RECLAMATION

Managing Water in the West

Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, Draft Environmental Impact Statement

New Mexico and Texas

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region

March 2016

MISSION STATEMENT

Protecting America's Great Outdoors and Powering Our Future

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Cover photo – Elephant Butte Dam, Powerplant & Reservoir, New Mexico, August 7, 2008 (Kevin Doyle, EMPSi)

Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas: Draft Environmental Impact Statement

Lead Agency:	Bureau of Reclamation, Upper Colorado Region
Responsible Official:	Brent Rhees, Regional Director
Cooperating Agencies:	Federal: U.S. Section, International Boundary and Water Commission State: Colorado Division of Water Resources Elephant Butte Irrigation District of New Mexico El Paso County Water Improvement District No.1 Texas Rio Grande Compact Commissioner

Abstract: The proposed Federal action analyzed in this draft environmental impact statement is to continue to implement the 2008 Operating Agreement for the Rio Grande Project and to implement long-term contracts for storage of San Juan-Chama water in Elephant Butte Reservoir. The Operating Agreement is a description of how Reclamation allocates, releases from storage, and delivers Rio Grande Project water to the Elephant Butte Irrigation District in New Mexico, the El Paso County Water Improvement District No. 1 in Texas, and Mexico.

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Comment Period: The comment period begins with the Federal Register Notice of Availability and extends for 45 days after that date.

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Contents

Figures

Page

Tables

Page

Appendices

ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations	Full Phrase
ABCWUA	Albuquerque Bernalillo County Water Utility Authority
AFY	acre-feet per year
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Convention of 1906	Convention between the United States and Mexico: Equitable Distribution of the Waters of the Rio Grande
CWA	Clean Water Act
EA	environmental assessment
EBID	Elephant Butte Irrigation District
EBR	Elephant Butte Reservoir
EIS	environmental impact statement
EPCWID	El Paso County Water Improvement District Number 1
ESA	Endangered Species Act
HCCRD	Hudspeth County Conservation and Reclamation District No. 1
IBWC	U.S. Section of the International Boundary and Water Commission
IMPLAN	IMpact analysis for PLANning
ITA	Indian Trust Asset
LFCC	low flow conveyance channel
MF-OWHM	MODFLOW (modular finite-difference flow model) One Water Hydrologic Model
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMDA	New Mexico Department of Agriculture
NMEMNRD	New Mexico Energy, Minerals, and Natural Resources Department
NMOSE	New Mexico Office of the State Engineer
NMRPTC	New Mexico Rare Plant Technical Council
NMSP	New Mexico State Parks
NRHP	National Register of Historic Places
OA	Operating Agreement for the Rio Grande Project
Reclamation	United States Department of the Interior, Bureau of Reclamation
RGP	Rio Grande Project
RMBHM	Rincon and Mesilla Basin Hydrologic Model
SEA	supplemental environmental assessment
Service	United States Department of the Interior, Fish and Wildlife Service

ACRONYMS AND ABBREVIATIONS *(continued)*

	Full Phrase
SHPO	State Historic Preservation Officer
U.S.	United States
USC	United States Code
USDA	United States Department of Agriculture

RECLAMATION
Managing Water in the West

Executive Summary Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, Draft Environmental Impact Statement

New Mexico and Texas

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region

March 2016

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Introduction

The United States (U.S.) Department of the Interior, Bureau of Reclamation (Reclamation) has prepared this environmental impact statement (EIS) to analyze the environmental effects of continuing to implement the Operating Agreement (OA) for the Rio Grande Project (RGP) through 2050. The OA is a written detailed description of how Reclamation allocates, releases from storage, and delivers RGP water to Mexico, the Elephant Butte Irrigation District (EBID), and the El Paso County Water Improvement District No. 1 (EPCWID). In addition, Reclamation will use this EIS to evaluate the environmental effects of a multi-year San Juan–Chama Project water storage contract under the Act of December 29, 1981, Public Law 97-140, 95 Stat. 1717, providing for storage in Elephant Butte Reservoir (EBR).

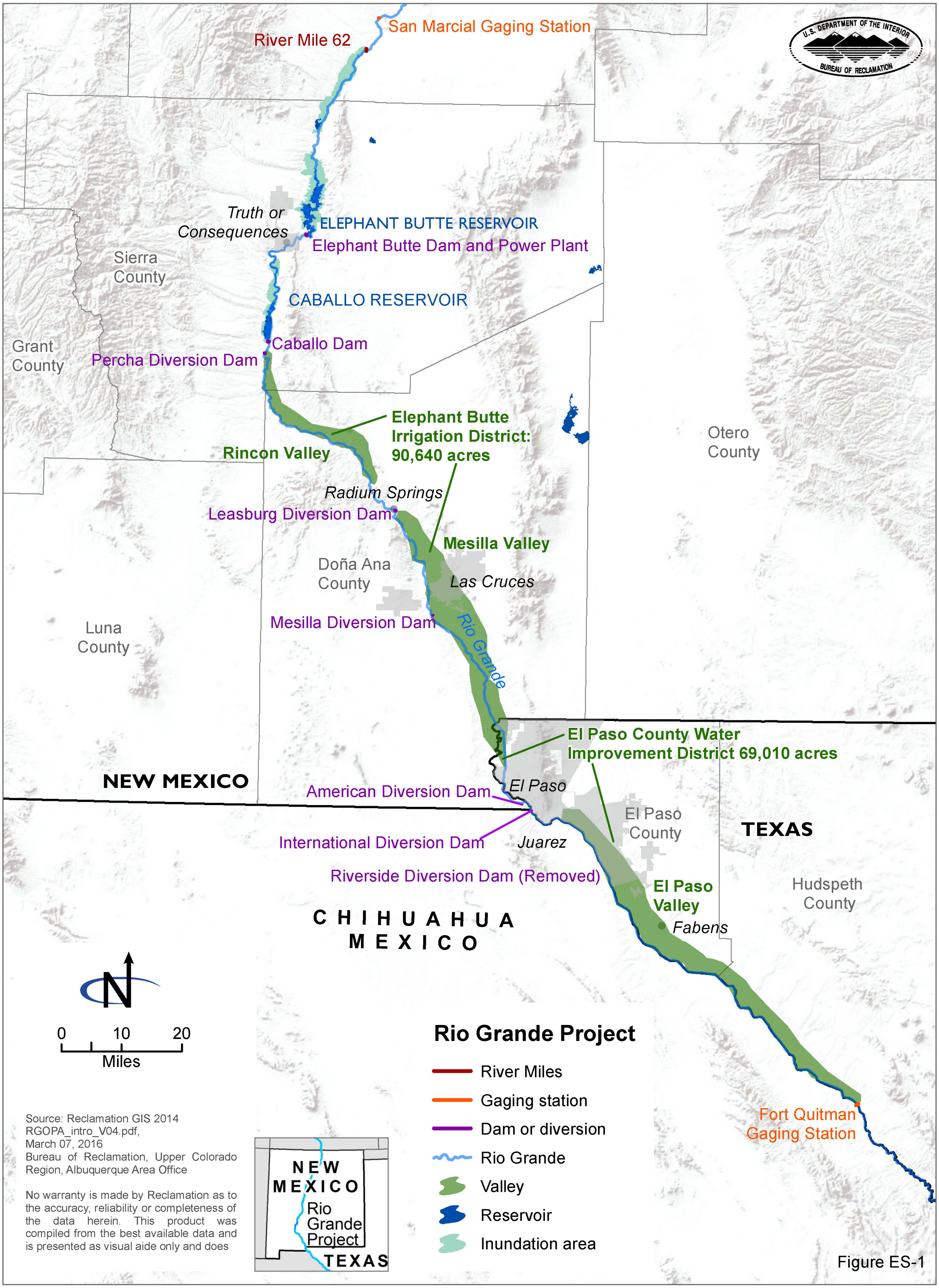
Reclamation held three public scoping meetings, one each in Albuquerque and Las Cruces, New Mexico, and El Paso, Texas. The public input received during the scoping period is summarized in a report available on the project website, http://www.usbr.gov/uc/albuq/rm/RGP/. Reclamation took these comments into consideration when developing the EIS and incorporated this feedback as appropriate during alternatives development, modeling, and impact analysis. As part of this EIS, Reclamation also reviewed and considered scoping input received for the Implementation of the Rio Grande Project Operating Procedures, New Mexico and Texas, Supplemental Environmental Assessment (SEA). A summary of scoping activities and input received for the SEA are included in the SEA on the project website. Reclamation will conduct public hearings during the 45-day public review period for the draft EIS. It will post information on these hearings, including dates and locations, on the project website.

Rio Grande Project Operating Agreement

The OA, signed in 2008, provides the means and methods for determining the annual allocation of the RGP supply to be proportionally delivered to EBID in New Mexico, EPCWID in Texas, and Mexico. Facilities and distribution infrastructure of the RGP are owned and operated by multiple entities, each with its own mission and responsibilities. Reclamation retains ownership of Elephant Butte Dam, reservoir, and power plant; Caballo Dam and reservoir; Leasburg Diversion Dam; Mesilla Diversion Dam; and Percha Diversion Dam. The American and International Dams are owned and operated by the U.S. Section of the International Boundary and Water Commission (IBWC). EBID and EPCWID own and operate their networks of canals, laterals, waste ways, and other structures.

Rio Grande Project

The RGP is in southern New Mexico and western Texas. Its facilities include Elephant Butte and Caballo Dams and Reservoirs; a power generating plant; the Percha, Leasburg, Mesilla, American, and International Diversion Dams; and an extensive network of canals and drains (see **Figure ES-1**, Rio Grande Project).



San Marcial Gaging Station
River Mile 62
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Truth or Consequences
ELEPHANT BUTTE RESERVOIR
Elephant Butte Dam and Power Plant
Sierra County
CABALLO RESERVOIR
Caballo Dam
Grant County
Percha Diversion Dam
Elephant Butte Irrigation District: 90,640 acres
Otero County
Rincon Valley
Radium Springs
Leasburg Diversion Dam
Mesilla Valley
Doña Ana County
Las Cruces
Luna County
Mesilla Diversion Dam
Rio Grande
El Paso County Water Improvement District 69,010 acres
NEW MEXICO
American Diversion Dam
El Paso
El Paso County
TEXAS
International Diversion Dam
Juarez
Riverside Diversion Dam (Removed)
El Paso Valley
Hudspeth County
CHIHUAHUA MEXICO
Fabens
0 10 20
Miles
Rio Grande Project
River Miles
Gaging station
Dam or diversion
Rio Grande
Valley
Reservoir
Inundation area
Fort Quitman Gaging Station
NEW MEXICO
Rio Grande Project
TEXAS
Source: Reclamation GIS 2014
RGOPA_intro_V04.pdf,
March 07, 2016
Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office
No warranty is made by Reclamation as to the accuracy, reliability or completeness of the data herein. This product was compiled from the best available data and is presented as visual aide only and does

Figure ES-1

Surface Water Supply

At the beginning of the calendar year and prior to the onset of the irrigation season, Reclamation determines the total water in RGP storage. In years when the total usable RGP water at the beginning of the calendar year is not sufficient to provide a full allocation, Reclamation reevaluates RGP storage each month during the irrigation season until a final allocation is determined. RGP releases, diversions, and deliveries depend on the usable water available to the RGP as well as water demands within the RGP, and are subject to limits specified by various statutory controls.

Allocation of Rio Grande Project Water

Reclamation allocates RGP water supplies such that the diversion allocations to EBID and EPCWID are proportionate to the district's respective acreages. EBID includes 90,640 acres authorized to receive RGP water in the Rincon and Mesilla Valleys of New Mexico, and EPCWID includes 69,010 acres authorized to receive RGP water in the Mesilla and El Paso Valleys of Texas; 57 percent of the acreage is in EBID, and 43 percent is in EPCWID. The annual diversion allocation is calculated based on the amount of RGP water in storage available for release and the estimated amount of water available for diversion at river headings accounting for canal bypass, drainage return flows, and other inflows to the Rio Grande, between Caballo Dam and International Dam.

Release and Diversion of Rio Grande Project Water

Reclamation delivers water to each district's diversion headings based on their water orders. Each district then distributes water through its conveyance system to its water users for irrigation or municipal use. El Paso Water Utilities also receives RGP water under the 1920 Miscellaneous Purposes Act contracts, which allow irrigation water to be converted to municipal and industrial uses. The IBWC carries out and times the deliveries at the request of Mexico. RGP water allocated to Mexico under the Convention between the United States and Mexico: Equitable Distribution of the Waters of the Rio Grande (herein referred to as the Convention of 1906) is officially delivered in the bed of the Rio Grande at the point adjacent to the head works of the Acequia Madre in Ciudad Juárez, about two miles downstream of the point where the river starts to form the international border.

Historic Operations

Beginning in 1980, Reclamation determined annual diversion allocations to each district and delivered water to the respective authorized points of diversion; the districts were then responsible for conveying water from the point of diversion to individual farm gates. Until a mutually agreeable operations plan was in place, Reclamation imposed ad hoc operating procedures to govern operations. It modified these procedures as needed between 1980 and 2007. During that time, Reclamation calculated, allocated, and delivered each district's annual diversion allocation; however, it modified and optimized the methods, equations, and procedures according to real-time water conditions. The lack of an operations plan led to conflicts and litigation during this period. EBID, EPCWID, and Reclamation agreed to execute and implement the OA in 2008 as a settlement of the litigation then pending and filed by both districts. The three parties are the only signatories of the OA. The term of the resulting 2008 OA is from January 1, 2008, until December 31, 2050.

Principles Underlying the Operating Agreement

The OA for the Rio Grande Project reflects the parties' interest in the long-term sustainability of the RGP. These include Rio Grande surface waters and hydraulically connected groundwater in both New Mexico and Texas. The interaction between the surface water and groundwater is a critical factor in understanding the OA. Groundwater recharge via seepage and deep percolation of RGP water will continue under the OA. In years when there is an increase in RGP allocation and delivery to EBID, there is a corresponding increase in recharge via seepage and deep percolation within EBID, as well as a decrease in demand for supplemental irrigation by groundwater pumping within EBID. Conversely, when the OA results in a decrease in allocation, recharge and deep percolation are likely to decrease, while demand for supplemental irrigation is likely to increase, which may result in increased groundwater pumping within the district, under permits issued by the State of New Mexico. Supplemental groundwater pumping is authorized and managed by the states, independently of the Federal Rio Grande Project, and is currently the subject of litigation in the U.S. Supreme Court.

D-1 and D-2 Curves

The D-1 and D-2 Curves were developed from operations data from 1951 to 1978. They reflect historical project performance during those years, including the effects of losses and inflows on project deliveries. The D-1 Curve is a linear regression equation that represents the historical relationship between the total annual release from RGP storage and the total project delivery to lands within the U.S., plus delivery in the bed of the river at the point adjacent to the head works of the Acequia Madre. The D-2 Curve is a linear regression equation that represents the historical relationship between the total annual release from project storage and the total project delivery to canal headings on the Rio Grande. It includes delivery to all authorized points of diversion for EBID, EPCWID, and Mexico.

Operations Manual

An addendum to the OA is a written Operations Manual, which describes the allocation provisions in the OA and RGP storage, release, and delivery. The OA largely reflects historical operation of the RGP, with two key changes. First, the OA provides carryover accounting for any unused portion of the annual diversion allocations to EBID and EPCWID. Under the OA, any unused portion of the annual diversion allocations to EBID and EPCWID, based on a regression line reflecting past delivery performance, referred to as the D-2 Curve, is carried over to that district's allocation balance the following year. The carryover provision of the OA is designed to encourage water conservation in the RGP by allowing each district to retain its unused allocation up to a specified limit.

Second, the OA adjusts the annual RGP allocations to EBID and EPCWID to account for changes in RGP performance, as characterized by its diversion ratio. The diversion ratio provision of the OA was developed to adjust the annual RGP allocation to EPCWID so as to provide RGP deliveries to the district consistent with historical operations, prior to substantial increases in groundwater pumping within EBID and corresponding decreases in RGP performance that has occurred. The annual RGP allocation to EBID is then adjusted to reflect current-year RGP performance as represented by the diversion ratio. When the diversion ratio is high, EBID generally receives an increase in allocation compared to historical RGP performance; when the diversion ratio is low, EBID generally receives a decrease in RGP allocation compared to historical RGP performance.

San Juan–Chama Project Water Storage

The San Juan–Chama Project was authorized as a participating project of the Colorado River Storage Project Act of April 11, 1956 (Ch. 203, 70 Stat. 105); it was specifically authorized by the Act of June 13, 1962 (Public Law 87-483, 76 Stat. 96). The San Juan–Chama Project diversion and storage facilities were created in 1971 and limited under statute to provide 96,200 acre-feet per year of water to San Juan–Chama Project contractors. The water is for supplemental irrigation and domestic, municipal, and industrial uses. San Juan–Chama Project repayment contractors receive their annual water allocations with no provisions for carryover; therefore, these contractors can benefit by storing unused annual allocations in EBR for future use.

Purpose and Need for Action

Operating Agreement

The purpose for action is to meet contractual obligations to EBID and EPCWID and comply with applicable law governing water allocation, delivery, and accounting. These obligations are currently fulfilled under the 2008 OA. The need for action is to resolve the long and litigious history of the RGP and enter into mutually agreeable, detailed operational criteria. The OA consists of a written set of criteria and procedures for allocating, delivering, and accounting for RGP water to both districts by Reclamation consistent with the Convention of 1906, the Rio Grande Project Compact, and other applicable law, and in compliance with various court decrees, settlement agreements, and contracts. These include the 2008 Compromise and Settlement Agreement among Reclamation, EBID, and EPCWID and contracts between the U.S. and EBID and EPCWID.

San Juan–Chama Project Storage

The purpose for a related action is to respond to a request to allow for a multi-year storage contract of San Juan–Chama Project water in EBR in accordance with the Act of December 29, 1981, Public Law 97-140.

Federal Decisions to Be Made

Whether to Continue to Implement the OA through 2050

The Federal decision is to determine whether to continue to meet contractual obligations to EBID and EPCWID using the OA through 2050. These obligations are for allocating, delivering, and accounting for RGP water in compliance with various court decrees, settlement agreements, and contracts. Reclamation will use the analysis in the EIS to select the preferred alternative and to prepare a Record of Decision on the continued implementation of the OA over the remaining term of the agreement.

Whether to Store San Juan–Chama Project Water in Elephant Butte Reservoir for Multiple Years

Reclamation will also determine whether, and if so how, to implement a multiyear contract covering the remaining term of the OA for storing San Juan–Chama Project water in EBR.

Reclamation will use the analysis in the EIS to select the preferred alternative and to prepare a Record of Decision for storing San Juan–Chama Project water in EBR.

Key Issues

Key issues were identified from the SEA prepared for the OA and comments received during scoping for the EIS. Key issues were also identified from internal scoping and outreach to Federal, state, and local agencies and tribal governments. Reclamation identified and addressed the following resource issues in this EIS.

Aquatic Resources, Vegetation Communities, and Wildlife

To comply with the Endangered Species Act (ESA) Section 7(a)(2), Reclamation submitted a biological assessment to the U.S. Fish and Wildlife Service (Service) on August 20, 2015, to address the potential effects of continuing to implement the OA and storing San Juan-Chama Project water in Elephant Butte Reservoir. The biological assessment analyzes impacts on the Southwestern willow flycatcher (*Empidonax traillii extimus*), the Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), and the Rio Grande silvery minnow (*Hybognathus amarus*). The Service prepared a biological opinion on effects of actions associated with the proposed continuation of the RGP OA and storage of San Juan-Chama Project water in EBR, New Mexico, on January 21, 2016. Reclamation requested an extension until March 22, 2016, to complete the review.

Water Resources

Reclamation, in collaboration with the U.S. Geological Survey, developed a detailed hydrologic model of the Rincon and Mesilla Basins, the Rincon and Mesilla Basin Hydrologic Model (RMBHM), and used this model to simulate operations under the alternatives and corresponding surface water and groundwater conditions in the basins.

Environmental Justice and Socioeconomics

There would be no disproportionately high or adverse effects on minority or low-income populations. For the socioeconomic analysis, outcomes from the RMBHM modeling are used to calculate net economic benefits, and the IMpact analysis for PLANning or IMPLAN modeling package is used to assess regional economic impact for each alternative.

Cultural Resources

To address requirements of Section 106 of the National Historic Preservation Act, Reclamation submitted documentation to the New Mexico State Historic Preservation Officer (SHPO) on October 29, 2015, requesting concurrence on the determination that there would be no adverse effects on historic properties from the federal action. Reclamation received the SHPO's concurrence on November 25, 2015.

Indian Trust Assets

In accordance with Executive Order 13175, Reclamation sent letters on June 24, 2014, requesting input for preparation of the EIS to the two tribes that requested consultation during the preparation of the SEA: the Ysleta del Sur Pueblo in Texas and the Mescalero Apache Tribe in New Mexico. Only the Mescalero Apache Tribe offered comments in response to

Reclamation's scoping letter on the SEA. Reclamation intends to honor the Mescalero Apache Tribe's response to the SEA in this EIS.

Description of Alternatives

Reclamation determined that, under the National Environmental Policy Act (NEPA), the No Action Alternative should reflect current operating procedures under the OA. Current operations are conducted in accordance with the OA and the compromise and settlement agreement among the United States, EBID, and EPCWID (Settlement Agreement 2008). Since 1979 and 1980, Reclamation, EBID, and EPCWID have had contractual obligations to agree on a detailed operational plan, setting forth procedures for allocation and delivery and accounting of RGP water. This EIS analyzes storing San Juan–Chama Project water in EBR, which is a separate activity than the OA. The Albuquerque Bernalillo County Water Utility Authority (ABCWUA) is seeking a multiyear contract for storage of up to 50,000 acre-feet per year (AFY) of San Juan–Chama Project water in EBR through 2050.

Reclamation determined that the carryover provision and the diversion ratio adjustment were the two key elements in the OA that were the basis of the settlement agreement and represented variables for comparing alternatives. The alternatives were derived from the methods, equations, and procedures that Reclamation, EBID, and EPCWID use in determining the annual diversion allocation and water accounting for the RGP. The No Action Alternative for the EIS is also the Proposed Action because it would continue to maintain the settlement.

Alternative 1

The No Action Alternative (Alternative 1) is the continued implementation through 2050 of the operating procedures defined in the OA and RGP Operations Manual, as amended for any given year. Under these operating procedures, the carryover accounting and the diversion ratio provisions would continue. Under the No Action Alternative, Reclamation would execute a multiyear contract through 2050 with the ABCWUA to store up to 50,000 AFY of San Juan–Chama Project water in EBR.

Alternative 2

Alternative 2 is the same as Alternative 1 (No Action Alternative), except Reclamation would not continue with contracts to store up to 50,000 AFY of San Juan–Chama Project water in EBR.

Alternative 3

Alternative 3 is the same as Alternative 1 (No Action Alternative), except Reclamation would not continue to implement the carryover accounting provisions of the OA. Alternative 3 would allow Reclamation to model and determine the effects of the carryover provision.

Alternative 4

Alternative 4 is the same as Alternative 1 (No Action Alternative), except Reclamation would not implement the diversion ratio adjustment provision of the OA. Alternative 4 would allow Reclamation to model and determine the effects of the diversion ratio adjustment provision.

Alternative 5

Alternative 5 would allow a comparison through 2050 of operations under the OA and a simulation of procedures prior to the OA by eliminating the carryover and diversion ratio adjustment provisions. Alternative 5 is the best possible representation of prior operating practices in a modeling context, but it is not the same as historical operations. This is because it does not include the ad hoc adjustments and is based on strict application of the D-1 and D-2 Curves. **Table ES-1** highlights the differences among alternatives selected for study in this EIS.

Table ES-1. Comparison of Key Elements of the Alternatives

Alternative	Continue Diversion Ratio Adjustment	Continue Carryover Accounting	Continue Storage Of San Juan–Chama Project Water
1	●	●	●
2	●	●	
3	●		●
4		●	●
5			●

Summary of Impacts

This EIS is not intended to be a comprehensive review of the resource issues of the RGP, its historical operations, and its geographic extent. The OA is implemented within the larger context of established RGP facilities and operations that predate the OA. The primary tools used for the impact analysis are the hydrologic and economic model simulations performed by Reclamation. The RMBHM simulates each alternative through 2050 under projected future climate and hydrologic conditions to consistently compare the effects of each alternative. Model simulations performed for this EIS indicate that relative water allocations between EBID and EPCWID would differ among the alternatives considered. The model simulations assume that farmers in the Rincon and Mesilla Basins would pump groundwater in order to make up for any surface water shortages that occur under the different alternatives and the three potential hydrologic scenarios. However, such groundwater pumping is performed under the authority of the states and at the discretion of the individual farmers.

For NEPA analyses of reasonably foreseeable hydrologic conditions that may occur under different alternatives, exceedance or non-exceedance curves may be used to display projected future hydrologic scenarios. For purposes of the impact analysis, the modeling results of the P50 central tendency scenario are used for most resources. However, the modeling results of the P25 drier scenario and the P75 wetter scenario are equally likely to occur in a given year. For the purpose of assessing the impacts on special status species that are present in the EBR pool, Reclamation used the wetter P75 scenario. This is consistent with the ESA Section 7 consultation, which assesses a conservative worst case based on the potential effects on these species and their habitats due to fluctuations in the reservoir pool and/or sustained high or low water levels in the reservoir.

Elephant Butte Reservoir Elevations

EBR elevations were very similar for all alternatives, except Alternative 2 is lower at the low end of the range. The projected range of monthly water levels is similar for each of the alternatives.

The differences among the alternatives are smaller than the differences among climate scenarios; i.e., the effect of future climate change is much larger than the effects of the agency's possible operating alternatives. In other words, the effects of the agency's discretionary action of selecting one or another operating procedure are less than the projected effects of future non-discretionary climate change. **Table ES-2** incorporates climate change modeling and shows the ranges of surface elevations for EBR.

Table ES-2. Simulated Elephant Butte Reservoir Water Surface Elevations

Alternative	Scenario P25 (Drier Climate Scenario)	Scenario P50 (Central Tendency Climate Scenario)	Scenario P75 (Wetter Climate Scenario)
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 2	4,254 to 4,377	4,254 to 4,407	4,283 to 4,407
Alternative 3	4,284 to 4,375	4,285 to 4,407	4,283 to 4,407
Alternative 4	4,284 to 4,368	4,283 to 4,407	4,283 to 4,407
Alternative 5	4,284 to 4,372	4,283 to 4,407	4,283 to 4,407

The time series for the three climate scenarios for EBR elevation are presented below in **Figures ES-2, ES-3,** and **ES-4**.

Figure ES-2. Monthly Water Surface Elevation: Elephant Butte Reservoir Simulated EBR Water-Surface Elevations, Scenario P25 (Drier)

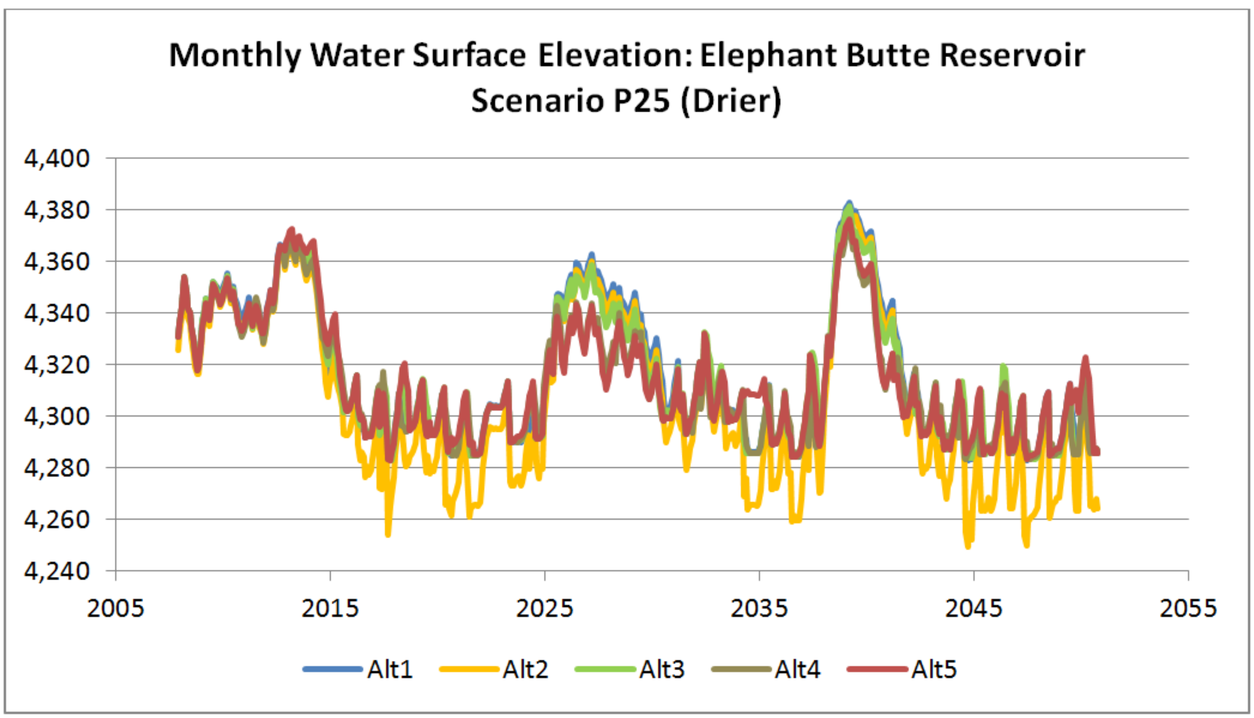


Figure ES-3. Monthly Water Surface Elevation: Elephant Butte Reservoir Simulated EBR Water-Surface Elevations, Scenario P50 (Central Tendency)

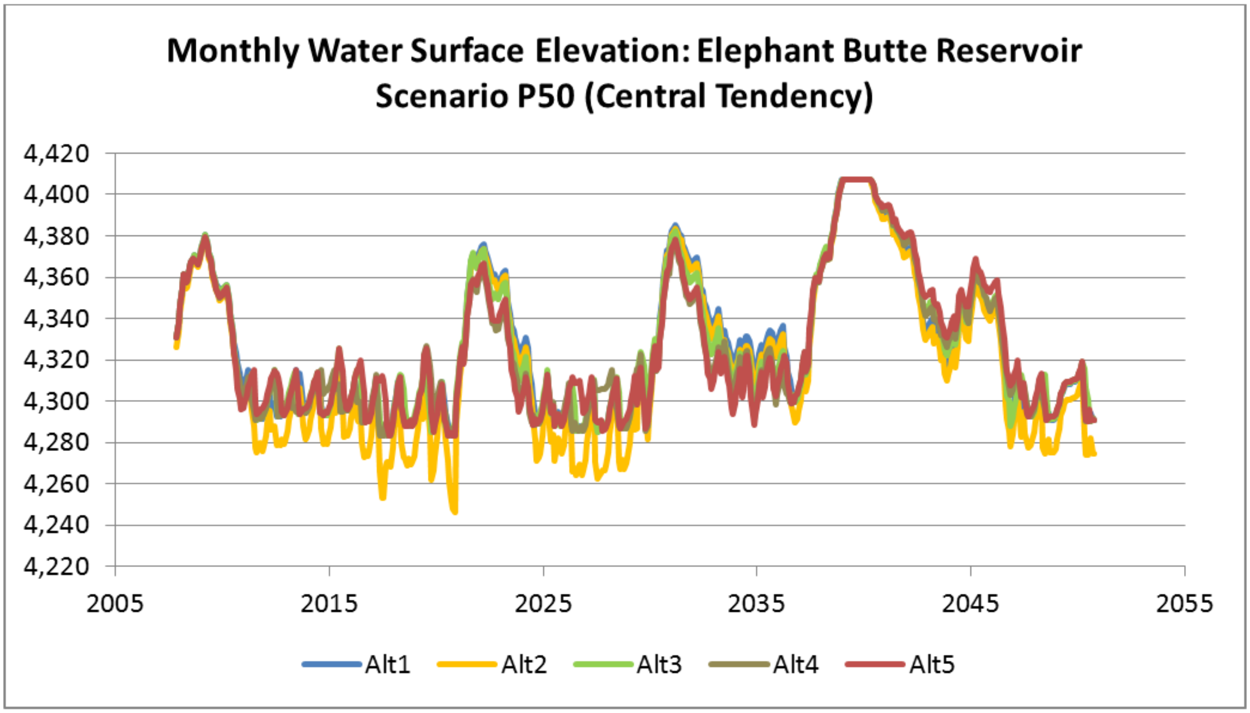
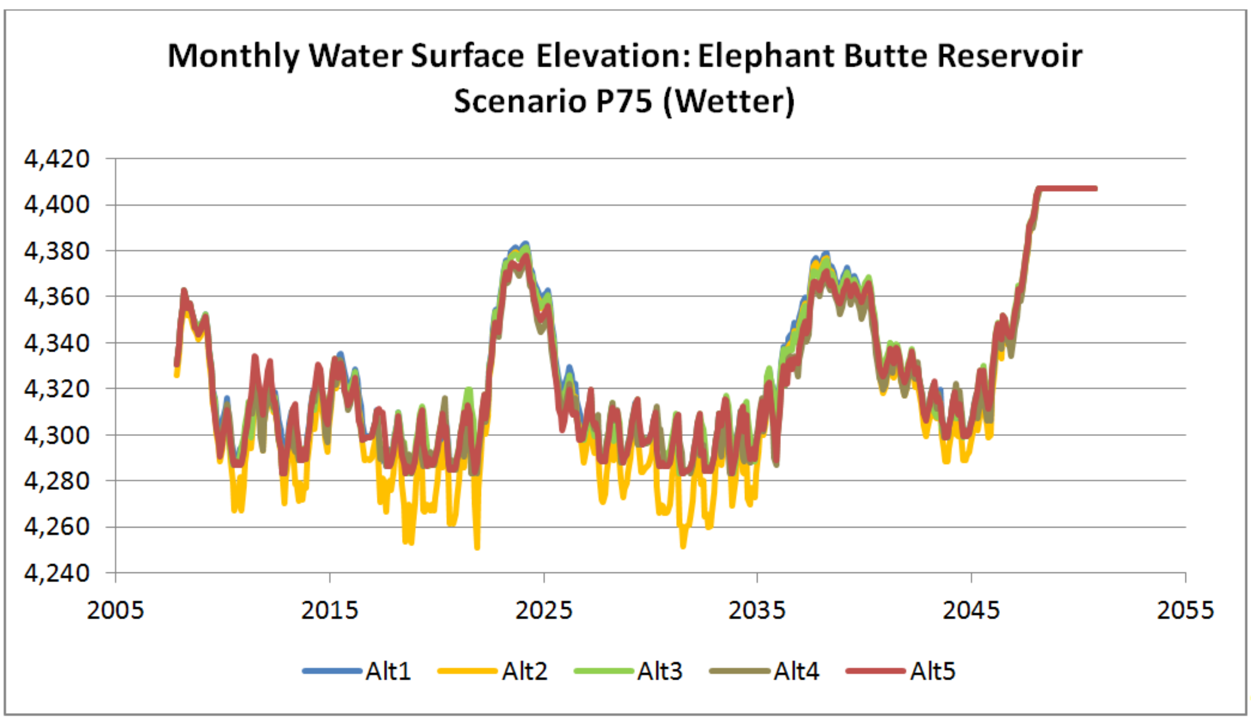


Figure ES-4. Monthly Water Surface Elevation: Elephant Butte Reservoir Simulated EBR Water-Surface Elevations, Scenario P75 (Wetter)



Annual Allocated Water

Modeling results for Alternatives 1 through 5 showed the following differences for annual allocated water to EBID and EPCWID:

EBID—Alternative 2 (No San Juan–Chama Project Storage) provides the same allocation as the No Action Alternative. Alternatives 3, 4, and 5 provide more water to EBID than the No Action Alternative. This is consistent across scenarios, though Alternative 4 provides more water than Alternative 5.

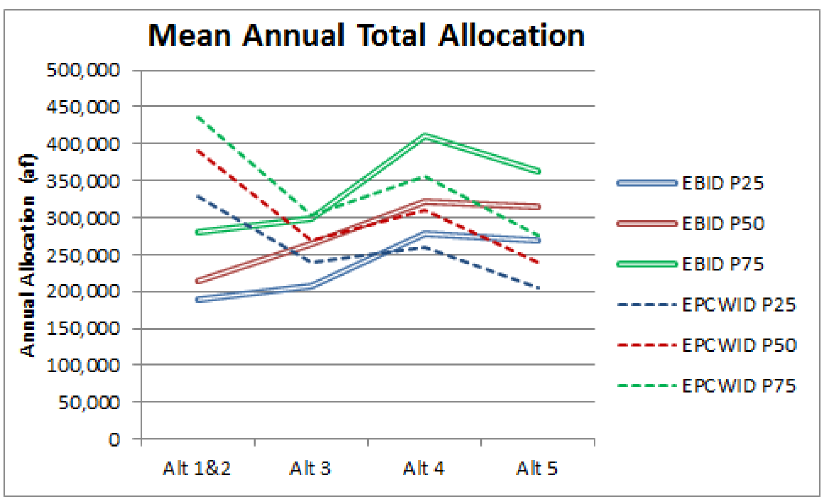
EPCWID—Alternative 2 (No San Juan–Chama Project Storage) provides the same allocation as the No Action Alternative. Alternatives 3, 4, and 5 provide less water than the No Action Alternative. This is consistent across scenarios, though Alternative 4 provides more water than Alternative 5.

Total Allocation

Total allocation of water trended in opposite directions for EBID and EPCWID for the various alternatives, with EBID getting more water than Alternative 1 and EPCWID getting less. Across the alternatives there was always more water allocated in the wetter scenarios than drier scenarios.

Figure ES-5 shows the variation in total allocation among alternatives and scenarios for both EBID and EPCWID.

Figure ES-5. Variation in Total Allocation



Past, Present, and Reasonably Foreseeable Future Actions

The impacts of past and present actions include the Delta Channel Maintenance Project and the Rio Grande Canalization Project. While supplemental groundwater pumping authorized and managed by the states is a past, present, and reasonably foreseeable action, Reclamation has no control over the regulation of groundwater pumping.

Table ES-3 provides a summary of the potential impacts on the resources evaluated in the Draft EIS on the five alternatives.

Table ES-3. Summary of the No Action Alternative Compared with the Other Alternatives

	Alternative 1—No Action	Alternative 2—No San Juan–Chama Project Storage	Alternative 3—No Carryover Provision	Alternative 4— No Diversion Ratio Adjustment	Alternative 5—Prior Operating (Ad Hoc) Practices
Section 4.4 Surface Water					
Elephant Butte pool elevation (feet)	4,318	4,312	4,314	4,312	4,313
Total project storage (average annual acre-feet)	409,453	409,453	399,510	371,591	389,109
Annual allocation to EBID	146,977	146,977	264,752	272,269	314,327
Annual allocation to EPCWID	266,327	266,327	267,973	207,296	239,317
Project releases (mean annual acre-feet)	524,597	524,597	525,808	531,229	527,421
Net diversions to EBID (acre-feet)	153,583	153,583	198,287	227,069	228,363
Net diversions to EPCWID (acre-feet)	46,703	46,703	34,805	29,491	25,543
Farm surface water deliveries to EBID (acre-feet)	72,841	72,841	94,477	110,782	110,314
Farm surface water deliveries to EPCWID (acre-feet)	15,954	15,954	15,029	14,964	13,896
Section 4.5 Groundwater					
Mean monthly elevation at Rin-2 (feet)	4,060	4,060	4,062	4,063	4,063
Mean monthly elevation at Mes-6 (feet)	3,814	3,814	3,815	3,816	3,815
Groundwater storage in the Rincon and Mesilla Basins (cumulative change)	Decrease	Decrease	Decrease	Decrease	Decrease
Section 4.6 Water Quality					
Groundwater elevations decline seasonably during sustained dry periods but recover during wet periods.	Negligible	Negligible	Negligible	Negligible	Negligible

Table ES-3. Summary of the No Action Alternative Compared with the Other Alternatives

	Alternative 1—No Action	Alternative 2—No San Juan–Chama Project Storage	Alternative 3—No Carryover Provision	Alternative 4— No Diversion Ratio Adjustment	Alternative 5—Prior Operating (Ad Hoc) Practices
Reservoir has no releases to the river below it in the non-irrigation season; changes depend on natural wet and dry cycles.	Negligible	Negligible	Negligible	Negligible	Negligible
Section 4.7 Vegetation					
EBR riparian vegetation	Some net loss	Some net loss	Some net loss	Some net loss	Some net loss
Rio Grande floodplain	None	None	None	None	None
Section 4.8 Wildlife					
Listed species (Southwestern willow flycatcher; Yellow-billed cuckoo) habitat	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Section 4.9 Aquatic Resources					
Aquatic resources	None to minor negative	None to minor negative	None to minor negative	None to minor negative	None to minor negative
Rio Grande silvery minnow	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Section 4.10 Cultural Resources	Not affected	Not affected	Not affected	Not affected	Not affected
Section 4.11 Indian Trust Assets	None	None	None	None	None
Section 4.12 Socioeconomics					
EPCWID average annual agricultural benefits (millions of dollars)	23.5	23.5	22.8	22.0	21.7
Section 4.13 Environmental Justice	None	None	None	None	None

317

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1. Purpose of and Need for Action

1.1 Introduction

The United States (U.S.) Department of the Interior, Bureau of Reclamation (Reclamation) has prepared this environmental impact statement (EIS) to analyze the environmental effects of continuing to implement the Operating Agreement (OA) for the Rio Grande Project (RGP) through 2050. The OA is a written, detailed description of how Reclamation allocates, releases from storage, and delivers RGP water to Mexico, the Elephant Butte Irrigation District (EBID), and the El Paso County Water Improvement District No. 1 (EPCWID). It is consistent with the applicable water contracts and water rights, the Rio Grande Compact, state and Federal laws, and international treaties.

In addition, Reclamation will use this EIS to evaluate the environmental effects of a multi-year San Juan–Chama Project water storage contract under the Act of December 29, 1981, Public Law 97-140, 95 Stat. 1717, providing for storage in Elephant Butte Reservoir (EBR) (see **Section 1.5**).

This EIS has been prepared in accordance with the National Environmental Policy Act (NEPA; 42 U.S. Code [USC], Section 4321, et seq.), the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] 1500-1508), the U.S. Department of the Interior's NEPA Regulations (43 CFR 46), and other relevant Federal and state laws and regulations.

This chapter summarizes the two key components of the proposed action, the OA and the San Juan–Chama Project Storage Contract. This chapter outlines the purpose and need for taking action along with key issues and steps taken for public involvement.

1.2 Rio Grande Project Operating Agreement

As described above, the OA is a written detailed description of how Reclamation allocates, releases from storage, and delivers RGP water to irrigation district diversion points (headings). The OA, signed in 2008, provides the means and methods for determining the annual allocation of the RGP supply to be proportionally delivered to EBID in New Mexico, EPCWID in Texas, and Mexico. The OA is **Appendix A** of this EIS. Facilities and distribution infrastructure of the RGP are owned and operated by multiple entities, each with its own mission and responsibilities. Reclamation retains ownership of Elephant Butte Dam, reservoir, and power plant; Caballo Dam and reservoir; Leasburg Diversion Dam; Mesilla Diversion Dam; and Percha Diversion Dam. The American and International Dams are owned and operated by the U.S. Section of the

International Boundary and Water Commission (IBWC). EBID and EPCWID own and operate their networks of canals, laterals, waste ways, and other structures.

1.3 Rio Grande Project

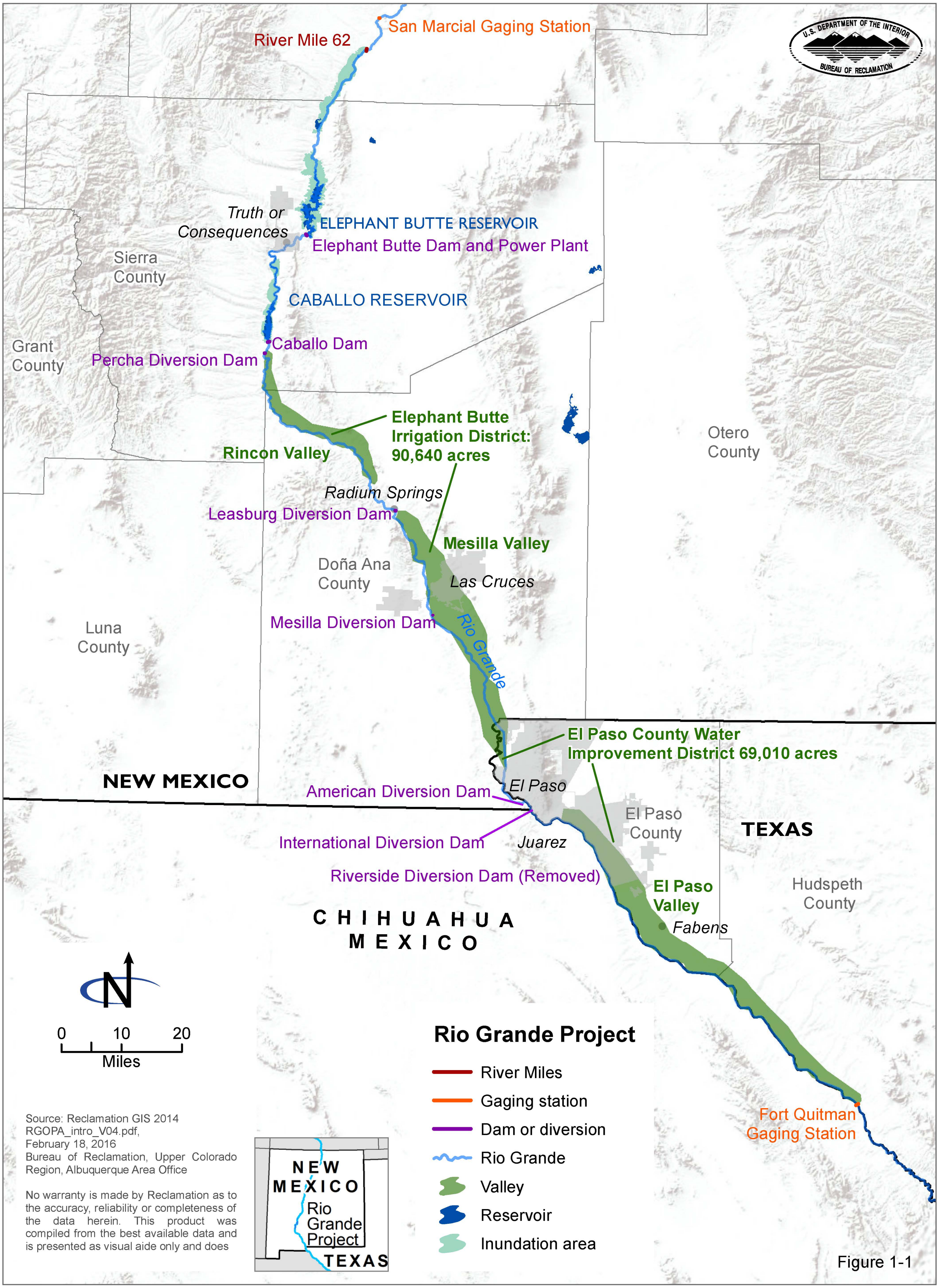
The RGP is in southern New Mexico and western Texas. Its facilities include the Elephant Butte and Caballo Dams and Reservoirs; a power generating plant; the Percha, Leasburg, Mesilla, American, and International Diversion Dams; and an extensive network of canals and drains (see **Figure 1-1**, Rio Grande Project). A sixth diversion dam, Riverside, was damaged by flood flows and was removed in 2003 to reduce flood hazards associated with further breaching.

RGP lands are located in the Rincon, Mesilla, and El Paso Valleys, all of which are basins or valleys within the Rio Grande Rift.

Congress authorized the RGP under the authority of the Reclamation Act of 1902 and the Rio Grande Project Act of February 25, 1905, to serve lands in New Mexico and Texas. RGP water is made available to irrigate a variety of crops and also for municipal and industrial water uses. RGP water is also diverted to Mexico under the Convention between the United States and Mexico: Equitable Distribution of the Waters of the Rio Grande (herein referred to as the Convention of 1906). The RGP is one of the most complex projects that Reclamation manages. The authorization for the RGP in 1902 and 1905 and some of the facility construction predates New Mexico’s statehood.

In 1907, Congress appropriated $1,000,000 to pay for the portion of the RGP necessary to provide storage of water for fulfillment of the Convention of 1906. As for funding the rest of the RGP, under the Reclamation Act of 1902, Congress intended that water projects would be self-supporting; each would generate sufficient revenue to cover the approximate costs of construction and operation and maintenance, and the total estimated RGP costs would be equitably borne by its beneficiaries. Therefore, EBID and EPCWID were required to enter into contracts with Reclamation under which they would cover these costs in the future. The Reclamation Act of 1902 further states that the right to use RGP water “shall be appurtenant to the land irrigated and beneficial use shall be the basis, the measure, and the limit of the right” (32 Stat. 390; 43 USC, Sections 372 and 383.) The contracts with EBID and EPCWID establish the allocation of water between the two districts, based on the irrigable acreage within each district.

A detailed history of the RGP may be found in the *Rio Grande Project* (Autobee 1994) and Appendix C of the Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas, Supplemental Environmental Assessment (SEA) (Reclamation 2013a).


San Marcial Gaging Station
River Mile 62
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Truth or Consequences
ELEPHANT BUTTE RESERVOIR
Elephant Butte Dam and Power Plant
Sierra County
CABALLO RESERVOIR
Grant County
Caballo Dam
Percha Diversion Dam
Elephant Butte Irrigation District: 90,640 acres
Rincon Valley
Otero County
Radium Springs
Leasburg Diversion Dam
Mesilla Valley
Doña Ana County
Las Cruces
Luna County
Mesilla Diversion Dam
Rio Grande
El Paso County Water Improvement District 69,010 acres
NEW MEXICO
American Diversion Dam
El Paso
El Paso County
TEXAS
International Diversion Dam
Juarez
Riverside Diversion Dam (Removed)
El Paso Valley
Hudspeth County
CHIHUAHUA
MEXICO
Fabens
N
0
10
20
Miles
Rio Grande Project
River Miles
Gaging station
Dam or diversion
Rio Grande
Valley
Reservoir
Inundation area
Source: Reclamation GIS 2014
RGOPA_intro_V04.pdf,
February 18, 2016
Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office
No warranty is made by Reclamation as to the accuracy, reliability or completeness of the data herein. This product was compiled from the best available data and is presented as visual aide only and does
NEW MEXICO
Rio Grande Project
TEXAS
Fort Quitman Gaging Station
Figure 1-1

1.4 Background

1.4.1 Operations Overview

The RGP provides surface water for irrigation in southern New Mexico, and for irrigation, municipal, and industrial uses in western Texas. It also provides for the delivery of surface water to the Republic of Mexico under the Convention of 1906. The RGP also provides hydropower generation as a secondary function.

Operation of the RGP involves four primary functions:

- Capture and storage of Rio Grande streamflow in Elephant Butte and Caballo Reservoirs;
- Allocation of RGP water to EBID, EPCWID, and Mexico;
- Release of RGP water to satisfy delivery orders from EBID, EPCWID, and the IBWC on behalf of Mexico; and
- Diversion of RGP water from the Rio Grande and delivery of RGP water to headings and municipal water treatment facilities for beneficial use.

The Rio Grande Compact contains a schedule for water that must be delivered by New Mexico to EBR every year. In addition, Reclamation allows storage of San Juan–Chama Project water in EBR currently under annual contracts with the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA).

Surface Water Supply

At the beginning of the calendar year and prior to the onset of the irrigation season, Reclamation determines the total water in RGP storage. Total storage includes annual Rio Grande Compact deliveries, which are comprised of any accumulated inflows, less evaporative losses. Reclamation then calculates the total usable RGP water by subtracting all non-RGP storage, including San Juan–Chama Project Water and Rio Grande Compact Credit Water, from the total water in storage.

In years when the total usable RGP water at the beginning of the calendar year is not sufficient to provide a full allocation, Reclamation reevaluates RGP storage each month during the irrigation season until a final allocation is determined. RGP releases, diversions, and deliveries depend on the usable water available to the RGP as well as water demands within the RGP, and are subject to limits specified by various statutory controls.

Allocation of Rio Grande Project Water

Reclamation allocates RGP water supplies such that the diversion allocations to EBID and EPCWID are proportionate to the district's respective acreages. EBID includes 90,640 acres authorized to receive RGP water in the Rincon and Mesilla Valleys of New Mexico, and EPCWID includes 69,010 acres authorized to receive RGP water in the Mesilla and El Paso Valleys of Texas; 57 percent of the acreage is in EBID, and 43 percent is in EPCWID.

The annual diversion allocation is the quantity of RGP water that is allocated each year for delivery to EBID, EPCWID, and Mexico at their respective diversion headings. The annual diversion allocation is calculated based on the amount of RGP water in storage available for release and the estimated amount of water available for diversion at river headings accounting for canal bypass, drainage return flows, and other inflows to the Rio Grande, between Caballo Dam and International Dam.

In addition to their allocations of surface water from the RGP, irrigators within EBID and EPCWID have historically relied on groundwater pumping for supplemental irrigation. It is widely recognized that groundwater pumping in the Rincon and Mesilla Valleys depletes RGP surface water supplies by increasing seepage losses from the Rio Grande and decreasing groundwater discharge to the Rio Grande and to the network of drains that extends throughout the RGP. The magnitude of surface water depletions due to groundwater pumping is currently being studied. While groundwater is used for supplemental irrigation in both EBID and EPCWID, estimates of pumping for irrigation within EBID are an order of magnitude larger than corresponding estimates for EPCWID.

To determine how to provide each district with its annual diversion allocation, EBID and EPCWID do most of the water monitoring in the river and water coming into the river from drains and other sources. These data are shared between parties and are used to schedule RGP orders, releases, and deliveries. Reclamation then executes the release determined by the districts. Under the Convention of 1906, the U.S. is obligated to deliver up to 60,000 acre-feet of water annually in a full allocation year. In drought years when the full allocation is not available, the allocation to Mexico is reduced in the same proportion as water delivered to U.S. district lands.

Release and Diversion of Rio Grande Project Water

Reclamation delivers water to each district's diversion headings based on their water orders. Each district then distributes water through its conveyance system to its water users for irrigation or municipal use. The two districts use RGP water to irrigate a variety of crops, including lettuce, chiles, onions, cotton, sorghum, and pecans. El Paso Water Utilities also receives RGP water under the 1920 Miscellaneous Purposes Act contracts, which allow irrigation water to be converted to municipal and industrial uses. El Paso Water Utilities receives this water through a contract with EPCWID. The City of El Paso also owns farmland with first class water rights, which it uses for municipal purposes (TWDB 2016).

Drainage and tailwater from RGP lands at the terminus of the RGP (the El Paso/Hudspeth County Line) provides supplemental water to 18,000 acres in the Hudspeth County Conservation and Reclamation District No. 1 (HCCRD) in Texas. Because HCCRD only receives seepage and drainage water from EPCWID and does not receive a direct allocation of RGP water, deliveries to HCCRD do not affect primary RGP operations.

The IBWC carries out and times the deliveries at the request of Mexico. RGP water allocated to Mexico under the Convention of 1906 is officially delivered in the bed of the Rio Grande at the point adjacent to the head works of the Acequia Madre in Ciudad

Juárez, about two miles downstream of the point where the river starts to form the international border.

1.4.2 Historic Operations

Project Initiation in 1979

From 1908 through 1979, Reclamation operated the RGP. Reclamation determined the annual allotment of RGP water per acre of authorized land and delivered the annual allotment to farm gates.

In 1937, Congress authorized the execution of amended repayment contracts with EBID and EPCWID. These contracts reduced the repayment obligations and established a corresponding right of use to a proportion of the annual water supply, based on an established irrigated acreage in each district: 57 percent to EBID and 43 percent to EPCWID.

The districts' amended repayment contracts also required three changes to occur in historical operations. First, once the two districts paid the total reimbursable costs for the RGP, they were required to take over the day-to-day responsibility for operating and maintaining the irrigation delivery and drainage system. Second, once this transfer of operation and maintenance occurred, Reclamation and the two districts were required to agree to and formalize a set of operating procedures that would govern the operations of those transferred project works. Third, on transfer, Reclamation would no longer calculate, allocate, and deliver water to project land; instead it would deliver an annual diversion allocation to each districts' headings.

In 1979, Reclamation contracted with EBID to assume responsibility for operating and maintaining the Percha, Leasburg, and Mesilla Diversion Dams in New Mexico. In 1980, Reclamation contracted with EPCWID to transfer operation and maintenance for the Riverside Diversion Dam (removed in 2003) and the distribution and downstream drainage system in Texas, which delivers tailwater to the HCCRD. Both contracts required Reclamation and the two districts to create a mutually agreeable "detailed operational plan…setting forth procedures for water delivery and accounting."

1980 to 2007

Beginning in 1980, Reclamation determined annual diversion allocations to each district and delivered water to the respective authorized points of diversion; the districts were then responsible for conveying water from the point of diversion to individual farm gates.

Until a mutually agreeable operations plan was in place, Reclamation imposed ad hoc operating procedures to govern operations. It modified these procedures as needed between 1980 and 2007. During that time, Reclamation calculated, allocated, and delivered each district's annual diversion allocation; however, it modified and optimized the methods, equations, and procedures according to real-time water conditions. The lack of an operations plan led to conflicts and litigation during this period.

1.4.3 2008 to Present

EBID, EPCWID, and Reclamation agreed to execute and implement the OA in 2008, as a settlement of the litigation then pending and filed by both districts. The three parties are the only signatories of the OA. The term of the resulting 2008 OA is from January 1, 2008, until December 31, 2050 (see **Appendix A**).

As a part of the OA, the three parties prepared the RGP Water Accounting and Operations Manual (Operations Manual; Reclamation 2012) that contains more detailed information regarding the methods, equations, and procedures that Reclamation, EPCWID, and EBID use to implement the OA. The Operations Manual is an addendum to the OA, is consistent with the OA, and does not modify the provisions in the OA. The parties to the agreement review the Operations Manual annually and most recently revised it in 2012; the current Operations Manual is provided as **Appendix B** of this EIS.

1.4.4 Principles Underlying the Operating Agreement

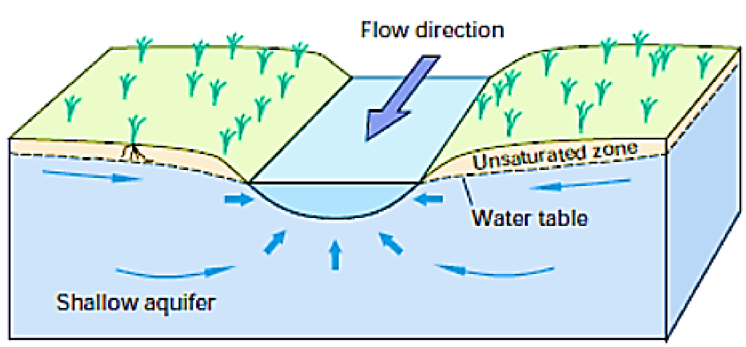
The provisions adopted in the OA for the Rio Grande Project reflect the parties' interest in the long-term sustainability of the RGP. These include Rio Grande surface waters and hydraulically connected groundwater in both New Mexico and Texas. Implementing the OA fulfills contractual obligations among Reclamation and the two irrigation districts and resolves litigation in compliance with the legal settlement (Reclamation 2013a).

Surface Water/Groundwater Interaction

The interaction between the surface water and groundwater is a critical factor in understanding the OA. Previous studies (Conover 1954; Haywood and Yager 2003; S. S. Papadopulos & Associates, Inc. 2007; Hanson et al. 2013) indicate a strong hydraulic connection between the Rio Grande and the underlying groundwater aquifers in the areas served by the RGP, particularly in the Rincon and Mesilla Basins. Groundwater recharge via seepage and deep percolation of RGP water will continue under the OA. In years when there is an increase in RGP allocation and delivery to EBID, there is a corresponding increase in recharge via seepage and deep percolation within EBID, as well as a decrease in demand for supplemental irrigation by groundwater pumping within EBID. Conversely, when the OA results in a decrease in allocation, recharge and deep percolation are likely to decrease, while demand for supplemental irrigation is likely to increase, which may result in increased groundwater pumping within the district, under permits issued by the State of New Mexico (Reclamation 2013b).

When groundwater elevations adjacent to the Rio Grande or a given drain segment are above the surface water elevation in the channel, the hydraulic gradient drives groundwater flows toward the channel (**Figure 1-2**).

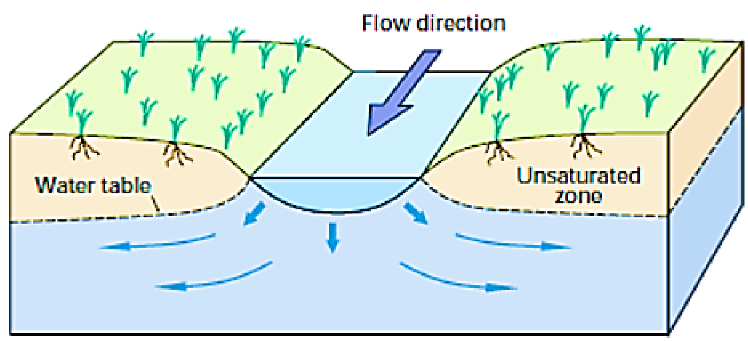
Figure 1-2. Gaining Stream



Gaining streams receive water from the groundwater system.

In this situation, groundwater discharge to the channel increases the available surface water supply. When groundwater elevations adjacent to the Rio Grande or a given drain segment are below the water elevation in the channel, the hydraulic gradient drives groundwater flow away from the river (**Figure 1-3**). In this situation, seepage from the channel into the underlying aquifer decreases the available surface water supply. In the event that groundwater elevations adjacent to a given channel segment fall substantially below the channel elevation, the channel may become hydraulically disconnected from the underlying aquifer (**Figure 1-4**); in this situation, seepage from the channel reaches a maximum rate and is no longer affected by fluctuations in groundwater elevation (Winter et al. 1998).

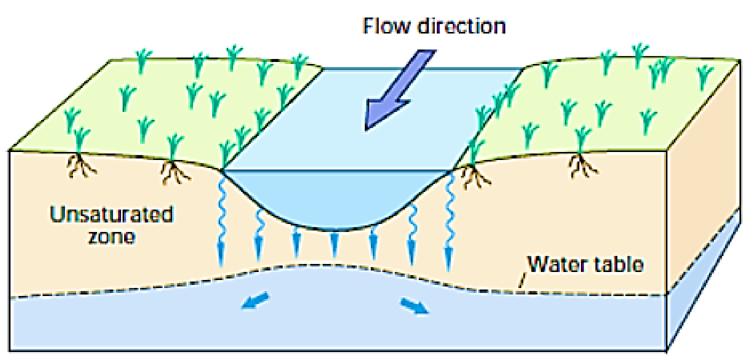
Figure 1-3. Losing Stream



Losing streams lose water to the groundwater system.

While numerous factors affect groundwater resources in the Rincon and Mesilla Valleys, groundwater pumping for supplemental irrigation is a primary driver of groundwater declines. In addition, irrigators within both the New Mexico and Texas portions of the RGP often supplement RGP surface water deliveries with groundwater from privately owned wells. Supplemental groundwater pumping is authorized and managed by the states, independently of the Federal Rio Grande Project, and is currently the subject of litigation in the U.S. Supreme Court.

Figure 1-4. Disconnected Stream



Disconnected streams are separated from the groundwater system by an unsaturated zone.

D-1 and D-2 Curves

The RGP serves irrigated lands in the Rincon, Mesilla and El Paso Valleys, as well as providing water to the City of El Paso for municipal and industrial uses. EBID provides water to 90,640 acres in the Rincon and Mesilla Valleys of New Mexico, and EPCWID provides water to 69,010 acres in the Mesilla and El Paso Valleys of Texas (**Figure 1-1**). Groundwater pumping in the El Paso Valley portion of EPCWID does not affect RGP deliveries (Reclamation 2015a). This is because the effects of pumping occur downstream of RGP diversion points. The OA represents mutually agreeable procedures for water delivery and accounting by Reclamation to satisfy objections by both EBID and EPCWID in how deliveries were provided starting in 1980. The D-1 and D-2 Curves used by Reclamation to determine annual RGP allocations represent the effects of inflows and losses within the RGP on historical RGP performance.

The D-1 and D-2 Curves were developed from operations data from 1951 to 1978. They reflect historical project performance during those years, including the effects of losses and inflows on project deliveries. The D-1 Curve is a linear regression equation that represents the historical relationship between the total annual release from RGP storage and the total project delivery to lands within the U.S., plus delivery in the bed of the river at the point adjacent to the head works of the Acequia Madre. The D-2 Curve is a linear regression equation that represents the historical relationship between the total annual release from project storage and the total project delivery to canal headings on the Rio Grande. It includes delivery to all authorized points of diversion for EBID, EPCWID, and Mexico.

Operations Manual

The OA represents a mutually agreeable solution to objections of both EPCWID and EBID. In addition, implementation of the OA is a result of settlement of litigation between Reclamation and the districts. An addendum to the OA is a written Operations Manual **(Appendix B)**, which describes the allocation provisions in the OA and RGP storage, release, and delivery.

The OA largely reflects historical operation of the RGP, with two key changes. First, the OA provides carryover accounting for any unused portion of the annual diversion allocations to EBID and EPCWID. Under historical operations prior to the OA, the unused portion of a district’s annual allocation balance contributed to the total amount of usable water available for allocation to both districts during the following year. As a result, a portion of one district’s unused allocation became part of the other district’s annual allocation the following year. Under the OA, any unused portion of the annual diversion allocations to EBID and EPCWID, based on a regression line reflecting past delivery performance, referred to as the D-2 Curve, is carried over to that district’s allocation balance the following year. The carryover provision of the OA is designed to encourage water conservation in the RGP by allowing each district to retain its unused allocation up to a specified limit.

Second, the OA adjusts the annual RGP allocations to EBID and EPCWID to account for changes in RGP performance, as characterized by its diversion ratio. The diversion ratio provision of the OA was developed to adjust the annual RGP allocation to EPCWID so as to provide RGP deliveries to the district consistent with historical operations, prior to substantial increases in groundwater pumping within EBID and corresponding decreases in RGP performance that has occurred. The annual RGP allocation to EBID is then adjusted to reflect current-year RGP performance as represented by the diversion ratio. When the diversion ratio is high, EBID generally receives an increase in allocation compared to historical RGP performance; when the diversion ratio is low, EBID generally receives a decrease in RGP allocation compared to historical RGP performance.

While numerous factors affect RGP performance, recent changes in performance are predominantly driven by the actions of individual landowners within the EBID service area. These changes are as follows:

- Crop selection and related effects on crop irrigation requirement
- Irrigation practices and related effects on farm irrigation efficiency
- Widespread use of groundwater for supplemental irrigation, as permitted and regulated by the State of New Mexico

The diversion ratio provision of the OA ensures that annual allocations and deliveries to EPCWID are consistent with historical performance. Moreover, it ensures that deviations in performance relative to historical conditions would be accounted for by adjusting the annual allocation to EBID.

Under the diversion ratio provision, the annual project allocation to EPCWID is equal to the district's historical diversion allocation, based on a regression line reflecting past delivery performance, as defined by the D-2 Curve (see **Section 2.5 of Appendix A**). The annual allocation to EBID is adjusted to reflect current year (actual) project performance, as reflected by the project diversion ratio. When the diversion ratio is high, relative to the baseline delivery performance defined by the D-2 Curve, EBID generally receives an increase in annual allocation, compared to its diversion allocation under prior operating practices; when the diversion ratio is low, relative to the D-2 Curve baseline, EBID generally receives a decrease in project allocation, compared to prior operating practices.

1.4.5 Ongoing Litigation

The OA is a result of settlement of litigation between Reclamation and the districts. After the OA was signed, the New Mexico Attorney General filed a complaint against Reclamation, seeking to stop it from implementing the OA. The subject of the complaint was RGP water allocations under the OA and the calculation of Rio Grande Compact credit waters.

In 2013, the State of Texas filed a complaint with the U.S. Supreme Court asking it to command New Mexico to deliver water apportioned to Texas under the 1938 Rio Grande Compact. Texas alleges that New Mexico is illegally allowing diversions of both surface water and groundwater hydrologically connected to the Rio Grande downstream of Elephant Butte. Texas is concerned that New Mexico's challenge to the OA could impact Rio Grande Compact compliance and RGP operations.

1.5 San Juan–Chama Project Water Storage

In addition to evaluating the long-term impacts of the OA, this EIS evaluates the environmental effects of continuing contract(s) for storing San Juan–Chama Project water in EBR, under the authority of the Act of December 29, 1981, Public Law 97-140, 95 Stat. 1717.

The San Juan–Chama Project was authorized as a participating project of the Colorado River Storage Project Act of April 11, 1956 (Ch. 203, 70 Stat. 105); it was specifically authorized by the Act of June 13, 1962 (Public Law 87-483, 76 Stat. 96). It consists of a system of diversion structures, trans-basin tunnels, and a storage reservoir to transfer water from the San Juan River in the Colorado River Basin to the Rio Chama in the Rio Grande Basin.

The San Juan–Chama Project diversion and storage facilities were created in 1971 and limited under statute to provide a firm yield of 96,200 acre-feet per year of water to San Juan–Chama Project contractors. The water is for supplemental irrigation and domestic, municipal, and industrial uses. Delivery of this water provides incidental recreation and fish and wildlife benefits in New Mexico's middle Rio Grande Valley. San Juan–Chama Project repayment contractors receive their annual water allocations with no provisions for carryover; therefore, these contractors can benefit by storing unused annual allocations in EBR for future use.

1.6 NEPA Analyses

1.6.1 Operating Agreement

Two NEPA documents were prepared for the OA before this EIS. In 2007, Reclamation prepared an environmental assessment (EA) to evaluate the effects of the OA through 2012. This EA committed Reclamation to gather data over the first five years of implementation to support future evaluation of effects on the environment (Reclamation 2007).

In 2013, Reclamation supplemented the 2007 EA (Reclamation 2007) to evaluate the effects of the OA for a 3-year period. This SEA was initially intended to analyze the potential impacts of implementing the OA through 2050. However, given the uncertainties of persisting drought conditions and the need to improve the analytical tools, Reclamation determined that analysis of a longer period would have been of limited use (Reclamation 2013a, 2013b).

In 2013, Reclamation began the development and refinement of modeling tools to thoroughly analyze the implementation of the OA over its remaining life and to document the information in this EIS.

1.6.2 San Juan–Chama Storage

In 2010, Reclamation prepared an EA for a 40-year replacement contract for storing ABCWUA San Juan–Chama Project water in the EBR. The contract was never implemented. Also, since the Final EA was issued, new information is available that renders the associated Finding of No Significant Impact obsolete; therefore, the Finding of No Significant Impact has been rescinded. The proposed action of issuing a contract is analyzed through 2050 in the context of this EIS.

Since 2010, Reclamation has been executing an annual contract with the ABCWUA to store up to 50,000 acre-feet of San Juan–Chama Project water in EBR, covered by a categorical exclusion. Once stored, San Juan–Chama Project water is not included in the total RGP storage but is maintained as a separate pool until exchanged upstream.

1.7 Proposed Action

Reclamation is proposing to continue implementing the 2008 OA for the RGP for its remaining term, through 2050. It is proposing a potentially similar action, under 40 CFR 1508.25, to implement long-term contracts for storing San Juan–Chama Project water in the EBR. The proposed action and alternatives are discussed in detail in **Chapter 2**, Alternatives, of this document.

1.8 Purpose and Need for Action

1.8.1 Operating Agreement

The purpose for action is to meet contractual obligations to EBID and EPCWID and comply with applicable law governing water allocation, delivery, and accounting. These obligations are currently fulfilled under the 2008 OA. The need for action is to resolve the long and litigious history of the RGP and enter into mutually agreeable, detailed operational criteria. The OA consists of a written set of criteria and procedures for allocating, delivering, and accounting for RGP water to both districts by Reclamation consistent with the Convention of 1906, the Rio Grande Compact, and other applicable law, and in compliance with various court decrees, settlement agreements, and contracts (**see Section 3.5.1**). These include the 2008 Compromise and Settlement Agreement among Reclamation, EBID, and EPCWID and contracts between the U.S. and EBID and EPCWID.

1.8.2 San Juan–Chama Project Storage

The purpose for a related action is to respond to a request to allow for a multiyear storage contract of San Juan–Chama Project water in EBR in accordance with the Act of December 29, 1981, Public Law 97-140.

1.9 Federal Decisions to Be Made

1.9.1 Whether to Continue to Implement the OA through 2050

The Federal decision is to determine whether to continue to meet contractual obligations to EBID and EPCWID using the OA through 2050. These obligations are for allocating, delivering, and accounting for RGP water in compliance with various court decrees, settlement agreements, and contracts. Reclamation will use the analysis in the EIS to select the preferred alternative and to prepare a Record of Decision on the continued implementation of the OA over the remaining term of the agreement. In evaluating the alternatives, Reclamation will consider whether the alternative:

- Meets the need to have a formal detailed operational plan, as required by the amended repayment contracts governing the operations of transferred RGP facilities.
- Provides a written set of procedures defining the allocation of RGP water to both districts, consistent with their rights under applicable law, with which both districts agree, and which can only be changed with the unanimous consent of the districts and Reclamation.
- Provides procedures that are consistent with Federal law and other existing agreements, including the Rio Grande Compact and Convention of 1906.
- Provides procedures that reflect the parties' interest in the long-term sustainability of the RGP and conservation of related resources, which include Rio Grande surface waters and hydraulically connected groundwater in New Mexico and Texas.
- Provides procedures that comply with environmental laws and do not contribute to any environmental violation or cause the RGP to not conform to applicable Federal, state, or local law, regulation, or standard, such as a Federal water quality standard.
- Provides procedures that would not result in the permanent degradation or loss of native vegetation communities, jurisdictional wetlands, or important wildlife habitat or jeopardize the continued existence of a listed species or adversely modify designated critical habitat under the Endangered Species Act (ESA) of 1973.
- Provides procedures that would not result in a predicted substantial deviation from historical water quantities or qualities, as evidenced by marked changes in RGP supplies, allocations, releases or quality of regulated water, such as drinking water.
- Provides procedures that would not result in adverse effects on historic properties or traditional cultural properties.
- Provides procedures that would not negatively affect public health, alter regional economics or recreational opportunities, or result in a disproportionately high and adverse human health or environmental effect on low-income or minority populations.

1.9.2 Whether to Store San Juan–Chama Project Water in Elephant Butte Reservoir for Multiple Years

Reclamation will also determine whether, and if so how, to implement a multiyear contract covering the remaining term of the OA for storing San Juan–Chama Project water in EBR. Reclamation will use the analysis in the EIS to select the preferred alternative and to prepare a Record of Decision for storing San Juan–Chama Project water in EBR. The following factors will be considered in evaluating each alternative:

- Whether it meets the need to implement provisions of the Act of December 29, 1981, Public Law 97-140

- Whether storage under a multiyear contract would continue to be consistent with RGP operations, Federal law, and other existing agreements
- Whether storage under a multiyear contract would continue to be consistent with compliance with environmental laws or would contribute to any environmental violation or not conform to applicable Federal, state, or local law, regulation, or standard
- Whether storage under a multiyear contract meets the ABCWUA's ongoing need for storage in EBR because available storage in upstream reservoirs is limited and continuing this storage allows the ABCWUA to take delivery of water that they otherwise could not

1.10 Description of the Area of Analysis

The area of analysis includes the RGP, which extends from the San Marcial Railroad Bridge above EBR in New Mexico to the El Paso/Hudspeth County Line in Texas (see **Figure 1-1**). Facilities and distribution infrastructure of the RGP are owned and operated by Reclamation as well as other multiple entities. The RGP includes the water retention and conveyance facilities and the operations that have been developed over the last century. The ongoing Federal action that is the subject of this EIS is to consider alternatives for allocating, delivering, and accounting for RGP water and a contract for storing San Juan–Chama Project water in EBR. This continuing Federal action is implemented entirely within the larger geographic context of the established RGP facilities and operations.

The area of analysis for the OA and EBR storage is relatively limited within the broader RGP geographic area and varies by resource and resource issues, as described in **Chapter 3**.

In addition to assessing the direct and indirect impacts of continuing to implement the OA, this EIS details the potential cumulative effects of the proposed action with other past, present, and reasonably foreseeable actions that the OA may impact. More details on the cumulative effects approach is provided in **Chapter 4**.

1.11 Compliance with Other Applicable Authorities

In addition to meeting the requirements of NEPA, the EIS must also document compliance with related environmental laws and regulations, as applicable:

- ESA
- National Historic Preservation Act (NHPA)
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

- Executive Order 13112, Invasive Species
- Executive Order 13175, Tribal Consultation

The CEQ's regulations for implementing NEPA require consideration of the relationship of the project and its impacts on other area projects and activities. Connected actions, as defined in 40 CFR 1508.25(a)(1), are those actions that are interrelated with the project and should be discussed in the same EIS. Similar actions, as defined in 40 CFR 1508.25(a)(3), are those actions that, when viewed with the project, have similarities to the project, such as common timing or geography that provide a basis for evaluation together. The effects and results of these actions were considered when evaluating existing conditions and analyzing alternatives. In accordance with 40 CFR 1508.25(a)(3), the analysis of a long-term contract for storing San Juan–Chama Project water in EBR is a potentially similar action sharing both common timing or geography with the OA.

1.12 Public Involvement

Public involvement is a vital part of the EIS process. It provides an opportunity for those affected by project actions to take part in the decision-making process and facilitates full environmental disclosure. Guidance for implementing public involvement under NEPA is codified in 40 CFR 1506.6, and 43 CFR 46, ensuring that Federal agencies make a diligent effort to involve the public in the NEPA process.

Public involvement is being conducted throughout the course of the EIS process; the public has specific opportunities to comment during two phases:

- Public scoping before NEPA analysis begins, to determine the scope of issues and alternatives to be addressed in the EIS; this phase occurred during the 30-day January 15 to February 14, 2014, scoping period and is summarized in a scoping report published on July 31, 2014
- Public review of and comment on this Draft EIS (March through May 2016)

Public outreach during the public scoping period included the following:

- Publishing a notice of intent to prepare the EIS in the *Federal Register* (Vol. 79, No. 10) on January 15, 2014
- Placing newspaper advertisements in the *Santa Fe New Mexican* on January 27 and 28, 2014, the *Albuquerque Journal* on January 26, 2014, the *Las Cruces Sun News* on January 26, 2014, and the *El Paso Times* on January 26, 2014
- Announcing the public scoping meetings via Reclamation's social media sites and the project website (http://www.usbr.gov/uc/albuq/rm/RGP/)

Scoping meetings were held on both weekday and weekend dates and during both daytime and evening. Reclamation held three public scoping meetings at each of the following locations:

- Thursday, January 30, 2014, 3:00 p.m. to 5:00 p.m.—Bureau of Reclamation, Albuquerque Area Office, 555 Broadway NE, Suite 100, Albuquerque, New Mexico
- Friday, January 31, 2014, 6:00 p.m. to 8:00 p.m.—Elephant Butte Irrigation District, 530 South Melendres Street, Las Cruces, New Mexico
- Saturday, February 1, 2014, 9:00 a.m. to 11:00 a.m.—Bureau of Reclamation, El Paso Field Division, 10737 Gateway West, Suite 350, El Paso, Texas

Reclamation staff conducted the meetings, prepared the handouts, and answered questions. Attending the Albuquerque and Las Cruces meetings were primarily representatives of government agencies, but only Reclamation staff attended the meeting in El Paso.

Two comment letters were received during the process, one from the New Mexico Interstate Stream Commission and the other from the City of Las Cruces. More information on the scoping process, including comments received, may be found in the NEPA Scoping Summary Report (Reclamation 2014), which is also available on the project website (http://www.usbr.gov/uc/albuq/rm/RGP/). Reclamation took these comments into consideration in developing the EIS and incorporated this feedback as appropriate, during alternatives development, modeling, and impact analysis.

1.13 Key Issues

Key issues were identified from the SEA prepared for the OA (Reclamation 2013a) and comments received during scoping for the EIS (which can be found in the project scoping report; Reclamation 2014). Key issues were also identified from internal scoping and outreach to Federal, state, and local agencies and tribal governments.

Reclamation has identified and addressed the following resource issues in this EIS.

Aquatic Resources, Vegetation Communities, and Wildlife

- Aquatic resources—Special status fish and reservoir fisheries
- Vegetation communities—Special status plants, habitat supporting special status species, and invasive plants
- Wildlife—Special status species, wildlife habitat, and other wildlife

Analysis of the effects of the alternatives on aquatic resources, vegetation communities, and wildlife are found in Sections 4.9, 4.7, and 4.8, respectively. To comply with ESA Section 7(a)(2), Reclamation submitted a biological assessment (Reclamation 2015b) to the U.S. Fish and Wildlife Service (Service) on August 20, 2015, to address the potential effects of continuing to implement the OA and storing San Juan-Chama Project water in Elephant Butte Reservoir. The biological assessment analyzes impacts on the Southwestern willow flycatcher (*Empidonax traillii extimus*), the Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), and the Rio Grande silvery minnow (*Hybognathus amarus*). The Service prepared a biological opinion on effects of actions associated with the proposed continuation of the RGP OA and storage of San Juan-Chama Project water in EBR, New Mexico, on January 21, 2016. In a memorandum dated February 19, 2016, Reclamation requested an extension until March 22, 2016, to complete the review.

Water Resources

- Water Resources—Climate change, RGP supply and storage, San Juan–Chama Project storage, EBR levels, total allocations, EBID and EPCWID allocations, RGP water releases, farm surface deliveries to users, and groundwater elevations, pumping, and water quality

Analysis of the effects of the alternatives on surface water, groundwater, and water quality are found in Sections 4.4, 4.5, and 4.6, respectively. Reclamation, in collaboration with the U.S. Geological Survey, developed a detailed hydrologic model of the Rincon and Mesilla Basins, the Rincon and Mesilla Basin Hydrologic Model (RMBHM), and used this model to simulate operations under the alternatives and corresponding surface water and groundwater conditions in the basins.

Environmental Justice and Socioeconomics

- Environmental justice – Effects on minority or low-income populations
- Socioeconomics—The economic value of agricultural water use, urban water use, recreation, and hydropower generation, regional employment, income, and sales

Analysis of the effects of the alternatives on environmental justice and socioeconomics are found in Sections 4.13 and 4.12, respectively. There would be no disproportionately high or adverse effects on minority or low-income populations. For the socioeconomic analysis, outcomes from the RMBHM modeling are used to calculate net economic benefits, and the IMpact analysis for PLANning (IMPLAN) modeling package is used to assess regional economic impact for each alternative.

Cultural Resources

- Cultural resources—Archaeological sites, historic structures, and traditional cultural properties

Analysis of the effects of the alternatives on cultural resources is found in Section 4.10. To address requirements of Section 106 of the NHPA, Reclamation submitted documentation to the New Mexico State Historic Preservation Officer (SHPO) on October 29, 2015, requesting concurrence on the determination that there would be no adverse effects on historic properties from the federal action. Reclamation received the SHPO's concurrence on November 25, 2015.

Indian Trust Assets

- Indian Trust Assets

Analysis of the effects of the alternatives on Indian Trust Assets is found in Section 4.11. In accordance with Executive Order 13175, Reclamation sent letters on June 24, 2014, requesting input for preparation of the EIS to the two tribes that requested consultation during the preparation of the SEA: the Ysleta del Sur Pueblo in Texas and the Mescalero Apache Tribe in New Mexico. Only the Mescalero Apache Tribe offered comments in response to Reclamation's scoping letter on the SEA. Reclamation intends to honor the Mescalero Apache Tribe's response to the SEA in this EIS.

Other key issues considered included the effect of climate change on RGP supply. The OA is a result of settlement of litigation between Reclamation and the districts, and this constraint is considered in this EIS.

2. Alternatives

2.1 Introduction

This chapter describes and compares the alternatives considered for implementing the 2008 RGP OA over its remaining term (through 2050). It also describes and compares the alternatives considered for implementing long-term contract(s) for storing San Juan–Chama Project water in EBR.

The alternatives development process incorporates a number of guiding principles, as provided by relevant laws and guidance. These are the CEQ's Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508), and U.S. Department of the Interior's NEPA Regulations (43 CFR 46).

Alternatives development is the heart of the EIS process, and NEPA regulations require agencies to adhere to the following:

- Rigorously explore all reasonable alternatives that meet the purpose of and need for the proposed action and, for alternatives that were eliminated from detailed study, briefly discuss the reasons for elimination
- Include reasonable alternatives not within the jurisdiction of the lead agency
- Include a no action alternative
- Identify the agency's preferred alternative (or alternatives, if one or more exists) in the draft EIS and identify such alternative in the final EIS (40 CFR 1502.14 and 43 CFR 46.415[b])

Collaboration is a critical component of the alternatives development process. Agencies should seek agreement from diverse interests on the goals, purposes, and needs for agency plans and activities, as well as the methods anticipated to carry out those plans and activities (43 CFR 46.110[a]). Reclamation used public scoping to help identify issues and concerns that could be addressed through alternative actions. Additionally, it coordinated with cooperating agencies in developing the alternatives.

2.2 Alternatives Development Process

The formulation of alternatives for this EIS began in the fall of 2014 and continued through early 2015. Reclamation compiled information gathered during scoping (Reclamation 2014). Some comments beyond the scope of NEPA, outside of the scope of the proposed project, outside of the affected area, or not related to the matter at hand, are not addressed in the EIS. Reclamation did receive suggestions for alternatives during scoping, and these were incorporated during the alternatives development process.

A key step in the alternatives development process was presenting a workshop on November 4, 2014, at the Reclamation office in El Paso, Texas. Reclamation staff, contractors, and representatives of the cooperating agencies—EBID, EPCWID, IBWC, the City of Santa Fe, and the Rio Grande Compact Commission's Texas Commissioner—participated in the workshop in person or remotely.

The participants reviewed and discussed the EIS purpose and need statement to assess where there was discretion for considering alternatives to current practices. The workshop included facilitated discussions of the No Action Alternative and a review and screening exercise of alternatives and alternatives elements that were proposed by the workshop participants or were compiled from scoping. The screening process helped to define those issues that were within the scope of NEPA and relevant to proposed action. It also clarified the difference between annual implementation of the Operations Manual and the overall water supply allocation process described in the OA.

Reclamation reviewed the output of the screening exercise and outlined the elements of the alternatives to be carried forward for further review and discussion. The agency determined that, under NEPA, the No Action Alternative should reflect current operating procedures under the OA. Current operations are conducted in accordance with the OA and the compromise and settlement agreement among the United States, EBID, and EPCWID (Settlement Agreement 2008). Reclamation also determined that the carryover provision and the diversion ratio adjustment were the two key elements in the OA that were the basis of the settlement agreement and represented variables for comparing alternatives.

The alternatives considered for detailed study were simulated using Reclamation's modeling tools that were developed to analyze the implementation of the OA over its remaining life. A description of the modeling methods used to simulate the effects of each alternative is found in **Chapter 4, Table 4-1** and in **Appendix C**, Hydrology Technical Memo (Reclamation 2015).

The variation and range of the alternatives includes exclusion or inclusion of San Juan–Chama Project water storage; the carryover provision; and diversion ratio adjustment. EIS alternatives were developed to analyze the differences, if any, between the two key elements in the OA (Alternatives 3 and 4) and the difference between operations prior to 2008 (Alternative 5) and the OA (Alternatives 1 and 2). Under the No Action Alternative, Reclamation would continue implementing the procedures defined in the OA from 2016 to 2050, while allowing storage, on request, of up to 50,000 acre-feet per year (AFY) of San Juan–Chama Project water in EBR, if space is available. Alternative 2 shows the effects of the OA without San Juan–Chama Project storage.

2.3 Description of Alternatives

The alternatives were derived from the methods, equations, and procedures that Reclamation, EBID, and EPCWID use in determining the annual diversion allocation and water accounting for the RGP. They represent consideration of a range of operating procedures based on current practices under the OA and the ongoing storage of San Juan–Chama Project water in EBR.

Below are descriptions of the final alternatives considered for detailed study:

Alternative 1—No Action Alternative

- Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations
- Continue to implement the carryover accounting provisions of the OA, which allows carryover of unused allotment balance from one year to the next
- Continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR

The No Action Alternative is the continued implementation through 2050 of the operating procedures defined in the OA and RGP Operations Manual, as amended for any given year (**Appendices A** and **B**, respectively). Under these operating procedures, the carryover accounting and the diversion ratio provisions would continue.

Under the No Action Alternative, Reclamation would execute a multiyear contract through 2050 with the ABCWUA to store up to 50,000 AFY of San Juan–Chama Project water in EBR.

Alternative 2—No San Juan–Chama Project Storage

- Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations
- Continue to implement the carryover accounting provisions of the OA, which allows carryover of unused allotment balance from one year to the next
- Do not store San Juan–Chama Project water in EBR

Alternative 2 is the same as Alternative 1 (No Action Alternative), except Reclamation would not continue with contracts to store up to 50,000 AFY of San Juan–Chama Project water in EBR.

Alternative 3—No Carryover Provision

- Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations
- Do not implement the carryover accounting provisions of the OA
- Eliminate the carryover allocations and relinquish the unused allotment balance at the end of each calendar year
- Continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR

Alternative 3 is the same as Alternative 1 (No Action Alternative), except Reclamation would not continue to implement the carryover accounting provisions of the OA. Alternative 3 would allow Reclamation to model and determine the effects of the carryover provision.

Alternative 4—No Diversion Ratio Adjustment

- Do not implement the diversion ratio adjustment provision of the OA
- Compute annual diversion allocations based only on the D-1 and D-2 regression equations without adjusting for variations in RGP performance
- Continue to implement the carryover accounting provisions of the OA, which allows carryover of unused allotment balance from one year to the next
- Continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR

Alternative 4 is the same as Alternative 1 (No Action Alternative), except Reclamation would not implement the diversion ratio adjustment provision of the OA. Alternative 4 would allow Reclamation to model and determine the effects of the diversion ratio adjustment provision.

Alternative 5—Prior Operating (Ad Hoc) Practices

- Do not implement the diversion ratio adjustment provision of the OA
- Compute annual diversion allocations based only on regression equations that reflect historical conditions and RGP performance, without adjusting for variations in RGP performance
- Do not implement the carryover accounting provisions of the OA
- Eliminate the carryover allocations and relinquish the unused allotment balance at the end of each calendar year
- Continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR

Alternative 5 would allow a comparison through 2050 of operations under the OA and a simulation of procedures prior to the OA by eliminating the carryover and diversion ratio adjustment provisions. Alternative 5 is the best possible representation of prior operating practices in a modeling context, but it is not the same as historical operations. This is because it does not include the ad hoc adjustments and is based on strict application of the D-1 and D-2 Curves.

Table 2-1 highlights the differences among alternatives selected for study in this EIS.

Table 2-1. Comparison of Key Elements of the Alternatives

Alternative	Continue Diversion Ratio Adjustment	Continue Carryover Accounting	Continue Storage Of San Juan–Chama Project Water
1	●	●	●
2	●	●	
3	●		●
4		●	●
5			●

Because they are not part of the OA, the alternatives do not include the following:

- Direct changes to the dams, storage facilities, the power generating plant, diversion facilities, and delivery points
- Negation of obligations under the Convention of 1906 and the Rio Grande Compact or compliance with various court decrees, settlement agreements, and contracts
- Construction of new facilities or other actions that are physically different or that exceed the bounds of historic operations within the RGP; the basic operation of dams and other RGP facilities, the maximum pool of the reservoirs, and channel capacity under the alternatives would remain within the range of current and historic RGP operations
- Change to the diversion points (Percha, Leasburg, Mesilla, and American diversion dams) for delivery of RGP water to the districts and the IBWC for Mexico

The final alternatives identified two operational changes included in the OA and provide for separate analysis of the carryover provision and diversion ratio adjustment described below in **Section 2.3.1**. The range of alternatives is designed to determine whether either of these changes or the OA as a whole would result in particular impacts when simulated using Reclamation's hydrology model. The range of alternatives includes one that considers the exclusion of San Juan–Chama Project water storage in EBR to determine the effects of the proposed contract(s).

This EIS No Action Alternative differs from the No Action Alternative analyzed in the SEA for the OA in 2013 (Reclamation 2013). In the 2007 EA the No Action Alternative was considered to be a return to pre-OA operations without the carryover provision and diversion ratio adjustment (Reclamation 2007). Therefore, the SEA (Reclamation 2013) considered the same No Action Alternative. In this EIS, Alternative 1 (No Action Alternative) is the continuation of operations under the OA.

Continuing to implement the OA is also part of the legal settlement of litigation. Since 1979 and 1980, Reclamation, EBID, and EPCWID have had contractual obligations to agree on a detailed operational plan, setting forth procedures for allocation, delivery, and accounting of RGP water. This need was finally satisfied in 2008, when the three parties entered into the 2008 settlement agreement, which required implementing the OA and the Operations Manual. Alternative 1 represents the status quo operational procedures in place since 2008 and an existing agreement among the parties to continue implementing the OA through 2050. The No Action Alternative for the EIS is also the Proposed Action because it would continue to maintain the settlement.

In this EIS, the No Action Alternative that was considered in the SEA is analyzed as Alternative 5 (Prior Operating [Ad Hoc] Practices). It simulates procedures prior to the OA by eliminating the carryover accounting and the diversion ratio adjustment provisions but it is not exactly the same as historical operations. This is because it does not include the ad hoc adjustments and is based on strict application of the D-1 and D-2 Curves.

Alternative 5 responds to scoping input for analyzing the pre-OA operating procedures. However, it would not satisfy the purpose and need for action, which require the development of operating procedures to govern the operations of the RGP (Reclamation 2014). Implementing this alternative would also breach the settlement agreement among the U.S., EBID, and EPCWID.

The No Action Alternative carried forward in the EIS includes consideration of a multiyear San Juan–Chama Project storage contract in lieu of annual contracts.

2.3.1 Operating Agreement Description

The RGP operating procedures are defined in the OA and the corresponding RGP Operations Manual, as amended, for any given year (**Appendices A** and **B**, respectively). General procedures for allocating RGP water under the OA are found in the text of the OA; the details of data, inputs, and calculations used in the allocation procedure are described in **Table 4** of the OA (**Appendix A**). Additional details on allocation calculations are provided in the RGP Operations Manual (**Appendix B**). The allocation committee, consisting of representatives of EBID, EPCWID, and Reclamation, reviews the RGP Operations Manual annually. The manual was last updated in 2012 to clarify calculations used in the allocation procedure and to optimize operations.

Reclamation stores, allocates, releases, and delivers RGP water for authorized uses in the U.S. and for delivery to Mexico. The agency determines annual RGP allocations based on the usable water in RGP storage available for release during the current year. This includes usable water in storage at the start of the year. Added to this is any usable water that becomes available during the year as inflow to RGP storage or as relinquishment of credit waters.

Annual diversion allocations to EBID, EPCWID, and Mexico are based on two linear regression relationships between RGP releases and RGP deliveries, referred to as the D-1 and D-2 Curves. The D-1 Curve is a linear regression equation that represents the historical relationship between the total annual release from RGP storage and the total RGP delivery to lands of the U.S. plus the quantity of the water delivered to the heading of the Acequia Madre. The D-2 Curve is a linear regression equation that represents the historical relationship between the total annual release from RGP storage and the total RGP delivery to canal headings on the Rio Grande. This includes delivery to all authorized points of diversion for EBID and EPCWID, and for diversion to Mexico. The D-1 and D-2 Curves reflect historical RGP performance from 1951 to 1978, including the effects of losses and inflows on RGP deliveries.

Reclamation and the IBWC developed the D-1 Curve in 1980 to calculate the annual allocation to Mexico when less than a full supply is available. In accordance with the Convention of 1906, the annual RGP allocation to Mexico is 60,000 AFY, except in years of “extraordinary drought or serious accident to the [U.S.] irrigation system.”

Under these conditions, Mexico's full allocation would be reduced in the same proportion as the RGP delivery to the U.S. If such were to happen, the annual allocation to Mexico would be equal to 11.3486 percent of the sum of the quantity of RGP water delivered to lands of the U.S., plus the quantity of RGP water delivered to the heading of the Acequia Madre for diversion by Mexico. The water is officially delivered in the bed of the Rio Grande at the point adjacent to the head works of the Acequia Madre, in cooperation with the IBWC.

The D-2 Curve represents the total (gross) amount of water available for diversion from the Rio Grande by EBID, EPCWID, and Mexico during that year under historical RGP performance conditions. The amount of water available for diversion in the United States by EBID and EPCWID would be determined by subtracting the annual allocation to Mexico from the total volume of water available for diversion during the year, as calculated by the D-2 Curve. EBID would then be allocated $88/155^{ths}$ (57 percent) of the volume of water available for diversion, and EPCWID would be allocated $67/155^{ths}$ (43 percent).

The annual diversion allocations to Mexico, EBID, and EPCWID would continue to be based on the D-1 and D-2 Curves; RGP releases would be scheduled and managed to meet delivery orders submitted by EBID, EPCWID, and IBWC on behalf of Mexico.

Key elements of the allocation calculations that were implemented in the OA are the carryover provision and the diversion ratio adjustment.

Carryover Provision

The carryover provision of the OA provides for carryover accounting for the unused allocation balances remaining on EBID's and EPCWID's respective RGP water accounts at the end of each year. If either district does not use all of its total diversion allocation during a given year, the quantity of water that would have been released from RGP storage to satisfy the unused portion of the district's allocation instead would remain in storage at the end of the year.

Each district may accrue and maintain carryover balance for any period of years and in any amount up to 60 percent of its respective full annual allocation under the OA. EBID, therefore, may accrue carryover balance up to a limit of 305,918 acre-feet, and EPCWID may accrue carryover balance up to 232,915 acre-feet. In the event that either district accrues carryover balance in excess of their respective limit, the excess balance would be transferred to the other district's RGP water account. In the event that both districts' carryover balances exceed their respective limits, excess carryover balance from both districts would revert to the RGP.

The carryover provision of the OA does not affect the procedure used to determine the annual RGP allocation to Mexico. In accordance with the Convention of 1906, the allocation to Mexico would be 60,000 AFY, except in years of "extraordinary drought or serious accident to the [U.S.] irrigation system." During extraordinary droughts, the annual allocation to Mexico would be determined based on the total annual delivery to headings within EBID and EPCWID, plus total deliveries to the heading of the Acequia Madre, as calculated using the D-1 Curve.

Diversion Ratio Adjustment

The diversion ratio represents the amount of diversion allocation that is used per unit release of RGP water from the Caballo Dam. It is a measure of RGP performance in meeting delivery obligations to EBID, EPCWID, and Mexico. The OA provides the method for determining the initial annual diversion allocations to EBID and EPCWID. It also includes the methods for adjusting these allocations based on RGP performance, as measured by the diversion ratio. Changes in RGP performance are predominantly driven by the actions of individual landowners in EBID. These actions are as follows:

- Crop selection and related effects on crop irrigation requirement
- Irrigation practices and related effects on farm irrigation efficiency
- Widespread use of groundwater for supplemental irrigation, as permitted and regulated by the State of New Mexico

Reclamation uses the diversion ratio to calculate the diversion ratio adjustment, which it uses to adjust allocations to EBID and EPCWID. This is done to account for the effects of groundwater and surface water conjunctive use, by irrigators in the Rincon and Mesilla Basins, on current year RGP performance, as characterized by the RGP diversion ratio. The diversion ratio adjustment ensures that the annual RGP allocation to EPCWID is consistent with historical RGP performance, as characterized by the D-2 Curve. It also ensures that deviations in RGP performance are accounted for by adjusting the annual RGP allocation to EBID.

Calculating annual allocations to EBID and EPCWID under the OA involves additional adjustments under some conditions. A positive adjustment (increase) is applied to both districts' allocations when the usable water available for current-year allocation is greater than 600,000 acre-feet and current (actual) RGP performance exceeds the historical D-2 baseline. A negative adjustment (decrease) is applied to both districts' allocations during extreme droughts. These are defined as consecutive years where RGP releases are below 400,000 AFY.

The OA implemented a minor modification to the application of the D-2 Curve. The 763,842 acre-feet for a full allocation release was increased to 790,000 AFY as specified as the normal release in the Rio Grande Compact.

2.4 San Juan–Chama Storage

This EIS analyzes storing San Juan–Chama Project water in the EBR, which is a separate activity than the OA. The ABCWUA is seeking a multiyear contract for storage of up to 50,000 AFY of San Juan–Chama Project water in EBR through 2050.

2.5 Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required to rigorously explore and objectively evaluate all reasonable alternatives and to discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). As stated above, some comments beyond the scope of NEPA, outside of the scope of the proposed project, outside of the affected area, or not related to the matter at hand were not addressed in the EIS. Reclamation did receive suggestions for alternatives during scoping, and these were incorporated during the alternatives development process.

As described in **Section 2.2**, issues identified by scoping and through the alternatives development process were considered and screened systematically. The resulting final alternatives incorporated elements that could be modeled and consistently compared. The final alternatives identified the two operational changes that were made in the OA for separate analysis. The range of alternatives was designed to determine whether either of these changes or the OA as a whole would result in particular impacts. The variation in alternatives also considers the exclusion of San Juan–Chama Project water storage in EBR (Alternative 2).

As an example of incorporating alternatives outside the scope of the proposed project based on scoping input (Reclamation 2014), Alternative 5, Prior Operating (Ad Hoc) Practices, is analyzed and takes into consideration suggested alternative elements referencing operations before 2008.

During the alternatives workshop, several suggestions were made to rigorously explore and objectively evaluate possible alternatives or elements of alternatives. These suggestions were evaluated for addressing in this EIS. Alternatives considered but eliminated from detailed study are summarized below.

2.5.1 Change the Rio Grande Compact Accounting Point to San Marcial

Reclamation considered an element of an alternative to change the Rio Grande Compact accounting point back to San Marcial. This was not carried forward because it is outside of the scope of the OA; moreover, the timeframe for obtaining and evaluating comparable hydrology data for modeling was not feasible. Reclamation lacks authority to change an accounting point under the Rio Grande Compact. Such a change would require a resolution of the Rio Grande Compact Commission, such as in 1948.

2.5.2 Removing Credits and Charges and Using Actual Deliveries of Water in Accounting

Reclamation considered an element of an alternative to remove credits and charges in water accounting for the RGP. Allocation charges reflect the volume of surface water diverted from the Rio Grande; allocation credits reflect the volume of water bypassed or returned to the Rio Grande and available for diversion at a downstream diversion point.

In general, allocation charges are computed as the greater of the volume of water ordered for diversion at a specified diversion point and the volume of water actually diverted; alternatively, allocation credits are computed as the lesser of the volume of water ordered or bypassed at specified bypass points and the actual volume of water bypassed or returned to the Rio Grande. Depending on the allocation charges and credits on corresponding RGP water orders promotes efficient operation of the RGP by creating an incentive to divert all water ordered. This was not carried forward because it does not meet the purpose and need and is outside of the scope of the OA.

2.5.3 Change Carryover Accounting to Reflect Actual Conservation

Reclamation considered an element of an alternative to change carryover accounting under the OA for actual conservation (i.e., as measured by reducing agricultural depletions). In accordance with 43 CFR 46.240, this was not included as an alternative because it is not feasible to integrate into a model that ensures a timely completion of the EIS. It would require acquiring relevant information on agriculture crop depletions and then determining whether this would double count the diversion allocation for the next year.

2.5.4 Changes in Drought Factor and Evaporation Calculations

Reclamation considered alternative elements to address how evaporation losses are calculated and potentially adjusting the drought factor. These elements were not carried forward as part of the final alternatives because they are potential adjustments that are made by revising the RGP Operations Manual. This is a written process by which the Allocation Committee implements the OA and does not need separate NEPA analysis.

2.5.5 Impairment from Groundwater Pumping

Reclamation reviewed an alternative to determine whether Reclamation could consider taking action if impairment from groundwater pumping is depleting RGP supply. This is outside the scope of the OA, and pending the outcome of existing litigation to protect RGP water, it was deemed speculative and impractical to attempt to analyze particular enforcement actions in this EIS.

2.5.6 Modeling and Analysis Assumptions

Reclamation received suggestions for alternatives to account fairly for changes in RGP efficiency caused by climate change and one that includes a full technical and legal analysis of how the OA affects Rio Grande Compact credit water accounting. Reclamation determined that these were not true alternatives, but were modeling and analysis assumptions or parameters contributing to the effects analysis.

2.5.7 San Juan–Chama Storage Contract Options

Reclamation considered comments requesting various alternatives on the volume of San Juan–Chama Project water storage and the contract duration. It also considered comments to eliminate storage or to not consider eliminating storage in EBR. Only the ABCWUA has expressed interest in continuing storage of up to 50,000 AFY for the full term of the OA under a multiyear contract. Historically, storage requests have not exceeded that amount. Analysis under Alternative 2 allows independent comparison of the effects of San Juan–Chama Project storage, while operating under the OA.

2.6 Comparison of Alternatives

Table 2-1 illustrates the differences among alternatives. Comparison of the effects of implementing the alternatives compared to the No Action Alternative is found in **Chapter 4, Table 4-6**.

2.7 Preferred Alternative

The preferred alternative is that alternative that Reclamation believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors described in **Chapter 4**, Environmental Consequences. Reclamation has not determined a preferred alternative.

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3. Affected Environment

3.1 Introduction

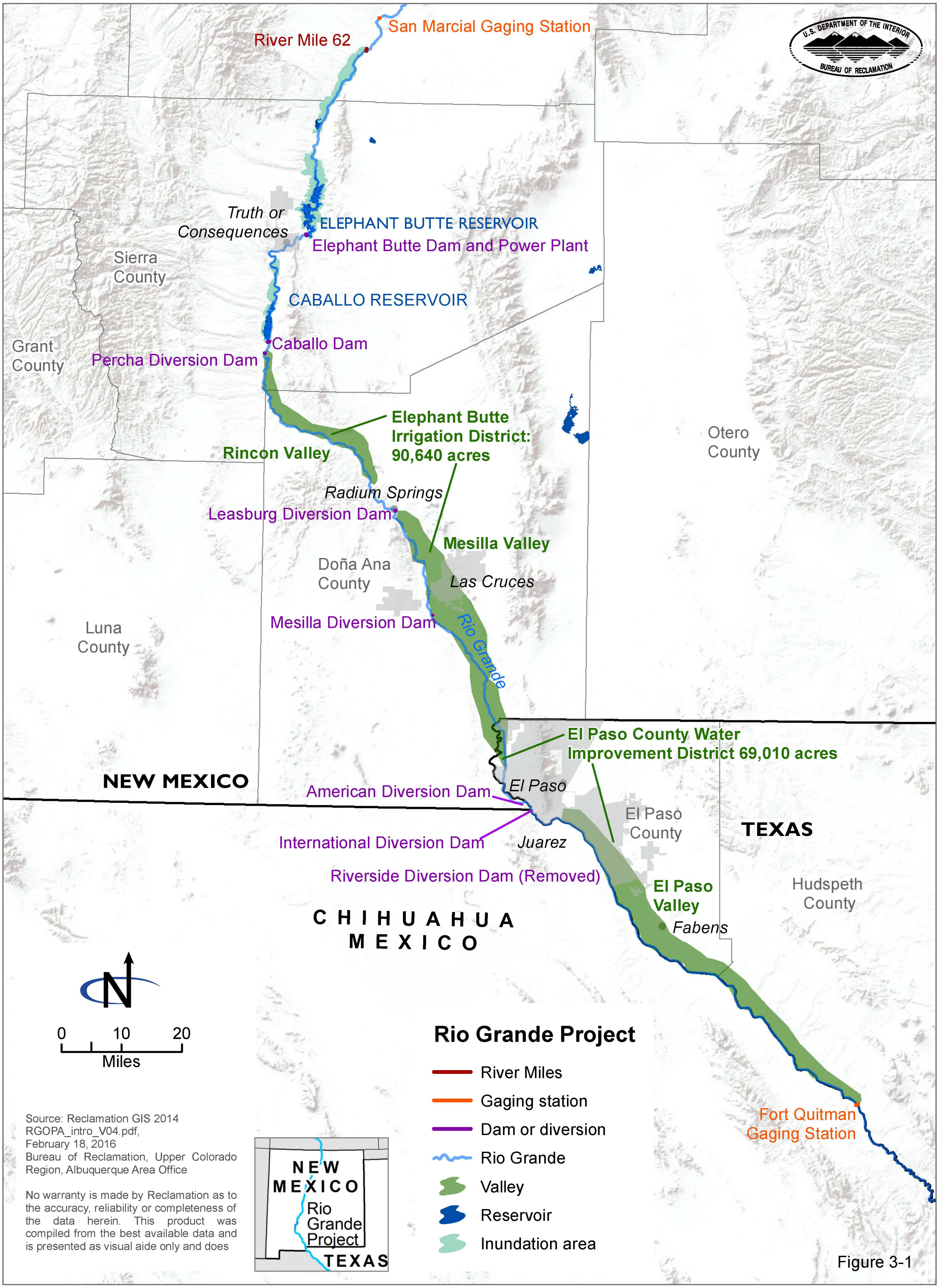
This chapter describes the current physical, biological, cultural, and socioeconomic conditions that could be directly, indirectly, or cumulatively affected by the alternatives discussed in **Chapter 2**. **Chapter 3** defines resources and resource issues that are addressed in detail in the EIS and summarizes those that are considered but not analyzed. Detailed resource discussions follow the description of the general setting of the RGP, the OA area, and the physical extent of the affected environment.

3.2 Affected Region

The geographic region that would be affected by the proposed Federal action begins with EBR and extends downstream along the Rio Grande floodplain to the El Paso/Hudspeth County line (**Figure 3-1**). The proposed Federal action could affect EBID and EPCWID.

3.3 Resources Considered in this Environmental Impact Statement

Reclamation's ongoing actions to meet contractual obligations to EBID and EPCWID for allocating, diverting to headings, and accounting for RGP water have not included facility construction or other direct physical impacts. Because of this, there is little potential for impacts on some resources or resource issues typically analyzed in an EIS. In addition, the OA functions in the context of established RGP operations of the reservoirs, dams, river conveyance, and diversions. In addition, the effects of OA implementation have been analyzed in two EAs, resulting in Findings of No Significant Impact (Reclamation 2007, 2013a). Therefore, in accordance with 40 CFR 1502.2, a systematic documentation of resources and resource issues that are, and are not, included in detail in this EIS is presented in **Table 3-1**. The resources considered but not analyzed may not be present in or relevant to the scope of the Federal action. In other cases any potential to impact the resource is negligible or speculative. This determination is based on scoping, input from cooperating agencies, the previous NEPA compliance documentation, and the experience of interdisciplinary team members.


San Marcial Gaging Station
River Mile 62
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Truth or Consequences
ELEPHANT BUTTE RESERVOIR
Elephant Butte Dam and Power Plant
Sierra County
CABALLO RESERVOIR
Caballo Dam
Grant County
Percha Diversion Dam
Elephant Butte Irrigation District: 90,640 acres
Rincon Valley
Otero County
Radium Springs
Leasburg Diversion Dam
Mesilla Valley
Doña Ana County
Las Cruces
Mesilla Diversion Dam
Rio Grande
Luna County
El Paso County Water Improvement District 69,010 acres
NEW MEXICO
American Diversion Dam
El Paso
El Paso County
TEXAS
International Diversion Dam
Juarez
Riverside Diversion Dam (Removed)
El Paso Valley
Hudspeth County
Fabens
CHIHUAHUA
MEXICO
N
0 10 20
Miles
Rio Grande Project
River Miles
Gaging station
Dam or diversion
Rio Grande
Valley
Reservoir
Inundation area
Fort Quitman Gaging Station
Source: Reclamation GIS 2014
RGOPA_intro_V04.pdf,
February 18, 2016
Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office
No warranty is made by Reclamation as to the accuracy, reliability or completeness of the data herein. This product was compiled from the best available data and is presented as visual aide only and does
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Rio Grande Project
TEXAS

Figure 3-1

Table 3-1. Resources and Issues Considered

Resource	EIS Section	Agency Determination
Aesthetics	Not included	This resource issue is not relevant to the scope of the Federal action.
Agricultural land use	Included as a subtopic under socioeconomic analysis	Agricultural land use is not covered in detail because Reclamation does not deliver project water to individual farmers or their fields. However, the hydrology model and economic analysis use constant cropping patterns to depict agricultural land use. As such, it is relevant to the scope of the Federal action.
Air quality	Not included	There are no effects on air quality or dust related to the Federal action—and no actions requiring a permit for air releases.
Biological resources—aquatic resources and special status fish	Included	This resource issue is relevant to the scope of the Federal action.
Biological resources—vegetation and special status plants	Included	This resource issue is relevant to the scope of the Federal action.
Biological resources—wildlife and special status wildlife	Included	This resource issue is relevant to the scope of the Federal action.
Climate change	Not Included	There are no changes in greenhouse gas emissions associated with the operating procedures. **Chapter 4** contains hydrology modeling data of future flows, storage, and reservoir releases. See also Table 2 of the scoping report (Reclamation 2014a).
Cultural resources	Included	This is relevant to the scope of the Federal action due to the presence of historic properties and known locations of native plant gathering. See scoping report (Reclamation 2014a, page 9).
Environmental justice	Included	This is relevant to the scope of the Federal action based on the presence of minority and low-income communities. Consideration in the EIS is required by Environmental Justice Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.
Geology/soils/ paleontology	Not included	There are no effects on geology and soils related to the Federal action. Although paleontological resources have been found within EBR, there is negligible potential to impact the resource based on the scope of the Federal action.
Indian Trust Assets (ITAs)	Included	This is relevant to the Federal action. Consideration in the EIS is required by Secretarial Order 3335—Reaffirmation of Federal Trust Responsibility to Federally Recognized Indian Tribes and Individual Indian Beneficiaries.
Noise	Not included	There are no effects on noise related to the Federal action.

Table 3-1. Resources and Issues Considered

Resource	EIS Section	Agency Determination
Hydropower	Included as a subtopic under socioeconomic analysis	This is relevant to the scope of the Federal action for the economic benefits of hydropower generated at the Elephant Butte Dam.
Recreation	Included as a subtopic under socioeconomic analysis	This is relevant to the scope of the Federal action for recreational uses of reservoirs, state parks, and other river corridors.
Socioeconomics	Included	This resource issue is relevant to the scope of the Federal action for potential effects of economic benefits (direct impacts) and regional economic indicators. See Tables 2 and 3 of the scoping report (Reclamation 2014a).
Solid and hazardous waste	Not included	There are no effects on solid and hazardous waste related to the Federal action.
Traffic	Not included	There are no effects on traffic related to the Federal action.
Water resources—surface water	Included	This resource issue is relevant to the scope of the Federal action. See Tables 2 and 3 of the scoping report (Reclamation 2014a).
Water resources—groundwater	Included	This resource issue is relevant to the scope of the Federal action. See Tables 2 and 3 of the scoping report (Reclamation 2014a).
Water resources—water quality	Included	This resource issue is relevant to the scope of the Federal action. See Table 2 of the scoping report (Reclamation 2014a).

3.4 General Setting

3.4.1 Rio Grande Project

The RGP is in southern New Mexico and western Texas. The RGP extends to the El Paso/Hudspeth County line along the Rio Grande, from the upstream end of the full pool of EBR or River Mile 62 at the power line in Sierra County. The constructed features of the RGP are the Elephant Butte and Caballo Dams and Reservoirs, six diversion dams, 139 miles of canals, 457 miles of laterals, 465 miles of drains, and a hydroelectric power plant. Reclamation and multiple entities own and operate the facilities and distribution infrastructure of the RGP.

The RGP serves 159,650 acres of irrigable land, 57 percent of which is in New Mexico and 43 percent of which is in Texas. EBID includes 90,640 acres authorized to receive RGP water in the Rincon and Mesilla Valleys of New Mexico, and EPCWID includes 69,010 acres authorized to receive RGP water in the Mesilla and El Paso Valleys of Texas. In addition, RGP water is diverted by the IBWC on behalf of Mexico.

The HCCRD, below the RGP boundary in Texas, uses excess flows from the RGP. Under a Warren Act contract between Hudspeth County and the U.S., HCCRD has been diverting drainage and wastewater from the RGP since 1925. The contract extends only to the return water as it occurs in the normal operation of the RGP; it does not obligate the RGP or Reclamation to deliver specific amounts of water.

3.4.2 Operating Agreement Study Area

Specific resource areas of analysis vary by resource and resource issues. Each resource area of analysis is described in its relevant section.

Implementation of the provisions of the OA or San Juan–Chama Project storage contracts has not included constructing new facilities or other actions that are physically different or that exceed the bounds of historical operations of the RGP. Thus, the operation of dams and other RGP facilities, the maximum pool of the reservoirs, and channel capacity under the OA and San Juan–Chama Project storage contracts are within the range of normal historical RGP operations.

The OA does not change the Percha, Leasburg, Mesilla, and American Dams for diverting RGP water to the districts and the IBWC. The OA also does not change obligations under the Convention of 1906, the Rio Grande Compact, or compliance with various court decrees, settlement agreements, and contracts.

3.5 Surface Water

This section summarizes existing conditions for surface water and includes consideration of surface water features, water operations, hydrology, water supply, and allocations and contracts. The study area includes the Elephant Butte and Caballo Reservoir pools, the Rio Grande between the Elephant Butte and Caballo Reservoirs, and the Rio Grande below the Caballo Reservoir to diversion points to EBID and EPCWID lands and Mexico (**Figure 3-2**).

3.5.1 Regulatory Framework

The legal and regulatory framework governing surface water in the study area is complex. The most important authorities, agreements, and contracts are as follow:

- Under the authority of the Reclamation Act of 1902 and the Rio Grande Project Act of 1905, the RGP was authorized to provide agricultural irrigation water to the water associations now known as EBID and EPCWID.
- Under the 1906 Convention between the U.S. and Mexico regarding equitable distribution of waters of the Rio Grande, the U.S. is obligated to deliver 60,000 acre-feet of water annually except in times of extraordinary drought, when reductions in delivery of water to Mexico are proportional to reductions in the quantity of water delivered to lands within the U.S.
- In 1939, Congress ratified the Rio Grande Compact, a tri-state agreement between Colorado, New Mexico, and Texas, to ensure an equitable apportionment of the waters of the Rio Grande. The Rio Grande Compact sets

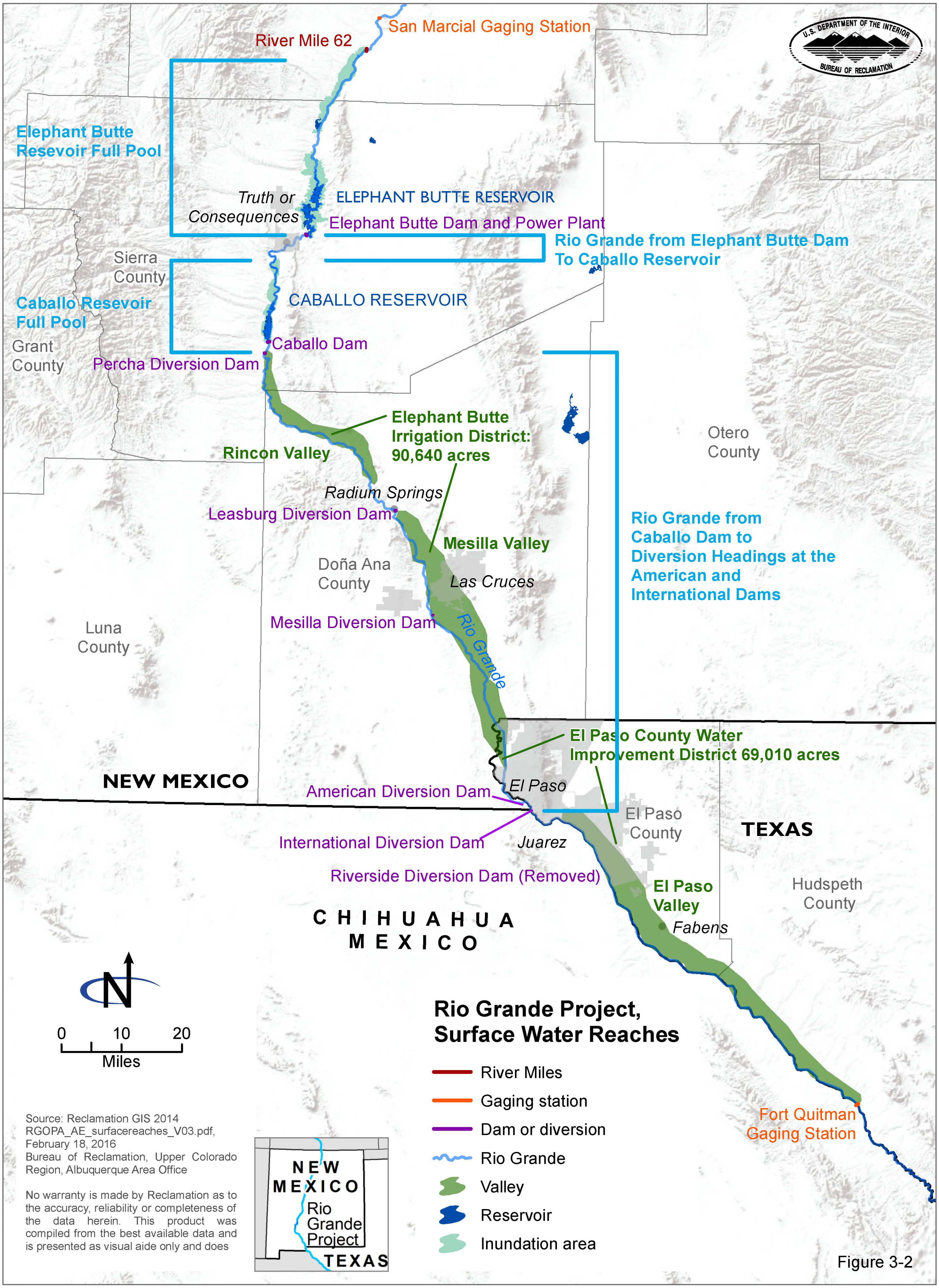
San Marcial Gaging Station
River Mile 62
Elephant Butte Reservoir Full Pool
Truth or Consequences
ELEPHANT BUTTE RESERVOIR
Elephant Butte Dam and Power Plant
Rio Grande from Elephant Butte Dam To Caballo Reservoir
Sierra County
Caballo Resevoir Full Pool
CABALLO RESERVOIR
Caballo Dam
Grant County
Percha Diversion Dam
Elephant Butte Irrigation District: 90,640 acres
Rincon Valley
Otero County
Radium Springs
Leasburg Diversion Dam
Mesilla Valley
Rio Grande from Caballo Dam to Diversion Headings at the American and International Dams
Doña Ana County
Las Cruces
Mesilla Diversion Dam
Rio Grande
Luna County
El Paso County Water Improvement District 69,010 acres
NEW MEXICO
American Diversion Dam
El Paso
El Paso County
TEXAS
International Diversion Dam
Juarez
Riverside Diversion Dam (Removed)
El Paso Valley
Hudspeth County
Fabens
CHIHUAHUA MEXICO
N
0 10 20
Miles
Rio Grande Project, Surface Water Reaches
River Miles
Gaging station
Dam or diversion
Rio Grande
Valley
Reservoir
Inundation area
Fort Quitman Gaging Station
Source: Reclamation GIS 2014
RGOPA_AE_surfacereaches_V03.pdf, February 18, 2016
Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office
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Figure 3-2

delivery requirements to states based on flows at specific measurement stations and delivery of water to the RGP at EBR. It specifies obligations for New Mexico and Colorado to deliver water to downstream states and sets limits on the accumulation of over-deliveries (credits) and under-deliveries (debits).

- In 1981, in accordance with Public Law 97-140, 95 Stat. 1717, the Secretary of the Interior was authorized to enter into agreements with San Juan–Chama Project contractors for storage in EBR.
- Public Law 102-575, Title XXXIII, in 1992 authorizes transferring to the districts the title of easements, ditches, laterals, canals, drains, and other rights-of-way but not storage or diversion structures.
- Court Order No. CIV-90-95-HB/WWD, October 17, 1996 (Court Order of 1996), was a negotiated settlement between Reclamation and the irrigation districts that determined that Caballo Reservoir storage would not exceed 50,000 acre-feet from October 1 to January 31, unless required by flood control operations, storage of water for conservation, regulation of releases from Elephant Butte Dam, safety of the dam's purposes, emergency operations, or any other purpose authorized by Federal law, except non-emergency power generation. Significant variation above 50,000 acre-feet from October through January requires consultation between the districts and Reclamation.
- The RGP Operating Agreement (Reclamation 2008a; **Appendix A**) between Reclamation, EBID, and EPCWID describes how Reclamation allocates, releases from storage, and delivers RGP water to irrigation district diversion points (headings).

3.5.2 Data Sources

Affected environment historical water data were compiled primarily from Reclamation sources, including the appendices to the Supplemental Environmental Assessment for the Implementation of RGP Operating Procedures (Reclamation 2013a; SEA Appendix F).

Reclamation has compiled and provided water resources data relevant to the scope of the Federal action. Data for water resources include the following:

- Inflows into EBR
- Reservoir storage amounts and elevation at and releases from EBR to the Caballo Reservoir
- Releases from the Caballo Reservoir and inflows to the river between the reservoir and heading, including flow returns back to the river from the irrigation systems and municipalities

3.5.3 Existing Conditions

The Rio Grande is a highly regulated river system, with many factors affecting the surface water available to the RGP. The hydrology of the river above EBR is highly variable and has been subject to relatively long periods of drought. The inflow to EBR is determined by gages at San Marcial that measure the combined flow of the river and the low flow conveyance channel (LFCC). This is an artificial channel that runs alongside the Rio Grande, between San Acacia, New Mexico, and EBR, that diverts some or all of the river's flow into a narrower, deeper, and more hydraulically efficient channel.

Elephant Butte and Caballo Reservoirs Storage

Reclamation stores RGP water in the Elephant Butte and Caballo Reservoirs. EBR has a capacity of 2,024,586 acre-feet, all of which is conservation storage for later release for authorized purposes (Reclamation 2008b). The Caballo Reservoir has a total capacity of 324,934 acre-feet, which includes 224,934 acre-feet of conservation storage and 100,000 acre-feet of flood control space (Reclamation 2008b). Total conservation storage within the RGP is 2,249,520 acre-feet.

In a typical year, storage in EBR generally increases in the spring due to snowmelt and is drawn down by late summer, although its contents can swing dramatically due to variations in runoff from summer monsoons.

Releases out of the EBR in any one year are based on maintaining irrigation demand downstream of the Caballo Reservoir, optimizing power generation, and maintaining key storage levels at the Caballo Reservoir during the irrigation season. These levels ensure that evaporation differences between the Elephant Butte and Caballo Reservoirs are minimized, in accordance with the Court Order of 1996. Releases from EBR are restricted by other factors, including the capacity of the power plant hydropower turbines, the limits of the flood control mechanisms for downstream communities, including Williamsburg and Truth or Consequences, New Mexico, and the limits of storage in the Caballo Reservoir. No water is released from Elephant Butte during the non-irrigation season under normal (non-flood) circumstances.

There are some arroyo inflows in the river reach between the EBR and the Caballo Reservoir. Storage in the Caballo Reservoir generally increases from January through March, decreases from March through April, increases from May through June, decreases from June through October, and increases from October through December (Reclamation 2013a).

Rio Grande below the Caballo Reservoir

The Rio Grande runs 106 miles, from the Caballo Reservoir downstream to American Dam in El Paso, Texas. EBID, EPCWID, and the IBWC on behalf of Mexico, place orders with Reclamation for releases from storage to meet their respective delivery requirements at authorized points of diversion. Orders are placed daily or as determined by the districts. If the districts cannot agree on the volume or timing of releases, Reclamation makes the final determination. In addition to releases ordered by the districts, Reclamation releases water from RGP storage for diversion by Mexico. Reclamation determines the amount and schedule of release for Mexico, under the authority of the Convention of 1906; Reclamation coordinates RGP releases to meet RGP deliveries and optimize RGP operations.

As part of the historical RGP operations and not a change under the OA, portions of the Rio Grande below the Caballo Reservoir are dry during the non-irrigation season because no surface water is being released. Portions may remain wet due to rain and snowfall, groundwater, or municipal discharges. The annual flow below the Caballo Reservoir was fairly constant from 1960 to 2013, with the exception of a few significant wet and dry periods. The most significant dry period occurred during the mid-1960s, while the two wettest periods occurred during the mid-1980s and mid-1990s.

In a typical year, flow below the Caballo Reservoir is at a low in January, gradually increases until March, decreases during April and May, peaks in July, and decreases until December. This flow pattern seems to reflect a typical rising and falling hydrograph resulting from irrigation crop demand, with the exception of the decrease that occurs during April and May.

3.6 Groundwater

This section summarizes existing conditions for groundwater and includes consideration of groundwater elevation, recharge, pumping for irrigation, use, and the interactions between groundwater and surface water. The focused study area is the Rincon Valley of New Mexico, the Mesilla Valley of New Mexico and Texas, and the El Paso Valley of Texas. The Mesilla Valley extends from Radium Springs, New Mexico, to the El Paso Narrows in El Paso, Texas, near the New Mexico-Texas-Mexico border. El Paso Valley is the low-lying area containing the Rio Grande channel, from south of the El Paso Narrows to near Fabens, Texas.

3.6.1 Regulatory Framework

The New Mexico Office of the State Engineer (NMOSE) is responsible for regulating groundwater in New Mexico. In 1980, NMOSE recognized the Lower Rio Grande Underground Basin and imposed a permit system on well drilling. Before this declaration, there were no restrictions on well drilling in this area (Reclamation 2013a; SEA Appendix C). Permits, however, would be required for any further groundwater development. The volume of groundwater that may be pumped under pre-basin groundwater rights[1] is currently being determined through a basin adjudication process by the State of New Mexico (Reclamation 2013a; SEA Appendix F).

Groundwater pumping within the inherent jurisdiction of Texas is managed and regulated by local or regional groundwater conservation districts, if present[2]. This part of Texas is governed by the rule of capture, and a landowner needs no authorization or permit to pump.

[1] That is, under water rights established by groundwater use prior to the basin being declared

[2] No Texas groundwater conservation districts exist in the RGP.

3.6.2 Data Sources

Affected environment historical data were compiled primarily from Reclamation sources, including the SEA appendices (Reclamation 2013a) and assumptions used in the modeling (Reclamation 2015c), found in **Appendix C**, Hydrology Technical Memo.

Background data sources compiled by Reclamation for the groundwater evaluation consist of aquifer and regional geology descriptions and existing and new modeling, datasets, and studies. Groundwater levels, groundwater recharge, and groundwater pumping are described for the Rincon and Mesilla Basins. All data uses are based on historical conditions, including measured values (e.g., groundwater elevations) or estimated values (e.g., groundwater recharge and pumping) under actual historical conditions. Data contributing to the analysis of groundwater are as follows:

- Groundwater elevation data was prepared by the U.S. Geological Survey using records extracted for individual groundwater measurement sites from a geo-database compendium (Burley 2010).
- Groundwater recharge has been estimated by assessing deep percolation of irrigation water, channel seepage from the Rio Grande and RGP conveyance facilities, and mountain-front and slope-front recharge from surrounding areas. Values have been extracted from the final model input files for the NMOSE and collaborators' groundwater model of the Rincon and Mesilla Basins (Lower Rio Grande Groundwater Flow Model; S. S. Papadopulos and Associates, Inc. 2007).
- Groundwater pumping for irrigation in the Rincon and Mesilla Basins has been estimated based on the Lower Rio Grande Groundwater Flow Model. While metering of groundwater pumping has occurred since the 1980s and has been required since 2009, obtaining comprehensive metering records of groundwater pumping for irrigation in the Rincon and Mesilla Basins was not possible.

3.6.3 Existing Conditions

Reclamation understands that the groundwater in the unconfined alluvial aquifers in the Rincon, Mesilla, and Hueco Basins of New Mexico and Texas is hydraulically connected to the surface water in the reach of the Rio Grande that flows through the project area. The river and irrigation canals of the project are the primary source of groundwater recharge to these aquifers. Groundwater pumping is under the jurisdiction of New Mexico and Texas, not Reclamation. Adapting to and managing for the impact on the RGP supply of groundwater pumping by irrigators in the RGP service area is a key purpose of the OA.

Lowering of the water table by pumping groundwater can also diminish flows in project drains. This decreases the project surface water supply. Although connected to project surface water supply, pumping groundwater is under the jurisdiction of New Mexico and Texas and not Reclamation.

Aquifers

The shallow unconfined aquifer systems in the Rincon and Mesilla Valleys are hydraulically connected to the Rio Grande; therefore, groundwater pumping from these aquifers in New Mexico and Texas has the potential to affect RGP supply and deliveries. The unconfined aquifer system in the El Paso Valley is also hydraulically connected to the Rio Grande. However, most of the RGP diversions and return flows occur upstream of the portion of this aquifer system that is affected by groundwater pumping and are not substantially affected by fluctuations in groundwater conditions in El Paso Valley (Reclamation 2013a; SEA Appendix F).

Groundwater Recharge and Demand

Groundwater use and recharge are currently being impacted by numerous natural and anthropogenic stressors in the basin, including severe and sustained drought conditions, increasing irrigation demand due to changes in cropping patterns, increasing municipal and industrial groundwater use associated with a growing population in the area, and changing farm irrigation efficiencies.

In the Lower Rio Grande Underground Water Basin (NMOSE 2015), including the Rincon and Mesilla Valleys of New Mexico, groundwater use has recently been estimated to range from 50,000 to 100,000 AFY in years of full RGP surface water supply and from 200,000 to 300,000 AFY in years of low RGP supply. Groundwater use for supplemental irrigation depends on irrigated acreage, crop distribution, and weather conditions during the growing season in addition to RGP supply (Barroll 2005, Reclamation 2013a). Average seasonal groundwater pumping is greater from March through October than from November to February, which reflects the use of the groundwater for supplemental irrigation. Pumping has varied over time, with the volume in years of extremely heavy pumping up to six times that of the years with the lowest pumping. Accurate estimates of historical and current groundwater pumping for supplemental irrigation of RGP lands in the Texas portion of the Mesilla Valley and in the El Paso Valley of Texas are not available at this time. Water quality considerations and other factors limit the groundwater use on RGP lands in the El Paso Valley of Texas, which overlies the Hueco Bolson groundwater aquifer.

In general, an increase in RGP allocation and surface water diversions to either district is expected to increase groundwater recharge from canal seepage and deep percolation of irrigation water in that district, along with a corresponding decrease in groundwater demand for supplemental irrigation. Conversely, a decrease in RGP allocation and diversions to either district is expected to decrease groundwater recharge in the district and increased groundwater demand for supplemental irrigation.

Previous analysis in the SEA determined that it was not possible at the time to quantify the total change in groundwater recharge and demand from 2008 to 2012 nor the portion of that total change that would be attributable to the OA. An order of magnitude estimate suggests that incremental changes in groundwater recharge and groundwater demand for supplemental irrigation in the Rincon and Mesilla Valleys during this period were small, compared to the total recharge and pumping in the region (Reclamation 2013a; SEA Appendix F).

Groundwater pumping is not an authorized function of the RGP and is not directly a part of RGP operations. However, it is worth noting that groundwater pumping from aquifers hydraulically connected to the Rio Grande, or to the network of canals, laterals, ditches, drains, and wasteways used to convey RGP deliveries and return flows, is likely to affect RGP supplies and deliveries through the interaction of the groundwater and surface water systems. In addition, groundwater demand for supplemental irrigation depends in part on the availability of surface water from the RGP. Previous studies have indicated that seepage from the Rio Grande and deep percolation of irrigation water from RGP lands to the underlying aquifer system are a primary source of groundwater recharge to the shallow unconfined aquifers of the Lower Rio Grande Underground Water Basin (Haywood and Yager 2003; S. S. Papadopulos and Associates, Inc. 2007; Hanson et al. 2013). This relationship is reflected by the fact that on average, the collective effects of channel loss, ditch loss, and deep percolation under farm fields have resulted in the river losing water during the summer irrigation season and gaining water during winter.

Groundwater Trends

Analysis based on historical measurements of groundwater elevations from monitoring wells in the RGP and surrounding areas of the Rincon and Mesilla Valleys demonstrates widespread and statistically significant negative trends in groundwater elevation from 1980 to the present. However, additional analysis of previous decades suggest that this trend is confined to the past decade, indicating that sustained groundwater pumping in excess of recharge (i.e., groundwater mining) was not prevalent in the RGP or adjacent lands before the current drought (Reclamation 2013a; SEA Appendix F).

Other details regarding trend analysis are the following:

- Trends in groundwater elevation are predominantly negative, although some wells exhibit no significant negative trends or significant positive trends over the same period. Trends in groundwater elevation at each measurement site reflect conditions near that site.
- Full allocations each year in the early 1990s to early 2000s lessened concerns about allocations, and no substantial changes in RGP operations, district operations, or groundwater use for supplemental irrigation in the RGP or adjacent areas of the Rincon or Mesilla Valleys occurred between the late 1990s and early 2000s.
- Efforts to increase irrigation efficiency and to reduce distribution losses, including lining and piping portions of the distribution system, may have contributed to recent groundwater declines in some portion of the Mesilla Valley by reducing recharge from deep percolation of irrigation and canal seepage. It is likely that recent groundwater declines are associated with the severe and sustained drought conditions that have affected the RGP since 2003 (Reclamation 2013a; SEA Appendix F).

The analysis presented in the SEA Appendix F (Reclamation 2013a) also indicates a statistically significant positive correlation between groundwater elevation and annual flow below the Caballo Dam, as well as the total annual RGP diversions under both wet and dry conditions. These results are intuitively consistent with conjunctive use of surface water and groundwater in the RGP. During periods of high surface water availability, streambed recharge from the Rio Grande to the underlying aquifer increases and groundwater pumping decreases, resulting in higher groundwater elevations; conversely, during periods of low surface water availability, streambed recharge decreases and pumping increases, resulting in declining groundwater levels. Results suggest a strong connection between surface water and groundwater resources in the basin, as indicated by numerous previous studies (Reclamation 2013a; SEA Appendix F).

3.7 Water Quality

This section summarizes existing conditions for water quality and includes consideration of surface and groundwater quality relevant to the scope of the Federal action. There have been no changes in overall water quality as described in the SEA (Reclamation 2013a; SEA Appendix H). Most changes occurring in the Rio Grande as a result of the OA likely fall within the range of variation measured between the irrigation and non-irrigation seasons (Reclamation 2013a).

3.7.1 Regulatory Framework

The legal and regulatory framework governing water quality includes:

- The Clean Water Act (CWA; 33 USC, Section 1251 et seq.) Sections 303, 304, 401, 402, and 404 outline Federal responsibilities protecting water quality; under Section 303(d) of the CWA, all states are required to submit for U.S. Environmental Protection Agency approval on even-numbered years a list of impaired and threatened waters (stream and river segments and lakes).
- New Mexico and Texas water quality laws and standards are found in 20.6.4 New Mexico Administrative Code and Title 30, Chapter 307 of the Texas Administrative Code.
- The Safe Drinking Water Act outlines Federal standards for drinking water quality.

3.7.2 Data Sources

Affected environment historical water quality data were compiled primarily from Reclamation sources, including the SEA appendices (Reclamation 2013a). For surface water, the beneficial uses and relevant water quality criteria are summarized based on existing data prepared by the New Mexico Environment Department and the Texas Commission on Environmental Quality under the CWA. All data were compared with the SEA (Reclamation 2013a; SEA Appendix H), and there have been no updates or changes in water quality relevant to the OA. As such, SEA Appendix H data is incorporated by reference in this EIS.

3.7.3 Existing Conditions

Surface water quality is most directly affected by reservoir levels, low flows, poor quality return flows, wastewater effluents, and groundwater inflows. Variations in surface water quality vary by season and location. Groundwater quality can be affected by salinity, agricultural wastes, and changes in groundwater levels due to pumping. Historical water quality concerns in the Rio Grande in the project area include bioaccumulation of pollutants, low dissolved oxygen, elevated levels of bacteria, salinity, fecal coliform, and non-point pollution.

Reservoirs

Surface water reservoirs in the project area include the Elephant Butte and Caballo Reservoirs. According to the August 4, 2014, water quality data provided under the CWA, EBR is listed as an impaired water body due to mercury and polychlorinated biphenyls in fish tissue. The Caballo Reservoir is impaired due to mercury in fish tissue. Both reservoirs require total maximum daily loads (U.S. Environmental Protection Agency 2015a).

Rio Grande

Consistent with the two adjacent reservoirs, the river segment between the Elephant Butte and Caballo Reservoirs is listed as impaired. However, the cause of impairment for this segment is due to dissolved oxygen (U.S. Environmental Protection Agency 2015a). Also, note that the river below the Caballo Reservoir is completely controlled and is allowed to go essentially dry during the winter, affecting water quality. This is not a function of the OA, but normal historical operations of the RGP. Bacteria levels are elevated between the Leasburg Diversion Dam and El Paso, Texas. Bacteria could come from agricultural runoff, stormwater runoff from developed lands, or ineffective sewage disposal systems. (Reclamation 2013a, SEA Appendix H; U.S. Environmental Protection Agency 2015b.

In the Rio Grande, another water quality constituent of concern is total dissolved solids, which is measured indirectly by specific conductivity. Between EBR and the American Diversion Dam, water quality on the Rio Grande has been consistently measured at two locations and sporadically measured at two more. Temperature and specific conductance have been measured at regular intervals at Leasburg Dam and El Paso. On average, the winter water temperature is a few degrees cooler at Leasburg than at El Paso, though summer temperatures are essentially the same. The temperatures have remained essentially constant from 2009 to 2013, when measurements were taken. Total dissolved solids are typically elevated in the winter when flows are lower and are reduced in the summer when higher flows dilute concentrations (Michelsen et al. 2009).

3.8 Vegetation Communities and Special Status Plant Species

This section summarizes existing conditions for vegetation communities and special status plant species. It includes consideration of vegetation communities and species occurring on land in the high pools of the reservoirs and along riverbanks within established RGP operations. For this EIS, special status species are state and Federally listed and proposed threatened or endangered species, candidate species, and species of concern. However, only state and Federally listed threatened and endangered species are afforded legal Federal protection; thus, only these species were evaluated.

The area of environmental review includes the Elephant Butte and Caballo Reservoir pools, the Rio Grande between the Elephant Butte and Caballo Reservoirs, and the Rio Grande below the Caballo Reservoir to diversion points in EBID and EPCWID lands and Mexico. These areas were the subject of the literature review and target species list developed for the Federal action. In general, the action area and impact assessment are anticipated to be limited to land and water within the Elephant Butte and Caballo Reservoirs high pools and between the riverbanks within established RGP operations.

3.8.1 Regulatory Framework

A number of laws, regulations, executive orders, and guidelines apply to protecting plant species. These are as follows:

- Under the authority of the ESA of 1973 (16 USC, Section 1531 et seq.), as amended, the Service is responsible for protecting and conserving threatened and endangered species.
- The Service also designates critical habitat for threatened and endangered species. Critical habitat is defined as “specific geographic areas, whether occupied by listed species or not, that are determined to be essential for the conservation and management of listed species, and that have been formally described in the *Federal Register*.”
- The Service maintains lists of threatened and endangered species and species of concern. Species of concern is an informal term that refers to species that are declining or appear to be in need of conservation. These include candidate species that are proposed for threatened or endangered status and are under scientific review. For planning purposes and to determine whether they could warrant future listing, the Service monitors information for species of concern (Service 2014a).
- The CWA regulates discharges to wetlands and effects on wetland water quality through Sections 401, 402, and 404.
- Executive Order 11990, Protection of Wetlands, requires Federal agencies to “avoid to the extent possible the long and short-term adverse impacts associated with the destruction or modification of wetlands.”
- The New Mexico Energy, Minerals, and Natural Resources Department (NMEMNRD) Forestry Division maintains a list of plant species considered threatened or endangered in New Mexico (NMEMNRD 2015). Section 75-6-1 NMSA 1978 directs the Forestry Division to gather information on habitat requirements, distribution, threats, and abundance to determine the status of

endangered plant species. The state list could include species not listed at the Federal level.

- Texas laws and regulations pertaining to state endangered or threatened plant species are contained in Chapter 88 of the Texas Parks and Wildlife Department Code and Sections 69.01 through 69.9 of the Texas Administrative Code. These regulations prohibit the taking, possession, transportation, or sale of any plant species designated by state law as endangered or threatened without a permit.
- The State of New Mexico, under the administration of the New Mexico Department of Agriculture (NMDA), lists certain weed species as noxious (NMDA 2009). “Noxious” in this context refers to plants that are not native to New Mexico, that are targeted for management and control, and that have a negative impact on the economy or the environment. Class C listed weeds are common, widespread species that are well established in the state; Class B weeds are considered fairly common but are not yet widespread in certain regions of the state; and Class A weeds have limited or no distribution in the state. Preventing new infestations of Class A species and eradicating their infestations is the highest priority. Class B species are found in limited portions of the state. In severe infestation areas, containing infestation and stopping further spreading is the management goal. Class C species are widespread in the state, and their management decisions are determined at the local level, based on feasibility of control and infestation level.
- Chapter 71, Subchapter D, of the Texas Agricultural Code requires the Texas Department of Agriculture to publish a list of noxious and invasive plant species. These species are listed in Subchapter T of the code.
- Executive Order 13112, Invasive Species, requires Federal agencies to identify actions that could affect the status of invasive species and prevent the introduction of invasive species. It also requires Federal agencies to not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the U.S.

3.8.2 Data Sources

Vegetation in the study area was assessed in terms of plant communities’ composition, including both native and nonnative riparian vegetation and infestation of invasive weeds. The vegetation’s potential for wildlife habitat was also assessed.

A list of target special status plant species was developed based on records from the New Mexico Rare Plant Technical Council (NMRPTC), Natural Heritage New Mexico, NMEMNRD, and the Service. Reclamation’s existing studies and data sources were examined to determine whether target special status plant species or their habitat or wetlands occur in the study area. A list of potential noxious weeds in the study area was prepared using applicable state and county weed lists.

Other data sources were the following:

- Field reports provided by Reclamation from recent vegetation mapping and surveys
- Aerial photography
- Vegetation descriptions from the IBWC and other agency reports

The potentially affected vegetation focused on possible inundation areas associated with reservoir pools. It included the frequency, timing, and extremes in reservoir elevation changes over the long term, with qualitative discussions for the Rio Grande between the Elephant Butte and Caballo Reservoirs and the Rio Grande below the Caballo Reservoir. Moreover, this information indicates the proposed action and alternatives' potential to affect vegetation communities and to promote or inhibit the spread of weeds.

3.8.3 Existing Conditions

Vegetation Communities

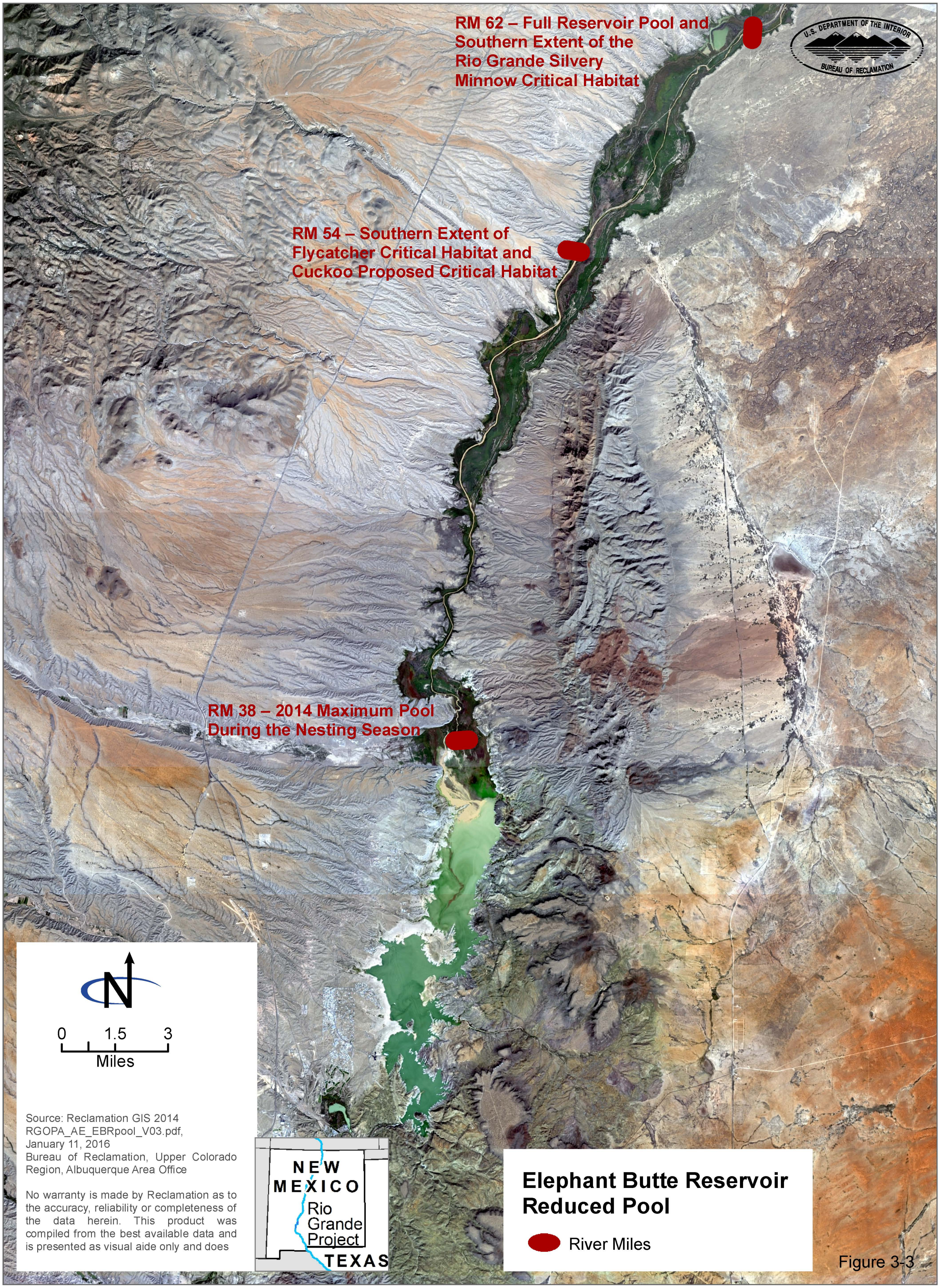
The RGP study area is in the Chihauhuan Desert on the ecotone[3] between Desert Scrub and Desert Grassland (Brown 1982; Dick-Peddie 1993). Riparian-wetland vegetation borders the study area along the shoreline of the Elephant Butte and Caballo Reservoirs and the Rio Grande. The species' location depends on the soil, elevation, degree of slope, and proximity to water. The Service has mapped wetlands and riparian areas in the National Wetland Inventory, and they are generally limited to the river edges, sand bars, low areas next to the river within the floodplain, and the fringes of the Elephant Butte and Caballo Reservoirs.

The Southwest Regional Gap Analysis Project (U.S. Geological Survey 2011) provides land cover data in the study area, classified according to the National Vegetation Classification System. Following this system, vegetation within the full-pool footprint of EBR and its delta are dominated by the following:

- Western Great Plains Riparian Woodland and Shrubland
- Smaller portions are classified as North American Arid West Emergent Marsh
- North American Warm Desert Playa
- North American Warm Desert Wash
- North American Warm Desert Riparian Woodland and Shrubland

Since 1995, EBR has receded more than 24 miles downstream, exposing thousands of acres of bare soil (**Figure 3-3**, Elephant Butte Reservoir Reduced Pool 2014). This habitat, which has regularly flooded from the LFCC outfall, is dominated by Goodding's willow, interspersed with marsh grasses and cattails. To the east, opposite the LFCC outfall, dense monotypic stands of nonnative tamarisk are dominant (Reclamation 2012a).

[3] An area where there is a transition between two biological communities


RM 62 – Full Reservoir Pool and Southern Extent of the Rio Grande Silvery Minnow Critical Habitat
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RM 54 – Southern Extent of Flycatcher Critical Habitat and Cuckoo Proposed Critical Habitat
RM 38 – 2014 Maximum Pool During the Nesting Season
N
0 1.5 3
Miles
Source: Reclamation GIS 2014
RGOPA_AE_EBRpool_V03.pdf,
January 11, 2016
Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office
No warranty is made by Reclamation as to the accuracy, reliability or completeness of the data herein. This product was compiled from the best available data and is presented as visual aide only and does
NEW MEXICO
Rio Grande Project
TEXAS
Elephant Butte Reservoir Reduced Pool
River Miles
Figure 3-3

Reclamation also described the vegetation at EBR (Reclamation 2003a) in the New Mexico State Parks' (NMSP) management plan (NMSP 2006) and in bird surveys (Sogge et al. 1997). To document actual or potential habitat for the listed Southwestern willow flycatcher (flycatcher), Reclamation conducted intensive and reconnaissance-level surveys of the area's vegetation (Reclamation 2012b). IBWC (2003) extensively addresses the reach's vegetation resources below the Caballo Reservoir to El Paso within the study area. The results of these habitat surveys are discussed in detail in the flycatcher discussion, below.

Scant riparian development exists along the Rio Grande between the Elephant Butte and Caballo Reservoirs. Riparian development is typically limited to relatively narrow bands of tamarisk, with a few overstory cottonwoods confined to the immediate banks of the Rio Grande (Reclamation 2012a). Much of this reach is also constricted by urban development and a relatively narrow floodplain.

Where the Rio Grande broadens into the upper delta of the Caballo Reservoir, several patches of tamarisk and overstory cottonwoods and a variety of herbaceous and grass species persist (Reclamation 2012a). The broadening of the floodplain and the Caballo Reservoir accounts for the relatively high water table, which supports this vegetation.

The 40-acre Las Palomas site is in the reservoir pool of the Caballo Reservoir on Federal land; it is fenced to exclude livestock. It now supports a mosaic of native riparian and wetland habitat. Downstream of the Las Palomas site, several large patches of native willows have developed in the bottom of the reservoir pool. Several of these patches are comparable to the high-quality habitat in the EBR and consist of young to middle-aged coyote and Goodding's willow. These riparian areas are classified as North American Arid West Emergent Marsh, North American Warm Desert Playa, and North American Warm Desert Riparian Woodland and Shrubland.

Several tracts along the western edge of the upper pool in the Caballo Reservoir have been cleared of exotic vegetation and are bare. Several other tracts in the upper pool are mowed annually (Reclamation 2012a).

Downstream of the Caballo Reservoir, Cultivated Cropland also becomes a major component of the vegetation classification along the Rio Grande, along with developed high- and low-intensity land cover. Many river segments south of the Caballo Reservoir are highly channelized and do not support native vegetation. Most of the farms have allowed a narrow vegetated buffer zone to exist between agricultural areas and the river's bank.

There are some areas where the river is next to upland slopes; those areas have no farming, and the riparian vegetation is slightly wider. The other vegetated areas occur on sand bars in the river channel. Flows in this section of the river rarely allow for overbanking to occur.

Through the years, the IBWC has implemented a river channel dredging program and a mowing program along the banks. Vegetation is maintained to reduce erosion potential, remove potential obstructions that could reduce flood containment capacity, help stabilize stream banks, control weed and brush including saltcedar, and provide wildlife habitat at suitable locations. The Record of Decision for River Management Alternatives for the Rio Grande Canalization Project increased acreage that would be allocated as no-mow zones (IBWC 2009). Ending mowing at restoration sites, riparian fringe, and managed grasslands, along with selective treatment of exotic vegetation, allows native vegetation to establish itself for the improvement and restoration of riparian habitats. The current River Management Plan has specified no-mow zones on 553 acres of habitat restoration sites and 1,983 acres of managed grasslands vegetation to establish itself for the improvement and restoration of riparian habitats (IBWC 2014b).

The minimal riparian vegetation below the Caballo Reservoir is classified as North American Arid West Emergent Marsh and North American Warm Desert Riparian Woodland and Shrubland.

Trends

The narrative above characterizes how EBR has receded, which has allowed the development of vast expanses of high-quality, native vegetation-dominated habitat, as well as areas of nonnative vegetation-dominated habitat (Reclamation 2012a). Similarly, where the Rio Grande broadens into the upper delta of the Caballo Reservoir, several patches of tamarisk and overstory cottonwoods and a variety of herbaceous and grass species persist (Reclamation 2012a). Some of these patches provide moderately suitable habitat for resident animals and migratory bird species. These habitat areas within the full pool footprint of both reservoirs are vulnerable to fluctuating reservoir levels.

Below Caballo Reservoir, there is minimal riparian vegetation on the banks of the Rio Grande. The river is highly channelized to accommodate agricultural and urban land uses, but additional acreage adjacent to the river has been allocated for riparian restoration and managed grasslands. There are approximately 350 additional acres that may be designated as no-mow zones in future years to accommodate new conditions, such as increased flycatcher habitat buffer areas or new restoration sites (IBWC 2014b).

Invasive Species

The land in the high pools of the reservoirs and along the banks of the river in the OA study area contains many forms of current and historical disturbances: settlement, agriculture, ranching, and commercial and transportation development. Disturbances such as these are conducive to the spread of noxious weed species. Noxious weeds could occur in varying degrees across the study area (NMDA 2009; U.S. Department of Agriculture [USDA] Natural Resources Conservation Service 2015).

Riparian areas may include Siberian elm (*Ulmus pumila*), tamarisk (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), and tree of heaven (*Ailanthus altissima).*

A comprehensive field survey for noxious weed species has not been conducted in the study area. A preliminary analysis of the New Mexico State Noxious Weed List related to the study area’s vegetation and disturbance patterns suggests the potential presence of the following:

- Five Class A species—camelthorn (*Alhagi maurorum*), hoary cress/whitetop (*Cardaria* spp.), parrot feather watermilfoil (*Myriophyllum aquaticum*), ravennagrass (*Saccharum ravennae*), and Scotch cottonthistle (*Onopordum acanthium*)
- Five Class B species—African rue (*Peganum harmala*), Malta starthistle (*Centaurea melitensis*), perennial pepperweed (*Lepidium latifolium*), Russian knapweed (*Acroptilon repens*), and tree of heaven (*Ailanthus altissima*)
- Six Class C species—cheatgrass (*Bromus tectorum*), field bindweed (*Convolvulus arvensis*), jointed goatgrass (*Aegilops cylindrical*), Russian olive (*Elaeagnus angustifolia*), saltcedar (*Tamarix* spp.), and Siberian elm (*Ulmus pumila*)
- Four watch list species—crimson fountaingrass (*Pennisetum setaceum*), giant cane (*Arundo donax*), Sahara mustard (*Brassica tournefortii*), and spiny cocklebur (*Xanthium spinosum*)

In Texas, noxious weed species of potential concern that could be found in the study area are camelthorn (*Alhagi maurorum*), field bindweed (*Convolvulus arvensis*), Japanese dodder (*Cuscuta japonica*), and saltcedar.

Special Status Plant Species

There are 13 state and Federally listed plant species in counties in the OA study area. There are also numerous other species listed as rare or state or Federal species of concern or are ranked as global or state critically imperiled, imperiled, or vulnerable. However, only state and Federally listed threatened and endangered species are afforded legal Federal protection; thus, only these species are evaluated. Of the 13 state and Federally listed plant species known to occur in counties in the study area, only the Pecos sunflower (*Helianthus paradoxus*) and Wright's marsh thistle (*Cirsium wrightii*) have the potential to occur in the study area, based on habitat requirements, soil associations, and known locations. No occurrences of either species have been reported. These species are discussed in more detail below.

New Mexico and Texas State Threatened Plant Species of Particular Concern

Pecos sunflower (*Helianthus paradoxus*)—The Pecos sunflower is a wetland species that requires saturated saline soils of desert wetlands. It is usually associated with desert springs (cienegas) or the wetlands created from modifying desert springs at 3,300 to 6,600 feet of elevation. Some activities that degrade or destroy wetlands and therefore threaten Pecos sunflower are channel incision that reduces water tables, groundwater depletion, water diversions, filling, and *Tamarix* spp. (saltcedar) invasion. Livestock will eat Pecos sunflower, especially the flower heads, when other green forage is scarce. Disturbance may facilitate hybridization (NMRPTC 2015).

Wright's marsh thistle (*Cirsium wrightii*)—This thistle grows in wet, alkaline soils in spring seeps and marshy edges of streams and ponds at elevations of 3,450 to 8,500 feet. Desert springs (cienegas) are susceptible to drying up or being diverted. Populations in the City of Roswell, Chavez County, at Lake Valley, Sierra County, and at the San

Bernardino Cienega in Arizona appear to be extirpated. Introducing insects as biological control for weedy thistles may pose a grave hazard for non-weedy thistle species. The effects of fire and livestock grazing on this species have not been studied (NMRPTC 2015).

3.9 Wildlife and Special Status Wildlife Species

This section summarizes existing conditions for terrestrial wildlife and special status wildlife species, including consideration of birds, mammals, reptiles, amphibians, arthropods, and gastropods in the study area. For this EIS, special status species are those that are state and Federally listed and proposed as threatened or endangered species, candidate species, and species of concern. The study area is the same as described in **Section 3.8**. These areas were the subject of the literature review and target species list developed for the proposed action. In general, these areas and the impact assessment are limited to land and water in the reservoir's high pools and between the riverbanks in established RGP operations. The affected environment for some species may extend beyond the immediate river corridor and lake margins to include migration corridors, breeding or nesting sites, wintering areas, or other wildlife habitats.

3.9.1 Regulatory Framework

The first four bullets in **Section 3.8.1** describing the Federal ESA of 1973 also apply when assessing the affected environment and potential impacts on wildlife and special status wildlife species. Additional applicable laws, regulations, executive orders, and guidelines are as follows:

- State-listed threatened and endangered species are afforded protection by the New Mexico Wildlife Conservation Act (17-2-40.1 NMSA 1978)[4]
- Texas laws and regulations pertaining to state endangered or threatened animal species are contained in Texas Parks and Wildlife Department Code, Chapters 67 and 68, and Texas Administrative Code, Sections 65.171-65.176, of Title 31
- The Bald and Golden Eagle Protection Act (16 USC, Sections 668-668d)
- The Migratory Bird Treaty Act of 1918 (16 USC, Sections 703-712), as amended
- Executive Order 13112, Invasive Species

3.9.2 Data Sources

In addition to the sources used to develop vegetation community associations described above, data describing the current status of Federally listed species in New Mexico and Texas by county (Socorro, Sierra, Doña Ana, and El Paso Counties) were obtained from

[4] http://www.bison-m.org/

information maintained by the Service. The purpose of obtaining these data was to determine the distribution of wildlife and bird species that could occur in the study area.

Reclamation consulted the online Critical Habitat Portal (Service 2014a) for maps showing designated critical habitat for protected species. Additionally, the New Mexico Department of Game and Fish online database for wildlife—Biota Information System of New Mexico—lists Federal and state threatened, endangered, and species of concern and New Mexico Natural Heritage Program sensitive species by county (New Mexico Department of Game and Fish 2015a). Similar information is included in the Texas Natural Diversity Database maintained by Texas Wildlife and Parks.

The New Mexico Ornithological Society has an online database of bird sightings throughout the state (New Mexico Ornithological Society 2015), and there are several available lists showing documented bird species for these counties. Some individual species, especially those that are Federally listed (e.g., Southwestern willow flycatcher; Service 2002) have individual recovery or management plans that provide considerable information on their biology. Reclamation reviewed these sources to identify wildlife species that inhabit the region and to gather information on their habitat requirements.

This discussion includes a general overview of the wildlife and bird species and their habitats that could be in the study area, with an emphasis on special status species. As with vegetation, the potentially affected habitat focused on potential inundation areas associated with reservoir pools and the effects of the frequency, timing, and extremes in reservoir elevation changes over the long term.

3.9.3 Existing Conditions

Wildlife

The Rio Grande, the two reservoirs, and the associated riparian vegetation provides habitat for wildlife (IBWC 2003; Reclamation 2002, 2003b). The two reservoirs provide lacustrine aquatic habitats and influence of fluvial habitat, where the river enters at the deltas. Common wildlife at both the Elephant Butte and Caballo Reservoirs are deer, coyote, rabbit, squirrel, chipmunk, raccoon, woodpecker, egret, killdeer, quail, great blue heron, and numerous species of shorebirds. Migratory bird species and waterfowl are also present. Previous studies by NMSP (2000) documented more than 250 species of birds in the region, many of which are associated with riparian-wetland habitats (Reclamation 2013a).

Downstream of the Caballo Reservoir, typical wildlife that could inhabit the study area are black-tailed jackrabbit, desert cottontail, cotton rat, ground squirrel, mourning dove, meadowlark, kestrel, red-tail hawk, skunk, burrowing owl, several species of waterfowl, other migratory birds, and non-game animals (IBWC 2007, 2014a).

Riparian areas constitute less than 1 percent of the land area in the arid Southwest, yet provide habitat to a greater number of wildlife species than any other ecological community in the region. These areas are also critical corridors for migratory species, especially migratory birds. When analyzing the river portion of the study area from

Caballo Reservoir to El Paso, IBWC assessed the quality of wildlife habitat in the area as below average to poor (IBWC 2003).

Some riverine wetlands in the river channel offer high-quality habitat, but these are small and far apart. Wildlife habitat along the river, from the Elephant Butte Dam to El Paso, has been impacted by agricultural and urban development. In general, the remaining high-value wildlife habitat is associated with the Elephant Butte and Caballo Reservoirs and a riparian strip next to the Rio Grande. The dynamic nature of flooding and drying at the upper portions of the EBR has allowed large areas of riparian vegetation to establish itself, which provides important wildlife habitat. Smaller patches of similar vegetation have developed on the drought-exposed bed of the Caballo Reservoir, as described in **Section 3.8.3.**

Special Status Species

This EIS addresses the potential effects from implementing the OA through 2050 on three special status wildlife species: the endangered Southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher), the endangered New Mexico meadow jumping mouse (*Zapus hudsonius luteus*; mouse) and the threatened Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*; cuckoo). A brief summary of the species, their habitat, and threats follows below; detailed discussions can be found in the biological assessment **(**Reclamation 2015d), Consultation and Coordination Correspondence, which was prepared by Reclamation for consulting with the Service on the OA.

Brief consideration was also given for two rare migrants: the endangered interior least tern (*Sterna antillarum*; tern) and the threatened piping plover (*Charadruis melodus*; plover). There is a lack of suitable habitat for the tern in the study area, and the plover could occur during transitory stopover periods for migrating individuals.

Southwestern Willow Flycatcher

The flycatcher is a small perching bird (order Passeriformes), about six inches long, with a life span of generally one to three years; some live four to seven years (Langridge and Sogge 1997; Paxton et al. 1997; Netter et al. 1998). They winter in neotropical areas of southern Mexico and Central America and begin to arrive at New Mexico breeding sites in early May. Flycatcher habitat along the Rio Grande has two primary functions: habitat for breeding and feeding during the breeding season and stopover habitat while migrating.

The flycatcher was originally listed as endangered due to the “extensive loss of habitat, brood parasitism, and lack of adequate protective regulations” (Service 1995). The greatest ongoing threats to flycatchers in the Rio Grande are the decline in the quality of critical nesting habitat related to drought conditions and reduced annual water supply, invasion of the saltcedar leaf beetle (*Diorhabda* spp.), and nest predation by brown-headed cowbird (*Molothrus ater*).

The Service published the final rule designating critical habitat for the flycatcher in 2013. It included areas around the EBR as critical habitat: the “180.4 kilometer (112.1 mile) segment of the Rio Grande … [including] about 14.4 kilometers (9.0 miles) of the upper part of Elephant Butte Reservoir" (Service 2013a, P. 380).

Of particular relevance to the OA, it reported that "Over time, as the lake at Elephant Butte has declined, there has been an increase of willows and other trees in the delta of EBR, and also an increase in flycatcher territories within the reservoir pool and north of the reservoir pool where the habitat is supported by the low-flow conveyance channel. The area within and north of EBR supports the largest known population of flycatchers in the range of the subspecies" (Service 2013a, P. 365).

The final rule also found that parts of the EBR south of this upper part of the reservoir contain "some elements of the physical or biological features of flycatcher habitat along the reservoir edge" (Service 2013a, P. 380). However, the Service determined that this lower segment in the active conservation pool of the EBR is not necessary for the conservation of flycatcher, and it was not designated as critical habitat (Service 2013a, P. 349).

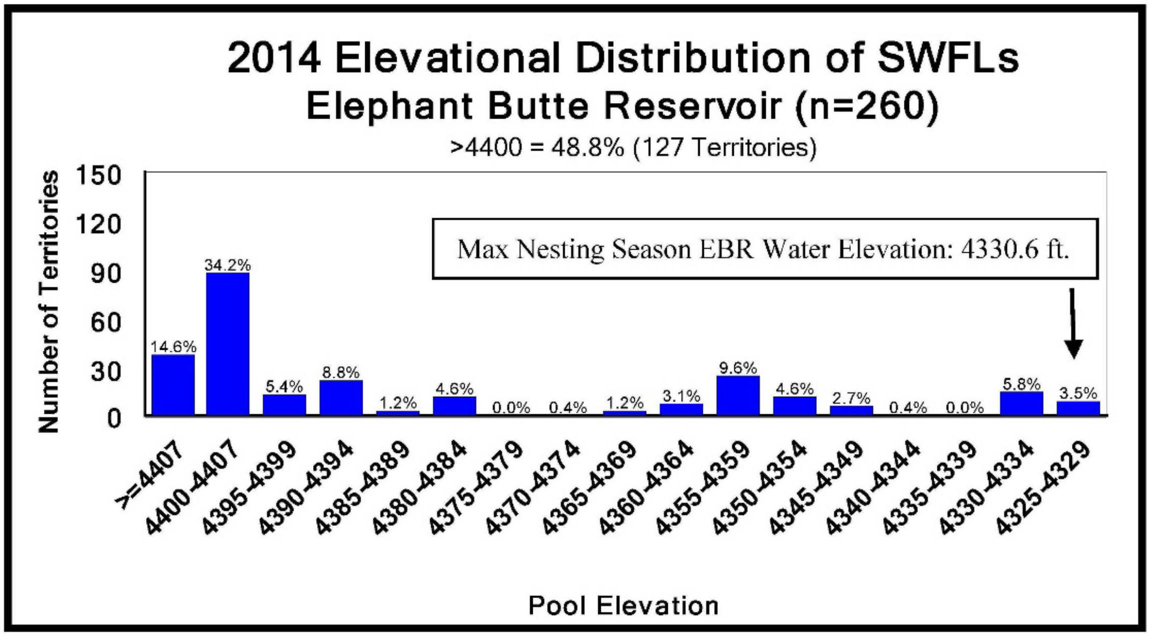
<u>Presence</u>

The upper part of EBR is located in the flycatcher Middle Rio Grande Management Unit. Patches of vegetation at the northernmost extent within the historic reservoir (considered south of River Mile 62) began to reach suitability for flycatchers in the mid-1990s. Flycatcher habitat is dynamic system, with the birds requiring dense patches of vegetation with tall trees. High-quality flycatcher habitat within the reservoir that has developed is a result of more recent reservoir recession that continues to improve and is providing new habitat for nesting and migrant flycatchers (Reclamation 2015a).

During the 2014 surveys, 598 resident flycatchers were documented throughout the Middle Rio Grande Management Unit, which included resident birds forming 234 pairs and establishing 364 territories (Reclamation 2015a). Consistent with previous years, the San Marcial Reach was the most productive, with 307 territories and 205 pairs. The 2014 surveys showed a second consecutive year of increased territory numbers after a large drop in 2012. The 2014 monitoring included nesting success rates, productivity, and brown-headed cowbird (*Molothrus ater*) parasitism. The San Marcial Reach was again most productive, with 255 nests and 151 flycatcher fledglings. Overall, nesting success for all of the Middle Rio Grande Management Unit was the lowest observed in the past 16 years of monitoring, with most failures due to depredation (Reclamation 2015a).

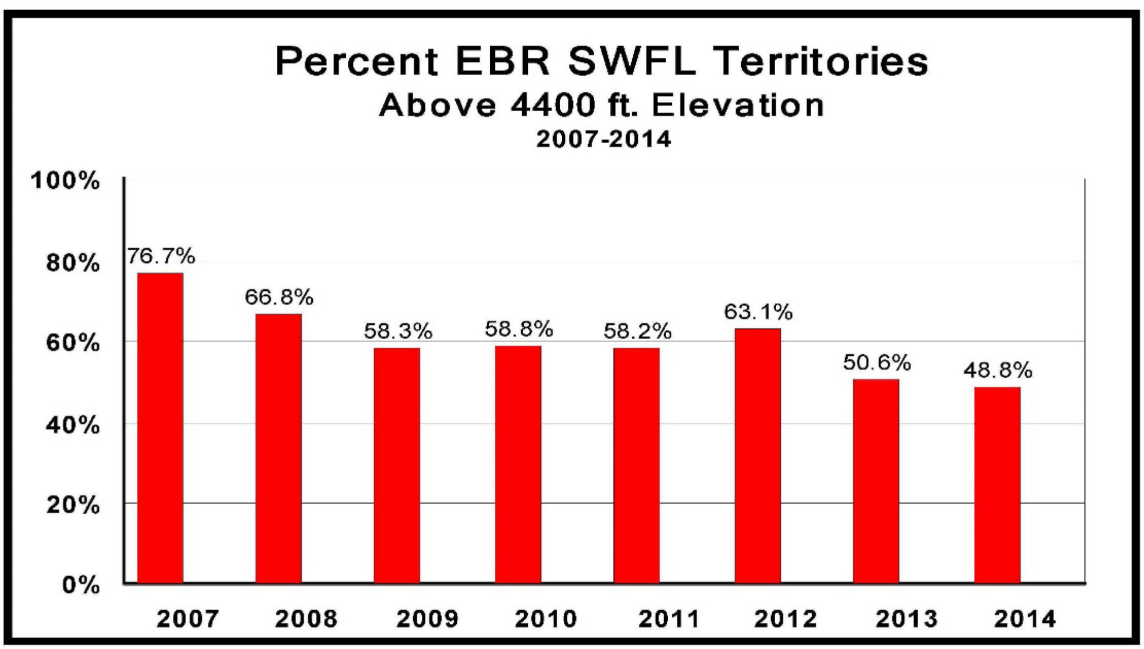
The distribution of flycatchers by elevation in EBR during the 2014 surveys is provided in **Figure 3-4**. Because the elevation of the full reservoir is approximately 4,400 feet, the reservoir is important in providing flycatcher habitat**. Figure 3-5** shows the trend of flycatcher territories found at lower elevations within the reservoir.

Figure 3-4. Elevational Distribution of Flycatcher (SWFL) Territories within EBR in 2014, with Maximum Water Levels



Source: Reclamation 2015d

Figure 3-5. Percentage of Flycatcher (SWFL) Territories above the High Pool of EBR from 2007 to 2014



Source: Reclamation 2015d

Yellow-Billed Cuckoo

Cuckoos are insect specialists but also prey on small vertebrates, such as tree frogs and lizards; they are also known to be nest parasites of other bird species, including flycatchers. In the arid west, cuckoos are usually found in cottonwood-willow riparian associations along watercourses. The cuckoo requires large tracts of willow-cottonwood or mesquite (*Prosopis* sp.) forest or woodland for its nesting season habitat. Hydrologic conditions at cuckoo breeding sites can vary between years. This year-to-year change in hydrology can affect food availability and habitat suitability for cuckoos. Extended inundation reduces habitat suitability because the larvae of sphinx moths pupate, and the eggs of katydids are laid underground; prolonged flooding kills the larvae and eggs (Service 2014b), thus removing important food sources.

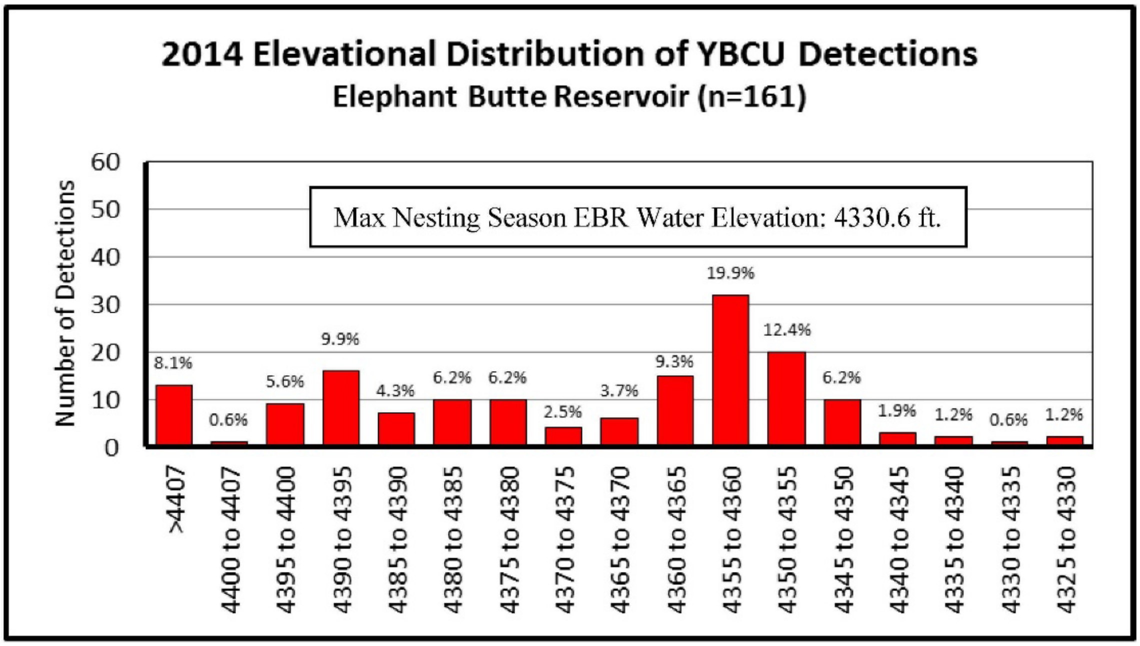
The cuckoo was listed as threatened due to the "habitat loss associated with [man-made] features that alter watercourse hydrology so that the natural processes that sustained riparian habitat in western North America are greatly diminished" (Service 2013b, P. 59992). In addition to habitat loss, reduction of prey insect abundance due to the use of pesticides has been identified as a major threat to the cuckoo (Service 2013b).

In August 2014, the Service proposed designating critical habitat for the cuckoo, which included the Middle Rio Grande Unit NM-8 (Service 2014b). It is 61,959 acres in extent and is an approximately 170-mile-long continuous segment of the Rio Grande, from the EBR in Sierra County at approximately River Mile 54, upstream through Socorro, Valencia, and Bernalillo Counties to below Cochiti Dam in Cochiti Pueblo in Sandoval County, New Mexico. This unit is consistently occupied by a large number of breeding cuckoos and currently is the largest breeding group of the species north of Mexico. The site also provides a movement corridor for cuckoos moving farther north. Tamarisk, a nonnative species that reduces habitat quality for cuckoos, is a major component of habitat in this unit. The Service has not yet finalized critical habitat designation for the species, including identifying actual boundaries at EBR.

Presence

In Reclamation's 2013 survey of cuckoos, from State Highway 60 downstream to the EBR, the San Marcial Reach (River Mile 68.5 to 38.5) had the most cuckoo habitat of any of the other reaches in the survey (Reclamation 2014b). In 2013, the exposed pool of the EBR constituted 86 percent of all cuckoo detections and 86 percent of all territories found within the San Marcial Reach. This subset of San Marcial also contained 48 percent of all cuckoo detections and 50 percent of all territories found in the entire Middle Rio Grande study area. The biological assessment (Reclamation 2015d) includes more information on the cuckoo and its distribution in the study area. The distribution of cuckoos by elevation in EBR during the 2014 surveys is provided in **Figure 3-6**.

Figure 3-6. Elevational Distribution of Yellow-billed Cuckoo Detections within EBR 2014



Source: Reclamation 2015d

New Mexico Meadow Jumping Mouse

There have been relatively few studies on this mouse and its natural life history. The mouse is unique in that it hibernates about eight to nine months out of the year, longer than most mammals, and it is active for only three to four months during the summer. Within this short time frame, it must breed, give birth, raise young, and store up sufficient fat reserves to survive the next year's hibernation period. As a result, if resources are not available in a single season, populations can be greatly impacted. In addition, New Mexico meadow jumping mice live three years or less and have one small litter annually, with seven or fewer young, so the species has limited capacity for high population growth rates due to this low fecundity.

This mouse has exceptionally specialized habitat requirements to support these life history needs and maintain adequate population sizes. Habitat requirements are characterized by tall (averaging at least 24 inches) dense herbaceous riparian vegetation, composed primarily of sedges and forbs. This suitable habitat is found only when wetland vegetation achieves full growth potential associated with perennial flowing water (Service 2013c).

The mouse was originally listed as endangered due to the "present or threatened destruction, modification, or curtailment of its habitat or range; the inadequacy of existing regulatory mechanisms; and the natural and manmade factors affecting its continued existence" (Service 2014c, P. 33120). In addition, isolated populations make natural recolonization of impacted areas highly unlikely or impossible in most areas (Service 2014c). Because the species occurs only in areas that are water saturated, populations have a high potential for extirpation when habitat dries due to ground and surface water depletion, draining of wetlands, or drought.

In April 2014, the Service reopened comment on proposed designated critical habitat for the mouse along the Rio Grande Valley (Service 2014d). Areas proposed for critical habitat for the mouse in this unit incorporate the Bosque del Apache National Wildlife Refuge, which is the only habitat believed to be occupied by the subspecies in the Middle Rio Grande with the capability to support its breeding and reproduction. Final designation of critical habitat has not yet occurred.

<u>Presence</u>

Based on work conducted in support of delta channel maintenance (Reclamation 2013b), mice are not expected to occur in the OA study area. Frey and Kopp (2014) completed a preliminary assessment of mouse habitat down to River Mile 38 using GIS-based vegetation mapping and field evaluations of irrigation drains and the LFCC. Mapping did identify potentially suitable habitat (herbaceous and regenerating willow) next to the LFCC. Because of the quality of available data, this was a conservative effort that overestimated the amount of habitat. Further assessment and surveys have not found potentially suitable mouse habitat (Frey and Kopp 2014).

3.10 Aquatic Resources and Special Status Fish Species

The area of analysis for Federal actions related to this OA includes the full-pool footprints of the Elephant Butte and Caballo Reservoirs, the Rio Grande, between the reservoirs, and the Rio Grande, downstream of the Caballo Dam to diversion facilities for the irrigation districts and the American Diversion Dam. Hydrological modeling simulates reservoir filling and drying affecting aquatic habitats along the EBR delta reach, from River Mile 62 to River Miles 38 to 36 and the Elephant Butte and Caballo Reservoirs. Such habitat changes can affect the numbers and life stage of fish.

This section summarizes existing conditions for aquatic habitats, the fish community, and special status fish species in this potentially affected environment.

3.10.1 Regulatory Framework

Sections 3.8.1 and **3.9.1** describe the primary guidance that Reclamation followed for assessing the existing ecological communities in the study area for the EIS, including various laws, regulations, and executive orders. These include the Federal ESA of 1973, New Mexico Wildlife Conservation Act of 1978, and various sections of the CWA. These regulations also apply to fisheries and other aquatic resources in the study area.

3.10.2 Data Sources

Data and information used to develop this general overview of conditions for aquatic resources in the study area include government-furnished information from Reclamation related to its unpublished sampling surveys on the endangered minnow and habitat, including maps. Additional data and information were derived from existing literature reports, particularly emphasizing information from the New Mexico Department of Game and Fish on sport and game fish species (New Mexico Department of Game and Fish 2015b). The sources for this information are cited in the relevant sections below. No original data were collected as part of the effort to produce the following section.

This summary is qualitative and is presented as a foundation for assessing potential biological responses to habitat condition modifications, including reservoir inundation extremes during the assessment period (relative to baseline conditions occurring at the end of September 2014).

3.10.3 Existing Conditions

Fisheries

Outside of the irrigation season, except for relatively limited durations of stormflow input from the watershed, the Rio Grande channel between the reservoirs and downstream of Caballo Dam has long periods of very low flow annually. The reaches of the Rio Grande below the reservoirs do not develop a sustainable or transient fishery or aquatic community, precluding needs for aquatic life assessment. Consequently, fisheries and other aquatic life resources of concern included in this assessment are limited to those in the delta reach inflows through the full-pool footprints and within the changing wetted perimeters of the two reservoirs.

Elephant Butte Reservoir Headwaters

With the drawdown of the water surface elevation since 1995, more than 24 miles of channel formed through the delta reach at EBR, from River Mile 62 to River Miles 38 to 36. Reclamation fisheries staff surveyed fish populations in this channel from 2010 through 2012 (**Table 3-2**). In 2010, minnows were the most abundant fish collected from this temporary delta channel. They were captured in a variety of habitat types at the four survey sites selected, based on accessibility between River Miles 45.8 and 51.3.

Table 3-2. Fish Species Collected during September Sampling in the Temporary Channel in the Elephant Butte Reservoir Pool from 2010 to 2012

	2010		2011		2012	
	Number	Number per 100 m^2	Number	Number per 100 m^2	Number	Number per 100 m^2
Rio Grande silvery minnow	233	24.07	65	2.83	0	0
Red shiner	78	6.68	219	9.53	1044	29.74
Western mosquitofish	41	3.70	26	1.13	1287	36.66
Channel catfish	24	1.93	55	2.39	11	0.31
Flathead chub	2	0.30	3	0.13	2	0.06
Threadfin shad	1	0.09	0	0	0	0
Yellow bullhead	1	0.08	0	0	0	0
River carpsucker	0	0	7	0.30	0	0
Common carp	0	0	0	0	2	0.06
Logperch	0	0	0	0	2	0.06
Fathead minnow	0	0	0	0	1	0.03

Source: Reclamation 2013a
m^2 = square meters

In 2011, silvery minnow was the second most abundant fish collected; however, overall fish densities were much lower than those observed in 2010. Five sites were selected between River Miles 46.5 and 54.5.

In October 2012, Reclamation sampled four sites, from River Miles 46 to 52, and captured seven fish species. No silvery minnows were captured during any of the 2012 field season. Sampling at two sites produced “no fish,” and there were no dry sites. Western mosquitofish were the most abundant, followed by red shiners. Red shiners were distributed fairly evenly across the sites, and mosquitofish were slightly more abundant at the downstream sites.

Elephant Butte Reservoir

EBR is the state’s largest lake and has its most popular state park for recreation. Due to its intense angling pressure, the lake’s age, and extreme fluctuations in water level, the fish community is monitored annually, in the spring and fall. The most recent available spring fish electroshocking survey reports provide information for the years 2007 through 2010 and fall experimental gill net surveys for 2007 to 2011 (New Mexico Department of Game and Fish 2012). Ten fish species were reported in these surveys, as follows:

- Smallmouth bass (*Micropterus dolomieu*)
- Largemouth bass (*M. salmoides*)
- Bluegill (*Lepomis macrochirus*)
- Longear sunfish (*Lepomis megalotis*)
- Green sunfish (*L. cyanellus*)
- White crappie (*Pomoxis annularis*)
- Black crappie (*P. nigromaculatus*)
- White bass (*Morone chrysops*)
- Striped bass (*M. saxatilis*)
- Walleye (*Sander vitreus*)

Although it is based on a relatively small sample size, the collection data for smallmouth bass indicated a relative imbalance, dominated by older, larger fish (New Mexico Department of Game and Fish 2012). The condition was most likely the result of “poor habitat, due to fluctuating water levels during the spring spawn, poor spawning substrate, water clarity, and inadequate forage fish” (New Mexico Department of Game and Fish 2012).

In contrast, collection data for largemouth bass indicated that their population had shifted to larger, healthier fish until 2010, when this trend reversed. It appeared that natural recruitment was very low (New Mexico Department of Game and Fish 2012).

Capture rates for other centrarchids (white bass, crappie, sunfish, striped bass, and walleye) were low. Catch data for populations for these fish was inconsistent between years, most likely due to sample bias, inappropriate habitat in the survey sites, and relatively low densities of many of these fish. Overall, Reclamation concluded that habitat quality undoubtedly restricted the abundance of centrarchids at EBR, with the lack of suitable spawning habitat and escape cover attributable to the age of the lake and water use practices (New Mexico Department of Game and Fish 2012).

The fall gill net surveys, conducted during November from 2007 to 2011, found the number of fish captured remained fairly stable (New Mexico Department of Game and Fish 2012). However, gizzard shad, normally the most commonly captured and abundant forage fish, showed a substantial population decrease through the survey period, and with an increase in size, makes the population potentially less available as forage. Blue catfish became the most abundant fish in the reservoir based on percent captured data, with their abundance more than doubling from 2009 to 2011. The relative abundance of both striped bass and white bass declined appreciably throughout the survey period.

A more recent report from the 2014 fall fish community (see **Table 3-3**) gill net survey in the reservoir provided updated information on status and trends related to 13 captured fish species. Blue catfish, gizzard shad, white bass, smallmouth buffalo, channel catfish, common carp, and walleye comprised most of the surveyed fish community; all other species accounted for less than 2 percent of the fish caught (Mammoser 2015).

Table 3-3. Community Composition of Elephant Butte Reservoir, 2014

Species	Common Name	Number	Percent Caught	Percent Biomass
Ictalurus furcatus	Blue catfish	597	52.09	27.08
Dorosoma cepedianum	Gizzard shad	207	18.06	9.38
Morone chrysops	White bass	138	12.04	7.34
Ictiobus bubalus	Smallmouth buffalo	98	8.55	42.05
Ictalurus punctatus	Channel catfish	48	4.19	1.26
Cyprinus carpio	Common carp	29	2.53	6.01
Sander vitreus	Walleye	23	2.01	4.95
Dorosoma petenense	Threadfin shad	1	0.09	0.01
Morone saxatilis	Striped bass	1	0.09	1.71
Lepomis macrochirus	Bluegill	1	0.09	0.01
L. megalotis	Longear sunfish	1	0.09	0.01
Micropterus salmoides	Largemouth bass	1	0.09	0.18
Aplodinotus grunniens	Freshwater drum	1	0.09	0.03

Source: Mammoser 2015

From a fish community perspective, EBR “suffers from age and management practices that have been, and will continue to be, detrimental to some species while benefitting others” (New Mexico Department of Game and Fish 2012). Present day management of the fishery populations is viewed to be affected by yearly fluctuating water levels due to irrigation demands and poor habitat created by severe drought conditions; centrarchid populations (e.g., bass and sunfish) are much below state management objectives (New Mexico Department of Game and Fish 2011).

The lack of submerged vegetation in the reservoir has limited the recruitment and survivorship of bass. The absence of vegetation to help filter suspended particulates, reduce the water’s turbidity, and stabilize the lake’s banks negatively affects many fish species, including white, largemouth, and smallmouth bass, which tend to avoid turbid areas. In contrast, other fish species, like blue catfish, can tolerate increased turbidity, with populations quadrupling in EBR in recent years, while channel catfish populations have markedly declined.

Caballo Reservoir

The only information obtained to date on the Caballo Lake fishery comes from experimental gill net surveys in mid-November 2008 (New Mexico Department of Game and Fish 2012). At the time, due to very low water levels in the lake, only three randomly selected sites were sampled. Catfish and walleye were the main game species captured, representing most of the community in percent captured and percent of biomass. Walleye, catfish, and white bass are the primary species targeted by anglers in the lake.

Gizzard shad represented 17.5 percent of the fish captured in 2008, a number very similar to those captured in 2006, and the capture data indicated a well-balanced population, with at least moderate recruitment (New Mexico Department of Game and Fish 2012). Walleye provided 27 percent of the 2008 fish captured. Walleye fry have been stocked in Caballo Reservoir every year since 2007. While their capture number was lower than in 2004 and 2006, their population remained abundant. Their population size reduction was attributed to the decrease in lake levels and the increase in the percent catch of blue catfish. Blue catfish capture numbers increased in 2008 from previous surveys in 2004 and 2006, and they had become the dominant game fish in 2008. The report suggested that water level effects on habitat conditions likely dictate which species are more prevalent each year.

Special Status Species

Rio Grande Silvery Minnow

The Rio Grande silvery minnow is the only ESA-listed fish species occupying habitat in the OA study area. Additional information related to the topic is discussed with more detail in the biological assessment (Reclamation 2015d).

Silvery minnows are pelagic spawners,[5] producing numerous semi-buoyant, nonadhesive eggs. Most spawning typically has been observed in the spring, from late April through June, accompanying the period of snowmelt runoff (Reclamation 2012c). Spawning also has been observed during runoff following summer monsoons. Both juvenile and adult minnows primarily use meso-habitats with moderate depths (15 to 40 centimeters), low water velocities (4 to 9 centimeters per second), and silt/sand substrates. During the winter, these minnows become less active and seek habitats with cover, such as debris piles and other areas with low water velocities.

During spring sampling, large concentrations of reproductively mature silvery minnows are often collected on inundated lateral overbank habitats (Hatch and Gonzales 2008). Further study is needed to determine whether minnows exhibit preferential use of lateral

[5] They lay their eggs in open water

habitat (including overbank) for spawning. Surveys of inundated overbank habitats often have captured large numbers of gravid females and ripe male minnows (Gonzales and Hatch 2009).

Threats

The original listing of the species as endangered (Service 1994, P. 36988) cited the following:

- The presence of mainstream dams
- The growth of agriculture and cities in the Rio Grande Valley
- Over-utilization for commercial, recreational, scientific, or educational purposes
- Disease or predation, particularly during periods of low or no flow
- Inadequacy of existing regulatory mechanisms, including the lack of recognition that instream flows are a beneficial use of state waters
- Dewatering of a large percentage of its habitat, including dewatering downstream from San Acacia

Silvery minnow populations remain at risk in the Rio Grande due to the following:

- Channel drying and the lack of suitable perennial refugia habitat during the irrigation season and periods of drought, leading to complete desiccation of potential habitat for minnows
- The lack of abundant feeding habitat consisting of channel flows less than a half a foot per second, and high flow velocities suspending and scouring away potential benthic and other attached food supplies for minnows, decreasing survival
- Floodplain habitats that fail to connect and inundate during spawn-stimulating flows, stranding minnow eggs and developing fry in high-velocity channel flows that have long been known to produce very high to total mortality of eggs and developing fry in small-bodied fish species (Harvey 1987)

Critical Habitat

The Service designated as critical habitat for the silvery minnow, from Cochiti Dam to the full pool at River Mile 62 (Service 2003). That designation also included areas bounded by existing levees or, in areas without levees, 300 feet of riparian zone outward from each side of the river during bank full stage of the Middle Rio Grande (Service 2003: 8088). Areas other than the Rio Grande, including the OA study area, were excluded from the designation of critical habitat for silvery minnow under Section 4(b)(2) of the ESA.

Presence

Historically, silvery minnows were distributed throughout most of the Rio Grande, from near the Gulf of Mexico to the upper reaches of both the Pecos River and the Rio Grande, reaching into the Rio Chama. The only reach in the EIS study area where silvery minnows currently occur is in the channel through the Elephant Butte delta reach from River Mile 62, extending south to the active pool at approximately River Miles 38 to 36.

3.11 Cultural Resources

Cultural resources refer to historic and prehistoric buildings, structures, sites, objects, districts, Indian sacred sites, and resources of tribal concern. Historic properties are the subset of cultural resources that are listed on or eligible for listing on the National Register of Historic Places (NRHP).

The relevant study area and area of potential effects for cultural resources is the extent of the full pools of the Elephant Butte and Caballo Reservoirs, dam infrastructure, the Rio Grande channel between the two reservoirs, and the Rio Grande below Caballo Dam to the diversions for the irrigation districts and Mexico.

3.11.1 Regulatory Framework

The principal Federal law addressing cultural resources is the NHPA of 1966, as amended (54 USC, Section 300101 et seq.), and its implementing regulations (36 CFR 800). Title 54 USC, Section 306108, commonly known as Section 106 of the NHPA, and its implementing regulations at 36 CFR 800, require Federal agencies to take into account the effects of their actions on historic properties and to allow the Advisory Council on Historic Preservation an opportunity to comment. Executive Order 13007 requires consultation with Indian tribes regarding Indian sacred sites. The executive memorandum from the White House of April 29, 1994, requires government-to-government consultation on other issues of tribal concern. These concerns may also involve cultural resources. Reclamation consulted with the New Mexico SHPO, and SHPO concurred with Reclamations determination of “no historic properties affected” (**Appendix D**, Consultation and Coordination Correspondence). In addition, Reclamation has completed consultation with concerned Indian tribes, and Reclamation received no updates to the issues of tribal concerns detailed in the SEA (Reclamation 2013a) and provided in **Appendix D**.

3.11.2 Existing Conditions

According to the SEA, historic properties listed on the NRHP are in the area of potential effects of this undertaking. The Elephant Butte Dam and the diversion dams and the Franklin Canal are listed on the NRHP as a historic district. Other historic properties are the Garfield Lateral (LA-111726), Pittsburg Placer Mine (LA-13557), a Mogollon pithouse site (LA-2806), and an Apache battle site (LA-132559). Class III surveys of the Elephant Butte and Caballo Reservoirs were conducted in 1998 and 1999, and there are archaeological resources in the reservoir pools (Reclamation 2013a).

As part of the tribal consultation supporting the SEA, the Mescalero Apache Tribe had concerns with native plants growing along the irrigation canals in the service areas of EBID and EPCWID. The Mescalero Tribe collects plant material for cultural purposes.

3.12 Indian Trust Assets

ITAs are legal interests in property held in trust by the U.S. for Federally recognized Indian tribes or individual Indians. An Indian Trust has three components: the trustee, the beneficiary, and the trust asset. ITAs can include land, minerals, Federally reserved hunting and fishing rights, Federally reserved water rights, and in-stream flows associated with trust land. Beneficiaries of the Indian Trust relationship are Federally recognized Indian tribes with trust land; the U.S. is the trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the U.S. The characterization and application of the U.S. trust relationship have been defined by case law that interprets congressional acts, executive orders, and historic treaty provisions.

3.12.1 Regulatory Framework

A number of laws, regulations, executive orders, policies, and guidelines apply to ITAs. All bureaus within the U.S. Department of the Interior, including Reclamation, are responsible for the following:

- Identifying any impact of their plans, projects, programs, or activities on ITAs
- Ensuring that potential impacts are explicitly addressed in planning, decision, and operational documents
- Consulting with Federally recognized tribes that could be affected by proposed actions
- Consistent with this, Reclamation's Indian Trust policy states that it will carry out its activities in a manner that protects ITAs and avoids adverse impacts, when possible, or provides appropriate mitigation or compensation when not possible. To carry out this policy, Reclamation incorporated into NEPA compliance its procedures to require evaluation of the potential effects of its proposed actions on ITAs.

Management of ITAs is based on the following regulations, executive orders, and agreements:

- Executive Order 13175, Consultation and Coordination with Indian Tribal Governments (65 *Federal Register* 67249, November 6, 2000)—This established regular and meaningful consultation and collaboration with tribal officials in developing Federal policies that have tribal implications. When implementing such policies, agencies must consult with tribal officials as to the need for Federal standards and any alternatives that limit their scope or otherwise preserve the prerogatives and authority of Indian tribes.
- Government-to-Government Relations with Native American Tribal Governments (memorandum signed by President Clinton; 59 *Federal Register* 22951, April 29, 1994)—This memorandum directs Federal agencies to consult, to the greatest extent practicable and to the extent permitted by law, with tribal governments before taking actions that affect Federally recognized tribal governments. Federal agencies must assess the impact of Federal

government plans, projects, programs, and activities on tribal trust resources and ensure that tribal government rights and concerns are considered during such development.

- Secretarial Order No. 3175, Departmental Responsibilities for Indian Trust Resources—This requires Department of the Interior bureaus and offices to consult with the recognized tribal government with jurisdiction over the trust property that a proposal could affect.
- Secretarial Order No. 3206, American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the ESA—This clarifies the responsibilities of the Department of the Interior agencies as to how ESA compliance actions affect, or could affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights. Department of the Interior agencies "will carry out their responsibilities in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the departments, and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species."
- Secretarial Order No. 3215, Principles for the Discharge of the Secretary's Trust Responsibility—This guides employees of the Department of the Interior, who are responsible for carrying out the Secretary's trust responsibility as it pertains to ITAs.
- Departmental Manual 512 DM Chapter 2, Departmental Responsibilities for Indian Trust Resources—This establishes the policies, responsibilities, and procedures for operating on a government-to-government basis with Federally recognized Indian tribes to identify, conserve, and protect American Indian and Alaska Native trust resources. It is intended to ensure the fulfillment of the Federal Indian Trust Responsibility.
- Indian Policy of the Bureau of Reclamation—This affirms that Reclamation will comply with both the letter and the spirit of Federal laws and policies relating to Indians, that it will acknowledge and affirm the special relationship between the U.S. and Federally recognized Indian tribes, and that it will actively seek partnerships with Indian tribes to ensure that they have the opportunity to participate fully in the Reclamation program as they develop and manage their water and related resources.

3.12.2 Data Sources

The presence of ITAs and the significance of impacts are best assessed by consulting with the appropriate Indian tribe or pueblo or individual. Additionally, Reclamation complies with Executive Order 13751. For this EIS, no ITAs have been identified.

3.13 Socioeconomics

The RGP water is provided by Reclamation to EBID and EPCWID. EBID provides water to approximately 90,640 acres in the Mesilla and Rincon Valleys of Doña Ana and Sierra

Counties in New Mexico. EPCWID provides water to 69,010 acres in the Mesilla and El Paso Valleys in El Paso County, Texas. Drainage water from project lands provides a supplemental supply for about 18,000 acres in Hudspeth County, Texas.

The study area for socioeconomics includes Doña Ana and Sierra Counties in New Mexico (New Mexico study area) and El Paso and Hudspeth Counties in Texas (Texas study area). A small portion of EBR is in Socorro County; however, no RGP-irrigated lands are in this county. Recreation facilities associated with EBR are in Sierra County.

3.13.1 Regulatory Framework

Socioeconomic conditions are affected by changes in water use. See **Sections 3.5.1** and **3.6.1** for laws and regulations related to surface water and groundwater use.

3.13.2 Data Sources

The affected environment section uses secondary data sources that describe the economic conditions found in the New Mexico and Texas study areas.

The data sources are referenced in each section. The general data sources include the U.S. Census Bureau (2013a), U.S. Department of Commerce (2014), U.S. Department of Labor (2015), Census of Agriculture (USDA 2012), and IMPLAN (2013) data.

3.13.3 Existing Conditions

To provide the context for the economic analysis, the following characteristics of the study areas were considered; some of these parameters are not expected to be affected by the alternatives:

- Population
- Employment
- Labor income
- Output
- Agricultural acreage
- Recreation visitation

Population

The U.S. Census estimated the 2013 population as 211,175 in Doña Ana County, New Mexico, and 11,898 in Sierra County, New Mexico. Las Cruces, New Mexico, the second largest city in the state, is in Doña Ana County and has a population of 99,116.

El Paso and Hudspeth Counties in Texas have populations of 813,015 and 3,394, respectively, according to the 2013 Census. The city of El Paso is in El Paso County, with a population of 660,795 in 2013. El Paso and Hudspeth Counties are part of the El Paso metropolitan statistical area (U.S. Census Bureau 2013a).

Employment

Total employment is 100,368 jobs (full and part time) in the New Mexico study area (IMPLAN 2013). The services-related industries employ the largest number of employees (63.3 percent) in the New Mexico area. The government-related industries employ the second largest number of employees in the New Mexico area (20.4 percent). Agricultural industries make up 6.8 percent of the non-services-related industries in the New Mexico study area. (These data are summarized in **Table 3-4**.) The unemployment rate in Doña Ana and Sierra Counties is 7.5 percent (U.S. Department of Labor 2015).

Total employment is 15,815,458 jobs (full and part time) in the Texas study area (IMPLAN 2013), where the service-related industries make up the largest number of employees (70.2 percent). The non-service-related industries make up the second largest number of employees (17.2 percent). The agricultural-related industries make up 1.9 percent of the non-service-related industries in El Paso and Hudspeth Counties (see **Table 3-4**). The unemployment rate in this area is 6.5 percent (U.S. Department of Labor 2015).

Table 3-4. Percent of Total Employment by Industry

	Doña Ana and Sierra Counties, New Mexico	**El Paso and Hudspeth Counties, Texas**
Non-service industries	**16.3%**	**17.2%**
Agriculture, Forestry, Fishing, and Hunting	6.8%	1.9%
Mining	0.2%	2.9%
Utilities	0.4%	0.4%
Construction	5.6%	5.9%
Manufacturing	3.3%	6.1%
Service Industries	**63.3%**	**70.2%**
Wholesale trade	1.6%	3.9%
Retail trade	9.2%	9.4%
Transportation and warehousing	2.3%	3.3%
Information	1.2%	1.6%
Finance and insurance	3.1%	6.2%
Real estate and rental	3.0%	4.5%
Professional, scientific, and technical services	5.9%	7.1%
Management of companies	0.1%	0.8%
Administrative and waste services	5.1%	6.8%
Educational services	1.0%	1.4%
Health and social services	15.6%	9.8%
Arts, entertainment, and recreation	1.6%	1.6%
Accommodation and food services	8.3%	7.7%
Other services	5.3%	6.1%
Government	**20.4%**	**12.6%**
Government and other	20.4%	12.6%

Source: IMPLAN 2013

Labor Income

The 2013 per capita income in the New Mexico study area (Doña Ana and Sierra Counties) is $32,384. Total income (employee compensation and proprietors' income) is equal to $4,223,973,218. The 2013 per capita income in the Texas study area (El Paso and Hudspeth Counties) is $31,654 (U.S. Department of Commerce 2014). Total income (employee compensation and proprietors' income) in the Texas study area is equal to $913,069,858,115. The service industries make up the largest percentage of total income in both study areas, followed by the non-service-related and government-related industries. Agriculture makes up 6.4 percent and 0.6 percent of total income in the New Mexico and Texas study areas, respectively. The percent of total income by industry is summarized in **Table 3-5**.

Table 3-5. Percent of Total Income (Employee Compensation and Proprietor's Income) by Industry

	Doña Ana and Sierra Counties, New Mexico	El Paso and Hudspeth Counties, Texas
Non-Service Industries	**17.0%**	**27.4%**
Agriculture, forestry, fishing, and hunting	6.4%	0.6%
Mining	0.1%	9.5%
Utilities	0.9%	1.0%
Construction	5.7%	7.3%
Manufacturing	3.9%	9.0%
Service Industries	**52.6%**	**58.6%**
Wholesale trade	1.8%	6.0%
Retail trade	5.8%	5.2%
Transportation and warehousing	4.1%	4.0%
Information	1.2%	2.3%
Finance and insurance	2.8%	5.7%
Real estate and rental	0.9%	2.2%
Professional, scientific, and technical services	8.9%	9.9%
Management of companies	0.1%	1.3%
Administrative and waste services	3.2%	4.3%
Educational services	0.6%	0.8%
Health and social services	14.4%	9.0%
Arts, entertainment, and recreation	0.8%	0.6%
Accommodation and food services	4.4%	3.2%
Other services	3.6%	4.2%
Government	**30.5%**	**13.9%**
Government and other	30.5%	13.9%

Source: IMPLAN 2013

Industry Output

Industry output or sales represent the value of goods and services produced by businesses within a sector of the economy. The New Mexico study area (Doña Ana and Sierra Counties) has $12.1 billion in industry output. The Texas study area (El Paso and Hudspeth Counties) has $2.866.6 billion in industry output. The service sectors make up the largest percentage of industry sales in both study areas. Non-service-related industries make up the second largest portion of total output. Agriculture makes up 4.4 percent and 0.9 percent of total output in the New Mexico and Texas study areas, respectively. **Table 3-6** summarizes the percent of output by industry.

Table 3-6. Percent of Total Output by Industry

	Doña Ana and Sierra Counties, New Mexico	El Paso and Hudspeth Counties, Texas
Non-Service Industries	**28.8%**	**44.2%**
Agriculture, Forestry, Fishing, and Hunting	4.4%	0.9%
Mining	0.3%	5.8%
Utilities	2.9%	2.3%
Construction	7.4%	6.1%
Manufacturing	13.8%	29.1%
Service Industries	**54.1%**	**49.6%**
Wholesale trade	2.4%	5.4%
Retail trade	5.3%	4.2%
Transportation and warehousing	2.7%	3.5%
Information	2.9%	3.6%
Finance and insurance	3.7%	5.6%
Real estate and rental	10.6%	7.7%
Professional, scientific, and technical services	7.1%	5.8%
Management of companies	0.1%	0.9%
Administrative and waste services	2.4%	2.4%
Educational services	0.4%	0.5%
Health and social services	9.3%	4.8%
Arts, entertainment, and recreation	0.9%	0.5%
Accommodation and food services	3.8%	2.5%
Other services	2.6%	2.2%
Government	**17.1%**	**6.2%**
Government and other	17.1%	6.2%

Source: IMPLAN 2013

Agricultural Conditions

According to the 2012 Census of Agriculture, there are 2,440 farms in the New Mexico study area and 334 farms in the Texas study area (USDA 2012). The average farm size ranged from 302 acres in Doña Ana County in New Mexico to 13,480 acres in Hudspeth County in Texas. The percentage of the total land in farms that is located in irrigated farms ranges from 5.6 percent in Hudspeth County to 32.2 percent in El Paso County, and the percentage of total land in farms that is irrigated ranges from 1.0 percent in Sierra County to 11.9 percent in El Paso County. **Table 3-7** summarizes the farm statistics by county.

The major crops grown in the New Mexico study area are chiles, cotton, pecans, and alfalfa. The major crops grown in the Texas study area are cotton and alfalfa. **Table 3-8** summarizes the major crops and acreages for each county, based on the 2012 Census of Agriculture (USDA 2012).

Table 3-7. Farm Statistics by County

	New Mexico	Dona Ana County, New Mexico	Sierra County, New Mexico	New Mexico Study Area	Texas	El Paso County, Texas	Hudspeth County, Texas	Texas Study Area
Approximate land area (acres)	77,630,902	2,437,000	2,674,533	5,111,533	167,189,947	648,206	2,925,329	3,573,535
Land in farms (acres)	43,201,023	659,970	1,250,136	1,910,106	130,153,438	209,393	2,251,109	2,460,502
Land in irrigated farms (acres)	8,308,583	181,380	145,665	327,045	21,492,404	67,416	126,760	194,176
Irrigated land (acres)	680,318	76,347	12,416	88,763	4,489,163	24,914	18,130	43,044
Number of farms	24,721	2,184	256	2,440	248,809	657	167	824
Average farm size (acres)	1,748	302	4,883	5,185	523	319	13,480	2,986
Percent of land in farms	55.6%	27.1%	46.7%		77.8%	32.3%	77.0%	

Source: Census of Agriculture (USDA) 2012

Table 3-8. Crop Acreage for Major Crops Grown by County

	Dona Ana County, New Mexico	Sierra County, New Mexico	El Paso County, Texas	Hudspeth County, Texas
Sorghum (grains)	d	d	-	-
Wheat	953	858	698	d
Cotton	7,745	d	11,142	3,738
Alfalfa	19,785	5,128	6,622	12,713
Other hay	5,641	366	586	3,067
Haylage	2,001	d	d	37
Pecans	28,729	363	d	37
Lettuce	518	d	-	-
Onions	3,526	96	d	d
Chiles	2,400	d	d	d

Source: USDA 2012, except for chiles (USDA National Agricultural Statistics Service 2013)
d: Withheld to avoid disclosing data for individual farms

Hydropower

Hydropower generation at Elephant Butte Power Plant is considered as part of the socioeconomic affected environment. The hydroelectric plant at Elephant Butte Dam generates power that is dependent on flow volume and head. Power production does not occur during the winter when RGP releases do not occur; hydropower calculations are thus based on the calculated average elevation from March to October only.

The Elephant Butte Power Plant has a rated head of 140 feet and is assumed to operate with 90 percent efficiency. Energy generation is calculated from reservoir elevation, with the rated head achieved at the maximum elevation over the study period and the potential energy conversion of 1.024 kilowatt-hours per acre-foot per foot of head. Calculated production based on the average March to October monthly elevation and release data for 2014 is 3 percent below the actual power plant production of 13.4 gigawatts per hour reported by Reclamation (2015b).

Recreation

The EBR has a surface area of 36,897 acres at the conservation pool and a water surface elevation of 4,407 feet. Located midway between Albuquerque, New Mexico, and El Paso, Texas, in scenic semi-desert mountainous terrain, the reservoir is popular throughout the entire Southwest for boating, fishing, and swimming. Cabin sites, boat rental, and fishing tackle are available.

The Caballo Reservoir has a surface area of about 11,500 acres. In rough desert terrain, 17 miles south of Truth or Consequences, New Mexico, it provides an all-year recreation program of picnicking, boating, and fishing. From 2000 to 2011, the EBR averaged 1,205,279 visitors per year, and the Caballo Reservoir averaged 216,219 visitors per year (Reclamation 2013a).

Recreation occurs primarily in parks at EBR, Caballo Reservoir, Percha Dam, and Leesburg Dam in New Mexico.

3.14 Environmental Justice

Environmental justice refers to the fair treatment and meaningful involvement of people of all races, cultures, and incomes with respect to the development, implementation, and enforcement of environmental laws, regulations, programs, and policies. It focuses on environmental hazards and human health to avoid disproportionate high and adverse human health or environmental effects on minority and low-income populations.

3.14.1 Regulatory Framework

Identification of environmental justice communities and an effects analysis will follow Environmental Justice Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, the Council on Environmental Quality's 1997 guidance on implementing Executive Order 12898, and 1995 direction provided in Environmental Compliance Memorandum ECM 95-03.

3.14.2 Data Sources

Low income is defined by the Office of Management and Budget's Statistical Policy Directive 14 as varying by family size; for 2013 data, this level is set at $11,888 for an individual and $23,624 for a family of four (U.S. Census Bureau 2013b). Minorities are defined as individuals who identify as African American, Hispanic, Asian American, American Indian, Native Hawaiian, or any combination of the above.

Areas are considered to contain environmental justice populations, in accordance with CEQ's Environmental Justice Guidelines for NEPA (CEQ 1997), if minority populations have one of the following characteristics:

- Represent over 50 percent of the population
- Are meaningfully greater than the general population of other appropriate unit of geographic analysis

For this analysis, a 20 percent difference from a reference population at the state level is considered to be meaningfully greater. A minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds.

The CEQ and U.S. Environmental Protection Agency guidance do not provide a quantitative threshold (e.g., a limit on the percent of persons in poverty) for determining whether a population should be considered low income. Identifying low-income populations follows the same thresholds established for minority populations.

3.14.3 Existing Conditions

Table 3-9, Study Area Race and Ethnicity, shows that three of the study area counties have high percentages of individuals identifying as Hispanic/Latino (Doña Ana County, New Mexico, at 66 percent, Hudspeth County, Texas, at 79 percent, and El Paso County, Texas, at 81.6 percent). For purposes of environmental justice analysis, Doña Ana

Table 3-9. Study Area Race and Ethnicity

	Doña Ana County, New Mexico	Sierra County, New Mexico	New Mexico	Hudspeth County, Texas	El Paso County, Texas	Texas
Total population	211,175	11,898	2,069,706	3,394	813,015	25,639,373
Hispanic or Latino of any race	139,372 (66.0%)	3,392 (28.5%)	966,268 (46.7%)	2,682 (79.0%)	663,256 (81.6%)	9,717,727 (37.9%)
White alone	62,794 (29.7%)	8,061 (67.8%)	828,574 (40.0%)	676 (19.9%)	109,106 (13.4%)	11,488,269 (44.8%)
African American alone	3,061 (1.4%)	39 (0.3%)	36,710 (1.8%)	17 (0.5%)	22,979 (2.8%)	2,956,545 (11.5%)
American Indian alone	1,702 (0.8%)	164 (1.4%)	177,269 (8.6%)	0 (0.0%)	2,154 (0.3%)	66,100 (0.3%)
Asian alone	2,313 (1.1%)	0 (0.0%)	26,202 (1.3%)	19 (0.6%)	8,277 (1.0%)	1,005,797 (3.9%)
Native Hawaiian or pacific islander alone	15 (<0.1%)	0 (0.0%)	1,160 (0.1%)	0 (0.0%)	899 (0.1%)	18,011 (0.1%)
Some other race	190 (0.1%)	0 (0.0%)	3,599 (0.2%)	0 (0.0%)	728 (0.1%)	34,413 (0.1%)
Two or more races	1,728 (0.8%)	242 (2.0%)	1,509 (1.4%)	0 (0.0%)	5,616 (0.7%)	352,511 (1.4%)
Aggregate minority population	70.3%	32.2%	60.0%	80.1%	86.6%	55.2%

Source: U.S. Census Bureau 2013a

Note: American Community Survey estimates are based on data collected over five years. The estimates represent data collected between 2009 and 2013 and do not represent a single point in time. Aggregate minority population includes any individuals who identified themselves as belonging to one or more ethnic or racial minority. This population is calculated by total population, minus those of white non-Hispanic origin.

County, New Mexico, and Hudspeth and El Paso Counties, Texas, have minority populations over 50 percent, which is higher than that of the comparison populations of New Mexico and Texas; therefore, these counties qualify as environmental justice communities.

The percent of the population below the poverty level for individuals and families is shown in **Table 3-10**, Study Area Poverty. Hudspeth County, Texas, has approximately 44.1 percent of the population with incomes below the poverty level, as compared to 14.3 percent for the U.S. and 17.6 percent for the state of Texas, and therefore qualifies as an environmental justice community.

Tribal populations with current or historical interest in the planning area are the Mescalero Apache Tribe and the Ysleta del Sur Pueblo in Texas. The Mescalero Tribe's historical lands are in the project area, and the tribe continues to use portions of the RGP for collecting native plant species for cultural purposes.

Table 3-10. Study Area Poverty

	Dona Ana County, New Mexico	Sierra County, New Mexico	New Mexico	Hudspeth County, Texas	El Paso County, Texas	Texas
Individuals below poverty level	27.0%	22.6%	20.4%	44.1%	23.3%	17.6%
Families below poverty level	21.5%	12.9%	15.6%	38.0%	20.1%	13.7%

Source: U.S. Census Bureau 2013a
Note: American Community Survey estimates are based on data collected over five years. The estimates represent data collected between 2009 and 2013 and do not represent a single point in time.

4. Environmental Consequences

4.1 Introduction

This chapter presents the potential direct, indirect, and cumulative impacts on the human and natural environment that could occur from implementing the alternatives presented in **Chapter 2**. The temporal scope of the cumulative effects analysis and the proposed action extend to 2050. As such, the impact analyses in this chapter include assumptions and modeling for the long-term trends for the resources considered in the affected environment. This chapter is organized by the topics introduced in **Chapter 3**. Under each topic is a discussion of impact indicators, analysis methods and assumptions, and effects from implementing each alternative. Separate sections describing short-term uses and long-term productivity, unavoidable adverse effects, and irreversible and irretrievable commitments of resources are presented at the end of the chapter.

This EIS is not intended to be a comprehensive review of the resource issues of the RGP, its historical operations, and its geographic extent. The focus remains on those locations or actions where impacts could result from the alternatives described in **Chapter 2**. The OA is implemented within the larger context of established RGP facilities and operations that predate the OA.

Model simulations performed for this EIS using Reclamation's Rincon and Mesilla Basin Hydrologic Model (RMBHM) indicate that relative water allocations between EBID and EPCWID would differ between the alternatives considered. The model simulations assume that farmers in the Rincon and Mesilla Basins would pump groundwater in order to make up for any surface water shortages that occur under the different alternatives and the three potential hydrologic scenarios. However, such groundwater pumping is performed under the authority of the states and at the discretion of the individual farmers. Individual farmers make decisions regarding which crops to grow, and may grow crops that require more than the available surface water. In these cases, they may decide to supplement their allotments of the RGP surface water supply with pumped groundwater, as authorized by the States. During periods of drought, supplemental groundwater pumping authorized and managed by the states is more likely to occur, but the State of New Mexico has indicated that significant groundwater pumping is likely to occur even without surface water shortage (D'Antonio 2005; Barroll 2005).

4.2 Impact Analysis Overview

The primary tools used for the impact analysis are the hydrologic and economic model simulations performed by Reclamation. The RMBHM simulates each alternative through 2050 under projected future climate and hydrologic conditions to consistently compare the effects of each alternative. Projections of potential future surface water and groundwater conditions are based on the results of the modeling, described further in **Sections 4.3, 4.4, 4.5** and **Appendix C.** For the socioeconomic analysis in **Section 4.12**, outcomes from the RMBHM modeling are used to calculate net economic benefits, and the IMPLAN modeling package is used to assess regional economic impact for each alternative.

The detailed impact analyses and conclusions are based on Reclamation's knowledge of resources in the study area, technical reports, and model simulations, reviews of existing literature, and previously completed NEPA analyses on implementing the OA (Reclamation 2007, 2013a). In 2007, Reclamation prepared an EA to evaluate the effects of the OA through 2012 (Reclamation 2007). In 2013, Reclamation supplemented the 2007 EA to evaluate the effects of the OA for a three-year period (Reclamation 2013a). In addition to providing relevant background information, these documents and their supporting appendices include analyses that are incorporated by reference, in accordance with 40 CFR 1502.21 and 43 CFR 46.135.

Assumptions were made to facilitate the analysis of the projected impacts. These assumptions set guidelines for analysis but should not be interpreted as constraining or redefining the actions proposed for each alternative described in **Chapter 2**. Any specific resource assumptions are provided in the *Analysis Methods and Assumptions* section for that resource.

Where information was incomplete or unavailable, Reclamation used the best available information for moving forward with the analysis. References used in the EIS and decisions regarding incomplete or unavailable data are documented in the administrative record.

4.2.1 Impact Analysis Terminology

Potential impacts are described in terms of context, duration, and intensity, which are generally defined as follows:

- Context—This describes the area or location in which the impact would occur. This is defined for each resource.
- Duration—This describes the length of time during which an effect would occur. For this analysis of ongoing operations, consideration is given to variable effects over time modeled for the duration of the full term of the OA through 2050.
- Intensity—Rather than categorizing impacts qualitatively (e.g., major, moderate, and minor), this EIS discusses impacts using quantitative data wherever possible.
- Direct Effects—Direct effects are caused by the action and occur at the same time and place.
- Indirect Effects—Indirect effects are caused by the action, occur later in time or farther removed in distance, but are still reasonably foreseeable. Indirect

effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on water and other natural resources, including ecosystems.

- Cumulative impact—the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative impacts discussions are included in the respective section of each resource analyzed.

4.2.2 Past, Present, and Reasonably Foreseeable Future Actions

The impacts of past and present actions are described in the affected environment (**Chapter 3**). For future actions, Reclamation reviewed a list of projects, plans, and current actions drawn from the SEA (Reclamation 2013a) and other sources that have a relationship to the location and/or timing of the proposed actions and alternatives. These include the Delta Channel Maintenance Project and the Rio Grande Canalization Project; both are described below.

In addition, increased groundwater demand in the Rincon and Mesilla Basins over recent decades has been documented (D'Antonio 2005) and is expected to continue in the future, especially during periods of low RGP surface water deliveries. While supplemental groundwater pumping authorized and managed by the states is a past, present, and reasonably foreseeable action, Reclamation has no control over the regulation of groundwater pumping.

River Maintenance Program—Delta Channel Maintenance Project Environmental Assessment

The Delta Channel Maintenance Project maintains the existing, human-made Delta Channel to facilitate delivery of Rio Grande water to the EBR pool. It involves such activities as sediment removal, berm repair, site access, and staging area maintenance (Reclamation 2014a).

The project is within the boundaries of the EBR. River maintenance is conducted annually along 20.8 miles of the Delta Channel; project-related road and staging area maintenance would be conducted annually within an approximately 293-square-mile study area boundary in Socorro and Sierra Counties, New Mexico.

The project includes a suite of conservation measures to minimize or avoid adverse impacts on resources, including water quality, vegetation, species habitat, and other measures. In addition, Reclamation is implementing recovery actions identified in the Southwestern willow flycatcher and Rio Grande silvery minnow recovery plans (Reclamation 2014a).

River Management Alternatives for the Rio Grande Canalization Project

The U.S. Section of the IBWC completed evaluation of river management alternatives for the Rio Grande Canalization Project. This is a 105.4-mile river corridor that extends along the Rio Grande, from below Percha Dam in Sierra County, New Mexico, to the American Dam in El Paso County, Texas.

The Rio Grande Canalization Project, operated and maintained by the IBWC since its completion in 1943, was constructed to facilitate water deliveries to the Rincon and Mesilla Valleys in New Mexico, El Paso's Upper Valley in Texas, and the Juárez Valley in Mexico. It includes a levee system for flood control. While the IBWC currently implements operation and maintenance procedures that enhance ecosystem functions in the Rio Grande Canalization Project, the river and floodway remain highly altered from events predating project construction. Thus, this project integrates flood control, water delivery, and operation and maintenance in a manner that enhances or restores the riparian ecosystem.

The Record of Decision for this project retains multiple operation and maintenance measures currently conducted for efficient water delivery and flood control within an adaptive management framework. At the same time, it increases flood containment capacity, improves soil erosion protection practices, and implements several environmental measures within the floodway and river channel. These environmental measures are intended to enhance or rehabilitate a mosaic of native riparian habitats, to restore river and floodplain connectivity where feasible, and to diversify the aquatic habitat (IBWC 2009).

4.3 Analysis Methods: Rincon and Mesilla Basins Hydrologic Model

4.3.1 Background

Reclamation, in collaboration with the U.S. Geological Survey, developed a detailed hydrologic model of the Rincon and Mesilla Basins, the RMBHM, and used this model to simulate operations under the alternatives and corresponding surface water and groundwater conditions in the basins. The objective of the modeling was to simulate potential future hydrologic conditions in the Rincon and Mesilla Basins under alternative operating procedures of the RGP and under a range of projected future climate and hydrologic conditions. More details about the model can be found in **Appendix C**, Hydrology Technical Memo (Reclamation 2015a).

Modeling Approach

The modeling objective was to provide projections of possible future surface water and groundwater conditions in the Rincon and Mesilla Basins under alternative operating procedures.

Modeling software was developed and configured to simulate operations and hydrology, including surface water and groundwater conditions, in the Rincon and Mesilla Basins under each of the alternative operating procedures proposed in the EIS. For each alternative, simulations were carried out under a range of projected future climate conditions. Model results were post-processed and compiled to facilitate comparison of operations and surface water and groundwater resources under the No Action Alternative to conditions under each action alternative. Parameters provided as model output and post-processing analysis are as follows:

- RGP storage, non-RGP storage, and total storage in Elephant Butte and Caballo Reservoirs
- Water surface elevations and area of EBR
- Reservoir releases from Caballo Dam
- Diversion of RGP surface water to EBID and EPCWID
- Delivery of RGP surface water to irrigated lands in EBID and to irrigated lands in the Mesilla Valley portion of EPCWID
- Groundwater pumping for irrigation of groundwater-only irrigated lands in New Mexico and for supplemental irrigation of irrigated lands in EBID and irrigated lands in the Mesilla Valley portion of EPCWID
- Changes in groundwater storage and water table elevations in the Rincon and Mesilla Valleys

Other important considerations are as follows:

- Model inputs representing future hydrologic conditions are based on previous analysis of projected future climate and hydrologic conditions for the Rio Grande basin above EBR. The climate and hydrologic scenarios analyzed here were selected to represent the range of projected future climate and hydrologic conditions; however, these scenarios are not predictions of future year-to-year variations in climate and hydrologic conditions in the basin.
- The EIS considers potential future conditions. Three hydrologic projections are used to analyze the potential effects of projected climate change under future conditions. Use of projections, rather than historical data, is necessary in order to consider climate change.
- The model reflects deliveries to Mexico as a constant. Consequently, the allocation and deliveries to Mexico are not included as indicators in this analysis.

Model Selection

The simulation of operations requires a hydrologic modeling approach that accounts for the interaction between surface water delivered by Reclamation and groundwater pumping managed by the States. Reclamation, in collaboration with the U.S. Geological Survey, developed the RMBHM to simulate operations and corresponding surface water and groundwater condition in the Rincon and Mesilla Basins. RMBHM uses integrated hydrologic modeling software that is based on the U.S. Geological Survey modular groundwater model, modular finite-difference flow model (MODFLOW) One Water Hydrologic Model (MF-OWHM), including the Farm Process and streamflow routing package (Reclamation 2015a).

Model Configuration

The model configuration includes the extent and discretization of the simulated area (spatial domain) and simulation period (temporal domain), as well as the physical and hydraulic properties (constant parameters) of the Rincon and Mesilla Basins.

Constant Model Parameters

In addition to the configuration of the model's spatial and temporal domain, RMBHM requires parameters representing the physical and hydraulic properties throughout its spatial domain. Groundwater pumping depths, including those for irrigation, occur in some instances below the shallow alluvium; however, by holding subsurface properties constant in the RMBHM, the depth of pumping is assumed to be from the shallow alluvium, for consistency in comparison of the alternatives. Parameters representing physical and hydraulic properties were held constant through the model simulation period and include the following:

- Subsurface properties
  - Aquifer hydraulic conductivity (horizontal and vertical)
  - Specific storage
  - Specific yield
- Channel properties
  - Hydraulic conductivity of channel beds
  - Channel geometry, slope, and roughness of channels
- Vegetation-related parameters
  - Root profiles of riparian vegetation
  - Soil capillary fringe depth
  - On-farm irrigation efficiency
  - Fractional distribution crop consumptive use between evaporation and transpiration

Time-Varying Model Inputs

In order to simulate transient conditions over the simulation period (November 2007 to October 2050), RMBHM requires inputs representing projected hydrologic, climatic, and anthropogenic stressors to the surface water and groundwater systems of the Rincon and Mesilla Basins over this period. Hydrologic stressors represented in RMBHM are surface water inflows to RGP storage; climatic stresses are reservoir precipitation and evaporation rates and crop irrigation in the Rincon and Mesilla Valleys; and anthropogenic stressors are cropping patterns, irrigated acreage, and on-farm irrigation efficiency of agricultural lands, municipal and domestic groundwater pumping rates and locations, and discharge of treated effluent from municipal wastewater treatment facilities. In addition, the storage and relinquishment of Rio Grande Compact credit waters in EBR is represented as a time-varying input.

For the purposes of this EIS, projected inflows, Rio Grande Compact credit water, and evaporation and precipitation rates for EBR were obtained from the Upper Rio Grande Simulation Model results for the Upper Rio Grande Impact Assessment "Base Case" operating scenario (Reclamation 2015a). The Upper Rio Grande Impact Assessment includes a detailed evaluation of the climate, hydrology, and water operations of the upper Rio Grande basin of Colorado and New Mexico. Also included is an evaluation of the potential impacts associated with climate change on streamflow, water demand, and water operations in the basin. The base case operating scenario represents changes in water supply, demand, and operations resulting directly from projected changes in the climate, assuming no change in infrastructure, operations, population, irrigated acreage and cropping patterns, and other non-climate-related parameters (Reclamation 2015a).

Three of the 112 base case simulations were selected as inputs to RMBHM to represent the range of projected future hydrologic conditions in the basins. Simulations were selected based on projected future surface water availability, as characterized by projected average annual inflow to EBR over the EIS simulation period (2007 to 2050). Selected simulations represent a drier scenario corresponding to the Upper Rio Grande Simulation Model simulation with the 25th percentile average annual inflow (Scenario P25), a central tendency scenario corresponding to the simulation with the 50th percentile (median) annual inflow (Scenario P50), and a wetter scenario corresponding to the simulation with the 75th percentile inflow (Scenario P75) relative to the ensemble of 112 simulations (Reclamation 2015a).

The median, or 50th percentile, reflects the central tendency of the projections, that is, the middle of the pack. Similarly, the range between the 25th percentile and the 75th percentile is simply the range from the 25th to 75th percentile values for the particular ensemble of climate projections considered in Upper Rio Grande Simulation Model. The 25th, 50th, and 75th percentiles are each equally as likely to occur.

For NEPA analyses of reasonably foreseeable hydrologic conditions that may occur under different alternatives, exceedance or non-exceedance curves may be used to display projected future hydrologic scenarios. For purposes of the impact analysis, the modeling results of the P50 central tendency scenario are used for most resources. However, the modeling results of the P25 drier scenario and the P75 wetter scenario are equally likely to occur in a given year. For the purpose of assessing the impacts on special status species that are present in the EBR pool, Reclamation used the wetter P75 scenario (See **Sections 4.8** and **4.9**). This is consistent with the ESA Section 7 consultation, which assesses a conservative worst case based on the potential effects on these species and their habitats due to fluctuations in the reservoir pool and/or sustained high or low water levels in the reservoir.

Uncertainty and Variability in Modeling and Climate Forecasts

Modeling future conditions implicitly includes uncertainties because of simplifications made in modeling, forecasts of future demands, and the variability of natural systems. To help quantify the uncertainty and variability in the model results, Reclamation summarized the model output in two ways: first with graphs of time series data and second with exceedance curves for relevant model output parameters.

A time-series graph displays data at different points in time, which, when put together, show how the measured variable changes over time. This is particularly useful for identifying patterns and trends in the data. Reclamation developed monthly and yearly time series graphs for the model output data for the modeled period of record, years 2008 to 2050.

Exceedance curves give the probability that the modeled parameter, shown on the horizontal axis, would be exceeded over the period of record. The shape of the exceedance curve can suggest where thresholds may exist in the operational or hydrologic parameters.

Model Correlation

As described in Reclamation (2015a), "strong agreement of RMBHM with historical records suggests that RMBHM captures the key operational and hydrologic factors that drive surface water and groundwater management and use in the Rincon and Mesilla Basins."

As illustrated in **Figure 4-1**, simulated total RGP storage is well correlated with observed historical storage and exhibits little systematic bias. Similarly, **Figure 4-2** shows that simulated annual releases from Caballo Dam also agree well with observed historical releases. The simulated average annual RGP release is within one percent of the historical average, and the simulated average annual total RGP diversion from the Rio Grande is within 5 percent of the historical average. Simulated surface water and groundwater deliveries to irrigated lands in the Rincon and Mesilla Valleys also agree well with previous estimates developed for the NMOSE (S. S. Papadopulos and Associates, Inc. 2007).

Model Assumptions

Irrigation demands in the Rincon and Mesilla Valleys were created assuming a constant crop mix, constant acreage, and constant on-farm efficiencies through the model period of record. The model also assumes that the irrigation demand is met in full every year. For years when deliveries of RGP water are insufficient to meet irrigation demands, the model assumes that farms would be able to pump the groundwater necessary to meet the irrigation requirement.

Non-irrigation water demands were created from the average historical values for the period from 1995 to 2004. The non-irrigation demands assume constant seasonal demands.

Total water demands in the El Paso Valley are not explicitly represented in the model. The maximum demand at the American Dam was estimated based on recent years, which had a full allocation to EPCWID. The simulated diversion was curtailed if the allocation was insufficient to meet the diversion demand.

Figure 4-1. Observed and Simulated Monthly Total Rio Grande Project Storage in Elephant Butte and Caballo Reservoirs (acre-feet) from 1960 to 2010

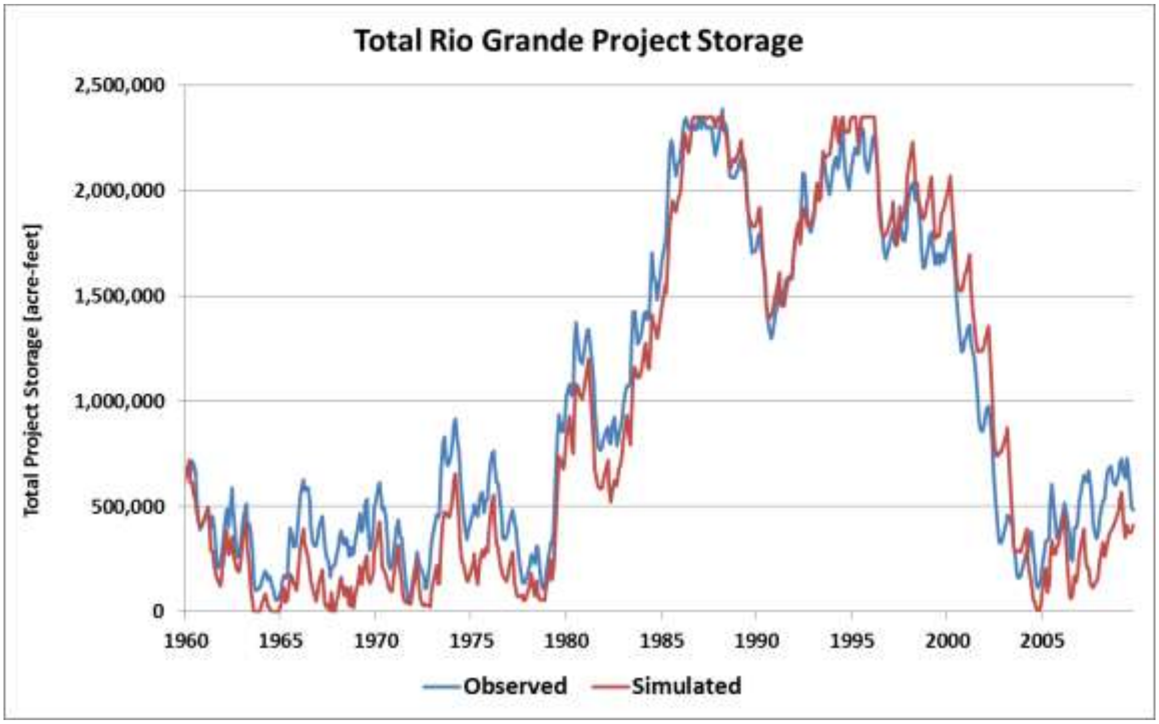
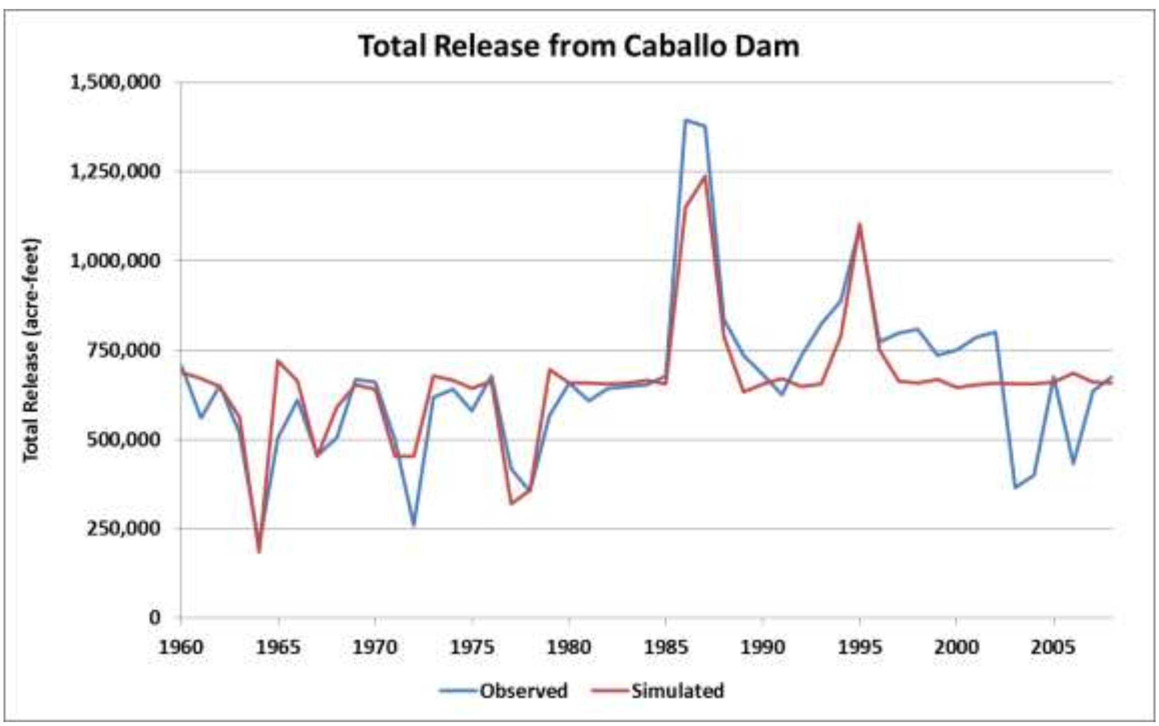


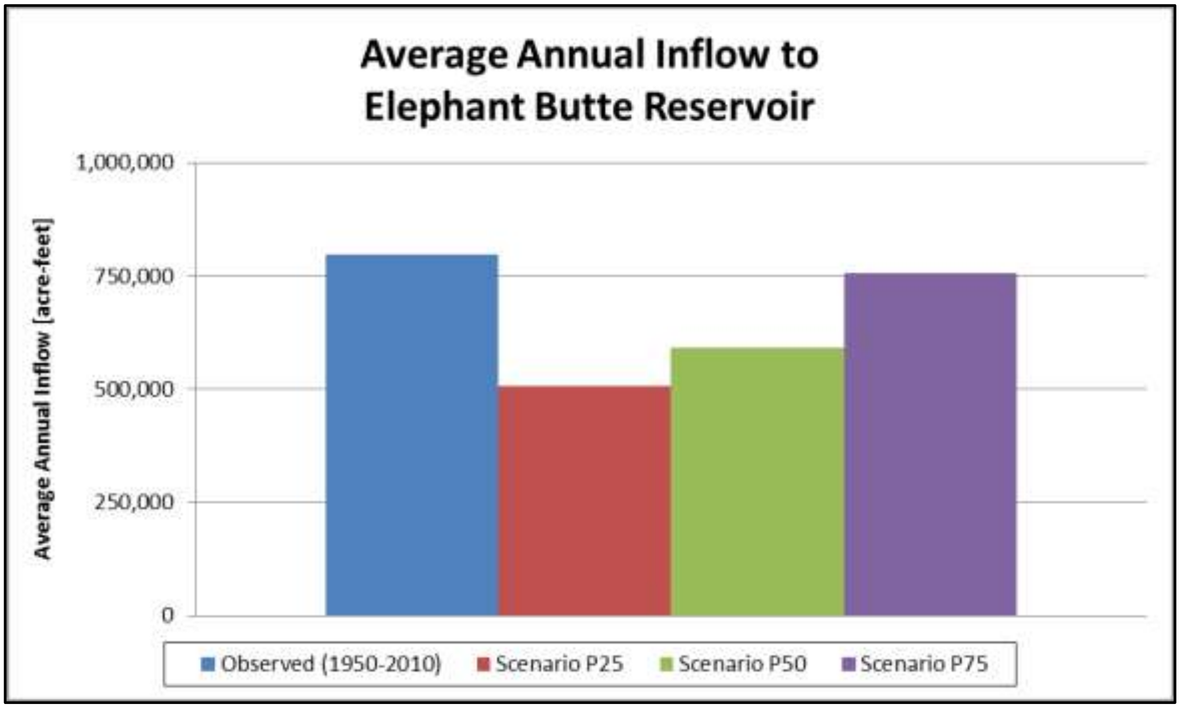
Figure 4-2. Observed and simulated annual release from Caballo Dam (acre-feet) from 1960 to 2010



The delivery requirement of RGP water to Mexico is calculated dynamically in the model, and the model is structured to short deliveries to the irrigation districts before reducing deliveries of water to Mexico. The model assumes that Mexico uses its full allocation in all years.

Average annual inflows to EBR are illustrated in **Figure 4-3** for observed historical conditions (average over the period 1950 to 2010) and for each of the three selected climate scenarios (average over the period 2007 to 2050). The modeling shows a future trend toward less average annual inflow in all scenarios.

Figure 4-3. Observed Historical Average Annual Inflow to EBR from 1950 to 2010 (acre-feet) and Projected Future Average Annual Inflow to EBR during the Simulation Period (2007 to 2050) for the Climate Scenarios Considered in Support of this EIS



San Juan–Chama Project inflows were subtracted from model inflow inputs, and the model runs were made without deliveries. The amount of San Juan–Chama Project water in EBR was calculated after the model runs were complete by assuming the available storage was 50,000 AFY or the unused storage in Elephant Butte, whichever is less.

4.3.2 Summary of Alternatives Simulated

Impacts were calculated by simulating five alternatives, and comparing the modeled output against the No Action Alternative. Each alternative was modeled using the three hydrologies representing a wet, dry, and average future hydrology.

Table 4-1 is a summary description of the final alternatives considered for detailed study and how each is modeled. A full description of the modeling methods and assumptions is in **Appendix C**, Hydrology Technical Memo (Reclamation 2015a).

Table 4-1. Summary of Alternatives Modeling

Alternative Number	Alternative Name	Description	Hydrologic and Water Operations Modeling Method
1	No Action Alternative	Continue to implement the OA and continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR.	Use the verified MF-OWHM model with Farm Process Package and model assumptions; added San Juan–Chama Project storage as post-processing package.
2	No San Juan–Chama Project Storage	Continue to implement the OA but do not store San Juan–Chama Project water in EBR.	Use the verified MF-OWHM model with Farm Process Package and model assumptions.
3	No carryover allocation	Implement only one of the two components of the OA and continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR.	Modify the code to remove carryover allocation and use the verified MF-OWHM model with Farm Process Package and model assumptions; add San Juan–Chama Project storage as post-processing package.
4	No diversion ratio adjustment	Implement only one of the two components of the OA and continue to store up to 50,000 AFY of San Juan–Chama Project water in EBR.	Modify the code to remove diversion ratios and use the verified MF-OWHM model with Farm Process Package and model assumptions; add San Juan–Chama Project storage as post-processing package.
5	Prior operating (ad hoc) practices	Continue operations before the OA (as summarized for the modeling) into the future condition.	Use the verified MF-OWHM model with Farm Process Package and model assumptions; add San Juan–Chama Project storage as post-processing package.

Modeling the alternatives was completed by alternating the status of the three variables. **Table 4-1** shows how the three variables—the diversion ratio adjustment, the carryover accounting, and the storage of San Juan–Chama water—were set in the five alternatives. Note that Alternative 5 would allow a comparison through 2050 of operations under the OA and a simulation of procedures prior to the OA by eliminating the carryover and diversion ratio adjustment provisions. This simulation cannot include certain adjustments that were made in operating methods, equations, and procedures prior to the OA. Alternative 5 is the best possible representation of prior operating (ad hoc) practices under this EIS model, but it is not the same as historical operations (often referred to as ad hoc operations), which varied over time. The simulated prior operating (ad hoc) practices are based on strict application of the D-1 and D-2 Curves. Alternative 5 represents the No Action Alternative in the SEA (Reclamation 2013a), using the MF-OWHM.

4.3.3 Summary of Model Outputs

Based on the modeling, key findings of the simulations are identified and described below. More detailed discussions of modeled results are provided for selected environmental indicators in the resource sections.

Rio Grande Project Storage

For each of the three climate scenarios (P25, P50, and P75), the rate and timing of simulated fluctuations in total storage and project storage in Elephant Butte and Caballo Reservoirs are qualitatively similar across all EIS alternatives. Modeling results suggest that EIS alternatives are not likely to have a strong effect on RGP storage or total annual RGP releases. Total storage is the total volume of water in Elephant Butte and Caballo Reservoirs at the end of each month (acre-feet), while project storage is the total volume of RGP water[1] in Elephant Butte and Caballo Reservoirs at the end of each month, exclusive of Rio Grande Compact credit water and San Juan–Chama Project water (acre-feet).

Rio Grande Project Diversions and Deliveries

The diversions and deliveries to EPCWID exhibit little sensitivity to alternative allocation and accounting procedures.

Total Farm Deliveries (Surface Water and Groundwater)

The simulations carried out in support of the EIS assume that crop irrigation requirements are met in full. Irrigation requirements that are not met by RGP surface water deliveries are assumed to be met through supplemental groundwater pumping. This supplemental water represents actions by individual farmers, neither pumped nor authorized by the Federal Project. As a result, combined total delivery of water, including RGP surface

[1] Project storage is the combined capacity of EBR 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 (http://www.wrri.nmsu.edu/wrdis/compacts/Rio-Grande-Compact.pdf).

water and supplemental groundwater to RGP lands in Rincon and Mesilla Valleys, is nearly identical under all alternatives.

Because the deliveries of RGP surface water vary among alternatives, the portion of total deliveries and consumptive use met by RGP surface water varies accordingly. The model simulations assume that the proposed alternatives do not affect the total delivery and consumptive use in EBID and the portion of EPCWID in the Mesilla Valley, but they do affect the portion of deliveries and consumptive use met by RGP surface water.

Groundwater Elevations and Rio Grande Project Performance

Groundwater elevations in the Rincon and Mesilla Basins exhibit both seasonal and multiyear variations under all alternatives. During years with full RGP water supply, groundwater elevations rise during the irrigation season under all alternatives. Recharge from river seepage, canal seepage, and deep percolation of irrigation water exceed groundwater pumping for supplemental irrigation. Groundwater elevations decline during the non-irrigation season when the hydraulic gradient of groundwater is from the aquifer into the surrounding drains and contributes to riparian evapotranspiration. In addition to seasonal fluctuations, groundwater elevations exhibit multiyear trends under all alternatives.

When the OA results in a decrease in allocation, recharge and deep percolation are likely to decrease, while demand for supplemental irrigation is likely to increase, which may promote increased groundwater pumping within the district, under permits issued by the State of New Mexico (Reclamation 2013b). Modeling results suggest that the diversion ratio adjustment provision of the OA correlates with increased declines in groundwater levels and RGP performance during sustained dry periods; however, these effects are temporary and do not result in permanent effects on groundwater resources or RGP performance.

Climate Uncertainties

For each EIS alternative, RGP storage, releases, diversions, and deliveries vary among the three climate scenarios. In addition, relative differences in storage, releases, diversions, and deliveries between alternatives also vary among climate scenarios. Results suggest that uncertainties in future operations resulting from variations in future climate and hydrologic conditions show effects that are much larger than the estimated effects of proposed allocation and accounting alternatives.

4.4 Surface Water

The water resource impacts are divided into surface water, groundwater, and water quality. The surface water in the reach of the Rio Grande that flows through the project area is hydraulically connected to the groundwater in the unconfined alluvial aquifers in the Rincon, Mesilla, and Hueco Basins of New Mexico and Texas. The river and irrigation canals of the project are the primary source of groundwater recharge to these aquifers. The study area reaches include Elephant Butte and Caballo Reservoir pools, the

Rio Grande between the Elephant Butte and Caballo Reservoirs, and the Rio Grande below Caballo Reservoir to diversion points to EBID, EPCWID, and Mexico.

The RGP provides surface water to EBID, which includes 90,640 authorized acres in the Rincon and Mesilla Valleys of southern New Mexico, and to EPCWID, which includes 69,010 authorized acres in the Mesilla and El Paso Valleys of western Texas.

4.4.1 Background

Hydrologic modeling was performed by Reclamation using RMBHM, with model results used to assess the potential differences between the alternatives. Assuming the selected scenarios provide a reasonable representation of future climate-hydrological conditions in the Rincon and Mesilla Basins, the model results can be compared between alternatives to quantify the difference between simulated reservoir operations, streamflows, and allocations of RGP water.

4.4.2 Impact Indicators

Impact indicators were used to quantify the variations between the modeled alternatives. The impact indicators analyzed and their definitions are as follows:

- RGP storage—Total volume of RGP water in Elephant Butte and Caballo Reservoirs at the end of each month, exclusive of Rio Grande Compact credit water and San Juan–Chama Project water (acre-feet).
- Elephant Butte elevation—Water surface elevation of EBR at the end of each month (feet above mean sea level using the RGP vertical datum).
- Annual allocated water—Diversion allocations to EBID and EPCWID determined during each year based on usable water available for current year allocation. Annual allocated water is updated each month throughout the year. Annual allocated water does not include carryover water.
- Total allocation—The total allocation is the sum of the annual allocation, plus the carryover allocation.
- RGP releases—Total volume of RGP water released from Caballo Dam during each year to meet RGP diversion demands (acre-feet).
- Net diversions—Net surface water diversions to each district (acre-feet).
- Farm surface water deliveries—Total volume of surface water delivered to farms (i.e., take out of conveyance and applied to irrigated lands; acre-feet).

Other Indicators

In addition to the seven analyzed indicators detailed above, the model output also included data related to the following:

- Total storage—Total volume of water in Elephant Butte and Caballo reservoirs at the end of each month (acre-feet). Carryover water—Diversion allocations to EBID and EPCWID determined at start of each year, based on the allotment balance remaining at the end of the previous year. Delivery efficiency of EBID and EPCWID—Annual delivery efficiency for each district, computed as total annual RGP surface water delivery, divided by total net surface water diversion for each district (dimensionless).

- Farm consumptive use of EBID and EPCWID—Total volume of water consumed by irrigated agriculture through evapotranspiration from crops within EBID and EPCWID (acre-feet).

4.4.3 Analysis Methods and Assumptions

Hydrologic modeling was performed by Reclamation using RMBHM, with model results used to assess the potential differences between the alternatives. The Reclamation Manual, Directives and Standards CMP 09-02 addresses consideration of the potential impacts of climate change when developing projections of environmental conditions, water supply and demand, and operational conditions at existing facilities (Reclamation 2012).

Model output representing the 25^{th} percentile (drier), the 50^{th} percentile (central tendency, not wetter or drier), and the 75^{th} percentile (wetter) for 3 of 112 scenarios is shown for each alternative. Because probabilities are not assigned to the scenarios, each scenario is statistically equally likely to occur in a given year. For this analysis, the interpretation of model results is that the most reasonably foreseeable future fluctuations would be within the range bracketed by the 20th and 80th exceedance probabilities for each scenario.

The selection of these values is based on the CEQ and DOI regulations for implementing NEPA (40 CFR 1502.22), which state that NEPA analyses should consider reasonably foreseeable environmental impacts and not worst case analyses with low probabilities of occurrence. This analysis uses the 20^{th} and 80^{th} percentiles of non-exceedance curves to represent a wider range of values for either extreme. The wider range of values allows consideration of possible future outcomes.

Each of the five alternatives was run three times, once with each of the runoff projections to determine the effects under wetter, drier, and no-change future conditions. Assuming the selected scenarios provide a reasonable representation of likely future climate-hydrological conditions in the Rincon and Mesilla Basins, the MF-OWHM output provides a quantitative comparison between alternatives between simulated reservoir operations, streamflows, allocations of RGP water, and groundwater elevations. The economic model analyzed the El Paso Valley by making assumptions using the Rincon and Mesilla Basins model information on diversions by EPCWID to estimate water deliveries to agriculture and municipal and industrial uses.

4.4.4 Effects Common to All Alternatives

A summary of general modeling outputs, including effects noted for all alternatives, is presented in **Section 4.3.3**. An important common modeling output is that the assumptions used to simulate the future climate/hydrologic scenarios show effects that are much larger than the effects of the OA alternatives. Therefore, the effects of the agency's discretionary action of selecting one or another operating procedure are less than the projected effects of future non-discretionary climate change.

Modeling results are shown for the following:

- Elephant Butte elevation
- Total storage
- RGP storage
- Annual allocated water
- Carryover water
- RGP releases
- Net diversions
- Farm surface water deliveries
- Delivery efficiency of EBID and EPCWID
- Farm consumptive use of EBID and EPCWID

Each of these terms has been defined previously in **Section 4.4.2**. Results for each alternative are compared to Alternative 1 (No Action Alternative). A comparison of impacts on surface water among alternatives is presented at the end of the section.

4.4.5 Alternative 1: No Action Alternative

Rio Grande Project Storage

RGP storage is defined as the total volume of RGP water in Elephant Butte and Caballo Reservoirs at the end of each month, exclusive of Rio Grande Compact credit water and San Juan–Chama Project water (acre-feet). Monthly RGP storage average values under Alternative 1 are as follows:

Alternative 1	**Rio Grande Project storage (acre-feet)**		
	P25	**P50**	**P75**
Average annual	235,889	409,453	421,483

Elephant Butte Elevations

Under Alternative 1 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. **Figure 4-4** presents the non-exceedance curve for Alternative 1. The simulated range of EBR elevations for each scenario under Alternative 1 is as follows:

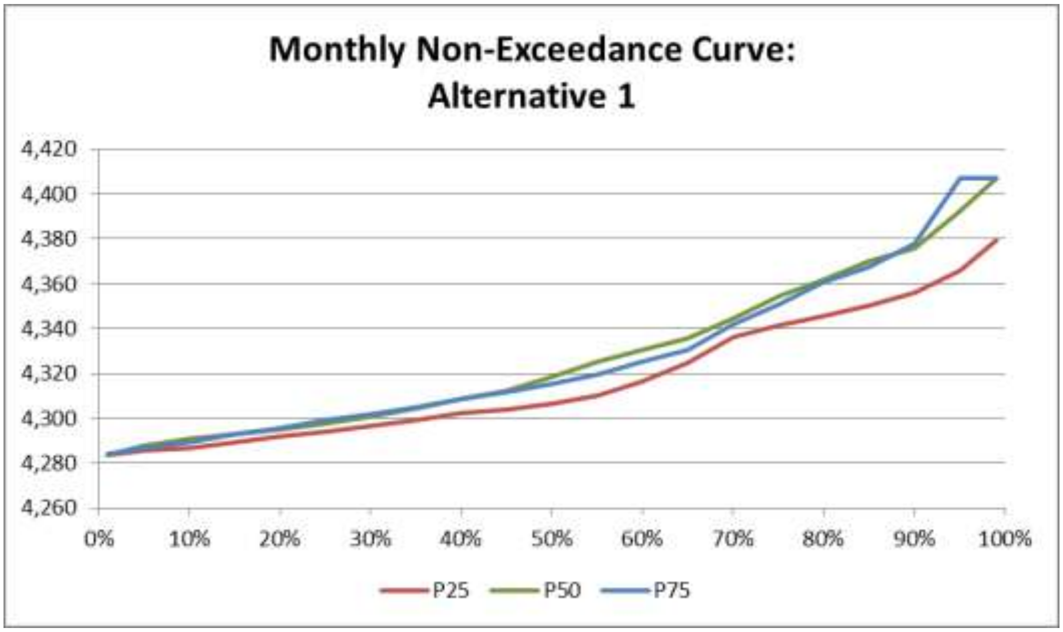
Alternative 1	**Elephant Butte elevation (feet)**		
	P25	**P50**	**P75**
Simulated range	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407

Annual Allocation to EBID and EPCWID

The mean annual allocations to EBID under Alternative 1 are as follows:

	EBID annual allocation (acre-feet)		
	P25	P50	P75
Alternative 1	128,759	146,977	196,998

Figure 4-4. Simulated EBR Water Surface Elevations, Alternative 1



The mean annual allocations to EPCWID are as follows:

	EPCWID annual allocation (acre-feet)		
	P25	P50	P75
Alternative 1	231,180	266,327	309,726

As detailed above, under the No Action Alternative, annual allocations to both EBID and EPCWID increase with the supply of water.

Total Allocation

The mean total allocations of water to EBID under Alternative 1 are as follows:

	EBID total allocation (acre-feet)		
	P25	P50	P75
Alternative 1	190,055	213,053	280,067

The mean total allocations of water to EPCWID are as follows:

	EPCWID total allocation (acre-feet)		
	P25	P50	P75
Alternative 1	328,487	389,524	435,555

As detailed above, under the No Action Alternative, total allocations to both EBID and EPCWID increase with the supply of water.

Rio Grande Project Releases

The mean annual releases of RGP water from Caballo Reservoir to meet RGP diversion demands under Alternative 1 are as follows:

	Rio Grande Project releases (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	477,934	524,597	582,525

As detailed above, under the No Action Alternative, RGP releases increase with the supply of water.

Net Diversions

The net diversions (as defined in **Appendix C**) to EBID under Alternative 1 are as follows:

	EBID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	131,931	153,583	197,272

The net diversions for Mesilla Valley in EPCWID are as follows:

	EPCWID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	38,500	46,703	43,221

As detailed above, under the No Action Alternative, net diversions by EBID increase with water supply, while diversions by EPCWID peak for the P50 scenario. Note that net diversions to EPCWID are calculated for Mesilla Valley only.

Farm Surface Water Deliveries

Farm surface water deliveries for EBID are as follows:

	EBID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	58,605	72,841	86,780

The farm surface deliveries for Mesilla Valley in EPCWID are as follows:

	EPCWID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	13,259	15,954	17,156

As detailed above, under the No Action Alternative, surface water deliveries to both EBID and EPCWID increase with the supply of water.

4.4.6 Alternative 2: No San Juan–Chama Project Storage

Rio Grande Project Storage

RGP storage is the same under Alternative 2 as under Alternative 1 for all three scenarios.

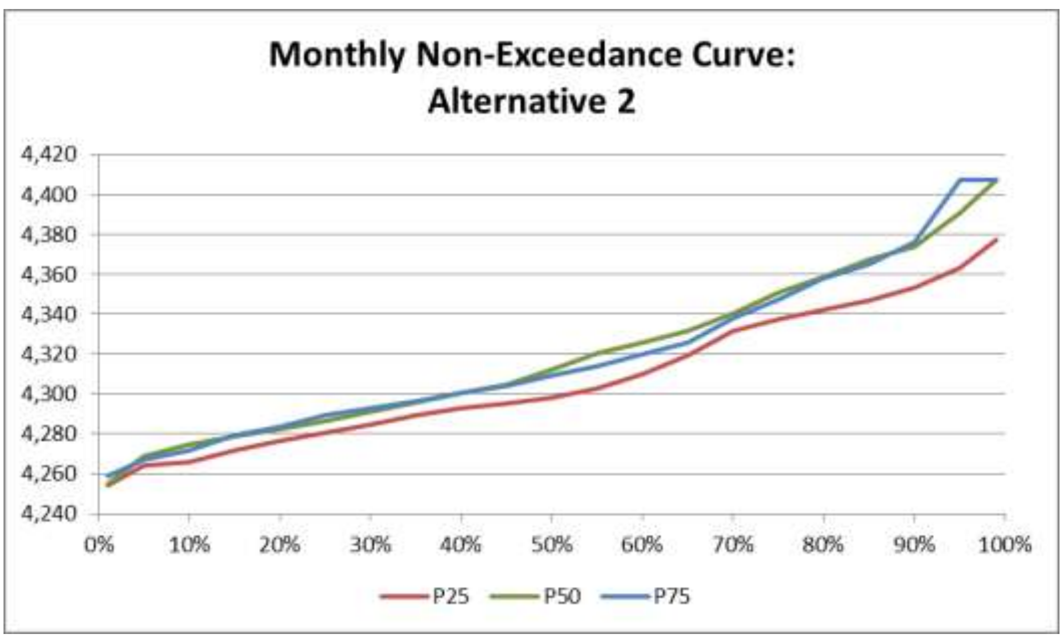
Elephant Butte Elevations

Under Alternative 2, the range of EBR elevations are as follows:

	Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 2	4,254 to 4,377	4,254 to 4,407	4,283 to 4,407

Under Alternative 2 the overall range of reservoir elevations modeled for the three climate scenarios is 4,254 to 4,407 feet. Over the period of record, the mean elevation for Alternative 2 is 4,307 feet for P25 (10 feet lower than the No Action Alternative) and the same mean elevation 4,319 feet for P50 and P75 (8 feet lower than the No Action Alternative). The simulations show that under Alternative 2, the percentage of the time the reservoir is full is the same for all scenarios under each of the three climate scenarios: never full in P25 climate scenario, full 3 percent of the time under P50, and full 6 percent of the time for the P75 climate scenario. **Figure 4-5** presents the non-exceedance curve for Alternative 2.

Figure 4-5. Simulated EBR water surface elevations, Alternative 2



Annual Allocation to EBID and EPCWID

The mean annual allocation of water to EBID and EPCWID is the same for Alternative 2 as for Alternative 1 under all three scenarios.

Total Allocation

The mean total allocations of water to EBID and EPCWID are the same for Alternative 2 as for Alternative 1 under all three scenarios.

Rio Grande Project Releases

The mean annual release of RGP water from Caballo Reservoir is the same for Alternative 2 as for Alternative 1 under all three scenarios.

Net Diversions

Net diversions (as defined in **Appendix C**) for EBID and for Mesilla Valley in EPCWID are the same for Alternative 2 as for Alternative 1 under all three scenarios (note that net diversions to EPCWID are calculated for Mesilla Valley only).

Farm Surface Water Deliveries

Farm surface water deliveries for EBID and for Mesilla Valley in EPCWID are the same for Alternative 2 as for Alternative 1 under all three scenarios.

4.4.7 Alternative 3: No Carryover Provision

Rio Grande Project Storage

The RGP storage under all scenarios (P25, P50, and P75) follow the same pattern, with a maximum storage in March, followed by a general decline until November. The ratio of the mean monthly RGP water supply for Alternative 3 compared to Alternative 1 is as follows:

	Rio Grande Project storage (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	235,889	409,453	421,483
Alternative 3	224,325	399,510	419,065
Percent of Alternative 1	95%	98%	99%

Alternative 3 results in a lower average project storage than Alternative 1. As shown above, this ranges from 95 percent of storage for the P25 Scenario to 99 percent in the P75 Scenario. This is expected because Alternative 3 does not include a provision to carry over storage, which results in less stored water in a given year.

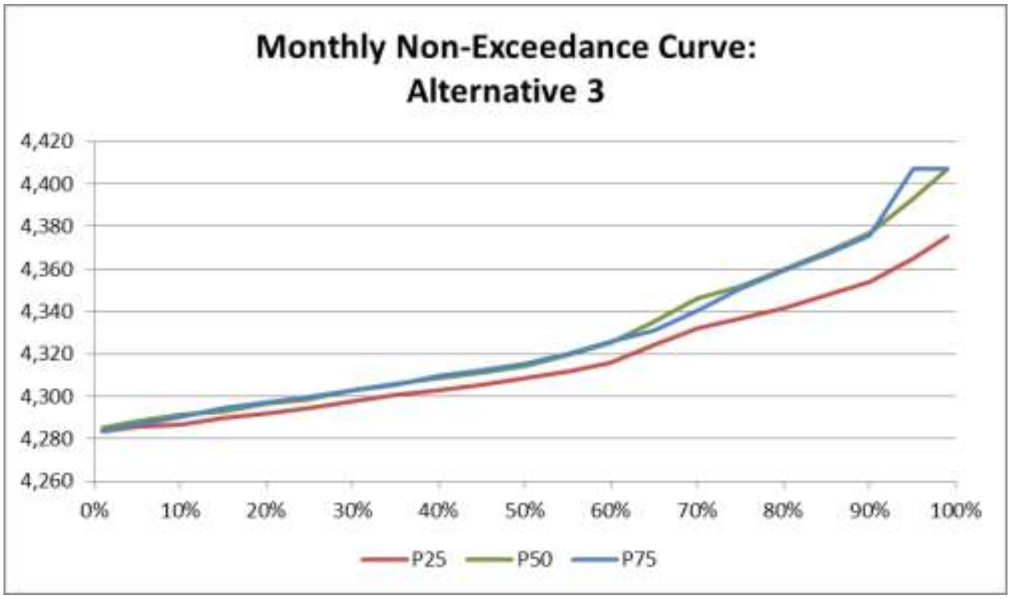
Elephant Butte Reservoir Elevations

Under Alternative 3, the range of EBR elevations are as follows:

	Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 3	4,284 to 4,375	4,285 to 4,407	4,283 to 4,407

Under Alternative 3 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Over the period of record, the mean elevation for Alternative 3 is 4,316 feet for P25 (1 foot higher than the No Action Alternative), and the 4,327 feet for P50 and P75 (the same as the No Action Alternative). The simulations show that under Alternative 3, the percentage of the time the reservoir is full is the same for all scenarios within each of the three climate scenarios; never full in P25 climate scenario, full 3 percent of the time under P50, and full 6 percent of the time for the P75 climate scenario. **Figure 4-6** presents the non-exceedance curve for Alternative 3.

Figure 4-6. Simulated EBR water-surface elevations, Alternative 3



Annual Allocation to EBID and EPCWID

The mean annual allocations to EBID under Alternative 3 are as follows:

	EBID annual allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	128,759	146,977	196,998
Alternative 3	207,180	264,752	298,875
Percent of Alternative 1	161%	180%	152%

The mean annual allocations to EPCWID under Alternative 3 are as follows:

	EPCWID Annual Allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	231,180	266,327	309,726
Alternative 3	240,025	267,973	303,640
Percent of Alternative 1	104%	101%	98%

Alternative 3 results in a significantly higher average annual allocation of project water to EBID than Alternative 1, while EPCWID would see a slight increase in Scenarios P25 and P50, with a slight decrease in P75. As shown above, EBID allocations range from 152 percent to 180 percent, while EPCWID ranges from 98 percent to 104 percent, with the largest allocation coming in Scenario P25.

Total Allocation

Under Alternative 3, the mean total allocations of water to EBID are as follows:

	EBID total allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	190,055	213,053	280,671
Alternative 3	207,180	264,752	298,875
Percent of Alternative 1	109%	124%	106%

The mean total allocations of water to EPCWID are as follows:

	EPCWID total allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	328,487	389,524	435,555
Alternative 3	240,025	267,973	303,640
Percent of Alternative 1	73%	69%	70%

Alternative 3 results in a slightly higher total annual allocation of project water to EBID than Alternative 1, while EPCWID would see decreases in all scenarios. As shown above, EBID allocations range from 106 percent to 124 percent, while EPCWID ranges from 69 percent to 73 percent.

Rio Grande Project Releases

The mean annual releases of RGP water from Caballo Reservoir under Alternative 3 are as follows:

	Rio Grande Project releases (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	477,934	524,597	582,525
Alternative 3	478,320	525,808	578,858
Percent of Alternative 1	100%	100%	99%

Mean annual releases of RGP water under Alternative 3 are the same as under Alternative 1 for the P25 and P50 scenarios and 99 percent of Alternative 1 under Scenario P75.

Net Diversions

The net diversions (as defined in **Appendix C**) for EBID under Alternative 3 are as follows:

	EBID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	131,931	153,583	197,272
Alternative 3	154,454	198,287	217,316
Percent of Alternative 1	117%	129%	110%

The net diversions for Mesilla Valley in EPCWID under Alternative 3 are as follows:

	EPCWID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	38,500	46,703	43,221
Alternative 3	30,554	34,805	36,805
Percent of Alternative 1	79%	75%	85%

Alternative 3 results in a higher Net Diversion of project water to EBID than Alternative 1, while EPCWID would see decreases in all scenarios. As shown above, the change in EBID allocations ranges from 110 percent to 129 percent, while the change in EPCWID allocation ranges from 75 percent to 85 percent.

Farm Surface Water Deliveries

Farm surface water deliveries for EBID under Alternative 3 are as follows:

	EBID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	58,605	72,841	86,780
Alternative 3	70,101	94,477	99,232
Percent of Alternative 1	120%	130%	114%

Farm surface water deliveries for Mesilla Valley in EPCWID are as follows:

	EPCWID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	13,259	15,954	17,156
Alternative 3	12,416	15,029	16,553
Percent of Alternative 1	94%	94%	96%

Deliveries of surface water to EPCWID are calculated for Mesilla Valley only. Alternative 3 results in a higher delivery of surface water to EBID than Alternative 1, while EPCWID deliveries are lower in all scenarios. As shown above, EBID allocations range from 114 percent to 130 percent, while EPCWID ranges from 94 percent to 96 percent.

4.4.8 Alternative 4: No Diversion Ratio Adjustment

Rio Grande Project Storage

RGP storage for all scenarios (P25, P50, and P75) would follow the same pattern, with a maximum storage in March, followed by a general decline until November. The ratio of the mean monthly RGP water supply for Alternative 4 compared to Alternative 1 is as follows:

	Rio Grande Project storage (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	235,889	409,453	421,483
Alternative 4	188,267	371,591	376,539
Percent of Alternative 1	80%	91%	89%

Alternative 4 results in less project storage than Alternative 1. As shown above, this ranges from 80 percent of storage for the P25 Scenario to 91 percent in the P50 Scenario. While the carryover of San Juan–Chama Project storage is allowed in this scenario, this additional water is more than offset by the discontinuation of diversion ratio adjustments.

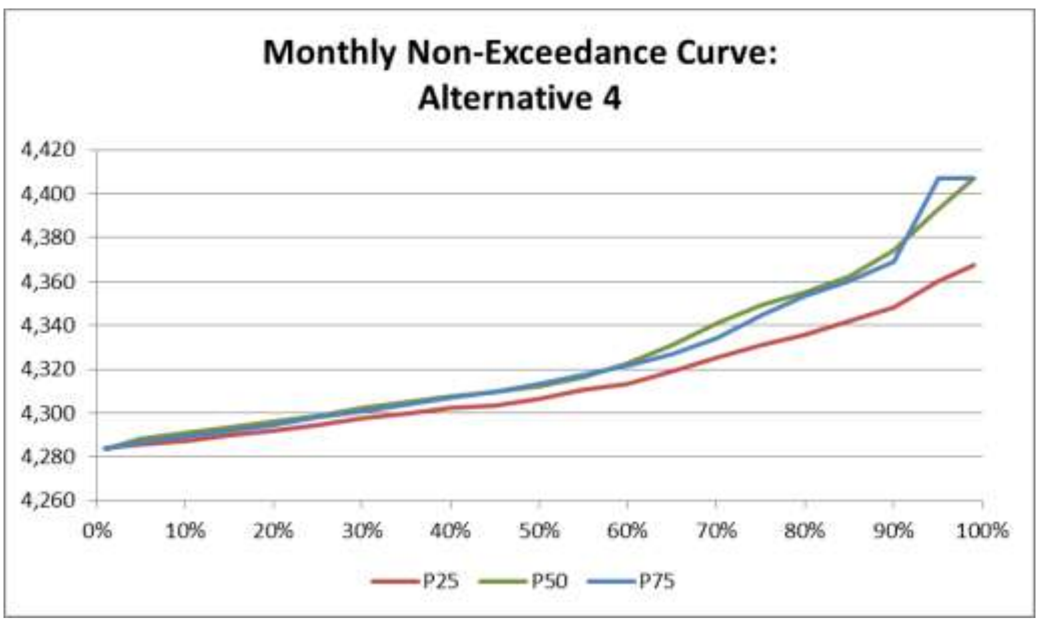
Elephant Butte Reservoir Elevations

Under Alternative 4, the range of EBR elevations are as follows:

	Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 4	4,284 to 4,368	4,283 to 4,407	4,283 to 4,407

Under Alternative 4 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Over the period of record, the mean elevation for Alternative 4 is 4,313 feet for P25 (4 feet lower than under the No Action Alternative), 4,325 feet for P50 (2 feet lower) and 4,324 feet for P75 (three feet lower). The simulations show that under Alternative 4, the percentage of the time the reservoir is full is the same for all scenarios under each of the three climate scenarios: never full in the P25 climate scenario, full 3 percent of the time under P50, and full 6 percent of the time for the P75 climate scenario. **Figure 4-7** presents the non-exceedance curve for Alternative 4.

Figure 4-7. Simulated EBR Water-Surface Elevations, Alternative 4



Annual Allocation to EBID and EPCWID

The mean annual allocations to EBID under Alternative 4 are as follows:

	EBID Annual Allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	128,759	146,977	196,998
Alternative 4	230,319	272,269	320,104
Percent of Alternative 1	179%	185%	162%

The mean annual allocation to EPCWID under Alternative 4 is as follows:

	EPCWID annual allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	231,180	266,327	309,726
Alternative 4	175,357	207,296	243,716
Percent of Alternative 1	76%	78%	79%

Alternative 4 results in a significantly higher average annual allocation of RGP water to EBID than Alternative 1, while EPCWID would see decreases in allocation. As shown above, EBID allocations range from 162 percent to 185 percent, while EPCWID ranges from 76 percent to 79 percent.

Total Allocation

Under Alternative 4, the mean total allocations of water to EBID are as follows:

	EBID total allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	190,055	213,053	280,671
Alternative 4	278,015	321,955	410,996
Percent of Alternative 1	146%	151%	146%

The mean total allocations of water to EPCWID are as follows:

	EPCWID total allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	328,487	389,524	435,555
Alternative 4	260,666	310,152	356,520
Percent of Alternative 1	79%	80%	82%

Alternative 4 results in a significantly higher total annual allocation of project water to EBID than Alternative 1, while EPCWID would see decreases in all scenarios. As shown above, EBID allocations range from 146 percent to 151 percent, while EPCWID ranges from 79 percent to 82 percent.

Rio Grande Project Releases

The mean annual releases of RGP water from Caballo Reservoir under Alternative 4 are as follows:

	Rio Grande Project releases (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	477,934	524,597	582,525
Alternative 4	482,903	531,229	578,718
Percent of Alternative 1	101%	101%	99%

Mean annual releases of RGP water are 1 percent higher under Alternative 4 than under Alternative 1 for the P25 and P50 scenarios and 99 percent of Alternative 1 under scenario P75.

Net Diversions

The net diversions (as defined in **Appendix C**) for EBID under Alternative 4 are as follows:

	EBID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	131,931	153,583	197,272
Alternative 4	190,038	227,069	266,742
Percent of Alternative 1	144%	148%	135%

The net diversions for Mesilla Valley in EPCWID under Alternative 4 are as follows:

	EPCWID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	38,500	46,703	43,221
Alternative 4	24,968	29,491	30,701
Percent of Alternative 1	64%	63%	71%

Net diversions to EPCWID are calculated for Mesilla Valley only. Alternative 4 results in a higher net diversion of project water to EBID than Alternative 1, while EPCWID saw decreases in all scenarios. As shown above, EBID allocations range from 135 percent to 148 percent, while EPCWID ranges from 63 percent to 71 percent.

Farm Surface Water Deliveries

Farm surface water deliveries for EBID under Alternative 4 are as follows:

	EBID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	58,605	72,841	86,780
Alternative 4	89,961	110,782	130,426
Percent of Alternative 1	154%	152%	150%

The surface water deliveries for Mesilla Valley in EPCWID under Alternative 4 are as follows:

	EPCWID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	13,259	15,954	17,156
Alternative 4	11,949	14,964	15,935
Percent of Alternative 1	90%	94%	93%

Deliveries of surface water to EPCWID are calculated for Mesilla Valley only. Alternative 4 results in a higher delivery of surface water to EBID than under Alternative 1, while EPCWID saw decreases in all scenarios. As shown above, EBID allocations range from 150 percent to 154 percent, while EPCWID ranges from 90 percent to 94 percent.

4.4.9 Alternative 5: Prior Operating (Ad Hoc) Practices

Rio Grande Project Storage

The RGP storage for all scenarios (P25, P50, and P75) follows the same pattern, with a maximum storage in March, followed by a general decline until November. The ratio of the mean monthly RGP water supply for Alternative 5 compared to Alternative 1 is as follows:

	Rio Grande Project storage (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	235,889	409,453	421,483
Alternative 5	200,092	389,109	398,595
Percent of Alternative 1	85%	95%	95%

Alternative 5 generally results in less project storage than Alternative 1. As shown above this ranges from 85 percent of storage for the P25 Scenario to 95 percent in the P75 scenario. This occurs because, while Alternative 5 does include San Juan–Chama Project storage, it discontinues the diversion ratio adjustment and discontinues the carryover accounting, resulting in less stored water.

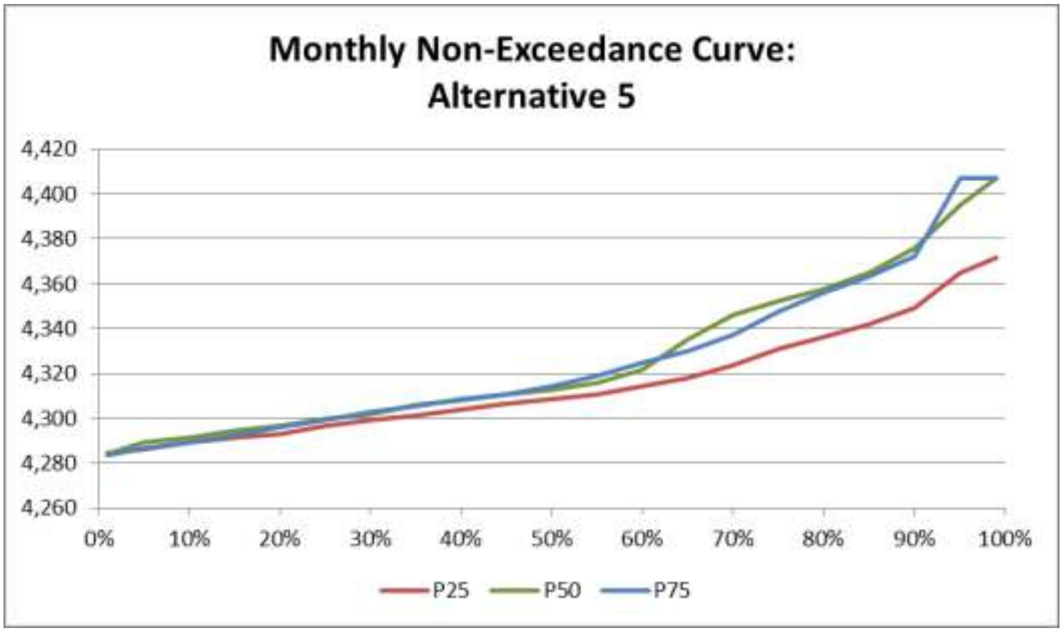
Elephant Butte Reservoir Elevations

Under Alternative 5, the range of EBR elevations are as follows:

	Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 5	4,284 to 4,372	4,283 to 4,407	4,283 to 4,407

Under Alternative 5 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Over the period of record, the mean elevation for Alternative 5 is 4,315 feet for P25 (2 feet lower than the No Action Alternative), 4,326 feet for P50 (1 foot lower) and 4,325 feet for P75 (2 feet lower). The simulations show that under Alternative 5, the percentage of the time the reservoir is full is the same for all scenarios within each of the three climate scenarios: never full under the P25 climate scenario, full 3 percent of the time under P50, and full 6 percent of the time under P75. **Figure 4-8** presents the non-exceedance curve for Alternative 5.

Figure 4-8. Simulated EBR water-surface elevations, Alternative 5



Annual Allocation to EBID and EPCWID

The mean annual allocations to EBID under Alternative 5 are as follows:

	EBID annual allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	128,759	146,977	196,998
Alternative 5	268,652	314,327	362,229
Percent of Alternative 1	209%	214%	184%

The mean annual allocations to EPCWID under Alternative 5 are as follows:

	EPCWID annual allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	231,180	266,327	309,726
Alternative 5	204,542	239,317	275,788
Percent of Alternative 1	88%	90%	89%

Alternative 5 results in a much higher average annual allocation of project water to EBID than Alternative 1, while EPCWID would see a decrease in all scenarios. As shown in the tables above, EBID allocations range from 184 percent to 214 percent, while EPCWID ranges from 88 percent to 90 percent.

Total Allocation

Under Alternative 5, the mean total allocations of water to EBID are as follows:

	EBID total allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	190,055	213,053	280,671
Alternative 5	268,652	314,327	362,229
Percent of Alternative 1	141%	148%	129%

The mean total allocations of water to EPCWID are as follows:

	EPCWID total allocation (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	328,487	389,524	435,555
Alternative 5	204,542	239,317	275,788
Percent of Alternative 1	62%	61%	63%

Alternative 5 results in higher total annual allocations of project water to EBID than Alternative 1, while EPCWID would see significant decreases under all scenarios. As shown in the tables above, EBID allocations range from 129 percent to 148 percent, while EPCWID ranges from 61 percent to 63 percent.

Rio Grande Project Releases

The mean annual releases of RGP water from Caballo Reservoir under Alternative 5 are as follows:

	Rio Grande Project releases (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	477,934	524,597	582,525
Alternative 5	480,759	527,421	579,785
Percent of Alternative 1	101%	101%	100%

Mean annual releases of RGP water are 1 percent higher under Alternative 5 than under Alternative 1 for the P25 and P50 scenarios and 100 percent under Alternative 1 for scenario P75.

Net Diversions

The net diversions (as defined in **Appendix C**) for EBID under Alternative 5 are as follows:

	EBID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	131,931	153,583	197,272
Alternative 5	189,864	228,363	256,654
Percent of Alternative 1	144%	149%	130%

The net diversions for Mesilla Valley in EPCWID under Alternative 5 are as follows:

	EPCWID net diversions (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	38,500	46,703	43,221
Alternative 5	21,361	25,543	29,397
Percent of Alternative 1	55%	55%	68%

Net diversions to EPCWID are calculated for Mesilla Valley only. Alternative 5 results in a higher net diversion of project water to EBID than under Alternative 1, while EPCWID saw decreases under all scenarios. As shown above, EBID allocations range from 130 percent to 149 percent, while EPCWID ranges from 55 percent to 68 percent.

Farm Surface Water Deliveries

Farm surface water deliveries for EBID under Alternative 5 are as follows:

	EBID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	58,605	72,841	86,780
Alternative 5	88,532	110,314	123,473
Percent of Alternative 1	151%	151%	142%

The surface water deliveries for Mesilla Valley in EPCWID under Alternative 5 are as follows:

	EPCWID surface water deliveries (acre-feet)		
	P25	**P50**	**P75**
Alternative 1	13,259	15,954	17,156
Alternative 5	10,999	13,896	15,456
Percent of Alternative 1	83%	87%	90%

Deliveries of surface water to EPCWID are calculated for Mesilla Valley only. Alternative 5 results in a higher delivery of surface water to EBID than Alternative 1, while EPCWID deliveries decrease under all scenarios. As shown in the tables above, EBID allocations range from 142 percent to 151 percent, while EPCWID ranges from 83 percent to 90 percent.

4.4.10 Cumulative Impacts

Surface water supply availability for allocation is not measurably vulnerable to the incremental effects of different operations. The Delta Channel Maintenance Project and Rio Grande Canalization Project listed in **Section 4.2.2** would help maintain available surface water allocations over the long term by improving water delivery into EBR and along the Rio Grande. Combined with the Delta Channel Maintenance Project and Rio Grande Canalization Project, all of the EIS alternatives would maintain surface water allocations to Mexico and would maintain storage in Elephant Butte and Caballo Reservoirs, RGP supply, and delivery efficiency to EBID and EPCWID. Similar beneficial effects would occur under each alternative; therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.4.11 Summary Conclusions

Impact indicators used to compare Alternatives 1 through 5 are described below.

Rio Grande Project Storage

Mean RGP storage was the same for Alternative 2 as Alternative 1, and lower in Alternatives 3, 4, and 5, with the lowest being Alternative 3.

Table 4-2. Summary of Mean Rio Grande Project Storage (acre-feet)

	Rio Grande Project storage (acre-feet)		
	P25	**P50**	**P75**
Alternatives 1 and 2	235,889	409,453	421,483
Alternative 3	224,325	399,510	419,065
Alternative 4	188,267	371,591	376,539
Alternative 5	200,092	389,109	398,595

The modeling results for Alternatives 1 through 5 showed differences of less than 15 percent for average annual total storage in Elephant Butte and Caballo Reservoirs, RGP storage, and delivery efficiency to EBID and EPCWID. Note that total storage is defined as the volume of water in Elephant Butte and Caballo Reservoirs at the end of each month, while project storage is defined as the total volume of RGP water in the Elephant Butte and Caballo Reservoirs at the end of each month, exclusive of Rio Grande Compact credit water and San Juan–Chama Project water.

Elephant Butte Reservoir Elevations

EBR elevations were very similar for all alternatives, except Alternative 2, which is at the low end of the range.

The projected range of monthly water levels is similar for each of the alternatives. The differences among the alternatives are smaller than the differences among climate scenarios; i.e., the effect of future climate change is much larger than the effects of the agency's possible operating alternatives. In other words, the effects of the agency's discretionary action of selecting one or another operating procedure are less than the projected effects of future non-discretionary climate change.

Table 4-3 incorporates climate change modeling and shows the ranges of surface water elevations for EBR.

Table 4-3. Simulated Elephant Butte Reservoir Water Surface Elevations

Alternative	Scenario P25 (Drier Climate Scenario)	Scenario P50 (Central Tendency Climate Scenario)	Scenario P75 (Wetter Climate Scenario)
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 2	4,254 to 4,377	4,254 to 4,407	4,283 to 4,407
Alternative 3	4,284 to 4,375	4,285 to 4,407	4,283 to 4,407
Alternative 4	4,284 to 4,368	4,283 to 4,407	4,283 to 4,407
Alternative 5	4,284 to 4,372	4,283 to 4,407	4,283 to 4,407

The time series for the three climate scenarios for EBR elevation are presented below in Figures **4-9, 4-10,** and **4-11**.

Figure 4-9. Monthly Water Surface Elevation: Elephant Butte Reservoir Simulated EBR Water-Surface Elevations, Scenario P25 (Drier)

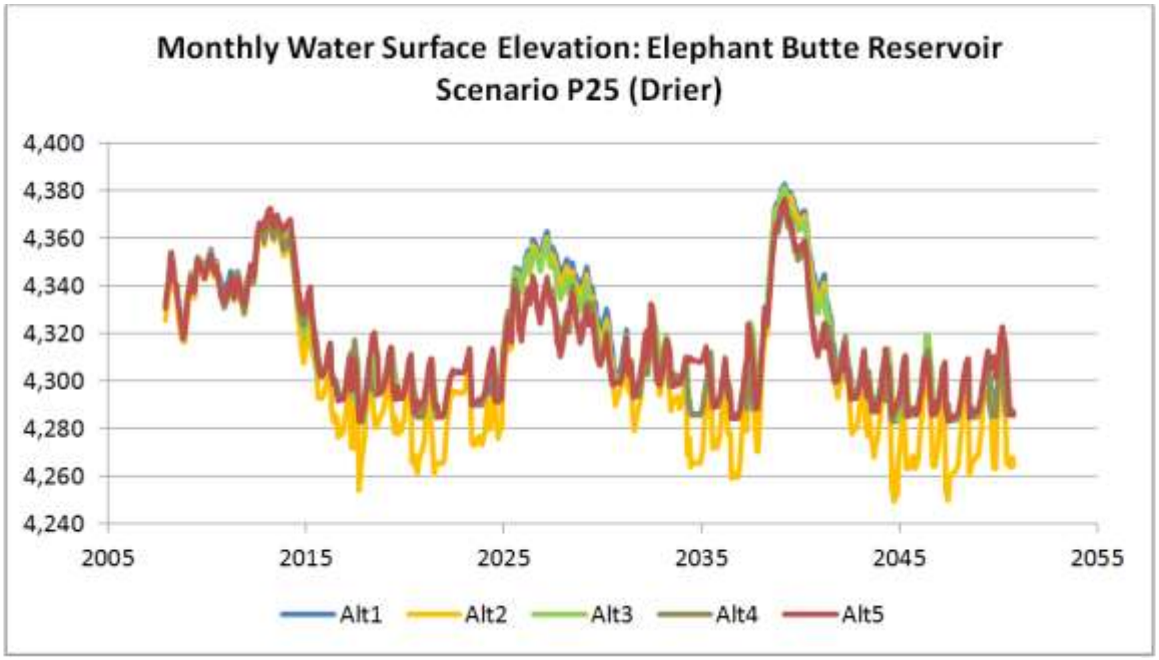


Figure 4-10. Monthly Water Surface Elevation: Elephant Butte Reservoir Simulated EBR Water-Surface Elevations, Scenario P50 (Central Tendency)

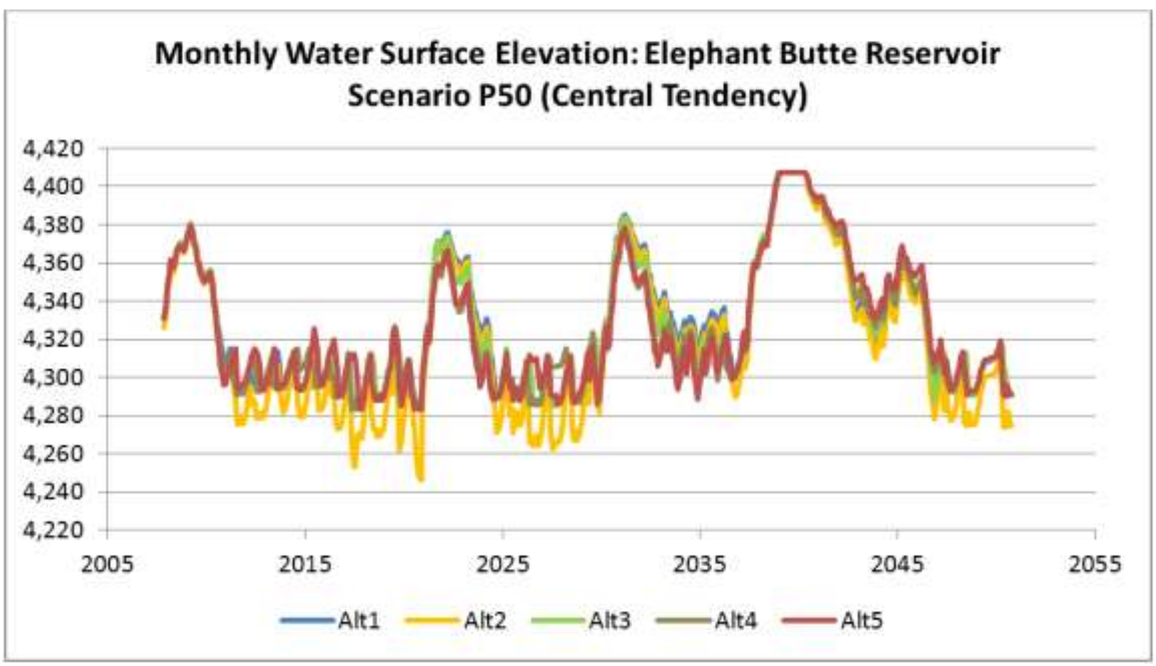
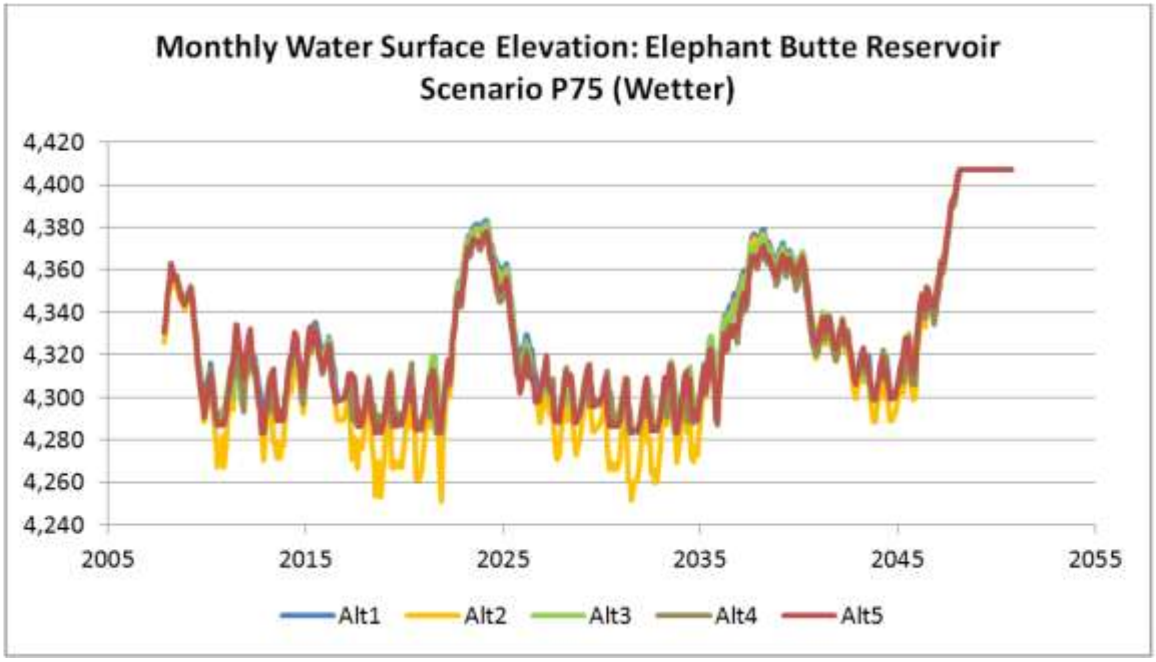


Figure 4-11. Monthly Water Surface Elevation: Elephant Butte Reservoir Simulated EBR Water-Surface Elevations, Scenario P75 (Wetter)



Annual Allocated Water

Modeling results for Alternatives 1 through 5 showed the following differences for annual allocated water to EBID and EPCWID:

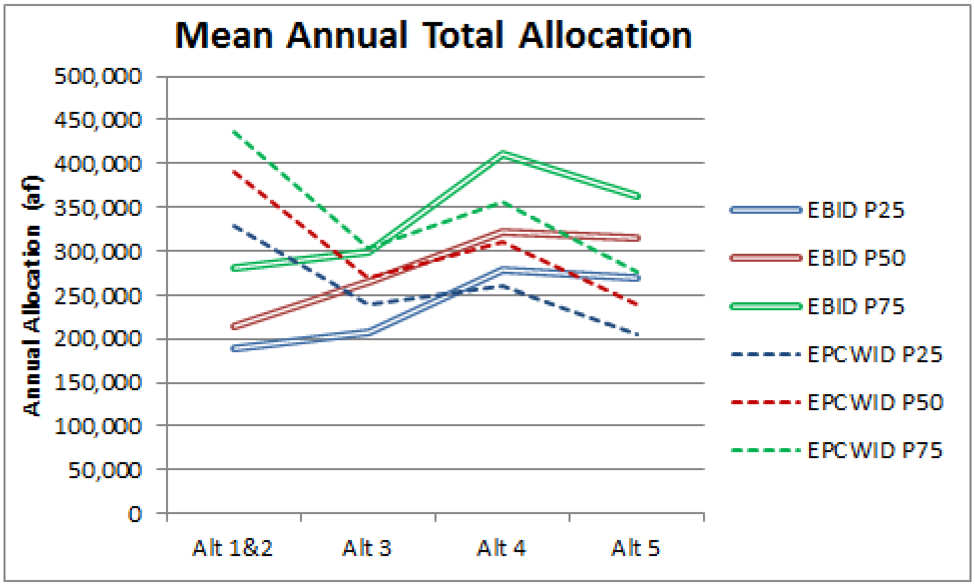
- EBID—Alternative 2 (No San Juan–Chama Project Storage) provides the same allocation as the No Action Alternative. Alternatives 3, 4, and 5 provide more water to EBID than the No Action Alternative. This is consistent across scenarios, though Alternative 4 provides more water than Alternative 5.
- EPCWID—Alternative 2 (No San Juan–Chama Project Storage) provides the same allocation as the No Action Alternative. Alternatives 3, 4, and 5 all provide less water than the No Action Alternative. This is consistent across all scenarios, though Alternative 4 provides more water than Alternative 5.

Total Allocation

Total allocation of water trended in opposite directions for EBID and EPCWID for the various alternatives, with EBID getting more water than Alternative 1 and EPCWID getting less. Across the alternatives there was always more water allocated in the wetter scenarios than drier scenarios.

Figure 4-12 shows the variation in total allocation between alternatives and scenarios for both EBID and EPCWID.

Figure 4-12. Variation in Total Allocation



Rio Grande Project Releases

The modeling results for Alternatives 1 through 5 showed differences of 1 percent or less in the RGP releases for farm use in EBID and EPCWID.

Table 4-4. Mean Annual Release of Rio Grande Project Water

	Mean Annual Release of Rio Grande Project Water (acre-feet)		
	P25	**P50**	**P75**
Alternatives 1 and 2	477,934	524,597	582,525
Alternative 3	478,320	525,808	578,858
Alternative 4	482,903	531,229	587,718
Alternative 5	480,759	527,421	579,785

Net Diversions

Modeling results for Alternatives 1 through 5 showed the following differences for net diversions to EBID and EPCWID:

- Alternatives 3, 4, and 5, when compared to Alternative 1, all provide more water to EBID under each of the three scenarios (P25, P50, and P75).
- Alternatives 3, 4, and 5, when compared to Alternative 1, all provide less water to EPCWID under each of the three scenarios (P25, P50, and P75).

Farm Surface Water Deliveries

Modeling results for Alternatives 1 through 5 showed the following differences for farm surface water deliveries to EBID and EPCWID:

- When compared to Alternative 1, Alternative 2 provides the same range of farm surface water deliveries to EBID. When compared to Alternative 1, Alternative 3 provides a smaller range of farm surface water deliveries, Alternative 4 provides approximately the same range of farm surface water deliveries, and Alternative 5 provides the smallest of farm surface water deliveries. This is true under each of the three scenarios (P25, P50, and P75).

- When compared to Alternative 1, Alternative 2 provides the same range of farm surface water deliveries to EPCWID. When compared to Alternative 1, Alternative 3 provides a smaller range of farm surface water deliveries, Alternative 4 provides approximately the same range of farm surface water deliveries, and Alternative 5 provides the smallest of farm surface water deliveries. This is true under each of the three scenarios (P25, P50, and P75).

4.5 Groundwater

The OA allocates RGP supply to the two irrigation districts and Mexico, although individual farmers may choose to pump groundwater to make up for surface water shortages. Groundwater is a significant supplemental source of irrigation water supply to farmers in EBID and EPCWID, who would pump different amounts of groundwater depending on the alternative and the climate scenario being modeled. However, Reclamation's discretion is only over the delivery of surface water to the diversion points. Modeling the surface water resource in the RMBHM requires inclusion of groundwater/surface water interactions.

For the EBID service area the modeling assumes that current crop demand is fully met by a combination of RGP supply and supplemental groundwater pumping. Groundwater is expected to provide between 71 and 81 percent of the supply under the P25 scenario, between 62 and 76 percent under the P50 scenario, and between 55 and 71 percent under the P75 scenario. For EPCWID, groundwater is projected to provide between 53 and 61 percent of supply to users in the Mesilla Valley portion of EPCWID under the P25 scenario, between 42 and 49 percent under the P50 scenario, and between 37 and 44 percent under the P75 scenario.

4.5.1 Impact Indicators

Three impact indicators were used to quantify the variations between the modeled alternatives, as follows:

- Groundwater pumped by irrigators in EBID and EPCWID
- Groundwater elevations at selected wells in the Rincon and Mesilla Basins
- Change in total groundwater storage in the Rincon and Mesilla Basins

4.5.2 Analysis Methods and Assumptions

Modeling background and overview information was provided in **Section 4.3.** Note that the model computes groundwater pumping based on the difference between the total amount of water required at each grid cell of the model to meet irrigation requirements and the surface water delivery to each cell; therefore, groundwater pumping is equal to the simulated shortage in surface water deliveries.

Operations directly impact surface flows. Crop demand met by pumping supplemental groundwater is not performed or regulated by Reclamation but is considered under cumulative impacts.

4.5.3 Effects Common to All Alternatives

Based on the modeling performed, certain effects are determined to be common to all alternatives. Groundwater levels and pumping in EPCWID are for the Mesilla Valley portion of EPCWID only.

Total Farm Deliveries (Surface Water and Groundwater)

As detailed above, irrigation requirements that are not satisfied by RGP surface water deliveries are assumed to be met through supplemental groundwater pumping. As a result, combined total delivery of RGP surface water and supplemental groundwater to RGP lands in Rincon and Mesilla Valleys is nearly identical under all alternatives.

Groundwater Elevations, Groundwater Storage, and Rio Grande Project Performance

Groundwater elevations and groundwater storage in the Rincon and Mesilla Basins exhibit seasonal and multiyear variations under all alternatives. During years with full RGP water supply, groundwater elevations rise and groundwater storage increases during the irrigation season under all alternatives. Under full RGP water supply conditions, recharge from river seepage, canal seepage, and deep percolation of irrigation water exceed groundwater pumping for supplemental irrigation. Groundwater elevations and storage subsequently decline during the non-irrigation season when the hydraulic gradient of groundwater is from the aquifer into the surrounding drains, and when groundwater contributes to riparian evapotranspiration. Under all alternatives, groundwater elevations and storage decline during the irrigation season during years with low RGP water supply. Under low RGP water supply conditions, groundwater pumping for supplemental irrigation exceeds groundwater recharge from seepage and deep percolation of irrigation water. During dry years, groundwater elevations in the low-lying areas of the Rincon and Mesilla Basins in the vicinity of the Rio Grande rise during the non-irrigation season, because the hydraulic gradient of groundwater flow is from surrounding areas into the low-lying areas. In addition to seasonal fluctuations, groundwater elevations and storage show multiyear trends under all alternatives. These trends are in response to sequences of consecutive wet or dry years. Consecutive wet years result in multiyear rise in groundwater elevations and storage, whereas consecutive dry years result in multiyear declines in groundwater elevations and storage.

RGP performance, as represented by the annual diversion ratio, exhibits similar multiyear behavior, with declines during sustained dry periods and recovery during sustained wet periods. Declines in groundwater levels and RGP performance are greatest under Alternatives 1, 2, and 3, which include the diversion ratio adjustment of the OA. However, groundwater levels, groundwater storage, and RGP performance recover to approximately the same level during sustained wet periods under all alternatives. The modeling results suggest that the diversion ratio adjustment provision of the OA may result in increased declines in groundwater levels and RGP performance during sustained dry periods, but these effects are temporary and do not result in permanent effects on groundwater resources.

4.5.4 Alternative 1: No Action Alternative

Groundwater Pumping in EBID and EPCWID for Supplemental Irrigation

Results indicate that farms in EBID rely more heavily on groundwater than farms in EPCWID under all three scenarios (P25, P50, and P75). For farms in EBID, the percentage of groundwater compared to total supply ranges from 71 to 81 percent, while for farms in EPCWID, the percentage ranges from 37 to 53 percent.

The mean annual pumping from within the area served by EBID is projected to be as follows:

- 251,998 acre-feet (81 percent of total supply) under the P25 scenario
- 221,170 acre-feet (76 percent of total supply) under the P50 scenario
- 211,052 acre-feet (71 percent of total supply) under the P75 scenario

The mean annual pumping from within the area served by EPCWID is projected to be as follow:

- 15,110 acre-feet (53 percent of total supply) under the P25 scenario
- 11,573 acre-feet (42 percent of total supply) under the P50 scenario
- 10,264 acre-feet (37 percent of total supply) under the P75 scenario

Groundwater Elevations at Selected Wells in the Rincon and Mesilla Basins

Water elevation data for 15 wells were used for analysis. Fluctuations in water elevations were similar among all wells within each basin. As a result, data from one well in each basin were used for analysis.

The mean monthly groundwater elevation for the representative well in the Rincon Basin (Rin-2) would be as follows:

- 4,058 feet under the P25 scenario
- 4,060 feet under the P50 scenario
- 4,062 feet under the P75 scenario

The mean monthly groundwater elevation for the representative well in the Mesilla Basin (Mes-6) would be as follows:

- 3,813 feet under the P25 scenario
- 3,814 feet under the P50 scenario

- 3,816 feet under the P75 scenario

Under Alternative 1, mean monthly groundwater elevations for each representative well varied four feet or less, between each climate scenario.

Change in Groundwater Storage in the Rincon and Mesilla Basins

Change in total groundwater storage in the Rincon and Mesilla Basins were used for analysis. Change in total groundwater storage was calculated as the cumulative change in groundwater storage over the RMBHM model domain between the start and end of the simulation period (November 2007 to October 2050).

The cumulative change in groundwater storage over the study period would be as follows:

- -59,118 acre-feet under the P25 scenario
- -31,462 acre-feet under the P50 scenario
- -4,489 acre-feet under the P75 scenario

Under Alternative 1, cumulative change in groundwater storage decreases under all climate scenarios. The decrease under the P25 and P50 scenarios is an order of magnitude greater than the decrease under the P75 scenario.

4.5.5 Alternative 2: No San Juan–Chama Project Storage

Results for Alternative 2 are the same as Alternative 1. See **Section 4.5.4** for numerical values.

Groundwater Pumping in EBID and EPCWID for Supplemental Irrigation

Results for Alternative 2 are the same as Alternative 1. See **Section 4.5.4** for numerical values.

Groundwater Elevations at Selected Wells in the Rincon and Mesilla Basins

Results for Alternative 2 are the same as Alternative 1. See **Section 4.5.4** for numerical values.

Change in Groundwater Storage in the Rincon and Mesilla Basins

Results for Alternative 2 are the same as Alternative 1. See **Section 4.5.4** for numerical values.

4.5.6 Alternative 3: No Carryover Provision

Groundwater Pumping in EBID and EPCWID for Supplemental Irrigation

Modeling results indicate that farms in EBID rely more heavily on groundwater than farms in EPCWID under all three scenarios (P25, P50, and P75).

The mean annual pumping for farms in EBID under Alternative 3 is as follows:

- 239,489 acre-feet (77 percent of total supply) under the P25 scenario

- 202,791 acre-feet (68 percent of total supply) under the P50 scenario
- 197,481 acre-feet (67 percent of total supply) under the P75 scenario

The mean annual pumping for farms in EPCWID under Alternative 3 is as follows:

- 15,951 acre-feet (56 percent of total supply) under the P25 scenario
- 12,486 acre-feet (45 percent of total supply) under the P50 scenario
- 10,859 acre-feet (40 percent of total supply) under the P75 scenario

Less groundwater is pumped in EBID under Alternative 3 than under Alternative 1 under all three climate scenarios. More groundwater is pumped in EPCWID under Alternative 3 than under Alternative 1 under all three climate scenarios.

Groundwater Elevations at Selected Wells in the Rincon and Mesilla Basins

Water elevation data for 15 wells was used for analysis. Variations in groundwater elevations were similar under all three climate scenarios, although elevations were lower in the drier (P25) scenario and higher in the wetter (P75) scenario. As a result, data from one well in each basin was used for analysis.

The mean monthly groundwater elevation for the representative well in the Rincon Basin (Rin-2) under Alternative 3 would be as follows:

- 4,060 feet under the P25 scenario
- 4,062 feet under the P50 scenario
- 4,063 feet under the P75 scenario

The mean monthly groundwater elevation for the representative well in the Mesilla Basin (Mes-6) under Alternative 3 would be as follows:

- 3,813 feet under the P25 scenario
- 3,815 feet under the P50 scenario
- 3,816 feet under the P75 scenario

Under Alternative 3, mean monthly groundwater elevations for each representative well are similar to Alternative 1 under all climate scenarios.

Change in Groundwater Storage in the Rincon and Mesilla Basins

Change in total groundwater storage in the Rincon and Mesilla Basins were used for analysis. Change in total groundwater storage was calculated as the cumulative change in groundwater storage over the RMBHM model domain between the start and end of the simulation period (November 2007 to October 2050).

The cumulative change in groundwater storage over the study period would be as follows:

- -55,139 acre-feet under the P25 scenario
- -28,055 acre-feet under the P50 scenario
- -4,361 acre-feet under the P75 scenario

Under Alternative 3, cumulative change in groundwater storage is similar to Alternative 1 under all climate scenarios.

4.5.7 Alternative 4: No Diversion Ratio Adjustment

Groundwater Pumping by EBID and EPCWID for Supplemental Irrigation

Modeling results indicate that farms in EBID rely more heavily on groundwater than farms in EPCWID under all three scenarios (P25, P50, and P75).

The mean annual pumping by farms in EBID under Alternative 4 is as follows:

- 217,637 acre-feet (71 percent of total supply) under the P25 scenario
- 184,273 acre-feet (62 percent of total supply) under the P50 scenario
- 161,595 acre-feet (55 percent of total supply) under the P75 scenario

The mean annual pumping by farms in EPCWID under Alternative 4 is as follows:

- 16,406 acre-feet (58 percent of total supply) under the P25 scenario
- 12,533 acre-feet (46 percent of total supply) under the P50 scenario
- 11,454 acre-feet (42 percent of total supply) under the P75 scenario

Less groundwater pumping would occur within EBID for supplemental irrigation under Alternative 4 than under Alternative 1 under all three climate scenarios. More groundwater is pumped for farms in EPCWID under Alternative 4 than under Alternative 1 under all three climate scenarios.

Groundwater Elevations at Selected Wells in the Rincon and Mesilla Basins

Water elevation data for 15 wells were used for analysis. Variations in groundwater elevations were similar under all three climate scenarios, with elevations lower in the drier (P25) scenario and higher in the wetter (P75) scenario. As a result, data from one well in each basin were used for analysis.

The mean monthly groundwater elevation for the representative well in the Rincon Basin (Rin-2) under Alternative 4 is as follows:

- 4,062 feet under the P25 scenario
- 4,063 feet under the P50 scenario
- 4,065 feet under the P75 scenario

The mean monthly groundwater elevation for the representative well in the Mesilla Basin (Mes-6) under Alternative 4 is as follows:

- 3,814 feet under the P25 scenario
- 3,816 feet under the P50 scenario
- 3,817 feet under the P75 scenario

Under Alternative 4, mean monthly groundwater elevations for each representative well are similar to Alternative 1 under all climate scenarios.

Change in Groundwater Storage in the Rincon and Mesilla Basins

Change in total groundwater storage in the Rincon and Mesilla Basins were used for analysis. Change in total groundwater storage was calculated as the cumulative change in groundwater storage over the RMBHM model domain between the start and end of the simulation period (November 2007 to October 2050).

The cumulative change in groundwater storage over the study period would be as follows:

- -44,472 acre-feet under the P25 scenario
- -25,657 acre-feet under the P50 scenario
- +937 acre-feet under the P75 scenario

Under Alternative 4, cumulative change in groundwater storage is similar to Alternative 1 for the P25 and P50 climate scenarios. Under Alternative 4, cumulative change in groundwater storage increases slightly under the P75 climate scenario.

4.5.8 Alternative 5: Prior Operating (Ad Hoc) Practices

Groundwater Pumping in EBID and EPCWID for Supplemental Irrigation

Results indicate that farms in EBID rely more heavily on groundwater than farms in EPCWID under all three scenarios (P25, P50, and P75).

The mean annual deliveries to EBID under Alternative 5 are as follows:

- 219,276 acre-feet (71 percent of total supply) under the P25 scenario
- 185,061 acre-feet (63 percent of total supply) under the P50 scenario
- 169,660 acre-feet (58 percent of total supply) under the P75 scenario

The mean annual deliveries to EPCWID under Alternative 5 are as follows:

- 17,357 acre-feet (61 percent of total supply) under the P25 scenario
- 13,607 acre-feet (49 percent of total supply) under the P50 scenario
- 11,939 acre-feet (44 percent of total supply) under the P75 scenario

Less groundwater is pumped by farms in EBID under Alternative 5 than under Alternative 1 under all three climate scenarios. More groundwater is pumped by farms in EPCWID under Alternative 5 than under Alternative 1 under all three climate scenarios.

Groundwater Elevations at Selected Wells in the Rincon and Mesilla Basins

Water elevation data for 15 wells were used for analysis. The groundwater elevations were similar under all three climate scenarios, with elevations lower in the drier (P25) scenario and higher in the wetter (P75) scenario. As a result, data from one well in each basin were used for analysis.

The mean monthly groundwater elevation for the representative well in the Rincon Basin (Rin-2) under Alternative 5 is as follows:

- 4,062 feet under the P25 scenario
- 4,063 feet under the P50 scenario
- 4,065 feet under the P75 scenario

The mean monthly groundwater elevation for the representative well in the Mesilla Basin (Mes-6) under Alternative 5 is as follows:

- 3,814 feet under the P25 scenario
- 3,815 feet under the P50 scenario
- 3,817 feet under the P75 scenario

Under Alternative 5, mean monthly groundwater elevations for each representative well are similar to Alternative 1 and varied three feet or less between each climate scenario.

Change in Groundwater Storage in the Rincon and Mesilla Basins

Change in total groundwater storage in the Rincon and Mesilla Basins were used for analysis. Change in total groundwater storage was calculated as the cumulative change in groundwater storage over the RMBHM model domain between the start and end of the simulation period (November 2007 to October 2050).

The cumulative change in groundwater storage over the study period would be as follows:

- -46,757 acre-feet under the P25 scenario
- -23,957 acre-feet under the P50 scenario
- -2,508 acre-feet under the P75 scenario

Under Alternative 5, cumulative change in groundwater storage is similar to Alternative 1 for all climate scenarios.

4.5.9 Cumulative Impacts

The Delta Channel Maintenance Project and Rio Grande Canalization Project listed in **Section 4.2.2** help maintain surface water delivery efficiency, thus reducing supplemental groundwater pumping and the temporary effects on groundwater elevations. Supplemental groundwater pumping and declines in groundwater levels are greatest during periods of sustained drying under Alternatives 1, 2, and 3, which include the diversion ratio adjustment provision. However, modeling shows that groundwater levels, groundwater storage, and RGP performance recover to approximately the same levels during sustained wetter periods under all alternatives. This is when full allocations are available and groundwater is replenished by surface flows. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.5.10 Summary Conclusions

Two impact indicators were used to compare Alternatives 1 through 5. The results indicate the following:

- Groundwater pumped by irrigators in EBID and EPCWID
  - Less groundwater is pumped in EBID under Alternatives 3, 4, and 5, when compared to Alternative 1 under all three climate scenarios. Under all climate scenarios, Alternatives 4 and 5 would provide less water to EBID than Alternative 3.
  - More groundwater is pumped in EPCWID under Alternatives 3, 4, 5 than under Alternative 1 under all three climate scenarios. Under all climate scenarios, Alternative 4 and 5 would provide more water to EPCWID than Alternative 3.
- Groundwater elevations at selected wells in the Rincon and Mesilla Basins
  - The groundwater elevation of the Rincon Basin representative well displayed a similar monthly variation over a year for Alternatives 1 through 5, with slight variations under the three climate scenarios. In general, the range for the mean monthly groundwater elevation increased from the P25 climate scenario to the P75 climate scenario.
  - The groundwater elevation of the Mesilla Basin representative well displayed a similar monthly variation over a year for Alternatives 1 through 5, with slight variations under the three climate scenarios. In general, the range for the mean monthly groundwater elevation increased from the P25 to the P75 climate scenario.
- Groundwater storage in the Rincon and Mesilla Basins
  - Total groundwater storage in the Rincon and Mesilla Basin exhibits similar seasonal and multiyear fluctuations for Alternatives 1 through 5, with variations in the timing and magnitude of groundwater storage fluctuations between the three climate scenarios. In general, changes in

total groundwater storage over the simulation period were larger under the P25 climate scenario and smaller under the P75 scenario.

Table 4-5 summarizes the groundwater indicators for the five scenarios and presents the acre-feet of groundwater pumped at the two wells for each of the five alternatives for the three climate scenarios. The percentage in parentheses to the right of the annual pumping is the amount of the total supply supplied by groundwater.

Table 4-5 shows that higher groundwater elevations and smaller changes in total groundwater storage correspond with the wetter climate scenarios. As expected, higher levels of groundwater pumping correlate with lower groundwater levels and larger declines in total groundwater storage.

Table 4-5. Groundwater Pumping and Elevations

	Alternative	P25	P50	P75
Annual pumping EBID (acre-feet)	1 and 2	251,998 (81%)	221,170 (76%)	211,052 (71%)
	3	239,489 (77%)	202,791 (68%)	197,481 (67%)
	4	217,637 (71%)	184,273 (62%)	161,595 (55%)
	5	219,276 (71%)	185,061 (63%)	169,660 (58%)
Annual pumping EPCWID (acre-feet)	1 and 2	15,110 (53%)	11,573 (42%)	10,264 (37%)
	3	15,951 (56%)	12,486 (45%)	10,859 (40%)
	4	16,406 (58%)	12,533 (46%)	11,454 (42%)
	5	17,357 (61%)	13,607 (49%)	11,939 (44%)
Mean monthly elevation at Rin-2 (feet)	1 and 2	4,058	4,060	4,062
	3	4,060	4,062	4,063
	4	4,062	4,063	4,065
	5	4,062	4,063	4,065
Mean monthly elevation at Mes-6 (feet)	1 and 2	3,813	3,814	3,816
	3	3,813	3,815	3,816
	4	3,814	3,816	3,817
	5	3,814	3,815	3,817
Change in Total Groundwater Storage (acre-feet)	1 and 2	-59,118	-31,462	-4,489
	3	-55,139	-28,055	-4,436
	4	-44,472	-25,657	+937
	5	-46,757	-23,957	-2,508

4.6 Water Quality

The RMBHM simulates the interaction between surface water and groundwater and does not include an analytical assessment of water quality. Areas of concern regarding water quality were identified in Appendix H of the SEA (Reclamation 2013a) and are discussed qualitatively (see 40 CFR 46.120). These areas of water quality concern are divided into six general categories:

- Mercury in fish tissue (Elephant Butte and Caballo Reservoirs)
- Dissolved oxygen/oxygen depletion (between reservoirs)

- Fecal coliform (Caballo Dam to Leasburg Dam)
- Bacteria (Leasburg Dam to International Diversion Dam)
- Nonpoint source pollutants (Riverside Diversion Dam to Alamo Arroyo Grande Structure)
- Groundwater quality

4.6.1 Impact Indicators

Impact indicators used to infer changes in water quality between the modeled alternatives include increases or decreases in reservoir storage and streamflow.

4.6.2 Analysis Methods and Assumptions

Water quality concerns identified in Appendix H of the SEA (Reclamation 2013a) are related to flow and volume. As such, this discussion assumes that increasing flow or reservoir storage would improve water quality. Other assumptions include:

- Water is generally not released from Caballo Reservoir in the non-irrigation season. As such water quality may fluctuate during this period but is not related to the OA.
- Water used by municipal users is treated, and the level of treatment would not change under the various alternatives.
- Changes in nonpoint source runoff would be the same under the various alternatives.

4.6.3 Effects Common to All Alternatives

Water quality is not a function of the OA but of historical RGP operations. This EIS incorporates U.S. Environmental Protection Agency's Watershed Assessment, Tracking and Environmental Results Mapper data (Reclamation 2013a). Based on this analysis, water quality effects are determined to be common to all alternatives. These are identified and described below.

Mercury Bio-Accumulation in Fish

According to U.S. Environmental Protection Agency's Watershed Assessment, Tracking and Environmental Results Mapper, 79 measurements of water quality were taken in Elephant Butte and Caballo Reservoirs (Reclamation 2013a). These measurements establish that fish in the reservoirs have elevated levels of mercury and highly toxic polychlorinated biphenyls. Given that the different alternatives cause relatively small changes in reservoir operations, it is unlikely that any one alternative would meaningfully affect the bio-accumulation of mercury in fish in the reservoir (Reclamation 2013a, SEA Appendix H).

Dissolved Oxygen

From the U.S. Environmental Protection Agency's Watershed Assessment, Tracking and Environmental Results website, the reach of the Rio Grande between EBR and Caballo Reservoir suffers from low dissolved oxygen due to oxygen depletion with organic enrichment. Changes to the amount of water released may or may not affect the dissolved oxygen content in the river (Reclamation 2013a, SEA Appendix H).

Fecal Coliform

Fecal coliform is associated with human and animal waste. The source of fecal coliform could be from inadequate wastewater processing, whether from individual septic systems or from a community wastewater treatment plant, or from livestock close to the river. The contribution of fecal coliform to the river is unlikely to change due to the selection of a particular alternative, because the sources of fecal coliform are unlikely to be related to river flows, and large differences in dilution flow would be unlikely (Reclamation 2013a, SEA Appendix H).

Bacteria

Bacteria levels are elevated between the Leasburg Diversion Dam and El Paso, Texas. Bacteria could come from agricultural runoff, stormwater runoff from developed lands, or ineffective sewage disposal systems. The contribution of bacteria to the river is unlikely to change due to the selection of a particular alternative, because the sources of bacteria are unlikely to be related to river flows. It is possible that there could be slight differences in bacteria levels from different alternatives, and large differences in dilution flow would be unlikely (Reclamation 2013a, SEA Appendix H).

Nonpoint-Source Pollutants

Nonpoint-source pollution has been identified in the area below El Paso, Texas. Nonpoint pollution could be from agricultural runoff, municipal runoff, or industrial processes. The contribution of nonpoint pollution to the river is unlikely to change due to the selection of a particular alternative, unless the alternative changed the amount of runoff from fields. In that case, a decrease in farm runoff may be correlated with a decrease in the contribution of nonpoint pollution to the river, and an increase in runoff could cause an increase in nonpoint pollution.

There could be some slight differences in levels of residual pollution from nonpoint sources if the amount of dilution flow were to change under the various alternatives, where higher stream flows would dilute pollution and lower flows would concentrate pollution. Contaminant loading from nonpoint pollutants would likely be unaffected by changes in flow among the different alternatives. Consequently, the different alternatives are unlikely to affect the amount of nonpoint pollution in the river (Reclamation 2013a, SEA Appendix H).

Salinity

While not identified in Appendix H of the SEA (Reclamation 2013a), salinity in the Rio Grande increases from EBR in New Mexico to Fort Quitman, Texas has been documented for more than 100 years (Stabler 1911).

Research has identified natural sources such as the upwelling of deep-circulating groundwater and geothermal waters as the principal salinity contributors in the region. Phillips et al. (2003) showed that salinity increases from approximately 40 milligrams per liter to approximately 2,000 milligrams per liter in a 750-mile stretch of the Rio Grande, with large increases localized at the southern ends of sedimentary sub-basins, such as at Elephant Butte (Truth or Consequences), Selden Canyon, and El Paso Narrows.

Groundwater Quality

Modeling results did not contain information about groundwater quality, potential sources of contamination, or direction of flow. Generally speaking, groundwater flows parallel to the ground surface, in this case, towards the Rio Grande.

Whether the quality of the groundwater improves or degrades due to the alternative depends on the relative quality of the groundwater and its relationship to the surface water. As listed in **Section 4.6.1**, one impact indicator has been identified to quantify the variations between the modeled alternatives. However, due to limited data, the impact indicator cannot be used to provide detailed water quality analysis per alternative.

4.6.4 Alternative 1: No Action Alternative

Results from the RMBHM indicate that groundwater elevations are lowest under Alternatives 1 and 2. This suggests that water from the Rio Grande is more likely to flow, or more water would flow, from the river to the groundwater system than under the other alternatives. Whether or not this would occur depends on the relative elevations of the groundwater and surface water.

4.6.5 Alternative 2: No San Juan–Chama Project Storage

Impacts are the same as described under Alternative 1.

4.6.6 Alternative 3: No Carryover Provision

Groundwater elevations are higher under Alternative 3 than under Alternative 1. Because of this, seepage losses under Alternative 3 would likely be less; gains to the Rio Grande would be greater, compared to Alternative 1. Whether or not this would occur depends on the relative elevations of the groundwater and surface water.

4.6.7 Alternative 4: No Diversion Ratio Adjustment

Groundwater elevations under Alternative 4 are similar to Alternative 5 and higher than under Alternatives 1, 2, and 3. This suggests that water from the alluvial aquifer is more likely to flow, or more water would flow, from the aquifer to the Rio Grande than under the other alternatives. If there are losing reaches within the RGP, this suggests there is less seepage loss rather than more base flow. If water flows from the aquifer to the river, water quality in the alluvial aquifer adjacent to the river would remain unchanged. Whether or not this would occur depends on the relative elevations of the groundwater and surface water.

4.6.8 Alternative 5: Prior Operating (Ad Hoc) Practices

Impacts are the same as described under Alternative 4.

4.6.9 Cumulative Impacts

The Delta Channel Maintenance Project would ensure that the river maintains connectivity with the reservoir, would preserve flowing river water, and would sustain surface water quality in EBR. Given that the different alternatives cause relatively small changes in reservoir operations and water levels, the effects on surface water quality in the reservoirs are unlikely to differ among the alternatives.

Because water is generally not released from Caballo Reservoir in the non-irrigation season as part of historical operations of the RGP, surface water quality downstream would continue to fluctuate and would not have the benefit of dilution flows for much of the year. The Rio Grande Canalization Project includes such improvements as more efficient water delivery, soil erosion prevention, and habitat restoration, all of which would contribute to better water quality. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.6.10 Summary Conclusions

As detailed above, modeling results did not contain information about groundwater quality, potential contamination sources, or flow direction. One impact indicator was identified to quantify the variations between the modeled alternatives. However, due to limited data, the impact indicator cannot be used to provide detailed water quality analysis by alternative.

4.7 Vegetation Communities and Special Status Plants

This section identifies impacts on vegetation communities and special status plant species that may occur in the study area. The study area for analysis of biological resources in this section and in **Sections 4.8** and **4.9** is the same as the action area considered for impacts on special status species and their habitats under the ESA. The action area is defined as all areas affected directly or indirectly by the Federal action (50 CFR 402.02), and is subdivided into the following reaches or segments within the RGP:

- EBR from full pool to dead pool
- The Rio Grande downstream from Elephant Butte Dam to Caballo Reservoir full pool
- Caballo Reservoir from full pool to dead pool
- The Rio Grande from Caballo Dam downstream to International Dam

The following analysis of effects on vegetation communities and special status plant species focuses on EBR storage levels, because there would be no effects below EBR from the OA that have not been previously considered by Reclamation in the SEA (Reclamation 2013a) or by the IBWC (IBWC 2001, 2004, 2011).

The IBWC has consulted on the effects on special status species in the reach of the Rio Grande downstream of the Percha Diversion Dam (IBWC 2001, 2004, and 2011; Service 2012). In 1936, Congress authorized the IBWC to dredge and channelize the river, and it has since maintained this channel and adjoining right-of-way from Percha Diversion Dam downstream. The IBWC's findings were that ongoing maintenance of this reach resulted in either "no effect" or "may affect but is not likely to adversely affect" Federally listed species with the implementation of a habitat restoration plan for the reach below Caballo Dam.

In addition, the OA would not substantially change the volume or pattern of releases from Caballo Reservoir from what has historically occurred. Water is released when there are calls for water by EBID, EPCWID, and/or Mexico.

As described by IBWC (2001, 2004, 2011), the river below Caballo Reservoir to Fort Quitman is mostly channelized. Within IBWC's jurisdictional land/river channel, vegetation has traditionally been mowed. Most of the farms in this reach have allowed a very narrow vegetated buffer zone to grow between the farmland and the river bank. There are some areas where the river is adjacent to upland slopes; these areas have no farming, and the riparian vegetation is wider. The other vegetated areas occur on sand bars in the river channel. These areas would be mowed, and any sediment would be removed by IBWC.

The Record of Decision for River Management Alternatives for the Rio Grande Canalization Project increased acreage that would be allocated as no-mow zones (IBWC 2009). Ending mowing at restoration sites, riparian fringe, and managed grasslands, along with selective treatment of exotic vegetation, allows native vegetation to establish itself for the improvement and restoration of riparian habitats. The current River Management Plan has specified no-mow zones on 553 acres of habitat restoration sites and 1,983 acres of managed grasslands vegetation to establish itself for the improvement and restoration of riparian habitats (IBWC 2014).

As described in **Section 3.8**, no special status plant species have been identified within the study area. The analysis is therefore focused on the vegetation communities within EBR that provide special status wildlife species habitat.

4.7.1 Impact Indicators

Because all of the alternatives are for surface water operations only, impact indicators pertain to the riparian, aquatic, and wetland vegetation and habitat found on the edges of the surface water. The surface water distribution across time largely determines the area's ecology, and in particular, the sensitive species' ecology. Impact indicators for vegetation are discussed below.

- Recession of reservoir levels
    - Spread of both native and nonnative or invasive plant species in newly exposed reservoir bottom.
    - Maturation of vegetation communities upstream and adjacent to the reservoir pool past the point of providing suitable habitat and eventual replacement by more upland communities except in river/delta channel of the EBR that is supported by the LFCC. As the vegetation matures in this area it is not replaced by more upland communities; it becomes new riparian areas as sediment load fills in from west to east and regrowth occurs.

When the reservoir recedes, it exposes reservoir-bottom lands and nutrient-enriched soils. These areas would quickly revegetate with desirable species, such as willow, and would create quality wildlife habitat. Undesirable species, such as nonnative or invasive plant species, could also revegetate these newly exposed areas. If the water level of the reservoir remains low, without periodic inundation, the habitat upstream and adjacent to the reservoir pool would ultimately mature through natural succession and would eventually be replaced by more upland species.

- Rising reservoir levels
  - Wetland vegetation enhancement
  - Loss of vegetation and habitat that supports special status species

Some habitat near the rising water levels can be enhanced by a rising water table. Habitat that is partially inundated could be enhanced through deposition of new sediments and nutrients, flushing of accumulated salts, and irrigation of the respective site. However, prolonged or complete inundation can result in the total loss of some riparian habitat, including special status species, which can depend on species composition and age class in determining survivability.

Prolonged inundation and drying at EBR occurred historically and is projected to occur under all alternatives and all climate scenarios. These conditions are typically what are observed within the pool of a large reservoir, no matter how it is operated.

4.7.2 Analysis Methods and Assumptions

The vegetation within the study area was considered in terms of composition of plant communities, including both native and nonnative riparian vegetation, and infestation of invasive weeds. The potential for wildlife habitat use was also considered. Hydrologic modeling of reservoir elevations was used to predict changes in biota. Upland and desert shrub communities further from the river would be unaffected by RGP operations. There is only a narrow band of riparian vegetation along the river banks that could be affected. The vegetation that has grown in the reservoir pools could also be affected by changes in reservoir elevations and releases or by changes that affect the water table adjacent to the river and the amount of water in the river during dry periods (i.e., groundwater discharge to the channel).

- Direct effects are based on modeled changes in reservoir elevations.
- Indirect effects are based primarily on the potential for long-term changes in the vegetation or ecosystem in the floodplains of the river reaches and in the habitat within the reservoirs.

Because the Caballo Reservoir pool level is relatively stable, the vegetation is relatively constant; it is dense near the water's edge and gradually reduces in density away from the water line.

Presently, most of the vegetation at EBR occurs in the delta, from full pool at River Mile 62 to where the Rio Grande enters into the current baseline pool at River Miles 38 to 36, and there is a gradient in density/quality from west to east and south to north.

Based on monitoring data, young Goodding's willows are more flood tolerant than saltcedars (Reclamation 2009). Following a period of six months of inundation with 18 to 24 inches of water over the terminal bud primarily during the dormant season, Goodding's willow densities and heights are increasing. Similar observations have been reported by Ellis et al. (2008), who reported a die-off of saltcedar understory and survival of Goodding's willow at Roosevelt Lake.

However, prolonged or complete inundation, which is expected to occur during the analysis period of the OA, can result in the total loss of some riparian habitat, and survivability would depend on species composition and age class. Ellis and others (2008) also found that most species were not able to survive more than one year of complete inundation. Reclamation (2009) has also previously reported that partial (10 to 15 feet) and temporary (less than six months) flooding would likely cause a reduction in woody vegetation. The shrub layer, if present, could be slow to recover.

4.7.3 Effects Common to All Alternatives

The results of the hydrologic modeling described in **Section 4.4** indicate that for each climate scenario, the rate and timing of simulated fluctuations in total storage and RGP storage in Elephant Butte and Caballo Reservoirs are qualitatively similar across all EIS alternatives (see **Appendix C**, Hydrology Technical Memo). While the alternatives have minor effects on reservoir elevations under all climate scenarios, the slight differences between the alternatives are discussed in the following sections. Reservoir storage, water elevations, and related downstream releases under all of the alternatives and climate change scenarios appear driven primarily by cyclic periods when wet weather produces prolonged storage peaks and extended droughts produce major storage declines in EBR. Temporary establishment and loss of vegetation and wildlife habitat below the full-pool elevations would occur under all alternatives.

It is important to recognize from the modeling that the reservoir elevations and releases related to the existing OA are inseparably coupled with inflow volume. Simulated inflows are based on projected future climate conditions. In addition, reservoir releases into the Rio Grande between the two reservoirs and downstream from Caballo Reservoir under all alternatives are anticipated to be within the flow range occurring during the 2014 baseline operations and during the preceding decades. Therefore, reservoir releases would not produce meaningful changes in flow regimes or adverse ecological effects on vegetation communities within these two reaches of the Rio Grande.

Invasive, Nonnative Vegetation under All Alternatives

The potential for invasive weeds to be introduced and spread would continue under all alternatives. To avoid or minimize the risk of noxious weed introduction or spread, Reclamation and IBWC have integrated pest management plans and policies.

4.7.4 Alternative 1: No Action Alternative

Under Alternative 1, there would be periods of both increasing and decreasing reservoir levels under all climate scenarios. Under Alternative 1, the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. The simulated range of EBR elevations for each scenario under Alternative 1 is as follows:

Alternative 1	Elephant Butte Elevation (feet)		
	P25	P50	P75
Simulated range	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407

As previously stated, effects on vegetation communities may occur under scenarios that decrease reservoir levels as well as scenarios that increase reservoir levels. When the reservoir recedes, the reservoir bottom lands or nutrient-enriched exposed soils would quickly revegetate. If the reservoir remains at low water levels, habitat upstream and adjacent to the reservoir pool would ultimately mature through natural succession past a point of suitability. Without inundation, replenishment of nutrients and flushing of salts would not occur, and the vegetation would be reduced in vigor, degrading its overall habitat suitability for flycatchers, cuckoos, and other species.

Short-term and long-term impacts on EBR existing habitat from a potential rising reservoir pool would depend largely on the timing, depth, and duration of inundation. Alternative 1 has the greatest potential for inundating the most acres of vegetation because reservoir elevations are predicted to reach higher maximums during modeled wet periods than predicted for the other alternatives (**Figures 4-9** to **4-11**). Loss or degradation of vegetation habitat due to increasing reservoir water levels could occur, although habitat in proximity to the rising water levels can be enhanced by a rising water table. Partially inundated habitat could be enhanced by deposition of new sediments and nutrients, by flushing of accumulated salts, and by irrigation of the respective site. However, prolonged or complete inundation could result in the total loss of some riparian habitat, which can depend on species composition and age class in determining survivability.

4.7.5 Alternative 2: No San Juan–Chama Project Storage

The effects on vegetation under Alternative 2 would be similar to those described under Alternative 1. Under Alternative 2, the overall range of reservoir elevations modeled for the three climate scenarios is 4,254 to 4,407 feet. Under Alternative 2, the range of EBR elevations are as follows:

	Elephant Butte Elevation (feet)		
	P25	P50	P75
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 2	4,254 to 4,377	4,254 to 4,407	4,283 to 4,407

Alternative 2 differs from Alternative 1 in that San Juan–Chama Project water would not be stored in the EBR. Therefore, the reservoir elevations would tend to be lower under this alternative than under the other alternatives. According to the projected range of elevations from all three future climate scenarios, Alternative 2 is predicted to reach a lower elevation than the other alternatives but a higher elevation than Alternatives 3 through 5 during most of the modeled wet periods. There would most likely be longer periods of lower elevations and the greatest range or fluctuation in reservoir elevations. However, when reservoir levels rise, it has the potential of filling to a higher elevation under Alternative 2 than under Alternatives 4 and 5 (**Figures 4-9** to **4-11**).

When the reservoir recedes, reservoir bottom lands or nutrient-enriched exposed soils would quickly revegetate with both desirable species, such as willow, and undesirable species, such as nonnative or invasive plant species. If the reservoir remains at low water levels, habitat upstream and adjacent to the reservoir pool would ultimately mature through natural succession past a point of suitability and would eventually be replaced by more upland species. Therefore, under Alternative 2, riparian vegetation and nonnative or invasive plant species have the greatest potential for initially expanding during periods of declining and low reservoir elevations.

Additionally, under Alternative 2, riparian vegetation has the greatest potential for maturing beyond the point of suitability for endangered species, such as the flycatcher and cuckoo, during prolonged periods of low water elevation. As such, there is the greatest potential for habitat drying and replacing riparian vegetation with upland vegetation. However, if prolonged wet periods do occur, this mature vegetation has the potential to eventually become inundated and replaced once again by new wetland vegetation.

4.7.6 Alternative 3: No Carryover Provision

The effects on vegetation under Alternative 3 would be similar to those described under Alternative 1 (No Action Alternative). Alternative 3 differs from Alternative 1 in that there is no carryover provision. Therefore, the reservoir would fluctuate less than under Alternative 1. Under Alternative 3, the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Under Alternative 3, the range of EBR elevations are as follows:

	Elephant Butte Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 3	4,284 to 4,375	4,285 to 4,407	4,283 to 4,407

Under Alternative 3, because reservoir elevations tend to be lower during wet periods than Alternative 1, it is predicted that fewer acres of vegetation would have the potential to become inundated during periods of reservoir filling, compared to Alternative 1, and vegetation upstream and adjacent to the reservoir pools would trend toward upland species (**Figures 4-9** to **4-11**).

4.7.7 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, there is no diversion ratio adjustment as there is under Alternative 1. Under Alternative 4, the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Under Alternative 4, the range of EBR elevations are as follows:

	Elephant Butte Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 4	4,284 to 4,368	4,283 to 4,407	4,283 to 4,407

Under the driest climate scenario, under Alternative 4, the water elevation in the reservior would fluctuate less than Alternative 1 and any of the other alternatives. Because the likely maximum reservoir elevation in this alternative under all climate scenarios during wet periods is lower than under all of the other alternatives, it is predicted that fewer acres of vegetation would have the potential to become inundated during periods of reservoir rise compared to Alternative 1, and vegetation upstream and adjacent to the reservoir pools would trend toward upland species. However, during dry periods the predicted reservoir elevation in Alternative 4 under all climate scenarios is similar to the other alternatives, except for Alternative 2, which is predicted to reach a lower elevation (**Figures 4-9** to **4-11**).

4.7.8 Alternative 5: Prior Operating (Ad Hoc) Practices

Alternative 5 differs from Alternative 1 in that there is no diversion ratio adjustment and no carryover provision, but San Juan–Chama Project water storage would continue. The effects on vegetation would essentially be the same as with the other alternatives in that there would be periods of reservoir rising and receding. Under Alternative 5, the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Under Alternative 5, the range of EBR elevations are as follows:

	Elephant Butte Elevation (feet)		
	P25	**P50**	**P75**
Alternative 1	4,283 to 4,379	4,284 to 4,407	4,283 to 4,407
Alternative 5	4,284 to 4,372	4,283 to 4,407	4,283 to 4,407

While the range of elevations for Alternative 5 is not the smallest of all alternatives, the reservoir elevations tend to be higher during prolonged dry periods and lower during prolonged wet periods under all climate scenarios under Alternative 5, compared with the other alternatives (**Figures 4-9** to **4-11**). Therefore, fewer acres of vegetation could be affected by increasing and decreasing reservoir elevations than would be affected under the other alternatives.

4.7.9 Cumulative Impacts

The Delta Channel Maintenance Project would help moderate potential impacts from inundating vegetation and vegetation loss or degradation in the EBR from reservoir level fluctuations. Conservation measures included in the project would avoid impacts on vegetation and habitat that supports special status bird species. The beneficial effects on vegetation of the Rio Grande Canalization Project would be realized in the reach below Caballo Reservoir where restoration projects are designed to improve habitat and enhance or rehabilitate a mosaic of native riparian habitats.

Modeling shows that reservoir elevations would fluctuate under all alternatives and are within the range of historical operations. The range of modeled elevations is similar for all of the alternatives. Establishment and loss of vegetation and habitat supporting special status wildlife habitat below the full-pool elevations would continue under all alternatives over time. The differences among the alternatives have little effect on the modeled reservoir elevations that would impact vegetation. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.7.10 Summary Conclusions

The potential effects on vegetation from the alternatives are summarized below:

- No special status plant species are known to occur or would be impacted by the alternatives.
- No potential impacts on vegetation are anticipated in the study area with the exception of the EBR pool.
- Most of the vegetation at EBR occurs from River Mile 62 to River Miles 38 to 36. Fluctuations in the reservoir pool would occur under all alternatives and are within the range of historical operations.
- Temporary establishment and loss of vegetation and wildlife habitat below the full-pool elevations would occur under all alternatives over time as they have historically.
- Reservoir fluctuations would continue the spread of invasive plant species.
- The differences among the alternatives have little effect on the modeled reservoir elevation and duration of inundation and drying cycles.

4.8 Wildlife and Special Status Wildlife Species

This effects analysis focuses on two reaches in the study area: EBR, including its delta reach, and Caballo Reservoir, both of which are in New Mexico.

4.8.1 Impact Indicators

Impact indicators pertain to riparian, aquatic, and wetland habitats and special status wildlife found on the edges of the surface water. This is because all alternatives address surface water resources operations only; therefore, it is the surface water distribution over time that largely determines the area's ecology, in particular the sensitive species' ecology. Impact indicators are those associated with this specific ecology: distribution and age structure of woody plants during the spring avian breeding season.

Specific indicators are as follows:

- Reservoir fluctuations and the duration of drying and wet cycles
  - Prolonged inundation, which could result in direct loss of wildlife habitat and degradation of wildlife habitat surrounding reservoirs and river reaches or enhancement in other areas

  - Decline in reservoir elevations, which degrades the habitat surrounding reservoirs, but also enhances and creates riparian habitat in the area from River Mile 62 to River Miles 38 to 36
- Death or decreased reproductive success of wildlife species due to habitat alteration

4.8.2 Analysis Methods and Assumptions

The method of analysis for wildlife involved considering the alternatives' potential effects on vegetation and water resources and determining whether they would cause changes affecting wildlife or their habitats. Predictions of reservoir fluctuations for all alternatives were used to predict changes in biota.

Upland and desert shrub communities supporting wildlife farther from the river would be unaffected by operations under all alternatives. The projected reservoir elevations would affect only the narrow ribbon of riparian vegetation along the river, the in-channel riverine habitats (such as sandbars, islands, and banks), and the vegetation that has grown in the reservoir pools. Therefore, only the riparian ecosystem, along with associated wildlife, was considered for this impact analysis.

The analysis of the impacts on wildlife focuses on the Southwestern willow flycatcher and the Western yellow-billed cuckoo. The endangered New Mexico meadow jumping mouse is not expected to occur in the study area because of the general lack of suitable habitat. Further, there is no proposed critical habitat for this species in the study area; the nearest proposed critical habitat is approximately 16 river miles upstream, at Bosque del Apache National Wildlife Refuge.

The analysis method for special status species is determined by their potential to occur in the study area. It uses current and historical information from field surveys conducted by Reclamation or others, as well as a literature review. If the presence of a listed species or supporting habitat features were determined to be likely, then the alternatives' potential effects were analyzed in order to determine whether they would impact the species or associated habitat.

The following predictions of reservoir levels under all alternatives were used, to the extent possible, to assess changes in biota:

- Fluctuations in EBR and Caballo Reservoir water levels up to the full pool have historically been a normal feature of the reservoirs.
- The habitat that currently supports the largest flycatcher population in the Southwest was created when the EBR receded, allowing various age classes of vegetation to develop.
- Based on hydrologic data collected since 2004, a large part of the northern portion of the reservoir pool receives water throughout the year. The source of this water is agricultural return from the outfall of the LFCC (Reclamation 2005) and not from the river channel into the EBR. Though habitats are

changing, suitable habitat in this portion of the reservoir pool remains relatively abundant.

- Direct effects are based on modeled changes in reservoir elevations.[2]
- Indirect effects are based principally on changes in time or on location effects concerning vegetation or ecosystem in the floodplains of the river reaches and habitat surrounding the reservoirs.
- The revised designated critical habitat for the flycatcher and proposed critical habitat for the cuckoo includes a part of the EBR delta reach, downstream to River Mile 54. Above River Mile 54, the reservoir inundates designated critical habitat.
- The flycatcher and cuckoo are presently restricted to the elevation in the EBR above 4,325 feet, which was used as the baseline for consultation with the Service. Flycatcher designated critical habitat and cuckoo proposed critical habitat extends to River Mile 54, at approximately the 4,380-foot elevation. The action's primary determinant of effect on birds would be months when EBR surface elevation rises and remains greater than 4,325 feet. Above this elevation, rising waters might inundate and potentially impact flycatcher and reservoir elevation cycles of rising and receding through 2050, as shown on **Figures 4-9**, **4-10**, and **4-11** for the P25, P50, and P75 scenarios.

4.8.3 Effects Common to All Alternatives

The results from the modeling simulation indicate that the alternatives are not likely to have a strong effect on RGP storage or total annual RGP releases (Reclamation 2015a). Instead, reservoir storage, water elevations, and related downstream releases of the alternatives appear driven primarily by climate rather than operations.

Based on the 2014 flycatcher surveys, approximately 31 percent of the flycatcher territories (260) and 65.1 percent (161) of cuckoo territories would be affected by the reservoir rising to 4,380 feet (Reclamation 2015b). The reservoir elevations typically begin rising in November, after minimum storage occurs in October, continuing to maximum storage peaks for the year as the spring releases begin, following irrigation demands. Thus, reservoir levels typically increase in the fall after flycatchers and cuckoos have departed for over-wintering territories, and higher reservoir levels due to runoff end in the spring when the birds begin to establish breeding territories.

The hydrologic model developed to analyze the OA can be used to extrapolate potential effects into the future, relative to 4,325 feet where flycatcher and cuckoo territories are currently, and 4,380 feet elevation at River Mile 54 where the flycatcher critical habitat and the proposed cuckoo critical habitat extends into EBR. The modeling simulates recurring cycles under the P25, P50, and P75 scenarios during which EBR elevation will

[2] Note, however, the hydrological model results produced for Caballo Reservoir included only storage volumes, not elevations, which somewhat limits the effects assessment possible for this reservoir.

rise above the elevation of 4,325 feet. As shown on **Figure 4-9**, under the P25 scenario two cycles are simulated, the first to a maximum elevation of 4,360 feet and the second to a maximum elevation of 4,380 feet. Under the P50 and P75 scenarios, as shown on **Figures 4-10** and **4-11**, three cycles are simulated: two cycles to a maximum elevation of approximately 4,380 feet, followed by a cycle where EBR would reach full pool at 4,407 feet. For the five alternatives and the three climate scenarios, the model results show recurring cycles during which EBR elevation will rise above the baseline elevation of 4,325 feet for different lengths of time. These cycles are the basis for assessing impacts to the existing vegetation when EBR elevation rises above 4,325 feet and then recedes back to that elevation.

As such, implementing the alternatives through 2050 is projected to produce little if any difference among alternatives in direct effects on flycatchers or their habitat in these segments, beyond impacts associated with current operations and climate variability.

Effects on flycatcher and cuckoo habitat under all alternatives are as follows:

- Without inundation from rising pool elevations, nutrients would not be replenished and salts would not be flushed in areas of riparian trees associated with flycatchers and cuckoos. This would reduce the vigor of vegetation, degrading its overall habitat suitability for flycatchers and cuckoos.
- Periods of lower water inflows and lower pool elevations in the EBR would lead to maturation of vegetation communities and changes in species composition; this could eventually render flycatcher and cuckoo nesting habitat unsuitable. This would come about without other types of disturbance in the delta reach, such as fire or mechanical disturbance.
- Inundation could create short-term impacts on birds and shrubs through the physical loss of riparian vegetation (Service 2014); however, over the long term, a rising reservoir would support riparian vegetation by increasing the water table in some areas, resulting in denser vegetation and taller trees favored by the birds. Inundation would also flush accumulated salts from the soils, replenish nutrients, and deposit new sediments.

4.8.4 Alternative 1: No Action Alternative

Under Alternative 1, there would be periods of both increasing and decreasing reservoir levels under all climate scenarios. As explained in **Section 4.7.5**, under Alternative 1 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet.

Southwestern Willow Flycatcher and Western Yellow-Billed Cuckoo

Implementation of the No Action Alternative would affect flycatchers and their habitat in EBR due to modeled cycles of continued drought, followed by wetter periods which would cause a rising reservoir. Such cycles could continue to occur through 2050 and may have both positive and negative effects on habitat in the reservoir. As the reservoir rises it may impact existing habitat, but as it lowers it leaves behind suitable conditions for new habitat to develop.

Direct Effects

Continued implementation of the No Action Alternative has potential direct effects on flycatchers. This would be caused by the increase in reservoir water elevations that displace flycatchers from active territories, the inundation and loss of active nests and nestlings, and the inundation and loss of active territories. Flycatcher critical habitat and cuckoo proposed critical habitat extends to River Mile 54 into the EBR delta; reservoir elevation levels at that location could produce direct effects on these designated habitats.

Indirect Effects

The indirect effect from the projected cycles of water surface elevations is due to changes in vegetation (see **Section 4.7.3**) and potentially due to changes in territories used by the flycatcher and cuckoo.

Lowering Water Supply and Reservoir Pool Elevation

Without other kinds of disturbance in the delta reach (e.g., fire or mechanical disturbance), periods of lower water deliveries and lowering pool elevation in the EBR would cause mature vegetation communities to develop; these communities are known to be unsuitable for flycatcher nesting habitat, as has already been observed in this reach (Reclamation 2014b). Such environmental conditions, while fundamentally a result of natural climatic conditions unrelated to the OA, could produce multiyear periods of negative impacts on flycatchers and their habitat.

Rising Water Supply and Reservoir Pool Elevation

Short-term and long-term impacts on existing EBR habitat from a rising reservoir pool would depend largely on the timing, level of water, and duration of inundation. The greater the degree and duration of flooding, the greater the anticipated reduction in vegetation structure. Loss or degradation of habitat due to increasing reservoir water levels has been found to reduce some bird populations, species richness, and nest success, while other bird species, such as shorebirds and waterfowl, can benefit from improved feeding conditions that result (Ellis et al. 2008; Reitan and Thingstad 1999; Warner and Hendrix 1984). Given the baseline distribution of the birds and the critical habitat in the north end of the reservoir at elevation 4,380 feet, the primary concern would be water surface elevations that rose above the 4,325- and 4,380-foot elevations during the months when the birds are present, and the water remained at these levels for extended periods. If the reservoir remained full or at high levels for extended periods, it could adversely affect habitat by killing the vegetation and not allowing for a revegetation process.

With a rising and receding reservoir and long stretches of low reservoir pool elevations, vegetation would be able to regrow in a short period and new areas could be vegetated. Existing vegetation would survive and could tolerate short inundation periods. These fluctuating reservoir levels would promote the growth of vegetation, which becomes the habitat for the territories used by the birds. It is likely that vegetation would quickly recolonize newly exposed reservoir bottomland and be able to grow faster under the EBR conditions, as has previously occurred. For example, under similar conditions of a shrinking EBR pool during the past two years, a high rate of vegetation growth has occurred, between River Mile 40 and 37, and has already been colonized by flycatchers.

Section 7 Consultation

Reclamation is conducting an ESA Section 7 consultation on the No Action Alternative. For the purpose of assessing the impacts on special status species whose habitat is present in the EBR pool, Reclamation used the wetter P75 scenario 100 percent non-exceedance simulation, which assessed a conservative worst case based on the potential impacts on these species and their habitats of sustained high water level in the reservoir. The strong influence of climate change-driven weather patterns as modeled, rather than continued implementation of the OA, is seen as the prime cause of future reservoir water elevation changes.

It is difficult to predict adverse effects with any reasonable degree of certainty. As evaluated in the biological assessment (Reclamation 2015c), Reclamation concluded that the continued implementation of the OA and San Juan–Chama storage with future climatic events as projected by the model **"may affect, and is likely to adversely affect"** Southwestern willow flycatcher and Western yellow-billed cuckoo that could be present in the EBR. Based on baseline conditions, as some individual birds may be displaced and some territories/nests may be inundated by a rising reservoir, these impacts may result in only a minor adverse effect because there is more suitable habitat available that is not being used, and vegetation regrowth can occur quickly under the right conditions.

A "**may affect, and is likely to adversely affect"** determination for flycatcher critical habitat and cuckoo proposed critical habitat is based on modeling that shows the reservoir filling would inundate this habitat. This determination is also appropriate for indirect effects related to the habitat south of River Mile 54, which is projected to be regularly inundated due to water level increases in the reservoir. Additionally, note that willow habitat, documented to be preferred for nesting in the delta reach of the EBR, matures with time, becoming unsuitable for flycatcher nesting (Service 2002; Reclamation 2013a). Similarly, as described in the proposed critical habitat designation (Service 2014), cuckoos require large tracts of willow-cottonwood forest or woodland for their nesting habitat. This habitat matures with time, becoming unsuitable for cuckoo nesting. Prolonged flooding of the overly mature habitat would likely destroy the old vegetation. Quality nesting habitat would be regenerated after the reservoir water level then recedes.

Reclamation requested that the Service consider whether incidental take for the continued implementation of the OA is required now or later based on modeled versus actual future conditions. When the Service finds that an action may adversely affect a species, but not jeopardize its continued existence, the Service prepares an incidental take statement for the proposed action. Considerations of such effects from the long-term hydrological modeled projections, however, may be most appropriately considered in the future, when specific conditions producing such effects can be better defined and are based on monitored responses to actual climatic conditions. Simulations of each of the climate scenarios do not show sustained wet conditions in the near-term given the baseline conditions in EBR.

The biological assessment (Reclamation 2015c**)** details the effects on the Southwestern willow flycatcher and Western yellow-billed cuckoo. **Chapter 5** and **Appendix D** include further information and correspondence regarding the ESA Section 7 consultation.

4.8.5 Alternative 2: No San Juan–Chama Project Storage

Alternative 2 differs from Alternative 1 (No Action Alternative) in that San Juan–Chama Project water would not be stored in the EBR. As explained in **Section 4.7.5**, under Alternative 2 the overall range of reservoir elevations modeled for the three climate scenarios is 4,254 to 4,407 feet.

Under this alternative, the EBR could reach a lower elevation than under the other alternatives, and there would most likely be longer periods of lower elevations (**Figures 4-9** to **4-11**). Therefore, impacts on flycatchers and cuckoos associated with declining or low reservoir elevations, as previously described under Alternative 1, could occur. However, the reservoir has the potential of rising to an elevation that is higher than under Alternatives 4 and 5; therefore, the impacts on flycatchers and cuckoos associated with a rising reservoir elevation and a greater number of acres of habitat being inundated, as previously described, could also occur.

When the reservoir recedes, reservoir bottomlands or nutrient-enriched exposed soils would quickly be revegetated with both desirable species, such as willow, and undesirable species, such as nonnative or invasive plants. This recession could create habitat for the flycatcher and cuckoo. If the reservoir were to remain at low water levels, habitat upstream and next to the reservoir pool would ultimately mature through natural succession past a point of suitability for the flycatcher and cuckoo. It would eventually be replaced by more upland species until the reservoir levels increase and this vegetation is replaced.

Alternative 2 has the greatest potential for creating habitat, if the reservoir were to fill, depending on the timing and duration of filling. Alternative 2 also has the greatest amount of habitat that could be inundated and potentially destroyed. Therefore, under Alternative 2, riparian vegetation would expand, leading to more flycatcher and cuckoo habitat. Conversely, under Alternative 2, flycatcher and cuckoo habitat has the greatest potential for maturing beyond the point of suitability. It could also lead to increased drying and expansion of upland vegetation into formerly riparian areas.

4.8.6 Alternative 3: No Carryover Provision

Under this alternative, the reservoir would fluctuate less than under Alternative 1 (**Figures 4-9** to **4-11**). As explained in **Section 4.7.5**, under Alternative 3 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet.

4.8.7 Alternative 4: No Diversion Ratio Adjustment

Under Alternative 4, there is no diversion ratio adjustment. As explained in **Section 4.7.5**, under Alternative 4 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Because the likely maximum reservoir elevation under this alternative and under all climate scenarios during wet periods is lower than Alternative 1 (**Figures 4-9** to **4-11)**, there would be less vegetation. As a result, there would be less flycatcher and cuckoo habitat to become inundated during periods of reservoir rise than under Alternative 1. Also, because less habitat is inundated under Alternative 4, fewer acres of mature habitat could be replaced by new vegetation when the reservoir recedes again.

4.8.8 Alternative 5: Prior Operating (Ad Hoc) Practices

Under Alternative 5, there is no diversion ratio adjustment and no carryover provision, but San Juan–Chama storage would continue. As explained in **Section 4.7.5**, under Alternative 5 the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. At EBR, modeling indicates that Alternative 5 could allow for slightly higher reservoir levels than under Alternative 1.

The effects on vegetation supporting wildlife habitat would essentially be the same as with the other alternatives, in that there would be periods of reservoir filling and receding. While the range of likely elevations under Alternative 5 is not the smallest, reservoir elevations during most of the dry periods under all climate scenarios tend to be higher than with the other alternatives (**Figures 4-9** to **4-11**).

Conversely, during the simulated wet periods, reservoir elevations are generally lower than the simulated reservoir elevations for the other alternatives. Therefore, under Alternative 5, by increasing and decreasing reservoir elevations, fewer acres of flycatcher and cuckoo habitat could be affected than under the other alternatives.

4.8.9 Cumulative Impacts

The cumulative effects analysis of wildlife and special status wildlife species is essentially the same as for vegetation communities. Habitat supporting the Southwestern willow flycatcher and Western yellow-billed cuckoo is present in the EBR pool and is degraded, expanded, or enhanced by reservoir level fluctuations.

Additionally there is the potential for direct impact from inundation of nests and loss of individuals; however, the reservoir levels would likely be highest outside of the nesting season, when these birds are not present. Conservation measures included in Delta Channel Maintenance Project restrict work when these birds and other species are present. Likewise, some beneficial effects on wildlife would result from the habitat restoration projects south of Caballo Reservoir from the canalization project.

Because the simulated reservoir fluctuations are within the range of historical operations and are similar for all of the alternatives, vegetation and habitat supporting special status wildlife habitat below the full-pool elevations would continue to be established or lost under all alternatives over time. The differences among the alternatives have little effect on the simulated reservoir elevations that would impact habitat. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.8.10 Summary Conclusions

- Because the alternatives address surface water resource operations, the potential for impacts on wildlife and special status species are those associated with the riparian habitat and reservoir lake levels.
- The flycatcher and the cuckoo use habitat in the EBR pool that can be affected by the duration, timing, and fluctuations in reservoir levels.
- The water level in the reservoir pool would fluctuate under all alternatives, which is within the range of historical operations.
- Temporary establishment and loss of vegetation and wildlife habitat below the full-pool elevations would occur under all alternatives.
- Based on the modeling through 2050, there are cycles of reservoir drying and rising where elevations would potentially remain high, potentially leading to inundation and loss of active nests and nestlings.
- The differences among the alternatives have little effect on the simulated reservoir elevation and duration of inundation and drying cycles.

4.9 Aquatic Resources and Special Status Fish Species

As described in **Section 4.8**, this assessment focuses on two segments in the study area that vary in degree and type of effects: EBR, including its upstream delta reach, and Caballo Reservoir, both of which are in New Mexico.

4.9.1 Impact Indicators

Previous studies indicate the reservoir fishery habitats and populations generally benefit under reservoir rise and with full, stable reservoirs. Fishery habitats and populations vary during conditions of reservoir drying and shallow, fluctuating water levels (Sammons and Bettoli 2000; Ozen 2002).

Specifically for EBR and Caballo Reservoir, New Mexico Department of Game and Fish (2011, 2015) reported that fluctuating water levels, both annual and inter-annual, plus resulting high turbidities and a general lack of emergent vegetation, have produced poor habitat conditions for centrarchid species,[3] white bass, gizzard shad, and channel catfish in the reservoirs. At the same time, fluctuating water levels apparently result in increased populations of other species, such as blue catfish.

The New Mexico Department of Game and Fish reported that declining water levels during spawning, water turbidity, and inadequate forage seem to be the most limiting factors for smallmouth bass and largemouth bass populations. Because EBR is almost 100 years old, it tends to have very little aquatic emergent or submergent vegetation to provide a viable seed bank in years when water levels rise. As such, the development of necessary emergent vegetation communities commonly associated with healthy bass

[3] E.g., largemouth and smallmouth bass, crappie, and bluegill

populations is lacking. The New Mexico Department of Game and Fish (2011) adds that it is important to have flooded vegetation every three to four years to produce strong year classes of largemouth bass.

The New Mexico Department of Game and Fish (2015) suggests that centrarchid habitat could be improved if the lake would refill to near capacity. However, multiple years of low lake levels have allowed natural revegetation in the upper lake and have depressed centrarchids and other fish populations.

4.9.2 Analysis Methods and Assumptions

The analysis method for aquatic resources and special status fish species involved considering the potential effects of the alternatives on water resources to determine whether these would affect aquatic wildlife and their habitats. Reclamation considered data and information related to hydrology modeling used to develop the baseline conditions for aquatic resources in the study area. It used these data to assess potential biological responses to habitat condition modifications, including reservoir inundation extremes, during the assessment period (relative to baseline conditions occurring at the end of September 2014).

4.9.3 Effects Common to All Alternatives

As described in **Section 4.8.3**, fluctuations in reservoir elevations are anticipated during the 43-year simulation period for all alternatives and climate scenarios. In general, riverine fish species in EBR headwaters, including the Rio Grande silvery minnow, would be expected to benefit from lower water levels and a longer river channel into EBR.

In addition, EBR is projected to reach capacity, or full pool, during both the central tendency P50 and wetter P75 climate scenarios (Reclamation 2015a). In general, lake fish species would benefit from an increasing reservoir shoreline and flooded vegetation; although riverine fish would have slightly less riverine habitat in the reservoir pool, they are expected to move upstream to suitable habitat as the reservoir fills. Therefore, implementing the OA, combined with the effects of climate change, would reduce the populations and potential diversity of fishery resources. This would happen during prolonged periods of declining reservoir water levels and low water levels. During wetter periods, when the RMBHM model simulates rising water levels in the reservoirs, fish populations may increase.

Should periods of low water elevations result in the localized loss of some species, restocking may be necessary to restore these species to one or both of the reservoirs. Fish stocking by New Mexico Department of Game and Fish is commonly practiced to augment various fish species populations in both reservoirs. Due to uncertainty in the frequency and magnitude of water level fluctuations, quantifying future fish population reductions or expansions is not possible.

Invasive, Nonnative Species under All Alternatives

The potential for spread and continued presence of invasive mussels would be the same under all alternatives. Invasive zebra and quagga mussels have been detected in upstream reservoirs. Under all alternatives, there is a potential for these mussels to become established in Elephant Butte and Caballo Reservoirs; however, slight alterations in reservoir operations or flows in the river reaches do not affect the potential for the reservoirs' colonization or infestation by mussels. Preventative measures to clean boats entering and leaving reservoirs would continue under all alternatives.

4.9.4 Alternative 1: No Action Alternative

Under Alternative 1, EBR is predicted to reach higher maximums during modeled wet periods than predicted for the other alternatives (**Figures 4-9** to **4-11**). Under Alternative 1, the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Lake fish species would be expected to benefit from an increasing reservoir shoreline and flooded vegetation; riverine fish would have slightly less habitat in the reservoir pool, but they are expected to move upstream to suitable habitat as the reservoir levels increase. Riverine fish species in EBR headwaters would benefit from a lower reservoir and a longer river channel into the reservoir, while lake fish would have slightly less habitat in the reservoir pool.

Rio Grande Silvery Minnow

The model simulation anticipates that EBR would fill under both the P50 and P75 climate scenarios (**Figures 4-9** to **4-11**) and would displace minnows in the delta channel as the elevation was rising. The minnows would be displaced to more upstream reaches of the river in the delta reach until EBR reaches its peak storage volume. This gradual upstream movement of minnows could extend into their critical habitat reach of the Rio Grande, upstream of the full pool extent of EBR (River Mile 62).

As the reservoir pool subsequently contracts, the minnows could and likely would again repopulate the river channel within the reservoir. Minnows are well known to swim freely in the available channel habitat of the Rio Grande. Reclamation would continue to maintain the delta channel for efficient delivery of water to the reservoir; even without a maintained channel, a naturally formed river channel would develop as long as upstream river flows were sufficient to enter the EBR pool. The minnow does not live within the EBR below the river channel due to a lack of appropriate food. Minnows also do not occur in the other downstream Rio Grande reaches of the OA study area below EBR. The minnow has been extirpated from the river below EBR, except for the population of introduced minnows in Big Bend, Texas. Due to the absence of minnows in these reaches of the study area, continued implementation of the OA would not affect this species.

Reclamation is conducting an ESA Section 7 consultation on the No Action Alternative. For the purpose of assessing the impacts on special status species whose habitat is present in the EBR pool, Reclamation used the wetter P75 scenario 100 percent non-exceedance value, which assessed a conservative worst case based on the potential impacts on these species and their habitats of sustained high water level in the reservoir. For the minnow, Reclamation has concluded a **"may affect, but not likely to adversely affect"** determination is warranted due to the ability of the minnow to move upstream, potentially into their critical habitat reach upstream of River Mile 62, whenever reservoir filling is of a sufficient magnitude and duration to produce such movement. With sufficient magnitude and duration of reservoir filling, critical habitat upstream of River Mile 62 may receive beneficial effects due to increased deposition of sediment in that reach.

4.9.5 Alternative 2: No San Juan–Chama Project Storage

The effects of Alternative 2 on aquatic resources would be similar to those described under Alternative 1, although EBR water levels under Alternative 1 tend to be higher than under Alternative 2 (**Figures 4-9** to **4-11**). Alternative 2 includes storage of 50,000 acre-feet of San Juan–Chama Project water in EBR when sufficient space is available. However, longer periods of lower elevations would be expected, which would increase the likelihood of aquatic habitat loss.

Rio Grande Silvery Minnow

The effects of Alternative 2 on the Rio Grande silvery minnow would be similar to those described under Alternative 1. The delta channel may extend farther into the reservoir for longer periods and would provide some additional riverine habitat.

4.9.6 Alternative 3: No Carryover Provision

Under Alternative 3, aquatic species in both the river above EBR and in EBR itself could benefit from relatively more stable reservoir elevations within the river delta channel (**Figures 4-9** to **4-11**) as compared to Alternative 1. Under Alternative 3, the overall range of reservoir elevations modeled for the three climate scenarios is 4,283 to 4,407 feet. Over the period of record, the mean elevation for Alternative 3 is 4,316 feet for P25 (one foot higher that Alternative 1), and 4,327 feet for P50 and P75 (the same as Alternative 1). When no carryover water is stored and EBR elevations fluctuate less, aquatic species in both the river above RM 62 and within EBR in the river/delta channel could benefit from a relatively stable reservoir elevation as compared to Alternative 1. However, carryover does not occur every year; thus Alternative 3 and Alternative 1 are similar during many years over the 35-year assessment period. When storage is low, a higher reservoir elevation from carryover water can be a positive effect to riverine conditions because of increased sediment deposition along the river/delta channel.

Rio Grande Silvery Minnow

The effects of Alternative 3 on the Rio Grande silvery minnow would be the same as those described under Alternative 1.

4.9.7 Alternative 4: No Diversion Ratio Adjustment

The predicted likely maximum reservoir elevation during wet periods is predicted to be lower than under Alternative 1 (**Figures 4-9** to **4-11**). Aquatic species in both the river above EBR and in the reservoir itself could benefit from relatively more stable reservoir elevations. Riverine species could have more habitat available; however, lake species could have slightly less habitat.

Rio Grande Silvery Minnow

The effects of Alternative 4 on the Rio Grande silvery minnow would be the same as those under Alternative 1.

4.9.8 Alternative 5: Prior Operating (Ad Hoc) Practices

While the range of likely predicted elevations under Alternative 5 is not the smallest, reservoir elevations during most of the predicted dry periods for all climate scenarios tend to be higher than under the other alternatives. Conversely, during the predicted wet periods, reservoir elevations are generally lower than the predicted reservoir elevations under the other alternatives (**Figures 4-9** to **4-11**). Lake species would benefit from higher reservoir elevations during dry periods, but they would not gain as much habitat during wet periods as under Alternative 1. Alternatively, riverine species would lose more habitat during dry periods and would gain more during wet periods than they would under Alternative 1.

Rio Grande Silvery Minnow

The effects of Alternative 5 on the Rio Grande silvery minnow would be the same as described under Alternative 1.

4.9.9 Cumulative Impacts

The Delta Channel Maintenance Project extends the river into EBR and provides additional occupied habitat for riverine species, including the endangered Rio Grande silvery minnow. Conservation measures included in the maintenance provide habitat features in the channel to support the minnow's life stages and to avoid harming the fish during construction.

Because the minnow cannot survive in the reservoir pool, the fluctuation of the reservoir can impact the channel habitat. With a higher reservoir, riverine fish would have slightly less habitat available in the reservoir pool but would move upstream to suitable habitat as the reservoir levels increase. Higher reservoir pools would provide additional habitat for lake fisheries. There are no special status fish in the Rio Grande in the reaches below Caballo Reservoir where the Rio Grande Canalization Project is located.

Similar to the other biological resources, the range of reservoir fluctuations is within the range of historical operations and is similar for all alternatives. Similar effects on habitat for the minnow and reservoir fisheries would occur under all alternatives over time. The differences among the alternatives have little effect on the modeled reservoir elevations that would impact habitat. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.9.10 Summary Conclusions

- The potential for impacts on aquatic resources and special status fish species is limited to the delta channel in EBR and reservoir fisheries. There are no releases to the river below Caballo Dam in the non-irrigation season.
- Water levels in the reservoir pool would fluctuate under all alternatives and would be within the range of historical operations.
- The differences among the alternatives have little effect on the simulated reservoir elevation and duration of inundation and drying cycles.

- Lake fish species would be expected to benefit from an increasing reservoir shoreline and flooded vegetation, while riverine fish would have slightly less riverine habitat in the reservoir pool but are expected to move upstream to suitable habitat as the reservoir levels increase.
- Riverine fish species, including the silvery minnow, in the delta channel above EBR would be expected to benefit from a lower reservoir and a longer river channel into the reservoir, while lake fish would have slightly less habitat in the reservoir pool.

4.10 Cultural Resources

Cultural resources, including those that are listed on the NRHP or that may be eligible for listing on the NRHP, are present within the Area of Potential Effects for the OA. Cultural resources identified in the SEA are water retention and conveyance infrastructure, archaeological resources, and traditional plant gathering locations (Reclamation 2013a).

4.10.1 Impact Indicators

The following indicator was used in the cultural resources analysis:

- The damage or loss of the physical integrity or the setting of NRHP-eligible cultural resources or locations important to contemporary tribal communities

4.10.2 Analysis Methods and Assumptions

For the purposes of this analysis, if the Federal action would result in an unresolved adverse effect on a historic property under the NHPA, there would be a significant impact under NEPA. Reclamation evaluated the alternatives using the criteria defined in 36 CFR 800, which define adverse effects as "direct or indirect alteration of the characteristics that qualify a property for inclusion in the NRHP in a manner that diminishes integrity of location, design, setting, materials, workmanship, feeling, or association." The integrity of cultural resources is assessed by the ability of the cultural, archaeological, or historic property to convey the important traditional, scientific, and public values for which it is determined to be historically significant. Adverse effects also include "reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative" (36 CFR 800.5[a][1]).

4.10.3 Effects Common to All Alternatives

Because the OA is a written algorithm regarding the process of accounting for storage and release of RGP water, continuation of the agreement would not change the character or use of RGP facilities. Therefore, no effects on these historic properties or contributing elements of the historic district would occur. None of the alternatives would affect the gathering and use of culturally important plant resources growing along canals in EBID and EPCWID service areas, because RGP water would continue to flow and allow the growth and harvesting of plants valued by the Mescalero Apache Tribe.

No sacred sites have been identified to date, and thus there would be no effect on these resources. None of the alternatives alter the maximum reservoir pools or current channel capacity of the Rio Grande or canals. The fluctuation of reservoir levels and any wave action would not affect undisturbed land or cultural resources around the perimeter of the reservoirs. The potential for impacts on cultural resources that may be within the reservoir pools would be unchanged from historical operations, and no new impacts on cultural resources are anticipated to result from reservoir fluctuations.

Reclamation concluded that a determination of "no historic properties affected," in accordance with 36 CFR 800.4(d)(1), is appropriate for this project's undertaking. In November 2015, the New Mexico SHPO concurred with Reclamation's determination. (See **Chapter 5**, Public Involvement, Consultation, and Coordination, **Section 5.5.2**, NHPA, for more information.) Consultation correspondence is found in **Appendix D**.

4.10.4 Cumulative Impacts

As described above, any potentially affected cultural resources are within the high pool of the reservoir and are already subject to inundation under historical operations. In addition, there would be no alteration of the historical dam and water infrastructure. Reclamation has determined, and the SHPO concurred, that there would be no adverse effects from implementing any alternative. The Delta Channel Maintenance Project and Rio Grande Canalization Project also must comply with Section 106 of the NHPA. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of the resource.

4.11 Indian Trust Assets

ITAs are legal interests in property held in trust by the U.S. for Federally recognized Indian tribes or individual Indians. Relevant regulations and existing conditions for ITAs are discussed in detail in **Section 3.12**.

4.11.1 Effects Common to All Alternatives

No ITAs have been identified previously in consultation with the Mescalero Apache, an Indian tribe whose aboriginal territory is within the current project area (Reclamation 2007, 2013a). Government-to-government consultation to date for the proposed action with potentially affected tribes, including the Mescalero Apache Tribe and the Pueblo of Ysleta del Sur, has not identified any ITAs. (See **Chapter 5**, Public Involvement, Consultation, and Coordination, **Section 5.3**, Tribal Consultation and Communication, for more information.) Under all alternatives, no ITAs relevant to the RGP or to implementation of the OA have been identified. As a result, implementing any of the proposed alternatives would have no impact on ITAs.

4.11.2 Cumulative Impacts

No ITAs relevant to the RGP or to implementation of the OA have been identified in the alternatives or in the past, present, and reasonably foreseeable future actions described in **Section 4.2.2**. As a result, there would be no cumulative effects on ITAs under any alternative.

4.12 Socioeconomics

4.12.1 Impact Indicators

The socioeconomic analysis evaluated impacts of the alternatives on economic benefits and regional economic indicators, as listed below. The summary of the results can be found in **Section 4.12.9**. For the first of the seven indicators listed below, the economic value of surface water in the Rincon and Mesilla Basins was modeled as the incremental cost of obtaining a substitute water supply, which is the energy cost associated with pumping groundwater as simulated in the RMBHM. However, as described in **Section 4.1**, surface-water shortages that occur under the various alternatives do not directly cause changes to the amount of groundwater pumped.

Economic benefit (direct impact) indicators:

1. Pumping costs in EBID and the Mesilla Valley of EPCWID (the incremental changes in pumping costs represent a change in economic value of agricultural water use)
2. Economic value of agricultural water use in EPCWID Economic value of urban water use (urban water in EPCWID)
3. Economic value of recreation (recreation at EBR)
4. Economic value of hydropower generation (at Elephant Butte Power Plant)

Regional economic indicators:

1. Employment (full- and part-time jobs)
2. Income (employee compensation and proprietors' income)
3. Output (sales)

4.12.2 Analysis Methods and Assumptions

The proposed alternatives are analyzed using two economic measures: 1) the economic benefits, or direct impacts; and 2) the regional economic impacts. The economic benefits or direct impacts measure the effects of each alternative from a societal standpoint (a gain or loss to society from a change in activities). The regional economic impacts measure the effects of each alternative on a region's economy (such as changes in employment and income).

The net economic benefit and regional economic impact calculations rely on hydrologic outcomes of project alternatives as provided by the hydrology technical memorandum (Reclamation 2015a; Appendix C) and available economic data.

The economic benefits and regional economic impacts stemming from the use of RGP water under each alternative are calculated and presented along with the differences from the No Action Alternative (Alternative 1). The economic benefits or direct impacts and regional economic impacts are calculated for the following general categories of water users:

1. EBID
2. EPCWID
3. Hydropower production at Elephant Butte Power Plant
4. Recreation benefits at EBR

Note that the regional economic impacts are measured based on the same general water use categories except for hydropower production at Elephant Butte Power Plant.

Economic Benefits (Direct Impacts)

Elephant Butte Irrigation District

The estimation of net economic benefit value is limited to agricultural users and is based on the findings shown in the hydrology technical memorandum (Reclamation 2015a; Appendix C). The hydrologic simulation found that, although depletion of shallow groundwater within the EBID service area occurs under all alternatives, the available supply to project irrigators was never exhausted, and therefore all crops received a full irrigation supply under all simulated conditions. The full impact of changes in project deliveries between alternatives is thus calculated as the differences in costs of pumping groundwater between alternatives.

The hydrologic modeling identified complete substitution of groundwater when surface water deliveries were not available. No changes in cropping or acreage resulted during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits between alternatives is limited to the differences in pumping costs incurred by project irrigators when surface water is not available.

Differences in costs of RGP (surface) water delivery between alternatives are not considered, because costs are almost entirely fixed and are not volume dependent. While irrigators may experience differences in labor costs and other factors in using surface water instead of groundwater, there is no basis for quantifying these differences and so they are not considered.

Pumping costs are determined by the total volume pumped and the total head. Because both volume and head differ by alternative, each factor is used in calculating pumping costs. Capital costs are not considered, as all project irrigators are assumed by the hydrology technical memorandum (Reclamation 2015a) to have access to available supplemental groundwater as needed, and the relatively small volumes that differentiate alternatives are assumed to have no effect on pump lifetimes or maintenance costs (Reclamation 2015a).

Groundwater pumping cost calculation

The calculation of groundwater pumping costs was based on the energy costs of delivering the quantity of groundwater identified under each project alternative. The annual average groundwater delivery and the elevations and beginning of period well depths were taken from the hydrology technical memorandum (Reclamation 2015a), and the static head was taken from crop enterprise budgets for Sierra and Doña Ana Counties (New Mexico State University 2005). Energy (electric) costs and pump efficiency were likewise obtained from the crop enterprise budgets. The wells cover all cropping areas in EBID, and the simple average well elevation changes within each cropping area were used to calculate average pumping heads for each alternative.

Groundwater elevations for regions served by major canals were taken from the hydrology technical memorandum (Reclamation 2015a), which calculated groundwater elevations and initial groundwater depths. Groundwater elevations reported under each alternative for the 15 wells in the project area were averaged for the Rincon Valley and the Mesilla Valley Leasburg, Eastside, and Westside Canals. The total groundwater deliveries to EBID were allocated to each region based on the acreage reported in the hydrology technical memorandum (Reclamation 2015a). The starting well depth was also taken from the hydrology technical memorandum (Reclamation 2015a). The typical head across the region and study period was 70 to 80 feet, with 50 feet of static head (New Mexico State University 2005) and a calculated 20 to 30 feet well depth to water.

A pump efficiency of 0.47 for electric pumps and an electricity cost of $0.1098/kilowatt-hour for electricity were taken from crop enterprise budgets (New Mexico State University 2005). The cost of electricity was adjusted to 2015 levels using the producer price index for North American Industry Classification System 2211, electric utilities. A resulting energy cost of $0.152/kilowatt-hour was used (price index 2015 = 144.3; 2005 index = 104.2). The potential energy conversion is 1.024 kilowatt-hour /acre-foot/foot, meaning that at 100 percent efficiency, 1.024 kilowatt-hour of energy is required to lift one acre-foot of water to a height of 1 foot.

El Paso County Water Improvement District Number 1

RGP deliveries to water users from the American Diversion Dam are not treated in the hydrologic modeling (Reclamation 2015a), and there is no specific information on the disposition of RGP waters after delivery (Reclamation 2015a). The most recent financial report from El Paso Water Utilities (2015) gives an average year surface water delivery of 60,000 acre-feet for municipal and industrial uses, with these flows providing approximately half of the El Paso Water Utility supply. The balance of the municipal and industrial water supplies is pumped from the Hueco and Mesilla Basins. All other surface water deliveries at the American Diversion Dam are then available for diversion for agricultural uses. (Deliveries to Mexico at the International Diversion Dam are included within the hydrologic modeling [Reclamation 2015a; Appendix C], and do not vary by alternative; therefore, they are not further considered in the economic analysis.) The historical full EPCWID allocation of 376,842 acre-feet then gives surface diversions of 316,842 acre-feet available for agricultural uses. Acreages of 6,494 and 62,516 in the Mesilla and El Paso Valleys, respectively, are used to calculate Mesilla and El Paso Valley full allocation diversions of 29,816 and 287,026 acre-feet, respectively. Any greater levels of urban surface water use would result in proportionally lower levels of Rio Grande agricultural diversions; this possibility is not considered here.

EPCWID El Paso valley agricultural water users

Net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012) are used to estimate the economic benefits associated with RGP surface water deliveries at the American Diversion Dam to El Paso Valley agricultural users. Their base scenario reports average deliveries to agricultural users of 237,000 acre-feet, with average net benefits of $112 per acre-foot. This is taken as the value of RGP surface water deliveries to El Paso Valley agricultural users when diversions fall below the full allocation level. According to Ward and Pulido-Velazquez (2012), agricultural users have not developed much groundwater pumping infrastructure and therefore are not reported to make significant use of groundwater to supplement their surface water use.

EPCWID urban water users

El Paso urban uses do rely heavily on groundwater, and sustainability of both the quantity and quality of groundwater supplies are a significant concern. To value the Rio Grande surface water delivered for urban use, the Ward and Pulido-Velazquez (2012) "sustaining" and "renewing" natural capital scenarios were used, which report a difference in urban water use of 6,000 acre-feet. The difference in the reported net benefits to urban water users is $574 per acre-foot and is taken here as the value of RGP water in El Paso urban uses when supply falls below 60,000 acre-feet.

Distribution between agricultural and urban users

The hydrology technical memorandum hydrologic studies provide no guidance on the distribution of RGP water to urban versus agricultural uses (Reclamation 2015a). Because values in urban and agricultural uses can be substantially different, economic valuation would be sensitive to this distribution. The economic analysis here assumes that RGP water is distributed proportionally to urban and agricultural uses throughout the study period, and that urban uses are held to 60/376.842 = 15.9 percent of total EPCWID diversions, and agricultural uses receive 84.1 percent of diversions.

Value of deliveries to EPCWID users in Mesilla Valley

Deliveries of RGP water to EPCWID agricultural water users in the Mesilla Valley are valued identically to EBID agricultural water users. The hydrologic studies show full availability of groundwater to substitute for surface water when diversions fall below allocations. Total benefits from the use of groundwater and RGP surface water are calculated identically to EBID project users.

Hydropower

The hydroelectric plant at Elephant Butte Dam generates power that is dependent on flow volume and head. Because both flows and reservoir elevation would differ between alternatives, expected power generation would also vary. There is currently no hydroelectric production at Caballo Dam, and thus no economic differences between alternatives exist, despite differing releases between alternatives.

Reservoir elevation and releases

The hydrology technical memorandum hydrologic study provides monthly elevations at EBR for each alternative (Reclamation 2015a). Power production does not occur during winter months when RGP releases do not occur. Hydropower calculations are thus based on the calculated average elevation during the March to October period only. Annual releases from EBR reported by the hydrology technical memorandum, reduced by the volume of spills, are used with the March to October average elevations (Reclamation 2015a).

Power plant characteristics and valuation

The Elephant Butte Power Plant has a rated head of 140 feet and is assumed to operate with 90 percent efficiency. Energy generation is calculated from reservoir elevation, with the rated head achieved at the maximum elevation over the study period, and the potential energy conversion of 1.024 kilowatt-hour per acre-foot per foot of head. Calculated production based on the average March to October monthly elevation and release data for 2014 is 3 percent below the actual power plant production of 13.4 gigawatt-hours reported by Reclamation (2015d). Economic valuation of production is based on the economic opportunity cost concept and uses the same $0.152/ kilowatt-hour value as is assigned to the cost of groundwater pumping. This neglects distribution costs and losses (which would suggest a lower figure), but also does not consider use of the power plant for short-term peaking operations (which suggest an increased valuation). Reservoir elevation for purposes of hydropower calculations use only Alternative 1 reported values.

Recreation

EBR provides a variety of recreational benefits that vary based on reservoir storage. Because storage varies between project alternatives, recreational benefits are calculated for EBR. Similarly, Caballo Reservoir provides recreational benefits. These benefits are not addressed, however, because the differences in Caballo Reservoir storage among alternatives are small and would not result in significant differences in economic benefits from recreation at Caballo Reservoir under each alternative.

Annual recreation benefits reported by Ward and Pulido-Velazquez (2012) are based on:

$$\textit{Value of Elephant Butte Reservoir recreation} = 379.82 + 2.21\,X - 0.0005030852\,X^2$$

where X equals the average annual storage in thousand acre-feet, and the economic value is in thousand dollars. Management costs of $0.31 per acre-foot of storage (due to increased visitation) are also identified (Ward 2014) and deducted from the economic benefit calculation reported here. The hydrology technical memorandum annual average reservoir storage is used with the above equation to estimate direct economic benefits of recreation (Reclamation 2015a).

Regional Economic Impacts

In addition to considering the net economic benefits or direct impacts of each alternative, the socioeconomic analysis estimates the potential regional economic impacts. The regional impacts may stem from changes in agricultural pumping costs, the costs of providing urban water, and recreation visitation expenditures. These direct economic impacts are input into the IMPLAN model to estimate total regional impacts. The direct economic impacts of hydropower are assumed to have no impacts on the regional economy.

IMPLAN is the modeling package used to assess the regional economic impacts stemming from the direct impacts associated with each alternative. IMPLAN is an economic input-output modeling system that estimates the effects of economic changes in a defined analysis area. IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data. IMPLAN measures the initial impact on the economy but does not consider long-term adjustments as labor and capital move into alternative uses. Realistically, the structure of the economy would adapt and change; therefore, the IMPLAN results can only be used to compare relative changes between the No Action Alternative and the action alternatives and cannot be used to predict or forecast future employment, labor income, or output (sales).

Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the analysis area (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived using a set of multipliers. The multipliers describe the change in output for each regional industry caused by a $1.00 change in final demand.

This analysis used 2013 IMPLAN data for the counties encompassing the study areas. IMPLAN data files for the analysis area are compiled from a variety of sources, including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau.

4.12.3 Impacts Common to All Alternatives

No impacts common to all alternatives were identified.

4.12.4 Alternative 1: No Action Alternative

4.12.4.1 Economic Benefits (Direct Impacts)

Elephant Butte Irrigation District

The hydrologic modeling assumes that there were no changes in cropping or acreage during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits or direct impacts between alternatives is limited to differences in pumping costs incurred by project irrigators when surface water is not available. The hydrology modeling assumes that the cropping pattern for each service area within the model domain was based on cropping data available for the year 2000.

The average annual water supply available to EBID as estimated by the hydrology model (Reclamation 2015a; Appendix C) is shown below. These EBID deliveries are split between the Rincon (roughly 20 percent) and Mesilla (roughly 73 percent) Valleys based on the acreage distribution between the two valleys (including EPCWID land in the Mesilla Valley).

EBID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 1

	P25[1]	**P50**[2]	**P75**[3]
EBID Average annual project diversion (thousand acre-feet)	150.3	176.5	219.2
EBID Groundwater Pumping Delivery (thousand acre-feet)	252.0	227.2	211.1

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

The estimated pumping costs under Alternative 1 equal $1.2 million in the Rincon Valley and $4.4 million in the Mesilla Valley based on the median hydrology simulation. These results are shown below.

EBID Average Annual Pumping Costs–Alternative 1

	P25[1]	**P50**[2]	**P75**[3]
	(millions of dollars)		
Pumping Costs – Rincon Valley	$1.4	$1.2	$1.1
Pumping Costs – Mesilla Valley	$4.9	$4.4	$4.0

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile

El Paso County Water Improvement District Number 1

As discussed in **Section 4.12.2**, EPCWID supplies water to both agricultural water users and urban users. The economic benefits and regional economic impacts are analyzed separately for both water uses (agricultural and urban).

The average annual water supply available to EPCWID as estimated by the hydrology model (Reclamation 2015a; Appendix C) is shown below for Alternative 1. The economic analysis here assumes that RGP water is distributed proportionally to urban (15.9 percent of diversions) and agricultural (84.1 percent of diversions) uses throughout the study period, as discussed in **Section 4.12.2**.

EPCWID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 1

	P25[1]	**P50**[2]	**P75**[3]
EPCWID Average annual project diversion (thousand acre-feet)	225.4	258.5	285.4

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

EPCWID Agricultural Water Use

The agricultural water use is analyzed separately for the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2**.

El Paso Valley agricultural use

EPCWID El Paso Valley agricultural water use value is based on the net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012). Agricultural users in this area are not reported to make significant use of groundwater to supplement their surface water use. Therefore, the agricultural benefit value is based on the effects of surface water deliveries for each alternative as it relates to surface water deliveries. The average annual agricultural benefit value for the median hydrology simulation is $23.5 million annually for the El Paso Valley water users, as shown below.

EPCWID El Paso Valley Average Annual Agricultural Benefits–Alternative 1

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
EPCWID Average annual benefits	$20.9	$23.5	$26.7

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Mesilla Valley agricultural use

The hydrologic studies show full availability of groundwater to substitute for surface water when diversions fall below allocations. The difference in the economic benefits or direct impacts between alternatives is limited to differences in pumping costs incurred by project irrigators when surface water is not available.

The pumping costs in the Mesilla Valley portion of EPCWID are estimated to be $0.3 million for the median hydrology simulation under Alternative 1, as shown below.

EPCWID El Paso Valley Average Annual Pumping Costs–Alternative 1

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
Pumping Costs – Mesilla Valley	$0.3	$0.3	$0.2

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

EPCWID Urban Use

The Ward and Pulido-Velazquez (2012) values were used to estimate the economic benefit values for urban water use in EPCWID as explained in **Section 4.12.2**. A value of $574 per acre-foot was applied to the estimated average annual urban deliveries to estimate the average annual benefits value for the alternative. The average annual benefit value for urban use for Alternative 1 equals $23.1 million for the median hydrology simulation, as shown below.

EPCWID Urban Average Annual Economic Benefits–Alternative 1

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
EPCWID Urban Benefits	$20.3	$23.1	$26.7

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Hydropower Production at Elephant Butte

Flows and reservoir elevations differ between alternatives; therefore, the expected power generation would also vary between alternatives. The generation at Elephant Butte Dam is estimated to be 33.4 gigawatt-hours under Alternative 1. The average annual economic benefits resulting from this amount of power generation is estimated to be $5.1 million using the median hydropower simulation. These results are shown below.

Elephant Butte Hydropower Average Annual Economic Benefits–Alternative 1

	P25[1]	P50[2]	P75[3]
Elephant Butte Mean Storage (thousand acre-feet)	284	444	445
Elephant Butte Generation (gigawatt-hours)	25.1	33.4	35.2
Elephant Butte Hydropower Benefits (millions of dollars)	$3.8	$5.1	$5.4

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Recreation at Elephant Butte Reservoir

EBR provides a variety of recreational benefits that vary based on reservoir storage. Because storage varies between alternatives, recreational benefits are calculated for EBR. Recreational activities at Caballo Reservoir also provide recreational benefits. Because the differences in Caballo storage between project alternatives are small and would not result in significant differences in economic benefits from Caballo recreation, these benefits were not estimated. Recreation benefits are estimated to be $1.1 million under Alternative 1 for the median hydrology simulation, as shown below.

Elephant Butte Recreation Economic Benefits–Alternative 1

	P25[1]	P50[2]	P75[3]
Elephant Butte Mean Storage (thousand acre-feet)	284	444	445
Elephant Butte Recreation Benefits (millions of dollars)	$0.9	$1.1	$1.1

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

4.12.4.2 Regional Economic Impacts

Regional Economic Impacts

The regional economic impacts are measured based on incremental changes from Alternative 1 conditions; therefore, the total regional impacts associated with Alternative 1 were not measured.

4.12.5 Alternative 2: No San Juan–Chama Project Storage

4.12.5.1 Economic Benefits (Direct Impacts)

Elephant Butte Irrigation District

Economic benefits (direct impacts) and regional economic impacts would be the same as described under Alternative 1.

El Paso County Water Improvement District Number 1

Economic benefits (direct impacts) and regional economic impacts would be the same as described under Alternative 1.

Hydropower Production at Elephant Butte

Economic benefits (direct impacts) from hydropower production would be the same as described under Alternative 1.

Recreation at Elephant Butte Reservoir

Economic benefits (direct impacts) and regional economic impacts from recreation would be the same as described under Alternative 1.

4.12.6 Alternative 3: No Carryover Provision

4.12.6.1 Economic Benefits (Direct Impacts)

Elephant Butte Irrigation District

The hydrologic modeling assumes no changes in cropping or acreage would occur during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits or direct impacts between alternatives would be limited to differences in pumping costs incurred by project irrigators when surface water is not available. The hydrology modeling assumes that the cropping pattern for each service area within the model domain was based on cropping data available for the year 2000.

The average annual water supply available to EBID as estimated by the hydrology model (Reclamation 2015a; Appendix C) under Alternative 3 conditions is shown below. These EBID deliveries are split between the Rincon (roughly 20 percent) and Mesilla (roughly 73 percent) Valleys based on the acreage distribution between the two valleys (including EPCWID).

EBID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 3

	P25[1]	P50[2]	P75[3]
EBID Average annual project diversion (thousand acre-feet)	167.3	213.3	234.2
EBID Groundwater Pumping Delivery (thousand acre-feet)	239.5	202.8	197.5

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

The pumping costs would decrease by $0.1 million in the Rincon Valley and by $0.6 million in the Mesilla Valley compared to Alternative 1 for the median hydrology simulation. The decreased pumping costs are considered the agricultural economic benefit under the Alternative 3 conditions using the median hydrology simulation, as shown below.

EBID Average Annual Pumping Costs–Alternative 3

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
Pumping Costs – Rincon Valley	$1.3	$1.1	$1.0
Change in pumping costs compared to Alternative 1	$-0.1	$-0.1	$-0.1
Pumping Costs – Mesilla Valley	$4.7	$3.8	$3.7
Change in pumping costs compared to Alternative 1	$-0.2	$-0.6	$-0.3

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

El Paso County Water Improvement District Number 1

As discussed in **Section 4.12.2**, EPCWID supplies water to both agricultural water users and urban users. The economic benefits and regional economic impacts are analyzed separately for both water uses (agricultural and urban). The agricultural water use is analyzed separately for the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2.**

The average annual water supply available to EPCWID as estimated by the hydrology model (Reclamation 2015a; Appendix C) is shown below. The economic analysis assumes that RGP water is distributed proportionally to urban (15.9 percent of diversions) and agricultural (84.1 percent of diversions) uses throughout the study period, as discussed in **Section 4.12.2**.

EPCWID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 3

	P25[1]	P50[2]	P75[3]
EPCWID Average annual project diversion (thousand acre-feet)	215.3	239.8	275.0

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

EPCWID Agricultural Water Use

The agricultural water use is analyzed separately for the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2**.

El Paso Valley agricultural use

EPCWID El Paso Valley agricultural benefit value is based on the net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012), as described in **Section 4.12.2**. Agricultural users in this area are not reported to make significant use of groundwater to supplement their surface water use. Therefore, the agricultural benefit value is based on the effects of surface water deliveries for each alternative as it relates to surface water deliveries. The average annual agricultural benefit value for the El Paso Valley water users under the median hydrology simulation is $22.8 million, as shown below. Under the Alternative 3 operations scenario, the agricultural benefit value decreases by $0.7 million annually compared to Alternative 1.

EPCWID El Paso Valley Average Annual Agricultural Benefits–Alternative 3

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
EPCWID Average annual agricultural Benefits - El Paso Valley	$20.5	$22.8	$26.3
Change from Alternative 1	$-0.4	$-.0.7	$-0.3

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Mesilla Valley agricultural use

No change would occur compared to Alternative 1.

EPCWID Urban Use

The Ward and Pulido-Velazquez (2012) values were used to estimate the economic benefit values for urban water use in EPCWID, as explained in **Section 4.12.2**. A value of $574 per acre-foot was applied to the estimated average annual urban deliveries to estimate the average annual benefits value for the alternative. The average annual benefits value for urban use for Alternative 3 equals $21.8 million for the median hydrology simulation, as shown below. This would represent a loss of $1.3 million annually compared to Alternative 1.

EPCWID Urban Average Annual Economic Benefits–Alternative 3

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
EPCWID Urban Benefits	$19.6	$21.8	$25.1
EPCWID Urban Change from Alternative 1	$-0.7	$-1.3	$-0.9

1 Based on hydrology simulation with 25^{th} percentile
2 Based on hydrology simulation with 50^{th} percentile (median)
3 Based on hydrology simulation with 75^{th} percentile
Source: Reclamation 2015a

Hydropower Production at Elephant Butte

Flows and reservoir elevations differ between alternatives; therefore, the expected power generation would also vary between alternatives. The generation at Elephant Butte Dam is estimated to be 34.7 gigawatt-hours under Alternative 3 conditions. The economic benefits resulting from this amount of power generation is estimated to be $5.3 million under the median hydropower simulation. Compared to Alternative 1, hydropower generation would increase slightly, resulting in a small increase in economic benefit of $0.2 million, as shown below.

Elephant Butte Hydropower Average Annual Economic Benefits–Alternative 3

	P25[1]	P50[2]	P75[3]
Elephant Butte Mean Storage (thousand acre-feet)	298	459	466
Elephant Butte Generation (gigawatt-hours)	26.6	34.7	36.6
Elephant Butte Hydropower Benefits (millions of dollars)	$4.0	$5.3	$5.6
Change from Alternative 1 (millions of dollars)	$0.2	$0.2	$0.2

1 Based on hydrology simulation with 25^{th} percentile
2 Based on hydrology simulation with 50^{th} percentile (median)
3 Based on hydrology simulation with 75^{th} percentile
Source: Reclamation 2015a

Recreation at Elephant Butte Reservoir

The differences in EBR storage compared to Alternative 1 are small and would not result in significant differences in economic benefits.

4.12.6.2 Regional Economic Impacts

Elephant Butte Irrigation District

The regional economic impacts would result from a change in pumping costs. A change in pumping costs would result in higher or lower net farm income, which translates to farm households having more or less money to spend within the regional economy. The pumping costs in the Rincon and Mesilla Valleys would decrease by $0.7 million for the median hydrologic simulation compared to Alternative 1, as shown below.

Under Alternative 3 conditions, household income is assumed to increase by $0.7 million. Stemming from an increase in household income, employment in the region is expected to increase by four jobs (full- and part-time jobs). Labor income is estimated to increase by $144,625. Finally, output is estimated to increase by $266,296, as shown below.

El Paso County Water Improvement District Number 1

El Paso Valley agricultural use
The regional economic impacts would result from a change in the value of crops produced in the region. The value of production would decrease by $0.7 million (distributed by crop acreage for IMPLAN analysis) for the median hydrologic simulation compared to Alternative 1, as shown below.

The decrease in agricultural production compared to Alternative 1 would result in less local expenditures related to farm inputs, wages, and household income. Stemming from the decrease in production, employment in the region is expected to decrease by 19 full- and part-time jobs. Labor income is estimated to decrease by $456,081. Final output is estimated to decrease by $1,315,393, as shown below.

Mesilla Valley agricultural use
No change would occur compared to Alternative 1.

EPCWID Urban Use
The estimated value of urban water in EPCWID is estimated to decrease by $1.3 million compared to Alternative 1. This decrease would result in changes in regional impacts. The loss in regional income stemming from the decrease in value of urban water is estimated to decrease employment by 10 full- and part-time jobs. Labor income is estimated to decrease by $644,673. Output is estimated to decrease by $2,230,601, as shown below.

Hydropower Production at Elephant Butte
The regional impacts are not impacted by hydropower production at Elephant Butte.

Recreation at Elephant Butte Reservoir
The differences in EBR storage compared to Alternative 1 are small and would not result in significant differences in regional economic impacts.

Regional Economic Impacts (Incremental to Alternative 1)–Alternative 3

	Employment	Labor Income	Output
EBID Agricultural Use	4	$144,625	$266,296
EPCWID El Paso Valley Agricultural Use	-19	$-456,081	$-1,315,393
EPCWID Mesilla Valley Agricultural Use	No change	No change	No Change
EPCWID El Paso Valley Urban Use	-10	$-644,673	$-2,230,601
Hydropower at EBR	No Impact	No Impact	No Impact
Recreation at EBR	No change	No change	No change

4.12.7 Alternative 4: No Diversion Ratio Adjustment

4.12.7.1 Economic Benefits (Direct Impact)

Elephant Butte Irrigation District

The hydrologic modeling assumes that no changes in cropping or acreage occurred during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits or direct impacts between alternatives is limited to differences in pumping costs incurred by project irrigators when surface water is not available. The hydrology modeling assumes that the cropping pattern for each service area within the model domain was based on cropping data available for the year 2000.

The average annual water supply available to EBID as estimated by the hydrology model (Reclamation 2015a; Appendix C) under Alternative 4 conditions is shown below. These EBID deliveries are split between the Rincon (roughly 20 percent) and Mesilla (roughly 73 percent) Valleys based on the acreage distribution between the two valleys (including EPCWID).

EBID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 4

	P25[1]	**P50[2]**	**P75[3]**
EBID Average annual project diversion (thousand acre-feet)	202.5	242.6	282.1
EBID Groundwater Pumping Delivery (thousand acre-feet)	217.6	184.3	161.6

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

The pumping costs would decrease by $0.3 million in the Rincon Valley and $1.0 million in the Mesilla Valley compared to Alternative 1 under the median hydrology simulation. The decreased pumping costs are considered the agricultural economic benefit under the Alternative 4 conditions using the median hydrology simulation, as shown below.

EBID Average Annual Pumping Costs–Alternative 4

	P25[1]	**P50[2]**	**P75[3]**
	(millions of dollars)		
Pumping Costs – Rincon Valley	$1.1	$0.9	$0.8
Change in pumping costs compared to Alternative 1	$-0.3	$-0.3	$-0.3
Pumping Costs – Mesilla Valley	$4.1	$3.4	$2.9
Change in pumping costs compared to Alternative 1	$-0.8	$-1.0	$-1.1

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

El Paso County Water Improvement District Number 1

As discussed in **Section 4.12.2**, EPCWID supplies water to both agricultural water users and urban users. The economic benefits and regional economic impacts are analyzed separately for both water uses (agricultural and urban). The agricultural water use is analyzed separately in the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2**.

The average annual water supply available to EPCWID as estimated by the hydrology model (Reclamation 2015a; Appendix C) is shown below. The economic analysis assumes that RGP water would be distributed proportionally to urban (15.9 percent of diversions) and agricultural (84.1 percent of diversions) uses throughout the study period, as discussed in **Section 4.12.2**.

EPCWID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 4

	P25[1]	**P50[2]**	**P75[3]**
EPCWID Average annual project diversion (thousand acre-feet)	200.4	231.8	261.0

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

EPCWID Agricultural Water Use

The agricultural water use is analyzed separately for the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2**.

El Paso Valley agricultural use

EPCWID El Paso Valley agricultural benefit value is based on the net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012), as described in **Section 4.12.2**. Agricultural users in this area are not reported to make significant use of groundwater to supplement their surface water use. Therefore, the agricultural benefit value is based on the effects of surface water deliveries for each alternative. The average annual agricultural benefit value for the El Paso Valley water users using the median hydrology simulation is $22.0 million, as shown below. Under the Alternative 4 operations scenario, the agricultural benefit value decreases by $1.5 million compared to Alternative 1.

EPCWID El Paso Valley Average Annual Agricultural Benefits–Alternative 4

	P25[1]	**P50[2]**	**P75[3]**
	(millions of dollars)		
EPCWID Average annual agricultural benefits - El Paso Valley	$19.2	$22.0	$25.6
Change from Alternative 1	$-1.6	$-.1.5	$-1.4

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Mesilla Valley agricultural use

No change would occur compared to Alternative 1.

EPCWID Urban Use

The Ward and Pulido-Velazquez (2012) values were used to estimate the economic benefit values for urban water use in EPCWID, as explained in **Section 4.12.2**. A value of $574 per acre-foot was applied to the estimated average annual urban deliveries to estimate the average annual benefits value for this alternative. The average annual benefit value for urban use for Alternative 4 equals $21.2 million under the median hydrology simulation, as shown below. This represents a loss of $2.0 million compared to Alternative 1.

EPCWID Urban Average Annual Economic Benefits–Alternative 4

	P25[1]	**P50**[2]	**P75**[3]
	(millions of dollars)		
EPCWID Urban Benefits	$18.3	$21.2	$23.8
EPCWID Urban Change from Alternative 1	$-2.0	$-2.0	$-2.2

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Hydropower Production at Elephant Butte

Flows and reservoir elevations would differ between alternatives; therefore, the expected power generation would also vary between alternatives. The generation at Elephant Butte Dam is estimated to be 33.9 gigawatt-hours under Alternative 4 conditions. The economic benefits resulting from this amount of power generation is estimated to be $5.1 million under the median hydropower simulation. Compared to Alternative 1, hydropower generation would increase slightly, resulting in a small increase in economic benefits of $0.1 million. These results are shown below.

Elephant Butte Hydropower Average Annual Economic Benefits–Alternative 4

	P25[1]	**P50**[2]	**P75**[3]
Elephant Butte Mean Storage (thousand acre-feet)	265	434	427
Elephant Butte Generation (gigawatt-hours)	25.3	33.9	35.3
Elephant Butte Hydropower Benefits (millions of dollars)	$3.8	$5.1	$5.4
Change from Alternative 1 (millions of dollars)	$0.0	$0.1	$0.0

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Recreation at Elephant Butte Reservoir

The differences in EBR storage compared to Alternative 1 are small and do not result in significant differences in economic benefits.

4.12.7.2 Regional Economic Impacts

Elephant Butte Irrigation District

The regional economic impacts would result from a change in pumping costs. Pumping cost changes would result in higher or lower net farm income, which translates to farm households having more or less money to spend within the regional economy. Pumping costs in the Rincon and Mesilla Valleys would decrease by $1.3 million under the median hydrologic simulation compared to Alternative 1, as shown below.

Under Alternative 4, household income is assumed to increase by $1.3 million. Stemming from an increase in household income, employment in the region is expected to increase by 8 jobs (full- and part-time jobs). Labor income is estimated to increase by $268,590. Finally, output is estimated to increase by $865,462. These results are summarized below.

El Paso County Water Improvement District Number 1

El Paso Valley agricultural use

The regional economic impacts would result from a change in the value of the crops produced in the region. The value of production would decrease by $1.5 million (distributed by crop acreage for IMPLAN analysis) under the median hydrologic simulation compared to Alternative 1. These results are summarized below.

The decrease in agricultural production would result in less local expenditures related to farm inputs, wages, and household income. Stemming from the decrease in production, employment in the region is expected to decrease by 40 full- and part-time jobs. Labor income is estimated to decrease by $977,317. Finally, output is estimated to decrease by $2,818,698. These results are summarized below.

Mesilla Valley agricultural use

No change would occur compared to Alternative 1.

EPCWID Urban Use

The estimated value of urban water in EPCWID is estimated to decrease by $2.0 million compared to Alternative 1. This decrease would result in regional impacts. The loss in regional income stemming from the decrease in value of urban water is estimated to decrease employment by 15 full- and part-time jobs. Labor income is estimated to decrease by $991,805. Output is estimated to decrease by $3,431,694. These results are shown below.

Hydropower Production at Elephant Butte

The regional impacts are not impacted by hydropower production at Elephant Butte.

Recreation at Elephant Butte Reservoir

The differences in EBR storage compared to Alternative 1 are small and would not result in significant differences in regional economic impacts.

Regional Economic Impacts (Incremental to Alternative 1)–Alternative 4

	Employment	Labor Income	Output
EBID Agricultural Use	8	$268,590	$865,462
EPCWID El Paso Valley Agricultural Use	-40	$-977,317	$-2,818,698
EPCWID Mesilla Valley Agricultural Use	No Change	No Change	No Change
EPCWID El Paso Valley Urban Use	-15	$-991,805	$-3,431,694
Hydropower at Elephant Butte	No Impact	No Impact	No Impacts
Recreation at EBR	No Change	No Change	No Change

4.12.8 Alternative 5: Prior Operating (Ad Hoc) Practices

4.12.8.1 Economic Benefits (Direct Impact)

Elephant Butte Irrigation District

The hydrologic modeling assumes that no changes in cropping or acreage resulted during the study period. Focusing solely on the Rincon and Mesilla Basins, the difference in the economic benefits or direct impacts between alternatives is limited to differences in pumping costs incurred by project irrigators when surface water is not available. The hydrology modeling assumes that the cropping pattern for each service area within the model domain was based on cropping data available for the year 2000.

The average annual water supply available to EBID as estimated by the hydrology model (Reclamation 2015a; Appendix C) under Alternative 5 conditions is shown below. These EBID deliveries are split between the Rincon (roughly 20 percent) and Mesilla (roughly 73 percent) Valleys based on the acreage distribution between the two valleys (including EPCWID).

EBID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 5

	P25[1]	P50[2]	P75[3]
EBID Average annual project diversion (thousand acre-feet)	200.0	239.8	271.1
EBID Groundwater Pumping Delivery (thousand acre-feet)	217.6	184.3	169.7

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

The pumping costs would decrease by $0.3 million in the Rincon Valley compared to Alternative 1 under the median hydrology simulation. The pumping costs would decrease by $1.0 million in the Mesilla Valley under the Alternative 5 conditions compared to

Alternative 1. The decreased pumping costs are considered an agricultural economic benefit under Alternative 5 under the median hydrology simulation. These results are shown below.

EBID Average Annual Pumping Costs–Alternative 5

	P25[1]	P50[2]	P75[3]
	(millions of dollars)		
Pumping Costs – Rincon Valley	$1.1	$0.9	$0.9
Change in pumping costs compared to Alternative 1	$-0.3	$-0.3	$-0.2
Pumping Costs – Mesilla Valley	$4.2	$3.4	$3.1
Change in pumping costs compared to Alternative 1	$-0.7	$-1.0	$-0.9

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

El Paso County Water Improvement District Number 1

As discussed in **Section 4.12.2**, EPCWID supplies water to both agricultural water users and urban users. The economic benefits and regional economic impacts are analyzed separately for both water uses (agricultural and urban). The agricultural water use is analyzed separately for the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2**.

The average annual water supply available to EPCWID as estimated by the hydrology model (Reclamation 2015a; Appendix C) is shown below. The economic analysis assumes that RGP water would be distributed proportionally to urban (15.9 percent of diversions) and agricultural (84.1 percent of diversions) uses throughout the study period, as discussed in **Section 4.12.2**.

EPCWID Average Annual Rio Grande Project Diversions and Groundwater Deliveries–Alternative 5

	P25[1]	P50[2]	P75[3]
EPCWID Average annual project diversion (thousand acre-feet)	200.0	226.2	259.6

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

EPCWID Agricultural Water Use

The agricultural water use is analyzed separately for the El Paso Valley and the Mesilla Valley, as noted in **Section 4.12.2**.

El Paso Valley agricultural use

EPCWID El Paso Valley agricultural benefit value is based on the net benefits of RGP water use reported by Ward and Pulido-Velazquez (2012), as described in **Section 4.12.2**. Agricultural users in this area are not reported to make significant use of groundwater to supplement their surface water use. Therefore, the agricultural benefit value is based on the effects of surface water deliveries for each alternative. The average annual agricultural benefit value for the El Paso Valley water users under the median hydrology simulation is $21.7 million, as shown below. Under Alternative 5, the agricultural benefit value decreases by $1.7 million compared to Alternative 1.

EPCWID El Paso Valley Average Annual Agricultural Benefits–Alternative 5

	P25[1]	**P50[2]**	**P75[3]**
	(millions of dollars)		
EPCWID Average annual agricultural benefits - El Paso Valley	$19.5	$21.7	$25.2
Change from Alternative 1	$-1.3	$-1.7	$-1.5

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Mesilla Valley agricultural use

No change would occur compared to Alternative 1.

EPCWID Urban Use

The Ward and Pulido-Velazquez (2012) values were used to estimate the economic benefit values for urban water use in EPCWID, as explained in **Section 4.12.2**. A value of $574 per acre-foot was applied to the estimated average annual urban deliveries to estimate the average annual benefits value for the alternative. The average annual benefit value for urban use for Alternative 5 equals $20.7 million under the median hydrology simulation, as shown below. This would represent a loss of $2.3 million compared to Alternative 1.

EPCWID Urban Average Annual Economic Benefits–Alternative 5

	P25[1]	**P50[2]**	**P75[3]**
	(millions of dollars)		
EPCWID Urban Benefits	$18.3	$20.7	$23.7
EPCWID Urban Change from Alternative 1	$-2.0	$-2.5	$-2.3

1 Based on hydrology simulation with 25th percentile
2 Based on hydrology simulation with 50th percentile (median)
3 Based on hydrology simulation with 75th percentile
Source: Reclamation 2015a

Hydropower Production at Elephant Butte

Flows and reservoir elevations differ between alternatives; therefore, the expected power generation would also vary among alternatives. The generation at Elephant Butte Dam is estimated to be 34.1 gigawatt-hours under Alternative 5 conditions. The economic benefits resulting from this amount of power generation is estimated to be $5.2 million using the median hydropower simulation. Compared to Alternative 1, hydropower generation would increase slightly, resulting in a small increase in economic benefits of $0.1 million, as shown below.

Elephant Butte Hydropower Average Annual Economic Benefits– Alternative 5

	P25[1]	P50[2]	P75[3]
Elephant Butte Mean Storage (thousand acre feet)	276	450	446
Elephant Butte Generation (gigawatt-hours)	25.3	34.1	35.6
Elephant Butte Hydropower Benefits (millions of dollars)	$3.8	$5.2	$5.4
Change from Alternative 1 (millions of dollars)	$0.0	$0.1	$0.1

1 Based on hydrology simulation with 25^{th} percentile
2 Based on hydrology simulation with 50^{th} percentile (median)
3 Based on hydrology simulation with 75^{th} percentile
Source: Reclamation 2015a

Recreation at Elephant Butte Reservoir

The differences in EBR storage compared to Alternative 1 are small and do not result in significant differences in economic benefits.

4.12.8.2 Regional Economic Impacts

Elephant Butte Irrigation District

Regional economic impacts would result from a change in pumping costs. Pumping cost changes would result in higher or lower net farm income, which would translate to farm households having more or less money to spend within the regional economy. Pumping costs in the Rincon and Mesilla Valleys would decrease by $1.3 million under the median hydrologic simulation compared to Alternative 1. These results are summarized below.

Under Alternative 5, household income is assumed to increase by $1.3 million. Stemming from an increase in household income, employment in the region is expected to increase by eight jobs (full- and part-time jobs). Labor income is estimated to increase by $268,590. Finally, output is estimated to increase by $865,462. These results are summarized below.

El Paso County Water Improvement District Number 1

El Paso Valley agricultural use

Regional economic impacts would result from a change in the value of the crops produced in the region. The value of production would decrease by $1.7 million (distributed by crop acreage for IMPLAN analysis) under the median hydrologic simulation compared to Alternative 1. These results are summarized below.

The decrease in agricultural production would result in less local expenditures related to farm inputs, wages, and household income. Stemming from the decrease in production, employment in the region is expected to decrease by 45 full- and part-time jobs. Labor income is estimated to decrease by $1,107,626. Finally, output is estimated to decrease by $3,194,525. These results are summarized below.

Mesilla Valley agricultural use
No change would occur compared to Alternative 1.

EPCWID Urban Use
The value of urban water in EPCWID is estimated to decrease by $2.5 million compared to Alternative 1. This decrease would result in changes in regional impacts. The loss in regional income stemming from the decrease in value of urban water is estimated to decrease employment by 18 full- and part-time jobs. Labor income is estimated to decrease by $1,239,756. Output is estimated to decrease by $4,289,617. These results are shown below.

Hydropower Production at Elephant Butte
The regional impacts are not impacted by hydropower production at Elephant Butte.

Recreation at Elephant Butte Reservoir
The differences in EBR storage compared to Alternative 1 are small and would not result in significant differences in regional economic impacts.

Regional Economic Impacts (Incremental to Alternative 1)–Alternative 5

	Employment	Labor Income	Output
EBID Agricultural Use	8	$268,590	$865,462
EPCWID El Paso Valley Agricultural Use	-45	$-1,107,626	$-3,194,525
EPCWID Mesilla Valley Agricultural Use	No Change	No Change	No Change
EPCWID El Paso Valley Urban Use	-18	$-1,239,756	$-4,289,617
Hydropower at Elephant Butte			
Recreation at EBR	No Change	No Change	No Change

4.12.9 Summary Conclusions
The average annual economic benefits (median hydrology simulation) for each alternative and water use category are summarized below. Generally, the alternatives would decrease the total benefits compared to Alternative 1. The economic benefits estimated for EBID would increase compared to Alternative 1 for all of the alternatives except Alternative 2, while the benefits estimated for EPCWID would decrease compared to Alternative 1 for all of the alternatives except for Alternative 2.

The regional impacts (median hydrology simulation) estimated for each alternative and water use categories are summarized below. Generally, the regional impacts in the New Mexico study area (Doña Ana and Sierra Counties, New Mexico), where EBID is located, increase compared to Alternative 1 for all the alternatives. The regional impacts estimated for the Texas study area (El Paso and Hudspeth counties), where EPCWID is located, decrease for all alternatives compared to Alternative 1. Compared to the overall region, these changes (positive and negative) are small compared to the entire regional economies of the New Mexico and Texas study areas.

Economic Benefits (Average Annual) Summary by Alternative (Median Hydrology Simulation)

	Alternative 2 No San Juan–Chama Project Storage	Alternative 3 No Carryover Provision	Alternative 4 No Diversion Ratio Adjustment	Alternative 5 Prior Operating (Ad Hoc) Practices
		(millions of dollars)		
EBID Rincon Valley Agriculture	No Change	$0.1	$0.3	$0.3
EBID Mesilla Valley Agriculture	No Change	$0.6	$1.0	$1.0
EPCWID – El Paso Valley Agriculture	No Change	$-0.7	$-1.5	$-1.7
EPCWID – Mesilla Valley Agriculture	No Change	$0	$0	$0
EPCWID - Urban	No Change	$-1.3	$-2.0	$-2.5
Hydropower	No Change	$0.2	$0.1	$0.1
Recreation	No Change	$0	$0	$0
Total		**$-1.1**	**$-2.1**	**$-2.8**

Regional Impacts Summary by Alternative (Median Hydrology Simulation)

	Alternative 2 No San Juan–Chama Project Storage	Alternative 3 No Carryover Provision	Alternative 4 No Diversion Ratio Adjustment	Alternative 5 Prior Operating (Ad Hoc) Practices
EBID Agriculture	No Change	4 Jobs $144,625 Labor Income $466,018 Output	8 Jobs $268,590 Labor Income $865,462 Output	8 Jobs $268,590 Labor Income $865,462 Output
EPCWID – El Paso Valley Agriculture	No Change	-19 Jobs -$456,081 Labor Income $-1,315,393 Output	-40 Jobs -$977,317 Labor Income -$2,818,698 Output	-45 Jobs $-1,107,626 Labor Income $-3,194,525 Output
EPCWID – Mesilla Valley Agriculture	No Change	0	0	0
EPCWID - Urban	No Change	-10 Jobs -$644,673 Labor Income -$2,230,601 Output	-15 Jobs -991,805 Labor Income -$3,431,694 Output	-18 Jobs $-1,239,756 Labor Income $-4,289,617

4.13 Environmental Justice

4.13.1 Impact Indicators

Reclamation is responsible for assessing whether the actions being considered as part of the continued implementation of the OA could disproportionately impact minority or low-income populations. Impact assessments determine whether the action would expose a minority or low-income population to disproportionately high and adverse impacts or hazards.

4.13.2 Analysis Methods and Assumptions

As discussed in **Section 3.14**, Environmental Justice, Doña Ana County, New Mexico and Hudspeth and El Paso Counties, Texas, have minority populations above 50 percent and meet CEQ criteria for minority populations for environmental justice consideration. In addition, Hudspeth County has a low-income population substantially above that of Texas and has therefore been identified as a low-income population for environmental justice consideration.

As noted in CEQ guidance, some population groups may have differential patterns of consumption of natural resources that could result in different degrees of impacts. The term “differential patterns of consumption of natural resources” relates to subsistence and differential patterns of subsistence. The term means differences in rates or patterns of fish, water, vegetation, or wildlife consumption among minority populations, low-income populations, or Indian tribes, as compared to the general population. The potential for differential patterns of consumption was examined in the study area.

Any potential disproportionately high human health, environmental, or social and economic effects on these groups (relative to total population effects) as a consequence of the scope of the Federal action were identified and characterized. A disproportionately high and adverse effect on an environmental justice community means the adverse effect would be predominately borne by that community or would be appreciable more severe or greater in magnitude on the environmental justice community than the effect on the overall population within the study area. Any proactive efforts needed to ensure meaningful participation from minority and low-income groups are identified, where appropriate.

4.13.3 Effects Common to All Alternatives

Under all alternatives, direct impacts on low-income or minority populations would be limited due to the lack of construction activities. No change in population or to the percentage or distribution of low-income or minority populations is anticipated as a result of the Federal action under any alternatives. As detailed in **Section 4.12,** Socioeconomics, economic impacts from area recreation due to the differences in EBR storage would vary significantly across alternatives and would not result in significant adverse impacts on low-income or minority populations.

In an effort to reach all audiences, including low-income and minority populations, Reclamation provided EIS project information in multiple formats during public scoping.

Public information was provided in the form of legal notices in local newspapers, information on social media, and updates to the project website. Three public scoping meetings were held throughout the study area, including daytime, evening, and one weekend, in an effort to allow for broader participation. Additional information on public involvement is included in the scoping summary report (Reclamation 2014c) and in **Chapter 6**, Public Involvement, Consultation and Coordination.

As discussed above, there is potential for some population groups to have differential patterns of consumption of natural resources that could result in different degrees of impacts. Within the study area, use of native plants for traditional tribal practices by Native Americans could be impacted by Federal actions that result in disturbance to these native plants, traditionally collected along area canals. Under all alternatives, however, RGP water would continue to flow in these canals, allowing for the growth and harvesting of plants.

4.13.4 Alternative 1: No Action

Under the No Action Alternative, RGP water would continue to support agricultural operations in EBID and EPCWID service areas as well as provide urban water source for EPCWID.

Elephant Butte Irrigation District

Socioeconomic modeling for direct impacts was based on pumping costs incurred by project irrigators when surface water is not available, as discussed in **Section 4.12,** Socioeconomics. Modeling was not separated at the county level; however, EBID generally supplies agriculture in the Mesilla Valley Basin (primarily Doña Ana County, New Mexico) and the Rincon Basin (primarily Sierra County, New Mexico), and impacts on pumping costs in EBID would most likely affect these counties. A minority population (based on CEQ definitions) is present in Doña Ana County. Under Alternative 1, current water distribution for agricultural purposes would continue, and no disproportionate impact would occur on this population.

El Paso County Water Improvement District Number 1

Socioeconomic modeling for EPCWID examined impacts on both agricultural and urban water users (see **Section 4.12,** Socioeconomics). Management actions that impact water supplies to EPCWID would be most likely to impact Texas study area counties of El Paso and Hudspeth, which include low-income and minority populations. Under Alternative 1, current water distribution for agricultural and urban purposes would be maintained and would have no disproportionate adverse impact on low-income or minority populations.

4.13.5 Alternative 2: No San Juan–Chama Project Storage

Under Alternative 2, impacts would be the same as described under Alternative 1.

4.13.6 Alternative 3: No Carryover Provision

Elephant Butte Irrigation District

Under Alternative 3, it is anticipated that pumping costs would decrease for both the Rincon and Mesilla Basins in EBID (see **Section 4.12,** Socioeconomics). Impacts may occur for minority populations in EBID service area; however, the exact impact by county cannot be determined here, and impacts would not be adverse.

El Paso County Water Improvement District Number 1

For EPCWID, in the El Paso service area, Federal actions could result in indirect impacts on economics (see **Section 4.12,** Socioeconomics). This could result in adverse impacts on the minority populations in El Paso and Hudspeth Counties. The exact level of impacts for each county cannot be determined with available IMPLAN analysis. Overall, impacts on the regional economy would be minimal for all populations, including low-income and minority populations.

No change is anticipated for costs of water and related economic impacts on the Mesilla Valley agricultural service area; therefore, no impacts would occur on low-income or minority populations in this area as a result of EPCWID management actions.

4.13.7 Alternative 4: No Diversion Ratio Adjustment

Elephant Butte Irrigation District

Impacts under Alternative 4 would be similar in nature to those described under Alternative 3. As discussed in **Section 4.12,** Socioeconomics, a minor increase in economic output may occur in the New Mexico study area. Impacts may occur for minority populations in EBID service area; however, the exact impact by county cannot be determined here, and impacts would not be adverse.

El Paso County Water Improvement District Number 1

As under Alternative 3, under Alternative 4 proposed management activities could result in indirect water rate increases and related economic impacts (see **Section 4.12,** Socioeconomics). This could impact minority populations in the region within El Paso and Hudspeth Counties. The exact level of impacts for each county cannot be determined with available IMPLAN analysis. Overall, impacts would be minimal on all populations, including low-income and minority populations. No change is anticipated for costs of water and related economic impacts on the Mesilla Valley agricultural service area.

4.13.8 Alternative 5: Prior Operating (Ad Hoc) Practices

Elephant Butte Irrigation District

Impacts under Alternative 5 would be similar in nature to those described under Alternatives 3 and 4. Under Alternative 5, it is anticipated that as a result of pumping cost decreases in the Rincon and Mesilla Basins in EBID, a minor increase in economic output may occur in the New Mexico study area (see **Section 4.12,** Socioeconomics). Impacts may occur for minority populations in EBID service area; however, the exact impact by county cannot be determined here, and impacts would not be adverse.

El Paso County Water Improvement District Number 1

As under Alternatives 3 and 4, under Alternative 5 proposed management actions could result in indirect water rate increases and related economic impacts for agricultural customers in the El Paso service area of EPCWID (see **Section 4.12,** Socioeconomics).

This could result in impacts on the racial and ethnic minorities in the region within El Paso and Hudspeth Counties. The exact level of impacts for each county cannot be determined with available IMPLAN analysis. Overall, impacts are likely to be minimal to all populations, including low-income and minority populations. No change is anticipated for costs of water and related economic impacts on the Mesilla Valley agricultural service area.

4.13.9 Cumulative Impacts

No disproportionately high and adverse impacts on a minority or low-income population from the alternatives were identified. The cumulative projects are associated with minor economic benefits that could increase economic opportunities for minority or low-income populations. The Delta Channel Maintenance Project involves actions in the EBR pool and thus has little potential for impacts on nearby communities or populations. The Rio Grande Canalization Project largely involves actions affecting existing infrastructure and may involve temporary construction. No cumulative environmental justice impacts are anticipated. Therefore, the proposed action would not incrementally change the cumulative effects or the current state of environmental justice.

4.13.10 Summary Conclusions

Based on examination of U.S. Census Bureau data, minority populations, as based on CEQ guidance for environmental justice analysis, have been identified in Doña Ana County, New Mexico, and Hudspeth and El Paso Counties, Texas. A low-income population has also been identified in Hudspeth County, Texas.

Under all alternatives, no construction would be authorized; therefore, no direct impacts, such as from dust, noise, or disturbance, would occur on identified minority or low-income populations.

Based on economic modeling, proposed management activities would result in increased economic opportunities under all alternatives for all populations, including minority populations in Doña Ana County, New Mexico, where EBID is located. The exact impacts on minorities in the county cannot be quantified but would not represent adverse impacts.

For minority and low-income populations in the Texas study area (El Paso and Hudspeth Counties) where EPCWID is located, proposed management activities may result in decreased economic opportunities under the action alternatives, as compared to Alternative 1. Exact impacts by county cannot be determined, but all changes in economic activity are small, compared to the entire regional economy for the Texas study area. As a result, it is anticipated that indirect impacts on the overall job market and economy would be minimal and that no disproportionate adverse impacts would occur on minority or low-income populations.

4.14 Unavoidable Adverse Effects

Unavoidable adverse effects are assumed to be long-term impacts on resources caused by implementation of an alternative. There are no unavoidable adverse effects attributable to the OA alternatives.

Associated with established RGP authorizations and reservoir operations, there is the modeled potential for inundation of the full reservoir pool with impacts on special status species and habitat. These habitats have been established within the authorized pool as a result of low reservoir levels. In some cases, the need for flood control may not be able to avoid these impacts.

4.15 Short-Term Uses and Long-Term Productivity

Section 102(2)(c)(iv) of NEPA and 40 CFR 1502.16, require comparison of the relationships between short-term uses of the human environment to the maintenance and enhancement of long-term productivity.

No construction or other short-term activities are proposed, so there would be no short-term impacts. Alternatives would continue operations and allocations over the long term, consistent with historical practices and the RGP authorization, the districts' rights, the Convention of 1906, the Rio Grande Compact, and other applicable law, and in compliance with various court decrees, settlement agreements, and contracts.

4.16 Irreversible and Irretrievable Commitments of Resources

Section 101(2)(c)(v) of NEPA and 40 CFR 1502.16, require a discussion of irreversible and irretrievable commitments of resources. This is interpreted to mean that those resources, once committed to the proposed alternative, would continue to be committed throughout the duration of operations and that those resources used, consumed, destroyed, or degraded during operations under the proposed alternative could not be retrieved or replaced for the life of the operations or beyond.

The alternatives ensure that RGP water would continue to be allocated consistently and efficiently with respect to the RGP authorization, the districts' rights, the Convention of 1906, the Rio Grande Compact, and other applicable law, and in compliance with various court decrees, settlement agreements, and contracts. Implementation of any of the alternatives involves neither irreversible nor irretrievable commitments of resources.

4.17 Summary of Impacts

Table 4-6, Summary of Impacts, provides a summary of the potential impacts on the resources evaluated in the Draft EIS on the five alternatives.

Table 4-6. Summary of the No Action Alternative Compared with the Other Alternatives

	Alternative 1—No Action	**Alternative 2—No San Juan–Chama Project Storage**	**Alternative 3—No Carryover Provision**	**Alternative 4— No Diversion Ratio Adjustment**	**Alternative 5—Prior Operating (Ad Hoc) Practices**
Section 4.4 Surface Water					
Elephant Butte pool elevation (feet)	4,318	4,312	4,314	4,312	4,313
Total project storage (average annual acre-feet)	409,453	409,453	399,510	371,591	389,109
Annual allocation to EBID	146,977	146,977	264,752	272,269	314,327
Annual allocation to EPCWID	266,327	266,327	267,973	207,296	239,317
Project releases (mean annual acre-feet)	524,597	524,597	525,808	531,229	527,421
Net diversions to EBID (acre-feet)	153,583	153,583	198,287	227,069	228,363
Net diversions to EPCWID (acre-feet)	46,703	46,703	34,805	29,491	25,543
Farm surface water deliveries to EBID (acre-feet)	72,841	72,841	94,477	110,782	110,314
Farm surface water deliveries to EPCWID (acre-feet)	15,954	15,954	15,029	14,964	13,896
Section 4.5 Groundwater					
Mean monthly elevation at Rin-2 (feet)	4,060	4,060	4,062	4,063	4,063
Mean monthly elevation at Mes-6 (feet)	3,814	3,814	3,815	3,816	3,815
Groundwater storage in the Rincon and Mesilla Basins (cumulative change)	Decrease	Decrease	Decrease	Decrease	Decrease
Section 4.6 Water Quality					
Groundwater elevations decline seasonably during sustained dry periods but recover during wet periods.	Negligible	Negligible	Negligible	Negligible	Negligible

Table 4-6. Summary of the No Action Alternative Compared with the Other Alternatives

	Alternative 1—No Action	**Alternative 2—No San Juan–Chama Project Storage**	**Alternative 3—No Carryover Provision**	**Alternative 4— No Diversion Ratio Adjustment**	**Alternative 5—Prior Operating (Ad Hoc) Practices**
Reservoir has no releases to the river below it in the non-irrigation season; changes depend on natural wet and dry cycles.	Negligible	Negligible	Negligible	Negligible	Negligible
Section 4.7 Vegetation					
EBR riparian vegetation	Some net loss	Some net loss	Some net loss	Some net loss	Some net loss
Rio Grande floodplain	None	None	None	None	None
Section 4.8 Wildlife					
Listed species (Southwestern willow flycatcher; Yellow-billed cuckoo) habitat	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Section 4.9 Aquatic Resources					
Aquatic resources	None to minor negative	None to minor negative	None to minor negative	None to minor negative	None to minor negative
Rio Grande silvery minnow	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Section 4.10 Cultural Resources	Not affected	Not affected	Not affected	Not affected	Not affected
Section 4.11 Indian Trust Assets	None	None	None	None	None
Section 4.12 Socioeconomics					
EPCWID average annual agricultural benefits (millions of dollars)	23.5	23.5	22.8	22.0	21.7
Section 4.13 Environmental Justice	None	None	None	None	None

5. Public Involvement, Consultation, and Coordination

This chapter details the consultation and coordination among Reclamation and other Federal, state, and local agencies, American Indian tribes, and the public in preparing this EIS. Since the Notice of Intent to prepare this EIS was published in January 2014, Reclamation has solicited input from a broad range of public constituencies as part of the ongoing public involvement process. The agency sought comments and involvement in the planning for and preparation of this EIS through the following actions, both of which invited input from the general public:

- Communication and consultation with a variety of Federal, state, and local agencies, American Indian tribes, and interest groups
- The formal EIS scoping process

Scoping is the phase in the NEPA process whereby the initial scope of issues to be analyzed is determined. This phase occurs early in the process, and its intent is to obtain the views of the public, other agencies, Indian tribes, and other interested parties regarding the scope of the analysis.

In addition to public involvement, consultation, and coordination for this EIS, Reclamation engaged in such activities during the preparation of two previous EAs. The agency considered all input and information when preparing this EIS.

Reclamation consulted with EBID, EPCWID, and the IBWC when preparing the 2007 EA (Reclamation 2007). For the SEA, Reclamation mailed scoping letters to potentially interested parties in January and April 2012 and publicized and hosted two public scoping meetings, one each in El Paso, Texas, and Las Cruces, New Mexico.

The outcome of this public input process was Reclamation’s decision to supplement the 2007 EA. Through the public and agency involvement, the period of analysis for the SEA was determined to be three years rather than the full term of the OA. During this period, Reclamation voluntarily developed and refined modeling tools to thoroughly analyze in an EIS the implementation of the OA over its remaining life, through 2050.

Reclamation issued a draft of the SEA for public review on May 8, 2013. The agency reviewed and incorporated into the final SEA the public comments it received during the comment period, which ended on June 6, 2013 (Reclamation 2013).

Public involvement is a vital part of the EIS process. It provides an opportunity for those affected by the federal action to take part in the decision-making process and facilitates full environmental disclosure. Guidance for implementing public involvement under

NEPA is codified in 40 CFR 1506.6, and 43 CFR 46, ensuring that Federal agencies make a diligent effort to involve the public in the NEPA process.

Public involvement is being conducted throughout the course of the EIS process; however, the public has specific opportunities to comment during two phases:

- Public scoping before NEPA analysis begins, to determine the scope of issues and alternatives to be addressed in the EIS; this phase occurred during the 30-day January 15 to February 14, 2014, scoping period and is summarized in a scoping report published on July 31, 2014
- Public review of and comment on this Draft EIS (March through May 2016)

Public outreach during the public scoping period was as follows:

- Publishing a notice of intent to prepare the EIS in the *Federal Register*
- Placing newspaper advertisements in the *Santa Fe New Mexican*, *Albuquerque Journal*, *Las Cruces Sun News*, and the *El Paso Times*
- Announcing the public scoping meetings via Reclamation's social media sites and the project website

Reclamation held three public scoping meetings, one each in Albuquerque and Las Cruces, New Mexico, and El Paso, Texas. Reclamation staff conducted the meetings, prepared the handouts, and answered questions. Attending the Albuquerque and Las Cruces meetings were primarily representatives of government agencies, but only Reclamation staff attended the meeting in El Paso.

The public input received during the scoping period is summarized in a report (Reclamation 2014) available at http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html. Reclamation took these comments into consideration when developing the EIS and incorporated this feedback as appropriate during alternatives development, modeling, and impact analysis. As part of this EIS, Reclamation also reviewed and considered scoping input received for the SEA (Reclamation 2013). A summary of scoping activities and input received for the SEA are included on the agency website listed above. Reclamation will conduct public hearings during the 45-day public review period for the draft EIS. It will post information on these meetings, including dates and locations, on the project website.

5.1 Cooperating Agency Involvement

Six agencies signed a memorandum of understanding with Reclamation to become cooperating agencies for this EIS. Reclamation has hosted periodic cooperating agency meetings throughout the preparation of this EIS to ensure that all the agencies were informed of and involved in the issues and analyses.

In October 2015, the City of Santa Fe Water Division ended its roles and responsibilities as a cooperating agency. The five remaining cooperating agencies are the following:

- Colorado Division of Water Resources
- Elephant Butte Irrigation District of New Mexico
- El Paso County Water Improvement District No. 1
- Texas Rio Grande Compact Commissioner
- U.S. Section, International Boundary and Water Commission

5.2 Tribal Consultation and Communication

In accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, Reclamation sent letters on June 24, 2014, requesting input for preparation of the EIS to the two tribes that requested consultation during the preparation of the SEA: the Ysleta del Sur Pueblo in Texas and the Mescalero Apache Tribe in New Mexico. In October 2015, Reclamation reached out to the tribes via phone call and follow-up e-mail. To date, it has received no response from either tribe.

During the preparation of the SEA covering the OA from 2013 to 2015, only the Mescalero Apache Tribe offered comments in response to Reclamation’s scoping letter on the SEA (Reclamation 2013). The tribe’s historical lands lie within the project area. The tribe had concerns about native plants growing along the irrigation canals in the service areas of EBID and EPCWID. Tribal members collect plant material for cultural purposes. Reclamation intends to honor the Mescalero Apache Tribe’s response to the SEA in this EIS.

5.3 Agency Coordination

A number of agencies have participated in the process as cooperating agencies (see **Section 5.1**, Cooperating Agency Involvement). The following agencies were invited to participate as cooperating agencies, but either declined or did not respond to the request: Hudspeth County Conservation and Reclamation District No. 1 of Texas, New Mexico Interstate Stream Commission, and Albuquerque Bernalillo County Water Utility Authority. The Service and the New Mexico SHPO participated through their regulatory consultation authorities.

During the preparation of the two previous EAs, Reclamation consulted with the following agencies: EPCWID, EBID, U.S. Section of the IBWC, and the Texas Rio Grande Compact Commissioner.

5.4 Other Consultations and Coordination

5.4.1 U.S. Fish and Wildlife Service, ESA Section 7 Consultation

To comply with ESA Section 7(a)(2), Reclamation submitted a biological assessment to the Service on August 20, 2015, to address the potential effects of continuing to implement the OA and storing San Juan-Chama Project water in Elephant Butte Reservoir.

The biological assessment analyzes impacts on the Southwestern willow flycatcher (*Empidonax traillii extimus*), the Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), and the Rio Grande silvery minnow (*Hybognathus amarus*). After it submitted the biological assessment, Reclamation confirmed the action area and addressed biological models, as requested by the USFWS. In a memorandum dated December 3, 2015, the USFWS acknowledged receipt of complete information to initiate formal consultation under ESA Section 7(a)(2) and to confirm the action area. ESA Section 7 allows the USFWS up to 90 calendar days to conclude formal consultation and an additional 45 days to prepare a biological opinion. In a memorandum dated February 19, 2016, Reclamation requested an extension until March 22, 2016, to review the Biological Opinion prepared by the Service (see Appendix D).

5.4.2 National Historic Preservation Act

To address requirements of Section 106 of the NHPA, Reclamation submitted documentation to the New Mexico SHPO on October 29, 2015, requesting concurrence on the determination that there would be no adverse effects on historic properties from the federal action. Any potentially affected cultural resources are in the high pool of the reservoir and are already subject to inundation under historical operations. In addition, there would be no alteration of the historic dam and water infrastructure. Reclamation received the SHPO's concurrence on November 25, 2015.

5.5 Distribution List

This list includes agencies, governments, and organizations that were involved in the scoping process, that were invited to participate as a cooperating agency, or that may use the EIS for discretionary or informational purposes. Reclamation continues to solicit input from these entities regarding the federal action by encouraging review of this draft EIS.

Federal agencies:

- Bureau of Indian Affairs, Mescalero Agency
- Bureau of Indian Affairs, Southern Pueblos Agency
- Bureau of Land Management, Las Cruces District Office

- United States Section, International Boundary and Water Commission
- U.S. Fish and Wildlife Service, Southwest Regional Office

State agencies:

- Attorney General, State of Colorado
- Colorado Division of Water Resources
- New Mexico Attorney General Office
- New Mexico Department of Game and Fish
- New Mexico Environment Department
- New Mexico Interstate Stream Commission
- New Mexico State Parks
- State of New Mexico Historic Preservation Division
- Texas Historical Commission
- Texas Parks and Wildlife Department
- Texas Rio Grande Compact Commissioner

Local agencies and entities:

- Albuquerque Bernalillo County Water Utility Authority
- City of Elephant Butte
- City of Las Cruces
- City of Santa Fe, Water Division
- Elephant Butte Irrigation District of New Mexico
- El Paso County Water Improvement District No. 1 of Texas
- El Paso Water Utilities
- Hudspeth County Conservation and Reclamation District No. 1 of Texas
- Paso del Norte Watershed Council

Tribal governments:

- Mescalero Apache Tribe
- Ysleta del Sur Pueblo

Other individuals:

• Beth Bardwell	Audubon New Mexico
• James C. Brockmann	Stein & Brockmann, PA
• Earl Conway	New Mexico B.A.S.S. Nation
• Jorge Garcia	City of Las Cruces
• Jen Pelz	Wild Earth Guardians
• Jay F. Stein	Stein & Brockmann, PA

6. List of Preparers

This *Draft Environmental Impact Statement* was prepared by the Bureau of Reclamation, Upper Colorado Region and its Albuquerque Area Office including contributions and/or review by Denver Policy & Administration, with assistance from Environmental Management and Planning Solutions, Inc. (EMPSi), Santa Fe, New Mexico. The names of persons who prepared various sections, provided extensive background information, or participated to a significant degree in reviewing the present document are listed below in **Table 6-1**.

Table 6-1. Preparers of Draft Environmental Impact Statement

Name and Title	Education and Professional Experience	EIS Responsibility
U.S. Department of the Interior Bureau of Reclamation		
Rhea Graham Special Project Officer	M.A., Oceanography Federal service: 8 years	Environmental Impact Statement Project Manager
Paula Engel Economist	M.S. Agricultural Economics Federal service: 23 years	IMPLAN modeling, socioeconomics analysis
Ian Ferguson Civil Engineer (Hydrologic)	PhD., Civil and Environmental Engineering Licensed Professional Engineer Federal service: 3 years	MODFLOW modeling, integrated surface water hydrology modeling with climate change scenarios
Hector Garcia Senior Environmental Protection Specialist	M.S., Biology and Anthropology Federal service: 25 years	Endangered Species Act consultation and coordination with the Service, National Environmental Policy Act compliance, biological data
Filberto Cortez Special Assistant	B.S., Civil Engineering Federal service: 45 years	Hydrologic modeling, Rio Grande Project water operations, Operating Agreement implementation
Nancy Coulam Supervisory Environmental Protection Specialist	PhD., Anthropology Federal service: 28 years	Regional Review Coordinator, National Environmental Policy Act and Endangered Species Act compliance
Catherine Cunningham Environmental Specialist	B.S. Animal Science Federal service: 27 years	National Environmental Policy Act policy guidance and review
Arthur Coykendall Environmental Specialist	M.S. Wildlife Management Federal service: 25 years	Endangered Species Act policy guidance and review
Beverley Heffernan Division Manager	B.A. History Federal service: 30 years	Regional Review, National Environmental Policy Act compliance
Dagmar Llewellyn Hydrologist	M.S. Civil/Environmental Engineering Federal service: 4 years	Hydrologic modeling, water resources climate change modeling

Table 6-1. Preparers of Draft Environmental Impact Statement

Name and Title	Education and Professional Experience	EIS Responsibility
Private Consultant		
James Booker Professor of Economics	PhD., Agricultural and Resource Economics Faculty service: 25 years	Direct economic benefit estimates, socioeconomic analysis
Environmental Management and Planning Solutions, Inc. (EMPSi)		
David Batts	M.S. Natural Resource Planning Years of Experience: 20	Principal-in-Charge
Kevin Doyle	B.A. Sociology Years of Experience: 30	Project Manager, Cultural Resources
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Melissa Estep	B.S. Industrial & Systems Engineering Years of Experience: 4	Water Resources
Zoe Ghali	M.S. Integrative Physiology (Environmental Physiology) Years of Experience: 8	Socioeconomics and Environmental Justice Lead
Nicholas Parker	M.A., Distinction, Archaeology Years of Experience: 15	Affected Environment; QA/QC
Katie Patterson, JD	J.D. Environmental Law Years of Experience: 7	Legal Sufficiency, NEPA Specialist
Holly Prohaska	M.S., Environmental Management, B.A., Marine Science / Biology, Years of Experience: 15	QA/QC
Kevin Rice	B.S. Environmental Science Years of Experience: 6	Biological Resources
Marcia Rickey	M.S. Biology, Conservation Biology Sequence Years of Experience: 15	GIS Specialist
Chad Ricklefs, AICP	MURP, Environmental Planning Years of Experience: 14	Cumulative Effects; QA/QC
Cindy Schad	B.F.A. Creative Writing Years of Experience: 21	Formatting, 508 Compliance
Drew Vankat	M.S., Environmental Policy and Planning, BPh, Urban and Environmental Planning Years of Experience: 11	Cumulative Effects; Public Involvement, Consultation and Coordination
Randy Varney	M.F.A. Writing Years of Experience: 22	Technical Editing
Tetra Tech, Inc.		
Mike Marcus, PhD Senior Environmental Scientist	Ph.D. Ecology, Toxicology, Statistics-Zoology and Physiology Years of experience: 49	Biological Resources and Biological Assessment Lead

Table 6-1. Preparers of Draft Environmental Impact Statement

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Merri Martz, Senior Biologist	M.M.A. Marine Affairs (Wetland Ecology) M.S. Marine Natural Products Chemistry Years of Experience: 23	Biological Resources
Alaina D. Pershall Environmental Scientist	B.S. Archaeological Anthropology/Biology Years of Experience: 14	Biological Resources
Precision Water Resources Engineering, Inc. (PWRE)		
Shane Coors, PE	M.E. Civil Engineering Years of Experience: 17	Water Resources Lead, Hydrology
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Heather Gacek, PE	M.S. Civil Engineering Years of Experience: 10	Water Resources, Hydrology
Anthony Powell, PE	M.S. Civil Engineering Years of Experience: 7	Water Resources, Hydrology
John Winchester, PE	M.S. Civil Engineering Years of Experience: 25	Water Resources, Hydrology

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7. References

Chapter 1 References

Autobee, R. 1994. Rio Grande Project. Internet website: http://www.usbr.gov/projects/ImageServer?imgName=Doc_1305577076373.pdf.

Conover, C. S. 1954. Ground-water Conditions in the Rincon and Mesilla Valleys and Adjacent Areas in New Mexico. U.S. Geological Survey, Washington, DC.

Hanson, R. T., S. E. Boyce, W. Schmid, J. Knight, and T. Maddock, III. 2013. Integrated Hydrologic Modeling of a Transboundary Aquifer System – Lower Rio Grande. MODFLOW and More 2013: Integrated Hydrologic Modeling, Golden, Colorado, June 5-8, 2011.

Haywood, C.E., and R.M. Yager. 2003. Simulated Ground-Water Flow in the Hueco Bolson, and Alluvial-Basin Aquifer System near El Paso, Texas. U.S. Geological Survey Water Resources Investigations Report 02-4108, 80p. Internet website: http://pubs.usgs.gov/wri/wri02-4108/pdf/wrir02-4108.pdf.

Reclamation (U.S. Department of the Interior, Bureau of Reclamation). 2007. Final Environmental Assessment, Bureau of Reclamation Federal Rio Grande Project New Mexico-Texas Operating Procedures, Doña Ana, Sierra, and Socorro Counties, New Mexico and El Paso County, Texas. June 2007. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/index.html.

_____. 2012. The Rio Grande Project Water Accounting and Operations Manual (Operations Manual) 2010, revision 2012. Addendum to the Rio Grande Project Operating Agreement. June 2012. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/Appdx.pdf.

_____. 2013a. Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

_____. 2013b. Finding of No Significant Impact, Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

_____. 2014. NEPA Scoping Summary on Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas. July 31, 2014. Internet website: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

_____. 2015a. Simulation of Rio Grande Project Operations in the Rincon and Mesilla Basins: Summary of Model Configuration and Results. Technical Memorandum No. 86-68210–2015-05. Bureau of Reclamation, Technical Service Center, Denver, Colorado.

_____. 2015b.Biological Assessment Rio Grande Project Operating Agreement. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico. August 19, 2015. Internet website: http://www.usbr.gov/uc/envdocs/biop.html

S. S. Papadopulos and Associates, Inc. 2007. Draft Groundwater Flow Model for Administration and Management in the Lower Rio Grande Basin. Technical Report prepared for the State of New Mexico. Boulder, Colorado. November 2007.

TWDB (Texas Water Development Board). 2016. 2016 Region E Regional Water Plan, pg. 3-12. Internet website: http://www.twdb.texas.gov/waterplanning/rwp/plans/2016/index.asp.

Winter, T. C., J. W. Harvey, O. L. Franke, and W. M. Alley. 1998. Ground Water and Surface Water: A Single Resource. U.S. Geological Survey Circular 1139, Denver, Colorado. Internet website: http://pubs.usgs.gov/circ/circ1139/. Accessed on December 8, 2015.

Chapter 2 References

Reclamation (U.S. Department of the Interior, Bureau of Reclamation). 2007. Final Environmental Assessment, Bureau of Reclamation Federal Rio Grande Project New Mexico-Texas Operating Procedures, Doña Ana, Sierra, and Socorro Counties, New Mexico and El Paso County, Texas. June 2007. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/index.html.

_____. 2013. Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013.Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

_____. 2014. NEPA Scoping Summary on Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas. July 31, 2014. Internet website: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

_____. 2015. Simulation of Rio Grande Project Operations in the Rincon and Mesilla Basins: Summary of Model Configuration and Results. Technical Memorandum No. 86-68210–2015-05. Bureau of Reclamation, Technical Service Center, Denver, Colorado.

Settlement Agreement. 2008. State of New Mexico ex rel. Office of the State Engineer v. Elephant Butte Irrigation District, et al.

Chapter 3 References

Barroll, P. 2005. Active Water Resources Management in the Lower Rio Grande: Tools for a New Era in Water Management. Lower Rio Grande Water Users Association, August 19, 2005, meeting presentation.

Brown, D. E. 1982. “Semidesert grassland.” *Desert Plants* 4:123-131.

Burley, T. E. 2010. Usage and administration manual for a geo-database compendium of water-resources data–Rio Grande Basin from Rio Arriba-Sandoval County line, New Mexico, to Presidio, Texas, 1889–2009: U.S. Geological Survey Open-File Report 2010-1331. Internet website: http://pubs.usgs.gov/of/2010/1331/.

CEQ (Council on Environmental Quality). 1997. Environmental Justice: Guidelines under the National Environmental Policy Act. Internet website: http://www3.epa.gov/environmentaljustice/resources/policy /ej_guidance_nepa_ceq1297.pdf. Accessed on December 11, 2015.

Dick-Peddie, W. A. 1993. *New Mexico Vegetation, Past, Present, and Future*. University of New Mexico Press, Albuquerque.

Frey, J. K., and D. A. Kopp. 2014. Preliminary Assessment of Jumping Mouse Habitat Associate with the Middle Rio Grande Project. Final Report: Contract R12PX43055. Report to the U.S. Department of the Interior, Bureau of Reclamation, Albuquerque, New Mexico.

Gonzales, E. J., and M. D. Hatch. 2009. Habitat Restoration Monitoring. Report to the New Mexico Interstate Stream Commission.

Hanson, R. T., S. E. Boyce, W. Schmid, J. Knight, and T. Maddock, III. 2013. Integrated Hydrologic Modeling of a Transboundary Aquifer System – Lower Rio Grande. MODFLOW and More 2013: Integrated Hydrologic Modeling, Golden, Colorado, June 5-8, 2011.

Harvey, B. C. 1987. “Susceptibility of young-of-the-year fishes to downstream displacement by flooding.” *Transactions of the American Fisheries Society* 116:851-855.

Hatch, M. D., and E. J. Gonzales. 2008. Habitat Restoration Monitoring. Report to the New Mexico Interstate Stream Commission.

Haywood, C.E., and R.M. Yager. 2003. Simulated Ground-Water Flow in the Hueco Bolson, and Alluvial-Basin Aquifer System near El Paso, Texas. U.S. Geological Survey Water Resources Investigations Report 02-4108, 80p. Internet website: http://pubs.usgs.gov/wri/wri02-4108/pdf/wrir02-4108.pdf.

IBWC (U.S. International Boundary and Water Commission). 2003. Draft EIS River Management Alternatives for the Rio Grande Canalization Project. Draft Environmental Impact Statement, International Boundary and Water Commission, El Paso, Texas.

_____. 2007. Final Environmental Assessment – Flood Control Improvements to the Rio Grande Canalization Project. Internet website: ftp://63.96.218.8/Final_EA_RGC_Levee_Raising.pdf.

_____. 2009. Record of Decision, River Management Alternatives for the Rio Grande Canalization Project, June 20. Internet website: http://www.ibwc.gov/EMD/CanalizationWebpage/ROD_EIS%20June2009.pdf.

_____. 2014a. Flood Control Improvements to the Rio Grande Canalization Project in Vado, New Mexico, United States Section, International Boundary and Water Commission, El Paso, Texas.

_____. 2014b. Rio Grande Canalization Project, River Management Plan. http://www.ibwc.gov/Files/Canalization_River_Management_Plan_112014.pdf

IMPLAN (IMPLAN Group, LLC). 2013. IMPLAN System (data and software), 16740 Birkdale Commons Parkway, Suite 206, Huntersville, NC 28078. Internet website: www.IMPLAN.com.

Langridge, S. M., and M. K. Sogge. 1997. Banding of the southwestern willow flycatcher in the White Mountains—1997 Summary Report. USGS Colorado Plateau Field Stat./No. Arizona University Report, Flagstaff.

Mammoser, E. 2015. Fall Reservoir Community Surveys. Appendix B in Final Performance Report, New Mexico Grant Number F-93-M-1, Sport Fisheries Management Grant, 1/1/2012 through 12/31/2014. New Mexico Department of Game and Fish, Santa Fe.

Michelsen, A. M, T. McGuckin, Z. Sheng, R. Lacewell, and B. Creel. 2009. Rio Grande Salinity Management Program: Preliminary Economic Impact Assessment. Prepared for the Rio Grande Salinity Management Coalition. Internet website: http://agrilifecdn.tamu.edu/elpaso/files/2011/10/Rio-Grande-Salinity-Preliminary-Economic-Assessment-Report-Dec-2009-Final.pdf. Accessed on October 16, 2014.

Netter, M. R., E. H. Paxton, and M. K. Sogge. 1998. Banding and Movements of the Southwestern Willow Flycatcher at Roosevelt Lake and San Pedro River/Gila River Confluence, Arizona 1998. USGS Colorado Plateau Field Station, Flagstaff, Arizona.

NMDA (New Mexico Department of Agriculture). 2009. New Mexico Noxious Weed List Update. Memorandum dated April 1, 2009. New Mexico State University, Las Cruces.

New Mexico Department of Game and Fish. 2011. Fisheries survey procedures. Fisheries Management Division. Santa Fe, New Mexico.

_____. 2012. Statewide Monitoring Grant SW Final Report 2007-2011. Fisheries Management Division. Santa Fe, New Mexico.

_____. 2015a. BISON-M (Biota Information System of New Mexico). Internet website: http://www.bison-m.org. Accessed in March 2015.

_____. 2015b. Final Performance Report, New Mexico Grant Number F-93-M-1, Sport Fisheries Management Grant, 1/1/2012 through 12/31/2014. Santa Fe, New Mexico.

NMEMNRD (New Mexico Energy, Minerals, and Natural Resources, Forestry Division). 2015. New Mexico State Endangered Plant Species. Internet website: http://www.emnrd.state.nm.us/SFD/ForestMgt/documents/NMENDANGEREDPLANTList.pdf.

New Mexico Ornithological Society. 2015. Searchable Database for the NMOS Field Notes. Internet website: http://nhnm.unm.edu/partners/NMOS.

NMOSE (New Mexico Office of the State Engineer). 2015. Map: New Mexico Office of the State Engineer, Underground Water Basins in New Mexico. Internet website: http://www.ose.state.nm.us/Maps/PDF/underground_water.pdf (accessed 12/29/2015)

NMRPTC (New Mexico Rare Plant Technical Council). 2015. New Mexico Rare Plants, Albuquerque, New Mexico Rare Plants Home Page. Updated April 20, 2015. Internet website: http://nmrareplants.unm.edu.

NMSP (New Mexico State Parks Division). 2000. Elephant Butte Lake State Park Management and Development Plan. New Mexico State Parks.

_____. 2006. Elephant Butte State Park Final Plan. New Mexico State Parks.

Paxton, E., S. Langridge, and M. K. Sogge. 1997. Banding and population genetics of southwestern willow flycatchers in Arizona – 1997 summary report. USGS Colorado Plateau Field Station, Northern Arizona University, Flagstaff.

Reclamation (U.S. Department of the Interior, Bureau of Reclamation). 2002. Elephant Butte and Caballo Reservoirs Resource Management Plan and Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2003a. Browsing Analysis of Riparian Vegetation: Elephant Butte Project Lands. U.S. Department of the Interior, Bureau of Reclamation, Denver Technical Service Center, Denver, Colorado.

_____. 2003b. Elephant Butte and Caballo Reservoirs Resource Management Plan. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2007. Final Environmental Assessment, Bureau of Reclamation Federal Rio Grande Project New Mexico-Texas Operating Procedures, Doña Ana, Sierra, and Socorro Counties, New Mexico and El Paso County, Texas. June 2007. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/index.html.

_____. 2008a. Operating Agreement for the Rio Grande Project. Internet website: http://www.usbr.gov/uc/albuq/rm/RGP/pdfs/Operating-Agreement2008.pdf. Accessed on October 29, 2015.

_____. 2008b. Elephant Butte Reservoir: 2007 Sedimentation Survey. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Water and Environmental Resources Division, Sedimentation and River Hydraulics Group, Denver, Colorado.

_____. 2012a. Southwestern Willow Flycatcher Management Plan for the Rio Grande Project. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2012b. 2012 Southwestern Willow Flycatcher Study Results—Selected Sites within the Rio Grande Basin from Caballo Reservoir, NM, to El Paso, TX. U.S. Department of the Interior, Bureau of Reclamation, Fisheries and Wildlife Resources, Denver, Colorado.

_____. 2012c. Joint Biological Assessment Bureau of Reclamation and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico Middle Rio Grande Project, New Mexico, San Juan-Chama Project, New Mexico. U.S. Department of the Interior Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2013a. Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

_____. 2013b. River Maintenance Program—San Marcial Delta Water Conveyance Channel Maintenance Project Biological Assessment. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2014a. NEPA Scoping Summary on Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas. July 31, 2014. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico. Internet website: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

_____. 2014b. Yellow-billed Cuckoo Study Results—2013 Survey Results from New Mexico State Highway 60 to EBR: Middle Rio Grande, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Fisheries and Wildlife Resources, Denver, Colorado.

_____. 2015a. 2014 Southwestern Willow Flycatcher Study Results. Selected Sites along the Rio Grande from Bandelier National Monument to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2015b. Calendar Year 2014 Report to the Rio Grande Compact Commission. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. March 2015.

_____. 2015c. Simulation of Rio Grande Project Operations in the Rincon and Mesilla Basins: Summary of Model Configuration and Results. Technical Memorandum No. 86-68210-2015-05. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. April 2015, Revised December 2015.

_____. 2015d. Biological Assessment Rio Grande Project Operating Agreement. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico. August 19, 2015. Internet website: http://www.usbr.gov/uc/envdocs/biop.html

Service (U.S. Department of the Interior, Fish and Wildlife Service). 1994. Endangered and threatened wildlife and plants; final rule to list the Rio Grande Silvery Minnow as an endangered species. *Federal Register* 59: 36988-36995.

_____. 1995. Endangered and Threatened Wildlife and Plants; Final Rule Determining Endangered Status for the Southwestern Willow Flycatcher. *Federal Register* 60:10694-10795.

_____. 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, New Mexico.

_____. 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Rio Grande Silvery Minnow; Final Rule. *Federal Register* 68: 8087-8135.

_____. 2013a. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Southwestern Willow Flycatcher, Final Rule. *Federal Register* 78:343-534.

_____. 2013b. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*); Final Rule. *Federal Register* 79:59992-60038.

_____. 2013c. Draft species status assessment report: New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*). May 30, 2013.

_____. 2014a. Information for Planning and Conservation. Resource List. Internet website: http://www.fws.gov/southwest/es/NewMexico/IPAC.cfm.

_____. 2014b. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo; Proposed Rule. *Federal Register* 79:48548-48652.

_____. 2014c. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the New Mexico Meadow Jumping Mouse throughout Its Range; Final Rule. *Federal Register* 79:33119-33137.

_____. 2014d. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse; Proposed Rule. *Federal Register* 78:37327-37363.

Sogge, M. K, R. M. Marshall, S. J. Sferra, and T. J. Tibbits. 1997. A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol. U.S. Department of the Interior, National Park Service.

S. S. Papadopulos and Associates, Inc. 2007. Draft Groundwater Flow Model for Administration and Management in the Lower Rio Grande Basin. Technical Report prepared for the State of New Mexico. Boulder, Colorado. November 2007.

U.S. Census Bureau. 2013a. Five-year American Community Survey Data (2009-2013). Internet website: http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed on October 5, 2015.

______. 2013b. Poverty threshold by size of family. Internet website: www.census.gov/hhes/www/poverty/data/threshld/index.html. Accessed on October 5, 2015.

USDA (U.S. Department of Agriculture). 2012. Census of Agriculture 2012 Report. Internet website: http://www.agcensus.usda.gov/Publications/2012/#full_report.

USDA (U.S. Department of Agriculture), National Agricultural Statistics Service. 2013. 2013 New Mexico Chile Production. Internet website: http://www.nass.usda.gov/Statistics_by_State/New_Mexico/Publications/Special_Interest_Reports/13-chile-release.pdf.

USDA (U.S. Department of Agriculture), Natural Resources Conservation Service. 2015. The PLANTS Database. National Plant Data Team, Greensboro, NC. Internet website http://plants.usda.gov. Accessed in March 2015.

U.S. Department of Commerce. 2014. Bureau of Economic Analysis, Regional Economic Accounts, Washington, DC. Internet website: http://www.bea.gov/regional/

U.S. Department of Labor. 2015. Bureau of Labor Statistics, Local Area Unemployment Statistics, Washington, DC. Internet website: http://www.bls.gov/lau/

U.S. Environmental Protection Agency. 2015a. New Mexico Water Quality Assessment Report. Internet website: http://ofmpub.epa.gov/tmdl_waters10/attains_state.control?p_state=NM#total_assessed_waters.

______. 2015b. Water Quality and TMDL Information. 2014 Waterbody Report for Rio Grande Above International Dam. Internet website: http://ofmpub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=TX-2314_01&p_cycle=2014

U.S. Geological Survey. 2011. Gap Analysis Program. National Land Cover, Version 2. August 2011. Internet website: http://gapanalysis.usgs.gov/gaplandcover/viewer/

Chapter 4 References

Barroll, P. 2005. Active Water Resources Management in the Lower Rio Grande: Tools for a New Era in Water Management. Lower Rio Grande Water Users Association, August 19, 2005, meeting presentation.

D'Antonio, J. R. 2005. Active Water Resources Management in the Lower Rio Grande: Tools for a New Era in Water Management. Lower Rio Grande Water Users Organization, August 19, 2005.

El Paso Water Utilities. 2015. Comprehensive Annual Financial Report. July 2015. Internet website: http://www.epwu.org/public_information/reports/2015/CAFR_FY14-15.pdf

Ellis, L. A., D. M. Weddle, S. D. Stump, H. C. English, and A. E. Graber. 2008. Southwestern Willow Flycatcher Final Survey and Monitoring Report. Arizona Game and Fish Department, Research Technical Guidance Bulletin #10, Phoenix, Arizona.

IBWC (U.S. International Boundary and Water Commission). 2001. Biological Assessment: USIBWC Rio Grande Projects, American Dam to Fort Quitman, Texas.

_____. 2004. Biological Assessment for River Management Alternatives for the Rio Grande Canalization Project. January 2004. Internet website: http://www.ibwc.state.gov/Files/RGCP_BA_final.pdf.

_____. 2009. Record of Decision, River Management Alternatives for the Rio Grande Canalization Project, June 20. Internet website: http://www.ibwc.gov/EMD/CanalizationWebpage/ROD_EIS%20June2009.pdf.

_____. 2011. Final Biological Assessment, Integrated Land Management for the Long-Term River Management of the Rio Grande Canalization Project, October. Internet website: http://www.ibwc.gov/EMD/documents/Final_IBWC_RGCP_BA2011.pdf

_____. 2014. Rio Grande Canalization Project, River Management Plan http://www.ibwc.gov/Files/Canalization_River_Management_Plan_112014.pdf

New Mexico State University. 2005. Cost and Return Estimates for Farms and Ranches. New Mexico State University, College of Agricultural, Consumer and Environmental Sciences. Internet website: http://costsandreturns.nmsu.edu/

New Mexico Department of Game and Fish. 2011. Fisheries survey procedures. Fisheries Management Division. Santa Fe, New Mexico.

_____. 2015. Final Performance Report, New Mexico Grant Number F-93-M-1, Sport Fisheries Management Grant, 1/1/2012 through 12/31/2014. Santa Fe, New Mexico.

Ozen, O. 2002. "Population dynamics of largemouth bass in Lucchetti Reservoir, Puerto Rico." Thesis, Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the Degree of Zoology, North Carolina State University, Raleigh.

Phillips, F. M., J. F. Hogan, S. K. Mills, and J. M. H. Hendricks. 2003. Environmental tracers applied to quantifying causes of salinity in arid-region rivers: Preliminary results from the Rio Grande, Southwestern USA, *in* Water Resources Perspectives: Evaluation, Management and Policy, ed. by A. S. Alsharhan and W. W. Wood, New York, Elsevier, pp. 327-334.

Reclamation (U.S. Department of the Interior, Bureau of Reclamation). 2005. Status and Monitoring of Southwestern Willow Flycatchers within Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado.

______. 2007. Final Environmental Assessment, Bureau of Reclamation Federal Rio Grande Project New Mexico-Texas Operating Procedures, Doña Ana, Sierra, and Socorro Counties, New Mexico and El Paso County, Texas. June 2007. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/index.html.

______. 2009. Elephant Butte Reservoir 5-year Operational Plan Biological Assessment. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico.

______. 2012. Reclamation Manual. Directives and Standards, Water and Related Resources Feasibility Studies, CMP 09-02. U.S. Department of Interior, Bureau of Reclamation, Washington, DC.

______. 2013a. Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

______. 2013b. Finding of No Significant Impact, Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013. U.S. Department of the Interior, Bureau of Reclamation Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

______. 2014a. Finding of No Significant Impact, River Maintenance Program – Delta Channel Maintenance Project: AAO-15-002. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico.

______. 2014b. Yellow-billed Cuckoo Study Results—2013 Survey Results from New Mexico State Highway 60 to EBR: Middle Rio Grande, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Fisheries and Wildlife Resources, Denver, Colorado.

______. 2014c. NEPA Scoping Summary on Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas. July 31, 2014. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region. Internet website: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

_____. 2015a. Simulation of Rio Grande Project Operations in the Rincon and Mesilla Basins: Summary of Model Configuration and Results. Technical Memorandum No. 86-68210–2015-05. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, Colorado.

_____. 2015b. 2014 Southwestern Willow Flycatcher Study Results. Selected Sites along the Rio Grande from Bandelier National Monument to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico.

_____. 2015c. Biological Assessment Rio Grande Project Operating Agreement. U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico. August 19, 2015.

_____. 2015d Calendar Year 2014 Report to the Rio Grande Compact Commission. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. March 2015.

Reitan, O., and P. G. Thingstad. 1999. "Responses of birds to damming—A review of the influence of lakes, dams, and reservoirs on bird ecology." *Ornis Norvegica* 22:3-37.

Sammons, S. M., and P. W. Bettoli. 2000. "Population dynamics of a reservoir sport fish community in response to hydrology." *North American Journal of Fisheries Management* 20:791-800.

Service (U.S. Department of the Interior, Fish and Wildlife Service). 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, New Mexico.

_____. 2012 Biological and Conference Opinion on the Effects of the United States Section of the International Boundary and Water Commission) Proposed Action of an Integrated Land Management Alternative for Long-Term Management of the Rio Grande Canalization Project in Sierra County and Doña Ana County, New Mexico, and El Paso County, Texas. August 30. Internet website: http://www.ibwc.gov/EMD/documents/RGCP_BiolOpin_final_2012.pdf

_____. 2014. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*); Final Rule. *Federal Register* Vol. 79, No. 192. October 3, 2014.

S. S. Papadopulos and Associates, Inc. 2007. Draft Groundwater Flow Model for Administration and Management in the Lower Rio Grande Basin. Technical Report prepared for the State of New Mexico. Boulder, Colorado. November 2007.

Stabler, H. 1911. Some stream waters of the western United States. USGS Water Supply Paper 274. U.S. Department of the Interior.

Ward, F. A. 2014. Rio Grande Basin Model with several sustainability conditions for reservoirs and aquifers.

Ward, F. A., and M. Pulido-Velázquez. 2012. "Economic costs of sustaining water supplies: Findings from the Rio Grande." *Water Resources Management*. DOI 10.1007/s11269-012-0055-8.

Warner, R. E., and K. M. Hendrix (editors). 1984. *California Riparian Systems: Ecology, Conservation, and Productive Management.* University of California Press, Berkeley.

Chapter 5 References

Reclamation (U.S. Department of the Interior, Bureau of Reclamation). 2007. Final Environmental Assessment, Bureau of Reclamation Federal Rio Grande Project New Mexico-Texas Operating Procedures, Doña Ana, Sierra, and Socorro Counties, New Mexico and El Paso County, Texas. June 2007. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/index.html.

_____. 2013. Supplemental Environmental Assessment, Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas. June 2013. Internet website: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/index.html.

_____. 2014. NEPA Scoping Summary on Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas. July 31, 2014. Internet website: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

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8. Index

Appendices

Appendix A. Operating Agreement

OPERATING AGREEMENT
FOR THE RIO GRANDE PROJECT

THIS OPERATING AGREEMENT (" Agreement ") is entered into this 10th day of March 2008, by and among the United States of America, by and through the Bureau of Reclamation (" United States " or " Reclamation " or " USA ") acting pursuant to the Reclamation Act of June 17, 1902, 32 Stat. 390, as amended and supplemented; the Elephant Butte Irrigation District (" EBID "), an irrigation district and a quasi municipal corporation in the State of New Mexico, incorporated and organized under New Mexico law, N.M.S.A. 1978, § 73 10 1 et seq. (1985 Repl. Pamp.); and the El Paso County Water Improvement District No. 1 (" EPCWID "), a political subdivision of the State of Texas, under Art. XVI, § 59 of the Texas Constitution (collectively, " the Parties " to this Agreement).

NOW THEREFORE, the Parties recognize the following terms and conditions to constitute an operational plan for the Rio Grande Project and the Parties agree as follows:

1 DEFINITIONS

When used in this Agreement, unless otherwise distinctly expressed or manifestly incompatible with the intent hereof, the following definitions shall apply:

1.1 Normal Annual Release

A Normal Annual Release from Project Storage for all authorized uses is 790,000 acre- feet as measured at the first gauging station downstream of Caballo Dam. It is possible that during any Water Year the aggregate quantity of water released for EBID and EPCWID, and for the United States (pursuant to the Convention of 1906), including release of Carryover Water for EBID and EPCWID, may be more or less than the Normal Annual Release from Project Storage of 790,000 acre-feet.

1.2 Project-Authorized Acreage

There are 159,650 authorized acres within the Project. Of the Project Authorized Acreage, 90,640 acres are within EBID and 69,010 acres are within EPCWID.

1.3 Project Storage

Elephant Butte Reservoir, Caballo Reservoir, and such additional storage facilities (less flood control space) as may be authorized by Congress or provided for pursuant to the Rio Grande Compact (Act of May 31, 1939, 53 Stat.785).

1.4 Rio Grande Project

The Project was authorized by an Act of Congress on February 25, 1905, 33 Stat. 814, pursuant to the Reclamation Act of 1902, 32 Stat. 390. The Project includes facilities and works with their appurtenant lands authorized by the Act of February 25, 1905, as amended and supplemented, particularly Elephant Butte Dam and Reservoir, Caballo Dam and Reservoir, a power generating plant, and six diversion dams (Percha, Leasburg, Mesilla, American, International, and Riverside) on the Rio Grande in New Mexico and Texas, and includes the Project lands and service area authorized for water delivery pursuant to the Rio Grande Project Act of February 25, 1905, as amended and supplemented and the Reclamation Act of 1902 as amended and supplemented.

1.5 Water Year

The water year shall be a calendar year beginning on the first day of January and ending on the thirty-first day of December.

1.6 Project Water

Project Water, as used herein, shall mean: l) usable water in Project Storage; 2) all water required by the Rio Grande Compact of 1938 to be delivered into Elephant Butte Reservoir; and 3) all water released from Project Storage and all inflows reaching the bed of the Rio Grande between Caballo Dam, New Mexico and Fort Quitman, Texas.

1.7 Annual Allocated Water

Annual Allocated Water is the quantity of Project Water that is determined by United States, in accordance with this Agreement, the Operations Manual, and in consultation with EBID and EPCWID, to be allocated each Water Year for delivery to EBlD and EPCWlD, and to the United States (pursuant to the Convention of 1906).

1.8 Carryover Water

Carryover Water is the Annual Allocated Water allotment balance remaining on the water account for each district at the end of a given Water Year. EBID and EPCWID shall have the right to carry over any amount of their respective Annual Allocated Water subject to provisions of Section 1.10 herein.

1.9 Actual Carryover Water

Actual carryover water is the increase in a district's allocation due to applying carryover water amounts for each district in the allocation calculations.

1.10 Carryover Limit

Actual carryover water may be accumulated in an account for each district to a maximum of sixty percent (60%) of each district's respective full yearly allocation or an amount of actual carryover water equal to 232,915 acre-feet for EPCWID and 305,918 acre-feet for EBID.

1.11 Excess Carryover Balance

At the end of the water year, either district's carryover balance in excess of its respective carryover limit shall be transferred to the carryover account of the other district. If both districts' carryover limits are exceeded, each district's carryover balance shall be equal to its respective limit.

1.12 Rio Grande Project Water Accounting and Operations Manual (Operations Manual)

The United States, EBID, and EPCWID shall produce an Operations Manual. The Operations Manual shall contain detailed information regarding the methods, equations, and procedures used by EBID, EPCWID, and the United States to account for all water charges and operating procedures for the Rio Grande Project. This Agreement shall be effective upon execution regardless of the status of the Operations Manual.

1.13 Non-Allocated Water

Project Water is available for diversion from the Rio Grande by EBID or EPCWID that is not charged by the United States against any allocation account. Non-Allocated water is typically available only during periods when no water is being released from storage or during flood events.

2 ALLOCATION OF PROJECT WATER

2.1 Use of Project Water

All Project Water in Project Storage, including any actual Carryover Water shall be used for the authorized purposes set forth in the Reclamation Act of June 17, 1902, 32 Stat. 390, and the Rio Grande Project Act of February 25, 1905, 33 Stat. 814, as amended and supplemented.

2.2 Determination of Project Water in Project Storage

At the beginning of each Water Year and during each month of the Water Year, The United States shall determine the total quantity of Project Water in Project Storage.

2.3 Determination of Annual Allocation to Mexico, EBID, and EPCWID

The United States shall determine the quantity of Annual Allocated Water to Mexico, EBID, and EPCWID by the first of December for the following Water Year utilizing the Project Water in storage amounts and Carryover Water amounts for each district. The United States may reconsider the Annual Allocated Water each month during a Water Year and adjust it as necessary in consultation with EBID and EPCWID in accordance with this Agreement.

2.4 Annual Allocation for United States for delivery to Mexico

The portion of the Annual Allocated Water which shall be allocated for the United States to meet its obligations pursuant to the Convention of 1906 shall be 11.3486 percent (11.3486%) of the sum of the quantity of Project Water delivered to lands in the United States plus the quantity of Project Water delivered to the head works of the Acequia Madre in acre-feet per Water Year as set forth in equation 2-1 and Table 1 that follow:

$$Y = 0.826093\,(X) - 102{,}305 \qquad (2\text{-}1)$$

where X =Annual Released Water (in acre-feet per Water Year), and Y = sum of the quantity of Project Water delivered to lands in the United States plus the quantity of Project Water delivered to the head works of the Acequia Madre (in acre-feet per Water Year).

Table 1

Annual Amount of Water Released from Caballo Reservoir (ac-ft/acre)	Sum of the quantity of Project Water delivered to lands in the United States plus the quantity of Project Water delivered to the head works of the Acequia Madre (in acre-feet per Water Year).	Quantity of Project Water delivered to the head works of the Acequia Madre (in acre-feet per Water Year)
790,000	550,309	60,000
763,842	528,700	60,000
700,000	475,960	54,015
650,000	434,656	49,327
600,000	393,351	44,640
550,000	352,046	39,952
500,000	310,742	35,265
450,000	269,437	30,577
400,000	228,132	25,890
350,000	186,828	21,202
300,000	145,523	16,515
250,000	104,218	11,827
200,000	62,914	7,140

The United States shall be entitles to release all or such portion of the Annual Allocated Water which has been allocated for the United States as it Deems necessary to meet the requirement of the Convention of 1906 to deliver water in the bed of the Rio Grande at the head works of the Acequia Madre.

2.5 Annual Allocation for EBID and EPCWID

EBID's and EPCWID's portions of the quantity of Annual Allocated Water, exclusive of the United States' portion of Annual Allocated Water pursuant to the Convention of 1906, shall be determined by the process described in Table 2 for a full allocation condition and Table 3 when there is less than a full water supply available. EBID 's and EPCWJD 's yearly allocation shall be determined using the empirically derived linear regression analysis equation (D-2). Equation D-2 was derived using historical Rio Grande Project data correlating releases from Rio Grande Project storage and corresponding yearly deliveries to Rio Grande Project diversions from the Rio Grande for EBID, EPCWID and Mexico during the Water Years 1951 to 1978 inclusive. The amount of Annual Allocated Water shall be determined using the D-2 equation for EPCWID, using equation 2-1 for the United States (pursuant to the Convention of 1906), and using the diversion ratio (ratio of the amount of water Charged to the amount of water Released) for EBID and in accordance with Tables 1 through 4 herein.

Table 2 – Rio Grande Project Hypothectical Example of Full Allocation

1	**Rio Grande Project Diversion Allocation**	**ac-ft**
2	Elephant Butte Reservoir Storage	1,000,000
3	Caballo Reservoir Storage	44,005
4	Total Rio Grande Project Storage	1,044,005
5	Estimated Rio Grande Compact Credit Waters	(196,000)
6	Estimated San Juan-Chama Water	(4,553)
7	Water Released from Storage	-
8	Total Usable Water Available for Release	843,452
9	Carryover Obligation using Estimated Diversion Ratio	14,654
10	Total Usable Water Available for Current Year Allocation	790,000
11	EBID Allocation Balance (Previous Year)	10,000
12	EPCWID Allocation Balance (Previous Year)	5,000
13	EBID Estimated Allocation Balance (End-of-Year)	-
14	EPCWID Estimated Allocation Balance (End-of-Year)	-
15	Storage for EBID and WPCWID Estimated Allocation Balance (End-of-Year)	-
16	Estimated Release of Current Usable Water	804,654
17	Estimated End-of-Year Release for Diversion Ratio	781,208
18	D1 Delivery	562,414
19	Mexico's Current Diversion Allocation	60,000
20	Gross D2 Diversion Allocation	972,709
21	EPCWID ACE Conservation Credit	-
22	Net D2 Diversion Allocation for EBID and EPCWID	912,709
23	D2 Diversion Allocation for EPCWID	394,526
24	EPCWID Diversion Allocation (w/o Conservation Credit)	399,526
25	EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	399,526
26	Diversion Ratio	1.023633
27	Diversion Ratio Adjustment	19,017
28	Sum of Release and Diversion Ratio Adjustment	823,670
29	EBID D2 Diversion Allocation	518,183
30	Difference between EBID Diversion Ratio Allocation and D2 Diversion Allocation	-
31	EBID Diversion Ratio Allocation	354,144
32	EBID Diversion Allocation	354,144
33	Total EBID Diversion Allocation (includes 88/155th of Value in Row 30)	364,144
34	Total EPCWID Allocation (includes Row 21 and 67/155th of Value in Row 30)	399,526
35	Total EBID, EPCWID, and Mexico Allocation	823,670

Table 3 – Rio Grande Hypothetical Example of Less than Full Allocation

1	**Rio Grande Project Diversion Allocation**	**ac-ft**
2	Elephant Butte Reservoir Storage	408,773
3	Caballo Reservoir Storage	23,772
4	Total Rio Grande Project Storage	432,545
5	Estimated Rio Grande Compact Credit Waters	(187,800)
6	Estimated San Juan-Chama Water	(4,053)
7	Water Released from Storage	-
8	Total Usable Water Available for Release	240,692
9	Carryover Obligation using Estimated Diversion Ratio	112,931
10	Total Usable Water Available for Current Year Allocation	127,761
11	EBID Allocation Balance (Previous Year)	-
12	EPCWID Allocation Balance (Previous Year)	106,982
13	EBID Estimated Allocation Balance (End-of-Year)	-
14	EPCWID Estimated Allocation Balance (End-of-Year)	-
15	Storage for EBID and WPCWID Estimated Allocation Balance (End-of-Year)	-
16	Estimated Release of Current Usable Water	240,692
17	Estimated End-of-Year Release for Diversion Ratio	800,000
18	D1 Delivery	96,529
19	Mexico's Current Diversion Allocation	10,955
20	Gross D2 Diversion Allocation	80,948
21	EPCWID ACE Conservation Credit	-
22	Net D2 Diversion Allocation for EBID and EPCWID	69,994
23	D2 Diversion Allocation for EPCWID	30,255
24	EPCWID Diversion Allocation (w/o Conservation Credit)	137,237
25	EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	137,237
26	Diversion Ratio	0.947320
27	Diversion Ratio Adjustment	(12,680)
28	Sum of Release and Diversion Ratio Adjustment	228,012
29	EBID D2 Diversion Allocation	39,738
30	Difference between EBID Diversion Ratio Allocation and D2 Diversion Allocation	40,082
31	EBID Diversion Ratio Allocation	79,820
32	EBID Diversion Allocation	39,738
33	Total EBID Diversion Allocation (includes $88/155^{th}$ of Value in Row 30)	62,495
34	Total EPCWID Allocation (includes Row 21 and $67/155^{th}$ of Value in Row 30)	154,563
35	Total EBID, EPCWID, and Mexico Allocation	228,012

Table 4 – Description of Values and Calculations Tables 2 and 3

Row	Description	Source of Value	Equation
1	Rio Grande Project Diversion Allocation	NA	NA
2	Elephant Butte Reservoir Storage	USBR	NA
3	Caballo Reservoir Storage	USBR	NA
4	Total Rio Grande Project Storage	Calculated	[2]+[3]
5	Estimated Rio Grande Compact Credit Waters	USBR	NA
6	Estimated San Juan-Chama Water	USBR	NA
7	Water Released from Storage	USBR	NA
8	Total Usable Water Available for Release	Calculated	[4] + [5] + [6] + [7]
9	Carryover Obligation using Estimated Diversion Ratio	Calculated	([11] + [12]) / [26]
10	Total Usable Water Available for Current Year Allocation	Calculated	MIN(790000,[8] – [9])
11	EBID Allocation Balance (Previous Year)	EPCWID, EBID, USBR	NA
12	EPCWID Allocation Balance (Previous Year)	USBR	NA
13	EBID Estimated Allocation Balance (End-of-Year)	EBID	NA
14	EPCWID Estimated Allocation Balance (End-of-Year)	EPCWID	NA
15	Storage for EBID and WPCWID Estimated Allocation Balance (End-of-Year)	Calculated	([14]+[13]) / [26]
16	Estimated Release of Current Usable Water	USBR	[10] + [9] – [15]
17	Estimated End-of-Year Release for Diversion Ratio	USBR	NA
18	D1 Delivery	Calculated	MAX(0,([16]*0.8260932) – 102305)
19	Mexico's Current Diversion Allocation	Calculated	MIN(60000,[18]*0.113486)
20	Gross D2 Diversion Allocation	Calculated	MIN(7638642,[10])*1.3377994-89970+MAX(0,[16]-763842)
21	EPCWID ACE Conservation Credit	USBR	NA
22	Net D2 Diversion Allocation for EBID and EPCWID	Calculated	[20] – [19]
23	D2 Diversion Allocation for EPCWID	Calculated	[22] * 67 / 155
24	EPCWID Diversion Allocation (w/o Conservation Credit)	Calculated	[23] + [12]
25	EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	Calculated	[24] – [14]
26	Diversion Ratio	Calculated	0.00000042113634*[17]+0.6946382
27	Diversion Ratio Adjustment	Calculated	([26] – 1) * [16]
28	Sum of Release and Diversion Ratio Adjustment	Calculated	[16] + [27]
29	EBID D2 Diversion Allocation	Calculated	[22] * 88 / 155
30	Difference between EBID Diversion Ratio Allocation and D2 Diversion Allocation	Calculated	IF([16]<60000, MAX(0,[31]-[29]),0)
31	EBID Diversion Ratio Allocation	Calculated	[28] – [25] – [19] – [11] – [21]
32	EBID Diversion Allocation	Calculated	IF([16]<600000, MIN([29],[31]),[31])
33	Total EBID Diversion Allocation (includes 88/155th of Value in Row 30)	Calculated	[32]+[11]+88/155*[30]
34	Total EPCWID Allocation (includes Row 21 and 67/155th of Value in Row 30)	Calculated	[24]+[30]*67/155+[21]
35	Total EBID, EPCWID, and Mexico Allocation	Calculated	[34]+[33]+[19]

3 RELEASE FROM STORAGE

3.1 Orders for Release of Rio Grande Project Water from Storage

EBID and EPCWID may order releases from Project storage to meet their respective delivery requirements of Annual Allocated Water or Carryover Water at their river headings during the Water Year at such times and in such quantities as they respectively elect. Water orders shall be delivered by the United States to their respective diversion and delivery points as prescribed by agreed to travel times, or as described in the Operations Manual when completed. EBID shall not order changes more frequently than four times per week. EPCWID shall not order changes more frequently than twice per week.

EBID and EPCWID shall determine the amount of water to be released from Caballo Reservoir necessary to meet the diversion orders at the time and days requested by EBID, EPCWID, and the United States (pursuant to the Convention of 1906). If EBID and EPCWID cannot agree on the amount or timing of release, then the United States shall make such determinations.

The parties shall develop a schedule of order changes that will best meet the needs of each party at their respective delivery points.

The United States shall only release Project Water ordered by EBJD when EBID has Annual Allocated Water or Carryover Water remaining in their allocation. The United States shall only release Project Water ordered by EPCWID when EPCWID has Annual Allocated Water or Carryover Water remaining in their allocation.

The Parties may make non-scheduled order changes to adjust for rainfall/runoff or flood events, accident to the delivery system, or for public safety.

The United States may make releases from storage in such quantities as necessary to meet the requirements of the Convention of 1906 and according to the schedule determined by the United States under the authority of the Convention of 1906.

4 DELIVERIES

4.1 Operation of Release and Diversion Structures

The United States shall operate Elephant Butte Reservoir so as to provide for sufficient quantities of water to be available for released from Caballo Reservoir to the Parties, as outlined in Section 3.1 herein. The United States or its designee shall operate Percha, Leasburg, and Mesilla diversion dams so as to provide sufficient flows for the districts' diversions on the Rio Grande. The United States shall operate the American and International diversion dams and make the diversions into the American Canal.

4.2 Obligations to Deliver Project Water

Within a reasonable amount of time from the time requested for the release by EBID and EPCWID, or as defined in the Operations Manual when completed, the United States shall release from project storage those quantities of Project Water which will meet the individual requirements of each district as communicated in their water order to the United States to be delivered at the Arrey Canal Heading, Leasburg Canal Heading, Eastside Canal Heading, Westside Canal Heading, Del Rio Lateral Heading and any additional authorized points of delivery for EBID, and to be delivered to the Franklin Canal Heading, the Riverside Canal Heading, the City of El Paso 's water treatment plants and any additional authorized points of delivery for EPCWID. Within a reasonable of amount time from the time requested for the delivery, or as defined in the Operations Manual when completed, the United States shall deliver those quantities of Project Water in the Rio Grande at the head works of the Acequia Madre in accordance with the orders designated by the United States.

5 FLOW REQUIREMENTS

5.1 Order

An " Order " is a request to the United States by a Party to deliver a quantity of Project Water to each district's delivery and accounting stations at a specific flow rate (cubic feet per second) and at specified delivery time and day.

5.2 Release

A " Release " is a flow rate (cubic feet per second) of Project Water released from Project Storage.

5.3 Delivered Flow

A " Delivered Flow " is a flow rate (cubic feet per second) of Project Water that meets the conditions required to meet the delivery requirement for each district and Mexico at their designated delivery point or metering stations (stations) and at specified delivery time and day.

5.4 Charge

A " Charge " is a quantity of Project Water (acre-feet) that is deducted from (i.e. charged against) a Party's Annual Allocated or actual Carryover Water account.

5.5 Charge Against EBID's and EPCWID's Annual Allocated Water including Carryover Water

EBID 's and EPCWID 's remaining Annual Allocated Water shall be computed by subtracting a Charge which shall be equal to EBID 's or EPCWID 's respective delivery at main canal headings and any other designated and authorized metering stations at the Rio Grande diversion dams against their respective remaining portion of Annual Allocated Water including carryover water.

Allocation charges for water diverted by EPCWID, EBID, and Mexico shall be made as follows, or in accordance with the procedures and methods contained in the Operations Manual when completed.

1. EBID and EPCWID shall report to the United States the flow records for their respective diversion and water delivery stations for each month by the 5•h day of the following month.

2. The reports may be transmitted electronically by any party to the other parties.

3. The United States shall report to EBID and EPCWID the previous month's Allocation Charges and the cumulative year-to-date Allocation Charges for EBID, EPCWID, and the United States by the 10th day of the month.

A hypothetical example of summary tables of the Allocation Charges for EBID and EPCWID is contained in Appendix A attached here to.

Water diverted from the Rio Grande by EBID may be returned (bypassed) to the Rio Grande for credit to their water allocation account at one designated location each within the Leasburg, Eastside, and Westside canal system, and two designated locations within the Arrey Canal system. Water diverted from the Rio Grande by EPCWID may be returned (bypassed) to the Rio Grande for credit to their water allocation account at one designated location on the La Union East Canal. Such credits shall be the smaller of the amount of water declared for bypass by the respective district or the actual amount of water that was measured and returned to the Rio Grande.

The United States shall make every effort to match the delivery and the order for each district at all designated metering and delivery stations in order to minimize spill water and meet the order at any given time.

5.6 Charge Against United States' Annual Allocated Water for Delivery to Mexico

United States' remaining quantity of Annual Allocated Water shall be equal to United States' previous allocation of Annual Allocated Water during the current Water Year minus the water delivered to Mexico at their diversion point on the Rio Grande at the Acequia Madre during the Water Year. The United States will maintain the gates at the International Dam so as to minimize the leakage to the greatest extent practical.

5.7 Compliance with Delivery of Project Water to Mexico at the Acequia Madre

If the flow at the first metering station above International Diversion Dam does not meet the Acequia Madre delivery requirement, the United States will adjust the gates at American Diversion Dam to reduce the flow to meet the corresponding delivery requirement for that day. The United States will give notice to EBID and EPCWID of such action except when such flow is due to storm runoff or flood events, short term debris clearing or sluicing operations. Any time the United States manually adjusts the flow at the American Diversion Dam by more than 25 cfs, for any reason, or at anytime the flow diverted at the American Diversion Dam into the American Canal exceeds the capacity of the American Canal, United States shall notify EPCWID as soon as possible.

5.8 Diversion Points

The diversion points used for EBID are as follows: Percha Lateral, Arrey Canal, Leasburg Canal, California Extension, various designated river pumps, Del Rio Lateral, East Side Canal, and West Side Canal. The diversion points used for the EPCWID are as follows: the New Mexico/Texas state line crossings for the La Union East Lateral, Three Saints Lateral, and La Union West lateral in the Mesilla Valley. In the El Paso Valley, deliveries to EPCWID will be made at the Robertson/Umbenhauer Water Treatment Plant, Franklin Canal, Jonathan Rogers Water Treatment Plant, and Riverside Canal.

5.9 Compliance with Delivery of Project Water to EBID and EPCWID

The United States shall closely match the order and diversion at each designated delivery metering station through close monitoring of releases from Project Storage and river accretions or losses. Close coordination and daily communication shall be maintained between EBID, EPCWID, and the United States in order to make adjustments to releases from Project Storage such that water deliveries match water order amounts as closely as possible at each delivery point in the Project.

6 GENERAL PROVISIONS

6.1 Compliance with Federal Law

The terms of this Agreement are subject to applicable federal law. All Parties will cooperate to comply with all federal law prior to and during implementation of this Agreement.

6.2 Other Agreements

This Agreement is not intended to conflict with terms of any prior agreements or contracts between the EBID and EPCWID, or EBID and the United States, or EPCWID and the United States, or among all of the Parties; however, the Agreement represents the current conditions and present understanding that future operations shall be as provided for herein unless further modified upon having reached unanimous consent of the Parties.

6.3 Required Continuous Flow Metering Stations

A list of required continuous flow metering stations is attached to this Agreement as Appendix B. Each Party shall distribute and exchange copies of all flow records for all flow metering stations for which it is responsible, as listed in Appendix B, among the other Parties at least monthly with a goal of real time data exchanges.

6.4 Regulating Reservoirs Downstream of Caballo Dam

Nothing in this Agreement shall be interpreted to prohibit the construction and/or operation of an off-channel regulating reservoir, providing however that no such reservoir shall affect the water order or delivery requirements of the Parties under this Agreement.

6.5 Emergency Conditions (Force Majeure)

If any Party through no fault of its own is rendered unable, wholly or in part, by Force Majeure to carry out its obligations under this Agreement, then the obligations of such Party, so far as they are affected by such Force Majeure, shall be suspended during the time reasonably necessary to remedy such inability, but for no longer period. The term "Force Majeure" shall mean acts of God, wars, terrorism, vandalism, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, hazardous spills, or explosions.

6.6 Term of Agreement

This Agreement shall be in effect from January 1, 2008 until December 31, 2050.

6.7 Modification of Agreement

The Parties may modify any provisions of this Agreement upon having reached unanimous consent.

6.8 Assignment Limited - Successors and Assigns Obligated

The provisions of this Agreement shall apply to and bind the successors and assigns of the Parties hereto. No assignment of any right or obligation shall be made by any Party without first obtaining written approval by the other Parties.

6.9 Obligations to Indian Tribes Not Affected

Nothing in this Agreement shall be construed as affecting the obligations of the United States of America to the Indian Tribes, or as impairing the rights of the Indian Tribes.

6.10 Obligations to Mexico Not Affected

Nothing in this Agreement shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties.

6.11 Amendment of Agreement

This Agreement shall be reviewed for improvement of operations at least on an annual basis or as agreed to by the majority of the parties. Any of the parties may submit a written request to the other parties for review of this Agreement at any time.

6.12 Rio Grande Compact

Nothing herein is intended to alter, amend, repeal, modify, or be in conflict with the provisions of the Rio Grande Compact.

APPENDIX A-Hypothetical Example of Allocation Charges for EBID and EPCWID

The tables below are hypothetical examples of summary tables of Allocation Charges for EBID and EPCWID. The Operations Manual, when completed, shall contain detailed information regarding the methods, equations, and procedures used by EBID, EPCWID, and the United States to account for all water charges and operating procedures for the Rio Grande Project.

EPCWID Diversion Allocation Charges

Diversion Location	Metered Volume	Adjustment for Conveyance Losses for NM Deliveries	Diversion Allocation Charges for Month	Beginning of Month Totals	End-of-Month Totals
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
L U E Canal – TX	2,395	95%	2,275	17,065	19,340
L U W Canal – TX	947	95%	900	6,620	7,520
Three Saints Lateral	134	100%	134	1,426	1,560
Total Mesilla Valley (Texas)			3,309	25,112	28,420
Umbenhauer/Robertson Water Treatment Plant	3,345	100%	3,345	16,701	20,046
Franklin Canal	7,400	100%	7,400	39,293	46,694
United States – Ysleta del Sur Agreement	0	100%	0	200	200
United States Section – IBWC (Construction Water)	1	100%	1	22	23
Jonathan W. Rogers Water Treatment Plant	4,666	100%	4,666	27,747	32,413
Riverside Canal	20,079	100%	20,079	125,831	145,910
Haskell R. Street WWTP Effluent	-1,599	100%	-1,599	-8,180	-9,779
Credit for Diversions greater than Orders (EP Valley)	-2,790	100%	-2,790	-3,233	-6,023
Total Allotment Diversion Charges			34,411	223,493	257,904
Diversion Allocation				382,486	390,105
Est. Annual Conservation Credit Diversion Allocation					18,742
Accrued Conservation Credit Diversion Allocation					12,390
Total Diversion Allocation				382,486	390,105
District Allotment Balance				158,993	144,591
2006 Carryover Balance					36,200

ELEPHANT BUTTE IRRIGATION DISTRICT

WATER ALLOTMENT CHARGES

SUBJECT TO REVISION

	GROSS DIVERSIONS	(AC-FT) TO DATE	DIVERTED TO TEXAS	(AC-FT) TO DATE	NET DIVERSIONS	(AC-FT) TO DATE
ARREY CANAL	9775	63725	[redacted]		9775	63725
PERCHA LATERAL	93	508	[redacted]		93	508
LEASBURG CANAL	8739	67663	[redacted]		8739	67663
CALIFORNIA EXTENTION	0	353	[redacted]		0	353
EASTSIDE CANAL	7295	48677	311	1920	5984	46757
DEL RIO LATERAL	476	2989	[redacted]		476	2989
WESTSIDE CANAL	18793	135991	5267	41097	13526	94894
PUMPED FROM RIVER**	0	56	[redacted]		0	56
GROSS TOTAL	45171	319962	5578	43017	39593	276945

	NET DIVERSION	TO DATE
TOTAL CHARGES (AC-FT)	39593	276945
CREDIT AT ARREY (-)	1215	3882
CREDIT AT LEASBURG (-)	0	233
NET ALLOTMENT CHARGE	38,377	272,830
DISTRICT ALLOTMENT		311,517
DISTRICT BALANCE		38,687

**GREENWOOD AND DURAN RIVER PUMPS (EBID DATA)

APPENDIX B – Required Flow Metering Stations

In order to assure accurate metering of allocated water deliveries to EBID, EPCWID and Mexico, the following metering stations will be maintained by the described agencies. The letter prefix before each metering station indicates the valley in which the metering station is located (R for Rincon, M for Mesilla, and E for El Paso).

The following continuous stage recorders shall be maintained by the United States:

R 1 - Rio Grande Below Caballo - located on the east side of the river and approximately 0.8 mile downstream of Caballo Dam.

M2 - Rio Grande al Leasburg Canal - located approximately 1.5 miles downstream of Leasburg Diversion Dam on the river channel just downstream of Leasburg Wasteway No. 1.

Miscellaneous Sites: Any location, not identified herein, at which water from Rio Grande downstream of Elephant Butte Dam and upstream of the Ft. Quitman, Texas, is diverted by the United States, including without limitation, diversions for the Bonita Lateral.

The following continuous stage recorders shall be maintained by EBID:

R2 - Arrey Canal·- The metering bridge is located just downstream of the canal heading and the CMP shelter and recorder are located just downstream of the Percha State Park bridge crossing.

R3 - Percha Lateral - The lateral water flow is measured just downstream of the lateral heading and the CMP shelter with recorder are located downstream of the metering RC Box culvert.

R4 -Wasteway No. 5 at Hatch Siphon -This wasteway is located upstream of the Hatch Siphon at the Rio Grande.

R5 - Garfield Drain ··located north of the US Hwy 85 bridge, 3 miles north of .Hatch, New Mexico, and west of the highway on the drain channel.

R6 - Rio Grande at Hatch - located approximately 3 miles north Hatch, New Mexico, and west of the US Hwy 85 bridge on the right side of the river channel.

R7 -Wasteway No. 16 at Rincon Siphon - located downstream on the river channel from the A.T. & S. F. Railroad crossing the Rio Grande approximately 2 miles east of Hatch, New Mexico.

R8 - Hatch Drain - located on the drain upstream of UW Hwy 85 approximately 2.5 miles east of Hatch, New Mexico.

R9 - Wasteway No. 18 from Rincon Lateral - located approximately 8 miles east of Hatch, New Mexico, north of the US Hwy 85, and on the left side of the Rio Grande.

Rl0 -Rio Grande at Hayner Bridge - located approximately 8 miles east of Hatch, New Mexico on the Rio Grande just upstream of the Tonuco River crossing.

R11 - Rincon Drain - located approximately 8 miles east of Hatch, New Mexico, l mile north of the Tonuco River crossing, and downstream of the intersection of the Rincon Lateral and Rincon Drain.

M1 -Leasburg Canal - located approximately 1.5 miles from the canal heading and approximately 0.5 miles east from the intersection of Fort Selden Road (from US I-25) and US Hwy 85.

M3 - Selden Drain - located approximately 3.5 miles south of Radium Springs, New Mexico and just east of U.S. Hwy 85, immediately upstream of the intersection of Kerr Lateral with the drain.

M4 -Wasteway No. 5 - located approximately 5 miles north of Las Cruces, New Mexico and one mile south of the intersection of NM Hwy 430 and US Hwy 85, on the left side of the river channel.

M5 - Wasteway No. 8 - located approximately 3 miles north of Las Cruces, New Mexico on the left side of the river approximately 2 miles west of US Hwy 85.

M6·- Picacho Drain - located approximately 2.0 miles northwest from Mesilla Diversion Dam, west of the Rio Grande, and just downstream from the Nusbaum Lateral inflow into the Picacho Drain.

M8 -West Side Canal - located west off the Mesilla Diversion Dam. Station is located approximately 0.5 miles downstream of the canal heading and contains a metering bridge and CMP shelter with recorder.

M9 -East Side Canal - located east off the Mesilla Diversion Dam. The Station is located approximately 0.25 miles downstream of the canal heading and contains a metering bridge and CMP shelter with recorder.

M10 - Del Rio Lateral - located east off the Mesilla Diversion Dam. Station is located approximately 0.5 miles downstream of the lateral heading and contains a metering bridge and CMP shelter with recorder.

M11 - Rio Grande Below Mesilla - located approximately 0.75 miles downstream of Mesilla Diversion Dam on the Rio Grande.

M12 - Wasteway No. 15 - located approximately 200 feet upstream of the left (east) of the river levee and 1.6 miles downstream from the New Mexico State Hwy No. 28 bridge crossing of the Rio Grande.

Ml3 - Santo Tomas River Drain - located approximately 3.4 miles downstream of the New Mexico State Hwy No. 28 bridge crossing and 0.8 miles upstream of the Mesquite- San Miguel Road bridge crossing the Rio Grande. The station is on the west side of the river on the Santo Tomas River Drain upstream of the culvert through the levee.

M14 - Wasteway No. 25 -located approximately 3.5 miles downstream of the New Mexico State Hwy No. 28 bridge crossing and 0.7 mile upstream of the Mesquite-San Miguel Road Bridge crossing the Rio Grande. The station is on the west side of the river on the tail end of the Santo Tomas River Lateral on the river side of the lateral embankment.

M15 - Wasteway No. 26 - located approximately 1.5 miles west of Mesquite, New Mexico on the right side of the river off the Upper Chamberino Lateral and just downstream of the river crossing the Mesquite-San Miguel state road.

Ml6 -Brazito River Lateral Wasteway - located on the east side and 0.7 mile downstream of the Mesquite-San Miguel Road bridge crossing the Rio Grande. The station is on the tail end of the Brazito River Lateral and is downstream of the river levee.

Ml7 - Wasteway No. 18 - located approximately 1.5 miles northwest from Vado, New Mexico on the left (east) side of the river. This station is just upstream where the wasteway crosses Del Rio Drain and downstream of the railroad tracks.

Ml9 - Del Rio Drain -- located approximately 3 miles south of Mesquite, New Mexico and north of Vado, New Mexico. Station is just west off US Hwy 85 and 125 feet downstream of the Vado Mesquite Road Crossing Del Rio Drain.

M20 - Wasteway No. 19 - located between a fork formed by the river on the west and the A.T. & S.F. railroad and approximately 2.0 miles northwesterly from Berino, New Mexico. The wasteway station is approximately 500 feet from the Three Saints Lateral and wastes this lateral into the Rio Grande.

M21 - Wasteway No. 30 - located downstream of the New Mexico State Road 226 from Berino, and downstream of the river levee between the Chamberino East Lateral and the Rio Grande.

M22- La Mesa Drain - located approximately 2 .5 miles west of Berino, New Mexico, west of the river, and ½ mile from wasteway No. 31.

M23 - Wasteway No. 31 - located approximately 2.5 miles southwest of Berino, New Mexico, west of the river, and 3 miles downstream from the intersection of the river with State Hwy 226 (Berino to Chamberino).

M24 -Wasteway No. 20 -located on the east side of the Rio Grande and wastes the Three Saints West Lateral. This wasteway is approximately 1.6 miles upstream of the Anthony bridge crossing the Rio Grande.

M25 -- Wasteway No. 3 l B -located approximately 0.5 mile upstream of the Anthony bridge crossing and on the west side of the Rio Grande. This wasteway is on the tail end of the Jimenez Lateral and is upstream of the river levee.

M26 -Wasteway No. 21 - located approximately 0.5 mile upstream and on the east side of the Rio Grande. This wasteway is on the tail end of the Three Saints West Lateral and is 300 feet upstream of the river levee.

M27 -La Union West Canal -located approximately 3 miles west of Anthony, New Mexico just downstream of the canal heading.

Miscellaneous Sites: Any location where diversion of water from the Rio Grande occurs in New Mexico downstream of Caballo Dam and upstream of the upstream of the American Diversion Dam, including but not limited to the California Lateral Extension and various river pumps.

The following continuous stage recorders shall be maintained by EPCWID:

M28 - La Union East Canal - located approximately 3 miles west of Anthony, New Mexico just downstream of the canal heading.

M29 - Three Saints East - located approximately 0.3 mile upstream of the intersection of the Three Saints Lateral and FM1905 from Anthony.

M30 -Wasteway No. 32 - located approximately 2 miles west of Anthony, New Mexico, on the right side of the river, and just downstream of New Mexico State Hwy 225.

M32 -East Drain - located approximately 2 miles south of Anthony, New Mexico and west of US Hwy 80A.

M33- Wasteway No. 32A - located 2 miles upstream of the Anthony bridge crossing and on the west side of the Rio Grande. This wasteway is on the tail end of the Rowley Lateral and just upstream of the river levee.

M35 - Wasteway No. 32B - located west and downstream of the Vinton bridge crossing the Rio Grande. Station is on the tail end of the Vinton Cutoff Lateral and just downstream of the river levee.

M36 - Wasteway No. 34 -- located just downstream of the Montoya Siphon and is on the tail end of the Canutillo Lateral.

M37 -Wasteway No. 34A - located approximately 0.6 mile upstream of the Combined La Union Lateral and on the west side of the Rio Grande.

M38 -Wasteway No. 35 - located 3.5 miles downstream from Canutillo, Texas on the right side (west) of the Rio Grande.

M39 - Wasteway No. 35C - located just downstream and on the west side of the Rio Grande. Station is on the tail end of the Schutz Lateral and upstream of the river levee.

M40 - Wasteway No. 36 - located at the tail end of the Montoya Lateral A and on the east side of the Rio Grande.

M41 - Montoya Drain - located in the Upper Valley, Texas, approximately two miles downstream of Country Club Road on the Montoya Drain.

M42 - Wasteway No. 38 - located just down stream of the Sunland Park Road on the Montoya Main Lateral.

M45 - Rio Grande at Canutillo - located approximately 1.0 mile north of Canutillo, Texas and on the right and west side of the Rio Grande.

El - American Canal - located off Paisano Drive on canal concrete lined channel just downstream of the Paisano Siphon and ASARCO plant.

E2 - Robertson/Umbenhauer Water Treatment Plant - located adjacent to the American Canal Extension near Canal Street in downtown El Paso.

E3 -Franklin Canal - located downstream of heading of the Franklin Canal near the 2nd Street Check on the American Canal Extension.

E4 -Jonathan Rogers Water Treatment Plant - located adjacent to the Riverside Canal immediately upstream of the ES metering station

E5 - Riverside Canal - located on the right side (south) and approximately 800 feet downstream of the canal heading.

E6 - Riverside Canal Wasteway No. 1 -- located on the right side of the canal just south of the Bosque Park. Wasteway is from Riverside Canal to the Rio Grande.

E7 -Riverside Canal Wasteway No. 2 - located downstream from Riverside Canal Wasteway No. 1, at a point where the canal channel departs from the river levee, approximately 2.5 miles northwest of Cuadrilla, Texas.

E8 - Fabens Waste Drain - located on the Waste Drain Channel just west of U.S. Hwy 20 at Fabens, Texas.

E9 - Fabens Waste Channel - located southeast of Fabens, Texas, downstream on the waste channel from the Tornillo Canal Heading and the Cook-Schultz Lateral inlet intersection.

E10 -Waste Channel Below Tornillo Wasteway No. 1 - located on the Fabens Waste Channel below the Tornillo Canal Wasteway and the Tornillo-Caseta Road.

El2 -Hudspeth Feeder Canal -located on the Hudspeth Feeder Canal approximately six miles downstream from the Guadalupe-Caseta Road and International Bridge in to Caseta, Mexico.

E13 - Tornillo Canal Wasteway No. 2 - located approximately I mile east of Alamo Alto, Texas on the canal channel adjacent to U.S. Hwy 20 Alternate.

E14 - Tornillo Drain - located on drain channel just downstream and 800 feet from the Alamo Alto Drain inlet, approximately 0.5 miles southeast of Alamo Alto, Texas.

Miscellaneous Sites: Any location where diversion of water from the Rio Grande occurs in Texas downstream of Mesilla Dam and upstream of the former location of Riverside Diversion Dam.

IN WITNESS WHEREOF, the Parties have executed this Agreement as of the 10th day of March, 2008.

Attest:

ELEPHANT BUTTE IRRIGATION DISTRICT

/s/ Willie Koenig
Willie Koenig
Secretary

By: /s/ James Salopek
James Salopek
President

Attest:

EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1

/s/ Indar Singh
Indar Singh
Secretary

By: /s/ Johnny Stubbs
Johnny Stubbs
President of the Board of Directors

Attest:

UNITED STATES OF AMERICA

/s/ Christopher B Rich
For Regional Solicitor

By: /s/ Larry Walkoviak
Regional Director
Upper Colorado Region
Bureau of Reclamation

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Appendix B. Operations Manual

Revision of May 2012

RIO GRANDE PROJECT - OPERATIONS MANUAL

Appendices

Exhibits

1 Disclaimer

This Rio Grande Project Water Accounting and Operations Manual (Operations Manual) contains detailed information regarding the methods, equations and procedures used by the United States Bureau of Reclamation (Reclamation), El Paso County Water Improvement District No. 1 (EPCWID), and Elephant Butte Irrigation District (EBID) to operate the Rio Grande Project and account for all water charges under the Rio Grande Project Operating Agreement. This Operations Manual is an addendum to the Rio Grande Project Operating Agreement and is intended to be consistent with the Project Storage, release and delivery and allocation provisions in the Rio Grande Project Operating Agreement; nothing in the Operations Manual modifies or changes the language and requirements set forth in the Operating Agreement. To the extent any provisions in this Operations Manual are inconsistent or incompatible with the Operating Agreement, such inconsistencies are superseded by the Operating Agreement and/or are null and void.

2 Definitions

Allocated Water: that portion of the project water supply, as defined in the Operating Agreement, which is determined to be available for diversion and use by EBID, EPCWID and the United States for delivery to Mexico during the primary irrigation season. Accounting of allocated water is subject to the time that it takes water to travel from Caballo Dam to each district's respective diversion points.

Primary Irrigation Season: the primary irrigation season is defined as that period of a year when water is being released from Caballo Reservoir for irrigation purposes.

Allocation Charge: the debit applied to EBID's, EPCWID's or Mexico's respective amount of allocated Allocation Water.

Non-Allocated Water: water in the Rio Grande, during non-irrigation season and after the closing of the Caballo Dam release gates and prior to opening of the Caballo Dam release gates for the subsequent primary irrigation season, which originates from drain flows and other sources which may be diverted by the irrigation districts for application to irrigable land area within their boundaries. All diversions made by the Districts during the non-irrigation season utilizing return flow waters shall not be charged against the District's respective allocations.

Operating Agreement: Agreement executed on March 10, 2008 between the United States, EBID and EPCWID.

3 Allocation of Project Water

3.1 EBID and EPCWID

The U.S. Bureau of Reclamation (Reclamation) shall, prior to the 2nd Tuesday of each month of, allocate Rio Grande Project water in accordance to the Operating Agreement to EBID, EPCWID, and the United States for delivery to Mexico. The final allocation for the year shall include storage and allocation accounting data through the month of October of such year.

3.2 Bonita Private Irrigation Canal

The Reclamation shall each month inform EBID, EPCWID, and US-IBWC of the amount of water diverted from Caballo Reservoir into the Bonita Private Irrigation Canal by the United States for use in New Mexico.

3.3 United States for Delivery to the Republic of Mexico

Reclamation shall advise US-IBWC based on the storage conditions at the end of November whether the project waters available for release from Project Storage for the following year are sufficient for a full allocation or whether a proportionally reduced allocation will be made. The initial allocation letter provided by the U.S. Bureau of Reclamation to the US-IBWC is received mid-December of each year, with projected storage conditions in Elephant Butte and Caballo reservoirs through the end of the year.

During drought years when proportionally reduced allotments are made, regular monthly meeting are held at the US-IBWC headquarters. Monthly updates based on the end of previous month reservoir storage conditions and allocation projections for the remainder of the year are presented by Reclamation to the US-IBWC, CILA, EBID, EPCWID and CONAGUA, Juarez irrigation district.

3.4 Diversion of Flood Water in Excess of Project Water Orders

Reclamation may declare that flood flows, in a specific amount and duration, entering the Rio Grande downstream of Caballo Dam and in amount in excess of Project Water Orders to be Non-Allocated Water and available for diversion by EBID and EPCWID.

4 Water Delivery and Accounting

4.1 Ordering of Water by the Districts

Figure 1 below shows the order forms to be completed by EPCWID and EBID for review by Reclamation. The amount of flow ordered for delivery to Mexico shall be specified by US-

IBWC. The data fields in Figure 1 shall be entered by EBID and EPCWID each order day during the primary irrigation season by 10:00 am. Based on the information entered into to Figure 1 and the “Flow Regulation Calibration at Caballo Dam” report contained in Appendix D, Prior to 11:00 am each order day, the low level gates at Caballo Dam shall be set to the opening values calculated in Figure 1. The official record of releases of Project Water from Caballo Reservoir shall be calculated by Reclamation and shall be based on the flows recorded by the metering station immediately downstream of Caballo Dam and operated by Reclamation. The amount of opening of the low-level gates shall not be changed if the difference in the amount of the gate opening is ± 0.02 feet from the prior gate setting. Reclamation will perform a flow measurement at the river station below Caballo Dam whenever there is a change in the release from Caballo Dam of ± 100 cfs.

Figure 1 - Internet-Based Order Forms

RIO GRANDE PROJECT ORDER

Ord:1124	Effective Date: 7/8/2008		Prior:1123	Effective Date: 7/7/2008	
BOR	Date/Time Received: 07/08/08 15:36	Received By: IO	BOR	Date/Time Received: 07/07/08 15:09	Received By: IO
EPCWID #1	Date/Time Entered: 07/08/08 08:39	Approved By: RR	EPCWID #1	Date/Time Entered: 07/07/08 09:49	Approved By: RR
EBID	Date/Time Entered: 07/08/08 08:49	Approved By: MJN	EBID	Date/Time Entered: 07/07/08 09:51	Approved By: MJN

Upper Valley From: 7/8/2008 To: 7/9/2008

Location	Current	Prior	Change
Arrey Canal	140	140	0
(-) Bypass	0	0	0
River Pumps	0	0	0
Leasburg Canal	170	230	-60
(-) Bypass	0	0	0
California Ext.	0	0	0
Del Rio Lateral	0	0	0
Eastside Canal	110	140	-30
Westside Canal	380	400	-20
(-) Bypass WW32	-30	-70	40
Total Upper Valley	770	840	-70

State Line From: 7/8/2008 To: 7/9/2008

Location	Current	Prior	Change
La Union West TX	20	30	-10
La Union West NM	20	30	-10

Gate Settings	Current	Prior	Change
East Gate Recommended	3.98	4.41	-0.43
West Gate Recommended	3.98	4.41	-0.43

EBID Comments

-

SUMMARY

	Current	Prior	Change
RIVER BOOST	50	0	50
River Reaches/Stations	Current	Prior	Change
Caballo Release	1683	1873	-190
Flow below Percha Dam	1543	1733	-190
Gain/Loss (+/-) above Leasburg	50	0	50
Flow at Leasburg Cable	1423	1503	-80
Gain/Loss (+/-) Leasburg/Mesilla	0	0	0
Flow below Mesilla Dam	933	963	-30
Gain/Loss (+/-) Mesilla-American	0	0	0
Flow at American Dam	963	1033	-70
District Totals	Current	Prior	Change
Total for EBID	690	780	-90
Total for EPCWID #1	866	916	-50
Total for Both Districts	1556	1696	-140
Project Totals	Current	Prior	Change
Total Gains/Loss	50	0	50
Total EBID, EPCWID, Mexico	1733	1873	-140
Release	1683	1873	-190

State Line From: 7/10/2008 To: 7/12/2008

Location	Current	Prior	Change
La Union East TX	60	30	30
La Union East NM	30	20	10
3 Saints East TX	0	0	0
3 Saints East NM	0	0	0
Total State Line	130	110	20

Lower Valley From: 7/11/2008 To: 7/13/2008

Location	Current	Prior	Change
UR-WTP	56	56	0
Franklin Canal	160	130	30
JR-WTP	85	85	0
Riverside Canal	485	585	-100
Total Lower Valley	786	856	-70

Comments - EPCWID

-

Mexico From: 7/11/2008 To: 7/13/2008

Location	Current	Prior	Change
Mexico	177	177	0
Total Mexico	177	177	0

Comments - Mexico

-

Reclamation Order # 1124

Caballo Elevation	Current	Prior	Change
USBR Elevation (ft)	4148.58	4148.44	0.14
Recommended River Boost (cfs)	0.00	0.00	0
Accretions (cfs)	50.00	0.00	50
Gate Settings	Current	Prior	Change
East Gate (ft)	3.98	4.41	-0.43
West Gate (ft)	3.98	4.41	-0.43
Recommended Flow Setting	Current	Prior	Change
CFS	1683	1873	-190
Scheduled Time of Change	10:00		
USBR River Measurement	Date	Time	Flow
Measured Flow (cfs)	7/8/2008	13:15	1756
USBOR Confirmation of Mexico Order	Yes		

Comments

BOR recom. gate settings @ 3.86 ea.=1683 Dist. recom. gate settings @ 3.98 ea.=1735

Date/Time Received: 07/08/08 15:36 Received By: IO

4.2 Estimate of the Time Required for Water Released from Caballo Reservoir to Travel in the Rio Grande to Diversion Dams

Project Water is released from Caballo Reservoir is diverted at the Percha, Leasburg, Mesilla, and American diversion dams located downstream of Caballo Dam on the Rio Grande. The time required for water released from Caballo Reservoir to travel to each of these dams varies with the amount of water in the Rio Grande, the amount of water released, the amount of change in the amount of water released (both magnitude and sign), the amount of water being diverted at each diversion point, and other considerations. As water released from Caballo travels from Caballo Dam towards American Dam in the Rio Grande it does such as a wave that is attenuated and modified with distance. For example, if the amount of flow released from Caballo Dam is changes from 1,000 cfs to 1,500 cfs, the 500 cfs increase occurs almost instantly, but assuming no water is lost or gained between Caballo Dam and American Dam, the arrival of the change-in-release would be gradual. Figure 2 below show the measured hydrographs during the initial release of water from Caballo Dam in 2007 at various locations on the Rio Grande downstream of Caballo Dam. Because the change-in-release is modified as it flows downstream, the estimated travel times are based on the time that 90% of the anticipated change arrives at the given diversion dam. For the above example of a 500 cfs change at Caballo with no loss or gain of water, the travel time would be that when 450 cfs of the change arrived at given location. Table 1 below lists the distance and average travel time for the Rio Grande Project diversion dams on the Rio Grande.

Figure 2 - Hydrographs for Initial Release of Water from Caballo Dam in 2007

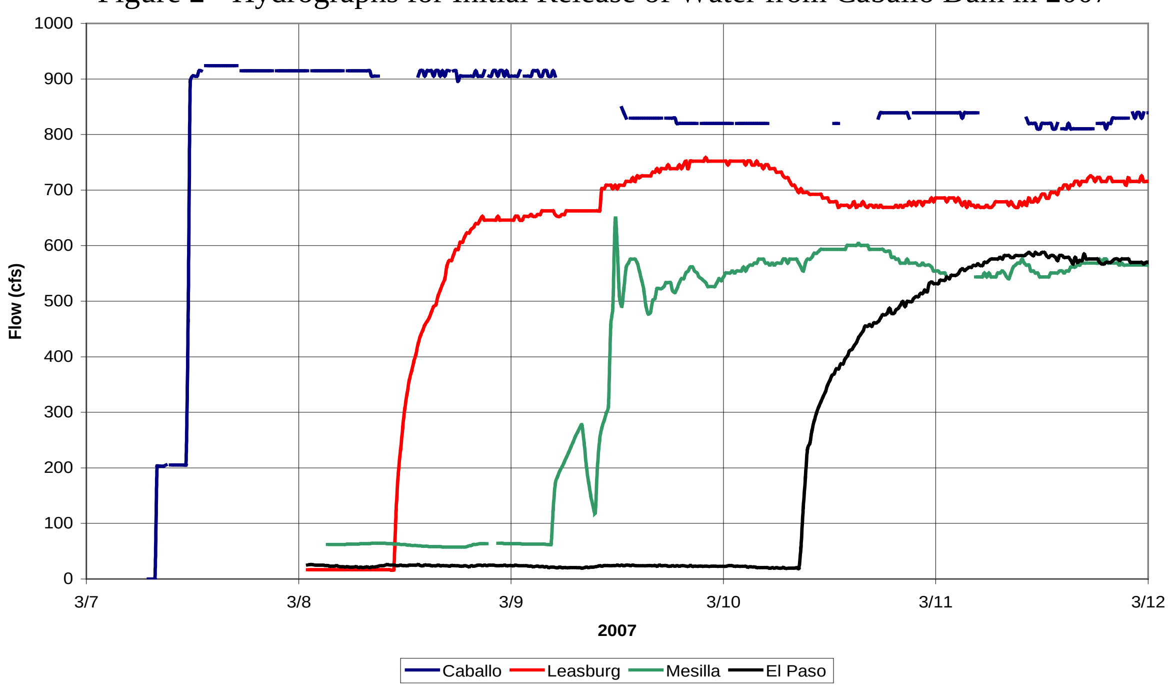

Table 1 - Average Travel from Caballo Dam to Various Diversion Dams

River Location / Reach	River Miles from Caballo Dam	River Reach Miles	Travel Velocity	Cumulative Travel Time in Hours	Travel Time per River Reach in Hours	Example Day of Week	Example Hour of Day
Rio Grande at Caballo Dam	0	-		0	0	Monday	11:00 AM
Percha Diversion Dam	1.2	1.2	0.6	2	2	Monday	1:00 PM
Leasburg Diversion Dam	44.8	43.6	2.4	20	18	Tuesday	7:00 AM
Mesilla Diversion Dam	67.5	22.7	2.3	30	10	Tuesday	5:00 PM
American Diversion Dam	106.8	39.3	1.1	66	36	Thursday	5:00 AM
International Diversion Dam	108.9	2.1	1.1	68	2	Thursday	7:00 AM

4.3 Sharing of Storages

Flows at American Canal Heading occasionally drop below the order of the EPCWID. At times when the actual flow at EPCWID delivery points is 100 CFS or more below the EPCWID's order, and at EPCWID option, the following method of sharing the shortage between EBID and EPCWID shall be implemented:

> EBID shall release additional water through wasteways equal to one half of the amount of shortage at Riverside Canal Heading. EBID and EPCWID shall adjust the order for release from Caballo Reservoir to correct for such shortage. EBID shall receive credit against their allocation charge for the amount of additional water released through their wasteways because of such shortage.

4.4 Water Flow Measurement Stations

Each party shall maintain and operate the water flow measurement (metering) stations as listed in the Operating Agreement. Each station used in accounting of delivery of allocated water and listed in sections 4.5.2 and 4.5.3 shall be equipped with a Steven's Type F recorder and the water levels shall be continuously recorded on paper charts. A digital copy of the charts shall be made available by the party maintaining the metering station upon request by any other party.

4.5 Measurement of Flow and Volume

Water flow and volume measurement shall generally following procedures as outlined in USGS Water Supply Paper 2175. Rating tables for metering stations shall be determined at least annually by the party maintaining the station using previous flow measurements.

4.5.1 United States Section of the International Boundary and Water Commission (US-IBWC)

The US-IBWC measures twice a week at the Below American Dam gaging station and twice weekly at the headworks of the Acequia Madre, preferably on Mondays and Fridays each week during the primary irrigation season. CILA measures the amount of water flowing in Acequia Madre at its headworks three times a week, usually on Mondays, Wednesdays and Fridays. All information regarding measurements are exchanged between the two sections. Based upon the latest US measurements, the US-IBWC determines the appropriate gage height setting at the metering station immediately downstream of American Dam on the Rio Grande and the corresponding gate setting at American Dam to deliver the requested flow rate into the Acequia Madre.

The water delivered to Mexico in the Rio Grande at the headworks of the Acequia Madre pursuant to the 1906 Convention is computed by subtracting 1) computed losses in the reach between Below American Dam gauging station and the Acequia Madre headworks and 2) estimated leakage through International Dam from the computed flows at the Below American Dam gauging station.

4.5.2 EBID

Figure 3 - Example of EBID's Monthly Water Allotment Charges Report

ELEPHANT BUTTE IRRIGATION DISTRICT
WATER ALLOTMENT CHARGES (acre-feet)
for Month of April 2008
SUBJECT TO REVISION

	Gross Diversions		**Diverted to Texas**		**Net Diversion**	
	Month	**Year to Date**	**Month**	**Year to Date**	**Month**	**Year to Date**
ARREY CANAL	12,091	22,237			12,091	22,237
PERCHA LATERAL	67	71			67	71
LEASBURG CANAL	11,439	18,710			11,439	18,710
CALIFORNIA EXTENTION	0	0			0	0
EASTSIDE CANAL	7,771	11,954	-353	-514	7,418	11,441
DEL RIO LATERAL	466	823			466	823
WESTSIDE CANAL	20,594	38,029	-6,248	-13,019	14,347	25,010
PUMPED FROM RIVER**	0	0			0	0
GROSS TOTAL	52,429	91,824	6,601	13,533	45,828	78,292
TOTAL CHARGES					45,828	78,292
CREDIT AT ARREY (-)					-692	-763
CREDIT AT LEASBURG (-)					-87	-87
NET ALLOTMENT CHARGE					45,049	77,442
DISTRICT ALLOTMENT						198,384
DISTRICT BALANCE						120,942

** GREENWOOD AND DURAN RIVER PUMPS (EBID DATA)

Charges to EBID are made using the following diversion points:

a) Arrey Canal,

b) Percha Lateral,

c) Irrigations from Leasburg Canal above gauging station,

d) Leasburg Canal,

e) California Lateral,

f) West Side Canal (NM portion),

g) East Side Canal (NM portion),

h) Del Rio Lateral, and

i) the Greenwood, Duran, Roundtree, Dulin, Dorser, and Thurston pumps located in the Rincon Valley.

4.5.3 EPCWID

Figure 4 - Example of EPCWID's Monthly Water Allotment Charges Report

EPCWID Diversion Allocation Charges for Mar 2008

Diversion Location	Metered Volume	Adjustment for Conveyance Losses for NM Deliveries	Diversion Allocation Charges for Month	Beginning-of-Month Totals	End-of-Month Totals
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
L U E Canal - TX	3,092	95%	2,937	0	2,937
L U W Canal - TX	1,096	95%	1,041	0	1,041
Three Saints Lateral	133	100%	133	0	133
Total Mesilla Valley (Texas)			4,112	0	4,112
Umbenhauer/Robertson Water Treatment Plant	1,820	100%	1,820	61	1,881
Franklin Canal	6,246	100%	6,246	256	6,502
United States - Ysleta del Sur Agreement	0	100%	0	0	0
United States Section - IBWC (Construction Water)	0	100%	0	0	0
Jonathan W. Rogers Water Treatment Plant	2,539	100%	2,539	0	2,539
Riverside Canal	21,751	100%	21,751	1,680	23,431
Haskell R. Street WWTP Effluent	-1,461	100%	-1,461	-239	-1,700
Credit for Diversions greater than Orders (El Paso Valley)	-200	100%	-200	0	-200
Total Allotment Diversions Charges			**34,806**	**3,132**	**36,565**
Diversion Allocation				232,339	257,951
Est. Annual Conservation Credit Diversion Allocation					16,207
Accrued Conservation Credit Diversion Allocation					2,297
Total Diversion Allocation				232,339	260,248
District Allotment Balance				**229,207**	**223,684**

Charges to EPCWID are made using the following diversion points:

a) East Side Canal (Texas portion)

b) La Union East Canal (Texas portion)

c) La Union West Canal (Texas portion)

d) Franklin Canal

e) City of El Paso Water Treatment Plants

f) American Canal Extension for the United States (Ysleta del Sur and US-IBWC)

g) Riverside Canal

4.6 Water Order by Only One District

4.6.1

At the start of the Primary Irrigation Season and when one District orders water for diversion prior to the other, allocation charges to that District shall start on the date and time that water arrives to the delivery point and shall equal the greater of the amount of water ordered for delivery or the amount of water released from Caballo Dam. Any charges based on the amount of water released from Caballo Dam shall be discontinued upon the other district or Mexico ordering water for delivery.

4.6.2

During years with less than a full allocation and diversion have been discontinued for only one district because of insufficient diversion allocation balance and during the time prior to the termination of release of water from Caballo Dam at the end of the Primary Irrigation Season (when only one District orders water for diversion), the allocation charges shall equal the greater of the amount of diversion charges made in accordance with Appendices A, B, and C of this manual or the amount of water released from Caballo Dam.

4.7 End of Primary Irrigation Season

Except when Section 4.6.2 is in effect and after the gates at Caballo Dam have been closed, allocated water will be charged to the Districts until such time as the stored water is no longer available at their respective headings or the estimated travel times listed in Section 4.2 above have elapsed, whichever is less. If Section 4.6.2 is in effect, allocation charges for either district shall end at the date and time the gates at Caballo Dam are closed..

4.8 Emergency Conditions

Each Party shall be allowed to make changes to the water order in response to emergencies such as ditch breaks, flood flows, excessive arroyo inflows, or other accidents to the system. Reclamation shall make the change in the release from Caballo Reservoir as soon as possible. The order change for accounting purposes, at the respective diversion point, shall take effect as per the travel times in Section 4.2.

In the event of a total closing of the release gates from Caballo due to an emergency, accounting of delivered allocated water shall be in accordance with Section 6.5 Emergency Conditions (Force Majeure) of the Operating Agreement. Documentation of the changes in orders shall be completed utilizing the process in Section 4.1 as soon as possible and verified by each party.

4.9 Accounting Mistakes Regarding Mexico's Allocation

During an extraordinary drought or serious accident to the irrigation system in the United States, Mexico's delivery allocation (that has been diminished in the same proportion as the water delivered to lands in the irrigation districts in the United States) shall not be decreased during the calendar year except in the situation where an accounting or measurement mistake has been made resulting in an allocation to Mexico in an amount greater than would have been made if such error had not been made.

In November of each year, if under any situation Mexico's allocation is greater than the same proportion as the water delivered to lands in the irrigation districts in the United States, then the difference in the amount greater than the proportion as the water delivered to lands in the irrigation districts in the United States shall be charged against the delivery allocation of the irrigation districts in amounts proportional to their respective irrigable acres.

4.10 Correction of D2- Linear Regression Equation During Multi-Year Extreme Drought

The D2 Linear Regression Equation fails to accurately predict the measured amount of water that was diverted from the Rio Grande during consecutive calendar years when the total amount of water released from Caballo Reservoir is less than 400,000 acre-feet. For example during the years 1954 through 1957 the amount of water released from Caballo Reservoir was less than 400,000 acre-feet, and the amount of measured diversions was 88%, 78%, and 75% of the amount predicted by the D2 Linear Regression Equation for the years 1955, 1956, and 1957, respectively. During the 2nd consecutive year when the amount of water released from Caballo Reservoir is less than 400,000 acres feet the "Corrected D2 Linear Regression Equation" shall equal the value predicted by the D2 Linear Regression Equation multiplied by 0.88.

During the 3rd consecutive year when the amount of water released from Caballo Reservoir is less than 400,000 acres feet the "Corrected D2 Linear Regression Equation" shall equal the value predicted by the D2 Linear Regression Equation multiplied by 0.78.

During the 4th and all following consecutive years when the amount of water released from Caballo Reservoir is less than 400,000 acre feet the "Corrected D2 Linear Regression Equation" shall equal the value predicted by the D2 Linear Regression Equation multiplied by 0.75.

If the measured diversion ratio for a consecutive drought year in which the correction to the D2 Linear Regression Equation is applied, is higher than the diversion ratio predicted by the Corrected D2 Linear Regression Equation defined in this section, the measured diversion ratio shall be used for allocation purposes.

5 Exchange of Information

5.1 Allocation Water Charges

Reclamation will provide the EBID and the EPCWID written notification of allocation water charges by the 10th of each following month.

5.2 Communications

Reclamation will provide timely information on any unusual circumstances which could affect the water deliveries to the Districts or Mexico. EBID and EPCWID will immediately notify Reclamation concerning ditch breaks, unusual operating conditions, climatic conditions, or other major disruptions to orderly irrigation operations.

Reclamation will provide river status information daily to the Districts. Additional information or assistance may be requested at any time during Reclamation's operation hours. Any requests for information or assistance during non-operating hours should be limited to emergencies and not routine items. Reclamation's project water operations office and field operating hours during the irrigation season will be as follows:

	Office	Field
Weekdays	6:00 am to 4:30 pm	NM: 6:00 am to 6:00 pm
		TX: 6:00 am to 2:30 pm
Weekends	(none)	NM: 6:00 am to 2:30 pm
		TX: 6:00 am to 2:30 pm

A current roster of contact numbers for EBID, EPCWID, US-IBWC and Reclamation shall be distributed by each of the above entities to EBID, EPCWID, US-IBWC, and Reclamation. The roster shall be updated as necessary.

5.3 Information Provided to Reclamation

EBID and EPCWID shall provide to Reclamation and the other district the following:

a) Water orders by 10:00 am on order days

b) Average flow data (cfs) for all metering station listed in the Operating Agreement by the 2nd Monday of each month following the month in which the data was measured.

c) Crop report information by January 15, each year.

d) Water charges to the farms by January 15, each year.

Reclamation shall obtain the following from US-IBWC:

a) Water orders by 10:00 am on order days.

b) Preliminary average flow data (cfs) for the Acequia Madre listed in the Operating Agreement by the 2nd Monday of each month following the month in which the data was measured.

c) Final average flow data (cfs) by the last day of each month following the month in which the data was measured.

5.4 Information Provided by Reclamation

Reclamation shall provide to EBID, EPCWID, and US-IBWC the following information by the 2nd Tuesday of each month.

a. Amount of water stored in Elephant Butte and Caballo Reservoirs

b. Amount of non-project water storage

c. Amounts of project water stored above Elephant Butte in the Upper Rio Grande Basin

d. Cumulative annual amount of water released from Elephant Butte and Caballo Reservoir

e. Current inflow to Elephant Butte and Caballo Reservoir

In addition to the above information, Reclamation shall, by January 15 of each year, provide to all parties documentation of compliance, during the previous year, by the City of El Paso with terms of “Exhibit C – Determination of Underflow of the Rio Grande Captured by the City of El

Paso's Groundwater Withdrawal" of the contract among the City of El Paso, EPCWID, the United States numbered 01-WC-40-6760 (2001 Implementing Contract).

6 Updating of Operations Manual

EBID, EPCWID, and Reclamation (including representation from US-IBWC under the auspice of Reclamation) will meet once a year in January, or more frequently if requested by one of the three parties, to review this operating manual. The Parties may modify any provisions of this manual upon having reached unanimous consent. No unilateral departure from this manual is allowed. Proposals for updates shall be submitted to all parties by January 1st of each year for review during the January meeting. The proposal shall consist of a detailed description of the proposed update with a justification for the update. Adoption of the update shall be by unanimous consent for the start of the irrigation season agreed to by the parties. At any time during the year any party may submit proposal for updating this manual. The proposal shall consist of a detailed description of the proposed update with a justification for the update.

Adoption of the update shall be by unanimous consent on the date agreed to by the parties. Consent of adoption of the update shall communicated by letter to each party. The Bureau of Reclamation shall make the updated manual available to the general public upon implementation. No unilateral departure from this manual is allowed.

7 Record of Changes Made to This Operating Manual

August 13, 2008	Original Manual
January 15, 2009	No changes made.
January 12, 2010	Deletions, additions, revisions, and changes made to sections 3.1, 3.3, 4.1,4.5.1, 4.6,1, 4.6.2, 4.7, 4.9, 5.2, 5.3, and 6. as shown in the redline version dated January 12, 2010. No changes made to appendices.
May 8, 2012	Addition of Section 4.10. No changes made to appendices.

APPENDIX A – RIO GRANDE PROJECT OPERATING AGREEMENT

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APPENDIX B – EXAMPLE OF EPCWID'S MONTHLY CHARGES

The following descriptions are provided for convenience only. The actual equations, procedures, and representations contained in the electronic spreadsheet named EPCWID_Charges_2008.xls and attached to this document as Exhibit 1 shall be used for determining EPCWID charges.

Description of Calculations used to determine EPCWID's Allocation Charges

Overview: EPCWID monthly allocation charge are calculated using information from Table B-1 –Monthly Summary, Table B-2 – Average Daily CFS Values, and Table B-3 – El Paso Valley Spills. Each of the three tables is specific for each month of the year and a single spreadsheet file (MS-EXCEL) shall be distributed by EPCWID to the other parties each month that contains the tables. Table B-1 is linked to Tables B-2 and B-3 and previous monthly tables to provide the summary of the allocation charges and a running balance of the amount of Project Water available for diversion by EPCWID. Table B-2 contains the daily flow (average cfs) values for each of the flow metering sites that is used in the calculations of charges and the respective amount of water ordered by EPCWID or EPCWID and EBID at La Union East, La Union West, and Three Saints irrigation canals. Table B-3 contains the daily volumes of water flowing out of EPCWID wasteways and spillways in the El Paso Valley. Table B-3 is used to determine the amount of water that is eligible for evaluation in Table B-2 for an allocation credit to EPCWID. The purpose of the allocation credit is to provide an accounting procedure that promotes conservation by allowing EPCWID to attempt to use water that is in excess of EPCWID's order for Project Water on any given day and is diverted at the American Diversion Dam into the American Canal.

Table B-1: EPCWID Diversion Allocation Charges Summary

Row 4: The La Union East irrigation canal supplies water to irrigable lands in both Texas and New Mexico. The metered volume for the La Union East irrigation canal is obtained from Table B-2. The EPCWID allocation charge is 95% of the metered volume. The 5% reduction is in consideration of the transportation losses associated with the water delivered to lands in New Mexico.

Row 5: The La Union West irrigation canal supplies water to irrigable lands in both Texas and New Mexico. The metered volume for the La West East irrigation canal is obtained from Table B-2. The EPCWID allocation charge is 95% of the metered volume. The 5% reduction is in consideration of the transportation losses associated with the water delivered to lands in New Mexico.

Row 6: The Three Saints irrigation canal downstream of the Texas state line only supplies water to irrigable lands in Texas. The metered volume for the La Union East irrigation canal is obtained from Table B-2.

Row 7: EPCWID total allocation charges for the Mesilla Valley equal the sum of charges for rows 4, 5, and 6.

Row 8: The Umbenhaur-Robertson WTP diverts water from the American Canal Extension upstream of the Franklin Canal Heading. The amount of water diverted is measured by the City of El Paso and Reported to EPCWID. The gross amount of the measured volume is used as the allocation charge.

Row 9: EPCWID diverts water from the American Canal Extension upstream at the Franklin Canal Heading. The amount of water diverted is measured by EPCWID. The gross amount of the measured volume is used as the allocation charge.

Row 10: The United States on behalf of the Ysleta del Sur Nation diverts water from the American Canal Extension into the Rio Grande immediately upstream of the former Riverside Diversion Dam. The Ysleta del Sur Nation owns irrigable land within EPCWID that receives and allocation of water from EPCWID.

Row 11: During maintenance of the Rio Grande levee system and other work, the US-IBWC uses water pumped from the American Canal Extension.

Row 12: The Jonathan Rogers WTP diverts water from the Riverside Canal upstream of the Riverside Canal metering station. The amount of water diverted is measured by the City of El Paso and Reported to EPCWID. The gross amount of the measured volume is used as the allocation charge.

Row 13: The American Canal Extension terminates in the Riverside Canal. EPCWID measures the amount of water in the Riverside Canal immediately downstream of the City of El Paso's diversion point for the Jonathan Rogers WTP. The amount of water diverted is measured by EPCWID. The gross amount of the measured volume is used as the allocation charge.

Row 14: In accordance with the 2001 Implement Agreement among the United States, EPCWID, and the City of El Paso, EPCWID receives credit for non-project water discharged into the American Canal Extension by the City of El Paso at their Haskell Street WWTP upstream of the Riverside Canal and downstream of the Franklin Canal Heading. The amount of water discharge is measured by the City of El Paso and reported to EPCWID.

Row 15: Tables B-2 and B-3 contain measurements and calculations required to determine the volume of credit to be applied to EPCWID allocation charges for water diverted into the Franklin or Riverside canals that is greater than the amount of water ordered by EPCWID for diversion and is not used by EPCWID. Details of the calculations are provided in the section regarding Tables B-2 and B-3 below.

Row 16: The total diversion allocation charges equal the sum of rows 7 through 15.

Row 17: Reclamation, in accordance with this manual and the Operating Agreement, provides EPCWID with its total diversion allocation.

Row 18: The maximum amount of diversion allocation that is eligible for determining the American Canal Extension Conservation Credit is 376,863 acre-feet per year.

Row 19: The estimated annual American Canal Extension Conservation Credit is calculated using the following formula:

> **[(-0.7908 x 0.8 x Estimated Annual Division / 376,840)^2**
>
> **+ (1.6477 x 0.8 x Estimated Annual Diversion / 376,840)+0.1431] x 20,052**
>
> **Where the Estimated Annual Diversion equals the Diversion Allocation for Conservation Credit – Estimate of Balance of Allocation at End-of-Year; that is, (Row 18 – Row 23)**

Row 20: The accrued annual American Canal Extension Conservation Credit is calculated using the following formula:

> **Total Allotment Diversions Charge / Diversion Allocation for Conservation Credit x Estimated Annual Conservation Credit Diversion Allocation; that is,**
> **(Row 16 / Row 18 x Row 19)**

Row 21: The total diversion allocation for EPCWID equals the sum of rows 17 and 20.

Row 22: EPCWID's end-of-month allocation balance equals Row 21 minus Row 16.

Row 23: At various times during the Primary Irrigation Season, EPCWID estimates the District Allocation Balance at the end-of-year. This estimate is subject to the limitation on the amount of Project Water that can be carried over from one year to the next as set forth in the Operating Agreement.

Table B-2: Average Daily CFS and Allocation Charges by Diversion Site

La Union East Canal (Texas Portion): The determination of EPCWID allocation charges for La Union East Canal (LUE) is complex and requires 11 columns of measured or calculated values. The complex calculations are a result of the fact that the LUE canal services land in both Texas and New Mexico. Also, water flows in the LUE canal for bypass to the Rio Grande through WW32 and downstream diversion into the American Canal, and WW32 is used to discharge excess flow from EBID. In general the allocations charges for LUE are based on the net amount of water measured by EPCWID at the LUE metering station multiplied (prorated) by the ratio of the EPCWID order to the total order for LUE. The net amount of water measured at LUE is equal to the gross amount of water metered at LUE minus the gross amount of water metered at WW32.

La Union West Canal (Texas Portion): EPCWID allocation charges for La Union West Canal are equal to the gross amount of water measured by EBID at the LUW metering station multiplied (prorated) by the ratio of EPCWID LUW order to the total order for LUW.

Three Saints Lateral Canal (Texas Portion): EPCWID's allocation charges for the Three Saints Lateral (TSL) are equal to net amount of water measured by EBID at the TSL metering station multiplied (prorated) by the ratio of EPCWID TSL order to the total order for TSL. The net amount of water measured at TSL is equal to the gross amount of water metered at TSL minus the gross amount of water metered at WW23A. If there is no order for water at TSL and the gross amount of flow at TSL is less than or equal to 5 cfs, then the gross amount of flow is assumed to be equal to zero.

Umbenhaur-Robertson WTP: The values in this column are the daily gross amount of water metered by the City of El Paso as it is diverted from the American Canal Extension for the Umbenhaur-Robertson WTP.

Franklin Canal: The values in this column are the daily gross amount of water metered by EPCWID as it is diverted from the American Canal Extension.

Jonathan Rogers WTP: The values in this column are the daily gross amount of water metered by the City of El Paso as it is diverted from the Riverside Canal for the Jonathan Rogers WTP.

Riverside Canal: The values in this column are the daily gross amount of water metered by EPCWID flowing in the Riverside Canal immediately downstream of the Jonathan Rogers WTP.

Haskell Street WWTP Water Credit: The values in this column are the daily gross amount of water metered by the City of El Paso as it is discharged into the American Canal Extension from the Haskell Street WWTP.

Total El Paso Valley Order: The values in this column are equal to the sum of the orders and diversion for all of the diversion sites described above.

<u>Table B-3: EPCWID El Paso Valley Daily Spills</u>

Riverside WW1: The estimate of the amount of flow discharged from the Riverside Canal through WW1 to the Rio Grande. The estimate is made based on cfs per inch of gate setting and the duration of flow. Normally all gates at WW1 are closed.

Riverside WW2: The estimate of the amount of flow discharge from the Riverside Canal through WW2 to the Rio Grande. The estimate is made based on cfs per inch of gate setting and the duration of flow. Normally all gates at WW2 are closed.

Fabens Waste Drain: The flow in Fabens Waste Drain has both agricultural drain water (groundwater water) and water discharge through upstream wasteways. The amount of waste water varies from hour to hour while the amount of drain flow is more steady and varies from week to week. The drain flow is estimated by inspection of the flow hydrographs. The Fabens Waste Drain flows into the Fabens Waste Channel.

Fabens Waste Channel: The Fabens Waste Channel flow includes both wasteway water and the Fabens Waste Drain drainage water. The net spill water is calculated by subtracting the Fabens Waste Drain agricultural drainage flow from the gross measure flow for the Fabens Waste Channel.

Tornillo WW2: Tornillo WW2 is near the El Paso / Hudspeth County Line and at the terminus of the Tornillo Canal. The waste flow is measured by EPCWID.

Total Spills: The values in this column equal the sum of the flows at Riverside WW1, Riverside WW2, Fabens Waste Channel, and Tornillo WW2.

Adjustment for Bustamante and Haskell WWTP: The sum of the gross amount of water discharged into the American Canal Extension from the Haskell WWTP and the gross amount of water discharged into the Riverside Canal from the Bustamante WWTP.

EP Valley Spills: This column equals the Total Spills minus the Adjustment for Bustamante and Haskell WWTP.

APPENDIX B – EXAMPLE OF EPCWID'S MONTHLY CHARGES (cont.)

Table B-1: EPCWID Diversion Allocation Charges Summary

EPCWID Diversion Allocation Charges for May 2008

Row	Diversion Location	Metered Volume	Adjustment for Conveyance Losses for NM Deliveries	Diversion Allocation Charges for Month	Beginning-of-Month Totals	End-of-Month Totals
3		ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
4	L U E Canal - TX	2,542	95%	2,414	5,338	7,752
5	L U W Canal - TX	971	95%	923	2,140	3,063
6	Three Saints Lateral	184	100%	184	308	493
7	Total Mesilla Valley (Texas)			3,521	7,786	11,308
8	Umbenhauer/Robertson Water Treatment Plant	3,592	100%	3,592	5,114	8,707
9	Franklin Canal	6,415	100%	6,415	12,738	19,153
10	United States - Ysleta del Sur Agreement	0	100%	0	0	0
11	United States Section - IBWC (Construction Water)	0	100%	0	0	0
12	Jonathan W. Rogers Water Treatment Plant	4,631	100%	4,631	6,895	11,525
13	Riverside Canal	19,105	100%	19,105	44,006	63,111
14	Haskell R. Street WWTP Effluent	-1,460	100%	-1,460	-3,058	-4,519
15	Credit for Diversions greater than Orders (El Paso Valley)	-163	100%	-163	-814	-977
16	**Total Allotment Diversions Charges**			**35,641**	**72,667**	**108,308**
17	Diversion Allocation				300,239	380,012
18	Diversion Allocation for Conservation Credit					376,863
19	Est. Annual Conservation Credit Diversion Allocation					19,008
20	Accrued Conservation Credit Diversion Allocation					5,463
21	Total Diversion Allocation				300,239	385,475
22	**District Allotment Balance**				**227,572**	**277,167**
23	Estimate of Balance of 2008 Allocation at End-of-Year					8,612

APPENDIX B – EXAMPLE OF EPCWID'S MONTHLY CHARGES (cont.)

Table B-2: Average Daily CFS and Allocation Charges by Diversion Site

EL PASO COUNTY WATER IMPROVEMENT DISTRICT Diversion Allocation Charges May 08

	La Union East Canal (Texas Portion)											La Union West Canal (Texas Portion)				Three Saints Lateral Canal (Texas Portion)					
Day	NM Order	TX Order	WW32 Bypass	Total Order + Bypass	LUE Avg. CFS	Excess Flow	WW32 Avg. CFS	WW32 Spill	WW32 Spill Charge	Net. Avg. CFS	Alloc. Charge	NM Order	TX Order	Avg. CFS	Alloc. Charge	NM Order	TX Order	Avg. CFS	WW23A	Net CFS	Alloc. Charge
1	15	25	60	100	106	6	56	0	0	50	31	30	10	46	12	15	0	17	6	11	0
2	15	25	30	70	76	6	59	29	23	17	25	30	10	40	10	0	0	6	6	0	0
3	0	0	70	70	75	5	69	0	0	6	6	30	10	31	8	0	0	3	3	0	0
4	0	0	70	70	79	9	66	0	0	13	13	40	0	41	0	0	0	4	4	0	0
5	0	0	70	70	66	0	58	0	0	8	8	40	0	40	0	0	0	2	2	0	0
6	0	0	70	70	75	5	15	0	0	60	60	40	0	41	0	0	0	11	2	9	0
7	20	40	40	100	109	9	16	0	0	93	62	50	10	39	7	10	15	22	0	22	13
8	20	40	40	100	114	14	2	0	0	112	75	50	10	57	10	10	15	27	2	25	16
9	30	60	10	100	99	0	0	0	0	99	66	50	10	55	9	10	15	10	6	4	6
10	30	60	10	100	100	0	0	0	0	100	67	50	10	59	10	0	0	10	8	2	0
11	20	40	60	120	100	0	7	0	0	93	62	50	20	56	16	0	0	0	0	0	0
12	20	40	60	120	112	0	40	0	0	72	48	50	20	51	15	0	0	0	0	0	0
13	20	40	60	120	121	1	43	0	0	78	52	50	20	51	15	0	0	0	0	0	0
14	20	40	60	120	116	0	39	0	0	77	51	50	20	61	17	0	0	3	1	2	0
15	30	60	30	120	108	0	31	1	1	77	52	40	40	57	29	0	0	7	3	4	0
16	30	60	30	120	118	0	32	2	2	86	59	40	40	70	35	0	0	5	4	1	0
17	30	60	30	120	117	0	27	0	0	90	60	40	40	66	33	0	0	10	3	7	0
18	20	30	70	120	124	4	28	0	0	96	58	30	50	63	39	15	0	18	18	0	0
19	20	30	70	120	124	4	58	0	0	66	40	20	20	66	33	0	0	12	12	0	0
20	20	30	70	120	121	1	66	0	0	55	33	20	20	70	35	0	0	13	10	3	0
21	20	30	70	120	117	0	75	5	5	42	28	20	20	50	25	0	0	11	13	0	0
22	20	20	80	120	115	0	75	0	0	40	20	20	20	48	24	0	15	17	10	7	17
23	20	20	80	120	121	1	62	0	0	59	30	50	10	68	11	0	0	8	4	4	0
24	20	20	80	120	120	0	63	0	0	57	29	50	10	76	13	0	0	9	5	4	0
25	20	20	80	120	120	0	65	0	0	55	28	50	10	67	11	0	0	10	5	5	0
26	20	20	80	120	125	5	50	0	0	75	38	50	10	68	11	0	0	9	2	7	0
27	20	20	80	120	116	0	66	0	0	50	25	50	10	64	11	0	0	1	0	1	0
28	20	20	80	120	113	0	59	0	0	54	27	50	10	60	10	0	0	4	1	3	0
29	20	20	80	120	108	0	49	0	0	59	30	50	10	58	10	15	15	33	1	32	17
30	30	50	40	120	126	6	43	3	0	83	52	50	20	58	17	15	15	33	7	26	17
31	30	50	40	120	115	0	35	0	0	80	50	50	20	58	17	15	15	15	15	0	8
SFD	600	970	1,800	3,370	3,356	76	1,354	40	31	2,002	1,281	1,290	510	1,735	490	105	105	330	153	179	93
AF	1,190	1,924	3,570	6,684	6,657	151	2,686	79	61	3,971	2,542	2,559	1,012	3,441	971	208	208	655	303	355	184

	Umbenhaur-Robertson WTP			Franklin Canal			Jonathan Rogers WTP			Riverside Canal			Haskell Street WWTP Water Credit		Total El Paso Valley Order				
Day	Order	Avg. CFS	Alloc. Charge	Order	Avg. CFS	Alloc. Charge	Order	Avg. CFS	Alloc. Charge	Order	Avg. CFS	Alloc. Charge	Avg. CFS	Credit	Order	Project Water	Potetial Credit	Spill	Actual Credit
1	43	56	56	70	71	71	65	67	67	330	322	322	24	24	508	492	0	0	0
2	43	56	56	50	75	75	59	66	66	290	268	268	25	25	442	441	0	0	0
3	43	57	57	50	71	71	59	66	66	290	285	285	23	23	442	456	14	22	14
4	43	56	56	50	53	53	59	67	67	290	320	320	23	23	442	472	30	0	0
5	46	57	57	60	83	83	65	68	68	380	381	381	23	23	551	567	16	0	0
6	46	56	56	60	105	105	65	70	70	380	335	335	25	25	551	540	0	0	0
7	46	58	58	60	103	103	65	70	70	380	294	294	25	25	551	500	0	0	0
8	46	56	56	60	127	127	65	71	71	380	263	263	24	24	551	493	0	0	0
9	51	54	54	160	142	142	68	70	70	370	337	337	25	25	649	577	0	0	0
10	51	59	59	160	125	125	68	73	73	330	305	305	24	24	609	538	0	0	0
11	51	58	58	60	99	99	68	72	72	330	279	279	23	23	509	486	0	0	0
12	51	59	59	60	73	73	68	74	74	360	325	325	23	23	539	508	0	0	0
13	51	58	58	60	107	107	68	73	73	420	365	365	23	23	599	581	0	0	0
14	51	58	58	60	100	100	68	71	71	420	370	370	23	23	599	576	0	29	0
15	51	58	58	60	102	102	68	71	71	420	356	356	24	24	599	563	0	109	0
16	51	54	54	160	151	151	68	70	70	300	337	337	25	25	579	587	8	85	8
17	51	47	47	160	141	141	68	68	68	300	323	323	23	23	579	556	0	69	0
18	51	48	48	60	102	102	68	69	69	240	256	256	23	23	419	453	34	64	34
19	51	56	56	70	100	100	68	69	69	315	372	372	23	23	504	574	70	15	15
20	51	59	59	70	101	101	68	70	70	315	341	341	23	23	504	547	43	0	0
21	51	62	62	70	101	101	68	71	71	315	289	289	24	24	504	499	0	49	0
22	51	64	64	70	103	103	68	82	82	315	243	243	24	24	504	468	0	0	0
23	51	64	64	50	97	97	68	90	90	270	200	200	23	23	439	428	0	0	0
24	51	63	63	50	78	78	68	90	90	270	231	231	23	23	439	439	0	30	0
25	51	61	61	50	77	77	68	90	90	270	246	246	23	23	439	451	12	33	12
26	54	63	63	60	84	84	73	89	89	450	388	388	25	25	637	600	0	0	0
27	54	63	63	60	115	115	73	78	78	450	403	403	25	25	637	634	0	0	0
28	54	62	62	60	129	129	73	87	87	450	390	390	26	26	637	643	6	0	0
29	54	63	63	60	129	129	73	86	86	450	322	322	24	24	637	576	0	0	0
30	56	63	63	160	155	155	85	87	87	305	264	264	25	25	606	544	0	0	0
31	56	62	62	160	135	135	85	88	88	250	222	222	21	21	551	487	0	0	0
SFD	1,551	1,811	1,811	2,450	3,234	3,234	2,120	2,335	2,335	10,635	9,632	9,632	736	736	16,756	16,275	232	505	82
AF	3,076	3,592	3,592	4,860	6,415	6,415	4,205	4,631	4,631	21,095	19,105	19,105	1,460	1,460	33,236	32,282	460	1,002	163

APPENDIX B – EXAMPLE OF EPCWID MONTHLY CHARGES (cont.)

Table B-3: EPCWID El Paso Valley Daily Spills

EL PASO COUNTY WATER IMPROVEMENT DISTRICT Diversion Allocation May 08

	Riverside WW1		Riverside WW2		Fabens Waste Drain		Fabens Waste Channel		Tornillo WW2		Total Spills	Adjustment for Bustamonte and Haskill WWTP	EP Valley Spills
Day	Avg CFS	Spill	Avg CFS	Spill	Avg CFS	Drain Flow	Avg CFS	Spill	Avg CFS	Spill	Avg CFS	Avg CFS	Avg CFS
1	0	0		0	64	40	56	0	45	45	45	65	0
2	0	0		0	45	40	48	8	44	44	52	65	0
3	0	0		0	44	44	42	0	16	16	16	65	0
4	0	0		0	56	40	90	50	37	37	87	65	22
5	0	0		0	43	40	74	34	29	29	63	65	0
6	0	0		0	44	45	48	3	3	3	6	65	0
7	0	0		0	37	45	48	3	5	5	8	65	0
8	0	0		0	41	45	51	6	2	2	8	65	0
9	0	0		0	49	45	52	7	0	0	7	65	0
10	0	0		0	62	45	59	14	14	14	28	65	0
11	0	0		0	64	45	63	18	27	27	45	65	0
12	0	0		0	56	45	57	12	4	4	16	65	0
13	0	0		0	47	45	52	7	3	3	10	65	0
14	0	0		0	46	45	57	12	4	4	16	65	0
15	0	0		0	46	45	117	72	22	22	94	65	29
16	0	0		0	46	45	178	133	41	41	174	65	109
17	0	0		0	46	45	153	108	42	42	150	65	85
18	0	0		0	46	45	117	72	62	62	134	65	69
19	0	0		0	46	45	118	73	56	56	129	65	64
20	0	0		0	82	45	104	59	21	21	80	65	15
21	0	0		0	64	45	78	33	30	30	63	65	0
22	0	0		0	77	45	109	64	50	50	114	65	49
23	0	0		0	46	45	46	1	28	28	29	65	0
24	0	0		0	60	45	57	12	26	26	38	65	0
25	0	0		0	72	45	98	53	42	42	95	65	30
26	0	0		0	76	45	106	61	37	37	98	65	33
27	0	0		0	53	45	58	13	15	15	28	65	0
28	0	0		0	51	45	69	24	10	10	34	65	0
29	0	0		0	54	45	65	20	5	5	25	65	0
30	0	0		0	55	45	52	7	2	2	9	65	0
31	0	0		0	54	45	53	8	5	5	13	65	0
1	0	0		0	54	45	53	8	5	5	13	65	0
CFS	0	0	0	0	1,672	1,374	2,375	987	727	727	1,714	2,015	505
AF	0	0	0	0	3,316	2,725	4,711	1,958	1,442	1,442	3,400	3,997	1,002

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APPENDIX C – EXAMPLE OF EBID'S MONTHLY CHARGES

The following descriptions are provided for convenience only. The actual equations, procedures, and representations contained in the electronic spreadsheet named EBID_Charges_2008.xls and attached to this document as Exhibit 1 shall be used for determining EBID charges.

Description of Calculations used to determine EBID's Allocation Charges

Overview: EBID monthly allocation charge are calculated using information from Table C-1 – Monthly Summary, Table C-2 – Westside Canal Charge Summary, Table C-3 – Eastside Canal Charge summary, Table C-4 La Union West Charge Summary, Table C-5 – La Union East Charge Summary, Table C-6 - Bypass Summary, Table C-7 – Actual Charge Summary and Table C-8-Daily Flows. Each of the seven tables is specific for each month of the year and a single spreadsheet file (MS-EXCEL) shall be distributed by EBID to the other parties each month that contains the tables. Table C-1 is linked to Tables C-2, C-3, C-4, C-5, C-6, C-7, C-8 and previous monthly tables to provide the summary of the allocation charges and a running balance of the amount of Project Water available for diversion by EBID. Table C-8 contains the daily flow (average cfs) values for each of the flow metering sites that is used in the calculations of charges and the respective amount of water ordered by EBID and EBID and EPCWID at La Union East, La Union West, and Three Saints irrigation canals. Table C-6 contains the daily volumes of water flowing out of EBID designated Spillways and water ordered for Bypass. Table C-6 is used to determine the amount of water that is eligible for an allocation credit to EBID. The purpose of the allocation credit is to provide an accounting procedure that promotes conservation by allowing EBID to attempt to use bypass water within EBID's order to manage its total release efficiently.

Table C-1: EBID Diversion Allocation Charges Summary

The Total Order for EBID is the sum of the orders for diversion from the Rio Grande at Arrey Canal, Percha Lateral, Leasburg Canal, Eastside Canal, Westside Canal, Del Rio Lateral, California Extension, and the Greenwood, Duran, Roundtree, Dulin, Dorser, and Thurston pumps located in the Rincon Valley. The orders for each heading are lagged in time from release based on the estimated travel times. The order listed for a given diversion point is for diversion on the day that it is listed. Changes in diversion orders after the corresponding release is made shall be documented with a change order, and diverted after the appropriate travel time from the release.

The daily diversion for EBID is the sum of the actual diversions from the above listed diversion points. The minimum daily charge to EBID is 95 percent of the Total Order for the given day. The actual daily charge to EBID is the larger of the daily diversion and the minimum daily charge. The monthly charge to EBID is the sum for the month of the actual daily charges to EBID.

Row 1: Total actual diversion acre feet for the current month and the year to date at the Arrey Canal Diversion.

Row 2: Total actual diversion acre feet for the current month and the year to date at the Percha Lateral.

Row 3: Total actual diversion acre feet for the current month and the year to date at the Leasburg Canal Diversion.

Row 4: Total actual diversion acre feet for the current month and the year to date at the California Extension Lateral.

Row 5: Total actual diversion acre feet for the current month and the year to date at the Eastside Canal Diversion. Row 5 also contains the State line diversion totals for the EPCWID at the Three Saints East Lateral. EBID charge is the Gross Total column subtracting out the Diverted to Texas column. The amount diverted to EPCWID at the Three Saints East Lateral is determined in Table C- 3. Detailed equation that determines the amount Diverted to Texas is described in the Table C-3 Summary detail.

Row 6: Total actual diversion acre feet for the current month and the year to date at the Del Rio Lateral.

Row 7: Total actual diversion acre feet for the current month and the year to date at the Westside Canal Diversion. Row 7 also contains the State line diversions totals to EPCWID at the La Union East and La Union West Canals. EBID charge is the Gross Total column subtracting out the Diverted to Texas column. The amount diverted to EPCWID in the La Union East Canal is determined in Table C-5 and the amount diverted to EPCWID in the La Union West Canal is determined in Table C- 4. Detailed equation that determines the amount Diverted to Texas is described in the Table C-2 Summary detail.

Row 8: Total actual diversion acre feet for the current month and the year to date for the River Pumps.

Row 9: Totals for Gross and Net diversions for Rows 1 through 8.

Row 10: Totals for Net diversion current month and year to date.

Row 11: Bypass water through designated spillways from the Arrey Canal Diversion. Totals come from Table C-6 Bypass Summary.

Row 12: Bypass water through designated spillways from the Leasburg Canal Diversion. Totals come from Table C-6 Bypass Summary.

Row 13: Adjustment for Diversion vs Delivery. This value is the difference of the Actual Monthly charge and the Actual Monthly Diversion.

Row 14: Total monthly and year to date allotment charge. This value is the sum of Rows 10, 11, 12 and 13.

Row 15: Reclamation, in accordance with this manual and the Operating Agreement, provides EBID with its total diversion allocation.

Row 16: EBID end of month allotment balance. Row 15 minus Row 14

Table C-2: Average Daily CFS and Allocation Charges Westside Canal Texas and New Mexico Portions

EBID's Allocation charge for the Westside canal is determined in this table. In order to determine the New Mexico Portion of the diversion, Texas calculations occur in Tables C-4 and C-5. The Westside canal delivers water to Texas lands through both the La Union West and the La Union East. The Texas portions are calculated in both Table C-4 for the La Union West and Table C-5 for the La Union West. Totals for each day from both Canals are added together and then a 15% carriage charge is applied. This amount is subtracted from the Westside diversion for that same day. This table also calculates the Texas Spillway 32 bypass amount. Spillway 32 initial calculation occurs in Table C-5. The initial calculation evaluates the amount of water ordered for bypass, the amount actually bypassed and the amount delivered to the La Union East. This evaluation results in the amount of water to be charged to Texas. A 15% carriage charge is also applied, then subtracted from the Westside Canal.

Table C-3: Average Daily CFS and Allocation Charges for Eastside Canal and the Three Saints East Lateral Texas Portion

EBID allocation charge for the Eastside Canal is determined in this table. In order to determine New Mexico portion of the diversion Texas portions are calculated in this table as well. EBID delivers water to Texas lands through the Three Saints East Canal. EPCWID's allocation charges (Texas Portion) for the Three Saints Lateral (TSL) are equal to net amount of water measured by EPCWID at the TSL metering station multiplied (prorated) by the ratio of EPCWID TSL order to the total order for TSL. The net amount of water measured at TSL is equal to the gross amount of water metered at TSL minus the gross amount of water metered at WW23A. If there is no order for water at TSL and the gross amount of flow at TSL is less than or equal to 5 cfs, then the gross amount of flow is assumed to be equal to zero. Once the Texas Portion is determined a 20% carriage charge is applied, then subtracted from the Eastside Canal Diversion leaving only the New Mexico Portion.

Table C-4: Average Daily CFS and Allocation Charges La Union West Diversion Site

La Union West Canal (Texas Portion): This table is used to determine the Texas Portion of the La Union West Order and Diversion. EPCWID allocation charges for La Union West Canal are equal to the gross amount of water measured by EBID at the LUW metering station multiplied (prorated) by the ratio of EBID LUW order to the total order for LUW. This prorated amount is then added to the La Union East total for the same day and displayed in Table C-2 Westside canal. These totals will be used to determine the total Diverted to Texas where it will then be subtracted from the Westside Canal Diversion leaving only the New Mexico Portion.

Table C-5: Average Daily CFS and Allocation Charges La Union East Diversion Site

La Union East Canal (Texas Portion): This table is used to determine the Texas Portion of the La Union East Canal. The determination of EPCWID allocation charges for La Union East Canal (LUE) is complex and requires 11 columns of measured or calculated values. The complex calculations are a result of the fact that the LUE canal services land in both Texas and New Mexico. Also, water flows in the LUE canal for bypass to the Rio Grande through WW32 and downstream diversion into the American Canal, and WW32 is used to discharge excess flow from EPCWID. In general the allocations charges for LUE are based on the net amount of water measured by EPCWID at the LUE metering station multiplied (prorated) by the ratio of the EPCWID order to the total order for LUE. The net amount of water measured at LUE is equal to the gross amount of water metered at LUE minus the gross amount of water metered at WW32. This prorated is then added to the La Union West total for the same day and displayed in Table C-2 Westside canal. These totals are used to determine the total Diverted to Texas where it will then be subtracted from the Westside Canal Diversion leaving only the New Mexico Portion.

Table C-6: Average Daily CFS and Bypass Credit Summary

This table contains the Amount of Bypass Ordered and Diverted for designated spillways in the Arrey and Leasburg Canals. Bypass is only a credit when an order for Bypass is made. Credit is limited to the amount of the bypass ordered. A travel time for the order is applied, then the actual diversion is used to determine whether a credit for bypass is applied. The Monthly total is used in Table C-1 if a credit is due.

Table C-7: Actual charge

This table contains each of the EBID diversion sites. Each site has the amount ordered and the actual amount diverted. The Total Order for EBID is the sum of the orders for diversion at Arrey Canal, Percha Lateral, Leasburg Canal, Eastside Canal, Westside Canal, Del Rio Lateral, California Extension, and the Greenwood, Duran, Roundtree, Dulin, Dorser, and Thurston pumps that divert water from the Rio Grande in the Rincon Valley. The orders for each heading are lagged in time from release based on the estimated travel times. The order listed for a given diversion point is for diversion on the day that it is listed. The daily diversion for EBID is the sum of the actual diversions from the above listed diversion points. The minimum daily charge to EBID is 95 percent of the Total Order for the given day. The actual daily charge to EBID is the larger of the daily diversion and the minimum daily charge. The monthly charge to EBID is the sum for the month of the actual daily charges to EBID. The Actual Charge is subtracted from the Total Diversion to determine the adjustment amount Row 13 of Table C-1.

Table C-8: Average Daily CFS Daily Flows

This contains the daily flow (average cfs) values for each of the flow metering sites that is used in the calculations of charges and the respective amount of water ordered by EBID and EBID and EPCWID at La Union East, La Union West, and Three Saints irrigation canals.

Table C-1 EBID Allocation Charges Summary

ELEPHANT BUTTE IRRIGATION DISTRICT

WATER ALLOTMENT CHARGES

May-08

SUBJECT TO REVISION

Row		GROSS DIVERSIONS (AC-FT)		DIVERTED TO TEXAS (AC-FT)		NET DIVERSIONS (AC-FT)	
			TO DATE		TO DATE		TO DATE
1	**ARREY CANAL**	12700	34941			12700	34941
2	PERCHA LATERAL	115	186			115	186
3	**LEASBURG CANAL**	14884	33594			14884	33594
4	CALIFORNIA EXTENTION	**0**	0			0	0
5	**EASTSIDE CANAL**	8519	20473	-363	-877	8156	19597
6	**DEL RIO LATERAL**	496	1319			496	1319
7	**WESTSIDE CANAL**	22534	60563	-6811	-19830	15723	40733
8	PUMPED FROM RIVER**	**0**	0			0	0
9	GROSS TOTAL	59248	151077	-7174	-20707	52074	130370

Row		NET DIVERSION	TO DATE
10	TOTAL CHARGES (AC-FT)	**52078**	**130370**
11	CREDIT AT ARREY (-)	**0**	**-763**
12	CREDIT AT LEASBURG (-)	**-28**	**-115**
13	ADJUSTMENT FOR CHARGE AT HEADING (+)	**10**	**10**
14	NET ALLOTMENT CHARGE	**52,060**	**129,502**
15	DISTRICT ALLOTMENT		**280,764**
16	DISTRICT BALANCE		**151,262**

** GREENWOOD, DURAN, ROUNTREE, DULIN, DORSAR AND THURSTON RIVER PUMPS (EBID DATA)

Table C-2 Westside Canal Diversion Charge Summary

WESTSIDE DIVERSION CHARGE SUMMARY EBID

May-08

DAY	WESTSIDE CANAL (1)	TX CHARGE LUE+LUW (2)	W.W. 32 SFD*1.15 (3)	115% OF 2 (4)	EBID WATER [1-(3+4)]
1	297	43	64	49	183
2	263	35	35	40	188
3	307	6	79	7	221
4	292	0	76	0	216
5	292	0	67	0	225
6	310	0	17	0	293
7	340	63	18	72	249
8	327	85	2	98	227
9	327	75	0	86	241
10	327	77	0	89	238
11	320	73	8	84	228
12	314	58	46	67	201
13	376	62	49	71	255
14	406	68	45	78	283
15	438	68	35	78	325
16	502	94	35	108	359
17	465	93	31	107	327
18	444	97	32	112	300
19	453	81	67	93	293
20	418	77	76	89	254
21	398	53	81	61	257
22	406	44	86	51	269
23	406	41	71	47	288
24	401	42	72	48	280
25	317	39	75	45	197
26	317	49	58	56	203
27	312	36	76	41	195
28	307	37	68	43	197
29	370	40	56	46	268
30	444	69	46	79	319
31	465	67	40	77	348
SFD	11361	1672	1511	1923	7927
AC-FT	22534	3316	2997	3814	15723

Table C-3 Eastside Canal Diversion Charge Summary

EASTSIDE DIVERSION CHARGE SUMMARY EBID

May-08

DAY	EASTSIDE CANAL SFD	3 SAINTS E SFD	W.W. 23 SFD	ADJUSTED SFD	3 SAINTS E TX-ORDER	3 SAINTS E. NM-ORDER	% TX	TX CHARGE *1.20%	EBID WATER
1	122	17	6	15	**0**	**15**	0%	0	122
2	146	6	6	0	**0**	**0**	0%	0	146
3	124	3	3	0	**0**	**0**	0%	0	124
4	80	4	4	0	**0**	**0**	0%	0	80
5	80	2	2	0	**0**	**0**	0%	0	80
6	107	11	2	9	**0**	**0**	0%	11	96
7	163	22	0	22	**15**	**10**	60%	16	147
8	172	27	2	25	**15**	**10**	60%	18	154
9	195	10	6	10	**15**	**10**	60%	7	188
10	171	10	8	2	**0**	**0**	0%	2	169
11	160	0	0	0	**0**	**0**	0%	0	160
12	159	0	0	0	**0**	**0**	0%	0	159
13	125	0	0	0	**0**	**0**	0%	0	125
14	96	3	1	2	**0**	**0**	0%	2	94
15	132	7	3	4	**0**	**0**	0%	5	127
16	160	5	4	1	**0**	**0**	0%	1	159
17	154	10	3	7	**0**	**0**	0%	8	146
18	136	18	18	15	**0**	**15**	0%	18	118
19	132	12	12	0	**0**	**0**	0%	0	132
20	130	13	10	3	**0**	**0**	0%	4	126
21	143	11	13	0	**0**	**0**	0%	0	143
22	150	17	10	15	**15**	**0**	100%	18	132
23	148	8	4	4	**0**	**0**	0%	5	143
24	136	9	5	4	**0**	**0**	0%	5	131
25	109	10	5	5	**0**	**0**	0%	6	103
26	108	9	2	7	**0**	**0**	0%	8	100
27	110	1	0	1	**0**	**0**	0%	1	109
28	136	4	1	4	**15**	**15**	50%	2	134
29	163	33	1	32	**15**	**15**	50%	19	144
30	193	33	7	30	**15**	**15**	50%	18	175
31	155	15	15	15	**15**	**15**	50%	9	146
SFD	4295	330	153	232	120	120	50%	183	4112
AC-FT	8519	655	303	460	238	238		363	8156

**ADJUSTED SFD=TOTAL ORDER OR 3SE SFD, WHICHEVER IS LESS

Table C-4 La Union West Canal Diversion Charge Summary

LA UNION WEST ORDER, DIVERSION, AND CHARGE SUMMARY EBID

May-08

DAY	N.M. ORDER	TEXAS ORDER	TOTAL ORDER	% N.M.	% TEX	LA UNION W. SFD	N.M. CHARGE	TEXAS CHARGE
1	**30**	**10**	40	75%	25%	46	35	12
2	**30**	**10**	40	75%	25%	40	30	10
3	**40**	**10**	50	80%	20%	31	25	6
4	**60**	**0**	60	100%	0%	41	41	0
5	**60**	**0**	60	100%	0%	40	40	0
6	**60**	**0**	60	100%	0%	41	41	0
7	**50**	**10**	60	83%	17%	39	33	7
8	**50**	**10**	60	83%	17%	57	48	10
9	**50**	**10**	60	83%	17%	55	46	9
10	**50**	**10**	60	83%	17%	59	49	10
11	**40**	**10**	50	80%	20%	56	45	11
12	**40**	**10**	50	80%	20%	51	41	10
13	**40**	**10**	50	80%	20%	51	41	10
14	**50**	**20**	70	71%	29%	61	44	17
15	**50**	**20**	70	71%	29%	57	41	16
16	**40**	**40**	80	50%	50%	70	35	35
17	**40**	**40**	80	50%	50%	66	33	33
18	**30**	**50**	80	38%	63%	63	24	39
19	**30**	**50**	80	38%	63%	66	25	41
20	**30**	**50**	80	38%	63%	70	26	44
21	**20**	**20**	40	50%	50%	50	25	25
22	**20**	**20**	40	50%	50%	48	24	24
23	**50**	**10**	60	83%	17%	68	57	11
24	**50**	**10**	60	83%	17%	76	63	13
25	**50**	**10**	60	83%	17%	67	56	11
26	**50**	**10**	60	83%	17%	68	57	11
27	**50**	**10**	60	83%	17%	64	53	11
28	**50**	**10**	60	83%	17%	60	50	10
29	**50**	**10**	60	83%	17%	58	48	10
30	**50**	**20**	70	71%	29%	58	41	17
31	**50**	**20**	70	71%	29%	58	41	17
ɔTAL SFD	1360	520	1880	72%	28%	1735	1258	480
TOTAL AF	2698	1031	3729			3441	2495	952

Table C-5 La Union East Canal Diversion Charge Summary

LA UNION EAST ORDER, DIVERSION, BYPASS, AND CHARGE SUMMARY EBID

May-08

	N.M. ORDER	TEXAS ORDER	BYPASS ORDER	TOTAL ORDER	LA UNION E SFD	W.W. 32 SFD	NET DELIVERY	% N.M.	% TEX	N.M. CHARGE	TEXAS CHARGE
1	**15**	**25**	**60**	100	106	56	50	38%	63%	19	31
2	**15**	**25**	**30**	70	76	59	40	38%	63%	15	25
3	**0**	**0**	**70**	70	75	69	6	0%	0%	0	0
4	**0**	**0**	**70**	70	79	66	13	0%	0%	0	0
5	**0**	**0**	**70**	70	66	58	8	0%	0%	0	0
6	**0**	**0**	**70**	70	75	15	60	0%	0%	0	0
7	**20**	**40**	**40**	100	100	16	84	33%	67%	28	56
8	**20**	**40**	**40**	100	114	2	112	33%	67%	37	75
9	**30**	**60**	**10**	100	99	0	99	33%	67%	33	66
10	**30**	**60**	**10**	100	100	0	100	33%	67%	33	67
11	**20**	**40**	**60**	120	100	7	93	33%	67%	31	62
12	**20**	**40**	**60**	120	112	40	72	33%	67%	24	48
13	**20**	**40**	**60**	120	121	43	78	33%	67%	26	52
14	**20**	**40**	**60**	120	116	39	77	33%	67%	26	51
15	**30**	**60**	**30**	120	108	31	78	33%	67%	26	52
16	**30**	**60**	**30**	120	118	32	88	33%	67%	29	59
17	**30**	**60**	**30**	120	117	27	90	33%	67%	30	60
18	**20**	**30**	**70**	120	124	28	96	40%	60%	38	58
19	**20**	**30**	**70**	120	124	58	66	40%	60%	26	40
20	**20**	**30**	**70**	120	121	66	55	40%	60%	22	33
21	**20**	**30**	**70**	120	117	75	47	40%	60%	19	28
22	**20**	**20**	**80**	120	115	75	40	50%	50%	20	20
23	**20**	**20**	**80**	120	121	62	59	50%	50%	30	30
24	**20**	**20**	**80**	120	120	63	57	50%	50%	29	29
25	**20**	**20**	**80**	120	120	65	55	50%	50%	28	28
26	**20**	**20**	**80**	120	125	50	75	50%	50%	38	38
27	**20**	**20**	**80**	120	116	66	50	50%	50%	25	25
28	**20**	**20**	**80**	120	113	59	54	50%	50%	27	27
29	**20**	**20**	**80**	120	108	49	59	50%	50%	30	30
30	**30**	**50**	**40**	120	126	43	83	38%	63%	31	52
31	**30**	**50**	**40**	120	115	35	80	38%	63%	30	50
SFD	600	970	1800	3370	3347	1354	2024	38%	62%	750	1192
AC-FT	1190	1924	3570	6684	6639	2686	4015			1488	2364

Table C-6 Bypass Credit Summary

ELEPHANT BUTTE IRRIGATION BYPASS SUMMARY
BYPASS SUMMARY
May-08

Day	Ordered Arrey Bypass	Arrey W.W. 5	Arrey W.W. 16	Actual Arrey Bypass	Arrey Spill	Ordered Leasburg Bypass	Leasburg W.W. 8	Actual Leasburg Bypass	Actual Leasburg Spill	Ordered Eastside Bypass	Eastside W.W. 18	Actual Eastside Bypass	Actual Eastside Spill	Ordered Westside Bypass	Westside W.W. 31	Actual Westside Bypass	Actual Westside Spill
1	0	1	3	0	4	0	5	0	5	0	0	0	0	0	0	0	0
2	0	1	3	0	4	0	4	0	4	0	0	0	0	0	0	0	0
3	0	1	3	0	4	0	7	0	7	0	0	0	0	0	0	0	0
4	0	1	1	0	2	0	23	0	23	0	0	0	0	0	0	0	0
5	0	1	3	0	4	0	20	0	20	0	0	0	0	0	0	0	0
6	0	1	2	0	3	0	4	0	4	0	0	0	0	0	0	0	0
7	0	1	2	0	3	0	3	0	3	0	0	0	0	0	0	0	0
8	0	1	2	0	3	30	14	14	0	0	0	0	0	0	0	0	0
9	0	1	1	0	2	0	15	0	15	0	0	0	0	0	0	0	0
10	0	1	1	0	2	0	8	0	8	0	0	0	0	0	0	0	0
11	0	1	2	0	3	0	16	0	16	0	0	0	0	0	0	0	0
12	0	1	2	0	3	0	5	0	5	0	0	0	0	0	0	0	0
13	0	1	1	0	2	0	4	0	4	0	0	0	0	0	0	0	0
14	0	1	1	0	2	0	3	0	3	0	0	0	0	0	0	0	0
15	0	1	1	0	2	0	6	0	6	0	0	0	0	0	0	0	0
16	0	1	1	0	2	0	9	0	9	0	0	0	0	0	0	0	0
17	0	1	1	0	2	0	4	0	4	0	0	0	0	0	0	0	0
18	0	1	1	0	2	0	7	0	7	0	0	0	0	0	0	0	0
19	0	0	1	0	1	0	12	0	12	0	0	0	0	0	0	0	0
20	0	0	1	0	1	0	10	0	10	0	0	0	0	0	0	0	0
21	0	0	1	0	1	0	5	0	5	0	0	0	0	0	0	0	0
22	0	0	1	0	1	0	5	0	5	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	6	0	6	0	0	0	0	0	0	0	0
24	0	1	0	0	1	0	6	0	6	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	7	0	7	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0
27	0	5	0	0	5	0	9	0	9	0	0	0	0	0	0	0	0
28	0	5	0	0	5	0	7	0	7	0	0	0	0	0	0	0	0
29	0	1	0	0	1	0	5	0	5	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	6	0	6	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0
SFD	0	30	35	0	65	30	244	14	230	0	0	0	0	0	0	0	0
ACFT	0	60	69	0	129	60	484	28	456	0	0	0	0	0	0	0	0

Table C-7 Allocation Charges Adjustment for Amount of Water Ordered

EBID Actual Charges for May 2008

	Orders									Diversions									Minimum	Actual	
	Arrey	Percha	Leasburg	Eastside	Westside	Del Rio	California	Pumpers	Total	Arrey	Percha	Leasburg	Eastside	Westside	Del Rio	California	Pumpers	Total	Charge	Charge	
1	200	0	252	100	285	0	0	0	837	202	1	254	122	297	24	0	0	900	795	900	
2	165	0	260	139	268	0	0	0	832	156	0	275	146	263	0	0	0	840	790	840	
3	130	0	238	144	332	0	0	0	844	134	0	246	124	307	0	0	0	811	802	811	
4	130	0	230	80	280	0	0	0	720	134	0	232	80	292	0	0	0	738	684	738	
5	145	0	230	80	280	0	0	0	735	153	0	226	80	292	0	0	0	751	698	751	
6	160	0	192	101	292	0	0	0	745	168	4	192	107	310	0	0	0	781	708	781	
7	190	0	180	165	330	0	0	0	865	202	3	185	163	340	24	0	0	917	822	917	
8	220	0	232	174	330	0	0	0	956	216	2	226	172	327	0	0	0	943	908	943	
9	220	0	250	194	330	0	0	0	994	206	8	239	195	327	0	0	0	975	944	975	
10	220	0	250	172	328	0	0	0	970	212	5	245	171	327	0	0	0	960	922	960	
11	220	0	205	165	320	0	0	0	910	215	5	215	160	320	0	0	0	915	865	915	
12	220	0	190	165	320	0	0	0	895	218	0	200	159	314	20	0	0	911	850	911	
13	220	0	212	150	344	0	0	0	926	219	0	221	125	376	0	0	0	941	880	941	
14	220	0	220	105	415	0	0	0	960	226	2	229	96	406	0	0	0	959	912	959	
15	220	0	265	118	435	0	0	0	1,038	223	0	264	132	438	23	0	0	1,080	986	1,080	
16	185	0	280	155	495	0	0	0	1,115	153	7	285	160	502	23	0	0	1,130	1,059	1,130	
17	150	0	242	152	481	0	0	0	1,025	157	0	254	154	465	0	0	0	1,030	974	1,030	
18	150	0	230	141	440	0	0	0	961	157	0	241	136	444	0	0	0	978	913	978	
19	215	0	230	130	440	0	0	0	1,015	252	4	243	132	453	0	0	0	1,084	964	1,084	
20	280	0	230	130	422	0	0	0	1,062	287	3	246	130	418	10	0	0	1,094	1,009	1,094	
21	280	0	230	134	370	0	0	0	1,014	272	3	244	143	398	26	0	0	1,086	963	1,086	
22	280	0	282	146	375	0	0	0	1,083	272	4	268	150	406	26	0	0	1,126	1,029	1,126	
23	245	0	300	150	390	0	0	0	1,085	273	0	287	148	406	13	0	0	1,127	1,031	1,127	
24	210	0	278	140	375	0	0	0	1,003	206	0	269	136	401	0	0	0	1,012	953	1,012	
25	210	0	270	110	330	0	0	0	920	191	3	249	109	317	0	0	0	869	874	874	
26	210	0	270	110	330	0	0	0	920	191	4	255	108	317	13	0	0	888	874	888	
27	210	0	270	110	330	0	0	0	920	189	0	260	110	312	8	0	0	879	874	879	
28	205	0	270	118	330	0	0	0	923	190	0	259	136	307	8	0	0	900	877	900	
29	210	0	232	152	371	0	0	0	965	221	0	229	163	370	25	0	0	1,008	917	1,008	
30	235	0	220	190	495	0	0	0	1,140	253	0	211	193	444	2	0	0	1,103	1,083	1,103	
31	250	0	250	172	490	0	0	0	1,162	255	0	255	155	465	5	0	0	1,135	1,104	1,135	Adjustment
																	SFD:	29,871		29,876	5
																	Acre-feet	59,248		59,258	10

Table C-8 EBID Allocation Charge Summary

ELEPHANT BUTTE IRRIGATION DISTRICT

DAILY FLOW FOR MAY-07

DAY	PERCHA EBID	ARREY EFAS	LEASBURG EBID	DEL RIO EBID	EASTSIDE EFAS	WESTSIDE EFAS	L.U.EAST EBID	L.U.WEST EBID
1	1	202	254	24	122	297	106	46
2	0	156	275	0	146	263	76	40
3	0	134	246	0	124	307	75	31
4	0	134	232	0	80	292	79	41
5	0	153	226	0	80	292	66	40
6	4	168	192	0	107	310	75	41
7	3	202	185	24	163	340	100	39
8	2	216	226	0	172	327	114	57
9	8	206	239	0	195	327	99	55
10	5	212	245	0	171	327	100	59
11	5	215	215	0	160	320	100	56
12	0	218	200	20	159	314	112	51
13	0	219	221	0	125	376	121	51
14	2	226	229	0	96	406	116	61
15	0	223	264	23	132	438	108	57
16	7	153	285	23	160	502	118	70
17	0	157	254	0	154	465	117	66
18	0	157	241	0	136	444	124	63
19	4	252	243	0	132	453	124	66
20	3	287	246	10	130	418	121	70
21	3	272	244	26	143	398	117	50
22	4	272	268	26	150	406	115	48
23	0	273	287	13	148	406	121	68
24	0	206	269	0	136	401	120	76
25	3	191	249	0	109	317	120	67
26	4	191	255	13	108	317	125	68
27	0	189	260	8	110	312	116	64
28	0	190	259	8	136	307	113	60
29	0	221	229	25	163	370	108	58
30	0	253	211	2	193	444	126	58
31	0	255	255	5	155	465	115	58
SFD	58	6403	7504	250	4295	11361	3347	1735
AC-FT	115	12700	14884	496	8519	22534	6639	3441

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APPENDIX D – Flow Regulation Calibration at Caballo Dam

(See Excel File)

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Appendix C. Hydrology Technical Memo

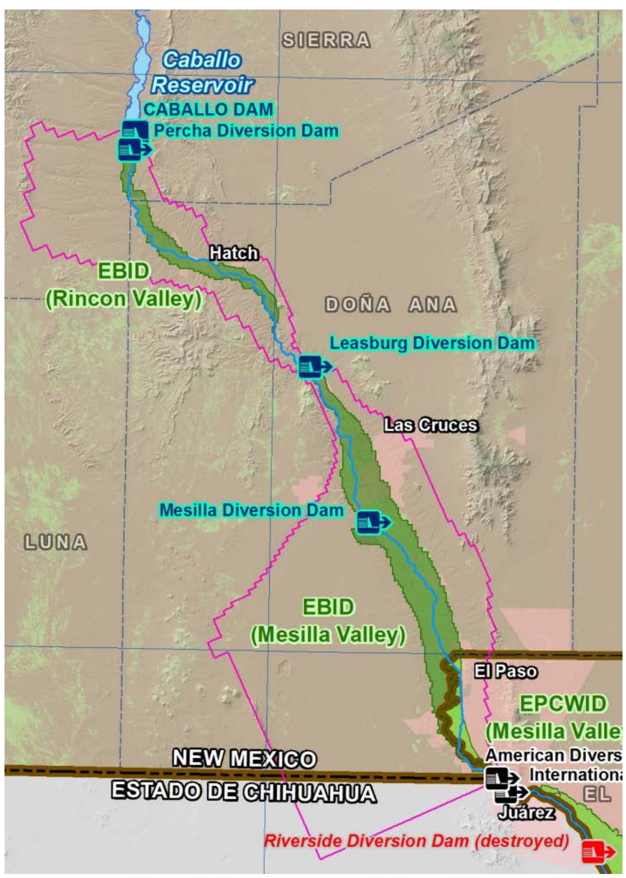
RECLAMATION

Managing Water in the West

Technical Memorandum No. 86-68210–2015-05

Simulation of Rio Grande Project Operations in the Rincon and Mesilla Basins:

Summary of Model Configuration and Results



U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

April 2015
Revised December 2015

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Technical Memorandum No. 86-68210–2015-05

Simulation of Rio Grande Project Operations in the Rincon and Mesilla Basins:

Summary of Model Configuration and Results

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Date

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Date

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

April 2015
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Contents

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

April 2015
Revised December 2015

Tables

No. *page*

Figures

No. *page*

Appendices

1 Introduction

The Bureau of Reclamation (Reclamation) is currently preparing an Environmental Impact Statement (EIS) to analyze the environmental effects from continuing to implement the Rio Grande Project (Project) Operating Agreement (OA; Reclamation et al. 2008) through the remainder of its term. In addition, Reclamation will use this EIS to evaluate the environmental effects of renewing San Juan-Chama Project (SJC Project) contracts for storage in Elephant Butte Reservoir. The EIS is being prepared by Reclamation and six cooperating agencies: Elephant Butte Irrigation District (EBID); El Paso County Water Improvement District No. 1 (EPCWID); City of Santa Fe Water Division; Colorado Division of Water Resources; Texas Commissioner to the Rio Grande Compact Commission; and U.S. Section of the International Boundary and Water Commission (US-IBWC).

In support of the EIS, Reclamation, in collaboration with the United States Geological Survey (USGS), has developed a detailed hydrologic and water operations model of the Rincon and Mesilla Basins and used this model to simulate Project operations, and corresponding surface-water and groundwater conditions within the Basins, under alternative operating procedures. This technical memorandum summarizes the modeling approach used to simulate projected future Project operations under alternative operating procedures and climate scenarios in support of the EIS.

Section 2 of this technical memorandum summarizes the objectives of this modeling effort in support of the EIS. Section 3 briefly describes the study area considered in this modeling effort. Sections 4 and 5 provide an overview of Project operations and proposed alternative operating procedures under consideration in the EIS. Section 6 summarizes the modeling approach used in this study, and Section 7 summarizes model outputs provided as a digital appendix to this technical memorandum.

Selected model results relevant to the analyses being performed for this EIS are provided, in graphical and tabular form, as a digital appendix to this memorandum (Appendix A), along with complete model files and unformatted outputs for each simulation described here (Appendix B). The results provided here may be used for evaluation of the effects of the alternative operating procedures under consideration in the EIS on the human environment and endangered species. Detailed analysis of model results will be performed as part of the EIS and is beyond the scope of this memorandum.

2 Modeling Objectives

The objective of this modeling effort is to provide projections of potential future surface water and groundwater conditions in the Rincon and Mesilla Basins under alternative operating procedures of the Project, and under a range of projected future climate and hydrologic conditions, in support of the EIS.

3 Study Area: Rio Grande Project and the Rincon and Mesilla Basins

The Project serves irrigated lands in the Rincon, Mesilla, and El Paso[1] Valleys, as well as providing water to the City of El Paso for municipal and industrial uses. The Project also delivers water to International Dam for diversion to Mexico.

The extent of the Project and key Project facilities are illustrated in Figure 1. The Project includes two storage dams and reservoirs, one hydropower generation facility, five diversion dams, and a complex network of conveyance and drainage channels, including canals, laterals, and open drains. The Project begins at Elephant Butte Reservoir, located near Elephant Butte, NM. Diversion dams and conveyance and drainage channels are located in the Rincon Valley of New Mexico (Percha Dam), the Mesilla Valley of New Mexico and Texas (Leasburg Dam, Mesilla Dam, and American Dam), and the El Paso Valley of Texas (International Dam). The Project terminates in Hudspeth County, TX near the town of Fort Hancock.

The Rio Grande and Project lands are underlain by an alluvial aquifer system, which is in turn underlain by deeper basin-fill aquifers (Hawley et al. 2001, Hawley and Kennedy 2004). Groundwater from these aquifers is the primary supply for municipal and domestic uses in the region and for irrigation outside the Project. In addition, irrigators within both the New Mexico and Texas portions of the Project often supplement Project surface-water deliveries with groundwater from privately-owned wells. Supplemental groundwater pumping is authorized and managed by the States, independently of the Federal Project. As a result, surface-water management in the Rincon and Mesilla Valleys—including Project operations—is carried out independently of groundwater regulation and management.

Groundwater use in Texas is governed by the so called “rule of capture” (Texas Water Code Section 36.002), which states that a landowner owns the groundwater beneath the surface of his or her land as real property, and may pump that water so long as that pumping does not cause waste or malicious drainage of other property or negligently cause subsidence. The area served by the Project lies within Texas’s Groundwater Management Area 5 (GMA 5); GMA 5 has not developed groundwater conservation districts or taken other steps to limit groundwater pumping within the GMA (Texas Water Development Board 2015). As a result, Project farmers in Texas are free to pump groundwater from privately-owned wells on their lands to supplement Project surface-water supplies.

[1] The El Paso Valley extends from Paso del Norte (also known as El Paso Narrows) southeast to approximately Fort Quitman, TX. The name El Paso Valley commonly refers to the United States portion of the topographic valley; the Mexican portion of the valley is commonly referred to as Juarez Valley.

The rights of Project farmers in New Mexico to supplement Project surface-water supplies with groundwater from privately-owned wells are subject to regulation and administration by the State of New Mexico. In 1980, the New Mexico Office of the State Engineer declared the Lower Rio Grande Underground Basin, within which permits would be required for any further groundwater development. Groundwater use that was initiated prior to the declaration of the underground basin was allowed to continue. The amount of water that can be pumped using pre-basin groundwater rights is currently being determined through a basin adjudication process by the State of New Mexico (Judicial Branch of New Mexico, 2015). In a settlement agreement associated with this ongoing water-rights adjudication, New Mexico allocated a Farm Delivery Requirement (FDR) of 5.5 AF/year and a Consumptive Irrigation Requirement (CIR) of 4.0 AF/year for pecan crops irrigated from a groundwater source established prior to the declaration of the groundwater basin. A final decree has not yet been issued in the adjudication; therefore, the adjudication does not yet form a basis for water-rights administration.

In the interim, the New Mexico Office of the State Engineer has the authority to administer water rights under its Active Water Resource Management (AWRM) program. However, basin-specific AWRM rules and regulations have not yet been finalized (New Mexico Office of the State Engineer / Interstate Stream Commission 2015). AWRM therefore does not yet provide a tool for administration of groundwater rights in the Rincon and Mesilla Basins. In 2004, the New Mexico State Engineer issued an Order (D'Antonio 2004) requiring metering of all groundwater diversions from the Lower Rio Grande Watermaster District by March 1, 2006. Although metering requirements are in effect per this Order, it has not been used to limit groundwater pumping. Therefore, as in Texas, Project farmers in New Mexico are free to pump groundwater from privately-owned wells on their lands to supplement Project surface-water supplies.

Previous studies indicate a strong hydraulic connection between the Rio Grande and the underlying groundwater aquifers in the areas served by the Project, particularly in the Rincon and Mesilla Basins (Conover 1954, Haywood and Yager 2003, SSPA 2007, Hanson et al. 2013). Groundwater pumping in the Rincon and Mesilla Basins results in capture (depletion) of Project surface-water supplies, which in turn affects the quantity of Project surface-water that can be delivered to authorized points of diversion. Conversely, Project operations affect the timing, distribution, and volume of groundwater recharge that occurs as seepage from surface-water channels, including the Rio Grande and unlined canals and laterals, and as deep percolation of applied irrigation water. Project operations also affect the timing, distribution, and volume of surface-water deliveries within the Project, which in turn affect incentives for groundwater pumping, as authorized by the States. Increased groundwater demand in the Rincon and Mesilla Basins over recent decades has been documented (e.g., D'Antonio 2005) and is expected to continue in the future, especially during periods of low Project surface water deliveries.

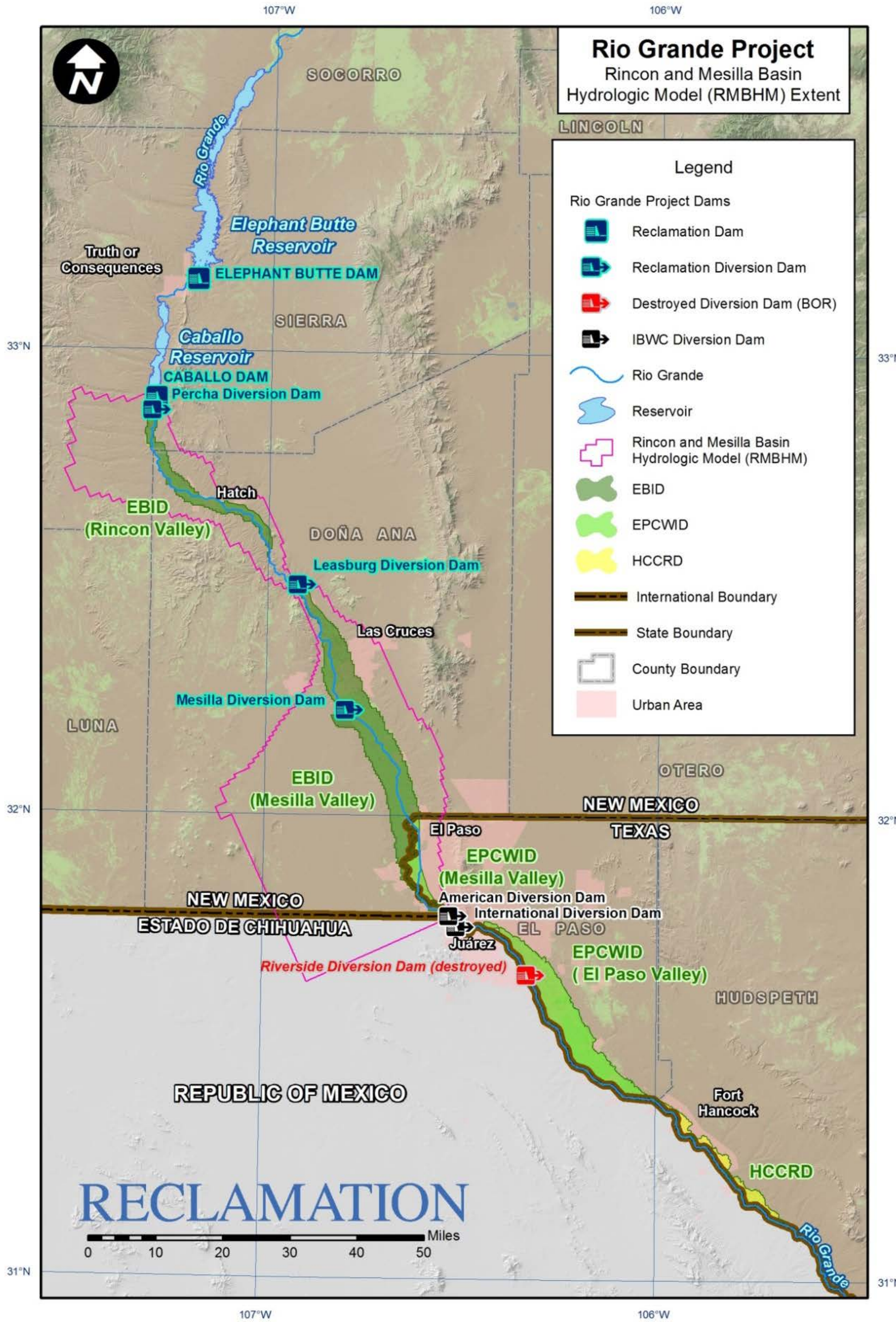

Figure 1: Overview of Rio Grande Project geographical extent and major facilities with outline of RMBHM model extent (active model grid cells).

4 Overview of Rio Grande Project Operations

The Project provides surface water for irrigation in southern New Mexico, and for irrigation, municipal, and industrial uses in western Texas. It also provides for the delivery of surface water to the Republic of Mexico under the 1906 Convention (United States of America and Republic of Mexico 1906). The Project also provides hydropower generation as a secondary function.

Operation of the Project involves four primary functions:

- Capture and storage of Rio Grande streamflow in Elephant Butte and Caballo Reservoirs;
- Allocation of Project water to EBID, EPCWID, and Mexico;
- Release of Project water to satisfy delivery orders from EBID, EPCWID, and the US IBWC on behalf of Mexico; and
- Diversion[2] of Project water from the Rio Grande and delivery[3] of Project water to individual farms and municipal water treatment facilities for beneficial use.

In addition to these primary functions, Project operations include monitoring of river flows, diversions, and return flows at locations throughout the Project and accounting for charges and credits to Project allocation balances. The Project also provides flood control benefits, and Elephant Butte Reservoir serves as an accounting point for the Rio Grande Compact. Lastly, Reclamation allows storage of SJC Project water in Elephant Butte Reservoir under agreements with the Albuquerque-Bernalillo County Water Authority (Authority) and City of Santa Fe.

It should be noted that in addition to allocation, diversion, and delivery of Project surface-water to EBID, EPCWID, and Mexico, seepage and drainage water from Project lands in El Paso Valley is delivered to Hudspeth County Conservation and Reclamation District No. 1 (HCCRD)[4]. Because HCCRD only receives seepage

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[2] Throughout this document, the term *diversion* refers to specifically the withdrawal of Project surface-water from the Rio Grande into an authorized Project conveyance facility at its heading.
[3] Throughout this document, the term *delivery* refers specifically to the withdrawal of Project surface-water from an authorized Project conveyance facility at a point of beneficial use (e.g., farm head gate or municipal water treatment plant intake).
[4] The United States and HCCRD entered into a Warren Act Contract in 1924, and amended in 1951, which provides for the use of Project Water by the HCCRD. The Warren Act Contract originally provided that "[t]he United States will deliver to [HCCRD] at the terminus of the Tornillo Main canal, during the irrigation season of 1925 and thereafter during each irrigation season as established on the Rio Grande project, such water from the project as may be available at said terminus *without the use of storage from Elephant Butte reservoir*" (emphasis added). The

and drainage water from EPCWID and does not receive a direct allocation of Project water, deliveries to HCCRD do not affect primary Project operations. The modeling and analysis described here therefore does not consider delivery to HCCRD.

The usable water available to the Project is determined according the accounting procedures specified in the Rio Grande Compact. Project releases, diversions, and deliveries depend on the usable water available to the Project as well as water demands within the Project, and are subject to limits specified by various statutory controls.

From 1916 through 1979, Reclamation operated all aspects of the Project. Reclamation determined the annual allotment of Project water per acre of authorized land and delivered the annual allotment to farm gates. In 1979 and 1980, Reclamation entered into contracts with EBID and EPCWID (collectively, the Districts), respectively, which transferred operation and maintenance responsibilities for Project conveyance and drainage systems to the Districts. Beginning in 1980, Reclamation determined annual diversion allocations to each district and delivered water to the respective authorized points of diversion; the Districts were then responsible for conveying water from the point of diversion to individual water users.

In the early 1980s, Reclamation developed a procedure to determine annual diversion allocations to EBID, EPCWID, and Mexico based on two linear regression relationships between Project releases and Project diversions and deliveries, respectively. The D-1 Curve is a linear regression relationship between annual Project releases from Caballo Dam and annual Project deliveries to lands within the US and to the heading of the Acequia Madre for diversion to Mexico. The D-2 Curve is a linear regression relationship between annual Project releases from Caballo Dam and annual gross Project diversions from river headings. Both relationships were developed based on Project operations data for the period 1951-1978 (inclusive).

During the period 1980-2007, annual Project diversion allocations to Mexico, EBID, and EPCWID were determined each year from the total amount of usable water in Project storage available for release during that year based on the D-1 and D-2 Curves. The D-1 Curve was used to estimate the total available annual delivery to Project lands in the United States and to the heading of the Acequia Madre from the usable water available for release; the D-2 Curve was used to estimate the total available annual diversion at Project diversion points from the usable water available for release.

Pursuant to the 1906 Convention, the annual allocation to Mexico during this period was 60,000 acre-feet (AF)/year, except under extraordinary drought

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1951 amendments to the Warren Act Contract added language specifying that the United States could deliver seepage or drainage water from land irrigated within the EPCWID, via canal, to HCCRD.

conditions. During extraordinary drought conditions, Mexico received a diversion allocation equal to 11.3486% of the sum of the total quantity of water delivered to lands within the United States plus delivery to the heading of the Acequia Madre. Between 1939 and 2014, Project allocations and deliveries to Mexico were reduced in approximately 30% of years, including significant reductions in 2012, 2013, and 2014 (Congressional Research Service 2015). Annual diversion allocations to EBID and EPCWID were then calculated from the quantity of water available for diversion after delivery obligations to Mexico were fully satisfied. Calculation of the allocation to each district was based on the percentage of authorized acreage within each district, or 88/155^{ths} [57%] of the estimated available annual Project diversion allocated to EBID and 67/155^{ths} [43%] to EPCWID. Reclamation made adjustments to annual diversion allocations in some years as needed to optimize Project operations and meet Project needs in response to actual Project performance (i.e., actual quantity of water available for diversion under current-year hydrologic conditions). Reclamation informed both districts of any adjustment made to the annual allocation procedure.

Beginning in 2008, Project operations have been carried out based on the procedures detailed in the Project OA (Reclamation et al. 2008) and corresponding Project Operations Manual (Reclamation et al. 2012). The OA is a written description of the procedures by which Reclamation operates the Rio Grande Project, including allocation of Project water to EBID, EPCWID, and Mexico; release of Project water from storage; delivery of Project water to authorized points of diversion; and accounting of allocation charges and credits. The Operations Manual further defines the procedures outlined within the OA for day-to-day operation of the Project. The OA and Operations Manual are reviewed annually and updated as needed to optimize Project operations consistent with applicable water rights, state and federal laws, and international treaties. Revision of the OA or Operations Manual requires unanimous consent of the Rio Grande Project Allocation Committee, which consists of one representative each from Reclamation, EBID, and EPCWID.

Operating procedures defined in the OA are largely consistent with prior operating practices during the period 1980-2007. The procedure used to determine the annual diversion allocation to Mexico is identical under the OA and prior operating practices. Similarly, the quantity of water available for diversion at Project diversion points each year is calculated from the estimated annual release of Project water according to the D-2 Curve, and the annual diversion allocations to EBID and EPCWID are calculated from the estimated water available for diversion after delivery obligations to Mexico are fully satisfied.

Two key provisions of the OA, however, deviate from prior operating practices. First, the OA provides carryover accounting for the unused balance of annual diversion allocation to EBID and EPCWID. Under prior operating practices, annual diversion allocations were calculated based only on the estimated release of Project water for the current year; the unused balance of each districts annual diversion allocation, if any, was implicitly relinquished at the end of each calendar year. Under the OA, the unused balance of each district's annual diversion allocation, if any, is carried over and becomes part of the district's total diversion allocation the following year. The OA specifies that carryover balance may be accumulated by either district up to 60% of each district's respective full annual allocation, or up to 305,918 AF for EBID and 232,915 AF for EPCWID; carryover balance in excess of this limit is transferred to the other district. The carryover provision is intended to encourage water conservation within the Project by allowing each district to maintain its unused allocation balance up to a specified limit.

Second, the OA provides for adjustment of annual diversion allocations to EBID and EPCWID to account for changes in annual Project performance—i.e., changes in the amount of water actually available for diversion compared to the estimated available diversion based on the D-2 Curve. The OA represents Project performance using the diversion ratio, which is calculated as the ratio of total annual Project allocation charges to total annual Project release. The diversion ratio adjustment provision of the OA allows for adjustment of the annual Project allocations to EBID and EPCWID so as to maintain district diversion allocations to EPCWID at a level consistent with historical Project performance as represented by the D-2 Curve. When the actual diversion ratio is greater than the D-2 Curve, EBID receives an increase in annual allocation compared to prior operating practices; when the diversion ratio is less than the D-2 Curve, EBID receives a decrease in allocation. The diversion ratio adjustment provision of the OA therefore mitigates potential negative effects of changes in Project performance, which result predominately from the actions of individual landowners within EBID, by ensuring that Project allocations and deliveries to EPCWID remain consistent with historical Project performance."

Project water accounting under the OA is consistent with water accounting under prior operating practices. Project water accounting involves the calculation of charges against the Project allocation balances of EBID, EPCWID, and Mexico, as well as credits to the allocations balances of EBID and EPCWID, consistent with each entity's use of Rio Grande surface water. Allocation charges reflect the amount of surface water diverted from the Rio Grande, and allocation credits reflect the amount of water bypassed or returned to the Rio Grande and available for diversion at a downstream diversion point. In general, allocation charges are computed as the greater of the amount of water ordered for diversion at a specified diversion point and the amount of water actually diverted, whereas allocation credits are computed as the lesser of the amount of water ordered or bypassed at specified bypass points and the actual amount of water bypassed or returned to the Rio Grande. Dependence of allocation charges and credits on corresponding Project water orders promotes efficient operation of the Project by creating an incentive to divert all water ordered.

Specific exceptions to these general accounting procedures are summarized below.

First, charges to EBID and EPCWID for water diverted to Eastside and Westside Canals depend on whether one or both districts have ordered water. EPCWID receives water in Mesilla Valley as bypass from EBID via the Eastside and Westside Canal systems. If only EBID has ordered water, EBID is charged as described above. If both districts have ordered water, EBID is charged for water diverted at the canal heading as described above and is credited for water bypassed to EPCWID in addition to water bypassed to the Rio Grande. EPCWID is then charged for water received as bypass from EBID; EPCWID is credited for water bypassed to the Rio Grande from the Westside Canal system at a designated location on the La Union East Canal (Reclamation et al. 2008), which contributes to the water available for diversion downstream at American and International Dams. Lastly, if only EPCWID has ordered water, EPCWID is charged at the canal heading, rather than at the district boundary, and is credited for water bypassed to the Rio Grande.

Second, charges to EPCWID for water diverted at American Dam for use in El Paso Valley are not determined at the heading of American Canal. For consistency with historical water distribution and accounting practices, charges are determined at four locations that receive water from American Canal: the intakes to the Umbenhaurer-Robertson and Jonathon W. Rogers water treatment facilities and the headings of Riverside and Franklin Canals. In order to promote maximal use of Project water available to the United States, EPCWID is encouraged to divert all flow reaching American Dam that is not allocated for delivery to Mexico. EPCWID is then charged for all water reaching the four accounting locations listed above, regardless of corresponding diversion orders. In the event that diversions to American Canal exceed the district's diversion order, EPCWID is credited for the unused portion of water diverted in excess of its order. Unused water in excess of EPCWID's order is computed by analysis of hydrographs of flow exiting the downstream end of the district.

Third, in addition to credit for water bypassed to the Rio Grande from the Eastside and Westside systems and for unused diversion in excess of its order at American Dam, EPCWID receives a credit towards their Project allocation balance for water savings associated with construction of the American Canal Extension. The original American Canal, completed in 1938, conveys water from American Dam approximately two miles south to Franklin Canal; the American Canal Extension, completed in 1998, carries water from the original terminus of the American Canal approximately 12 miles further south to Riverside Canal. Historically, water was diverted from the Rio Grande to Riverside Canal at Riverside Dam. The American Canal Extension is concrete lined and provides for surface-water savings through reduced seepage losses compared to historical conveyance in the Rio Grande and diversion of water at Riverside Dam. The annual credit towards EPCWID's allocation balance for water savings from the

American Canal Extension is calculated based on annual flow in the American Canal.

Lastly, in the event that only one district or Mexico has ordered water, the charge against that entity's Project allocation balance is equal to the greater of the amount of water released from Caballo Dam or the amount of water diverted at the specified diversion point(s).

In addition to storing and releasing water for the Project, Reclamation also allows storage of SJC Project water in Elephant Butte Reservoir. In 1983, Reclamation and the Authority entered into a 25-year agreement (Contract No. 3-CS-53-01510) to allow the Authority to store up to 50,000 acre-feet of water in Elephant Butte Reservoir. The amount accounted as non-Project inflow to Elephant Butte Reservoir is equal to the amount released from upstream minus agreed-upon transport losses for the conveyance of non-Project water to the reservoir, unless that water was moved downstream for reasons that benefit Reclamation (such as to support riverine habitat for endangered species). The amount accounted as non-Project water stored by the Authority is then calculated as the Authority's previous non-Project storage, plus non-Project inflows, and minus evaporation of non-Project water from storage.

The 1983 agreement between Reclamation and the Authority expired in 2008. Since then, water storage in Elephant Butte Reservoir by the Authority has been managed under annual contract extensions, with the intent to execute another long-term agreement. Current storage is under an extension that allows storage through February 2016, ending on March 1, 2016.

In recent years, the City of Santa Fe (City) has also stored water in Elephant Butte, first under a sublease to the Authority's agreement, and then under annual agreements of its own. Since the spring of 2014, Santa Fe has not had water in Elephant Butte. The City has not requested future storage.

5 Summary of Proposed Alternatives Simulated in Support of EIS

The EIS will analyze environmental effects associated with continuing to implement OA for the remainder of its term through December 31, 2050, and associated with the renewal of SJC Project storage contracts that provide for storage of up to 50,000 acre-feet of SJC Project water in Elephant Butte Reservoir. The EIS will consider five alternatives, including a No Action alternative and four action alternatives. The No Action alternative reflects continuation of current operating procedures, as defined by the OA (Reclamation et al. 2008) and current Project Operations Manual (Reclamation et al. 2012), and with renewal of contracts for storage of up to 50,000 acre-feet of SJC Project water in Elephant Butte Reservoir. Action alternatives reflect potential changes in Project operating procedures and/or storage of SJC Project water in Elephant Butte. Alternatives are summarized below in Table 1.

Each alternative is simulated using two tools: a detailed hydrologic and water operations model of the Rincon and Mesilla Basins (Basins), which simulates Project operations and surface-water and groundwater conditions within the Basins; and a spreadsheet post-processing tool, which computes total storage in Elephant Butte Reservoir, including Project water, Rio Grande Compact Credit water and SJC Project water. Each alternative operating procedure is simulated by implementing a consistent set of Project allocation and accounting procedures within the Rincon and Mesilla Basins Hydrologic Model (RMBHM; see Section 6). RMBHM simulates Project operations and corresponding surface-water and groundwater conditions under projected future climate and hydrologic conditions according to the specified procedures. In the simulations carried out in support of the EIS, RMBHM does not account for SJC Project water in Elephant Butte Reservoir. SJC Project water and total storage in Elephant Butte Reservoir under each alternative are computed using a post-processing tool which calculates available storage for SJC Project water.

Unique simulations with RMBHM and the associated post-processing tool were carried out for Alternatives 1, 3, 4, and 5. Alternative 2 does not include storage of SJC Project water in Elephant Butte Reservoir; Alternative 2 is therefore represented by the RMBHM results from Alternative 1, without applying the post-processing tool for calculation of SJC Project water.

Table 1: Summary of Project Operating Alternatives Simulated In Support of the EIS

Alt.	Name	Description
1	No Action	• Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations; • Continue to implement the carryover accounting provision of the OA allowing carryover of unused allotment balance from one year to the next; • Continue to store up to 50,000 acre-feet per year of SJC Project water in Elephant Butte Reservoir.
2	No Action without SJC Project Storage	• Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations; • Continue to implement the carryover accounting provision of the OA allowing carryover of unused allotment balance from one year to the next; • Do not store SJC Project water in Elephant Butte Reservoir.
3	No Action without Carryover Provision	• Continue to implement the diversion ratio adjustment provision of the OA in computing annual diversion allocations; • Do not implement the carryover accounting provision of the OA – relinquish unused allotment balance at the end of each calendar year and eliminate carryover allocations; • Continue to store up to 50,000 acre-feet per year of SJC Project water in Elephant Butte Reservoir.
4	No Action without Diversion Ratio Adjustment	• Do not implement the diversion ratio adjustment provision of the OA – compute annual diversion allocations based only on the D1 and D2 regression equations without adjustment for variations in Project performance; • Continue to implement the carryover accounting provision of the OA allowing carryover of unused allotment balance from one year to the next; • Continue to store up to 50,000 acre-feet per year of SJC Project water in Elephant Butte Reservoir.
5	Prior Operating Practices	• Do not implement the diversion ratio adjustment provision of the OA – compute annual diversion allocations based only on the D1 and D2 regression equations without adjustment for variations in Project performance; • Do not implement the carryover accounting provision of the OA – relinquish unused allotment balance at the end of each calendar year and eliminate carryover allocations; • Continue to store up to 50,000 acre-feet per year of SJC Project water in Elephant Butte Reservoir.

6 Summary of Modeling Approach

Modeling software was selected and configured to simulate Project operations and hydrology, including surface-water and groundwater conditions, in the Rincon and Mesilla Basins under each of the alternative operating procedures proposed for the EIS. For each alternative, simulations were carried out under a range of projected future climate conditions. Model results were post-processed and compiled to facilitate comparison of Project operations and surface-water and groundwater resources under the No Action Alternative to conditions under each action alternative. Parameters provided by the model output and post-processing analysis include:

- Project storage, non-Project storage, and total storage in Elephant Butte and Caballo Reservoirs;
- Water surface elevation and area of Elephant Butte Reservoir;
- Reservoir releases from Caballo Dam;
- Diversion of Project surface-water to EBID, EPCWID, and Mexico;
- Delivery of Project surface-water to irrigated lands within EBID and to irrigated lands in the Mesilla Valley portion of EPCWID;
- Groundwater pumping for irrigation of groundwater-only irrigated lands in New Mexico and for supplemental irrigation of irrigated lands within EBID and irrigated lands in the Mesilla Valley portion of EPCWID;
- Changes in groundwater storage and water table elevations in Rincon and Mesilla Valleys.

In addition to analysis of surface-water resources, model results also provide a basis for analysis of potential effects of proposed alternatives on the human environment and socioeconomics, ecological conditions, and other environmental resources.

6.1 Model Selection

Simulation of Project operations requires a hydrologic modeling approach that accounts for interactions and feedbacks between surface-water and groundwater management and use. In response to this requirement, Reclamation, in collaboration with the USGS, developed the RMBHM to simulate Project operations and corresponding surface-water and groundwater conditions in the Rincon and Mesilla Basins. RMBHM builds on previous hydrologic models developed by the (NMOSE; SSPA 2007) and the USGS (Hanson et al. 2013).

RMBHM uses integrated hydrologic modeling software that is based on the USGS Modular Groundwater Model, MODFLOW. This software, the One Water Hydrologic Flow Model (MF-OWHM; Hanson et al. 2014), has been enhanced with additional software features developed and implemented by Reclamation in collaboration with USGS (Ferguson et al. 2014). New software features implemented by Reclamation provide the capability to simulate Project surface-water operations, including Project storage, allocation, release, diversion, delivery, and water accounting. New features are linked to existing features of MF-OWHM, including the Farm Process (FMP) and streamflow routing package (SFR), to allow dynamic simulation of both surface-water and groundwater management and use, including the coupled use and movement of surface water based on reservoir supply, agricultural demand, and specified Project operating procedures.

RMBHM simulates interactions and feedbacks between Project surface-water operations and groundwater recharge, incentives for groundwater pumping for supplemental irrigation, and groundwater/surface-water interactions in the Rincon and Mesilla Basins. Dynamic representation of these interactions and feedbacks is necessary to accurately represent Project operations and potential effects of alternative operating procedures on groundwater and surface-water resources.

6.2 Model Configuration

RMBHM utilizes the most recent release of the MF-OWHM (Hanson et al. 2014), with additional software features developed and implemented by Reclamation in collaboration with USGS. RMBHM was developed by configuring MF-OWHM to represent the physical and hydraulic properties specific to the groundwater and surface-water systems of the Rincon and Mesilla Basins and the operating procedures of the Project. Model configuration includes the extent and discretization of the simulated area (spatial domain) and simulation period (temporal domain), as well as the physical and hydraulic properties (constant parameters) of the Rincon and Mesilla Basins.

The RMBHM spatial domain is identical to that of previous model versions[5] developed by NMOSE and USGS (SSPA 2007; Hansen et al. 2013). The spatial domain encompasses the Rincon Valley of New Mexico and the Mesilla Valley of New Mexico and Texas, including all authorized Project lands within the Arrey, Leasburg, Eastside, and Westside Canal service areas. The model domain includes the Rio Grande, Project conveyance facilities (canals and laterals), and Project drainage facilities between Caballo Dam and Paso del Norte (El Paso Narrows), as well as all diversion points serving Project users in the United States: Percha Dam, Leasburg Dam, Mesilla Dam, and American Dam. It should

[5] The term "model version" refers here to the specific combination of modeling software and its implementation (configuration) to simulate surface-water and groundwater hydrology of a given area.

be noted that the model spatial domain does not include International Dam, where Project water is diverted from the Rio Grande for use in Mexico. International Dam is located approximately 1.5 miles downstream of American Dam; Project diversions to Mexico are approximated based on simulated flow in the Rio Grande out of the model domain.

Consistent with previous model versions, the RMBHM spatial domain is discretized on a uniform grid with lateral resolution of one quarter mile (1320 ft) in both the X- and Y-dimensions: each model grid cell is a square covering an area one quarter mile by one quarter mile, equal to 40 acres. The model grid is rotated 24 degrees counter-clockwise from the local meridian to align with the dominant orientation of topographic and hydrogeological features of the Rincon and Mesilla Basins. In the vertical dimension, the aquifer system is represented by five model layers of varying thickness and extent. The uppermost layer represents the Rio Grande alluvial aquifer system within the Rincon and Mesilla Valleys, and lower layers represent deeper basin-fill deposits. The vertical discretization of RMBHM was adopted directly from previous model versions and is based on the hydrogeologic framework developed by Hawley and Kennedy (2004).

RMBHM represents surface-water channels within the model spatial domain—including the Rio Grande, canals and laterals, wasteways, and open drains—as a discrete network of channel segments and reaches using the SFR package in MF-OWHM. The network of canals, laterals, wasteways, and drains represented in RMBHM was adopted from previous model versions, where previous modeling teams selected channels primarily based on their rated capacity and acreage served (SSPA 2007). As in previous model versions, RMBHM explicitly represents the majority of larger canals and laterals within the model domain, while excluding smaller laterals that generally have rated capacities less than 40 cfs and/or serve relative small areas (refer to SSPA 2007, Appendix M, for details). RMBHM utilizes the lumped representation of surface-water deliveries developed by NMOSE for a previous model version, with surface-water deliveries to Project lands occurring at 30 locations throughout the conveyance network (SSPA 2007). Calibration and sensitivity analysis carried out during previous modeling efforts demonstrate that the simplified and lumped representation of the surface-water conveyance and drainage network was sufficient to represent surface-water operations and surface-water/groundwater interactions within the Rincon and Mesilla Basins (SSPA 2007, Hanson et al. 2013).

It should be noted that the model domain does not encompass Project lands in El Paso Valley, downstream of Paso del Norte (also known as El Paso Narrows). As summarized above, previous studies indicate significant interaction and feedbacks between Project operations and groundwater storage and use in the Rincon and Mesilla Valleys. By contrast, Project water delivered to EPCWID for use in El Paso Valley is diverted at American Dam, located at the southern end of Mesilla Valley upstream of Paso del Norte. Water diverted at American Dam is conveyed to Project accounting points in El Paso Valley[6] via the American Canal, which is concrete-lined and therefore assumed not to interact with the underlying groundwater aquifer. Drainage and return flows from EPCWID in El Paso Valley do not contribute to downstream Project diversions and therefore do not affect Project diversion orders or accounting. While groundwater/surface-water interactions in El Paso Valley may affect surface-water deliveries and return flows within EPCWID and the availability of Project seepage and drainage water to HCCRD, these interactions do not affect the quantity or quality of Project water available for diversion, accounting of Project charges and credits, nor the allocation of project surface-water supplies between EBID, EPCWID, and Mexico. For these reasons, Project deliveries to EPCWID lands in El Paso Valley are not explicitly represented in the model domain. Instead, Project demands and deliveries in El Paso Valley are represented by a specified diversion demand at American Canal (see Section 6.5).

In order to support comparison of proposed operating alternatives for the EIS, the RMBHM temporal domain encompasses the full term of the OA, from 2008-2050. The simulation period extends from the start of the 2007-2008 non-irrigation season (November 1, 2007) through the end of the 2050 irrigation season (October 31, 2050). The temporal domain is discretized into seasonal stress periods and approximately monthly time steps. Each simulated year contains two seasonal stress periods: a non-irrigation season stress period from November through February (120.25 days), and an irrigation season stress period from March through October (245 days). Irrigation stress periods are divided into eight nominally monthly time steps of 30.625 days each and non-irrigation stress periods are divided into four nominally monthly time steps of 30.0625 days each.

Subsurface and channel hydraulic properties are held constant throughout the model simulation. Hydraulic properties were largely adopted from previous model versions, which were subjected to extensive calibration and verification; however, selected parameters were adjusted during development and evaluation of RMBHM to improve simulation of Project surface-water operations (see Section 6.3 below). Subsurface hydraulic properties include horizontal hydraulic conductivity, the ratio between horizontal and vertical hydraulic conductivity, specific storage, and specific yield; channel hydraulic properties include channel bed hydraulic conductivity as well as channel geometry, slope, and roughness, which affect stream stage (head) and wetted perimeter, and thus seepage across the channel bed.

RMBHM simulates the transient groundwater and surface-water responses to spatially and temporally varying hydrologic stresses, including Project surface-water releases and diversions and both agricultural and non-agricultural groundwater pumping within the model domain (see Section 6.4 below). As in

[6] Project allocation charges in El Paso Valley are computed at the following locations: Umbenhaurer-Robertson Water Treatment Plant intake, intake to Jonathon W. Rogers Water Treatment Plant intake, Franklin Canal heading, and Riverside Canal heading.

previous model versions, non-agricultural groundwater stresses such as domestic and municipal well groundwater pumping rates and mountain-front recharge are specified as seasonally-varying inputs[7]. By contrast, irrigation-related stresses such as Project releases, diversions, and deliveries, farm well pumping rates, and farm net recharge are simulated dynamically by RMBHM and updated at each time step. Irrigation stresses are calculated based on specified crop irrigation requirements and simulated Project surface-water operations. The crop irrigation requirements for each Project service area in the Rincon and Mesilla Basins are specified for each stress period as a time-varying input; Project storage is simulated for each time step based on specified monthly reservoir inflows, precipitation and evaporation rates, non-Project water in storage, and simulated Project releases; and groundwater pumping for irrigation is calculated as the difference between the total farm delivery requirement and simulated surface-water delivery.

6.3 Constant Model Parameters

In addition to configuration of the model's spatial and temporal domain, RMBHM requires parameters representing the physical and hydraulic properties throughout its spatial domain. Parameters representing physical and hydraulic properties are held constant throughout the model simulation period. Constant model parameters include:

- Subsurface Properties:
  - aquifer hydraulic conductivity (horizontal and vertical)
  - specific storage
  - specific yield

- Channel Properties:
  - hydraulic conductivity of channel beds
  - channel geometry, slope, and roughness of channels

- Vegetation Related Parameters:
  - root profiles of riparian vegetation
  - soil capillary fringe depth
  - on-farm irrigation efficiency
  - fractional distribution crop consumptive use between evaporation and transpiration

The RMBHM spatial domain—including the model's spatial extent, spatial discretization, hydrogeologic framework, and surface channel network—is

[7] Seasonally-varying inputs vary between irrigation and non-irrigation stress periods, but do not vary between years; for example, a seasonally varying input has a single value for all irrigation stress periods and a single value for all non-irrigation stress periods, but may differ between irrigation and non-irrigation stress periods.

identical to the spatial domain used in previous model versions (SSPA 2007, Hanson et al. 2013). Similarly, the initial parameter set for RMBHM was adopted directly from Hanson et al. (2013). Initial parameter values for subsurface properties were developed by SSPA (2007) and adopted by Hanson et al. (2013). Parameter values were developed through a combination of manual (trial-and-error) calibration and parameter estimation simulations using PEST, a model-independent parameter optimization software (Watermark Numerical Computing 2005); calibration was carried out with respect to observed historical groundwater heads at monitoring well locations throughout the model domain and drain flows at selected Project drains where sufficient data were available (SSPA 2007). Initial parameters defining channel properties were developed by Hanson et al. (2013) based on further sensitivity analysis with respect to observed historical surface water flows.

The initial parameters set adopted from Hanson et al. (2013) was evaluated by simulating Project operations under historical hydrology, climate, and cropping conditions for the period 1960-2009 and comparing simulation results to observed historical conditions during this period. For evaluation purposes, historical Project operations were represented by implementing a consistent set of Project allocation and accounting procedures representative of historical operations for the period 1990-2006. Historical hydrology and climate conditions were represented through time-varying model inputs, including historical inflows to Elephant Butte Reservoir, historical reservoir precipitation and evaporation rates, and crop irrigation requirement computed based on historical meteorology, crop distribution, and irrigated acreage data. RMBHM uses a fixed set of operating rules representative of Project allocation and accounting practices during this period, whereas actual operations during the evaluation period varied from year to year; simulated operations are therefore not expected to match historical measurements perfectly.

Model results were compared to historical records of Project storage, releases, diversions, and flow in the Rio Grande below Caballo Dam and at El Paso, and to previous estimates of Project surface-water deliveries and groundwater deliveries for supplemental irrigation for Project service areas in the Rincon and Mesilla Valleys. The model evaluation and sensitivity analysis conducted with RMBHM did not re-evaluate simulated groundwater heads and drain flows. Model results using the initial parameter set adopted from Hanson et al. (2013) exhibit surface-water releases and diversions consistent with historical observations; however simulated surface-water deliveries were higher than historical observations and simulated groundwater deliveries were lower than previous historical estimates. Results suggest that the initial parameter set overestimates conveyance efficiency of Project canals and laterals, resulting in underestimated groundwater pumping for supplemental irrigation.

In response to these evaluation results, a limited sensitivity analysis was carried out to assess model sensitivity to selected parameters and to identify a preferred parameter set for simulations conducted in support of the EIS. A large number of simulations were carried out with varying parameter values for selected parameters, including subsurface and channel bed hydraulic conductivities, aquifer specific storage and specific yield, capillary fringe depth, and on-farm irrigation efficiency. Sensitivity results revealed that simulated Project storage, allocations, releases, and diversions are weakly sensitive (less than 10% change) to all model parameters. Simulated surface-water and groundwater deliveries to irrigated lands in Rincon and Mesilla Valleys were found to be moderately sensitive (between 10% and 20% change) to changes in the hydraulic conductivity of canal beds, which affects canal seepage losses; capillary fringe depth, which affects direct uptake of groundwater by crops; and on-farm irrigation efficiency, which affects the total delivery requirement to farms.

A preferred parameter set was selected based on comparison of historical and simulated Project storage, releases, diversions, and surface-water deliveries. With the selected parameter set, Project operations simulated by RMBHM closely match historical Project records. As illustrated in Figure 2, simulated total Project storage is well correlated with observed historical storage ($R^2 = 0.94$) and exhibits little systematic bias. Similarly, Figure 3 shows that simulated annual releases from Caballo Dam also agree well with observed historical releases. The simulated average annual Project release is within one percent of the historical average, and the simulated average annual total Project diversion from the Rio Grande is within 5% of the historical average. Simulated surface-water and groundwater deliveries to irrigated lands in the Rincon and Mesilla valleys also agree well with previous estimates developed by NMOSE (SSPA 2007).

Strong agreement of RMBHM with historical records suggests that RMBHM captures the key operational and hydrologic factors that drive surface-water and groundwater management and use in the Rincon and Mesilla Basins. Discrepancies between simulated and observed Project operations likely reflect uncertainties in the historical data used to develop model inputs, including historical records of inflows to Elephant Butte Reservoir, meteorological conditions throughout the study area, and cropping patterns, irrigated acreage, and on-farm irrigation efficiencies in the Rincon and Mesilla valleys. Simplifications required to simulate Project operations also contribute to discrepancies between simulated and observed conditions. Key simplifications include the spatial and temporal discretization of RMBHM and the use of a consistent set of operation procedures throughout the simulation, in contrast to actual operating procedures which evolved over time, especially between 1980 and 2008. Key simplifications and assumptions are discussed in Section 6.5.

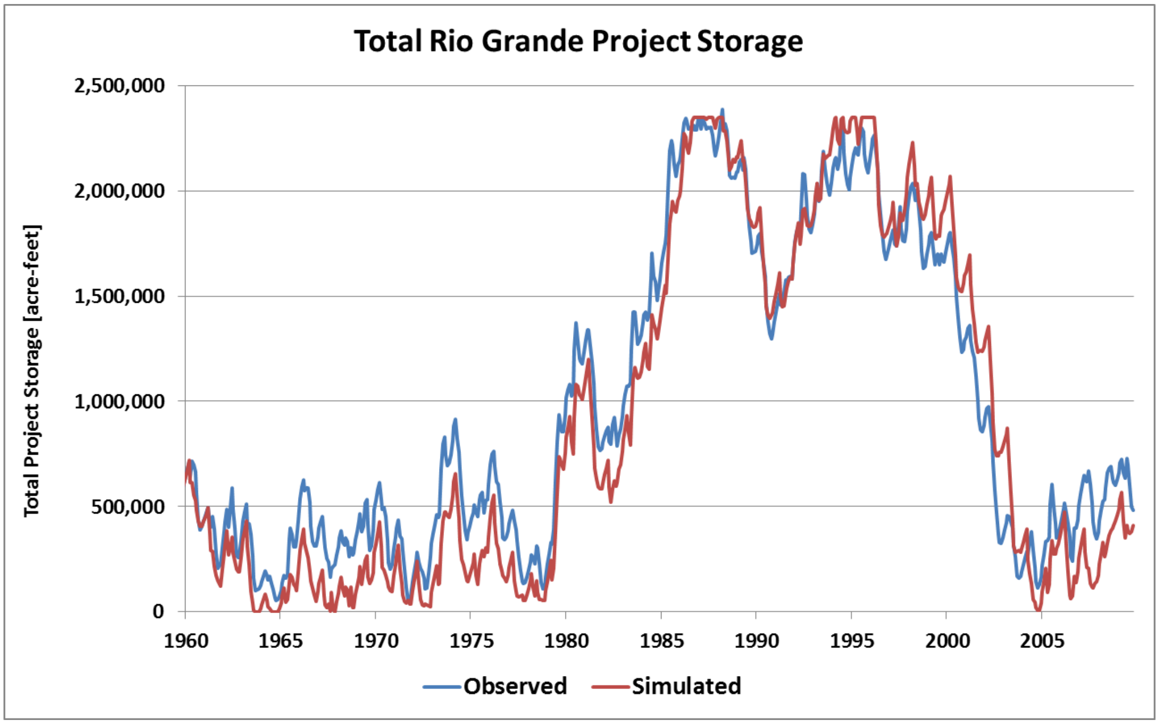

Figure 2: Observed and simulated monthly total Rio Grande Project storage in Elephant Butte and Caballo Reservoirs (acre-feet) for the period 1960-2010.

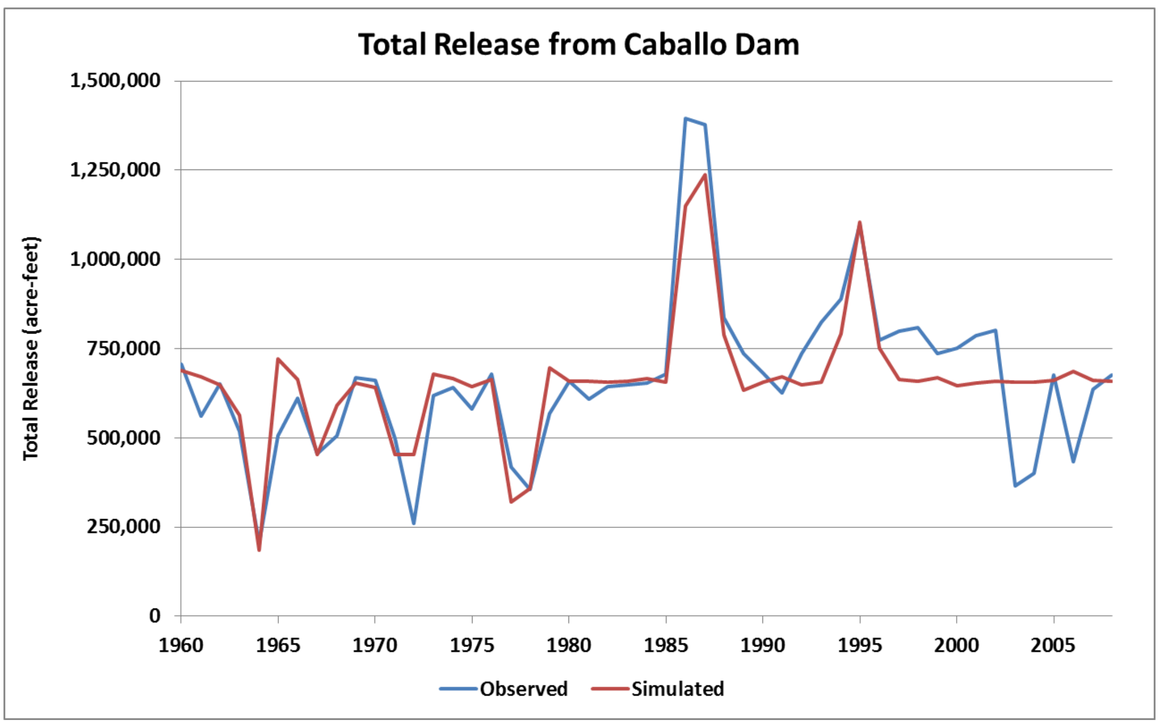

Figure 3: Observed and simulated annual release from Caballo Dam (acre-feet) for the period 1960-2010.

6.4 Time-Varying Model Inputs

In order to simulate transient conditions over the simulation period (November 2007 – October 2050), RMBHM requires time-varying inputs representing projected hydrologic, climatic, and anthropogenic stresses to the surface-water and groundwater systems of the Rincon and Mesilla Basins over this period. Hydrologic stresses represented in RMBHM include surface-water inflows to Project storage; climatic stresses include reservoir precipitation and evaporation rates and reference evapotranspiration in the Rincon and Mesilla Valleys; and anthropogenic stresses include cropping patterns, irrigated acreage, and on-farm irrigation efficiency of agricultural lands, municipal and domestic groundwater pumping rates and locations, and discharge of treated effluent from municipal wastewater treatment facilities. In addition, the storage and relinquishment of Rio Grande Compact credit waters in Elephant Butte Reservoir is represented as a time-varying input.

Hydrology and climate inputs to RMBHM for simulations carried out in support of the EIS are based on a combination of recent historical conditions and projections of future conditions, including projected effects of climate change. Projected future inflows to Elephant Butte Reservoir, reservoir precipitation and evaporation rates, and precipitation and temperature conditions in Rincon and Mesilla Valleys were obtained from previous analyses carried out by Reclamation and others as part of the West Wide Climate Risk Assessment (WWCRA; Reclamation 2011a, Reclamation 2011b) and Upper Rio Grande Impact Assessment (URGIA; Reclamation 2011a, Reclamation 2013).

Projections of future climate and hydrologic conditions were developed through a multi-phase modeling approach (Reclamation 2013). The three primary modeling phases are summarized below:

- Downscale temperature and precipitation projections from global climate models to a spatial scale relevant for regional analysis.

- Perform hydrologic modeling to develop projections of future streamflow at selected locations within the Rio Grande Basin.

- Use the downscaled projections of temperature, precipitation, and streamflow as inputs to a local monthly operations model, the Upper Rio Grande Simulation Model (URGSiM; see Reclamation 2013, Appendix E), to simulate future operations of Reclamation projects and related Federal and non-Federal activities and infrastructure in the basin under projected future climate and hydrologic conditions.

Climate and hydrologic projections used here are based on an ensemble of 112 projections of 21st century climate developed and archived as part of the World Climate Research Programme (WCRP) Coupled Model Inter-comparison Project Phase 3 (CMIP3) (Meehl et al. 2007) and Intergovernmental Panel on Climate

Change (IPCC) Fourth Assessment Report (IPCC 2007). The CMIP3 ensemble includes projections from 16 global climate models (GCMs; also referred to as general circulation models) and representing a variety of initial conditions of global ocean-atmosphere system and future scenarios regarding the evolution of atmospheric greenhouse gas concentrations over the 21st century (see Meehl et al. 2007, IPCC 2000, and IPCC 2007 for details).

Reclamation, in cooperation with Lawrence Livermore National Laboratory, Santa Clara University, Climate Central, and the Institute for Climate Change and its Societal Impacts, performed Bias Correction and Spatial Disaggregation (BCSD) of the 112 projections of future temperature and precipitation using the statistical technique of Wood et al (2004). The resulting BCSD dataset includes 112 projections of monthly temperature and precipitation over the continental United States at 1/8 degree spatial resolution (12 km) for the period from 1950 through 2099 (see Reclamation 2011a for details). Reclamation then used the BCSD precipitation and temperature projections as input to the Variable Infiltration Capacity (VIC) hydrology model (Liang et al. 1994, Liang et al. 1996, and Nijssen et al. 1997) to develop projections of future hydrologic conditions over the western United States, including simulated natural streamflow variability for the period 1950-2099 (see Reclamation 2011a for details). Projected streamflow at selected locations within the Rio Grande basins were then bias corrected[8] to remove systematic biases between simulated and observed streamflow and to ensure that projected flows are consistent with long-term statistics of observed streamflow in the basin (see Reclamation 2013, Appendix D, for details).

Finally, projections of future water operations in the Upper Rio Grande Basin were developed using the URGSiM (Reclamation 2013, Appendix E), including reservoir storage and releases, groundwater/surface-water interactions, municipal and agricultural water deliveries, and agricultural and riparian consumptive use. URGSiM simulates water operations from the San Luis Valley in southern Colorado to Caballo Reservoir in southern New Mexico based on specified operating rules and time-varying inputs of monthly streamflow, precipitation, and maximum and minimum temperatures. URGSiM simulates storage, releases, flows, and deliveries on the Rio Grande mainstem, the Rio Chama and Jemez River tributary systems, and the Española, Albuquerque, and Socorro regional groundwater basins, including:

- Operations of nine dams
- Interbasin transfers from the Colorado River Basin to the Rio Grande Basin (via Reclamation's San Juan-Chama project)

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[8] Bias correction was carried out using the quantile-mapping bias correction technique detailed in Wood et al. 2004.

- Agricultural diversions and depletions in the Chama, Española, and Middle Rio Grande Valleys (most of which occur via irrigation infrastructure originally built by Reclamation as part of the Middle Rio Grande Project)

- Evapotranspiration (ET) i.e., the evaporation plus water use by riparian plants and crops

For the purposes of the EIS, projected inflows, Rio Grande Compact credit water, and evaporation and precipitation rates for Elephant Butte Reservoir were obtained from URGSiM results for the URGIA “Base Case” operating scenario. The Base Case operating scenario represents changes in water supply, demand, and operations resulting directly from projected changes in the climate, assuming no change in infrastructure, operations, population, irrigated acreage and cropping patterns, and other non-climate-related parameters. In addition, Base Case operating scenario assumes that Colorado and New Mexico meet their respective surface-water delivery requirements under the Rio Grande Compact. Water shortages in each state are managed by decreasing water use in the San Luis valley in Colorado and the Middle Rio Grande Valley in New Mexico, respectively, so that accumulated debits do not exceed 100,000 AF. Compact credits are allowed to accumulate, but are relinquished to Texas when credits exceed 70,000 AF. A total of 112 Base Case simulations were conducted as part of URGIA, corresponding to the suite of 112 BCSD climate projections.

Three of the 112 Base Case simulations were selected as inputs to RMBHM to represent the range of projected future hydrologic conditions in the basin. Simulations were selected based on projected future surface-water availability as characterized by projected average annual inflow to Elephant Butte Reservoir over the EIS simulation period (2007-2050). Selected simulations represent a drier scenario corresponding to the URGSiM simulation with the 25th percentile average annual inflow (Scenario P25), a central tendency scenario corresponding to the simulation with the 50th percentile (median) annual inflow (Scenario P50), and a wetter scenario corresponding to the simulation with the 75th percentile inflow (Scenario P75) relative to the ensemble of 112 simulations. Average annual inflows to Elephant Butte Reservoir are illustrated in Figure 4 for observed historical conditions (average over period 1950-2010) and for each of the three selected climate scenarios (average over period 2007-2050).

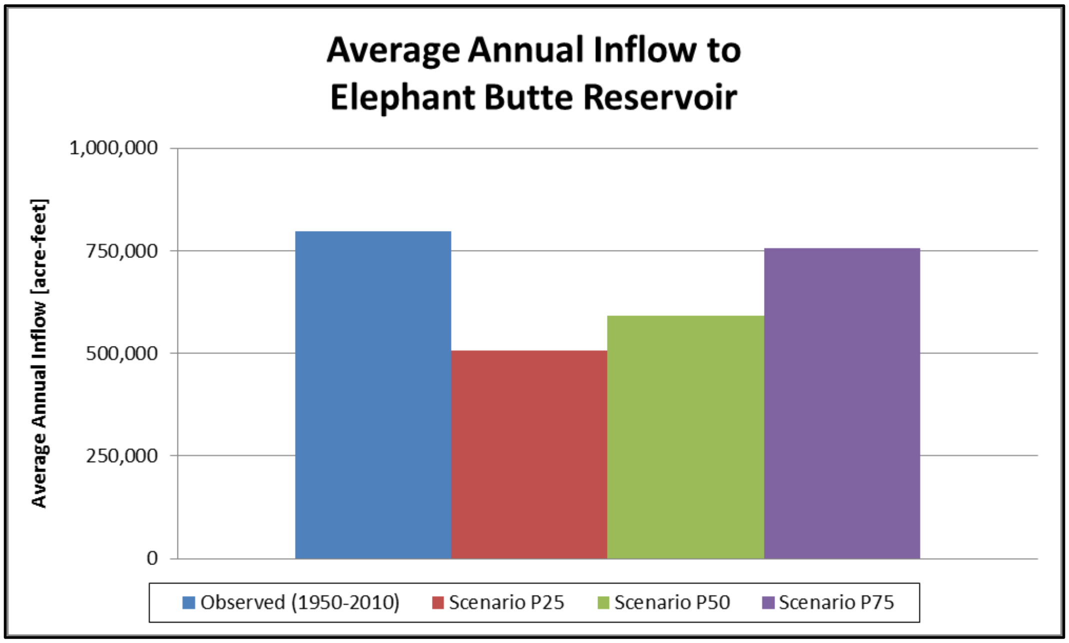

Figure 4: Observed historical average annual inflow to Elephant Butte Reservoir during the period 1950-2010 (acre-feet) and projected future average annual inflow to Elephant Butte Reservoir during the simulation period (2007-2050) for the climate scenarios considered in support of the Rio Grande Project Operating Agreement EIS.

For each scenario, time-varying climate and hydrologic inputs were developed from URGSiM results and corresponding BCSD climate projections. RMBHM inputs of monthly inflows to Elephant Butte Reservoir, monthly reservoir precipitation and evaporation rates, and monthly Rio Grande Compact credit water in Elephant Butte Reservoir over the simulation period were adopted directly from URGSiM model outputs. Seasonal crop irrigation requirement (CIR) inputs to RMBHM for each Rio Grande Project service area in the Rincon and Mesilla valleys were developed by adjusting calculated historical crop evapotranspiration for a selected base year according to the projected change in reference evapotranspiration (reference ET) between the base and future years. Projected future reference ET was calculated using the Hargreaves-Samani method (Hargreaves and Samani 1985) based on projected future temperatures from the BCSD climate projections corresponding to the selected URGSiM simulations. Seasonal CIR was then calculated by subtracting effective precipitation during the irrigation season from calculated crop evapotranspiration, with precipitation taken from the corresponding BCSD climate projections and effective precipitation calculated using the USDA Soil Conservation Service method (Dastane 1978). Monthly average precipitation, temperature, and reference ET at weather stations in Hatch, NM and Las Cruces, NM are illustrated in Figures 5-7, respectively, for observed historical conditions (average over period 1950-2010) and for each of the three selected climate scenarios (average over period 2007-2050).

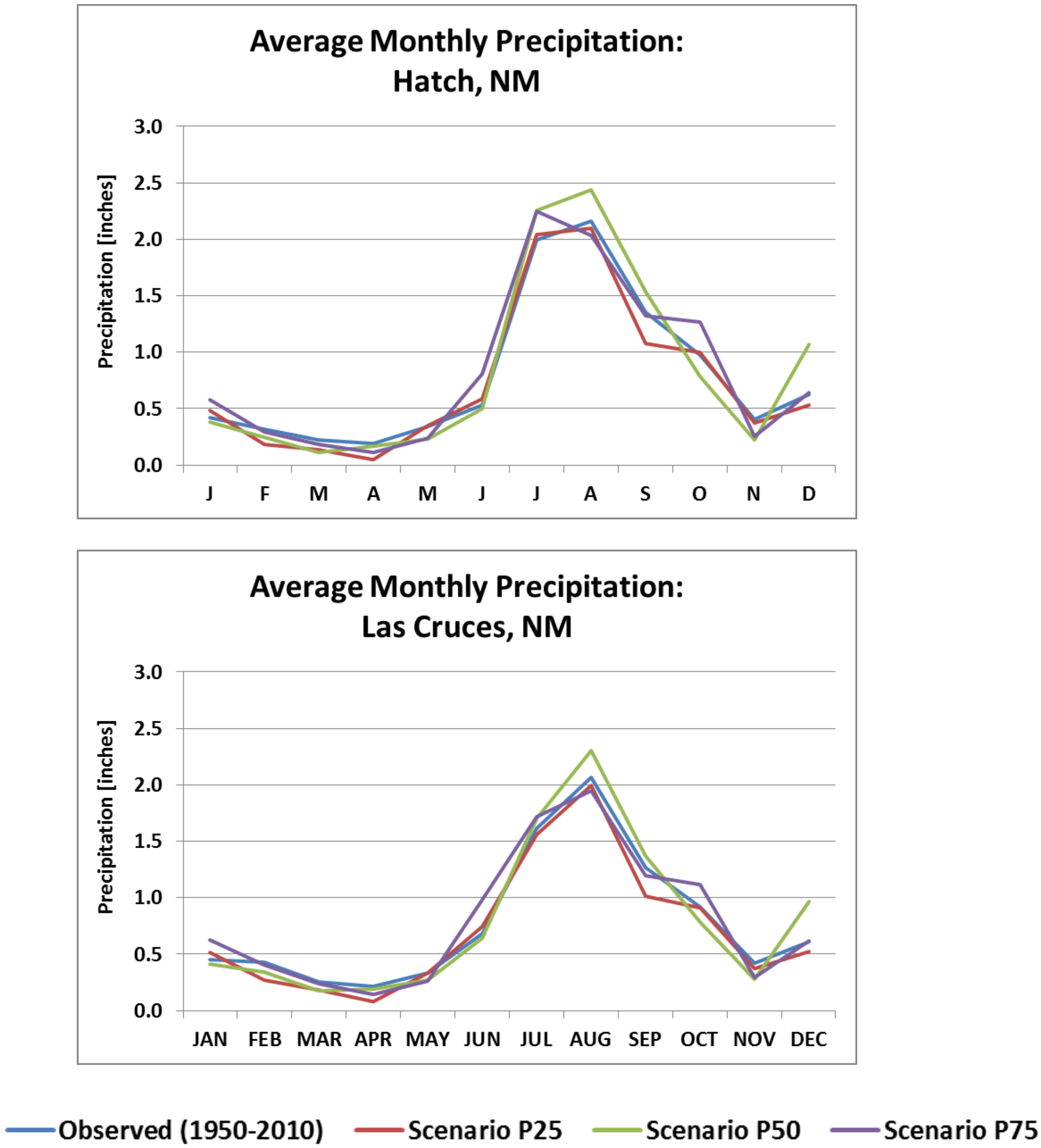

Figure 5: Observed historical average monthly precipitation at Hatch, NM and Las Cruces, NM during the period 1950-2010 (inches) and projected future historical average monthly precipitation during the simulation period (2007-2050) for climate scenarios considered in support of the Rio Grande Project Operating Agreement EIS.

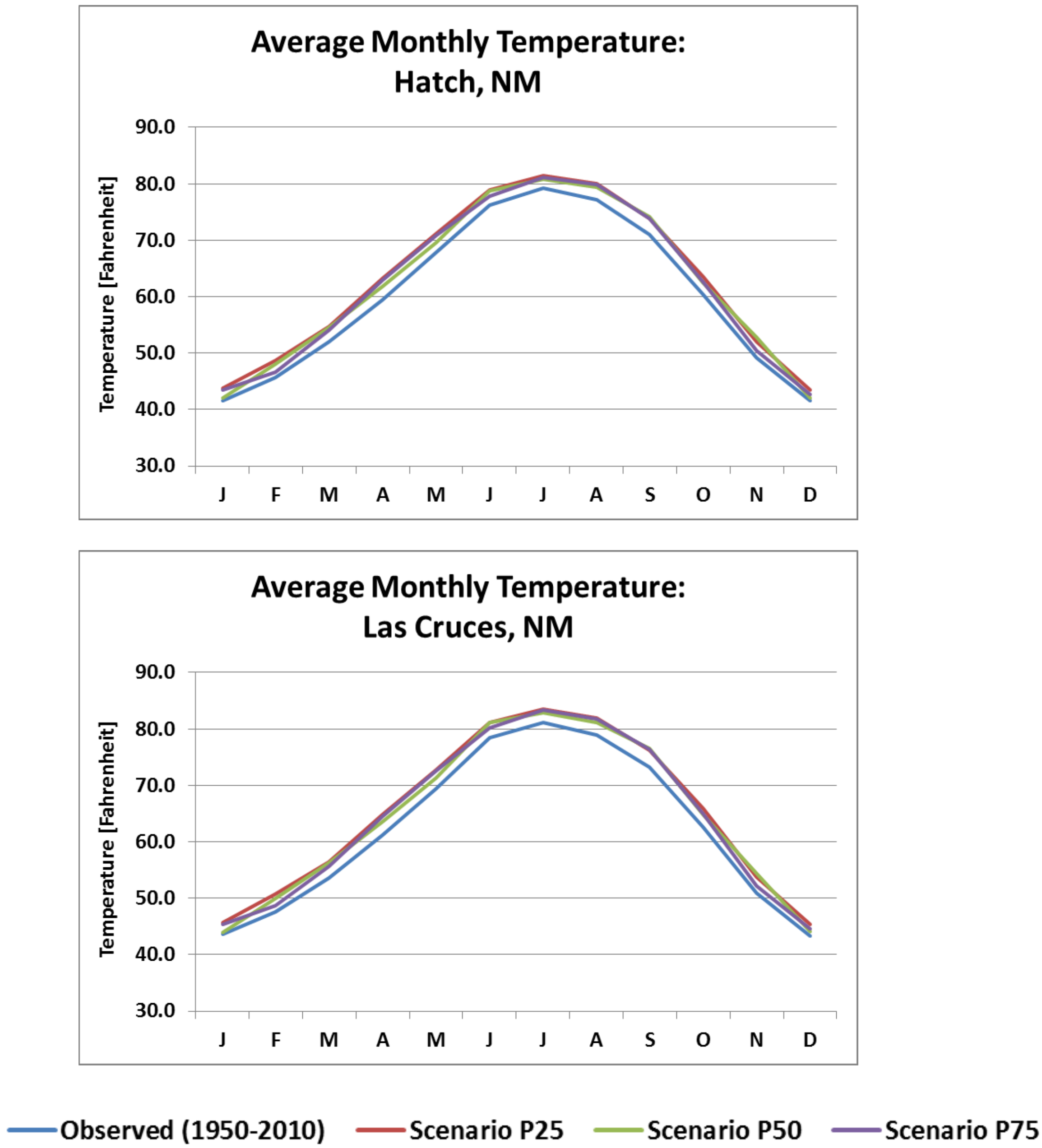

Figure 6: Observed historical average monthly mean temperature at Hatch, NM and Las Cruces, NM during the period 1950-2010 (inches) and projected future historical average monthly precipitation during the simulation period (2007-2050) for climate scenarios considered in support of the Rio Grande Project Operating Agreement EIS.

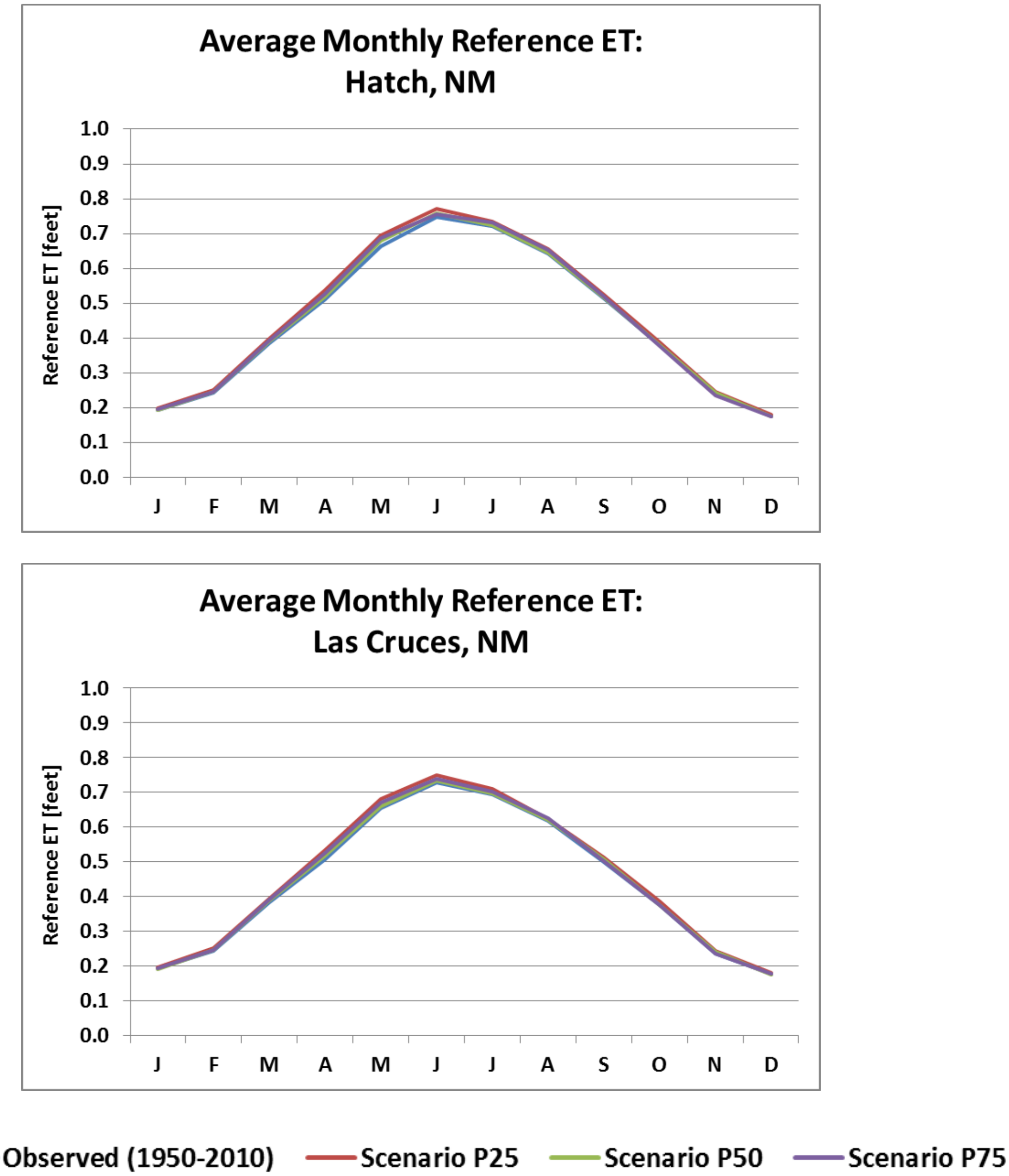

Figure 7: Observed historical average monthly mean temperature at Hatch, NM and Las Cruces, NM during the period 1950-2010 (inches) and projected future historical average monthly precipitation during the simulation period (2007-2050) for climate scenarios considered in support of the Rio Grande Project Operating Agreement EIS.

6.5 Model Assumptions

Simulation of future Project operations and corresponding surface-water and groundwater conditions in the Rincon and Mesilla Basins requires several assumptions regarding future conditions, including future climate and hydrology, cropping and irrigation practices, and non-agricultural water uses. Additional assumptions are required to approximate day-to-day operational decisions by Reclamation, EBID, EPCWID, and individual irrigators that are not specified in the OA or Operations Manual. Important assumptions used to represent Project operations in RMBHM are briefly summarized below.

- *Irrigation Water Demands in Rincon and Mesilla Valleys*

  As described above, time-varying (seasonal) crop irrigation requirement for irrigated lands within the Rincon and Mesilla Basins is a required model input. In order to develop projections of future crop irrigation requirement for the model simulation period, it was necessary to make assumptions regarding future cropping patterns, irrigated acreage, and irrigation response to surface-water deficiencies.

  The cropping pattern for each service area within the model domain was based on cropping data available for the year 2000. Crop evapotranspiration was first calculated for each canal service area for the year-2000 irrigation season, based on previous analysis conducted by NMOSE. Projected seasonal reference evapotranspiration was then calculated for each year in the model simulation period, and projected crop evapotranspiration over the simulation period was calculated by adjusting the year-2000 crop evapotranspiration in accordance with projected variations in annual reference evapotranspiration. Crop irrigation requirement was then calculated by subtracting effective precipitation during the irrigation season from calculated crop evapotranspiration. This approach assumes constant cropping pattern, acreage, and crop coefficients over the simulation period, with variations in crop evapotranspiration driven only by to variations in reference evapotranspiration.

  The distribution of irrigated lands within the model domain is based on geospatial data available for the year 2000 and was held constant over the simulation period. This approach assumes that irrigated lands remain in production for the duration of the simulation and therefore are independent of Project surface-water supply.

  For simulations performed in support of the EIS, it is assumed that all irrigated lands have physically and legally unrestricted access to sufficient supplemental groundwater to fully meet the consumptive irrigation requirement on the land, and therefore that crop irrigation requirement is fully met throughout the simulation period. This approach allows the model to compute groundwater pumping for irrigation as the difference between the total farm delivery required to meet the crop irrigation requirement and the actual quantity of Project surface-water delivered to farms. The assumption that crop irrigation requirement is fully met throughout the simulation period is consistent with assumptions used in previous analyses (SSPA 2007, Hanson et al. 2013). This assumption may over-estimate groundwater deliveries in cases where actual well locations and capacities limit actual groundwater use.

- *Non-Irrigation Water Demands in Rincon and Mesilla Valleys*

  Non-irrigation water uses in Rincon and Mesilla Valleys include municipal, industrial, and domestic uses by the City of El Paso, City of Las Cruces, the Santa Teresa development, several smaller mutual domestic associations and local water agencies, and individual domestic water users. Non-irrigation water demands in the Rincon and Mesilla Valleys are met exclusively from groundwater. In order to develop projections of future groundwater withdrawals for non-irrigation purposes over the model simulation period, it was necessary to make assumptions regarding the location and quantity of groundwater extracted for municipal, industrial, and domestic uses.

  For simulations performed in support of the EIS, it is assumed that the location and quantity of groundwater pumping for non-irrigation uses over the simulation period will be consistent with historical uses over the period 1995-2004. Time-varying model inputs for non-irrigation groundwater pumping were developed based on model inputs for the period 1995-2004 in a previous model version developed by NMOSE (SSPA 2007). Locations of non-irrigation wells were adopted directly from the previous model version, and the seasonal pumping rate for each non-irrigation well was set equal to the well's average seasonal pumping rate during the period 1995-2004 for irrigation and non-irrigation seasons, respectively. Seasonal non-irrigation pumping rates were held constant over the simulation period. This assumption implies that any population and economic growth during the simulation period will be accompanied by reductions in per capita water demand such that total non-irrigation demands remain constant at average 1995-2004 levels.

- *Non-Project Releases from Elephant Butte Reservoir.*

  Releases of non-Project water from Project storage are limited to the direct release from Caballo Dam to Bonita Private Lateral and reservoir spills under flood conditions. Non-Project releases to Bonita Private Lateral serve irrigation demands in the northern Rincon Valley between Caballo Dam and Percha Dam. RMBHM does not simulate demand-driven non-Project releases; rather, non-Project releases are represented as a time-varying input. For simulations performed in support of the EIS, it is assumed that non-Project releases are constant for each season over the model simulation period. Non-Project releases during the irrigation season were approximated based on the average annual non-Project release during recent years (2001 through 2010); non-Project releases during this period are consistent with the long-term average non-Project releases over the period 1950-2010. Consistent with recent historical records, non-Project releases during the non-irrigation season are assumed to be zero.

- *Project Water Demands in El Paso Valley*

  Project water demands in El Paso Valley are not explicitly simulated in RMBHM. In order to represent Project diversions at American Dam to American Canal, a diversion demand was specified at the heading of American Canal. RMBHM then simulates Project diversions to American Canal based on the specified diversion demand and the simulated diversion allocation available to EPCWID; water diverted to American Canal is subsequently routed out of the model domain. This approach allows RMBHM to simulate Project diversions to American Canal without explicitly simulating water demands and routing of Project surface water to delivery points for use in El Paso Valley, which lies outside of the model spatial domain.

  For simulations performed in support of the EIS, it is assumed that Project demands in the El Paso Valley portion of EPCWID can be adequately represented as a diversion demand at the American Canal heading, as opposed to end-user demands at points of delivery (e.g., farm or municipal delivery requirement). In addition, it was assumed that future diversion demands over the simulation period will be consistent with recent diversions in years when Project allocation to EPCWID was equal to or greater than the district's historical full allocation of 376,842 acre-feet under prior operating practices. The EPCWID diversion demand for American Canal was therefore calculated based on historical gross diversions to American Canal for the years 2007-2010. The diversion demand for American Canal was specified as constant for all irrigation seasons over the simulation period.

  The diversion demand used here represents the expected maximum diversion to American Canal under full-supply conditions. It should be noted that simulated actual diversions to American Canal are curtailed (reduced) when the simulated diversion allocation available to EPCWID is less than full. Simulated diversions are constrained such that for each year, the sum of diversion charges and credits to EPCWID are less than or equal to the district's total diversion allocation for that year.

- *Project Water Demands for Delivery to Mexico*

  Project water demands in Mexico are not explicitly simulated in RMBHM. In order to represent Project deliveries to the heading of the Acequia Madre for diversion to Mexico, a diversion demand was specified at the downstream-most segment of the Rio Grande represented on the model domain, located at Paso del Norte, approximately 1.5 miles upstream of International Dam. RMBHM then simulates Project deliveries to Mexico based on the specified diversion demand and the simulated diversion allocation available to Mexico; water delivered to Paso del Norte for diversion to Mexico is subsequently routed out of the model domain.

  For simulations performed in support of the EIS, it is assumed that Project deliveries to the heading of the Acequia Madre are always equal to the annual Project allocation to Mexico, where the annual allocation to Mexico is calculated based on the D1 Curve as described above in Section 4. In the event of a discrepancy between diversion allocation and actual water available for diversion, delivery to Mexico takes priority over diversions to serve Project lands in the United States. This assumption is consistent with historical operations and ensures that Project obligations to deliver water to the heading of the Acequia Madre according to the 1906 Convention are satisfied.

- *Project Water Accounting for Diversions in Rincon and Mesilla Valleys*

  As summarized in Section 6.2, the surface water network in the Rincon and Mesilla valleys is represented in RMBHM as a network of discrete segments and reaches. Larger channels are represented explicitly in the model, whereas smaller channels are not represented explicitly. As a result, several smaller Project diversions in the Rincon and Mesilla valleys are not explicitly represented in the simulated Project accounting. These smaller diversions include the Del Rio Lateral, which receives water at Mesilla Diversion Dam, and pumping of surface water directly from the Rio Grande at several locations. These smaller diversions and the corresponding accounting charges are lumped with the major diversions represented explicitly in the model (Percha Lateral, Arrey Canal, Leasburg Canal, Eastside Canal, Westside Canal, American Canal, and Acequia Madre).

- *Project Water Accounting for Diversions to El Paso Valley*

  Project water accounting involves the calculation of charges and credits to the Project allocation balances of EBID, EPCWID, and Mexico representing each entity’s use of Project surface-water supplies. Allocation charges represent the amount of Project water diverted from the Rio Grande and thus not available for downstream diversion, and allocation credits represent the amount of water returned to the Rio Grande that contributes to the supply available for downstream diversions (see Section 4).

Actual charges and credits to EPCWID's Project allocation balance for water delivered to El Paso Valley are based on water orders and deliveries at four locations served by American Canal: the intakes to the Umbenhaurer-Robertson and Jonathon W. Rogers water treatment facilities and the headings of Riverside and Franklin Canals. RMBHM specifies a diversion demand at American Canal and simulates diversion of Project water at American Dam to the heading of American Canal; however, routing and delivery of Project water to accounting points in El Paso Valley is not explicitly represented (see previous assumption regarding water demands for El Paso Valley).

In order to represent allocation charges and credits to EPCWID for Project water diverted to El Paso Valley, RMBHM approximates allocation charges and credits by multiplying simulated gross diversions to American Canal by a constant charge factor and credit factor, respectively. Charge and credit factors are specified as inputs to RMBHM. The charge factor represents the charge in acre-feet against EPCWID's water allotment balance per acre-foot of water diverted at the heading of the American Canal. Similarly, the credit factor represents the credit, in acre-feet, to EPCWID's water account per acre-foot of water diverted. The use of charge and credit factors allows RMBHM to represent charges and credits to EPCWID for water diverted to El Paso Valley without explicitly routing water to the four delivery locations listed above.

For simulations performed in support of the EIS, charge and credit factors were calculated based on records of gross diversions and charges to EPCWID in El Paso Valley during recent years when the Project diversion allocation to EPCWID was greater than or equal to the district's historical full allocation of 376,842 AF under prior operating practices (2007-2010). The charge factor was calculated as the ratio of total annual Project charges to EPCWID for El Paso Valley divided by the annual gross diversion at American Canal, averaged over the period 2007-2010. Similarly, a credit factor was calculated as the ratio of total annual credits to EPCWID for El Paso Valley divided by the annual gross diversion at American Canal, averaged over the same period. Based on recent Project records, a charge factor of 0.908 and credit factor of 0.086 were used for simulations performed to support the EIS.

- *Surface Water Inflows below Caballo Dam*

Surface water inflows to the Rio Grande within the RMBHM model domain—i.e., between Caballo Dam and Paso del Norte—include storm runoff and treated effluent from wastewater treatment facilities. Storm runoff originates primarily in the mountains bordering the Rincon and Mesilla valleys and reaching the valleys via ephemeral arroyos, with minor contributions from local runoff within the valleys. Neither comprehensive records nor estimates of storm runoff exist within the RMBHM model domain; however, previous studies suggest that storm runoff accounts for a small fraction of the total water entering the basins (Conover 1954, SSPA 2007). Given the lack of available data, storm runoff is neglected in RMBHM.

Records of treated effluent returned to the river system are available for Las Cruces, NM and Anthony, TX. Previous modeling efforts represented treated effluent as a time-varying inflow to the Rio Grande, with seasonal effluent rates based on historical records (SSPA 2007). For simulations performed to support the EIS, the rate of effluent discharge to the Rio Grande was assumed to be constant over the simulation period (2007-2050), with effluent rates calculated as the average rate over the period 1995-2004. This assumption implies that effluent reaching the Rio Grande will not be affected by potential population and economic growth during the simulation period.

- *Calculation of San Juan-Chama Project Water in Elephant Butte Reservoir*

The quantity of SJC Project water in Elephant Butte Reservoir is calculated using a spreadsheet post-processing tool. Input to the post-processing tool includes Project storage in Elephant Butte and Caballo reservoirs simulated by RMBHM, as well as Rio Grande Compact credit water and area-capacity-elevation tables for Elephant Butte and Caballo reservoirs used as input to RMBHM. The post-processing tool uses these inputs to compute the amount of SJC Project water in Elephant Butte, which is calculated as the lesser of the available storage (reservoir capacity minus reservoir storage at each time step) and 50,000 AF.

This post-processing approach is based on two assumptions. First, Rio Grande Project water and Rio Grande Compact credit water in Elephant Butte are not affected by storage of SJC Project water. As a result, the amount of SJC Project water in Elephant Butte Reservoir is limited to the lesser of the contractual storage volume (50,000 acre-feet) and the available storage in Elephant Butte Reservoir. This approach implies that Project water is not released from Elephant Butte to allow for additional storage of SJC Project water in Elephant Butte, even if additional storage is available in Caballo Reservoir. Similarly, this approach implies that Rio Grande Compact credit water is not relinquished or released to allow for storage of SJC Project water.

Second, this post-processing approach assumes that SJC Project contractors will fully utilize their contractually available storage. Analysis of San Juan-Chama Project operations and availability of SJC Project water for storage in Elephant Butte Reservoir is beyond the scope of the modeling and analysis described here. It is therefore assumed that SJC Project contractors will fully utilize the contractually available storage.

- *Consistent Representation of Project Operating Procedures over Simulation Period*

  Historically, Project operating procedures have been modified and improved over time to reflect changes in operating priorities and responsibilities between Reclamation, EBID, and EPCWID, and to respond to changes in hydrologic, climatic, and regulatory conditions affecting the Project. The OA allows for modification of the operating procedures defined in the OA and corresponding Operations Manual, provided that all parties to the OA agree to the modifications.

  It is not possible to anticipate future modifications to Project operating procedures that may occur during the remaining term of the OA through December 31, 2050. For simulations performed in support of the EIS, it was therefore assumed that operating procedures would remain consistent over the full simulation period.

7 Summary of Model Output

RMBHM was used to simulate each of five EIS alternatives (see Section 5) under each of three selected projections of future climate and hydrologic conditions (see Section 6.4). Formatted model outputs for selected hydrologic and operational parameters are provided as Appendix A of this technical memorandum; complete model files and unformatted model outputs are provided as Appendix B.

Model outputs are provided to support analysis of the potential effects of alternative Project operating procedures and SJC Project storage contracts on Project operations and surface-water and groundwater resources in the Rincon and Mesilla Basins as part of the EIS. A brief summary of key findings from the model simulations performed in support of the EIS is provided below. Detailed analysis of model results will be performed as part of the EIS and is beyond the scope of this memorandum.

(1) Project Storage: For each climate scenario, the rate and timing of simulated fluctuations in total storage and Project storage in Elephant Butte and Caballo reservoirs are qualitatively similar across all EIS alternatives. Results suggest that EIS alternatives are not likely to have a strong effect on Project storage or total annual Project releases.

(2) Project Diversions and Deliveries: Project diversions and deliveries to EBID vary between EIS alternatives; by contrast, diversions and deliveries to EPCWID exhibit little sensitivity to alternative allocation and accounting procedures. Differences in Project diversions and deliveries to EBID between EIS alternatives are consistent with the diversion ratio provision of the OA, which maintains the annual Project diversion

allocation to EPCWID based on the D-2 Curve and adjusts the annual Project diversion allocation to EBID to account for changes in Project performance (see Section 4). Results suggest that EIS alternatives are likely to affect the magnitude of surface water depletions due to groundwater pumping in the Rincon and Mesilla Valleys, annual Project performance, the quantity of surface water diversions to EBID, and the distribution of Project diversions between EBID and EPCWID.

(3) Total Farm Deliveries (Surface Water + Groundwater): As discussed in Sections 6.2 and 6.5, simulations carried out in support of the EIS assume that crop irrigation requirements are met in full: irrigation requirement that is not satisfied by Project surface-water deliveries is met through supplemental groundwater deliveries. Groundwater deliveries to irrigated lands represent supplemental groundwater pumping by individual farmers, as authorized by the States; groundwater pumping is neither performed nor authorized by the Federal project, and the model does not represent groundwater pumping by either irrigation district. Combined total delivery of Project surface-water and supplemental groundwater to Project lands in Rincon and Mesilla Valleys is, therefore, nearly identical under all alternatives. However, since the deliveries of Project surface-water vary between alternatives, the portion of total deliveries and consumptive use met by Project surface-water varies accordingly. Results suggest that the proposed alternatives do not affect the total delivery and consumptive use within EBID and the portion of EPCWID in the Mesilla Valley, but do affect the portion of deliveries and consumptive use met by Project surface-water.

(4) Groundwater Levels and Project Performance: Groundwater levels in the Rincon and Mesilla Basins exhibit seasonal declines (drawdown) during the irrigation season and multi-year declines during sustained dry periods under all alternatives, with corresponding seasonal recovery during the non-irrigation season and multi-year recovery during sustained wet periods. Project performance, as represented by the annual diversion ratio, exhibits similar multi-year behavior, with declines during sustained dry spells and recovery during sustained wet spells. Declines in groundwater levels and Project performance are greatest under alternatives that include the diversion ratio adjustment provision of the OA (Alternatives 1, 2, and 3). However, groundwater levels and Project performance recover to approximately the same level during sustained wet spells under all alternatives. Results suggest that the diversion ratio adjustment provision of the OA may result in increased declines in groundwater levels and Project performance during sustained dry periods, but that these effects are temporary and do not results in permanent effects on groundwater resources or Project performance.

(5) Climate Uncertainties: For each EIS alternative, Project storage, releases, diversions, and deliveries vary substantially between the three climate

scenarios. In addition, relative differences in storage, releases, diversions, and deliveries between alternatives also vary between climate scenarios. Results suggest that uncertainties in future Project operations resulting from uncertainties in future climate and hydrologic conditions are substantially larger than the estimated effects of proposed allocation and accounting alternatives.

To support further analysis for the EIS, formatted simulation results for key operational and hydrologic parameters are provided in graphical and tabular form as a digital appendix to this memorandum; operational and hydrologic parameters included in the attached simulation results are briefly described below and are listed in detail in Table 2 (below). All data provided in the digital appendix are RMBHM model output for the operating alternatives and climate scenarios described herein; corresponding historical records for the parameters listed below and in Table 2 are not provided here.

- *Reservoir Storage, Elevation, and Area:*

  Monthly storage in Elephant Butte and Caballo reservoirs, including storage of Project water, Rio Grande Compact credit water, and SJC Project water. Monthly reservoir surface elevation and area for Elephant Butte Reservoir, computed from monthly total storage using the current area-capacity-elevation tables for Elephant Butte Reservoir.

- *Releases:*

  Annual release from Caballo Dam, including releases for Project diversions, spills, and non-Project deliveries to Bonita Private Lateral.

- *Project Diversions:*

  Annual Project surface-water diversions from the Rio Grande, including gross diversions at each Project canal heading and net diversions to each canal service area. Project canal headings include Percha Lateral, Arrey Canal, Leasburg Canal, Eastside Canal, Westside Canal, American Canal, and Acequia Madre. Canal service areas include Percha Lateral, Arrey Canal, Leasburg Canal, Eastside Canal in New Mexico, Westside Canal in New Mexico, Eastside Canal in Texas, Westside Canal in Texas, American Canal, and Acequia Madre

- *Project Deliveries:*

  Annual Project surface-water deliveries to Project lands in EBID and to Project lands in the Mesilla Valley portion of EPCWID.

- *Groundwater Deliveries:*

  Annual Supplemental groundwater deliveries to Project lands in EBID and to Project lands in the Mesilla Valley portion of EPCWID.

- *Project Performance Metrics:*

  Annual Project performance metrics, including the Project diversion ratio and service area delivery efficiencies. The Project diversion ratio is calculated as the sum of gross annual Project allocation charges divided by annual Project releases from Caballo Dam. Service area delivery efficiencies are calculates as the total Project surface-water delivery divided by the net surface-water diversion to each service area.

Model results for the parameters listed above are presented, in graphical and tabular form, in a digital appendix to this memorandum.

Table 2: Summary of Formatted Operational and Hydrologic Parameters Provided in Appendix A

Parameter Name	Description	Workbook(s) / Worksheet(s)
Annual Allocated Water	Diversion allocations to EBID and EPCWID determined during each year based on usable water available for current year allocation. Annual allocated water is updated each month throughout the year. **Alternatives 1, 2, 3**: Annual Allocated Water is computed based on the D1 and D2 equations, adjusted for current-year actual project performance per the diversion ratio provision of the Operating Agreement. **Alternatives 4, 5**: Annual Allocated Water is computed based on the D1 and D2 equations, without adjustment.	ALLOCATION.xlsx / EBID Annual ALLOCATION.xlsx / EPCWID Annual
Carryover Water	Diversion allocations to EBID and EPCWID determined at start of each year based on the allotment balance remaining at the end of the previous year **Alternatives 1, 2, 4**: Carryover Water is computed at the start of each water year from each district’s unused allocation balance at the end of the previous year per the carryover provision of the Operating Agreement; Carryover Water is then held constant over the year. **Alternatives 3, 5**: Carryover Water is equal to zero.	ALLOCATION.xlsx / EBID Carryover ALLOCATION.xlsx / EPCWID Carryover

Parameter Name	Description	Workbook(s) / Worksheet(s)
Total Diversion Allocation	Total diversion allocations to EBID, EPCWID, and Mexico each year. **Alternatives 1-5**: Total diversion allocations to EBID and EPCWID are equal to the sum of each district's respective Annual Allocated Water and Carryover Water. Total diversion allocation to Mexico is calculated based on the D1 regression equation as specified in the Operating Agreement.	ALLOCATION.xlsx / EBID Total ALLOCATION.xlsx / EPCWID Total ALLOCATION.xlsx / MEXICO Total
Total Storage	Total volume of water in Elephant Butte and Caballo reservoirs at the end of each month (acre-feet). **Alternatives 1, 3, 4, 5**: Total storage computed as sum of Project water, Rio Grande Compact credit water, and San Juan-Chama Project water in Elephant Butte Reservoir and Project water in Caballo Reservoir; Rio Grande Compact credit water adopted from URGIA; Rio Grande Project water simulated by RMBHM; San Juan-Chama water storage computed via post-processing. **Alternatives 2**: Total storage computed as sum of Project water and Rio Grande Compact credit water in Elephant Butte Reservoir and Project water in Caballo Reservoir; Rio Grande Compact credit water adopted from URGIA; Rio Grande Project water simulated by RMBHM; no San Juan-Chama Project water is stored in this alternative.	RESERVOIR_STORAGE.xlsx / STORAGE Total

Parameter Name	Description	Workbook(s) / Worksheet(s)
Project Storage	Total volume of Project water in Elephant Butte and Caballo reservoirs at the end of each month, exclusive of Rio Grande Compact credit water and San Juan-Chama Project water (acre-feet) **Alternatives 1-5**: Total storage computed as sum of Project water in Elephant Butte and in Caballo Reservoirs; Rio Grande Project water simulated by RMBHM.	RESERVOIR_STORAGE.xlsx / STORAGE ElephantButte.Project RESERVOIR_STORAGE.xlsx / STORAGE Caballo.Project
Elephant Butte Storage	Total volume of water in Elephant Butte Reservoir at the end of each month, including Project water, Rio Grande Compact credit water, and San Juan-Chama Project water (acre-feet) **Alternatives 1, 3, 4, 5**: Total Elephant Butte storage computed as sum of Project water, Rio Grande Compact credit water, and San Juan-Chama Project water in Elephant Butte Reservoir; Rio Grande Compact credit water adopted from URGIA; Rio Grande Project water simulated by RMBHM; San Juan-Chama water storage computed via post-processing. **Alternative 2**: Total Elephant Butte storage computed as sum of Project water and Rio Grande Compact credit water; Rio Grande Compact credit water adopted from URGIA; Rio Grande Project water simulated by RMBHM; no San Juan-Chama Project water is stored in Elephant Butte Reservoir under Alternative 2.	RESERVOIR_STORAGE.xlsx / STORAGE ElephantButte.Project RESERVOIR_STORAGE.xlsx / STORAGE ElephantButte.RGCC RESERVOIR_STORAGE.xlsx / STORAGE ElephantButte.SJC Project RESERVOIR_STORAGE.xlsx / STORAGE ElephantButte.Total

Parameter Name	Description	Workbook(s) / Worksheet(s)
Elephant Butte Elevation	Water surface elevation of Elephant Butte Reservoir at the end of each month (feet above mean sea level). **Alternatives 1-5**: Reservoir elevation computed from Elephent Butte storage using Elephant Butte Reservoir area-capacity-elevation relationship (Reclamation 2007, Reclamation 2008a).	RESERVOIR_ELEVATION.xlsx / ELEVATION ElephantButte
Elephant Butte Surface Area	Reservoir surface area of Elephant Butte Reservoir at the end of each month (acres). **Alternatives 1-5**: Reservoir surface area computed from Elephent Butte storage using Elephant Butte Reservoir area-capacity-elevation relationship (Reclamation 2007, Reclamation 2008a).	RESERVOIR_AREA.xlsx / AREA ElephantButte
Project Release	Total volume of Project water released from Caballo Dam during each year to meet Project diversion demands (acre-feet). **Alternatives 1-5**: Project release simulated by RMBHM.	RELEASE.xlsx / RELEASE Project
Non-Project Release	Total volume of non-Project water released Caballo Dam during each year for non-Project purposes (acre-feet). **Alternatives 1-5**: Non-Project release specified as input to RMBHM.	RELEASE.xlsx / RELEASE Non-Project

Parameter Name	Description	Workbook(s) / Worksheet(s)
Spill Release	Total volume of water released from Caballo Dam as reservoir spills during each year (acre-feet). **Alternatives 1-5**: Project release simulated by RMBHM.	RELEASE.xlsx / RELEASE Spill
River Release	Total volume of water released from Caballo Dam to the Rio Grande during each year (acre-feet). **Alternatives 1-5**: Total Release is calculated as the sum of Project and spill releases; non-Project water is released directly to Bonita Private Lateral.	RELEASE.xlsx / RELEASE RiverTotal
Total Release	Total volume of water released from Caballo Dam during each year (acre-feet). **Alternatives 1-5**: Total Release is calculated as the sum of Project, non-Project, and spill releases.	RELEASE.xlsx / RELEASE Total

Parameter Name	Description	Workbook(s) / Worksheet(s)
Gross Diversions	Total volume of Project surface-water diverted from the Rio Grande at canal headings for Percha Canal, Arrey Canal, Leasburg Canal, Eastside Canal, Westside Canal, American Canal, and Acequia Madre and summed over headings; total volume of Project surface-water diverted to EBID at river headings; total volume of water diverted to EPCWID at river headings and bypass locations; total volume of water diverted to Mexico at river headings (acre-feet). **Alternatives 1-5**: Gross diversions simulated by RMBHM.	DIVERSION_GROSS.xlsx / Gross Diversion PERCHA LATERAL DIVERSION_GROSS.xlsx / Gross Diversion ARREY CANAL DIVERSION_GROSS.xlsx / Gross Diversion LEASBURG CANAL DIVERSION_GROSS.xlsx / Gross Diversion EASTSIDE CANAL DIVERSION_GROSS.xlsx / Gross Diversion WESTSIDE CANAL DIVERSION_GROSS.xlsx / Gross Diversion AMERICAN CANAL DIVERSION_GROSS.xlsx / Gross Diversion ACEQUIA MADRE DIVERSION_GROSS.xlsx / Gross Diversion EBID DIVERSION_GROSS.xlsx / Gross Diversion EPCWID DIVERSION_GROSS.xlsx / Gross Diversion MEXICO
Net Diversions	Net surface-water diversion to each district (acre-feet). **Alternatives 1-5**: Net diversions calculated for each district as gross diversions minus water bypassed to a downstream district or to the Rio Grande. NOTE: Net diversions to EPCWID calculated for Mesilla Valley only.	DIVERSION_NET.xlsx / Net Diversion EBID DIVERSION_NET.xlsx / Net Diversion EPCWID (R&M Only)

Parameter Name	Description	Workbook(s) / Worksheet(s)
Farm Surface Water Deliveries	Total volume of surface-water delivered to farms (i.e., take out of conveyance and applied to irrigated lands; acre-feet). **Alternatives 1-5**: Farm surface-water deliveries simulated by RMBHM. NOTE: Farm surface-water deliveries to EPCWID calculated for Mesilla Valley only.	FARM_SW_DELIVERY.xlsx / SW Delivery EBID FARM_SW_DELIVERY.xlsx / SW Delivery EPCWID (R&M Only)
Farm Groundwater Deliveries	Total volume of groundwater delivered to farms (i.e., groundwater pumping for supplemental irrigation; acre-feet). **Alternatives 1-5**: Farm groundwater deliveries simulated by RMBHM. NOTE: Farm groundwater deliveries to EPCWID calculated for Mesilla Valley only.	FARM_GW_DELIVERY.xlsx / GW Delivery EBID FARM_GW_DELIVERY.xlsx / GW Delivery EPCWID (R&M Only)
Farm Consumptive Use	Total volume of water consumed by irrigated agriculture through evapotranspiration from crops within EBID and EPCWID (acre-feet). **Alternatives 1-5**: Farm consumptive use simulated by RMBHM. NOTE: Farm consumptive use by EPCWID calculated for Mesilla Valley only.	FARM_CONSUMPTIVE_USE.xlsx / FarmConsumptiveUse EBID FARM_CONSUMPTIVE_USE.xlsx / FarmConsumptiveUse EPWID (R&M)

Parameter Name	Description	Workbook(s) / Worksheet(s)
Farm Deep Percolation	Total volume of deep percolation below the root zone in irrigated areas within EBID and EPCWID (acre-feet). **Alternatives 1-5**: Farm deep percolation simulated by RMBHM. NOTE: Farm deep percolation in EPCWID calculated for Mesilla Valley only.	FARM_DEEP_PERCOLATION.xlsx / FarmDeepPercolation EBID FARM_DEEP_PERCOLATION.xlsx / FarmDeepPercolation EPWID(R&M)
Farm Net Recharge	Total volume of net recharge below the root zone in irrigated areas within EBID and EPCWID (acre-feet). **Alternatives 1-5**: Farm net recharge simulated by RMBHM as deep percolation minus farm well pumping minus direct uptake of groundwater by crops. NOTE: Farm net recharge in EPCWID calculated for Mesilla Valley only.	FARM_NET_RECHARGE.xlsx / FarmNetRecharge EBID FARM_NET_RECHARGE.xlsx / FarmNetRecharge EPWID(R&M)
Seepage Recharge	Total volume of recharge to groundwater from stream seepage within EBID and EPCWID (acre-feet). **Alternatives 1-5**: Seepage recharge simulated by RMBHM using SFR package in MODFLOW-OWHN; seepage summed over stream segments within each district. NOTE: Seepage recharge within EPCWID calculated for Mesilla Valley only.	SEEPAGE_RECHARGE.xlsx / SEEPAGE RECHARGE EBID SEEPAGE_RECHARGE.xlsx / SEEPAGE RECHARGE EPWID(R&M)

Parameter Name	Description	Workbook(s) / Worksheet(s)
Groundwater Head (timeseries)	Monthly groundwater head (water table elevation) at selected locations corresponding to monitoring wells in the Rincon and Mesilla valleys (feet above mean sea level). **Alternatives 1-5**: Groundwater head simulated by RMBHM. <u>NOTE</u>: See worksheet 'WELL LOCATIONS' for description of well locations, depths, and distance from the Rio Grande.	HEAD.xlsx / <Well-ID>
Groundwater Head (grids)	Spatially distributed groundwater heads in the upper model layer (layer 1) at selected times throughout the simulation period (feet above mean sea level). **Alternatives 1-5**: Groundwater head simulated by RMBHM.	HEAD.Grid_<YEAR>.xlsx / <Alternative>.<Scenario>
Diversion Ratio	Annual diversion ratio for Rio Grande Project, computed as total annual Project diversions at river headings divided by total annual Project release (dimensionless). **Alternatives 1-5**: Calculated from sum of simulated annual gross diversions and annual releases.	CONVEYANCE.xlsx / DivRatio

Parameter Name	Description	Workbook(s) / Worksheet(s)
Delivery Efficiency	Annual delivery efficiency for each district, computed as total annual Project surface-water delivery divided by total net surface-water diversion for each district (dimensionless). **Alternatives 1-5**: Calculated from sum of simulated annual surface-water deliveries and net diversions. NOTE: Delivery efficiency for EPCWID calculated for Mesilla Valley only.	CONVEYANCE.xlsx / DeliveryEfficiency EBID CONVEYANCE.xlsx / DeliveryEfficiency EPCWID (R&M)

8 References

Congressional Research Service, 2015. U. S. – Mexico Water Sharing: Background and Recent Developments, Congressional Research Service document 7-5700, January 23, 2015.

Conover, C.S. 1954. Ground-water Conditions in the Rincon and Mesilla Valleys and Adjacent Areas in New Mexico. U.S. Geological Survey, Washington, DC: US GPO, 1954.

Dastane, N.G. 1978. Effective Rainfall in Irrigated Agriculture. FAO Irrigation and Drainage Paper No. 25, FAO, Rome, Italy, http://www.fao.org/docrep/x5560e/x5560e00.htm

D'Antonio, J.R. 2004. Order of the Office of the State Engineer, State of New Mexico, in the Matter of the Requirements for Metering Groundwater Withdrawals in the Lower Rio Grande Watermaster District, New Mexico, December 3, 2004.

D'Antonio, J.R. 2005. Active Water Resources Management in the Lower Rio Grande: Tools for a New Era in Water Management. Lower Rio Grande Water Users Organization, August 19, 2005.

Ferguson, I.M., R.T. Hanson, S.E. Boyce, D. Llewellyn. 2014. Fully-Integrated Simulation of Conjunctive Use from Field to Basin Scales: Development of a Surface Water Operations Module for MODFLOW-OWHM. American Geophysical Union Fall Meeting 2014.

Hanson, R.T., S.E. Boyce, W. Schmid, J.D. Hughes, S.M. Meehl, S.A. Leake, T. Maddock, III, and R.G. Niswonger. 2014. One-Water Hydrologic Flow Model (MODFLOW-OWHM): U.S. Geological Survey Techniques and Methods 6-A51, 120 p., http://dx.doi.org/10.3133/tm6A51

Hanson, R.T., S.E. Boyce, W. Schmid, J. Knight, and T. Maddock, III. 2013. Integrated Hydrologic Modeling of a Transboundary Aquifer System – Lower Rio Grande. MODFLOW and More 2013: Integrated Hydrologic Modeling, Golden, Colorado, June 5-8, 2011.

Hargreaves, G.H. and Z.A. Samani. 1985. Reference crop Evapotranspiration from Temperature. Transaction of ASAE 1(2):96-99.

Hawley, J.W., J.F. Kennedy, and B.J. Creel (2001). The Mesilla Basin Aquifer System of New Mexico, West Texas, and Chihuahua—An Overview of its Hydrogeologic Framework and Related Aspects of Groundwater Flow and Chemistry, *in* Aquifers of West Texas: Texas Water Development Board Report 356, p76-99.

Hawley, J. W. and J. F. Kennedy. 2004. Creation of Digital Hydrologic Framework Model of the Mesilla Basin and Southern Jornada Del Muerto Basin, Report prepared for the Lower Rio Grande Water Users Organization.

Haywood, C.E. and R.M. Yager. 2003. Simulated Ground-Water Flow in the Hueco Bolson, and Alluvial-Basin Aquifer System near El Paso, TX. U.S. Geological Survey Water Resources Investigations Report 02-4108, 80p., http://pubs.usgs.gov/wri/wri02-4108/pdf/wrir02-4108.pdf.

Intergovernmental Panel on Climate Change (IPCC). 2000. Special Report on Emissions Scenarios. Page 599 in N. Nakicenovic and R. Swart, editors. Cambridge University Press. Cambridge, United Kingdom. Online: http://www.grida.no/climate/ipcc/emission/.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: The Physical Science Basis. Cambridge University Press, Cambridge, United Kingdom and New York, NY.

Judicial Branch of New Mexico. 2015. Website for Lower Rio Grande (LRG) Water Rights Adjudication. URL: https://lrgadjudication.nmcourts.gov. Accessed April 1, 2015.

Liang, X., D. P. Lettenmaier, E. F. Wood, and S. J. Burges. 1994. A Simple Hydrologically Based Model of Land Surface Water and Energy Fluxes for General Circulation Models. Journal of Geophysical Research 99(D7):14415–14428.

Liang X., E. F. Wood, and D. P. Lettenmaier. 1996. Surface Soil Moisture Parameterization of the VIC-2L Model: Evaluation and Modifications. Global Planet Change 13: 195-206.

Meehl, G. A., C. Covey, K. E. Taylor, T. Delworth, R. J. Stouffer, M. Latif, B. McAvaney, and J. F. B. Mitchell. 2007. The WCRP CMIP3 Multimodel Dataset: A New Era in Climate Change Research. Bulletin of the American Meteorological Society 88:1383-1394.

New Mexico Office of the State Engineer / Interstate Stream Commission. 2015. Active Water Resources Management (AWRM) Website. http://www.ose.state.nm.us/AWRM/index.php. Accessed April 20, 2015.

Nijssen, B., D.P. Lettenmaier, X. Liang, S.W. Wetzel, and E.F. Wood. 1997. Streamflow Simulation for Continental-Scale River Basins. Journal of Water Resources Research 33: 711–724.

Reclamation. 2007. Elephant Butte Reservoir Area and Capacity Tables. US Department of Interior, Bureau of Reclamation, Technical Service Center, October 2007, 58 pp.

Reclamation. 2008a. Elephant Butte Reservoir 2007 Sedimentation Survey. Technical Report No. SRH-2008-4, September 2008, 154 pp.

Reclamation. 2008b. Caballo Reservoir 2007 Sedimentation Survey. US Department of Interior, Bureau of Reclamation, Technical Service Center, May 2008, 37 pp.

Reclamation. 2011a. West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections. U. S. Department of the Interior, Bureau of Reclamation Technical Memorandum No. 86-68210-2011-01, Denver, Colorado.

Reclamation. 2011b. SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water Report to Congress. 2011. U.S. Department of the Interior, Bureau of Reclamation, Office of Policy and Administration, Denver, Colorado.

Reclamation. 2013. Upper Rio Grande Impact Assessment, U. S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, Albuquerque Area Office, Albuquerque, New Mexico

Reclamation, Elephant Butte Irrigation District (EBID), and El Paso County Water Improvement District No. 1 (EPCWID). 2008. Operating Agreement for the Rio Grande Project; March 10, 2008. Available at URL: http://www.usbr.gov/uc/albuq/rm/RGP/pdfs/Operating-Agreement2008.pdf

Reclamation, Elephant Butte Irrigation District (EBID), and El Paso County Water Improvement District No. 1 (EPCWID). 2012. Rio Grande Project – Operations Manual. Revised May 8, 2012.

S.S. Papadopulos & Associates (SSPA). 2007. Groundwater Flow Model for Administration and Management in the Lower Rio Grande Basin (Draft). Technical Report prepared for the State of New Mexico.

Texas Water Code Section 36.002: http://www.weblaws.org/texas/laws/tex._water_code_section_36.002_ownership_of_groundwater. Accessed April 20, 2015.

Texas Water Development Board. 2015. Groundwater Management Area 5 Website. http://www.twdb.texas.gov/groundwater/management_areas/gma5.asp. Accessed April 20, 2015.

United States of America and Republic of Mexico. 1906. Convention between the United States and Mexico [for the] Equitable Distribution of the Waters of the Rio Grande; signed at Washington May 21, 1906, Ratification advised by the Senate June 26, 1906, Ratified by the President December 26, 1906, Ratified by Mexico January 5, 1907, Ratifications Exchanged at Washington January 16, 1907, Proclaimed January 16, 1907 by the President of the United States, Theodore Roosevelt.

Wood, A. W., L. R. Leung, V. Sridhar, and D. P. Lettenmaier. 2004. Hydrologic Implications of Dynamical and Statistical Approaches to Downscaling Climate Model Outputs. Climatic Change 15: 189-216.

Appendix A:

Formatted Model Results for Selected Operational and Hydrologic Parameters

Digital Appendix File List:

ALLOCATION.xlsx
CONVEYANCE.xlsx
DIVERSION_GROSS.xlsx
DIVERSION_NET.xlsx
FARM_CONSUMPTIVE_USE.xlsx
FARM_DEEP_PERCOLATION.xlsx
FARM_GW_DELIVERY.xlsx
FARM_NET_RECHARGE.xlsx
FARM_SW_DELIVERY.xlsx
HEAD.xlsx
RELEASE.xlsx
RESERVOIR_AREA.xlsx
RESERVOIR_ELEVATION.xlsx
RESERVOIR_STORAGE.xlsx
SEEPAGE_RECHARGE.xlsx
HEAD.GRID_2010.xlsx
HEAD.GRID_2020.xlsx
HEAD.GRID_2030.xlsx
HEAD.GRID_2040.xlsx
HEAD.GRID_2050.xlsx

Appendix B:

Model Files and Unformatted Model Output

Digital Appendix File List[9]:

EIS.Alt1.ScenarioP25.zip
EIS.Alt1.ScenarioP50.zip
EIS.Alt1.ScenarioP75.zip
EIS.Alt3.ScenarioP25.zip
EIS.Alt3.ScenarioP50.zip
EIS.Alt3.ScenarioP75.zip
EIS.Alt4.ScenarioP25.zip
EIS.Alt4.ScenarioP50.zip
EIS.Alt4.ScenarioP75.zip
EIS.Alt5.ScenarioP25.zip
EIS.Alt5.ScenarioP50.zip
EIS.Alt5.ScenarioP75.zip

[9] Alternatives 1 and 2 utilize the same Rio Grande Project operating procedures and differ only with respect to storage of SJC Project water (see Section 5). RMBHM model files and unformatted output for Alternative 1 are used to evaluate Alternative 2; differences between Alternative 1 and Alternative 2 occur during post-processing of SJC Project water in Elephant Butte Reservoir. Post-processed storage results for Alternatives 1 and 2 are provided in Appendix A.

Addendum:

Additional Documentation of Model Software

This addendum provides additional documentation of the integrated hydrologic modeling software used by RMBHM.

As summarized in Section 6.1 of this technical memorandum, RMBHM uses a version of the MODFLOW One Water Hydrologic Flow Model (MODFLOW-OWHM) that has been enhanced with additional software features developed and implemented by Reclamation in collaboration with USGS. These new software features provide the capability to simulate Rio Grande Project (Project) surface-water operations, including Project storage, allocation, release, diversion, delivery, and water accounting. New features are linked to existing features of MF-OWHM, including the Farm Process (FMP) and streamflow routing package (SFR), to allow dynamic simulation of both surface-water and groundwater management and use.

The new software features used by RMBHM to simulate Project surface-water operations are the basis of the newly developed Surface Water Operations Process (SWO) for MODFLOW-OWHM (Reclamation 2015)[1]. SWO was developed as a collaborative effort between the Reclamation and USGS to allow dynamic simulation of large-scale surface-water management within MODFLOW-based hydrologic models. By simulating large-scale water management within the integrated hydrologic framework of MODFLOW-OWHM, SWO allows for simulation and analysis of two-way feedbacks between groundwater and surface-water management and use. As summarized in Section 6.1, the new features provided by SWO allow for analysis of the effects of reservoir operations and surface-water distribution on groundwater recharge and demand, as well as effects of groundwater use on surface-water availability, conveyance, and management. Detailed documentation of SWO is provided by Reclamation (2015).

As described in Section 3.5 of Reclamation (2015), SWO requires the user to specify a project-specific allocation procedure in the form of a Fortran subroutine compiled with the MODFLOW-OWHM source code. Four allocation subroutines were developed for RMBHM corresponding to each of the four allocation alternatives considered in the Rio Grande Project Operating Agreement EIS (see Section 5 of this technical memorandum). The allocation procedure for Alternative 1 calculates annual diversion allocations to EBID, EPCWID, and

[1] Reclamation (2015). User Guide to the Surface Water Operations Process: An Integrated Approach to Simulating Large-Scale Surface Water Management in MODFLOW-Based Hydrologic Models. U.S. Department of the Interior, Bureau of Reclamation, Technical Memorandum No. 86-68210-2016-02; Denver, CO; December 2015.

Mexico according to the procedures specified in the Rio Grande Project Operating Agreement (Reclamation et al. 2008) and the corresponding Operations Manual (Reclamation et al. 2012). The allocation procedure was subsequently modified for Alternatives 3, 4, and 5 as summarized in Section 5 of this technical memorandum.

In addition to the allocation subroutines developed for each alternative, the version of SWO used by RMBHM exhibits minor differences compared to the description provided by Reclamation (2015). These differences are summarized below.

Changes to SWO Input Files:
The version of SWO used by RMBHM exhibits minor changes to the SWO inputs compared to the detailed description provided by Reclamation (2015). These changes do not affect the calculations performed by SWO. Changes to inputs include:

- **SWO Key Word**
  Reclamation (2015) describes the SWO input file as being read from the MODFLOW name file. The version of SWO used by RMBHM instead reads the SWO input file from within the input file for the Farm Process (FMP). In this version, SWO is activated by specifying the key word "SWOPS" in the FMP input file following the list of surface-water flags in Item 2(c) (see Hanson et al. 2014, Appendix A). If the key word "SWOPS" is included in the FMP file, then the file path and filename of the SWO input file are read from the following line of the file.

- **SWO Input Items**
  The version of SWO used by RMBHM includes several input items that are not included in the description provided by Reclamation (2015). These inputs were anticipated to be used by SWO in surface-water allocation and accounting calculations. The final version of SWO, however, did not actually use these inputs in any calculations; the inputs were therefore removed from the general SWO input file described by Reclamation (2015). These inputs are present in the input files for RMBHM used in support of the EIS and are therefore described below. These input items do not affect any of the calculations performed by SWO as described by Reclamation (2015).

  <u>Input Item 8: Allocation Options</u>
  Chapter 5 of Reclamation et al. (2015) defines Item 8 of the SWO input file as consisting of a single allocation option **AllocDate** that specifies the day of year for the first day of the water year as a decimal date. The RMBHM input file includes two input flag in Item 8, read from the same line. The additional option in the RMBHM input file is read as an integer value before **AllocDate** (i.e., the unused option is the first item on this line

of the SWO input file). This item was intended to specify the allocation type used in a given simulation; however, SWO ultimately requires that the allocation procedure be specified by the user as a Fortran subroutine. As a result, this option is not used. However, this option must be present in the SWO input files for RMBHM or an error will occur when reading the input file.

Input Item 9: SWO Reservoir Dimensions
Chapter 5 of Reclamation (2015) defines Item 9 of the SWO input file as consisting of a single list of integers **IRESFL(NPROJ)** specifying the number of reservoirs for each project. The RMBHM input file includes a second input list in Item 9, read from the line following **IRESFL(NPROJ)**. The second list was intended to specify whether a given reservoir is linked to the General Head Boundary Package (GHB) to a head boundary corresponding to the reservoir surface elevation. The linkage between SWO and GHB was not implemented in the initial version of SWO described by Reclamation (2015) and is therefore not described in Chapter 5 of that document. However, this option must be present in the SWO input files for RMBHM or an error will occur when reading the input file.

Input Item between Item 9 and Item 10: Grid Index Arrays
The RMBHM input file includes four additional input items between Items 9 and 10 described by Reclamation (2015), each read from a separate line of the SWO input file. Each of the four inputs between Items 9 and 10 is a two-dimensional array of integer index values. These arrays were intended to define which grid cells in the model are associated with each *project*, *division*, *unit*, and FMP-linked *beneficiary* defined in the model (see Reclamation (2015), Chapter 2). These index arrays ultimately are not used by SWO in any calculations; as a result, they were removed from the SWO input file described by Reclamation (2015). However, all four arrays must be present in the SWO input files for RMBHM or an error will occur when reading the input file.

Changes to SWO Output Files:
The version of SWO used by RMBHM includes one additional output file that is not included in the general version of SWO described by Reclamation (2015). The additional input file is similar to the *service area* output file described in Chapter 6 of Reclamation (2015), which provides detailed information of surface-water demands, delivery and diversion orders, and actual diversions and deliveries for each *service area* represented in a given model. The additional output file in the version of SWO used by RMBHM, however, provides similar information for all conveyance network junctions within all *service areas* represented in the model. This additional output file was added to SWO for RMBHM in order to evaluate the distribution of water demands and supplies at a finer spatial scale, including distribution of water through the branched conveyance network within

each *service area*. This output file provides additional information for evaluating surface-water distribution and does not affect the calculations performed by SWO.

Changes to SWO Diversion Order Calculation:
The version of SWO used by RMBHM includes one change to the calculations performed by SWO compared to those described by Reclamation (2015). This change only applies to the proportionate reduction of *service area* diversion orders under over-allocated conditions—i.e., in cases where the reservoir release required to meet diversion orders exceeds the maximum possible release of project water for the current time step. As described in Reclamation (2015), in cases where the maximum project release is less than the demand-driven project release—i.e., in cases where the user-specified allocation procedure for the given *project* results in over-allocated conditions—all surface-water diversion orders served by the reservoir are reduced proportionately. This calculation was modified for RMBHM to reduce only the diversion orders for EBID and EPCWID, without reducing the delivery order for Mexico. This change was made to ensure that Mexico receives its full entitlement each year under the Convention of 1906.

Appendix D. Consultation and Coordination Correspondence

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

IN REPLY REFER TO:

ALB-150
ENV-6.00

SEP 16 2013

Interested Parties (See Enclosed List)

Subject: Invitation to Participate as a Cooperating Agency for an Environmental Impact Statement on Certain Actions within the Rio Grande Project

Dear Ladies and Gentlemen:

The Bureau of Reclamation is preparing an environmental impact statement (EIS), pursuant to the National Environmental Policy Act (NEPA), to analyze the environmental effects of continued implementation of the Rio Grande Project Operating Agreement (OA) over its entire remaining term, through 2050. In addition, this EIS will evaluate the environmental effects of renewing San Juan Chama Project storage contracts under authority of the Act of December 29, 1981, 97, 95 Stat. 1717 in Elephant Butte Reservoir.

Reclamation is responsible for coordinating the preparation of the EIS, for the administrative tasks associated with the NEPA process, and for making the final decisions, according to our authorities. The Council on Environmental Quality NEPA Implementing Regulations (40 CFR 1500-1508) call for lead agencies to reduce paperwork and delay; and eliminate duplication with state and local procedures by inviting participation of cooperating agencies to prepare an EIS. Cooperating agencies assume certain responsibilities, which may include participating in the scoping process, developing applicable information, supporting environmental analyses, and assisting the lead agency with preparation of the EIS on those topics that pertain to the cooperating agency's jurisdiction by law or special expertise.

We invite you to participate in preparing this EIS as a cooperating agency because we believe your agency or organization may have jurisdiction by law or special expertise, with respect to this actions and/or issues to be considered in this EIS. Please provide a written response by October 4, 2013, to indicate your interest in becoming a cooperating agency. In your response, please specify a point of contact. Should you request to participate as a cooperating agency, we will provide a Memorandum of Understanding (MOU) template. The MOU, which is executed through signature by Reclamation and the cooperating agency, defines the roles, responsibilities, points of contact, and other requirements and agreements, for both Reclamation and the cooperating agency.

If you have any questions about the project; or for additional information, please contact Ms. Rhea Graham at 505-462-3560 or at rgraham@usbr.gov. Thank you for your interest and consideration.

Sincerely,

Mike A. Hamman
Area Manager

Enclosure

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education activities, scientific research projects, boundary marking, and enforcement of existing regulations. There would be no manipulation of the marsh other than emergency, safety-related, or limited improvements or maintenance actions. The destabilized marsh would continue to erode at an accelerated rate.

Alternative B: Hydrologic Restoration and Minimal Wetland Restoration—Under alternative B, the focus is on the most essential actions to reestablish hydrologic conditions that shield the marsh from erosive currents and protect the Hog Island Gut channel and channel wall. A breakwater structure would be constructed on the south end of the marsh, in alignment with the northernmost extent of the historic promontory, and wetlands would be restored to strategic areas where the water is less than 4 feet deep. This alternative also includes fill of some deep channel areas near the breakwater. The final element of this alternative is the reestablishment of hydrologic connections to the inland side of the Haul Road to restore bottomland swamp forest areas that were cut off when the Haul Road was constructed. Approximately 30 acres west of the Haul Road could be influenced by tidal flows as a result. These actions would not necessarily happen in any particular order, and may be dictated by available funds. However, it is assumed that the breakwater would be constructed first. This alternative would create approximately 70 acres of various new wetland habitats and allow the continued natural accretion of soils and establishment of wetlands given the new hydrologic conditions.

Alternative C: Hydrologic Restoration and Fullest Possible Extent of Wetland Restoration (NPS Preferred Alternative)—Under alternative C, the marsh would be restored in a phased approach up to the historic boundary of the marsh and other adjacent areas within NPS jurisdictional boundaries. Phased restoration would continue until a sustainable marsh is achieved and the overall goals of the project are met. The historic boundaries lie between the historic promontory and Dyke Island, the triangular island off the end of the Haul Road. The outer edges of the containment cell structures would be placed at the park boundary in the river.

The initial phase of this alternative would first establish a breakwater structure at the southern alignment of the historic promontory to provide immediate protection to Dyke Marsh from erosion. After the breakwater is established, the deep channel areas north of the historic promontory would be filled within the NPS boundary, and the marsh would be restored to the 4-foot contour at strategic locations to further reduce the risk of erosion and storm surges and promote sedimentation within the existing marsh. Afterwards, two cells would be constructed along the northern edge of the breakwater, restoring the original extent of the promontory's land mass.

All subsequent phases would establish containment cells out no further than the historic marsh boundary. The location of these cells would be prioritized based on the most benefits the specific locations could provide to the existing marsh. The timing of these subsequent phases and the size and number of cells built during these phases would be dependent upon available funds and materials.

In addition to the construction of containment cells, tidal guts would be cut into the restored marsh area that would be similar to the historical flow channels of the original marsh.

This alternative, like Alternative B, would also introduce breaks in the Haul Road, returning tidal flows to approximately 30 acres west of the Haul Road, which would help to re-establish the historic swamp forest originally found on the site.

Additional wetland may be restored south of the new breakwater to fill out the southernmost historic extent of the marsh. This area would not be protected from storms, and would be one of the last features implemented. In addition, the marsh restoration would extend north of Dyke Island, and tidal guts would be created. This alternative contains an optional restoration cell in the area currently serving as a mooring area for the marina. Such an option would only be implemented should the marina concession no longer be economically viable for the current concessioner, and then only if no other concessioner expresses interest in taking over the business, which would eliminate the need for the mooring field. In total, under this alternative, approximately 245 acres of various wetland habitats could be created.

Dated: October 21, 2013.

Stephen E. Whitesell,

Regional Director, National Park Service, National Capital Region.

[FR Doc. 2014–00633 Filed 1–14–14; 8:45 am]

BILLING CODE 4310–DL–P

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[14XR0680A1, RX.00236101.0021000, RR04313000]

Notice of Intent To Prepare an Environmental Impact Statement and Announcement of Public Scoping Meetings for Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent.

SUMMARY: The Bureau of Reclamation is issuing this notice to advise the public that an environmental impact statement (EIS) will be prepared for the proposed continued implementation of the 2008 Operating Agreement over its entire remaining term (through 2050) for the Rio Grande Project in New Mexico and Texas. The Operating Agreement is a written detailed description of how Reclamation allocates, releases from storage, and delivers Rio Grande Project water to users within the Elephant Butte Irrigation District (EBID) in New Mexico, the El Paso County Water Improvement District No. 1 (EPCWID) in Texas, and to users covered by the 1906 international treaty with Mexico. In addition, this EIS proposes to evaluate the environmental effects of renewing San Juan Chama Project storage contracts under authority of the Act of December 29, 1981, Pub. L. 97–140, 95 Stat. 1717, providing for storage in Elephant Butte Reservoir.

DATES: Comments on the scope of the EIS must be received by February 14, 2014.

Three public scoping meetings will be held to solicit public input on the scope of the EIS, potential alternatives, and issues to be addressed in the EIS. See the **SUPPLEMENTARY INFORMATION** section for meeting dates.

ADDRESSES: Written comments regarding the scope and content of the EIS should be sent to Ms. Rhea Graham, Bureau of Reclamation, Albuquerque Area Office, 555 Broadway NE., Suite 100, Mail Stop ALB–103, Albuquerque, New Mexico 87102, or provided via email at *rgraham@usbr.gov.*

Those not desiring to submit comments or suggestions at this time, but who would like to receive a copy of the EIS, should contact Ms. Graham using the information cited above. See the **SUPPLEMENTARY INFORMATION** section for locations of public scoping meetings.

FOR FURTHER INFORMATION CONTACT: Ms. Rhea Graham, Bureau of Reclamation;

telephone 505–462–3560; email at *rgraham@usbr.gov.* Individuals who use a telecommunications device for the deaf may call the Federal Information Relay Service (FIRS) at 1–800–877–8339 to contact Ms. Graham during normal business hours. The FIRS is available 24 hours a day, 7 days a week, to leave a message or question with Ms. Graham. You will receive a reply during normal business hours.

SUPPLEMENTARY INFORMATION: Pursuant to the National Environmental Policy Act, Reclamation will serve as the lead federal agency for preparation of the EIS on the continued implementation of the Operating Agreement for the Rio Grande Project, New Mexico and Texas. The responsible official for this action is Reclamation's Upper Colorado Regional Director.

Background

The Rio Grande Project includes Elephant Butte and Caballo dams and reservoirs, a power generating plant, and five diversion dams (Percha, Leasburg, Mesilla, American, and International) located on the Rio Grande in New Mexico and Texas. The Rio Grande Project was authorized by Congress under the authority of the Reclamation Act of 1902 and the Rio Grande Project Act of February 25, 1905. The Rio Grande Project Operating Agreement was signed in 2008 to allocate Rio Grande Project water, which includes water stored in Elephant Butte and Caballo reservoirs and return flows to the Rio Grande between the EBID in the Rincon and Mesilla valleys of New Mexico and the EPCWID in the Mesilla and El Paso valleys of Texas and Mexico. The Rio Grande Project also provides water to Mexico under the 1906 international treaty. Rio Grande Project water is provided by Reclamation to irrigate a variety of crops and for municipal and industrial water uses.

Purpose and Need for Action

The purpose and need for action is to meet contractual obligations to EBID and EPCWID to implement a written set of criteria and procedures for allocating, delivering, and accounting for Rio Grande Project water to both districts consistent with their rights under applicable law each year in compliance with various court decrees, settlement agreements, and contracts. These include the 2008 Compromise and Settlement Agreement among Reclamation, EBID, and EPCWID, and contracts between the United States and the EBID and EPCWID. The purpose and need of an ancillary but potentially similar action is to implement the provisions of the Act of December 29, 1981, to allow the storage of San Juan-Chama project water acquired by contract with the Secretary of the Interior pursuant to Public Law 87–483 in Elephant Butte Reservoir.

Proposed Action

The proposed federal action is to continue to implement the 2008 Operating Agreement for the Rio Grande Project over the remaining term (through 2050), and a potentially similar action under 40 CFR 1508.25, to implement long-term contracts for storage of San Juan-Chama water in the Rio Grande Project.

Scoping Process

This notice initiates the scoping process which guides the development of the EIS. To ensure that the full range of issues related to this proposed action are addressed and all significant issues identified, comments and suggestions are invited from all interested parties. Comments or questions concerning this proposed action and the EIS should be directed to Reclamation using the contact information provided above. To be most effective, written comments should be received prior to the close of the comment period and should clearly articulate the commentor's concerns.

Dates and Addresses of Public Scoping Meetings

The scoping meeting dates and addresses are:

- Thursday, January 30, 2014, 3:00 p.m. to 5:00 p.m., Bureau of Reclamation, Albuquerque Area Office, 555 Broadway NE., Suite 100, Albuquerque, New Mexico 87102
- Friday, January 31, 2014, 6:00 p.m. to 8:00 p.m., Elephant Butte Irrigation District, 530 South Melendres Street, Las Cruces, New Mexico 88005
- Saturday, February 1, 2014, 9:00 a.m. to 11:00 a.m., Bureau of Reclamation, El Paso Field Division, 10737 Gateway West, Suite 350, El Paso, Texas 79935

Special Assistance for Public Scoping Meetings

If special assistance is required at the scoping meetings, please contact Ms. Graham at 505–462–3560 or email at *rgraham@usbr.gov.* Please notify Ms. Graham at least two weeks in advance of the meeting to enable Reclamation to secure the needed services. If a request cannot be honored, the requestor will be notified.

Public Disclosure

Before including your address, phone number, email address, or other personal identifying information in your comment, please be advised that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Dated: November 5, 2013.

Brent Rhees,

Deputy Regional Director—Upper Colorado Region, Bureau of Reclamation.

[FR Doc. 2014–00476 Filed 1–14–14; 8:45 am]

BILLING CODE 4310–MN–P

INTERNATIONAL TRADE COMMISSION

[Investigation No. 337–TA–904]

Certain Acousto-Magnetic Electronic Article Surveillance Systems, Components Thereof, and Products Containing Same; Institution of Investigation Pursuant to 19 U.S.C. 1337

AGENCY: U.S. International Trade Commission.

ACTION: Notice.

SUMMARY: Notice is hereby given that a complaint was filed with the U.S. International Trade Commission on December 11, 2013, under section 337 of the Tariff Act of 1930, as amended, 19 U.S.C. 1337, on behalf of Tyco Fire & Security GmbH of Switzerland; Sensormatic Electronics, LLC of Boca Raton, Florida; and Tyco Integrated Security, LLC of Boca Raton, Florida. A letter supplementing the complaint was filed on December 23, 2013. The complaint alleges violations of section 337 based upon the importation into the United States, the sale for importation, and the sale within the United States after importation of certain acousto-magnetic electronic article surveillance systems, components thereof, and products containing same by reason of infringement of U.S. Patent No. 5,729,200 (''the '200 patent'') and U.S. Patent No. 6,181,245 (''the '245 patent''). The complaint further alleges that an industry in the United States exists as required by subsection (a)(2) of section 337.

The complainants request that the Commission institute an investigation and, after the investigation, issue a general exclusion order and cease and desist orders.

ADDRESSES: The complaint, except for any confidential information contained therein, is available for inspection

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, UT 84138-1102

IN REPLY REFER TO:
ALB-103
ENV-3.00

JUN 24 2014

Honorable Frederick Chino, Senior
Mescalero Apache Tribe of the
Mescalero Reservation
P.O. Box 227
Mescalero, NM 88340

Subject: Request for Consultation on Environmental Impact Statement (EIS), (Action by August 15, 2014)

Dear President Chino:

The purpose of this letter is to consult with the Mescalero Apache Tribe of the Mescalero Reservation during the preparation of the EIS for the proposed continued implementation of the 2008 Operating Agreement over its entire remaining term (through 2050) for the Rio Grande Project in New Mexico and Texas. The operating agreement is a written detailed description of how the Bureau of Reclamation allocates, releases from storage, and delivers Rio Grande Project water to users within the Elephant Butte Irrigation District (EBID) in New Mexico, the El Paso County Water Improvement District No. 1 (EPCWID) in Texas, and to users covered by the 1906 international treaty with Mexico. In addition, the EIS proposes to evaluate the environmental effects of renewing San Juan-Chama Project storage contracts under authority of the December 29, 1981, Act, Public Law 97-140, 95 Statute 1717, providing for storage in Elephant Butte Reservoir.

Reclamation's goal is to complete National Environmental Policy Act of 1969 (NEPA) compliance, in the form of a Record of Decision after completion of the EIS, no later than December 31, 2015, in order to annotate the results in the water operations manual for the Rio Grande Project before the start of the 2016 irrigation season. The enclosed Notice of Intent to prepare an EIS was issued on January 15, 2014, and scoping comments were received from two agencies. We are preparing a scoping report, and hope to award a contract for EIS preparation by October 1, 2014.

During the preparation of the Supplemental Environmental Assessment (SEA) covering the 2008 Operating Agreement from 2013-2015, the Mescalero Apache Tribe was the only tribe offering comments. The SEA is available at: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/Final-SuppEA.pdf. As noted on page 76 of that document, "... in response to a Reclamation scoping letter, the Mescalero Apache Tribe had concerns with native plants growing along the irrigation canals in the service areas of the EBID and EPCWID. The Mescalero Tribe collects plant material for cultural purposes."

The EIS will build on the SEA analyses and findings along with other appropriate analyses. Please advise if you prefer a consultation meeting with your Tribal Council, or at some other venue. We are contacting you in accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, for recommended options to facilitate further coordination. A reply by August 15, 2014, regarding your preference for consultation would be appreciated.

Please contact Ms. Rhea Graham, Special Project Officer at 505-462-3560, to request a consultation with either myself or Mr. Mike Hamman the Albuquerque Area Office Manager.

Sincerely,

Larry Walkoviak
Regional Director

Enclosure

VIA ELECTRONIC MAIL

cc: Rene Cochise, Superintendent
Mescalero Agency
P.O. Box 189
Mescalero, NM 88340
Rene.cochise@bia.gov

Mr. Mike Hamman, Area Manager
Albuquerque Area Office
Bureau of Reclamation
555 Broadway Avenue Northeast
Suite 100 (ALB-100)
Albuquerque, NM 87102
Mhamman@usbr.gov

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, UT 84138-1102

IN REPLY REFER TO:
ALB-103
ENV-3.00

JUN 24 2014

Honorable Frank Paiz
Ysleta Del Sur Pueblo
Tribal Council Office
P.O. Box 17579
El Paso, TX 79907

Subject: Request for Consultation on Environmental Impact Statement (EIS), (Action by August 15, 2014)

Dear Governor Paiz:

The purpose of this letter is to consult with the Ysleta Del Sur Pueblo during the preparation of the EIS for the proposed continued implementation of the 2008 Operating Agreement over its entire remaining term (through 2050) for the Rio Grande Project in New Mexico and Texas. The operating agreement is a written detailed description of how the Bureau of Reclamation allocates, releases from storage, and delivers Rio Grande Project water to users within the Elephant Butte Irrigation District in New Mexico, the El Paso County Water Improvement District No. 1 in Texas, and to users covered by the 1906 international treaty with Mexico. In addition, the EIS proposes to evaluate the environmental effects of renewing San Juan-Chama Project storage contracts under authority of the December 29, 1981, Act, Public Law 97-140, 95 Statute 1717, providing for storage in Elephant Butte Reservoir.

Reclamation's goal is to complete the National Environmental Policy Act of 1969 (NEPA) compliance, in the form of a Record of Decision on the NEPA review after completion of the EIS, no later than December 31, 2015, in order to annotate the results in the water operations manual for the Rio Grande Project before the start of the 2016 irrigation season. The enclosed Notice of Intent to prepare an EIS was issued on January 15, 2014, and scoping comments were received from two agencies. We are preparing a scoping report, and plan to award a contract for EIS preparation by October 2014.

During the preparation of the Supplemental Environmental Assessment (SEA) covering the 2008 Operating Agreement from 2013-2015, the Pueblo of Ysleta del Sur did not offer comments. The SEA is available at: http://www.usbr.gov/uc/albuq/envdocs/ea/riogrande/op-Proced/Supplemental/Final-SuppEA.pdf. The EIS, will build on the SEA analyses and findings along with other appropriate analyses. Please advise if you prefer a consultation meeting with your Tribal Council, or some other venue. We are contacting you in accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, for recommended options to facilitate further coordination. A reply by August 15, 2014, regarding your preference for consultation would be appreciated.

Please contact Ms. Rhea Graham, Special Project Officer at 505-462-3560, to request a consultation with either myself or Mr. Mike Hamman the Albuquerque Area Office Manager.

Sincerely,

Larry Walkoviak
Regional Director

Enclosure

VIA ELECTRONIC MAIL

cc: Mr. John Antonio, Superintendent
Southern Pueblos Agency
1001 Indian School Road, Northwest
Albuquerque, NM 87104
John.antonio@bia.gov

Mr. Mike Hamman, Area Manager
Albuquerque Area Office
Bureau of Reclamation
555 Broadway Avenue, Northeast
Suite 100 (ALB-100)
Albuquerque, NM 87102
Mhamman@usbr.gov

BISON CONNECT

Graham, Rhea <rgraham@usbr.gov>

EIS on Operating Agreement for Rio Grande Project--Letter regarding consultation

1 message

Graham, Rhea <rgraham@usbr.gov> Wed, Oct 14, 2015 at 3:33 PM
To: sskin@mescaleroapachetribe.com

Sher,

Thank you for taking my call and for following up with President Danny Breuninger, Sr., regarding Reclamation's letter to the Mescalero Apache Tribe (attached). The Environmental Impact Statement (EIS) is for continuation of the Operating Agreement for the Rio Grande Project until 2050, and the Supplemental Environmental Assessment (sEA), available at: http://www.usbr.gov/uc/albuq/envdocs/ealriogrande/opProced/Supplemental/Final-SuppEA.pdf, was for continuation of the Operating Agreement for the Rio Grande Project from 2012-2015.

As noted on page 76 of that document, "... in response to a Reclamation scoping letter, the Mescalero Apache Tribe had concerns with native plants growing along the irrigation canals in the service areas of the EBID and EPCWID. The Mescalero Tribe collects plant material for cultural purposes." We intend to honor the Mescalero Apache Tribe's response to the sEA going forward in the EIS. Our report on public scoping for this EIS can be viewed at: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

We are hoping to complete the Record of Decision before the start of the irrigation season, and anticipate publishing the Draft EIS in January 2016.

Thank you for your assistance.

Rhea

Rhea Graham, Special Project Officer

Bureau of Reclamation Albuquerque Area Office

555 Broadway N.E., Suite 100, Mail Stop ALB-103

Albuquerque, NM 87102

(505) 462-3560 (Office) (505) 221-0470 (Mobile) (505) 462-3793 (Fax)

http://www.usbr.gov/uc/albuq/rm/RGP/

PresChinoEIS.pdf
1638K

Graham, Rhea <rgraham@usbr.gov>

EIS on Operating Agreement for Rio Grande Project--Letter regarding consultation

1 message

Graham, Rhea <rgraham@usbr.gov> Wed, Oct 14, 2015 at 3:43 PM
To: svillarreal@ydsp-nsn.gov

Samantha,

Thank you for taking my call and for following up with Governor Carlos Hisa regarding Reclamation's letter to the Pueblo of Ysleta del Sur (attached). The Environmental Impact Statement (EIS) is for continuation of the Operating Agreement for the Rio Grande Project until 2050, and the Supplemental Environmental Assessment (sEA), available at: http://www.usbr.gov/uc/albuq/envdocs/ealriogrande/opProced/Supplemental/Final-SuppEA.pdf, was for continuation of the Operating Agreement for the Rio Grande Project from 2013-2015.

During the preparation of the Supplemental Environmental Assessment (SEA) covering the 2008 Operating Agreement from 2013-2015, the Pueblo of Ysleta del Sur did not offer comments. Our report on public scoping for this EIS can be viewed at: http://www.usbr.gov/uc/albuq/rm/RGP/EIS/RGOA-EIS-ScopingSummary.pdf.

We are hoping to complete the Record of Decision before the start of the irrigation season, and anticipate publishing the Draft EIS in January 2016.

Thank you for your assistance.

Rhea

Rhea Graham, Special Project Officer

Bureau of Reclamation Albuquerque Area Office

555 Broadway N.E., Suite 100, Mail Stop ALB-103

Albuquerque, NM 87102

(505) 462-3560 (Office) (505) 221-0470 (Mobile) (505) 462-3793 (Fax)

http://www.usbr.gov/uc/albuq/rm/RGP/

GovPaizEIS.pdf
1597K

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

ORIGINAL

102529

IN REPLY REFER TO:

ALB-180
ENV-3.00

OCT 29 2015

Jeff Pappas, PhD
Mr. Bob Estes
New Mexico State Historic Preservation Division
Department of Cultural Affairs
Bataan Memorial Building
407 Galisteo Street, Suite 236
Santa Fe, NM 87501

Subject: National Historic Preservation Act (NHPA) Section 106 Consultation for the Rio Grande Project Operating Agreement, Rio Grande Project, New Mexico (Action by 30 days of receipt of this letter)

Dear Dr. Pappas and Mr. Estes:

The Bureau of Reclamation initiated consultation with you in 2013 under Title 54 U.S.C. § 306108, commonly known as Section 106 of the NHPA and its implementing regulations found at 36 CFR Part 800, for the "Continued Implementation of the 2008 Operating Agreement for the Rio Grande Project, New Mexico and Texas." The Operating Agreement (OA) is a written description of how Reclamation allocates, releases from storage, and delivers Rio Grande Project water to users within the Elephant Butte Irrigation District (EBID) in New Mexico, the El Paso County Water Improvement District No. 1 in Texas, and to users covered by the 1906 international treaty with Mexico.

In 2013 Reclamation had determined that the continued implementation of the OA was an undertaking as defined in 36 CFR § 800.16(y). OA's are the type of activity that have the potential to cause effects on historic properties under 36 CFR § 800.3(a). On October 13, 2013, Dr. Estes sent us a letter declining our invitation to become a cooperating agency, but indicating his availability for continued consultation on the undertaking.

Since then Reclamation determined that the area of potential effects of the undertaking equates with the facilities of the Rio Grande Project, as shown in Figure 1. These include the federal facilities of Elephant Butte Dam, Caballo Dam, and five diversion dams, Percha, Leasburg, Mesilla, American, and International, and the non-federal facilities of the associated irrigation systems. It is our opinion that application of the Criteria for Evaluation and Effect has the results shown in the following table.

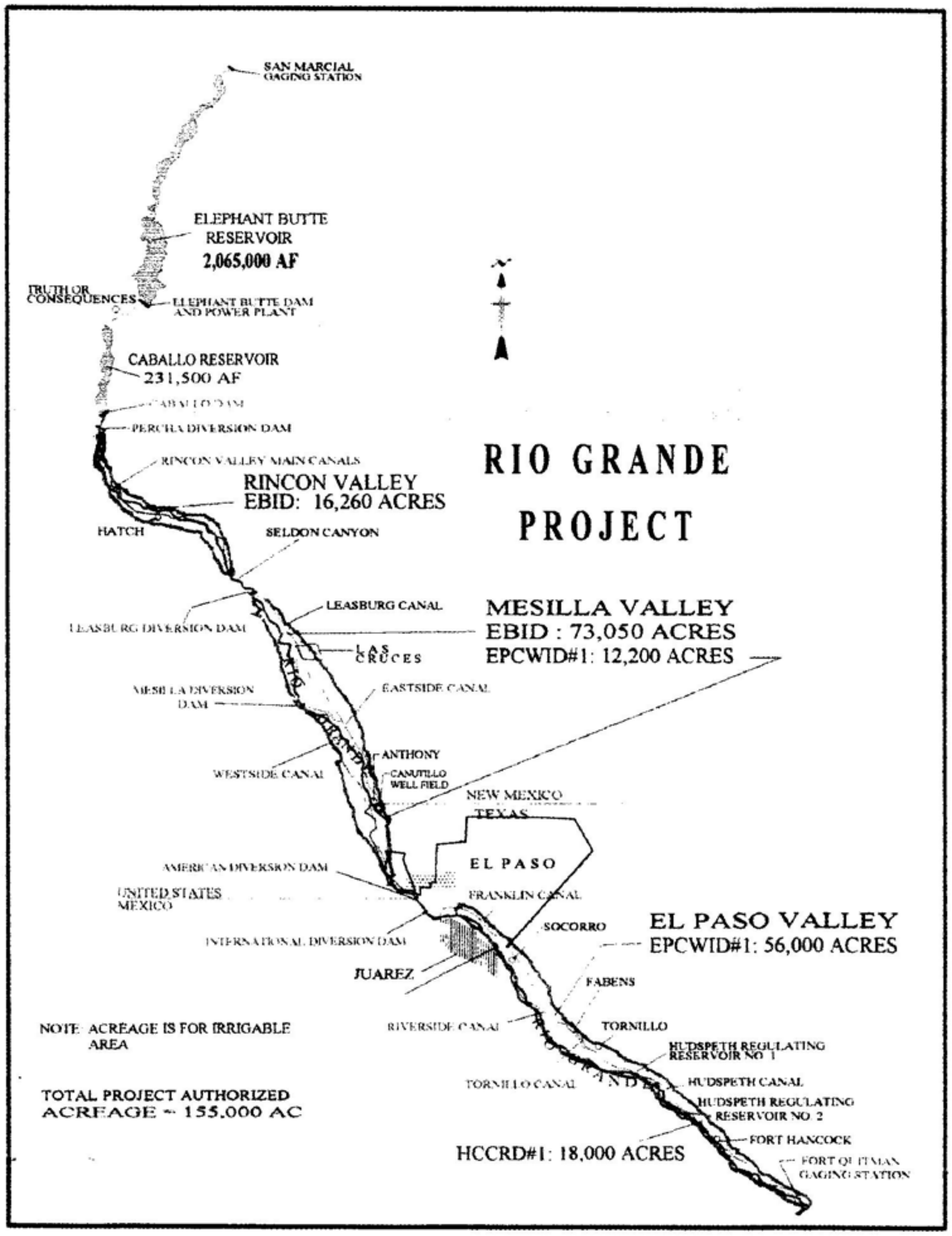

Figure 1: Map of the Rio Grande Project, showing all project facilities and area of potential effects.

Site Designation	Eligible	Criteria	Effect
Elephant Butte Dam, Sierra County, NM (NR ID 79001556)	Listed	A	No Historic Properties Affected
Percha Diversion Dam, Sierra County, NM (NR ID 789001555)	Listed	A	No Historic Properties Affected
Franklin Canal, El Paso County, TX (NR ID 92000696)	Listed	A	No Historic Properties Affected
Elephant Butte Irrigation District (NR 96001616)	Eligible	A,C	No Historic Properties Affected

Because the OA is merely a written algorithm regarding the process of accounting for storage and release of Rio Grande Project water, continuation of the agreement would not change the character or use of Rio Grande Project facilities. Reclamation has therefore concluded that a determination of "No Historic Properties Affected" pursuant to 36 CFR 800.4(d(1)) is appropriate for this undertaking.

We are submitting this finding to you. If we do not receive your response within 30 days of receipt of this letter, we shall assume your concurrence. As part of the National Environmental Policy Act review process, we have initiated consultation with two Native American Tribes to address our responsibilities at 36 CFR 800.2(c)(ii). We trust you will agree with this finding and seek your concurrence that the Section 106 consultation process has been successfully completed for the undertaking. If there are any questions, please contact Mr. Hector Garcia at 505-462-3550, or at hgarcia@usbr.gov.

Sincerely,

Jennifer Faler
Area Manager

Concur with recommendations as proposed.

Nov 20, 2015

for NM State Historic Preservation Officer

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

IN REPLY REFER TO:

AUG 20 2015

ALB-180
ENV 7.00

HAND DELIVERED

MEMORANDUM

To: U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, 2105 Osuna NE, Albuquerque, NM 87113
Attention: Mr. Wally Murphy

From: Jennifer Faler
Area Manager

Subject: Biological Assessment (BA) for the Bureau of Reclamation's Proposed Continuation of the Rio Grande Project Operating Agreement (RGOA) and for the Storage of San Juan-Chama (SJ-C) Project Water in Elephant Butte Reservoir (EBR), Rio Grande Project (RGP)

The attached BA is submitted to the U.S. Fish and Wildlife Service (Service) to address the potential effects of Reclamation continuing to implement the RGOA and storing SJ-C water in EBR; on the Southwestern Willow Flycatcher (*Empidonax traillii extimus*; flycatcher), the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*; cuckoo), the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*; mouse), and the Rio Grande silvery minnow (*Hybognathus amarus*, minnow).

The RGOA is a written description of how Reclamation allocates RGP water to Elephant Butte Irrigation District (EBID), El Paso County Water Improvement District No.1 (EPCWID), and Mexico; consistent with applicable water rights, state and federal laws, and international treaties. The RGP and the RGOA have a long and litigious history, culminating in 2007 with Reclamation and the two districts agreeing on operating procedures. In 2008, Reclamation and the two districts signed an agreement through 2050, the RGOA, and developed a written Operations Manual, which is reviewed annually. The RGOA largely reflects historical operation of the RGP, with two key changes. First, the RGOA provides carryover accounting for any unused portion of the annual diversion allocations to EBID and EPCWID. Second, the RGOA adjusts the annual allocations by calculating the diversion ratio. The diversion ratio represents the amount of allocation used per unit release of project water from Caballo Dam.

In addition to evaluating the effects of the RGOA, this BA evaluates the effects of a Reclamation contract for storage of SJ-C water in EBR. Currently, only the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA) has a contract for storage of a maximum of 50,000 acre feet per year of SJ-C water in EBR. In the future, other entities could enter into storage contracts, but the proposed action under consultation at this time is only for the ABCWUA long-term contract. Reclamation has limited discretion associated with normal EBR operations under the RGOA. Water stored in the RGP is the result of inflows dictated by Compact guidelines for New Mexico and Colorado. The needs of irrigators and irrigation delivery orders are non-discretionary and include treaty obligations to the Republic of Mexico. Irrigation release rates and times are determined by the two districts and Mexico, and are calculated to meet daily irrigation demands. Reclamation cannot restrict or increase releases to affect Article VII restrictions on upstream States. Reclamation's only discretionary actions associated with the RGOA are general operational guidelines and the two changes from historical operation mentioned above; the diversion ratio adjustments and the carry-over concept. Reclamation also has discretion over the storage of SJ-C water in EBR, and the timing of releases from EBR into Caballo Reservoir to maintain sufficient water in Caballo for irrigation demands.

Reclamation analyzed the RGOA from 2007 to 2012 with an Environmental Assessment (EA) and then from 2013 to 2015 with a Supplemental EA, both with an Endangered Species Act (ESA) determination of no effect. Throughout this period Reclamation was working on a model that could assess the RGOA for its duration through 2050 under an Environmental Impact Statement (EIS) process. Reclamation, in collaboration with the United States Geological Survey (USGS), developed the Rincon and Mesilla Basins Hydrological Model (based on the USGS's MODFLOW model) to project the effects of the RGOA and climate on water surface elevations in EBR.

Simulations were carried out using this model for three equally likely projections of future climate scenarios, including a drier scenario, a central tendency scenario, and a wetter scenario. Assuming these scenarios provide a reasonable representation of likely future climatic/hydrological conditions in the Rincon and Mesilla basins through 2050, the model results give an estimate of the expected frequency and duration of EBR at particular water surface elevations. From these elevations, we can extrapolate to effects on listed species. Reclamation's model at this time cannot separate the impacts of the RGOA, which has a much higher operational value during drought periods, from future climatic conditions. The model only projects what may happen through 2050 and is being updated in the next couple of years. For the flycatcher and cuckoo we have made a determination of "**may affect and likely to adverse affect**" the species and designated and proposed critical habitat. Since all impacts are based on a model that shows distinct EBR filling/emptying cycles, the analysis considers a range of impacts that could occur through 2050. However, the specific timing, duration, and magnitude of impacts is uncertain. Considering the current EBR water level and habitat elevation in EBR, the model under the three scenarios does not identify any adverse impacts to flycatchers and cuckoos for about 5-7 years. There is even a strong likelihood that the modeled cycles through 2050 would allow for vegetation to re-establish within EBR resulting in no net loss of habitat.

We request the Service issue a Biological Opinion (BO) that does not initially offer an incidental take statement (ITS), but that identifies a process to monitor and assess take over time. If the modeled cycles become reality, Reclamation proposes to assess potential impacts from a rising reservoir to flycatchers/cuckoos and their habitat prior to inundation, and would then seek an ITS from the Service. Reclamation would continue to monitor and assess during inundation, and specific reasonable prudent measures and terms and conditions would be identified after the reservoir recedes and the re-establishment of vegetation has been assessed.

In consideration of the information provided in the BA, our determination is that the proposed action would have **"no effect"** on the mouse or its critical habitat. For the minnow, a **"may affect, but not likely to adversely affect"** determination is warranted due to the ability of the minnow to move upstream, potentially into their critical habitat reach upstream of RM 62, whenever reservoir filling is of a sufficient magnitude and duration to produce such movement as modeled to occur after 2047.

We look forward to working cooperatively with your staff throughout this ESA consultation process to support the completion of a BO within the schedule for the associated EIS by spring 2016. Please direct any questions to Mr. Hector Garcia at 505-462-3550 or by email at hgarcia@usbr.gov.

Attachment

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

IN REPLY REFER TO:

ALB-180
ENV 3.00

NOV 18 2015

MEMORANDUM

To: U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, 2105 Osuna NE, Albuquerque, NM 87113
Attention: Mr. Wally Murphy

From: Jennifer Faler

Subject: Action Area for the Biological Assessment (BA) for the Bureau of Reclamation's Proposed Continuation of the Rio Grande Project Operating Agreement (RGOA) and for the Storage of San Juan-Chama (SJ-C) Project Water in Elephant Butte Reservoir (EBR), Rio Grande Project (RGP)

Reclamation submitted the subject BA to the U.S. Fish and Wildlife Service (Service) on August 20, 2015. The RGOA Environmental Impact Statement (EIS) will address the potential effects of Reclamation's proposal to continue through 2050, to implement the RGOA and to store SJ-C water in EBR. After several meetings with the Service, Reclamation is defining the action area under the subject BA to only cover that area with potential effects to federally listed or proposed species, which is EBR from full pool to dead pool.

Under the National Environmental Policy Act process, the area of analysis for the RGOA EIS is relatively limited within the broader RGP geographic area and varies by resource and resource issues. The provisions of the RGOA and storage contract do not include construction of any new facilities, or other actions that are physically different or that exceed the bounds of historic operations of the RGP.

As discussed by our staff, Reclamation will continue to update both the hydrological and biological models as they pertain to the RGP, and specifically for EBR. When both models are updated and new data is available, we will coordinate with your office. The value of the biological model will be based on existing and/or updated data from the hydrological model, as it applies to the current modeled period of EBR rising between 2021 and 2026.

We look forward to continued cooperation with your staff throughout this EIS process. Please direct any questions to Mr. Hector Garcia at 505-462-3550 or by e-mail at hgarcia@usbr.gov.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New Mexico Ecological Services Field Office
2105 Osuna Road NE
Albuquerque, New Mexico 87113
Telephone 505-346-2525 Fax 505-346-2542
www.fws.gov/southwest/es/newmexico/

December 3, 2015

Cons. #02ENNM00-2015-F-0734

Memorandum

To: Area Manager, Bureau of Reclamation, Albuquerque, New Mexico

From: David Campbell, Branch Chief, Large River Recovery and Restoration Programs, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico

Subject: Initiation of Formal Consultation in response to the Biological Assessment for the Bureau of Reclamation's Proposed Continuation of the Rio Grande Project Operating Agreement and for the Storage of San Juan-Chama Project Water in Elephant Butte Reservoir, Rio Grande Project

The U.S. Fish and Wildlife Service (Service) received the U.S. Bureau of Reclamation (Reclamation) Memorandum and Biological Assessment (BA) requesting the initiation of formal consultation on the Proposed Continuation of the Rio Grande Project Operating Agreement and for the Storage of San Juan-Chama Project Water in Elephant Butte Reservoir, Rio Grande Project (Lower Rio Grande Project) on August 21, 2015, held several meetings soon thereafter, and received a memorandum dated November 25, 2015. Correspondence since the submission of the BA has addressed the action area and biological models as requested by the Service. The information required of you to initiate consultation is now considered complete.

Section 7 allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion. However, we understand your abbreviated timeline and will attempt to accommodate that schedule.

For further correspondence associated with the Lower Rio Grande Project, please reference consultation number 02ENNM00-2015-F-0734. Please contact Ms. Vicky Ryan, Fish and Wildlife Biologist, at 505-761-4738 with any questions.

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Region
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

IN REPLY REFER TO:
ALB-180
ENV-7.00

FEB 19 2016

VIA HAND-DELIVERY

MEMORANDUM

To: Field Supervisor, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, 2105 Osuna NE, Albuquerque, New Mexico 87113
Attn: Mr. Wally Murphy

From: Jennifer Faler
Area Manager

Subject: Biological Opinion on Effects of Actions Associated With the "Proposed Continuation of the Rio Grande Project Operating Agreement and Storage of San Juan-Chama Project Water in Elephant Butte Reservoir, New Mexico", Consultation #02ENNM00-2015-F-0734, Rio Grande Project

Thank you for providing the Bureau of Reclamation with the subject Biological and Conference Opinion (BO), dated January 21, 2015 (sic, 2016). This BO is part of an ongoing Environmental Impact Statement, which requires review by Area and Regional Office staff and management. Your BO stated that it would be considered final within a 30-day period ending on February 22, 2016. I recently informally communicated with you requesting an extension of time before finalizing the BO. Reclamation has several comments that need to be resolved before finalization of the BO. Through this memorandum Reclamation is formally requesting a 30-day extension through March 22, 2016. Reclamation will seek to set up meetings shortly to discuss our comments on the BO.

We look forward to continued cooperation with your staff throughout this process. If you have any questions, please contact Mr. Hector Garcia at 505-462-3550 or by e-mail at hgarcia@usbr.gov.

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