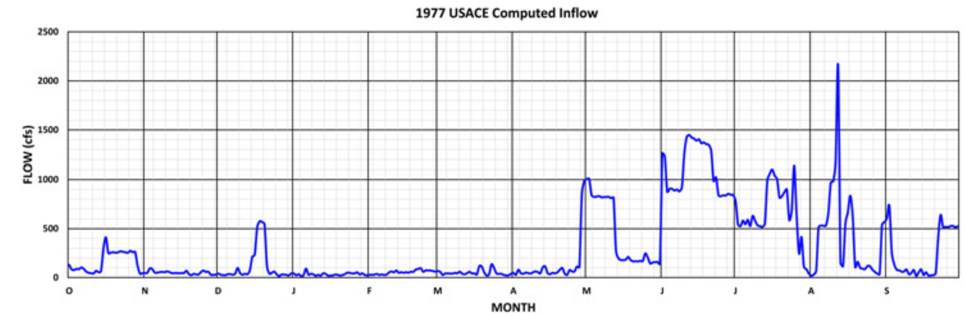


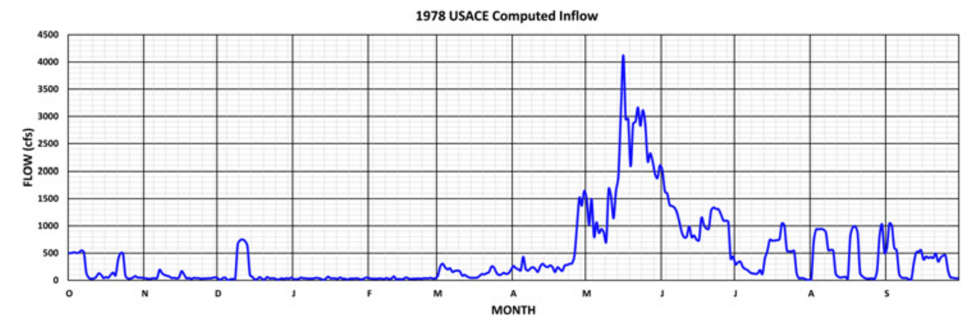


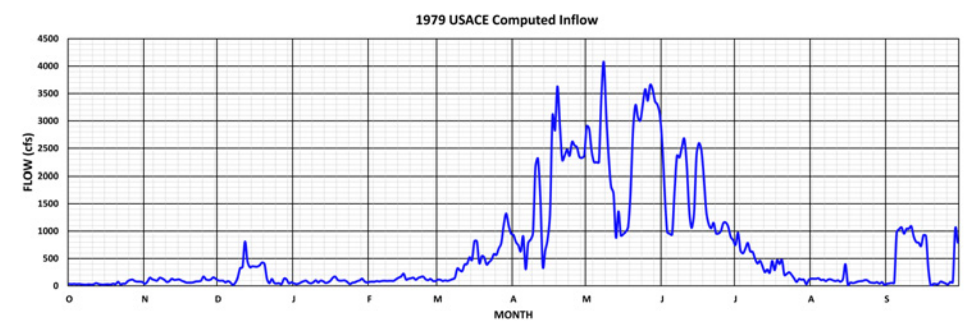


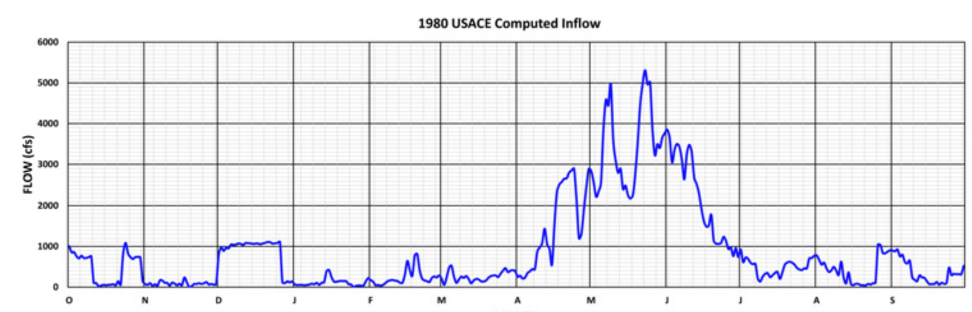


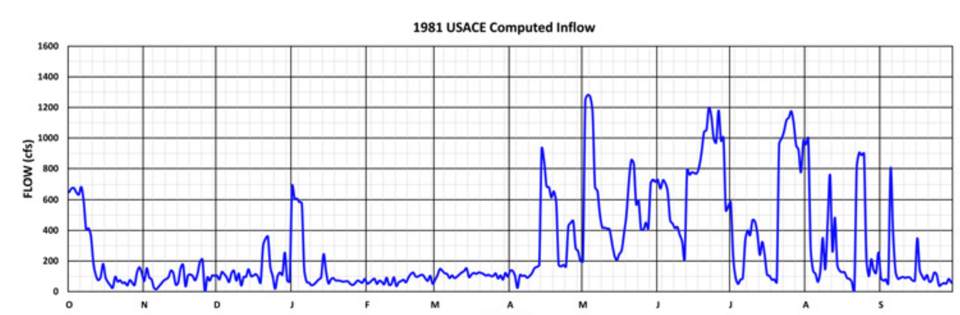












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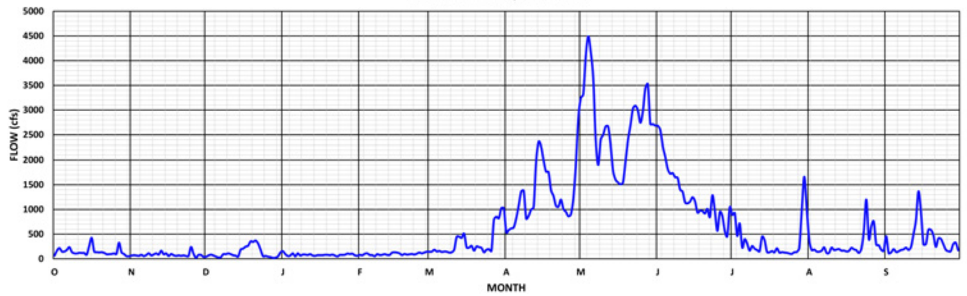
OBSERVED DAILY FLOW HYDROGRAPHS 1972 - 1981

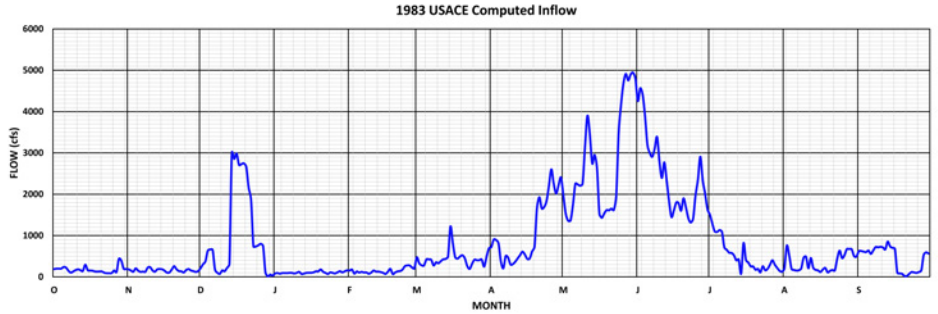
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-5D

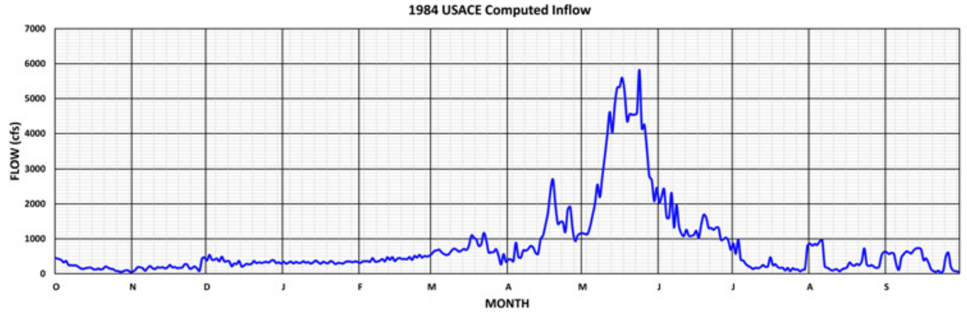
1982 USACE Computed Inflow



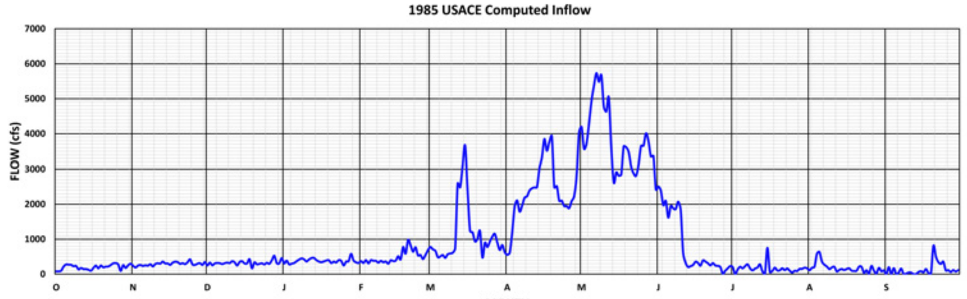
1983 USACE Computed Inflow



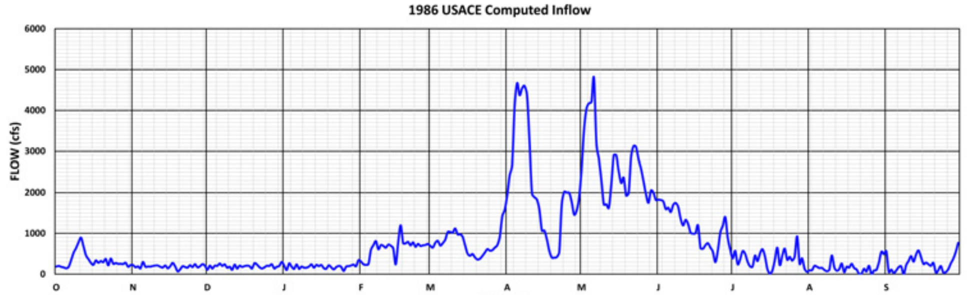
1984 USACE Computed Inflow



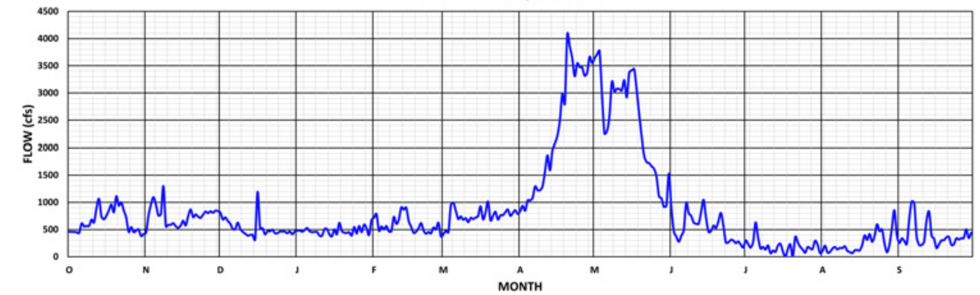
1985 USACE Computed Inflow



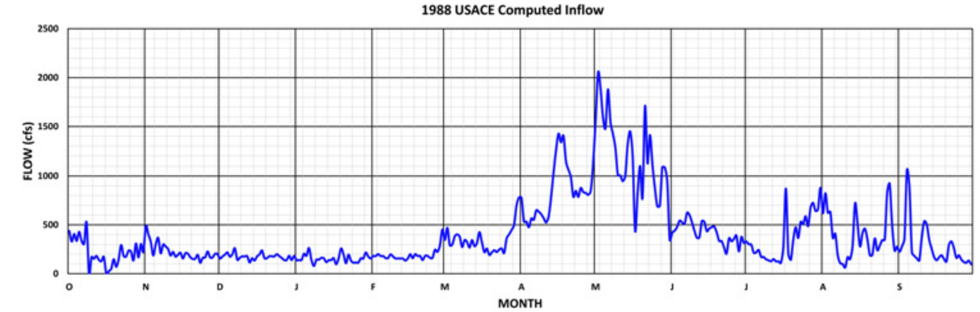
1986 USACE Computed Inflow



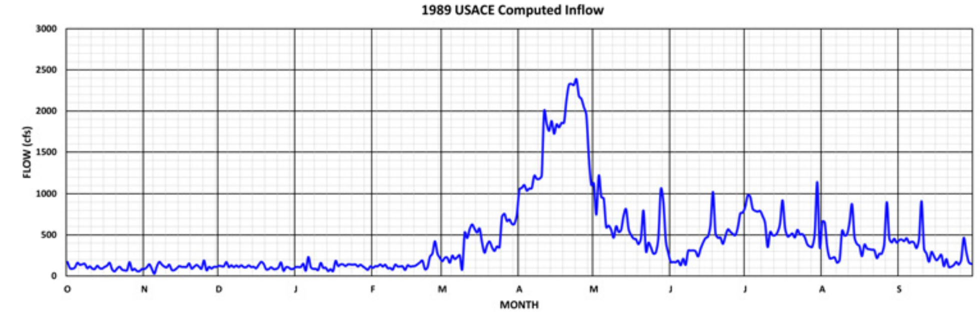
1987 USACE Computed Inflow



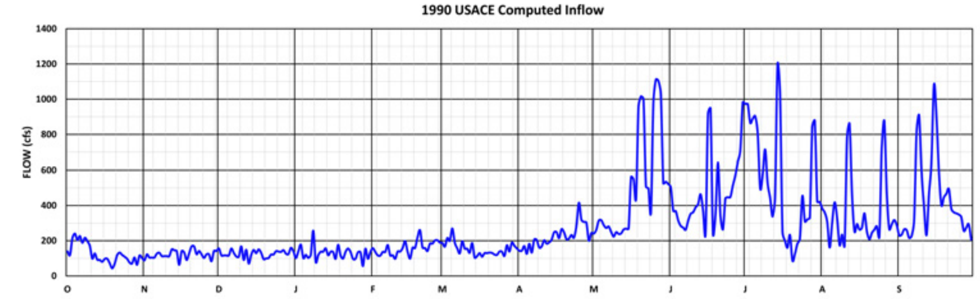
1988 USACE Computed Inflow



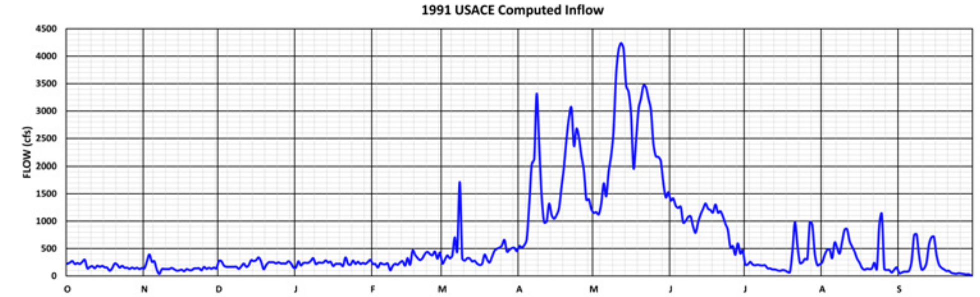
1989 USACE Computed Inflow



1990 USACE Computed Inflow



1991 USACE Computed Inflow



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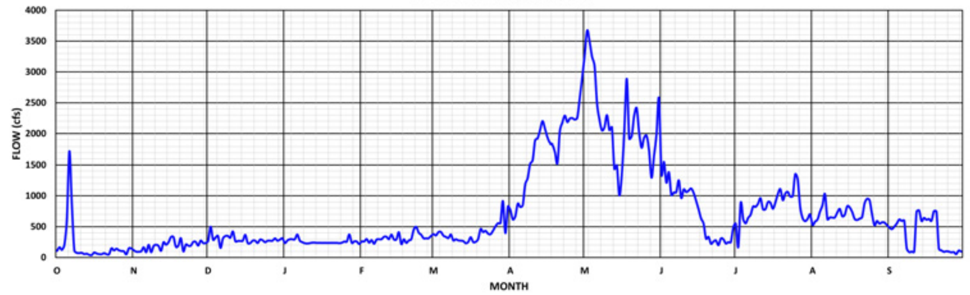
OBSERVED DAILY FLOW HYDROGRAPHS 1982 - 1991

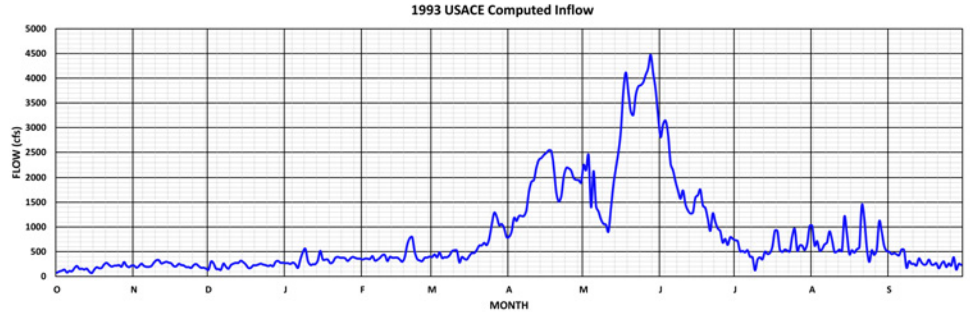
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-5E

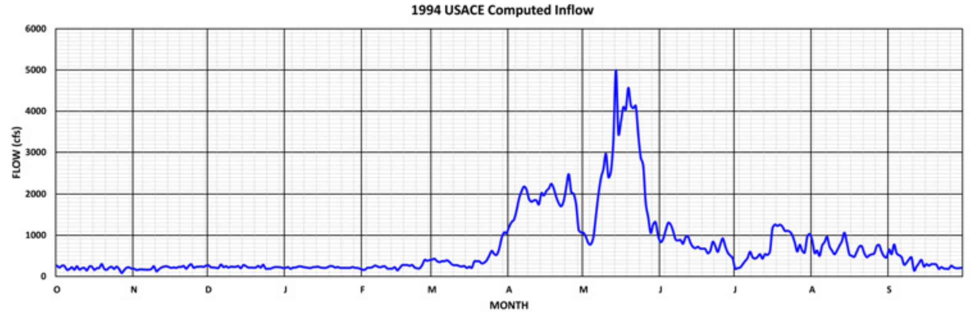
1992 USACE Computed Inflow



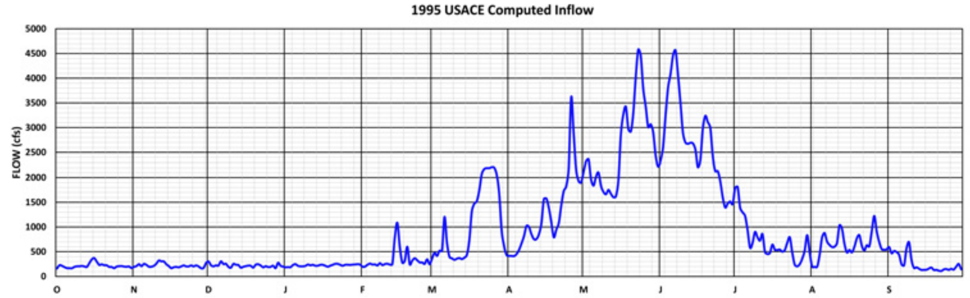
1993 USACE Computed Inflow



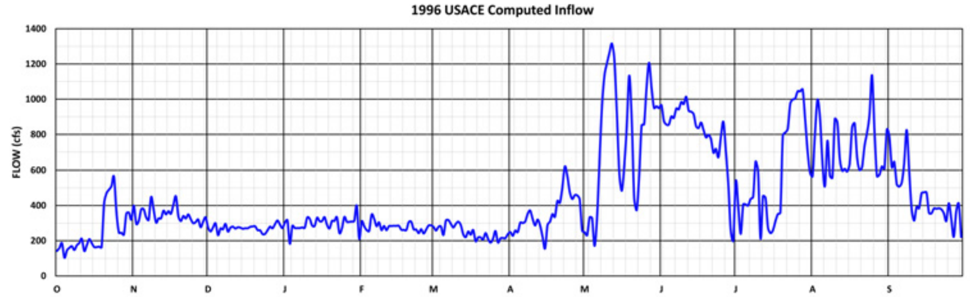
1994 USACE Computed Inflow



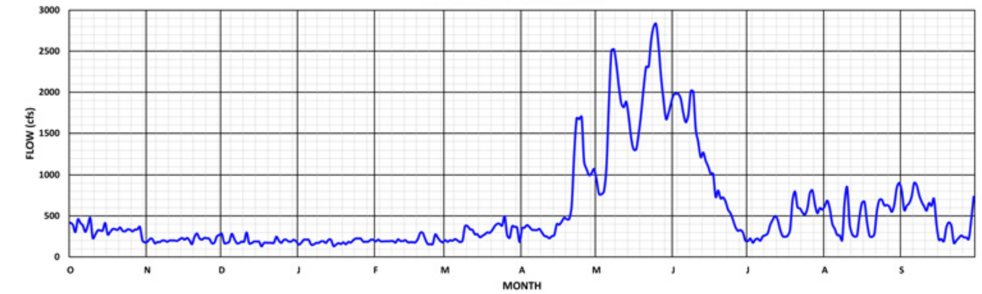
1995 USACE Computed Inflow



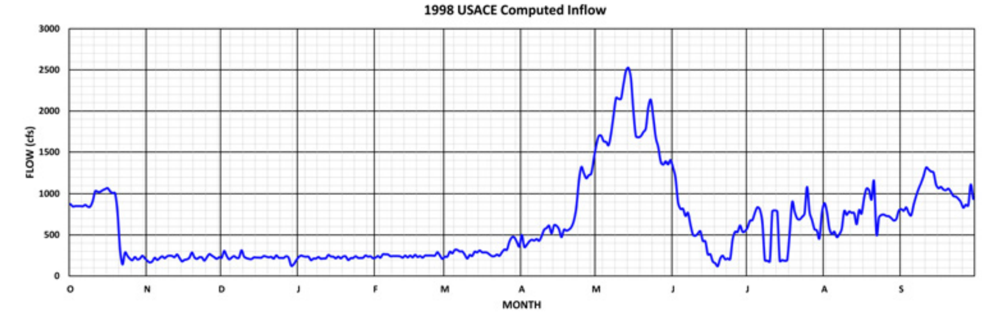
1996 USACE Computed Inflow



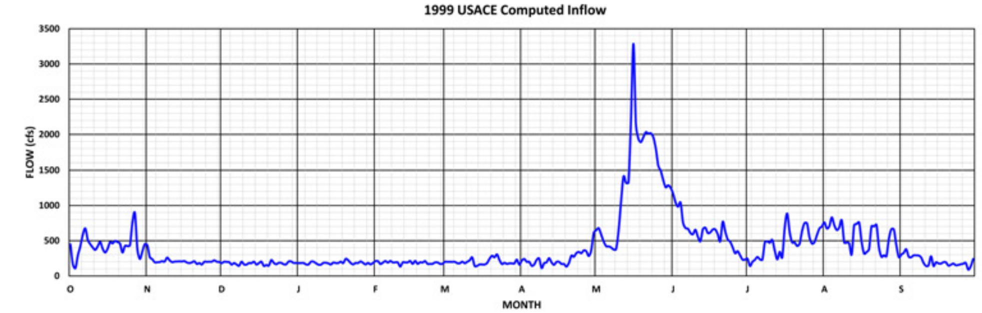
1997 USACE Computed Inflow



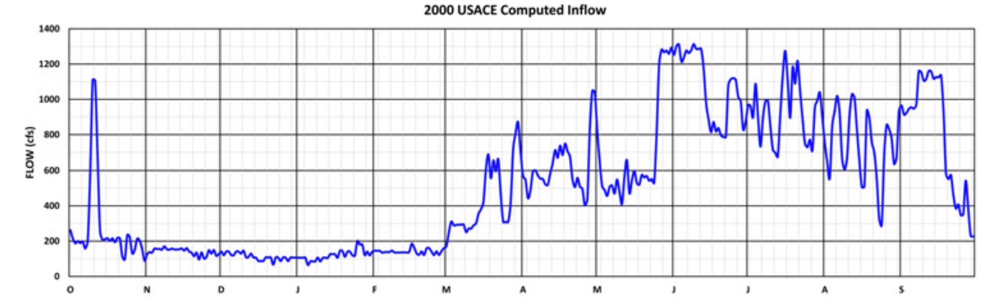
1998 USACE Computed Inflow



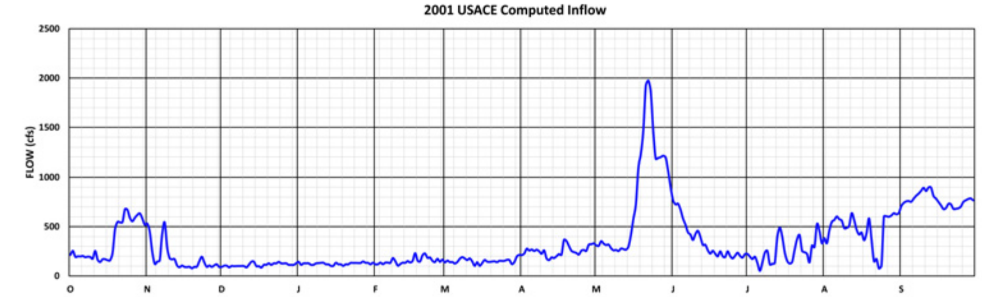
1999 USACE Computed Inflow



2000 USACE Computed Inflow



2001 USACE Computed Inflow



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ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

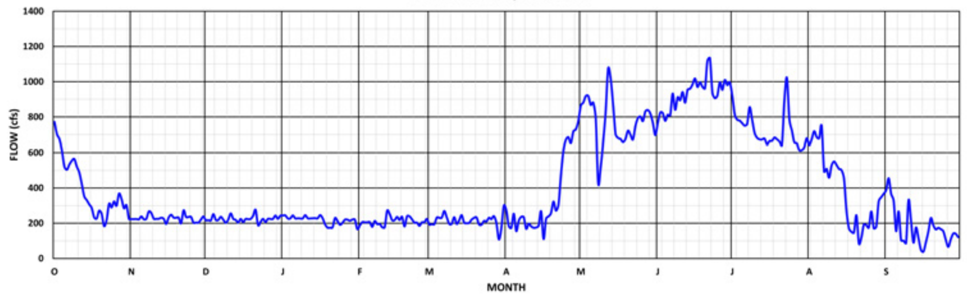
ABIQUIU DAM

OBSERVED DAILY FLOW HYDROGRAPHS 1992 - 2001

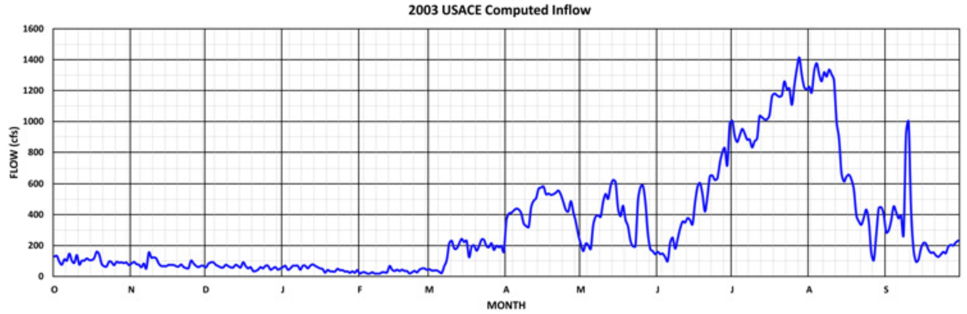
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-5F

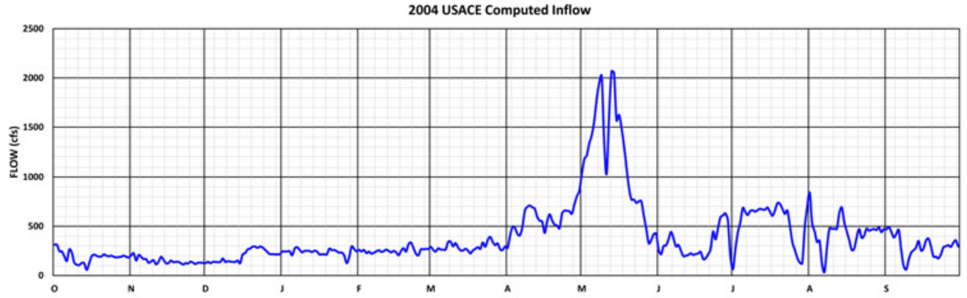
2002 USACE Computed Inflow



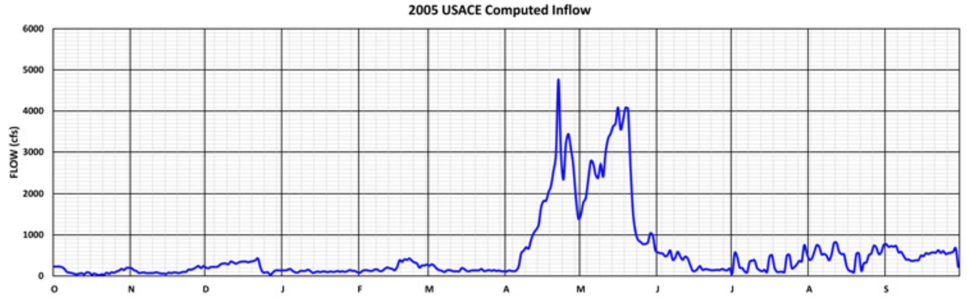
2003 USACE Computed Inflow



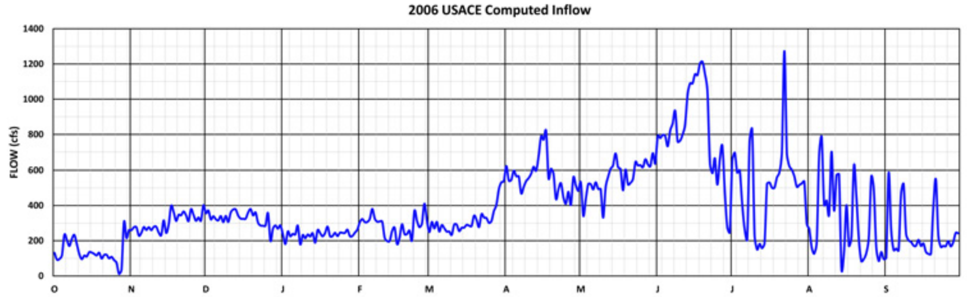
2004 USACE Computed Inflow



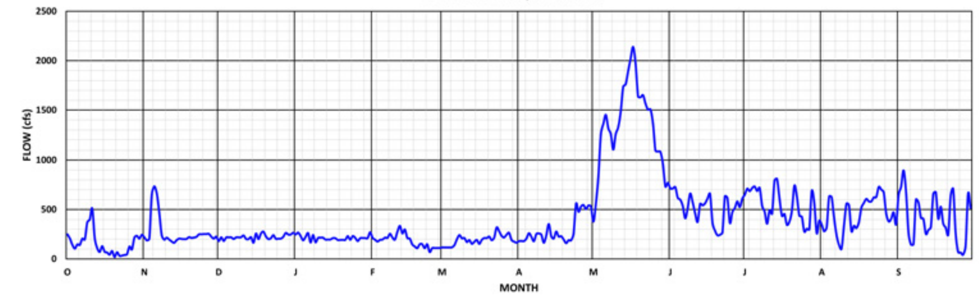
2005 USACE Computed Inflow



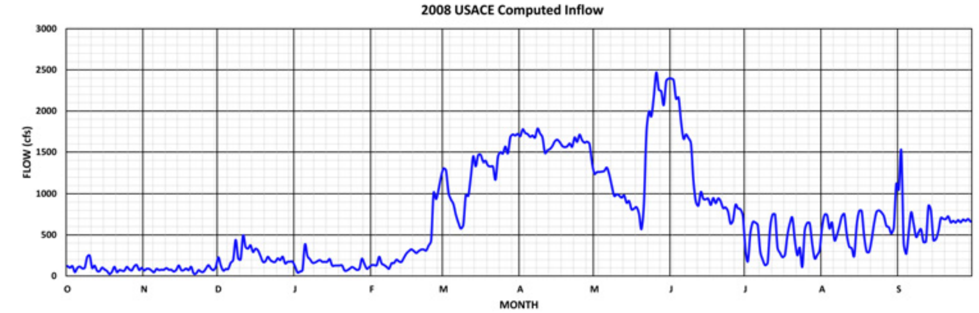
2006 USACE Computed Inflow



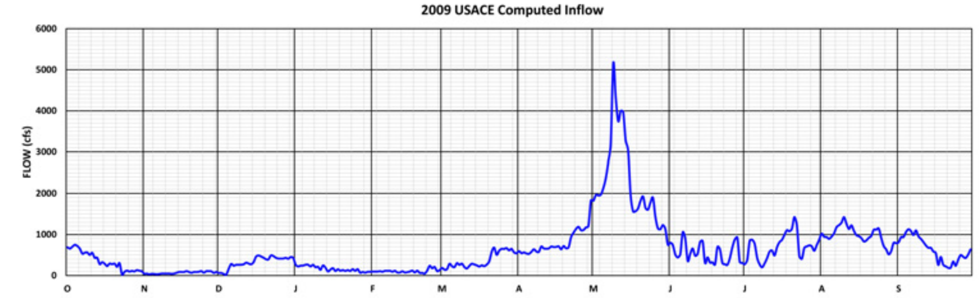
2007 USACE Computed Inflow



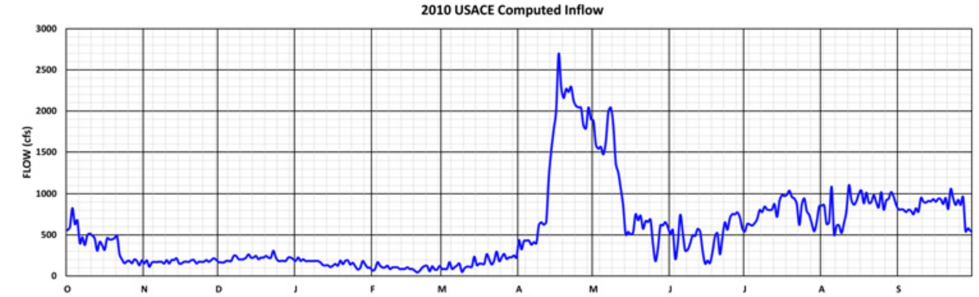
2008 USACE Computed Inflow



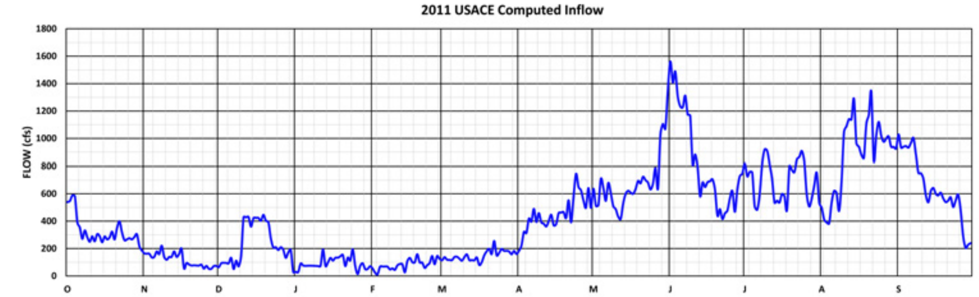
2009 USACE Computed Inflow



2010 USACE Computed Inflow



2011 USACE Computed Inflow



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RIO GRANDE BASIN — NEW MEXICO

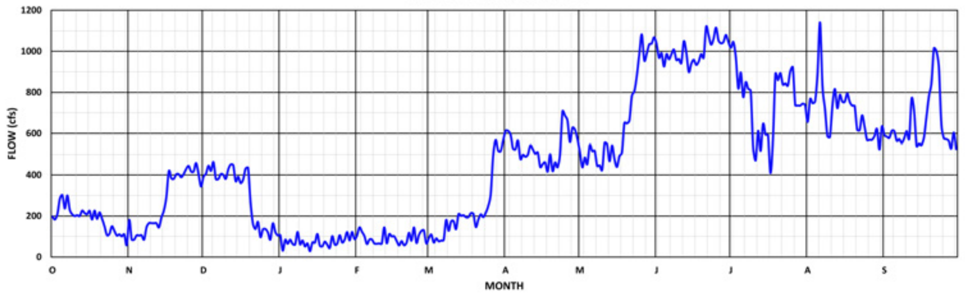
ABIQUIU DAM

OBSERVED DAILY FLOW HYDROGRAPHS 2002 - 2011

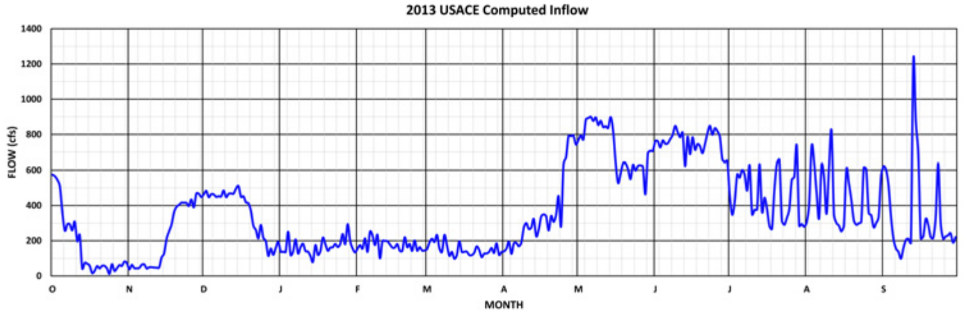
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-5G

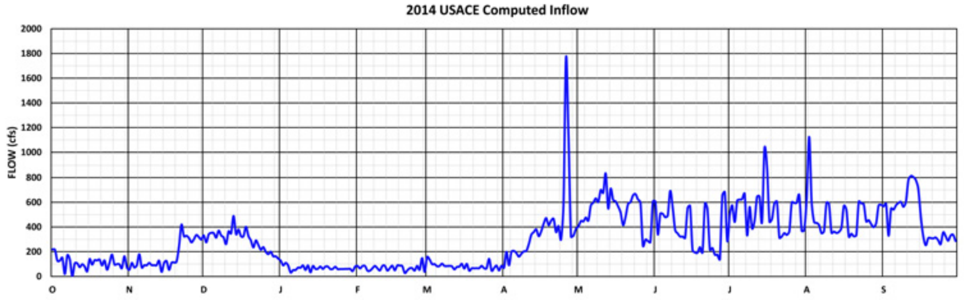
2012 USACE Computed Inflow



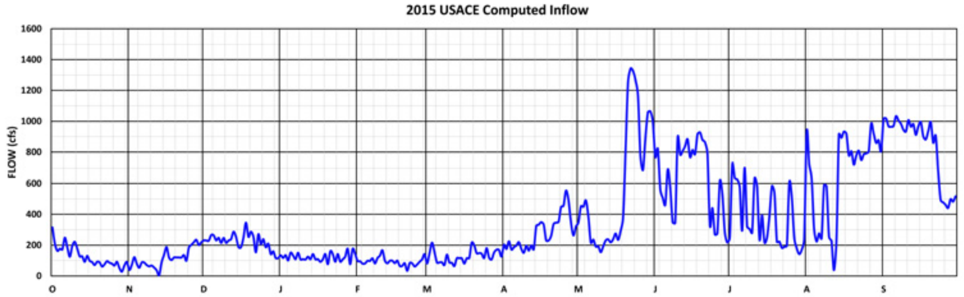
2013 USACE Computed Inflow



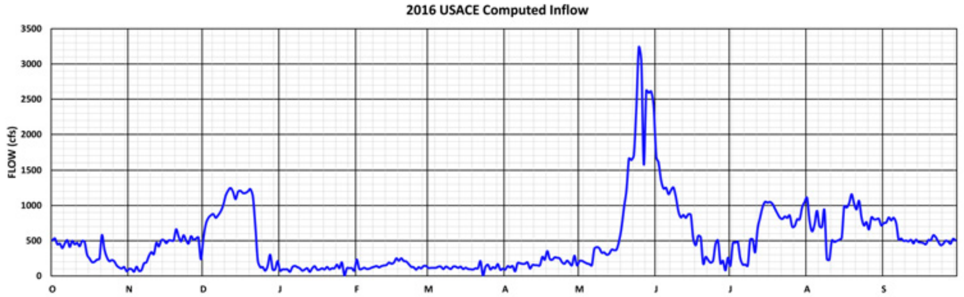
2014 USACE Computed Inflow



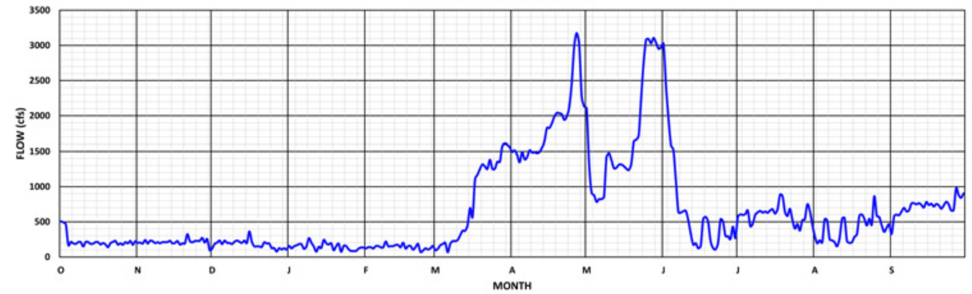
2015 USACE Computed Inflow



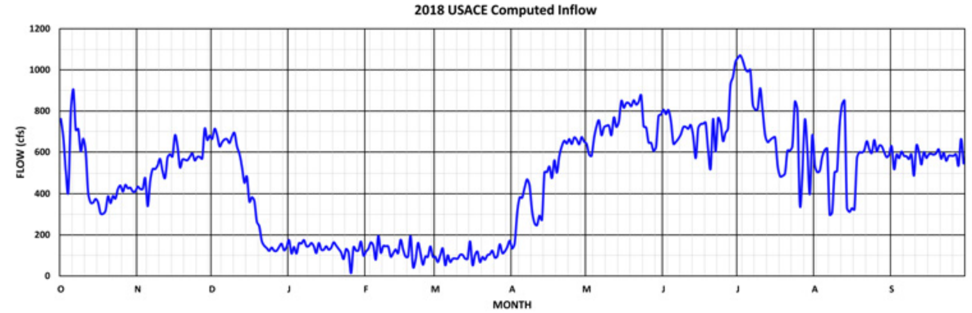
2016 USACE Computed Inflow



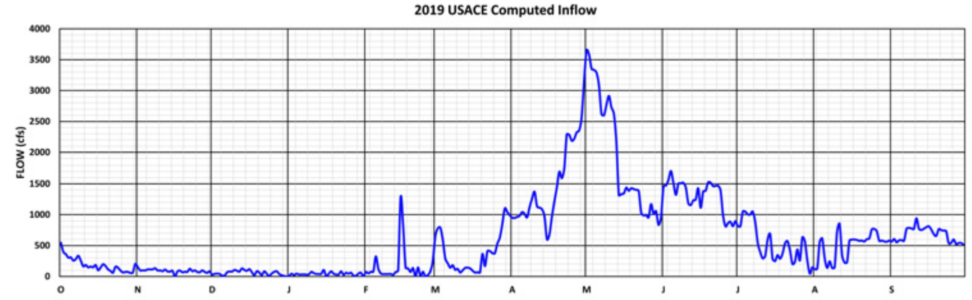
2017 USACE Computed Inflow



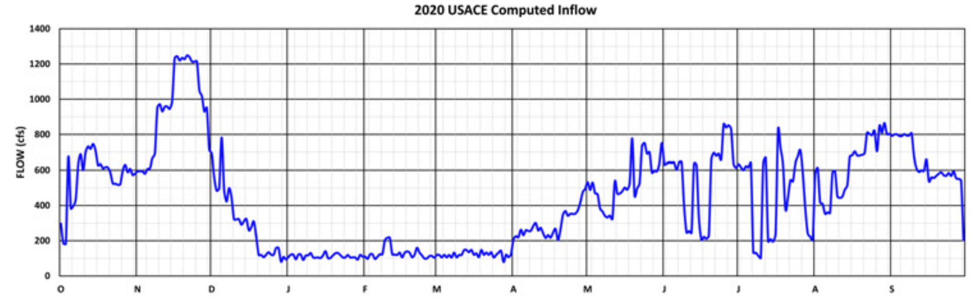
2018 USACE Computed Inflow



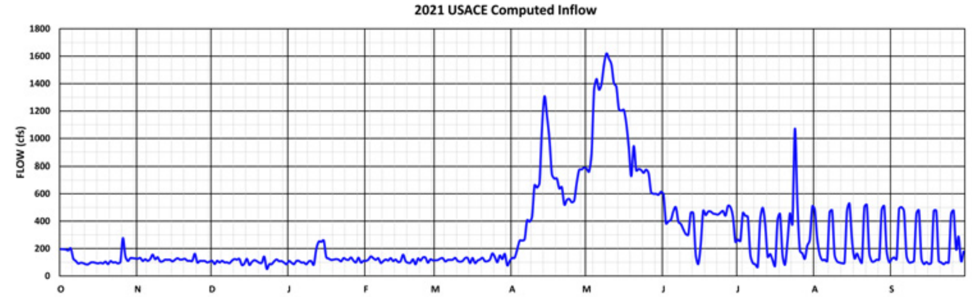
2019 USACE Computed Inflow



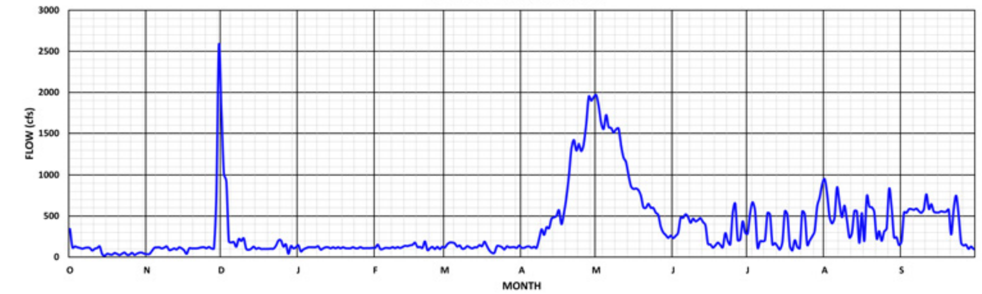
2020 USACE Computed Inflow



2021 USACE Computed Inflow



2022 USACE Computed Inflow



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RIO GRANDE BASIN — NEW MEXICO

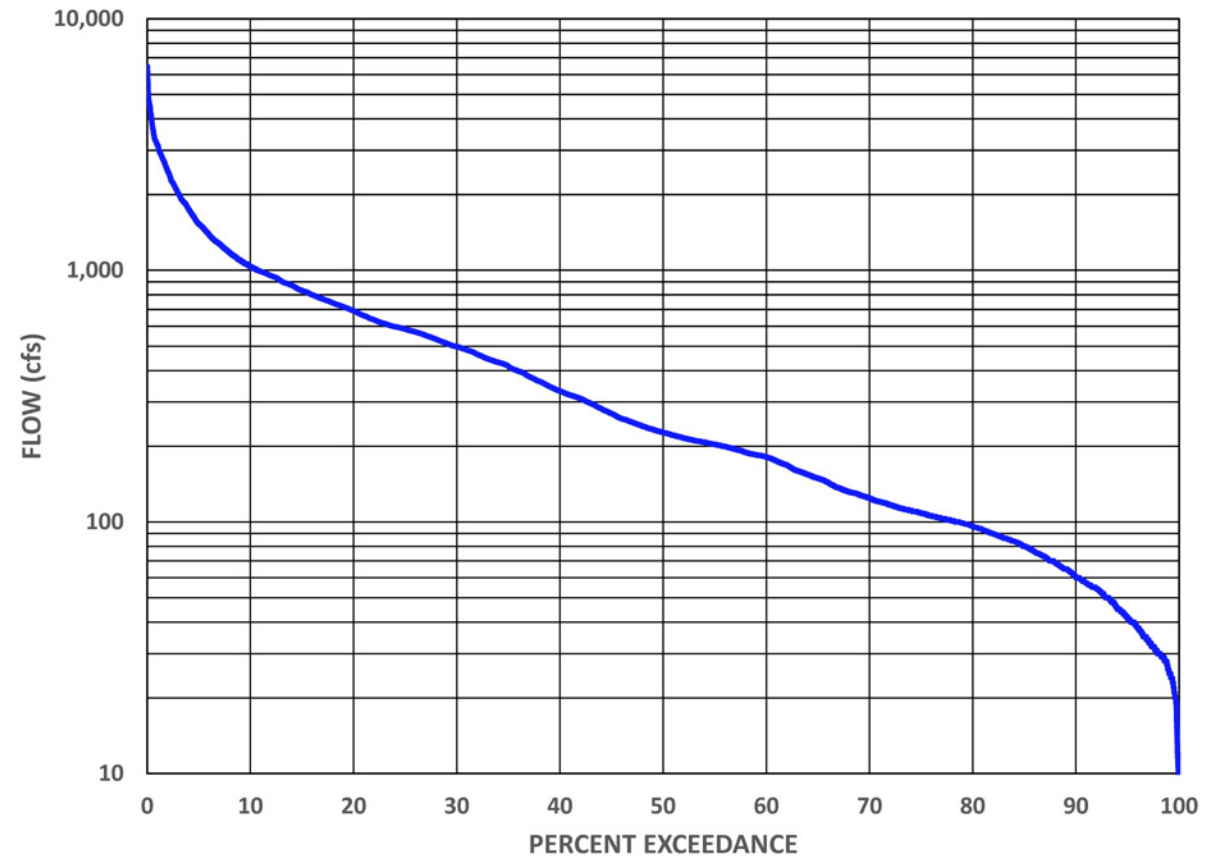
ABIQUIU DAM

OBSERVED DAILY FLOW HYDROGRAPHS 2012 - 2022

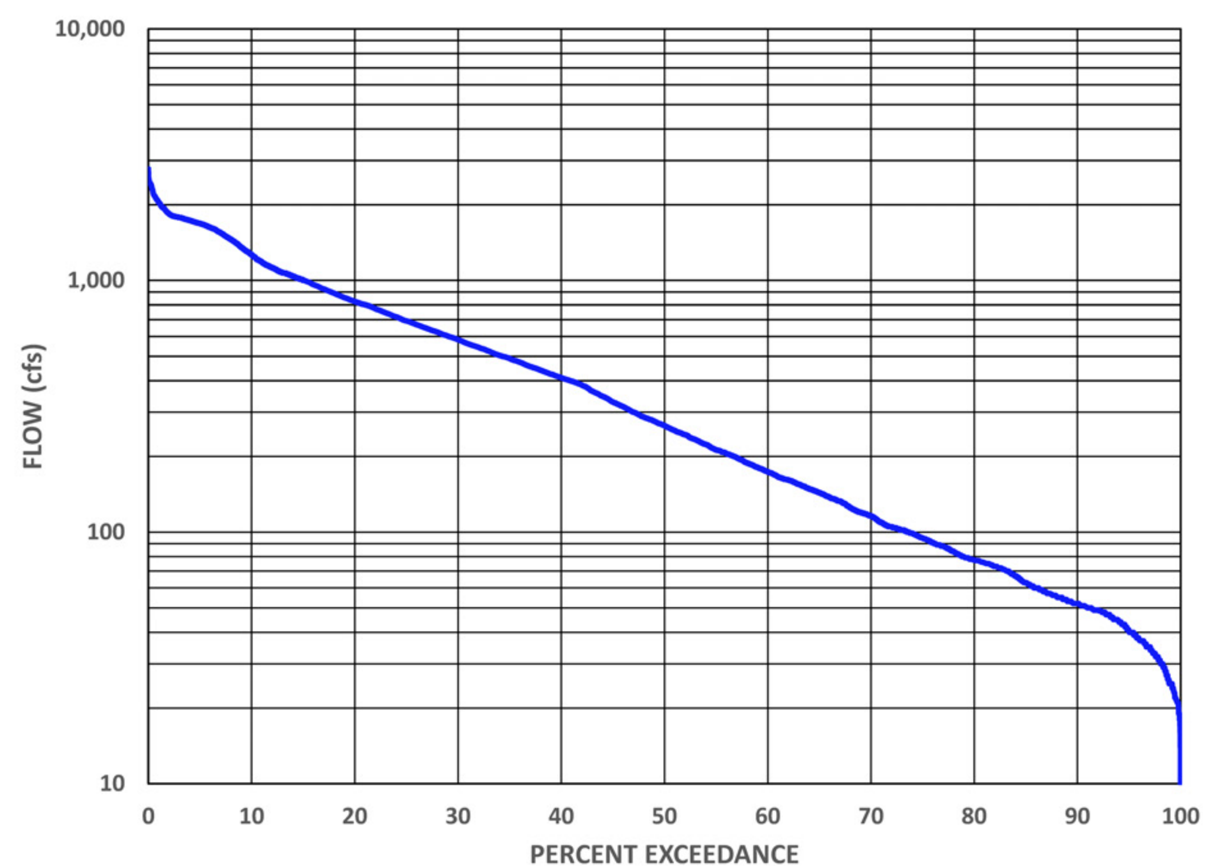
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-5H

USGS 08286500 RIO CHAMA ABOVE ABIQUIU RESERVIOR, NM



USGS 08287000 RIO CHAMA BELOW ABIQUIU RESERVIOR, NM



DURATION DATA COMPUTED
USING HEC-SSP (VER 2.2)
1963 - 2022

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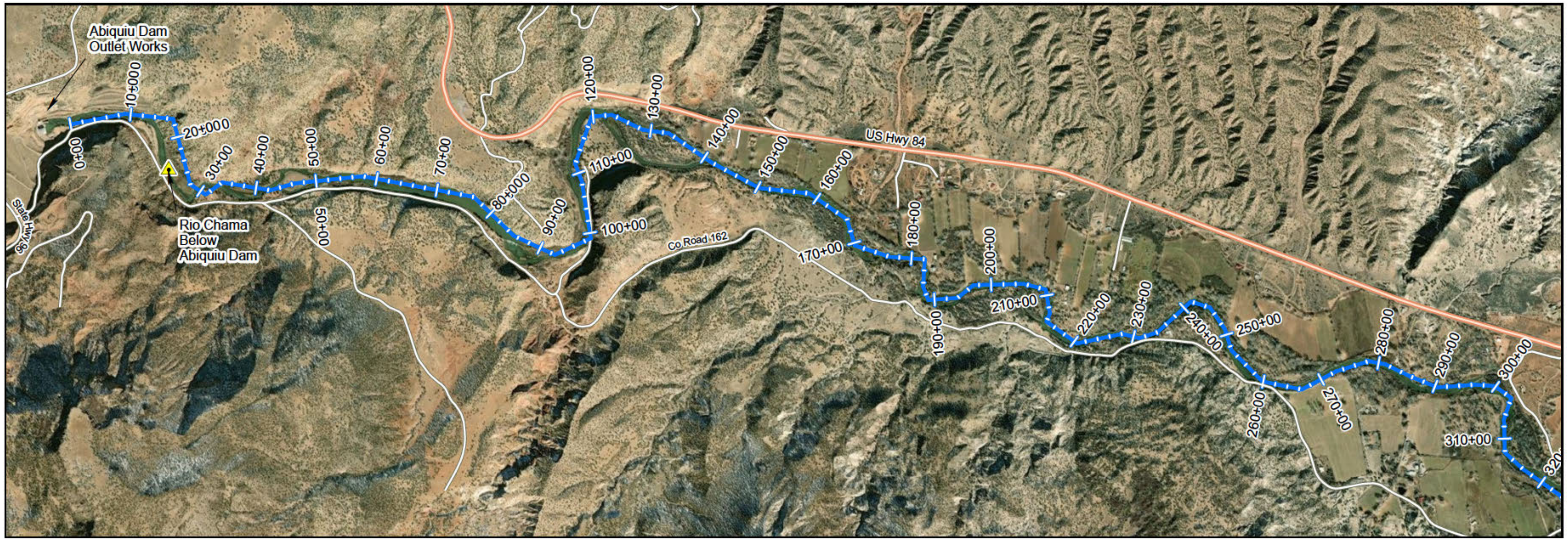
RIO GRANDE BASIN	NEW MEXICO
ABIQUIU DAM **DURATION CURVES ABOVE AND BELOW ABIQUIU DAM**	
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024	**Plate 4-6**



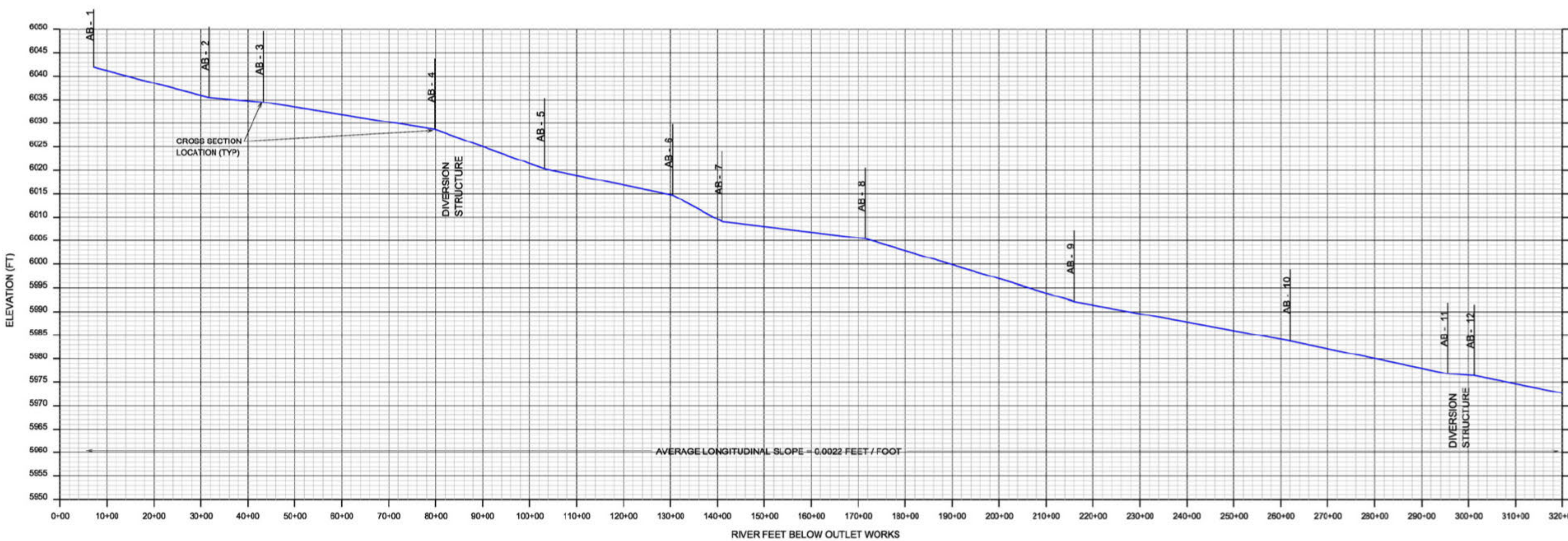
Legend
- Stream Gage
- Primary Highway
- Local Road
- Rio Chama Profile Centerline

N

0 2,000 Feet

1:24,000

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters



Profiles taken from RAS geometry
from 2015 CWMS model

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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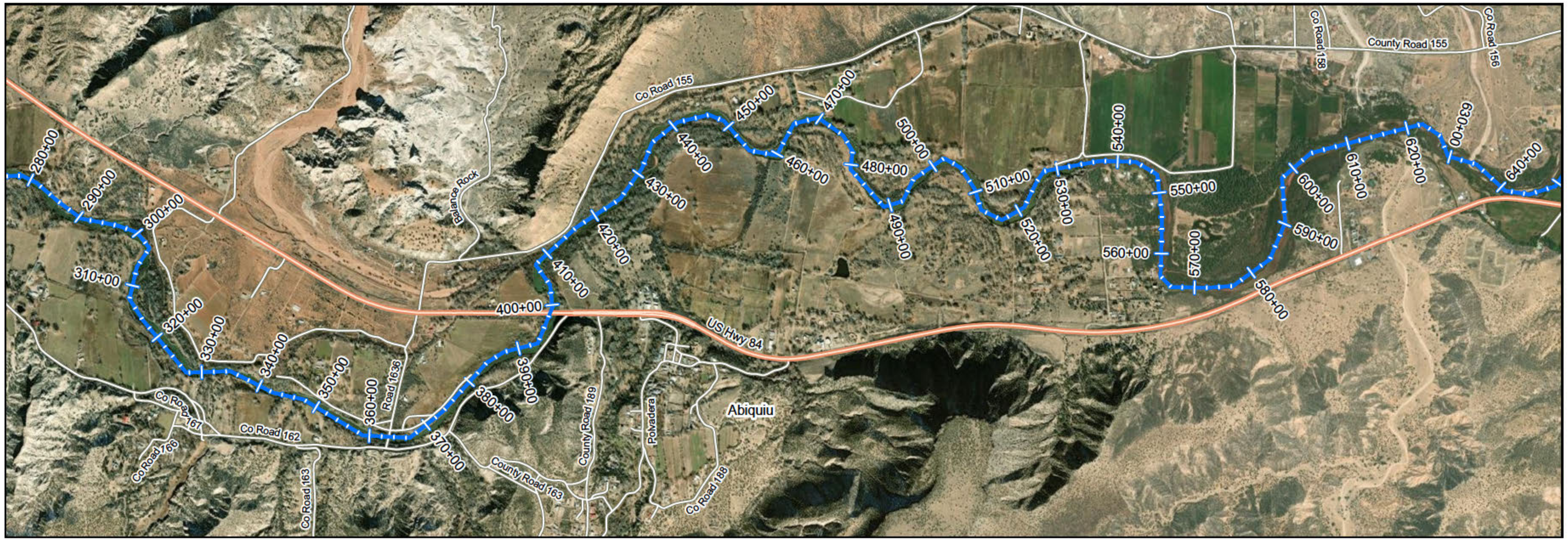
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM
RIO CHAMA PROFILE
ABIQUIU DAM TO RIO GRANDE
Station 0+00 to 320+00

TO ACCOMPANY WATER
CONTROL MANUAL
DATED APRIL 2024

Plate 4-7A



Legend

Primary Highway

Local Road

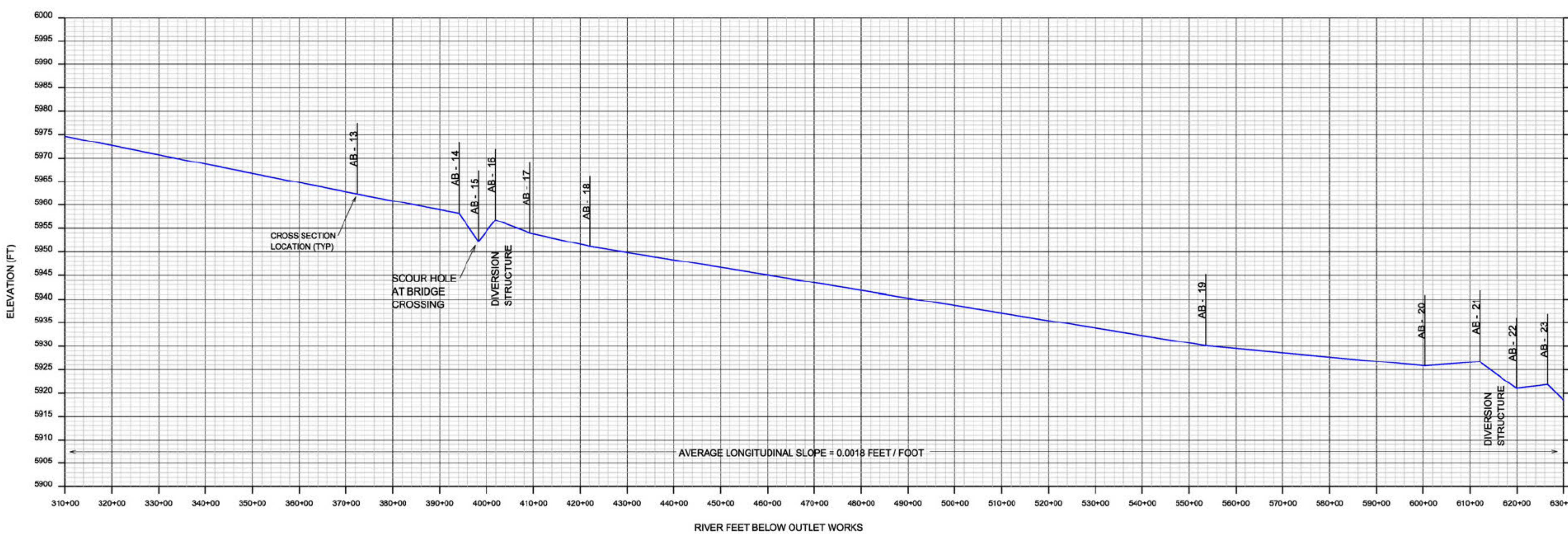
Rio Chama Profile Centerline

N

0 2,000 Feet

1:24,000

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters



Profiles taken from RAS geometry from 2015 CWMS model

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

RIO CHAMA PROFILE
ABIQUIU DAM TO RIO GRANDE
Station 320+00 to 630+00

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-7B

Legend

- Stream Gage
- Primary Highway
- Local Road
- Rio Chama Profile Centerline

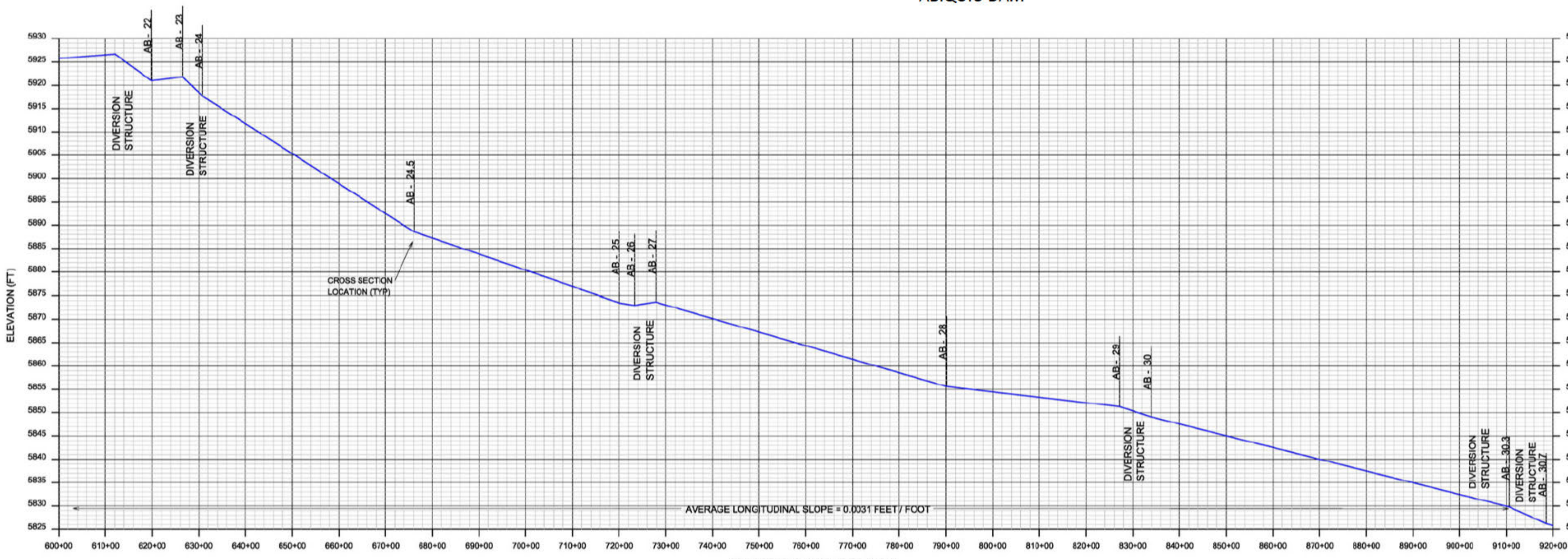
N

0 2,000 Feet

1:24,000

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

ABIQUIU DAM



Profiles taken from RAS geometry from 2015 CWMS model

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

RIO CHAMA PROFILE
ABIQUIU DAM TO RIO GRANDE
Station 630+00 to 920+00

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

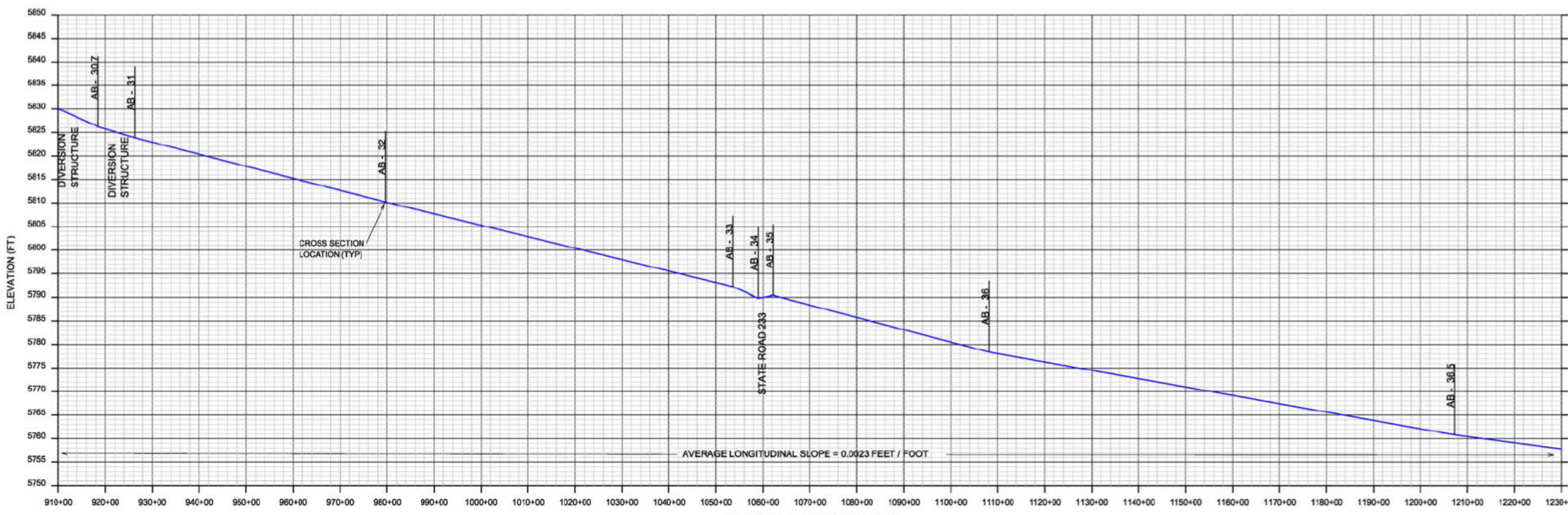
Plate 4-7C

Legend
- Primary Highway
- Local Road
- Rio Chama Profile Centerline

0 2,000 Feet

1:24,000

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters



Profiles taken from RAS geometry from 2015 CWMS model

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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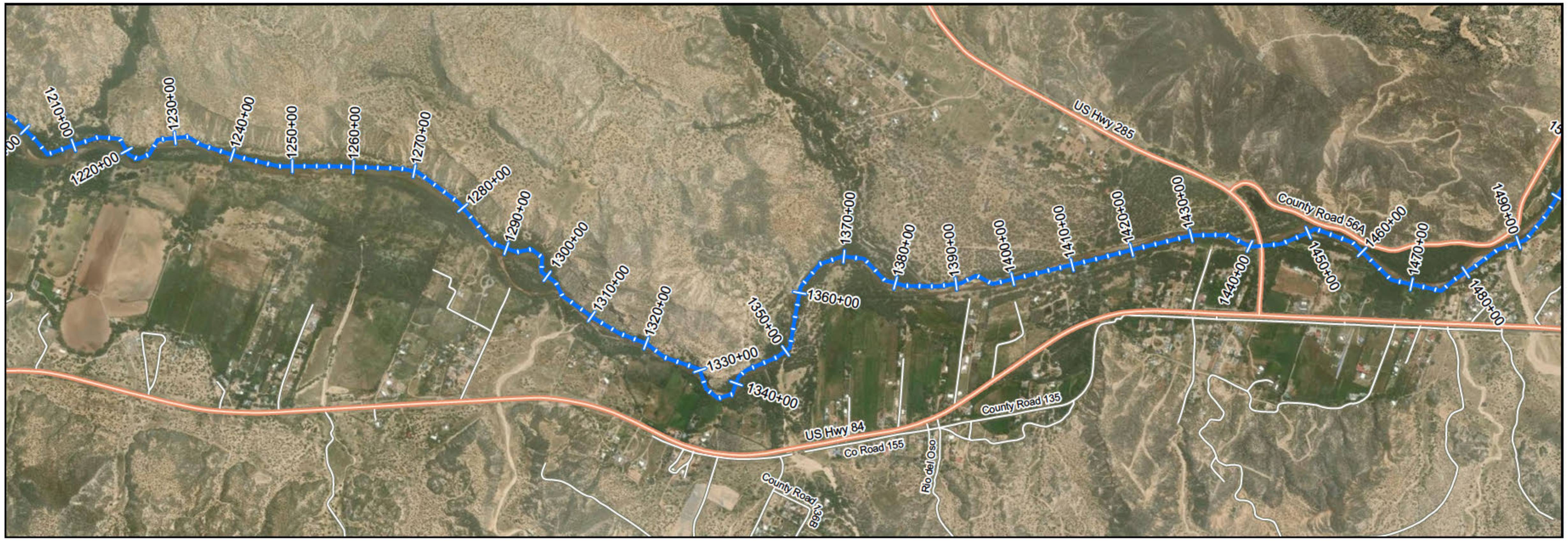
RIO GRANDE BASIN — NEW MEXICO

ABIQUIU DAM
RIO CHAMA PROFILE
ABIQUIU DAM TO RIO GRANDE
Station 920+00 to 1230+00

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-7D



Legend

Primary Highway

Local Road

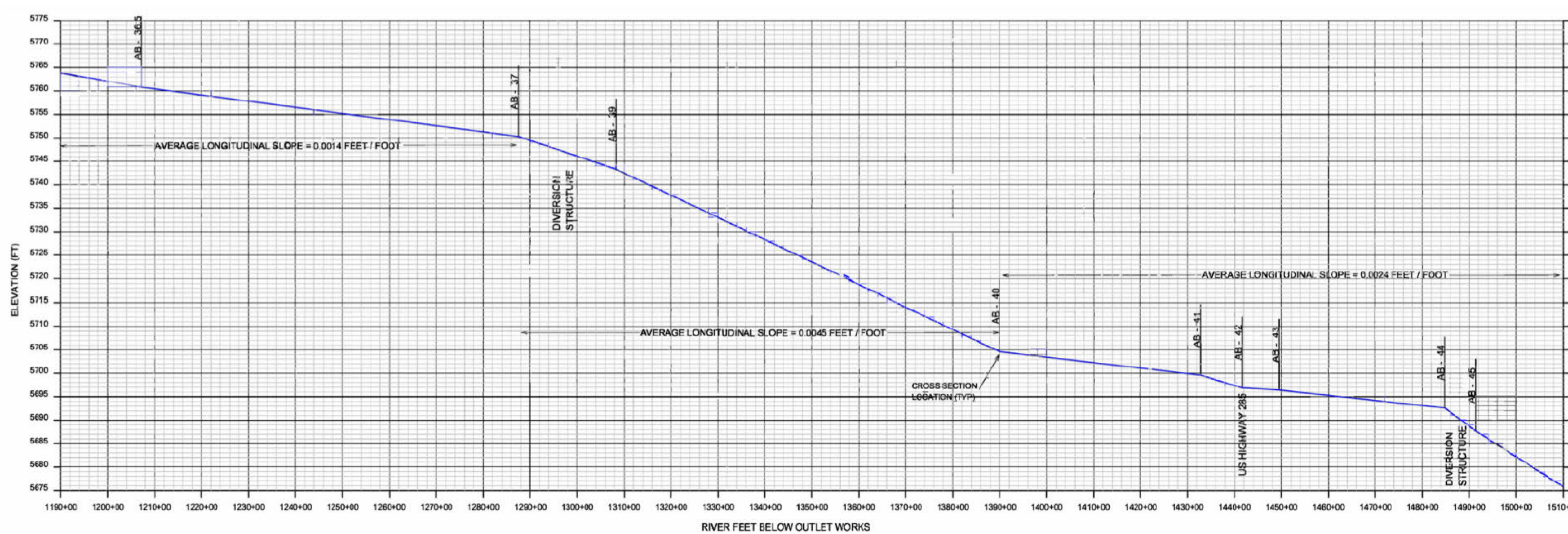
Rio Chama Profile Centerline

N

0 2,000 Feet

1:24,000

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters



Profiles taken from RAS geometry
from 2015 CWMS model

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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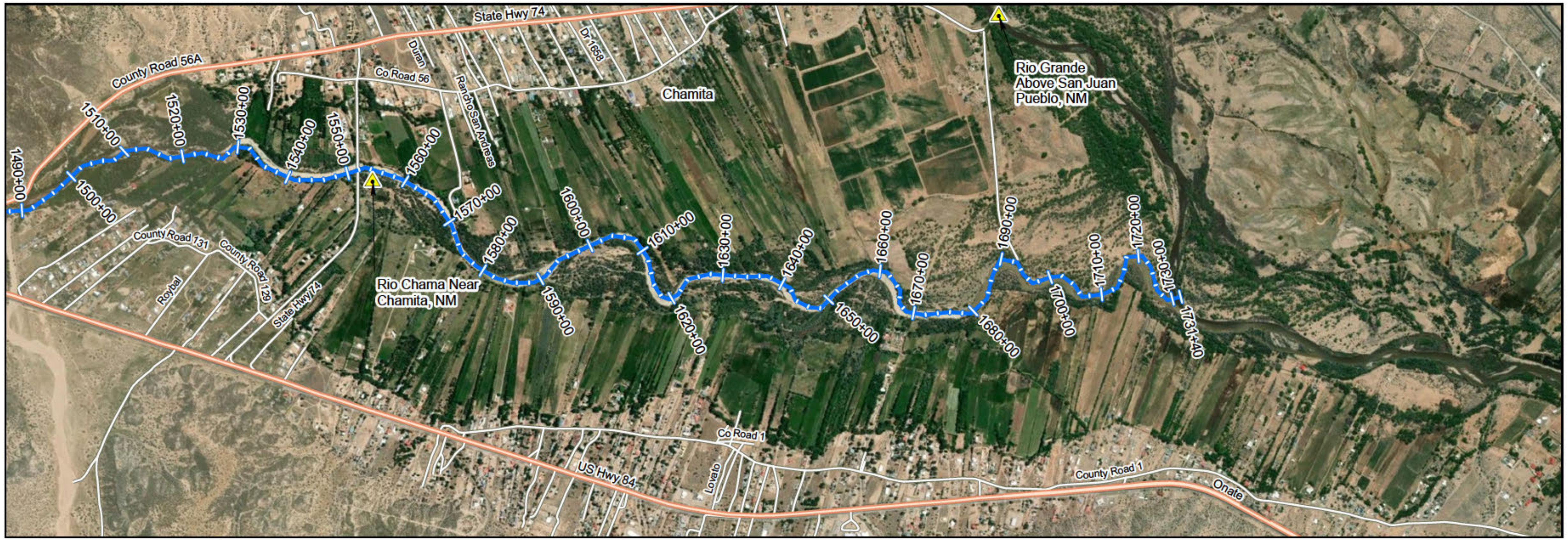
RIO GRANDE BASIN | NEW MEXICO

ABIQUIU DAM

RIO CHAMA PROFILE
ABIQUIU DAM TO RIO GRANDE
Station 1230+00 to 1510+00

TO ACCOMPANY WATER
CONTROL MANUAL
DATED APRIL 2024

Plate 4-7E

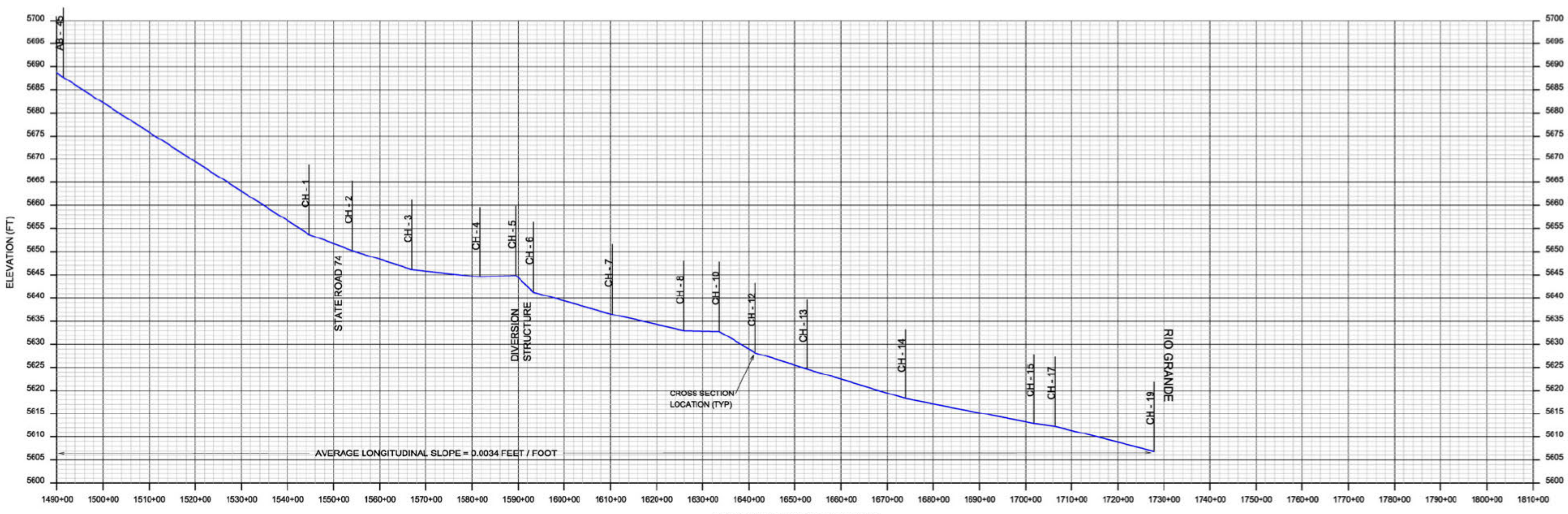


Legend
- Stream Gage
- Primary Highway
- Local Road
- Rio Chama Profile Centerline

0 2,000 Feet

1:24,000

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters



Profiles taken from RAS geometry from 2015 CWMS model

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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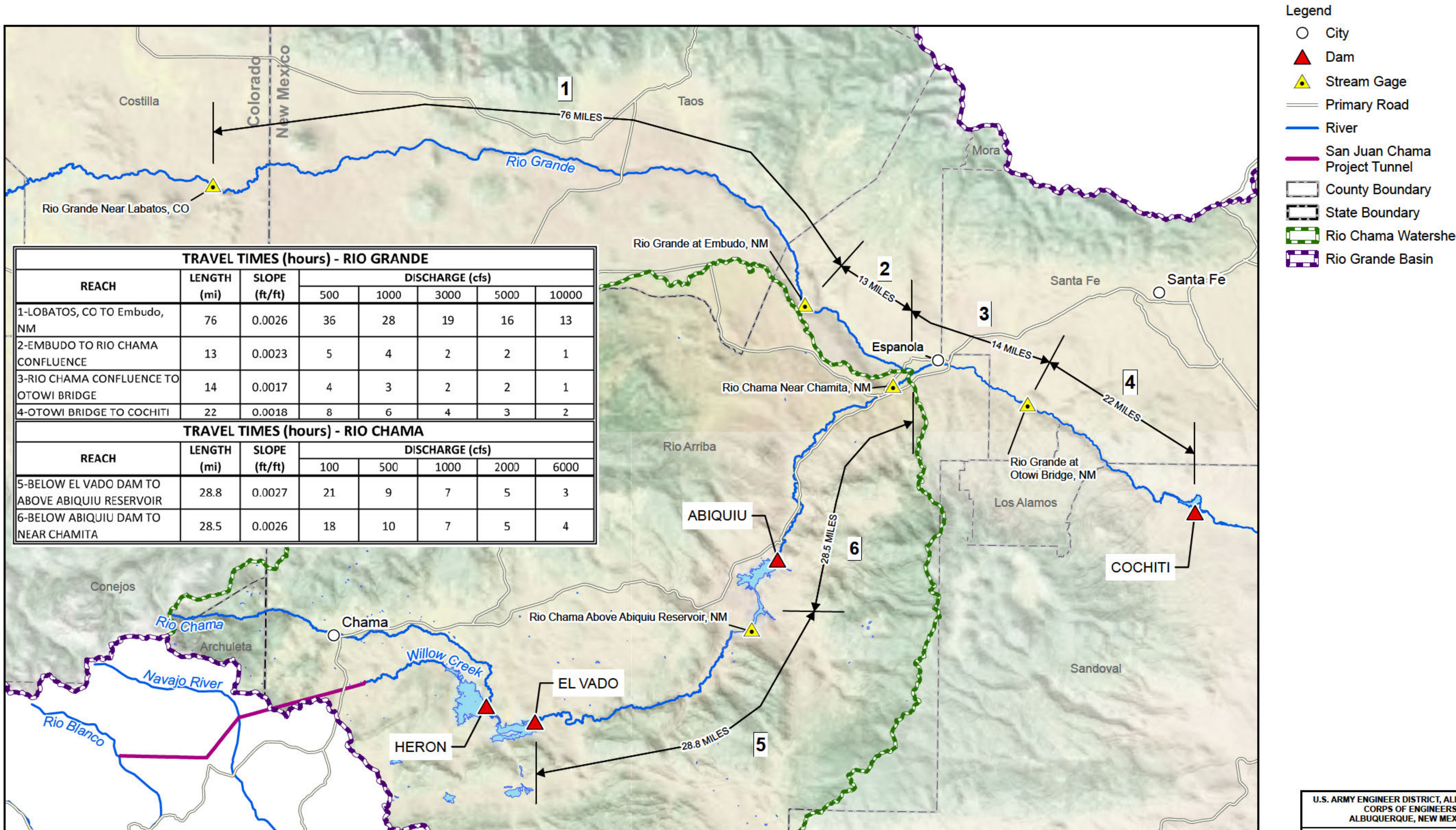
RIO GRANDE BASIN — NEW MEXICO

ABIQUIU DAM
RIO CHAMA PROFILE
ABIQUIU DAM TO RIO GRANDE
Station 1510+00 to 1728+00

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-7F



TRAVEL TIMES (hours) - RIO GRANDE							
REACH	LENGTH (mi)	SLOPE (ft/ft)	DISCHARGE (cfs)				
			500	1000	3000	5000	10000
1-LOBATOS, CO TO Embudo, NM	76	0.0026	36	28	19	16	13
2-EMBUDO TO RIO CHAMA CONFLUENCE	13	0.0023	5	4	2	2	1
3-RIO CHAMA CONFLUENCE TO OTOWI BRIDGE	14	0.0017	4	3	2	2	1
4-OTOWI BRIDGE TO COCHITI	22	0.0018	8	6	4	3	2

TRAVEL TIMES (hours) - RIO CHAMA							
REACH	LENGTH (mi)	SLOPE (ft/ft)	DISCHARGE (cfs)				
			100	500	1000	2000	6000
5-BELOW EL VADO DAM TO ABOVE ABIQUIU RESERVOIR	28.8	0.0027	21	9	7	5	3
6-BELOW ABIQUIU DAM TO NEAR CHAMITA	28.5	0.0026	18	10	7	5	4

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0 10 20 30 40 Miles

1:633,600

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

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RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

TRAVEL TIMES

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 4-8

US Army Corps of Engineers ®
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0 9 18 27 36 Miles

1:570,240

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

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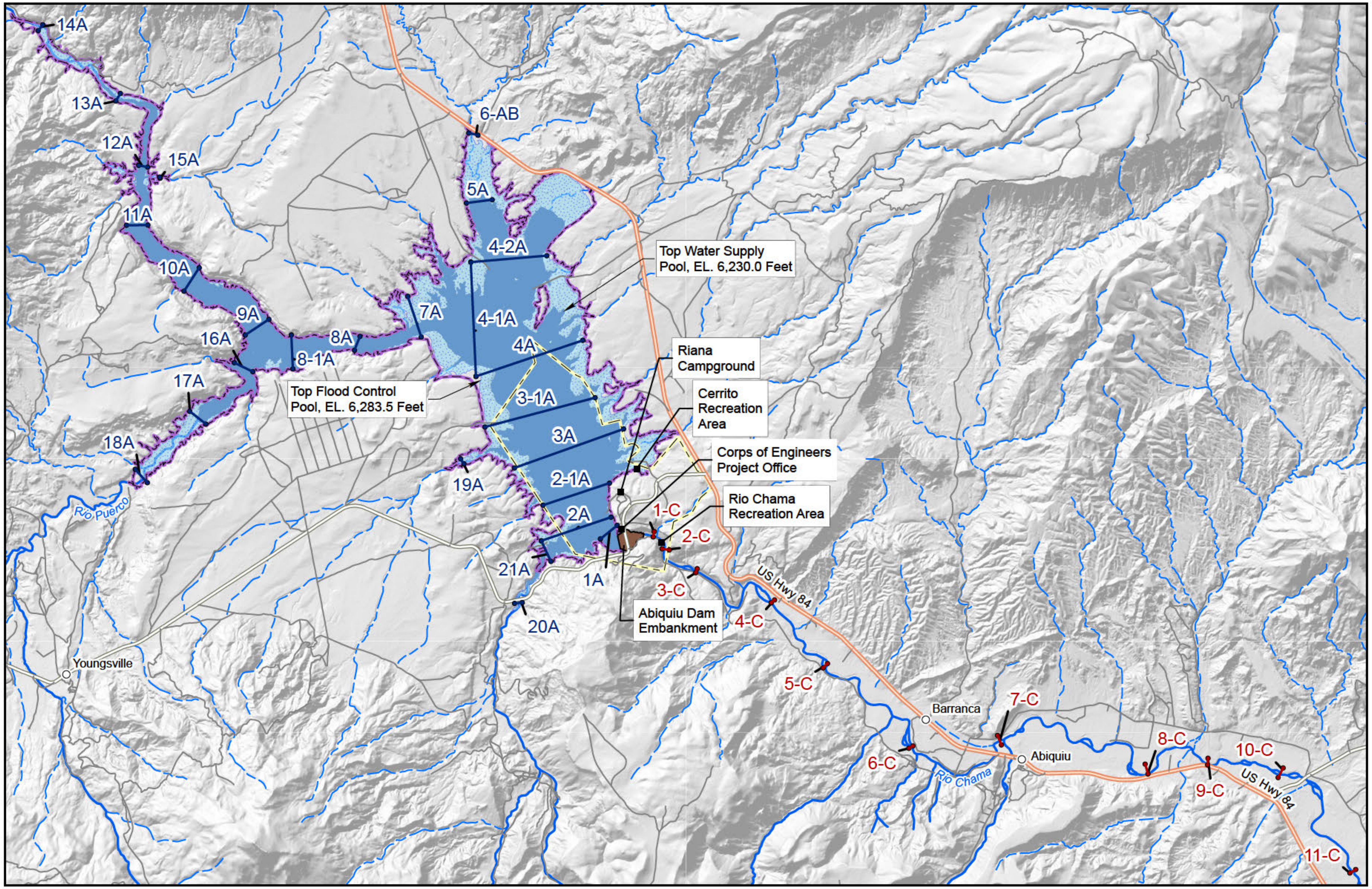
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

HYDROMETEOROLOGICAL ACTIVE STATIONS

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 5-1



Legend

- Community
- Ephemeral Stream
- River
- Primary Highway
- Major Road
- Local Road
- Degradation Range Line
- Sedimentation Range Line
- Fee Boundary
- Flowage Easement
- Embankment
- Top Water Supply Pool
- Top Flood Control Pool

Location of downstream degradation range lines copied from 1995 Abiquiu Water Control Manual Plate 5-1.

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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0 1.5 3 4.5 6 Miles

1:95,040

N

Map Projection:
Universal Transverse Mercator
Zone 13 North, NAD83
Units = meters

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ABIQUIU DAM

SEDIMENT AND DEGRADATION RANGE LINES

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 5-2

ABIQUIU
DAILY REPORT
(For 24-Hour Period from 0000 to 2400 on 03 JUN 2023)

DAILY RESERVOIR OPERATION SUMMARY

2400 Hour Summary	0000Hrs	2400Hrs	Change	Water Yr-Sums	Daily CFS	Daily AC-FT	Yearly AC-FT
Elev.(FT)	6230.67	6230.72	0.05	Releases	1570.5	3115	240,726
				Evaporation	41.7	83	7,361
				Unid. losses	0.0	0	0
Stor(AC-FT)	232,353	232,591	238	Stor. Change	120.0	238	109,394
				Comp. Inflow	1732.2	3436	357,481

MAX. allowable lake elevation = 6,220.00 184,753 AC-FT.

0800 - WEATHER DATA - 04 JUN 2023

PRECIP	PAN EVAP	TEMP 0800	TEMP MAX	TEMP MIN	% CLD	% ICE
0.00	.30	54	74	48	8	0

SPD - Morning Report Data

Proj.	0000 Elev.	Latest 0800 Elev.	Rain	Net Evap.	Turbine Gen.	24hr Release	24hr Losses	Latest 0800 Release
15505	6230.72	6230.73	0.00	0.30	0	1570.5	0.0	1572.6
		Stor.						Stage
		232,637						4.87

Downstream Shift = N/A

Gage Readings

DATE	TIME	ELEVATION	STORAGE	GATE#1 SETTING	GATE#2 SETTING	DOWNSTREAM STAGE	DOWNSTREAM FLOW (cfs)
02JUN2023	0845	6230.64	232,212	8.00	8.00	4.81	1534

COMMENTS:

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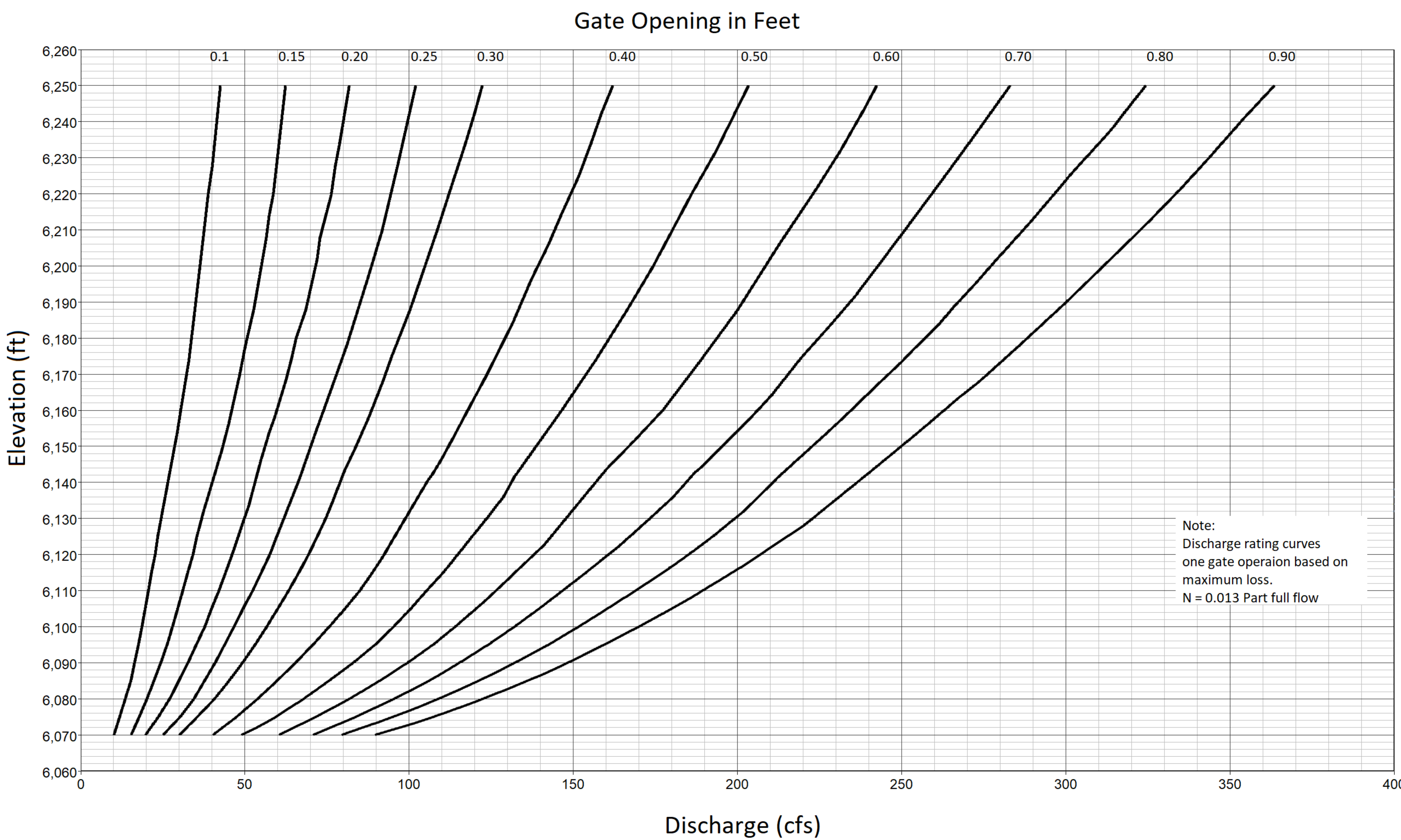
ABIQUIU DAM

DAILY REPORT

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024



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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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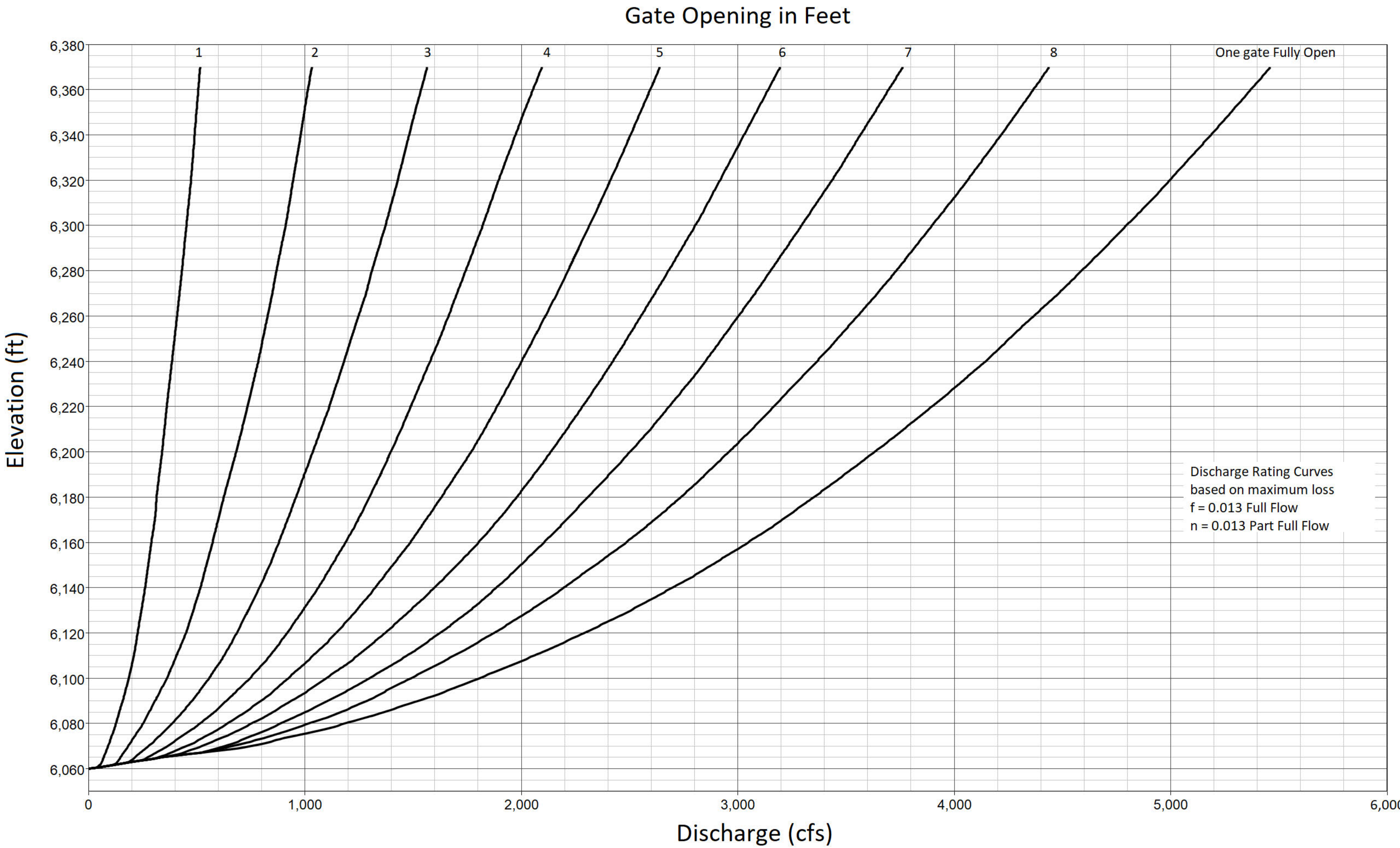
ABIQUIU DAM

CONDUIT RATING CURVES

ONE GATE, INCREMENTS LESS THAN ONE FOOT

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 7-1A



US Army Corps of Engineers ® Albuquerque District

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

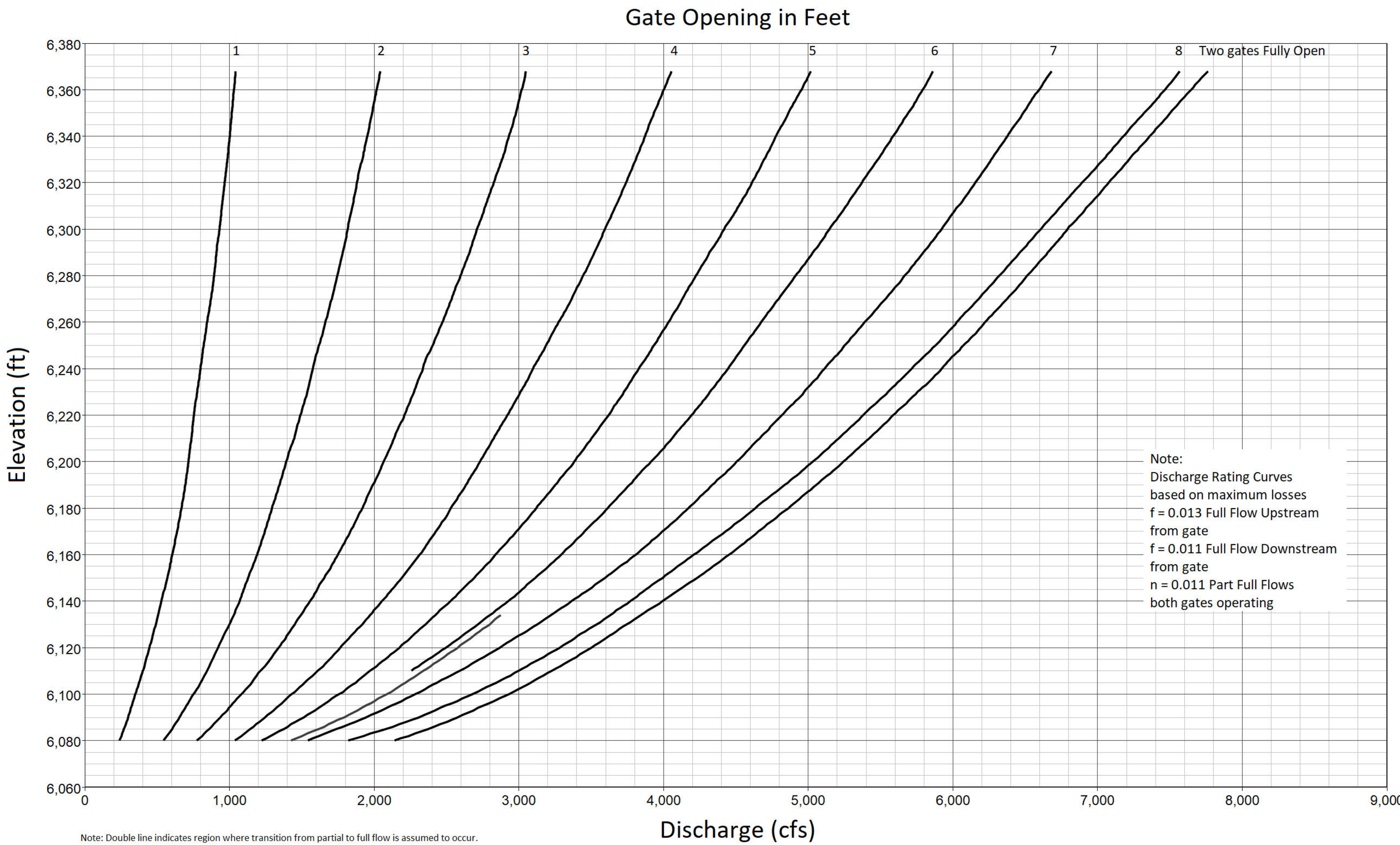
ABIQUIU DAM

CONDUIT RATING CURVES

ONE GATE, ONE-FOOT INCREMENTS

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 7-1B



Note: Double line indicates region where transition from partial to full flow is assumed to occur.

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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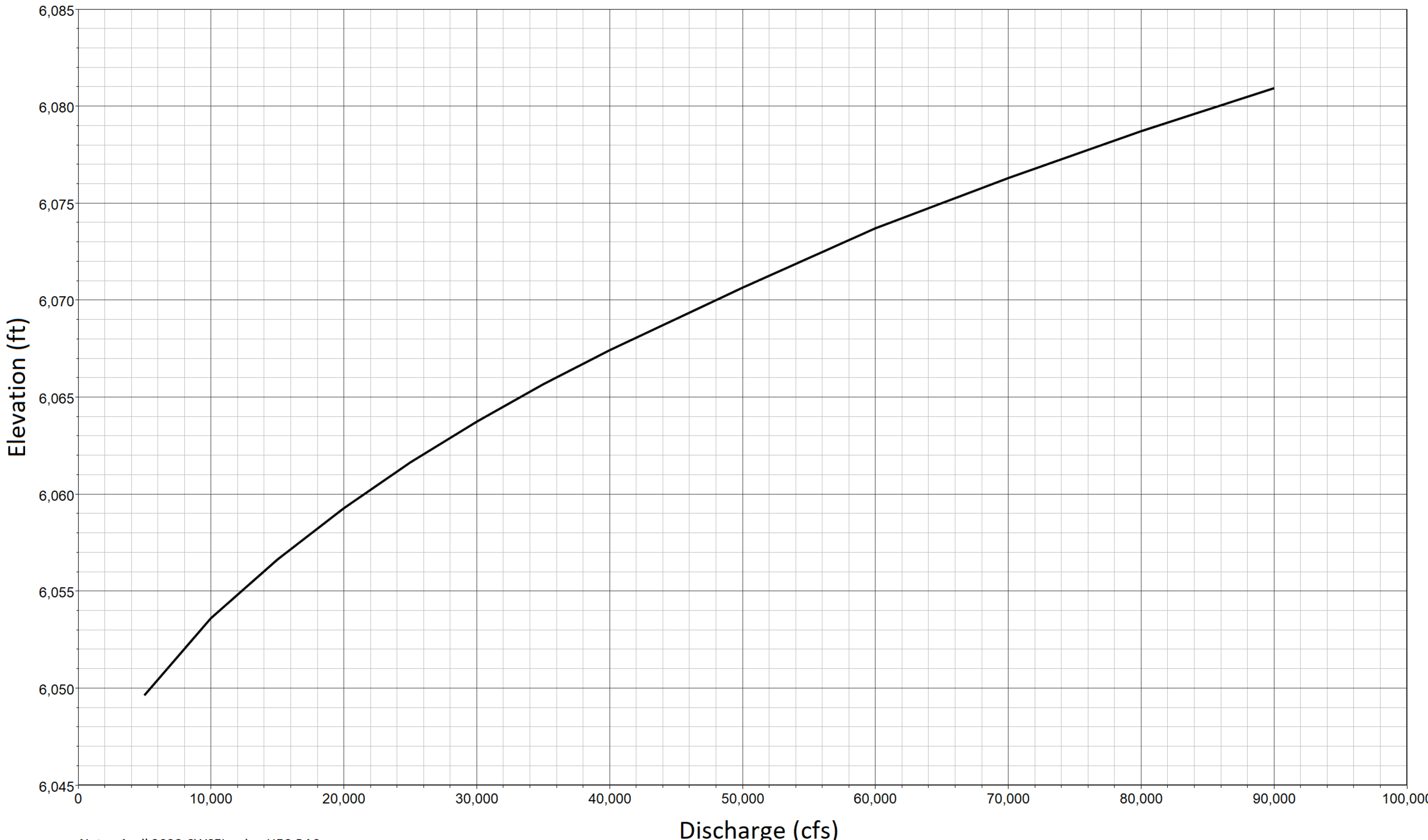
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN | NEW MEXICO

ABIQUIU DAM
CONDUIT RATING CURVES
TWO GATES, ONE-FOOT INCREMENTS

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 7-1C



Note : April 2023 CWSEL using HEC-RAS

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
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ALBUQUERQUE, NEW MEXICO

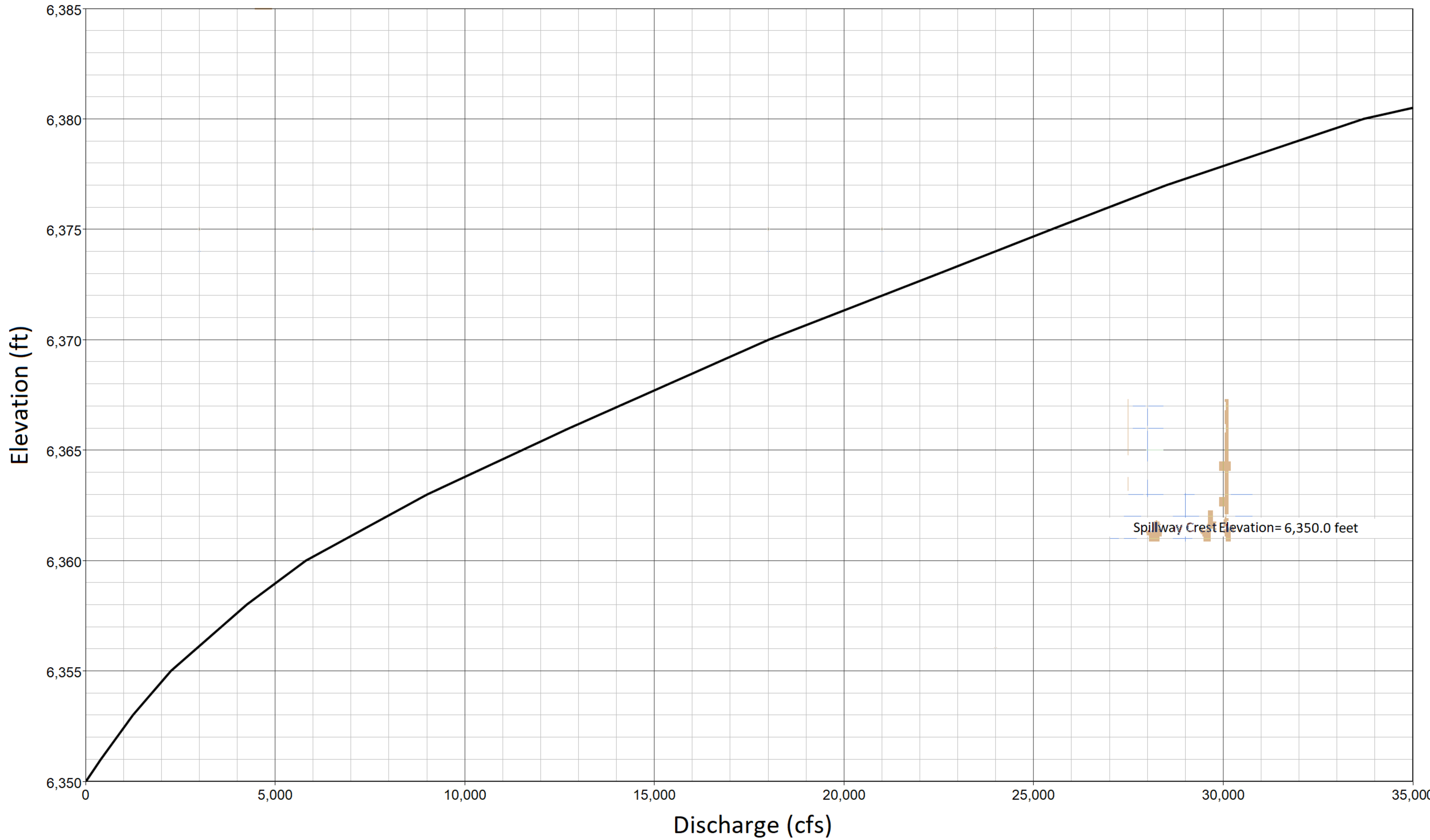
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

TAILWATER RATING CURVE

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 7-2



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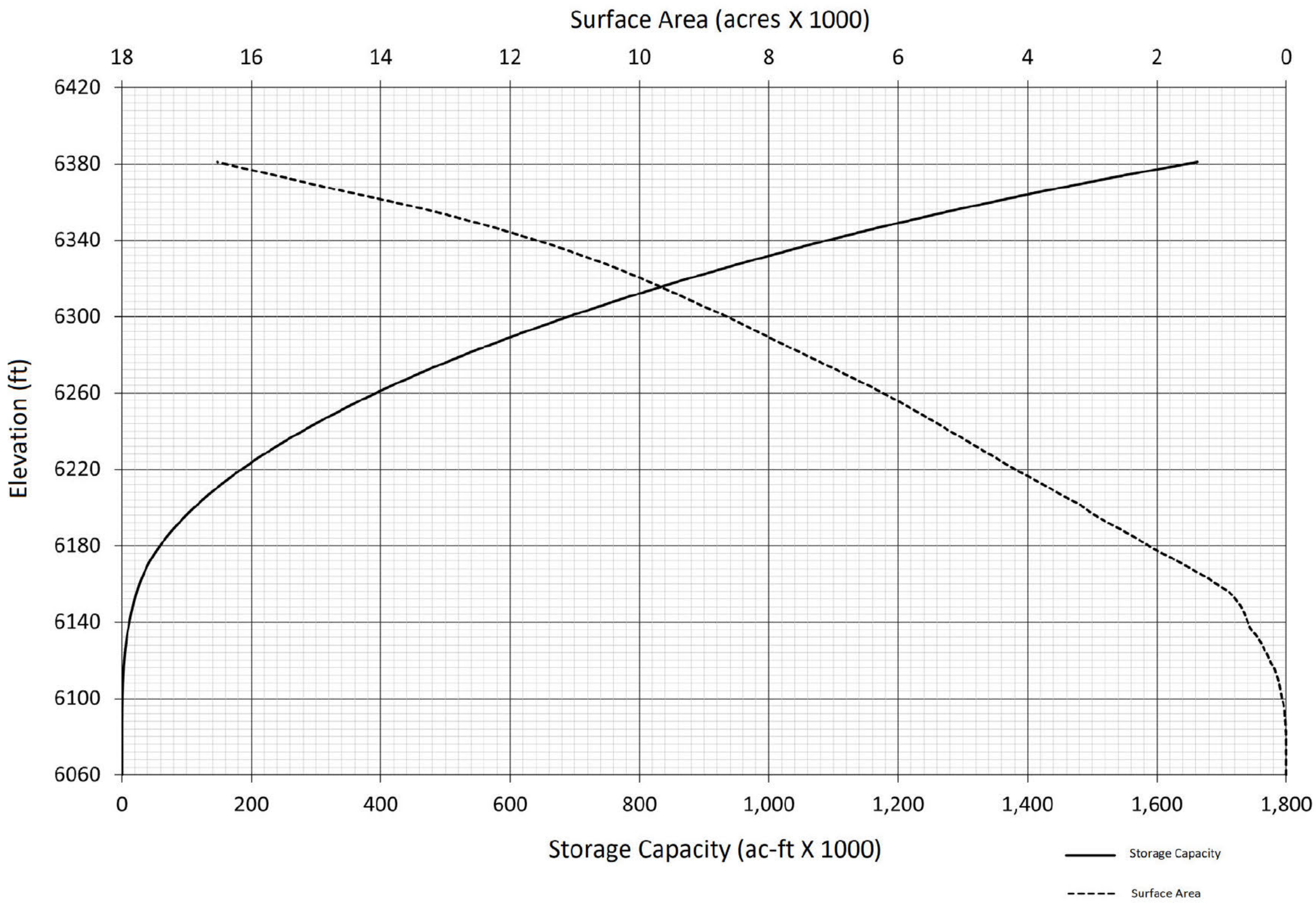
Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
RIO GRANDE BASIN	NEW MEXICO
ABIQUIU DAM **SPILLWAY RATING CURVE**	
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024	**Plate 7-3**



Survey Collected in 2020
Table Applied in 2022

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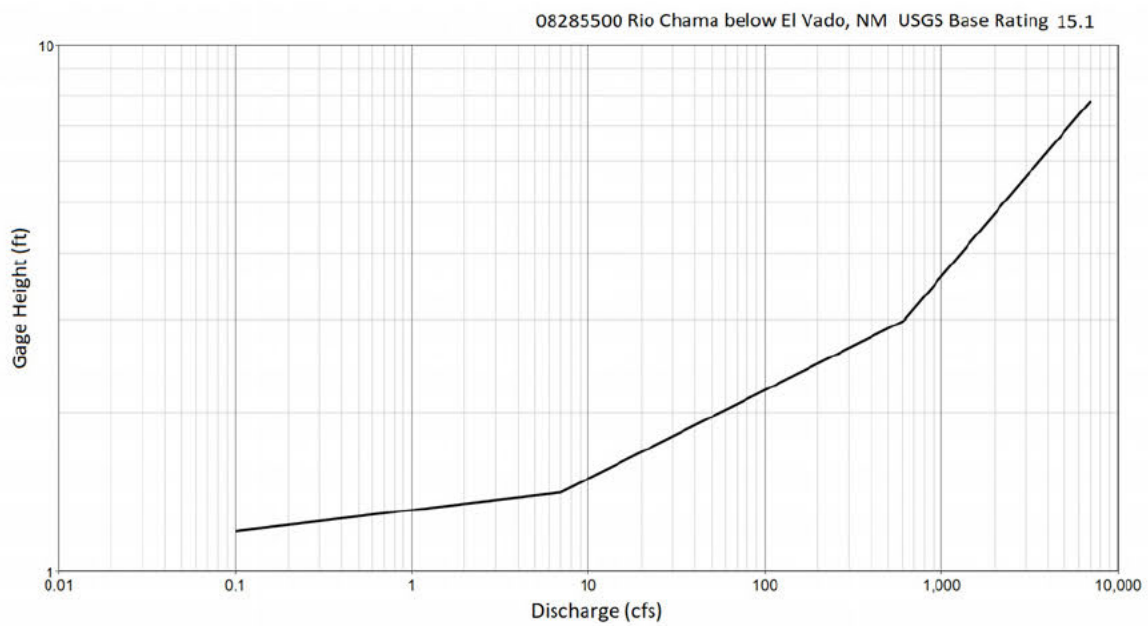
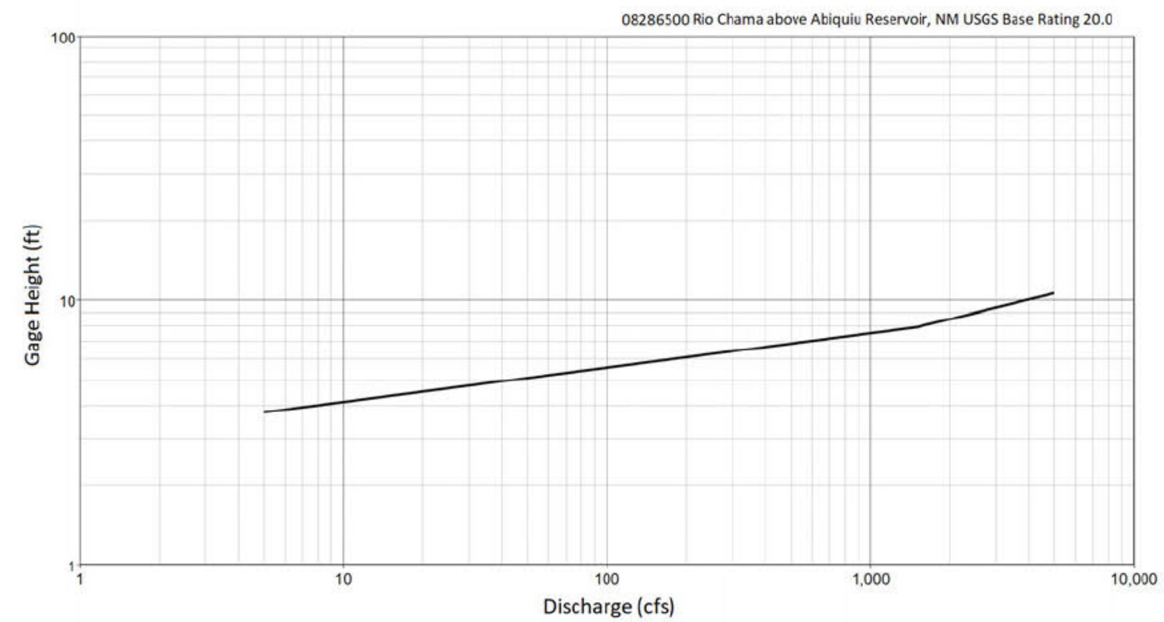
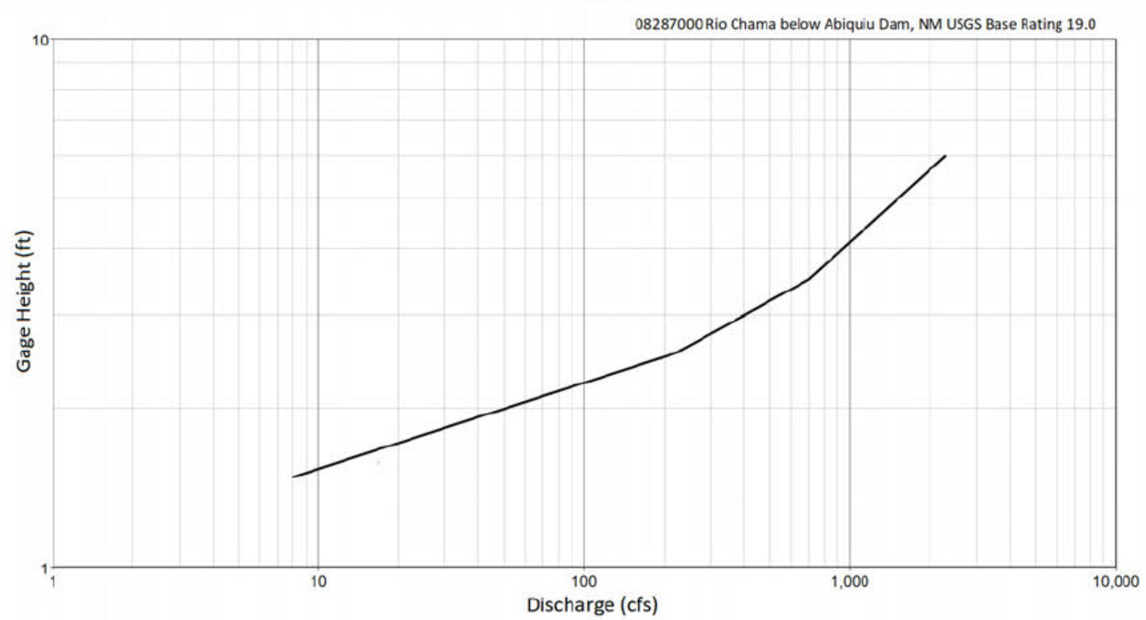
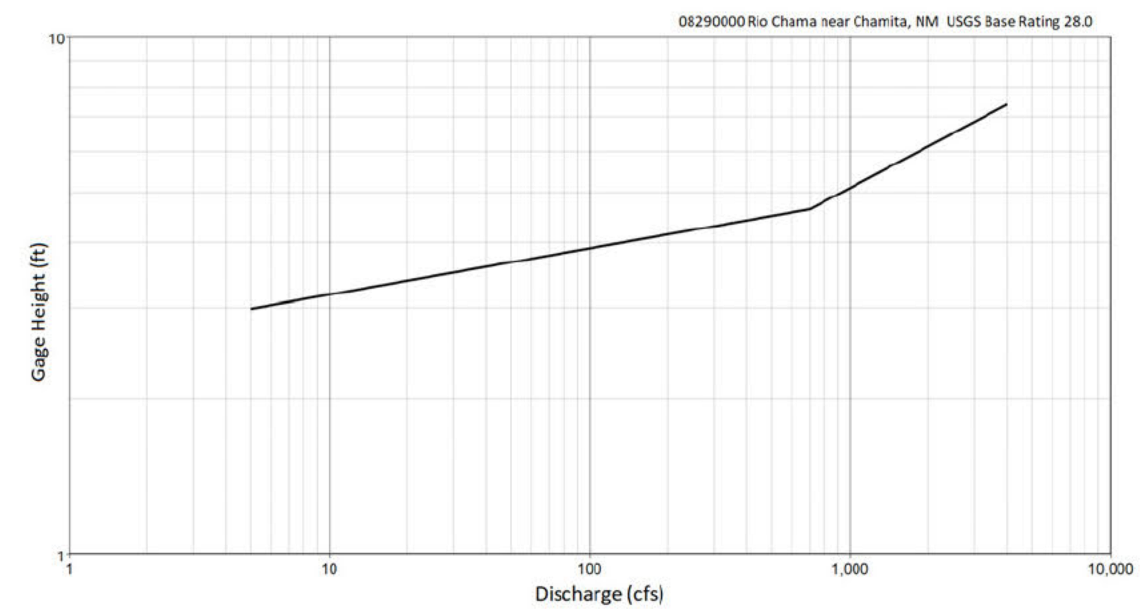
Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

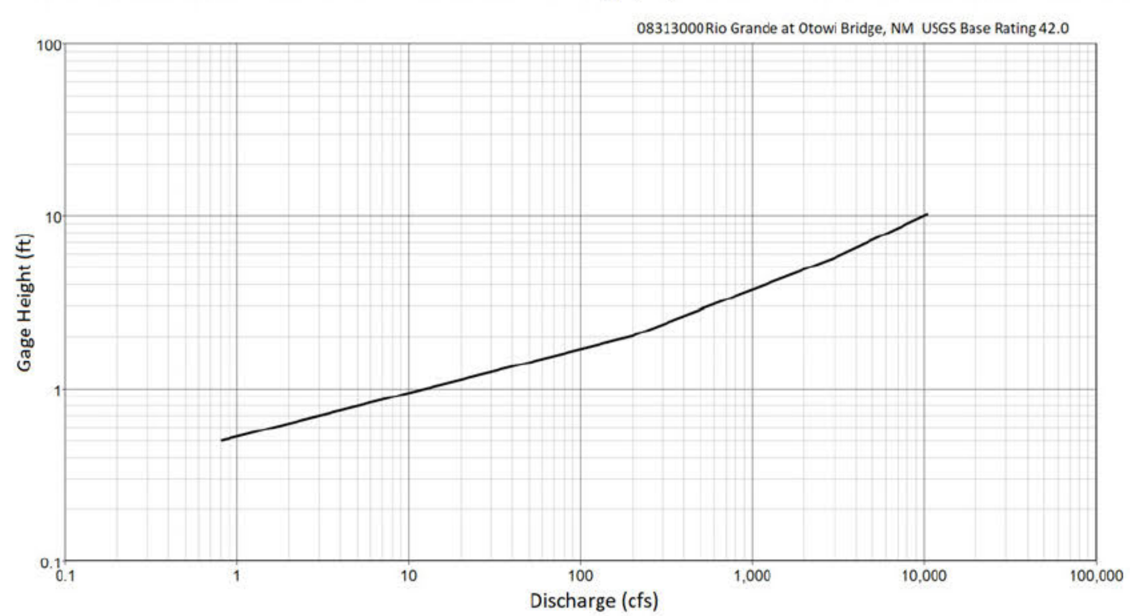
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
RIO GRANDE BASIN	NEW MEXICO
ABIQUIU DAM **ELEVATION-AREA-CAPACITY CURVES**	
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024	**Plate 7-4**











USGS INFORMATION

DESCRIPTION

Stage-discharge relations (ratings) are usually developed from a graphical analysis of numerous discharge measurements. Measurements are made on various schedules and sometimes for different purposes. All discharge measurements are compiled and maintained in a data base. Each measurement is carefully made, and undergoes quality assurance review. Some measurements indicate a temporary change in the rating, often due to a change in the streambed (for example, erosion or deposition) or growth of riparian vegetation. Such changes are called shifts; they may indicate a short- or long-term change in the rating for the gage. In normal usage, the measured shifts (or corrections) are applied mathematically to a defined rating.

WARNING

The stage-discharge rating provided in this file should be considered provisional and subject to change. Stage-discharge ratings change over time as the channel features that control the relation between stage and discharge vary. Users are cautioned to consider carefully the applicability of this rating before using it for decisions that concern personal or public safety or operational consequences.

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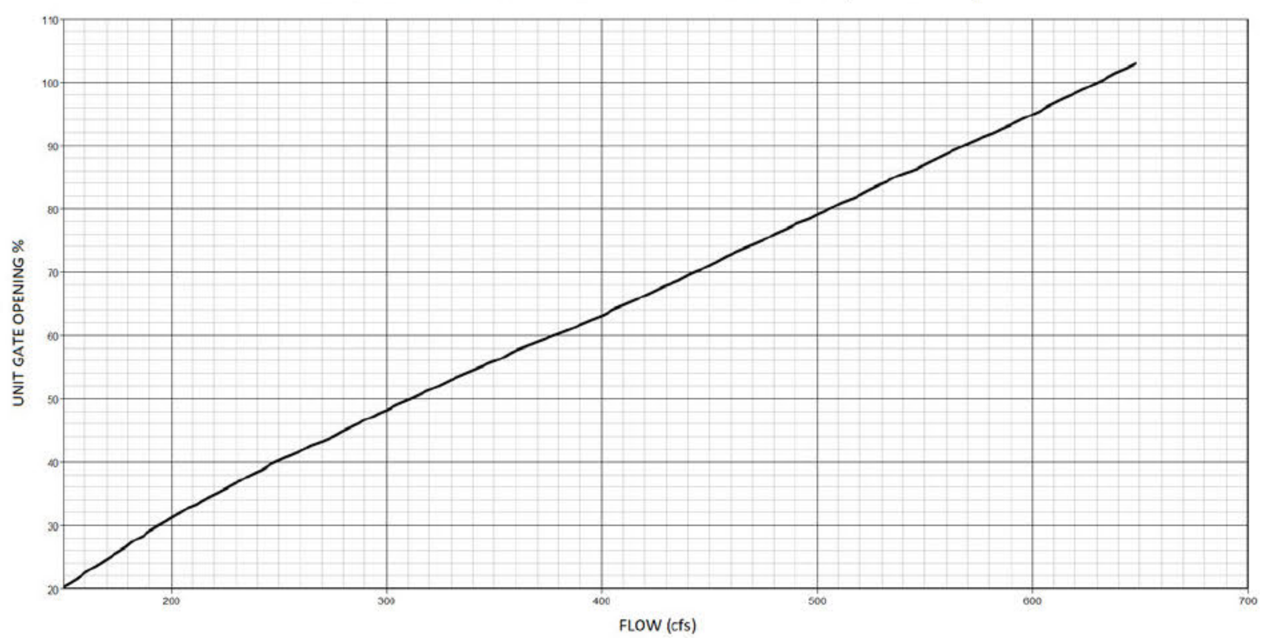
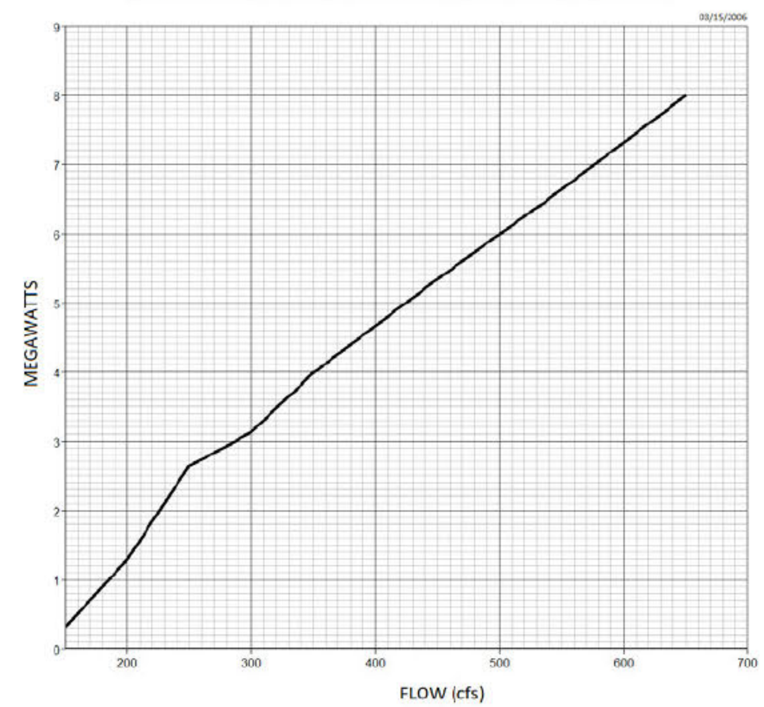
ABIQUIU DAM **USGS RATING CURVES**	
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024	Plate 7-5

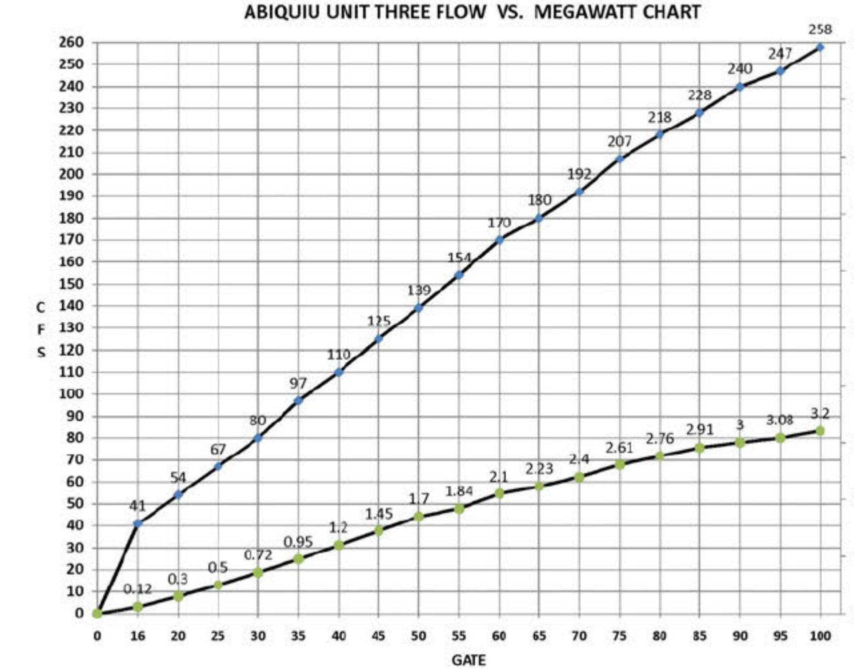
ABIQUIU UNIT ONE & TWO GATE OPENING vs. FLOW IN CFS (FOR ONE UNIT)



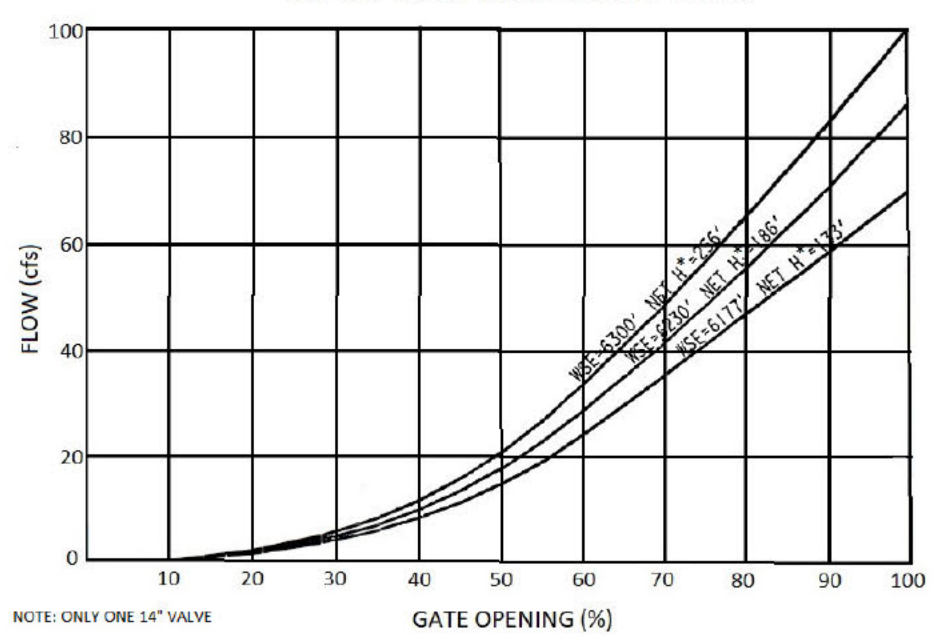
ABIQUIU UNIT ONE & TWO MEGAWATTS vs. FLOW IN CFS



ABIQUIU UNIT THREE FLOW VS. MEGAWATT CHART

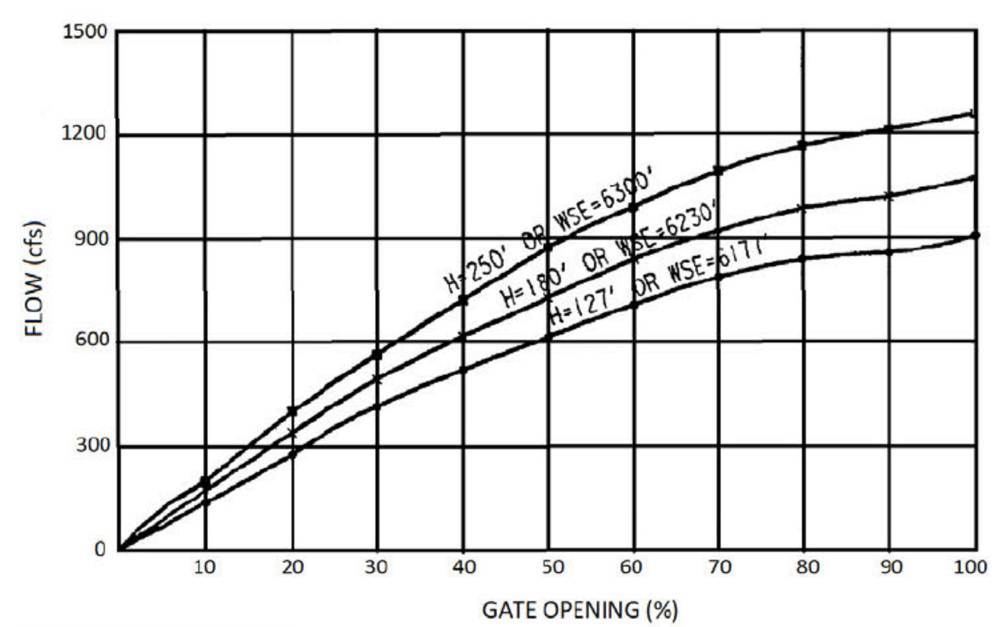


14" JET FLOW VALVE RATING CURVE



NOTE: ONLY ONE 14" VALVE

54" FIXED CONE BYPASS VALVE RATING CURVE (ONE VALVE)



NOTE: THERE ARE A TOTAL OF TWO 54" VALVES

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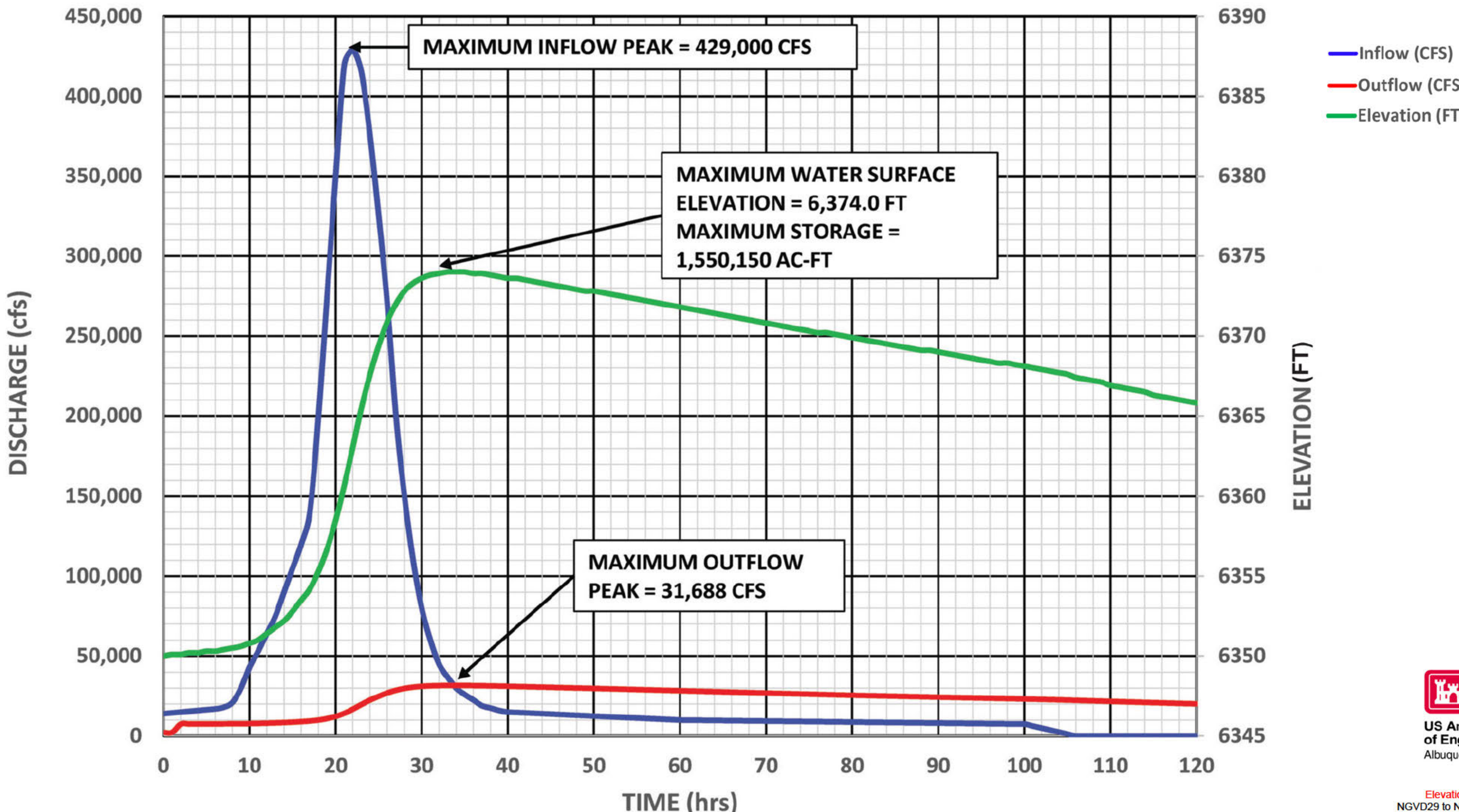
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

HYDROELECTRIC POWER FACILITY RATING CURVES

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 7-6



NOTES:
TOP OF DAM ELEVATION = 6381.0 Feet
SPILLWAY CREST ELEVATION = 6350.0 Feet
ELEVATION - AREA - CAPACITY FROM APRIL 2021 RESERVOIR SURVEY

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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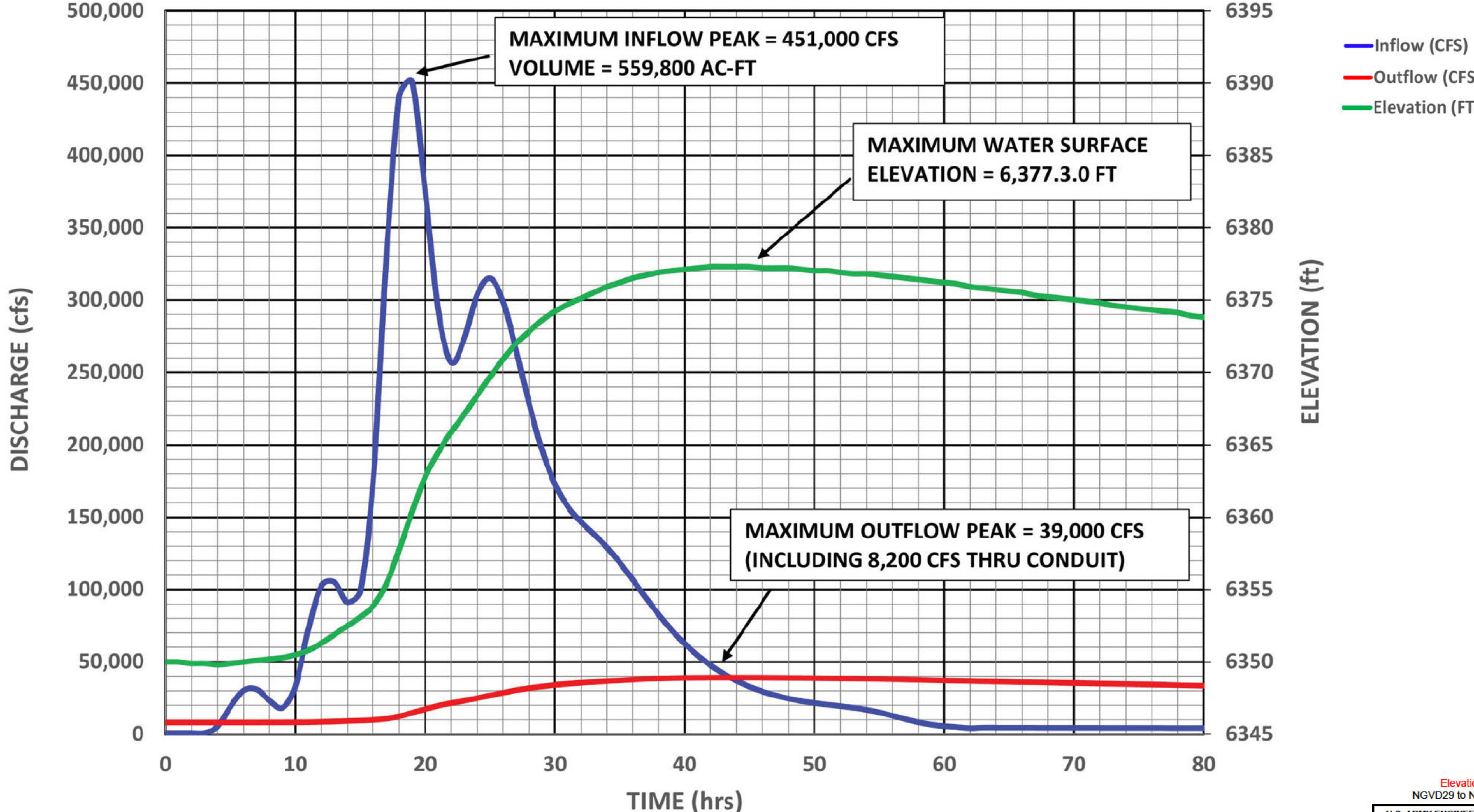
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM
1985 PROBABLE MAXIMUM FLOOD STARTING ELEVATION 6,350.0

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-1



Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

Routing Assumptions:
1. Beginning storage of 1,212,000 AF at spillway crest elevation 6,350.0
2. Outlet conduit completely open
3. Spillway bottom width = 68 ft

Source:
Feature Design Memorandum No. 18
Project Modification for the Dam Safety Assurance Program
Abiquiu Dam, New Mexico
Plate No. 3 - June 1982

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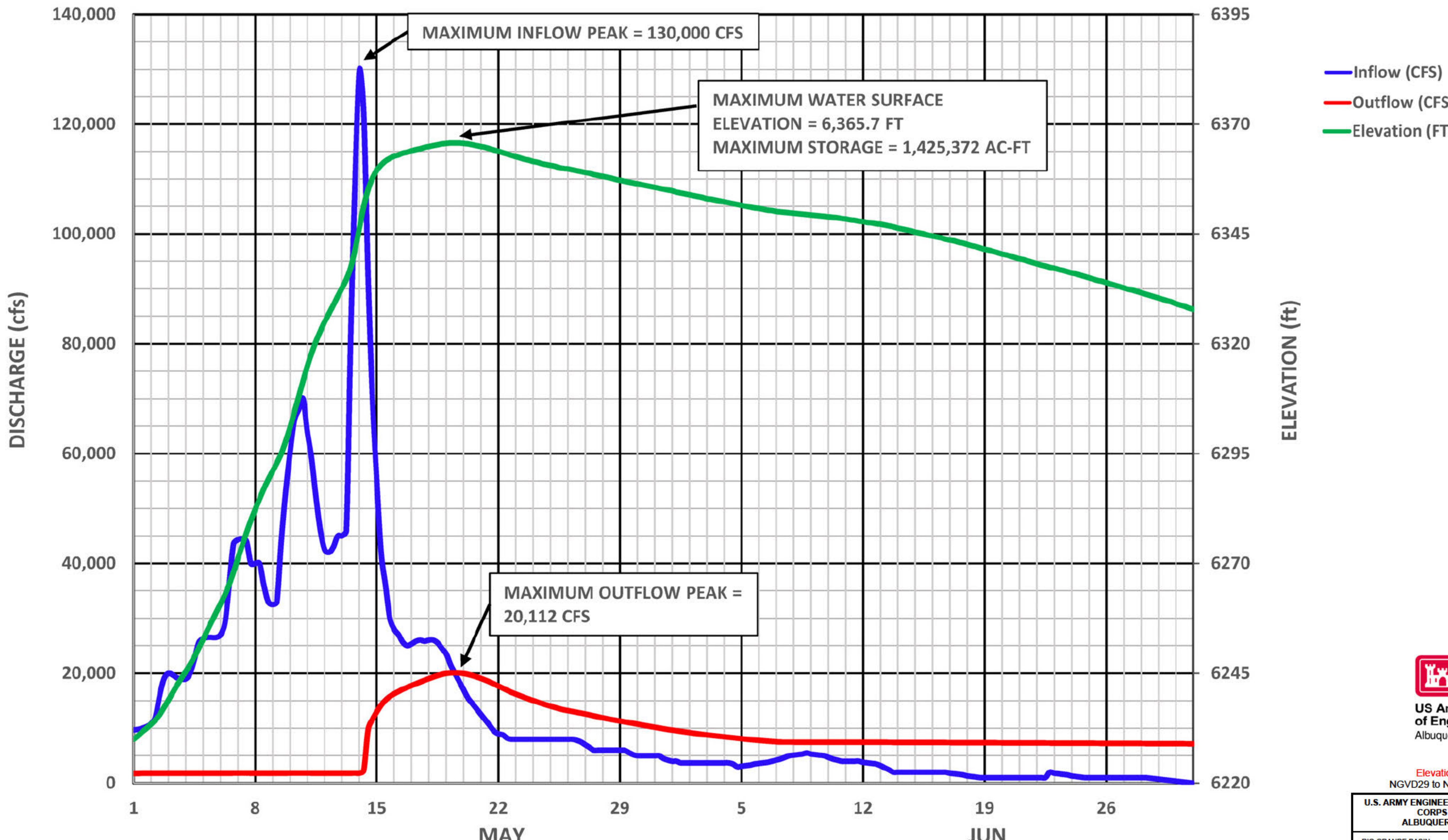
ABIQUIU DAM
1982 SPILLWAY DESIGN FLOOD STARTING AT ELEVATION 6,350.0

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-2



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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

NOTES:
TOP OF DAM ELEVATION = 6381.0 Feet
SPILLWAY CREST ELEVATION = 6350.0 Feet
ELEVATION - AREA - CAPACITY FROM APRIL 2021 RESERVOIR SURVEY

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RIO GRANDE BASIN NEW MEXICO

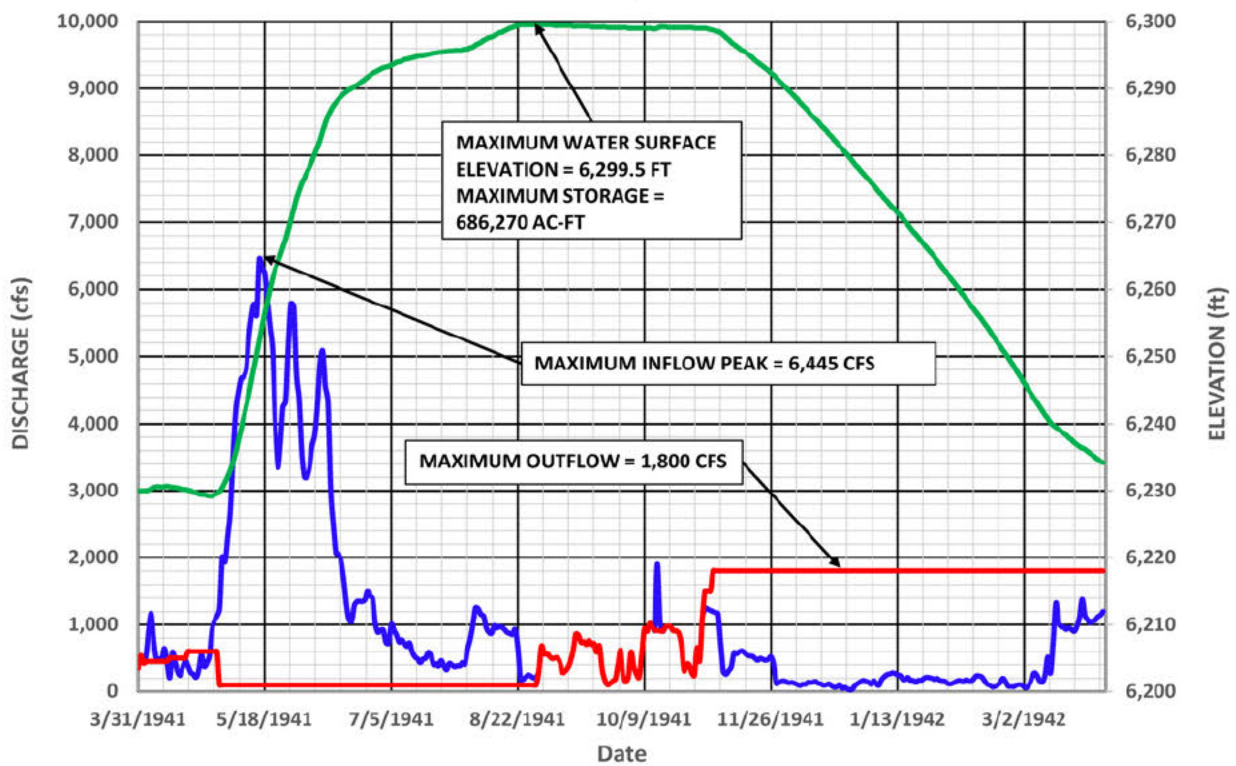
ABIQUIU DAM

RESERVOIR DESIGN FLOOD
STARTING AT ELEVATION 6,230.0

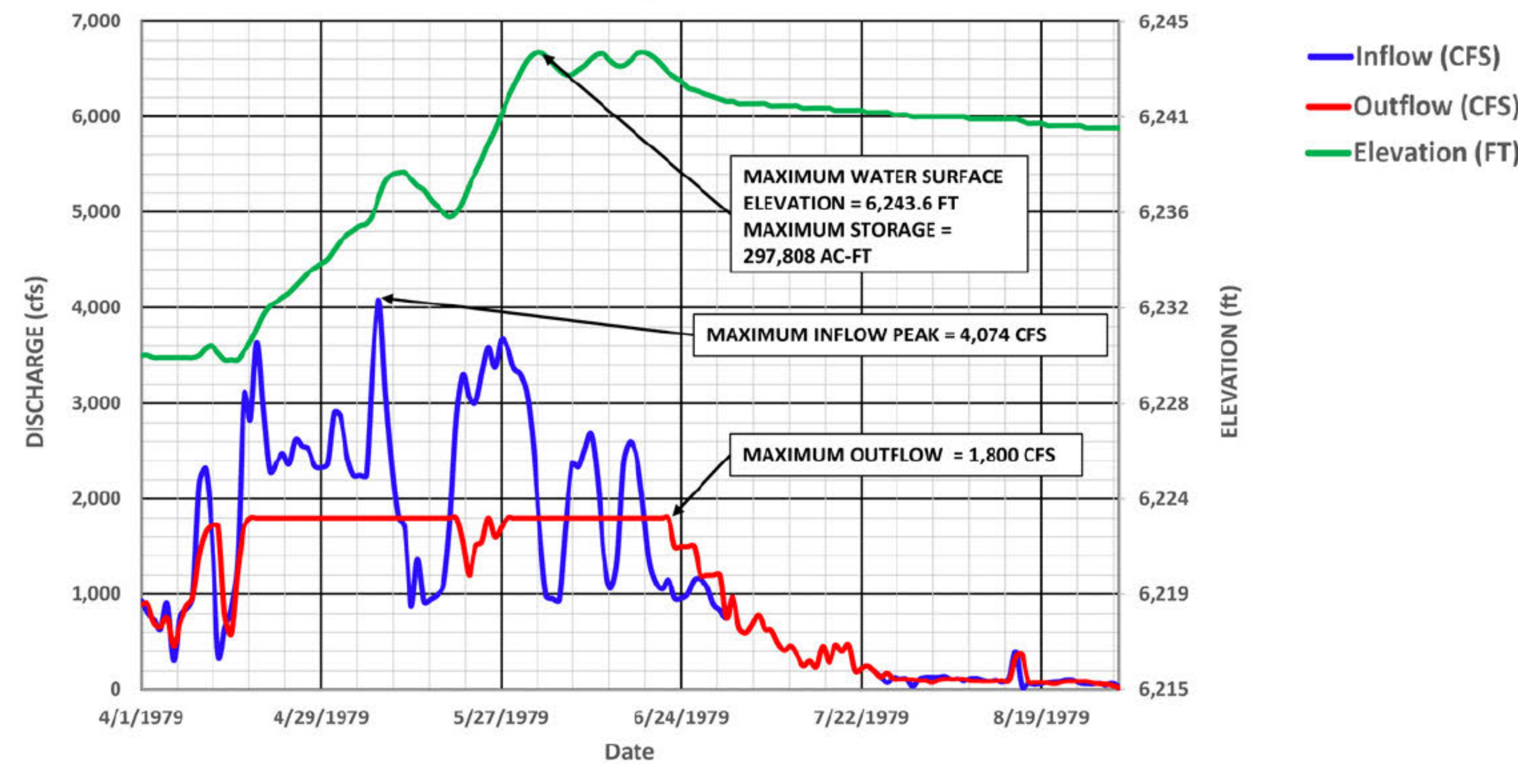
TO ACCOMPANY WATER
CONTROL MANUAL
DATED APRIL 2024

Plate 8-3

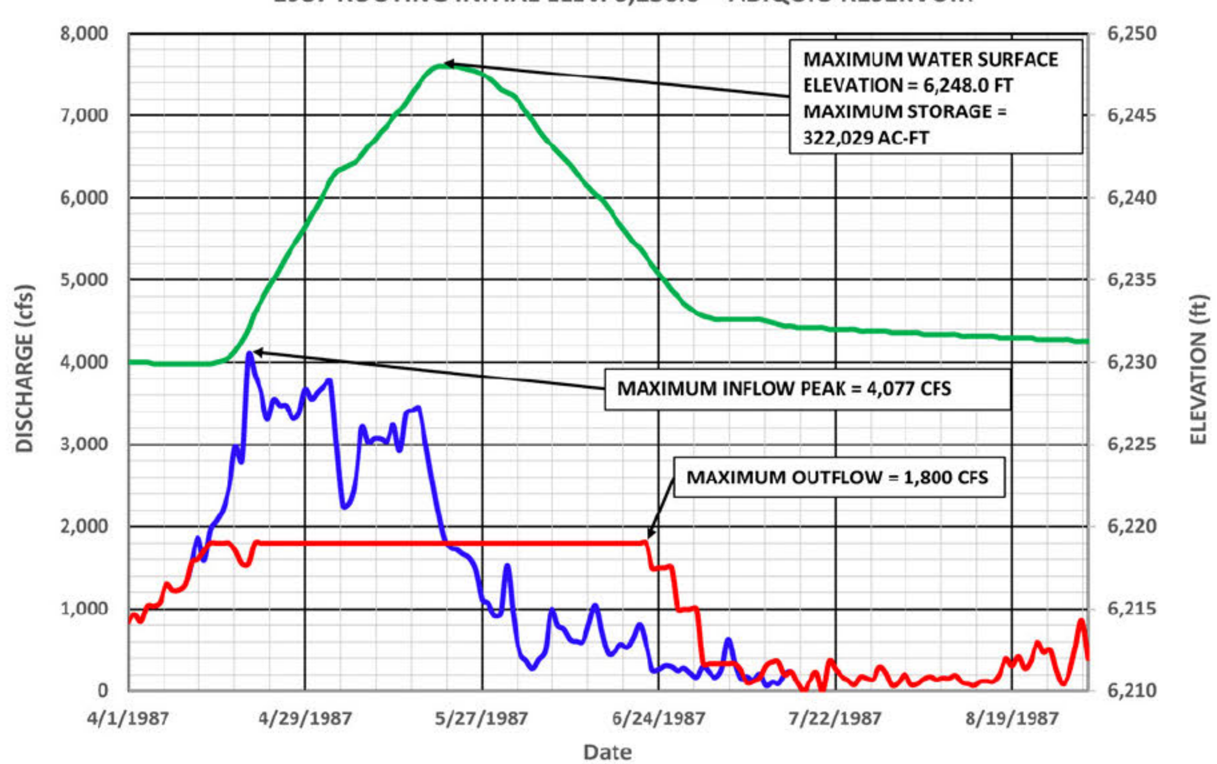
1941 ROUTING INITIAL ELEV. 6,230.0' - ABIQUIU RESERVOIR



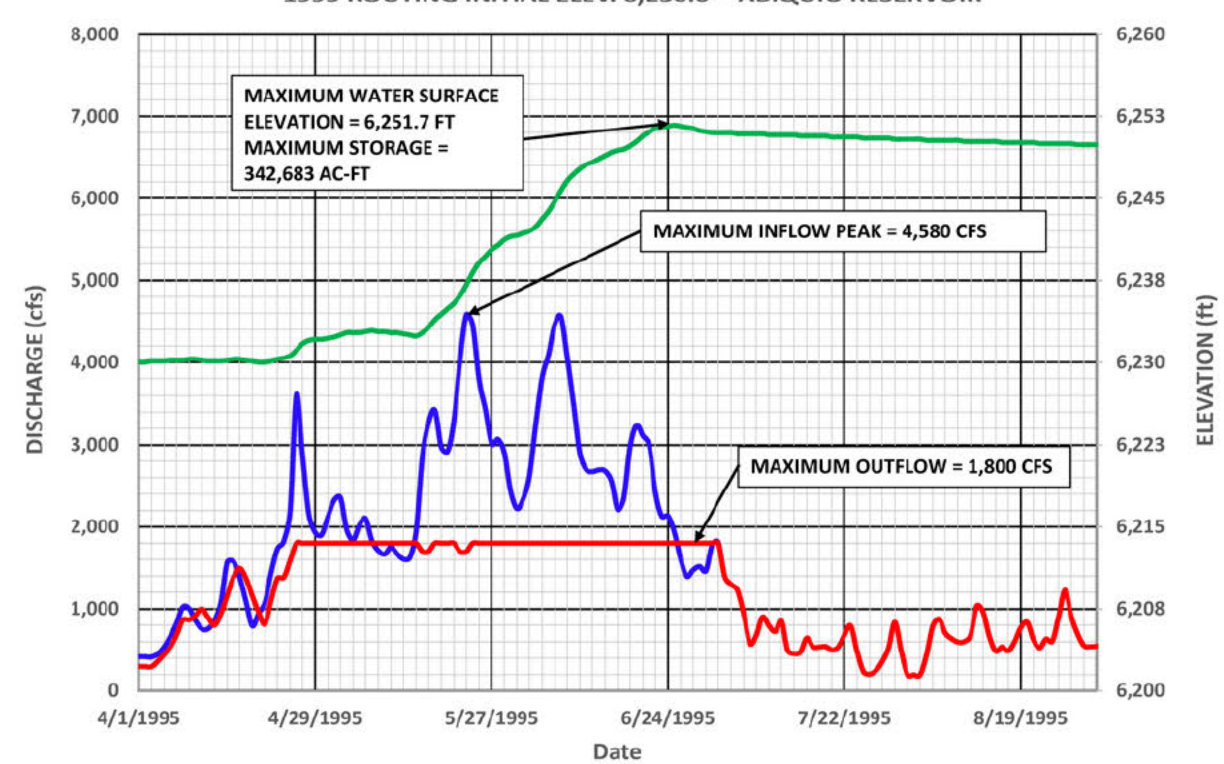
1979 ROUTING INITIAL ELEV. 6,230.0' - ABIQUIU RESERVOIR



1987 ROUTING INITIAL ELEV. 6,230.0' - ABIQUIU RESERVOIR



1995 ROUTING INITIAL ELEV. 6,230.0' - ABIQUIU RESERVOIR



NOTES:
TOP OF DAM ELEVATION = 6381.0 Feet
SPILLWAY CREST ELEVATION = 6350.0 Feet
ELEVATION - AREA - CAPACITY FROM APRIL 2021 RESERVOIR SURVEY

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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
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RIO GRANDE BASIN NEW MEXICO

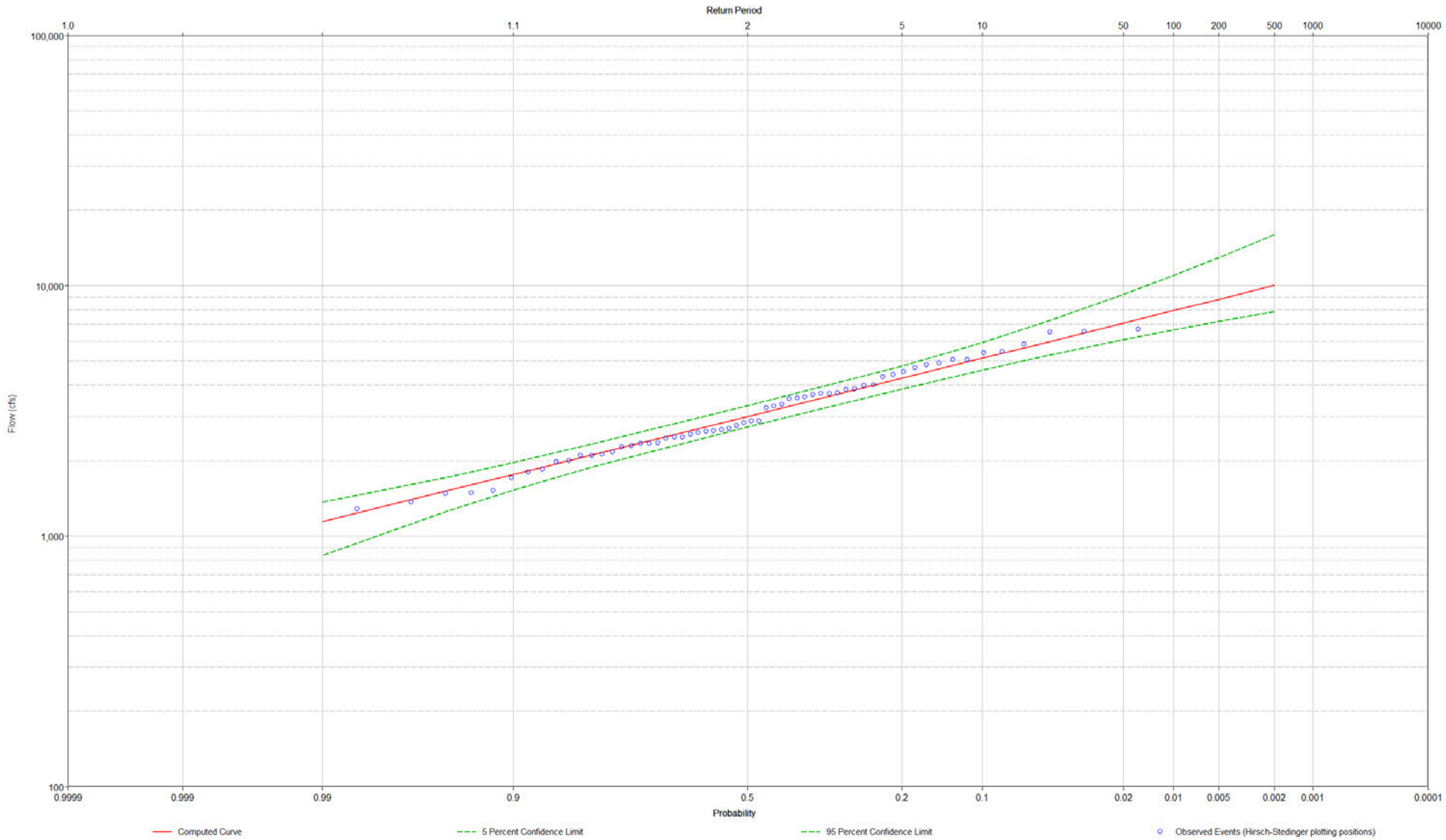
ABIQUIU DAM
HYPOTHETICAL ROUTING MAJOR FLOODS 1941, 1979, 1987 & 1995

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-4

Bulletin 17C Plot for Rio Chama Above Abiquiu Reservoir, NM

USGS 08286500



Note:
Bulletin 17C (Java) Frequency Analysis
Computed By: HEC-SSP Version 2.3-beta.4
Skew Option: Use Station Skew
Plotting Position Type: Hirsch-Stedinger

COMPUTED CURVE	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS FLOW (cfs)	
FLOW (cfs)		0.05	0.95
10,020.70	0.2	16,012.10	7,867.10
8,824.80	0.5	12,966.20	7,194.10
7,947.00	1	10,981.60	6,655.00
7,088.10	2	9,233.10	6,084.00
5,971.80	5	7,234.90	5,268.50
5,129.30	10	5,930.60	4,596.20
4,267.70	20	4,778.30	3,863.30
3,004.20	50	3,308.10	2,728.40
2,116.90	80	2,337.70	1,892.30
1,763.60	90	1,966.70	1,527.80
1,517.10	95	1,717.70	1,255.70
1,144.30	99	1,364.60	834.4

EVENTS ANALYZED				ORDERED EVENTS			
DAY	MONTH	YEAR	FLOW (cfs)	RANK	WATER YEAR	FLOW (cfs)	H-S PLOT POSITION
21	Apr	1962	1,370.00	1	1985	6,680.00	1.64
3	Aug	1963	1,800.00	2	1973	6,550.00	3.28
12	Aug	1964	2,610.00	3	1984	6,520.00	4.92
1	Aug	1965	4,520.00	4	2009	5,820.00	6.56
9	Mar	1966	1,520.00	5	1983	5,450.00	8.2
11	Aug	1967	3,860.00	6	1986	5,400.00	9.84
11	Aug	1968	4,890.00	7	1994	5,070.00	11.48
31	Jul	1969	3,980.00	8	1980	5,070.00	13.11
13	May	1970	3,670.00	9	1968	4,890.00	14.75
30	Sep	1971	2,000.00	10	1995	4,820.00	16.39
20	Oct	1971	1,480.00	11	1993	4,700.00	18.03
20	May	1973	6,550.00	12	1965	4,520.00	19.67
29	Jul	1974	2,120.00	13	2005	4,410.00	21.31
19	May	1975	3,240.00	14	1991	4,310.00	22.95
14	May	1976	1,850.00	15	2016	4,000.00	24.59
12	Aug	1977	2,630.00	16	1969	3,980.00	26.23
17	May	1978	3,300.00	17	1967	3,860.00	27.87
8	May	1979	3,530.00	18	1982	3,850.00	29.51
25	May	1980	5,070.00	19	1987	3,730.00	31.15
10	Jul	1981	2,340.00	20	2021	3,710.00	32.79
5	May	1982	3,850.00	21	2018	3,700.00	34.43
30	May	1983	5,450.00	22	1970	3,670.00	36.07
18	May	1984	6,520.00	23	2019	3,590.00	37.7
8	May	1985	6,680.00	24	1992	3,550.00	39.34
6	May	1986	5,400.00	25	1979	3,530.00	40.98
2	May	1987	3,730.00	26	2017	3,360.00	42.62
24	Aug	1988	2,550.00	27	1978	3,300.00	44.26
20	Apr	1989	2,290.00	28	1975	3,240.00	45.9
14	Sep	1990	2,480.00	29	2014	2,880.00	47.54
13	May	1991	4,310.00	30	1997	2,880.00	49.18
2	May	1992	3,550.00	31	2002	2,830.00	50.82
28	May	1993	4,700.00	32	2006	2,750.00	52.46
21	May	1994	5,070.00	33	1998	2,690.00	54.1
24	May	1995	4,820.00	34	2008	2,650.00	55.74
12	Jul	1996	2,350.00	35	1977	2,630.00	57.38
7	May	1997	2,880.00	36	1964	2,610.00	59.02
14	May	1998	2,690.00	37	1999	2,590.00	60.66
16	May	1999	2,590.00	38	1988	2,550.00	62.3
13	Jun	2000	1,280.00	39	2010	2,480.00	63.93
22	May	2001	2,340.00	40	1990	2,480.00	65.57
22	Jul	2002	2,830.00	41	2015	2,450.00	67.21
10	Sep	2003	2,100.00	42	1996	2,350.00	68.85
8	May	2004	2,160.00	43	2001	2,340.00	70.49
20	May	2005	4,410.00	44	1981	2,340.00	72.13
10	Aug	2006	2,750.00	45	1989	2,290.00	73.77
2	Sep	2007	2,090.00	46	2013	2,270.00	75.41
23	May	2008	2,650.00	47	2004	2,160.00	77.05
9	May	2009	5,820.00	48	1974	2,120.00	78.69
17	Apr	2010	2,480.00	49	2003	2,100.00	80.33
1	Jun	2011	1,980.00	50	2007	2,090.00	81.97
26	Jul	2012	1,710.00	51	1971	2,000.00	83.61
14	Sep	2013	2,270.00	52	2011	1,980.00	85.25
2	Aug	2014	2,880.00	53	1976	1,850.00	86.89
2	Jul	2015	2,450.00	54	1963	1,800.00	88.52
26	May	2016	4,000.00	55	2012	1,710.00	90.16
28	May	2017	3,360.00	56	1966	1,520.00	91.8
12	Aug	2018	3,700.00	57	2020	1,490.00	93.44
1	May	2019	3,590.00	58	1972	1,480.00	95.08
27	Jul	2020	1,490.00	59	1962	1,370.00	96.72
23	Jul	2021	3,710.00	60	2000	1,280.00	98.36

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CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

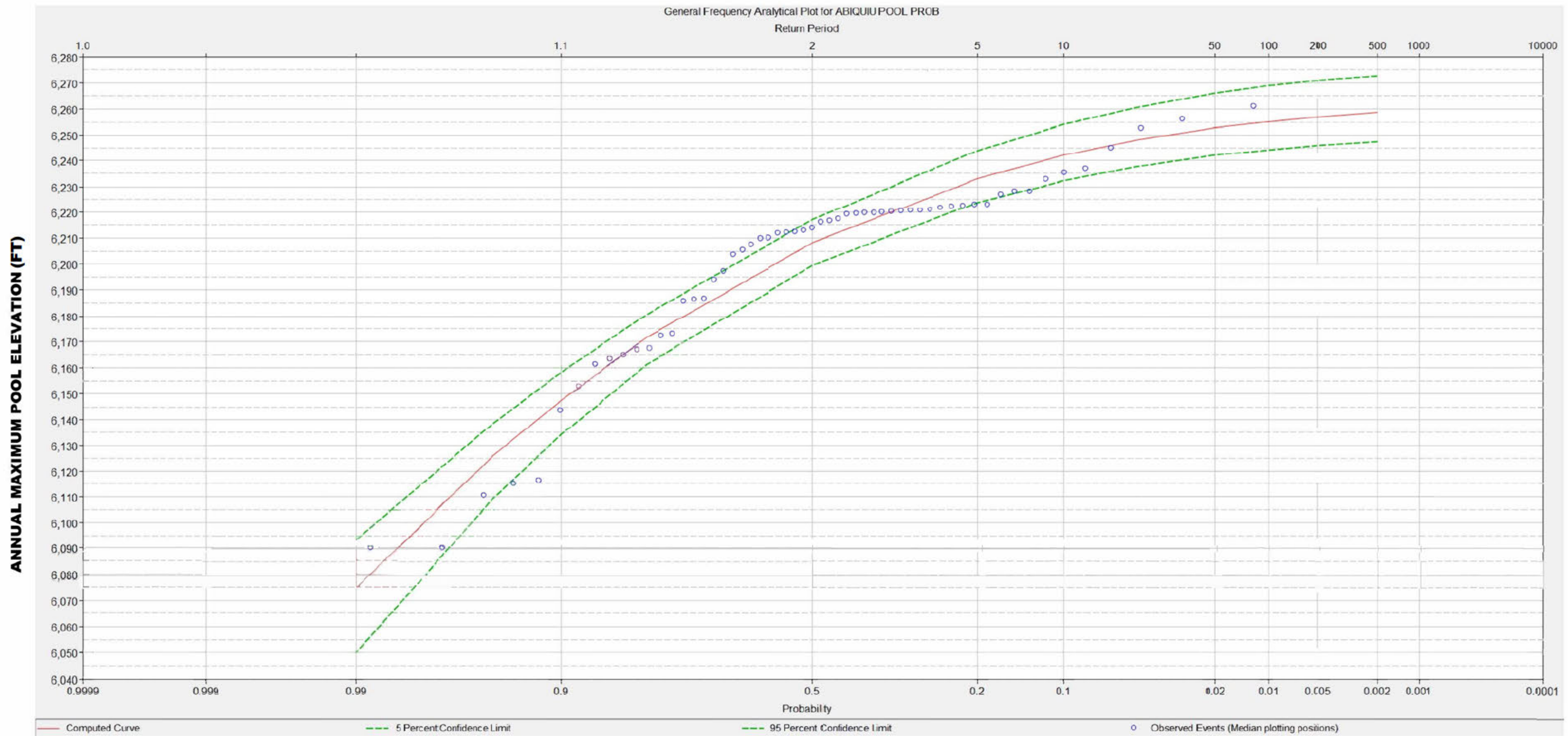
INFLOW FREQUENCY CURVE

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-5

PERCENT CHANCE EXCEEDANCE	COMPUTED CURVE
0.2	6258.7
0.5	6257.0
1	6255.2
2	6252.8
5	6247.9
10	6242.1
20	6233.0
50	6208.1
80	6171.7
90	6147.5
95	6124.7
99	6074.9

YEAR	MAXIMUM STAGE (FT NGVD)
1963	6,090.1
1964	6,090.2
1965	6,186.6
1966	6,143.6
1967	6,110.5
1968	6,167.3
1969	6,172.2
1970	6,167.0
1971	6,116.4
1972	6,115.1
1973	6,219.9
1974	6,163.2
1975	6,193.9
1976	6,161.2
1977	6,152.8
1978	6,172.9
1979	6,205.3
1980	6,219.6
1981	6,164.8
1982	6,185.8
1983	6,213.9
1984	6,228.1
1985	6,256.2
1986	6,252.6
1987	6,261.1
1988	6,220.8
1989	6,221.7
1990	6,216.2
1991	6,235.3
1992	6,223.1
1993	6,236.8
1994	6,232.7
1995	6,244.9
1996	6,226.9
1997	6,221.0
1998	6,219.1
1999	6,220.5
2000	6,219.6
2001	6,212.1
2002	6,212.9
2003	6,186.7
2004	6,207.4
2005	6,222.3
2006	6,217.4
2007	6,220.8
2008	6,222.5
2009	6,228.2
2010	6,223.1
2011	6,220.3
2012	6,219.4
2013	6,216.7
2014	6,212.4
2015	6,209.9
2016	6,209.8
2017	6,211.9
2018	6,203.5
2019	6,197.3



Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

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CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

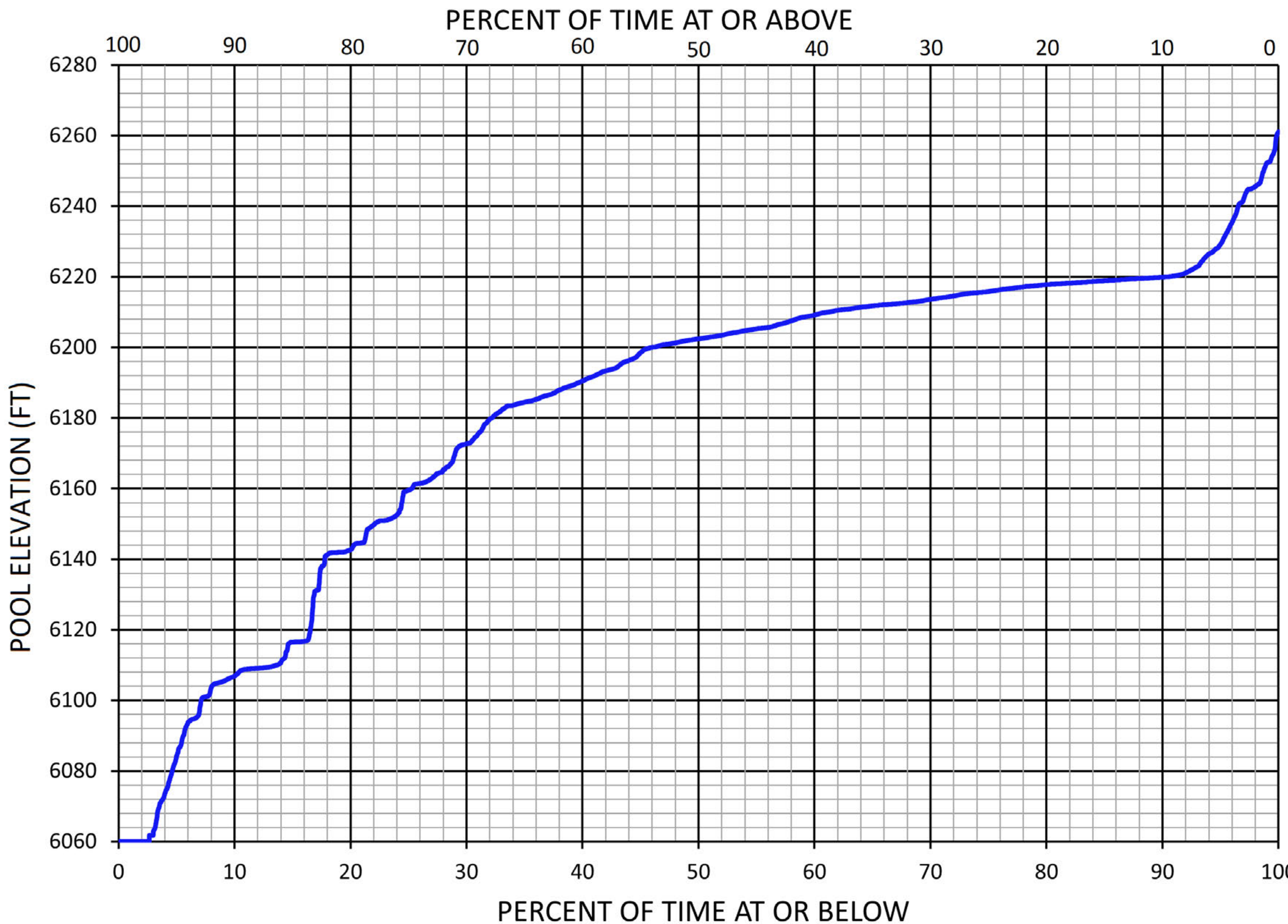
RIO GRANDE BASIN NEW MEXICO

ABIQUIU DAM

ANNUAL PEAK POOL ELEVATION PROBABILITY

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-6



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Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

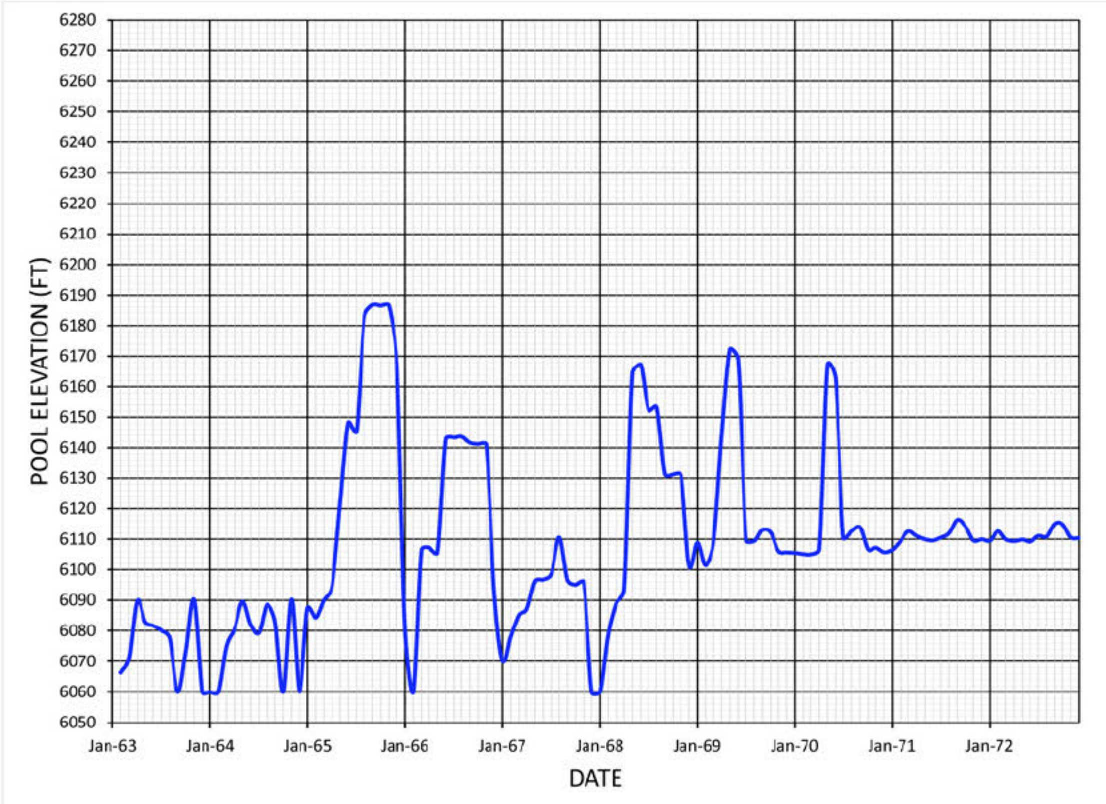
RIO GRANDE BASIN NEW MEXICO

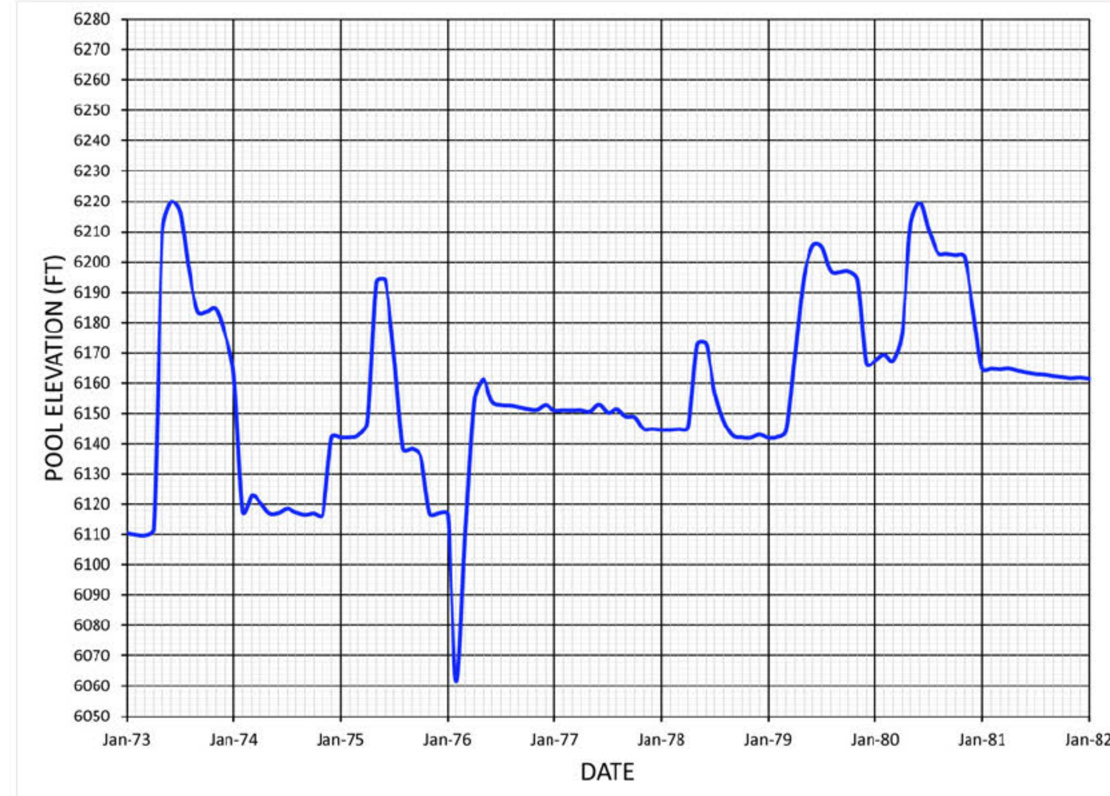
ABIQUIU DAM

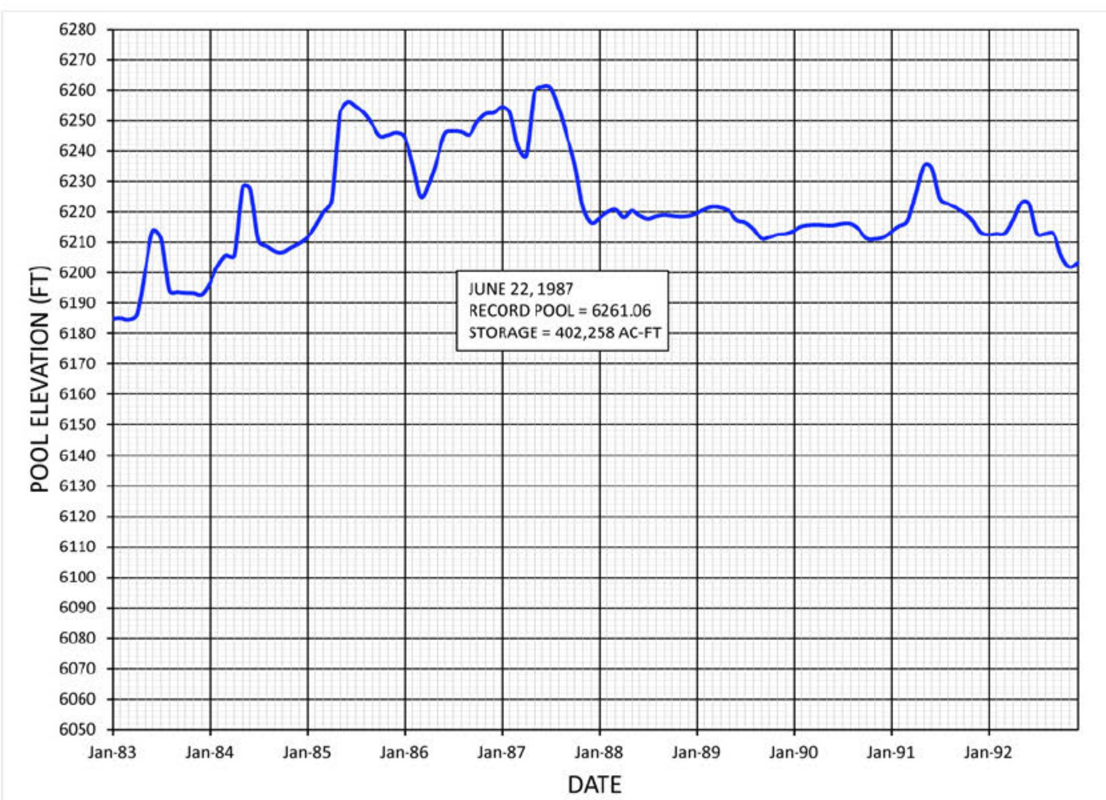
POOL ELEVATION DURATION CURVE

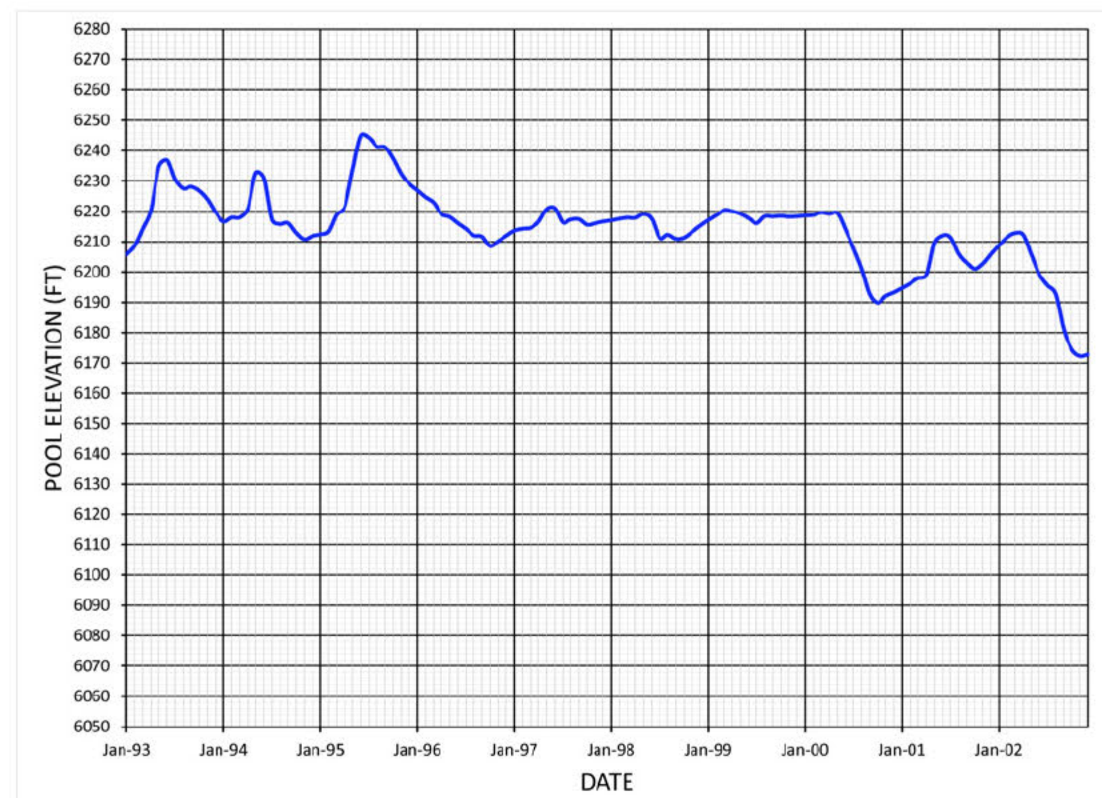
TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-7









US Army Corps of Engineers ®
Albuquerque District

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

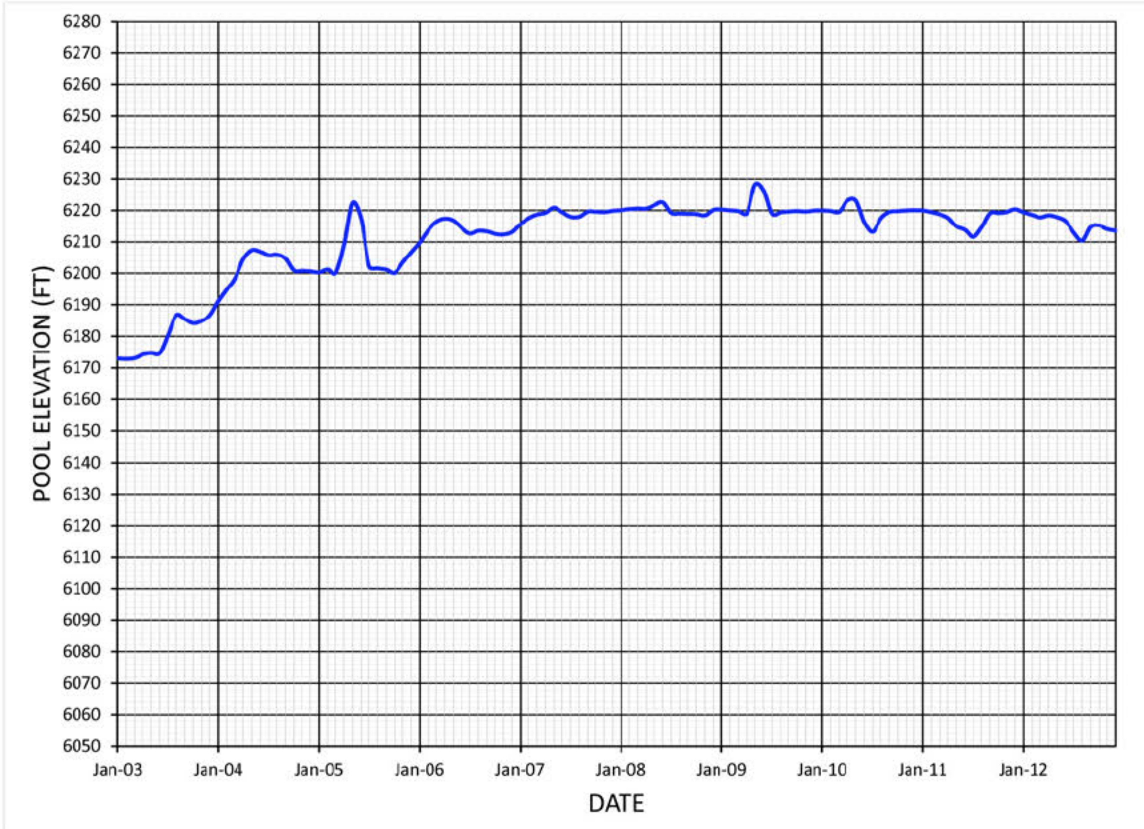
RIO GRANDE BASIN NEW MEXICO

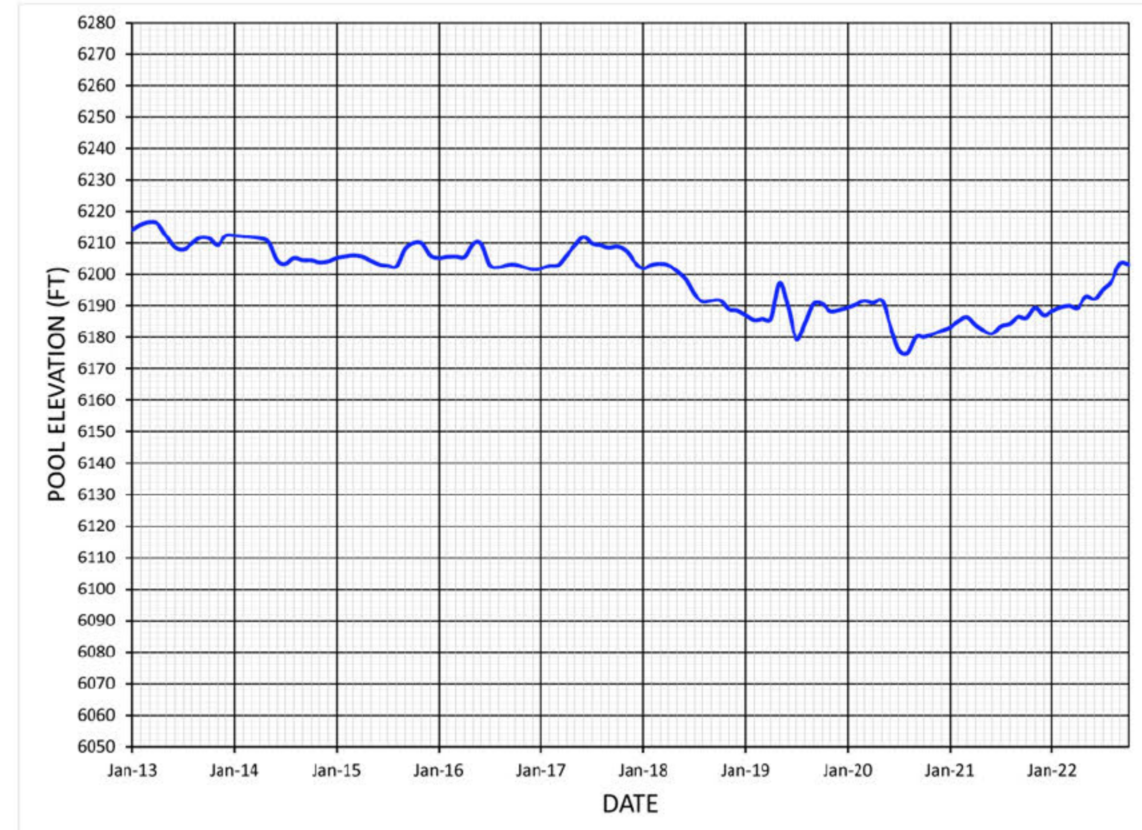
ABIQUIU DAM

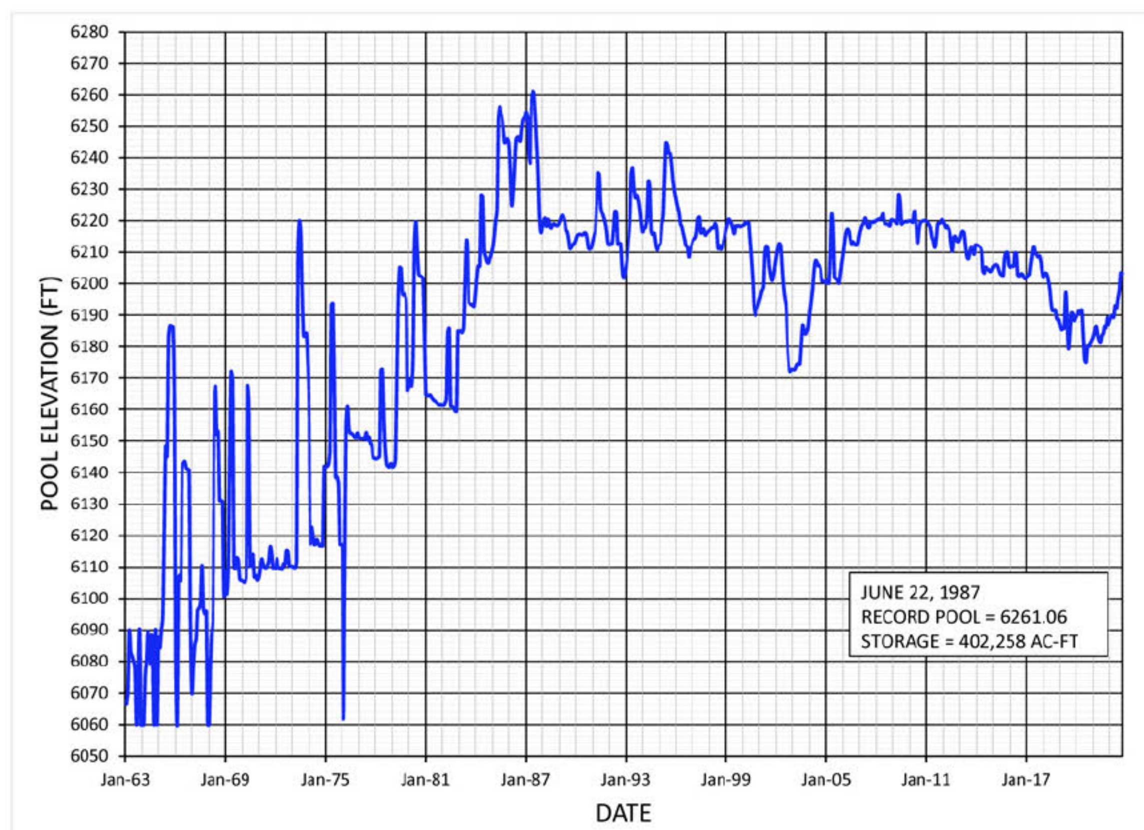
END OF MONTH POOL ELEVATION

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-8A







US Army Corps of Engineers ®
Albuquerque District

Elevations in NGVD29
NGVD29 to NAVD88 add 3.33 feet

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

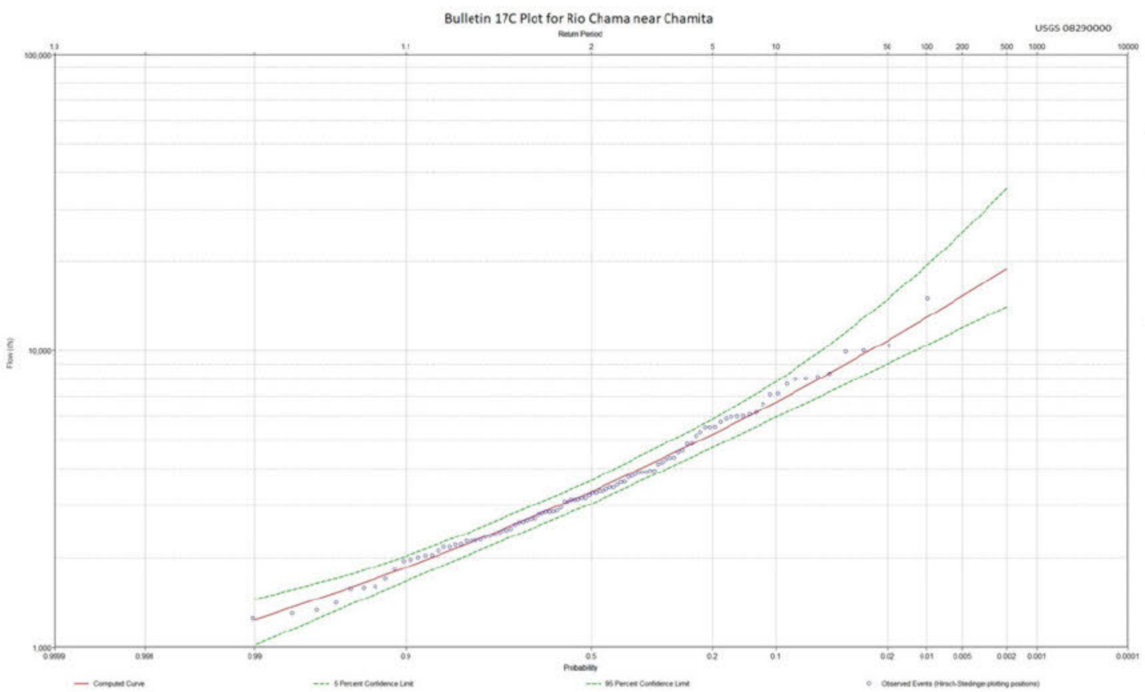
RIO GRANDE BASIN NEW MEXICO

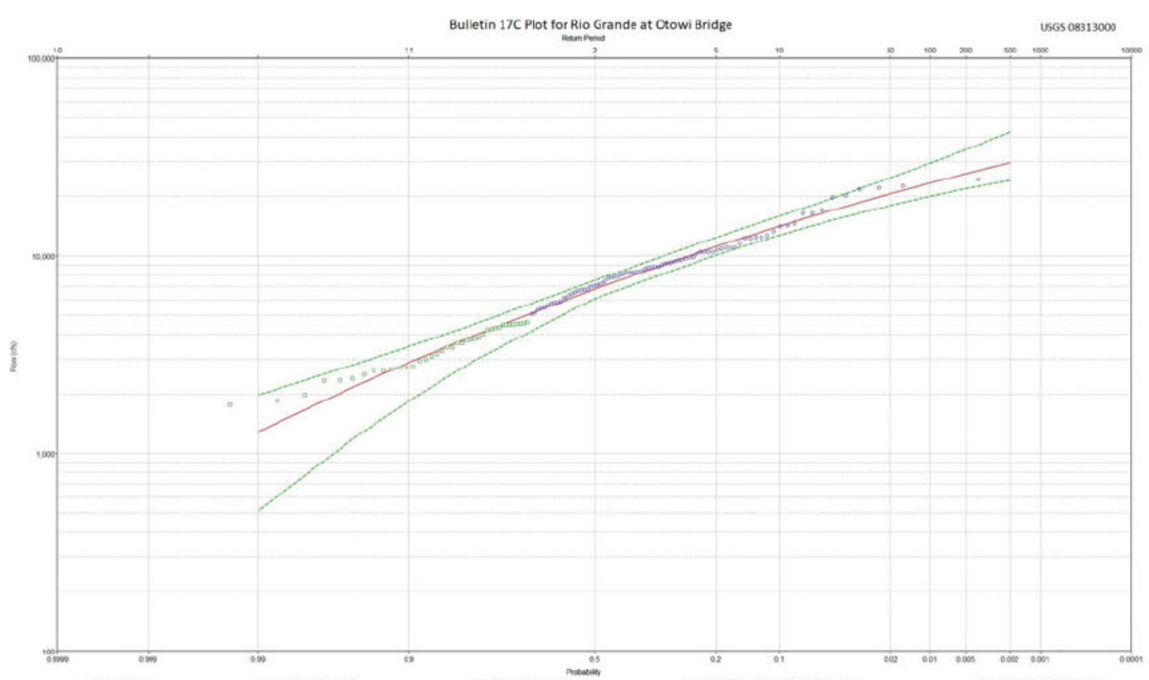
ABIQUIU DAM

END OF MONTH POOL ELEVATION

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-8B





Bulletin 17C Plot for Rio Chama near Chamita

COMPUTED CURVE	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS FLOW (cfs)	
FLOW (cfs)		0.05	0.95
18,933.70	0.2	35,090.50	14,081.90
15,329.80	0.5	25,082.70	11,953.80
12,945.90	1	19,362.40	10,446.90
10,820.50	2	14,872.20	9,019.80
8,354.40	5	10,394.60	7,239.90
6,707.60	10	7,856.80	5,957.80
5,207.70	20	5,853.30	4,708.50
3,332.90	50	3,649.00	3,043.80
2,238.30	80	2,438.50	2,049.80
1,851.60	90	2,022.40	1,669.20
1,597.80	95	1,764.90	1,403.70
1,238.60	99	1,456.50	1014.7

Note:

Bulletin 17C (Java) Frequency Analysis
Computed By: HEC-SSP Version 2.3-beta.4
Skew Option: Use Station Skew
Plotting Position Type: Hirsch-Stedinger

Bulletin 17C Plot for Rio Chama near Chamita

EVENTS ANALYZED				ORDERED EVENTS			
DAY	MONTH	YEAR	FLOW (cfs)	RANK	WATER YEAR	FLOW (cfs)	H-S PLOT POSITION
1	Jun	1915	5,980.00	1	1920	15,000.00	0.97
9	May	1916	6,000.00	2	1929	10,400.00	1.94
19	May	1917	4,600.00	3	1969	10,000.00	2.91
9	May	1918	2,630.00	4	1941	9,910.00	3.88
25	Apr	1919	5,500.00	5	1942	8,350.00	4.85
12	May	1920	15,000.00	6	1967	8,150.00	5.83
6	May	1921	2,850.00	7	1933	8,040.00	6.8
19	May	1922	3,310.00	8	1961	8,000.00	7.77
19	Sep	1927	6,180.00	9	1932	7,700.00	8.74
1	May	1928	5,300.00	10	2013	7,150.00	9.71
12	Aug	1929	10,400.00	11	1935	7,100.00	10.68
20	Apr	1930	5,170.00	12	1937	6,610.00	11.65
20	Sep	1931	3,530.00	13	1927	6,180.00	12.62
20	May	1932	7,700.00	14	1943	6,100.00	13.59
13	Jul	1933	8,040.00	15	1916	6,000.00	14.56
13	Apr	1934	1,600.00	16	1915	5,980.00	15.53
16	May	1935	7,100.00	17	1955	5,970.00	16.5
24	Apr	1936	5,510.00	18	1952	5,880.00	17.48
16	Apr	1937	6,610.00	19	1965	5,730.00	18.45
3	Aug	1938	3,360.00	20	1936	5,510.00	19.42
5	Apr	1939	3,600.00	21	1919	5,500.00	20.39
12	Aug	1940	3,360.00	22	1945	5,490.00	21.36
14	May	1941	9,910.00	23	1928	5,300.00	22.33
23	Apr	1942	8,350.00	24	1930	5,170.00	23.3
18	Aug	1943	6,100.00	25	1984	4,840.00	24.27
14	May	1944	3,190.00	26	1958	4,830.00	25.24
7	May	1945	5,490.00	27	1917	4,600.00	26.21
19	Aug	1946	2,360.00	28	1994	4,530.00	27.18
8	Aug	1947	2,670.00	29	2014	4,350.00	28.16
14	Oct	1947	2,500.00	30	1980	4,330.00	29.13
28	May	1949	2,580.00	31	1957	4,280.00	30.1
13	Jul	1950	3,100.00	32	1998	4,190.00	31.07
11	Feb	1951	1,410.00	33	1983	4,140.00	32.04
28	Jul	1952	5,880.00	34	1993	3,920.00	33.01
29	May	1953	1,330.00	35	1985	3,920.00	33.98
17	May	1954	2,000.00	36	1977	3,880.00	34.95
20	Aug	1955	5,970.00	37	1971	3,880.00	35.92
17	Apr	1956	1,300.00	38	1962	3,870.00	36.89
7	Aug	1957	4,280.00	39	1991	3,820.00	37.86
20	Apr	1958	4,830.00	40	2018	3,780.00	38.83
9	Aug	1959	1,580.00	41	1982	3,730.00	39.81
11	Apr	1960	2,470.00	42	1939	3,600.00	40.78
12	Aug	1961	8,000.00	43	1966	3,590.00	41.75
21	Apr	1962	3,870.00	44	1931	3,530.00	42.72
11	Mar	1963	1,830.00	45	1986	3,460.00	43.69
14	Aug	1964	2,390.00	46	2005	3,450.00	44.66
17	Jun	1965	5,730.00	47	1979	3,410.00	45.63
2	Aug	1966	3,590.00	48	1940	3,360.00	46.6
9	Aug	1967	8,150.00	49	1938	3,360.00	47.57
13	Aug	1968	2,170.00	50	1973	3,310.00	48.54
29	Aug	1969	10,000.00	51	1922	3,310.00	49.51
13	Jun	1970	2,270.00	52	1995	3,260.00	50.49
18	Aug	1971	3,880.00	53	2000	3,190.00	51.46
4	Aug	1972	2,350.00	54	1944	3,190.00	52.43
12	Jul	1973	3,310.00	55	1978	3,150.00	53.4
17	Dec	1973	1,250.00	56	2009	3,140.00	54.37
26	Apr	1975	2,790.00	57	1989	3,140.00	55.34
24	Aug	1976	2,210.00	58	1987	3,100.00	56.31
21	Jul	1977	3,880.00	59	1950	3,100.00	57.28
4	Aug	1978	3,150.00	60	2012	2,950.00	58.25
12	May	1979	3,410.00	61	2006	2,880.00	59.22
8	Jul	1980	4,330.00	62	2019	2,860.00	60.19
5	Sep	1981	2,220.00	63	1992	2,850.00	61.17
30	Jul	1982	3,730.00	64	1921	2,850.00	62.14
11	Jul	1983	4,140.00	65	2010	2,820.00	63.11
18	Jun	1984	4,840.00	66	1975	2,790.00	64.08
3	May	1985	3,920.00	67	1957	2,710.00	65.05
2	May	1986	3,460.00	68	2017	2,700.00	66.02
19	Apr	1987	3,100.00	69	1947	2,670.00	66.99
2	Nov	1987	2,270.00	70	2008	2,640.00	67.96
18	Apr	1989	3,140.00	71	1918	2,630.00	68.93
5	Aug	1990	2,470.00	72	1949	2,580.00	69.9
13	Jun	1991	3,820.00	73	1948	2,500.00	70.87
15	Apr	1992	2,850.00	74	1990	2,470.00	71.84
17	May	1993	3,920.00	75	1960	2,470.00	72.82
14	Aug	1994	4,530.00	76	2001	2,420.00	73.79
12	May	1995	3,260.00	77	1964	2,390.00	74.76
22	Aug	1996	2,280.00	78	1946	2,360.00	75.73
10	May	1997	2,710.00	79	1972	2,350.00	76.7
29	Sep	1998	4,190.00	80	1999	2,300.00	77.67
30	May	1999	2,300.00	81	1996	2,280.00	78.64
29	Jul	2000	3,190.00	82	1988	2270	79.61
26	Jul	2001	2,420.00	83	1970	2270	80.58
9	Jul	2002	1,950.00	84	1981	2220	81.55
10	Sep	2003	2,110.00	85	1976	2210	82.52
15	May	2004	2,040.00	86	2007	2170	83.5
11	May	2005	3,450.00	87	1968	2170	84.47
6	Aug	2006	2,880.00	88	2003	2110	85.44
26	Jul	2007	2,170.00	89	2004	2040	86.41
25	Apr	2008	2,640.00	90	2015	2030	87.38
21	Jul	2009	3,140.00	91	1954	2000	88.35
24	Aug	2010	2,820.00	92	2016	1970	89.32
13	Aug	2011	1,570.00	93	2002	1950	90.29
17	Aug	2012	2,950.00	94	1963	1830	91.26
18	Sep	2013	7,150.00	95	2020	1700	92.23
26	Jul	2014	4,350.00	96	1934	1600	93.2
15	Aug	2015	2,030.00	97	1959	1580	94.17
1	Jun	2016	1,970.00	98	2011	1570	95.15
19	Apr	2017	2,700.00	99	1951	1410	96.12
21	Aug	2018	3,780.00	100	1953	1330	97.09
30	Apr	2019	2,860.00	101	1956	1300	98.06
22	Jul	2020	1,700.00	102	1974	1250	99.03

Bulletin 17C Plot for Rio Grande at Otowi Bridge

EVENTS ANALYZED				ORDERED EVENTS			
DAY	MONTH	YEAR	FLOW (cfs)	RANK	WATER YEAR	FLOW (cfs)	H-S PLOT POSITION
21	Apr	1895	9,500.00	1	1920	24,400.00	0.39
8	May	1896	5,800.00	2	1941	22,500.00	1.6
19	May	1897	16,400.00	3	1904	22,000.00	2.43
28	Apr	1898	7,800.00	4	1912	21,700.00	3.25
15	Sep	1899	6,710.00	5	1905	20,200.00	4.08
31	May	1900	8,200.00	6	1903	19,700.00	4.9
22	May	1901	8,800.00	7	1921	17,000.00	5.72
21	Sep	1902	6,980.00	8	1942	16,400.00	6.55
15	Jun	1903	19,700.00	9	1897	16,400.00	7.37
29	Sep	1904	22,000.00	10	1932	14,500.00	8.19
25	May	1905	20,200.00	11	1924	14,200.00	9.02
1	May	1910	12,700.00	12	1916	14,100.00	9.84
23	Jul	1911	12,300.00	13	1919	13,300.00	10.66
7	Oct	1911	21,700.00	14	1910	12,700.00	11.49
11	Jun	1913	9,250.00	15	1985	12,400.00	12.31
25	May	1914	9,140.00	16	1948	12,400.00	13.13
11	May	1916	14,100.00	17	1979	12,300.00	13.96
19	May	1917	10,400.00	18	1911	12,300.00	14.78
24	May	1919	13,300.00	19	1929	11,500.00	15.6
23	May	1920	24,400.00	20	1958	11,000.00	16.43
16	Jun	1921	17,000.00	21	1931	11,000.00	17.25
2	Jun	1922	10,400.00	22	1927	11,000.00	18.07
12	May	1923	8,250.00	23	1937	10,800.00	18.9
14	May	1924	14,200.00	24	1949	10,700.00	19.72
18	Apr	1925	5,340.00	25	1945	10,400.00	20.54
4	Jul	1927	11,000.00	26	1944	10,400.00	21.37
3	May	1928	8,990.00	27	1922	10,400.00	22.19
22	Sep	1929	11,500.00	28	1917	10,400.00	23.02
25	Apr	1930	6,520.00	29	1994	10,200.00	23.84
24	Sep	1931	11,000.00	30	1987	9,860.00	24.66
20	May	1932	14,500.00	31	1984	9,790.00	25.49
22	May	1933	6,400.00	32	1952	9,700.00	26.31
23	Sep	1934	3,180.00	33	1967	9,520.00	27.13
17	May	1935	8,220.00	34	1895	9,500.00	27.96
25	Apr	1936	9,350.00	35	1936	9,350.00	28.78
12	May	1937	10,800.00	36	1913	9,250.00	29.6
3	May	1938	7,740.00	37	2005	9,190.00	30.43
5	Apr	1939	5,770.00	38	1914	9,140.00	31.25
22	Aug	1940	2,330.00	39	1928	8,990.00	32.07
16	May	1941	22,500.00	40	1995	8,800.00	32.9
23	Apr	1942	16,400.00	41	1901	8,800.00	33.72
18	Aug	1943	7,100.00	42	1983	8,760.00	34.54
16	May	1944	10,400.00	43	1961	8,700.00	35.37
8	May	1945	10,400.00	44	1991	8,560.00	36.19
6	Jul	1946	2,610.00	45	1973	8,350.00	37.01
10	May	1947	5,750.00	46	1980	8,270.00	37.84
28	May	1948	12,400.00	47	1923	8,250.00	38.66
23	Jun	1949	10,700.00	48	1935	8,220.00	39.48
8	Jul	1950	4,590.00	49	1993	8,200.00	40.31
4	Aug	1951	1,440.00	50	1900	8,200.00	41.13
9	May	1952	9,700.00	51	2013	8,080.00	41.96
31	May	1953	3,300.00	52	1986	7,980.00	42.78
24	Jul	1954	3,100.00	53	1971	7,820.00	43.6
21	Aug	1955	5,140.00	54	1898	7,800.00	44.43
3	May	1956	1,850.00	55	1938	7,740.00	45.25
30	Aug	1957	6,650.00	56	1965	7,660.00	46.07
29	May	1958	11,000.00	57	1962	7,400.00	46.9
15	Aug	1959	2,740.00	58	1997	7,220.00	47.72
12	Apr	1960	4,490.00	59	2016	7,130.00	48.54
23	Aug	1961	8,700.00	60	1943	7,100.00	49.37
21	Apr	1962	7,400.00	61	2014	7,000.00	50.19
1	Apr	1963	2,670.00	62	1902	6,980.00	51.01
27	May	1964	2,720.00	63	1969	6,760.00	51.84
18	Jun	1965	7,660.00	64	1899	6,710.00	52.66
10	May	1966	3,600.00	65	1992	6,690.00	53.48
9	Aug	1967	9,520.00	66	1957	6,650.00	54.31
2	Jun	1968	4,490.00	67	1930	6,520.00	55.13
6	Aug	1969	6,760.00	68	1933	6,400.00	55.95
22	Jul	1970	5,860.00	69	2017	6,320.00	56.78
26	Jul	1971	7,820.00	70	2009	6,150.00	57.6
30	Aug	1972	1,660.00	71	2008	6,130.00	58.42
13	May	1973	8,350.00	72	1970	5,860.00	59.25
1	Jan	1974	1,760.00	73	1896	5,800.00	60.07
19	May	1975	5,070.00	74	1939	5,770.00	60.9
31	Jul	1976	4,480.00	75	1947	5,750.00	61.72
5	Sep	1977	2,620.00	76	2010	5,590.00	62.54
21	May	1978	4,020.00	77	1982	5,460.00	63.37
9	Jun	1979	12,300.00	78	1999	5,410.00	64.19
25	May	1980	8,270.00	79	1925	5,340.00	65.01
12	Aug	1981	2,340.00	80	1955	5,140.00	65.84
31	Jul	1982	5,460.00	81	1975	5,070.00	66.66
3	Jun	1983	8,760.00	82	1950	4,590.0*	67.86
17	May	1984	9,790.00	83	2001	4,550.0*	68.69
10	May	1985	12,400.00	84	2002	4,530.0*	69.52
12	Jun	1986	7,980.00	85	2003	4,510.0*	70.35
20	May	1987	9,860.00	86	1968	4,490.0*	71.18
12	Sep	1988	3,720.00	87	1960	4,490.0*	72.01
12	Apr	1989	4,210.00	88	1976	4,480.0*	72.84
11	Jul	1990	4,260.00	89	2006	4,460.0*	73.67
22	May	1991	8,560.00	90	2015	4,340.0*	74.5
14	Apr	1992	6,690.00	91	1998	4,310.0*	75.33
30	May	1993	8,200.00	92	1990	4,260.0*	76.16
19	May	1994	10,200.00	93	1989	4,210.0*	76.99
6	Jul	1995	8,800.00	94	1978	4,020.0*	77.82
9	Jul	1996	3,790.00	95	2007	3,840.0*	78.65
8	Jun	1997	7,220.00	96	1996	3,790.0*	79.49
25	May	1998	4,310.00	97	2000	3,760.0*	80.32
25	May	1999	5,410.00	98	1988	3,720.0*	81.15
30	Jul	2000	3,760.00	99	2004	3,600.0*	81.98
8	Aug	2001	4,550.00	100	1966	3,600.0*	82.81
13	Sep	2002	4,530.00	101	1972	3,440.0*	83.64

Bulletin 17C Plot for Rio Grande at Otowi Bridge

EVENTS ANALYZED				ORDERED EVENTS			
DAY	MONTH	YEAR	FLOW (cfs)	RANK	WATER YEAR	FLOW (cfs)	H-S PLOT POSITION
25	Aug	2003	4,510.00	102	1951	1,440.0*	84.47
10	May	2004	3,600.00	103	1953	3,300.0*	85.3
27	May	2005	9,190.00	104	1934	3,180.0*	86.13
6	Jul	2006	4,460.00	105	1954	3,100.0*	86.96
18	May	2007	3,840.00	106	2018	2,980.0*	87.79
24	May	2008	6,130.00	107	2011	2,930.0*	88.62
11	May	2009	6,150.00	108	1959	2,740.0*	89.45
22	Sep	2010	5,590.00	109	2022	2,720.0*	90.28
21	Aug	2011	2,930.00	110	1964	2,720.0*	91.11
31	Mar	2012	2,390.00	111	1963	2,670.0*	91.94
13	Sep	2013	8,080.00	112	1977	2,620.0*	92.77
22	Sep	2014	7,000.00	113	1946	2,610.0*	93.6
23	May	2015	4,340.00	114	2021	2,510.0*	94.44
4	Jun	2016	7,130.00	115	2012	2,390.0*	95.27
11	May	2017	6,320.00	116	1981	2,340.0*	96.1
5	Oct	2017	2,980.00	117	1940	2,330.0*	96.93
21	Nov	2019	1,980.00	118	2020	1,980.0*	97.76
6	Jul	2021	2,510.00	119	1956	1,850.0*	98.59
30	Apr	2022	2,720.00	120	1974	1,760.0*	99.42

Bulletin 17C Plot for Rio Grande at Otowi Bridge

COMPUTED CURVE	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS FLOW (cfs)	
FLOW (cfs)		0.05	0.95
29,608.00	0.2	42,362.90	24,128.50
26,092.30	0.5	34,391.60	21,941.40
23,397.90	1	29,451.80	20,101.50
20,668.40	2	24,869.40	18,086.00
16,990.90	5	19,541.20	15,143.10
14,131.80	10	15,912.70	12,712.90
11,158.40	20	12,413.30	10,104.00
6,813.80	50	7,116.40	6,071.10
3,933.30	80	4,487.30	2,923.00
2,883.90	90	3,485.70	1,849.50
2,204.80	95	2,449.20	1,224.30
1,292.40	99	1,173.90	513.4

Note:

Bulletin 17C (Java) Frequency Analysis
Computed By: HEC-SSP Version 2.3
Skew Option: Use Station Skew
Plotting Position Type: Hirsch-Stedinger

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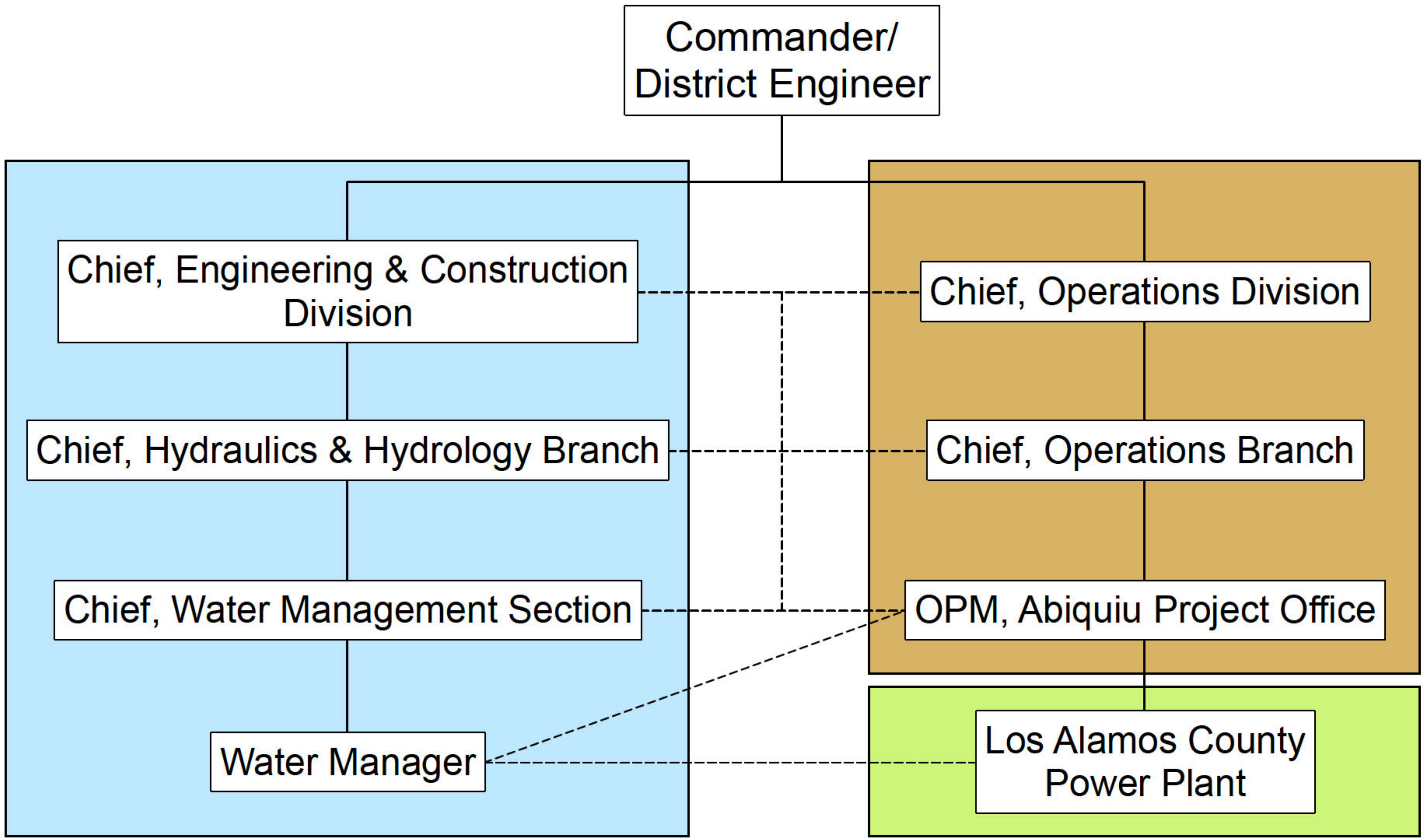
DISCHARGE FREQUENCY CURVES AT KEY DOWNSTREAM CONTROL POINTS

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 8-9



Water Management Decisions

O&M Decisions

Los Alamos County Power Plant

US Army Corps of Engineers ®
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CORPS OF ENGINEERS
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DISTRICT ORGANIZATION CHART

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate 9-1

Station	County	State	Date (*Month & Yr.*)	Time of Complete Observation (*Local time*)	Standard Time in Use	RECORD OF EVAPORATION AND CLIMATOLOGICAL OBSERVATIONS

DATE	AIR TEMPERATURE °F – 24 Hours Ending at Observation – Max.	Min.	At Observation – Dry-bulb	Wet-bulb	Dew Point	Supplemental Readings of ______ – Dry-bulb	Wet-bulb	Dew Point	PRECIPITATION – Time of beginning	Time of ending	Time of beginning	Time of ending	24 Hour Amounts – Rain, Melted snow, etc. (*in &hundredths*)	Snow, Ice Pellets, Hail (*in. & tenths*)	At Obsn. – Snow, Ice Pellets, Hail, Ice on ground (*in.*)	WIND – Ane-mometer dial Reading (miles)	24 Hour Movement	EVAPORATION (*Inches & hundredths*) – Gage Reading or Amount Added +	Reading When Tank Filled or Amount Removed -	Amount of Evapor-ation	WATER TEMP. °F – 24 Hours Ending at Observation – Max.	Min.	ADDITIONAL DATA/REMARKS
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Sum.																							
Avg.											Greatest						Adjusted Total						

WS Form B-92
(5-89)
(PRES. By WSOM B-17)

U.S. DEPARTMENT OF COMMERCE
NOAA
NATIONAL WEATHER SERVICE

OBSERVER	STATION NUMBER

US Army Corps of Engineers®
Albuquerque District

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CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

RIO GRANDE BASIN — NEW MEXICO

ABIQUIU DAM

DATA ENTRY FORM

TO ACCOMPANY WATER CONTROL MANUAL DATED APRIL 2024

Plate F-1