



Supplemental Environmental Assessment

**Implementation of Rio Grande Project Operating
Procedures, New Mexico and Texas**

APPENDICES

June 21, 2013

Appendix A – 2008 Operating Agreement

Appendix A

2008 Operating Agreement for the Rio Grande Project

Dated March 10, 2008



IN REPLY REFER TO:

EP-100
PRJ-1.10

United States Department of the Interior

BUREAU OF RECLAMATION

El Paso Field Division
10737 Gateway West, Suite 350
El Paso, Texas 79935

MAR 10 2008

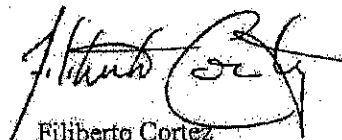
Mr. Gary Esslinger
Manager-Treasurer
Elephant Butte Irrigation District
P.O. Drawer 1509
Las Cruces, NM 88004-1509

Subject: Signed Rio Grande Project Operating Agreement

Dear Mr. Esslinger,

It is with extreme pleasure that I enclose for your files a signed Operating Agreement for the Rio Grande Project dated March 10, 2008. I offer my appreciation and congratulations to the Elephant Butte Irrigation District in helping to make the Operating Agreement possible.

Sincerely,


Filiberto Cortez
Manager

Enclosure

cc: Mr. Patrick R. Gordon
Commissioner
Rio Grande Compact Commission for Texas
P.O. Box 1917
El Paso, TX 79950-1917

Mr. Lee Leininger
US Department of Justice
Environment and Natural Resources Division
1961 Stout Street, Suite 800
Denver, CO 80294

Mr. Jesus Reyes
General Manager
El Paso County Water Improvement District No. 1
294 Candelaria
El Paso, TX 79907-5599

Mr. Chris Rich
Office of the Solicitor
125 South State Street, Rm 6201
Salt Lake City, UT 84138



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BUREAU OF RECLAMATION

El Paso Field Division
10737 Gateway West, Suite 350
El Paso, Texas 79935

MAR 10 2008

Mr. Jesus Reyes
General Manager
El Paso County Water Improvement District No. 1
294 Candelaria
El Paso, TX 79907-5599

Subject: Signed Rio Grande Project Operating Agreement

Dear Mr. Reyes,

It is with extreme pleasure that I enclose for your files a signed Operating Agreement for the Rio Grande Project dated March 10, 2008. I offer my appreciation and congratulations to the El Paso County Water Improvement District #1 in helping to make the Operating Agreement possible.

Sincerely,

Filiberto Cortez
Manager

Enclosure

cc: Mr. Gary Esslinger
Manager-Treasurer
Elephant Butte Irrigation District
P.O. Drawer 1509
Las Cruces, NM 88004-1509

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Salt Lake City, UT 84138

OPERATING AGREEMENT
FOR THE RIO GRANDE PROJECT

THIS OPERATING AGREEMENT ("Agreement") is entered into this 12th 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. Pam.); 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: 1) 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 EBID and EPCWID, 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:

$$Y = 0.8260932 (X) - 102,305 \quad (2-1)$$

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 entitled 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 EPCWID'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 Hypothetical Example of Full Allocation

1 Rio Grande Project Diversion Allocations	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	14,854
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 EPCWID 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 67/155th 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)	384,144
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 Project Hypothetical Example of Less than Full Allocation

1	Rio Grande Project Diversion Allocations	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	112,831
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 EPCWID Estimated Allocation Balance (End-of-Year)	-
16	Estimated Release of Current Usable Water	240,692
17	Estimated End-of-Year Release for Diversion Ratio	600,000
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 88/155th of Value in Row 30)	62,495
34	Total EPCWID Allocation (includes Row 21 and 67/155th 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 Allocations	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	$\text{MIN}(790000, [8] - [9])$
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 EPCWID 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	$\text{MAX}(0, ([16] * 0.8260832) - 102305)$
19	Mexico's Current Diversion Allocation	Calculated	$\text{MIN}(60000, [18] * 0.113486)$
20	Gross D2 Diversion Allocation	Calculated	$\text{MIN}(763842, [10]) * 1.3377884 - 89970 + \text{MAX}(0, [15] - 763842)$
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	$[22] * 87 / 155$
24	EPCWID Diversion Allocation (w/o Conservation Credit)	Calculated	$[23] + [21]$
25	EPCWID Diversion (w/o Conservation Credit or 67/155th of Row 30)	Calculated	$[24] - [14]$
26	Diversion Ratio	Calculated	$0.0000042113634 * [17] + 0.8946382$
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	$\text{IF}([16] < 600000, \text{MAX}(0, [31] - [29]), 0)$
31	EBID Diversion Ratio Allocation	Calculated	$[28] - [25] - [18] + [11] - [21]$
32	EBID Diversion Allocation	Calculated	$\text{IF}([16] < 600000, \text{MIN}([28], [31]), [31])$
33	Total EBID Diversion Allocation (includes 68/155th of Value in Row 30)	Calculated	$[32] + [11] + 68/155 * [30]$
34	Total EPCWID Allocation (includes Row 21 and 67/155th of Value in Row 30)	Calculated	$[24] + [30] * 87/155 + [21]$
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 EBID 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 amount of 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 5th 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 BBID 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 BBID 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 BBID 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 BBID, 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 ac-ft	Adjustment for Conveyance Losses for NM Deliveries ac-ft	Diversion Allocation Charges for Month ac-ft	Beginning-of-Month Totals ac-ft	End-of-Month Totals 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	38,293	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 Diversions 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	402,495
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			9775	63725
PERCHA LATERAL	93	508			93	508
LEASBURG CANAL	8739	67663			8739	67663
CALIFORNIA EXTENTION	0	353			0	353
EASTSIDE CANAL	7285	48677	311	1920	6984	46757
DEL RIO LATERAL	476	2989			476	2989
WESTSIDE CANAL	18793	135991	5267	41087	13526	94894
PUMPED FROM RIVER**	0	58			0	58
GROSS TOTAL	45171	319862	5578	43047	39593	276945
NET DIVERSION TO DATE						
TOTAL CHARGES (AC-FT)			39593	276945		
CREDIT AT ARREY (-)			1216	3882		
CREDIT AT LEASBURG (-)			0	233		
NET ALLOTMENT CHARGE			38,377	272,830		
DISTRICT ALLOTMENT				311,517		
DISTRICT BALANCE				36,687		

** 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:

R1 – Rio Grande Below Caballo – located on the east side of the river and approximately 0.8 mile downstream of Caballo Dam.

M2 – Rio Grande at 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.
- R10 - Rio Grand at Hayner Bridge - located approximately 8 miles east of Hatch, New Mexico on the Rio Grande just upstream of the Tenuco River crossing.
- R11 - Rincon Drain - located approximately 8 miles east of Hatch, New Mexico, 1 mile north of the Tenuco 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.

M13 – 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.

M16 – 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.

M17 – 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.

M19 – 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 1/2 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. 31B - 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 downstream 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.

E1 - American Canal - located off Paisano Drive on canal concrete lined channel just downstream of the Paisano Siphon and ASARCO plant.

E2 - Robertson/Umberhauer 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 E5 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.

E12 - 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 1 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 April, 2008.

Attest:

ELBPHANT BUTTE IRRIGATION DISTRICT

Willie Koehnig By: James Salopek
Willie Koehnig James Salopek
Secretary President

Attest:

EL PASO COUNTY WATER IMPROVEMENT
DISTRICT NO. 1

Inder Singh By: Johnny P. Stabbs
Inder Singh Johnny P. Stabbs
Secretary President of the Board of Directors

Attest:

UNITED STATES OF AMERICA

Christina B. B. B. By: Lucy Waldman
for Field Solicitor Regional Director
Upper Colorado Region
Bureau of Reclamation

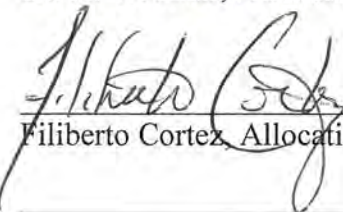
Appendix B – 2012 Operations Manual

**Recommendation of Changes to Rio Grande Project
Operation Manual Proposed on May 8, 2012**

F. 001-7
MAY 18 2012

 Date: 5/16/12
Dr. James Phillip King, Allocation Committee Member representing EBID

 Date: 5/20/12
Dr. A. W. Blair, Allocation Committee Member representing EPCWID

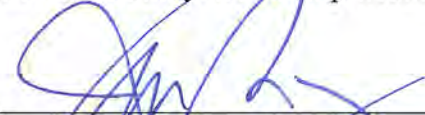
 Date: 5-18-12
Filiberto Cortez, Allocation Committee Member representing USA

**Approval of Changes to Rio Grande Project
Operation Manual Proposed on May 8, 2012**

Elephant Butte Irrigation District (EBID)

 Date: 5/16/12
Gary Esslinger, General Manager and Treasurer
(Approved at EBID's May __, 2012 Board Meeting)

El Paso County Water Improvement District No. 1 (EPCWID)

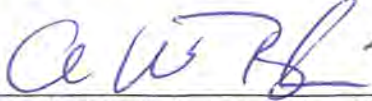
 Date: 5-7-12
Jesus Reyes, General Manager
(Approved at EPCWID's May 14, 2012 Board Meeting)

United States of America

 Date: 5/25/2012
Larry Wakoviak, Director
Upper Colorado Region, Bureau of Reclamation

**Recommendation of Changes to Rio Grande Project
Operation Manual Proposed on May 8, 2012**

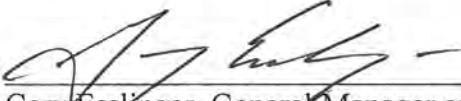
 Date: 5/16/12
Dr. James Phillip King, Allocation Committee Member representing EBID

 Date: 5/20/12
Dr. A. W. Blair, Allocation Committee Member representing EPCWID

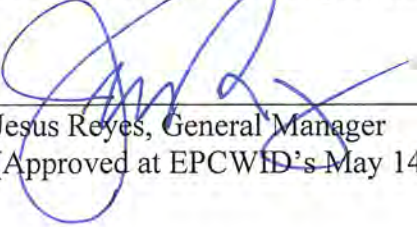
 Date: 5-18-12
Filiberto Cortez, Allocation Committee Member representing USA

**Approval of Changes to Rio Grande Project
Operation Manual Proposed on May 8, 2012**

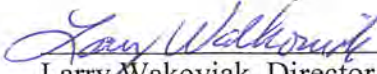
Elephant Butte Irrigation District (EBID)

 Date: 5/16/12
Gary Esslinger, General Manager and Treasurer
(Approved at EBID's May __, 2012 Board Meeting)

El Paso County Water Improvement District No. 1 (EPCWID)

 Date: 6-7-12
Jesus Reyes, General Manager
(Approved at EPCWID's May 14, 2012 Board Meeting)

United States of America

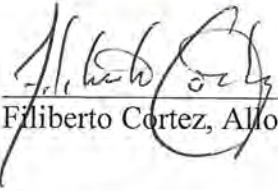
 Date: 5/25/2012
Larry Wakoviak, Director
Upper Colorado Region, Bureau of Reclamation

**Recommendation of Changes to Rio Grande Project
Operation Manual Proposed on May 8, 2012**

FILED
MAY 13 2012
FBI - EL PASO

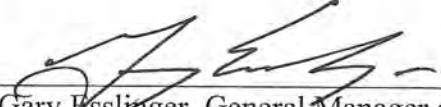
 Date: 5/16/12
Dr. James Phillip King, Allocation Committee Member representing EBID

 Date: 6/20/12
Dr. A. W. Blair, Allocation Committee Member representing EPCWID

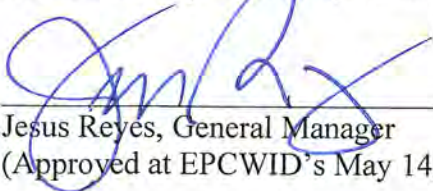
 Date: 5-18-12
Filiberto Cortez, Allocation Committee Member representing USA

**Approval of Changes to Rio Grande Project
Operation Manual Proposed on May 8, 2012**

Elephant Butte Irrigation District (EBID)

 Date: 5/16/12
Gary Esslinger, General Manager and Treasurer
(Approved at EBID's May __, 2012 Board Meeting)

El Paso County Water Improvement District No. 1 (EPCWID)

 Date: 6-7-12
Jesus Reyes, General Manager
(Approved at EPCWID's May 14, 2012 Board Meeting)

United States of America

 Date: 5/25/2012
Larry Wakoviak, Director
Upper Colorado Region, Bureau of Reclamation

Revision of January 12, 2010
RIO GRANDE PROJECT - OPERATIONS MANUAL

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Appendices

- A – Rio Grande Project Operating Agreement
- B – Example of Allocation Charges for EPCWID
- C – Example of Allocation Charges for EBID
- D – Flow Regulation Calibration at Caballo Dam

Exhibits

- 1 – CD-ROM of Ordering and Allocation Spreadsheets

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 the year, 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

Order #1124	Effective Date: 7/8/2008	Received By: IO	Order #1123	Effective Date: 7/7/2008	Received By: IO
BOR	Date/Time Received: 07/08/08 15:36	Approved By: RR	BOR	Date/Time Received: 07/07/08 15:09	Approved By: RR
EPCWID #1	Date/Time Entered: 07/08/08 08:39	Approved By: MJN	EPCWID #1	Date/Time Entered: 07/07/08 09:49	Approved By: MJN
EBID	Date/Time Entered: 07/08/08 08:49		EBID	Date/Time Entered: 07/07/08 09:51	

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: 7/11/2008	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
USBR 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 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

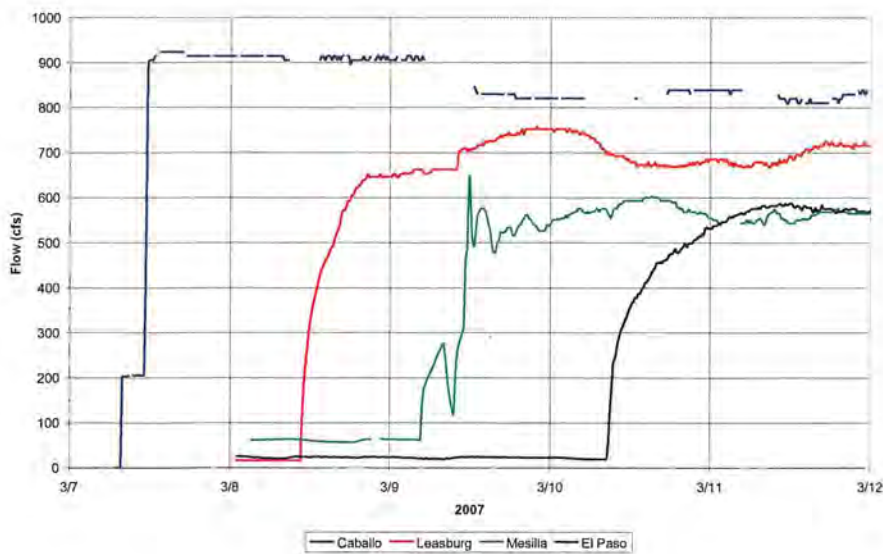


Table 1 Average Travel Times from Caballo Dam to Various Diversion Dams

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:

- Arrey Canal,
- Percha Lateral,
- Irrigations from Leasburg Canal above gauging station,
- 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 diversion 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.

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During the 4th and all following consecutive years 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 0.75.

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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.

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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 be 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	Section

Appendix C - Comprehensive Background

Origins of the Rio Grande Project

The origins of the Rio Grande Project (Project) date to the 1880s, when extensive farming in the San Luis Valley in Colorado and along the Middle Rio Grande Valley in the Albuquerque region created serious water shortages along the lower Rio Grande in the New Mexico territory and in the El Paso, Texas and Ciudad Juarez area (Littlefield 1987). The Rio Grande Compact (Compact) arose from conflicts between Colorado, New Mexico and Texas in the United States and Mexico over the use and development of the waters of the Rio Grande. These conflicts were reported to the federal government and both the Department of the Interior and the Department of State began trying to find a long-term solution. In the 1890's, the United States Congress began investigations for what would become the Project by ordering studies of storage and irrigation systems in the area by the United States Geological Survey (USGS) and the United States Army Corps of Engineers (Corps).

The eventual decision resulting from those and other studies was to build storage works on the Rio Grande in the area of Elephant Butte and deliver water from that storage, along with flows accruing downstream, to irrigate lands in New Mexico, Texas and Mexico.

Federal Authorization

Under the authority of the Rio Grande Project Act of 1905 (1905 Project Act), the Project was authorized to provide agricultural irrigation water to the water districts now known as Elephant Butte Irrigation District (EBID) and El Paso County Water Improvement District #1 (EPCWID).

Congress also took action to settle the conflict with Mexico over how much water would be delivered to Mexico. Under the 1906 Convention between the United States and Mexico regarding equitable distribution of waters of the Rio Grande (Convention), the United States is obligated to deliver up to 60,000 acre-feet (AF) of water annually in a full allocation year; otherwise, the water allocation to Mexico is reduced by the same percentage as is the water allocated to the irrigated Project lands in the United States.

The Reclamation Act of 1902 (1902 Act) provides that Reclamation shall proceed in conformity with State or Territory laws relating to the control, appropriation, use, or distribution of water used in irrigation, or any vested right to water acquired under such laws. Section 8 of the 1902 Act also provides that "...nothing herein shall in any way affect any right of any State or of the Federal Government or of any landowner, appropriator, or use of water in, to, or from any interstate stream or the waters thereof...". Consistent with this mandate, after passage of the 1905 Rio Grande Project Act, the

United States filed notices in 1906 and in 1908 alerting the Territory of New Mexico of federal ownership of specified waters of the Rio Grande.¹ The 1906 filing notified the Territorial Irrigation Engineer that the United States intended to utilize "730,000 AFY requiring a maximum diversion or storage of 2,000,000 miner's inches said water to be diverted or stored from the Rio Grande River" near Engle, New Mexico, and diversion dams near Palomas, Rincon, Mesilla, and El Paso Valleys in New Mexico and Texas (Hall 1906). In April 1908, the Reclamation Service provided a second notice of its intent "to utilize ...all of the waters of the Rio Grande and its tributaries, said water to be diverted or stored from the Rio Grande River at [Elephant Butte] ...and diversion points below in Palomas, Rincon, Mesilla and El Paso Valleys in New Mexico and Texas" for the Project (WaterBank 2008).

In 1907, Congress appropriated \$1,000,000 to pay for the portion of the Project necessary to provide storage of water for fulfillment of the 1906 Convention with Mexico. (Act of March 4, 1907, 34 Stat. 1357.) As for funding the rest of the Project, under the 1902 Act, Congress intended that water projects would be self-supporting; each would generate sufficient revenues to approximately cover costs of construction and operation and maintenance, and the total estimated Project costs would be equitably borne by Project beneficiaries.² Therefore, EBID and EPCWID were required to enter into contracts with Reclamation under which they would cover these costs in the future. The 1902 Act further states that the right to use Project 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 U.S.C. §§ 372, 383.) The contracts with EBID and EPCWID establish the allocation of water between the two districts based on the irrigable acreage within each district.

In the 1920's and 1930's, pursuant to the 1902 Act, Reclamation constructed a series of drains that provided a means by which Project water used on fields and seeped underground would get back to the river as return flow. These drains assured that the lands would remain irrigable and ensured that the Project could appropriate or re-claim these return flows which became an integral part of the total Project water supply. Additionally, during construction of the Project, Reclamation purchased essentially all the existing canals in the Project area and either re-built or replaced them. These canals, which had priority dates from the 1840s, would be used to deliver Project water.

Rio Grande Compact

The Project could only succeed if the upstream areas in New Mexico and Colorado agreed to deliver sufficient water to keep it viable. Recognizing this, the three Rio Grande basin states negotiated an agreement to establish minimum delivery requirements

¹ The filing was made in compliance with a notification provision of the Act Creating the Office of Territorial Irrigation Engineer, to Promote Irrigation Development and Conserve the Waters of New Mexico for the Irrigation of Lands and Other Purposes, March 16, 1905. See also Territorial Act of March 19, 1907, chap. 49, § 40 (1907).

² See Reclamation Act of 1902, § 4, 43 U.S.C. §§ 419, 461 ("The said charges shall be determined with a view of returning to the reclamation fund the estimated costs of construction of the project, and shall be apportioned equitably."); *Swigart v. Baker*, 229 U.S. 187, 193-94 (1913)

by Colorado and New Mexico. In 1939 Congress ratified the Rio Grande Compact, as a tri-state agreement between Colorado, New Mexico, and Texas to ensure an equitable apportionment of the waters of the Rio Grande. The Compact sets delivery requirements to states based upon flows at specific measurement stations; and delivery of water to the Project at Elephant Butte Reservoir. The Compact specifies an obligation for New Mexico and Colorado to deliver water to Texas and sets limits on the accumulation of over-deliveries (credits) and under-deliveries (debits).

State Water Laws

Beginning with the drought of the 1950's, farmers in New Mexico began to install pumps to supplement their surface supply from the Project with groundwater. The wells also provided district water users the opportunity to supplement their full Project allocations when the drought ended and when full diversion allocations from the Project were again available. The availability of this additional water supply led to a large-scale change in cropping patterns as irrigators began a shift to plant high-value crops such as pecans, which also have higher water requirements than crops historically planted.

The New Mexico Office of the State Engineer (NMOSE) is responsible for regulating groundwater within the state. In 1980, NMOSE declared the Lower Rio Grande (LRG) underground basin, and imposed a permit system on well drilling. Prior to this declaration, there were no restrictions upon well drilling. Under Texas state law, groundwater is managed as groundwater conservation districts within Groundwater Management Areas (GMA). Groundwater conservation districts are local government organizations authorized by the Texas Legislature and ratified by local populations to manage and protect groundwater resources.³

On January 5, 1999, in an effort to further protect existing water rights from impairment caused by groundwater pumping, the NMOSE published the Mesilla Valley Administrative Area Guidelines (Turney 1999). The Guidelines' objectives state: "The primary aquifer within the Mesilla Valley Administrative Area is recognized as a stream-connected system in which groundwater withdrawals will ultimately result in depletions of surface-water sources." The Guidelines created strict criteria for evaluating applications for new appropriations, applications for supplemental wells, and applications to change point of diversion, or place or purpose of use, and provided "Administrative standards which quantify allowable surface water depletions and water level declines."

Beginning in 2004, due to "a water shortage crisis" caused by drought and "to ensure protection of existing water rights in [EBID] from impairment", the NMOSE further enhanced its efforts to administer water rights in the LRG area (Order of the State Engineer, December 3, 2004.) By two separate orders, the NMOSE created the Lower Rio Grande Water Master District and imposed metering requirements on wells within

³ The right of an irrigator to pump groundwater is regulated by the state. The federal government has no legal authority or discretion to allow or disallow groundwater pumping within the Project area. New Mexico law provides that the State Engineer's jurisdiction extends to "underground streams, channels, artesian basins, reservoirs or lakes, having reasonable ascertainable boundaries," once they are "declared to be public waters and to belong to the public and to be subject to appropriation for beneficial use." (NMSA 1978, § 72-12-1).

the District (Metering Order) (amended December 20, 2005). The Metering Order required “that all wells in the LRG Water Master District be metered by March 1, 2006, except for those wells that serve one household or livestock” and provided a grace period for enforcement until November 1, 2006. According to its 2009-2011 Annual Report, (Stangle 2011) NMOSE water master staff has conducted meter installation field checks on 827 wells and red-tagged 123 wells, which led to 19 compliance orders being issued for non-compliance. Additionally, water master staff has acquired meter readings for about 90 to 93 percent of the actively metered wells in the area.

Lower Rio Grande Adjudication

In 1997, the NMOSE filed a complaint with the Third Judicial District Court of Doña Ana County to begin the adjudication of water rights in the LRG, which will establish the quantity, place and purpose of use, and the priority date of each and every water right in the area.

Over the last few years, the NMOSE has entered into several settlement agreements involving the legal limits of surface use and groundwater pumping, which were approved by the adjudication court in the Final Judgment of Stream System Issue 101 filed on August 22, 2011. In February 2008, the NMOSE entered into a Settlement Agreement with the New Mexico Pecan Growers, which granted pecan growers a farm delivery requirement⁴ (FDR) of 5.5 acre-feet per year (AFY) and a consumptive irrigation requirement⁵ (CIR), which is transferable to non-irrigation uses, of 4.0 AFY. The agreement provides that pecan growers can use groundwater to irrigate their trees so long as they fully use their surface allocation. In June 2011, the NMOSE entered into a Settlement Agreement with the Pecan Growers and the Southern Rio Grande Diversified Crop Farmers Association, which granted the following:

- surface water right owners an FDR of 3.024 AFY or greater and a CIR of 2.6 AFY;
- groundwater right owners an FDR of 4.5 AFY, and a CIR of 2.6 AFY; and
- Allowing a water right owner to prove an FDR up to 5.5 AFY.⁶

⁴ The farm delivery requirement (FDR) is the consumptive irrigation requirement (defined below) plus farm losses due to evaporation, deep percolation, surface waste, and nonproductive consumption. The losses are measured by the Farm Irrigation Efficiency, which is the percent of farm-delivered water that remains in the root zone and is available for crop growth.

⁵ The consumptive irrigation requirement (CIR) is the quantity of irrigation water, exclusive of precipitation, stored soil moisture, or ground water that is required consumptively for crop production.

⁶ By comparison, just due east, in the adjudication of the Carlsbad Project located in the Lower Pecos River Basin, the NMOSE granted and the court approved an FDR of just 3.697 AFY and a CIR of 2.218 AFY for surface water and/or supplemental groundwater irrigation in the Carlsbad Irrigation District. The Carlsbad Project has lower water use requirements than the Rio Grande Project because the NMOSE began declaring portions of the Carlsbad underground basin as early as 1947 and water users did not establish high water use crops. In both areas, groundwater pumping was originally used to supplement surface supply, but only in the Rio Grande did groundwater use become a primary source. In the Roswell area, just north of Carlsbad, the OSE declared the main section of the underground basin in 1931, and the FDR is just 3.0

In the LRG adjudication, the United States has claimed enough water to fulfill its obligations under contracts with Project beneficiaries in New Mexico and Texas and under the Convention with Mexico. The United States' claim is based upon the statutory authorizations of Congress following investigations that began in the 1890s, the purchase of older canals and associated water rights, and the filings made in accordance with New Mexico Territorial law at the time the Project was authorized.

Texas Water Law and Administration

In 1913, the Texas legislature enacted an irrigation act that centralized the licensing process by limiting the permitting authority to the Texas Board of Water Engineers. Another act replaced this act in 1967, which established a procedure to adjudicate a water rights claim. In Texas, individuals do not own surface water but acquire a right to use it under state law; however, recent case law has declared an overlying landowner owns groundwater under its lands. The Texas Commission on Environmental Quality (TCEQ) evaluates all claims of water rights to state water, except for domestic or livestock purposes, for each stream in Texas. That evaluation is subject to judicial review and confirmation.

Texas Groundwater Administration

Texas is a "rule of capture" state in which groundwater is property of the owner of the surface estate. Texas law distinguishes between percolating groundwater and underflow, with a presumption that underground water is percolating groundwater (Caroom and Maxwell 2009) .

Under the Texas state law, groundwater is managed as groundwater conservation districts within GMAs. Groundwater conservation districts are local government organizations authorized by the Texas Legislature and ratified by local populations to manage and protect groundwater resources. There are no groundwater conservation districts within the Project area, which is GMA #5.

Adjudication of Water Rights in the Upper Rio Grande Segment of the Rio Grande Basin

In 1993, EPCWID filed application for a permit for use of Project water in Texas. In 2006, the United States and EPCWID obtained a court-decreed right to specified Project water (Honorable Linda Chew 2006). Under Section 11.307 of this decree, EPCWID is authorized to divert and use 376,000 AF of water per year for irrigation, municipal, industrial, mining and recreational use. In addition EPCWID is authorized any measurable surface water-based effluent, groundwater-based effluent, or groundwater discharged into the Rio Grande pursuant to contracts between EPCWID and Reclamation, and an average of 1,899 AF averaged over any five years from tributary inflows to the

AFY and the CIR is 2.1 AFY. There, farmers must acquire additional water rights and stack them on their land if their crops need additional water.

Rio Grande between the Texas/New Mexico state line and the (former) location of the Riverside Dam. The latest priority date of this filing is January 1, 1918.

Reclamation's Contractual Obligations

Amended Repayment Contracts

Under the authority of the 1905 Rio Grande Project Act, as well as the Sale of Water for Miscellaneous Purposes Act of 1920 (43 USC §521), Reclamation entered into contracts with EBID and EPCWID for the repayment of construction costs and the delivery of irrigation water. 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 upon an established irrigated acreage in each district: 56.7742 percent to EBID and 43.2258 percent to EPCWID. In 1938, subsequent amendments to these contracts added a three percent buffer to the authorized amount of land that could be irrigated with Project water. Today, the Project irrigates 159,650 (original 155,000 plus three percent) total acres within the United States: 69,010 acres of land within EPCWID and 90,640 acres of land within EBID with Project-water rights.

The districts' amended repayment contracts required three changes to occur in historic operations.

1. When the two districts had repaid the total reimbursable costs for the Project, they were required to take over the day-to-day responsibility for operation and maintenance of the irrigation delivery and drainage system, including 141 miles of canals, 462 miles of laterals, and 457 miles of drains.
2. 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.
3. Upon that transfer, Reclamation would no longer calculate, allocate, and deliver water to Project land but rather would deliver an annual water allocation—an “annual diversion allocation”—to each district in an amount that corresponded to the percentage of Project land within their boundaries: 57 percent of the usable available Project water supply to EBID and 43 percent to EPCWID. These diversion allocations continue to govern the division of Project water between the districts except as provided in the OA.

In 1979 and 1980, when the districts fulfilled their repayment obligations as established in 1937 and 1938, they and Reclamation entered into contracts that transferred the day-to-day responsibility for operation and maintenance of the irrigation delivery and drainage systems to each district⁷. These contracts required the districts and Reclamation to

⁷ Title to the easements, ditches, laterals, canals, drains and other rights-of-way was transferred to the districts in 1996, under the authority of PL 102-575, Title 33, as documented in Reclamation's 1996 *Final EA and FONSI for the Transfer of Lands and Irrigation Facilities, Rio Grande Project to Elephant Butte Irrigation District and El Paso County Water Improvement District No. 1*.

develop operating procedures to govern the operations of the Project. Because the districts and Reclamation could not agree on a formalized set of operating procedures, the transfer occurred but the Secretary, through Reclamation's El Paso office, imposed *ad hoc* operating procedures to govern Project operations in the interim. These *ad hoc* operating procedures were modified by Reclamation as needed between 1980 and 2007. During that time Reclamation calculated, allocated, and delivered each district's annual diversion allocation (e.g., the district's proportion of the usable available water supply) but the methods, equations, and procedures used were modified as needed and optimized, according to real-time water conditions. The period of 1979 thru 2002 were full allocation years; however decreased inflows to the Project began in 1996. Accumulated Project storage carried over from previous years provided full allocations until 2002. The first reduced allocation year was in 2003. . .

Contracts with City of El Paso

The City of El Paso diverts its Project water from the American Canal and Riverside Canal. Under a 1941 contract between Reclamation and the city (Contract No. Il6r-1541), the city, as El Paso Water Utilities (EPWU), was able to acquire up to 2,000 acres of EPCWID's irrigated Project lands, and therefore receives its diversion as a water-user member of EPCWID. Subsequent contracts have increased the amount of acreage that the city is allowed to acquire for the conversion of water. Rio Grande water is only available during the irrigation season. (Caroom and Maxwell 2009)

Contract with HCCRD

In 1924, the Hudspeth County Conservation and Reclamation District No. 1 (HCCRD) was organized to consolidate several ditches that had been built in and around 1915 and were diverting water from the Rio Grande at various points between the Project boundary and Guayuco Arroyo into one canal system. Under a Warren Act contract between Hudspeth County and the United States, HCCRD has been diverting drainage and wastewaters from the Project since 1925. The contract extends only to the return water as it occurs in the normal operation of the Project and puts no obligation upon the Project or Reclamation for delivery of any specific amounts of water.

Litigation History

Starting in the 1980's, legal complaints arose over how the functions remaining under Reclamation's control were handled. EPCWID complained that due to the conservation efforts of the district's farmers, they were not using their full annual diversion allocation in many years. EPCWID asserted that it was, in effect, leaving a portion of its annual diversion allocation in Elephant Butte Reservoir each year. EPCWID further asserted that as EPCWID had repaid 43 percent of the reimbursable costs, it had a property right in its 43 percent of the annual diversion allocation, and Reclamation was treating it unfairly when the unused portion of EPCWID's annual diversion allocation was re-divided each year through the allocation process, which resulted in EBID receiving 57 percent of the water conserved by EPCWID.

EPCWID also protested that groundwater pumping in New Mexico was causing the Texas district to receive less water than the 43 percent to which it was entitled. EPCWID stated that it lost a portion of its water share because: 1) surface water transfers to groundwater pumped by EBID, essentially increasing the overall supply available to EBID, because they could obtain water through both Project deliveries as well as through groundwater pumping; and 2) the water released to make deliveries to EPCWID was lost in conveyance as the Rio Grande became less efficient due to losses of water from groundwater pumping.

EBID also complained that the ad hoc procedures and other operational choices by Reclamation were depriving them of entitlements. In 1990, EBID filed suit against the Secretary challenging, among other things: 1) operational decisions on reservoir management made under the ad hoc criteria; 2) crediting miscellaneous revenues from Project lands; 3) charges to the districts for operation and maintenance functions performed by Reclamation, and 4) the validity of the recreational leases at Elephant Butte and Caballo Reservoirs. EPCWID also joined as a plaintiff, first in an involuntary capacity and later as a voluntary plaintiff.

Following the conclusion of the earlier cases, in 2007, EBID and EPCWID filed new separate actions in the federal courts of New Mexico and Texas, respectively, seeking declaratory judgments confirming and validating the rights and obligations of each party, based upon their individual repayment contracts with the United States. Among other things, EPCWID asserted that it was being deprived of its 43 percent of the legally available annual diversion allocation by both the re-allocation of its unused allocation, and by increased conveyance losses caused by groundwater pumping in New Mexico. EBID's demands included an operating agreement and both complaints asserted the United States must implement a set of operating procedures based upon the district's respective interpretations of the United States' contractual obligations rather than continue the ad hoc administration of Project operations.

The 2007 lawsuits were dismissed by EBID and EPCWID when the parties, in conjunction with Reclamation, agreed to execute and implement an operating agreement in 2008, as a settlement of the pending litigation. The term of the resulting 2008 OA is from January 1, 2008, until December 31, 2050.

Timeline

- | | |
|------|---|
| 1890 | Congress orders investigations of irrigation and storage by USGS and the Corps. |
| 1902 | Reclamation Act—authorizing irrigation project to “reclaim” the arid West. |
| 1905 | Congress authorized the construction of a dam and reservoir on the Rio Grande in New Mexico, for the impounding of flood waters of said river for the purposes of irrigation. |
| 1906 | Convention Between The United States and Mexico |

- 1908 Leasburg Dam and Canal completed.
- 1917 El Paso Valley Water Users Association dissolved and reorganized as EPCWID, with 69,010 irrigable acres located in the Mesilla and El Paso valleys of Texas.
- 1924 HCCRD organized. United States enters into Warren Act contract for return flows.
- 1936 Rio Grande Canalization Project Act (49 Stat. 1463).
- 1937 Elephant Butte Water Users Association dissolved and reorganized into EBID, with 102,000 irrigable acres in Rincon and Mesilla valleys.
- 1937 Congress authorized the execution of amended repayment contracts with EBID and EPCWID.
- 1938 Rio Grande Compact entered into between Colorado, New Mexico and Texas, which becomes the institutional mechanism for interstate water allocation.
- 1938 Caballo Dam completed.
- 1939 Congress ratifies Rio Grande Compact (53 Stat. 785).
- 1940 Elephant Butte Powerplant becomes operational.
- 1951 Onset of drought requires Reclamation to develop allocation strategy in order to be in compliance with Convention of 1906 with Mexico and the irrigated acreage in the U.S. portion of the Project.
- 1974 Title XIV of the Reclamation Development Act of 1974 (88 Stat. 1498) authorizes the storage of San Juan Chama water in Elephant Butte Reservoir to establish a recreational pool.
- 1979/80 Districts fulfill their repayment obligations and enter into contracts with Reclamation to transfer operation and maintenance of facilities.
- 1992 Public Law (PL) 102-575, Title XXXIII authorizes transfer of the title to easements, ditches, laterals, canals, drains, and other rights-of-way, but not storage or diversion structures, which the United States had acquired on behalf of the Project.
- 1993 EPCWID filed application for a permit for use of Project water in Texas.
- 1995 Southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher) listed as endangered by Service. (Critical habitat designated on 10/19/2005.)
- 1996 Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the Transfer of Lands and Irrigation Facilities, Rio Grande Project to EBID and EPCWID

1996	Court Order—restricting storage at Caballo (paragraph in “Storage” below)
2006	The United States and EPCWID obtained a court-decreed right to 376,000 AFY of Project water
2007	Reclamation EA/FONSI
2008	Reclamation and districts entered into OA
2011	Final Judgment for New Mexico Stream Issue 101, August 2011
2012	Preparation of Supplemental EA

Appendix D - Listed Species Technical Information

Species Identified for Analysis

Based on literature review and field surveys, four threatened or endangered species occur or have been observed within the action area of the environmental assessment (EA): the Interior Least Tern, Piping Plover, Southwestern Willow Flycatcher (flycatcher), and Rio Grande silvery minnow (silvery minnow) (Table D.1).

Table D.1. Four threatened or endangered species in the action area including listing status.

Scientific Name	Common Name	ESA Status
<i>Sterna antillarum</i>	Interior Least Tern	Endangered
<i>Charadrius melodus</i>	Piping Plover	Threatened
<i>Empidonax traillii extimus</i>	Southwestern Willow Flycatcher	Endangered
<i>Hybognathus amarus</i>	Rio Grande silvery minnow	Endangered

The only critical habitat contained within the action area is for the flycatcher. This designation was revised by the U.S. Fish and Wildlife Service (Service) in January 2013 (78 FR 343-534). The southern boundary of critical habitat along the Rio Grande in New Mexico was extended to about river mile (RM) 54, or about eight miles into the upper end of the Elephant Butte Reservoir pool (Figure D.1). No critical habitat was designated south of this point, including proposed areas south of Elephant Butte and Caballo Reservoirs.

Action Area

For analysis purposes, there are four segments of the action area that vary in degree and type of effects. These geographical segments include:

- Elephant Butte Reservoir, New Mexico
- Rio Grande downstream from Elephant Butte Dam to the inflow to Caballo Reservoir
- Caballo Reservoir
- Rio Grande from Caballo Dam to the El Paso-Hudspeth County line in Texas.

The International Boundary and Water Commission (IBWC) has already consulted on effects of its operations from Percha Diversion Dam to the southerly international boundary with Mexico. The issued biological opinion (BiOp) committed IBWC to maintain at least 53.5 acres of dense riparian habitat for flycatchers and implement a flycatcher management plan by 2015 (Service 2012). Reclamation has reviewed the proposed action in the EA and concluded that the range of operations under the proposal was fully covered by IBWC in their consultation.

Interior Least Tern (Sterna antillarum)

Status and Distribution

The Service stated in the 2003 BiOp (consultation #2-22-03-F-0129) that “the interior least tern occurs as a vagrant along the Middle Rio Grande, and no nesting has been recently documented. Therefore, effects from the proposed action are likely to be insignificant or discountable.”

The Interior Least Tern (*Sternula antillarum athalassos*, tern) was listed as endangered by the Service in 1985 (50 CFR 21784). This subspecies historically bred along the Colorado (in Texas), Red, Rio Grande (in Texas), Arkansas, Missouri, Ohio, and Mississippi River systems and has been found on braided rivers of southwestern Kansas, northwestern Oklahoma, and southeastern New Mexico (American Ornithologists' Union 1957). In New Mexico, the tern was first recorded (including nesting) at Bitter Lake National Wildlife Refuge (NWR) in 1949; and since then, it remained present essentially annually (Marlatt 1984, New Mexico Department of Game and Fish 2008). The species also occurs as an occasional breeder in Eddy County, New Mexico (Moore 2011). The tern has been observed as a ‘vagrant’ or ‘highly unusual’ species among the 377 avian species detected on the Bosque del Apache NWR since 1940 (Service 1995). In 2005, a rangewide survey of terns was completed, and the Rio Grande/Pecos River systems collectively made up 0.8% of the population (Lott 2006). Historically, tern nesting has been confirmed on six reservoirs along the Rio Grande/Pecos reach at Bitter Lake NWR, Brantley Lake, and Imperial Reservoir on the Pecos; and Lake Casa Blanca, Amistad Reservoir, and Falcon Reservoir on the Rio Grande in Texas (Lott 2006) (Figure 9).

Life History and Ecology

Terns nest colonially on bare or sparsely vegetated sand along rivers, lakes, or reservoirs and along mudflats along coasts and rivers. Nesting occurs from late April to August. Sand is the dominant nesting substrate (New Mexico Avian Conservation Partners 2012). Chicks leave the nest a few days after hatching, but parental attention continues until migration in early September. Terns' diet consists of small fish and invertebrates. At the Bitter Lake NWR, the terns are reported to fly at least 3 kilometers (km) from nesting colonies to foraging areas (Johnson et al. 1997).

Breeding habitat requirements for this species include the presence of bare or nearly bare ground on alluvial islands, shorelines, or sandbars for nesting, the availability of food (primarily small fish), and the existence of favorable water levels during the nesting season so nests remain above water (Ducey 1981). Breeding colonies contain from 5–75 nests. Although most nesting occurs along river banks and reservoirs, the tern also nests on barren flats of saline lakes and ponds. Nests are constructed by scraping a depression within the sand.

Habitat Description

From late April to August, terns use sparsely vegetated beaches and sandbars along rivers or lake or reservoir shorelines. Wide river channels with scattered sand bars are the preferred habitat, but terns use sand and gravel pits. Their nest is a shallow depression in

an open area, above high water levels and safe from ground predators; thus islands are favored habitats (Thompson et. al.1997).

Threats

The primary threat to the tern is loss and degradation of habitat. Dams and other alterations to river systems have reduced their preferred sandbar nesting habitat. Fluctuating water levels in streams may cause scouring of sandbars or high flows that wash away chicks and nests. Recreational use of beaches and sandbars results in reduced use of such areas by the tern.

Presence-Absence within the Action Area

Altered flows and channelization of the Rio Grande have eliminated suitable nesting habitat; however, terns may use the river corridor for feeding or resting during migration and as mentioned above, they have been documented as present south of the action area. At least one tern was observed in the southern portion of the action area by IBWC during fall surveys in September 2000, presumably in the process of migrating south. The U.S. Geological Survey (USGS) reports no tern at Fort Bliss in El Paso County (USGS 2013) (Table D.2). In short, it would be extremely unlikely for this species to be found in the action area. No tern have been incidentally recorded during flycatcher surveys within the action area since the mid-1990s, however, it should be noted that these surveys are not generally conducted in habitat suitable for terns and surveyors are not asked to record other bird observations specifically (Wilber, pers. comm.).

Table D.2. Bird occurrence at Fort Bliss, Texas by month.

Common Name	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Interior Least Tern												
Piping Plover								--6				
Willow Flycatcher				-4	444		--4	333	445			
Yellow-Billed Cuckoo					--4	444	444	444	44-			

Source: USGS 2013. Legend: 1=abundant; 2=common; 3=fairly common; 4=uncommon; 5=rare/irruptive; 6=very rare.

As previously mentioned in the Status and Distribution section of this analysis, the tern can be considered a vagrant on the middle Rio Grande and no tern nesting has been recently documented (Service 1995). According to the recovery plan from the Service in 1990, the only documented breeding along the Rio Grande takes place in Texas, and the only documented breeding within the state of New Mexico can be found on the Pecos River (Service 1990), similar conclusions are drawn in the complete rangewide survey collected in 2005 (Lott 2006).

Piping Plover (Charadrius melodus)

Status and Distribution

In 1986, the Great Lakes population of Piping Plover (*Charadrius melodus*) was listed as endangered and the species is threatened in the northern Great Plains and Atlantic coast. A recovery plan was published by the Service in 2003. In the spring and summer they breed in the U.S. and Canada. Piping Plovers are migratory birds. In the spring and summer they breed in the northern United States and Canada. In the fall, they migrate south to winter along the Gulf of Mexico and more southerly locations. The Piping Plover has been documented in the Bosque del Apache NWR in New Mexico north of the action area (IBWC 2004) and at Fort Bliss, Texas (USGS 2013).

Life History and Ecology

The Piping Plover arrives on northern or coastal breeding grounds from early to mid-March. They often nest with a colony of terns. The young leave the nest shortly after hatching and by early September most have departed for their wintering areas. The Piping Plover diet consists of marine worms, fly larvae, beetles, crustaceans, mollusks, and other small animals and their eggs. Food is obtained by foraging on beaches, dunes and in tidal wrack.

Site Specific Habitat or Critical Habitat

Piping Plovers use wide, flat, open, sandy beaches with little vegetation. Nesting territories include beaches and sand flats along creeks and wetlands. Most adults return to their previous nesting sites. They also nest in riverine sand or gravel bars.

Threats

Habitat loss or degradation and poor breeding success are major reasons for the population decline. Construction of reservoirs on the rivers and channelization has resulted in a loss of sandbar habitat. Too much water in the spring floods nests and vegetation growth on nesting beaches makes sites unsuitable for nesting. Piping Plovers are sensitive to nest disturbance and the presence of people.

Presence-Absence within the Action Area

The Piping Plover is a rare migrant to New Mexico and Texas and it has never been documented in the action area. It was sighted at Fort Bliss once in August (USGS 2013) (Table D.2), and it is possible, although unlikely, that it would be present in the action area as it migrates south. No Piping Plovers have been incidentally recorded during flycatcher surveys within the action area since the mid-1990s, however, it should be noted that these surveys are not generally conducted in habitat suitable for plovers and surveyors are not asked to record other bird observations specifically (Wilber, pers. comm.).

Southwestern Willow Flycatcher (Empidonax traillii extimus)

Status and Distribution

The southwestern subspecies of the flycatcher (*Empidonax traillii extimus*) was listed as endangered in 1995 (Service 1995; 60 FR 10694). A final recovery plan was completed in August 2002 (Service 2002). Background information on the flycatcher is found in the critical habitat rule published in 2005 (Service 2005; 70 FR 60886). A revised critical habitat designation was published on January 3, 2013 (78 FR 343-534).

The flycatcher is a neotropical migrant that breeds in the southwestern United States and winters in Mexico, Central and South America. Migration flyways include major river corridors and tributaries including the Rio Grande (Service 2005, Sogge et al. 1997, 2003).

Life History and Ecology

The flycatcher is a late spring breeder, typically arriving in the action area in early May. Nest construction, breeding, incubation, and hatching of eggs occur from mid-May to mid-July in dense patches of cottonwood, willow, and tamarisk (Sogge and Marshall 2000). The bird is highly territorial, with territories clustered rather than spread out (Service 2002). Territory sizes vary from 0.1 hectare (ha) to 2.3 ha, with most territories being between 0.2 and 0.5 ha. Average clutch size is three to four eggs. The time from egg laying to fledging is about 28 days with juveniles fledged through mid-August. They depart for their winter range in mid-September (Service 2002).

Habitat Description

The recovery plan (Service 2002) divide the range of the flycatcher into six recovery units representing major river drainages. Each recovery unit is subdivided into smaller management units. The action area is located within the Rio Grande Recovery Unit and in the Middle Rio Grande Management Unit and Lower Rio Grande Management Unit. Flycatchers breed in dense riparian vegetation near lentic water, such as river backwaters, oxbows, or marshy areas or saturated soil (Service 2002, 2005; Sogge and Marshall 2000). In the middle Rio Grande, Smith and Johnson (2007) found most nests are constructed over standing water or wet soil. Flycatchers no longer breed in Texas (Service 2002).

The Service revised the designation of critical habitat in January 2013 (78 FR 343-534). The southern boundary of critical habitat along the Rio Grande in New Mexico was extended to about RM 54, or about eight miles into the upper end of the Elephant Butte Reservoir pool (Figure D.1) with the lateral extent including the riparian areas and streams that occur within the 100-year floodplain or flood-prone areas. No critical habitat was designated south of this point, including proposed areas south of Elephant Butte and Caballo Reservoirs, i.e. the area that the IBWC has consulted on with its Rio Grande Canalization Project, 46.1 miles (74.2 km) from Percha to American Diversion Dam.

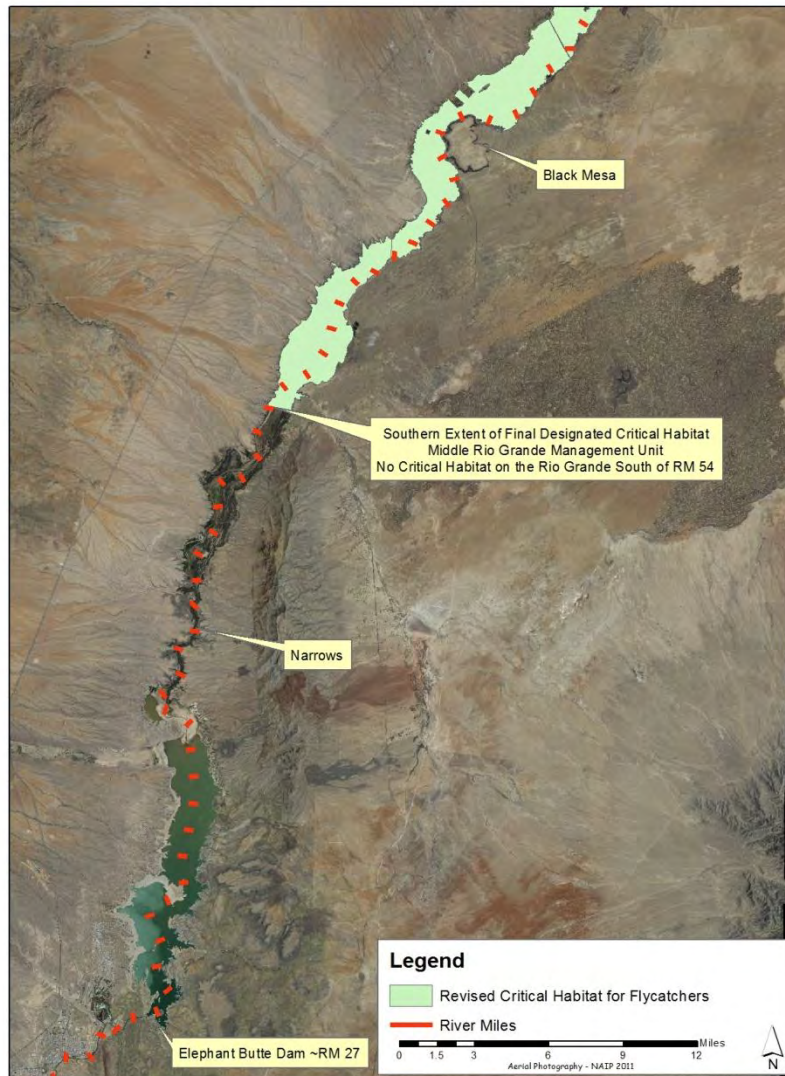


Figure D.1. Revised critical habitat for Southwestern Willow Flycatcher.

The Service has determined that the primary constituent elements of habitat needed by the flycatcher are:

1. Riparian vegetation in a dynamic river or lakeside, natural or manmade successional environment comprised of trees and shrubs and some combination of:
 - a) Dense riparian vegetation with thickets of trees and shrubs; and/or
 - b) Areas of dense riparian foliage at least from the ground level up to approximately 4 to 8 m (13 ft) above ground; and/or
 - c) Sites for nesting that contain a dense (about 50 percent to 100 percent) tree or shrub canopy; and/or
 - d) Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation.

2. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments.

Threats

The primary threat to the flycatcher is the loss, alteration, and fragmentation of their breeding habitat (Service 2002, Sogge et al. 1997). Factors contributing to habitat loss include water management, including surface water diversion, impoundment and channelization, groundwater pumping, livestock grazing, phreatophyte control, and increased recreation and urbanization. Any hydrological changes, whether natural or human-caused, can reduce the quality and amount of breeding habitat. Fire and nest parasitism by the brown-headed cowbird (*Molothrus ater*) are also factors in the decline of flycatcher populations ((New Mexico Avian Conservation Partners 2012; Service 2002). The replacement of native vegetation by exotics is a potential threat, though breeding occurs regularly in non-native vegetation, especially salt cedar (Moore and Ahlers 2006, Sogge et al. 2003).

Presence-Absence within the Action Area

Surveys for the flycatchers have been conducted at Elephant Butte Reservoir since the 1990s. The surveys show the birds now occupy the reservoir from full pool elevation at 4407 feet down to 4345 feet (Table D.3).

Table D.3. Territories occupied by Southwestern Willow Flycatchers in Elephant Butte Reservoir in 2003-2012 from full pool elevation down to 4345 feet in five foot intervals.

[illegible]

4360-										
4365	0	0	0	0	0	3	2	0	11	6
4355-										
4360	0	0	0	1	1	3	4	4	20	18
4350-										
4355	0	0	0	0	2	7	18	9	6	4
4345-										
4350	0	0	0	0	0	1	1	3	2	2
Total	82	113	107	134	189	229	309	291	306	236

Reclamation surveyed for flycatchers from Caballo to El Paso in areas of suitable flycatcher habitat during the summer of 2012. Twenty-eight total flycatcher territories were observed, which exceeds the recovery goals for this Rio Grande Management Unit of 25 total territories. The IBWC has also surveyed for the birds (2004) and documented the birds in the Seldon Canyon region of the Rio Grande (IBWC 2004). These Seldon Canyon birds occur beyond the 100-year floodplain of the Rio Grande Project. The IBWC found that suitable dense vegetation that would be occupied by the birds does not occur south of Percha Diversion Dam. Although salt cedar does exist along the river banks, these shrubs and trees do not meet the minimum patch size and density requirements for the flycatcher.

As mentioned above, the IBWC committed to a restoration plan in their 2011 consultation on the Rio Grande canalization project. The restoration plan includes up to 30 riparian restoration sites, of which about 8 are specifically designed to create flycatcher habitat on at least 21 hectares (53 acres) and as many as 42 hectares (105 acres), and to include management of saltcedar that is intermixed with cottonwood, willow, mesquite, and arrowweed to maximize potential value for nesting or migratory flycatchers. These sites are to be restored by 2019. The restoration plan also calls for discontinuing mowing willows along the river for the benefit of flycatchers and planting willows in other areas where hydrological conditions are favorable. Restoration efforts will also physically reconnect old river channels and lower incised banks to the main river channel where appropriate. These efforts should result in additional flycatcher habitat beyond the minimum restoration sites. The restoration plan has established collaborative relationships between the EBID, EP#1, IBWC, Audubon Society, Reclamation, and Service to benefit the flycatcher, including monitoring for flycatcher presence and habitat condition throughout the reach.

Rio Grande Silvery Minnow (Hybognathus amarus)

Status and Distribution

The silvery minnow was once one of the most abundant and widespread fishes in the Rio Grande Basin. Historically, silvery minnow occurred in the Rio Grande from Española, NM, to the gulf coast of Texas and in larger tributaries including the Pecos River encompassing more than 1,500 river miles. Today, silvery minnow are restricted to the reach of the Rio Grande in New Mexico from the vicinity of Bernalillo downstream to

the headwaters of Elephant Butte Reservoir. The occupied distance is approximately 10% of its presumed historic range (approximately 150 river miles).

Catch rates at sites in the middle Rio Grande upstream of Elephant Butte Reservoir were highest in 2005, and were similar in 2004, 2006, 2010, and 2011. During October 2012, silvery minnow was not present in any of the seine hauls that yielded fish, as compared with four of the seine hauls that yielded fish during September 2012. Silvery minnow were present in 79 of the seine hauls that yielded fish during December 2012 (Dudley and Platania, 2012).

Impacts of the severe drought in New Mexico are reflected in the 2012 silvery minnow population monitoring results. It should be noted that population monitoring results are an indicator of relative and not absolute abundance. The lack of silvery minnow in the October 2012 density data does not mean there are no silvery minnow in the river but, instead, indicates that the species is near its lowest numbers since monitoring began in 1993.

Life History and Ecology

Silvery minnow are pelagic spawners producing numerous semi-buoyant, nonadhesive eggs and generally spawn in the spring, from late April through June (Platania and Dudley 1999–2010). Peak egg production typically occurs in mid- to late-May, coinciding with high spring discharge produced by snowmelt runoff. Each female produces several clutches of eggs during spawning, ranging from 2,000–3,000 (Age 1) to 5,000+ eggs (Age 2) per female (Platania and Altenbach 1996). Adult silvery minnow are strong swimmers capable of moving upstream during high flow events (Bestgen et al. 2010). However, studies conducted tracking hatchery fish indicate that there is not likely a population wide migration behavior for silvery minnow. It appears that movement is somewhat random with a net downstream trend for marked individuals though a few individuals moved upstream substantial distances (25 km).

Age determination for museum specimens collected in 1874 based on scales (Cowley et al. 2006) indicated silvery minnows may live up to 5 years. However, more recent analysis of the same museum material and contemporary specimens indicate a maximum age of 3 (Horwitz et al. 2011). The majority of the population captured by population monitoring during prespawn seining surveys is comprised of Age 1 fish (1 year old) with older, larger fish (Age 2+) constituting less than 10% of the spawning population (Platania and Altenbach 1996, Horwitz et al. 2011).

Habitat

Critical habitat was designated for silvery minnow in 1999 (64 FR 36274-36290), with revisions published February 19, 2003 (68 FR 8088-8135). Designated critical habitat in the Rio Grande extends through Sandoval, Bernalillo, Valencia, and Socorro Counties, New Mexico, generally beginning at Cochiti Dam downstream to the utility line crossing the Rio Grande at the upstream end of the Elephant Butte Reservoir full pool. The reservoir and the Rio Grande Project are acknowledged to have led to the extirpation of the species from this area.

Both juvenile and adult silvery minnow primarily used mesohabitats with moderate depths (15–40 centimeters), low water velocities (4–9 centimeters per second) and silt/sand substrates. Young-of-year silvery minnow are generally found in shallower and lower velocity habitats than adult individuals. During winter months, silvery minnow become less active and seek habitats with cover such as debris piles and low water velocities. During spring sampling, large concentrations of reproductively mature silvery minnow are often collected on inundated lateral overbank habitats (Hatch and Gonzales 2008, LL Study). Further hypothesis testing to determine if silvery minnow exhibit preferential use of lateral habitat (including overbank) for spawning is underway. Surveys of inundated overbank habitats often capture large numbers of gravid females (Gonzales and Hatch 2009).

Threats

The original listing of the species as endangered (58 FR 11823) cited the presence of mainstream dams; growth of agriculture and cities in the Rio Grande Valley; overutilization 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.

Presence-Absence Analysis within the Action Area

In 2010, silvery minnow were the most abundant fish collected within the temporary channel. Silvery minnow were captured in a variety of habitat types. Four sites were selected based on accessibility between RM 45.8 and 51.3. Mean density of silvery minnow was significantly higher in habitats less than 0.25 meters deep. 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 RM 46.5 and 54.5.

Sampling for 2012 was conducted on October 10th and 11th. Four sites between RM 46 to 52 were selected. A total of seven different fish species were captured during the sampling. No silvery minnows were captured during any of the samplings on either day. Two samplings at two different sites produced “no fish” and there were no sites dry. Western mosquitofish were the most abundant and red shiners were the second most abundant. Red shiners were distributed fairly evenly from top to bottom throughout the sites and the mosquitofish were a little more plentiful in the lower sites.

Refer to Table D.4 for a summary of the species collected during sampling in the temporary channel over the past three years. In general, silvery minnow were more

abundant at sites above RM 50. No sampling occurred downstream of RM 45.8. The fish has been extirpated from the rest of the action area.

Table D.4. Fish species collected during September sampling in the temporary channel within Elephant Butte Reservoir pool from 2010 – 2012.

	2010		2011		2012	
	#	#/100 m ²	#	#/100 m ²	#	#/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

Appendix E - Definitions

Definition of Allocation Components: OA

For the purposes of this analysis, the Total Diversion Allocations to EBID and EPCWID each year are parsed into three components: Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. Each district's Total Diversion Allocation is the sum of its Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. Calculation of allocation components under the OA and under prior operating practices is summarized below.

- **Accrued Carryover Balance**

- Under the OA, each district's Accrued Carryover Balance for a given year is equal to the balance on its Project water account on January 1 of that year, which in turn is equal to the district's prior-year unused allocation balance after accounting for all Project charges as well as any transfer of excess carryover balance per Section 1.11 of the OA. Accrued Carryover Balance reflects the cumulative balance on a district's Project water account over all prior years under the OA, including allocations, charges, and transfers. The term Accrued Carryover Balance as used here is equivalent to the term Actual Carryover Water defined in the OA.
- As under the OA, each district's Accrued Carryover Balance under prior operating practices for a given year is taken as the balance on its Project water account on January 1 of that year, which in turn is equal to the district's prior-year unused allocation balance after accounting for all Project charges as well as any (implicit) transfer of allocation balance between districts (see below). As under the OA, each district's Accrued Carryover Balance reflects the cumulative balance on a district's Project water account over all prior years, including allocations, charges, and transfers. As carryover accounting did not exist under prior operating practices, this term is defined here for comparison purposes.

- **Annual Allocated Water**

- Under the OA, each district's Annual Allocated Water for a given year is equal to the increase in the balance on its Project water account between January 1 and the end of that year's irrigation season. Annual Allocated Water thus represents the Project allocation received by each district during the current year based on current-year inflows to Project storage and prior-year inflows to Project storage that did not contribute to prior-year Project allocations (i.e., previously unallocated Project water).
- As under the OA, each district's Annual Allocated Water under prior operating practices for a given year is taken as the increase in the balance on its Project water account balance between January 1 and the end of the current-year irrigation season. As under the OA, Annual Allocated Water represents the allocation received by each district during the current year based on current-year inflows to Project storage and prior-year inflows to Project storage that did not contribute to prior-year Project allocations. Because carryover accounting did not

exist under prior operating practices, this term is defined here for comparison purposes only.

- **Transfer of Allocation Balance**

- Under the OA, each district's Transfer of Allocation Balance for a given year is equal to the change in balance on its Project water account between the end irrigation season (October 31) and the end of the Water Year (December 31) due to transfer of excess balance under Section 1.11 of the OA. Transfer of Allocation Balance is negative if water is transferred from a district's balance to the other district's balance and is positive if water is transferred to a district's balance from the other district's balance. For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year, and that the only change in a district's water account during this period is due to transfer of allocation balance per Section 1.11 of the OA. Under Section 1.11, if either district's allocation balance at the end of the water year exceeds its Carryover Limit—defined as 60% of the district's fully yearly allocation, or 232,915 AF for EPCWID and 305,918 AF for EBID—then the excess balance is transferred to the other district. The term Transfer of Allocation Balance as used here is equivalent to the term Transfer of Excess Carryover Balance defined in the OA.
- As noted above, under prior operating practices each district effectively lost a portion of its unused allocation balance at the end of the year due to the lack of carryover accounting. As used here, Transfer of Allocation Balance under prior operating practices is equal to this implicit loss of unused allocation balance by each district (and corresponding gain of allocation balance by the other district) that occurred under prior operating practices. Transfer of Allocation Balance to EBID is calculated at the start of each water year as the sum of 57% of EBID's allocation balance at the end of the previous year (i.e., EBID's Accrued Carryover Balance, taken as negative) and 57% of EPCWID's allocation balance at the end of the previous year (i.e., EPCWID's Accrued Carryover Balance, taken as positive). Transfer of Allocation Balance to EPCWID is calculated at the end of each irrigation season as the sum of 43% of EBID's allocation balance at the end of the previous year (i.e., EBID's Accrued Carryover Balance, taken as positive) and 43% of EPCWID's allocation balance at the end of the prior year (i.e., EPCWID's Accrued Carryover Balance, taken as negative). As carryover accounting and transfer of allocation did not exist under prior operating practices, this term is defined here for comparison purposes only.

- **Total Diversion Allocation**

- Under the OA and prior operating practices, the Total Diversion Allocation to each district for a given year is the sum of the three allocation components for that district. Each district's Total Diversion Allocation is thus determined after the current-year irrigation season has ended, rather than at the start of the current-year irrigation season. This is consistent with the fact that actual historical operations under both prior operating practices (1980-2007) and under the OA (2008-2012) allowed Reclamation and the districts to update Project allocations regularly

throughout the irrigation season and determined final Project allocations even after all releases for the season had been made.

- **Total Allocation Charges**

- Sum of a district's gross diversions of Project water minus the sum of the district's allocation credits between January 1 of the current year and the end of the current-year irrigation season
- Gross diversions of Project water correspond to diversions of Delivered Flow as defined in Section 5.3 of OA; allocation credits correspond to credits applied to a district's Project water account for bypassed (returned) flows as defined in Section 5.5 of OA plus credit for unused diversions which exceed the order.
- For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year.

- **Unused Allocation Balance**

- Difference between Total Diversion Allocation and Total Allocation Charges at the end of the current-year Water Year
- It should be noted that current-year Accrued Carryover Balance is equal to prior-year Unused Allocation Balance

Definition of Allocation Components: Prior Operations

- **Implicit Accrued Carryover Balance**

- Carryover accounting did not exist under prior operating practices; this term is defined here for comparison purposes only.
- Implicit Carryover Balance is defined here as the balance on a district's Project water account on December 31 of the prior water year, after all charges and transfers have been enacted (see below)

- **Annual Allocated Water**

- Carryover accounting did not exist under prior operating practices; this term is defined here for comparison purposes only.
- Increase in district's Project water account balance between January 1 of the current year and the end of the current-year irrigation season (assumed to be October 31)
- For the purposes of this analysis, it is assumed that the final Annual Allocated Water for the current year is determined on or before the end of the current-year irrigation season.

- **Implicit Transfer of Carryover Balance**

- Carryover accounting did not exist under prior operating practices; this term is defined here for comparison purposes only.

- Under prior operating practices, the unused balance on each district's Project water account at the end of each Water Year was effectively relinquished. Accrued Carryover Balance was not considered under prior operating practices.
- This relinquishment constituted an implicit transfer of Accrued Carryover Balance between districts—EBID effectively transferred 43% of its balance to EPCWID, and EPWCID effectively transferred 57% of its balance to EBID.
- For the purposes of this analysis, this implicit transfer of unused allocation balance between districts is considered comparable to the transfer of excess carryover under the OA.
- EBID's implicit transfer of carryover balance is the sum of 57% of EBID's allocation balance at the end of the current-year irrigation season (taken as negative) and 57% of EPCWID's allocation balance at the end of the current-year irrigation season (taken as positive)
- EPCWID's implicit transfer is the sum of 43% of EBID's allocation balance at the end of the current-year irrigation season (taken as positive) and 43% of EPCWID's allocation balance at the end of the current-year irrigation season (taken as negative)
- For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year, and that the only change in a district's water account during this period is due to transfer of excess carryover
- **Total Diversion Allocation**
 - Total allocation allotment on district's Project Water Account for the current year
 - Total Diversion Allocation for the current year is the sum of the district's Accrued Carryover Water, Annual Allocated Water, and Transfer of Excess Carryover Water for the current year
- **Total Allocation Charges**
 - Sum of a district's gross diversions of Project water minus the sum of the district's allocation credits between January 1 of the current year and the end of the current-year irrigation season
 - For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year.
- **Unused Allocation Balance**
 - Difference between Total Diversion Allocation and Total Allocation Charges at the end of the current Water Year
 - It should be noted that current-year Accrued Carryover Balance is equal to prior-year Unused Allocation Balance

Appendix F – Hydrology Technical Information

RECLAMATION

Managing Water in the West

Technical Memorandum No. 86-68210-2013-3

Rio Grande Project: Analysis of Surface Water and Groundwater Resources under the 2008 Operating Agreement



U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

June 2013

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. 86-68210-2013-3

Rio Grande Project: Analysis of Surface Water and Groundwater Resources under the 2008 Operating Agreement

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**U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado**

June 2013

Executive Summary

This report details modeling and analysis conducted to assess potential effects of the 2008 Rio Grande Project Operating Agreement (OA) on surface water and groundwater resources within the Project and surrounding areas of New Mexico and Texas. Potential effects on surface water resources were assessed by modeling and comparing Project operations under the OA and under operating practices consistent with Project operations during the period 1980-2007 (prior operating practices). Potential effects on groundwater resources were assessed based on analysis of historical groundwater conditions within the Project and surrounding areas and analysis of the relationship between Project operations and groundwater recharge and demand.

The Rio Grande Project (Project) provides water to the Elephant Butte Irrigation District (EBID), which includes 90,640 acres in the Rincon and Mesilla Valleys of southern New Mexico, and to the El Paso County Water Improvement District No. 1 (EPCWID), which includes 69,010 acres in the Mesilla and El Paso valleys of western Texas. The Project also provides water for Mexico under international treaty. The Project includes two dams and associated reservoirs, Elephant Butte and Caballo, a power generating plant, and five diversion dams (Percha, Leasburg, Mesilla, American, and International). The 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 OA is a written description of the procedures by which Reclamation operates the Rio Grande Project, including allocation of Project water EBID, EPCWID, and Mexico; release of Project water from storage; delivery of Project water to authorized points of diversion; and accounting for allocation charges and credits. The operating procedures defined within the OA were developed by EBID, EPCWID, and Reclamation, and the OA was signed by all three parties on March 10, 2008. A Rio Grande Project Operations Manual was subsequently developed by EBID, EPCWID, and Reclamation in 2008 to further define the procedures outlined within the OA. The OA and Operations Manual are reviewed annually and updated as needed and with unanimous consent of all parties in order to optimize Project operations consistent with applicable water rights, state and federal laws, and international treaties.



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Denver, Colorado**

June 2013

Operating procedures defined in the OA are largely consistent with prior operating practices during the period 1980-2007. 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. Carryover accounting was not considered under prior operating practices. Second, the OA provides for adjustment of the annual allocations to EBID and EPCWID to account for changes in Project performance, as characterized by the Project diversion ratio ($\rho_{Project}$, calculated as the ratio of total Project allocation charges to total Project releases during a given period). While numerous factors affect Project performance, recent changes in Project performance are predominately driven by the actions of individual landowners within EBID, including crop selection and related effects on crop irrigation requirement; irrigation practices and related effects on on-farm irrigation efficiency; and widespread use of groundwater for supplemental irrigation as permitted and regulated by the State of New Mexico (see Section 4.2). The OA ensures that the annual Project allocation to EPCWID is consistent with historical Project performance as characterized by the D2 Curve (see Sections 2.4 and 3.1), and that deviations in Project performance relative to historical conditions are accounted for through adjustment of the annual Project allocation to EBID.

The modeling and analysis detailed in this report were carried out in support of the Rio Grande Project Supplemental Environmental Assessment (EA) for Implementation of the Rio Grande Project Operating Procedures, New Mexico and Texas (Supplemental EA). This analysis addresses the following study objectives:

- Evaluate effects of the OA on Project operations over the period 2008-2012, including effects on Project allocations, releases, deliveries, and storage and reservoir elevation in Elephant Butte Reservoir
- Evaluate the probable effects of the OA on Project operations over the period 2013-2015 (through the end of the 2015 irrigation season), including effects on Project allocations, releases, deliveries, and storage and reservoir elevation in Elephant Butte Reservoir
- Evaluate historical groundwater measurements to assess trends in groundwater elevation within the Project and surrounding areas and to assess the relationship between Project operations and groundwater fluctuations
- Evaluate effects of the OA on groundwater recharge and demand within the Project during the periods 2008-2012 and 2013-2015

One of the key principles underlying the OA is the need to account for effects of changes in Project performance on Project deliveries. As detailed in Section 1.2 of

this report, Project performance depends in a number of factors, including cropping patterns, conveyance and on-farm efficiencies, and groundwater pumping within the Project and surrounding areas, including groundwater pumping for supplemental irrigation within the Project. In addition to the objectives outlined above, this analysis briefly considers the relative effects of these factors on Project deliveries and estimates their cumulative effects on Project performance during the period 2008-2012 compared to historical conditions. The cumulative effects of these factors are then compared to the estimated changes in Project allocation and delivery to under the OA.

Effects of the OA on annual Project operations during the periods 2008-2012 and 2013-2015 are evaluated quantitatively. Due to the short timeline of the Supplemental EA, evaluation of effects of the OA on groundwater resources, including effects on groundwater-surface water interaction, is predominately qualitative. Quantitative evaluation of effects on groundwater resources will require the use of sophisticated numerical groundwater models, which in turn require a substantial amount of time to develop, verify, apply, and analyze. The use of numerical groundwater models is beyond the scope of the current study due to the time constraints of the Supplemental EA. Reclamation is committed conducting further analysis of the potential effects of the OA and other factors on groundwater resources and groundwater-surface water interaction in the future using the most appropriate data and methods, including numerical groundwater models. The predominately qualitative evaluation presented here is sufficient to draw conclusions regarding the potential effects of the OA on of groundwater resources within the Project and surrounding areas.

Potential Effects of the OA on Surface Water Resources

Potential effects of the OA on surface water resources were first analyzed by comparing actual Project operations during the first five years of the OA (2008-2012) to estimated Project operations that would have occurred during this period under prior operating practices that were in place during the period 1980-2007. Potential effects were then evaluated for the three year period from the start of the 2013 irrigation season to the end of the 2015 irrigation season. Due to the uncertainty in future Project inflows, potential effects over the period 2013-2015 were characterized as probability distributions.

This analysis considers potential effects of the OA on the management usable water available to the Rio Grande Project, including all water stored in Project storage, excluding Rio Grande Compact credit water and San Juan-Chama water, and available for release to meet Project demands and all waters reaching the bed of the Rio Grande within the Project. Two annual allocation models were developed to calculate Project operations under the OA and under prior operating practices, respectively. Each annual allocation model calculates annual Project allocations, releases, diversions, and storage at the end of irrigation season. The data, methods, and assumptions used in the annual allocation models developed

for this study are detailed in Section 3.1 of this report, along with uncertainties associated with the modeling approach used here.

Actual Project allocations to EBID under the OA during the period 2008-2012 are summarized in Table ES-1; calculated allocations to EBID that would have occurred during this period under prior operating practices are summarized in Table ES-2. Corresponding allocations to EPCWID under the OA and prior operating practices are provided in Tables ES-3 and ES-4, respectively. The Total Diversion Allocation to each district consists of three components: Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. These components are explicitly accounted for in the allocation procedure defined in the OA. While these components were not explicitly considered under prior operating practices, they are considered here for comparison purposes. Allocation components are defined in Section 3.1.4.

The analysis detailed here indicates a decrease in average Annual Allocated Water to EBID of 55,760 AF/yr (22%) under the OA during the period 2008-2012 compared to the estimated Annual Allocated Water that EBID would have been allocated during this period had the project been operated under prior operating practices. EBID's average Accrued Carryover Balance increased by an estimated 14,677 AF/year under the OA; EBID's estimated Accrued Carryover Balance was zero for all years under prior operating practices. Under the OA, Transfer of Allocation Balance to EPCWID decreased by an estimated average of 6,055 AF/year (30%). The estimated change in average Total Diversion Allocation to EBID under the OA was therefore a net decrease of 47,138 AF/year (17%). Results indicate that the OA resulted in an overall decrease in average annual net diversion (i.e., Project charges) to EBID of 62,065 AF/year, equal to a reduction in average annual charges of 22% compared to estimated prior operating practices.

Table ES-1: EBID Annual Project Allocations, Charges, and Releases under the OA (Actual) (2008-2012)

	Annual Allocated Water	Accrued Carryover Balance¹	Transfer of Allocation Balance²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	324,990	0	0	324,990	329,294 ³	-4,304
2009	255,598	-4,304	80,879	332,173	291,830 ³	40,343
2010	255,257	40,343	10,271	305,871	285,856 ³	20,015
2011	57,089	20,015	0	77,104	59,771 ³	17,333
2012	118,300	17,333	0	135,633	134,386	1,247
Average	202,247	14,677	18,230	235,154	220,227	14,927

¹ Balance from district's prior-year unused allocation balance (Table 4, Row 11 of OA)

² Transfer of allocation balance from EPCWID under Section 1.11 of OA.

³ Discrepancies exist between values provided on district charge sheets and values used in annual Project allocation worksheets; in these cases, charges used here were estimated from annual Project allocation worksheets from each district's Total Diversion Allocation and subsequent year carryover balance.

Table ES-2: EBID Annual Project Allocations, Charges, and Releases under Prior Operating Practices (Estimated) (2008-2012)

	Annual Allocated Water	Accrued Carryover Balance¹	Transfer of Allocation Balance²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	434,275	0	60,738	495,013	495,013	0
2009	269,542	0	42,342	311,884	311,884	0
2010	288,476	0	0	288,476	288,476	0
2011	77,551	0	0	77,551	77,551	0
2012	220,193	0	18,346	238,539	238,539	0
Average	258,007	0	24,285	282,293	282,293	0

¹ Accrued Carryover Balance from prior-year unused allocation balance is not applicable under prior operating practices; contribution of carryover water estimated as portion of district's total allocation that is not supplied by current-year inflows to Project storage

² Accrued Carryover Balance from transfer of excess carryover is not applicable under prior operating practices

Table ES-3: EPCWID Annual Project Allocations, Charges, and Releases under the OA (Actual) (2008-2012)

	Annual Allocated Water	Accrued Carryover Balance¹	Transfer of Allocation Balance²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	388,192	106,982	0	495,174	262,292	232,882
2009	400,984	232,882	-80,879	552,987	320,072	232,915
2010	291,905	232,915	-10,271	514,549	290,201	224,348
2011	43,466	224,348	0	267,814	258,772	9,042
2012	132,935	9,042	0	141,977	136,380	5,597
Average	251,496	161,234	-18,230	394,500	253,543	140,957

¹ Balance from district's prior-year unused allocation balance (Table 4, Row 11 of OA)

² Transfer of allocation balance from EPCWID under Section 1.11 of OA.

³ Discrepancies exist between values provided on district charge sheets and values used in annual Project allocation worksheets; in these cases, charges used here were estimated from annual Project allocation worksheets from each district's Total Diversion Allocation and subsequent year carryover balance.

Table ES-4: EPCWID Annual Project Allocations, Charges, and Releases under Prior Operating Practices (Estimated) (2008-2012)

	Annual Allocated Water	Accrued Carryover Balance¹	Transfer of Allocation Balance²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	330,641	106,982	-60,738	376,885	302,305	74,580
2009	205,220	74,580	-42,342	237,457	237,457	0
2010	219,635	0	0	219,635	219,635	0
2011	59,044	0	0	59,044	26,730	32,314
2012	167,647	32,314	-18,346	181,615	181,615	0
Average	196,437	42,775	-24,285	214,927	193,548	21,379

¹ Accrued Carryover Balance from prior-year unused allocation balance is not applicable under prior operating practices; contribution of carryover water estimated as portion of district's total allocation that is not supplied by current-year inflows to Project storage

² Accrued Carryover Balance from transfer of excess carryover is not applicable under prior operating practices

The estimated change in average Annual Allocated Water to EPCWID under the OA compared to prior operations is an increase of 55,059 AF/yr (28%). Most notably, the average Accrued Carryover Balance to EPCWID increases by 118,459 AF/year under the OA, corresponding to an increase of 277% compared to prior operating practices; this large increase in Accrued Carryover Balance is a direct result of the carryover provision of the OA. However, Transfer of Allocation Balance from EPCWID to EBID increased by an estimated 6,055 AF/year on average due Section 1.11 of the OA. The estimated change in average Total Diversion Allocation to EPCWID under the OA was therefore a net increase of 179,573 AF/year (84%). The large increase in Total Diversion Allocation compared to Annual Allocated Water reflects the fact that the district maintains a significant Accrued Carryover Balance, which contributes to the Total Diversion Allocation in multiple years; the change in average Total Diversion Allocation therefore reflects double counting of Accrued Carryover Water that remains on the district's allocation balance for multiple years. Results suggest that on average, the OA resulted in an estimated increase in annual diversion to EPCWID of 59,995 AF/year, equivalent to an increase in average annual diversion of 31% compared to prior operating practices.

Actual Project storage under the OA and estimated total Project storage under prior operating practices at the start and end of irrigation season (March 1 and October 31, respectively) for the period 2008-2012 are provided in Table ES-5; the corresponding usable water at the start and end of irrigation season are provided in Table ES-6. Usable water is calculated as the total amount of water in Project storage minus Rio Grande Compact credit waters and San Juan-Chama waters. Total Project storage and usable water in Project storage are generally greater under the OA than under prior operating practices due to the carryover provision of the OA, which allows each district to carryover the unused balance remaining on its Project water account at the end of each year as a diversion credit on its Project account the following year. Increases in Project storage under the OA results in corresponding increases in reservoir elevation in Elephant Butte, as detailed in Section 3.2.1 of this report.

Differences in Project allocations and diversions under the OA compared to prior operating practices drive differences in annual reservoir releases, with corresponding differences in total Project storage and usable water in Project storage. Differences in Project allocations result from a combination of the diversion ratio and carryover provisions of the OA. For any given year, the diversion ratio provision affects the apportionment of Annual Allocated Water between EBID and EPCWID, while the carryover provision affects each districts' Transfer of Allocated Water at the end of a given year and its Accrued Carryover Balance at the start of the following year. Over successive years, however, the cumulative effects of the diversion ratio provision on each district's Annual Allocated Water affect both districts' Accrued Carryover Balance; conversely, the cumulative effects of the carryover provision on each district's Accrued Carryover Balance—and thus on the total usable water available for allocation in

a given year—affect both districts’ Annual Allocated Water. The analysis presented here indicates that estimated changes in Project allocation to EBID are largely driven by the diversion ratio provision of the OA, whereas estimated changes in Project allocation to EPCWID are driven by a combination of the diversion ratio provision and the carryover provision.

In accordance with the 1906 Treaty with Mexico, Mexico receives a diversion allocation of 60,000 AF/year under both the OA and prior operating practices, except during extraordinary drought conditions. During extraordinary drought conditions, Mexico receives 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. The procedure used to determine the annual diversion allocation to Mexico is identical under the OA and prior operating practices. However, because the OA may result in a change in the total Project release and delivery during any given year, the OA may result in a corresponding and proportionate change in the allocation to Mexico in a given year during extraordinary drought conditions. Effects are due to potential change in the timing of releases and deliveries between years, not to a change in the total volume of releases; effects therefore average out over time. As a result, the OA has no effect on the long-term average annual allocation to Mexico.

Table ES-5: Total Project Storage at Start and End of Irrigation Season under the OA and Prior Operating Practices (2008-2012)

	OA (Actual)		Prior Operating Practices (Estimated)	
	Total Project Storage (Start of Season)	Total Project Storage (End of Season)	Total Project Storage (Start of Season)	Total Project Storage (End of Season)
2008	510,339	510,339	510,339	369,635
2009	724,149	493,961	473,263	163,898
2010	630,160	476,076	476,076	162,096
2011	529,699	437,632	437,632	235,072
2012	384,278	463,553	463,553	109,609
Average	555,725	476,312	472,173	208,062

Table ES-6: Usable Water in Project Storage at Start and End of Irrigation Season under the OA and Prior Operating Practices (2008-2012)

	OA (Actual)		Prior Operating Practices (Estimated)	
	Usable Water (Start of Season)	Usable Water (End of Season)	Usable Water (Start of Season)	Usable Water (End of Season)
2008	417,109	506,351	417,109	276,405
2009	560,251	316,736	309,365	0
2010	468,064	228,747	313,980	0
2011	341,880	30,377	249,813	47,253
2012	274,669	10,378	353,944	0
Average	412,395	218,518	328,842	64,732

The effects of the OA on Project operations during the period 2013-2015 will depend on annual inflows to Project storage and annual Project diversion ratios during this period, as well annual diversions by EBID, EPCWID, and Mexico. It is not possible to accurately predict Project inflows multiple years into the future. Moreover, it is not possible to accurately predict Project diversions or the Project diversion ratio years into the future due to the many complex and interrelated factors that affect both. For this analysis, potential effects of the OA during the period 2013-2015 were therefore considered using a probabilistic approach.

Because future inflows over the period 2013-2015 are not known, historical annual inflows for the period 1951-2012 were resampled to develop a probability distribution of three-year Project inflow sequences representative of historical hydrologic conditions. This distribution of Project inflows was then used to develop probability distributions of Project operations over the period 2013-2015, including distributions of annual Project allocations; diversions, releases, and storage (see Section 3.2.2). The resulting distributions of annual Project inflows are represented here as non-exceedance probabilities, where low non-exceedance probabilities are associated with generally drier conditions and high non-exceedance probabilities are associated with generally wetter conditions over a given three-year simulation period.

Estimated 20%, 50%, and 80% non-exceedance values of Annual Allocated Water, Accrued Carryover Balance, Transfer of Allocation Balance, and Total Diversion Allocation to EBID for years 2013-2015 are provided in Table ES-7; corresponding values for EPCWID are provided in Tables ES-8. Overall, estimated differences in Total Diversion Allocation to EBID under the OA compared to prior operating practices are relatively small for drier conditions (20% non-exceedance), when differences in Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance are all relatively minor. Under wetter conditions (80% non-exceedance), however, the Total Diversion

Allocation to EBID is as much as 124,000 AF less under the OA compared to prior operating practices. Estimated Total Diversion Allocation to EPCWID under the OA is generally greater than under prior operating practices for dry and normal conditions (20% and 50% non-exceedance). Under wet conditions (80% non-exceedance), however, allocation to EPCWID is slightly less under the OA. Differences are generally small under both dry and wet conditions, with the greatest differences occurring under normal conditions. Under normal conditions, the estimated Total Diversion Allocation to EPCWID as much as 106,000 AF greater under the OA compared to prior operating practices.

Similar to result for the period 2008-2012, estimated differences in Project allocations to EBID over the period 2013-2015 are largely driven by the diversion ratio provision of the OA, whereas estimated differences in allocation to EPCWID result from a combination of the diversion ratio and carryover provisions. However, estimated differences are strongly dependent on both water supply conditions and the Project diversion ratio during the three-year simulation period. For example, under drier and normal water supply conditions, the estimated diversion allocation to EBID for the 2015 irrigation season is slightly less under the OA than under prior operating practices, with differences less than 10% for a broad range of diversion ratios. Under wetter conditions, however, the estimated allocation to EBID for the 2015 season differs by as much as 30% under the OA compared to prior operating practices. When wet conditions coincide with very low values of the diversion ratio, allocation to EBID may be as much as 30% less under the OA; conversely, when wet conditions coincide with very high values of the diversion ratio, allocation to EBID may be as much as 30% greater under the OA.

The large decrease in allocation to EBID under wet conditions (80% non-exceedance) shown in Table ES-7 reflects the general low estimates of the diversion ratio used in this analysis. Low values of the diversion ratio reflect recent Project performance during recent severe and sustained drought conditions. However, it is unlikely that low values of the diversion ratio will continue if a series of high supply years were to occur during the period 2013-2015. Estimates of future values of the Project diversion ratio are a key uncertainty in this analysis.

Table ES-7: Estimated Non-Exceedance Values of Project Allocations to EBID (2013-2015)

Annual Allocated Water	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	123,918	160,424	301,356	123,918	230,029	419,612
2014	138,430	195,246	339,285	145,183	253,522	455,473
2015	151,143	322,643	371,141	172,168	272,368	456,995
Accrued Carryover Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	2,573*	2,573*	2,573*	2,573*	2,573*	2,573*
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
Transfer of Alloc. Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	0	0	0	2,065**	2,065**	2,065**
2014	0	0	0	0	4,486	18,548
2015	0	0	0	0	10,863	32,807
Total Diversion Allocation	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	126,491	162,997	303,929	128,556	234,668	424,250
2014	138,430	195,246	339,285	158,857	261,598	495,013
2015	151,143	322,643	371,141	180,058	280,099	495,013

* District's historical (actual) Accrued Carryover Balance used for 2013

** Calculation of implicit Transfer of Allocation Balance under prior operating practices for 2013 based on district's historical (actual) Accrued Carryover Balance

Table ES-8: Estimated Non-Exceedance Values of Project Allocations to EPCWID (2013-2015)

Annual Allocated Water	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	94,347	249,028	304,241	94,347	175,136	319,477
2014	146,834	278,940	304,241	110,537	193,022	346,780
2015	157,311	304,241	304,241	131,083	207,371	347,939
Accrued Carryover Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	5,597*	5,597*	5,597*	5,597*	5,597*	5,597*
2014	8,819	20,211	43,031	0	7,901	32,669
2015	20,082	46,735	57,813	0	19,134	57,785
Transfer of Alloc. Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	0	0	0	-2,065**	-2,065**	-2,065**
2014	0	0	0	-18,539	-4,486	0
2015	0	0	0	-28,351	-10,863	0
Total Diversion Allocation	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	99,944	254,625	309,838	97,878	178,667	323,009
2014	173,620	304,241	323,787	120,948	199,171	376,885
2015	209,900	319,485	342,422	137,089	213,257	376,885

* District's historical (actual) Accrued Carryover Balance used for 2013

** Calculation of implicit Transfer of Allocation Balance under prior operating practices for 2013 based on district's historical (actual) Accrued Carryover Balance

As for the period 2008-2012, changes in Project allocation to EBID and EPCWID under the OA during the period 2013-2015 will result in a corresponding change in annual net diversions (i.e., Project charges) by the districts. Because EBID typically uses its full diversion allocation each year, estimated changes in net diversions to EBID under the OA are equal to changes in the district's Total Diversion Allocation, discussed above. By contrast, because EPCWID typically does not divert its full allocation in most years, the OA has little effect on estimated annual diversions to EPCWID under most water supply conditions. Estimated annual diversions to EPCWID under the OA generally differ from those under prior operating practices by less than 10%. However, when normal water supply conditions (non-exceedance probabilities between 33% and 66%), coincide with very low values of the diversion ratio, annual diversions to EPCWID may be as much as 20% greater under the OA compared to prior operating practices.

The decrease in estimated annual diversions to EBID under wetter conditions results in a decrease in estimated annual releases from Project storage under the OA compared to prior operating practices under wetter conditions, whereas the estimated increase in diversions to EPCWID under normal conditions results in a small increase in release under these conditions. Changes in estimated Project releases over the period 2013-2015 result in a greater amount of water remaining in Project storage. By the end of the 2015 irrigation season, estimated total storage under the OA is estimated to range from approximately 60,000 AF greater under the OA for dry to normal conditions and up to 270,000 AF greater under wet conditions.

As summarized here, results of this analysis indicates that Project allocations to EPWID were generally greater under the OA than under prior operating practices during period 2008-2012 and are likely to be greater under the OA during the period 2013-2015, particularly under drier and normal water supply conditions. By contrast, results indicate that allocations to EBID were generally lower under the OA during the period 2008-2012 and are likely to remain lower under the OA during the period 2013-2015, except in the case that higher inflow conditions occur and the Project performance improves over the coming years. The increase in Project allocation to EPCWID results from a combination of the carryover provision of the OA, and hence the large increase in the district's Accrued Carryover Balance under the OA compared to prior operating practices, as well as the diversion ratio provision, which results in a moderate increase in annual allocation to EPCWID under the OA. By contrast, the decrease in Project allocation to EBID under the OA results primarily from the diversion ratio provision.

As noted above, one of the key principles underlying the OA is the need to account for effects of groundwater pumping and other factors within the Project and surrounding areas on Project performance with respect to the delivery of

Project water from storage to authorized points of diversion. The diversion ratio provision of the OA adjusts Project allocations to EBID and EPCWID to mitigate potential negative effects of changes in Project delivery performance on Project allocations and deliveries to EPCWID. Consideration of the effects of the OA on Project allocations therefore warrants consideration of changes in Project performance and corresponding shortfalls in Project deliveries.

Groundwater pumping within the Project and surrounding areas began in the 1950s and increased steadily during subsequent decades. Groundwater pumping is under the jurisdiction of the states, not the Federal project. However, it is widely recognized that groundwater pumping within the Project and surrounding areas depletes surface waters within the basin by inducing flow from the surface water into the groundwater system to replenish the pumped water, thereby decreasing the amount of water that the Federal project is able deliver to its constituents.

Previous studies suggest that changes in Project performance are largely driven by groundwater pumping within the Rincon and Mesilla Valleys. Groundwater pumping for irrigation is the largest component of groundwater demand in the region, particularly during dry years. In 2005, the New Mexico Office of the State Engineer estimated that groundwater pumping for irrigation in the Rincon and Mesilla Valleys in New Mexico, the majority of which occurs within EBID to supplement Project surface water supplies, is between 200,000 and 300,000 AF/year in dry years. Similar estimates of pumping for irrigation in the Texas portion of the Mesilla Valley range from 18,000 and 22,000 AF/year under dry conditions.

Since groundwater pumping for supplemental irrigation in the New Mexico portion of the region is approximately an order of magnitude greater than in the Texas portion of the region, it is reasonable to conclude that the majority of the effects of groundwater pumping on Project performance result from pumping within New Mexico, the majority of which occurs by individual landowners within EBID as permitted and regulated by the State of New Mexico. In addition, as described in Section 4.4, recent changes in cropping and irrigation practices and other factors by individual landowners within EBID have likely contributed to changes in recharge and groundwater pumping that further impact Project performance. The diversion ratio 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.

Shortfalls in Project deliveries due to recent deviations in Project performance can be estimated by comparing the annual gross Project diversion for a given year to the corresponding baseline annual diversion calculated using the D-2 Curve (see Sections 2.4 and 3.1.2). The D-2 Curve is a linear regression equation that

represents the historical relationship between annual Project releases and annual gross diversions at river headings. For a given annual release, the D-2 Curve calculates the annual gross diversion that can be delivered to Project headings under historical baseline performance conditions. The D-2 Curve was developed using historical Project operations data for the period 1951-1978 and therefore reflects the effects of groundwater pumping on Project performance during this period; shortfalls estimated with respect to a D-2 baseline therefore reflect the change in shortfall of Project deliveries compared to the period 1951-1978, rather than the total shortfall caused by groundwater pumping.

Analysis of historical Project diversions indicates that Project deliveries remained consistent with the D-2 baseline throughout the period 1980-2002. These results suggest that the D-2 curve is a reasonable depiction of baseline conditions that prevailed throughout more than 40 years of Project operation. Beginning in 2003, however, Project deliveries are substantially below the D-2 baseline. Analysis of groundwater trends within the Project and surrounding areas indicates widespread and significant declines in groundwater elevations also became prevalent in the Rincon and Mesilla Valleys around this time. Both Project performance and groundwater elevations throughout much of the Rincon and Mesilla Valleys have continued to decline over recent years.

Historical (actual) annual Project releases and gross diversions for the period 2008-2012 are shown in Table 9, along with corresponding baseline diversions calculated using the D-2 Curve. Actual diversions were substantially below the D-2 baseline in all years, with an average annual shortfall of 148,357 AF/year below the D-2 level. Under prior operating practices, shortfalls would have been apportioned between EBID and EPCWID according to the authorized acreage within each district (i.e. 57% to EBID and 43% to EPCWID). For 2008-2012, the average annual delivery shortfall under prior operating practices would thus be -84,228 AF/year to EBID and -64,128 AF/year to EPCWID.

Table ES-9: Annual Project Releases, Diversions, and Estimated Depletions (2008-2012)

Year	Annual Release	Annual Gross Diversion (Actual)	Annual Gross Diversion (D-2 Curve)	Estimated Shortfall
2008	674,724	645,870	812,675	-166,805
2009	694,199	667,554	838,729	-171,175
2010	660,300	612,357	793,378	-181,021
2011	396,876	342,795	440,971	-98,176
2012	372,600	283,886	408,494	-124,608
Average	559,740	510,492	658,850	-148,357

Under the OA, effects of groundwater pumping on Project diversions are accounted for by adjusting allocations to EBID and EPCWID according to the diversion ratio provision. The diversion ratio provision adjusts the annual Project allocation to EPCWID to maintain the district's D-2 baseline diversion. The annual Project allocation to EBID is then adjusted to reflect current-year Project performance as reflected by the diversion ratio. When the diversion ratio is high, EBID generally receives an increase in allocation compared to the D-2 baseline; when the diversion ratio is low, EBID generally receives a decrease in Project allocation compared to the D-2 baseline.

The average annual allocation to EPCWID during the period 2008-2012, excluding carryover balance, was 62,675 AF/year greater under the OA than the estimated allocation under prior operating practices, whereas the average annual allocation to EBID during this period, excluding carryover balance, was 63,739 AF/year less under the OA than under prior operating practices. The estimated increase in allocation to EPCWID is therefore approximately equal to the district's estimated shortfall during this period with respect to the D-2 baseline. The estimated increase in allocation to EPCWID is accounted for by a corresponding decrease in allocation to EBID. In the years covered by this EA, 2013-2015, the same principles apply, and the diversion ratio is likely to be similar to the diversion ratio experienced in recent years. Therefore, EPCWID is likely to continue to experience increases in annual allocation, and EBID is likely to continue to experience decreases in annual allocation, in magnitudes that reflect the shortfalls in EPCWID deliveries relative to the D-2 baseline.

Potential Effects of the OA on Groundwater Resources

Groundwater pumping is not an authorized function of the Rio Grande Project, and Project operations neither include nor directly affect groundwater use within the Project and surrounding areas. Since the 1950s, however, groundwater has been used for supplemental irrigation by many individual landowners within the Project as permitted and regulated by the states of New Mexico and Texas. In addition, groundwater is used for irrigation outside of the Project (groundwater-only lands) and for domestic and municipal purposes in the region. Groundwater pumping within the Project and surrounding areas depletes surface waters within the basin by inducing flow from the surface water into the groundwater system to replenish the pumped water, thereby decreasing the amount of water that the Federal project is able deliver to its constituents. Groundwater use therefore has an indirect on the project to the extent that pumping depletes Project surface water supplies.

Conversely, studies have shown that seepage of Project water from the Rio Grande, seepage from Project canals and laterals, and deep percolation of surface water irrigation supplied by the Project are the primary source of recharge within the basin. Project operations therefore have an indirect effect on groundwater recharge and demand within the Project and surrounding areas to the extent that

Project operations affect recharge from seepage and deep percolation of Project water and demand for supplemental irrigation on Project lands.

Changes in the distribution of Project allocations and deliveries between EBID and EPCWID are likely to affect the volume of recharge occurring as seepage losses from the Rio Grande. In the case that EBID receives a larger portion of the total Project diversions, water is diverted from the Rio Grande higher in the system; in the case that EPCWID receives a larger portion of the total diversion, water is diverted from the Rio Grande lower in the system. It is likely that seepage from the river would be greater in the latter case as the volume of water in the river would be greater over a longer stretch of river, which in turn would support increased seepage over a longer stretch. In general, the OA results in a decrease in Project allocation and deliveries to EBID and an increase in allocation and deliveries to EPCWID. As a result, it is likely that the OA will result in an overall increase in groundwater recharge from seepage of Project water from the bed of the Rio Grande. However, accurate estimation of changes in seepage losses from the Rio Grande under the OA—including changes in the timing and location of seepage, and to the extent that seepage contributes to usable groundwater supplies—is a significant challenge. It is not possible to quantify changes in seepage losses from the Rio Grande based on the data available for this study.

Changes in Project diversions to EBID and EPCWID are likely to result in changes in the timing and quantity of groundwater recharge within each district, respectively. A decrease in Project diversions to either district will result in decreased recharge within the district via seepage losses from canals and laterals, along with decreased recharge via deep percolation of surface water irrigation.

An order of magnitude estimate of the change in recharge and demand for supplemental irrigation within EBID resulting from a change in Project deliveries can be calculated from the average conveyance efficiency (f_{canal}) and on-farm irrigation efficiency (f_{farm}) within the district (see Section 4.42 and 4.43). The estimated change in average annual net diversion to EBID under the OA compared to prior operating practices during the period 2008-2012 is a decrease of 63,989 AF/year, with a corresponding decrease of 31,994 AF/year in estimated surface water deliveries to farms. This results in an estimated decrease in average annual recharge within the district of 41,593 AF/year and an estimated increase in groundwater demand for supplemental irrigation of 31,994 AF/year. The net effect of the OA on groundwater resources within EBID is thus an estimated decrease of 73,587 AF/year through decreased recharge and increased pumping demand.

It is not possible to develop an order of magnitude estimate of change in recharge and demand for supplemental irrigation within EPCWID at this time due to the complexity of operations within the district, including trade-offs between agricultural and municipal water uses and blending of multiple water sources and related water quality considerations. The allocation analysis developed for this

study does not differentiate between EPCWID uses for irrigation and municipal supply, and does not differentiate between district delivery to lands within the Mesilla and the El Paso Valleys. However, as detailed above, Project allocations and diversions to EPCWID are generally greater under the OA than under prior operating practices. It is therefore reasonable to conclude that recharge within the district via seepage of Project water from canals and laterals and deep percolation of Project irrigation water will also be generally greater under the OA. Conversely, to the extent that groundwater demand depends on Project supply—e.g., for supplemental irrigation—it is reasonable to conclude that groundwater demand within the EPCWID will also increase under the OA.

Conclusions

The analysis summarized here indicates that the OA will result in changes in the allocation of Rio Grande Project water between EBID and EPCWID, with subsequent effects on Project storage, releases, and deliveries. Estimated changes in Project allocations are consistent with the underlying principles of the OA, including promotion of water conservation through the carryover provision and mitigation of potential negative effects of deviations in Project performance, which result largely from the actions of individual landowners within EBID, on Project allocation and deliveries to EPCWID. In general, Project allocations and deliveries to EPCWID will remain consistent with historical Project conditions, while allocations and deliveries to EBID will increase when Project performance exceeds the historical baseline and decrease when Project performance is below the historical baseline. Results indicate that the OA will have no effect on the long-term average allocation to Mexico.

Effects of the OA on groundwater resources within the Project are generally consistent with the effects on Project surface water deliveries. By maintaining Project allocations and deliveries to EPCWID consistent with historical conditions, the OA will also maintain groundwater recharge via seepage and deep percolation of Project water. In years when the OA results in an increase in Project allocation and delivery to EBID, the OA will result in a corresponding increase in recharge via seepage and deep percolation within the district as well as a decrease in demand for supplemental irrigation within the district. 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 promote increased groundwater pumping within the district of permitted by the State of New Mexico.

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Acronyms

%	percent
AF	acre feet
EBID	Elephant Butte Irrigation District
EPCWID	El Paso County Water Improvement District No. 1
EPWU	El Paso Water Utility
km	kilometer
NMOSE	New Mexico Office of the State Engineer
OA	Rio Grande Project Operating Agreement
RGP	Rio Grande Project
US	United States



**U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado**

June 2013

1 Introduction

The Rio Grande Project Operating Agreement (OA) was developed and signed by Elephant Butte Irrigation District (EBID), El Paso County Water Improvement District No. 1 (EPCWID), and the United States Bureau of Reclamation (Reclamation) in 2008. The OA defines operating procedures for the Rio Grande Project, including procedures for storage, allocation, release, and accounting of Project water. The OA fulfills the parties' obligations under contracts entered into in 1979 and 1980 to develop a mutually agreeable "detailed operational plan...setting forth procedures for water delivery and accounting." In addition, the OA addresses and settles complaints brought forth by the districts over recent decades regarding Project operations.

This report details modeling and analysis conducted to assess potential effects of the OA on surface water and groundwater resources within the Project and surrounding areas. Potential effects on surface water resources were assessed by modeling and comparing Project operations under the OA and under operating procedures consistent with Project operations during the period 1980-2007 (prior operating practices). Potential effects on groundwater resources were assessed based on analysis of historical groundwater conditions within the Project and surrounding areas and estimated seepage losses from conveyance of Project water.

1.1 Brief History of Rio Grande Project Operations

The Rio Grande Project (Project) was authorized by Congress through the Rio Grande Project Act of February 25, 1905, under authority of the Reclamation Act of 1902. The Project includes two storage facilities: Elephant Butte Reservoir, which has a storage capacity of 2,024,586 AF, and Caballo Reservoir, which has a storage capacity of 324,934 AF. The Project provides irrigation water to Elephant Butte Irrigation District (EBID) and El Paso County Water Improvement District No. 1 (EPCWID). EBID is located in the Rincon and Mesilla Valleys of New Mexico and encompasses 90,640 acres authorized to receive Project water; EPCWID is located in the Mesilla and El Paso Valleys of Texas and encompasses 69,010 acres authorized to receive Project water. The Project also provides water for diversion by Mexico via the Acequia Madre under the Convention of 1906. The City of El Paso also receives water from the Project under a series of 1920 Act contracts which allow the conversion of irrigation water to municipal and industrial uses. Drainage and tail water from Project lands at the terminus of the Project provides a supplemental water supply to 18,000 acres in Hudspeth County Conservation and Reclamation District No. 1 (HCCRD) in Texas.

An overview map of the Project and surrounding areas is provided Figure 1.1-1. Figure 1.1-1 shows the locations of Reclamation dams (Elephant Butte, Caballo, Leasburg, Mesilla, and American) and reservoirs (Elephant Butte and Caballo), along with district boundaries for EBID, EPCWID, and Hudspeth County Conservation and Reclamation District No. 1 (HCCRD). Also shown is the boundary of the two hydrologic region encompassing the project, defined as the Rio Grande–Caballo and Rio Grande–Fort Quitman hydrologic units¹. It should be noted that HCCRD receives drainage and tailwater from the Rio Grande Project but is not part of the Project itself.

From 1916 through 1979, Reclamation operated the Rio Grande Project in full. 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, 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 farm gates.

The contracts entered into in 1979 and 1980 require that Reclamation and the districts develop a mutually agreeable operating plan defining procedures for operation of the Project, including allocation of Project water; however, no operating plan was established between 1980 and 2007 due to disagreements between the districts. In the early 1980s, Reclamation developed a procedure to determine annual diversion allocations to EBID and EPCWID based on two linear regression relationships between Project releases and Project deliveries, commonly referred to as the D-1 and D-2 Curves. The D-1 Curve is a linear regression relationship between annual gross 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 1951-1979 (inclusive).

¹ Hydrologic units defined based on six-digit hydrologic unit codes established by US Geological Survey and Natural Resources Conservation Service.

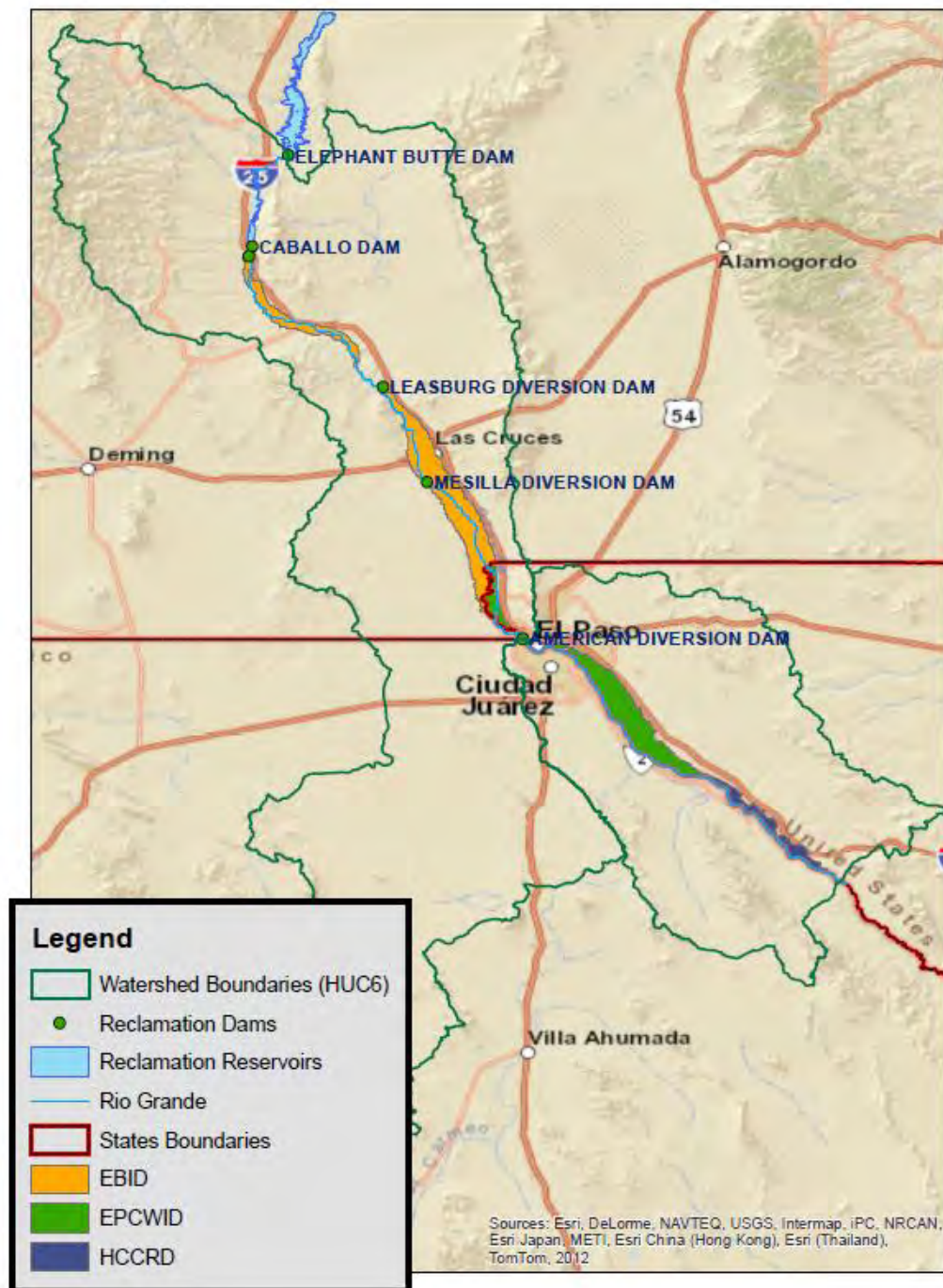


Figure 1.1-1: Project overview map.

During the period 1980-2007, the D-1 and D-2 Curves were used to determine the annual Project allocations to Mexico, EBID, and EPCID each year based on the total amount of usable water in Project available for release during that year. Pursuant to the Convention of 1906, the annual Project allocation to Mexico was 60,000 AF/year, except under extreme drought conditions in which case the annual allocation to Mexico is equal to 11.3486% of the total annual Project deliveries to lands within the US and to the heading of the Acequia Madre for diversion to Mexico. During this period, the annual Project delivery to lands in the within the US and to the heading of the Acequia Madre was calculated from the D-1 Curve. Annual Project allocations to EBID and EPCWID were then calculated from the quantity of water available for diversion after fully satisfying delivery obligations to Mexico based on the percentage of originally authorized acreage within each district (88/155^{ths} [57%] to EBID, 67/155^{ths} [43%] to EPCWID). During this period, the quantity of water available for diversion was in a given year was calculated from the D-2 Curve.

From 1980 through 2007, Reclamation determined annual Project allocations to EBID and EPCWID based largely on the D-2 Curve. However, Reclamation made adjustments to annual D-2 allocations in some years as needed to optimize Project operations and meet Project needs as consistent with applicable water rights, state and federal laws, and international treaties. Reclamation informed both districts of any adjustment made to the annual allocation procedure.

During this period, both districts filed a number of legal complaints over Project operations. EPWCID asserted that annual allocation of Project water based on the D-2 Curve did not appropriately account for carryover of the unused portion of the district's prior-year allocation. Due to conservation efforts by the district's farmers, the district did not use its full annual diversion allocation in many years, thus leaving a portion of its annual diversion allocation in Project storage. Under the procedure of the D-2 Curve, annual allocations were determined based on the total usable water available each year, without consideration of prior-year unused allocation balance. EPCWID asserted that as a result, 57% of the district's unused prior-year allocation remaining in Project storage the following year was effectively re-allocated to EBID, thus depriving the district of its property right to 43% of the total Project diversion allocation.

In addition, EPCWID asserted that groundwater pumping within EBID negatively impacted Project deliveries to EPCWID. Irrigation within EBID relies on conjunctive use of surface water and groundwater, and previous studies indicate a strong hydraulic connection between the Rio Grande and the shallow unconfined groundwater aquifers underlying the river. EPCWID asserted that groundwater pumping for supplemental irrigation within EBID resulted in declining groundwater elevations adjacent to the Rio Grande, which in turn caused increased seepage losses and decreased inflows from drain flows and groundwater discharge.

Also during this period, EBID filed complaints asserting that the lack of clearly defined operating procedures and resulting *ad hoc* operations by Reclamation negatively affected the district. EBID challenged operational decisions regarding reservoir management and charges to the district for operation and maintenance functions performed by Reclamation, as well as the validity of recreation leases at Elephant Butte and Caballo reservoirs and crediting miscellaneous revenues from Project lands. EPCWID joined EBID as a plaintiff in this suit, first in an involuntary capacity and later as a voluntary plaintiff.

The Rio Grande Project Operating Agreement (OA) was finalized and signed by EBID, EPCWID, and Reclamation in 2008. The OA fulfills the parties' obligations under contracts entered into in 1979 and 1980 to develop a mutually agreeable "detailed operational plan...setting forth procedures for water delivery and accounting." In addition, the OA addresses and settles complaints brought forth by the districts over recent decades regarding Project operations. Since 2008, Project operations have followed the procedures defined by the OA.

In addition to EBID and EPCWID, the United States and the 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." The 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. Because HCCRD only receives return flows and other runoff from EPCWID and does not receive a direct allocation of Project water, deliveries to HCCRD do not affect primary Project operations, including storage, allocation, and release of Project water. The analysis presented here therefore does not consider delivery to HCCRD. However, because the OA maintains Project allocations and deliveries to EPCWID consistent with historical Project conditions, it is reasonable to conclude that delivery of return flows and other runoff from EPCWID to HCCRD will also remain at historical levels.

1.2 Summary of Changes under the OA

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 for allocation charges and credits. The operating procedures defined within the OA were developed by EBID, EPCWID, and Reclamation, and was signed by all three parties on March 10, 2008. A Rio Grande Project Operations Manual was subsequently developed by EBID, EPCWID, and Reclamation in 2008 to further define the procedures

outlined within the OA. The OA and Operations Manual are reviewed annually and updated as needed and with unanimous consent of all parties in order to optimize Project operations consistent with applicable water rights, state and federal laws, and international treaties.

Operating procedures defined in the OA are largely consistent with prior operating practices during the period 1980-2007. Under the OA, the annual diversion allocation to Mexico is calculated according to the provisions of the Convention of 1906, as under prior operating practices. Similarly, the total annual diversion allocation is calculated from the estimated annual release of Project water according to the D-2 Curve, and the annual diversion allocation to EBID and EPCWID is calculated from the total annual diversion allocation after deducting the annual allocation to Mexico.

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, the unused balance of a district's annual diversion allocation contributed to the total usable water available for release during the following year; as a result, a portion of the unused allocation balance became part of the other district's annual allocation the following year—in essence, EBID lost 43% of its unused allocation balance to EPCWID, and EPCWID lost 57% of its unused allocation balance to EBID. Under the OA, the unused balance of either district's annual diversion allocation, if any, is carried over and becomes part of the district's 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 water in excess of this limit is transferred to the other district. The carryover provision is designed to encourage water conservation within the Project by allowing each district to maintain its unused allocation up to a specified limit.

Second, the OA provides for adjustment of the annual allocations to EBID and EPCWID to account for the conjunctive use of surface water and groundwater within EBID and corresponding effects on the Project diversion ratio. The gross diversion ratio (ρ_{Gross}) is the ratio of gross Project diversions to gross Project releases over a given period of time and has historically been used to characterize performance of the Rio Grande Project. The Project diversion ratio ($\rho_{Project}$) is the ratio of Project charges to Project releases, where Project charges are the quantity of Project water deducted from a party's Project allocation and are calculated as the gross Project diversion minus metered return flows at specified locations. Similar to the gross diversion ratio, the Project diversion ratio is a measure of the overall performance of the Rio Grande Project and quantifies the effects of conveyance losses and return flows on Project supply and delivery. Data for the period 2008-2012 indicate that the gross diversion ratio and Project diversion

ratio are generally very close in value, with differences of less than 0.5% in most years.

In addition to their allocations of surface water from the Project, irrigators within EBID and EPCWID have historically relied on groundwater pumping for supplemental irrigation. It is widely recognized that groundwater pumping from unconfined aquifers in the Rincon and Mesilla Valleys depletes Project 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 Project. While groundwater is used for supplemental irrigation in both EBID and EPCWID, estimates of pumping for irrigation within EBID are an order of magnitude large than corresponding estimates for EPCWID. It is therefore reasonable to conclude that pumping within EBID has a significantly greater effect on Project operations than pumping within EPCWID. The diversion ratio provision of the OA was therefore developed to adjust the annual Project allocation to EPCWID so as to provide Project deliveries to the district consistent with historical operations, prior to substantial increases in groundwater pumping with EBID and corresponding decreases in Project performance that occurred over the recent decade. The annual Project allocation to EBID is then adjusted to reflect current-year Project performance as represented by the Project diversion ratio. When the diversion ratio is high, EBID generally receives an increase in allocation compared historical Project performance; when the diversion ratio is low, EBID generally receives a decrease in Project allocation compared historical Project performance.

Procedures for calculating Project allocations under the OA and under prior operating practices are detailed in full below in Sections 3.1.2 and 3.1.3.

1.3 Study Objectives

This report details modeling and analysis conducted to assess potential effects of the OA on surface water and groundwater resources within the Project and surrounding areas. The modeling and analysis detailed here were carried out in support of the Rio Grande Project Supplemental Environmental Assessment (EA) for Implementation of the Rio Grande Project Operating Procedures, New Mexico and Texas. This analysis addresses the following study objectives:

- Evaluate effects of the OA on Project operations over the period 2008-2012, including effects on Project allocations, deliveries, and storage and reservoir elevation in Elephant Butte Reservoir
- Evaluate the probable effects of the OA on Project operations over the period 2013-2015 (through the end of the 2015 irrigation season), including effects on Project allocations, deliveries, and storage and reservoir elevation in Elephant Butte Reservoir

- Evaluate historical groundwater measurements to determine whether sustained groundwater overdraft has occurred within the Project and surrounding areas
- Evaluate historical groundwater measurements to determine whether fluctuations in groundwater elevation are directly correlated with Project operations

One of the key principles underlying the OA is the need to account for effects of groundwater pumping on Project performance, including shortfalls in Project deliveries resulting from groundwater pumping. In addition to the objectives outlined above, this analysis briefly considers the effects of groundwater pumping within the districts and surrounding areas on Project deliveries and compares these effects to the estimated changes in Project allocation and delivery to under the OA.

2 Summary of Project Operations

This chapter briefly describes Rio Grande Project operations under prior operating practices and under the 2008 Operating Agreement, including groundwater use for supplemental irrigation within the Project.

The Project provides water to EBID and EPCWID for authorized agricultural and municipal uses. EBID is located in the Rincon and Mesilla Valleys of New Mexico and encompasses 90,640 acres authorized to receive Project water; EPCWID is located in the Mesilla and El Paso Valleys of Texas and encompasses 69,010 acres authorized to receive Project water. Within EBID, Project water is used primarily for irrigated agriculture; within EPCWID, Project water is used for irrigated agriculture as well as to meet municipal demands within the City and County of El Paso through sale of water to El Paso Water Utility.

Conjunctive use of groundwater and surface water resources is prevalent throughout the Project and surrounding areas. Within EBID, groundwater use for supplemental irrigation began during the drought of the 1950s and is now widespread within the district. Within EPCWID, groundwater use for supplemental irrigation within the Mesilla Valley of Texas is similar to groundwater use within the EBID; groundwater pumping for supplemental irrigation within the El Paso Valley is limited due to water quality and other factors. Groundwater pumping for supplemental irrigation is drawn primarily from shallow unconfined aquifers that are hydraulically connected to the Rio Grande.

In addition to providing supplemental irrigation within the Project, groundwater is the primary source of domestic water within the Project and municipal supply in areas surrounding to the Project (e.g., Las Cruces, NM and El Paso, TX). Domestic groundwater use draws from shallow unconfined aquifers; however, groundwater pumping for domestic uses is small compared to pumping for supplemental irrigation. Municipal groundwater pumping draws primarily from deeper groundwater storage that is not in direct hydraulic connection with the Rio Grande. Groundwater pumping for domestic and municipal purposes is therefore not considered in this analysis.

Operation of the Rio Grande Project involves four primary functions:

- Capture and storage of Rio Grande streamflow in Elephant Butte and Caballo reservoirs in for later beneficial use;
- Allocation of Project water to EBID, EPCWID, and Mexico;
- Release of Project water to satisfy delivery orders from EBID, EPCWID, and the International Boundary Water Commission (IBWC) on behalf of Mexico; and
- Diversion of Project water from the Rio Grande and distribution of Project water to individual farm gates for application to Project lands.

Since 1980, EBID and EPCWID have been responsible for diversion and delivery of Project water for their respective districts. In addition to these primary functions, Project operations also include monitoring of river flows, diversions, and return flows at locations throughout the Project; accounting for charges and credits to Project allocation balances; and communication of Project supply, allocations, and accounting to all parties. Lastly, the Project also provides flood control benefits, and Elephant Butte Reservoir serves as an accounting point for the Rio Grande Compact.

Because groundwater pumping for supplemental irrigation is drawn primarily from shallow unconfined aquifers that are hydraulically connected to the Rio Grande, pumping for supplemental irrigation affects Project operations; conversely, groundwater recharge from seepage of Project water through the bed of the Rio Grande, through unlined canals and laterals, and as deep percolation of irrigation water directly affect groundwater resources. In general, supplemental irrigation is used when the farm delivery required to meet crop water demand exceeds the Project delivery. Although groundwater pumping for supplemental irrigation began during the drought of the 1950s and was initially limited to dry periods when the Project was not able to provide a full allocation, over time groundwater pumping for supplemental irrigation came to support high water use crops whose consumptive irrigation requirement is not fully met by the Project even under full allocation.

Procedures governing the storage, release, diversion, delivery, and allocation of Project water under prior operating practices and under the OA are detailed below. Storage, release, diversion, and delivery of Project water are similar under both operating procedures; however, the procedure for determining Project allocations to EBID and EPCWID differs between operations. Groundwater pumping for supplemental irrigation within the Project is also described below.

2.1 Storage of Project Water

Storage of Project water is identical under the OA and under prior operating practices. Reclamation stores Project water in Elephant Butte and Caballo Reservoirs. Elephant Butte Reservoir has a total capacity of 2,024,586 AF, all of which is conservation storage (Reclamation 2008a). Caballo Reservoir has a total capacity of 324,934 AF, which includes 224,934 AF of conservation storage and 100,000 AF of flood control space (Reclamation 2008b). Total conservation storage within the Project is 2,249,520 AF. However, Reclamation is currently restricted to storing no more than 50,000 AF in Caballo Reservoir during the non-irrigation season per a 1996 court order².

At the beginning of the calendar year and prior to the onset of the irrigation season, Reclamation determines the total water in Project 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 Project water by subtracting all non-Project storage, including San Juan–Chama Project Water³ and Rio Grande Compact Credit Water, from the total water in storage. In years when the total usable Project water at the beginning of the calendar year is not sufficient to provide a full Project allocation, Reclamation reevaluates Project storage each month during the irrigation season until a final allocation is determined.

² According to Court Order No. CIV-90-95- HB/WWD of October 17, 1996, which resulted from a negotiated settlement with the U.S. irrigation districts, the Caballo Reservoir storage level is targeted not to exceed 50,000 AF (4,146.11 ft) from October 1 to January 31 of each year, unless flood control operations, storage of water for conservation purposes, regulation of releases from Elephant Butte Dam, safety of dams purposes, emergency operations, or any other purpose authorized by Federal law, except non-emergency power generation, dictate otherwise. Significant variation above 50,000 AF during the winter months of October through January requires collaboration and consultation between the districts and Reclamation.

³ The San Juan–Chama Project was authorized in 1962 (PL 87-483) to allow diversion of Colorado River basin water into the Rio Grande basin of New Mexico. Subsequent authorizations under PL 97-140 allowed for the Cities of Albuquerque and Santa Fe to enter into agreements with Reclamation to store 50,000 and 25,000 AF, respectively, in Elephant Butte Reservoir. San Juan–Chama Water is not included in total Project storage for the Rio Grande Project.

2.2 Release of Project Water

Project water is released from Caballo Dam to meet Project delivery requirements. EBID, EPCWID, and the United States section of the International Boundary Water Commission (US-IBWC) on behalf of Mexico place orders with Reclamation for releases from Project 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 amount or timing of releases, Reclamation makes the final determination. In addition to releases ordered by the districts, Reclamation makes releases from Project storage to deliver water to the heading of the Acequia Madre for diversion by Mexico. The amount and schedule of release for Mexico is determined by Reclamation under the authority of the Convention of 1906. Project releases are coordinated by Reclamation to meet Project deliveries and optimize Project operations.

Reclamation schedules releases of water from Elephant Butte Dam so as to ensure sufficient water is available in Caballo Reservoir to meet Project releases and to optimize hydropower generation. Releases from Elephant Butte 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 Caballo Reservoir. No water is released from Elephant Butte during the non-irrigation season under normal (non-flood) circumstances.

Flood control is an authorized function of Caballo Dam. In addition to releases from Caballo Dam to meet Project deliveries as detailed above, Reclamation may adjust releases from Caballo Reservoir during irrigation and non-irrigation seasons as needed for flood control purposes.

2.3 Diversion and Distribution of Project Water

Diversion of Project water from the Rio Grande and distribution of Project water from river head gates to individual water users was delegated to EBID and EPCWID in 1979 and 1980, respectively. Reclamation bears no responsibility for distribution of Project water from river headings to end users.

2.4 Allocation of Project Water

Operating procedures defined in the OA are largely consistent with prior operating practices that were in place during the period 1980-2007. Under both the OA and prior operating practices, the annual diversion allocation to Mexico is calculated according to the provisions of the Convention of 1906 according to the D-1 Curve, described below. Similarly, under both the OA and prior operating practices, the total annual diversion allocation is calculated from the estimated annual release of Project water according to the D-2 Curve, and the annual

diversion allocation to EBID and EPCWID is calculated from the total annual diversion allocation after deducting the annual allocation to Mexico.

As noted in Section 1.2, however, two key provisions of the OA deviate from prior operating practices. First, the OA provides carryover accounting for the unused portions of EBID's and EPCWID's annual allocation balances, if any. Second, the OA provides for adjustment of annual allocations to EBID and EPCWID to account for the conjunctive use of groundwater and surface water within EBID and corresponding effects on the Project operations as reflected by the Project diversion ratio ($\rho_{Project}$).

Under the OA, each district's Total Diversion Allocation for any given year consist of three separate components: Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. These components are defined below in Section 3.1.4. In order to provide a complete comparison of Project allocations to EBID and EPCWID under the OA and Prior Operating Practices, each component of a district's allocation must be considered. This is particularly important in evaluating the potential effects of the OA on the initial allocation of water between districts, where initial allocation refers to allocation of "new" or previously unallocated water (i.e., Annual Allocated Water).

Under prior operating practices, district allocations were defined only in terms of the Total Diversion Allocation. However, the lack of explicit carryover accounting under prior operating practices resulted in an implicit carryover balance and implicit transfer of allocation balance between districts in years when one or both districts did not utilize their full allocation. For the purposes of this analysis, annual Project allocations to EBID and EPCWID under prior operating practices are divided into three components analogous to those under the OA: Annual Allocated Water, Implicit Accrued Carryover Balance, and Implicit Transfer of Allocation Balance. These components are defined below in Section 3.1.4.

Allocation of Project Water under Prior Operating Practices

Procedures for allocation of Project water under prior operating practices are documented in annual correspondences from Reclamation to the districts and to IBWC on behalf of Mexico during the period 1980-2007. For the purposes of this study, the general procedure used by Reclamation to determine annual allocations to EBID, EPCWID, and Mexico was obtained from Reclamation's El Paso Field Division, who operated the Project and determined annual Project allocations during this period. Full and complete details of annual allocation calculations, including all data used in the calculations and any adjustments or deviations from the general allocation procedure, may be requested from Reclamation's El Paso Field Division.

Under prior operating practices, annual Project diversion allocations were determined based on the usable water available for release from Project storage during a given year (U), including the usable water in storage at the start of the

year plus any usable water that becomes available during the year as inflow to Project storage or as relinquishment of credit waters. Usable water consists of all water stored in Project storage, excluding Rio Grande Compact credit water and San Juan-Chama water, and available for release to meet Project demands and all waters reaching the bed of the Rio Grande within the Project. Prior to the start of the year, Reclamation determined initial Project allocations to EBID, EPWID, and Mexico based on usable water in Project storage according to the D-1 Curve and D-2 Curve as detailed below. Full Project supply was defined as usable water available for release equal to 763,842 AF, which corresponds to an estimate of 931,897 AF available for diversion based on the D-2 Curve.

In years when the usable water available for release at the start of the year was equal to or greater than 763,842 AF, a full allocation was issued at the start of the year. In years when the usable water available for release at the start of the year was less than 763,842 AF, allocations were updated on a monthly basis throughout the season to account for inflows and/or relinquishment of credit waters during the year until a final allocation was determined. In years when usable water was less than full supply, the final allocation did not always correspond to the amount of usable water in Project storage at any particular time during the year. While the usable water allocated in any given year under prior operating practices was limited to the full Project supply of 763,823 AF, the actual release in any given year was not limited to this amount. Actual Project releases during the period 1980-2007 were greater than 763,842 AF in 8 out of 28 (29%) years, plus three additional years when high releases were required for flood control purposes.

Pursuant to the Convention of 1906, the annual Project allocation to Mexico is 60,000 AF/year, except under extreme drought conditions in which case the annual allocation to Mexico is equal to 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 heading of the Acequia Madre for diversion by Mexico. Under Prior Operating Practices, the total annual Project delivery to Project lands within the United States (i.e., delivery to individual farm gates within EBID and EPCWID) plus total deliveries to the heading of the Acequia Madres was calculated from the estimated annual release of Project water based on Equation 1, which is referred to as the D-1 Curve:

$$D_{D1} = 0.8260932 \cdot R_{Caballo}^{Est} - 102,305 \quad (1)$$

In Equation 1, D_{D1} is the calculated total annual Project deliveries to lands in the United States plus deliveries to the heading of the Acequia Madre [AF], and $R_{Caballo}^{Est}$ is the estimated annual release of Project water from Caballo Dam [AF]. The D-1 Curve was developed via linear regression based on Project operations data for the period 1951-1979 (inclusive). Under Prior Operating Practices, the estimated annual release of Project water ($R_{Caballo}^{Est}$) was determined assumed to equal the usable water available for current-year allocation.

The annual allocation to Mexico was subsequently calculated according to Equation 2:

$$A_{Mexico} = \min[60,000; D_{D1} \cdot 0.113486] \quad (2)$$

where A_{Mexico} is the annual diversion allocation to Mexico.

The total amount of water available for diversion at river headings for the year was then calculated based on the D-2 Curve, given by Equation 3:

$$A_{GrossD2} = W \cdot 1.3377994 - 89,970 \quad (3)$$

where $A_{GrossD2}$ is the gross D-2 diversion allocation and W is the total usable water available for current year allocation, which was equal to the estimated annual release of Project water.

The D-2 Curve relates Project diversions to Project releases, and therefore is essentially an estimate of the Project diversion ratio for a given year. As noted above, the Project diversion ratio is a measure of Project performance used by Reclamation, EBID, EPCWID, and IBWC to characterize current performance of the Rio Grande Project in conveying Project water from release to authorized points of diversion. As detailed in above, the D-2 Curve was derived from historical Project operations data for the period 1951-1978. The D-2 Curve therefore does not consider changes in Project performance relative to this historical baseline period.

During some years under prior operating practices, particularly during the period 2003-2007, actual Project performance was below the baseline historical condition represented by the D-2 Curve. In these years, Reclamation generally released additional water above the usable water allocated that year in order to compensate for deviations in Project performance (i.e., the actual release exceeded the estimated release $R_{Caballo}^{Est}$ used to calculate annual Project allocations). Additional usable water was therefore released in order to ensure total delivery to Project heading remained consistent with annual allocations in spite of decreased Project performance.

In some of these years, however, the annual diversion allocations to EBID and EPCWID determined by Reclamation based on the D-2 Curve could not be satisfied from the usable water available for release from Project storage because additional usable water was not available to compensate for decreased Project performance. In these years, Reclamation operated the Project so as to maximize deliveries to EBID and EPCWID while ensuring that EBID received 57% and EPCWID received 43% of the total Project diversion within the United States. Thus under prior operating practices, Reclamation would adjust Project allocations to EBID and EPCWID on an *ad hoc* basis in years when Project performance was below the historical D-2 baseline such that it would not be possible to satisfy diversion allocations calculated from the D-2 Curve. For the

purposes of this analysis, this affect is achieved by applying a drought adjustment factor to the gross D-2 diversion allocation to ensure that the total diversion allocation to EPCWID, EBID, and Mexico for the year can be delivered based on the usable water available for release and current-year Project performance conditions. The drought adjustment factor used here is detailed in Section 3.1.2.

The total diversion to allocation to EBID and EPCWID, referred to as the net D-2 diversion allocation, was then calculated by subtracting the annual allocation to Mexico A_{Mexico} from the gross D-2 allocation:

$$A_{NetD2} = A_{GrossD2} - A_{Mexico} \quad (4)$$

Finally, the final annual diversion allocations to EBID and EPCWID (A_{EPCWID}^{Final} and A_{EBID}^{Final} , respectively) were calculated based on the percentage of originally authorized Project acreage within each district according to Equations 5 and 6, respectively:

$$A_{EBID}^{Final} = A_{NetD2} \cdot \left(\frac{88}{155}\right) \quad (5)$$

$$A_{EPCWID}^{Final} = A_{NetD2} \cdot \left(\frac{67}{155}\right) \quad (6)$$

The maximum total diversion allocation under prior operating practices was 931,897 AF corresponding to a full Project supply of 763,842 AF. The maximum diversion allocation to Mexico was 60,000 AF; the maximum diversion allocation to EBID was 495,013 AF; and the maximum diversion allocation to EPCWID was 376,885 AF.

As noted above, the components that make up district allocations—Annual Allocated Water, Implicit Accrued Carryover Balance, and Implicit Transfer of Allocation Balance—are not explicitly defined under prior operating practices. However, the lack of explicit carryover accounting under Prior Operating Practices resulted in an implicit carryover balance and implicit transfer of allocation balance between districts in years when one or both districts did not use their full allocation. Under Prior Operating Practices, the unused portion of each district's annual diversion allocation contributed to the total usable water available for release during the following year; as a result, a portion of the unused allocation balance became part of the other district's annual allocation the following year—in essence, EBID lost 43% of its unused allocation balance to EPCWID, and EPCWID lost 57% of its unused allocation balance to EBID. The lack of explicit carryover accounting thus resulted in implicit carryover balance and implicit transfer of allocation balance between the districts.

For the purposes of this study, Annual Allocated Water under prior operations is defined as the portion of each district's final total diversion allocation (i.e., A_{EBID}^{Final} or A_{EPCWID}^{Final}) that is supplied by current year inflows or previously unallocated water in Project storage. Each district's Transfer of Allocation Balance is

calculated as the portion of the district's unused allocation balance that is implicitly transferred to the other district as summarized above, and each district's Accrued Carryover Balance is calculated as the sum of the unused portion of each district's allocation balance and its implicit Transfer of Allocation Balance. Allocation components considered in this study under prior operating practices are described in more detail below in Section 3.1.4.

Under prior operating practices, all water reaching the bed of the Rio Grande within the Project area contributes to Project supply and is captured and used for Project deliveries, including operational spills, bypass flows, and other return flows from EBID and EPCWID, groundwater discharge to the Rio Grande and to Project drains, and any other tributary inflows that reach the bed of the Rio Grande within the Project. All losses of surface water from within the Project, including seepage and evaporation as well as decreased groundwater discharge, thus affects the total Project supply. The D-1 and D-2 Curves used by Reclamation to determine annual Project allocations under the No Action Alternative represent the effects of inflows and losses within the Project on historical Project performance. The D-1 and D-2 Curves were developed from Project operations data for the period 1951-1978 and thus reflect historical Project performance during this period, including effects of losses and inflows on Project deliveries.

Allocation of Project Water under the OA

General procedures for allocation of Project water under the OA are defined in the text of the OA and details of data, inputs, and calculations used in the allocation procedure are described in Table 4 of the OA. Additional details regarding allocation calculations are provided in the Rio Grande Project Operations Manual.

The Operations Manual was initially developed in 2008. Both the OA and the Operations Manual are reviewed annually by Reclamation, EBID, and EPCWID, and both may be modified upon unanimous consent of all parties. While the OA has not been modified, the Operations Manual has been updated several times to clarify calculations used in the allocation procedure and to optimize Project operations to better meet the needs of the Districts, particularly during severe and sustained drought conditions such as those experienced in the Lower Rio Grande Basin during the past decade.

Under the OA, as under prior operating practices, Reclamation determines annual Project allocations to EBID, EPCWID, and Mexico at the start of each calendar year based on the total usable water in Project storage available for release during the current year, including usable water in storage at the start of the year plus any usable water that becomes available during the year as inflow to Project storage or as relinquishment of credit waters. Total usable water available for current year allocation is calculated in a similar manner as under prior operating practices, except that adjustment is made to account for district carryover balances, which are equal to each district's respective unused allocation balance at the end of the prior year. Total usable water available for release (U) is first calculated as the

total water in Project storage minus non-Project water in storage (i.e., total storage minus San Juan-Chama Water and Rio Grande Compact Credit Water) and the estimated release required to meet carryover obligations; total usable water available for current-year allocation (W) is then calculated as the lesser of the total usable water available for release and the normal annual release of 790,000 AF.

As under prior operating practices, if the total usable water available for current year allocation at the start of the year is not sufficient to provide a full allocation, Reclamation reevaluates the usable water available for current-year allocation on a monthly basis and updates Project allocations throughout the irrigation season until final allocations are determined. Each district's Total Diversion Allocations is then calculated as the sum of its Accrued Carryover Balance and Annual Allocated Water. At the end of the irrigation season, each district's Total Diversion Allocation is updated to reflect the district's Transfer of Excess Carryover Balance, if any.

As under Prior Operating Practices, pursuant to the Convention of 1906, the annual Project allocation to Mexico is 60,000 AF/year, except under extreme drought conditions in which case the annual allocation to Mexico is equal to 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 heading of the Acequia Madre for diversion by Mexico. As under prior operating practices, the total annual Project delivery to Project lands within the United States (i.e., delivery to individual farm gates within EBID and EPCWID) plus total deliveries to the heading of the Acequia Madres is calculated from the estimated annual release of Project water ($R_{Caballo}^{Est}$) based on the D-1 Curve (Equation 1). As under Prior Operating Practices, the annual diversion allocation to Mexico (A_{Mexico}) is subsequently calculated as the minimum of 60,000 AF or 11.3486% of the total annual Project delivery to Project lands within the United States plus total deliveries to the heading of the Acequia Madres (D_{D1}) per Equation 2, above.

Similar to prior operating practices, under the OA, the total amount of water available for diversion at river headings during the current year is calculated based on a modified form of the D-2 Curve. The Modified D-2 Curve is given by Equation 7:

$$A_{GrossD2} = \min(W; 763,842) \cdot 1.3377994 - 89,970 + \max(0.0, R_{Caballo}^{Est} - 763,842) \quad (7)$$

The minimization term in Equation 7 was added to the original D-2 regression equation (Equation 3) to explicitly limit the usable water available for current-year allocation to 763,842 AF; this limit was similarly imposed under prior operating practices, but is made explicit in the OA. An additional term was then included in the equation to allow for Project releases of up to 790,000 AF, equal to the normal annual release defined under the OA and the average annual release of usable water specified under the Rio Grande Compact. In addition, the

maximization term was added to the equation to ensure that the annual D-2 diversion allocation cannot be negative.

The total annual diversion allocation available to EBID and EPCWID for the current year, referred to as the Net D-2 allocation (A_{NetD2}), is then calculated from Equation 4 in the same manner as under Prior Operating Practices.

Up to this point, the OA differs from prior operating practices in two ways. First, the total usable water available for current year allocation is adjusted under the OA to account for district carryover balances. This difference provides the basis for the carryover provision of the OA, which adjusts the amount of water allocated in a given year to reflect carryover obligations based on each district's unused allocation balance. Second, the OA uses a modified form of the D-2 Curve (Equation 7). Modification of the D-2 Curve was implemented to allow Project allocations to consider usable water up to a limit of 790,000 AF as defined by the Rio Grande Compact, rather than the limit of 764,842 AF used under prior operating practices. Differences between the original D-2 Curve and the Modified D-2 Curve are limited to years when the usable water available for allocation is between 763,842 AF and 790,000 AF. In these years, the gross D-2 allocation is up to 26,158 AF (2.8%) greater under the OA than under prior operating practices.

As described below, apportioning of the current-year diversion allocation (i.e., Annual Allocated Water) between EBID and EPCWID (A_{NetD2}) differs under the OA compared to prior operating practices. These differences constitute the diversion ratio provision of the OA, which adjusts annual allocations to the districts so as to mitigate potential negative effects of deviations in Project performance with respect to historical conditions on Project allocations and deliveries to EPCWID as detailed in Section 1.2.

Under the OA, annual diversion allocations to EBID and EPCWID are first calculated as under prior operating practices according to Equations 5 and 6, respectively. The annual diversion allocation to EPCWID is then adjusted to account for the district's carryover balance from the previous year and estimated end-of-year allocation balance for the current year per Equations 8 and 9:

$$A'_{EPCWID} = A_{EPCWID}^{D2} + A_{EPCWID}^{Carryover} \quad (8)$$

$$A''_{EPCWID} = A'_{EPCWID} - C_{EPCWID} \quad (9)$$

Where $A_{EPCWID}^{Carryover}$ is EPCWID's Accrued Carryover Balance, which is equal to the district's prior-year unused allocation balance after any transfer of excess carryover balance; C_{EPCWID} is EPCWID's projected end-of-year allocation balance for the current year, and A'_{EPCWID} and A''_{EPCWID} are intermediate adjusted EPCWID allocations used in subsequent calculations.

The annual Project diversion ratio ($\rho_{Project}$) for the year is then calculated based on the most recent Project operations data; the Project diversion ratio is monitored during the irrigation seasons, and allocations are updated as needed throughout the season to accurately reflect current Project performance conditions. The Project diversion ratio is used to calculate the diversion ratio adjustment (D), which is used to adjust allocations to EBID and EPCWID to account for the effects of conjunctive use of groundwater and surface water within EBID on current year Project performance as characterized by the Project diversion ratio. The diversion ratio adjustment (D) is calculated from the Project diversion ratio ($\rho_{Project}$) and the estimated annual release of Project water ($R_{Caballo}^{Est}$) according to Equation 10:

$$D = (\rho_{Project} - 1) \cdot R_{Caballo}^{Est} \quad (10)$$

The annual diversion ratio allocation to EBID ($A_{EBID}^{DivRatio}$) is then calculated according to Equation 11:

$$A_{EBID}^{DivRatio} = (R_{Caballo}^{Est} + D) - (A_{Mexico} + A_{EPCWID}'' + A_{EBID}^{Carryover} + ACE) \quad (11)$$

where $A_{EBID}^{DivRatio}$ is the annual diversion ratio allocation to EBID, $A_{EBID}^{Carryover}$ is EBID's Accrued Carryover Balance, ACE is the annual conservation credit accredited to EPCWID for water salvaged due to the American Canal Extension, and the remaining terms are defined above.

The diversion ratio adjustment (D) is the estimated difference between the amount of water released from Project storage and total net diversion during the current year, where total net diversion is given by the total Project diversions by EBID, EPCWID, and Mexico minus the total metered return flows at authorized locations (i.e., total net diversions equals total Project charges). When the Project diversion ratio is greater than 1.0, the diversion ratio adjustment is positive; when the diversion ratio is less than 1.0, the diversion ratio is negative. The corresponding annual diversion ratio allocation to EBID ($A_{EBID}^{DivRatio}$) is the estimated volume of water that can be delivered for diversion by EBID during the current year after satisfying delivery obligations to Mexico and EPCWID. The diversion ratio allocation reflects current Project performance and accounts for any difference between the D-2 Curve and actual current conditions within the Project. The diversion ratio adjustment and diversion ratio allocation thus more accurately reflect the effects of seepage losses, return flows, and groundwater-surface water interactions on current-year Project operations than the D-2 Curve.

The adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID (Δ) is calculated per Equation 12:

$$\Delta = \text{IF}\{ [R_{Caballo}^{Est} < 600,000], \max[0.0, (A_{EBID}^{DivRatio} - A_{EBID}^{D2})], [0.0] \} \quad (12)$$

The intermediate adjusted diversion allocation to EBID is then determined based on the district's D-2 and diversion ratio allocation and the estimated release of Project water during the current year per Equation 13:

$$A'_{EBID} = \text{IF}\{ [R_{Caballo}^{Est} < 600,000], \min[A_{EBID}^{DivRatio}, A_{EBID}^{D2}], [A_{EBID}^{DivRatio}] \} \quad (13)$$

where A'_{EBID} is the intermediate adjusted annual diversion allocation to EBID, which is used in subsequent calculation of the district's total diversion allocation.

Finally, Total Diversion Allocation to EPCWID is calculated from the intermediate annual allocation A''_{EPCWID} detailed above, the annual American Canal Extension (ACE) conservation credit, and 67/155th (43%) of the adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID (Δ). Note that the intermediate annual allocation A''_{EPCWID} includes the districts initial D-2 diversion allocation as well as its Accrued Carryover Balance. The Total Diversion Allocation to EBID is calculated from the intermediate adjusted diversion allocation A'_{EBID} , the district's Accrued Carryover Balance ($A_{EBID}^{Carryover}$), and 88/155th (57%) of the adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID (Δ). Current-year Total Diversion Allocations to EBID and EPCWID are calculated from Equations 14 and 15, respectively:

$$A_{EPCWID}^{Final} = A''_{EPCWID} + ACE + \left(\frac{67}{155}\right) \cdot \Delta \quad (14)$$

$$A_{EBID}^{Final} = A'_{EBID} + A_{EBID}^{Carryover} + \left(\frac{88}{155}\right) \cdot \Delta \quad (15)$$

The OA allocation procedure ensures that the annual allocation to EPCWID, excluding ACE conservation credits, is consistent with historical Project performance as represented by the D-2 Curve, while the annual allocation to EBID reflects current-year Project performance as characterized by the current Project diversion ratio. Unlike prior operating practices, the OA allocation procedure ensures that the sum of the total diversion allocations to EBID, EPCWID, and Mexico, including annual allocations as well as carryover obligations, can be satisfied based on usable water available for release during the current irrigation season under current (actual) Project performance conditions. As a result, the OA avoids over-allocation—i.e., allocation of water that cannot be delivered during the current year—as occurred under prior operating practices in years with low Project supply and low Project performance relative to the D-2 baseline.

2.5 Groundwater Pumping for Supplemental Irrigation

Groundwater pumping is not an authorized function of the Rio Grande Project, and Project operations neither include nor directly affect groundwater use within the Project and surrounding areas. Since the 1950s, however, groundwater has been used for supplemental irrigation within the Project, including Project lands within the Rincon and Mesilla valleys of New Mexico and within the Mesilla Valley of Texas. Project operations therefore have an indirect effect on groundwater use within the Project to the extent that Project operations affect demand for supplemental irrigation on Project lands.

Prior to the 1950s, Rio Grande surface water allocated and delivered by Rio Grande Project was the sole source of irrigation water for lands within the Project. During the severe drought of the 1950s, many wells were drilled within the Project to provide a supplemental water source. Wells were drilled by individual irrigators to supplement Project deliveries to their respective lands; groundwater use was neither authorized nor regulated under the Project. At that time, groundwater use within the Project and surrounding areas was not subject to local, state, or federal regulations. After the drought had subsided, groundwater use continued to expand as the availability of unregulated groundwater provided irrigators with an additional reliable water supply, which in turn allowed irrigators to shift to higher value—and higher water-use—crops such as pecans, corn, and onions, among others. Unrestricted groundwater development resulted in significant increases in groundwater use throughout the 1960s and 1970s.

In 1980, NMOSE declared the Lower Rio Grande Underground Basin. Within the Basin, groundwater use that was initiated prior to the declaration was allowed to continue; however, permits would be required for any further groundwater development. The amount of groundwater that may be pumped under pre-basin groundwater rights (i.e., under water rights established by groundwater use prior to the basin being declared) is currently being determined through a basin adjudication process by the State of New Mexico.

Recent estimates of groundwater use for supplemental irrigation within the Lower Rio Grande Basin, including the Rincon and Mesilla Valleys of New Mexico, range from 50,000 to 100,000 AF/year in years of full Project surface water supply and from 200,000 to 300,000 AF/year in years of low Project supply. In addition to Project supply, groundwater use for supplemental irrigation depends on irrigated acreage, crop distribution, and weather conditions during the growing season (Barroll 2005). Accurate estimates of historical groundwater pumping for supplemental irrigation of Project lands within the Texas portion of the Mesilla Valley and within the El Paso Valley of Texas are not available at this time. Groundwater use on Project lands located in the El Paso Valley of Texas, which overlies the Hueco Bolson groundwater aquifer, is generally limited due to water quality considerations and other factors.

While groundwater pumping is not an authorized function of the Project and is not directly affected by Project operations, groundwater use for supplemental irrigation within the Project is relevant to Project operations for two primary reasons. First, groundwater pumping from aquifers that are hydraulically connected to the Rio Grande, or to the network of canals, laterals, ditches, drains, and wasteways used to convey Project deliveries and return flows, is likely to affect Project supplies and deliveries through the interaction of the groundwater and surface water systems. Second, as noted above, groundwater demand for supplemental irrigation depends in part on the availability of surface water from the Project; Project operations therefore are likely to have an indirect effect on groundwater demand for supplemental irrigation within the Project. In addition, previous studies have also indicated that seepage from the Rio Grande and deep percolation of irrigation water from Project lands to the underlying aquifer system are a primary source of groundwater recharge to the shallow unconfined aquifers of the Lower Rio Grande Basin. Project operations and irrigation practices within the Project are therefore likely to affect groundwater recharge within this region.

3 Analysis of Surface Water Resources

Modeling and analysis was conducted to evaluate the potential effects of the OA on Project operations and subsequent effects on surface water resources within the Project and surrounding areas. Potential effects of the OA were first analyzed by comparing actual Project operations during the first five years of the OA (2008-2012) to estimated Project operations that would have occurred during this period under prior operating practices that were in place during the period 1980-2007. Potential effects were then evaluated for the three year period from the start of the 2013 irrigation season to the end of the 2015 irrigation season. Due to the uncertainty in future Project inflows, potential effects over the period 2013-2015 were characterized as probability distributions.

The OA has no effect on inflows to Project storage or surface runoff within the Project, and therefore has no effect on the total volume of surface water available for use within the basin. Analysis was therefore limited to consideration of potential effects of the OA on management of the available surface water supply, including annual Project allocations to EBID, EPCWID, and Mexico; total annual releases from Project storage; total annual diversions by EBID, EPCWID, and Mexico; and total Project storage at the start and end of irrigation season (March 1 and October 31 of each year, respectively).

In order to evaluate potential effects of the OA over the period 2008-2012, it is necessary to estimate Project operations during this period under prior operating practices—i.e., to estimate the Project allocations, releases, diversions, and storage that would have been made each year had Project operations followed prior operating practices rather than the operating procedures specified in the OA.

Similarly, in order to evaluate potential effects of the OA over the period 2013-2015, it is necessary to estimate Project operations under the OA as well as under prior operating practices. Two annual allocation models were therefore developed to calculate Project operations under the OA and under prior operating practices, respectively. Each annual allocation model calculates annual Project allocations, releases, diversions, and storage based on reservoir storage at the end of the previous irrigation season (i.e., storage on October 31 of the prior year), specified reservoir inflows prior to the onset of irrigation season (i.e., inflows from November 1 through February 28), and specified reservoir inflows during irrigation season (i.e., inflows from March 1 through October 31).

Data, methods, and assumptions used in the annual allocation models developed for this study are detailed in Section 3.1. Model results for the periods 2008-2012 and 2013-2015 are provided in Section 3.2. Section 3.3 provides a summary of the results along with key conclusions regarding potential effects of the OA on surface water resources.

3.1 Development of Annual Allocation Models

Two annual allocation models were developed to estimate annual Project operations under prior operating practices and under the OA, respectively. Each model calculates annual Project allocations to EBID, EPCWID, and Mexico based on total Project storage at the end of the prior irrigation season (October 31 of prior year) and total inflows through the end of the current irrigation season (November 1 of prior year through October 31 of current year). Annual net diversions by the districts and Mexico are estimated from relationships derived from historical Project operations data, and the total annual release from Project storage is calculated based on the estimated total net diversion and Project diversion ratio.

This section provides details of the data, methods, and assumptions used in the annual allocation models used in this study. Annual allocation models were used here to estimate Project operations under prior operating practices for the period 2008-2012 and to estimate Project operations under both the OA and prior operating practices for the period 2013-2015.

3.1.1 Data Sources, Processing, and Analysis

Historical data were used to evaluate historical Project operations and to develop and verify the annual allocation models used in this study. In addition, historical Project inflows were resampled to develop probabilistic projections of Project operations under the OA and under prior operating practices for the period 2013-2015. This section details the sources and uses of historical data in this analysis.

Project Storage

Historical records of total Project storage at the start and end of the irrigation season (March 1 and October 31, respectively) for the period 1951-2012 were

obtained from Reclamation's El Paso Field Office. Historical total Project storage at the start and end of irrigation season are shown in Figure 3.1-1. Start-of-season storage is greater than end-of-season storage when inflows over the course of the irrigation season exceed total Project releases and evaporative losses; start-of-season storage is less than end-of-season storage when total inflows are less than releases and losses. Figure 3.1-1 clearly illustrates the predominately dry conditions that occurred from the 1950s through 1970s and more recently from the early 2000s to present compared to the predominately wet conditions that occurred throughout the 1980s and 1990s.

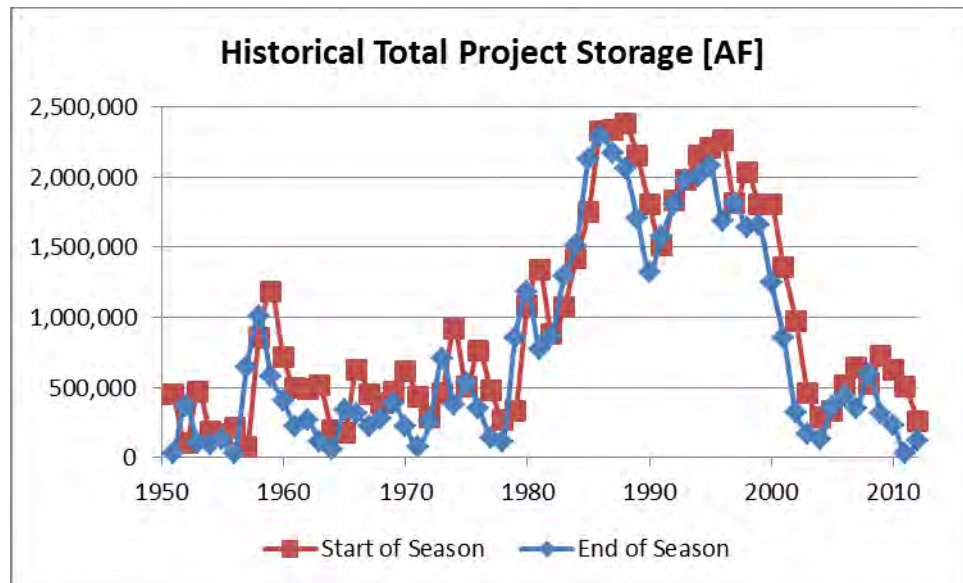


Figure 3.1-1: Historical total Project storage at the start and end of irrigation season (March 1 and October 31, respectively) for the period 1951-2012.

Annual Releases from Project Storage

Historical annual releases from Project storage were calculated from streamflow measurements taken at USGS stream gage 08362500, located on the Rio Grande below Caballo Dam. Gage 08362500 is operated by Reclamation and data are provided to USGS. It should be noted that gage 08362500 is located below the point of diversion for Bonita Ditch; diversions to Bonita Ditch are therefore not included in the annual Project releases evaluated here. Monthly diversions to Bonita Ditch are generally less than 0.5 percent of the measured monthly flow below Caballo Dam and are therefore considered negligible for the purposes of this analysis.

Annual Project releases for the period 1951-2012 are shown in Figure 3.1-2. Annual releases were calculated from measured daily mean flow at gage 08362500; annual calculations were carried out for the period November 1 through October 31 in order to coincide with the end of irrigation season (i.e.,

annual release for 1951 is calculated over the period November 1, 1950 through October 31, 1951).

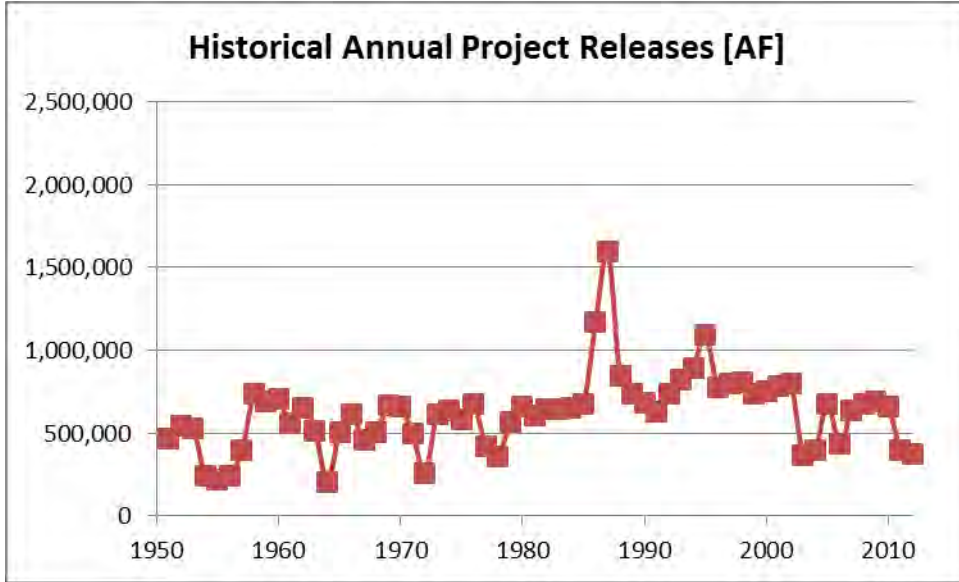


Figure 3.1-2: Historical annual Project releases for the period 1951-2012 as measured at the stream gage below Caballo Dam (USGS gage 08362500, operated by Reclamation).

Annual Inflow to Project Storage

Actual annual inflows to Project storage for the period 2008-2012 were used as inputs to the annual allocation model in order to estimate Project operations under prior operating practices during this period. Actual historical annual inflows for the period 1951-2012 were sampled to develop probability distributions of Project operations under prior operating practices and under the OA for the period 2013-2015, as detailed in Section 3.2.2.

Due to the dynamic nature of the Rio Grande channel at the San Marcial gaging station upstream of Elephant Butte Reservoir, gaged inflows to the reservoir exhibit substantial uncertainty. In addition, the annual allocation models used here do not explicitly account for evaporation and seepage losses from Elephant Butte and Caballo reservoirs. For these reasons, calculated historical annual net inflow to Project storage (inflows minus evaporation) for the period 1951-2012 were used in this analysis.

Historical annual net inflows were calculated according to Equation 16 as the change in Project storage during a given year plus the total release from Caballo Dam during that year:

$$I_t = S_t^{EoY} - S_{t-1}^{EoY} + R_{Caballo,t} \quad (16)$$

where I_t is the calculated total inflow during year t , S_t^{EoY} is the historical total Project storage at the end of the irrigation season for year t , S_t^{EoY} is the historical total Project storage at the end of the prior irrigation season (i.e., year $t-1$), and $R_{Caballo,t}$ is the historical total release from Caballo Dam during year t including releases to meet Project deliveries as well as releases for flood control, reservoir spill, and other purposes. Historical Project storage data were obtained from Reclamation's El Paso Field Office; historical annual release data were calculated from daily flow records for the stream gage below Caballo Reservoir (USGS gage 08362500; operated by Reclamation). For the purposes of this study, annual Project inflows were calculated for the period November 1 through October 31 in order to coincide with the end of the irrigation season (i.e., annual inflow for year 2008 is calculated over the period November 1, 2007 through October 31, 2008).

Annual inflows calculated according to Equation 16 are shown in Figure 3.1-3 for the period 1951-2012 (red squares); measured inflows at San Marcial are also shown for comparison (blue diamonds). Annual inflow values for the period 2008-2012 are provided in Table 3.1-1. Measured inflows at San Marcial are the sum of measured flows in the Rio Grande conveyance channel (gage 08358300) and measured flows in the Rio Grande floodway (gage 08358400).

Figure 3.1-3 clearly shows that measured inflows are generally greater than calculated inflows. On average, inflows calculated according to Equation 16 are approximately 13% less than measured inflows. This difference reflects reservoir losses that reduce the amount of inflow the ultimately available to the Project. These losses include reservoir evaporation, reservoir seepage losses, seepage losses between Elephant Butte and Caballo reservoirs, and seepage losses between Caballo Dam and stream gage 08362500. Equation 16 thus returns the historical amount of inflow to Project storage during each year that was actually available to the Project.

The use of historical Project inflows to calculate and compare Project operations under the OA and under prior operating practices assumes that Project operations have no effect on operations within the Rio Grande basin upstream of Elephant Butte Reservoir and no effect on the usable inflows to Project storage—i.e., inflows that contribute to usable water in Project storage rather than Rio Grande Compact credit waters.

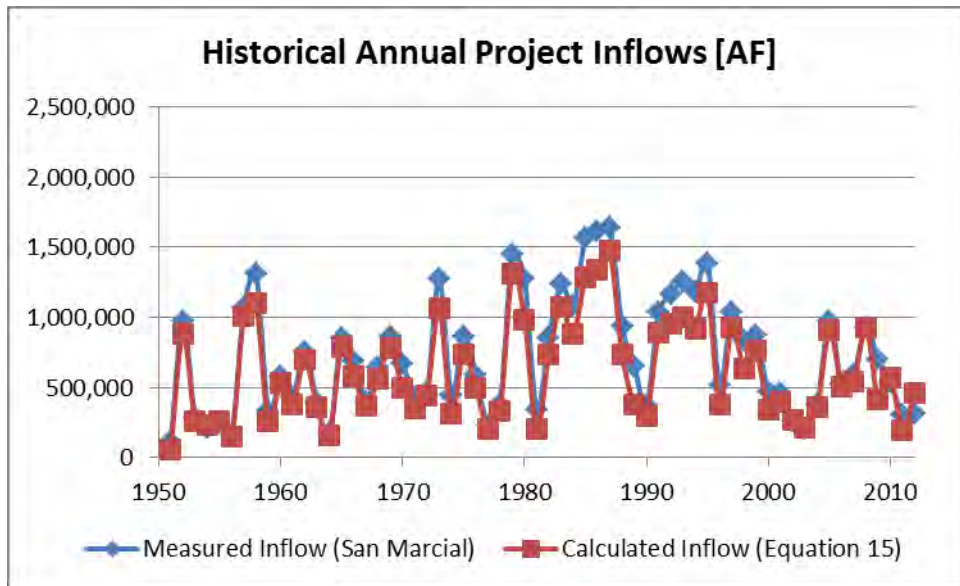


Figure 3.1-3: Historical annual Project inflows for the period 1951-2012 measured at San Marcial (USGS gages 08358300 and 08358400; blue diamonds) and historical annual net Project inflows for the same period calculated from historical Project storage and releases according to Equation 16.

Table 3.1-1: Annual Project Inflows (2008-2012)

Year	Annual Project Inflow (Equation 16)	Annual Project Inflow (Measured at San Marcial)
2008	929,174	929,848
2009	410,757	695,535
2010	572,312	541,105
2011	198,509	300,196
2012	462,223	309,349

Annual Project Operations Data

Historical annual net Project diversions by EBID, EPCWID, and Mexico—i.e., annual Project allocation charges—for the period 2008-2012 were used to evaluate the potential effects of the OA over this period. Annual gross diversions, allocation credits, and allocation charges were obtained from annual Project allocation worksheets and annual district charge reports provided by Reclamation’s El Paso Field Office.

Table 3.1-2: Annual Project Charges to EBID, EPCWID, and Mexico (2008-2012)

Year	EBID	EPCWID	Mexico
2008	329,294*	262,292*	56,048
2009	291,830*	320,072*	58,688
2010	285,856*	290,201*	56,882
2011	59,771*	258,772	25,650
2012	134,386	136,380	23,187

* Discrepancies exist between values provided on district charge sheets and values used in annual Project allocation worksheets; in these cases, charges used here were estimated from annual Project allocation worksheets from each district's Total Diversion Allocation and subsequent year carryover balance.

In addition to Project charges for the period 2008-2012, historical records of annual gross diversions within Rincon and Mesilla valleys, El Paso Valley, and at the heading of the Acequia Madre for the period 1951-2012 were obtained from Reclamation's El Paso Field Office; comprehensive records of annual allocation charges by district were not readily available for this period at the time of this analysis. Annual gross diversions to Mexico are equal to the annual gross diversion at the heading of the Acequia Madre. Annual gross diversions to EBID were estimated from the annual gross diversion within Rincon and Mesilla valleys by deducting the estimated portion of the gross diversion that served lands within EPCWID. Annual gross diversions to EPCWID were subsequently estimated as the sum of the annual gross diversion in El Paso Valley and the estimated portion of the diversion in Mesilla Valley that served lands in EPCWID. The portion of the total gross diversion in Rincon and Mesilla valleys that served Project lands within EPCWID was estimated based on the percentage of total irrigated Project acreage within Rincon and Mesilla valleys that occurred within EPCWID in a given year.

EPCWID historically did not utilize its entire Project allocation in most years. As a result, annual allocation models must estimate diversions by EPCWID under prior operating practices for the period 2008-2012 and under both prior operating practices and the OA for the period 2013-2015. In addition to the data provided in Table 3.1-2, annual gross Project diversions for the period 1951-2012 were analyzed in order to develop a relationship to estimate annual diversions by EPCWID in a given year (see Section 3.1.2). Similarly, annual allocation models must estimate the annual Project diversion ratio for each year during the period 2013-2015. Annual Project operations data for the period 1951-2012 were used to calculate the annual diversion ratio for each year in this period. Diversion ratio data and other Project operations data were then evaluated to identify a relationship that could be used to predict the diversion ratio in a given year based on prior and concurrent Project conditions (see Section 3.1.2).

Historical annual gross diversions to EBID, EPCWID, and Mexico for the period 1951-2012 are shown in Figures 3.1-4, 3.1-5, and 3.1-6, respectively. Historical annual gross diversion ratios for this period are shown in Figure 2.2-8.

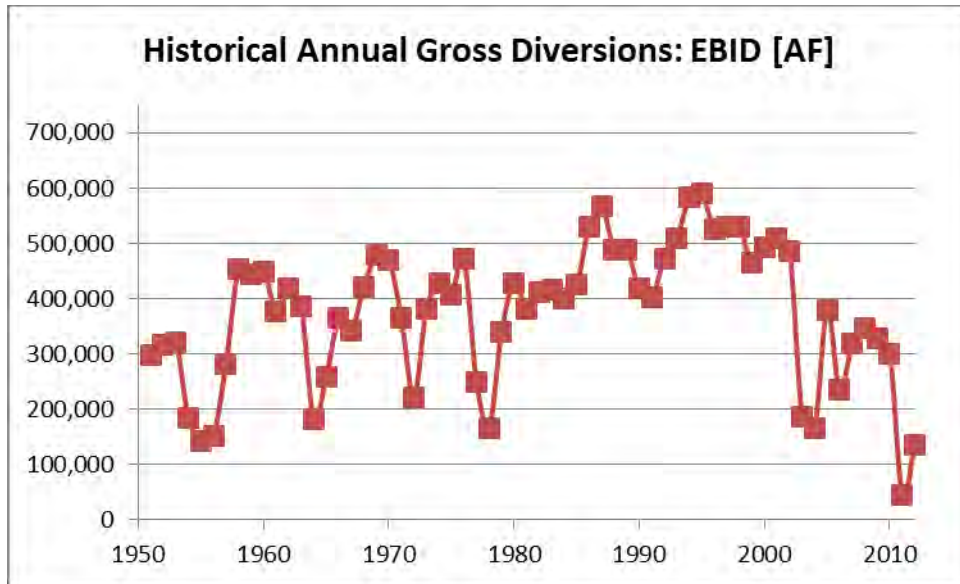


Figure 3.1-4: Historical annual gross diversions to EBID (AF/year).

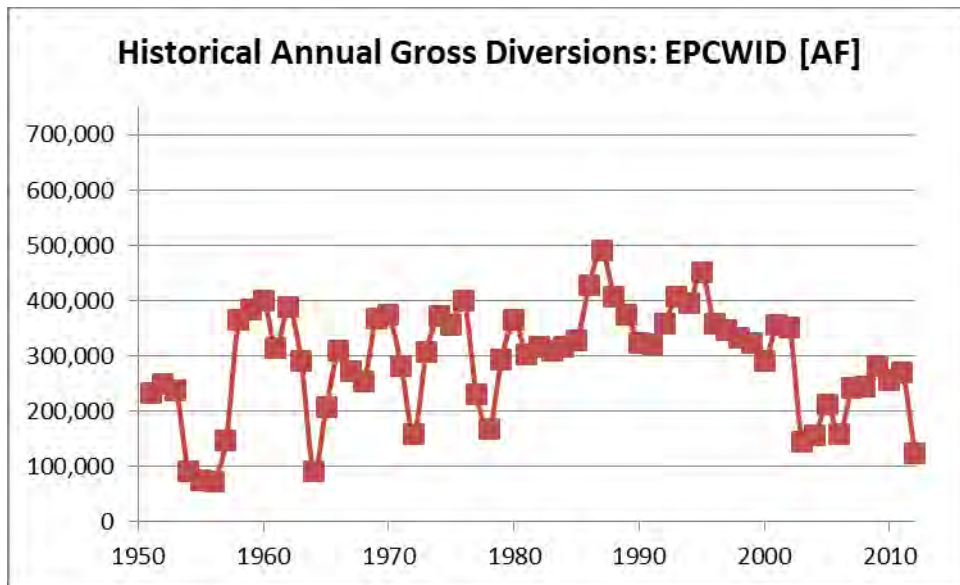


Figure 3.1-5: Historical annual gross diversions to EPCWID (AF/year).

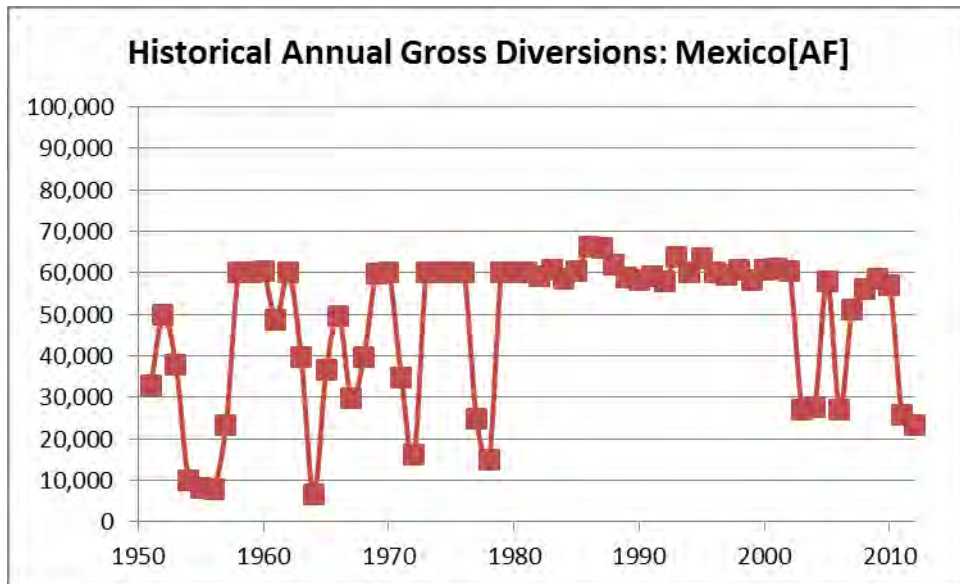


Figure 3.1-6: Historical annual gross diversions to Mexico (AF/year).

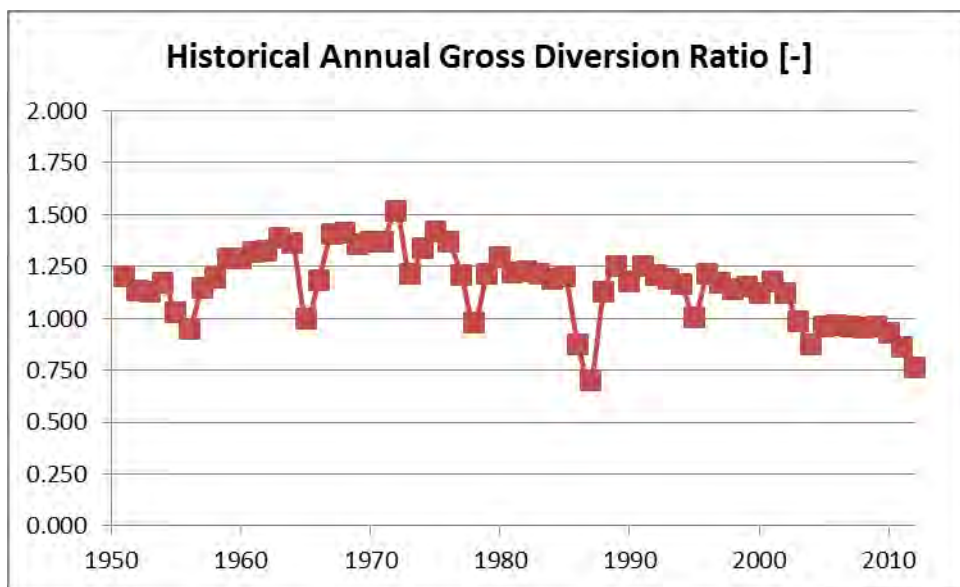


Figure 3.1-7: Historical annual gross diversions ratio (i.e., ratio of gross Project diversions to total releases from Project storage). Note that low values of the diversion ratio in years 1986, 1987, and 1995 occurred due to release of excess water for flood control purposes; due to the excessively wet conditions these years, water released for flood control was not diverted thereby reducing the ratio of diversions to releases in these years.

Annual Project Cropping Data

For the purposes of this analysis, annual cropping data were used only to estimate the portions of the historical annual gross diversion from Rincon and Mesilla valleys that served lands within EBID and EPCWID, respectively.

Annual cropping data for Rincon and Mesilla valleys for the period 1951-2009 were obtained from the US Geological Survey (USGS) hydrological modeling team that is currently leading the development of the Lower Rio Grande Hydrologic Model. Data were provided as part of the Lower Rio Grande Basin Canal Budget dataset (Canal.V11.0.xls), which contains agricultural acreage and water use data for the Rincon and Mesilla valleys of New Mexico and the Mesilla Valley of Texas for the period 1938-2009. The Canal Budget dataset was developed by the New Mexico Office of the State Engineer (NMOSE) and Spunk Water Engineers for the period 1938-2004 and was recently updated by USGS to include estimated values through 2009.

The Canal Budget dataset was previously used to develop water budget inputs to a groundwater flow model of the Lower Rio Grande basin that was developed by S.S. Papadopoulos & Associates, Inc. for NMOSE, including inputs related to agricultural groundwater pumping, recharge from canal seepage, and recharge from deep percolation of irrigation water. As part of the model development effort, the Canal Budget dataset and other model inputs were reviewed and approved by representatives from NMOSE, EBID, EPCWID, the State of Texas, and Reclamation, as well as technical reviewers from USGS and University of Arizona. Acreage data from the Canal Budget dataset have therefore been subjected to extensive review and verification.

Available annual cropping data for the period 2008-2012 were obtained from Reclamation's El Paso Field Office. Data were provided in the form of annual crop reports for Project sub-divisions within the Rincon and Mesilla Valleys. Irrigated acreage within EBID and EPCWID, respectively, was aggregated for each year based on the available crop reports. Data for lands within EBID were not available for the 2012 irrigation season; data for lands within EPCWID were not available for the 2010, 2011, or 2012 irrigation seasons. For these years, irrigated acreages were estimated from prior year data.

Annual irrigated acreages in the Rincon and Mesilla valleys that lie within EBID and EPCWID are shown in Figure 3.1-8. Annual irrigated acreages for the period 2008-2012 are provided in Table 3.1-3.

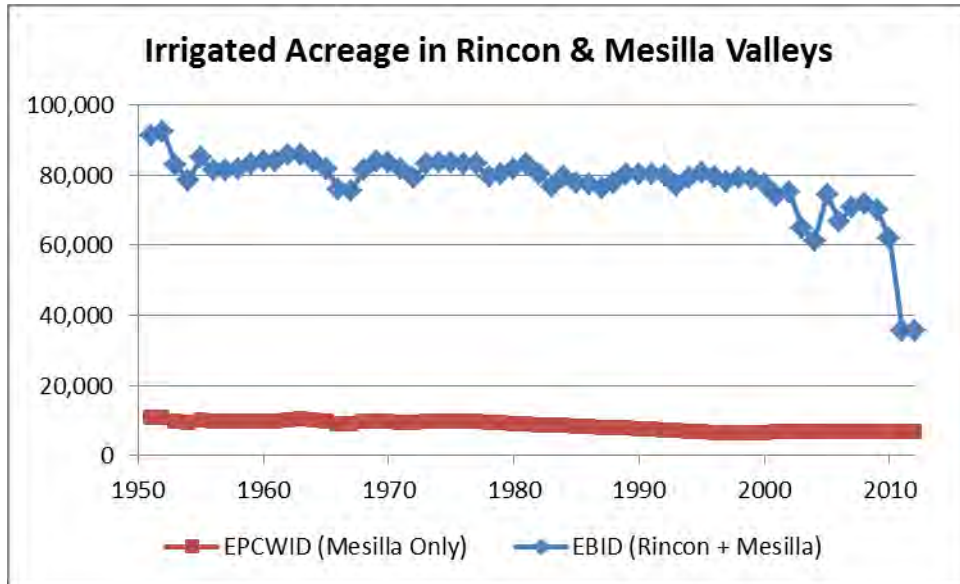


Figure 3.1-8: Irrigated Project acreage within Rincon and Mesilla Valleys. Irrigated acreage within EBID is shown in blue, irrigated acreage within EPCWID is shown in red. Irrigated acreage within EBID includes all EBID lands, as the entire district lies within the Rincon and Mesilla Valleys. Irrigated acreage within EPCWID includes only the portion of the district that lies within the Mesilla Valley.

Table 3.1-3: Irrigated Acreage in Rincon and Mesilla Valleys (2008-2012)

Year	EBID Acreage (Rincon + Mesilla Valleys)	EPCWID Acreage (Mesilla Valley Only)	Total Acreage (Rincon + Mesilla Valleys)
2008	71,788	6,518	78,306
2009	70,005	6,526	76,531
2010	61,928	6,500*	68,428
2011	35,563	6,500*	42,063
2012	35,563*	6,500*	42,063

* Estimated value; data not available.

3.1.2 Methods and Assumptions: Annual Allocation Model of Rio Grande Project Operations under Prior Operating Practices

Potential effects of the OA on Project operations are evaluated by comparing Project operations under the OA to operations under prior operating practices. For the purposes of this study, potential effects of the OA are evaluated for two periods, 2008-2012 and 2013-2015. During the period 2008-2012, project operations followed the procedures detailed in the OA; Project operations consistent with prior operating practices therefore must be estimated for this period. For the future period 2013-2015, Project operations must be estimated for both operating practices.

As part of this study, two annual allocation models were developed to estimate annual Project operations under the OA and under prior operating practices, respectively. This section details all calculations and assumptions used in the annual allocation model representing prior operating practices.

Total Usable Water Available for Release (U_t)

The total usable water available for release is calculated from the total Project storage at end of the prior irrigation season (S_{t-1}^{EoY}), annual Project inflows during the current year (I_t), and non-Project water in storage at the start of the current year (i.e., the sum of San Juan-Chama Water S_t^{SJC} and Rio Grande Compact Credit Water $S_t^{Compact}$) according to Equation 17:

$$U_t = S_{t-1}^{EoY} + I_t - S_t^{SJC} - S_t^{Compact} \quad (17)$$

Actual historical annual inflows are used throughout this analysis. For the period 2008-2012, the actual historical non-Project storage (S_t^{SJC} , $S_t^{Compact}$) is provided as model inputs. Non-Project storage is not known for the period 2013-2015; the total annual non-Project storage for 2013-2015 is therefore assumed to equal the average annual non-Project storage over the period 2008-2012.

Equation 17 assumes that the total annual Project inflows during the current year (I_t) are known at the start of the year. This assumption is required in order to calculate a single annual allocation, and is a common assumption among allocation models used in water resources planning and operations. In reality, however, allocation calculations are updated throughout the year as inflows occur. The assumption that annual inflow calculations are made once each year based on inflows that occur throughout the year is commonly referred to as the assumption of perfect foresight.

Total Usable Water Available for Current Year Release (V_t)

The total usable water available for release during the current year is equal to the minimum of the total usable water available for release and the normal annual release of 790,000 AF:

$$V_t = \min[U_t, 763,842] \quad (18)$$

Total Usable Water Available for Current Year Allocation (W_t)

Under prior operating practices, the total usable water available for current year allocation is equal to the total usable water available for current year release:

$$W_t = V_t \quad (19)$$

Estimated Annual Release of Project Water ($R_{Caballo}^{Est}$)

The annual D-1 delivery is calculated from the annual release of Project water using Equation 1. Because the actual annual release of Project water ($R_{Caballo}$)

during a given irrigation season is not known until the end of the season, the estimated annual release of Project water ($R_{Caballo}^{Est}$) is used to calculate the annual D-1 delivery. The estimated annual release of Project water during the current year under prior operating practices is assumed to equal the total usable water available for current year allocation:

$$R_{Caballo,t}^{Est} = W_t \quad (20)$$

The estimated annual release of Project water is used only to calculate the annual D-1 delivery and the gross D-2 diversion allocation. The annual allocation model calculates actual annual releases based on the estimated allocations, demands, and annual Project diversion ratio as detailed below.

Annual D-1 Delivery (D_{D1})

The annual D-1 delivery (D_{D1}) is the estimated total annual Project delivery to Project lands within the United States (i.e., delivery to individual farm gates within EBID and EPCWID) plus total deliveries to the heading of the Acequia Madres. The annual D-1 delivery is calculated from the estimated annual release of Project water based on Equation 1, defined in Section 2.4, which is referred to as the D-1 Curve.

Annual Allocation to Mexico (A_{Mexico})

Pursuant to the Convention of 1906, the annual allocation to Mexico (A_{Mexico}) is 60,000 AF, except under extreme drought conditions. Under extreme drought conditions, the annual allocation to Mexico is 11.3486% of the sum of the total quantity of water delivered to lands within the United States plus total deliveries to the heading of the Acequia Madre. For the purposes of this study, the annual allocation to Mexico is calculated as the minimum of 60,000 AF or 11.3486% of the annual D-1 delivery per Equation 2, defined in Section 2.4.

Annual Gross D-2 Diversion Allocation ($A_{GrossD2}$)

The annual gross D-2 diversion allocation ($A_{GrossD2}$) is the estimated total amount of water available for diversion during the current year based on the total usable water available for current-year allocation. The annual gross D-2 diversion allocation is calculated from the total usable water available for current year allocation (W_t) using Equation 3, defined in Section 2.4.

As discussed above in Section 2.4, a drought adjustment factor is required in years when the gross D-2 diversion allocation is greater than the amount of water that can actually be delivered for diversion based on the usable water available for release and the current-year diversion ratio. For the purposes of this analysis, a drought adjustment factor is applied to the annual gross D-2 allocation as needed during the period 2008-2012. The magnitude of the drought adjustment factor is determined so such that the gross D-2 allocation equals the total amount of water that can be delivered for diversion based on the total usable water available for release and the current diversion ratio:

$$f_{drought,t} = \frac{U_t \cdot \rho_t}{A_{GrossD2}} \quad (21)$$

Where ρ_t is the current-year diversion ratio, described below.

For the purposes of this analysis, a drought adjustment factor is applied to the annual gross D-2 allocation under prior operating practices as needed in analysis of periods 2008-2012 and 2013-2015. The drought adjustment factor ensures that the gross D-2 allocation does not exceed the total amount of water that can be delivered for diversion based on the total usable water available for release and the current diversion ratio.

Annual Net D-2 Diversion Allocation (A_{NetD2})

The annual net D-2 diversion allocation (A_{NetD2}) specifies total water available for current year allocation to EBID and EPCWID. The annual net D-2 diversion allocation is calculated as the difference between the annual gross D-2 diversion allocation and the annual allocation to Mexico using Equation 4, defined in Section 2.4.

Annual Diversion Allocation to EBID (A_{EBID}^{Final})

Under prior operating practices, the final annual diversion allocation to EBID (A_{EBID}^{Final}) is calculated as 88/155^{ths} (57%) of the annual net D-2 diversion allocation according to Equation 5, defined in Section 2.4.

Annual Diversion Allocation to EPCWID (A_{EPCWID}^{Final})

Under prior operating practices, the final annual diversion allocation to EPCWID (A_{EPCWID}^{Final}) is calculated as 67/155^{ths} (43%) of the annual net D-2 diversion allocation according to Equation 6, defined in Section 2.4.

Annual Diversion to Mexico (D_{Mexico})

For the purposes of this analysis, the annual allocation model of Prior Operating Practices assumes that Mexico diverts its full allocation in all years during the periods 2008-2012 and 2013-2015.

Annual Diversion to EBID (D_{EBID})

Annual diversions to EBID (D_{EBID}) during the period 1951-2007 were generally equal to the district's final annual diversion allocation (A_{EBID}^{Final} ; J. Phillip King 2013 pers. comm.; Filiberto Cortez 2013 pers. comm.; Al Blair 2013 pers. comm.). For the purposes of this analysis, it is therefore assumed that EBID diverts its full annual allocation in all years during periods 2008-2012 and 2013-2015—i.e., the annual diversion to EBID is equal to the district's final annual diversion allocation.

Annual Diversion to EPCWID (D_{EPCWID})

The annual diversion to EPCWID (D_{EPCWID}) for most years during the period 1951-2007 was less than or equal to the district's final annual allocation (A_{EPCWID}^{Final}). In order to estimate EPCWID's annual diversions under Prior Operating Practices during the period 2008-2012, historical project data were evaluated to identify the best predictor of the annual diversion to EPCWID. Several predictors were considered, including annual allocation to EPCWID and annual usable water available for release. It should be noted that total annual release was not considered, as total annual release for each year depends on the districts' and Mexico's diversions during the year. The strongest relationship was found to be a piece-wise relationship between the annual diversion to EPCWID (D_{EPCWID}) and the total usable water available for release (U_t).

Figure 3.1-9 shows the historical annual diversion to EPCWID (ordinate) as a function of annual total usable water (abscissa). Because complete records of Project charges and credited return flows are not available for the full period of analysis (1951-2012), analysis focused on annual gross diversions to EPCWID rather than annual net diversions (i.e., annual Project charges). For the purposes of this analysis, the annual diversions to EPCWID under Prior Operating Practices during the period 2008-2012 are calculated according to the piece-wise relationship provided in Equation 22:

$$D_{EPCWID,t} = \begin{cases} 0.4945 \cdot U_t - 58,713; & U_t \leq 680,000\text{AF} \\ 0.0414 \cdot U_t + 253,884; & 680,000 < U_t < 3,000,000\text{AF} \\ 376,000; & 3,000,000\text{AF} \geq U_t \end{cases} \quad (22)$$

The coefficients of determination (R^2) for the linear relationships between historical annual diversions and total usable water available for release are 0.63 and 0.21, respectively, for $U_t \leq 680,000$ AF and $680,000 < U_t \leq 3,000,000$ AF. It should be noted that the annual diversion to EPCWID is capped at 376,000 AF due to the 2006 Texas adjudication.

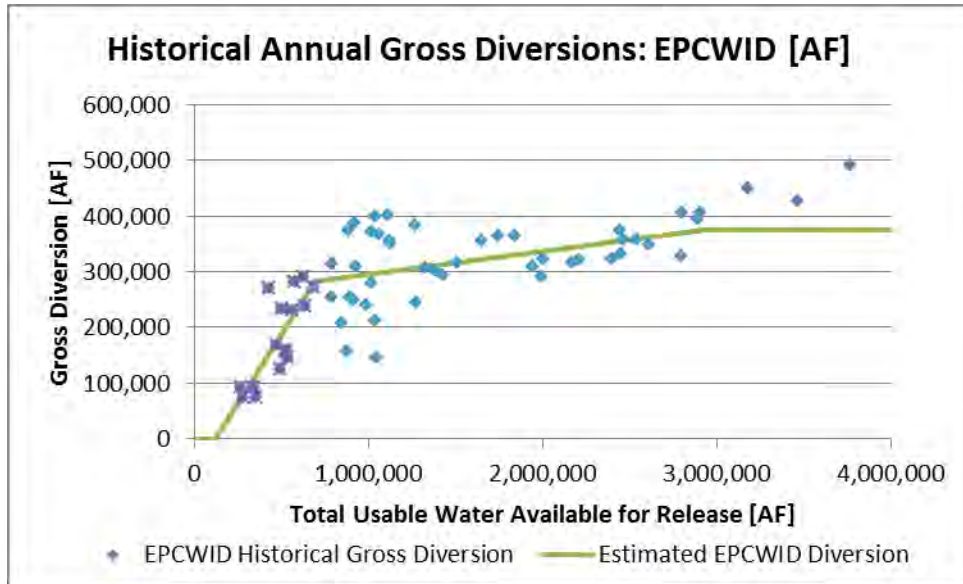


Figure 3.1-9: Historical annual diversions to EPCWID over the period 1951-2012 plotted as a function of the historical total usable water available for release (points). The green line shows the piece-wise equation relating annual diversion to EPCWID to total usable water available for release.

The relatively low R^2 value for the range $680,000 \leq U_t \leq 3,000,000$ AF reflects the complex mix of factors affect district operations within EPCWID and corresponding Project diversions by the district. In addition to diverting Project water for irrigation purposes, EPCWID supplies water to El Paso Water Utilities (EPWU) for municipal and industrial uses. Diversions to meet municipal and industrial demands are affected by availability of other water sources (i.e., whether EPWU has access to alternative supplies in a given year) as well as water quality considerations associated with blending of multiple sources of water. As a result, annual diversions to EPCWID are highly variable under a broad range of total usable water.

As noted above, Equation 22 was developed from historical gross diversion records as historical net diversion records (i.e., historical Project charges) are not available for the full period of analysis (1951-2012). Under Prior Operating Practices, credited return flows from EPCWID to the Rio Grande were generally small. Based on the lack of available data, this analysis assumes that credited return flows from EPCWID are negligible.

Annual Project Diversion Ratio ($\rho_{Project}$)

For the purposes of this analysis, annual releases from Project storage under prior operating practices during the periods 2008-2012 and 2013-2015 are estimated from the annual diversion to EBID, EPCWID, and Mexico and the annual Project diversion ratio ($\rho_{Project}$). Annual diversions to EBID, EPCWID, and Mexico are estimated as described above. In order to calculate the annual release from Project

storage required to satisfy the estimated diversions, it is necessary to estimate the annual Project diversion ratio for each year.

Extensive analysis of historical Project operations data was carried out in an effort to identify a reliable predictor of the annual diversion ratio for a given year based on data available at the start of the irrigation season for that year. Analysis considered relationships between annual diversion ratio and total Project storage at the end of the prior irrigation season; total Project storage at the start of the current irrigation season; total usable water available for current year release; total usable water available for current year allocation; total Project allocations to EBID, EPCWID, and Mexico; total Project releases during the prior year; total Project diversions during the prior year; annual gross diversion ratio for the prior year; and combinations of the above. The only predictor that was found to exhibit a statistically significant relationship with current-year diversion ratio is the prior year diversion ratio—i.e., the only reliable predictor of the annual diversion ratio is the year-to-year persistence (serial correlation) of the diversion ratio itself.

Due to the generally weak relationships between the annual diversion ratio and the available predictors, historical (actual) annual diversion ratios were used in the analysis of the period 2008-2012. The annual diversion ratio under Prior Operating Practices for each year during the period 2008-2012 was assumed to equal the actual annual diversion ratio for that year calculated from historical Project operations data. While it is likely that diversion ratios would have been different during this period if the Project had been operated under Prior Operating Practices, analysis of the available data indicates that estimates of the annual diversion ratio are highly uncertain. These results suggest that actual Project operations data provide the best available estimate of the annual diversion ratio for this period. Annual Project diversion ratios used for years 2008-2012 are provided in Table 3.1-4.

Table 3.1-4: Actual Annual Project Charges, Releases, and Diversion Ratios (2008-2012)

Year	EBID Net Diversion (Charge) [AF]	EPCWID Net Diversion (Charge) [AF]	Mexico Net Diversion (Charge) [AF]	Total Net Diversion (Charge) [AF]	Total Project Release* [AF]	Project Diversion Ratio [-]
2008	329,294	262,292	56,048	647,634	674,724	0.985
2009	291,830	320,072	58,688	670,590	694,199	0.986
2010	285,856	290,201	56,882	632,939	660,300	0.975
2011	59,771	258,772	25,650	344,193	396,876	0.867
2012	133,060	136,380	23,187	292,627	372,600	0.790

* Actual release during irrigation season; releases during non-irrigation season are not included in calculation of Project diversion ratio. For the years considered here, releases during the non-irrigation season were less than 0.1% of the total annual release.

Due to the lack of Project operations data for future periods, analysis of the period 2013-2015 required estimating the annual Project diversion ratio for each future year. As detailed above, the only available predictor of the annual diversion ratio is the prior year diversion ratio. The annual Project diversion ratio for each year in the period 2013-2015 was therefore calculated based on the serial regression relationship defined in Equation 23:

$$\rho_{Project,t} = 0.7233 \cdot \rho_{Project,t-1} + 0.3155 \quad (23)$$

Figure 3.1-10 shows the historical Project diversion ratio data used to develop Equation 23. For analysis of the period 2013-2015, the annual Project diversion ratio for year 2013 is estimated using Equation 23 based on the actual diversion ratio for 2012 as calculated from Project operations data. The annual diversion ratio for each subsequent year was determined from the estimated prior-year Project diversion ratio per Equation 23.

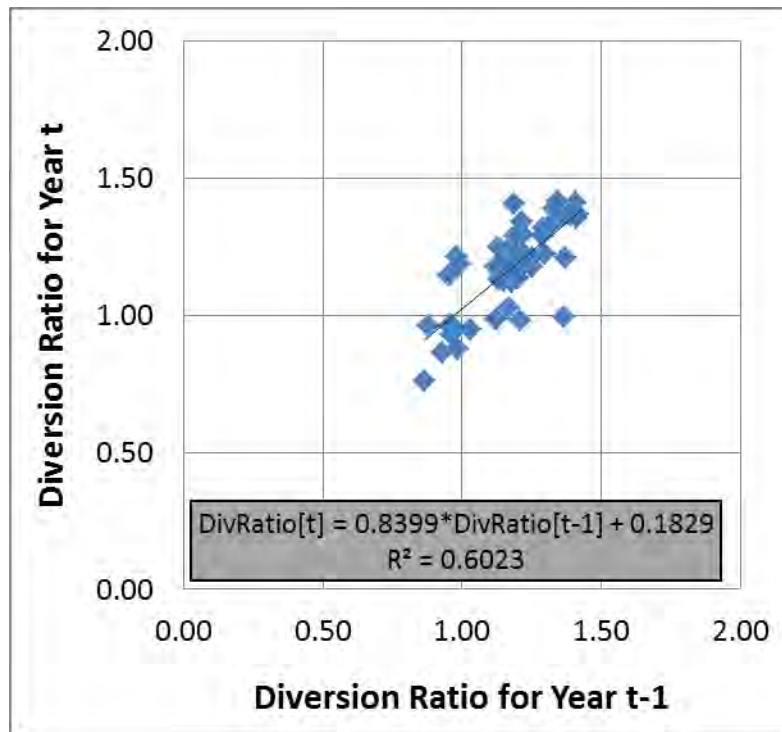


Figure 3.1-10: Current-year annual diversion ratio plotted as a function of prior-year annual diversion ratio. Annual diversion ratios were calculated from historical Project operations data for the period 1951-2012; the following years were excluded as outliers: 1972, 1986, 1987, 1995.

Due to the lack of comprehensive data regarding Project charges and credited return flows for the full 1951-2012 period, Equation 23 was developed based on historical annual gross diversions rather than annual Project charges. Use of Equation 23 to estimate the annual Project diversion ratio assumes that the year-

to-year serial correlation of the Project diversion ratio is consistent with that of the gross diversion ratio. Uncertainties in the results of this analysis due to uncertainties in estimating the annual Project diversion ratio are discussed below in Sections 3.1.5 and 3.2.3.

Annual Release from Project Storage ($R_{Caballo}$)

The annual release from Project storage required to meet Project diversions is determined from the calculated annual diversion to EBID, EPCWID, and Mexico and the estimated annual Project diversion ratio. Additional release from Project storage due to reservoir spill is calculated as the difference between the end-of-year total Project storage and the total Project storage capacity. The total annual Project release is thus calculated according to Equation 24:

$$R_{Caballo,t} = \frac{D_{EBID,t} + D_{EPCWID,t} + D_{Mexico,t}}{\rho_{Project,t}} + \max[0.0, (S_{initial,t}^{EoY} - S_{cap})] \quad (24)$$

The annual allocation model cannot resolve flood operations within a given year. In the event that the initial end-of-year storage $S_{initial,t}^{EoY}$ exceeds the total Project storage capacity S_{cap} , the annual release due to reservoir spill is therefore calculated simply as the difference between the initial estimated end-of-year storage and the total Project storage capacity. The initial end-of-year storage is calculated according to Equation 25:

$$S_{initial,t}^{EoY} = S_{t-1}^{EoY} + I_t - \frac{D_{EBID,t} + D_{EPCWID,t} + D_{Mexico,t}}{\rho_{Project,t}} \quad (25)$$

Annual End-of-Year Project Storage (S^{EoY})

Total Project storage remaining at the end of the current irrigation season (S_t^{EoY}) is calculated from the total Project storage at the end of the prior irrigation season (S_{t-1}^{EoY}), annual Project inflows during the current year (I_t), and total Project releases during the current year ($R_{Caballo,t}$) according to Equation 26:

$$S_t^{EoY} = S_{t-1}^{EoY} + I_t - R_{Caballo,t} \quad (26)$$

3.1.3 Methods and Assumptions: Annual Allocation Model of Project Operations under the OA

As detailed above, potential effects of the OA on Project operations are evaluated here by comparing Project operations under the OA to operations under prior operating practices. For the purposes of this study, potential effects of the OA are evaluated for two periods, 2008-2012 and 2013-2015. During the period 2008-2012, actual project operations followed the procedures detailed in the OA; actual historical Project operations data are therefore used to characterize Project

operations under the OA for this period. For the future period 2013-2015, Project operations must be estimated under both operating procedures.

As noted above, as part of this study, two annual allocation models were developed to estimate annual Project operations under the OA and under prior operating practices, respectively. This section details all data, calculations, and assumptions used in the annual allocation model representing Project operations under the OA.

Total Usable Water Available for Release (U_t)

Under the OA, the total usable water available for release is calculated from Equation 17 as under prior operating practices, as detailed above in Section 3.1.2.

EBID Allocation Balance (Previous Year) ($A_{EBID}^{Carryover}$)

The EBID allocation balance at the end of the previous year—i.e., EBID's Accrued Carryover Balance—is the difference between the prior-year Total Diversion Allocation to EBID and the prior-year total Project charges (net Project diversions) to EBID. For the period 2008-2012, actual Project operations data were used to calculate EBID's prior-year allocation balance. For the period 2013-2015, EBID's prior-year allocation balance is determined from the prior-year allocations and diversions calculated by the annual allocation model as detailed below.

EPCWID Allocation Balance (Previous Year) ($A_{EPCWID}^{Carryover}$)

As for EBID, the EPCWID allocation balance at the end of the previous year—i.e., EPCWID's Accrued Carryover Balance—is the difference between the prior-year Total Diversion Allocation to EPCWID and the prior-year total Project charges (net Project diversions) to EPCWID. For the period 2008-2012, actual Project operations data were used to calculate EPCWID's prior-year allocation balance. For the period 2013-2015, EPCWID's prior-year allocation balance is determined from the prior-year allocations and diversions calculated by the annual allocation model as detailed below.

EBID Estimated Allocation Balance (End-of-Year) (C_{EBID})

Under the OA, each district may specify its projected end-of-year allocation balance; the specified end-of-year allocation balance is not available for current-year allocation.

The EBID allocation balance at the end of the current year is the projected district carryover at the end of the current year. For the period 2008-2012, actual values of the EBID estimated end-of-year allocation balance from annual Project allocation calculations were used in the analysis carried out here. For the period 2013-2015, the EBID estimated end-of-year allocation balance was assumed to be zero for all years.

EPCWID Estimated Allocation Balance (End-of-Year) (C_{EPCWID})

As for EBID, the EPCWID allocation balance at the end of the current year is the projected district carryover at the end of the current year. For the period 2008-2012, actual values of the EPCWID estimated end-of-year allocation balance from annual Project allocation calculations were used in the analysis carried out here. For the period 2013-2015, the EPCWID estimated end-of-year allocation balance was assumed to be zero for all years.

Carryover Obligation using Estimated Diversion Ratio (X_t)

The carryover obligation during a given year is the volume of water that must be released from storage in order to satisfy prior year carryover obligations—i.e., in order to deliver a quantity of water equal to the sum of EBID's and EPCWID's Accrued Carryover Balance to the respective districts under current Project performance. The current year carryover obligation is thus calculated from the estimated Project diversion ratio ($\rho_{Project}^{Est}$) according to Equation 27:

$$X_t = \frac{A_{EBID}^{Carryover} + A_{EPCWID}^{Carryover}}{\rho_{Project}^{Est}} \quad (27)$$

where the estimated annual Project diversion ratio $R_{Project}^{Est}$ is described below.

Storage for EBID and EPCWID Estimated Allocation Balance ($S_{Carryover}$)

Total storage required to meet the estimated EBID and EPCWID allocation balances is calculated from the estimated Project diversion ratio ($\rho_{Project}^{Est}$) in a similar manner to the current year carryover obligation (Equation 28).

$$S_{Carryover} = \frac{C_{EBID} + C_{EPCWID}}{\rho_{Project}^{Est}} \quad (28)$$

Total Usable Water Available for Current Year Allocation (W_t)

Under the OA, the total usable water available for current year allocation is equal to the minimum of the total usable water available for current year release (U_t) minus the current-year carryover obligation and the normal annual release of 790,000 AF, minus storage for the estimated end-of-year allocation balance ($S_{Carryover}$). Total usable water available for current year allocation is thus calculated from Equation 29:

$$W_t = \min[(U_t - X_t), 790,000] - S_{Carryover} \quad (29)$$

Estimated Release of Current Usable Water ($R_{Caballo}^{Est}$)

Under the OA, the annual D-1 delivery (D_{D1}), the annual diversion ratio adjustment (D), and the adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID (Δ) are all calculated based on the annual release of Project water during the current irrigation season. Because the actual annual release of Project water ($R_{Caballo}$) during a given irrigation season is not

known until the end of the irrigation season, the estimated annual release of Project water ($R_{Caballo}^{Est}$) is used to calculate these values.

For the period 2008-2012, the estimated release of current useable water used in this analysis is equal to the value used in the final Project allocation worksheet for the corresponding year. The estimated release of current useable water used for allocation purposes therefore may differ from the actual release during the irrigation season.

For the period 2013-2015, the estimated release of current usable water is assumed to equal the total usable water available for current year allocation:

$$R_{Caballo,t}^{Est} = W_t \quad (30)$$

For both periods of analysis, the annual allocation model calculates actual annual releases based on estimated annual total Project diversions and the annual Project diversion ratio as detailed below. Actual annual releases may therefore differ from the estimated release used to calculate the annual D-1 delivery, annual diversion ratio adjustment, and the adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID. This is consistent with actual Project operations, as the final allocation calculation does not require perfect agreement between the estimated release used for allocation purposes and actual release over the course of the irrigation season.

Annual Project Diversion Ratio (for allocation calculation) ($R_{Project}^{Alloc}$)

The annual Project diversion ratio is used in several of the calculations in the allocation procedure defined by the OA, including calculation of the annual carryover obligation, storage for end-of-year estimated allocation balances, the diversion ratio adjustment, and the EBID diversion ratio allocation. However, the actual annual Project diversion ratio is not known until the end of the irrigation season. The annual Project diversion ratio therefore must be estimated in order to calculate Project allocations. The the OA does not prescribe the data or time period to be used in calculating the Project diversion ratio that is used in Project allocation calculations. Further, the estimated annual Project diversion ratio used in the final allocation calculations for a given year may differ from the actual Project diversion ratio for that year.

As detailed above, estimation of the current-year annual Project diversion ratio at the start of the irrigation season is highly uncertain. For the period 2008-2012, the estimated annual Project diversion ratio used in the annual allocation model to calculate the annual Project allocations under the OA were assumed to equal the actual values of the Project diversion ratio used in the final allocation calculations for the corresponding year. Actual values were obtained from the final annual allocation worksheet for each year and are provided in Table 3.1-5. As noted above, the annual Project diversion ratio used in annual allocation calculations

differs slightly from the actual annual Project diversion ratio calculated from Project operations data.

Table 3.1-5: Actual Values of the Project Diversion Ratio Used in Annual Allocation Calculations and Actual Values Calculated from Project Charge and Release Data (2008-2012)

Year	Project Diversion Ratio used in Annual Allocation Calculations	Actual Project Diversion Ratio Calculated from Project Data
2008	1.000	0.960
2009	0.987	0.966
2010	0.980	0.959
2011	0.868	0.867
2012	0.788	0.789

Due to the fact that Project operations data does not exist for future periods, analysis of the period 2013-2015 requires calculating the annual Project diversion ratio. As detailed above, the only available predictor of annual diversion ratio is the prior year diversion ratio. The annual Project diversion ratio for each year in the period 2013-2015 was therefore calculated based on the serial regression relationship defined in Equation 23 (see Section 3.1.2). The annual Project diversion ratio for year 2013 is calculated from the actual Project diversion ratio for 2012 calculated from Project operations data using Equation 23. The annual Project diversion ratio for each subsequent year was determined from the calculated prior-year Project diversion ratio per Equation 23. Annual Project diversion ratios estimated from Equation 23 were used to calculate annual Project allocations as well as to determine the annual Project release required to satisfy Project diversions.

Annual D-1 Delivery (D_{D1})

Under the OA, the annual D-1 delivery (D_{D1}) is calculated from Equation 1 as under prior operating practices, as detailed above in Sections 2.4 and 3.1.2.

Annual Allocation to Mexico (A_{Mexico})

Under the OA, the annual D-1 allocation to Mexico (A_{Mexico}) is calculated from Equation 2 as under prior operating practices, as detailed above in Sections 2.4 and 3.1.2.

Annual Gross D-2 Diversion Allocation ($A_{GrossD2}$)

Under the OA, the annual gross D-2 diversion allocation ($A_{GrossD2}$) is calculated from the total usable water available for current year allocation (W_t) in a similar manner to prior operating practices. However, as described above in Section 2.4, the OA uses a modified form of the D-2 Curve given by Equation 7.

As discussed above in Section 2.4, a drought adjustment factor is required in years when the gross D-2 diversion allocation is greater than the amount of water that can actually be delivered for diversion based on the usable water available for release and the diversion ratio for that year. As detailed in Section 3.1.2, for the purposes of this analysis, a drought adjustment factor is applied to the annual gross D-2 allocation as needed during the period 2008-2012. The magnitude of the drought adjustment factor is determined so such that the gross D-2 allocation equals the total amount of water that can be delivered for diversion based on the total usable water available for release and the current diversion ratio:

The OA allocation procedure largely avoids the need for a drought factor. However, as demonstrated during recent severe and sustained drought conditions, a drought adjustment factor is also required under the OA during multi-year drought events. The Rio Grande Project Operations Manual was therefore recently updated to include a drought factor during consecutive years with total Project releases less than 400,000 AF. The value of the drought factor depends on the number of consecutive years with total Project release less than 400,000 AF as shown in Table 3.1-6.

Table 3.1-6: Drought Factors Under the OA

Number of Consecutive Years with Total Release Less than 400,000 AF	Drought Factor
0	NA
1	1.0
2	0.88
3	0.78
≥ 4	0.75

Annual Net D-2 Diversion Allocation (A_{NetD2})

Under the OA, the annual net D-2 diversion allocation ($A_{GrossD2}$) is calculated from the gross D-2 diversion allocation and the annual allocation to Mexico (A_{Mexico}) using Equation 4, as detailed above in Section 2.4 and Section 3.1.2.

EPCWID ACE Conservation Credit (ACE)

Under the OA, EPCWID is credited for water salvaged by conveyance of water from the American Dam to the Riverside Canal Heading via the American Canal Extension (ACE) rather than the Rio Grande, where salvage occurs due to reduced seepage losses from the concrete-lined ACE compared to historic seepage losses from the unlined river channel. In practice, the annual ACE conservation credit (ACE) is calculated based on a non-linear relationship between the annual flow through the ACE and the estimated salvage. However, the procedure for calculating the annual ACE conservation credit (ACE) is not specified in the OA or the Rio Grande Project Operations Manual.

For the purposes of this analysis, the ACE conservation credit used in the annual allocation model to calculate the Project allocations under the OA for the period 2008-2012 were assumed to equal the actual values used in the final annual Project allocation calculations for each of these years. Actual values were obtained from the final annual allocation worksheet for each year and are provided in Table 3.1-7. Note that due to severe drought conditions, EPCWID did not receive conservation credits in 2010, 2011, or 2012.

Table 3.1-7: Actual Values of the ACE Conservation Credit Used in Annual Allocation Calculations (2008-2012)

Year	ACE Conservation Credit [AF]
2008	16,818
2009	17,988
2010	0
2011	0
2012	0

The annual allocation model used here does not distinguish the portion of the annual diversion to EPCWID that passes through the ACE and therefore cannot be used to accurately estimate the annual ACE conservation credit. For the purposes of this analysis, ACE conservation credits were therefore assumed to be zero for the period 2013-2015. ACE conservation credits are likely to be zero during this period if the current drought persists; if Project supplies return to normal, conservation credits will constitute a small portion of the final annual allocation to EPCWID. This assumption is therefore not likely to substantially affect the results of this analysis.

D-2 Diversion Allocation to EPCWID (A_{EPCWID}^{D2})

Under the OA, the annual D-2 diversion allocation to EPCWID (A_{EPCWID}^{D2}) is calculated as 67/155th (43%) of the annual net D-2 diversion allocation according to Equation 6, defined in Section 2.4.

EPCWID Diversion Allocation (without ACE) (A'_{EPCWID})

Under the OA, the annual diversion allocation to EPCWID without the annual ACE conservation credit (A'_{EPCWID}) is calculated as an intermediate step in the allocation calculation procedure. The annual EPCWID diversion allocation without ACE conservation credit is calculated according to Equation 8 as the sum of the annual D-2 diversion allocation to EPCWID and the annual carryover allocation to EPCWID.

EPCWID Diversion Allocation (without ACE or 67/155ths of Row 30) (A''_{EPCWID})

Under the OA, the annual diversion allocation to EPCWID without the annual ACE conservation credit or 67/155th (43%) or the adjusted difference between

the D-2 and diversion ratio allocations to EBID (A''_{EPCWID} ; see Row 30 of Table 4 of the Agreement) is calculated as an intermediate step in the allocation calculation procedure; A''_{EPCWID} is calculated according to Equation 9 as detailed in Section 2.4.

D-2 Diversion Allocation to EBID (A_{EBID}^{D2})

Under the OA, the annual D-2 diversion allocation to EBID (A_{EBID}^{D2}) is calculated as 88/155^{ths} (57%) of the annual net D-2 diversion allocation according to Equation 5, defined in Section 2.4.

Diversion Ratio Adjustment (D)

The diversion ratio adjustment (D) is calculated from the estimated annual Project diversion ratio ($R_{Project}^{Alloc}$) and the estimated annual release of Project water ($R_{Caballo}^{Est}$) according to Equation 10 as detailed in Section 2.4.

Diversion Ratio Allocation to EBID ($A_{EBID}^{DivRatio}$)

The annual diversion ratio allocation to EBID ($A_{EBID}^{DivRatio}$) is calculated from the estimated annual release from Project storage ($R_{Caballo}^{Est}$), the diversion ratio adjustment (D), the annual allocation to Mexico (A_{Mexico}), the annual diversion allocation to EPCWID without ACE or 67/155ths of Row 30 (A''_{EPCWID}), and the annual ACE conservation credit (ACE) according to Equation 10 as detailed in Section 2.4.

Adjusted Difference between D-2 and Diversion Ratio Allocations to EBID (Δ)

The adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID (Δ) is used in calculating the final annual allocations to EBID and EPCWID under the OA. The adjusted difference is calculated according to Equation 12 as detailed in Section 2.4.

Adjusted Annual Diversion Allocation to EBID (A'_{EBID})

The adjusted annual diversion allocation to EBID is calculated from the estimated annual release from Project storage and the annual D-2 and diversion ratio allocations to EBID according to Equation 13 as detailed in Section 2.4.

Final Annual Diversion Allocation to EBID (A_{EBID}^{Final})

The final annual diversion allocation to EBID is calculated from the adjusted annual diversion allocation A'_{EBID} , the district's unused prior-year allocation balance after transfer of any excess carryover balance ($A_{EBID}^{Carryover}$), and 88/155^{ths} (57%) of the adjusted difference between the annual D-2 allocation and diversion ratio allocation to EBID (Δ) according to Equation 14 as detailed in Section 2.4.

Final Annual Diversion Allocation to EPCWID (A_{EPCWID}^{Final})

The final annual diversion allocation to EBID is calculated from the annual diversion allocation to EPCWID without ACE or 67/155^{ths} (43%) of Row 30 (A''_{EPCWID}), the annual American Canal Extension (ACE) conservation credit (ACE), and 67/155^{ths} (43%) of the adjusted difference between the annual D-2

allocation and diversion ratio allocation to EBID (Δ) according to Equation 15 as detailed in Section 2.4.

Annual Diversion to Mexico (D_{Mexico})

For the period 2008-2012, annual diversions to Mexico under the OA are specified based on actual historical annual diversions during this period. For the purposes of this analysis, the annual diversion to Mexico under the OA during the period 2013-2015 is assumed to equal the annual allocation to Mexico during this period. The annual diversion to Mexico under during the period 2013-2015 is thus assumed to equal the calculated annual allocation to Mexico for each of these years.

Annual Diversion to EBID (D_{EBID})

As noted in Sections 3.1.1 and 3.1.2, the annual diversion to EBID (D_{EBID}) is generally equal to the annual allocation to EBID (A_{EBID}). For the period 2008-2012, annual diversions to EBID under the OA are specified based on actual historical annual diversions during this period. For the period 2013-2015, annual diversion to EBID is assumed to equal the corresponding calculated annual allocation to EBID for each year.

Annual Diversion to EPCWID (D_{EPCWID})

As noted in Sections 3.1.1 and 3.1.2, the annual diversion to EBID (D_{EBID}) is generally less than the district's annual diversion allocation (A_{EPCWID}^{Final}). For the period 2008-2012, annual diversions to EPCWID under the OA are specified based on actual historical annual diversions during this period. For the period 2013-2015, annual diversions to EPCWID are calculated from the total usable water available for release (U_t) according to a piece-wise regression equation developed from historical Project operations data (Equation 22; see Section 3.1.2).

Annual Release from Project Storage ($R_{Caballo}$)

Under the OA, annual release from Project storage ($R_{Caballo}$) is estimated in the same manner as under prior operating practices. Annual release is estimated as the total annual release required to meet annual Project diversions to EBID, EPCWID, and Mexico plus any reservoir spill that occurs due to Project storage exceeding total Project storage capacity (Equation 24; see Section 3.1.2)

Annual End-of-Year Project Storage (S_t^{EoY})

Under the OA, annual end-of-year Project storage (S_t^{EoY}) is estimated in the same manner as under prior operating practices. Total Project storage remaining at the end of the current irrigation season (S_t^{EoY}) is calculated from the total Project storage at the end of the prior irrigation season (S_{t-1}^{EoY}), annual Project inflows during the current year (I_t), and total Project releases during the current year ($R_{Caballo,t}$) according to Equation 26 (see Section 3.1.2).

3.1.4 Calculation of Allocation Components

Under the OA, the Total Diversion Allocation to EBID and EPCWID for a given year each consists of three components: Accrued Carryover Balance (referred to as Actual Carryover Water in the OA), Annual Allocated Water, and Transfer of Excess Carryover Balance. In order to provide a complete comparison of Project allocations under the OA and prior operating practices, each allocation components must be consider. This is particularly important in evaluating the potential effects of the OA on the initial allocation of water between districts, where initial allocation refers to allocation of previously unallocated or “new” water (i.e., Annual Allocated Water, defined below).

Project allocations to EBID and EPCWID under prior operating practices consisted of a single value, equivalent to the Total Diversion Allocation under the OA. Allocation components are not explicitly defined under prior operating practices. For comparison purposes, however, district allocations under prior operating practices can be parsed into components analogous to those defined in the OA. The lack of explicit carryover accounting under prior operating practices resulted in an implicit carryover balance and implicit transfer of allocation balance between districts in years when one or both districts did not use their full allocation. Under prior operating practices, the unused portion of each district’s annual diversion allocation contributed to the total usable water available for release during the following year; as a result, a portion of the unused allocation balance became part of the other district’s annual allocation the following year. In essence, EBID lost 67/155^{ths} (43%) of its unused allocation balance to EPCWID, and EPCWID lost 88/155^{ths} (57%) of its unused allocation balance to EBID. The lack of explicit carryover accounting thus resulted in implicit carryover balance and implicit transfer of allocation balance between the districts. While these components were not explicitly defined or considered under Prior Operating Practices, these components are implicit in the calculation and accounting of Project allocations under prior operations.

For the purposes of this analysis, the Total Diversion Allocations to EBID and EPCWID each year are parsed into three components: Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. Each district’s Total Diversion Allocation is the sum of its Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. Calculation of allocation components under the OA and under prior operating practices is summarized below.

Accrued Carryover Balance

Under the OA, each district’s Accrued Carryover Balance for a given year is equal to the balance on its Project water account on January 1 of that year, which in turn is equal to the district’s prior-year unused allocation balance after accounting for all Project charges as well as any transfer of excess carryover balance per Section 1.11 of the OA. Accrued Carryover Balance reflects the cumulative balance on a district’s Project water account over all prior years under

the OA, including allocations, charges, and transfers. The term Accrued Carryover Balance as used here is equivalent to the term Actual Carryover Water defined in the OA.

As under the OA, each district's Accrued Carryover Balance under prior operating practices for a given year is taken as the balance on its Project water account on January 1 of that year, which in turn is equal to the district's prior-year unused allocation balance after accounting for all Project charges as well as any (implicit) transfer of allocation balance between districts (see below). As under the OA, each district's Accrued Carryover Balance reflects the cumulative balance on a district's Project water account over all prior years, including allocations, charges, and transfers. As carryover accounting did not exist under prior operating practices, this term is defined here for comparison purposes.

Annual Allocated Water

Under the OA, each district's Annual Allocated Water for a given year is equal to the increase in the balance on its Project water account between January 1 and the end of that year's irrigation season. Annual Allocated Water thus represents the Project allocation received by each district during the current year based on current-year inflows to Project storage and prior-year inflows to Project storage that did not contribute to prior-year Project allocations (i.e., previously unallocated Project water).

As under the OA, each district's Annual Allocated Water under prior operating practices for a given year is taken as the increase in the balance on its Project water account balance between January 1 and the end of the current-year irrigation season. As under the OA, Annual Allocated Water represents the allocation received by each district during the current year based on current-year inflows to Project storage and prior-year inflows to Project storage that did not contribute to prior-year Project allocations. Because carryover accounting did not exist under prior operating practices, this term is defined here for comparison purposes only.

Transfer of Allocation Balance

Under the OA, each district's Transfer of Allocation Balance for a given year is equal to the change in balance on its Project water account between the end irrigation season (October 31) and the end of the Water Year (December 31) due to transfer of excess balance under Section 1.11 of the OA. Transfer of Allocation Balance is negative if water is transferred from a district's balance to the other district's balance and is positive if water is transferred to a district's balance from the other district's balance. For the purposes of this analysis, it is assumed that no charges or credits are accrued between the end of irrigation season and the end of the Water Year, and that the only change in a district's water account during this period is due to transfer of allocation balance per Section 1.11 of the OA. Under Section 1.11, if either district's allocation balance at the end of the water year exceeds its Carryover Limit—defined as 60% of the district's fully yearly

allocation, or 232,915 AF for EPCWID and 305,918 AF for EBID—then the excess balance is transferred to the other district. The term Transfer of Allocation Balance as used here is equivalent to the term Transfer of Excess Carryover Balance defined in the OA.

As noted above, under prior operating practices each district effectively lost a portion of its unused allocation balance at the end of the year due to the lack of carryover accounting. As used here, Transfer of Allocation Balance under prior operating practices is equal to this implicit loss of unused allocation balance by each district (and corresponding gain of allocation balance by the other district) that occurred under prior operating practices. Transfer of Allocation Balance to EBID is calculated at the start of each water year as the sum of 57% of EBID's allocation balance at the end of the previous year (i.e., EBID's Accrued Carryover Balance, taken as negative) and 57% of EPCWID's allocation balance at the end of the previous year (i.e., EPCWID's Accrued Carryover Balance, taken as positive). Transfer of Allocation Balance to EPCWID is calculated at the end of each irrigation season as the sum of 43% of EBID's allocation balance at the end of the previous year (i.e., EBID's Accrued Carryover Balance, taken as positive) and 43% of EPCWID's allocation balance at the end of the prior year (i.e., EPCWID's Accrued Carryover Balance, taken as negative). As carryover accounting and transfer of allocation did not exist under prior operating practices, this term is defined here for comparison purposes only.

Total Diversion Allocation

Under the OA and prior operating practices, the Total Diversion Allocation to each district for a given year is the sum of the three allocation components for that district. Each district's Total Diversion Allocation is thus determined after the current-year irrigation season has ended, rather than at the start of the current-year irrigation season. This is consistent with the fact that actual historical operations under both prior operating practices (1980-2007) and under the OA (2008-2012) allowed Reclamation and the districts to update Project allocations regularly throughout the irrigation season and determined final Project allocations even after all releases for the season had been made.

3.1.5 Uncertainties and Limitations

A number of assumptions and approximations used to calculate annual Project operations under prior operating practices and under the OA are described in Sections 3.1.2 and 3.1.3, respectively. Three key assumptions result in potentially significant uncertainties and limitations with respect to estimating the effects of the OA on Project operations compared to prior operating practices. These assumptions are discussed below.

Estimation of the Annual Project Diversion Ratio

As detailed in Section 3.1.2 above, the annual Project diversion ratio ($\rho_{Project,t}$) is required in order to calculate the annual release from Project storage that is needed to satisfy annual Project diversions under prior operating practices for the period 2008-2012 and under both the OA and prior operating practices for the

period 2013-2015. As summarized in Section 3.1.2, extensive analysis was carried out to identify a reliable predictor of the Project diversion ratio for a given year based on information available at the start of the year—e.g., based on prior-year releases, total usable water available for the current year, etc). The most reliable predictor was found to be the persistence (serial correlation) of the diversion ratio itself—i.e., the prior-year diversion ratio was found to be the most reliable predictor of current-year diversion ratio. Despite being a statistically significant predictor, however, estimates of the diversion ratio based on serial correlation are highly uncertain.

Due to large uncertainties in the estimated diversion ratio, it was determined that the historical (actual) annual Project diversion ratios for the period 2008-2012 are likely to provide the most accurate estimate of annual Project diversion ratios for this period under prior operating practices. Annual Project diversion ratios under prior operating practices are therefore assumed to equal actual annual Project diversion ratios that occurred under the OA during this period. However, the diversion ratio depends on hydrologic conditions within the Project, including Project operations and surface water operations by the districts, as well as groundwater use, cropping patterns, and irrigation practices within the districts and surrounding areas. Therefore the annual Project diversion ratios during this period likely would have been somewhat different had the Project been operated under prior practices during this period. This assumption affects calculation of estimated project releases and end-of-year total project storage under prior operating practices for years 2008-2012, as well as the drought year adjustment applied to the gross D-2 allocation.

For the period 2013-2015, the annual Project diversion ratio was estimated based on the serial regression equation defined in Section 2.2.2 (Equation 22). Despite the large uncertainties inherent in this relationship, a more reliable predictor of the Project diversion ratio is not available for this analysis. Uncertainties associated with Equation 22 affect calculation of project operations under both the OA and prior operating practices for the period 2013-2015. Under prior operating practices, these uncertainties affect calculation of releases and end-of-year total Project storage under prior operating practices, as well as the drought year adjustment applied to the gross D-2 allocation under dry inflow scenarios. Under the OA, these uncertainties affect calculation of the carryover delivery obligation, the diversion ratio allocation to EBID, the diversion ratio adjustment, and the drought year adjustment applied to gross D-2 allocation under dry inflow scenarios, as well as Project releases and end-of-year total Project storage. A sensitivity analysis was conducted to assess the sensitivity of estimated Project operations to uncertainties in the annual Project diversion ratio for the period 2013-2015; results of the sensitivity analysis are discussed in Section 3.2.3.

Estimation of Annual Project Diversions by EBID and EPCWID

Historically, EBID tended to utilize its full Project allocation during most years; however, diversions to EPCWID were generally less than the district's Project allocation in most years. For the purposes of this analysis, the annual net Project

diversion to EBID (i.e., annual Project charge to EBID) is assumed to equal to the district's annual Project allocation. This assumption is consistent with the district's historical operations and therefore is not likely to substantially affect estimated diversions under prior operating practices during the periods 2008-2012 and 2013-2015. However, district operations may change in the future under the OA. Changes in district operation cannot be accurately predicted and therefore are not considered in this analysis. The assumption that EBID uses its full annual allocation in all years therefore may affect estimated annual diversions to EBID for the period 2013-2015.

For the period 2008-2012, historical (actual) annual diversions to EPCWID are used to evaluate Project operations under the OA. Annual diversions to EPCWID under prior operating practices during periods 2008-2012 and 2013-2015 and under the OA during the period 2013-2015 are estimated using a piece-wise regression equation developed from historical Project operations data, as detailed above in Sections 3.1.2 and 3.1.3. Estimated diversions are uncertain, particularly for years when Project allocations are less than full. Uncertainties may affect estimated Project operations under prior operating practices during the period 2008-2012 and under both the OA and prior operating practices for the period 2013-2015.

Use of Historical Project Inflows and Credit Waters

This analysis uses historical Project inflows and historical Rio Grande Compact and San Juan-Chama waters to determine the usable water in Project storage during the period 2008-2012 under both the OA and prior operating practices. The use of historical inflows under both operating procedures implicitly assumes that Project operations have no effect on operations within the Rio Grande basin upstream of Elephant Butte Reservoir and no effect on the usable inflows to Project storage—i.e., inflows that contribute to usable water in Project storage rather than Rio Grande Compact credit waters.

However, a change in operating procedures may affect the amount of water in Project storage at any time, which in turn may have implications for the distribution of Rio Grande waters between the States of Colorado, New Mexico, and Texas under the Rio Grande Compact. These implications could include:

- Potential changes in timing of Article VII restrictions within New Mexico, which prohibit storage in upstream reservoirs constructed after 1929 at times when the Usable Project Storage for the Rio Grande Project in Elephant Butte and Caballo Reservoirs is below 400,000 acre feet, and
- Potential changes in the evaporative losses applied to Colorado's and New Mexico's Rio Grande Compact Credit Water stored in Elephant Butte as a result of changes in the amount of water stored in Elephant Butte.

Any change in Article VII restrictions or evaporation losses under the OA compared to prior operating practices may therefore affect the usable inflows to Project storage. Estimating the effects of Project operations on usable inflows to Project storage due to implications under the Rio Grande Compact and related upstream operations would require detailed analysis of the compact and upstream operations. Such analysis is beyond the scope of the current study due to the limited timeline of the Supplemental EA. Potential effects of the OA on Rio Grande inflows and Rio Grande Compact credit waters in Elephant Butte Reservoir will be considered in future studies.

3.2 Results and Discussion

The potential effects of the OA on Project operations during the first five years under the OA (2008-2012) and during the subsequent three irrigation seasons (2013-2015) were evaluated using the data and methods detailed above in Section 3.1. Analysis focused on estimating changes in Project operations under the OA compared to prior operating practices, including changes in Project allocations to EBID, EPCWID, and Mexico; total annual releases from Project storage; annual net diversions by EBID, EPCWID, and Mexico (i.e., Project charges); and total Project storage at the start and end of each irrigation season (March 1 and October 31, respectively).

Estimated effects of the OA for the periods considered here reflect the severe and sustained drought conditions that have affected the Project over the past decade. Recent drought conditions have contributed to lower than average surface water supplies from the Project, and have likely contributed to recent declines in groundwater levels throughout much of the Project as well as declines in Project diversion ratio. The recent drought conditions are not unprecedented in the history of the Project; however, conditions during the period 2008-2012 do not reflect normal Project conditions over the last several decades. The estimated effects of the OA on Project operations during the period 2008-2012 therefore may not accurately reflect the likely long-term effects under a broader range of hydrologic conditions. Moreover, analysis of the period 2013-2015 is initialized from actual Project conditions at the end of the 2012 irrigation season; estimated effects of the OA over this period therefore also reflect the low Project storage and unused allocation balances (i.e., Accrued Carryover Balance) caused by recent drought conditions.

3.2.1 Potential Effects of the OA: 2008-2012

Complete calculations of annual Project allocations under the OA and under prior operating practices are provided in Tables 3.2-1 and 3.2-2, respectively, for the period 2008-2012. Table 3.2-1 contains actual allocation calculations based on final Project allocation worksheets and final district data regarding annual diversions and credits; Table 3.2-2 contains allocation calculations based on the

annual allocation model of prior operating practices developed for this study. Both tables are organized and labeled in a manner similar to the allocation calculations defined in Tables 2-4 of the OA; in Table 3.2-2, the designation “N/A” corresponds to calculations that are not applicable under prior operating practices. All calculations shown in Tables 3.2-1 and 3.2-2 are carried out as detailed in Sections 3.1.2 and 3.1.3, respectively.

Annual Project allocations, charges, and unused allocation balance for the period 2008-2012 under the OA and under prior operating practices are summarized in Tables 3.2-3 and 3.2-4, respectively, for EBID and Tables 3.2-5 and 3.2-6 for EPCWID. Allocations, charges, and releases shown in Tables 3.2-3 and 3.2-5 reflect actual Project operations through the end of the 2012 irrigation season; values in Tables 3.2-4 and 3.2-6 reflect estimated Project operations based on the annual allocation model of prior operating practices developed for this study. All values shown in and Tables 3.2-3 through 3.2-6 were calculated out as detailed in Sections 3.1.2 and 3.1.3.

Table 3.2-1: Complete Allocation Calculations Under the OA (Actual End-of-Year Values) (2008-2012)

	2008	2009	2010	2011	2012
Elephant Butte Reservoir Storage	582,902	454,530	372,460	208,055	114,212
Caballo Reservoir Storage	17,272	26,100	18,380	10,141	5,775
Total Rio Grande Project Storage	600,174	480,630	390,840	218,196	119,987
Estimated Rio Grande Compact Credit Waters	-65,500	-126,600	-101,300	-132,038	-65,189
Estimated San Juan-Chama Water	-27,730	-37,298	-60,796	-55,781	-44,420
Water Released From Storage (Current Year, Through End of October)	674,724	693,289	659,679	396,444	371,271
Usable Water Available For Release	1,181,668	1,010,021	888,423	426,821	381,649
Carryover Obligation using Estimated Diversion Ratio	106,982	235,960	278,835	281,459	33,463
Usable Water Available for Current Year Allocation	790,000	774,061	609,588	145,362	348,186
EBID Allocation Balance (Previous Year)	0	-4,304	40,343	20,015	17,333
EPCWID Allocation Balance (Previous Year)	106,982	232,882	232,915	224,348	9,042
EBID Estimated Allocation Balance (End-of-Year)	0	51,301	0	0	0
EPCWID Estimated Allocation Balance (End-of-Year)	138,000	232,915	0	0	0
Storage for EBID and EPCWID Estimated Allocation Balance (End-of-Year)	138,000	287,972	0	0	0
Estimated Release of Current Usable Water	758,982	722,049	888,423	426,821	381,649
Estimated End-of-Year Release for Diversion Ratio	675,090	748,600	659,679	397,426	371,271
D1 Delivery	524,685	494,175	442,651	226,006	204,399
Mexico's Current Diversion Allocation	60,000	56,082	50,235	25,649	23,196
Drought Adjustment Factor	1.00	1.00	1.00	1.00	0.88
Gross D2 Diversion Allocation	958,055	942,117	725,537	104,495	330,733
EPCWID ACE Conservation Credit	16,818	17,988	0	0	0
Net D2 Diversion Allocation for EBID and EPCWID	898,055	886,035	675,302	78,847	307,536
D2 Diversion Allocation for EPCWID	388,192	382,996	291,905	34,082	132,935
EPCWID Diversion Allocation (W/O Conservation Credit)	495,174	615,878	524,820	258,430	141,977
EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	357,174	382,963	524,820	258,430	141,977
Diversion Ratio	1.00000	0.98696	0.98000	0.86820	0.78818
Diversion Ratio Adjustment	0	-9,418	-17,768	-56,255	-80,842
Sum of Release and Diversion Ratio Adjustment	758,982	712,631	870,655	370,566	300,807
EBID D2 Diversion Allocation	509,864	503,039	383,397	44,765	174,601
Difference Between EBID Diversion Ratio Allocation and D2 Diversion Allocation	0	0	0	21,708	0
EBID Diversion Ratio Allocation	324,990	255,598	255,257	66,473	118,300
EBID Diversion Allocation	324,990	255,598	255,257	44,765	118,300
Total EBID Diversion Allocation (includes 88/155ths of Value in Row 30)	324,990	251,294	295,600	77,104	135,633
Total EPCWID Allocation (Includes Row 21 and 67/155ths of Value in Row 30)	495,174	633,866	524,820	267,814	141,977
Total EBID, EPCWID, and Mexico Allocation	880,164	941,242	870,655	370,566	300,807
Total EBID Charges	329,294	291,830	285,856	59,771	134,386
Total EPCWID Charges	262,292	320,072	290,201	258,772	136,380
Transfers to EBID	0	80,879	10,271	0	0
Transfers to EPCWID	0	-80,879	-10,271	0	0
FINAL EBID (after transfers)	324,990	332,173	305,871	77,104	135,633
FINAL EPCWID (after transfers)	495,174	552,987	514,549	267,814	141,977
EBID End-of-Year Allocation Balance	-4,304	40,343	20,015	17,333	1,247
EPCWID End-of-Year Allocation Balance	232,882	232,915	224,348	9,042	5,597

Table 3.2-2: Complete Allocation Calculations Under Prior Operating Practices (Estimated End-of-Year Values)
(2008-2012)

	2008	2009	2010	2011	2012
Elephant Butte Reservoir Storage	469,032	745,275	703,080	344,378	665,917
Caballo Reservoir Storage	41,307	35,118	33,129	16,227	31,378
Total Rio Grande Project Storage	1,262,814	780,392	736,210	360,605	697,295
Estimated Rio Grande Compact Credit Waters	-65,500	-126,600	-101,300	-132,038	-65,189
Estimated San Juan-Chama Water	-27,730	-37,298	-60,796	-55,781	-44,420
Water Released From Storage (Current Year, Through End of October)	#N/A	#N/A	#N/A	#N/A	#N/A
Usable Water Available For Release	1,169,584	616,494	574,114	172,786	587,686
Carryover Obligation using Estimated Diversion Ratio	#N/A	#N/A	#N/A	#N/A	#N/A
Usable Water Available for Current Year Allocation	763,842	616,494	574,114	172,786	587,686
EBID Allocation Balance (Previous Year)	#N/A	#N/A	#N/A	#N/A	#N/A
EPCWID Allocation Balance (Previous Year)	#N/A	#N/A	#N/A	#N/A	#N/A
EBID Estimated Allocation Balance (End-of-Year)	#N/A	#N/A	#N/A	#N/A	#N/A
EPCWID Estimated Allocation Balance (End-of-Year)	#N/A	#N/A	#N/A	#N/A	#N/A
Storage for EBID and EPCWID Estimated Allocation Balance (End-of-Year)	#N/A	#N/A	#N/A	#N/A	#N/A
Estimated Release of Current Usable Water	#N/A	#N/A	#N/A	#N/A	#N/A
Estimated End-of-Year Release for Diversion Ratio	#N/A	#N/A	#N/A	#N/A	#N/A
D1 Delivery	528,700	406,977	371,966	40,433	383,179
Mexico's Current Diversion Allocation	60,000	46,186	42,213	4,589	43,485
Drought Adjustment Factor	1.0000	0.8105	0.8116	1.0000	0.6659
Gross D2 Diversion Allocation	931,897	595,528	550,324	141,183	463,640
EPCWID ACE Conservation Credit	#N/A	#N/A	#N/A	#N/A	#N/A
Net D2 Diversion Allocation for EBID and EPCWID	871,897	549,342	508,111	136,595	420,154
D2 Diversion Allocation for EPCWID	376,885	237,457	219,635	59,044	181,615
EPCWID Diversion Allocation (W/O Conservation Credit)	#N/A	#N/A	#N/A	#N/A	#N/A
EPCWID Diversion (w/o Conservation Credit or 67/155ths of Row 30)	#N/A	#N/A	#N/A	#N/A	#N/A
Diversion Ratio	#N/A	#N/A	#N/A	#N/A	#N/A
Diversion Ratio Adjustment	#N/A	#N/A	#N/A	#N/A	#N/A
Sum of Release and Diversion Ratio Adjustment	#N/A	#N/A	#N/A	#N/A	#N/A
EBID D2 Diversion Allocation	495,013	311,884	288,476	77,551	238,539
Difference Between EBID Diversion Ratio Allocation and D2 Diversion Allocation	#N/A	#N/A	#N/A	#N/A	#N/A
EBID Diversion Ratio Allocation	#N/A	#N/A	#N/A	#N/A	#N/A
EBID Diversion Allocation	#N/A	#N/A	#N/A	#N/A	#N/A
Total EBID Diversion Allocation (includes 88/155ths of Value in Row 30)	#N/A	#N/A	#N/A	#N/A	#N/A
Total EPCWID Allocation (Includes Row 21 and 67/155ths of Value in Row 30)	#N/A	#N/A	#N/A	#N/A	#N/A
Total EBID, EPCWID, and Mexico Allocation	#N/A	#N/A	#N/A	#N/A	#N/A
Total EBID Charges	495,013	311,884	288,476	77,551	238,539
Total EPCWID Charges	302,305	237,457	219,635	26,730	181,615
Transfers to EBID	#N/A	#N/A	#N/A	#N/A	#N/A
Transfers to EPCWID	#N/A	#N/A	#N/A	#N/A	#N/A
FINAL EBID (after transfers)	#N/A	#N/A	#N/A	#N/A	#N/A
FINAL EPCWID (after transfers)	#N/A	#N/A	#N/A	#N/A	#N/A
EBID End-of-Year Allocation Balance	0	0	0	0	0
EPCWID End-of-Year Allocation Balance	74,580	0	0	32,314	0

Table 3.2-3: EBID Annual Project Allocations, Charges, and Releases under the OA (Actual) (2008-2012)

	Annual Allocated Water	Carryover Water (Prior-Year Balance)¹	Carryover Water (District Transfer)²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	324,990	0	0	324,990	329,294 ³	-4,304
2009	255,598	-4,304	80,879	332,173	291,830 ³	40,343
2010	255,257	40,343	10,271	305,871	285,856 ³	20,015
2011	57,089	20,015	0	77,104	59,771	17,333
2012	118,300	17,333	0	135,633	134,386	1,247
Average	202,247	14,677	18,230	235,154	220,227	14,927

¹ Carryover Water from district's prior-year unused allocation balance (Table 4, Row 11 of the OA)

² Carryover Water from transfer of excess carryover from EPCWID under Section 1.11 of the OA.

³ Discrepancies exist between values provided on district charge sheets and values used in annual Project allocation worksheets; in these cases, charges used here were estimated from annual Project allocation worksheets from each district's Total Diversion Allocation and subsequent year carryover balance.

Table 3.2-4: EBID Annual Project Allocations, Charges, and Releases under Prior Operating Practices (Estimated) (2008-2012)

	Annual Allocated Water	Carryover Water (Prior-Year Storage)¹	Carryover Water (District Transfer)²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	434,275	0	60,738	495,013	495,013	0
2009	269,542	0	42,342	311,884	311,884	0
2010	288,476	0	0	288,476	288,476	0
2011	77,551	0	0	77,551	77,551	0
2012	220,193	0	18,346	238,539	238,539	0
Average	258,007	0	24,285	282,293	282,293	0

¹ Carryover Water from prior-year unused allocation balance is not applicable under prior operating practices; contribution of carryover water estimated as portion of district's total allocation that is not supplied by current-year inflows to Project storage

² Carryover Water from transfer of excess carryover is not applicable under prior operating practices

Table 3.2-5: EPCWID Annual Project Allocations, Charges, and Releases under the OA (Actual) (2008-2012)

	Annual Allocated Water	Carryover Water (Prior-Year Storage)¹	Carryover Water (District Transfer)²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	388,192	106,982	0	495,174	262,292 ³	232,882
2009	400,984	232,882	-80,879	552,987	320,072 ³	232,915
2010	291,905	232,915	-10,271	514,549	290,201 ³	224,348
2011	43,466	224,348	0	267,814	258,772	9,042
2012	132,935	9,042	0	141,977	136,380	5,597
Average	251,496	161,234	-18,230	394,500	253,543	140,957

¹ Carryover Water from prior-year unused allocation balance is not applicable under prior operating practices; contribution of carryover water estimated as portion of district's total allocation that is not supplied by current-year inflows to Project storage

² Carryover Water from transfer of excess carryover is not applicable under prior operating practices

³ Discrepancies exist between values provided on district charge sheets and values used in annual Project allocation worksheets; in these cases, charges used here were estimated from annual Project allocation worksheets from each district's Total Diversion Allocation and subsequent year carryover balance.

Table 3.2-6: EPCWID Annual Project Allocations, Charges, and Releases under Prior Operating Practices (Estimated) (2008-2012)

	Annual Allocated Water	Carryover Water (Prior-Year Storage)¹	Carryover Water (District Transfer)²	Total Diversion Allocation	Total Project Charges	Unused Allocation Balance
2008	330,641	106,982	-60,738	376,885	302,305	74,580
2009	205,220	74,580	-42,342	237,457	237,457	0
2010	219,635	0	0	219,635	219,635	0
2011	59,044	0	0	59,044	26,730	32,314
2012	167,647	32,314	-18,346	181,615	181,615	0
Average	196,437	42,775	-24,285	214,927	193,548	21,379

¹ Carryover Water from prior-year unused allocation balance is not applicable under prior operating practices; contribution of carryover water estimated as portion of district's total allocation that is not supplied by current-year inflows to Project storage

² Carryover Water from transfer of excess carryover is not applicable under prior operating practices

Annual Project Allocations to EBID, EPCWID, and Mexico

As detailed in Section 3.1.4, the Total Diversion Allocations to EBID and EPCWID for any given year consist of Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. By contrast, the Total Diversion Allocation to Mexico in any given year is calculated based on the total release from Project storage during that year, without explicit accounting of prior-year allocation balance (see Sections 2.4 and 3.1).

Under the OA, Annual Allocated Water is determined from the quantity of usable water available for release during the current year, excluding the portion of usable water that contributed to prior year Annual Allocated Water (i.e., excluding the quantity of water that must be released from Project storage to satisfy the districts' Accrued Carryover Balance; see Section 3.1.4). Accrued Carryover Balance is determined from the allotment balance remaining on the water account for each district at the end of the prior year (i.e., the unused portion of each district's prior-year allocation; see Section 3.1.4). Transfer of Allocation Balance is determined at the end of each irrigation season per Section 1.11 of the OA.

For the purposes of this study, under prior operating practices, Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance are determined as detailed in Section 3.1.4. As under the OA, Accrued Carryover Balance is determined from the allotment balance remaining on each districts' water account at the end of the prior year. Transfer of Allocation Balance is given by the implicit transfer of allocation balance that occurred under prior operating practices due to lack of explicit carryover accounting. Finally, Annual Allocated Water is determined as the portion of the Total Diversion Allocation to each district in a given year, excluding Accrued Carryover Balance and Transfer of Allocation Balance.

Figure 3.2-1 shows historical (actual) Project allocations to EBID under the OA and estimated Project allocations to EBID under prior operating practices for the period 2008-2012, including Annual Allocated Water, Accrued Carryover Balance, Transfer of Allocation Balance, and Total Diversion Allocation. Corresponding Project allocations to EPCWID are shown in Figures 3.2-2. Values corresponding to Figures 3.2-1 and 3.2-2 are provided in Tables 3.2-3 through 3.6-6, above. Figure 3.2-3 shows historical (actual) Project allocations to Mexico under the OA during the period 2008-2012 and estimated Project allocations to Mexico during this period under prior operating practices; corresponding allocation values are provided in Table 3.2-7, below.

The analysis conducted here indicates a decrease in average Annual Allocated Water to EBID of 55,760 AF/yr (22%) under the OA compared to the estimated Annual Allocated Water that EBID would have been allocated had the project been operated under prior operating practices during this period. EBID's average Accrued Carryover Balance increased by an estimated 14,677 AF/year under the OA; EBID's Accrued Carryover Balance was zero for all years under prior

operating practices. Under the OA, Transfer of Allocation Balance to EPCWID decreased by an estimated average 6,055 AF/year (25%). The estimated change in average Total Diversion Allocation to EBID under the OA was therefore a net decrease 47,138 AF/year (17%).

The estimated change in average Annual Allocated Water to EPCWID under the OA compared to prior operations is an increase of 55,059 AF/yr (28%). Most notably, the average Accrued Carryover Balance to EPCWID increases by 118,459 AF/year under the OA, corresponding to an increase of 277% compared to prior operating practices; this large increase in Accrued Carryover Balance is a direct result of the carryover provision of the OA. However, Transfer of Allocation Balance from EPCWID to EBID increased by an estimated 6,055 AF/year on average due Section 1.11 of the OA. The estimated change in average Total Diversion Allocation to EPCWID under the OA was therefore a net increase of 179,573 AF/year (84%).

The average Total Diversion Allocation to Mexico for the period 2008-2012 is 43,032 AF/year under the OA and 39,295 AF/year under prior operating practices. Results indicate that the average total allocation to Mexico increased by an estimated 3,738 AF/year (10%) under the OA. As detailed in Section 2.2, the procedures used to determine allocation to Mexico are identical under the OA and prior operating practices. The estimated difference in average annual allocation to Mexico results from differences in the timing of Project releases; under both the OA and prior operating practices, the Total Diversion Allocation to Mexico is equal to 11.3846% of the sum of the delivery to Project lands within the US plus delivery to the heading of the Acequia Madre as determined by the D-1 Curve.

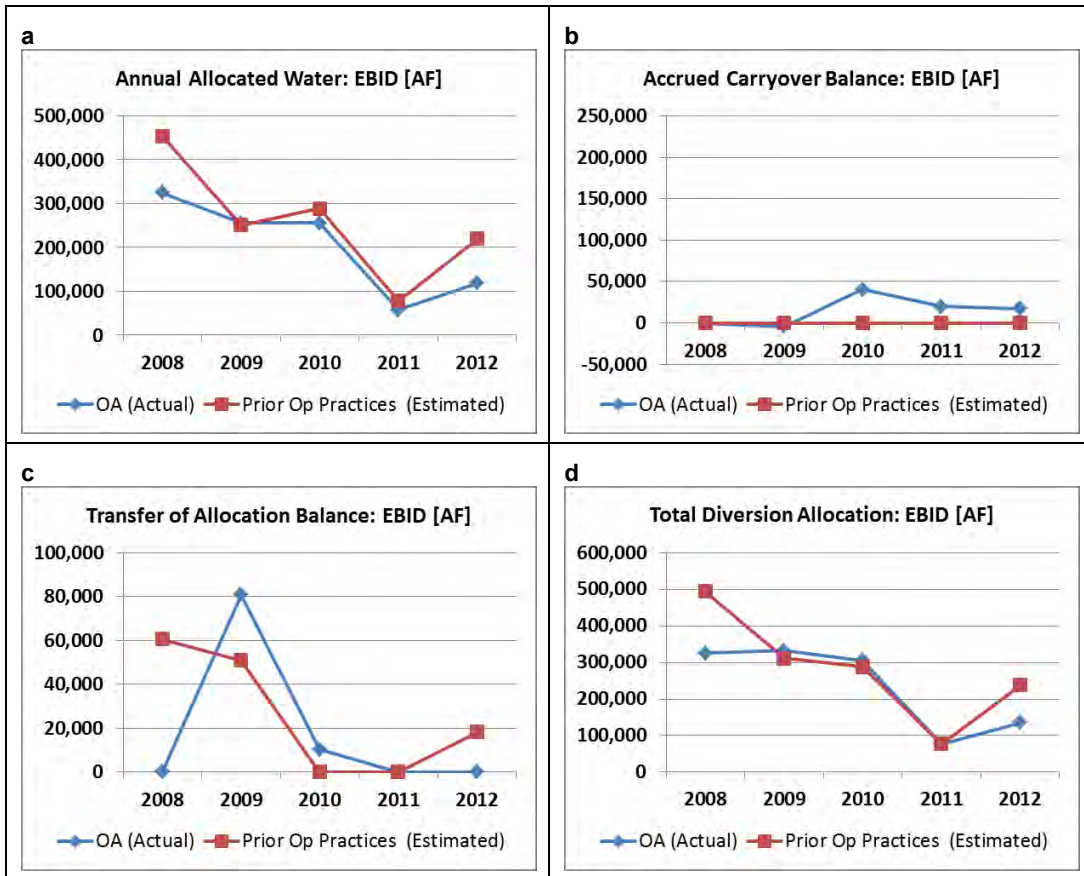


Figure 3.2-1: Historical (actual) Project allocations to EBID under the OA and estimated annual allocations to EBID under prior operating practices for the period 2008-2012. (a) Annual Allocated Water; (b) Accrued Carryover Balance; (c) Transfer of Allocation Balance; (d) Total Diversion Allocation.

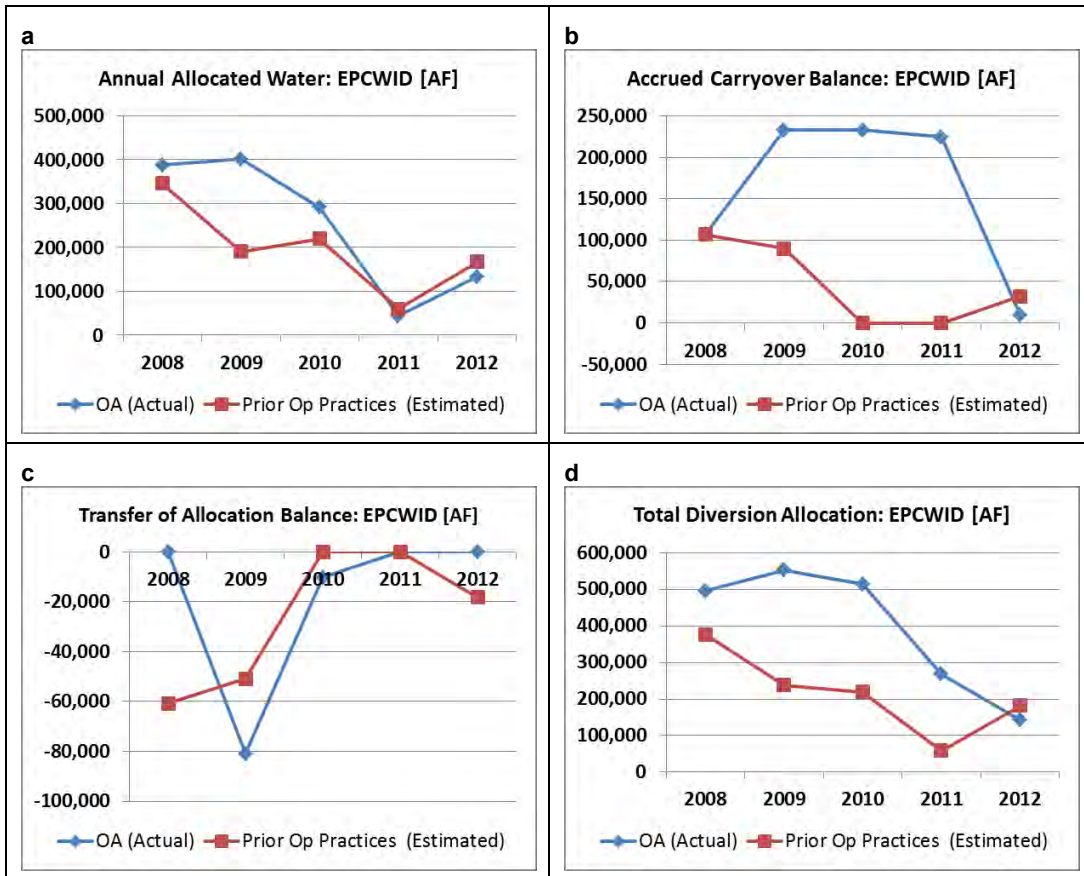


Figure 3.2-2: Historical (actual) Project allocations to EPCWID under the OA and estimated annual allocations to EPCWID under prior operating practices for the period 2008-2012. (a) Annual Allocated Water; (b) Accrued Carryover Balance; (c) Transfer of Allocation Balance; (d) Total Diversion Allocation.

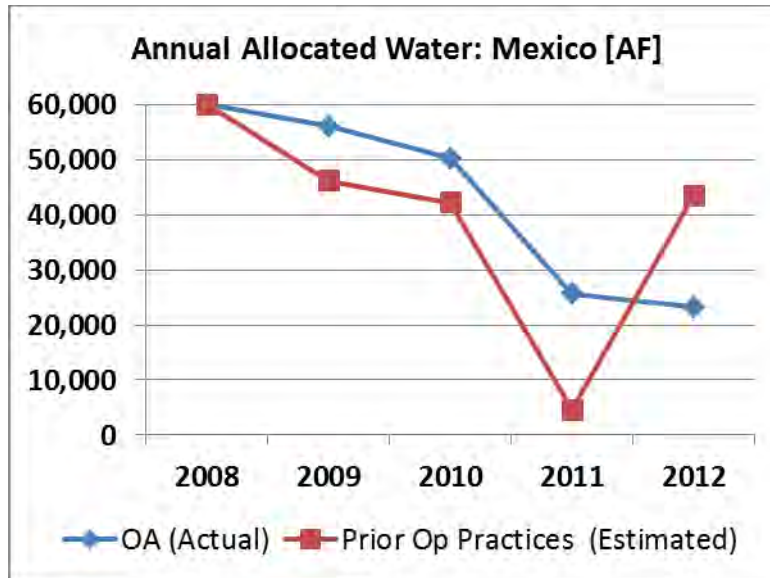


Figure 3.2-3: Historical (actual) final annual allocations to Mexico under the OA and estimated annual allocations to Mexico under prior operating practices for the period 2008-2012.

Table 3.2-7: Annual Project Allocation to Mexico (2008-2012)

Year	Annual Allocation to Mexico OA (Actual)	Annual Allocation to Mexico Prior Operations (Estimated)
2008	60,000	60,000
2009	56,082	46,186
2010	50,235	42,213
2011	25,649	4,589
2012	23,196	43,485
Average	43,032	39,295

Differences in Project allocations under the OA compared to prior operating practices result from a combination of the diversion ratio and the carryover provisions of the OA (see Section 1.2). For any given year, the diversion ratio provision affects the apportionment of Annual Allocated Water between EBID and EPCWID, while the carryover provision affects each districts' Transfer of Allocated Water at the end of a given year and its Accrued Carryover Balance at the start of the following year. Over successive years, however, the cumulative effects of the diversion ratio provision on each district's Annual Allocated Water affect both districts' Accrued Carryover Balance; conversely, the cumulative effects of the carryover provision on each district's Accrued Carryover Balance—and thus on the total usable water available for allocation in a given year—affect both districts' Annual Allocated Water.

Under the diversion ratio provision of the OA, apportionment of the total Annual Allocated Water allotted to lands in the US between EBID and EPCWID is adjusted to reflect current-year Project performance as characterized by the Project diversion ratio. Low values of the Project diversion ratio throughout the period 2008-2012 resulted in a greater portion of Annual Allocated Water being allotted to EPCWID and a smaller portion being allotted to EBID compared to prior operating practices. After accounting for implicit carryover and transfer of allocation balance under prior operating practices, EBID and EPCWID received an average of 57% and 43% of the total Annual Allocated Water allotted to US lands each year under prior operating practices. Under the OA, however, EPCWID received an average of 53% of the total Annual Allocated Water, while EBID received an average of 47%. The decrease in the percentage of Annual Allocated Water allotted to EBID results primarily from the diversion ratio provision of the OA.

In addition to the effects of the diversion ratio provision on apportionment of Annual Allocated Water, the carryover provision of the OA also affects Annual Allocated Water by reducing the total usable water available for current-year allocation. As part of the carryover provision, the amount of water that must be released in order to deliver each district's Accrued Carryover Balance to authorized points of diversion is explicitly excluded from the total useable water available for allocation. As a result, the average total Annual Allocated Water allotted to lands in the US during the period 2008-2012 is less under the OA than under prior operating practices. This results in an additional decrease in total Annual Allocated Water. However, the reduction in average Annual Allocated Water allotted to lands in the US is negligible over the period 2008-2012. The estimated effects of the OA on Annual Allocated Water to EBID and EPCWID are thus largely driven by the diversion ratio provision.

Under the carryover provision of the OA, the unused portion of each district's Annual Allocated Water at the end of any given year contributes to the district's Accrued Carryover Balance the following year. Under the OA, EPCWID maintained a large balance at the end of years 2007-2010, which resulted in the district's substantial Accrued Carryover Balance in years 2008-2011. EPCWID maintained this large carryover balance for multiple years, which also contributed the district's Total Diversion Allocation in multiple years. In contrast, EBID maintained a much smaller balance of unused allocation throughout the period 2008-2012. Moreover, EBID's Accrued Carryover Balance in 2009 and 2010 consists exclusively of transfer of excess carryover water from EPCWID at the end of the 2008 and 2009 irrigation seasons, respectively, per Section 1.11 of the OA.

Under prior operating practices, EPCWID's estimated allocation balance is zero for most years. As detailed in Section 3.1.2, annual diversions by EPCWID under prior operating practices are estimated from the total usable water available for a

given year based on a piece-wise regression relationship derived from historical Project data. EPCWID's estimated allotment of Annual Allocated Water under prior operating practices is less than the district's estimated diversion for 2009, 2010, and 2012. As a result, EPCWID is assumed to use its full allocation in these years under prior operating practices. The large Accrued Carryover Balance maintained by EPCWID under the OA thus results from an increase in Annual Allocated Water combined with the district's ability to carryover over their unused allocation balance under the OA.

Based on the results presented here, the OA results in an estimated average increase in EBID Accrued Carryover Balance of 14,677 AF/year and an estimated average increase EPCWID Accrued Carryover Balance of 118,459 AF/year. Estimated changes in Accrued Carryover Balance are partially offset by changes in Transfer of Allocation Balance between districts, which averages 18,230 AF/year under the OA compared to 24,285 AF/year under prior operating practices. All transfer of allocation balance is from EPCWID to EBID under both operating procedures. Under prior operating practices, EBID is assumed to use its full allotment of Annual Allocated Water in all years; EBID's Accrued Carryover Balance is therefore zero in all years. Under the OA, EBID maintains an average Accrued Carryover Balance of 14,677 AF; however, this balance is less than the district's average Transfer of Allocation Balance from EPCWID. This indicates that EBID's entire Accrued Carryover Balance is provided by Transfer of Allocation Balance.

Differences in Total Diversion Allocation under the OA compared to prior operating practices reflect changes in each district's Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. The large estimated increase in average Total Diversion Allocation to EPCWID is driven predominately by the district's large increase in Accrued Carryover Balance under the OA, whereas the estimated decrease in average Total Diversion Allocation to EBID reflects a general decrease in Annual Allocated Water allotted to the district. Because Accrued Carryover Balance remains on a district's allocation balance for multiple years, the change in Total Diversion Allocation associated with a change in Accrued Carryover Balance is misleading. Accrued Carryover Balance is counted each year it appears on a district's balance, and is therefore double counted when calculating the average Total Diversion Allocation over a given period.

Under the OA, EBID's unused allocation balance in 2008 and 2012 was negative, indicating that the district's net diversion (i.e., charge) was greater than its Total Diversion Allocation for that year. Further, that under the OA, EBID maintained a positive unused allocation balance in 2009, 2010, and 2011. EBID's unused allocation balance in 2009 is less than the end-of-year transfer excess EPCWID carryover allocation, indicating that EBID actually diverted its full allocation prior to transfer of excess carryover balance. In 2010 and 2011, however, EBID

diversions were less than the district's final allocation, which is inconsistent with the district's historical practice of using its full annual allocation.

Under prior operating practices, EPCWID is estimated to use its full diversion allocation in years 2009-2012, which is inconsistent with the district's historical tendency to use less than its full allocation in years with less than normal Project supply. This inconsistency is due to the drought adjustment factor applied to the annual gross D-2 allocation due to severe drought conditions, as well as the assumption that under prior operations, EPWID diverted up to its actual historical diversion (see Section 3.1.2). Due to the drought adjustment factor, use of Equation 22 to estimate EPCWID's annual diversion allocation also results in EPCWID using its full annual allocation in 2010, 2011, and 2012. Uncertainties regarding the calculated annual diversion to EPCWID under prior operating practices therefore have no influence on the outcome of this analysis.

Annual Project Diversions

Figure 3.2-4 shows historical (actual) annual net Project diversions (i.e., Project charges) to EBID under the OA and estimated annual diversions to EBID under prior operating practices for the period 2008-2012. Historical and estimated annual net diversions to EPCWID and Mexico are shown in Figures 3.2-5 and 3.2-6, respectively. Annual net diversions to EBID, EPCWID, and Mexico under the OA and prior operating practices for this period are provided in Table 3.2-8. Annual net diversions under prior operating practices are calculated as detailed in Section 3.1.2.

The average net diversion to EBID under the OA during this period was 220,227 AF/year; the estimated average annual allocation to EBID during this period had prior operating practices been in place is 282,293 AF/year, equal to the estimated average annual diversion allocation to EBID during this period. Consequently, the OA is estimated to have resulted in a decrease average annual net diversion to EBID of 62,065 AF/year, equal to a reduction in average annual diversion of 21% compared to estimated prior operating practices during this period.

The average annual diversion to EPCWID under the OA during the period 2008-2012 was 253,543 AF/year; the estimated average annual diversion to EPCWID had prior operating practices been in place is 193,584 AF/year. The estimated effect of the OA on average annual diversion to EPCWID is therefore an increase of 59,959 AF/year, equivalent to an increase in average annual diversion of 31% compared to prior operating practices.

Also, during this period, the average annual diversion to Mexico was 44,091 AF/year under the OA, with an estimated average diversion of 39,295 AF/year under prior operating practices during this period. The average annual diversion to Mexico is therefore estimated to be 4,796 AF/year greater under the OA than under prior operating practices, corresponding to an estimated increase of 10%.

Differences in Project diversions are directly attributable to differences in the respective annual diversion allocations, particularly with respect to EBID and Mexico as their respective annual Project diversions are assumed to equal their respective Project allocations. As discussed in Section 3.1.2, EPCWID historically did not utilize its full Total Diversion Allocation during most years. By contrast, as shown above in Table 3.2-6, the analysis presented here indicates that EPCWID would have utilized its full allocation in years 2009, 2010, and 2012 under prior operating practices and therefore that the estimated diversion to EPCWID in these years was limited by the district's Total Diversion Allocation. This result—i.e., estimated annual diversion to EPCWID equal to the district's Total Diversion Allocation—results from the reduction in annual gross D-2 diversion allocation in these years due to use of the drought adjustment factor (see Section 3.1.2).

As detailed above, a drought adjustment factor is used here to ensure that Project diversion allocations based on the D-2 Curve can be fully satisfied from usable water available for release under actual Project performance conditions in a given year (i.e., under the actual Project diversion ratio). The drought adjustment factor reduce the gross D-2 allocation in cases when the actual Project diversion ratio is so low than the total diversion allocation determined from the D-2 Curve—the gross D-2 allocation—cannot be satisfied from the usable water available for release during the current year. The drought adjustment factor reduces the annual D-2 allocation to EPCWID, and as a result the annual diversions to EPCWID estimated from Equation 22 may be limited by the district's annual allocation, resulting in diversion of their full annual allocation in some years.

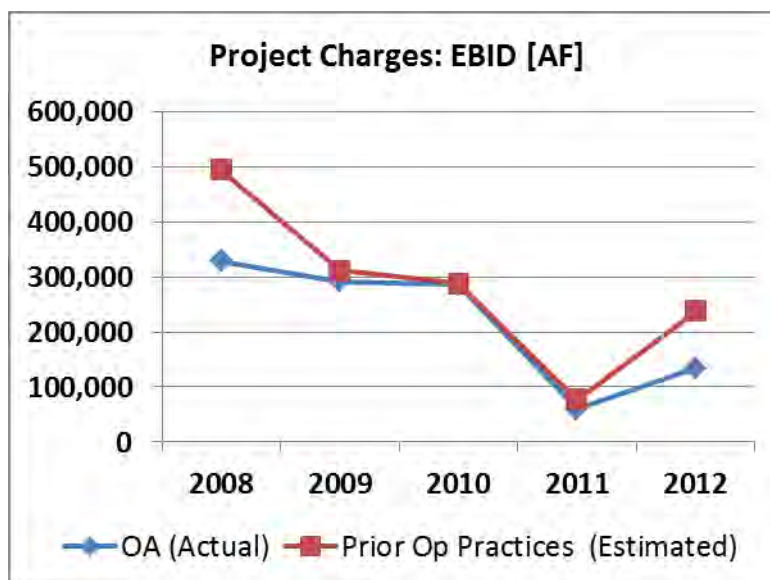


Figure 3.2-4: Historical (actual) annual Project charges (net Project diversions) to EBID under the OA and estimated annual Project charges to EBID under prior operating practices for the period 2008-2012.

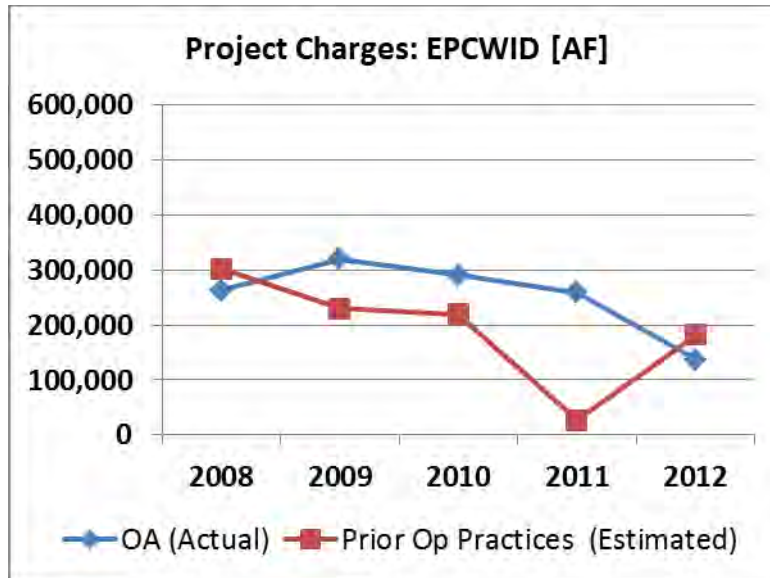


Figure 3.2-5: Historical (actual) annual Project charges (net Project diversions) to EPCWID under the OA and estimated annual Project charges to EPCWID under prior operating practices for the period 2008-2012.

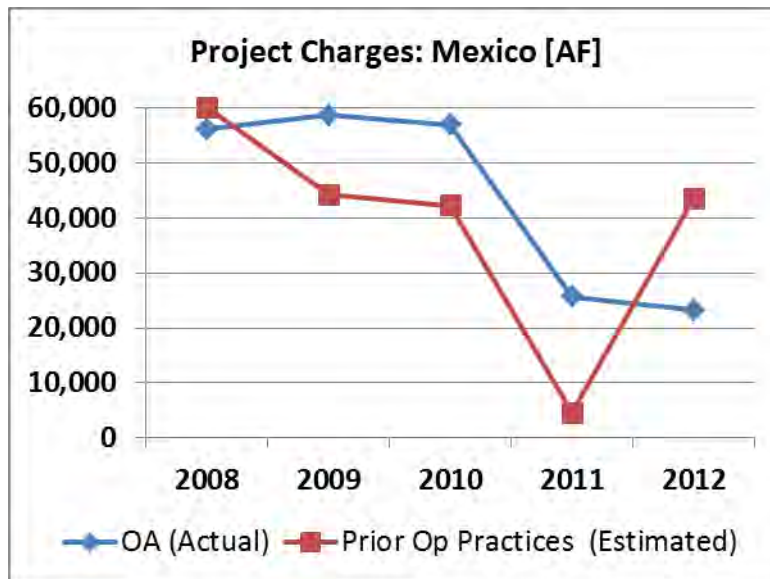


Figure 3.2-6: Historical (actual) annual Project charges (net Project diversions) to Mexico under the OA and estimated annual Project charges to Mexico under prior operating practices for the period 2008-2012.

Table 3.2-8: Annual Project Charges (Net Project Diversions) to EBID, EPCWID, and Mexico (2008-2012)

	OA (Actual)			Prior Operations (Estimated)		
	EBID	EPCWID	Mexico	EBID	EPCWID	Mexico
2008	329,294	262,292	56,048	495,013	302,305	60,000
2009	291,830	320,072	58,688	311,884	237,457	46,186
2010	285,856	290,201	56,882	288,476	219,635	42,213
2011	59,771	258,772	25,650	77,551	26,730	4,589
2012	134,386	136,380	23,187	238,539	181,615	43,485
Average	220,227	253,543	44,091	282,293	193,548	39,925

Annual Release from Project Storage

Actual total annual releases from Project storage under the OA and estimated releases under prior operating practices are illustrated in Figure 3.2-7 and annual release values are provided in Table 3.2-9.

Average annual release for the period 2008-2012 under the OA (actual) is 559,740 AF/year; average release under prior operating practices (estimated) is 559,401 AF/year. The estimated difference in average annual release is thus 339 AF, or less than 0.01%. This negligible difference in average annual release results from the fact that the total usable water available during the 2008-2012 period is identical under both operating procedures, and total usable water is almost fully depleted at the end of the 2012 irrigation season under both procedures. As a result, the total amount of water released from Project storage during the period 2008-2012—and hence the average annual release over this period—must be nearly identical under both operating procedures. The analysis presented here therefore indicates that while the distribution of Project releases between years was affected by the OA, the OA had essentially no effect on the average annual release from Project storage during the period 2008-2012.

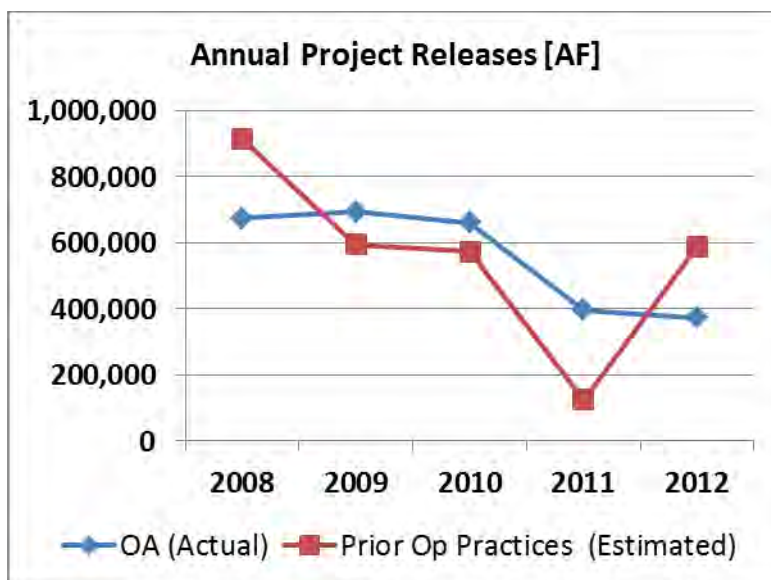


Figure 3.2-7: Historical (actual) annual Project releases from Caballo Dam under the OA and estimated total annual releases under prior operating practices for the period 2008-2012.

Table 3.2-9: Total Annual Releases from Caballo Dam (2008-2012)

Year	Annual Release OA (Actual)	Annual Release Prior Operations (Estimated)
2008	674,724	893,178
2009	694,199	616,494
2010	660,300	574,114
2011	396,876	125,533
2012	372,600	587,686
Average	559,740	559,401

Total Project Storage and Usable Water Available for Release

Figures 3.2-8 and 3.2-9 show the historical (actual) total Project storage at the start and end of irrigation season for the period 2008-2012 and the corresponding estimated storage under prior operating practices; values of total Project storage at the start and end of irrigation season are shown in Tables 3.2-10 and 3.2-11, respectively. Figures 2.3-10 and 2.3-11 show the historical (actual) and estimated total usable water available for release during irrigation season for each year and the total usable water remaining in storage at the end of each irrigation season, respectively; values of total usable water available during the season and remaining at the end of the season are provided in Tables 23.2-12 and 3.2-13, respectively.

Project storage at the start and end of each irrigation season under the OA was determined from records of actual Project storage in Elephant Butte and Caballo reservoirs on March 1 and October 1 of each year, respectively, and values of non-Project water provided on annual Project allocation worksheets for each year. Project storage at the start and end of the irrigation season under prior operating practices was estimated from the total usable water available for release and total annual release calculated under prior operations.

Total Project storage at the start of the 2008 irrigation season, Project inflows during the 2008-2012 period, and non-Project water in storage during the 2008-2012 period are all identical under the OA and prior operating practices. Total Project storage at both the start of irrigation season in years 2009-2011 is greater under the OA than under prior operating practices. The estimated increase in storage is consistent with the substantial allotment of Accrued Carryover balance maintained by EPCWID throughout these years under the OA. The amount of water required to satisfy EPCWID's Accrued Carryover Balance is excluded from the usable water available for allocation and thus remains in Project storage. Similarly, the increase in Project storage at the end of each irrigations season under the OA compared to prior operating practices results primarily from the large unused allocation balance and multi-year carryover exercised by EPCWID under the OA. By contrast, under prior operating practices, much of this water is implicitly transferred to EBID due to the lack of carryover accounting and is subsequently utilized by EBID.

As detailed in Section 2.4, total usable water available for release is calculated by deducting non-Project water (i.e., San Juan-Chama Waters and Rio Grande Compact Credit Waters) from the total water in Project storage. For the purposes of this analysis, the start of irrigation season is taken as March 1 of each year, the end of irrigation season is taken as October 31, and releases from Project storage between November 1 and February 28 of each year are considered negligible. In addition, for comparison purposes, total usable water under the OA is calculated from Project storage, Project inflows, and non-Project water in storage; values of total usable water provided on annual allocation worksheets does not correspond to a specific date within the season and therefore does not provide an appropriate comparison to the annual allocation model results.

Total usable water available for release during the current irrigation season consists of the total amount of water in Project storage at the start of irrigation season plus inflows to Project storage over the course of the season minus non-Project water in storage during the irrigation season. Similarly, total usable water remaining at the end of the season consists of the total amount of water in Project storage minus the total non-Project water in storage. For the purposes of this analysis, non-Project water is assumed to equal the non-Project water used in annual Project allocation calculations (obtained from annual allocation worksheets) and is assumed to be constant throughout the irrigation season. Because inflows to Project storage are identical under the OA and prior operating

practices, effects of the OA on total usable water available during a given irrigation season and remaining at the end of the season are identical to effects on Project storage at the start and end of the irrigation season, respectively.

In several years under prior operating practices, usable water is fully depleted at the end of the irrigation season. Complete depletion of usable water is consistent with the low Project supplies experienced during the period 2008-2012 due to ongoing drought conditions, as well as with the lack of conservation incentives under prior operating practices as reflected by the lack of carryover accounting.

Lastly, the results of this analysis are closely tied to the ongoing drought conditions. It is unlikely that the total usable water in project storage would be fully depleted under either the OA or prior operating practices during normal Project conditions.

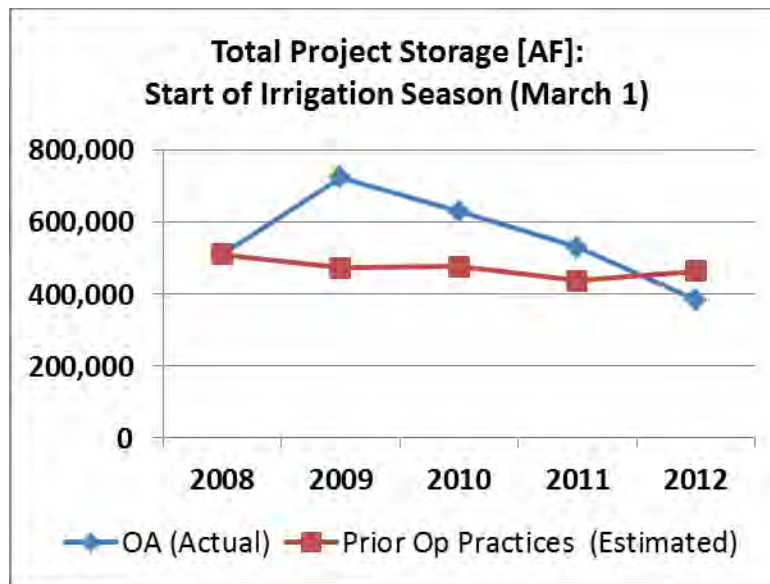


Figure 3.2-8: Historical (actual) total Project storage at the start of irrigation season, taken as March 1, under the OA (blue) and estimated total Project storage at the start of irrigation season under prior operating practices (red) for the period 2008-2012.

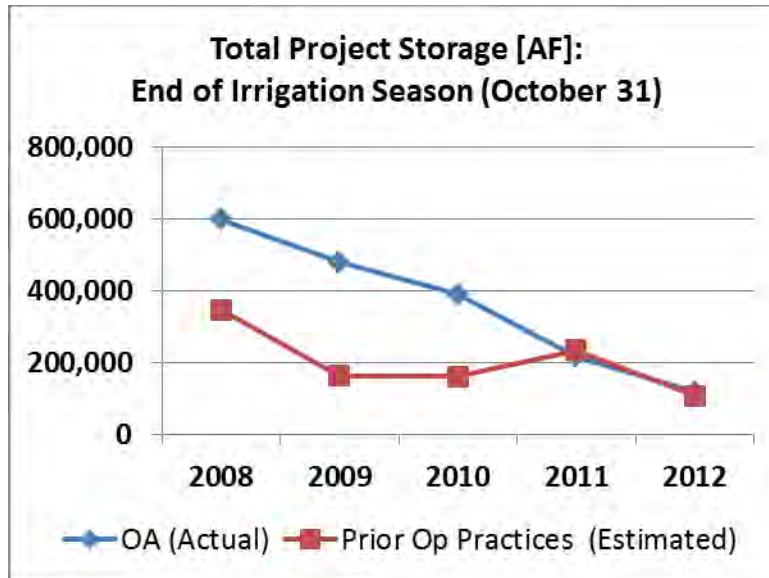


Figure 3.2-9: Historical (actual) total Project storage at the end of irrigation season, taken as October 31, under the OA (blue) and estimated total Project storage at the end of irrigation season under prior operating practices (red) for the period 2008-2012.

Table 3.2-10: Total Project Storage at the Start of Irrigation Season (March 1) (2008-2012)

Year	Total Project Storage OA (Actual)	Total Project Storage Prior Operations (Estimated)
2008	510,339	510,339
2009	724,149	493,961
2010	630,160	476,076
2011	529,699	437,632
2012	384,278	463,553
Average	555,725	476,312

Table 3.2-11: Total Project Storage at the End of Irrigation Season (October 31) (2008-2012)

Year	Total Project Storage OA (Actual)	Total Project Storage Prior Operations (Estimated)
2008	599,581	369,635
2009	480,634	163,898
2010	390,843	162,096
2011	218,196	235,072
2012	119,987	109,609
Average	361,848	208,062

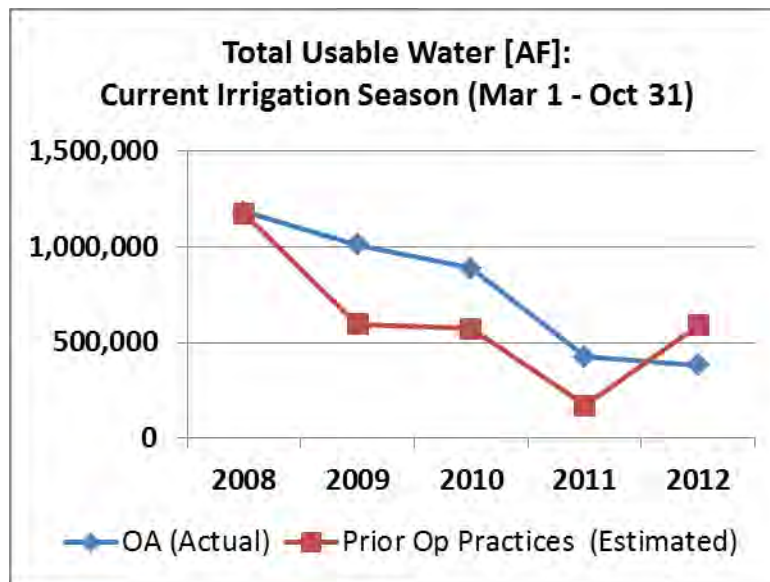


Figure 3.2-10: Historical (actual) total usable water available for release during the current-year irrigation season under the OA and estimated total usable water available for release under prior operating practices for the period 2008-2012. Total usable water available for release includes usable storage at the start of the irrigation season plus inflows to Project storage during the irrigation season.

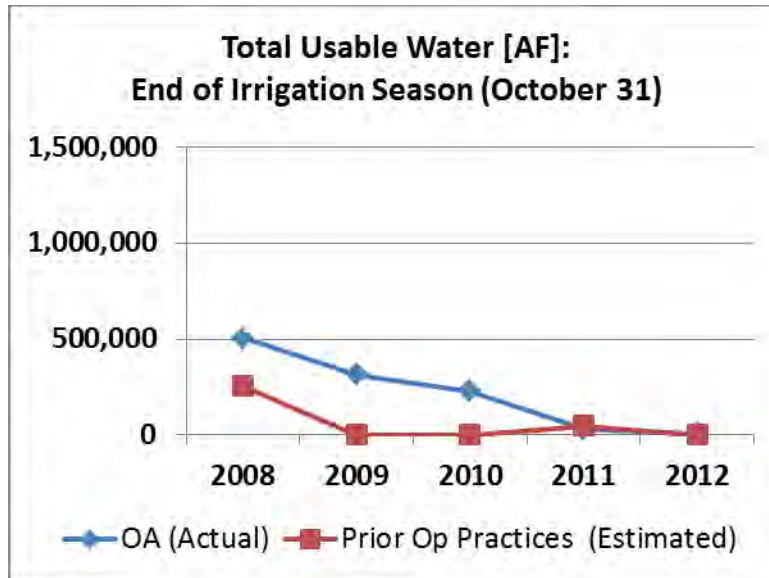


Figure 3.2-11: Historical (actual) total usable water remaining at the end of the current-year irrigation season under the OA and estimated total usable water remaining under prior operating practices for the period 2008-2012. Total usable water remaining at the end of irrigation season consists of the usable water in Project storage on October 31 of each year.

Table 3.2-12: Total Usable Water Available for Release during Irrigation Season (March 1 – October 31) (2008-2012)

Year	Total Project Storage OA (Actual)	Total Project Storage Prior Operations (Estimated)
2008	1,169,584	1,262,814
2009	846,682	780,392
2010	728,198	736,210
2011	264,853	360,605
2012	508,411	697,295
Average	703,545	767,463

Table 3.2-13: Total Usable Water Remaining at the End of Irrigation Season (October 31) (2008-2012)

Year	Total Project Storage OA (Actual)	Total Project Storage Prior Operations (Estimated)
2008	506,351	276,405
2009	316,736	0
2010	228,747	0
2011	30,377	47,253
2012	10,378	0
Average	218,518	64,732

Elephant Butte Reservoir Elevation

Figures 3.2-12 and 3.2-13 show the historical (actual) reservoir surface elevation in Elephant Butte Reservoir and the estimated reservoir elevation under prior operating practices at the start and end of irrigation season, respectively, for the period 2008-2012. For the purposes of this analysis, reservoir elevation at the start of the irrigation season is assumed to approximate the maximum reservoir surface elevation during any given year. In years when reservoir inflows exceed Project releases during initial months of the irrigation season, the actual maximum reservoir elevation exceeds the elevation at the start of irrigation season. Reservoir surface elevations were calculated based on the current Area-Capacity-Elevation Tables for Elephant Butte Reservoir (Reclamation 2007).

Reservoir elevations under the OA were calculated from actual storage in Elephant Butte at the start and end of each irrigation season (March 1 and October 31, respectively). Estimated reservoir elevations under prior operating practices were calculated based on estimated storage in Elephant Butte Reservoir at the start and end of each irrigation season. For the purposes of this analysis, storage in Elephant Butte Reservoir was assumed to be 95.5% of the total Project storage at any given time, which is consistent with the average portion of actual total Project storage in Elephant Butte over the period 2008-2012.

Results shown in Figures 3.2-12 and 3.2-13 indicate that reservoir elevations in Elephant Butte are up to 16 feet higher at the start of the irrigation season and up to 32 feet higher at the end of irrigation season under the OA compared to prior operating practices. However, during 2011 and 2012, reservoir elevations are up to 7 feet higher at the start of the season under prior operating practices. Differences in reservoir storage elevation are directly attributable to differences in total Project storage; however, the assumption that 95.5% of Project storage resides in Elephant Butte Reservoir in all years under the OA is likely to have a minor effect on estimated differences.

The black dashed lines on Figures 3.2-12 and 3.2-13 indicate an elevation of 4,350 feet above sea level, corresponding to the elevation at which previous studies have observed southwest willow flycatcher territories. Under the OA, actual reservoir elevation exceeded 4,350 feet in one year (2009) during the period 2008-2012. Estimated reservoir elevations under prior operating practices remain below 4,350 feet in all years.

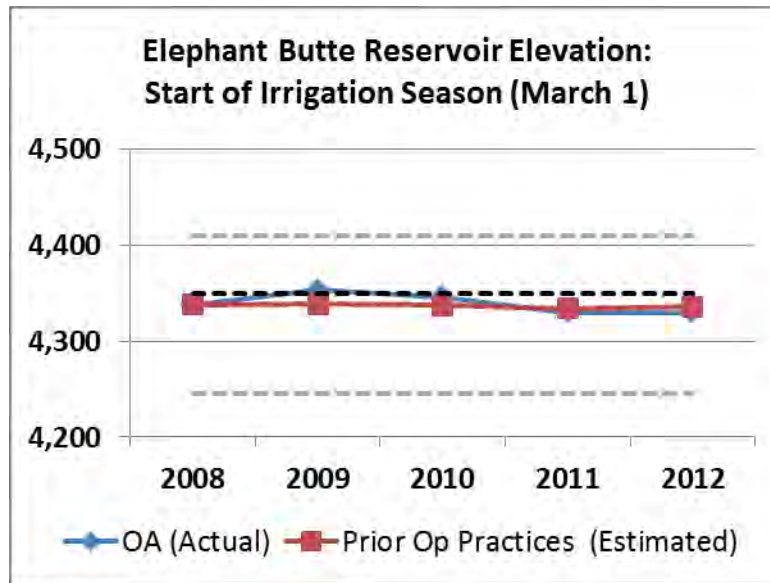


Figure 3.2-12: Historical (actual) reservoir surface elevation in Elephant Butte Reservoir at the start of irrigation season under the OA and estimated reservoir surface elevation under prior operating practices for the period 2008-2012. Gray dashed lines indicate maximum and minimum reservoir elevations at full pool and zero storage, respectively; the black dashed line indicates the elevation at which territories for sensitive species have been identified.

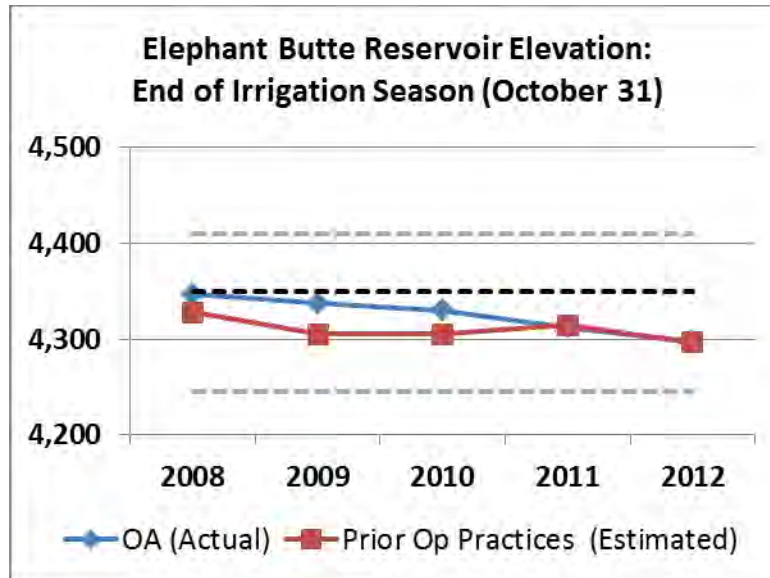


Figure 3.2-13: Historical (actual) reservoir surface elevation in Elephant Butte Reservoir at the end of irrigation season under the OA and estimated reservoir surface elevation under prior operating practices for the period 2008-2012. Gray dashed lines indicate maximum and minimum reservoir elevations at full pool and zero storage, respectively; the black dashed line indicates the elevation at which territories for sensitive species have been identified.

3.2.2 Potential Effects of the OA: 2013-2015

The effects of the OA on Project operations during the period 2013-2015 will depend on annual inflows to Project storage and annual Project diversion ratios during this period, as well annual diversions by EBID, EPCWID, and Mexico. It is not possible to accurately predict Project inflows multiple years into the future. Moreover, as discussed in Section 3.1, it is not possible to accurately predict Project diversions or the Project diversion ratio years into the future due to the many complex and interrelated factors that affect both. For this analysis, potential effects of the OA during the period 2013-2015 were therefore considered using a probabilistic approach.

Because future inflows over the period 2013-2015 are not known, historical annual inflows for the period 1951-2012 were resampled to develop a probability distribution of three-year Project inflow sequences representative of historical hydrologic conditions. This distribution of Project inflows was then used to develop probability distributions of Project operations over the period 2013-2015, including distributions of annual Project allocations, diversions, releases, and storage (see Section 3.2.2). The resulting distributions of annual Project inflows are represented here as non-exceedance probabilities, where low non-exceedance probabilities are associated with generally drier conditions and high non-exceedance probabilities are associated with generally wetter conditions over a given three-year simulation period.

Probability distributions of Project inflows and operations for the period 2013-2015 were sequences was developed by systematically sampling historical three-year inflow traces from the period 1951-2012 and then calculating and comparing Project operations under the OA and under prior operating practices for each historical three-year inflow trace. For example, the annual allocation models developed for this study were used to calculate Project operations based on historical inflows over the periods 1951-1953, 1952-1954, 1953-1955, and so on through 2012, resulting in a total of 62 three-year simulations of Project operations. For each simulation, annual allocation models were initialized based on actual Project storage, diversion ratio, and allocation balances at the end of the 2012 irrigation season (October 31, 2012), and Project operations were calculated over a three-year period as detailed in Sections 3.1.2 and 3.1.3. Results from these scenarios were then used to develop probability distributions of annual Project allocations, diversions, releases, and storage over the future period 2013-2015. In addition to the assumptions and uncertainties identified throughout Sections 3.1, this probabilistic approach assumes that the probability distribution of historical Project inflows is representative of likely inflows over the period 2013-2015.

The resulting probability distributions of annual Project inflows, allocations, diversions, releases, and storage are represented here as non-exceedance curves. In each of the non-exceedance curves shown here, low non-exceedance probabilities are associated with generally drier conditions and high non-exceedance probabilities are associated with generally wetter conditions over a given three-year simulation period. Due to non-linear aspects of Project allocation procedures, however, non-exceedance percentiles do not correspond exactly to water supply conditions.

The non-exceedance curve for a given variable shows the range values of that variable (ordinate) plotted as a function of the probability that a randomly selected value is less than the value on the ordinate. Non-exceedance curves were constructed by first ranking all values of the variable under consideration from smallest to largest and then calculating the non-exceedance probability associated with each value as the corresponding plotting position (i.e., rank divided by one plus the number of values). For example, let I_x be an annual inflow value randomly selected from the population of all historical inflows I ; each point $[p_y, I_y]$ on the annual inflow non-exceedance curve represents the probability p_y that the randomly selected value I_x is less than the specified value I_y . Figure 3.2-14 below thus indicates that the probability that annual inflow during any single year will be less than 500,000 AF is approximately 40%; the corresponding probability that annual inflow will be greater than 500,000 AF is thus 60%.

As detailed in Section 3.1.2, the estimated annual Project diversion ratio for future years is highly uncertain. For the purposes of this analysis, annual Project diversion ratios during the period 2013-2015 were estimated using Equation 23, which provides the best available estimate of the annual diversion ratio in future years. Additional analysis was carried out to assess the sensitivity of Project

operations to the estimated Project diversion ratios; results of this sensitivity analysis are also provided in the following section. Lastly, annual diversions to EBID, EPCWID, and Mexico during future years are also uncertain. Annual diversions during the period 2013-2015 were calculated as detailed in Sections 3.1.2 and 3.1.3. Uncertainties associated with district diversions are considered in the following section.

While there is considerable uncertainty in the projections of future hydrology, by using the same hydrologic data for each alternative, differences between the alternatives can be isolated and compared. It must be noted that the hydrologic conditions used in this study for the period 2013-2015 are not predictions of future conditions; rather, they represent a probabilistic estimate of the range of likely hydrologic conditions that might occur during this period based on the probability distribution of historical hydrologic variability in the Project. The effects of climate change were not considered in this analysis due to the limited time horizon of the analysis. Over the three-year period evaluated, any effects attributable to climate change are negligible in comparison to the substantial range of climatic and hydrologic variability experienced over the history of the Project.

Annual Inflows to Project Storage

As detailed in Section 2.2.1, this study uses annual net inflows to Project storage calculated from historical Project storage and release data, which are more appropriate with respect to the current analysis than Project inflows measured at the San Marcial gaging stations upstream of Elephant Butte Reservoir. Annual net inflows to Project storage were calculated using Equation 16 as detailed in Section 3.1.1. Figure 3.2-14 shows the non-exceedance curve of annual inflows to Project storage based on historical inflows for the period 1951-2012. The 20%, 50%, and 80% non-exceedance inflow values are provided in Table 3.2-14.

Historical annual inflows vary by approximately two orders of magnitude, with a low of 147,456 AF in 1956 and a high of 1,473,826 AF in 1987. The median inflow over the period 1951-2012 is 559,838 AF. The resampling approach used here assumes that the probability distribution of historical annual inflows during the period 1951-2012 accurately represent of the probability distribution of future annual inflows during the period 2013-2015.

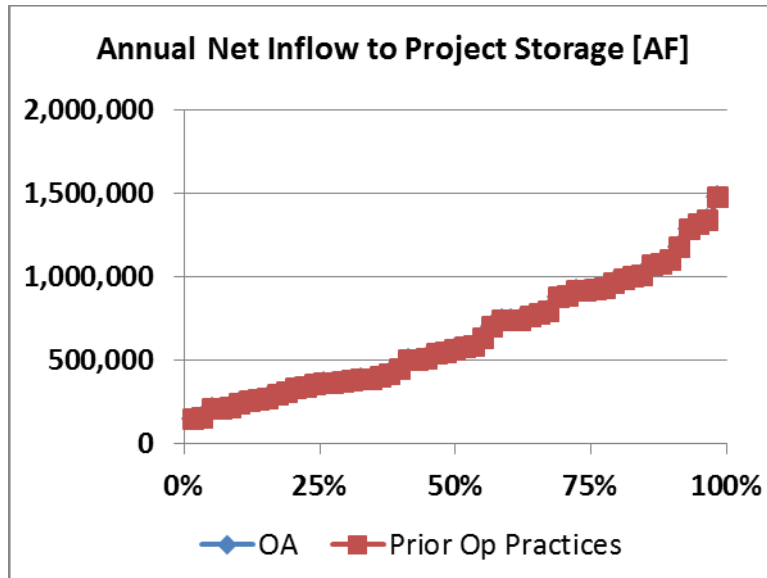


Figure 3.2-14: Non-exceedance curve of annual net inflow to Project storage based on calculated net inflows during the period 1951-2012, where net inflows are calculated using Equation 16 (see Section 3.1.1).

Table 3.2-14: Annual Inflow Non-Exceedance Values (2013-2015)

Year	Non-Exceedance Values		
	20%	50%	80%
2013	310,230	559,838	981,469
2014	310,230	559,838	981,469
2015	310,230	559,838	981,469

Project Allocations to EBID, EPCWID, and Mexico

As detailed in Section 3.1.4, the Total Diversion Allocations to EBID and EPCWID for any given year consist of Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance. Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance under the OA and prior operating practices are detailed above. By contrast, the Total Diversion Allocation to Mexico in any given year is single value based on the total release from Project storage during that year; Project allocation to Mexico does not consider carryover or transfer of allocation balance.

Non-exceedance curves of annual Project allocations to EBID and EPCWID for the 2015 irrigation season are shown in Figures 3.2-15 and 3.2-16, respectively. Figures show non-exceedance curves of Annual Allocated Water, Accrued Carryover Balance, Transfer of Allocation Balance, and Total Diversion Allocation. The non-exceedance curve of the Total Diversion Allocation to Mexico for the 2015 irrigation season is shown in Figure 3.2-17. While the non-

exceedance curve of annual inflow is the same for all years, non-exceedance curves of Project allocations differ between years due to the effects of prior-year operations on current year allocations; however, the general characteristics of non-exceedance curves for 2013 and 2014 are largely consistent with those for 2015. The 20%, 50%, and 80% non-exceedance values of Annual Allocated Water, Accrued Carryover Balance, Transfer of Allocation Balance, and Total Diversion Allocation to EBID for years 2013-2015 EBID are provided in Table 3.2-15; corresponding values for EPCWID are provided in Tables 3.2-16. The 20%, 50%, and 80% non-exceedance values of Total Diversion Allocation to Mexico for years 2013-2015 are provided in Table 3.2-17.

Under both the OA and prior operating practices, the amount of Annual Allocated Water that is allocated to EBID and EPCWID is largely determined by the total usable water available for current-year allocation. The Accrued Carryover Balance available to each district depends on inflows, allocations, and charges over the preceding years, whereas each district's Transfer of Allocation Balance depends on its Total Diversion Allocation and total Project charges at the end of the current irrigation season. Note that Transfer of Allocation Balance is positive if water is transferred to the district (i.e., from the other district) and negative if water is transferred from the district (i.e., to the other district).

Results shown in Figure 3.2-15 indicate that under dry and normal conditions (non-exceedance probabilities less than 66%), the estimated allotment of Annual Allocated Water to EBID for the 2015 irrigation season under the OA is largely similar to that under prior operating practices. Under wet conditions (non-exceedance probabilities greater than 66%), however, the estimated Annual Allocated Water to EBID for 2015 is as much as 120,000 AF less under the OA. As during the period 2008-2012, estimated decreases in Annual Allocated Water are largely driven by the diversion ratio provision of the OA. However, the effect of the diversion ratio provision on Annual Allocated Water is highly sensitive to the estimated Project diversion ratio, with lower values of the diversion ratio resulting in lower allocation of Annual Allocated Water to EBID and higher values resulting in higher Annual Allocated Water. The estimated decrease in Annual Allocated Water to EBID shown in Figure 3.2-15 reflects the low projected Project diversion ratio used in this analysis. Sensitivity of the results presented here to the estimated Project diversion ratio is discussed in detail in Section 3.2.3.

EBID's estimated Accrued Carryover Balance for 2015 is zero under both the OA and prior operating practices for all inflow conditions. The district's lack of Accrued Carryover Balance under both operating procedures stems from the fact that the district is assumed to utilize its entire allocation balance in all years (see Sections 3.1.2 and 3.1.3). In addition, due to the severe drought conditions preceding the projection period (i.e., due to actual dry conditions in 2012), it is estimated that no Transfer of Allocation Balance from EPCWID to EBID will occur during the 2013-2015 period under the OA because EPCWID will not

accrue sufficient carryover balance to trigger transfer under Section 1.11 of the OA. Transfer of Allocation Balance to EBID is similarly projected to be zero under prior operating practices if drier conditions continue through the 2015 irrigation season. If wetter conditions prevail during the period 2013-2015, however, implicit Transfer of Allocation Balance under prior operating practices is estimated to reach as high as 45,000 AF in 2013.

Overall, projected changes in Total Diversion Allocation to EBID are generally small under drier conditions, when differences in Annual Allocated Water, Accrued Carryover Balance, and Transfer of Allocation Balance compared to prior operating practices are all minor. Under wetter conditions, however, the Total Diversion Allocation to EBID is as much as 123,000 AF less under the OA compared to prior operating practices. Differences in Total Diversion Allocation under wetter conditions represent the effect of the diversion ratio provision on Annual Allocated Water combined with the effect of the carryover provision on Accrued Carryover Balance.

Results shown in Figures 3.2-16 indicate that under very dry conditions (non-exceedance probabilities less than 20%), the estimated allotment of Annual Allocated Water to EPCWID is similar under the OA and prior operating practices. However, Annual Allocated Water to EPCWID differs substantially under normal and wet conditions. Under normal conditions (non-exceedance probabilities between 33% and 66%), estimated Annual Allocated Water is as much as 105,000 AF greater under the OA than under prior operating practices; under wet conditions (non-exceedance probabilities greater than 66%), however, estimated Annual Allocated Water is up to 73,000 AF greater under prior operating practices. The estimated Accrued Carryover Balance for EPCWID for the 2015 irrigation season is greater under the OA under all but the wettest conditions, with a maximum difference of approximately 30,000 AF; the estimated increase in Accrued Carryover Balance is further augmented by an estimated decrease in Transfer of Allocation Balance from EPCWID to EBID under the OA (see above).

Overall, the projected change in Total Diversion Allocation to EPCWID is generally positive, indicating an increase in Total Diversion Allocation under the OA. As shown in Figure 3.2-16(d), differences are generally small under very wet and very dry conditions and greatest under normal water supply conditions. Results shown here indicate that the Total Diversion Allocation to EPCWID for the 2015 irrigation season is likely to be greater under prior operating practices compared to the OA unless abnormally wet conditions prevail throughout the coming years. However, further analysis indicates that after one more year of simulation (i.e., at the end of the 2016 irrigation season), the projected Total Diversion Allocation to EPCWID is projected to be greater under the OA for all water supply conditions, though differences remain small under very dry and very wet conditions.

Results shown in Figure 3.2-17 indicate that the estimated Total Diversion Allocation to Mexico for the 2015 irrigation season is generally similar under the OA and prior operation practices for drier conditions. Under normal conditions, the annual allocation to Mexico is up to 15,000 AF greater under the OA compared to prior operating practices. Under wetter conditions, the annual allocation to Mexico reaches its maximum of 60,000 AF under both operations. As noted above, annual allocation to Mexico is calculated identically under the OA and under prior operating practices. Differences in allocation under the two operating procedures result from differences in the total Project delivery in any given year. Under both operating procedures, Mexico continues to receive 60,000 AF per year except under extreme drought conditions in which case Mexico receives 11.3486% of the sum of the total delivery to lands within the US plus delivery to the heading of the Acequia Madre.

Results shown here suggest that the OA will have little effect on the annual allocations to EBID for the 2015 irrigation season if dry conditions persist within the Project. If wetter conditions prevail during the period 2013-2015, the OA will result in a decrease in Total Diversion Allocation available to EBID in 2015 of up to 123,000 AF, which corresponds to a 25% decrease compared to the estimated allocation under prior operating practices. By contrast, results of this analysis suggest that the OA will result in an increase in the Total Diversion Allocation to EPCWID under dry and normal conditions, but may result in a minor increase in Total Diversion Allocation if abnormally wetter conditions prevail.

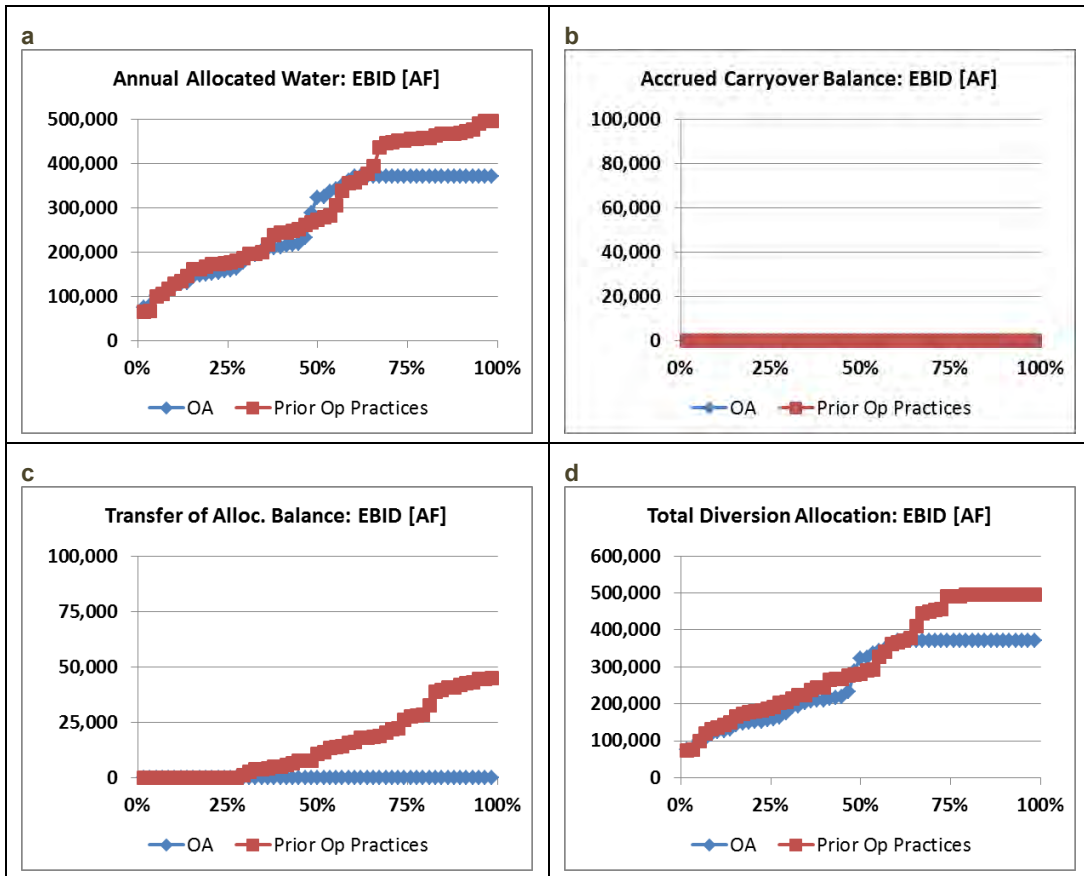


Figure 3.2-15: Non-exceedance curves of estimated Project allocations to EBID under the OA and under prior operating practices for the 2015 irrigation season. (a) Annual Allocated Water; (b) Accrued Carryover Balance; (c) Transfer of Allocation Balance; (d) Total Diversion Allocation.

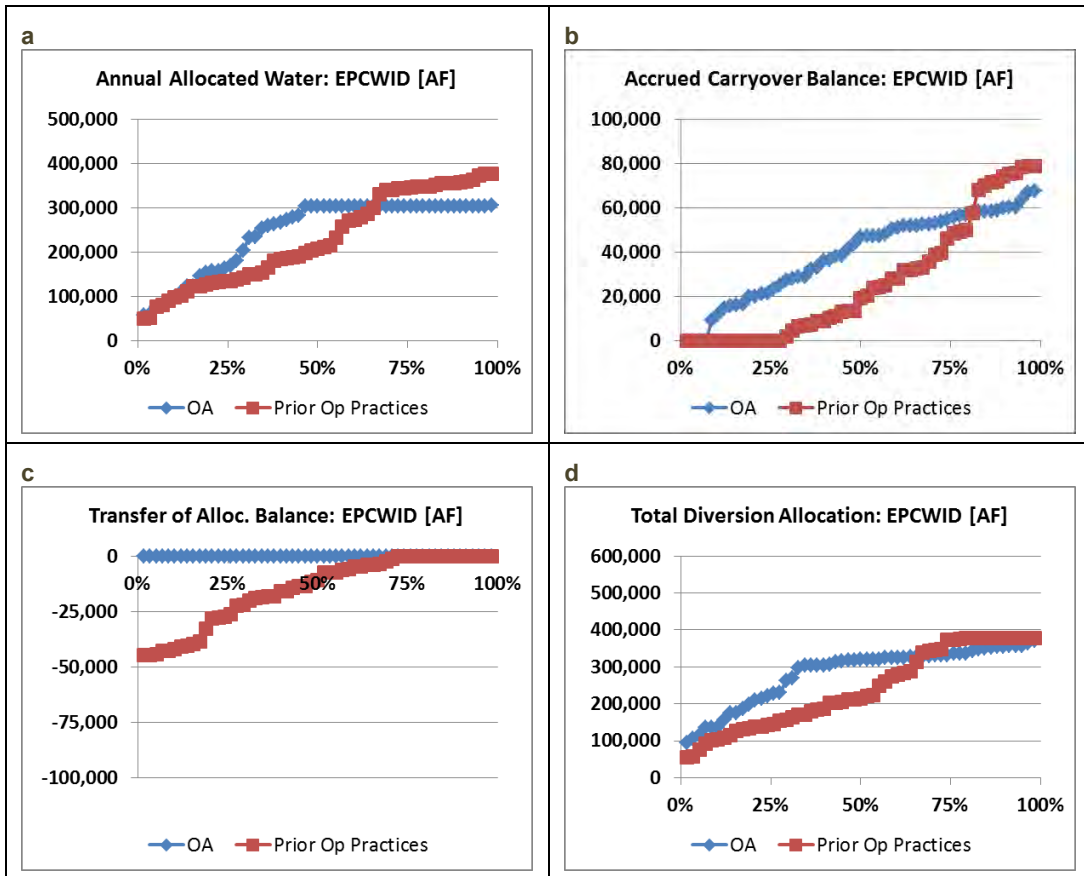


Figure 3.2-16: Non-exceedance curves of estimated Project allocations to EPCWID under the OA and under prior operating practices for the 2015 irrigation season. (a) Annual Allocated Water; (b) Accrued Carryover Balance; (c) Transfer of Allocation Balance; (d) Total Diversion Allocation.

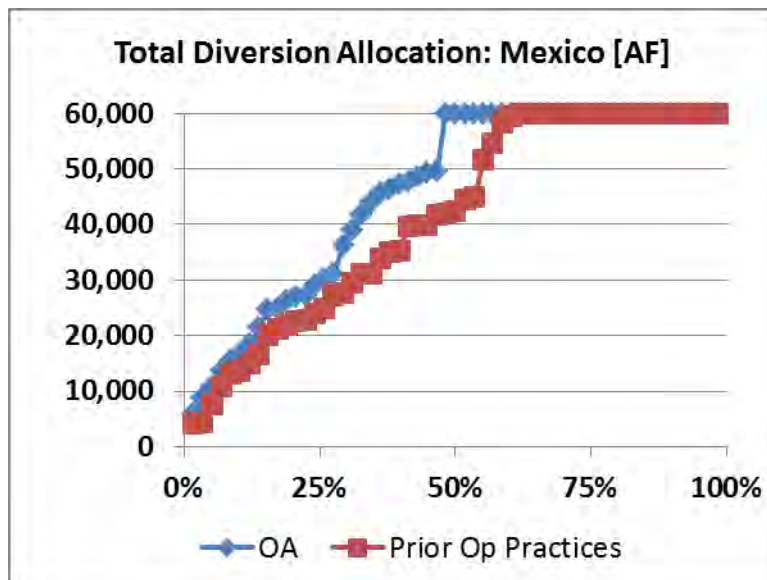


Figure 3.2-17: Non-exceedance curves of Project allocation to Mexico under the OA and under prior operating practices for water year 2015.

Table 3.2-15: Estimated Non-Exceedance Values of Project Allocations to EBID (2013-2015)

Annual Allocated Water	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	123,918	160,424	301,356	123,918	230,029	419,612
2014	138,430	195,246	339,285	145,183	253,522	455,473
2015	151,143	322,643	371,141	172,168	272,368	456,995
Accrued Carryover Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	2,573*	2,573*	2,573*	2,573*	2,573*	2,573*
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
Transfer of Alloc. Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	0	0	0	2,065**	2,065**	2,065**
2014	0	0	0	0	4,486	18,548
2015	0	0	0	0	10,863	32,807
Total Diversion Allocation	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	126,491	162,997	303,929	128,556	234,668	424,250
2014	138,430	195,246	339,285	158,857	261,598	495,013
2015	151,143	322,643	371,141	180,058	280,099	495,013

* District's historical (actual) Accrued Carryover Balance used for 2013

** Calculation of implicit Transfer of Allocation Balance under prior operating practices for 2013 based on district's historical (actual) Accrued Carryover Balance

Table 3.2-16: Estimated Non-Exceedance Values of Project Allocations to EPCWID (2013-2015)

Annual Allocated Water	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	94,347	249,028	304,241	94,347	175,136	319,477
2014	146,834	278,940	304,241	110,537	193,022	346,780
2015	157,311	304,241	304,241	131,083	207,371	347,939
Accrued Carryover Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	5,597*	5,597*	5,597*	5,597*	5,597*	5,597*
2014	8,819	20,211	43,031	0	7,901	32,669
2015	20,082	46,735	57,813	0	19,134	57,785
Transfer of Alloc. Balance	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	0	0	0	-2,065**	-2,065**	-2,065**
2014	0	0	0	-18,539	-4,486	0
2015	0	0	0	-28,351	-10,863	0
Total Diversion Allocation	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	99,944	254,625	309,838	97,878	178,667	323,009
2014	173,620	304,241	323,787	120,948	199,171	376,885
2015	209,900	319,485	342,422	137,089	213,257	376,885

* District's historical (actual) Accrued Carryover Balance used for 2013

** Calculation of implicit Transfer of Allocation Balance under prior operating practices for 2013 based on district's historical (actual) Accrued Carryover Balance

Table 3.2-17: Estimated Non-Exceedance Values of Project Allocations to Mexico (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	15,287	38,687	60,000	15,287	38,687	60,000
2014	24,179	45,675	60,000	19,945	41,238	60,000
2015	27,063	60,000	60,000	22,607	42,341	60,000

Annual Project Diversions

Figures 3.2-18, 3.2-19, and 3.2-20 show estimated non-exceedance curves of annual Project diversions to EBID, EPCWID, and Mexico, respectively, for the 2015 irrigation season. Similar to annual allocations, non-exceedance curves for annual diversions differ between years due to the effects of prior-year inflows and operations on current-year allocations and diversions; however, the general characteristics of non-exceedance curves for 2013 and 2014 are similar to those shown here for 2015. Estimated 20%, 50%, and 80% non-exceedance values of annual Project diversions to EBID, EPCWID, and Mexico for years 2013-2015 are provided in Tables 3.2-18, 3.2-19, and 3.2-20, respectively.

As detailed in Sections 3.1.2 and 3.1.3, the annual allocation models used here assume that EBID and Mexico both utilize their respective Total Diversion Allocation in full each year—i.e., the annual diversion to EBID is assumed to equal the Total Diversion Allocation to EBID, and the annual diversion to Mexico is assumed to equal the Total Diversion Allocation to Mexico. Estimated non-exceedance curves for annual diversions to EBID are therefore equal to the corresponding non-exceedance curves for annual allocation to EBID detailed above. Similarly, estimated differences between annual diversions to EBID under the OA versus prior operating practices are identical to differences in annual allocation, which are also detailed above.

For the purposes of this analysis, the annual diversion to EPCWID is calculated as the lesser of the district's annual allocation and the district's estimated annual diversion requirement, which is calculated from the total usable water available for release according to Equation 22 (see Section 3.1.2). As shown in Figure 3.2-19, estimated annual diversions to EPCWID are nearly equal under the OA and prior operations for both dry and wet conditions. Under a small subset of normal conditions (non-exceedance probabilities from approximately 30% to 50%), diversions under the OA are greater than corresponding diversions under prior operating practices. This difference occurs because diversions under prior operations are limited by the district's annual allocation, whereas diversions under the OA are not limited due to the district's higher Total Diversion Allocation under the OA (see above).

Results presented here suggest that the OA will have little difference on annual Project diversions to EBID if drier conditions persist through the 2013-2015 period, and will have a negligible impact on annual Project diversions to EPCWID under most hydrologic conditions. Annual Project diversions to Mexico are likely to be slightly greater under the OA until conditions support the maximum allocation of 60,000 AF, at which point annual diversions under the OA are equal to diversions under prior operating practices.

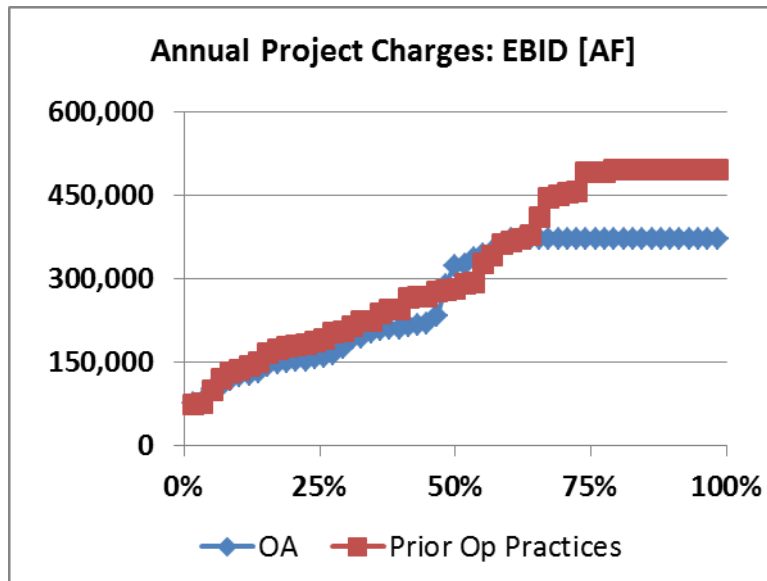


Figure 3.2-18: Non-exceedance curves of estimated annual Project charges (net Project diversions) to EBID for water year 2015 under the OA and prior operating practices.

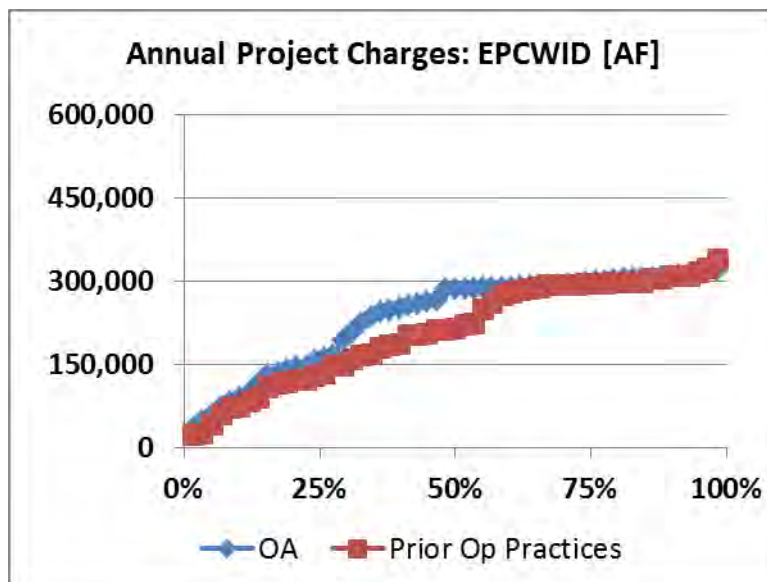


Figure 3.2-19: Non-exceedance curves of estimated annual Project charges to EPCWID for water year 2015 under the OA and prior operating practices.

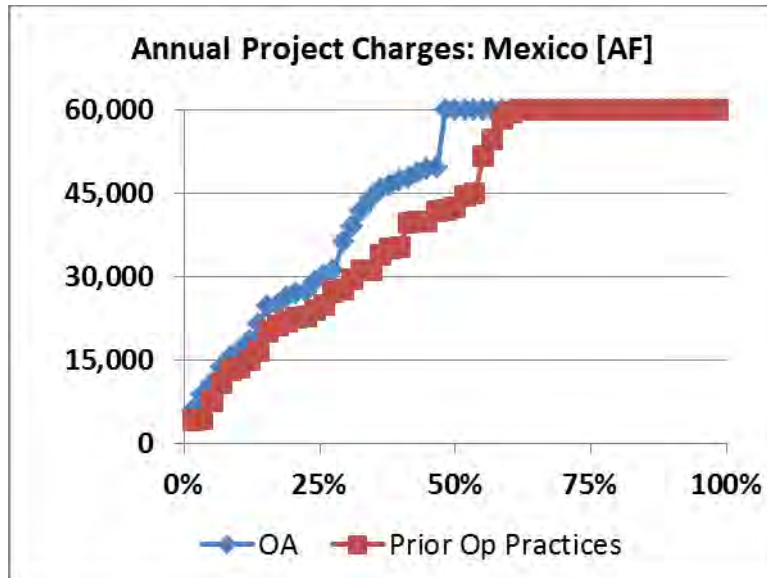


Figure 3.2-20: Non-exceedance curves of estimated annual Project charges to Mexico for water year 2015 under the OA and prior operating practices.

Table 3.2-18: Estimated Non-Exceedance Values of Annual Diversion to EBID (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	126,491	162,997	303,929	128,556	234,668	424,250
2014	138,430	195,246	339,285	158,857	261,598	495,013
2015	151,143	322,643	371,141	180,058	280,099	495,013

Table 3.2-19: Estimated Non-Exceedance Values of Annual Diversion to EPCWID (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	83,159	206,590	293,551	83,159	178,667	293,551
2014	130,064	243,450	300,126	107,732	199,171	298,011
2015	145,273	285,592	303,553	121,774	213,257	297,728

Table 3.2-20: Estimated Non-Exceedance Values of Annual Diversion to Mexico (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	15,287	38,687	60,000	15,287	38,687	60,000
2014	24,179	45,675	60,000	19,945	41,238	60,000
2015	27,063	60,000	60,000	22,607	42,341	60,000

Annual Release from Project Storage

Figure 3.2-21 shows the estimated non-exceedance curve of annual Project releases for the 2015 irrigation season. Similar to annual allocations and diversions, non-exceedance curves for annual releases differ between years due to the effects of prior-year inflows and operations on current-year allocations and diversions; however, the general characteristics of non-exceedance curves for 2013 and 2014 are similar to those shown here for 2015. Values of the 20%, 50%, and 80% non-exceedance allocation are provided in Table 3.2-21 for years 2013-2015.

As detailed in Section 3.1.2, annual releases are calculated from the estimated total annual diversion to EBID, EPCWID, and Mexico and the estimated Project diversion ratio. For the purposes of this analysis, the estimated project diversion ratio is identical under the OA and prior operating practices. Differences in annual release between the OA and prior operating practices therefore reflect differences in estimated annual total Project diversions, detailed above. Annual releases are generally greater under the OA for dry to normal conditions and are generally less under the OA for normal to wet conditions compared to prior operating practices.

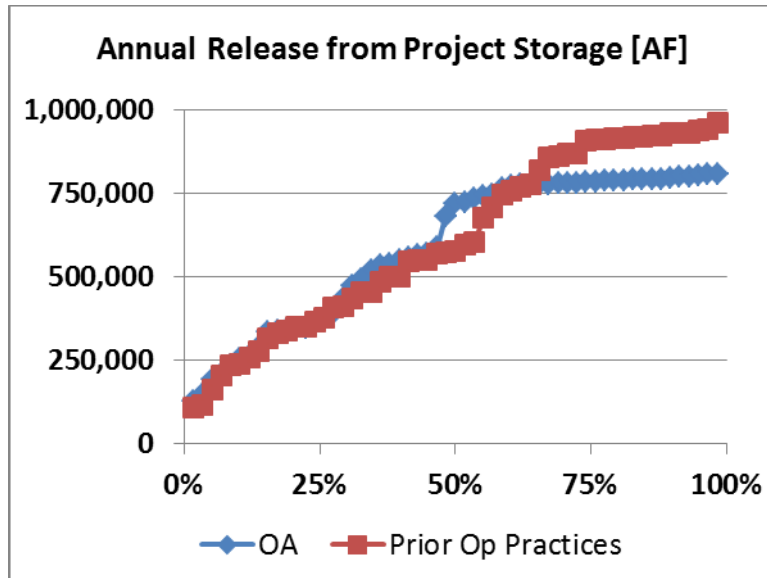


Figure 3.2-21: Non-exceedance curves of estimated annual release from Project storage for water year 2015 under the OA and prior operating practices.

Table 3.2-21: Estimated Non-Exceedance Values of Annual Project Releases (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	266,978	479,494	780,365	269,430	536,507	923,175
2014	337,683	543,908	785,379	321,754	563,711	957,874
2015	341,051	718,869	789,261	348,535	575,484	916,074

Total Project Storage and Total Usable Water Available for Release

Figures 3.2-22 and 3.2-23 show the estimated non-exceedance curves for total Project storage at the start and end of the 2015 irrigation season, respectively, under the OA and prior operating practices. Figure 3.2-24 and 3.2-25 show the corresponding estimated non-exceedance curves for total usable water available for release during the 2015 and total usable water remaining in storage at the end of the 2015 irrigation season. The 20%, 50%, and 80% non-exceedance values for total Project storage at the start and end of irrigation season are provided in Tables 3.2-22 and 3.2-23, respectively, for years 2013-2015; corresponding non-exceedance values for total usable water available for use during the irrigation season and remaining at the end of irrigations season are provided in Tables 3.2-24 and 3.2-25, respectively.

As detailed above, total Project storage was estimated from the total usable water available for release and total annual release calculated by the annual allocation models. Total Project storage at the start of the irrigation season, Project inflows

during each season period, and non-Project water in storage during each season are all identical under the OA and prior operating practices for a given inflow trace. The large range of historical Project inflows results in a similarly large range of estimated total Project storage. Estimated total Project storage at the start of the 2015 irrigation season ranges from 247,427 AF to 1,558,809 AF under the OA, compared to a range of 230,380 AF to 1,133,307 AF under prior operations. Estimated total storage at the end of the 2015 irrigation season ranges from 175,784 AF to 1,834,856 AF under the OA, compared to a range of 143,330 AF to 1,249,924 AF under prior operating practices. Note that storage at the end of the irrigation season is greater than storage at the start of the irrigation season in years when inflows to Project storage between March 1 and October 31 exceed annual Project releases.

Projected Total Project Storage is generally greater under the OA at both the start and end of irrigation season, particularly under wetter conditions. This difference is due largely to the carryover provision of the OA, which allows EPCWID to accrue its unused allocation balance over multiple years as Accrued Carryover Balance. Because the water needed to satisfy EPCWID's Accrued Carryover Balance is excluded from the total usable water available for allocation in subsequent years, this water remains in storage and increases the Total Project Storage until it is utilized by the district.

As detailed in Section 2.1.4, total usable water available for release is calculated by deducting non-Project water (i.e., San Juan-Chama Waters and Rio Grande Compact Credit Waters) from the total water in Project storage. For the purposes of this analysis, the start of irrigation season is taken as March 1 of each year, the end of irrigation season is taken as October 31, and releases from Project storage between November 1 and February 28 of each year are considered negligible. In addition, for comparison purposes, total usable water under the OA is calculated from Project storage, Project inflows, and non-Project water in storage; values of total usable water provided on annual allocation worksheets does not correspond to a specific date within the season and therefore does not provide an appropriate comparison to the annual allocation model results.

Total usable water available for release during the current irrigation season consists of the total amount of water in Project storage at the start of irrigation season plus inflows to Project storage over the course of the season minus non-Project water in storage during the irrigation season. Similarly, total usable water remaining at the end of the season consists of the total amount of water in Project storage minus the total non-Project water in storage. For the purposes of this analysis, non-Project water is assumed to equal the non-Project water used in annual Project allocation calculations (obtained from annual allocation worksheets) and is assumed to be constant throughout the irrigation season. Because inflows to Project storage are identical under the OA and prior operating practices for any given inflow trace, effects of the OA on total usable water available during a given irrigation season and remaining at the end of the season

are identical to effects on Project storage at the start and end of the irrigation season, respectively.

The results presented here reflect the very low Project storage at the end of the 2012 irrigation season, as well as low values of the estimated annual Project diversion ratio over the period 2013-2015. The combination of low initial storage and low Project diversion ratio result in full depletion of usable Project water under a broad range of inflow conditions for years 2013 and 2014. By 2015, the estimated Project diversion ratio calculated from Equation 23 rebounds sufficiently that full depletion occurs only under dry conditions.

Actual storage at the start of the 2013 irrigation season was not used in this analysis, as the analysis was conducted prior to the start of irrigation season (i.e., prior to March 1, 2013). As detailed in above, the annual allocation models used here were initialized to actual Project storage at the end of the 2012 irrigation season. Project storage at the start of the 2013 irrigation season was then estimated based on 2012 end-of-season storage and the historical distribution of winter season inflows (i.e., the distribution of inflows between November 1 and February 28).

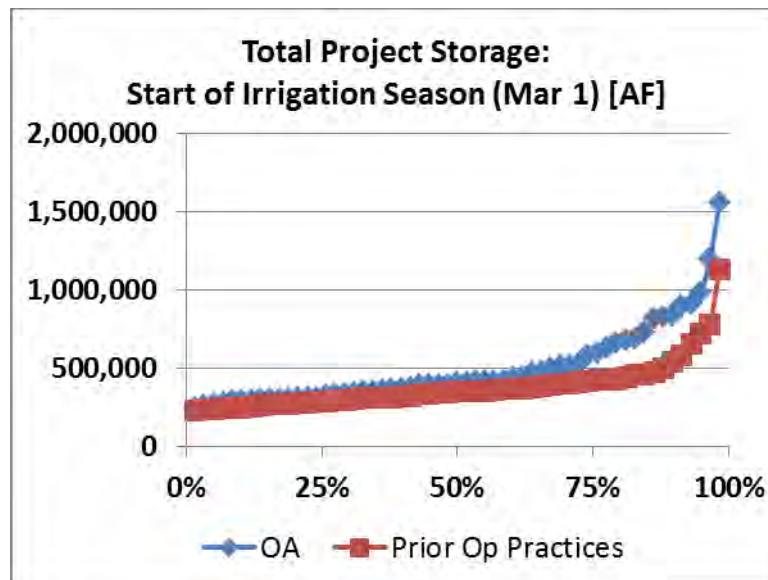


Figure 3.2-22: Non-exceedance curves of estimated total Project storage at the start of the 2015 irrigation season (i.e., March 1, 2015) under the OA and prior operating practices.

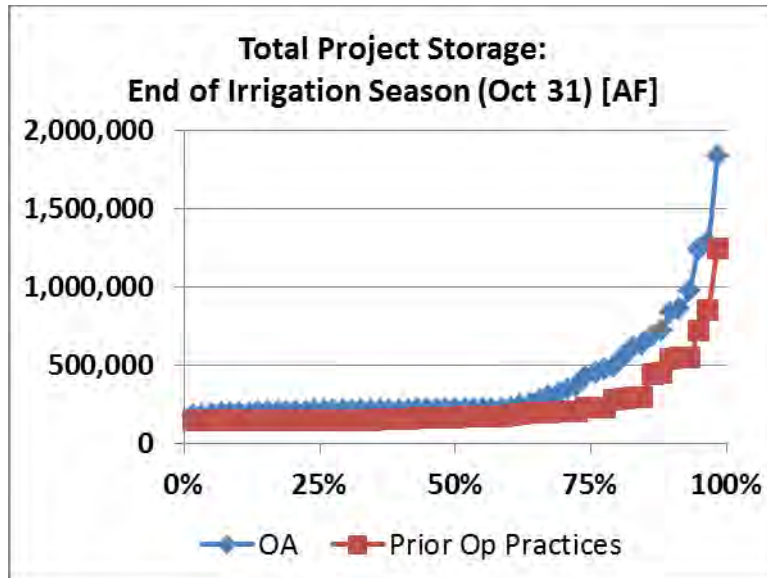


Figure 3.2-23: Non-exceedance curves of estimated total Project storage at the end of the 2015 irrigation season (i.e., October 31, 2015) under the OA and prior operating practices.

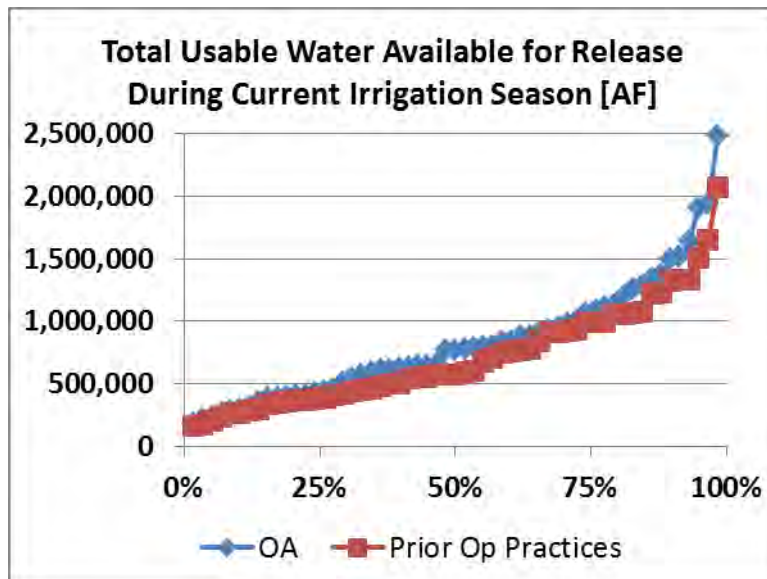


Figure 3.2-24: Non-exceedance curves of estimated total usable water available for release during the 2015 irrigation season (i.e., March 1, 2015) under the OA and prior operating practices. Note that total usable water available during the 2015 irrigation season includes usable water in Project storage at the start of irrigating season as well as inflows to Project storage during the irrigation season.

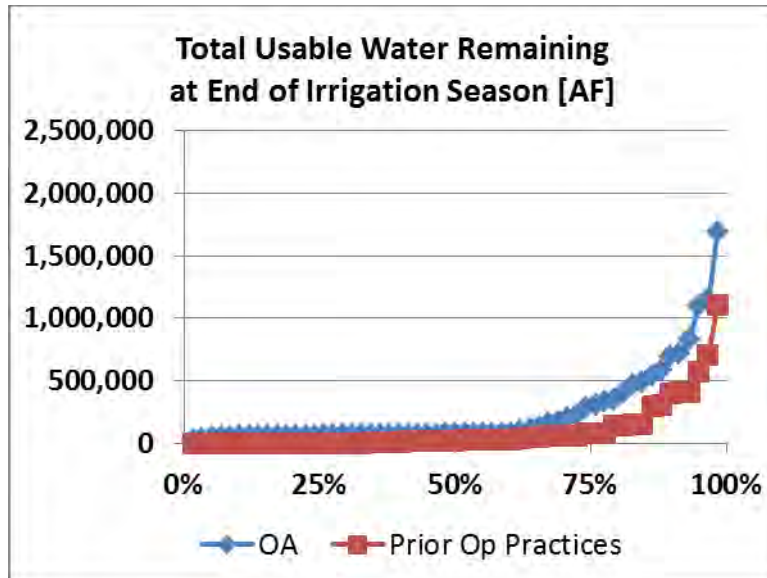


Figure 3.2-25: Non-exceedance curves of estimated total usable water available for release at the end of the 2015 irrigation season (i.e., October 31, 2015) under the OA and prior operating practices. Note that total usable water remaining at the end of the 2015 irrigation season includes only the usable water remaining in Project storage at the end of the season.

Table 3.2-22: Estimated Non-Exceedance Values of Total Project Storage at the Start of Irrigation Season (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	252,950	286,550	335,500	224,280	286,550	335,500
2014	289,076	376,325	487,674	271,772	339,754	393,630
2015	307,768	406,972	683,214	278,907	351,370	444,802

Table 3.2-23: Estimated Non-Exceedance Values of Total Project Storage at the End of Irrigation Season (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	194,652	194,652	321,103	143,330	152,708	189,143
2014	192,556	208,699	474,904	143,330	164,816	251,335
2015	207,340	221,681	553,813	143,330	163,830	286,285

Table 3.2-24: Estimated Non-Exceedance Values of Total Usable Water Available for Release During the Current-Year Irrigation Season (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	286,900	536,507	958,138	286,900	536,507	958,138
2014	381,754	611,047	1,116,952	336,593	563,711	1,065,879
2015	412,509	765,905	1,199,744	364,988	575,484	1,059,028

Table 3.2-25: Estimated Non-Exceedance Values of Total Usable Water Remaining at the End of Irrigation Season (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	23,199	51,322	177,773	0	9,377	45,813
2014	49,226	65,369	331,574	0	21,486	108,005
2015	64,009	78,350	410,483	0	20,499	142,954

Elephant Butte Reservoir Elevation

Figures 3.2-26 and 3.2-27 shows the non-exceedance curves for estimated reservoir surface elevation in Elephant Butte Reservoir at the start and end of the 2015 irrigation season under the OA and prior operating practices. The grey dashed lines in each figure illustrate the maximum and minimum reservoir elevations (4,245 ft and 4,410 ft, respectively); the black dashed line indicates a reservoir elevation of 4,350 ft, which corresponds to the elevation at which water levels may encroach on previously identified southwest willow flycatcher territories. Reservoir elevations are provided as elevation above mean sea level. The 20%, 50%, and 80% non-exceedance values of Elephant Butte reservoir elevation at the start and end of irrigation season are provided in Tables 3.2-26 and 3.2-27, respectively, for years 2013-2015. For the purposes of this analysis, storage in Elephant Butte Reservoir is estimated as 95.5% of total water in Project storage and the corresponding reservoir elevation is calculated based on the current area-capacity table for Elephant Butte Reservoir.

The range of estimated reservoir surface elevations in Elephant Butte Reservoir reflects the broad range of inflow conditions considered in this analysis. Under the OA, estimated elevations at the start of the 2015 irrigation season range from 4,316 feet for extreme dry conditions to 4,390 feet for extreme wet conditions; under prior operations, estimated reservoir elevations range from 4,314 feet to 4,387 feet under extreme dry and wet conditions, respectively. Estimated elevations at the end of the 2015 irrigation season range from 4,307 feet to 4399

feet under the OA and 4,303 feet to 4,379 feet under prior operating practices. As noted above, the estimated amount of water in Project storage at the start and end of irrigation season under normal and wet conditions is greater under the OA than under prior operating practices. This results in higher estimated reservoir elevations in Elephant Butte Reservoir.

Based on this analysis, the estimated probability of reservoir levels exceeding an elevation of 4,350 feet at the start of the 2015 irrigation season under prior operating practices is approximately 7%; by contrast, the estimated probability of exceeding 4,350ft is 20% under the OA. At the end of the 2015 irrigation season, the estimated probability of Elephant Butte Reservoir exceeding 4,350 feet is approximately 5% under prior operating practices compared to 14% under the OA.

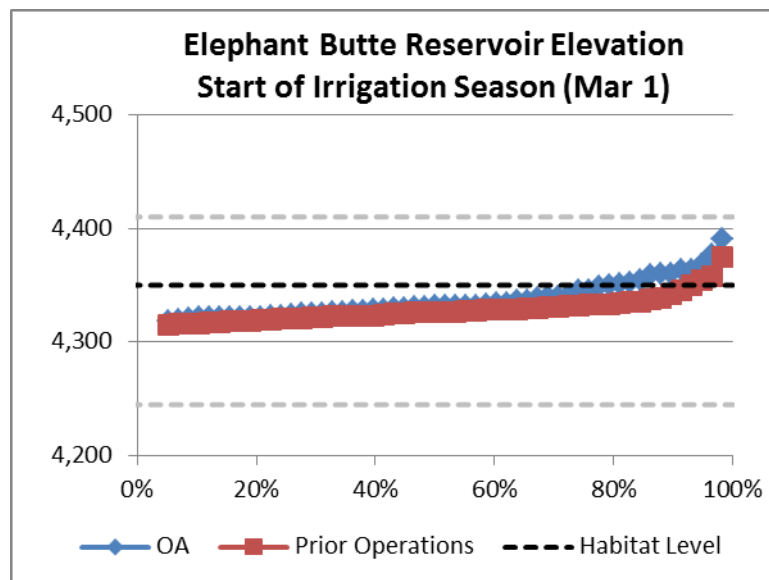


Figure 3.2-26: Non-exceedance curves of estimated Elephant Butte Reservoir surface elevation at the start of the 2015 irrigation season (i.e., March 1, 2015) under the OA and prior operating practices.

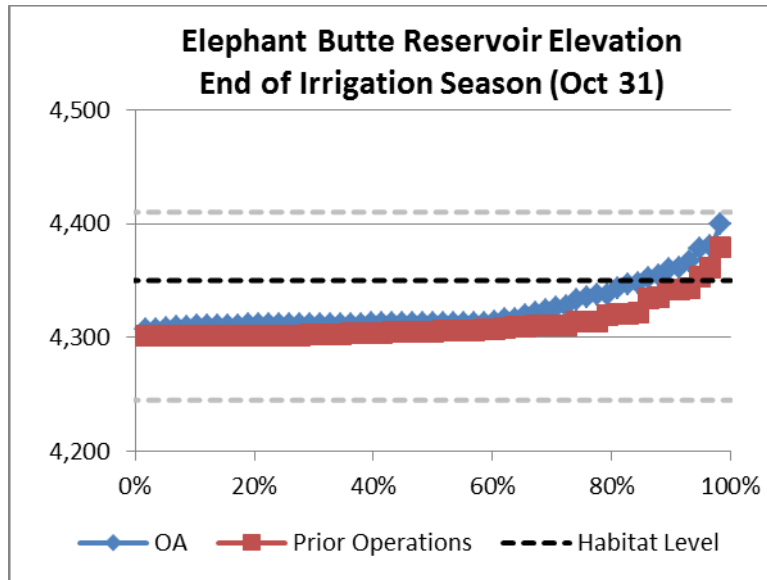


Figure 3.2-27: Non-exceedance curves of estimated Elephant Butte Reservoir surface elevation at the end of the 2015 irrigation season (i.e., October 31, 2015) under the OA and prior operating practices.

Table 3.2-26: Estimated Non-Exceedance Values of Elephant Butte Reservoir Surface Elevation at the Start of Irrigation Season (March 1) (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	4,309	4,310	4,324	4,302	4,303	4,309
2014	4,309	4,311	4,337	4,302	4,305	4,316
2015	4,311	4,313	4,343	4,302	4,305	4,320

Table 3.2-27: Estimated Non-Exceedance Values of Elephant Butte Reservoir Surface Elevation at the End of Irrigation Season (October 31) (2013-2015)

	OA (Estimated)			Prior Operations (Estimated)		
	20%	50%	80%	20%	50%	80%
2013	4,322	4,321	4,326	4,315	4,321	4,326
2014	4,322	4,330	4,342	4,320	4,326	4,331
2015	4,323	4,332	4,354	4,320	4,327	4,336

3.2.3 Uncertainties and Limitations

As detailed in Section 3.1.5 above, the annual Project diversion ratio ($\rho_{Project,t}$) is required in order to calculate the annual release from Project storage that is needed to satisfy annual Project diversions under prior operating practices for the period 2008-2012 and under both the OA and prior operating practices for the period 2013-2015. As summarized in Section 3.1.2, extensive analysis was carried out to identify a reliable predictor of the Project diversion ratio for a given year based on information available at the start of the year—e.g., based on prior-year releases, total usable water available for the current year, etc). The most reliable predictor was found to be the persistence (serial correlation) of the diversion ratio itself—i.e., the prior-year diversion ratio was found to be the most reliable predictor of current-year diversion ratio. Despite being a statistically significant predictor, however, estimates of the diversion ratio based on serial correlation are highly uncertain. Additional analysis was therefore carried out to assess the sensitivity of estimated differences between Project operations under the OA and prior operating practices to the assumed diversion ratio during the period 2008-2012 and to the projected diversion ratio during the period 2013-2015.

For the period 2008-2012, sensitivity analysis was conducted by manually perturbing values of the Project diversion ratio used to estimate Project operations under prior operating practices. Increases in the assumed diversion ratio resulted in an increase in the estimated difference in annual Project allocations to EBID and a decrease in the estimated difference in annual Project allocations to EPCWID under the OA compared to prior operating practices. Increasing the diversion ratio results in a greater impact on annual allocation to EBID because the higher diversion ratio allows for a larger drought factor and thus a smaller decrease in the gross D-2 diversion allocation. As noted above, the drought factor is used to reduce the gross D-2 diversion allocation in years when the usable water available for release during the current year is not sufficient to satisfy the initial gross D-2 diversion allocation under the current diversion ratio. Increasing the gross D-2 diversion allocation in turn increases the annual allocation to EBID. Because the OA results in a reduced allocation to EBID, the apparent reduction is greater for larger values of the diversion ratio. Conversely, using a smaller value of the diversion ratio to estimate Project operations under prior operating practices reduces the estimated effect of the OA on the annual allocation to EBID. Changes in the diversion ratio have the opposite impact on the estimated effects of the OA on Project allocations to EPCWID: increasing the diversion ratio results in a smaller estimated difference between the OA and prior operations, while decreasing the diversion ratio results in a larger estimated difference.

A more extensive sensitivity analysis was conducted for the period 2013-2015. Figures 3.2-28, 3.2-29, and 3.2-30 show differences between Annual Allocated Water and Total Diversion Allocation to EBID and EPCWID, respectively, under the OA versus prior operating practices for the 2015 irrigation season as a function of non-exceedance probability. In each of these figures, the thick black line (solid black diamonds) corresponds to differences calculated from results shown in Figures 3.2-15, 3.2-16, and 3.2-17, respectively (i.e., the difference

between the estimated non-exceedance curves under the OA [blue line] and prior operating practices [red line] in each figure). The gray lines correspond to differences based on Project operations calculated using different values of the Project diversion ratio. For each gray line, Project operations were calculated as detailed above using the annual allocation models developed for this study; however, fixed (constant) values of the Project diversion ratio were used in place of values estimated by Equation 23. Thin gray lines with hollow symbols correspond to annual Project diversion ratios ranging from 0.8 to 1.3. The thick gray line (solid gray diamonds) corresponds to an annual Project diversion ratio of 1.16, which is equal to the long-term average gross diversion ratio; note that the long-term average Project diversion ratio was not available at the time of this analysis due to the lack of comprehensive data for Project charges.

Figure 3.2-28 reveals that differences in EBID's Annual Allocated Water and Total Diversion Allocation between the OA and prior operations are relatively small under drier conditions (non-exceedance probabilities less than approximately 25%) for a wide range of Project diversion ratios. For Project diversion ratios between 0.8 and 1.3, the difference in annual allocation to EBID under drier conditions is less than approximately 50,000 AF. Differences in Annual Allocated Water are positive for some values of the diversion ratio (increase under OA) and negative for others (decrease under OA); differences in Total Diversion Allocation are predominately negative (decreased under OA) under all values of the diversion ratio.

Under normal and wet conditions (non-exceedance probabilities greater than 25%), estimated difference in Annual Allocated Water and Total Diversion Allocation to EBID become much larger; the sensitivity of estimated differences to the estimated value of the diversion ratio also becomes much larger. Annual Allocated Water and Total Diversion Allocation both tend to increase when the Project diversion ratio is greater than 1.0 and decrease when the diversion ratio is less than 1.0. For a Project diversion ratio of 1.3, increases in Annual Allocated Water reach nearly 200,000 AF; for a Project diversion ratio of 0.8, decreases in Annual Allocated Water reach as much as 180,000 AF.

Similar to EBID, Figure 3.2-29 shows that differences in the 2015 annual allocation to EPCWID under dry conditions (non-exceedance probabilities less than 25%) are relatively small and are not strongly sensitive to the Project diversion ratio. Under normal conditions, differences are highly sensitive to the Project diversion ratio; however, sensitivity decreases again under wet conditions. In general, Annual Allocated Water to EPCWID is slightly less under the OA during drier conditions and substantially less under wet conditions; under normal conditions, however, differences are highly sensitive to the diversion ratio.

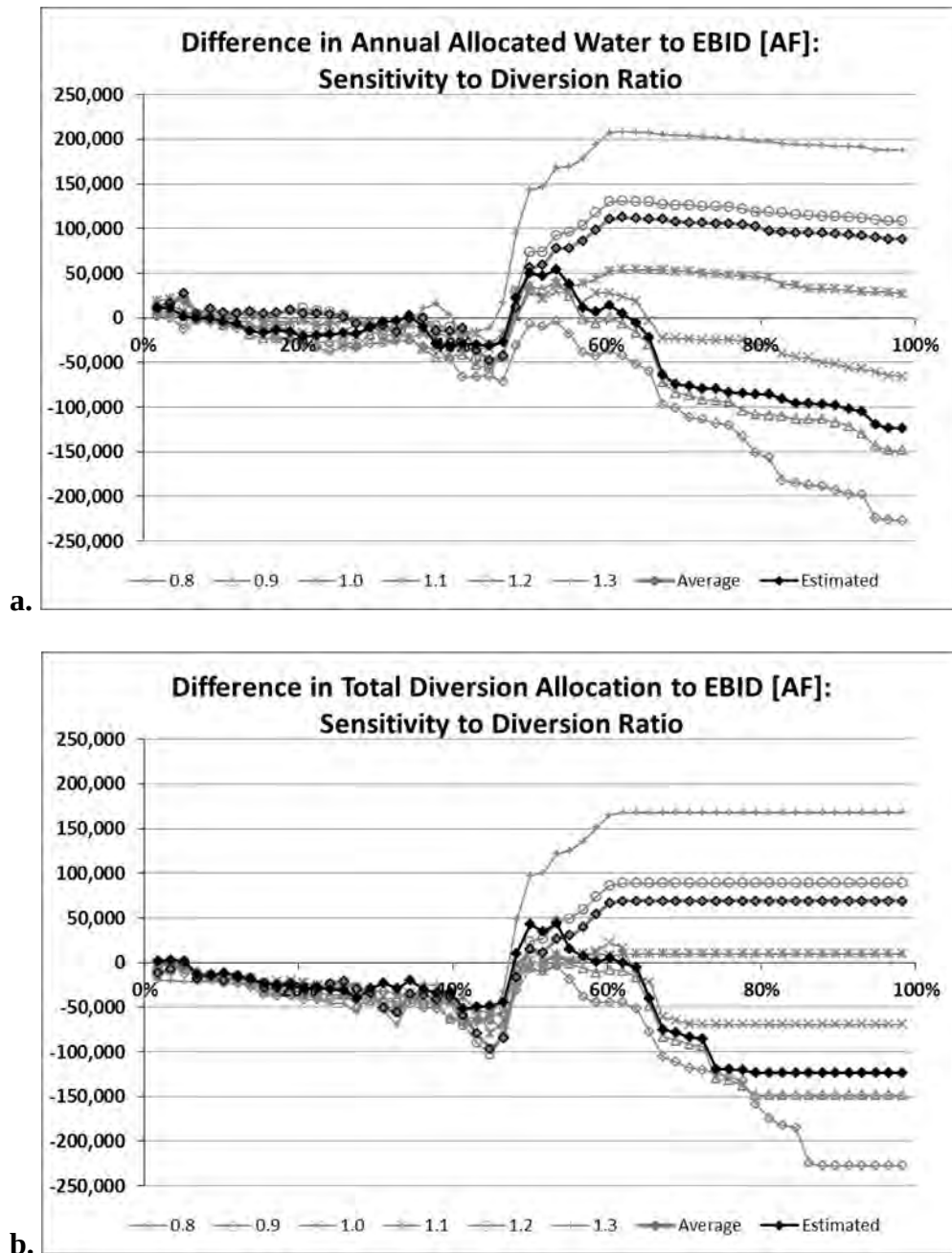


Figure 3.2-28: Difference between estimated non-exceedance curves of (a) Annual Allocated Water and (b) Total Diversion Allocation to EBID for water year 2015 under the OA and prior operating practices for various values of annual Project diversion ratio; see text for complete description.

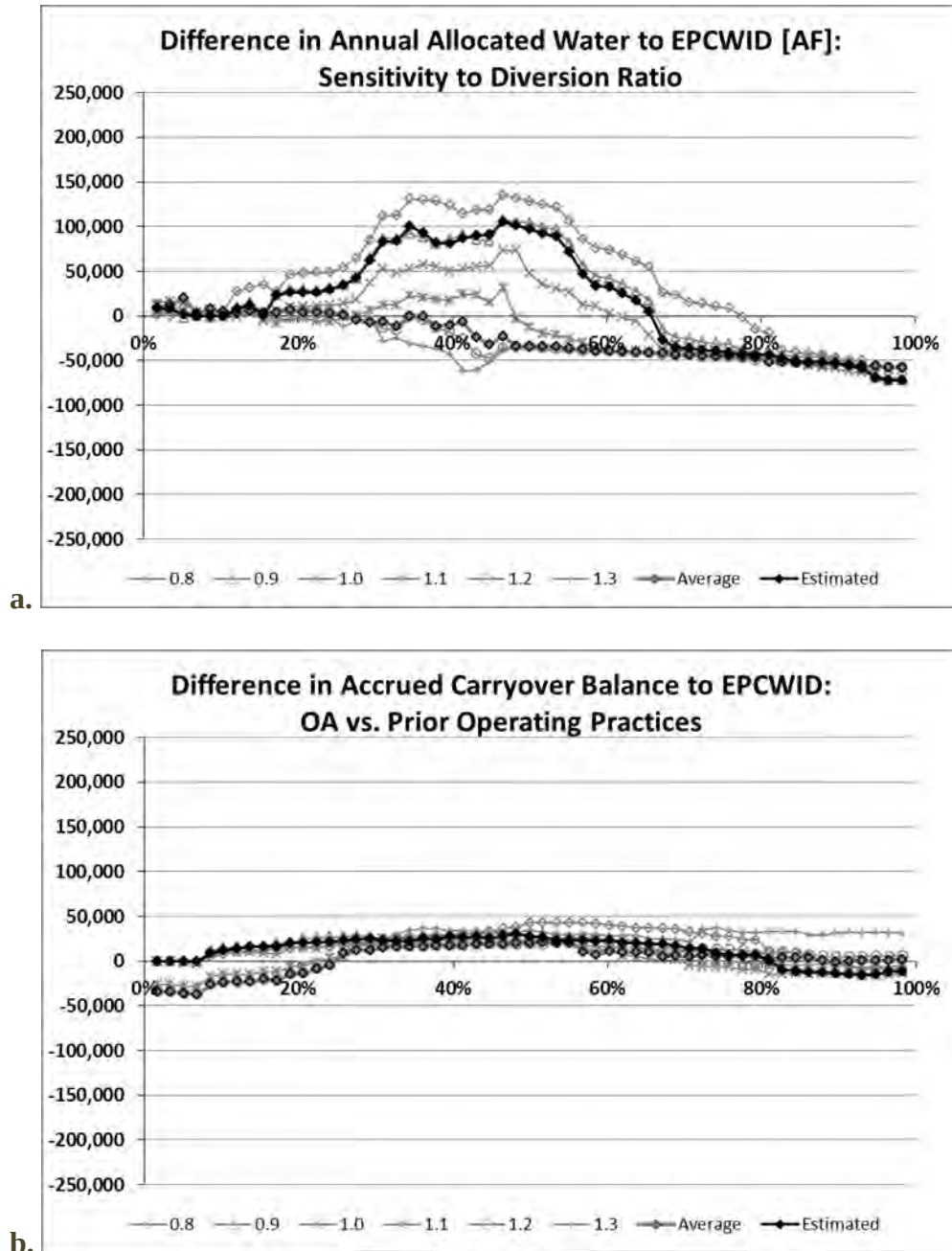


Figure 3.2-29: Difference between estimated non-exceedance curves of (a) Annual Allocated Water and (b) Total Diversion Allocation to EPCWID for water year 2015 under the OA and prior operating practices for various values of annual Project diversion ratio; see text for complete description.

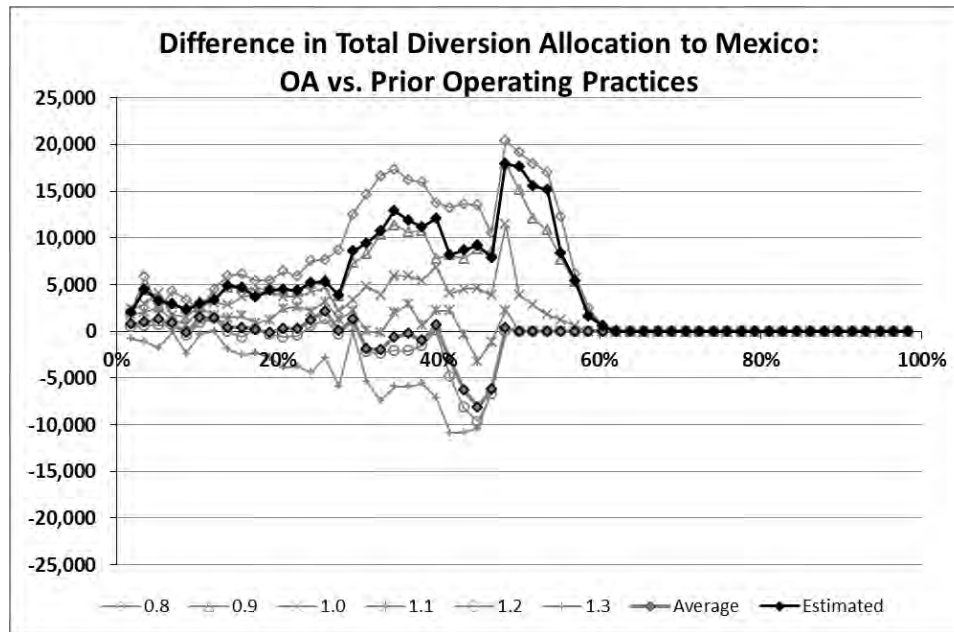


Figure 3.2-30: Differences between estimated non-exceedance curves of Total Diversion Allocation to Mexico for water year 2015 under the OA and prior operating practices for various values of annual Project diversion ratio; see text for complete description.

3.3 Summary and Conclusions

The Rio Grande Project Operating Agreement (OA) was developed and signed by EBID, EPCWID, and Reclamation in 2008 to define Project operating procedures, including procedures for storage, allocation, release, and accounting of Project water. The OA achieves the following objectives that were not achieved under prior operating practices:

- Fulfills the parties' obligations under contracts entered into in 1979 and 1980 to develop a mutually agreeable operating plan for the Rio Grande Project;
- Addresses concerns brought forth by EBID regarding lack of formal operating rules and the *ad hoc* nature of prior operating practices;
- Addresses concerns brought forth by EPCWID regarding lack of carryover accounting under prior operating practices; and
- Addresses concerns brought forth by EPCWID regarding potential effects of conjunctive use of groundwater and surface water within EBID on Project deliveries to downstream points of diversion.

Starting in 2008, Rio Grande Project has been operated according to the procedures defined in the OA. The analysis presented in this chapter evaluates the

effects of the OA on Project operations, including storage, allocation, release, and diversion of Project water. Effects of the OA for the period 2008-2012 were evaluated by comparing historical (actual) Project operations during this period under the OA to estimated Project operations that would have occurred during this period had the Project been operated according to the standard operating practices that were in place prior to the OA. Potential effects of the OA for the period 2013-2015 were then evaluated by developing and comparing probability distributions of estimated Project operations during this period under the OA and under prior operating practices.

The results presented here suggest that the effects of the OA on overall Project releases and deliveries during the period 2008-2012 were generally minor when averaged over this period. Average annual Project releases and diversions were very similar during this period under both operating procedures, and project storage at the start and end of irrigation season exhibits little change, particularly for years 2011 and 2012. Similarly, annual Project allocations and diversions to Mexico are generally similar under the OA compared to estimated allocations and diversions under prior operating practices.

Effects of the OA on annual allocations to EBID and EPCWID vary between years. The estimated Total Diversion Allocations to EBID under prior operating practices for 2009, 2010, and 2011 are nearly identical to the district's actual allocations under the OA for these years; by contrast, Total Diversion Allocation to EBID is notably greater under prior operating practices for 2008 and 2012. Overall, the OA resulted in an estimated decrease in average Annual Allocated Water of 55,760 AF (22%) and an estimated decrease in average Total Diversion Allocation of 47,138 AF (17%). The estimated difference in average Annual Allocated Water for the period 2008-2012 is thus equal to approximately 10% of the district's historical full allocation under prior operating practices.

The Total Diversion Allocation to EPCWID was substantially greater under the OA for years 2008-2011 and similar for 2012 compared to estimated allocations under prior operating practices for these years. However, it should be noted that differences in Total Diversion Allocation result primarily from differences in EPCWID's Accrued Carryover Balance, which is included in the district's Total Diversion Allocation for multiple years. Differences in Annual Allocated Water are much smaller, particularly for years 2010-2012 when Annual Allocated Water under the OA was very similar to estimated values under prior operating practices. Overall, the estimated increase in average Annual Allocated Water to EPCWID for the period 2008-2012 is 55,059 AF (28%), which corresponds to approximately 15% of the district's historical full allocation under prior operating practices.

The effects of the OA on Project operations during the period 2013-2015 will depend on annual inflows to Project storage and annual Project diversion ratios during this period, as well annual diversions by EBID, EPCWID, and Mexico. In

general, annual allocations to EPCWID are greater under the OA compared to prior operating practices. However, if wetter conditions occur during this period and Project performance returns to historical levels reflected by the D-2 Curve, then the total diversion allocation to EPCWID may be up to approximately 10% lower under the OA than under prior operating practices. Project allocations to EBID during the 2013-2015 period are likely to be approximately 10% to 15% less under the OA than under prior operating practices if dry or normal water supply conditions occur during this period. If wetter conditions occur, the difference in allocation to EBID between the OA and prior operating practices is highly dependent on Project performance. If wetter conditions coincide with higher Project performance, annual allocation to EBID will be greater under the OA, with increases up to 35% for a Project diversion ratio of 1.3; if wetter conditions coincide with low Project performance, allocation to EBID will be lower under the OA, with decreases up to 45% for a Project diversion ratio of 0.8.

As noted above, one of the key principles underlying the OA is the need to account for effects of groundwater pumping and other factors within the Project and surrounding areas on Project performance with respect to the delivery of Project water from storage to authorized points of diversion. The diversion ratio provision of the OA adjusts Project allocations to EBID and EPCWID to mitigate potential negative effects of changes in Project delivery performance on Project allocations and deliveries to EPCWID. Consideration of the effects of the OA on Project allocations therefore warrants consideration of changes in Project performance and corresponding shortfalls in Project deliveries.

Groundwater pumping within the Project and surrounding areas began in the 1950s and increased steadily during subsequent decades. Groundwater pumping is under the jurisdiction of the states, not the Federal project. However, it is widely recognized that groundwater pumping within the Project and surrounding areas depletes surface waters within the basin by inducing flow from the surface water into the groundwater system to replenish the pumped water, thereby decreasing the amount of water that the Federal project is able deliver to its constituents.

Previous studies suggest that changes in Project performance are largely driven by groundwater pumping within the Rincon and Mesilla Valleys. Groundwater pumping for irrigation is the largest component of groundwater demand in the region, particularly during dry years. In 2005, the New Mexico Office of the State Engineer estimated that groundwater pumping for irrigation in the Rincon and Mesilla Valleys in New Mexico, the majority of which occurs within EBID to supplement Project surface water supplies, is between 200,000 and 300,000 AF/year in dry years. Similar estimates of pumping for irrigation in the Texas portion of the Mesilla Valley range from 18,000 and 22,000 AF/year under dry conditions.

Since groundwater pumping for supplemental irrigation in the New Mexico portion of the region is approximately an order of magnitude greater than in the Texas portion of the region, it is reasonable to conclude that the majority of the effects of groundwater pumping on Project performance result from pumping within New Mexico, the majority of which occurs by individual landowners within EBID as permitted and regulated by the State of New Mexico. In addition, as described in Section 4.4, recent changes in cropping and irrigation practices and other factors by individual landowners within EBID have likely contributed to changes in recharge and groundwater pumping that further impact Project performance. The diversion ratio 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.

Shortfalls in Project deliveries due to recent deviations in Project performance can be estimated by comparing the annual gross Project diversion for a given year to the corresponding baseline annual diversion calculated using the D-2 Curve (see Sections 2.4 and 3.1.2). The D-2 Curve is a linear regression equation that represents the historical relationship between annual Project releases and annual gross diversions at river headings. For a given annual release, the D-2 Curve calculates the annual gross diversion that can be delivered to Project headings under historical baseline performance conditions. The D-2 Curve was developed using historical Project operations data for the period 1951-1978 and therefore reflects the effects of groundwater pumping on Project performance during this period; shortfalls estimated with respect to a D-2 baseline therefore reflect the change in shortfall of Project deliveries compared to the period 1951-1978, rather than the total shortfall caused by groundwater pumping.

Analysis of historical Project diversions indicates that Project deliveries remained consistent with the D-2 baseline throughout the period 1980-2002. These results suggest that the D-2 curve is a reasonable depiction of baseline conditions that prevailed throughout more than 40 years of Project operation. Beginning in 2003, however, Project deliveries are substantially below the D-2 baseline. Analysis of groundwater trends within the Project and surrounding areas indicates widespread and significant declines in groundwater elevations also became prevalent in the Rincon and Mesilla Valleys around this time. Both Project performance and groundwater elevations throughout much of the Rincon and Mesilla Valleys have continued to decline over recent years.

Historical (actual) annual Project releases and gross diversions for the period 2008-2012 are shown in Figure 3.3-1, along with corresponding baseline diversions calculated using the D-2 Curve; values shown in Figure 3.3-1 are provided in Table 3.3-1. Actual diversions were substantially below the D-2 baseline in all years, with an average annual shortfall of 148,357 AF/year below the D-2 level. Under prior operating practices, shortfalls would have been

apportioned between EBID and EPCWID according to the authorized acreage within each district (i.e. 57% to EBID and 43% to EPCWID). For 2008-2012, the average annual delivery shortfall under prior operating practices would thus be - 84,228 AF/year to EBID and -64,128 AF/year to EPCWID.

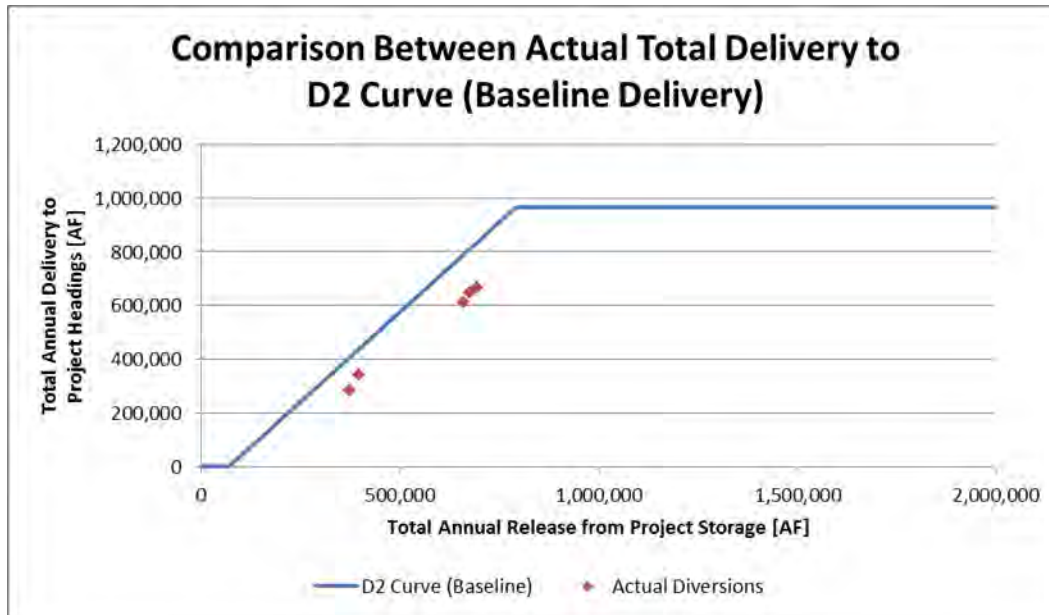


Figure 3.3-1: Historical (actual) gross Project diversions to EBID, EPCWID, and Mexico over the period 2008-2012 compared to the D-2 Curve.

Table 3.3-1: Annual Project Releases, Diversions, and Estimated Depletions (2008-2012)

Year	Annual Release	Annual Gross Diversion (Actual)	Annual Gross Diversion (D-2 Curve)	Estimated Shortfall
2008	674,724	645,870	812,675	-166,805
2009	694,199	667,554	838,729	-171,175
2010	660,300	612,357	793,378	-181,021
2011	396,876	342,795	440,971	-98,176
2012	372,600	283,886	408,494	-124,608
Average	559,740	510,492	658,850	-148,357

Under the OA, effects of groundwater pumping on Project diversions are accounted for by adjusting allocations to EBID and EPCWID according to the diversion ratio provision. The diversion ratio provision adjusts the annual Project allocation to EPCWID to maintain the district's D-2 baseline diversion. The annual Project allocation to EBID is then adjusted to reflect current-year Project

performance as reflected by the diversion ratio. When the diversion ratio is high, EBID generally receives an increase in allocation compared to the D-2 baseline; when the diversion ratio is low, EBID generally receives a decrease in Project allocation compared to the D-2 baseline.

The average annual allocation to EPCWID during the period 2008-2012, excluding carryover balance, was 61,114 AF/year greater under the OA than the estimated allocation under prior operating practices, whereas the average annual allocation to EBID during this period, excluding carryover balance, was 61,816 AF/year less under the OA than under prior operating practices. The estimated increase in allocation to EPCWID is therefore approximately equal to the district's estimated shortfall during this period with respect to the D-2 baseline. The estimated increase in allocation to EPCWID is accounted for by a corresponding decrease in allocation to EBID. In the years covered by this EA, 2013-2015, the same principles apply, and the diversion ratio is likely to be similar to the diversion ratio experienced in recent years. Therefore, EPCWID is likely to continue to experience increases in annual allocation, and EBID is likely to continue to experience decreases in annual allocation, in magnitudes that reflect the shortfalls in EPCWID deliveries relative to the D-2 baseline.

Further analysis is required to address the key uncertainties and limitations of current analysis discussed in Sections 3.1.5 and 3.2.3. In particular, further analysis is required to accurately quantify the effects of groundwater pumping on Project operations, including total Project diversions and the Project diversion ratio. Moreover, further analysis is also required to accurately assess the whether the diversion ratio provision of the OA, which adjusts the annual allocation to EBID based on current-year Project performance as reflected by the diversion ratio, effectively accounts for the effects of groundwater pumping by EBID on total Project diversions. Accurate quantification of these aspects of the OA will likely require simultaneous consideration of Project operations, conveyance and irrigation practices within the districts, and groundwater-surface water interactions throughout the Project and surrounding areas using an integrated numerical modeling approach.

4 Analysis of Groundwater Resources

Irrigation within the Rio Grande Project relies on conjunctive use of groundwater and surface water. Previous studies have shown that interactions between groundwater and surface water play an important role in the hydrology of the Project area, particularly within the Rincon and Mesilla Valleys. Changes in Project operations thus have the potential to affect groundwater recharge and use within the Project; conversely, changes in groundwater use within the Project have the potential to affect Project operations, including seepage losses, return flows, and total Project deliveries.

As noted in Chapter 2, groundwater pumping is not an authorized function of the Rio Grande Project, and Project operations neither include nor directly affect groundwater use within the Project and surrounding areas. However, due to the hydraulic connection and resulting interaction between groundwater and surface water resources within the Lower Rio Grande Basin, it is necessary to consider potential (indirect) effects of the OA on groundwater resources within the Project in order to fully assess the potential effects of the OA.

For the purposes of this study, previous studies of groundwater use and groundwater-surface water interaction within the Lower Rio Grande Basin were reviewed to develop a qualitative understanding of groundwater-surface water interaction in the Basin and the potential effects of the OA on groundwater resources. Analysis was then carried out to characterize fluctuations in groundwater elevation within the Project over the past several decades. Analysis utilized available historical measurements of groundwater elevations from monitoring wells throughout Project and surrounding areas within the Rio Grande hydrologic basin to address three primary questions:

- (1) Do observed groundwater elevations exhibit significant positive or negative trends over recent decades; and
- (2) Are observed fluctuations in groundwater elevation significant correlated with project operations over recent decades?
- (3) Has the Rio Grande become hydraulically disconnected from the underlying aquifer during the past decade?

By addressing the above questions, this analysis helps to clarify the context within which potential effects of the OA on groundwater resources should be considered.

In addition to addressing the questions outlined above, potential effects of the OA on groundwater recharge and demand within the Project were also evaluated, along with potential effects on the overall condition of groundwater aquifers and groundwater-surface water interaction within the Project and surrounding areas. Order of magnitude estimates of changes in groundwater recharge and groundwater demand for supplemental irrigation were developed based on assumptions used in previous studies. Despite the uncertainties inherent in these assumptions, the resulting order of magnitude estimates provide a reasonable basis for considering the potential effects of the OA on groundwater resources within the Basin. Additional consideration of potential effects of changes in cropping and irrigation practices are based on the previous studies indicating the strong connection between Project operations, irrigated agriculture, and groundwater recharge and demand within the Basin. The predominately qualitative evaluation presented here is sufficient to draw conclusions regarding the potential effects of the OA on groundwater resources within the Project and surrounding areas.

Due to the short timeline of the Supplemental EA, the evaluation of potential effects on groundwater resources presented here is predominately qualitative. Quantitative evaluation of effects on groundwater resources will require the use of sophisticated numerical groundwater models that are capable of simulating the many complex and interrelated factors that affect groundwater resources within the Rincon and Mesilla Valleys. The use of such a sophisticated modeling approach, however, will require a substantial amount of time to develop, verify, apply, and analyze and is therefore beyond the scope of the current study due to the time constraints of the Supplemental EA. Reclamation is committed conducting further analysis of the potential effects of the OA on groundwater resources and groundwater-surface water interaction within the Rincon and Mesilla Valleys in the future. Future analysis will consider the effects of the OA relative to other factors that affect groundwater resources in the area. Moreover, future analysis will utilize the best available data and methods, including the use of numerical groundwater models to quantify changes in groundwater head distribution, aquifer mass balance, and groundwater-surface water interaction. The predominately qualitative evaluation presented here is sufficient to draw conclusions regarding the potential effects of the OA on of groundwater resources within the Project and surrounding areas.

Groundwater resources within the Rio Grande Project and adjacent areas are briefly reviewed in Section 4.1, and historical groundwater use within the region is summarized in Section 4.2. Quantitative analysis of trends in groundwater elevation within the Project and surrounding areas and their relationship to Project operations is summarized in Section 4.3, and a predominately qualitative assessment of the potential effects of the OA on groundwater recharge and demands is presented in Section 4.4. Conclusions regarding potential effects of the OA on groundwater resources are provided in Section 4.5.

4.1 Overview of Groundwater Resources

Groundwater is an important source of water supply for agricultural, domestic, and municipal uses in the Rincon Valley of New Mexico, the Mesilla Valley of New Mexico and Texas, and the El Paso Valley of Texas. The Rincon Valley extends from below Caballo Dam to a narrow gap approximately 10 river miles upstream of Radium Springs, NM. The Mesilla Valley extends from Radium Springs, NM to the El Paso Narrows, located within the City of El Paso, TX, near the New Mexico-Texas-Mexico border. For the purposes of this study, El Paso Valley refers to the low-lying area containing the Rio Grande channel from south of the El Paso Narrows to near Fabens, TX.

The shallow unconfined aquifer systems in the Rincon and Mesilla valleys are hydraulically connected to the Rio Grande; groundwater conditions in these aquifers therefore has the potential to affect Project supply and deliveries. While

the shallow unconfined aquifer system in the El Paso Valley is hydraulically connected to the Rio Grande, the majority of Project diversions and return flows occur upstream of the portion of this aquifer system that is affected by groundwater pumping and therefore are not substantially affected by fluctuations in groundwater conditions in El Paso Valley. This study therefore focuses primarily on groundwater resources in the shallow unconfined aquifer systems in the Rincon and Mesilla valleys.

4.2 Summary of Historical Groundwater Use

Historically, agricultural groundwater pumping within the Rincon, Mesilla, and El Paso valleys was not metered; as a result, reliable records of groundwater pumping for agricultural use are not available. However, estimates of agricultural pumping have been developed based on information regarding crop irrigation requirements, availability of surface water supplies, and estimates of conveyance and on-farm efficiencies. Groundwater pumping from private domestic wells is also not metered; estimates of domestic pumping have been developed largely based on information regarding population and average per capita water use. Groundwater pumping for municipal purposes is metered in the Lower Rio Grande Basin.

Groundwater is the primary source of irrigation water for approximately 7,500 acres within the Rincon and Mesilla Valleys of New Mexico and a supplemental source of irrigation water for approximately 82,000 acres within Rincon and Mesilla Valleys of New Mexico and the Mesilla Valley of Texas, including lands within EBID and EPCWID (see Canal Budget Dataset referred to in Section 3.1.1). At the time of this study, data were not available regarding irrigated acreage within the Mesilla Valley of Texas that relies primarily on groundwater or irrigated acreage within the El Paso Valley of Texas that relies on groundwater as a primary or supplemental source of irrigation water. Total groundwater pumping for irrigation use within the Mesilla Valley of New Mexico and Texas is estimated to be between 50,000 and 100,000 AF/year in years of full Project (surface water) supply; however, pumping for irrigation within the Mesilla Valley is estimated to reach between 200,000 and 300,000 AF/year in years of low Project supply, depending on crop distributions, available surface water supplies, and weather conditions (Barroll 2005). At the time of this study, estimates of groundwater pumping for irrigation were not available for irrigated lands within the Rincon Valley of New Mexico or the El Paso Valley of Texas.

Domestic (self-supplied, private) water use within the Project and surrounding areas is supplied almost exclusively by groundwater. Domestic well use has increased over recent decades as a result of rural development. While domestic groundwater use in the Mesilla Valley is not metered, domestic pumping is currently estimated at approximately 30,000 AF/year (Erek Fuchs, EBID Groundwater Manager, Personal Communication).

Municipal water use within the Rincon and Mesilla valleys is primarily supplied by groundwater; municipal water use within the El Paso Valley is supplied by multiple sources, including surface water, groundwater pumping from the Hueco Bolson groundwater aquifer, which underlies much of El Paso Valley, and groundwater pumping in the Mesilla Valley of Texas and transported to the El Paso Valley. Municipal groundwater pumping within the Mesilla Valley of New Mexico is estimated at approximately 60,000 AF/year, including major municipalities, smaller mutual domestic associations, and commercial and industrial groundwater users (S.S. Papadopoulos & Associates 2007). Municipal groundwater pumping from the Canutillo well field located in the Mesilla Valley of Texas averaged approximately 23,000 AF/year over the recent decade (S.S. Papadopoulos & Associates 2007). At the time of this study, additional information regarding municipal pumping within the Project and surrounding areas is not available.

It should be noted here that the hydraulic connection between surface water and shallow ground-water within the Project, particularly within the Rincon and Mesilla Valleys, was recognized prior to the first Project water deliveries. A 1917 supplemental Congressional authorization for the Project recognized this relationship when it specified excavation of drains that would collect shallow groundwater and deliver it to the river, and thereby augmenting Project deliveries to downstream points of diversion. Return flows supplied by groundwater discharge to drains were subsequently identified as an important component of the total Project water supply in Joint Investigations Report developed in 1938 (National Resources Committee 1938). Notably, water managers throughout the Project have long known that pumping of shallow groundwater for supplemental irrigation did not represent a new or independent supply of water to the basin, but rather represented a change in the method, time, and place of diversion of available Project water supply (Conover 1954).

4.3 Analysis of Historical Groundwater Fluctuations within the Lower Rio Grande Basin

Analysis was carried out to characterize fluctuations in groundwater elevation within the Project and surround areas over the past several decades. Analysis focused on two key aspects of groundwater fluctuations: long-term trends in groundwater elevation within the basin, and correlation between interannual variations in groundwater elevation and Project operations. Analysis utilized available historical measurements of groundwater elevations from monitoring wells throughout Project and surrounding areas within the Rio Grande hydrologic basin to address three primary questions:

- (1) Do observed groundwater elevations exhibit significant positive or negative trends over recent decades; and

- (2) Are observed fluctuations in groundwater elevation significant correlated with project operations over recent decades?
- (3) Has the Rio Grande become hydraulically disconnected from the underlying aquifer during the past decade?

4.3.1 Study Area

This analysis considers lands within the Rio Grande Project and adjacent areas of the Rincon Valley, which is located within New Mexico, and the Mesilla Valley, which extends from New Mexico into Texas. The study area considered here was delineated based on the Rio Grande–Caballo six-digit hydrologic unit defined by USGS and NRCS (see Figure 1.1-1), plus additional lands between the downstream boundary of the hydrologic unit and International Dam. The Rio Grande–Caballo hydrologic unit encompasses all lands draining to the Rio Grande between Caballo Dam (below dam) to the junction of the Mexico, New Mexico, and Texas international boundary (above junction). Additional lands between the junction and International Dam within 2.0km of the Rio Grande were also included in this analysis. For the purposes of this study, only the US portion of the hydrologic unit was considered; lands located within Mexico are not considered here.

4.3.2 Data Sources and Processing

Analysis relied on groundwater data and Project operations data obtained from multiple sources. Data sources, processing, and quality control for each data source used here are briefly summarized below.

Groundwater Data

Groundwater data were obtained from a geodatabase compendium of water resources data developed by the US Geological Survey in cooperation with the New Mexico Interstate Stream Commission (see Burley 2010). The locations of all monitoring wells included in the geodatabase compendium are illustrated in Figure 4.3-1.

A computer script was developed to extract and reformat groundwater measurement records from the geodatabase compendium and reformat data for subsequent analysis. For each groundwater measurement site located within the study area, data were extracted from and reformatted to simple ASCII files which could then be read by other scripts and software packages for processing and analysis. ASCII files consist of 14 header lines containing site information, format information, and delimiting characters, followed by measurement records in tab-delimited column format. A snapshot of a portion of a formatted data file is provided in Figure 4.3.1.


```
#####
site_id:      MES_14R
site_dscr:    Replacement Piezometer
agency:       NMISC-SM2009
data type:    GW
sub type:     WELL
well depth:   44 [ft]
hole depth:   [ft]
elevation:    3866.71 [ft]
dist to RG:   2.79833247627e+003
[lat,lon]:    [3.22283000000e+001,-1.06746400000e+002]
record count: 25
|RECORD|      |DATE|      |GW_ELEV|      |WT_DEPTH|      |UNITS|      |PARAM_ID|
#####
0001  2009-08-15 00:00:00      3844.580000      22.130000      ft      NMISC_1
0002  2009-09-15 00:00:00      3844.710000      22.000000      ft      NMISC_1
0003  2009-10-15 00:00:00      3844.040000      22.670000      ft      NMISC_1
0004  2009-11-15 00:00:00      3843.630000      23.080000      ft      NMISC_1
0005  2009-12-15 00:00:00      3843.610000      23.100000      ft      NMISC_1
0006  2010-01-15 00:00:00      3843.650000      23.060000      ft      NMISC_1
0007  2010-02-15 00:00:00      3843.680000      23.030000      ft      NMISC_1
0008  2010-03-15 00:00:00      3844.610000      22.100000      ft      NMISC_1
0009  2010-04-15 00:00:00      3845.240000      21.470000      ft      NMISC_1
0010  2010-05-15 00:00:00      3844.310000      22.400000      ft      NMISC_1
0011  2010-06-15 00:00:00      3844.040000      22.670000      ft      NMISC_1
0012  2010-07-15 00:00:00      3843.770000      22.940000      ft      NMISC_1
```

Figure 4.3-1: Snapshot of a portion of a formatted data file.

As part of the data extraction procedure, each record was evaluated to determine whether data represent groundwater elevation, given as feet above mean sea level, or groundwater depth, given as feet below ground surface. The measurement unit (elevation vs. depth) is defined by a parameter code associated with each record; however, many records were found to be miscoded. For example, many coded as groundwater elevation were found to have values thousands of feet below the corresponding well depth, suggesting that a value of depth to groundwater was miscoded as groundwater elevation.

To address this issue, a simple screening step was introduced into the extraction script. Records coded as depth to groundwater were checked to ensure that the data value was less 2000.0; if the value was greater than 2000.0, the record was recoded as groundwater elevation. Records coded as groundwater elevation were checked to ensure that the data value was greater than 2000.0; if the value was less than 2000.0, the record was recoded as depth to groundwater. For convenience in subsequent analysis and plotting, formatted data files contain data in both units, where groundwater elevation and depth to groundwater by:

$$D_{gw} = Z_{land} - Z_{gw} \quad (31)$$

In Equation 31, D_{gw} is depth to groundwater, Z_{land} is the land surface elevation at the well location, and Z_{gw} is the groundwater elevation measured in the well; elevations are given in feet above mean sea level and depth is given in feet below ground surface.

More than 4000 groundwater measurements sites were identified within the study area; however, many measurement records are not sufficient for statistical analysis due to a number of data characteristics which result in statistical biases and other limitations. First, data were screened to remove measurement records

with insufficient data, defined here as records with less than 10 measurements taken within the same month over multiple years (e.g., measurements taken in January of years 1990-1999). A threshold of ten measurements was selected because this coincides with the minimum threshold for applying the Gaussian approximation of Kendall's S-score, which is used in the statistical methods applied here.

The statistics used in this analysis are calculated on a monthly basis and then aggregated over all months to obtain the annual value. Months for which less than 10 values were available were removed from analysis. Removal of any given month from the annual statistic is accounted for in the analysis and does not bias the results. Records with at least 10 measurements for a single month were considered for further analysis. The non-parametric statistical methods and corresponding data selection procedures used here allow measurement records with inconsistent and/or infrequent sampling intervals to be included in the analysis without biasing the results provided that the minimum sample size of 10 measurements from the same month over multiple years.

Project Operations Data

Project operations data were obtained from Reclamation's El Paso Field Office. Operations data considered in this analysis include:

- Total annual Project releases from Caballo Dam
- Total annual (gross) Project diversions to EBID, EPCWID, and Mexico

Details of the Project operations data used in this analysis are provided in Section 3.1.1, above. In addition to Project releases and gross diversions, the annual gross diversion ratio (ratio of annual gross diversions to total releases) was included in the correlation analysis presented here. As noted above, comprehensive data regarding Project charges over the period of analysis were not available at the time of this analysis; as a result, the Project diversion ratio (ratio of annual Project charges to total releases) is not considered here (see Sections 1.2 and 3.1.1). The Project diversion ratio is calculated as the ratio of total annual gross Project diversions to total annual Project releases from Caballo Dam.

4.3.3 Methods and Assumptions

Trends in groundwater elevation at monitoring wells within the study area were evaluated to assess whether the available data provided evidence of statistically significant positive or negative trends in groundwater elevations over recent decades. The presence of statistically significant trends would suggest long-term groundwater depletion within the basin, which in turn would suggest that groundwater pumping generally exceeded recharge over recent decades.

Trends were evaluated using the Kendall-Theil Robust Line and the Seasonal Mann-Kendall Test (Hipel and McLeod 2005, Granato 2006). The Kendall-Theil

Robust Line is a non-parametric estimator of the magnitude of the monotonic linear trend in a bivariate (paired) dataset (e.g., groundwater elevation vs. time). The Seasonal Mann-Kendal Test is a non-parametric test of the statistical significance of the monotonic trend in a bivariate dataset. Both statistics are robust against seasonality, non-Gaussian data distributions, and statistical outliers.

Further analysis was conducted to determine whether available groundwater data provided evidence of a direct relationship (correlation) between Rio Grande Project operations and groundwater elevations in the study area. Similar to the trend analysis, the Kendall-Theil Robust Line was used to evaluate the magnitude of the linear relationship between groundwater elevations at each monitoring location and annual Project operations during the corresponding year, and the Seasonal Mann-Kendall Test was used to determine the statistical significance of the linear relationship between groundwater elevation and Project operations. While both of these statistical methods are commonly used to evaluate trends in time series data, the methods are broadly applicable to assessing monotonic behavior of bivariate (paired) datasets. In this case, the methods were used to assess the relationship between groundwater elevation and Project operations rather than groundwater elevation and time.

For this analysis, a significance level of 0.05 was used to identify statistically significant trends and correlations. A significance level of 0.05 indicates that the magnitude of the trend calculated from a given dataset is likely to occur by chance less than 5% of the time.

4.3.4 Uncertainties and Limitations

The interaction between groundwater and surface water in the Lower Rio Grande Basin has been studied intensely for more than fifty years (see S.S. Papadopoulos & Associates 2007 and references therein). The analysis presented here is represents a preliminary statistical analysis of available groundwater data. This analysis relies on previously compiled groundwater monitoring records from numerous sources; the quality of these original data is not known, and no additional quality assessment or control was carried out as part of this analysis.

Statistical analysis of observed groundwater elevations within the Project is challenging due to the characteristics of available groundwater measurements within the study area. Data characteristics such as infrequent and inconsistent sampling intervals, small sample sizes, strong seasonality, and significant serial correlation are evident in most available well records within the study area; each of these characteristics biases classical statistical metrics of trend and correlation. Substantial effort was therefore made to identify records suitable for analysis, and non-parametric statistical methods were used to eliminate biases associated with these challenging data characteristics.

The small sample size available for most monitoring locations contained within the geodatabase compendium significantly limits the statistical analysis that can be carried out in this study. The statistical methods used here are robust against potential biases due to seasonality, non-Gaussian distributions, statistical outliers, and infrequent or irregular sampling intervals. However, these methods—like virtually all statistical methods—suffer from low power at small sample sizes. As a result, while records were screened to ensure that minimum sample size criteria were met, the generally small sample sizes of most records is likely to result in high incidence of type II errors (i.e., failure to reject a false null hypothesis, commonly referred to as a false negative).

4.3.5 Results: Trend Analysis

Figure 4.3-2 illustrates time series of selected wells from within the basin that illustrate the broad range of observed behaviors among measurement records. Details at the top of each panel indicate the depth of each well, its distance from the Rio Grande, and the starting and ending year of the available record. As shown, some measurement records exhibit little variation in groundwater elevation over time, while others exhibit strong fluctuations without any apparent long-term trend. Some wells exhibit obvious trends toward declining groundwater elevations, whereas others exhibit strong trends towards rising groundwater elevations. Figure 4.3-2 also exhibits variations in sampling frequency between wells, as well as variations in sampling frequency at individual wells over time.

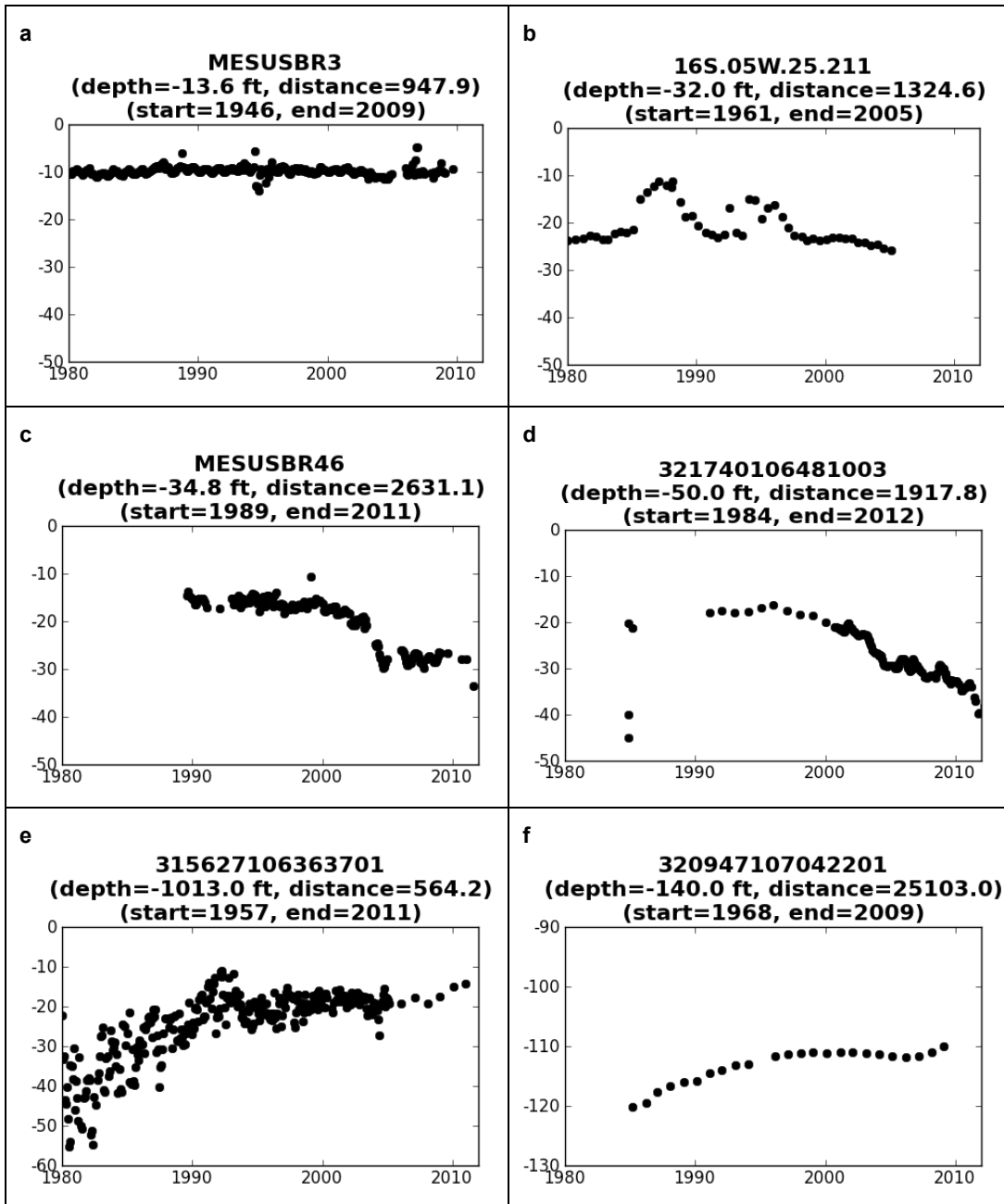


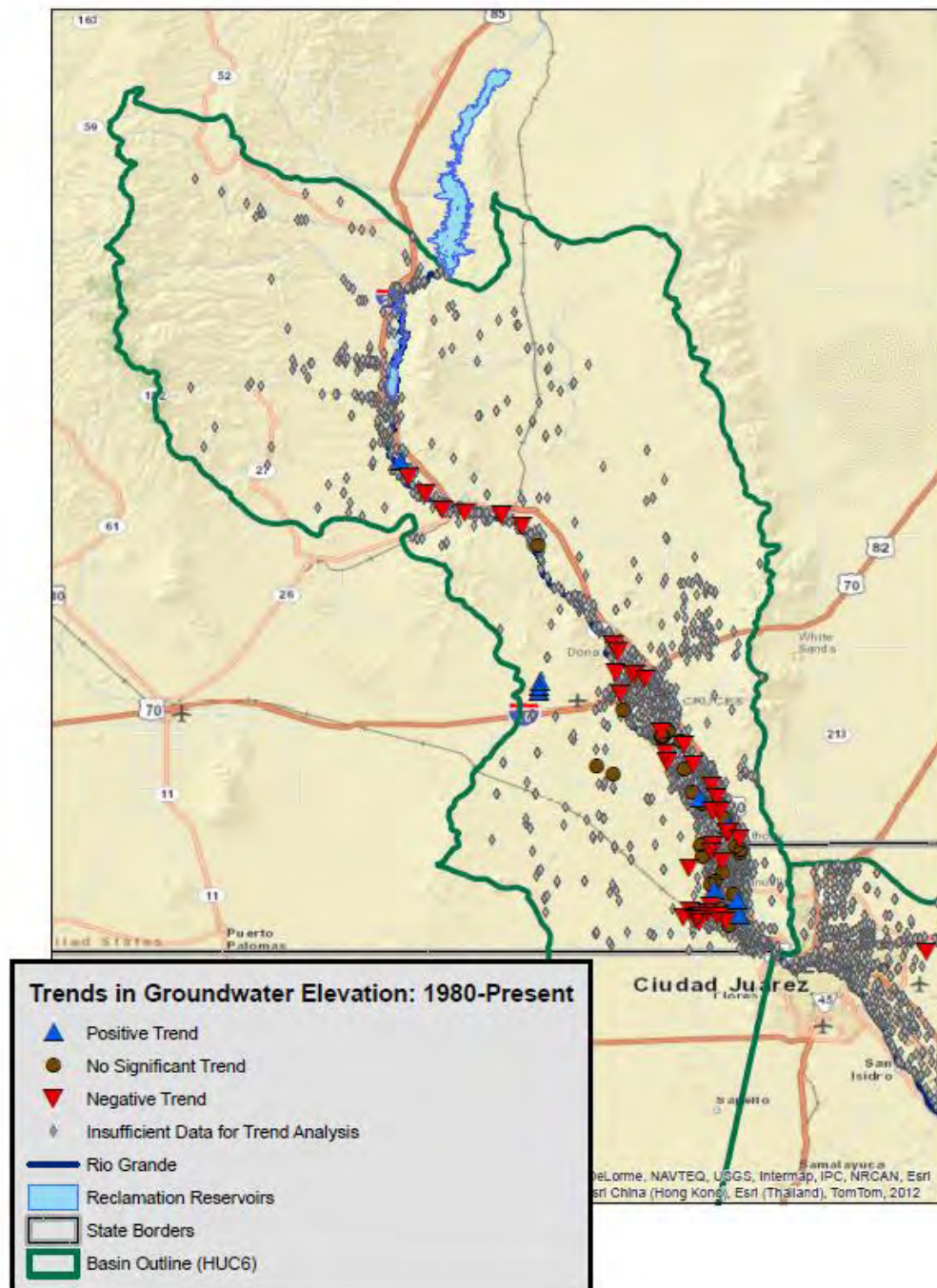
Figure 4.3-2: Example records from selected monitoring wells within the study area exhibiting a broad range of behavior over recent decades presented as groundwater depth below ground surface [feet]. Details at the top of each record indicate the monitoring well identification number, well depth below ground surface, well distance from the Rio Grande, and starting and ending years of the available record.

Results of trend analysis for groundwater measurement sites throughout the basin are summarized in Figure 4.3-3. Red triangles (▼) indicate statistically significant negative trends in groundwater elevation (i.e., declining water table), while blue triangles (▲) indicate significant positive trends (i.e., rising water table); brown circles (●) indicate no significant trend and gray diamonds (◆) indicate measurement sites where insufficient data are available to evaluate trends. The map on the left side of Figure 4.3-3 illustrates trends evaluated over the period 1980-present. Where sufficient data are available for analysis, trends are predominately negative indicating declining groundwater elevations throughout much of the Project area over this period.

In order to assess whether trends are associated with sustained drought conditions in the study area, which began in 2003 and continue through present, trends over the period 1980-present were compared to trends over the period 1970-1999, shown on the right side of Figure 4.3-3. In contrast to the period 1980-present, statistically significant trends over the period 1970-1999 are predominately positive indicating rising groundwater elevations. It should be noted that fewer measurement sites have sufficient data to evaluate trends over the period 1970-1999 compared to the later period.

Results suggest that widespread trends towards declining groundwater levels are a recent phenomenon. Reclamation's El Paso Field Office and Elephant Butte Irrigation District (EBID) indicate that no substantial change in Project operations, district management, or groundwater use within Rincon or Mesilla Valleys occurred between the late 1990s and early 2000s. It is likely that recent groundwater declines are associated with the severe and sustained drought conditions that have affected the Project since 2003; however, the analysis presented here cannot attribute observed trends to any single driver.

a.



b.

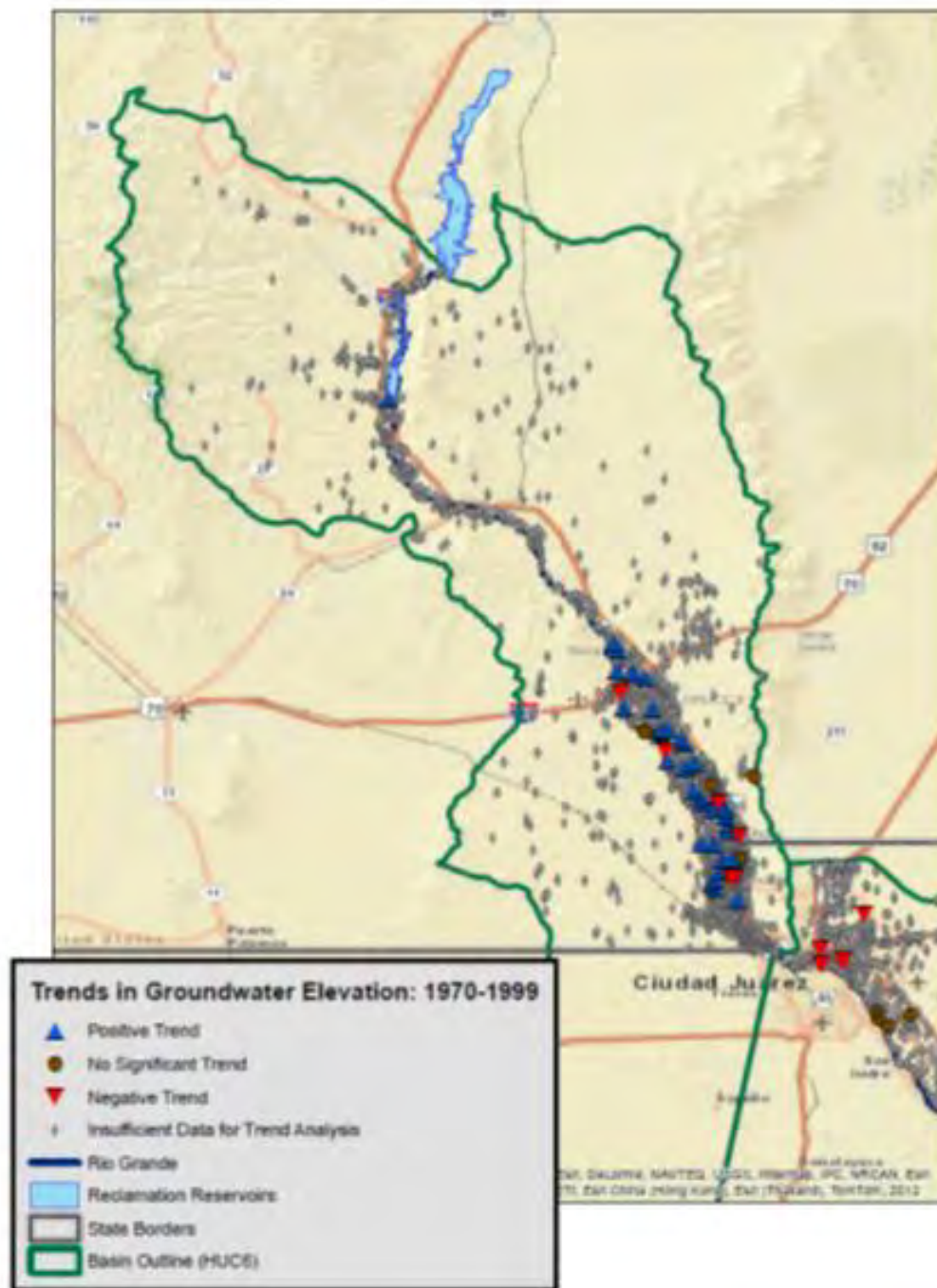


Figure 4.3-3: Trends in groundwater elevation over the periods 1980-present (left) and 1970-1999 (right) based on available groundwater measurements.

4.3.6 Results: Correlation Analysis

Figure 4.3-4 illustrates the relationship between groundwater elevation at a selected well and annual flow below Caballo Dam. Similar to many measurement sites within the study area, the relationship between groundwater elevation and flow below Caballo Dam is noisy, but a general correspondence between higher flows and higher groundwater levels is readily apparent.

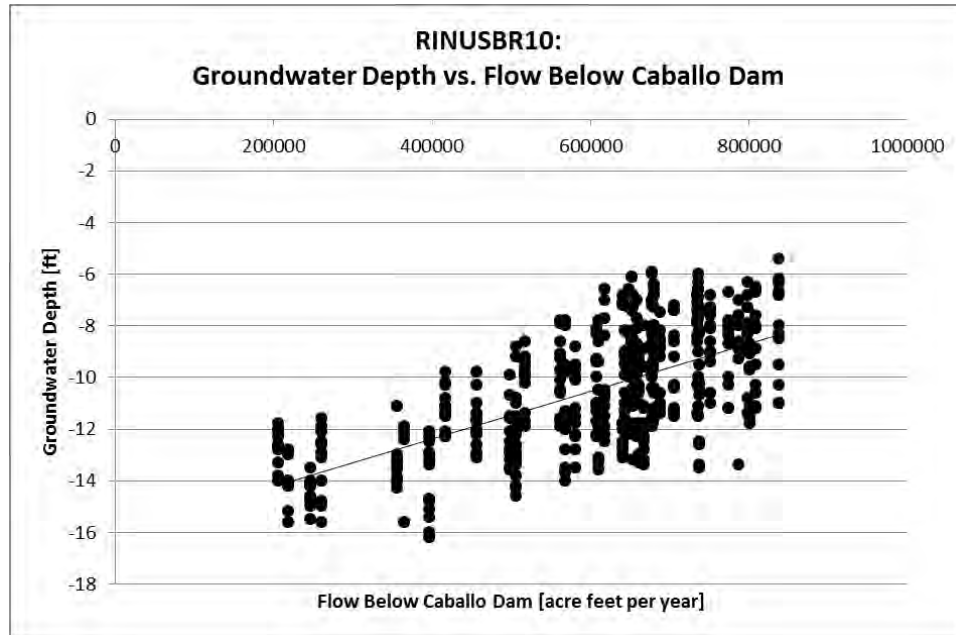
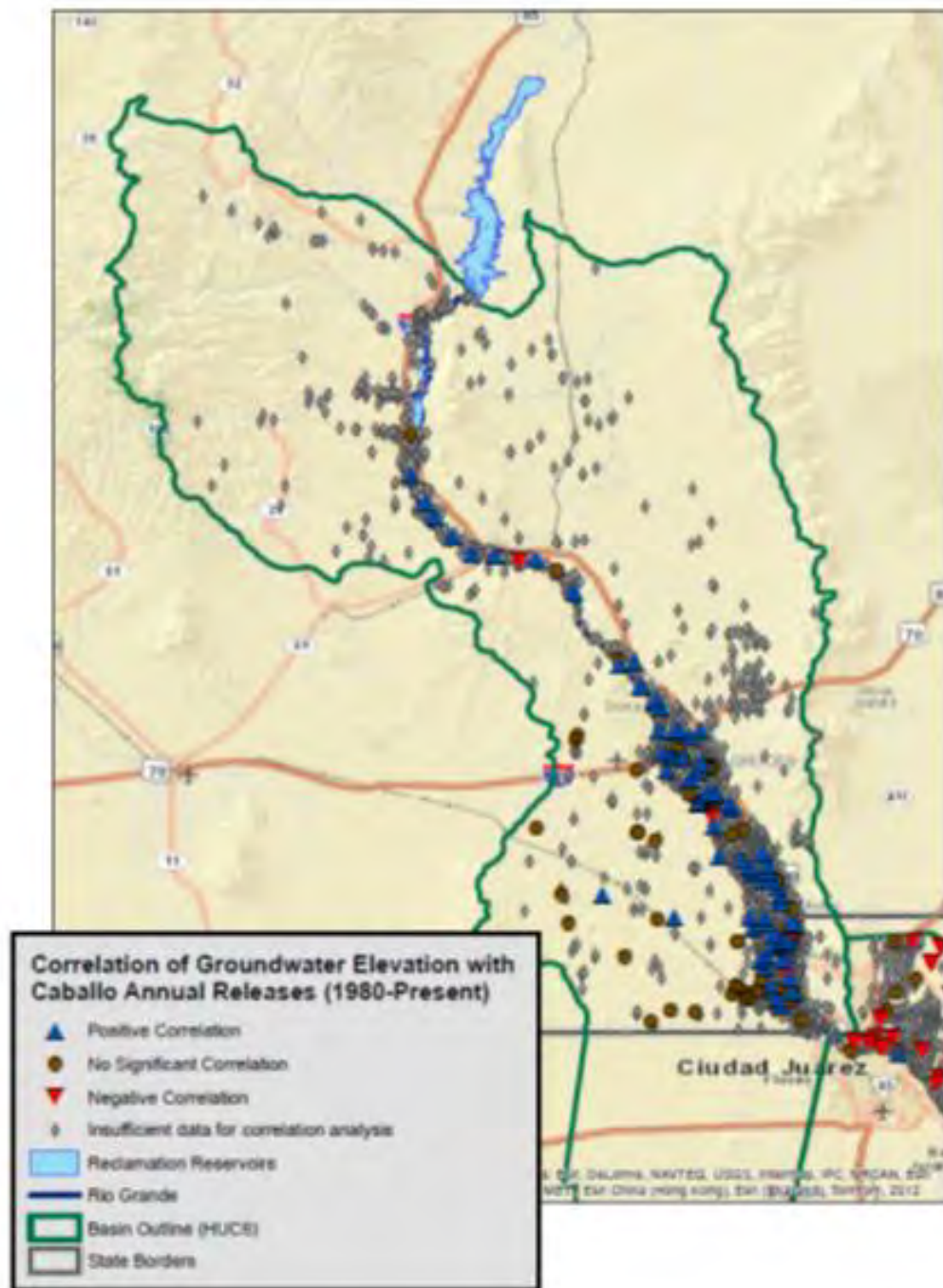


Figure 4.3-4: Groundwater elevation plotted against total annual flow below Caballo Dam for a selected groundwater measurement site. Measurement well is approximately 20ft deep, and measurement site is located approximately 450m from the Rio Grande upstream of Garfield, NM.

Correlation analysis was carried out to assess the relationship between historical fluctuations in groundwater elevations and historical Project operations. Specifically, correlations were evaluated between groundwater levels and three variables representing project operations: total annual flow in the Rio Grande below Caballo Dam, total annual Project diversions, and annual diversion ratio of the Rio Grande Project. Data for annual flow below Caballo Dam and annual Project diversions were obtained from Reclamation's El Paso Field Office; diversion ratio was calculated as the ratio of diversions to releases for each year, where flow below Caballo Dam was used to represent releases.

Results of correlation analysis for annual flow below Caballo Dam and annual diversion ratio for the period 1980-present are shown in Figure 4.3-5. Red triangles (▼) indicate statistically significant negative correlation, while blue triangles (▲) indicate significant positive correlation; brown circles (●) indicate no significant correlation and gray diamonds (◆) indicate measurement sites where insufficient data are available to evaluate correlation.

a.



b.

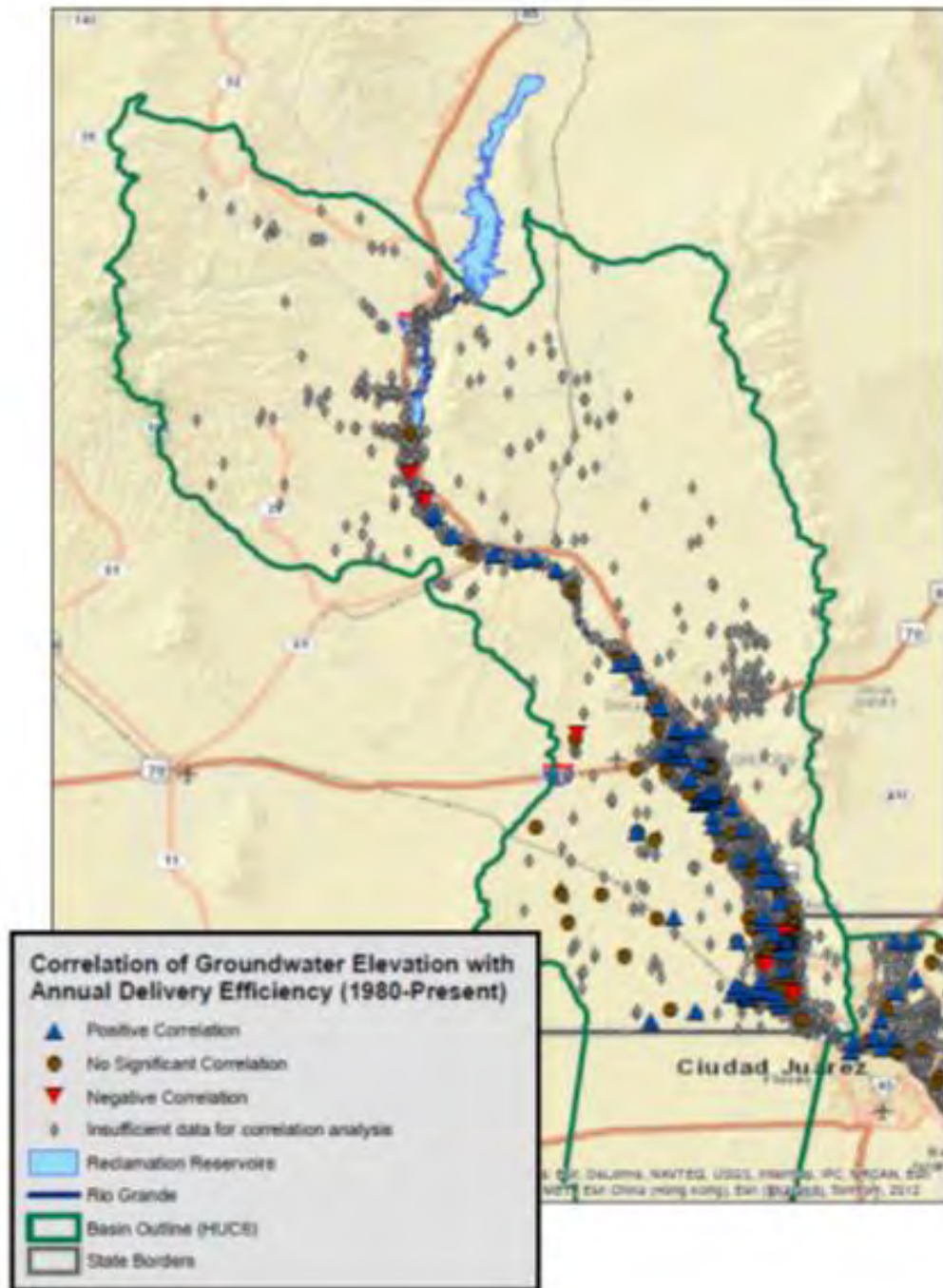


Figure 4.3-5: Correlation of groundwater elevation with annual flow below Caballo Dam (left) and annual diversion ratio (right) over the period 1980-present based on available groundwater measurements.

Results indicate widespread and statistically significant positive correlation of groundwater elevation with annual flow below Caballo Dam and annual diversion ratio; correlation between groundwater elevation and total annual Project deliveries is similar to those for flow below Caballo Dam and therefore is not shown here. Results for annual flow below Caballo Dam are intuitively consistent with conjunctive use of surface water and groundwater within the Project. 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 within the basin, as indicated by numerous previous studies. Correlations between groundwater elevations and annual flow below Caballo Dam are consistent between periods 1960-1989, 1970-1999, and 1980-present, suggesting that correlations are robust and are not significantly affected by the ongoing drought.

Correlation results for diversion ratio are more complicated than those for annual flow and diversions. As shown in Figure 4.3-5, results indicate significant widespread correlation between groundwater elevations and diversion ratio over the period 1980-present. However, correlations over the period 1960-1989 are predominately negative and correlations over 1970-1999 are an approximately even mix of positive and negative correlations. Diversion ratio depends on current-year as well as prior-year conditions within the Project. During a single wet year, it is expected that groundwater elevations will exhibit an increasing trend, resulting in higher groundwater levels in the alluvial aquifer; rising groundwater levels contribute to increased baseflow and decreased stream seepage, therefore increasing the diversion ratio. The converse is expected during a single dry year: groundwater elevations will exhibit a decreasing trend, resulting in declining groundwater levels in the alluvial aquifer, which in turn drive decreasing baseflow, increasing stream seepage, and decreasing diversion ratio. Under either of these conditions, a positive correlation is expected between groundwater levels and diversion ratio.

However, the relationship between groundwater elevation and diversion ratio is more complex when one considers a series of successive wet or dry years. During a series of sustained wet or dry years, groundwater elevations are likely to stabilize, rather than exhibiting a continuous unconstrained rise. As groundwater elevations stabilize, there is little change in diversion ratio from one year to the next. By contrast, groundwater levels may exhibit continuous declines during a series of sustained dry years. Diversion ratio will likely to decrease with declining groundwater levels until the river and underlying aquifer become hydraulically disconnected; at this point, the diversion ratio reaches a relatively stable minimum value and is not affected by further groundwater declines. Moreover, during the transition from wet to dry conditions, changes in groundwater elevation may lag changes in surface water conditions—e.g.,

multiple years of high surface water flows may be required to bring groundwater levels back up to the point where diversion ratio increases. The lagged nature of groundwater-surface water interaction confounds the relationship between groundwater elevation and diversion ratio.

Results suggest that the relationship between groundwater elevation and diversion ratio is complex, and that diversion ratio cannot be estimated directly from changes in groundwater elevation (e.g., through regression). Further analysis is necessary to assess whether a multivariate or lagged regression can represent the relationship between groundwater elevations and diversion ratio.

4.3.7 Results: Hydraulic Connection of Groundwater and Surface Water within the Study Area

Project releases and diversions have fluctuated widely over the last ten years, with a low of 372,600 AF in 2012 and a high of 694,199 AF in 2009. During this period, however, the gross diversion ratio remained consistently between 0.85 and 0.95, excluding 2012 when the gross diversion ratio fell to a low of 0.76. The consistency of the gross diversion ratio despite large fluctuations in Project releases suggests that the surface water network within the Project has become largely hydraulically disconnected from the underlying groundwater system.

Inspection of individual groundwater monitoring wells close to the Rio Grande indicate that groundwater elevations in many stretches of the river have fallen to their lowest values in decades. Other wells, however, do not exhibit a notable decrease in groundwater elevations during the recent decade. More importantly, examination of monitoring records from a limited number of wells with infrequent (monthly and longer) sampling intervals is not sufficient to clearly assess the hydraulic connectivity between the Rio Grande and the underlying groundwater system.

It should also be noted that the gross diversion ratio has continued to decline throughout the past 10 years, reaching a minimum value during the 2012 irrigation season. To the extent that the diversion ratio reflects the effects of groundwater-surface water interaction on Project operations, the fact that the diversion ratio continues to decline suggests that the system continues to exhibit hydraulic connectivity. However, the diversion ratio is also affected by operational factors such as the timing and volume of releases within a given season.

Based on the data available at the time of this analysis, it is not possible to conclusively determine whether the Rio Grande has become hydraulically disconnected from the underlying groundwater system within the Lower Rio Grande Basin.

4.3.8 Summary and Conclusions

Trend analysis demonstrates widespread and statistically significant negative trends in groundwater elevations within the Project and surrounding areas of the Rincon and Mesilla Valleys over the period 1980-present. Significant negative trends suggest declining groundwater levels over this period. However, analysis of previous decades indicates widespread positive trends in groundwater elevation over the periods 1960-1989 and 1970-1999. Results therefore suggest that the occurrence of widespread trends towards declining groundwater levels is confined to the past decade; visual inspection of selected groundwater measurement records confirms this to be the case. These results indicate that sustained groundwater pumping in excess of recharge—i.e., groundwater mining—was not prevalent within the Project or adjacent areas prior to the current drought. Refer to Section 4.1 for further details regarding trends in groundwater elevation.

While recent trends in groundwater elevation are predominately negative, indicating declining groundwater elevations, it should be noted that some wells exhibit no significant trend or significant positive trend over the same period. Trends in groundwater elevation at each measurement site reflect conditions in the vicinity of that site. The prevalence of negative trends suggests that groundwater levels throughout the Project and adjacent areas have generally experienced significant declines over the past decade. The occurrence of no significant trend or significant positive trends at some locations reflects conditions local to that well.

Reclamation's El Paso Field Office and Elephant Butte Irrigation District (EBID) indicate that no substantial change in Project operations, district operations, or groundwater use for supplemental irrigation within the Project or adjacent areas of the Rincon or Mesilla Valleys occurred between the late 1990s and early 2000s. Efforts to increase irrigation efficiency and reduce distribution losses, including lining and piping of portions of the distribution system, may have contributed to recent groundwater declines in some portions of the Mesilla Valley by reducing recharge from deep percolation of irrigation and canal seepage; however, discussion with Reclamation's El Paso Field Office indicates that increases in irrigation efficiency and decreases in distribution losses have not been widespread during this period. It is therefore likely that recent groundwater declines are associated with the severe and sustained drought conditions that have affected the Project since 2003; however, the analysis presented here cannot attribute observed trends to any particular driver.

Correlation analysis indicates widespread and statistically significant positive correlation between groundwater elevation and annual flow below Caballo Dam as well as total annual Project diversions. Correlations are consistent over periods 1960-1989, 1970-1999, and 1980-present, suggesting that correlations are robust under both wet and dry conditions. These results are intuitively consistent with conjunctive use of surface water and groundwater within the Project. 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 within the basin, as indicated by numerous previous studies.

Correlation of groundwater elevations with diversion ratio is more complicated than for annual flow and diversions. Results indicate widespread positive correlation between groundwater elevations and diversion ratio over the period 1980-present; however, correlations over the periods 1960-1989 are predominately negative and correlations over 1970-1999 are an approximately even mix of positive and negative. As detailed in Section 4.2, the relationship between groundwater elevation and diversion ratio is affected by prior-year conditions, which result in a complicated relationship between the two variables that is not well represented by correlation analysis. These results suggest that the relationship between groundwater elevation and diversion ratio is complex, and that diversion ratio cannot be estimated directly from changes in contemporaneous changes in groundwater elevation (e.g., through regression). Further analysis is necessary to assess whether a multivariate or lagged regression can represent the relationship between groundwater elevations and diversion ratio.

The results presented here should be interpreted cautiously. As detailed below, statistical analysis of observed groundwater elevations in the Project and surrounding areas is challenging due to the nature of the available data. In addition, the correlation analysis presented here evaluates the relationship between groundwater elevations at individual measurement sites and Project operations data which represent the Project as a whole. Correlation analysis therefore does not take into account local conditions and confounding factors that may affect groundwater elevations within the vicinity of individual measurement sites.

Finally, the results presented here do not provide conclusive evidence that the Rio Grande, the network of agricultural drains that extends throughout the Project and surrounding agricultural lands, or portions thereof have become hydraulically disconnected from the underlying groundwater system over recent years. Based on the data available at the time of this analysis, it is not possible to conclusively determine whether the Rio Grande has become hydraulically disconnected from the underlying groundwater system within the Lower Rio Grande Basin.

4.4 Analysis of Effects of the OA on Groundwater Recharge and Use within the Lower Rio Grande Basin

It is widely accepted that groundwater and surface water resources within the Project are hydraulically connected, and therefore that groundwater use is likely to affect Project operations, including Project supplies and Project deliveries to EBID, EPCWID, and Mexico, while Project operations, in turn, are likely to affect groundwater resources, including groundwater recharge and groundwater pumping for supplemental irrigation. However, the extent to which groundwater use affects Project supply and operations, and the extent to which Project operations affect groundwater recharge and supply, remain uncertain. This section provides a predominately qualitative discussion of the potential effects of the OA on groundwater recharge and extraction within the Project.

4.4.1 Groundwater-Surface Water Interactions within the Project

As noted above, infiltration of surface water from the Rio Grande and its tributaries, including canals, laterals, and drains, and deep percolation from irrigated agriculture are the primary sources of groundwater recharge in the Rincon and Mesilla Valleys. Moreover, groundwater pumping for irrigation, groundwater discharge to drains, and direct evapotranspiration of groundwater by crops represent the primary groundwater losses within the Project and surrounding areas. Project operations—i.e., storage, release, and delivery of Project surface water for agricultural and municipal purposes—therefore has a direct effect on groundwater resources within the region.

Conversely, groundwater pumping for agricultural and domestic uses within the Rincon and Mesilla valleys draws water primarily from shallow unconfined aquifer systems that are hydraulically connected to the Rio Grande and the network of drains that extends throughout the Project. Previous studies have shown that as a result of this hydraulic connection, groundwater pumping within the Rincon and Mesilla Valleys results in increased seepage losses from the Rio Grande, decreased groundwater discharge to drains, and thus a decrease in available surface water supplies. Groundwater pumping for agricultural and domestic purposes therefore has a direct effect on surface water resources within the region.

Beginning in the 1950s, irrigated agriculture within the Rincon and Mesilla Valleys has benefitted from conjunctive use of surface water and groundwater resources, with shortages in Project surface water supplies being made up for by groundwater pumping and the seepage losses from Project surface water operations, in turn, providing recharge to the groundwater system. The hydraulic connection between surface water and shallow ground-water within the Project, particularly within the EBID service area, was recognized prior to the first Project water deliveries. A 1917 supplemental Congressional authorization for the Project recognized this relationship when it specified excavation of drains that would collect shallow groundwater and deliver it to the river, and thereby augmenting

Project deliveries to downstream points of diversion. Return flows supplied by groundwater discharge to drains were subsequently identified as an important component of the total Project water supply in Joint Investigations Report developed in 1938 (National Resources Committee 1938). Water managers have long known that pumping of shallow groundwater for supplemental irrigation did not represent a new or independent supply of water to the basin, but rather represented a change in the method, time, and place of diversion of available Project water supply (Conover 1954).

Accurate quantification of the effects of groundwater use on Project supply and operations, and the corresponding effects of Project operations on groundwater supply and uses, is a significant challenge due to complexity of groundwater-surface water interactions in time and space and the lack of comprehensive (spatial and temporal) data on surface water flows and groundwater pumping over the historical period. Quantification of the effects of the OA on groundwater resources within the Project and surrounding areas is further confounded by the many external factors that affect groundwater use within the basin, including:

- Persistent drought (shortage in usable water available for project allocation)
- Changes in the administration of groundwater rights by the State of New Mexico
- Changes in cropping patterns from low-water-use crops to high-water-use crops
- Improvements in on-farm irrigation efficiency, which affect return flows drain flows and therefore influence the Project diversion ratio
- Population growth, increases in domestic well use and municipal pumping, and urbanization of Project agricultural acreage

The following discussion provides a qualitative discussion of the potential effects of the OA on groundwater recharge and use within the basin.

4.4.2 Potential Effects of the OA on Groundwater Recharge

Previous studies indicate that seepage of surface water from the Rio Grande and from the network of canals and laterals extend throughout the Project and deep percolation of irrigation supplied by surface water are the primary sources of recharge within the Rincon and Mesilla Valleys. As detailed in Section 3.2 of this report, the OA is likely to have a negligible effect on the average annual release from Project storage and the average total annual Project diversion. However, the OA may affect the volume of release and the total diversion during any given year, as well as the distribution of diversions between EBID and EPCWID. Accurate estimation of the likely change in recharge under the OA is a significant

challenge due to the number of interrelated factors that affect recharge within the Project. This section provides a qualitative discussion of the potential effects of the OA on two key sources of recharge: recharge due to seepage of Project surface water from the Rio Grande, and recharge due to seepage and deep percolation of Project water within the districts.

Recharge due to Seepage of Project Surface Water from the Rio Grande

Changes in the distribution of Project diversions between EBID and EPCWID are likely to affect the volume of recharge occurring as seepage losses from the Rio Grande. In the case that EBID receives a larger portion of the total Project diversions, water is diverted from the Rio Grande higher in the system; in the case that EPCWID receives a larger portion of the total diversion, water is diverted from the Rio Grande lower in the system. It is likely that seepage from the river would be greater in the latter case as the volume of water in the river would be greater over a longer stretch of river, which in turn would support increased seepage over a longer stretch. In general, the OA results in a decrease in Project allocation and deliveries to EBID and an increase in allocation and deliveries to EPCWID. Consequently, the OA will likely result in an overall increase in groundwater recharge from seepage of Project water from the bed of the Rio Grande.

Nevertheless, seepage losses from the Rio Grande depend on the quantity of water in the river, the timing within the season (e.g., early in the season when bed and bank storage are less than full versus later in the season when voids in the porous materials that make up the river bed and banks are fully saturated), as well as the distribution of releases within a given season (e.g., high-volume, short-duration pulse releases versus low-volume, long-duration continuous releases). In addition, seepage losses depend on the spatial distribution of groundwater elevations along the river corridor, which in turn depend on many factors as discussed above. The effects of district return flows on the volume, timing, and location of water in the river also affects seepage from the river channel. As a result, accurate estimation of changes in seepage losses from the Rio Grande under the OA is a significant challenge. It is therefore not possible to reasonably estimate changes in seepage losses from the Rio Grande under the OA based on the data available for this study.

Recharge due to Seepage of Project Surface Water from the Rio Grande

Changes in Project diversions to EBID and EPCWID are likely to result in changes in the timing, location, and quantity of groundwater recharge within each district, respectively. A decrease in Project diversions to either district will result in decreased recharge within the district due to seepage losses from canals and laterals, along with decreased recharge within the district from deep percolation of surface water irrigation. An order of magnitude estimate of the change in recharge within a district due to a change in Project deliveries to the district can be calculated based on the estimated conveyance efficiency (f_{canal}) and on-farm irrigation efficiency (f_{farm}) within the district.

The canal conveyance efficiency is the fraction of the gross diversion at river headings and is ultimately delivery to farms, excluding evaporation and seepage losses from canals and laterals. District-average canal conveyance efficiency is given by Equation 32:

$$f_{canal} = \frac{D_{farm}}{D_{gross}} \quad (32)$$

Where D_{gross} is a district's gross diversion at river headings (i.e., gross Project diversion) and D_{farm} is the district's total surface water delivery to farms. The on-farm irrigation efficiency represents the fraction of applied irrigation water that goes to meeting crop irrigation requirements, excluding losses to evaporation, deep percolation to groundwater, and surface runoff (tailwater). District-average on-farm irrigation efficiency is given by Equation 33:

$$OFE = \frac{ET_{crop}}{D_{farm} + \Delta S} \quad (33)$$

Where ET_{crop} is total evapotranspiration by crops within the district (i.e., beneficial consumptive use) and ΔS is the change in soil moisture storage aggregated over the district. The volume of groundwater recharge from Project water within a district can then be estimated using Equation 34:

$$Q_{recharge} = D_{gross} \cdot (1 - f_{canal}) + D_{gross} \cdot (f_{canal}) \cdot (1 - f_{farm}) \quad (34)$$

Average seepage losses from EBID canals and laterals between the river heading and farm gates range from approximately 35% under wet conditions to approximately 55% under extreme dry conditions, corresponding to canal conveyance efficiencies of 0.65 and 0.45, respectively (J.P. King, Professor and Associate Department Head, New Mexico State University, personal communication, May 3, 2012). These estimates are generally consistent with estimated seepage losses provided in the Canal Budget dataset previously developed by NMOSE and updated by USGS (see Section 3.1.1 under Annual Project Cropping Data). The Canal Budget dataset also provides estimates of district-average on-farm irrigation efficiencies for EBID and for the portion of EPCWID located in Mesilla Valley. Estimated on-farm irrigation efficiency ranges from 0.59 prior to widespread adoption of laser leveling in the early 1980s to a maximum achievable efficiency of 0.70 under recent cropping and irrigation practices. Estimated conveyance and on-farm efficiencies for EPCWID lands within El Paso Valley are not currently available.

An order of magnitude estimate of the change in groundwater recharge within EBID can be calculated based on these previous estimates of conveyance and on-farm irrigation efficiency combined with the estimated difference in average annual diversion to EBID under the OA compared to prior operating practices for the period 2008-2012 (see Section 3.2). The estimated change in average annual net diversion to EBID (i.e., gross diversion minus credited return flows) under the

OA is 62,093 AF/year. The corresponding estimated change in average annual groundwater recharge within the district from Project surface water ranges from a decrease of 33,841 AF/year under high conveyance and on-farm efficiencies to 45,607 AF/year under low efficiencies. Change in recharge within EPCWID under the OA is not considered here due to the lack of available estimates of on-farm and conveyance efficiencies for the district.

The estimated change in recharge under the OA is highly uncertain at this time, and that the estimated change provided here should be considered an order of magnitude estimate only. Actual change in recharge is likely to vary widely between years depending on Project diversions by each district, actual district operations, and actual cropping and irrigation practices within the district for that year. Conveyance efficiency is likely to vary within a district due to differences in the construction, condition, and operation of canals and laterals across the district, as well as differences in underlying soils and underlying groundwater elevations. Similarly, on-farm irrigation efficiency is likely to vary widely within a district due to differences in irrigation methods, scheduling, and operations between individual farms. Differences in crops, soil types, and underlying groundwater conditions are also likely to contribute to variations in on-farm irrigation efficiency within a district. Efficiencies may also vary in time due to variations in hydrologic conditions (e.g., groundwater elevations, wetting and drying of canals and laterals, etc.), district operations, and cropping and irrigation practices over time.

Detailed information regarding variations in conveyance and on-farm efficiencies within each district is not available at this time. For the purposes of this study, previous estimates of district-average conveyance efficiency and on-farm irrigation efficiency are used here. In addition, no information is currently available regarding the percentage of conveyance and on-farm losses that occur as evaporation verses losses that occur as seepage and deep percolation, or the portion of canal seepage losses that ultimately reaches the groundwater table. For the purposes of this study, evaporative losses are assumed to be negligible compared to seepage losses and all seepage losses are assumed to reach the water table (i.e., all seepage losses are assumed to contribute to recharge). These assumptions likely result in overestimation of the change in average annual recharge within EBID under the OA.

4.4.3 Potential Effects of the OA on Groundwater Demand

As noted above, groundwater demands within the Project and surrounding areas include pumping for supplemental and primary (groundwater-only) irrigation, pumping for private domestic uses, and pumping for municipal and industrial uses. Project supply and operations has no effect on pumping for private domestic uses or pumping for primary (groundwater-only) irrigation use. Moreover, Project supply and operation have no effect on municipal uses in the Rincon and Mesilla Valleys of New Mexico or the Mesilla Valley of Texas. Because EPWU obtains Project surface water under contract with EPCWID, changes in Project allocations

and deliveries to EPCWID may affect groundwater pumping for municipal purposes in Texas, including pumping from the Canutillo Well Field in the southern Mesilla Valley in addition to pumping from the Hueco Bolson within El Paso Valley. The primary potential effects of Project supply and operations on groundwater demand, however, are effects on groundwater use for supplemental irrigation within the Rincon and Mesilla Valleys of New Mexico.

Where groundwater is used to supplement Project surface water supplies, groundwater demand depends on the total surface water delivery to a given farm and the total farm delivery required in order satisfying the crop irrigation requirement given the on-farm irrigation efficiency for that farm. Assuming that groundwater is used for supplemental irrigation throughout Project lands in the Rincon and Mesilla Valleys, the potential effect of the OA on groundwater demand can be estimated as equal to the incremental change in Project surface water delivery to farms within the valleys.

Based on the estimated change in net Project diversions to EBID under the OA (see Section 3.2.1) and the estimated range of conveyance efficiencies noted above (see Section 4.4.3), the estimated change in average annual surface water deliveries to farms within EBID under the OA for the period 2008-2012 is between 27,942 AF/year assuming low conveyance efficiency and 40,360 AF/year assuming high conveyance efficiency. Based on previous estimates of groundwater pumping for supplemental irrigation during drought conditions (Barroll 2005), it is estimated that the OA resulted in an increase in groundwater demand for supplemental irrigation of between 9% and 20% compared to estimated demand under prior operating practices. Given that supplemental irrigation demand is likely to have been near the high end of the estimated range during this period due to severe drought conditions, and given that conveyance estimated efficiency is lowest during dry periods, it is appropriate to conclude that the OA likely resulted in an increase in groundwater demand for supplemental irrigation of approximately 10% during the period 2008-2012 compared to prior operating practices. Similar to estimated effects of the OA on groundwater recharge, however, estimated effects on groundwater demand for supplemental irrigation are highly uncertain due to the numerous interrelated factors that affect groundwater use within the Project.

The annual allocation models used in this study do not distinguish between EPCWID diversions in Mesilla Valley and El Paso Valley. The analysis presented here (see Section 3.2) therefore does not provide an estimate of the change in Project diversions serving EPCWID lands within the Mesilla Valley under the OA. In addition, groundwater use by EPCWID in El Paso Valley is subject to water quality constraints and other factors that are not reflected in this analysis. As a result, it is not possible to reasonably estimate the change in supplemental irrigation pumping within EPCWID. However, it should be noted that because EPCWID receives an increase in annual average allocation and deliveries under the OA, it is reasonable to conclude that groundwater demand for supplemental

irrigation pumping within the district decreases under the OA. In addition, to the extent that increased allocation to EPCWID results in increased sale of Project water to EPWU, it is reasonable to conclude that groundwater demand for municipal purposes in the City of El Paso are also likely to decrease under the OA.

4.4.4 Summary and Conclusions

As discussed in this section, Project operations have the potential to affect groundwater recharge and groundwater demand for supplemental irrigation within the Project, and to a lesser extent for municipal uses by EPWU. In general, an increase in Project allocation and surface water diversions to either district is expected to result in a corresponding increase in groundwater recharge from canal seepage and deep percolation of irrigation water within that district, along with a corresponding decrease in groundwater demand for supplemental irrigation. Conversely, a decrease in Project allocation and diversions to either district is expected to result in decreased groundwater recharge within the district and increased groundwater demand for supplemental irrigation.

Changes in recharge under the OA compared to prior operating practices depend on numerous interrelated factors, including:

- Project supply, allocations, and deliveries to EBID, EPCWID, and Mexico
- Timing and volume of releases from Project storage
- Location of Project diversions (e.g., distribution of gross diversions between EBID, EPCWID, and Mexico)
- Operation and maintenance of surface water conveyance facilities within the districts (e.g., construction, condition, and operation of individual canals and laterals)
- Cropping and irrigation practices by individual landowners (e.g., crop selection, irrigation methods, and irrigation scheduling)
- Prevailing hydrologic and meteorological conditions (e.g., precipitation, storm runoff, and groundwater elevations during the irrigation season)

It is not possible to address the majority of the factors listed above in this study. However, for the purposes of this study, order of magnitude estimates of the change in recharge from canal seepage and deep percolation of surface water irrigation and the change in groundwater demand for supplemental irrigation pumping within EBID were developed based on broad assumptions regarding conveyance efficiency, on-farm irrigation efficiency, and supplemental irrigation demand within the district. The method used here assumes that the percent change

in groundwater recharge is equal to the percent change in gross Project diversions. The volumetric change in recharge is then calculated from the estimated (volumetric) change in diversion under the OA and the estimated conveyance and on-farm efficiencies within the district. Similarly, the volumetric change in groundwater demand for supplemental irrigation is assumed to equal the volumetric change in total Project surface water deliveries to farms within the district based on the estimated conveyance efficiency.

As discussed above, the assumptions and efficiency values used here are consistent with previous studies. However, it should be emphasized that the estimated changes in groundwater recharge and demand within EBID are highly uncertain at this time. The estimates presented here should therefore be considered order of magnitude estimates only. Project surface water diversions to EBID are estimated to be 62,093 AF/year less on average under the OA than under prior operating practices for the period 2008-2012, corresponding to a relative decrease of 22% under the OA. Based on the range of efficiencies used here, this corresponds to a volumetric decrease in recharge between 33,800 and 45,600 AF/year and a volumetric decrease in surface water deliveries to farms between 27,942 and 40,360 AF/year. The estimated increase in groundwater demand for supplemental irrigation is assumed to equal the estimated decrease in surface water deliveries to farms. This incremental increase in groundwater demand corresponds to an estimated increase of approximately 10% in total groundwater demand for supplemental irrigation within the project.

As noted above, it was not possible to reasonably estimate changes in groundwater recharge and demand within EPCWID under the OA due to the lack of information regarding canal losses and on-farm irrigation efficiencies in portion of EPCWID located within El Paso Valley. In addition, no information is currently available regarding potential changes in groundwater recharge and demands associated with the sale of Project water from EPCWID to EPWU for municipal purposes. However, given that the OA results in an estimated increase in Project diversions to EPCWID during the period 2008-2012, it is reasonable to conclude that the OA has likely resulted in a corresponding increase in groundwater recharge and decrease in groundwater demand within the district during this period.

In many basins, the effects of changes in groundwater recharge and storage are evaluated with respect to the aquifer's firm yield, which is commonly defined as the aquifer yield that is balanced by groundwater recharge and therefore does not result in depletion ("mining") of the aquifer. However, due to the strong interdependence between groundwater and surface water systems within the Project, the firm-yield approach is circular. Seepage from the Rio Grande and Project conveyance facilities and deep percolation of irrigation water have long served as the primary source of groundwater recharge in the basin. Groundwater pumping lowers the water table and increases seepage losses from the river and canals as surface flows recharge the aquifers to replenish the water that has been

extracted by pumping (Maddock 2012). Lowering of the water table due to groundwater pumping can also diminish groundwater discharge to Project drains, which results in decreases in Project surface water supply. Changes in Project operation thus affect surface water and groundwater resources within the basin, as well as interactions between the two. In this case, the concept of firm yield must be adapted to consider firm yield of the total water supply—including both surface water and groundwater—rather than firm yield of the aquifer alone.

In considering the potential effects of the OA on groundwater resources within the basin, it is also important to recognize the OA is just one of many concurrent and interrelated factors currently affecting groundwater resources in the basin. As noted above, groundwater recharge and use are currently being impacted by numerous natural and anthropogenic stressors within the basin, including severe and sustained drought conditions, increasing irrigation demand due to changes in cropping patterns, increasing in on-farm irrigation efficiencies, and increasing municipal and industrial groundwater use associated with a growing population in the area. At this time, it is not possible to quantify the total change in groundwater recharge and demand during the period 2008-2012, nor the portion of that total change that is attributable to the OA. The order of magnitude estimates provided here, however, suggest that incremental changes in groundwater recharge and groundwater demand for supplemental irrigation within the Rincon and Mesilla Valleys during this period were small compared to the total recharge and pumping within the region.

4.5 Discussion and Conclusions

Seepage from the Rio Grande and Project conveyance facilities and deep percolation of irrigation water have long served as the primary source of groundwater recharge in the basin. Groundwater pumping lowers the water table and increases seepage losses from the river and canals as surface flows recharge the aquifers to replenish the water that has been extracted by pumping (Maddock 2012). Lowering of the water table due to groundwater pumping can also diminish groundwater discharge to Project drains, which results in decreases in Project surface water supply. Changes in Project operation thus affect surface water and groundwater resources within the basin, as well as interactions between the two.

In considering the potential effects of the OA on groundwater resources within the basin, it is also important to recognize the OA is just one of many concurrent and interrelated factors currently affecting groundwater resources in the basin. As noted above, groundwater recharge and use are currently being impacted by numerous natural and anthropogenic stressors within the basin, including severe and sustained drought conditions, increasing irrigation demand due to changes in cropping patterns, increasing in on-farm irrigation efficiencies, and increasing municipal and industrial groundwater use associated with a growing population in the area. At this time, it is not possible to quantify the total change in groundwater

recharge and demand during the period 2008-2012, nor the portion of that total change that is attributable to the OA. The order of magnitude estimates provided here, however, suggest that incremental changes in groundwater recharge and groundwater demand for supplemental irrigation within the Rincon and Mesilla Valleys during this period were small compared to the total recharge and pumping within the region.

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Appendix G – Public Comments

Reclamation issued a draft of this supplemental EA for a 30-day public review on May 8, 2013. The initial 15-day comment period ran through May 22, 2013 and, in response to comments received, was extended another 15-days through June 6, 2013. Five comment documents were received during this period resulting in a total of 97 individual comments. To facilitate the review of Reclamation's response to comments, the five comment documents are presented below followed by the response table.

Analysis of the individual comments shows that the greatest public concern was with the Project water supply and how the effects of the alternatives were modeled. There were 39 comments on this topic. The topic of next greatest concern was groundwater, with 18 comments. The NEPA process and how Reclamation would be evaluating significance were of next greatest interest with 8 and 5 comments respectively. The Rio Grande Compact, climate change, water quality, and socioeconomics were also mentioned in the comments, with one to three comments issued by the public.



June 7, 2013

Via Email

Bureau of Reclamation
Albuquerque Area Office
Attn: Jim Wilber
ALB-150, 555 Broadway NE, Ste. 100
Albuquerque, NM 87102
jwilber@usbr.gov

**RE: COMMENTS OF WILDEARTH GUARDIANS ON THE DRAFT
SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR
IMPLEMENTATION OF RIO GRANDE OPERATING PROCEDURES,
NEW MEXICO AND TEXAS DATED MAY 8, 2013**

Dear Mr. Wilber:

This letter is submitted by WildEarth Guardians to provide the Bureau of Reclamation ("Reclamation") with comments on the *Draft Supplemental Environmental Assessment for the Implementation of Rio Grande Operating Procedures, New Mexico and Texas* dated May 8, 2013 ("EA").

WildEarth Guardians is a regional nonprofit environmental advocacy organization dedicated to protecting and restoring the wildlife, wild places and wild rivers in the American West.

A. Background

The original environmental review of the proposed action was made in the Environmental Assessment and Finding of No Significant Impact for the Bureau of Reclamation Federal Rio Grande Project New Mexico-Texas Operating Procedures, Dona Ana, Sierra, and Socorro Counties, New Mexico and El Paso County, Texas ("2007 EA"). The 2007 EA analyzed the operating procedures that are now included in the 2008 Operating Agreement ("OA"). The term of the 2007 EA was 2007-2012.

In the twelve-page 2007 EA/FONSI, Reclamation determined that based on the information and data available in 2007, none of the environmental impacts were anticipated to reach a level of significance as defined in 40 C.F.R. § 1508.27. Reclamation reasoned in the 2007 EA that the proposed action "is essentially a water delivery accounting change which will

not cause deviation from historic parameters of water in storage or in the Rio Grande” and “would not have any significant effect on the human environment.”

WEG-01

Furthermore, the 2007 EA committed Reclamation to collect data during the first five years of implementation of the new operating procedures in order to use it in support of a future environmental analysis of the effected environment. Based on this data, it is apparent that impacts on the environment have occurred despite the findings in the 2007 EA/FONSI, and that substantial questions are raised as to whether the continuation of the proposed action for the short-term (3 years) or long-term (through 2050) pose significant impacts warranting the preparation of an environmental impact statement (“EIS”).

B. Comments on Supplemental Draft EA

WEG-02

1. Scope of Alternatives Inadequate.

The supplemental EA fails to provide a reasonable range of alternatives to meet the purpose and need of the proposed action. The EA only analyzes two alternatives (the proposed action and no action alternative). The EA makes it clear that the no action alternative (1) does not meet the purpose and need of the proposed action and (2) is not a legally viable option because failure to implement the proposed action would result in violation of the terms of the settlement agreement between the parties to the OA. *See* EA at 50. Thus, the analysis simply becomes an exercise in futility because there is no legally valid option in the no action alternative and no other options were presented to the proposed action. Such a one-sided analysis goes against the spirit and mandate of National Environmental Policy Act (“NEPA”).

2. Period of Analysis Arbitrarily Segmented.

The supplemental EA fails to adequately analyze the entire term of the proposed action. The EA was originally intended to analyze the potential impacts of the OA for its entire term through 2050; however, a three-year period from 2013-2015 was arbitrarily used instead. *See* EA at 1. The EA rationalizes segmentation of the analysis as follows:

further analysis and review of the potential effects of implementation of the OA revealed two points: 1) for the period 2013-2015, differences in potential impacts between previous operations of the project under the No Action alternative and the projected operations under the OA are projected to be minimal and insignificant, and 2) based on the available data and analytical tools, we can only reasonably predict potential impacts to the human environment over a limited time frame.

Id. The EA then concludes that based on “uncertainties regarding the persistence of drought conditions and need to improve the analytical tools to detect impacts of the OA” analyzing any period beyond the 2013-2015 period would be “of limited utility.” *Id.*

By choosing this limited period, the proposed action is segmented to prevent the impacts from appearing significant rather than simply studying the entire period and developing the

WEG-03

appropriate tools in conducting the analysis. The EA presumes that once this NEPA analysis is complete Reclamation will begin analyzing the implementation of the OA over its remaining life through 2050, which admittedly will require preparation of an EIS. The purpose of the interim supplemental EA is questionable at best.

Furthermore, in limiting the term to three years, the EA forecloses any evaluation of the effects of climate change in its modeling due the “limited time horizon of the analysis.” *Id.* at 32. The EA provides “[o]ver the three-year period evaluated, any effects attributable to climate change would be negligible in comparison to the substantial range of possible effects associated with existing year-to-year variability in system inflows and other hydrologic drivers.” *Id.* The analysis in the supplemental EA is short-sighted and fails to consider factors not present historically in the Rio Grande Project (i.e. climate change) that area now causing significant changes to the baseline. While it might be easier to evaluate the effects of three years of operation in the short-term, such segmented analysis is not adequate under NEPA. *See* 40 C.F.R. §1508.27(b)(7).

3. Environmental Baseline Fails to Address Climate Change.

The historic environmental baseline used in the EA is inadequate under changing climatic conditions to evaluate impacts on the environment. The EA does not consider the impacts of the historic activities under the Rio Grande Project, but rather folds these activities into the baseline condition. The narrow scope of this EA forecloses proper analysis of the impacts of the proposed action. For example, the EA describes conditions outside the 20th and 80th percentiles as “represent[ing] conditions with a low probability of occurrence” and outside the reasonably foreseeable impacts of the analysis, this may not be the case based on the impacts of climate change. *Id.* at 18.

In a report by the New Mexico State Engineer’s Office and Interstate Streams Commission, impacts of climate change on water resources were analyzed and there was agreement that the following conditions will likely be observed: (1) an increase in temperature – and potentially, extreme heat waves; (2) a trend towards a higher freezing altitude and reduction in snowpack with delays in the arrival of snow season, acceleration of spring snowmelt, a decrease in total snowfall, and rapid and earlier seasonal runoff (including, under regional models, a loss of sustained snowpack south of Santa Fe and the Sangre de Cristo range); (3) uncertain changes to precipitation, overall, but intensified evaporative losses from temperature increases that could counteract any increase in precipitation; (4) severe droughts; and (5) an increase in flood events. *The Impact of Climate Change on New Mexico’s Water Supply and Ability to Manage Water Resources* (“NM SEO/ISC Report”) at 5-16.

Further, in predicting future allocations for the 2013-2015 analysis-period, the EA uses probability distributions of Project operations from 1951-2012. *See* EA at 31. While the beginning of the period includes a drought similar in magnitude to the one have been facing over the past three years, the 1951-2012 period does not likely represent what the lower Rio Grande basin will see in the next fifty years.

WEG-04

WEG-05

Based on this draft guidance by the current administration, agencies have a duty in conducting analysis under NEPA to consider the effects of climate change. See Memorandum for Heads of Federal Departments and Agencies dated February 18, 2010¹, regarding NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions. The effects of climate change are significant and should be considered as a part of any analysis of the effects of the proposed action.

4. Significance of Impacts Warrant Preparation of an EIS.

WEG-06

When a proposed action will have “significant” impacts on the environment an EIS must be prepared.² See 40 C.F.R. § 1508.27. Factors to be considered in evaluating the significance of the impacts include: (1) the degree to which the possible effects are highly uncertain; (2) the degree to which the action may adversely effect endangered species or its critical habitat; (3) whether the action threatens a violation of Federal, State or local law or requirement imposed for protection of the environment; and (4) whether the action has cumulatively significant impacts. *Id.*

a. *Uncertainty.*

WEG-07

The supplemental EA states that there are uncertainties regarding the effects of the proposed action and the conditions that may be present during the term of the proposed action. For example, the EA: (1) limits the term of the analysis based on “uncertainties regarding the persistence of drought conditions” and “need to improve the analytical tools to detect impacts of the OA” (See EA at 1); (2) states that there is uncertainty as to the cause of recession in groundwater levels in the lower Rio Grande (*Id.* at 45); and (3) “the estimated annual Project diversion ratio for future years is highly uncertain” (*Id.* at 31-2). These and other uncertainties revealed in preparing the supplemental EA trigger the requirement under NEPA for preparation of an EIS to take a “hard look” at the environmental impacts of the proposed action.

b. *Endangered Species.*

WEG-08

Implementation of the proposed action requires a detailed analysis of the impacts on endangered and threatened species and the critical habitat designated within the action area. The brief analysis in the supplemental EA regarding the recently designated habitat of the southwestern willow flycatcher is not adequate to address the potential impacts of implementing the proposed action. The supplemental EA admits that from 2008-2010 (after implementation of the proposed action) reservoir elevations reached higher than 4,355 feet, which resulted in inundation of several flycatcher territories. See EA at 62. Such inundation was not predicted in the 2007 EA/FONSI, which found implementation of the proposed action to have no effect on the listed species. The EA also notes that in 2011 and 2012 an increase in the number of

1

http://ceq.hss.doe.gov/nepa/regs/Consideration_of_Effects_of_GHG_Draft_NEPA_Guidance_FINAL_02182010.pdf

² Courts have held that plaintiff need not show that significant effects will in fact occur, but if a plaintiff raises substantial questions whether a project may have a significant effect, and EIS must be prepared. *Idaho Sporting Congress v. Thomas*, 137 F.3d 1146, 1150 (9th Cir. 1998).

territories at a similar elevation suggests the extent and timing of inundation may have benefited the habitat. *Id.* Even if that is the case, 40 C.F.R. §1508.27(b)(1) requires any significant impact to be addressed even if that impact may be beneficial.

WEG-09

Based on the failed 2007 environmental analysis in predicting effects on the listed species and the 2013 designation of critical habitat for the flycatcher to include Elephant Butte Reservoir, the supplemental EA should take a closer look at the potential for habitat inundation over the remainder of the term of the OA. The segmented analysis of the next three years due to dry conditions are of little utility in addressing the impacts of the proposed action as a whole.

c. *Proposed Action Threatens Violation of Clean Water Act.*

WEG-10

Implementation of the proposed action threatens violation of the Clean Water Act. The supplemental EA provides that “it is highly likely that any changes occurring in the Rio Grande as a result of the OA will fall within the range of variation measured between the irrigation and non-irrigation seasons.” *See* EA at 51. The EA’s analysis, however, finds that non-irrigation season peaks in total dissolved solids (“TDS”) during implementation of the proposed action from 2007-2011 were above the range found prior to implementation (2007-2011). *Id.* These peaks in TDS are above El Paso’s threshold for drinking water purposes. *Id.*

The EA surmises that “[o]n the basis of these data, it therefore appears that the proposed action does not contribute to any additional adverse effect to water quality, as compared to the No Action Alternative.” *Id.* at 52. This conclusion simply cannot be justified based on the fact that water quality standards were found to peak above the range typical prior to implementation of the OA. At a minimum, further analysis in the form of an EIS must be made to determine the contribution of implementation of the OA on water quality standards in the action area.

d. *Cumulative Environmental Effects.*

WEG-11

The supplemental EA fails to address the cumulative environmental effects of the proposed action. Cumulative impacts are those impacts that may be individually minor but when added to other past, present and reasonably foreseeable future actions are collectively significant. 40 C.F.R. § 1508.7.

For example, the impacts of the proposed action on groundwater levels is cumulatively significant based on the other impacts to groundwater in the action area. For example, the EA states that “widespread declining groundwater levels since project inception are confined to the past decade, beginning in 2003” and the period of decline includes the period of operation under the OA. *See* EA at 45. Reclamation dismisses this impact finding “changes in groundwater levels during the period covered by the OA are confounded by many other impacts on groundwater levels” and proceeds to list the other causes. *Id.* This is exactly the type of individually minor impact that becomes collectively significant based on other past, present and reasonably foreseeable future actions in the area. Reclamation even admits that “[t]he analysis considered here is not sufficiently detailed to accurately differentiate the potential impacts to groundwater demand and groundwater resources within the Project caused by the Proposed Action from those caused by these other factors.” *Id.* Therefore, Reclamation is compelled by the mandate of NEPA

to conduct a more detailed analysis so it can show that the proposed action is or is not that particular driver of groundwater decline in the area.

Furthermore, the proposed action is just one of many actions ongoing in the lower Rio Grande Basin and therefore the impacts of those actions must be viewed collectively in evaluating effects on the human environment.

C. Conclusion

For the reasons detailed above, the draft supplemental EA fails to meet the legal requirements of the NEPA. Substantial questions have been raised as to whether the proposed action may cause a significant impact on the environment. Therefore, we urge Reclamation to (1) prepare an EIS analyzing the direct, indirect and cumulative effects of the proposed action along with other past, present and reasonably foreseeable future actions; (2) analyze the proposed action for the full term of the OA through 2050; (3) properly consider the baseline based on the impacts of climate change; and (4) analyze a reasonable range of alternatives to the proposed action.

Thank you for the opportunity to submit comments on the DEA.

Sincerely,

Jen Pelz
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June 6, 2013

SENT BY EMAIL TO: jwilber@usbr.gov

United States Bureau of Reclamation
Albuquerque Area Office
Attn: Jim Wilber, ALB-150
555 Broadway NE, Suite 100
Albuquerque, NM 87102

***Re: City Las Cruces' Comments on Draft Supplemental Environmental Assessment:
Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas***

Dear Mr. Wilber,

SB-01

The City of Las Cruces submits these comments on the Bureau of Reclamation's Draft Supplemental Environmental Assessment of May 8, 2013 (EA) to the Operating Agreement (OA) for the Rio Grande Project. As Reclamation had not completed its Technical Appendix, the City joins in the New Mexico Interstate Stream Commission's request for a 30-day review period following receipt of a revised EA and complete Technical Appendix together with all complete and final versions of data and related analyses. The City will then be able to make final comments.

SB-02

The term of the EA is stated at Section 3.3.1 as follows: "[w]hile the term of the OA is January 1, 2008, to December 31, 2050, Reclamation determined the duration of analysis for this EA should only be for another three years." Two grounds were stated: "for the period 2013-2015, differences in potential impacts between previous operations of the project under the No Action alternative and the projected operations under the OA are projected to be minimal and insignificant;" and "based on the available data and analytical tools, we can only reasonably predict potential impacts to the human environment over a limited time frame." (See EA at 1).

The City submits that any comparison against the previous inadequate period (2008-2012) creates a false baseline where the effects of the federal actions are assumed to be minimal

SB-03

and require only an EA, and therefore cannot be used for comparative purposes. Accordingly, the EA is insufficient to analyze impacts of the OA on the “human environment” and the issues of concern to Las Cruces. More particularly, the EA excludes the environmental issues related to the “human environment” of concern to the City of Las Cruces and its more than 100,000 residents. Specifically, the EA fails to take the required “hard look” at the impacts of the OA on increased pumpage on water in storage in the aquifer over the 50-year life of the OA, and the feasibility of Ag/MI (agriculture to municipal/industrial) transfers.

SB-04

With respect to the 50-year time period for a full Environmental Impact Statement (EIS), the City does not understand what will change with respect to “available data” and “analytical tools” that in three years will allow for a full EIS to be performed.

SB-05

The term “human environment” is “interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment.” *See* 40 C.F.R. § 1508.14. The City notes that social effects must be considered once NEPA is triggered by impacts to the natural or physical environment and the relationship with people within that environment. Las Cruces’ interest is two-fold: protection of the human environment through conservation of water resources and sustainability of water supply. This EA only addresses a small number of short term impacts when it should address the long-term impacts of the OA. *See* 40 C.F.R. § 1508.27. The impacts must include the degree of effect on public health and safety. *See* 40 C.F.R. § 1508.27. Effects to be considered include direct effects, indirect effects, secondary effects and cumulative effects. *See* 40 C.F.R. § 1508.8. The EA does not address those effects on groundwater in storage in the aquifer.

In addition, the City has an Ag/MI transfer program that depends on the long-term supply of surface water. In that regard, the City is a member of EBID with water righted lands entitled to yearly allocations of Rio Grande Project surface water. The City’s water planning calls for the transition to renewable surface water where and when it is available for future growth and to preserve its groundwater rights as a sustainable supply under a program of conjunctive use of surface and groundwater. To this end, the City was established as a Special Water Users’ Association for the purpose of utilizing the annual allocations of agricultural project water for future municipal water supply through the conversion of agricultural surface water to municipal uses through a surface water treatment facility, and is listed on the EBID assessment rolls. Large amounts of money have been spent to acquire surface water rights and the viability of the City’s surface water treatment component of its future water supply is now in jeopardy. The OA appears to have eviscerated that program by shutting off much of the surface supply. The City will only know if the program is viable if we can have a reliable long-term analysis. However, the BOR continues to deny the City the ability to assess this program by preparing only short-term analyses.

Further, the OA provides a new basis for calculating project operations for EBID. The EA states:

Diversion allocations to EBID would be made using a new method (D-3 adjustment) originally proposed by EBID, which provides Mexico and EPCWID water deliveries as stated above as the D-1 and D-2 curves, respectively, and

forgoes a calculated proportion of EBID's allotment to make up for any decrease in river system delivery performance which may have been caused by changes in hydrologic conditions in New Mexico. The D-3 adjustment is a change from the D-2 allocation to EBID which would either deduct from or add to their allocation depending on daily delivery efficiencies. Declines or increases in groundwater table elevations resulting from EBID's surface and groundwater irrigation practices will affect downstream deliveries, and the D-3 methodology is designed to reflect this. The D-3 adjustment basically provides EBID the water remaining after all the allocations to EPCWID and Mexico are made, and adjusted for the diversion ratio.

Las Cruces' comments are made against this background

Initially, the City concurs in the comments to the EA submitted by the New Mexico Interstate Stream Commission.

Surface Water Allocation

SB-06 In Section 4.2.2.2., the EA addresses surface water allocations. However, the methodology for determining that there are only minimal differences with the No Action alternative is unclear and the water balance does not compute. There is no way to analyze the effects of the redistribution of water in Elephant Butte Reservoir on Ag/MI on the basis of the
SB-07 EA.

DATA

SB-08 The City notes especially that the quantitative analysis in the EA is poorly documented. At a minimum, the City needs to know the origin of all data and documentation in order to understand, describe, and attempt to correct the obvious errors in the analysis. One example of an obvious error stems from the calculation that "[t]he average Total Project Allocation to EPCWID during this period [2008-2012] was 182,738 AF/yr greater under the OA while the average allocation to EBID was 46,105 AF/yr less under the OA than it is estimated it would have been under the No Action alternative." (See EA at 21). The City does not understand how the Bureau of Reclamation, using this information, concludes New Mexico loses very little water under the OA, but Texas gains large volumes.

"Wet Water" v. "Paper Water"

SB-09 The EA does not do a good job of separately explaining impacts to wet water versus paper water. For example, the benefits to Texas are presented as AFY without regard to whether the acre-feet are a number in a spreadsheet, or actual drops of water that will be capable

of physical delivery. (See EA at 21). In addition, the EA fails to address the distinction between ownership of a certain quantity of water rights and the actual amount of those water rights available for use in a given year.

Groundwater

SB-10

Groundwater supply is analyzed in Section 4.2.2.3. The EA states that “[p]roject operations directly impact surface flows, and only indirectly impact groundwater,” and “the impact of the Proposed Action on groundwater demand is minimal.” However, the analysis fails to accurately describe groundwater administration in New Mexico. It does not provide a baseline of water in storage in the aquifer against which to measure depletions.

SB-11

The evaluation of impacts to groundwater in New Mexico also appear to be based on a water budget that cannot be defended. We see no recognition of the impacts from reduced canal losses and farm return flows. The benchmark value for historical pumping in New Mexico is way off, with the result that incremental effects of the OA are significantly understated. It is not mentioned that agricultural pumping constitutes 93% of all groundwater pumping in the Lower Rio Grande.

EIS

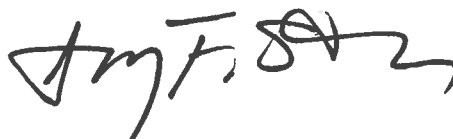
SB-12

The promise to eventually prepare an environmental impact statement is evidence of the City’s long-standing position that only an EIS will provide a proper NEPA analysis of the OA, and that the Bureau has failed in its obligation to provide such an analysis. However, if the eventual EIS is as flawed as this EA, having an EIS will be of no real value. In this regard, the BOR states that it lacked the “available data” or “analytical tools” to perform an EIS at this time, without explaining how that would change in a few years.

Recommendations

It is obvious that no resolution of concerns over the OA can occur until all parties agree as to methodologies for analyzing the effects of the Proposed Action and impacts. We recommend the Bureau consider a cooperative effort to model and analyze the effects of the OA. Such an effort would make use of the considerable expertise available in New Mexico, expertise that is now used only to find the (many) problems in what BOR has done.

Sincerely,

A handwritten signature in black ink, appearing to read 'Jay F. Stein', with a stylized flourish at the end.

JAY F. STEIN
SETH R. FULLERTON

Comments to Jim Wilber, United States Bureau of Reclamation
June 6, 2013
Page 5

cc: Jorge Garcia, Ph.D., P.E., Utilities Director, City of Las Cruces
Marcy Driggers, Esq., Assistant City Attorney, City of Las Cruces
Lee Wilson, Ph.D.



DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATER RESOURCES

John W. Hickenlooper
Governor

Mike King
Executive Director

Dick Wolfe, P.E.
Director/State Engineer

May 22, 2013

Mike Hamman, Area Manager
Bureau of Reclamation
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque NM 87102-2352

Re: State of Colorado Comments on the *Supplemental Environmental Assessment for Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas*

Dear Mr. Hamman:

The State of Colorado thanks you for the opportunity to comment on the *Supplemental Environmental Assessment for Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas* (the "Supplemental EA") released by the Bureau of Reclamation (the "Bureau") on May 8, 2013.

Although Colorado is not a party to the 2008 Operating Agreement, which is the impetus for the procedures contemplated in the Supplemental EA, or a participating member of the Rio Grande Project, it has an undeniable interest in the wise administration of the Rio Grande River System and System reservoirs, including Elephant Butte. The Rio Grande and its tributaries, in conjunctive use with groundwater, irrigate over 600,000 acres in the San Luis Valley of Colorado. Moreover, because no major rivers flow into Colorado, the State must satisfy all its water demands from sources within Colorado. As a signatory to the Rio Grande Compact of 1938, Colorado is required leave sufficient water in the system and limit storage in upstream reservoirs to satisfy its commitments downstream. Not surprisingly, therefore, the State considers its past, present, and future to be directly tied to the efficient management of its interstate rivers, including the Rio Grande and its related reservoirs

The state of Colorado understands the Bureau's obligation to operate Elephant Butte reservoir pursuant to the Rio Grande Compact, 1906 Treaty, and federal and state laws. To this end, Colorado emphasizes that the Rio Grande System and its reservoirs must be administered and managed in a manner that meets the needs of interested stakeholders without jeopardizing Colorado's significant, legally protected rights to the waters of the Rio Grande, or compromising its ability to serve the present uses and future needs of Colorado citizens. It is in

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<http://water.state.co.us>

the interest of protecting the rights and needs of its citizens that Colorado submits the following comments to the EA.

The State of Colorado comments that:

CO-01

- **Accounting of Available Water Supply.** Operations at Elephant Butte under the No Action and Proposed Alternatives are subject to and must remain consistent with the Rio Grande Compact as administered by the Rio Grande Compact Commission. Accordingly, Colorado objects to and does not support the Bureau's description of "contractually and legally available water supply" to the extent it may be construed to conflict with the Compact Commissions' procedures for accounting for the availability of useable and credit water under the Compact. *See e.g.*, Supplemental EA at pp. 9, 13, 14, 20
- **Reservation of Rights.** Because the procedures contemplated in the Supplemental EA do not expressly address distribution and allocation of water upstream of Elephant Butte Dam, the State does not take a formal position at this time regarding the accuracy and/or appropriateness of the environmental evaluation performed for the No Action or Proposed Action Alternatives. In declining to comment or correct what it may believe to be inaccurate descriptions, however, Colorado does not waive, limit or otherwise alter the any rights for the purposes of any future legal, administrative or other proceeding.



Dick Wolfe, P.E.

Colorado State Engineer

Colorado Commissioner to Rio Grande Compact Commission

cc: Larry Walkoviak, Regional Director, Upper Colorado Region
Scott Verhines, New Mexico Commissioner to Rio Grande Compact
Commission
Pat Gordon, Texas Commissioner to Rio Grande Compact Commission

NEW MEXICO INTERSTATE STREAM COMMISSION

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Transmittal: Via email jwilber@usbr.gov and US Postal Service

June 6, 2013

Mr. Jim Wilber
Bureau of Reclamation, Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102

**Re: United States Bureau of Reclamation Draft Supplemental Environmental Assessment –
Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas [May 8,
2013]**

Dear Mr. Wilber:

The New Mexico Interstate Stream Commission (NMISC) submits the following comments concerning the U.S. Bureau of Reclamation (Reclamation) May 8, 2013 Draft Supplemental Environmental Assessment, Rio Grande Project Operating Procedures (Draft EA).

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At the outset, the NMISC reiterates its concern that the review and comment deadline imposed by Reclamation has stifled meaningful public review and comment upon the complex technical issues addressed in the Draft EA. The limited comment period provided does not allow a reasonable opportunity for input. *See* Reclamation Manual ENV P03, Establish policy for implementation of the National Environmental Policy Act § 1.B(1) ("Reclamation will provide all reasonable opportunity for input and involvement from the public and other Federal, State, Tribal, and local agencies on environmental issues.") On May 15, 2013, NMISC requested a four-week extension of the comment period to obtain supporting technical information, hold a public meeting, and review, analyze, and comment on the Draft EA and supporting technical information. Reclamation denied the full requested extension on May 21, 2013, allowing instead a two-week extension (until June 6, 2013), and, on that same date, provided the NMISC with large (although incomplete) technical data files (data, spreadsheets and calculation scripts). Reclamation conceded in its data submittal communication that its technical report was not complete:

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The details provided here will be addressed in a technical appendix to the final Supplemental EA. The technical appendix is currently being developed and is not yet available. It should be noted that a number of data values, calculations and assumptions have been revised since the release of the Draft Supplemental EA.... Where discrepancies occur, the data, methods,

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assumptions and calculations detailed in this response and the accompanying files supersede those in the Draft Supplemental EA.

In light of the fact that Reclamation has not yet completed its Technical Appendix, it is premature for NMISC to provide final and complete comments on technical conclusions. NMISC requests a 30-day review period following the receipt of a revised Draft Supplemental EA and complete Technical Appendix, along with all "final" versions of data, methods, assumptions and calculation scripts. Notwithstanding this request, in the meantime the NMISC has made reasonable efforts to conduct a preliminary review and provides preliminary comments herein on Reclamation's preliminary analyses. The NMISC's general comments are included below and more specific comments are included in Attachment 1. Attachment 2 contains a summary of NMISC correspondence to Reclamation regarding the Draft EA process.

General Comments

As you know, NEPA is the fundamental federal law to ensure that federal agencies make informed decisions and provide for timely public notice and participation in environmental analyses and decision-making. The Council on Environmental Quality (CEQ) regulations are binding on all federal agencies, and each federal agency has its own NEPA guidance consistent with the statute and CEQ guidelines. Reclamation's Draft EA violates NEPA, including the CEQ regulations and Reclamation's own NEPA handbook.

NMISC
003 Since 2007 Reclamation has repeatedly violated NEPA regarding Rio Grande Project operations by undertaking a major federal action significantly affecting the environment without preparing the required Environmental Impact Statement (EIS). Reclamation cannot continue issuing interim EAs while ignoring the significant, cumulative and long-term effects of the 2008 Operating Agreement for the Rio Grande Project (2008 OA). In the 2007 EA, Reclamation claimed to examine the effects of the operating agreement over a five-year period, and promised that in 2012 it would issue a study of the 50-year life of the agreement. Now, in 2013, Reclamation instead issued another draft 3-year study, this time promising to analyze the environmental effects of the 50-year period of the 2008 OA in a later EIS, which Reclamation estimates it will prepare in 2016. Neither the original 2007 EA nor the current Draft EA address the actual fifty-year 2008 OA federal action. NMISC
004 Reclamation's continued failure to analyze impacts over the 50-year period avoids analysis of the cumulative and long-term impacts to New Mexico's Project water supply, economic impacts to farmers and communities in New Mexico, and ongoing harm to the aquifer. Reclamation's actions are akin to the prohibited practice of segmenting a large project into many small projects in order to avoid NEPA analysis. Rather than continuing to "segment" its analysis to avoid revealing the cumulative and long-term impacts, in order to comply with NEPA and applicable regulations, Reclamation must withdraw the Draft EA, revert to its pre-2007 operating practices, and complete an EIS that adequately examines the impacts over the life of the 2008 OA.

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005 The Draft EA also violates NEPA because it fails to consider all impacts that are reasonably related to the 2008 OA, including without limitation the impacts related to other federal laws, including the Endangered Species Act and the Rio Grande Compact. Specifically, the Draft EA fails to analyze impacts to critical habitat upstream of Elephant Butte Dam, and fails to describe how Project Operations, including carry-over storage, can be implemented in a manner that is consistent with the requirements of the Rio Grande Compact.

NMISC
006 Reclamation has also violated NEPA's prohibition against predetermined outcomes because it irretrievably committed Reclamation to a course of action before engaging in a valid NEPA process. Reclamation signed the 2008 OA on March 10, 2008 and only now, five years later, concedes that it will prepare an EIS on that federal action, but nevertheless proposes to continue implementing the 2008 OA in the interim. By agreeing that an EIS is necessary, Reclamation admits the 2008 OA is a major federal action significantly impacting the human environment. And Reclamation's ongoing operations under the 2008 OA are an express violation of NEPA because an EIS must *precede* implementation of the major federal actions significantly affecting the human environment. Reclamation's NEPA compliance handbook, states at section 11.5, "Doing NEPA on Decisions Already Made--NEPA compliance is required **before any discretionary** Federal action with potentially significant environmental impacts is initiated. Decisions should not be made without full compliance with NEPA. **To do this is illegal and a violation of NEPA.** The one exception to this requirement is in emergency situations." Bureau of Reclamation, Reclamation's NEPA Handbook at 11-4 (2012) (emphasis added). There is no emergency here nor has Reclamation claimed there is an emergency.

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007 In addition, the Draft EA describes the impacts of the proposed action quite differently than they were described in the initial 2007 FONSI/EA, e.g., the Draft EA indicates the 2008 OA results in increased groundwater pumping and aquifer impacts in New Mexico (see, p. 46) whereas the initial FONSI/EA speculated the effect of the 2008 OA might be to *reduce* EBID's reliance on groundwater. (See, para. 5, p. ii). The Draft EA must explain and quantify the differences with respect to groundwater pumping and aquifer impacts in New Mexico and must provide a similar analysis for groundwater pumping and aquifer impacts in Texas.

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009 Reclamation also has not adequately considered alternatives to the proposed action. 40 C.F.R. § 1502.14. First, and as explained in more detail below, Reclamation considered only two alternatives: a no-action alternative and the proposed alternative. Agencies are required to analyze reasonable alternatives to the proposed action. There are numerous reasonable alternatives to the proposed action, including but not necessarily limited to those previously raised by NMISC, that Reclamation did not consider, including removing carryover storage from the agreement, eliminating groundwater pumping as Project water in conformance with the State Court adjudication ruling, and accounting for groundwater pumping in Texas. Reclamation's failure to evaluate these reasonable alternatives violates NEPA.

NMISC
010 Further, Reclamation has failed to take the requisite "hard look" at the impacts of the proposed action. The analysis in the Draft EA, as discussed in more detail below and in Attachment 1, relies on flawed, incomplete, and outdated information. It fails to utilize the best available science, fails to analyze impacts to the aquifer, contains many vague and incomplete conclusions, and fails to recognize judicial determinations by the New Mexico adjudication court regarding rights to groundwater. For all these reasons, the draft EA is inadequate to inform either Reclamation or the public of the likely impacts of the 2008 OA, let alone allow Reclamation to make an informed decision about whether an EIS is required.

General Comments on Draft EA by Section

Section 1, Summary:

Reclamation states on page1 that it attempted to conduct a technical analysis as part of the Draft EA, but concludes, in part, that:

NMISC
011 1) for the period 2013-2015, differences in potential impacts between previous operations of the project under the No Action alternative and the projected operations under the OA are projected to be minimal and insignificant, and 2) based on the available data and analytical tools, we can only reasonably predict potential impacts to the human environment over a limited time frame.

However, there is no empirical evidence to support the conclusion that the short term impacts will be minimal.

The justification for not doing a full fifty-year analysis of the potential impacts of the 2008 OA in an EIS is not valid for the following reasons:

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- 1- The results presented in tables 4.1 to 4.7 show significant changes to each district's allocations.
 - 2- Existing groundwater models were not used to evaluate the impact on groundwater resources, riparian habitat and economic loss/gain. This indicates that the best available science was not used in developing the Draft EA.
 - 3- The Draft EA fails to consider potential impacts from the designation of Critical Habitat for the Southwestern Willow Flycatcher by the U.S. Fish and Wildlife Service.
 - 4- The Draft EA recognizes that the 2008 OA has resulted in significant adverse effects in New Mexico but fails to analyse any alternatives that minimize those impacts.

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Even in the face of its statements in the Draft EA and its analysis that the 2008 OA has had a significant negative effect on EBID water supplies and significantly increased the supplies for EP1 (Section 4.2.2.2 Surface Water), Reclamation proposes to continue operations under the 50-year 2008 OA while an EIS is being prepared and tools further developed or refined. Reclamation must revert to the historic operating procedures used for the Rio Grande Project before the 2007 EA was completed, and immediately commence an EIS. The NMISC once again formally requests that Reclamation do so.

Section 3, Alternatives:

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From the brief description in the Draft EA, it is not clear what operations the No Action Alternative entails. The No Action alternative appears to be a modification of the 2008 OA; not the operation conducted by Reclamation prior to 2007. Reclamation must describe whether the no action alternative is the operation that occurred immediately prior to 2007 or something different. In either case, Reclamation must describe the No Action Alternative in more detail.

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In regard to the "proposed action," the Draft EA is unclear as to what operations the proposed action entails. Is it the operations that were used for the 2007 Operating Procedures (OP), the 2008 OA in the first year, or the

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(cont'd)

2008 OA as operated today? NMISC is aware that the Reclamation's Allocation Committee has made a number of changes to operations since 2008, some of which may be significant. But, to the best of our knowledge, no technical descriptions of their changes have been provided to interested public stakeholders, nor has any NEPA analysis been conducted on them. Reclamation must document all changes that have been made to Rio Grande Project operations subsequent to the 2007 OP, describe their effects, and then fully describe what the "proposed" action entails relative to changes made since 2007.

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As mentioned above, other alternatives are and have been available for review. They include, but are not limited to, removing carryover, modifying carryover to be a wet water operation that reflects a real decrease in consumption in EP1, and modifying the D3 procedure so that EP1's allocation is appropriately reduced, and EBID not charged, for pumping in Texas, for actual EP1 deliveries as opposed to charged deliveries, and for credits. Reclamation must also work with its cooperating agencies in Texas to meter all Texas groundwater pumping so that the effects of the pumping would be appropriately accounted against EP1's allocations. Reclamation's failure to collect such data means that it cannot and has not adequately analyzed the effects of the proposed action, or analyze other alternatives.

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Further, rather than presenting an analysis of the environmental impacts of the 2007 OP and 2008 OA, much of the Draft EA focuses on the United States' and EP1's previous litigation positions concerning the Rio Grande Project, some of which have been rejected by the courts or are currently being litigated. In Stream System Issue 104 of the New Mexico Lower Rio Grande Adjudication, to which Reclamation is a party and EP1 is Amicus, Judge Wechsler rejected Reclamation's claim to groundwater as a source of water for the Project. And, in Stream System Issue 101 the farm delivery and crop irrigation requirements of individual farmers were adjudicated and are now binding on all farmers. Therefore, the descriptive assumptions about groundwater use in the Draft EA are now out of date and inaccurate. Reclamation must revise its analysis and description of alternatives in accordance with the Court's decision and New Mexico state law.

NMISC
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It also appears the Project area of the Draft EA is different than that of both the 2007 EA and the 2008 OA. The 2007 EA and its operations as well as those in the 2008 OA relate to Rio Grande Project operations in their entirety from Caballo Dam to the El Paso-Hudspeth County line in Texas. But the Draft EA analysis focuses solely on operations in New Mexico. This is a structural flaw in the Draft EA that results in a failure to fully address the cumulative and long-term impacts of the proposed action. Reclamation must revise its analysis to include Project operations in their entirety from Caballo Dam to the El Paso-Hudspeth County line in Texas.

Please do not hesitate to contact me at 505-827-6160 or at rolf.schmidt@state.nm.us if you have questions.

Sincerely,



Rolf Schmidt-Petersen
Rio Grande Basin Manager
NM Interstate Stream Commission

Jim Wilber
Page 6 of 6
June 6, 2013

Attachment 1 – Additional NMISC Comments by Draft EA Section

Attachment 2 - Summary of NMISC Correspondence to Reclamation Prior to Release of the Draft EA

cc: Ken Rice, Reclamation
Stephen Farris, NMAGO

**ATTACHMENT 1:
ADDITIONAL NMISC COMMENTS ON THE DRAFT EA**

Comments: NMISC

1. Summary Section

Comment 1

022 The Draft EA stated that the 2008 OA has two key and significant changes: First, the OA provides carryover accounting for EBID and EP1, and second, it explicitly but inaccurately purports to account for the conjunctive use of surface water and groundwater within EBID. The Draft EA, however, does not provide adequate evaluations for these two key changes because:

023

- The carryover accounts change Elephant Butte reservoir storage and its storage pattern in a year. Several Rio Grande Compact provisions are related to Elephant Butte storage. The impact on the Compact due to this key change was not evaluated. Reclamation must assess this issue.

024

- For the 2008 OA, D-2 curve is used for Project Allocation to EP1 and D-3 adjustment is used for Project Allocation to EBID. The Draft EA assumes that the D-2 curve that was developed based on 1951-1978 historical data could represent the Project system if no extra EBID (or New Mexico) groundwater pumping occurred beyond the level of the 1951-1978 period. In reality, the whole system has changed in many ways. The changes include, but are not limited to, groundwater pumping in both New Mexico and Texas (including municipal and industrial), cropping patterns in both New Mexico and Texas, timing and duration of irrigation season, accounting, etc. And, in the 2008 OA, EBID is debited for all changes in Project efficiency regardless of cause. This has resulted in significant reductions in EBID allocations for reasons beyond New Mexico groundwater pumping above the 1951-1978 levels. For these reasons, in part, the D-2 curve cannot be used as the basis for EP1 and Mexico allocations without adjustments for all these factors. The Draft EA does not recognize these facts. It is suggested that Reclamation assess the incremental changes in Project Allocation (especially to EP1) and delivery induced by factors other than New Mexico pumping.

Comment 2

Section 1.3 Principles Underlying the Operating Agreement – Pages 3-4

- 025
 1. Both key changes (carryover accounting and D-3) constitute a significant deviation from historical operations and were not analyzed in detail in the current EA.
 2. The second key change effectively allocates farmers individual groundwater uses as Project water to EBID, and therefore significantly changes the distribution of water among EBID farmers because not all of them own groundwater wells. This is in direct contradiction to the state adjudication court's ruling in Stream System Issue 104 and violates the federal requirement that the Rio Grande Project deliver an equal amount of water to each irrigated acre.

026

3. The diversion ratio described in the last paragraph does not represent the interaction between surface water and groundwater as Reclamation indicates since it uses charged diversions not actual diverted water at each river head-gate, as was done for the D-2 method.

027

4. Section 1.3, P. 4, Para 1, Line 5: Historically, farmers in both EBID and farmers and EP1 used groundwater pumping for supplemental irrigation. Thus, groundwater pumping has occurred in both New Mexico and Texas. It is not appropriate to only include EBID's pumping without recognizing Texas pumping (not only for irrigation but also municipal and industrial uses). Please depict fully and clearly the historical pumping in the Project area, including Texas.

028

5. The Draft EA fails to mention a major change in operations related to the ability of each district to call for all its allocated and carryover water in any given year, which would increase reservoir releases and, consequently, can cause a direct impact on upstream states and the Rio Grande Compact. Under the Rio Grande Project, Reclamation cannot deliver more water annually to either District than is necessary for equal delivery and beneficial use on each irrigable acre within the Project.
6. Section 1.4, P. 6: Neither the 2007 EA nor this Draft EA evaluated the effect of the 2008 OA on the Rio Grande Compact.

2. Purpose and Need to Implement Operating Procedures Section

029

Page 7: The third paragraph indicates that the allocation is adjusted to reflect changes in actual river conveyance efficiency; this is not the case. The diversion ratio is influenced by a number of factors, included changes in Project Accounting, that are not related to actual river conveyance efficiency.

3. Alternatives Section

Comment 1

030

As outlined in a number of instances below, the Project data provided in the Draft EA is not consistent with Project data previously reported by Reclamation to the Rio Grande Compact Commission or other official datasets previously provided by Reclamation, for the same time period.

Comment 2

031

The no-action alternative, as it is represented in the spreadsheet, does not accurately represent prior operations (1980 to 2007) for the following reasons:

- a. It is not consistent with Reclamation's reported historical data.
- b. It includes a drought adjustment factor that was not used during the 1980 to 2007 period.
- c. It uses current estimated diversion ratio. Under prior operations EBID would have been allocated and delivered more surface water, hence, the diversion ratio would be different than the values calculated during the past 5 years.
- d. It assumes that EBID uses all its allocated water each year but EP1 does not. This is not consistent with actual and prior Rio Grande Project operations in which both Districts did not use all their allocated water.

Comments: NMISC

Comment 3

032

Reclamation inappropriately uses, or mislabels, “usable water in Project storage” with “total Project storage”, as indicated by data provided by Reclamation after the Draft EA was released.

Comment 4

033

The use of Project Net Inflow is not appropriate for simulating pre-2008 OA operations since the reservoir storage, evaporation and credit water data represented in the Draft EA are not consistent with actual data and operational procedures.

Comment 5

034

The Draft EA does not adequately analyze the effects of the 2008 OA on the Mesilla and Rincon aquifers. The only estimate of changes to aquifer recharge are associated with the seepage from the mainstem of the Rio Grande, which does not include other physical sources of recharge such as canal seepage and on-farm recharge.

Comment 6

035

Section 3.2 No Action: Page-8

Delivering water to the Hudspeth County Irrigation District was not mentioned as a Reclamation action. Reclamation delivers return flows from the Project to the Hudspeth Irrigation District.

Comment 7

036

Section 3.2.1 Storing Project Water: Page-9

It is not clear how computations of “legally available water for release” take into account Rio Grande Compact credit water. More details are needed on how this amount is computed.

Comment 8

037

Section 3.2.2 Allocating Project Water:

A release of about 763,842 AF, not 790,000 AF, results in about 931,000 AF of water available for diversions according to the D-2 curve.

Comment 9

Section 3.2.2.2 Allocation to EBID and EP1: Page-10–11

038a

1. Under no action, the D-2 equation should not include the third term ($\max(0, X-763842)$). This was added during the development of the 2008 OA.

038b

2. It should be noted that, in contrast to how D-1 and D-2 are used in the 2008 OA, in developing the D-1 and D-2 curves, all annual (January to December) releases and actual gross diversions were taken into account.

038c

3. Various pages (11,13): The Draft EA implies all differences between the diversion ratio and D-2 Diversions/Release are caused by changes in Project Supply and groundwater pumping. This ignores other factors including changes in Project accounting practices since the D-2 period.

Comment 10

039

Section 3.3 Proposed Action (continued Implementation of OA): Page 13

The first paragraph indicates that the 2008 OA takes into account conjunctive management of surface water and groundwater within EBID and ignores any impact of groundwater pumping within EP1. To the best of our knowledge, the 2008 OA is silent in regard to groundwater with the exception of a reference to pumping from the Canutillo well field in Texas. Please reference the specific section of the 2008 OA where groundwater is discussed to support the statement in the first paragraph and provide reasons for not taking into account conjunctive management within EP1. When and if discussed in the next version of the Supplemental Environmental Assessment, please apply the discussion to both Districts.

Comment 11

040

Section 3.3.1 The Operating Agreement: Page 13

The last paragraph implies that the reduction in EBID's allocation under the D-3 is due to changing hydrologic conditions within New Mexico. That is not correct; under the D-3 accounting procedures, EBID pays for all losses in the Project area, including losses due to Texas and Mexico groundwater pumping, and drought conditions.

Comment 12

Section 3.3.2 Carryover Water: Page 14

041a

1. Last paragraph: Mexico's allocation under the no action alternative is computed based on stored usable water in the reservoir; while, under the 2008 OA, Mexico's allocation is computed based on water released from the reservoir (estimated or actual). Therefore, the description provided in the text is not correct, and the carryover provision has a significant impact on Mexico's allocation.

041a

2. The description of the carryover provision ignores the fact that carryover water does not suffer any evaporative losses and transport losses are not well accounted.

Comment 13

Section 3.3.3 Offsets for Water Conveyance Efficiencies: Page 15

042

1. Second paragraph: Nothing in the 2008 OA or the operation manual obligates EP1 to offset their groundwater pumping impact on the river. For the past five years (2008 to 2012), EP1 was only been charged once for 10,000 AF (during 2010), while they pump annually between 30,000 AF to 40,000 AF (estimated number for EP1 pumping for municipal, industrial, and irrigation uses in the Mesilla basin, not counting Hueco Bolson basin pumping). That

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indicates that the description of the action does not match Project operations in the period from 2008 to 2012.

2. The equation above the last paragraph confirms that EBID pays for all losses in the Project area.

Comment 14

043

On Page 15: Reclamation includes an inaccurate characterization of the effects on EBID of use of the “diversion ratio”. EBID does not lose water only when the diversion ratio is less than 1.0. EBID loses water whenever the diversion ratio is less than the Diversion/Release ratio from the D-2 curve, for the pertinent release amount. Note that since the Diversion Ratio used in the OA is Charges/Releases, not Diversions/Releases, and since Charges are systematically less than Diversions in most years, EBID loses water for that reason alone (in addition to other factors that reduce delivery efficiency within the Project such as groundwater pumping in New Mexico and Texas.)

4. Environmental Consequences Section

Comment 1

044

The Draft EA does not include narrative or empirical analyses that demonstrate the Proposed Action will not result in a predicted deviation from historic water quantities or qualities, as evidenced by marked change in Rio Grande Project supplies, allocations, and quality of regulated water, such as drinking water. In a similar manner, Reclamation does not provide evidence of a thorough and objective review of potential impacts to vegetation and wildlife communities, including incremental cumulative impacts, by imposition of the OA in the Lower Rio Grande Basin.

Comment 2

Section 4.2.2.2 Surface Water: Page 24

045

“[T]he estimated difference in annual Project allocation to EBID is similar in magnitude to the estimated recharge to EBID groundwater supplies” These statements are unsupported. What is the legal basis for EBID's "groundwater supplies?" What is the extent of such supplies? And how do EBID farmers without rights to groundwater pumped from wells make up for the surface water relinquished by EBID under the Operating Agreement?

Comment 3

Section 4.2.2.3 Groundwater: Page 42

046

“This physical connection between the surface water and the shallow groundwater in the Project, as described in Section 1.3, was understood prior to the first Project water deliveries, particularly within the EBID service area. A 1917 supplemental Congressional authorization for the Project recognized this relationship when it specified excavation of drains that would collect shallow groundwater and deliver it to the river, and thereby transport water downstream.”

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(cont'd)

This statement misstates the purpose for construction of drains in the Project, which was to correct the problem of waterlogged lands. The Reclamation Service attributed the problem of waterlogged lands to inefficient irrigation practices. For example, see a report on Drainage on the Rio Grande Project included in the 1918 Rio Grande Project History that describes the traditional irrigation method and later water logging problems. Thus rather than intending to appropriate the shallow groundwater for use in the Project, the intent was to drain off waste water that impeded beneficial uses.

The circumstances under which drains in the Rio Grande Project were constructed are discussed in Ira G. Clark's treatise, *Water in New Mexico, A History of Its Management and Use* (University of New Mexico, 1987). Clark writes as follows:

The Reclamation Service had assumed that some drainage would be needed, but it was soon apparent that it had not fully recognized the possibility of critical waterlogging due to the slow escapement of groundwater from the irrigated valleys . . . Having depended on a highly unpredictable water supply in the past, farmers flooded their fields far in excess of their needs and actually to the detriment of their crops.

* * *

Incorporation of the community ditches into the project alleviated the situation somewhat. The Reclamation Service could now deal directly with each water user, and it replaced cost-plus rental with individual contracts. This discouraged prodigal use because the charge for water was increased sharply after the irrigator had received three acre-feet for each acre he farmed. This eased rather than resolved the problem, however, and the district was still in dire need of a large-scale drainage system. In 1916 the companion Texas and New Mexico water users' associations had voted to contract with the government for the expenditure of not to exceed then dollars per acre for drainage, and the Reclamation Service prepared a plan. The interior department appropriation included an item for the work, subject to the provision that it could be spent only after the formation of irrigation districts which could execute agreements for repaying the entire cost, a power which the association lacked. Both Texas and New Mexicans hurriedly set about organizing such districts, but the situation in New Mexico was too critical to delay action until this could be done. Senator Andreius A. Jones secured the adoption of a joint resolution in October, 1917 for the immediate expenditure of \$15,000 for drainage in New Mexico pending the formation of an irrigation district, a meager but helpful beginning. Work progressed more rapidly after the Elephant Butte Irrigation district replaced the water users' association, and by the end of 1920 \$1,500,000 had been spend in building a system of deep drains for the Mesilla and Rincon valleys. By 1921 the most critical period was passed, and two years later the Reclamation Service could report a substantial lowering of the water table and rapid rehabilitation of damaged acreage.

Water in New Mexico at 197.

Comment 4

Section 4.2.2.3 Groundwater: Page 43

“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.”

047

1. The information in the Draft EA is not current. The settlement agreement referenced was superseded by a subsequent settlement between the State, EBID, the New Mexico Pecan Growers Association and the Southern Rio Grande Diversified Crop Farmers Association, reached after two days of trial. Under the settlement, rights to irrigate from surface water and groundwater combined, and rights to irrigate from groundwater only, were adjudicated a FDR of 4.5 AFY and transferrable CIR of 2.6 AFY. Individual farmers may prove up to a FDR of 5.5 AFY based upon proof of beneficial use of that amount of water. Neither the United States, which was a party to the proceeding, nor EP1, which was an *amicus*, attended trial or participated in pre-trial proceedings.
2. Prior to the settlement for irrigation water requirements in the LRG stream adjudication, there were no effective limits on the amount of water that could be pumped for irrigation from pre-basin wells. To this date, to the best of our knowledge, no limits exist for water pumped for irrigation from wells within EP1.

Comment 5

Section 4.4 Socioeconomic Resources:

048

This section should be refined. The information, data, and methodology are incomplete, fail to support the narrative and claimed assertions in the Draft EA, and do not conform with accepted economic and financial methodology and reporting practices that are commonly used by economists and financial analysts.

Comment 6

Section 4.2.2.2 Surface Water: Page 20

049

The Draft EA concluded that the 2008 OA has no effect on the total available surface water supply because the 2008 OA has no effect on inflows to Project storage or surface runoff within the Project. It may be true that the Proposed Action has no effect on inflows to Project storage if the Compact is not impacted. Even so, it does not mean that the Project storage itself, which is affected by the operations, is not impacted. Therefore, both the Project Inflows and Elephant Butte’s elevation are needed for the analysis. Figure 4.3 should present a comparison between the Proposed Action and No Action for the 2008-2012 period. Please evaluate changes in the storage under the 2008 OA and the Prior Op.

Comment 7

Section 4.2.2.2 Surface Water: Page 22 Table 4.1a, b and c

The Allocation Summary results in provided in Chapter 4, Tables 4.1a, b and c, contained a number of errors. This table has since been superseded by information in spreadsheet form provided by Reclamation on 5/21/2013. However, conclusions based on this original Table occur throughout the Draft EA.

- 050
- (1) The “Prior Operations (Estimated)” are based on a model of Project Operations that is as yet unreliable. The analysis we have reviewed tends to underestimate the water availability under “Prior Operations”, and thus underestimate the difference between EBID’s allocation under the 2008 OA and EBID’s allocation under Prior Operations.
 - (2) Exception: the 2008 numbers (Prior Ops allocation to EBID: 495KAF, difference from 2008 OA Actual: -170KAF) are consistent with other Reclamation records and New Mexico’s findings in Barroll, Shafike and Liu (2011) and Barroll’s affidavit.

Comment 8

Section 4.2.2.2 Surface Water: Page 23

051 In the last paragraph there is an apparent attempt to estimate “seepage” and by inference “recharge to EBID” associated with recent Project Operations. This estimate is incorrect in theory and in calculation. To calculate seepage, a physical water budget would be required. The Draft EA instead compares releases with charged deliveries: since charged deliveries are not physical diversions, using them in a physical water budget is invalid. Deliveries to Mexico would be a necessary term in such an analysis, and are not mentioned here. In fact, the change in recharge within EBID caused by the change in operations is in the opposite directions, and much larger. In full supply years EBID’s allocation is 170,000 AF smaller, which corresponds to a reduction in canal seepage on the order of 75,000 AF and a reduction in on-farm return flow from surface water application on the order of 25,000 AF.

Comment 9

Section 4.2.2.2 Surface Water: Pages 23-28

- 052 a. Last paragraph on page 23: The discussion is incorrect since Project charges are not the same as actual gross diversions.
- 053 b. The discussion on page 26 shows that releases under the proposed action are higher than releases under the no action alternative (Releases under the no action alternative could not be verified and seem overestimated; specifically for 2008, the release was estimated at 843,545 AF.) If this is true, the proposed action would have an impact on Article VII and Article VIII of the Rio Grande Compact.
- 054 c. Reclamation claims the reason for the 10,720 AF/y average increase in total Project releases is due to uncertainty in the analysis. Reclamation does not acknowledge other possible reasons for this increase, such as the improper release of New Mexico’s credit water by Reclamation in 2011 and 2012. The discussion on page 28 on computing usable water needs more detail describing how credit water was computed and if it was decreased monthly by evaporation or not.

Comment 10

Section 4.2.2.2 Surface Water: Page 30

055

The analysis of 2013-2015 effects, starting page 30, appears to be based on a similar analysis to Table 4.1a, b and c, and is similarly biased toward underestimation of the impact of the 2008 OA on EBID's allocation.

Comment 11

056

Page 32: "Importantly, the OA results in a large increase in annual allocation to EBID under wetter conditions when the diversion ratio is greater than 1.2."

Based on actual conditions already experienced, this statement is false. It describes conditions that have never in fact occurred, despite full-supply conditions in 2008, 2009 and 2010, and are unlikely to ever occur under the 2008 OA. The diversion ratio is already biased to the low side because of accounting changes since the D2 period, plus it is highly dependent on drain flows within New Mexico that cannot return to pre-2008 OA levels so long as EBID is not allocated a full supply of surface water.

Comment 12

Section 4.2.2.2 Surface Water: Page 33

057

NMISC does not have comments on the probabilistic analysis and at this time. However, table 4.3 indicated that the average decrease in EBID allocations under wet conditions (80% non-exceedence probability) is 205,800 AF. This, if technically correct, supports the State's stated concerns about significant impact.

Comment 13

Section 4.2.2.2 Surface Water Page 40

Conclusions on page 40 not supported:

058

- a. The conclusion that EBID's overall conjunctive supply is not anticipated to be affected by the proposed action is not supported by the analysis.
- b. The conclusion on the annual release from Project storage is not supported since there is nothing in the proposed action that limits reservoir releases.

Comment 14

Section 4.2.2.3 Groundwater:

059

(1) The Draft EA gives an erroneous and misleading account of how groundwater pumping impacts are treated under the 2008 OA. On page 45 the Draft EA reads "EP1 accepted direct charges against its diversion allocation to offset the effects to the Project surface supplies caused by withdrawals from the Canutillo well field and other identified pumping in the Texas portion of the Mesilla Valley." The discussion is not correct. The 2008 OA only includes references to Reclamation's requirements to report the effects of Canutillo pumping, and contains no mention of other Texas pumping in the Mesilla Basin. No such reporting or any adjustment to accounting was performed in 2008, 2009 or 2011, so the full impact of Canutillo pumping was charged against the EBID allocation.

060

(2) On page 15: "Under the Proposed Action, and in accordance with the 2008 Settlement, both districts would be accountable for offset losses in river efficiency within their respective states." This is

060
(cont'd)

not correct. The 2008 OA does not contain any provision to address Texas' pumping impact on Project supply and delivery. In fact, the Texas pumping impact has been counted against EBID's allocation in the past five years. Any temporary adjustment, such as the 2010 charge for EP1 pumping in the Mesilla Valley, does not change the fact that the 2008 OA must be changed to consider all the factors, other than New Mexico pumping, that affect Project deliveries.

Comment 15

Section 4.2.2.3 Groundwater: Pages 46-49

The Draft EA has an inadequate and erroneous description of the effects of the Proposed Action (the 2008 OA) on groundwater:

061

(1) The change in groundwater recharge to EBID omits the largest components of recharge: canal seepage and on-farm return flows from surface water application. In full supply years, the reduction in EBID's allocation probably results in a decrease in recharge from those sources of approximately 100,000 AF.

062

(2) The estimated change in groundwater pumping within EBID (25,600 AF on page 48) is based on the unreliable results in Table 4.1a. In fact, during full supply years, the reduction in EBID's allocation by over 150,000 AF would result in EBID farmers requiring approximately 75,000 AF of additional groundwater, approximately doubling the amount of irrigation well pumping that would have occurred in such a year.

063

(3) The impacts of increased groundwater demands and decreased recharge in New Mexico have not been analyzed in any way. This must be addressed in an EIS.

Comment 16

Section 4.2.2.3 Groundwater: Page 48

064

The Draft EA used average values of reallocation and the associated increased groundwater demand to suggest that there would be only a small impact on EBID and New Mexico aquifers. It is not appropriate to use an average when depicting a situation when variance is large or the distribution is not normal. Please include minimum and maximum impacts in the evaluation.

Comment 17

Section 4.2.2.3 Water Quality

(Note that this is the second section with this same designation. Should be Section 4.2.2.4)

065

This Draft EA did not assess changes in groundwater quality due to implementation of the 2008 OA. Reclamation must assess groundwater water quality changes for 2008-2012 and perform model simulations for the future. Impacts on groundwater quality must be evaluated because of the strong interconnection between the groundwater and surface water, as the Draft EA acknowledged.

5. Consultation and Coordination Section

066

The statement on Page 81 of Appendix C is not correct. The Compact does not guarantee delivery of water to the Project sufficient to provide a specific release.

ATTACHMENT 2: SUMMARY OF NMISC CORRESPONDENCE TO RECLAMATION PRIOR TO RELEASE OF THE DRAFT EA

The NMISC previously submitted six (6) letters to Reclamation concerning development of the Draft EA:

2/3/12, Rolf Schmidt- Petersen to Marsha Carra

NMISC provides questions, in response to Reclamation's 1/10/2012 Scoping Notice to conduct a 5-Year EA, regarding: the scoping process, whether an EIS might be considered, whether Reclamation has authority to modify procedures from those of the 2008 Operating Agreement (OA), and whether this action is associated with the federal litigation NM v US, BOR. NMISC asserts that an EIS for a full 50-year period is needed to remedy the lack of analysis prior to execution of the 2008 OA.

2/17/12, Estevan Lopez to Mike Hamman

NMISC provides questions in response to Reclamation's invitation to ISC to be a cooperating agency for an Environmental Assessment for Rio Grande Project Operating Procedures. NMISC notes that questions of the 2/3/2012 letter remain unanswered, asks for clarification regarding the scope of the NEPA action, i.e., whether it will include a 5- or 50-year period of analysis; and asks for clarification regarding "role of cooperating agency".

4/11/12, Estevan Lopez to Mike Hamman

NMISC responds to Reclamation's invitation to be a cooperating agency for a Long-Term (through 2050) Environmental Assessment for the Rio Grande Project Operating Procedures, declines to participate as a cooperating agency, noting that scoping does not address the issues raised in previous letters nor those raised in litigation. The NMISC requests participation as an interested and affected stakeholder.

4/25/12, Rolf Schmidt-Petersen to Molly Thrash

NMISC responds to Reclamation's announcement of a 7-day window for public comment and provides three documents noting the State of New Mexico's concerns regarding the 2008 Rio Grande Project Operating Agreement and the "profound changes that Reclamation has made pursuant to this agreement". NMISC requests that information provided in these documents be considered in the NEPA process, and notes that additional comments will be provided prior to the end of the 7-day comment period.

4/30/2012, Rolf Schmidt-Petersen to Molly Thrash

NMISC provides comments, responding to Reclamation's 4/23/12 *email*, inviting public comments as part of the Scoping Process. NMISC requests: confirmation that a 50-year analysis will be conducted, clarification of Purpose and Need, formal identification of Federal *discretionary* action, inclusion of clear articulation of baseline data and conditions, and, credible technical evaluation of impacts to specific resources and receptors including consideration of Texas actions on Project supply. Among other topics, NMISC requests that the analysis consider impacts on Endangered Species Act issues, on Articles VI, VII and VIII of the Rio Grande Compact, and the upstream water supply; and, impacts on the sustainability of the groundwater resource in New Mexico including groundwater salinity.

11/6/2012, Rolf Schmidt-Petersen to Molly Thrash

NMISC reiterates previous concerns with the NEPA process being implemented, including concern that a FONSI will be the outcome with insufficient technical analysis of impacts on New Mexico water users. NMISC itemizes specific technical concerns and requests preparation of an EIS.

Outcome

None of the NMISC letters were directly acknowledged. Partial answers to some of the questions have emerged with the issuance of the Draft Supplemental Environmental Assessment; however, many of the stated NMISC concerns remain unaddressed.

From: **Conrad Keyes** <cgkeyesjr@q.com>

Date: Wed, May 15, 2013 at 3:26 PM

Subject: Re: Draft Supplemental EA on Implementation of Operating Procedures for RG Project

To: James Wilber <jwilber@usbr.gov>

Cc: Amy SPA Louise <amy.louise@usace.army.mil>

Keyes
001

Jim - I spent a few hours on reviewing the Draft-SuppEA of RGP Operations. I admit that most of my suggestions wouldn't change most of the conclusions of this document; but I do have some reservations about the overall WQ results used in light of the forthcoming Final NMDA & PdNWC WBP that should be available by June 2013.

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Responses to Comments recieved under the Supplemental Environmental Assessment for the Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas

Index	Commenter-- Comment #	Comment Summary	Response to Comment	Change to EA or Other Action	Category
1	WEG-001	The comment says that the 2007 EA committed Reclamation to collect data during the first 5 years of implementation of the new operating procedures to use it in support of a future environmental analysis. Based on these data, impacts on the environment have occurred despite the findings in the 2007 EA/FONSI, and this raises the question as to whether continuation of the proposed action for either the short-term or long-term pose significant impacts warranting an EIS.	The 2007 EA/FONSI predicated that effects of implementing the OA (action alternative) would not have a significant effect on the human environment, but as the commenter noted, committed to a 5-year review. The SEA analysis showed that variations in water supply and related resources was and is predicted to be within the range of historic fluctuations and an EIS does not need to be prepared.	No change to SEA. Significance review will be disclosed and documented in the FONSI.	significance
2	WEG-002	The scope of alternatives is inadequate. The SEA fails to provide a reasonable range of alternatives to meet the purpose and need for action. The No Action Alternative does not meet purpose and need and is not legally viable because it would result in violating the settlement agreement. Thus the analysis becomes an exercise in futility because there is no legally valid option in the No Action Alternative and no other options were presented.	Reclamation's need to deliver water and to manage the Rio Grande Project in compliance with international treaties, the Rio Grande Compact, federal and state laws, contracts, the settlement agreement and other requirements detailed in the SEA's Comprehensive Background (Appendix C) drove the selection of alternatives. Development of both action and no action alternatives were iterative processes with the no action alternative being how Reclamation operated the project historically and the action alternative developed in coordination and consultation with project stakeholders. During scoping for the SEA, other action alternatives were suggested, but these were not found to meet the need for action or purposes.	No change to SEA.	alterantives
3	WEG-003	The comment is the period of analysis is arbitrarily segmented. The SEA fails to analyze the entire term of the proposed action. The comment says that by choosing this limited period, the proposed action is segmented to prevent impacts from appearing significant rather than simply studying the entire period. The EA presumes that once this NEPA analysis is complete, Reclamation will begin analyzing the implementation of the OA through 2050. The purpose of the SEA is questionable at best.	The agency had committed to a supplemental NEPA analysis by the end of 2013, so the SEA was necessary to meet this commitment at this time. For projecting effects, the agency determined the 3 years for the analysis period was reasonable based in large part on its ability to extrapolate and model the water supply over this period using currently available data and models. It is anticipated that when the International Panel on Climate Change releases the new emissions scenarios sometime in 2013-2014 (AR5), Reclamation will be able to prepare a new bias-corrected and spatially downscaled model that will be applied to the RGP.	No change to SEA.	period of analysis
4	WEG-004	The comment is that the environmental baseline fails to address climate change. In limiting the term to 3 years, the SEA forecloses any evaluation of the effects of climate change. The analysis is short-sighted and fails to consider factors of climate change not present historically that are now causing significant changes to the baselines. While it might be easier to evaluate the effects of 3 years, such a segmented analysis is not adequate under NEPA. The comment offers a citation to a study of the impact of climate change on New Mexico's water supply from the New Mexico state engineer.	The Project is currently under extreme drought conditions and this is recognized in the SEA. The projections over the next 3 years take into account continuing extreme climatic conditions. Thus, the last 5 years and the projections over the next 3 provide a working test of the viability of the OA to successfully manage the Project and also the choice of analytical period was made in recognition of the current climatic conditions. Also see answer to WEG-003 and WEG-005.	No change to SEA.	climate change

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5	WEG-005	The comment is that in predicting future allocations for the 2013-2015 period, the SEA uses probability distributions of Project operations from 1951-2012. While the beginning of the period includes a drought of similar magnitude to the present one, the 1951-2012 period does not likely represent what will be seen in the next 50 years.	Given the severity of the current drought, Reclamation took a conservative approach and made projections for only the next 3 years. Reclamation agrees that it cannot assume stationarity over the next 50 years, and with the forthcoming publication of new emission scenarios from the International Panel on Climate Change (AR5), a new bias-corrected and spatially downscaled model should be prepared and applied to the RGP. But the new IPCC scenarios and an appropriate climate change model that is bias-corrected and spatially downscaled to the project area is not currently available.	No change to SEA.	
6	WEG-006	The comment is that the significance of impacts requires preparation of an EIS.	The factors cited in the comment will be reviewed in the FONSI, Reclamation does not agree that the effects/impacts rise to the level of significance necessitating an EIS.	No change to SEA. Significance review will be disclosed and documented in the FONSI	significance
7	WEG-007	The comment is that uncertainties of climate change and groundwater trigger preparation of an EIS to take a "hard look" at the environmental impacts of the proposal.	Reclamation felt that conditions over the next 3 years are reasonably foreseeable given the starting conditions of the storage reservoirs and using the probabilistic modelling approach provided in the SEA and Technical Appendix. (See the response to WEG-05 for additional comments on long-term climate change modelling.) With respect to groundwater, Reclamation could only provide a qualitative discussion in the SEA and Technical appendix due to a lack of quantitative data. To meet our commitment for this 5-year NEPA review, quantitative data on groundwater (particularly in Texas) were not available to the interdisciplinary team. The assumptions made about how to project effects on surface water and groundwater are provided in the Technical Appendix and the data have been checked throughout the SEA.	Data and descriptions of modelling of water resources is provided in the Technical Appendix and these data and results of modelling were reviewed and updated in the SEA.	climate change, groundwater
8	WEG-008	The comment is that the SEA found reservoir elevations from 2008-2010 reaching higher than 4,355 ft., which inundated flycatcher territories. The SEA stated that this inundation might be beneficial, and 40 CFR 1508.27(b)(1) requires that any significant impact to be addressed, even if the effect is beneficial.	The documentation of reservoir levels and the effects on riparian vegetation and birds were reviewed and updated in the final SEA in the Natural Resources section of Environmental Consequences. The potential beneficial effect to riparian vegetation, but this effect did not create a significant effect on the riparian environment or the birds. The final SEA clarifies that no flycatcher nests were impacted.	Figure 4.10 of SEA was updated and additional information provided under "conclusion for Elephant Butte" for the fly catcher	ESA
9	WEG-009	Based on the failed 2007 analysis in predicting effects on listed species and the 2013 designation of critical habitat for the flycatcher, the SEA should take a closer look at the potential for habitat inundation over the 50-year term of the OA. The segmented analysis for the next 3 years due to dry conditions is of little utility in addressing impacts of the proposal as a whole.	See answer to WEG-003 and WEG-005.	No change to SEA.	period of analysis, ESA
10	WEG-010	The comment is that implementation of the action threatens violation of the Clean Water Act. The SEA found that non-irrigation season peaks in total dissolved solids from 2007-2011 were above the range found previously and are above El Paso's threshold for drinking water purposes. The comment questions the conclusion that the proposed action does not contribute to any additional adverse effect to water quality compared to No Action. The comment says that this requires an EIS to determine the contribution of the OA to water quality standards in the action area.	We assume this comment meant to reference the Safe Drinking Water Act, rather than the Clean Water Act. Under the SDWA, El Paso's drinking water has had no water quality violations according to the U.S. Environmental Protection Agency and Texas Commission on Environmental Quality regulations. The drought on the Rio Grande has continued such that surface water flows used by the City of El Paso have been reduced to less than average in 12 of the past 15 years. During this time, El Paso Water Utilities has been able to consistently treat its surface water to 0.1 NTUs, which is significantly better than the 0.3 NTUs required by EPA regulation. See 2012 Drinking Water	No change to SEA. Significance review will be disclosed and documented in the FONSI.	public health and safety

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11	WEG-011	The comment is that the SEA fails to address cumulative impacts; in particular, the impact on groundwater. The comment is that the OA is just one of many actions ongoing in the lower Rio Grande Basin and those impacts must be viewed collectively.	Reclamation cataloged relevant actions that were considered in the SEA and tiered the analysis from the EISs and other cited federal or state actions cited in the SEA. In addition to this tiering and the description of cumulative impacts to groundwater, the SEA acknowledges that Reclamation has no authority to authorize or prevent individual farmers or those with state(s) permits from pumping groundwater. Thus, the cumulative effects of Reclamation's action, added to the effects of individual pumpers, were disclosed in the Environmental Consequences section. Reclamation's action cannot be considered the proximate cause of groundwater environmental consequences because the agency has no ability to prevent the environmental consequences that were projected in the SEA due to its limited statutory authority over groundwater in the two states.	No change to SEA.	NEPA process
12	SB-001	The comment is that because the Technical Appendix was not ready, a 30-day review period should be provided following receipt of a revised EA and complete Technical Appendix.	See answer to NMISC-002.	No change to SEA. Technical Appendix updated.	NEPA process
13	SB-002	The comment is that comparison against the previous inadequate period (2008-2012) creates a false baseline where the effects are assumed to be minimal and only require an EA. The EA is insufficient to analyze impacts on the human environment.	In 2007, Reclamation considered 5 years a reasonable amount of time to validate the predicted effects of the action on the environment. The SEA was prepared to determine whether continued implementation of the action alternative would create effects to a degree of intensity that they would be "significant" as defined by CEQ regulations at 40 CFR 1508.27.	No change to SEA. Significance review will be disclosed and documented in the FONSI.	significance
14	SB-003	The comment is that the EA excludes environmental issues of concern to the City of Las Cruces and specifically that it fails to take a hard look at impacts of the OA on increased pumpage of water in storage in the aquifer over the 50-year life of the OA and the feasibility of agriculture to municipal/industrial transfers.	A public scoping meeting for this action was held in the City of Las Cruces, although the specific issue raised here was not brought forward then. To respond to the comment, the duration of analysis is covered in other responses (see WEG-003), but to respond regarding agriculture to M&I transfers, this issue is out-of-scope for the SEA. Such transfers are not affected by the action, but would require separate NEPA. All lands within the district, including forborne acreage converted to M&I water, will receive the same allocation of Project water.	No change to SEA.	period of analysis
15	SB-004	The commenter questions what will change with respect to available data and analytical tools that in 3 years will allow for a full EIS.	See response to WEG-003, the tools will include the use of the new IPCC emissions scenarios and probably better groundwater data and modelling.	No change to SEA.	NEPA process
16	SB-005	The comment is that the EA only addresses short-term impacts when it should address the full effects of implementing the OA over 50 years. In particular the EA does not include the degree of effect on public health and safety, groundwater in the aquifer, the City of Las Cruces' surface water supply, and the City's surface water treatment facility. The City's future water supply is now in jeopardy due to the OA. The City will only know if the program is viable if we can have a reliable long-term analysis.	See other responses about the duration of analysis. With respect to the City of Las Cruces future water supply, we are assuming that Las Cruces has projected a future M&I requirement which it will either get from the Project or from Project appurtenant groundwater. Impacts from ground water pumping may affect Project surface water and the volume of water converted to M&I which the City would receive from EBID. The City of El Paso recognizes this tie and offsets it's allocation by a contractually determined amount related to the amount pumped from its wells in the Mesilla Valley.	No change to SEA.	period of analysis

Responses to Comments recieved under the Supplemental Environmental Assessment for the Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas

17	SB-006	The method for determining differences between alternatives is unclear and the water balance does not compute.	Data and presentation in tables have been checked and updated for the final SEA and the technical appendix. The OA is designed to evaluate the changes in over all system efficiency for water deliveries. The baseline for deliveries to EPCWID and Mexico was derived using the D-1 and D-2 regression analysis curves. Maintaining a consistent delivery to EPCWID and Mexico for a given release requires an offset in allocation to EBID therefor the water balance includes water used to offset losses in the system.	Changes made to SEA and Technical Appendix.	modelling water supply
18	SB--007	There is no way to analyze the effects of the redistribution of water in Elephant Butte Reservoir on agriculture to municipal & industrial (M&I) on the basis of this EA.	The effect to agriculture to M&I water allocation is equal to the effect on agricultural allocations. Allocations in both cases are to the point of delivery and not in reservoir storage.	No change to SEA.	modelling water supply
19	SB-008	The comment is that the quantitative analysis in the EA is poorly documented and the origin of all data and documentation must be provided.	The data have been checked and updated for the final and the Technical Appendix.	Changes made to SEA and Technical Appendix.	modelling water supply
20	SB-009	The comment is the EA does not explain impacts to wet water versus paper water. For example, benefits to Texas are presented as AFY without regard to whether the AF are a number in a spreadsheet, or actual drops of water that will be capable of physical delivery. The EA fails to address the distinction between ownership of a water right and the actual amount of those water rights available for use in a given year.	The OA is designed so that allocations of water are for deliverable water. The analysis was made using wet water released and delivered. Rio Grande project water rights are tied to the lands. The adjudication in New Mexico assigns the differing interest in the water to different entities. Reclamation has the right to store, release and deliver water to a diversion point. EBID has a right to divert for delivery to a land owner. The land owner has a right to beneficially use diverted water on his lands for irrigation. Each one of the components has a different amount and time of use. The OA defines the amounts and time of use for water delivered from Project storage to the districts' diversions and Mexico.	No change to SEA.	modelling water supply
21	SB-010	The comment is the EA fails to accurately describe groundwater administration in NM. It does not provide a baseline of water in storage in the aquifer against which to measure depletions.	The Comprehensive Legal Background describes groundwater administration so the general reader can understand it, but details and actions related to NM groundwater administration are not provided because they are not part of the Federal action and are not relevant to this particular analysis.	No change to SEA.	groundwater
22	SB-011	The comment is they see no recognition of impacts from reduced canal losses and farm return flows in NM. The benchmark value for historical pumping in NM is way off, with the result that the incremental effects of the OA are significantly understated. It is not mentioned that agricultural pumping constitutes 93% of all groundwater pumping in the Lower Rio Grande.	The statement that 93% of all groundwater pumping in the Lower Rio Grande is agricultural is the point the OA is addressing. The OA adjusts release of Project surface water for the effects of groundwater pumping, in order to meet mandated delivery requirments. Any additional information on historical pumping would be of value.	No change to SEA.	modelling water supply
23	SB-012	The promise to prepare an EIS evidences that only an EIS will provide proper NEPA analysis of the OA. However, if the EIS is as flawed as this EA, having an EIS will be no real value. The BOR states it lacked available data or analytical tools, without explaining how that would change in a few years. It is obvious that no resolution of concerns over the OA can occur until all parties agree as to methods for analyzing effects of the action and impacts. We recommend Reclamation consider a cooperative effort to model and analyze the effects of the OA. Such an effort would make use of the considerable expertise available in NM, expertise that is now used only to find the (many) problems in what Reclamation has done	The availability of data and development of groundwater data and models are continually being advanced by various agencies working on the issue at local, state, and Federal government levels, and with input from stakeholders. As these data and refined models become available, they will be utilized in future analysis. See SB-013. Comment noted about the recommendation for collaboration moving forward.	No change to SEA.	modelling water supply

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24	CO-001	Operations at Elephant Butte under the alternatives are subject to and must remain consistent with the Rio Grande Compact, as administered by the Rio Grande Compact Commission. Accordingly, Colorado objects to and does not support the Bureau's description of "contractually and legally available water supply" to the extent it may be construed to conflict with the Compact Commissions' procedures for accounting for the availability of useable and credit water under the Compact. In declining to comment or correct what it may believe to be inaccurate descriptions, Colorado does not waive, limit, or otherwise alter the rights for purposes of future legal, administrative or other	Reclamation manages the Rio Grande Project in recongition of the complex set of international, federal, state, and local treaties, compacts, laws, contracts, requirements or institutions. Reclamation agrees and will do all possible to operate within the Compact. Current disputes on the accounting of Compact water will hopefully be resolved by the Compact commissioners. Until unanimous direction is received from the Rio Grande Compact Commission, the Rio Grande Project will operate in accordance with the Texas interpretation of Rio Grande Compact accounting.	No change to SEA.	Compact
25	NM-001	The commenter expressed concerns about the comment deadline, stating that it "has stifled meaningful public review..." and "does not allow reasonable opportunity for input." The commenter goes on to state, "Reclamation denied the full requested extension..." The commenter further stated that on the same date Reclamation granted a two-week extension, "provided NMISC with a large (although incomplete) technical data files."	After release of the draft SEA on May 8, 2013, Reclamation provided the technical data to the public, including the commenter on May 21. To provide the opportunity to review these additional data, Reclamation provided a two week extension of the public review and comment period. Under CEQ and DOI NEPA implementing regulations, in particular 43 CFR 46.305, Reclamation is not required to issue draft EAs nor to make an EA available to the public for review. Recognizing the public interest in the proposal, Reclamation exceeded regulatory requirements in making the draft available for review and in extending the original comment period by two weeks. Reclamation notes that the commenter declined Reclamation's invitation to participate as a cooperating agency in the preparation of this SEA, which would have provided for early and additional review and coordination	No change to SEA.	NEPA process
26	NM-002	The comment is that it is premature to provide comments when the technical information have not been fully provided for review. They also request an additional 30-day review period, along with all final versions of data, methods, assumptions, and calculations.	Technical information were provided to this commenter and others and the Technical Appendix for the SEA is being updated.	SEA and Technical Appendix being checked and updated.	modelling water supply
27	NM-003	The commenter states, "Since 2007, Reclamation has repeatedly violated NEPA regarding Rio Grande Project operations by undertaking a major federal action significantly affecting the environment without preparing the required (EIS). Reclamation cannot continue issuing interim EAs while ignoring the significant, cumulative and long-term effects of the 2008 (OA)."	Reclamation has been operating under a valid EA and FONSI since 2007. That FONSI documented no significant effects as a result of the proposed action and to date, our analysis has been consistent with that finding.	No change to SEA. Significance review will be disclosed and documented in the FONSI.	NEPA process
28	NM-004	The commenter states, "In the 2007 EA, Reclamation claimed to examine the effects of the (OA) over a five-year period and promised that in 2012 it would issue a study of the 50-year life of the agreement." "Reclamation's continued failure to analyze impacts over the 50-year period avoids analysis of the cumulative and long-term impacts..." "Reclamation's actions are akin to the prohibited practice of segmenting a large project into many small projects in order to avoid NEPA analysis." The commenter calls on Reclamation to "withdraw the Draft EA, revert to its pre-2007 operating practices and complete an EIS that adequately examines the impacts over the life of the 2008 OA."	Same as WEG-005. Given the severity of the current drought, Reclamation took a conservative approach and made projections for only the next 3 years. Reclamation cannot assume stationarity over the next 50 years, and with the forthcoming publication of new emission scenarios from the International Panel on Climate Change (AR5), a new bias-corrected and spatially downscaled model should be prepared and applied to the RGP. But the new IPCC scenarios and an appropriate climate change model that is bias-corrected and spatially downscaled to the project area is not currently available.	No change to SEA	period of analysis

29	NM-005	The commenter states that the EA violates NEPA “because it fails to consider all impacts that...including...the impacts related to other federal laws...” “Specifically, the Draft EA fails to analyze impacts to critical habitat upstream of Elephant Butte Dam, and fails to describe how Project Operations, including carry-over storage, can be implemented in a manner that is consistent with the requirements of the Rio Grande Compact.”	There are two issues in this comment: 1) that critical habitat upstream of the Rio Grande Project is not analyzed; and 2) that the action is inconsistent with the Rio Grande Compact. The action area (affected environment for NEPA) begins at the headwaters of Elephant Butte Reservoir and critical habitat for silvery minnow is upstream. Critical habitat for Southwestern willow flycatcher that has been newly designated as including a portion of Elephant Butte Reservoir was incorporated into the analysis so that Reclamation could make a finding regarding adverse modification of critical habitat. With respect to the second concern about the Rio Grande Compact, Reclamation operates the Rio Grande Project in compliance with the Compact. This is one of our legally binding requirements for project operations. Carry over as described in the OA is not storage. Carry over is an account for each district which may be called upon for delivery at their respective designated delivery points. This essentially equivalent to adhoc operations which set the allocation at the turn out for each farmer and the amount of release or storage needed to meet that demand was reserved. Reclamation reports usable project water the same as has historical reporting. Therefor consistent with the requirements of the Compact. The Project has usable water remaining in storage every year.	No change to SEA	ESA, Compact
30	NM-006	The commenter states that Reclamation has violated NEPA’s “prohibition against predetermined outcomes because it irretrievably committed Reclamation to a course of action before engaging in a valid NEPA process.” The commenter continues, “By agreeing that an EIS is necessary, Reclamation admits the 2008 OA is a major federal action significantly impacting the human environment.”	The 2007 EA and FONSI were in compliance with NEPA regulations and the action was not implemented until the FONSI was signed. The SEA extended the analysis as committed to in 2007. Reclamation has decided to voluntarily prepare an EIS to further the purposes of NEPA, to facilitate future planning, to assist in resolving conflicts concerning alternative uses of available resources, and to make use of the EIS format and procedures to address concerns raised by the public—it is not because this is considered a major federal action.	No change to SEA.	NEPA process
31	NM-007	The commenter states that the Draft SEA describes impacts differently than in the 2007 EA/FONSI, citing the example, “Draft EA indicates the 2008 OA results in increased groundwater pumping and aquifer impacts in New Mexico (see, p. 46), whereas the initial FONSI/EA speculated the effect of the 2008 OA might be to reduce EBID’s reliance on groundwater (See, paragraph. 5, p. ii).	Analysis and conclusions in the SEA update and supersede those of the 2007 EA/FONSI. In 2007, the present drought had not yet taken its full effect and past climate trends did not predict the deepening of the drought that has occurred. At the time of the 2007 EA/FONSI, “normal” climate patterns were expected to occur which would have provided larger amounts of water to EBID as well as EPCWID and Mexico	No change to SEA.	groundwater
32	NM-008	The commenter states that the Draft EA “must explain and quantify the differences with respect to groundwater pumping and aquifer impacts in New Mexico and must provide a similar analysis for groundwater pumping and aquifer impacts in Texas.”	The currently available groundwater data was utilized in the analysis as well as reports produced by the NMISC. Aquifer impacts which occur in Texas upstream of the final diversion points were also taken into account. Reclamation acknowledges that the Texas data are largely qualitative, but Reclamation used the data that were available during the preparation of the SEA.	No change to SEA.	groundwater

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33	NM-009	The commenter states that Reclamation has not adequately considered alternatives to the proposed action by only considering the no-action alternative and the proposed alternative. The commenter states that “Agencies are required to analyze reasonable alternatives to the proposed action.” The commenter provides examples of additional alternatives, “previously raised by NMISC that Reclamation did not consider, including removing carryover storage from the agreement, eliminating groundwater pumping as Project water in conformance with the State Court adjudication ruling, and accounting for groundwater pumping in Texas.” “Reclamation’s failure to evaluate these reasonable alternatives violates NEPA.”	See WEG-002 and note that analysis of a proposed action and no-action alternative is allowed under NEPA and described in 43 CFR 46.310, making the analysis of a broader range of alternatives possible rather than mandatory. Selection of the action alternative in the 2007 EA and this SEA is based on the need to implement the negotiated OA and settlement agreement among Reclamation and the two irrigation districts. Implementation of other alternatives raised during scoping would require the re-negotiation of the OA and settlement agreement and the three parties did not find the recommended changes reasonable. Therefore the suggested alternatives from NMISC are not reasonable because of legal and contractual requirements.	No specific change to SEA, but it and Technical Appendix were reviewed and updated to correct data.	alterantives
34	NM-010	The commenter states that Reclamation has “failed to take the requisite ‘hard look’ at the impacts of the proposed action. The analysis in the Draft EA, as discussed in more detail...relies on flawed, incomplete, and outdated information. It fails to utilize the best available science, fails to analyze impacts to the aquifer, contains many vague and incomplete conclusions, and fails to recognize judicial determinations by the New Mexico adjudication court regarding rights to groundwater. For all these reasons, the draft EA is inadequate to inform either Reclamation or the public of the likely impacts of the 2008 OA, let alone allow Reclamation to make an informed decision about whether an EIS is required.”	We disagree with this comment about a “hard look” at projected effects. The analysis in the SEA and Technical Appendix are robust because they are based on current and state of the science data, which were reviewed by EBID and EPCWID to ensure accuracy and adequacy. We appreciate this and other commenters’ specific suggestions on the draft SEA to help correct and clarify any portions of the document that were in error or unclear. As a result, changes have been made to the final SEA and Technical Appendix, as appropriate. We note that the rights to ground water and groundwater administration are actions of the NM OSE, and these cumulative actions have been described to the extent that data are available. The OA was designed to address actions taken within each state in which the Project operates.	No specific change to SEA, but it and Technical Appendix were reviewed and updated to correct data.	NEPA process
35	NM-011	Section 1 Summary: The commenter states, “there is no empirical evidence to support the conclusion that the short term impacts will be minimal.”	The evidence to support our conclusion is contained in the body of the SEA and technical appendix of the document. Where this and other commenters’ suggestions have provided information to correct and clarify information, we have incorporated and updated the document accordingly. The purpose of an EA is to assess “significance” within the CEQ regulations, and the FONSI is where these conclusions about NEPA significance are found.	No change to SEA. Significance review will be disclosed and documented in the FONSI.	significance
36	NM-012	Section 1 Summary: The commenter states, “the justification for not doing a full fifty-year analysis of the potential impacts of the 2008 OA in an EIS is not valid because (of additional reasons noted in the commenter’s list and expanded upon, throughout the commenter’s letter).	See other comments about 3 year period. NMISC-004	No change to SEA except as noted to specific comments and their respective responses below.	period of analysis
37	NM-013	The commenter states, “Even in the face of its statements in the Draft EA and its analysis that the 2008 OA has had a significant negative effect on EBID water supplies and significantly increased the supplies for EP1 (Section 4.2.2.2 Surface Water), Reclamation proposes to continue operations under the 50-year 2008 OA while an EIS is being prepared and tools further developed or refined.	We agree regarding inappropriate use of the term “significant” in the draft SEA. An EA is a document intended for analysis; whereas a related determination of “significance” should be reserved for a finding of no significant impact (FONSI).	Significance language deleted from text. Significance review will be disclosed and documented in the FONSI.	significance
38	NM-014	The commenter repeats that Reclamation “must revert to the historic operating procedures and commence an EIS.”	The commenter is recommending implementation of No Action, as well as conducting an EIS. Reclamation's decision will be within the FONSI. Reclamation is proposing to prepare an EIS to enhance agency planning and incorporate climate change into its decision-making.	No change to SEA. Decision will be made in FONSI.	alterantives

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39	NM-015	The commenter states, “it is not clear what operations the No Action Alternative entails...it appears to be a modification of the 2008 OA; not the operation conducted by Reclamation prior to 2007.	The No Action for the SEA is the same as in 2007 EA; which is the same as operations prior to the 2007 OA; and is equivalent to the term “ad hoc operations.” The commenter correctly notes that the No Action and the Proposed Action employ many of the same operating tools and methods which were developed prior to the 2007 OA starting in 1980 after the transfer of operations from Reclamation to the irrigation district in their respective states. The analysis done for the SEA points out that the Project has always carried over water and in times of drought imposed a restricted allocation to the districts and Mexico.	The Technical Appendix has been clarified to provide details responsive to this comment.	alterantives
40	NM-016	The commenter states, “it is unclear as to what operations the proposed action entails.” The commenter states their awareness that “Reclamation’s allocation Committee has made a number of changes to operations since 2008, some of which may be significant. But, to the best of our knowledge, no technical descriptions of their changes have been provided to interested public stakeholders nor has any NEPA analysis been conducted on them. Reclamation must document all changes that have been made to the Rio Grande Project operations subsequent to the 2007 OP, describe their effects, and then fully describe what the “proposed” action entails relative to changes made since 2007.”	The Proposed Action for the SEA is the same as in the 2007 EA. All operations and procedures conducted since the 2007 EA and implementation of the OA have been within the bounds of the OA and 2007 EA. The Operations Manual which details the Project yearly, seasonal, and daily operations is designed to be flexible and can be changed within the bounds of the Rio Grande Compact, international treaties, federal laws, Project authorizations, and state laws based upon unanimous agreement of the signatories. The changes referred to are for clarification of the intent of the OA, additional detail on application of the OA and modifications to address previously unforeseen issues	The Technical Appendix has been clarified to provide details responsive to this comment.	
41	NM-017	The commenter suggests additional alternatives.	See also NMISC-09.	No change to SEA	alterantives
42	NM-018	The commenter states, “Reclamation must also work with its cooperating agencies in Texas to meter all Texas groundwater pumping so that effects of the pumping would be appropriately accounted against EP1’s allocations.”	To meter all Texas groundwater pumping is beyond the scope of this SEA. Reclamation gathered as much quantitative groundwater data as possible given the constraints and allowances recognized in 43 CFR 46.125 and 40 CFR 1502.22. Note that EP1 is charged for ground water extractions in the Texas portion of the Mesilla Valley. Pumping in the Hueco Bolson aquifer in the El Paso Valley does not affect allocations to Project water users. Pumping by others in the Hueco Bolson has an effect on the delivery efficiencies within EP1’s system after it has taken delivery of its allocation.	No change to SEA.	groundwater
43	NM-019	The commenter states, Reclamation’s failure to collect such data means that it cannot and has not adequately analyzed the effects of the proposed action, or analyze other alternatives.”	While additional groundwater pump metering and data in Texas and NM would be useful in the future, the absence of such quantitative data is not essential to making a reasoned choice among alternatives under the scope of this SEA. The availability of addition groundwater data would not expand the number of alternatives, but would enhance the quantitative analysis of effects.	No change to SEA.	groundwater

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44	NM-020	The commenter states, “Rather than presenting analysis of the environmental impacts...much of the Draft EA focuses on the United States’ and EP1’s previous litigation positions concerning the Rio Grande Project, some of which have been rejected by the courts or are currently being litigated. In Stream System Issue 104 of the New Mexico Lower Rio Grande Adjudication...Judge Wechsler rejected Reclamation’s claim to groundwater as a source of water for the Project. And, in Stream System Issue 101 the farm deliver and crop irrigation requirements of individual farmers were adjudicated and are now binding on all farmers. Therefore, the descriptive assumptions about groundwater use in the Draft EA are now out of date and inaccurate. Reclamation must revise its analysis and description of alternatives in accordance with the Court’s decision and New Mexico state law.”	We have reviewed the document to ensure the characterization of Project water is appropriate and consistent with court decisions. Stream System Issue 104 did leave open the issue of drain return flows as being part of the Project water supply. Drain return flows have been relied upon to provide a component of the deliveries to all project users. Interception of drain flows and ground water directly tied to the Rio Grande effects the total supply available	Comment noted and text corrected as appropriate.	groundwater
45	NM-021	The commenter states, “It also appears the Project area of the Draft EA is different than that of both the 2007 EA and 2008 OA. The (2007 EA and 2008 OA) relate to Rio Grande Project operations in their entirety from Caballo Dam to El Paso-Hudspeth County line in Texas. But the Draft (supplemental) EA analysis focuses solely on operations in New Mexico. This is a structural flaw in the Draft EA that results in a failure to fully address the cumulative and long-term impacts of the proposed action. Reclamation must revise its analysis to include Project operations in their entirety from Caballo Dam to the El Paso-Hudspeth County line in Texas.”	The EA and SEA defined the affected environment as the extent of the Rio Grande Project in both NM and TX. Reclamation typically “follows the water” in environmental analyses to the point at which control of the water is turned over to private entities who then exercise control over it. In this case, Reclamation considered effects beyond that—i.e., it included socioeconomic analysis to the county level and it looked at water quality for the City of El Paso. If the comment relates to the Hudspeth irrigation district, the OA does not affect EP1 irrigable acreage and therefor would not change the use of their allocation or the tail water from the end of their system which is the component of water which goes to HCCRD.	No change to SEA.	NEPA process
46	NM-022	The commenter states, “The OA provides carryover accounting for EBID and EP1, and...explicitly but inaccurately purports to account for the conjunctive use of surface water and groundwater within EBID.”	The supplemental EA accurately reflects all components of the OA. This comment appears to reflect the commenter’s concern with the OA, rather than with the EA.	No change to SEA.	
47	NM-023	The commenter states the Draft EA does not provide adequate evaluations for the changes in the OA because (1 st bullet) “The carryover accounts change Elephant Butte reservoir storage and its storage pattern in a year. Several Rio Grande Compact provisions are related to Elephant Butte storage. The impact on the Compact due to this key change was not evaluated.”	This comment is related to potential implications under the Rio Grande Compact of changes in Project storage under the OA, namely changes in Project storage and releases due to the carryover provision of the OA.	The final SEA includes discussion and consideration of potential implications of the OA under the Rio Grande Compact.	

48	NM-024	The commenter states the draft EA does not provide adequate evaluations for the changes in the OA because (2 nd bullet) “For the 2008 OA, D-2 curve is used for Project Allocation to EP1 and D-3 adjustment is used for Project Allocation to EBID. The Draft e EA assumes that the D-2 curved that was developed based on 1951-1978 historical data could represent the Project system if no extra EBID (or NM) groundwater pumping occurred beyond the level of the 1951-78 period. In reality, the whole system has changed in many ways...including...groundwater pumping in NM and TX, timing and duration of irrigation season, accounting, etc.” “And in the 2008 OA, EBID is debited for all changes in Project efficiency, regardless of cause. This has resulted in significant reductions in EBID allocations for reasons beyond NM groundwater pumping above the 1951-1978 levels.” “For these reasons, in part, the D-2 curve cannot be used as the basis for EP1 and Mexico allocations without adjustments for all these factors.” The commenter suggests	The OA was developed and negotiated by Reclamation, EBID, and EPCWID specifically to acknowledge and account for deviations in Project performance relative to historical conditions during the period 1951-1978 as characterized by the D-2 Curve. As detailed in the SEA, Reclamation agrees that deviations in Project performance are caused by groundwater pumping along with a number of other factors. These factors are clearly discussed in the SEA.	The draft SEA was revised to provide additional clarification regarding the factors affecting Project performance.	
49	NM-025	The commenter states both carryover accounting and D-3 “constitute a significant deviation from historical operations and were not analyzed in detail in the current EA;” 2) “(D-3)...effectively allocates farmers individual groundwater uses as Project water to EBID, and therefore significantly changes the distribution of water among EBID farmers because not all of them own groundwater wells.” The commenter states that this is a “direct contradiction to the state adjudication court’s ruling...that the Rio Grande Project deliver an equal amount of water to	The SEA analyzes the effects of the OA on surface water and groundwater resources within the Project, including effects of the carryover and diversion ratio provisions of the OA. As stated in the SEA, Project operations under the OA and under the No Action alternative consider only Project water, which is limited to the usable water in Project storage, water released from Project storage, and all inflows reaching the bed of the Rio Grande between Caballo Dam and Fort Quitman, TX.	The draft SEA was revised to provide additional clarification regarding the waters allocated and managed by the Project.	
50	NM-026	“The diversion (description in last paragraph) does not represent the interaction between surface water and groundwater...since it uses charged diversions not actual diverted water at each river head-gate, as was done for the D-2 method.”	The diversion ratio is a measure of Project performance developed and agreed upon by Reclamation, EBID, EPCWID, and USIBWC. Differences between the gross diversion ratio, which is calculated from gross diversions, and the project diversion ratio, which is calculated from Project charges, are addressed in Appendix F of the SEA. Both the gross diversion ratio and Project diversion ratio are measures of Project performance with respect to conveyance and delivery of Project water from Caballo Dam to authorized points of diversion.	The draft SEA was revised to provide additional clarification regarding the diversion ratio as a measure of Project performance.	
51	NM-27	Pg. 4, Para 1, Line 5: “Historically, farmers in both EBID and..EP1 used groundwater pumping for supplemental irrigation. Thus groundwater pumping has occurred in both New Mexico and Texas. It is not appropriate to only include EBID’s pumping.”	As stated in the SEA, Reclamation agrees that groundwater pumping occurs throughout the Project.	No change to SEA.	
52	NM-028	The Draft EA fails to mention a major change in operations related to ability of each district to call for all its allocated and carryover water in any given year, which would increase reservoir releases and, consequently, can cause a direct impact on upstream states and the Rio Grande Compact. Under the Rio Grande Project, Reclamation cannot deliver more water annually to either District than is necessary for equal delivery and beneficial use on each irrigable acre within the Project;” and 6) “Section 1.4, Pg 6: “Neither the 2007 EA nor this Draft EA evaluated the effect of the 2008 OA on the Rio Grande Compact ”	This comment is related to potential implications under the Rio Grande Compact of changes in Project storage under the OA, namely changes in Project storage and releases due to the carryover provision of the OA.	The final SEA includes discussion and consideration of potential implications of the OA under the Rio Grande Compact.	
53	NM029	Paragraph indicates that the allocation is adjusted to reflect changes in actual river conveyance efficiency; this is not the case. The diversion ration is influenced by a number of factors, included changes in Project Accounting, that are not related to actual river conveyance efficiency.	This comment is related to the diversion ratio provision of the OA, which adjusts Project allocations to account for changes in Project performance.	The Technical Appendix has been clarified to provide details responsive to this comment.	

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54	NM-030	"Project data provided in the Draft EA is not consistent with Project data previously reported by Reclamation to the Rio Grande Compact Commission or other official datasets previously provided by Reclamation, for the same period."	Discrepancies exist between Project charge values provided on district charge sheets and Project charge values used in annual Project allocation worksheets. Where discrepancies exist, this analysis uses charge values consistent with the final annual Project allocation spreadsheets. Discrepancies are identified in Appendix F.	No change to SEA.	
55	NM-031	The no-action alternative, as represented in spreadsheet, does not accurately represent prior operations and is not consistent with Reclamation's reported historical data. Drought adjustment factors that were not used during the 1980-2007 period. It is not consistent with Reclamation's reported historical data.	See NMISC-030/NMISC-031a, above.	No change to SEA.	
56	NM-031b	The No-action alternative, as represented in spreadsheet, does not accurately represent the drought adjustment factor--the factor was not used during the 1980-2007 period.	The drought adjustment factor used in the annual allocation model of prior operating practices is consistent with actual Project operations during this period. Refer to Appendix F, Section 3.1.2 for details.	Appendix F adjusted to respond to comment.	
57	NM-031c	The No-action alternative is wrong-it uses current estimated diversion ratio. Under prior operations EBID would have been allocated and delivered more surface water, hence, the diversion ration would be different than the values calculated during the past 5 yrs.	The SEA specifically discusses this assumption as a source of uncertainty; uncertainties associated with the diversion ratio are quantified in Appendix F, Section 3.2.3	No change to SEA or Technical Appendix.	
58	NM-031d	The no action alternative wrongly assumes that EBID uses all its allocated water each year but EP1 does not. This is not consistent with actual and prior Rio Grande Project operations in which both Districts did not use all their allocated water.	Analysis conducted for the SEA assumes that EBID typically uses its full Project allocation in all years. This assumption is consistent with analysis of historical district operations and has been confirmed by representatives of the district for use in evaluating both historical and future Project operations. Refer to Appendix F, Section 3.1 for details.	No change to SEA.	
59	NM-032	Reclamation inappropriately uses, or mislabels, "usable water in Project storage" with "total Project storage."	The term "total Project storage" refers to all water stored in Elephant Butte and Caballo Reservoirs. The term "usable water in Project storage" refers to all water stored in Elephant Butte and Caballo Reservoirs, exclusive of Rio Grande Compact Credit Water and San Juan-Chama Water. Both terms are used appropriately through the SEA.	The draft SEA was revised to provide additional clarification of terms used in the document.	
60	NM-033	Use of the Project Net Inflow is not appropriate for simulating pre-2008 OA operations since the reservoir storage, evaporation and credit water data represented in the Draft EA are not consistent with actual data and operational procedures.	As described in the SEA, net inflow to Project storage was used in this analysis due to the complexity and uncertainty regarding compliance with Rio Grande Compact delivery requirements. The OA acknowledges this as a potential source of uncertainty in this analysis.	The final SEA includes discussion and consideration of potential implications of the OA under the Rio Grande Compact	

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61	NM-034	The Draft EA does not adequately analyze the effects of the 2008 OA on the Mesilla and Rincon aquifers. The only estimate of changes to aquifer recharge are associated with the seepage from the mainstem of the Rio Grande, which does not include other physical sources of recharge such as canal seepage and on-farm recharge.	Evaluation of effects of the OA on groundwater resources is predominately qualitative. Quantitative evaluation of effects on groundwater resources will require the use of sophisticated numerical groundwater models, which in turn require a substantial amount of time to develop, verify, apply, and analyze. The use of numerical groundwater models is therefore beyond the scope of the current study due to the time constraints of the SEA. The predominately qualitative evaluation presented here is sufficient to draw conclusions regarding the potential effects of the OA on of groundwater resources within the Project and surrounding areas. Reclamation is committed to conduct further analysis of the potential effects of the OA and other factors on groundwater resources and groundwater-surface water interaction in the future.	No change to SEA.	
62	NM-35	Delivering water to Hudspeth County Irrigation District was not mentioned as a Reclamation action. Reclamation delivers return flows from the Project to the Hudspeth Irrigation District.	HCCRD is neither allocated nor charged for Rio Grande Project water. HCCRD is therefore not explicitly considered in the quantitative analysis of Project operations detailed in the SEA.	The draft SEA was revised to clarify the relationship between HCCRD and	
63	NM-036	Storing Project Water, Pg 9: It is not clear how computations of “legally available water for release” take into account Rio Grande Compact credit water. More details are needed on how this amount is computed.	The term “legally available water for release” is equivalent to the term “usable water in Project storage”. See NMISC-032.	The draft SEA was revised to provide additional clarification of terms used in the document.	
64	NM-037	A release of about 763,842 AF, not 790,000 AF, results in about 931,000 AF of water available for diversions according to the D-2 curve.	The reviewer is correct. The value 790,000 AF refers to the average quantity of water that Texas may release to be in full compliance with the Rio Grande Compact.	The draft SEA was revised to correct the error identified in this comment.	
65	NM-038	Section 3.2.2.2 Allocation to EBID and EP1, Pg 10-11: a. Under no action, the D2 equation should not include the third term(max(0,X-763842)). This was added during development of the 2008 OA	The reviewer is correct. Under the No Action alterntive, this term is not included in the D-2 Curve.	The text of the draft SEA was revised to correct the error identified in this comment. In addition, all analysis was reviewed to ensure that equations used to	
66	NM-038b	It should be noted that, in contrast to how D1 and D2 are used in the 2008 OA, in developing the D1 and D2 curves, all annual (Jan-Dec) releases and actual gross diversions were taken into account	During the period 2008-2012, a total of 450 AF was released through seepage outside of the primary irrigation season. The difference between full-year releases (January through December) and releases during the irrigation season (March through October) is therefore negligible and has no effect on the analysis and results presented in the SEA	No change to SEA.	
67	NM-038c	Various pages (11,13): The Draft EA implies all differences between the diversion ration and D2 Diversions/Release are caused by changes in Project Supply and groundwater pumping. This ignores other factors including changes in Project accounting practices since the D2 period.	As detailed in the SEA, Reclamation agrees that deviations in Project performance are caused by groundwater pumping along with a number of other factors. These factors are clearly discussed in the SEA.	The draft SEA was revised to provide additional clarification regarding the factors affecting Project performance.	

68	NM-039	Section 3.3, Pg 13, 1 st para: Indicates that the 2008 OA takes into account conjunctive management of surface water and groundwater within EBID and ignores any impact of groundwater pumping within EP1. To the best of our knowledge the 2008 OA is silent in regard to groundwater with the exception of a reference to pumping from the Canutillo well field in Texas. Please reference the specific section of the 2008 OA where groundwater is discussed to support the statement in the 1 st paragraph and provide reasons for not taking into account conjunctive management within EP1. Please apply discussions to both Districts (in the supplemental EA).	Ground water pumping in Texas, El Paso Valley does not affect the OA allocation and accounting.	The SEA and Technical Appendix were checked to verify and validate data.	
69	NM-40	Section 3.3.1, Pg 13: Last paragraph implies that the reduction in EBID's allocation under the D3 is due to changing hydrologic conditions within New Mexico. That is not correct; under the D3 accounting procedures, EBID pays for all losses in the Project area, including losses due to Texas and Mexico groundwater pumping, and drought conditions.	The statement of hydrologic conditions in New Mexico refers to ground water pumping and drought conditions in addition to changed farming practices.	No change to SEA.	
70	NM-41	Section 3.3.2, Pg 14: Las paragraph—Mexico's allocation under the no action alternative is computed based on stored usable water in the reservoir; whil, under the 2008 OA, Mexico's allocation is computed based on water released from the reservoir (estimated or actual). Therefore, the description provided in the text is not correct, and the carryover provision has a significant impact on Mexico's allocation.	Under both alternatives, the annual allocation to Mexico is based on the annual release from Project storage. Methods of calculation are identical. Timing of delivery to Mexico may change under either alternative and still be in compliance with treaty obligations. See Appendix F and summarized in Chapter 4 of SEA. Results indicate the OA will have no effect on annual allocation to Mexico.	The draft supplemental EA was revised to clarify that annual allocation to Mexico is determined based on the annual release from Project storage under both	
71	NM-41b	Section 3.3.2, Pg 14: The description of the carryover provision ignores the fact that carryover water does not suffer any evaporative losses and transport losses are not well accounted.	Carryover water is accounted at point of delviery. Therefore, transport losses are included.	No change to SEA.	
72	NM-42	Section 3.3.3, Pg 15, 2 nd Para: Nothing in the 2008 OA or the operation manual obligates EP1 to offset their groundwater pumping impact on the river. For the past 5 years (2008-2012), EP1 was only charged once for 10,000 AF (2010), while they pump annually between 30,000 AF to 40,000 AF (estimated number for EP1 pumping for municipal, industrial, and irrigation uses in the Mesilla basin, not counting Hueco Bolson basin pumping). That indicates that the description of the action does not match Project operations in the period from 2008 to 2012. The equation above the last paragraph confirms that EBID pays for all losses in the	This comment appears to reflect concern with the OA, rather than with the EA. EP1's impact on the river, as it affects Project water accounting, is taken into account. Groundwater pumping by EPWU at the Canutillo wells will continue to be charged against EP1's allocation.	The SEA and Technical Appendix were checked to verify and validate data.	
73	NM-43	Pg 15: Inaccurate characterization of the effects on EBID of use of the "diversion ratio" – EBID does not lose water only when the diversion ration is less than 1.0. EBID loses water whenever the diversion ratio is less than the Diversion/Release ration from the D2 curve, for the pertinent release amount. Note that since Charges are systematically less than Diversions in most years, EBID loses water for that reason along (in addition to other factors that reduce deliver efficiency within	Under the Proposed Action, project allocations are adjusted to reflect deviations in Project performance relative to historical conditions, not relative to a diversion ratio of 1.0.	The draft supplemental EA was revised to accurately describe the adjustment of Project allocations under the diversion	

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74	NM-44	Draft EA does not include narrative or empirical analysis that demonstrate the Proposed Action will not result in a predicted deviation from historic water quantities or qualities, as evidenced by marked change in Rio Grande Project supplies, allocations, and quality of regulated water, such as drinking water. In a similar manner, Reclamation does not provide evidence of thorough and objective review of potential impacts to vegetation and wildlife communities, including incremental cumulative impacts, by imposition of the OA in the Lower Rio Grande Basin.	We disagree with the commenter's statement. The evidence and sufficient detail to support our conclusion are contained in the body and analysis in the SEA. The analysis is based on current and state of the science data, which was reviewed by EBID and EPCWID to ensure accuracy and adequacy. We appreciate this and other commenters' specific suggestions on the draft SEA to help correct and clarify any portions of the document that were in error or unclear. As a result, changes have been made to the final SEA, as appropriate. Additionally, the OA will not impact vegetation and wildlife above and beyond impacts as a result of naturally occurring changes in the environment.	No change to SEA.	
75	NM-45	Section 4.2.2.2, Pg 24: The statements, "estimated difference in annual Project allocation to EBID is similar in magnitude to the estimated recharge to EBID groundwater supplies...". What is the legal basis for EBID's "Groundwater supplies?" What is the extent of such supplies? And how do EBID farmers without rights to groundwater pumped from wells make up for the surface water relinquished by EBID under the OA?	See NMISC-025.	The SEA and Technical Appendix were checked to verify and validate data.	
76	NM-46	Section 4.2.2.3, Pg 42: This physical connection between the surface water and the shallow groundwater in the Project...was understood prior to the first Project water deliveries, particularly within the EBID service area..." The commenter states that Reclamation "misstates the purpose for construction of drains in the Project, which was to correct the problem of waterlogged lands.	The drains were constructed to reclaim lands within the Project, although the statement still holds since the connection between the surface water and the shallow ground water needed to be understood in order to design and construct the drains. The drains were constructed to return water back to the Rio Grande which was subsequently utilized to make irrigation water deliveries downstream. In addition, only enough water was released from storage to supplement drain flow to meet the order for all the users in the RGP.	Statement removed from SEA.	
77	NM-47	Section 4.2.2.3, Groundwater, Pg. 43: Referring to the statement, "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 NM," 1. the commenter states that the information in the Draft EA is not current. 2. The commenter further states, "Prior to the settlement for irrigation water requirements in the LRG stream adjudication, there were no effective limits on the amount of water that could be pumped for irrigation from pre-basin wells. To this date, to the best of our knowledge, no limits exist for water pumped for irrigation from wells within EP1.	The reviewer is correct.	The draft supplemental EA has been revised to correctly portray current conditions.	groundwater
78	NM-48	Section 4.4, Socioeconomic Resources: This section should be refined. The information, data, and methodology are incomplete, fail to support the narrative and claimed assertions in the Draft EA, and do not conform with accepted economic and financial methodology and reporting practices that are commonly used by economists and financial analysts.	The comment does not provide specificity to understand exactly what the commenter believes is deficient. On one hand, the commenter states the section should be refined and on the other, to be expanded. We believe the analysis is adequate for the scope of the supplemental EA and to make a reasoned choice among alternatives.	No change to SEA.	socioeconomics

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79	NM-49	Section 4.2.2.2 Surface Water, Pg. 20: The Draft EA concluded that the 2008 OA has no effect on the total available surface water supply because the 2008 OA has no effect on inflows to Project storage or surface runoff within the Project. It may be true that the Proposed Action has no effect on inflows to the Project storage if the Compact is not impacted. Even so, it does not mean the Project storage itself, which is affected by the operations is not impacted. Therefore, both the Project Inflows and Elephant Butte's elevation are needed for the analysis. Figure 4.3 should present a comparison between the Proposed Action and No Action of the 2008-2012 period. Please evaluate changes in the storage under the 2008 OA and the Prior Op	Refer to NMISC-023.	No change to SEA.	modeling water supply
80	NM-50	Section 4.2.2.2 Surface Water, Pg. 22, Table 4.1a, b, and c: The allocation Summary provided in the tables of the draft EA contained a number of errors and conclusions based on the tables occur throughout the draft EA: 1) Prior Operations (Estimated) are based on a model of Project Operations that is as yet unreliable. The analysis we have reviewed tends to underestimate the water availability under "Prior Operations," and thus underestimate the difference between EBID's allocation under the 2008 OA and EBID's allocation under Prior Operations; and 2) Exception: the 2008 numbers (Prior Ops allocation to EBID: 495KAF, difference from 2008 OA Actual: - 170KAF) are consistent with other Reclamation records and New Mexico's findings in Barroll, Shafike and Liu (2011) and Barroll's affidavit	The analysis of Project allocations conducted for the supplemental EA is fully detailed in Appendix F. All data and models used in the analysis were verified by technical experts from Reclamation, EBID, and EPCWID. See also NMISC-030.	No change to SEA.	modeling water supply
81	NM-51	Section 4.2.2.2 Surface Water, Pg. 23, Last Paragraph: There is an apparent attempt to estimate "seepage" and by inference "recharge to EBID" associated with recent Project Operations. This estimate is incorrect in theory and in calculation. To calculate seepage, a physical water budget would be required. The Draft EA instead compares releases with charged deliveries: since charged deliveries are not physical diversions, using them in a physical water budget is invalid. Deliveries to Mexico would be a necessary term in such an analysis, and are not mentioned here. In fact, the change in recharge when EBID caused by the change in operations is in the opposite directions, and much larger. In full supply years EBID's allocation is 170,000 AF smaller, which corresponds to a reduction in canal seepage on the order of 75,000 AF and a reduction in on-farm return flow from surface water application on the order of 25,000 AF.	Estimates of recharge within the Project were revised during final technical review. Data and methods used to estimate Recharge within the Project are detailed in Appendix F, Section 4.4.	Analysis presented in the draft SEA has been revised.	modeling water supply
82	NM-52	Section 4.2.2.2 Surface Water, Pg. 23, Last paragraph: The discussion is incorrect since Project charges are not the same as actual gross diversions.	The discussion referred to in this comment has been removed from the final SEA	Discussion referred to in this comment has been removed from the final SEA	modeling water supply
83	NM-53	Section 4.2.2.2 Surface Water, Pg. 26: Shows that releases under the proposed action are higher than releases under the no action alternative (Releases under the no action alternative could not be verified and seem overestimated; specifically for 2008, the release was estimated at 843,545 AF.) If this is true, the proposed action would have an impact on Article VII and Article VIII of the Rio Grande Compact	Estimates of Project releases under the No Action alternative were revised during final technical review. Data and methods used to estimate Project operations under the No Action alternative are detailed in Appendix F, Section 3.1.	Analysis presented in the draft supplemental EA has been revised.	modeling water supply

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84	NM-54	Section 4.2.2.2 Surface Water: Reclamation claims the reason for the 10,720 AF/y average increases in total Project releases is due to uncertainty in the analysis. Reclamation does not acknowledge other possible reasons for this increase, such as the improper release of New Mexico's credit water by Reclamation in 2011 and 2012. The discussion on page 28 on computing usable water needs more detail describing how credit water was computed and if it was decreased monthly by evaporation or not.	See NMISC-053.	Analysis presented in the draft supplemental EA has been revised.	modeling water supply
85	NM-55	Section 4.2.2.2 Surface Water, Pg30: The analysis of 2013-2015 effects appears to be based on a similar analysis to Table 4.1a, b, and c and is similarly biased toward underestimation of the impact of the 2008 OA on EBID's allocation	The analysis of Project allocations conducted for the SEA is fully detailed in Appendix F. All data and models used in the analysis were verified by technical experts from Reclamation, EBID, and EPCWID. See also NMISC-030.	No change.	modeling water supply
86	NM-56	The comment is that the statement about the OA resulting in a large increase in annual allocation to EBID on page 32 of the document is false. It describes conditions that have never in fact occurred, despite full-supply conditions in 2008, 2009, and 2010 and are unlikely to ever occur under the 2008 OA. The diversion ratio is already biased to the low side because of accounting changes since the D2 period, plus it is highly dependent on drain flows within NM that cannot return to pre-2008 OA levels as long as EBID is not allocated a full supply of surface water.	The discussion referred to in this comment states that "the OA results in a large increase in annual allocation to EBID under wetter conditions when the diversion ratio is greater than 1.2." Contrary to the reviewer's comment, these conditions did not occur during the period 2008-2012 as the diversion ratio was less than 1.0 throughout this period.	No change.	modeling water supply
87	NM-57	Table 4.3 indicated the average decrease in EBID allocations under wet conditions (80% non-exceedence) is 205,800 AF. This supports the concerns about significant impact	Effects of the OA on Project allocations to EBID are discussed in the main body of the supplemental EA; additional details are provided in Appendix F.	The draft supplemental EA was revised to further clarify the likely effects of the OA on Project allocations.	modeling water supply
88	NM-58	Conclusions about EBID's overall conjunctive supply is unaffected is not supported; conclusion about annual release from storage is not supported since nothing in the proposal limits reservoir releases	See NMISC-057.	The draft supplemental EA was revised to further clarify the likely effects of the OA on Project allocations.	modeling water supply
89	NM-59	The draft gives an erroneous account of how groundwater pumping impacts are treated under the OA...the SEA contains no mention of other Texas pumping in the Mesilla Basin. No reporting was done in 2008, 2009, or 2011, so the fill impact of Canutillo pumping was charged against the EBID allocation	See NMISC-039.	The SEA and Technical Appendix were checked to verify and validate data.	groundwater
90	NM-60	The comment is that the statement on page 15 is not correct where it says both districts would be accountable for offset losses in river efficiency within their respective states. The OA does not contain a provision to address Texas's pumping impact on project supply and delivery.	The OA does not contain provisions specifically requiring either district to offset groundwater pumping or changes in Rio Grande conveyance efficiency. This statement has been removed.	Statement referred to in this comment has been removed from the final supplemental EA.	modeling water supply
91	NM-61	The comment is the EA has an inadequate and erroneous description of the effects of the action on groundwater. Three examples given are that the change in groundwater recharge to EBID omits the largest components of recharge: canal seepage and on-farm return flows from surface water application.	Estimates of recharge within the Project were revised during final technical review. Additional discussion and clarification of effects on groundwater resources are provided in the SEA.	The final supplemental EA provides additional discussion of effects on groundwater resources.	groundwater

Responses to Comments recieved under the Supplemental Environmental Assessment for the Implementation of Rio Grande Project Operating Procedures, New Mexico and Texas

92	NM-62	The estimated change in groundwater pumping in EBID on page 48 is based on unreliable results in Table 4.1a.	Estimates of recharge within the Project were revised during final technical review. Additional discussion and clarification of effects on groundwater resources are provided in the final supplemental EA.	Analysis presented in the draft supplemental EA has been revised	modeling water supply
93	NM-63	The impacts of increased groundwater demand and decreased recharge in NM have not been analyzed in anyway and must be addressed in an EIS.	Estimates of potential change in demand for supplemental irrigation within the Project were revised during final technical review. Data and methods used to estimate groundwater demand within the Project are detailed in Appendix F, Section 4.4.	No change.	groundwater
94	NM-64	The EA used average values of reallocation and the associated increased groundwater demand to suggest there would only be a small impact on EBID and NM aquifers. It is not appropriate to use an average when the variance is large or the distribution is not normal. Please include the min and max in the evaluation	Estimated changes in annual allocation values and corresponding estimates of changes in groundwater recharge are summarized in the body of the EA, with further details provided in Appendix F	No change.	groundwater
95	NM-65	The EA did not assess changes in groundwater quality due to the OA. Reclamation must assess groundwater quality changes for 2008-2012 and perform model simulations for the future. Impacts on groundwater quality must be evaluated.	Additional consideration of water quality effects has been added to the final supplemental EA. See also NM-34.	Changes made to SEA.	groundwater
96	NM-66	The statement on page 81 of Appendix C is not correct. The Compact does not guarantee delivery of water to the project sufficient to provide a specific release	This is correct, statement corrected.	Comment removed from Appendix.	Compact
97	KC-01	The comment is that he spent time reviewing and admits most of his comment wont change most of the conclusions, but he does have some reservations about the water quality results used in light of the forthcoming Final NMDA & PdNWC WBP that should be available by June 2013.	Comment noted and water quality section edited accordingly.	Changes made to SEA.	water quality

Appendix H – Water Quality Technical Information

Appendix H:
Water Quality Technical Information
Rio Grande Project 0023



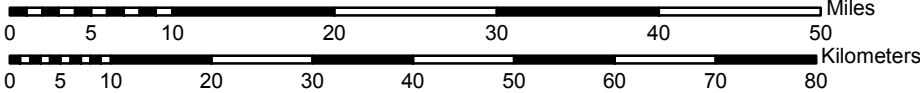
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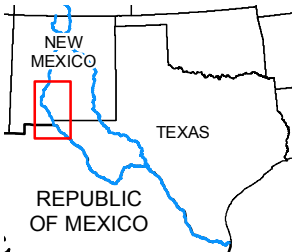
Produced by: *Matthew J. Dorsey*
GIS Specialist
Date: 20130610
Printed: 20130619

Vector:
Hydrology: National Hydrography Dataset (NHD)
Dams: FEMA
Water Quality: Derived from U.S. EPA WATERS

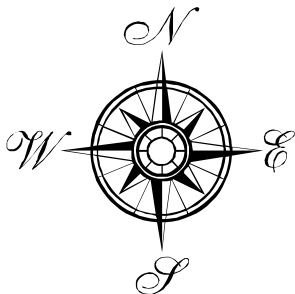
Scale 1:750,000



North American Datum of 1983 / World Geodetic System of 1984
Projection and 1,000 meter grid:
Universal Transverse Mercator, Zone 13S



U.S. National Grid			
100,000m Square ID			
370	BT	CT	DT
360	BS	CS	DS
350	BR	CR	DR
	BQ	CQ	DQ
	30	40	
Grid Zone Designation			
32° N 13S			
13R			



U. S. Department of the Interior
BUREAU OF RECLAMATION

Legend

Dams along the Rio Grande Project

Rio Grande

Reservoirs

HUC 8-digit (Subbasin)

State/International Boundary

County Boundary

Layers

U.S. National Grid

Analysis

1

2

3

Maximum functionality for this map is achieved using **Adobe® Reader®** or Adobe® Acrobat®. Map layer visibility can be toggled using the Layer Panel. Areas of Impairment can be investigated with the 1) Object Data tool and distances and coordinates can be derived with the 2) Measuring and 3) Geospatial Location tools respectively on the Analysis Toolbar (Acrobat®) or Edit>Analysis> menu (Reader®).

#	WATERS Waterbody ID	Area of Impairment	Impairment
1	NM-2104_00	Fisheries at Elephant Butte Reservoir	Mercury in fish tissue
2	NM-2103.A_00	Rio Grande between reservoirs	Dissolved oxygen / Oxygen depletion with organic enrichment
3	NM-2102.B_00	Fisheries at Caballo Reservoir	Mercury in fish tissue
4	NM-2101_10	One mile above Percha Dam to Leasburg Dam	Fecal Coliform
5	NM-2101_02	Leasburg Dam to Picacho Bridge	Bacteria
6	NM-2101_01	Picacho Bridge to Anthony Bridge	Bacteria
7	NM-2101_00	Anthony Bridge to International Boundary EXCLUDING areas entirely within TX	Bacteria
8	TX-2314	Texas state line to International Boundary (inclusive of areas Shared with NM)	Bacteria
9	TX-2307_05	Riverside Diversion Dam (Destroyed) to Guadalupe Bridge	Non-point source pollutants / Bacteria
10	TX-2307_04	Guadalupe Bridge to El Paso / Hudspeth county line (continuing to Alamo Arroyo Grade Structure)	Non-point source pollutants / Bacteria

This map contains hyperlinks to the U.S. EPA's [Watershed Assessment, Tracking, and Environmental Results](#) (WATERS) webpage for more information on 303(d) Listed Impaired Waters.

RECLAMATION