Use of Alternative Transfer Methods to Increase Water Supplies for Conejos Basin Agriculture, Municipal, and Environmental Purposes

Prepared For Conejos Water Conservancy District
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Front cover: Trujillo Meadows Reservoir
Photo by Dick Stenzel

San Antonio River

Contents

Contents, cont.

List of Figures

List of Figures, cont.

List of Tables

An Irrigation Ditch

1. Introduction

1.1 : Overview of Project

The Conejos Water Conservancy District (CWCD) is in Conejos County in southern Colorado in the Rio Grande Basin (Water Division 3). The CWCD includes 88,000 acres of irrigated agriculture and the towns of Manassa, Romeo, Sanford, Conejos, Antonito, Ortiz, and San Antonio. The Town of La Jara is directly adjacent to the CWCD. Collectively, these towns will be referred to in this report as the Towns.

The CWCD provides multiple services within its boundaries. These include allocation of Project Water stored in the Platoro Reservoir (see Section 2.1); operations and maintenance of the Platoro Reservoir (Platoro) augmenting well-pumping depletions; monitoring and measuring groundwater and surface water; and forecasting snow water equivalent for the Conejos portion of the Rio Grande Compact (Compact) deliveries. In addition, CWCD is involved in water rights protection via involvement in water court proceedings, State Engineer rules and regulations, and other legal proceedings.

All of these Towns (except Antonito) rely entirely on confined aquifer groundwater pumping for their water supply. The Town of Antonito has a surface water supply in addition to using groundwater. Pending Colorado Division of Water Resources (DWR) groundwater rules and regulations will require augmentation of well-pumping depletions. The Towns will likely look to agricultural water resources within the basin as a potential replacement source as there is not enough water available for appropriation under a new water right. The purpose of this Alternative Agricultural Transfer Method (ATM) project is to investigate the opportunities for the transfer of the allocation of San Antonio River agricultural water users' CWCD Project Water allocation to the Towns to meet their augmentation water requirement without loss or impact to the irrigated agricultural lands. This could be accomplished by providing alternative water supplies to the agricultural users on the San Antonio through the regulation of existing water supplies via an enlarged Trujillo Meadows Reservoir (Trujillo Meadows). In this report, the Trujillo Meadows Reservoir ATM Study is referenced as "The TMR Study."

The Towns will likely look to agricultural water resources within the basin as a potential replacement source as there is not enough water available for appropriation under a new water right.

1.2 : Project Objectives

The primary objective of the TMR Study is to investigate the feasibility of a unique ATM that involves enlarging Trujillo Meadows to provide intra-year regulation of water supplies including direct flow storage and storage of other agricultural and augmentation water rights for agricultural users diverting from the San Antonio (see Section 2.5). This reregulation of existing and augmentation supplies could provide a more reliable supply for existing agricultural users and potentially allow these agricultural users to lease their Project Water to the Towns for replacement of well-pumping depletions owed by the Towns. In addition, the project evaluated other potential multiple-objective benefits, such as enhanced recreational opportunities at Trujillo Meadows and retiming of releases from Trujillo Meadows for environmental benefits such as enhanced riparian habitat and streamflows on the Rio De Los Pinos (Los Pinos). Potential indirect benefits include retimed streamflows on the Conejos River below Platoro Reservoir (Platoro) due to the release of Project Water for augmentation of the Towns' pumping depletions and meeting Compact delivery requirements.

Platoro Reservoir
Photo by Dick Stenzel

2. Background

2.1 : Platoro Reservoir

Platoro is a post-Compact reservoir with Conejos priority no. 196. It was constructed between 1949 and 1951 by the U.S. Bureau of Reclamation (BOR) and has a capacity of 53,500 acre-feet (AF) and a surface area of 960 acres. Platoro is a post-Compact reservoir and cannot store water under its priority if Article VII of the Compact is in effect. Article VII states that:

> "Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage…"

Elephant Butte Reservoir in New Mexico provides the project storage referenced in the Compact. Water stored in priority in Platoro (Project Water) is allocated by the CWCD to users within its boundaries, including the Towns and agricultural users. Project allocations do not occur every year and are dependent upon Elephant Butte storage and water supply conditions in Colorado. Project Water can be held over in storage for use in subsequent water years. Agricultural users on the San Antonio, while within the CWCD, cannot directly receive direct delivery of Project allocation by gravity flow or

other existing infrastructure. San Antonio agricultural users historically have leased their Project allocation to other users on the Conejos mainstem.

Annually, and also during times when Elephant Butte is storing less than 400,000 AF, Platoro can legally operate under its direct flow storage decree, which allows temporary storage of water in Platoro within the water year.

Platoro is also currently used to facilitate a winter flow program that provides for the transfer of transmountain water into the reservoir via exchange during the irrigation season. This transmountain water is not subject to Article VII of the Compact. The transmountain water is released during the winter season to voluntarily increase streamflows in the Conejos below Platoro beyond the minimum seven cubic feet per second (cfs) release requirement.

Platoro Dam is owned by the Bureau of Reclamation, but the Conejos Water Conservancy District is responsible for operations and maintenance.

The Platoro Dam is owned by the BOR; however, the CWCD is exclusively responsible for the operations and maintenance of the dam. The BOR is responsible for safety and security. Recreation is managed by the U.S. Forest Service (USFS) and Colorado Parks and Wildlife (CPW.) Recreational use includes fishing, camping, boating, and hunting. The CWCD cooperates with the Army Corps of Engineers on operations of Platoro for flood control.

2.1.1 : Existing Platoro Reservoir Operations

Located on the mainstem of the Conejos, Platoro can provide supplemental water supply to a large part of the irrigated lands within the CWCD. Project Water is allocated pro rata to lands within the CWCD based on acreage. The CWCD includes water users diverting from the San Antonio. Agricultural irrigators on the San Antonio within the CWCD are entitled to a pro rata share of Project Water in Platoro, but Project Water cannot physically be delivered to these users by gravity flow or any existing infrastructure. Due to early runoff that peaks before the major irrigation season, San Antonio irrigators cannot efficiently utilize the peak flows and are making Compact deliveries that benefit all Conejos water users, while not receiving any benefit from Platoro Project Water.

Platoro has a capacity of 54,000 AF. That capacity includes 10,000 AF for flood control and 44,000 AF of working storage. Most of the storage in the reservoir is currently used for direct flow storage of water rights owned by ditches diverting downstream on the Conejos. Any ditch desiring to implement direct flow storage is required to divert direct flow water in priority for 10 days before Platoro can start storing direct flow storage for that ditch. This usually occurs near the peak of the runoff. Any Compact storage is directed by the Water Commissioners and is shown on the 10-Day Report provided by the Division 3 Engineer.

There are 88,000 irrigated acres in the CWCD. Project Water storage is Priority 196 and can divert inflows more than 7.0 cfs from November 1 through March 31. Article VII of the Compact states that Elephant Butte Reservoir in New Mexico must have a minimum of 400,000 AF in storage

before any Project Water can be stored. Elephant Butte has an evaporation rate of approximately 20%, whereas Platoro has an evaporation rate of approximately 2%, based on weather station data. Project Water is delivered from Platoro to the Conejos for downstream use within CWCD.

2.1.2 : Direct Flow Storage

CWCD decreed direct flow storage in Platoro in Case No. 90CW0048. This decree has terms and conditions regulating the use of direct flow storage. The 90CW0048 decree terms include:

- The Compact shall not be affected.
- Any water right going into Platoro direct flow storage must have been diverted for 10 days prior to direct flow storage.
- Bypasses from a ditch may be required by the Division Engineer for return flow.
- When released from Platoro storage, direct flow storage will be assessed transit loss.
- Direct flow storage flowrate shall not exceed the physical capacity of a ditch or historical sustained diversions for beneficial use.
- Water will not be allowed to be stored for any priority that was not being beneficially used or wasted preceding the switch to direct flow storage. No expansion of irrigated acreage can occur because of direct flow storage. Water releases must be made during the same irrigation season as the water was stored and returned to the same ground from where the diversion was foregone.
- Physical shortages of Platoro inflows will be divided equitably among users wishing to store their direct flow right.

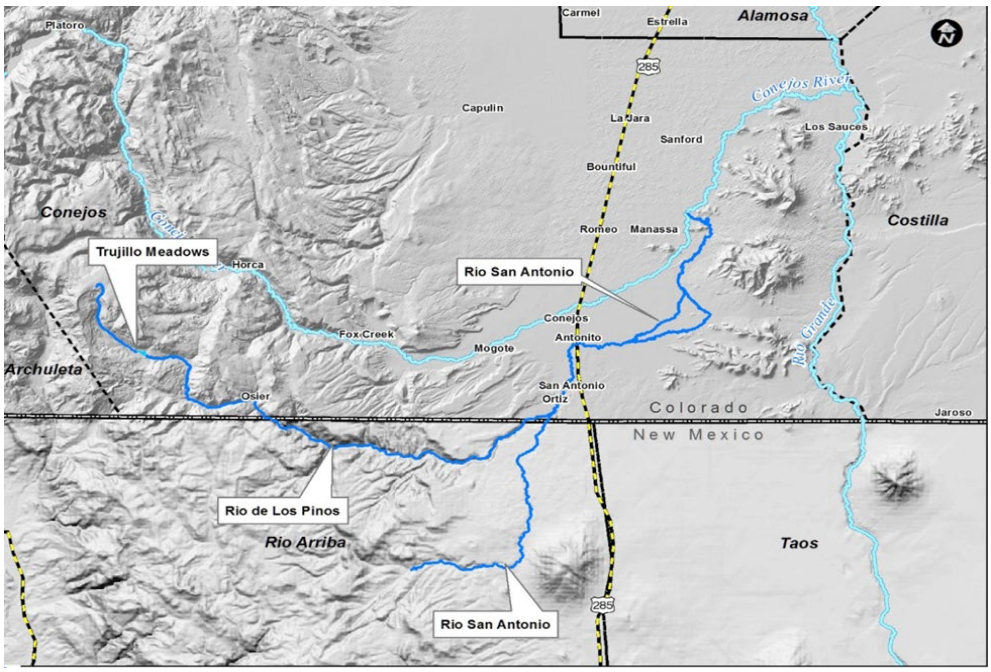
The direct flow storage right is an important administrative tool for improving water supplies.

2.2 : Existing Agricultural Shortages on San Antonio

The Los Pinos flows into the San Antonio River near the New Mexico-Colorado state line, flowing north to the confluence with the Conejos as shown in Figure 1. There are 37 irrigation ditches that divert from the Los Pinos that irrigate approximately 9,760 acres. From 1980 to 2015, the average date of historical peak runoff is May 5 for the San Antonio River at the Ortiz, CO gage and May 22 at the Los Pinos near Ortiz, CO. The historical peak of the combined flow is May 21. Runoff generally occurs too early in the season for optimizing beneficial use by irrigated agricultural users diverting from the San Antonio, as the peak growing season and irrigation needs occur after the peak of the runoff and there is not any reservoir storage. A comparison of the average flows as measured at the San Antonio near Ortiz with the average river headgate demand for irrigation for ditches diverting from the San Antonio is shown in Figure 2. The irrigation water requirement (IWR) represents the volume of water that is required to be delivered to the farm field to meet the full crop water demand after accounting for irrigation efficiency. The river headgate demand is the IWR plus the water that is needed to be diverted to account for ditch conveyance losses.

FIGURE 1.

Map of Area Rivers



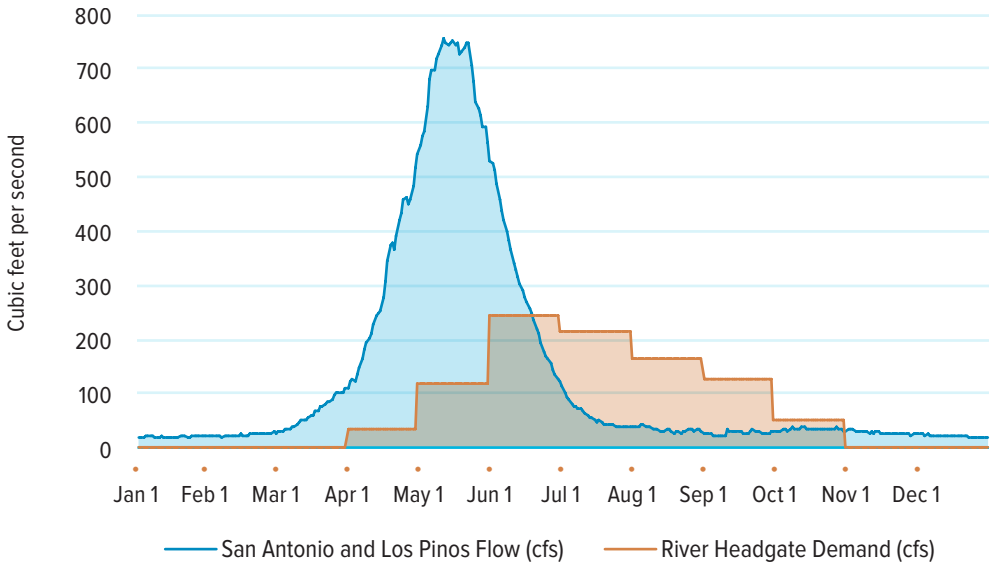


FIGURE 2.

San Antonio and Los Pinos Flows v. IWR

diversion requirements (ditch conveyance loss from the river headgate to the farm headgate plus IWR) of the ditches exceed the available flow in the River. This supply vs. demand situation is described as water short. The water diversion requirements and IWR for the ditches diverting from the San Antonio were analyzed using the data provided through the Rio Grande Decision Support System (RGDSS). Agricultural shortages (the differences between available supply and water diversion requirements) were analyzed for the period of 1980–2008. During that time, water shortages based on IWRs, which were estimated using the crops grown as reported in the RGDSS, were also calculated. Those shortages averaged 23,970 AF with a minimum of 18,340 AF and a maximum of 33,450 AF.

Table 1 shows the annual estimated available supply, IWR, and shortages on the San Antonio River. The shortages were estimated by modeling with RiverWare, a water allocation model developed as part of the Rio Grande Basin Implementation Plan for the Rio Grande Basin Roundtable. RiverWare uses a variety of data sources and logic to calculate daily diversions from the San Antonio and Los Pinos to meet IWR on the various ditch systems. The Colorado priority system and the Compact are some of the various logic overlays within the model that ensure accurate representation of river conditions.

TABLE 1.

Modeled Irrigation Shortages on the San Antonio and Los Pinos Rivers (AF)

Year	Available River Supply (AF)	Total IWR (AF)	Total River Headgate Demand Assuming 50% Ditch and Irrigation Efficiency (AF)	River Headgate Shortage Assuming 50% Ditch and Irrigation Efficiency (AF)
1981	7,610	29,340	58,680	51,070
1982	11,550	24,750	49,500	37,940
1983	10,780	28,000	56,000	45,210
1984	12,640	28,320	56,640	43,990
1985	11,980	27,050	54,100	42,120
1986	10,250	23,480	46,960	36,710
1987	8,790	27,650	55,300	46,510
1988	9,050	29,290	58,580	49,520
1989	10,480	33,490	66,980	56,500
1990	8,110	28,110	56,220	48,110
1991	11,280	28,230	56,460	45,180
1992	9,150	29,030	58,060	48,910
1993	13,760	26,050	52,100	38,350
1994	11,970	29,520	59,040	47,070
1995	11,630	26,880	53,760	42,130
1996	7,840	31,700	63,400	55,560
1997	11,520	29,050	58,100	46,590
1998	10,550	30,740	61,480	50,920
1999	12,250	27,280	54,560	42,310
2000	5,480	33,510	67,020	61,540
2001	8,870	31,220	62,440	53,580
2002	2,390	34,640	69,280	66,890
2003	7,370	28,240	56,480	49,100
2004	8,740	28,240	56,480	47,730
2005	10,690	28,240	56,480	45,790
2006	7,570	28,240	56,480	48,900
2007	8,480	28,240	56,480	47,990
2008	11,210	28,240	56,480	45,260
2008	11,210	28,240	56,480	45,260
Average	**9,740**	**28,850**	**57,690**	**47,950**
Max	**13,760**	**34,640**	**69,280**	**66,890**
Min	**2,390**	**23,480**	**46,960**	**36,710**

Table 1 shows the water shortage for each irrigation season from 1980–2008. The first column shows the IWR shortage at the farm field and the second column shows the river headgate shortage if 50% of headgate diversions are lost due to ditch seepage and irrigation practice inefficiency. The RGDSS StateCU files indicate a maximum efficiency of 50% to 60% for most ditches on the Los Pinos and San Antonio Rivers.

Figure 3 shows the modeled IWR met and remaining shortage on the San Antonio and Los Pinos Rivers below Trujillo Meadows Reservoir (Trujillo Meadows). The sum of the met and unmet IWR is the total irrigation demand for the two river systems. On average between 1980 and 2008, the modeled total IWR demand is 28,850 AF; the total consumptive demand met is 4,870 AF; and the average unmet irrigation requirement is 23,970 AF. To meet the full unmet demand, Table 1 shows that on average, an additional 47,950 AF would have to be diverted from the Los Pinos and San Antonio Rivers, noting that ditch and irrigation inefficiency cause return flows that would be diverted again downstream or would meet Compact delivery requirements. Therefore, the required draw on the stream would be less than 47,950 AF.

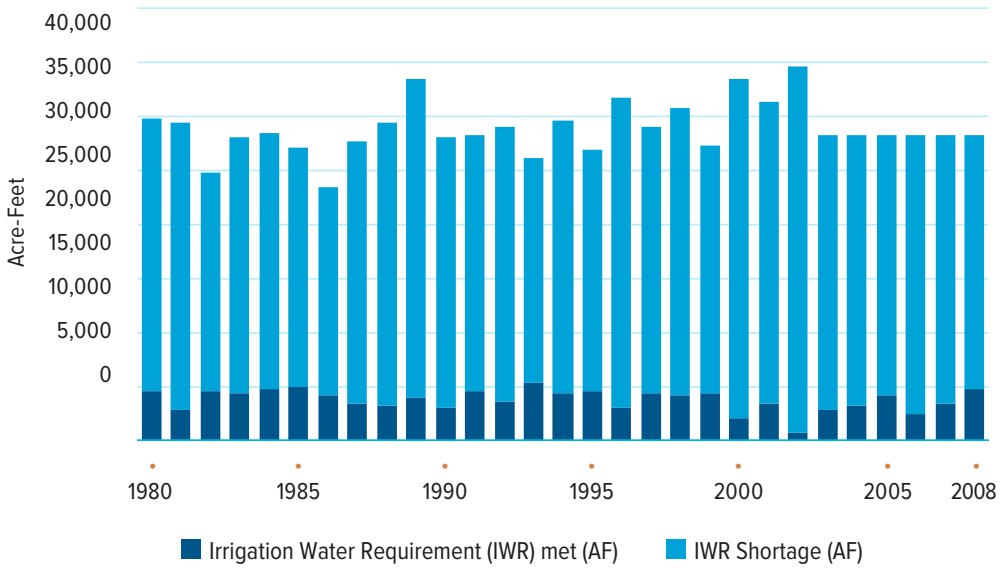


FIGURE 3.

Modeled IWR Met and Shortage on the San Antonio and Los Pinos Rivers From 1980 to 2008

Note: The sum of the two bars is the total IWR demand. Data drawn from RGDSS StateCU model.

Figure 4 shows a time-series of river headgate demand for all the ditches on the Los Pinos and San Antonio Rivers below Trujillo Meadows Reservoir. This time-series was created by using the RGDSS IWR and dividing by 0.5, the assumed combined ditch and irrigation efficiency. This time-series shows that irrigation season demand to meet crop requirements peaks around 250–300 cfs. The sum of all the water rights on the Los Pinos and San Antonio Rivers below Trujillo Meadows is 789 cfs. This number is somewhat skewed by the Taos No. 3 ditch that has a 245 cfs water right (230 cfs remains in river channel for augmentation and 15 cfs can be diverted for irrigation of

out-of-district lands). Removing this ditch from the analysis still leaves 544 cfs of water rights for 188 cfs of modeled river headgate demand. This large discrepancy between the sum of the Los Pinos and San Antonio water rights and the maximum river headgate demand is presumably because ditches on this system would only ever divert their full water right during the peak growing season or to flush the ditch at the beginning of the irrigation season.

Figure 5 illustrates river headgate demand on Los Pinos and San Antonio during wet, dry, and average hydrologic years.

FIGURE 4.

Time-series of River Headgate Demand on Los Pinos and San Antonio Rivers Assuming 50% Ditch and Irrigation Efficiency

Note: IWR derived from RGDSS StateCU model.

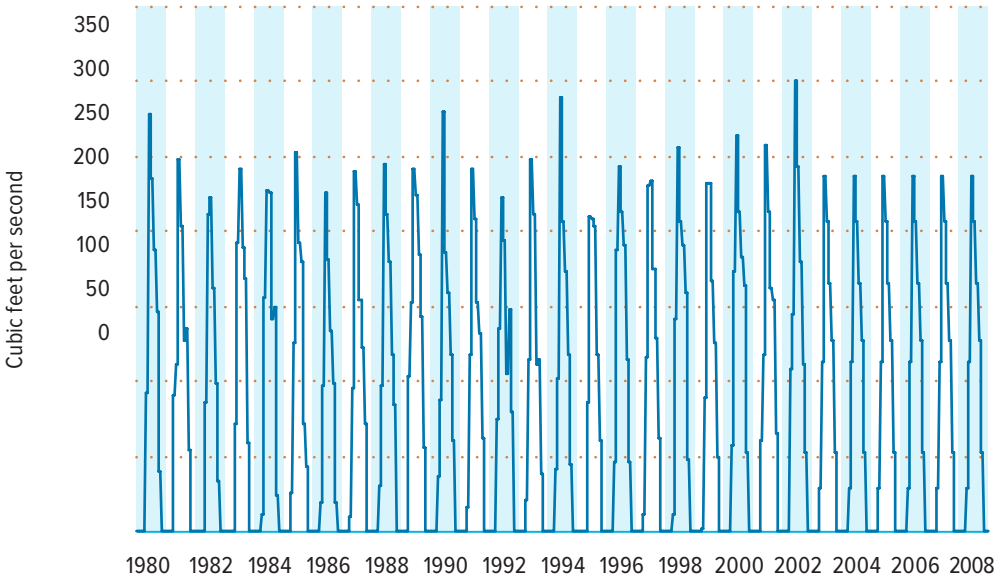
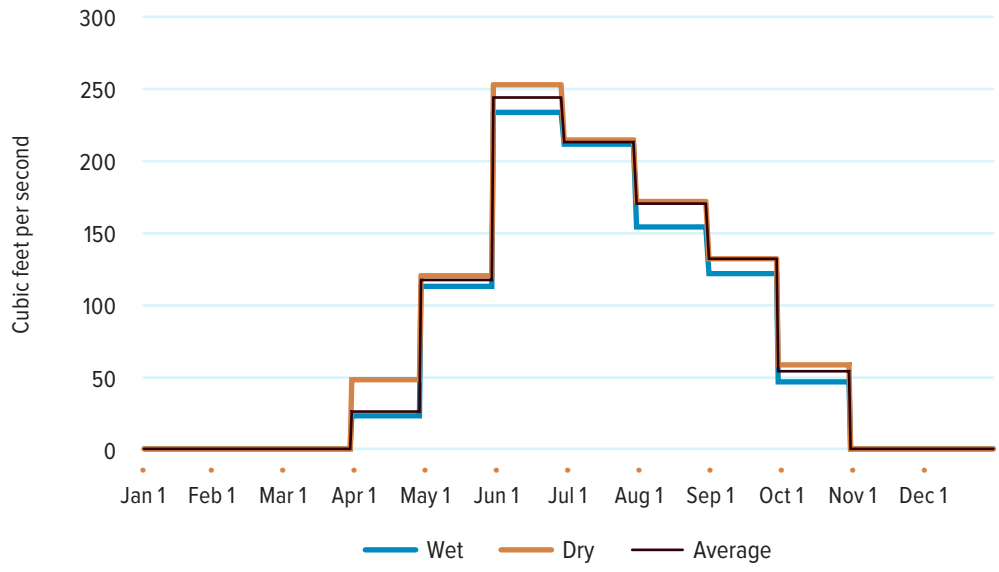


FIGURE 5.

River Headgate Demand on Los Pinos and San Antonio During Wet, Dry, and Average Hydrologic Years

Note: Years from 1980–2008 were categorized as wet, dry, or average and the river headgate demand was averaged for those years.



2.3 : Well-pumping Rules and Regulations

As required by SB 04-222, the State Engineer has finished the process of preparing Well Rules and Regulations for existing uses of groundwater in Division 3. The rules are to prevent injury to water right holders; provide for sustainable groundwater supplies; and prevent interference with the Compact. The promulgation of these rules was delayed by the need to update and recalibrate the RGDSS groundwater model to include, among other things, measured well-pumping data being obtained pursuant to the Division 3 Groundwater Measurement Rules. The updating and recalibration effort was completed by mid-2015, when the Well Rules and Regulations (Rules) were promulgated. Protests were filed by 30 objectors. A hearing on the Rules has been set for January 2018. In the meantime, the State Engineer's Office (SEO) has been meeting with many of the objectors to the Rules to reach written stipulations. As of the date of this report, there remained several objectors.

The proposed Well Rules and Regulations will require well owners to meet one of the following criteria:

- Join a Groundwater Management Subdistrict
- Have an approved Plan of Augmentation for their well
- Cease use of their well

The Rules, once finalized, will require the Towns to replace approximately 17% of any groundwater pumping, most likely through the release of augmentation water. To meet their replacement requirements, the Towns will likely seek to acquire and transfer agricultural water resources within the basin as there is no water available for appropriation under a new water right.

The proposed Well Rules and Regulations will require all well owners to replace well-pumping depletions.

2.4 : Trujillo Meadows Reservoir

Trujillo Meadows is located on the Los Pinos in southwestern Colorado in the San Juan Mountains. Trujillo Meadows is situated just north of the Township line between Township 32 and 33 North in Range 5 East at an elevation of approximately 10,000 feet. Figure 6 is a location map showing the general reservoir location.

CPW owns and operates Trujillo Meadows Dam and Reservoir, which is a post-Compact reservoir used for recreation. The reservoir bypasses all inflows and maintains a constant pool elevation to the extent inflows exceed evaporation and seepage. Out-of-priority evaporation losses from Trujillo Meadows are augmented through releases by CPW from Beaver Reservoir, a pre-Compact reservoir owned by CPW situated on a tributary of the South Fork of the Rio Grande.

The Trujillo Meadows dam, originally constructed in 1956 and shown in Figure 7, has had excessive and chronic seepage problems since the initial reservoir filling, primarily through the landslide deposits on the left dam abutment. After the completion of four phases of lining work in recent years, the seepage rate has been reduced to levels considered acceptable by the SEO of Dam Safety. Records for the 2013 SEO of Dam safety inspection indicate that the dam and reservoir has been approved for conditional full storage, with requirements for ongoing maintenance items and seepage monitoring. The 2014 dam safety inspection revealed that the outlet conduit was in a "substantially deteriorated condition" and "gate leakage is considerable." The 2014 inspection report also stated that "The Screening Level Risk Analysis concluded that the conduit needs to be rehabilitated." The 2015 dam safety inspection noted similar concerns: "The outlet conduit needs to be rehabilitated in the near future. Seepage monitoring remains a high priority." The July 10, 2017, dam safety report noted that seepage measured downstream of the toe of the dam had been steadily increasing since 2014 and that CPW had not been submitting data to the Office of Dam Safety. It also noted that the "Hazard Class was formally changed to High earlier this year" and that "Outlet rehab project is underway and will be constructed later this year."

FIGURE 6.

Trujillo Meadows Location Map

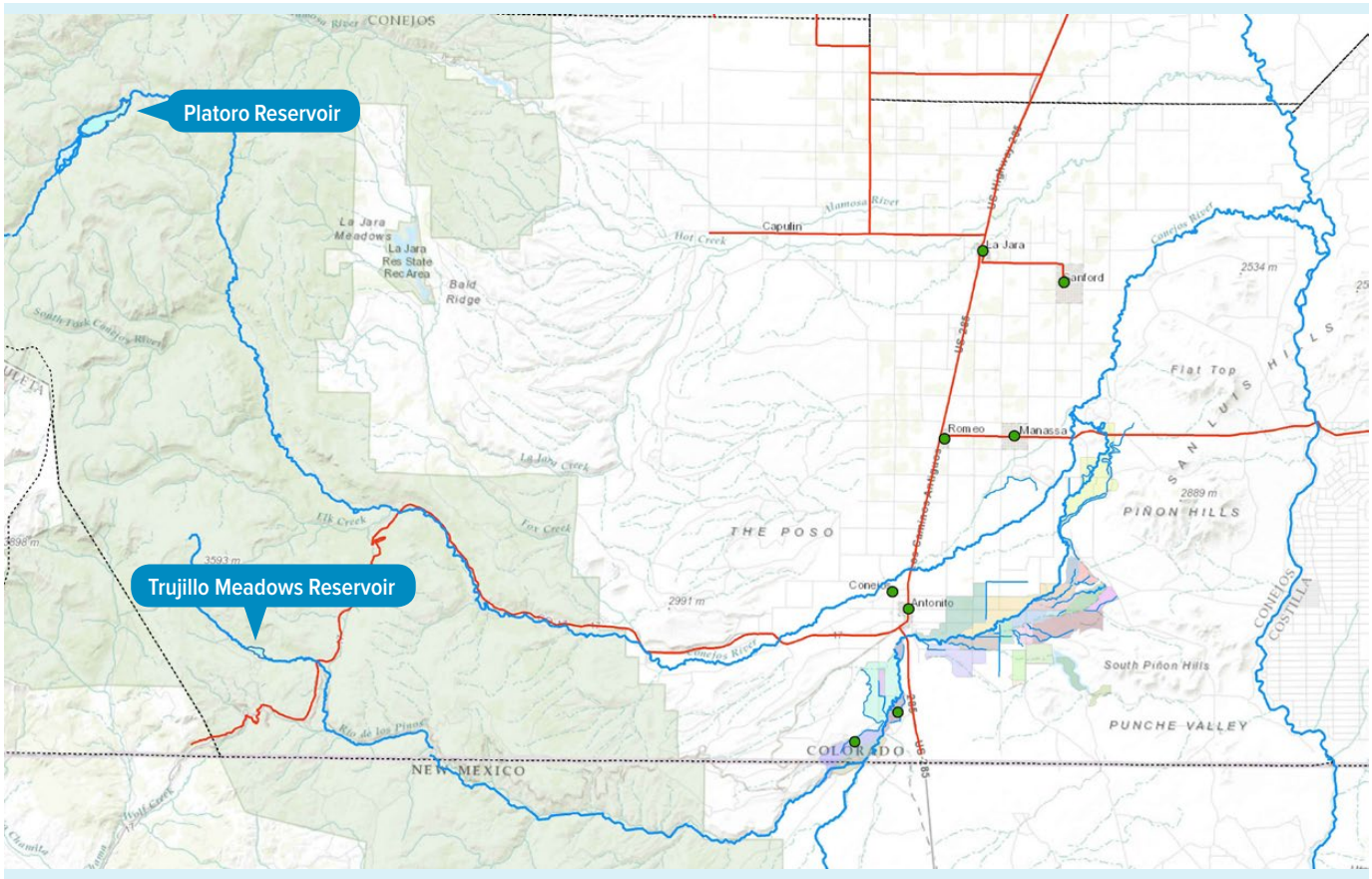


FIGURE 7.

The Dam on Trujillo Meadows

2.5 : Potential Water Sources

There are several potential sources of water that could be stored in an enlarged Trujillo Meadows, including:

- Direct flow storage of San Antonio agricultural water rights
- Transmountain water via exchange
- Compact water
- Transferred agricultural water rights

Runoff in the Los Pinos/San Antonio system normally occurs before the peak irrigation demand season. It is possible that some of the peak flow could be stored in Trujillo Meadows under a new direct flow storage decree. Given the shorter duration of runoff and time that ditches are in priority, rules for implementing direct flow storage might need to be different than the CWCD's Platoro direct flow decree. For example, the term requiring that a ditch be in priority for 10 days before implementing direct flow storage could significantly limit the ability of junior ditches on the San Antonio to implement direct flow storage since they are not in priority for extended periods.

As described in Section 2.1, there is currently a voluntary winter flow program at Platoro where transmountain water is exchanged into Platoro for release during the winter. There is a possibility of exchanging transmountain

water into Trujillo Meadows for release for agricultural or augmentation purposes while also enhancing streamflow.

Trujillo Meadows is a post-Compact reservoir and cannot store when Article VII of the Compact is in effect. However, DWR could elect to implement Compact storage and regulate flows intra-year on Los Pinos to allow for better use of flows for agricultural purposes while improving streamflows and Compact deliveries.

The CWCD is currently working with the San Luis Valley Well Owners to evaluate the potential of transferring a portion of the Cove Lake pre-Compact storage right to Platoro and Trujillo Meadows Reservoirs. The well owners acquired this water right, which has a significant portion decreed for augmentation, for augmenting agricultural well-pumping depletions. Since the Cove Lake decree is pre-Compact, a transfer of this right to Trujillo Meadows could allow storage even when Article VII is in effect.

An irrigation ditch in the San Antonio River region.

3. Conceptual Schematic of the Project ATM

Retiming of runoff or storage of other sources in an enlarged Trujillo Meadows along with releases for multiple uses can better meet the needs of agricultural irrigation users and, additionally, enhance streamflows. This could allow some agricultural water users to lease their Platoro Project Water to the Towns for augmentation purposes, since there are not currently any identified augmentation sources for the Towns. The Towns will owe 81.1% of their stream depletions to the reaches "Conejos above Seledonia/Garcia" and "Conejos below Seledonia/Garcia" (Table 3), which can be met with releases out of Platoro Reservoir. The remaining depletions to other stream reaches will have to be met with other sources. A schematic of the Trujillo Meadows ATM project is shown in Figure 8 below.

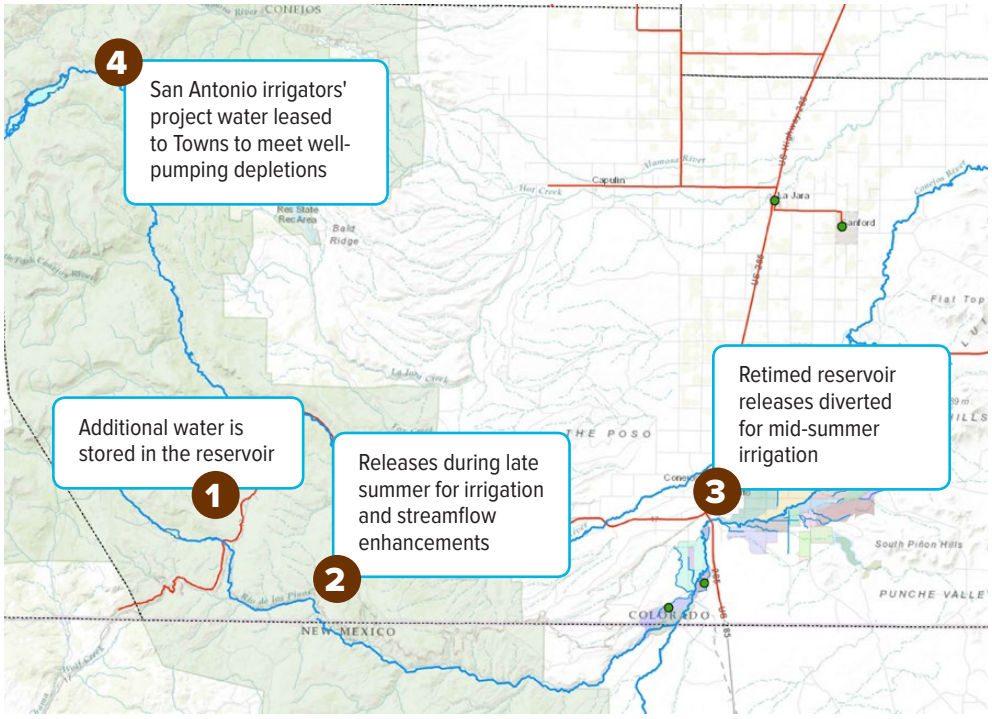


FIGURE 8.

Schematic of Trujillo Meadows Project

3.1 : Potential Recreational and Environmental Benefits

Storage in Trujillo Meadows could be used to re-time runoff to accomplish the following:

- Reduce agricultural water shortages for users on the San Antonio
- Enhance streamflow for a longer period during the runoff season
- Provide a more reliable supply of agricultural water so that the San Antonio River irrigators can lease their Project Water allocation to the Towns for their well augmentation needs

Releases of direct flow or other legally available water stored in Trujillo Meadows could be timed to enhance streamflow while releasing water for additional supplies to irrigators. Specific benefits identified as part of the TMR Study include:

FIGURE 9. A small boat on Trujillo Meadows

- Platoro water augmentation deliveries can be retimed to provide streamflow enhancements.
- Coordinated operations of Rio Grande, Beaver, Platoro, and Trujillo Meadows Reservoirs could provide for streamflow enhancements while replacing well-pumping depletions.
- Enhanced/prolonged stream releases could result in improved riparian values through spring and into summer.
- Improved quality of aquatic habitat and species diversity downstream due to prolonged stream volume after peak runoff could result in lower temperatures and improved dissolved oxygen.
- Increased surface acres and shoreline miles of Trujillo Meadows could be available for wildlife use and wildlife-related recreation (fishing, hunting, wildlife watching) and boating.

4. Municipal Augmentation Demand

4.1 : Quantification/Estimate of Town Pumping

DiNatale Water assessed potential future municipal augmentation demand for the projected well pumping by the Towns in the CWCD. The Towns include Antonito, Manassa, Romeo, Sanford, and Rural Residential (Conejos, Ortiz, San Antonio, and others, including nearby La Jara).

Based on information from the Rio Grande Basin Municipal and Rural Residential Water Pumping Statistics (2009–2013) and the Rio Grande Basin Implementation Plan, Table 2 provides estimated pumping, consumptive use (CU), and return flow for the selected Towns and rural residential areas for 2013 and 2050.

TABLE 2.

Estimate of Pumping by Towns in Conejos County

			2013 Acre-Feet			2050 Acre-Feet		
County	Towns and Rural Residential	CU Factor	Pumping	CU	Return Flow	Pumping	CU	Return Flow
Conejos	Manassa	0.507	614	311	303	658	334	324
	Sanford	0.507	601	305	296	644	327	317
	La Jara	0.507	450	228	222	482	244	238
	Antonito	0.507	230	117	113	246	125	122
	Romeo	0.507	70	35	35	75	38	37
	Rural Residential (Conejos, Ortiz, San Antonio, etc.)	0.218	704	153	551	754	164	590
	Total		**2,669**	**1,150**	**1,519**	**2,860**	**1,230**	**1,230**

4.2 : Rio Grande Support System Response Functions to Estimate Augmentation Demand

The Towns within the CWCD are not currently required to replace their well-pumping depletions. However, they will be required to do so once the rules and regulations requiring augmentation of pumping depletions are adopted. The RGDSS response functions will be used to estimate the augmentation requirements in time, location, and amount. It is currently estimated that the Towns in the Conejos Basin will need to augment on average approximately 17% of their well pumping. The Town of La Jara is in the Alamosa basin directly adjacent to the Conejos Basin, and its average augmentation requirement for well pumping is estimated at approximately 12%. According to the RGDSS model, the estimated well-pumping depletion percentage for Towns in the CWCD has ranged from 12% to 22% for the period of 2001–2015.

Figure 10 is a map developed by the Colorado DWR of the augmentation reaches where pumping depletions are owed. Using the most recent well-pumping depletion percentage from 2015 for the Conejos Response Area (17.4%) and the Alamosa-La Jara Response Area (12.3%), the augmentation requirements per stream reach due to pumping in 2013 and projected pumping in 2050 were calculated. Table 3 and Table 4 below show the estimated well-pumping depletion per stream reach based on 2013 well pumping and projected 2050 augmentation requirements. The well-pumping depletions for the Towns were developed by DWR and its contractors. It includes estimates of the return flows that physically reach the river.

TABLE 3. Conejos and Alamosa-La Jara Response Areas Estimated Well-pumping Depletions Based on 2013 Pumping per Stream Reach (in Acre-Feet)

	Conejos Response Area							
	Conejos above Seledonia/ Garcia	Conejos below Seledonia/ Garcia	Rio Grande Del Norte-Excelsior	Rio Grande Excelsior-Chicago	Rio Grande Chicago-State Line	Alamosa River	San Antonio River	Total
Town	2.87%	12.03%	0.32%	0.47%	1.67%	0.42%	-0.41%	
Manassa	17.6	73.8	2.0	2.9	10.2	2.6	-2.5	106.5
Sanford	17.2	72.3	1.9	2.8	10.0	2.5	-2.5	104.3
Antonito	6.6	27.7	0.7	1.1	3.8	1.0	-0.9	39.9
Romeo	2.0	8.4	0.2	0.3	1.2	0.3	-0.3	12.1
Rural Residential (includes San Antonio, Conejos, and Ortiz)	20.2	84.7	2.2	3.3	11.7	2.9	-2.9	122.2
Total	**63.6**	**266.9**	**7.1**	**10.4**	**37.0**	**9.2**	**-9.1**	**385.0**

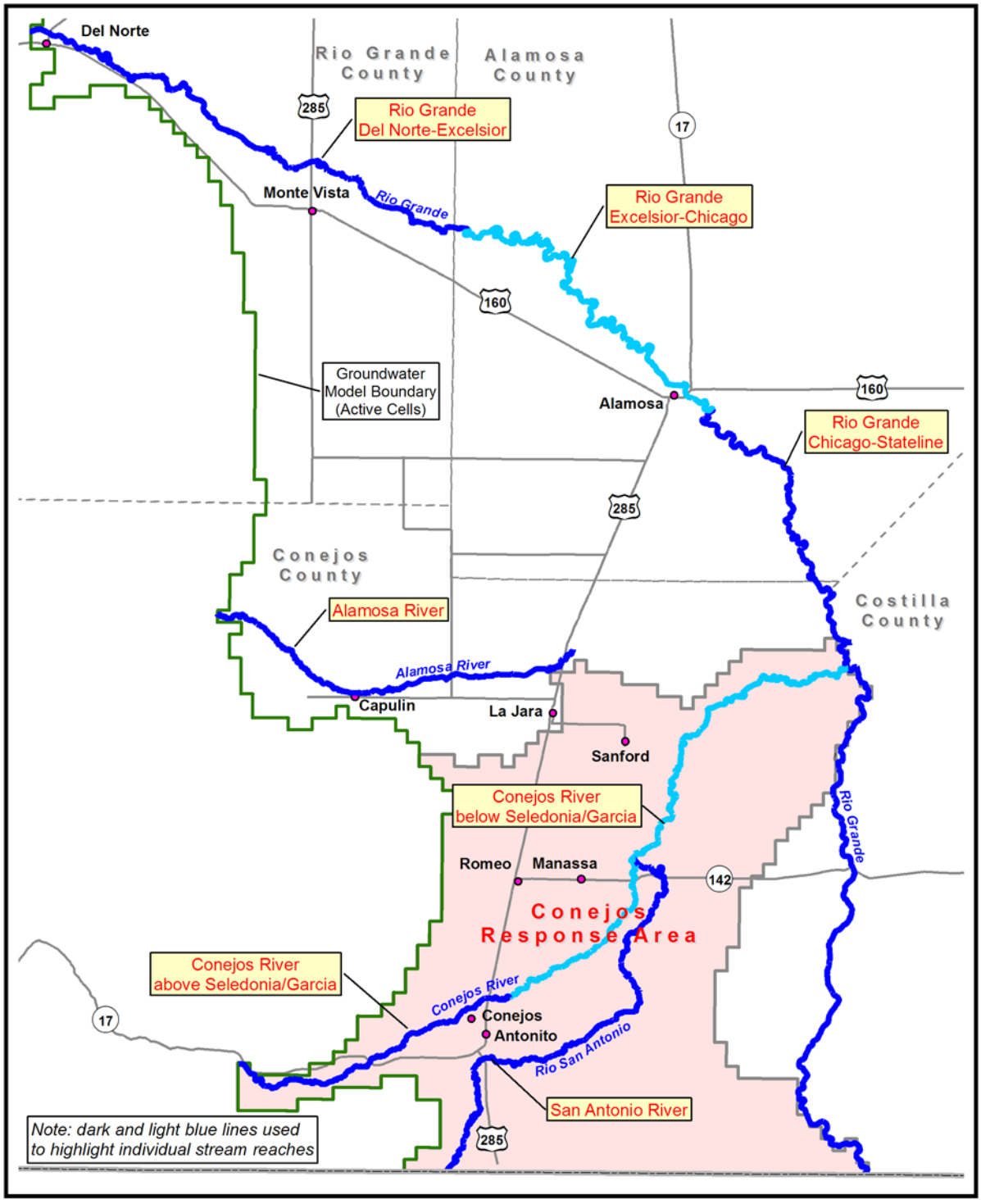
	Alamosa-La Jara Response Area						
	Conejos above Seledonia/ Garcia	Conejos below Seledonia/ Garcia	Rio Grande Del Norte-Excelsior	Rio Grande Excelsior-Chicago	Rio Grande Chicago-State Line	Alamosa River	Total
Town	0.21%	5.72%	2.69%	3.60%	-0.71%	0.76%	
La Jara	0.9	25.7	12.1	16.2	-3.2	3.4	55.2

TABLE 4. Conejos and Alamosa-La Jara Response Areas Projected Augmentation for 2050 Pumping per Stream Reach

	Conejos Response Area							
	Conejos above Seledonia/ Garcia	Conejos below Seledonia/ Garcia	Rio Grande Del Norte-Excelsior	Rio Grande Excelsior-Chicago	Rio Grande Chicago-State Line	Alamosa River	San Antonio River	Total
Town	2.87%	12.03%	0.32%	0.47%	1.67%	0.42%	-0.41%	
Manassa	18.9	79.1	2.1	3.1	11.0	2.7	-2.7	114.2
Sanford	18.5	77.5	2.1	3.0	10.7	2.7	-2.7	111.7
Antonito	7.1	29.6	0.8	1.2	4.1	1.0	-1.0	42.8
Romeo	2.2	9.0	0.2	0.4	1.3	0.3	-0.3	13.0
Rural Residential (includes San Antonio, Conejos, and Ortiz)	21.6	90.7	2.4	3.5	12.6	3.1	-3.1	130.9
Total	**68.2**	**286.0**	**7.6**	**11.1**	**39.7**	**9.9**	**-9.8**	**412.6**

	Alamosa-La Jara Response Area						
	Conejos above Seledonia/ Garcia	Conejos below Seledonia/ Garcia	Rio Grande Del Norte-Excelsior	Rio Grande Excelsior-Chicago	Rio Grande Chicago-State Line	Alamosa River	Total
Town	0.21%	5.72%	2.69%	3.60%	-0.71%	0.76%	
La Jara	1.0	27.6	13.0	17.3	-3.4	3.7	59.1

FIGURE 10. Conejos Response Area Stream Reaches With Response Functions



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Department of Natural Resources

Figure 1. Conejos Response Area Stream Reaches with Response Functions

4.3 : Estimate of Dry-up Acreage to Meet Augmentation Demand From Agricultural Water

With the current water resources and operations in the Conejos watershed, agricultural water rights are a potential source of water for meeting municipal well-pumping augmentation requirements. Based on the projected augmentation requirement, an estimate of the agricultural acreage required to be dried up to meet this requirement was made.

The 2004 Rio Grande StateCU model was used to calculate irrigated acreage and crop CU from surface water sources from the period 1950–2002 in each water district within the Rio Grande Basin. When a water right is changed from agricultural to municipal, the historical use is analyzed to determine the consumptive portion that can be transferred. Additionally, the historical draw on the river and return flow pattern must be maintained to protect other water rights.

El Coda Lateral Ditch

As seen in Table 3 and Table 4, municipal pumping depletions are expected to range from 440 acre-feet per year (AFY) in 2013 to 472 AFY by 2050. These depletions will occur on the Rio Grande, Conejos, San Antonio, and Alamosa Rivers. While the possibility exists for subdistricts and municipalities to swap depletions in reaches that are physically far from their wells and instead meet depletions in their closest reach, it is expected that changes of water rights and exchanges would need to occur throughout the Rio Grande Basin to meet depletions due to pumping in the Conejos and Alamosa/La Jara response areas.

Historical CU may vary greatly between irrigated parcels in the Rio Grande basin depending on seniority of water rights, crop choice, irrigation practice, water source, supplemental supply, and several other factors. These factors are all considered during the engineering process for a change-of-use of water right. For this analysis, we have chosen to use the Rio Grande Basin-wide CU per-acre annual value when determining acreage as we feel this best represents the yield per dried-up acre that may be required to meet depletions throughout the Basin.

Table 5 shows the average annual irrigated acreage; crop CU met with surface water supply; and CU divided by acreage over the period 1950–2002 in each district within the Rio Grande Basin. This period is representative of many hydrologic conditions and provides a good estimate of the average annual transferable water associated with the dry-up of an acre of land in the Rio Grande Basin. Crop CU per acre varies greatly across the basin due to the range of factors listed above with District 27 (Carnero Creek) yielding the least CU per acre on average with 0.32 AF per acre and District 24 (Culebra Creek) yielding the greatest CU per acre on average with 1.36 AF per acre. On average, the irrigation surface water rights in the Rio Grande Basin yield an average of 0.84 AF per acre.

Table 6 shows the irrigated acreage; crop CU met with surface water supply; CU divided by acreage in 2002, which was the year with the lowest crop CU met with surface water supply in the years 1950–2002; and the percentage of average yielded in 2002. In a change-of-use case, this value of transferrable water would likely be used as a dry-year yield and represent the minimum yield during a drought. The water rights in the Rio Grande Basin as a whole yielded 30% of the average CU in 2002. While the most senior water rights in the Basin may have experienced a near- or above-average yield in 2002, many more junior water rights would have received little or no surface water in that year. District 24 (Culebra Creek) received 70% of its average yield during 2002, which is not surprising given the senior water rights as well as the lack of water rights on the mainstem of the Rio Grande below the confluence of Culebra Creek and the Rio Grande. The Compact curtailment was 0% from April 1, 2002 to November 22, 2002 due to the low native flow, so diversions on Culebra Creek would have been limited by physical supply, not more senior water rights or Compact curtailment. Conversely, Districts 35 (Trinchera Creek); 21 (Alamosa-La Jara); and 20 (Rio Grande) received only 23%, 24%, and 25% of their average annual CU per acre respectively during 2002. Although Trinchera Creek and the Alamosa-La Jara are similar to

Culebra Creek in terms of their water rights and location of their confluences with the Rio Grande, physical supply may have differed substantially.

Municipal pumping depletions are likely to be steady from year to year, including during dry years with hydrology similar to 2002. By 2050, municipal pumping depletions are projected to reach 471.7 AFY (Table 4). To ensure that sufficient augmentation water is available during a dry year, sufficient water rights would need to be transferred such that the dry-year yield is sufficient to cover the 471.7 AFY. Using the Basin-wide dry-year yield of 0.25 AF/acre, 1,887 acres would need to be dried up to ensure that 471.7 AFY is available during a dry year. Another possibility would be to dry up less irrigated acreage and develop storage to store transferred CU in years that the transferred water rights yield greater than 471.7 AF and release from storage during years when the water rights yield less than 471.7 AF. At a minimum, sufficient water rights need to be transferred such that the average transferrable yield (0.84 AF/acre) covers the municipal pumping depletions. In this case, 561 acres would need to be dried up and storage developed. However, this calculation ignores the evaporation associated with storage.

A simple reservoir model was constructed to model storage of changed water rights to determine the minimum amount of dry-up required if evaporation in storage is considered as well as the volume of storage required under various dry-up acreage scenarios. For this simple scenario, the historical annual Basin-wide CU per acre from 1950–2002 was used as an input to the model; it was assumed that 20% of the water in storage evaporates per year. Assuming that storage volume is not a limiting constraint, the model determined that 660 acres of dry-up is required to cover the annual pumping

TABLE 5. Average Irrigated Acreage and Annual Crop CU From 1950 to 2002 in the Rio Grande Basin

Water District	20	21	22	24	25	26	27	35	All
Irrigated Acreage	314,960	52,701	82,109	23,112	33,457	29,268	20,412	25,110	581,129
Crop CU (AF)	266,897	36,313	79,688	31,485	23,584	19,277	6,620	24,534	488,398
CU (AF) per Acre	0.85	0.69	0.97	1.36	0.70	0.66	0.32	0.98	0.84

TABLE 6. Irrigated Acreage and Annual Crop CU in 2002 in the Rio Grande Basin

Water District	20	21	22	24	25	26	27	35	All
Irrigated Acreage	343,183	47,150	75,171	26,507	35,799	30,686	24,285	28,421	611,202
Crop CU (AF)	73,751	7,893	23,378	25,403	7,726	5,736	2,662	6,460	153,009
CU (AF) per Acre	0.21	0.17	0.31	0.96	0.22	0.19	0.11	0.23	0.25
Percent of average yield	25%	24%	32%	70%	31%	28%	34%	23%	30%

Data Obtained From the 2004 Rio Grande StateCU model.

depletion demand as well as losses associated with evaporation in storage. The 660 acres of dry-up averages 556 AFY of transferrable CU yield and more realistically represents the minimum dry-up required. Using 660 acres of dry-up in the model, it was then determined that storage can be reduced to 440 AF and depletions are able to be covered every year.

These two areas of dried-up irrigated agriculture (1,900 acres or 660 acres plus 440 AF of storage) represent the bookends of required dry-up to meet the future municipal pumping depletions. The simple reservoir model was run iteratively to create a curve of dry-up acreage and reservoir storage required for acreages of dry-up between these two bookends (Figure 11). While costs for both the water rights and their transfer through Water Court and development of storage would need to be weighed before determining the amount of each, the plot below shows that the largest reduction in storage required results from increasing dried-up acreage from 660 acres to roughly 800 acres. This additional 140 acres (and its associated average CU of 118 AF) reduce the required storage from 440 AF to 280 AF. While it may seem counterintuitive that storage could be reduced by more than the increase in annual CU, this results from the particular sequence of yields in the years preceding the critical drought year, 2002. Above 800 acres of dry-up, Figure 11 shows diminishing returns in the volume of storage required to manage the water rights. With each additional 100 acres of dry-up, the required storage volume only decreases by about 25 AF until we reach 1,887 acres of dry-up and the dry-year yield is sufficient to cover the full pumping depletion demand, thus requiring no storage.

Between 660 and 1,900 acres of irrigated agriculture would need to be dried up to meet the Towns' well-pumping depletions.

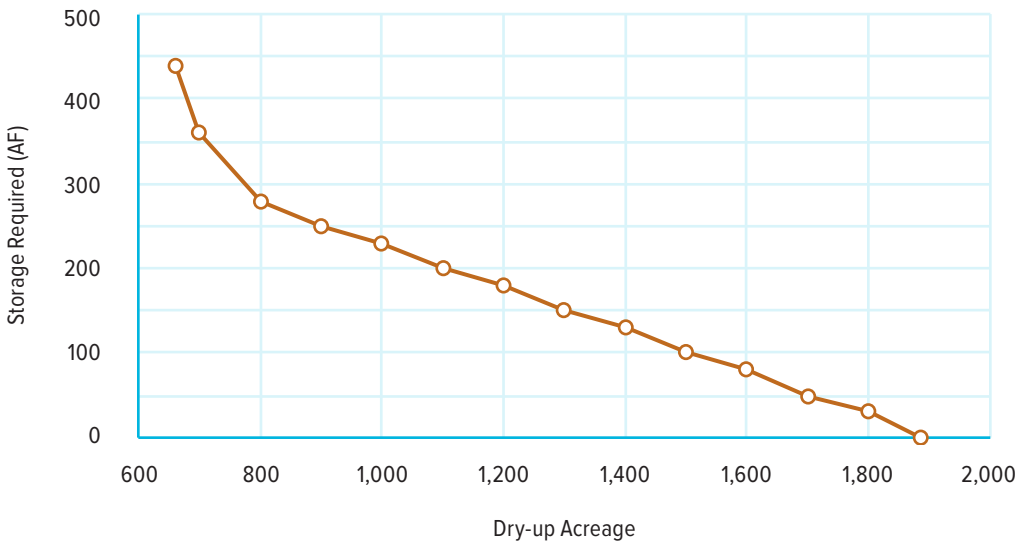


FIGURE 11.

Volume of Storage Needed to Manage Transferred CU Associated With Various Acreages of Dry-up to Meet 471.7 AF Annual Pumping Depletion Demand From 1950–2002

5. Trujillo Meadows Enlargement Feasibility

Deere & Ault, the geotechnical subcontractor, along with SME Environmental, Inc. (SME), the environmental and biological subcontractor for the TMR Study, examined the feasibility of Trujillo Meadows enlargement through a reconnaissance-level consideration of the following components:

- Geotechnical analysis
- Environmental analysis, wetlands mapping, and cultural resources survey
- Biological analysis including threatened and endangered species

In addition, DiNatale Water performed a hydrological analysis including estimation of river flow and summarized institutional challenges with a potential reservoir enlargement including Compact issues, environmental permitting, New Mexico's use of water, and Federal Reserved water rights, among others.

A summary of these findings is included in this section.

5.1 : Geotechnical Analysis of the Dam and Reservoir Enlargement

A geotechnical analysis was conducted to determine the dam enlargement location and the possible size of the enlarged reservoir. The existing dam is located at a narrow section of the valley created by a huge, ancient landslide on the left abutment. The existing dam, constructed in 1956, has experienced excessive seepage through the left abutment. The seepage resulted in large sinkholes that developed in the spillway channel. Attempts to reduce the seepage have included construction of a cement/bentonite slurry wall followed by blanketing of parts of the abutment slopes with an impervious geomembrane. Increasing the hydraulic head on the left abutment landslide area by raising the water level is likely to promote new seepage paths and possibly new sinkholes. To counter the increased seepage, the entire landslide area on the left dam abutment will need to be blanketed with a low-permeability soil blanket. To avoid the potential problems with the landslide deposits, a new spillway will need to be constructed on the right dam abutment. Even with these improvements, seepage may still be excessive.

The valley upstream of the existing dam is broad, having relatively gentle lower valley slopes and a broad, flat valley bottom upstream of the reservoir. There appears to be unconsolidated soils on the lower valley slopes and in the valley bottom upstream of the reservoir. Field investigations with test pits will be required to access the soils for possible use in the construction of dam embankments.

FIGURE 12.

Trujillo Meadows Dam With Landslide Area Shown on Left

5.1.1 : History of Dam Construction and Repairs

The history of Trujillo Meadows Dam operation and maintenance, including historical problems with the dam, was also assessed and considered in the dam enlargement feasibility. The files on Trujillo Meadows Dam are extensive. The dam, originally constructed in 1956, has had excessive and chronic seepage problems since the initial reservoir filling, mainly through the landslide deposits on the left dam abutment. In 1999, plans were prepared by CPW and approved by the SEO to enlarge the spillway through the left abutment, raise the dam embankment to increase the freeboard for spillway flood flows, and construct a cement/bentonite slurry wall through the dam embankment across the spillway to reduce the seepage. The records indicate the slurry wall was not effective in reducing the seepage.

The seepage from the reservoir through the landslide deposits became excessive. Nearly six cfs of seepage (2,700 gallons per minute [GPM]) was measured by flume in 2004 and the dam and reservoir were placed under a storage restriction by the SEO.

In 2006, plans were prepared by CPW to attempt to reduce the seepage using a synthetic PVC liner. Additional sets of plans were prepared through 2010 documenting four phases of seepage control measures. In each phase, additional sections of the left abutment, including the spillway channel, were lined with the synthetic PVC liner to reduce the seepage. During the synthetic liner construction in 2010, large sinkholes developed in the spillway channel. Following this development, additional lining work was completed in the spillway channel.

FIGURE 13.

Sinkhole in Trujillo Meadows Spillway Channel

FIGURE 14.

Closeup of Sinkhole in Trujillo Meadows Spillway Channel

Additional assessments for a potential enlargement included embankment design considerations, existing structures, and future investigations and design considerations. The outlet works consist of an upstream concrete outlet structure with a rising stem slope stem gate; a 24-inch diameter corrugated metal pipe outlet conduit; and a downstream concrete outlet structure. The gate lift operator is in a concrete vault on the downstream slope. The downstream end of the conduit and downstream outlet structure were observed during the September 4, 2013 site visit. The outlet gate was apparently closed and there was no discharge from the outlet conduit. The Parshall flume that collects seepage from the spillway and left dam abutment was flowing at about 98 GPM. However, the flume did not appear to be measuring accurately and Deere & Ault estimated the flows to be about 30 GPM. There were other small seeps downstream on both the left and right side that were not measured by the flume. The existing outlet conduit is corrugated metal pipe (CMP) and will need to be replaced with a more durable outlet conduit. Since the existing CMP is probably near the end of its useful life, the CMP will need to be excavated and removed and a new outlet works constructed before constructing a new higher embankment.

5.1.2 : Dam Enlargement Options

Two options were considered for increasing Trujillo Meadows storage. Option 1 involves constructing a new higher dam at the location of the existing dam with the reservoir elevation raised 24 feet and increasing the total reservoir storage to approximately 4,300 AF. Option 2 involves construction of a new 80-foot-high dam upstream of the existing dam and away from the landslide area. Although the valley is considerably broader upstream, requiring a larger

The existing storage capacity of Trujillo Meadows is approximately 617 AF.

dam embankment, the upstream site appears much more suitable from a geotechnical and seepage standpoint. A service and emergency spillway will need to be constructed on the north or south valley slopes. The new dam would impound a reservoir of approximately 5,750 AF.

Option 1, constructing a new, higher dam at the existing location, will have an estimated cost of $17,330,000, or $4,700 per AF (2017 dollars), increasing the total reservoir storage from 617 to approximately 4,300 AF. We anticipate extensive work will be required to reduce the potential for seepage through the landslide deposits on the left abutment. Even with this work, there will be significant risks for excessive seepage.

Option 2, constructing a new dam upstream and away from the landslide, requires a much larger embankment but appears to have fewer technical issues. A dam with a structural height of approximately 80 feet will store approximately 5,750 AF. Cost estimates for this option are approximately $22,600,000, or $4,400 per AF (2013 dollars).

Deere & Ault, the geotechnical subcontractor to DiNatale Water, recommends choosing Option 2 (the new dam upstream of the existing dam) because of the potential for seepage problems through the landslide deposits associated with Option 1. Proceeding with either option will require detailed site geologic and geotechnical investigations to further evaluate the technical feasibility of the project considering the foundation conditions, borrow availability, hydraulic requirements, and permitting requirements.

FIGURE 15.

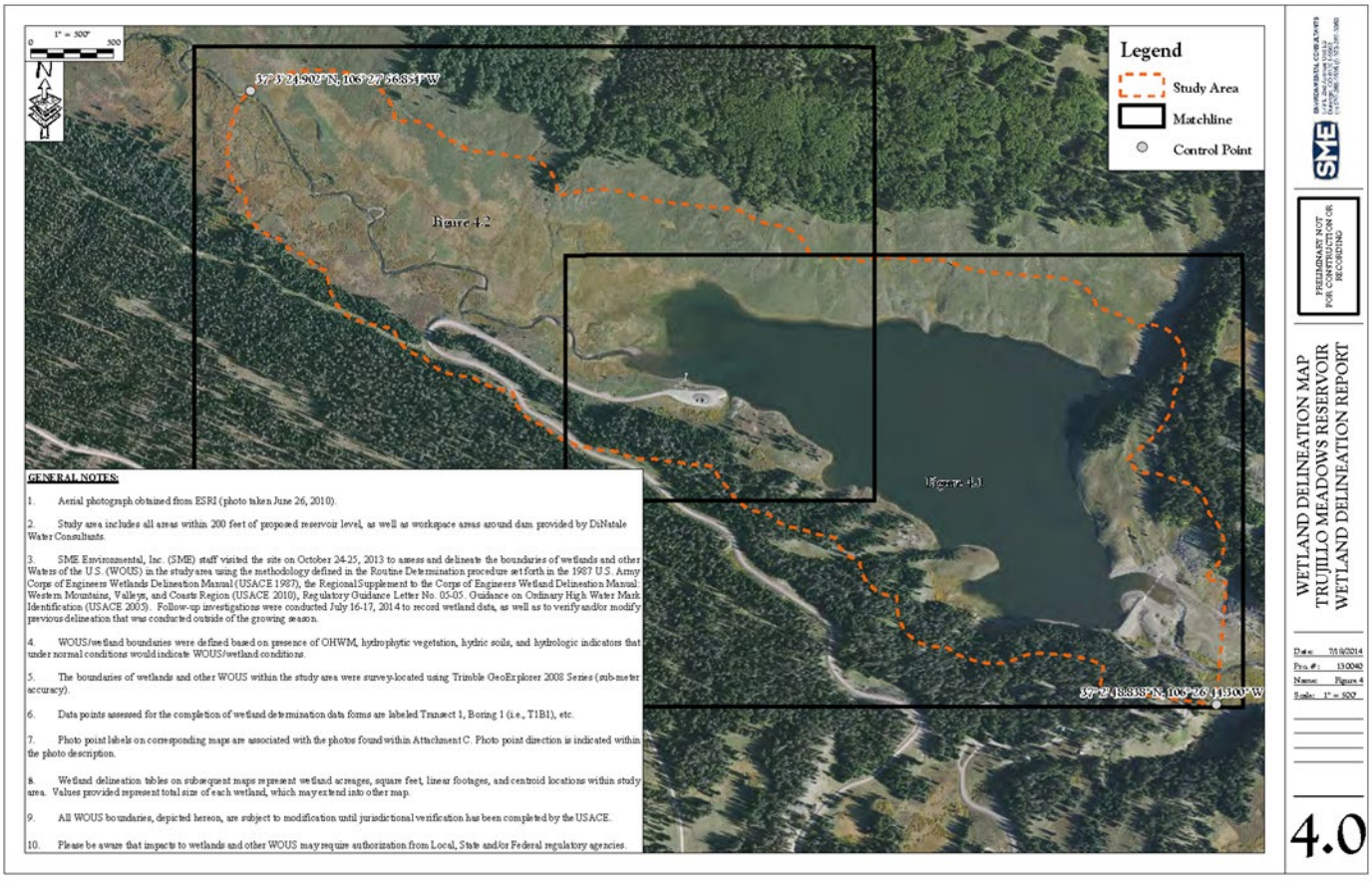
Measurement of Seepage From Left Abutment in June 2017

5.2 : Environmental Analysis of the Dam and Reservoir Enlargement

Environmental analysis of the dam and reservoir enlargement was conducted to determine any negative impacts on wetlands, wildlife, and the surrounding habitat. SME investigated the Trujillo Meadows project setting on July 16 and 17, 2014, including the site location, physical setting, regional conditions, and current land use. SME documented their findings regarding Waters of the U.S., vegetation types and wetland classifications around the project site, soils, hydrology, and limitations in the SME Wetland Delineation Report. Figure 4.0 from that report, which shows the study area, is reproduced here as Figure 16.

FIGURE 16.

Trujillo Meadows Study Area for Environmental Surveys



A portion of a map unit that covers the project area is reported by the Natural Resources Conservation Service (NRCS) to contain 8% Histosols. Groundwater-fed wetlands composed of soils that meet the definition of a Histosol (i.e., a soil layer at least 16 inches thick comprised of muck, peat, or mucky peat) are considered fens per the U.S. Army Corps of Engineers (USACE) Nationwide Permit Regional Conditions for Colorado (2012). However, SME did not locate areas meeting the technical definition of a Histosol in the field. SME did encounter areas of peat; however, peat layers

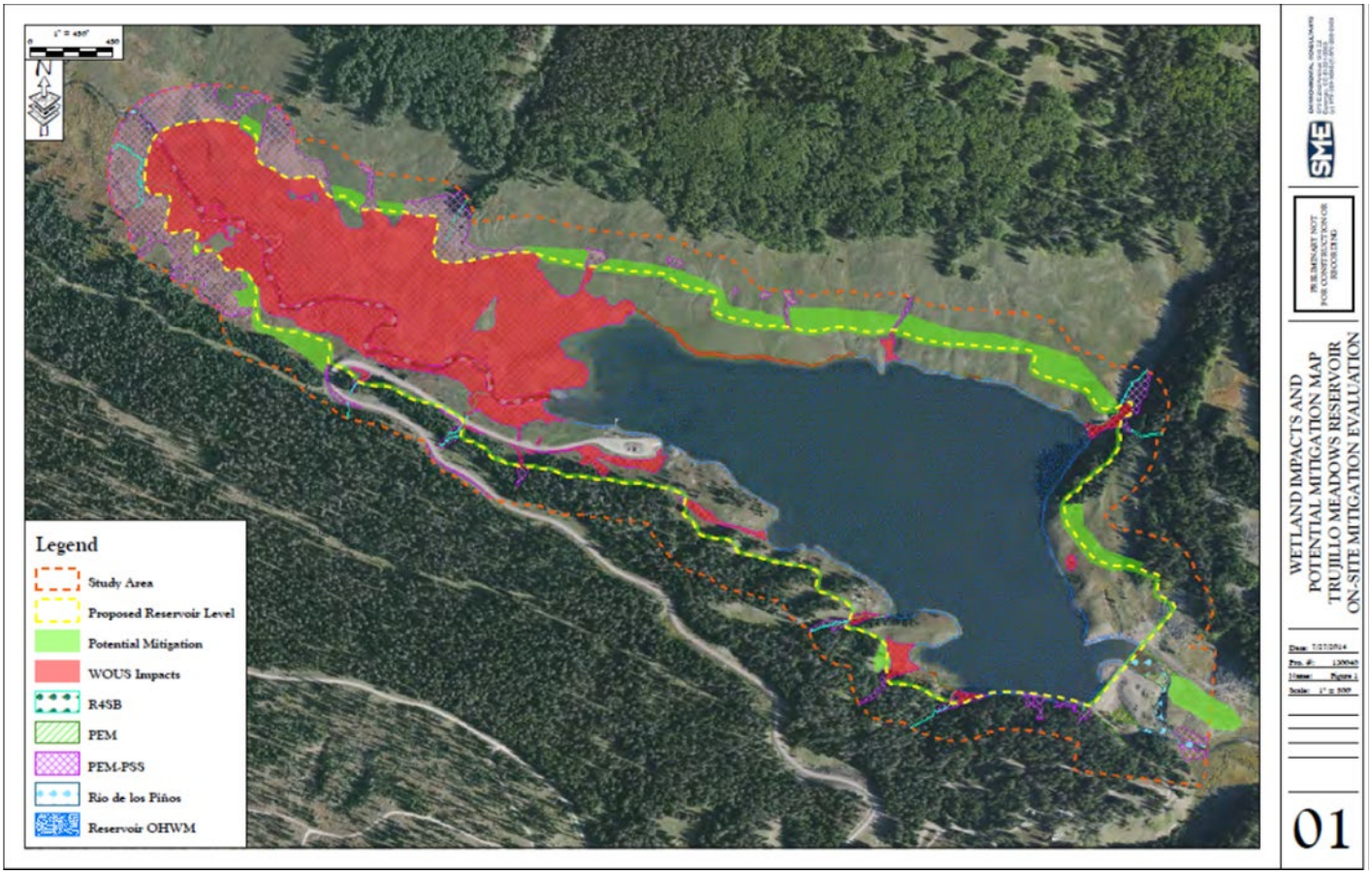
were less than 16 inches thick. SME observed one location with a layer of silty peat that exceeded 16 inches in thickness; however, laboratory analysis of a soil sample taken at this location indicated it contained less than 12% organic carbon by weight, meaning it did not meet the definition of a Histosol (USDA NRCS 2010).

Based on the site investigation, 55.16 acres of wetlands, 69.92 acres of open water, and 8,775 linear feet of stream (3.98 acres) exist in the study area, as shown in Figure 17. In addition to the site investigation, these findings are based on the following:

- Examination of the vegetation, soils, and hydrology in available reference documents at the time of the investigation
- Laboratory results
- An analysis of frequency and duration of flows, ordinary high-water mark, and connectivity or proximity to interstate waters

FIGURE 17.

Map of the Inundation That Will Occur With Reservoir Enlargement



All aquatic resources delineated as part of this report and described in the SME reports and technical memos are likely jurisdictional under Section 404 of the Clean Water Act. Unavoidable impacts to wetlands and other waters of the U.S. (WOUS) require a Clean Water Act Section 404 Permit from the USACE. There are two types of permits: standard (Individual) and general (nationwide permit [NWP] and regional permit [RP]). Due to the number of wetlands surrounding the Reservoir, we do not believe this project would

qualify for an NWP; therefore, no further discussion of NWPs is included in this document. In addition to NWPs, the USACE's Albuquerque District (which includes Conejos County) has issued several RPs; however, none of these are applicable to this project.

For projects that do not meet the terms/conditions for processing under an NWP or RP, authorization from the USACE would be provided under an Individual Permit (IP). Processing of an IP involves the evaluation of individual, project-specific applications in what can be considered three steps: pre-application consultation (for larger projects); formal permit application review; and decision-making.

FIGURE 18.

The Area Upstream From Trujillo Meadows Reservoir

5.2.1 : National Environmental Policy Act Process

SME provided the following summary of National Environmental Policy Act (NEPA) compliance for the Trujillo Meadows expansion project.

All federal agencies are required to show compliance with the NEPA for all major projects funded or approved by the agency. Trujillo Meadows and all surrounding lands are owned and managed by the USFS. The only other federal agency thought to be involved in the funding and permitting of the proposed action is the USACE. SME presumes that the USFS would be the lead federal agency for NEPA for the proposed action as it is the USACE's policy to defer to federal land management agencies in such instances. As the lead federal agency, the USFS would direct all stages of the NEPA process. NEPA documentation would be produced in accordance with established

USFS procedures for compliance with NEPA and USFS rules, regulations, and guidelines.

A Categorical Exclusion for the proposed action is not available, and it is presumed that there are no other existing NEPA documents that analyze the impacts of expanding Trujillo Meadows; therefore, either an Environmental Assessment (EA) or Environmental Impact Statement (EIS) would be required. It is unlikely that the USFS would request an EA for the sole purpose of determining if an EIS would be required. If a clear proposal is put forward, the impacts should be predictable and the level of documentation (EA or EIS) determinable by the USFS.

The NEPA process required for the proposed action will be clearer after USFS review of a developed project proposal. At this point, it is uncertain as to what level of documentation the USFS would require.

5.2.2 : US Army Corps of Engineers Permitting

USACE permitting of the proposed reservoir expansion is likely to require compensatory mitigation for the estimated 40.25 acres of wetlands and approximately 4,575 linear feet of stream that would potentially be impacted by the proposed full-pool elevation for the maximum enlargement scenario. The actual acres of wetlands and linear feet of stream impacted are dependent on the dam enlargement scenario selected. We anticipate that the extent of wetland mitigation that would be required would be determined through a functional assessment using the FACWet methodology and would not likely exceed a 1:1 ratio. There are opportunities for on-site wetland creation totaling approximately 16 acres as depicted on the attached map. Detailed topographic information either in the form of a ground-run survey or LIDAR (a surveying method that measures distance to a target by illuminating that target with a laser light) would provide more exact limits of potential wetland creation.

USACE is likely to require some form of stream restoration for the proposed stream impacts. The extent of stream mitigation would also likely be determined through a functional assessment. SME did not observe opportunities for stream restoration within the delineated study area; however, it is possible that segments of the Los Pinos below the Trujillo Meadows may benefit from stream restoration.

5.2.3 : Cultural Survey

A cultural survey was conducted on November 23, 2013, assessing the potential impacts of construction on significant indigenous and non-indigenous archaeological and cultural heritage values. One site, consisting of open lithic scatter of unspecified Native American cultural affiliation, lies within the project area. Two sites also consisting of open lithic scatters of unspecified Native American cultural affiliation lie within one-half mile of the

project area. The Colorado Office of Archaeology and Historic Preservation determined that all three sites were officially not eligible for nomination to the National Register of Historic Places. More details can be found in the SME Trujillo Meadows Cultural Investigation.

5.3 : Biological Analysis of the Dam and Reservoir Enlargement

SME assessed special status species potentially impacted by the proposed expansion of Trujillo Meadows. The area of assessment includes the proposed project area, i.e., the proposed reservoir at capacity and the areas anticipated to be the limits of disturbance associated with the proposed dam modifications shown in Figure 17, as well as an action area, i.e., adjacent areas that could also be directly or indirectly impacted by the proposed action. SME identified existing habitat and proposed practical management strategies to minimize impacts on area wildlife populations. Of special concern are federally listed threatened, endangered, proposed and candidate species, or designated critical habitats listed under the Endangered Species Act (ESA) of 1973 (16 U.S.C. § 1531 et seq.) and other species of interest as provided by the USFS, Rio Grande National Forest. Field work associated with the findings of this report was conducted October 24 and 25, 2013. The SME Assessment of Special Status Species Report gives further information, including Federally listed Species by the U.S. Fish and Wildlife Service (USFWS) and the USFS.

5.3.1 : Endangered Species

SME identified species listed or proposed for listing by the USFWS as endangered or threatened under the ESA with potential to occur on the Rio Grande National Forest. *High, moderate,* and *low* are used to qualify the potential of occurrence. In general, *high* is used to describe a species that was observed in the area; *moderate* designates a species that was not observed but was thought to occur in the area based on available suitable habitat and a known distribution in the region; and *low* is reserved for species with habitat components in the area, but the habitat may not be ideal or the species may be rare. Of the species listed under the ESA, only the Canada lynx and Rio Grande cutthroat trout were qualified as moderate. The North American wolverine was qualified as having a low potential to occur in the project area. See Table 1 in the SME Assessment of Special Status Species Report for the full listing and information.

5.3.2 : Forest Service Sensitive Species

Species classified by the Forest Service Region 2 as sensitive species with potential to occur on the Rio Grande National Forest and their potential to occur in or near the project area were identified and listed. None of the

species selected had a high potential to occur in the project area. Tables 7 and 8 below summarize the species that were designated with either a moderate or low potential to occur in the project area.

TABLE 7.

Sensitive Species and Potential to Occur Within Study Area

Species Name	Potential to Occur in Project Area
Mammals	
American marten	Moderate
Hoary bat	Moderate
River otter	Low
Birds	
American peregrine falcon	Moderate
Bald eagle	Moderate
Boreal owl	Moderate
Northern goshawk	Low
Olive-sided flycatcher	Moderate
Amphibians	
Boreal toad	Low
Northern leopard frog	Moderate
Plants	
Eriphorum altaicum var. neogaeum	Moderate
Eriphorum chamissonis	Low
Eriphorum gracile	Moderate
Salix arizonica	Moderate
Utricularia minor	Low

Refer to Table 2 in the SME Assessment of Special Status Species Report for the full listing of species and complete information.

5.3.3 : Migratory Birds

Migratory birds protected from take under the Migratory Bird Treaty Act are considered Birds of Conservation Concern by the USFWS for Bird Conservation Region 16. The list used by the Rio Grande National Forest to assess the impacts of actions is not a complete list of migratory birds that may be present or may nest in or near the project area. Additional species not listed here may be a concern if they are found to be nesting in the project area during project activities.

Similar to the sensitive species identified by the USFS, the bald eagle and the Peregrine falcon are also qualified as moderate under the Birds of Concern

designation. In addition, Cassin's finch is also listed as moderate and the golden eagle is listed as low.

Refer to Table 3 in the SME Assessment of Special Status Species Report for the full listing of species and complete information.

5.3.4 : Forest Service Management Indicator Species

Table 4 in the SME Assessment of Special Status Species Report lists the Rio Grande National Forest Management Indicator Species (MIS) and their potential presence in or near the project area. Potential impacts to these species are also estimated. The Forest Service uses MIS as a proxy to quantitatively and qualitatively assess the potential impact of a proposed action on ecosystems as a whole. They are generally common species that represent particular ecosystems.

Almost all the MIS have a moderate or high potential to occur in the project area. Table 8 summarizes the species and their potential to occur in the project area.

TABLE 8.

MIS and Potential to Occur in Study Area

Species Name	Potential to Occur in Project Area
Lincoln's sparrow	Moderate
Wilson's warbler	Moderate
Brown creeper	High
Hermit thrush	Moderate
Vesper sparrow	Moderate
Elk	High
Mule deer	High
Rio Grande cutthroat trout	High

Refer to Table 4 in the SME Assessment of Special Status Species Report for the full listing of species and complete information.

5.3.5 : Summary of Findings and Recommendations

A number of species of interest to the Rio Grande National Forest, the USFWS, and the State of Colorado are likely to occur in the study area. Limiting vegetation removal and construction activities, especially loud disturbances such as blasting, to outside of the migratory bird breeding season (April 1 to August 31) would reduce impacts on raptors and song birds nesting in the area. Limiting construction during this period would also reduce the impacts on lynx and marten by reducing the likelihood of

impacting an active den or impacting survivability of young. Due to the large area of potential boreal toad breeding habitat in the project area, SME recommends surveying for the boreal toad prior to project activities to determine the impacts on this State-protected species. If toads are present, mitigation such as creating maintainable suitable shallow breeding habitat within the expanded reservoir may be prudent. Impacts to rare wetland plants would likely be minimized through wetland mitigation efforts. The status of several wetland plants was not determinable during field surveys; additional surveys during the growing season are recommended to determine if rare wetland plants are present and what level of mitigation is necessary to reduce impacts on any identified species. Additional mitigation measures may result from consultation with Federal and State agencies and interested parties as a result of NEPA scoping/comment periods. While not present in the project area vicinity, water quality impacts during construction and hydrograph impacts during dam operation may also impact downstream habitat for the Rio Grande sucker and Rio Grande chub.

5.4 : Hydrological Analysis and Inflow Quantification

Melted snowpack from within the watershed of the Los Pinos is anticipated to be the primary source of wetland hydrology for the study area. The watershed includes runoff from Jarosa Peak, the Continental Divide, and alpine meadows within the South San Juan Wilderness. Tributaries to the Los Pinos collect precipitation and seasonal runoff from melted snowpack from the surrounding watershed and flow into Trujillo Meadows. Runoff is collected in and discharged slowly to the study area from numerous perched wetlands located on the adjacent slopes. The impoundment of the Los Pinos to form the reservoir provides wetland hydrology to the narrow palustrine emergent wetlands (PEM) that fringe the reservoir.

The Los Pinos River flows into the San Antonio River two miles south of San Antonio.

Downstream from the open water reservoir, the Los Pinos carries controlled flows downstream and south of the dam and supports adjacent wetlands within the low-angle depressions. The Los Pinos flows into the San Antonio two miles south of San Antonio, Colorado to the east of the project area in the San Luis Valley. The San Antonio flows to the Conejos, which flows to the Rio Grande.

There are no stream gage measurements into or out of the reservoir, so to estimate potential storage yield for the reservoir, an inflow had to be estimated. We analyzed the Colorado DWR and USGS records including streamflow data, water commissioner records, and GIS spatial data to determine the current amount of water that flows into and out of Trujillo Meadows via the Los Pinos.

Due to the mountainous nature of the area, it was decided that a like-basin method using a nearby basin with stream measurement would be the best

way to estimate flow in the Los Pinos above Trujillo Meadows. The Conejos River basin was chosen as it has stream gages near the top and bottom of the basins (below Platoro Reservoir and near Mogote); Platoro is only 21 miles north of Trujillo Meadows; and the Conejos near Mogote gage is only 6 miles from the Los Pinos near Ortiz gage. The Los Pinos has a gage at the bottom of the basin (near Ortiz) which was used as the basis for the inflow to Trujillo Meadows.

For the period of record 1980–2008, daily naturalized gage data from Conejos near Mogote and Conejos below Platoro Reservoir were compared to determine what portion of the flow near Mogote came from the watershed above Platoro Reservoir. Over the period of record, the area above Platoro Reservoir contributed on average 23% of the total flow in the Conejos River near Mogote despite only containing 14% of the watershed acreage. This daily contribution of Platoro Reservoir to the Conejos was then applied to the Los Pinos near Ortiz gage to estimate the inflow to Trujillo Meadows. An adjustment was made for the contributing watershed since only 8% of the watershed area for the Los Pinos near Ortiz gage is above Trujillo Meadows. No adjustments were made for elevation because the elevations of the Los Pinos near Ortiz gage and the Conejos near Mogote gages are very similar (8,040' vs. 8,274') and the elevations of Trujillo Meadows and Platoro Reservoir are very similar (10,040' vs. 10,000').

Monthly estimates of inflow into Trujillo Meadows from 1980–2014 are tabulated in Appendix A. The hydrology varies greatly year to year with annual estimated flows into the reservoir as high as at 27,600 AF in 1985 to as low as 1,850 AF in 2002. On average, 13,660 AF is estimated to flow into the reservoir annually with peak inflow typically in May but occasionally in June or April.

Estimated annual inflow into Trujillo Meadows varies greatly from a minimum of 1,850 to a maximum of 27,600.

Figure 19 shows the average daily estimated flow into Trujillo Meadows compared to the average measured streamflow downstream at the gage at Los Pinos near Ortiz. On average, the Los Pinos peaks on May 22 at 655 cfs near Ortiz while the estimated inflows to Trujillo Meadows peak at 110 cfs. The estimated winter flow into Trujillo Meadows is around 2 cfs while the measured average winter flow near Ortiz is between 15-20 cfs.

This analysis (discussed in Section 7.2) was used to assist in determining optimal storage increase for Trujillo Meadows for maximum beneficial use.

FIGURE 19.

Average 1980–2014 Daily Estimated Inflow at Trujillo Meadows and Gaged Flow at Los Pinos Near Ortiz

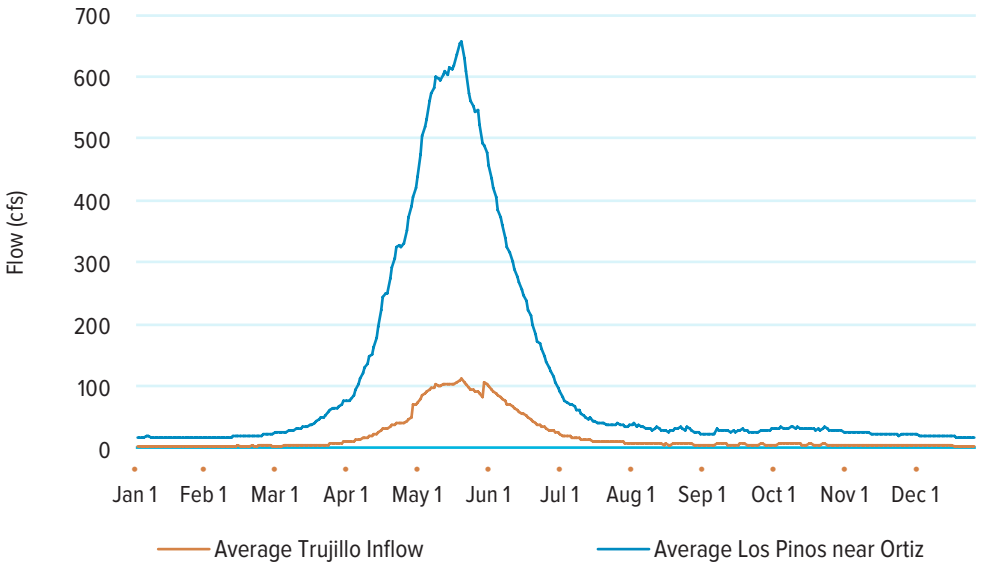


FIGURE 20.

The Los Pinos Flowing Into Trujillo Meadows

5.5 : Institutional Challenges With Reservoir Enlargement

The following institutional and legal issues and next steps were identified through the feasibility investigations and stakeholder meetings and would be addressed in future project phases.

The status of CPW's existing USFS permit for the existing reservoir is unclear and may require renewal. Regardless of the status of the existing CPW permit, a new USFS permit would be required for an enlargement. Interviews with the USFS District Ranger will be required to determine permit concerns, and any potential special permit concerns will be evaluated.

There are potential Compact issues associated with the enlarged reservoir. DWR and other basin water users will need to be consulted on the proposed operations, including the use of Compact storage.

The Los Pinos flows from Colorado into New Mexico and then back into Colorado. Discussions with New Mexico will be required to ensure that releases from Trujillo Meadows can be protected as they flow through New Mexico before reentering Colorado.

Water court approvals will be required to obtain the right for direct flow storage in Trujillo Meadows. In addition, a transfer of the Cove Lake storage right and/or the exchange of the Taos Valley No. 3 water right for storage in Trujillo Meadows will also require water court approval and is subject to limitations under the Federal Reserved Right.

Water Court approvals will be required to obtain the right for direct flow storage in Trujillo Meadows Reservoir.

5.5.1 : Federal Reserved Right

In Consolidated Case No. 81CW183, The United States of America acting under the USFS was granted multiple Federal Reserved Water Rights on multiple rivers and creeks within Colorado Division 3 including on the Los Pinos. The quantification point for the right on the Los Pinos is designated as QP 22H in the decree and appendices. The quantification point is located at the Colorado-New Mexico state line where the Los Pinos flows out of Colorado into New Mexico, which is downstream of Trujillo Meadows. The decreed beneficial use for the water right is for "Instream Flow for National Forest Purposes" and has a date of reservation/appropriation of March 2, 1907.

The instream flow right varies by month and appropriates water between the minimum high flow and maximum high flow during the peak of the hydrograph. Table 9 shows the instream flow right at QP 22H for each month's base flow as well as the minimum and maximum flowrates during the peak of the hydrograph.

When natural flow reaches the minimum high flow, the U.S. has the right to receive at and upstream of its quantification point all flow up to and including the flow equal to the maximum high flow until the natural flow decreases below the minimum high flow.

TABLE 9. Table Entry for QP 22H of Appendix A of Case No. 81CW183

	Minimum High Flow	183.66
	Maximum High Flow	612.2
Monthly Base Flow (cfs)	Jan	17.0
	Feb	19.4
	Mar	24.5
	Apr	56.8
	May	146.9
	Jun	111.1
	Jul	46.5
	Aug	35.7
	Sep	22.2
	Oct	19.3
	Nov	15.9
	Dec	18.2

Section 35. a. of the decree defines the minimum high flow and maximum high flow terms as follows:

The "*Minimum High Flow*" means the lower limit of flows to which the U.S. is entitled during the runoff period, which is a flow equal to 60% of the $Q_{1.5}$ flow.

The "*Maximum High Flow*" means the upper limit of the flows to which the U.S. is entitled during the runoff period, which is a flow equal to the highest instantaneous flow historically occurring, on average, once in every 10 years. This correlates to a flow equal to two times the $Q_{1.5}$ flow.

While the flowrates listed in Table 9 were determined using a generic methodology based on estimated flow at the quantification point, there is no gage at the quantification point, meaning that flows at that point, and most other points in the decree, were estimated by the Forest Service. We estimated flow at the quantification point from 1980–2014 using the same methodology as described in Section 5.4 and then determined the number of days per month that the flow at that point was below the Federal Reserved instream flowrate as defined in Table 9. On days that the flowrate was estimated to be lower than the instream flow right, Trujillo Meadows would not be able to store water for purposes of this project. This includes storage through a storage right, exchange, or direct flow storage right. This would also include transfer of the Cove Lake water right since the change would be junior to the Federal Reserved right. This analysis is shown in Table 10.

Number of Days Flow at QP 22H Above Monthly Base Flow

	Total 1980-2014	Dry Year (25%, 1988)	Avg Year (50%, 1999)	Wet Year (75%, 1997)
Jan	5%	0%	0%	0%
Feb	5%	0%	0%	0%
Mar	14%	0%	32%	52%
Apr	28%	70%	38%	43%
May	19%	13%	23%	32%
Jun	15%	30%	17%	0%
Jul	34%	19%	79%	71%
Aug	24%	23%	50%	48%
Sep	24%	13%	35%	70%
Oct	30%	3%	21%	68%
Nov	23%	0%	42%	63%
Dec	9%	0%	19%	10%

TABLE 10.

Estimated Days Per Month Flow at QP 22H Above Federal Instream Flow Right

The Federal Reserved water right on the Los Pinos limits the opportunity to store water in Trujillo Meadows. In total between 1980–2014, Trujillo Meadows would have opportunity to store in December, January, and February only 6% of the time due to the Federal Reserved right. Compact Article VII restrictions (see Section 2.5) may further limit the winter storage opportunity under a new storage right since Trujillo Meadows is a post-Compact reservoir. We analyzed three specific years that represent dry (1988); average (1999); and wet hydrology (1997) flow at the quantification point in comparison to the Federal Reserved Right; flowrates varied greatly. During 1988, which was at the 25% quartile of hydrology from 1980–2014, there were no days in November–December and January–March that flow at the quantification point was greater than the instream flow right. During 1997, which was at the 75% quartile of hydrology from 1980–2014, Trujillo Meadows would have been able to store subject to the instream flow right more than 50% of the days in March–May and July–November. During June, flow at the quantification point was between the minimum high-flow rate (183.66 cfs) and maximum high-flow rate (612.2 cfs) every day, meaning that Trujillo Meadows would have had no opportunity to store. The greatest opportunity to store water was historically in July.

The Federal Reserved Right on the Los Pinos River limits the opportunity to store water in Trujillo Meadows Reservoir.

6. Stakeholders Meetings

6.1 : Federal and State Agencies Stakeholders Meetings

A meeting and field trip to Trujillo Meadows was held on September 22, 2015. Representatives from the USFS, CPW, DWR, and Trout Unlimited (TU) attended in addition to CWCD and DiNatale Water staff. The Trujillo Meadows ATM concept was explained; the site visit led to discussions about impacts and benefits from a potential enlargement. The following is a summary of key discussion items during this meeting:

- CPW expressed concern with the potential impacts of reservoir drawdown on the fishery and the food chain in the reservoir. Follow-up discussion centered on whether an enlargement with reservoir drawdown no lower than current reservoir level might enhance the fishery.

- The Rio Grande Chub and Sucker habitat in the area currently dries up at times. Retiming streamflows to prevent dry-up could potentially improve habitat for these species. This is part of CPW's Strategic Plan.

- A future phase would need to include an expanded biological assessment.

- The USFS noted that permitting could potentially be straightforward. The USFS could likely support a multiple benefit project that improved habitat for the cub, sucker, and Rio Grande cutthroat trout.

- The modeling should be refined to determine potential yields for exchanges.

- There is a potential for a streamflow yield partnership pilot between CWCD and CPW using Colorado Water Conservation Board Water Supply Reserve Account (WSRA) funds.

- Carson National Forest in New Mexico might be supportive of this project due to its interest in enhanced recreation and environment on public lands.

- CPW inquired if the CWCD might consider evaluating an outright purchase of Trujillo Meadows from CPW.

A second meeting was held with representatives from the USFS on October 31, 2017 to update USFS staff on the project and potential operations. USFS attendees were Andrea Jones, Judi Perez, Ivan Geroy, Jeremiah Martinez, and Kelly Garcia. CPW was invited but unable to attend. Heather Dutton of the San Luis Valley Water Conservancy District, who is also the basin CWCB board member, and Kevin Terry of TU also attended. The biological and wetlands assessments prepared by SME for the TMR Study were reviewed. USFS representatives noted that the proposed exchange of Cove Lake storage rights and direct flow storage would be junior to the Federal Reserved water right for quantification point QP22H, which is where the Los Pinos enters New Mexico downstream from Trujillo Meadows. A comparison of the Federal Reserved right's impacts on potential operations is discussed in Section 5.5.1.

6.2 : Agricultural Stakeholders Meeting

A meeting was held at the CWCD office on June 5, 2017 with agricultural stakeholders that have rights diverting from Los Pinos or San Antonio. An overview of the ATM Project was presented and discussed. The early runoff in the San Antonio was identified by the stakeholders as a concern. This early runoff limits the ability to maximize the beneficial use of the San Antonio and results in a greater than pro rata portion of the Conejos portion of the Compact obligation being satisfied by San Antonio users. The stakeholders also identified flooding during high runoff years as an additional concern. Storage was identified as a need for the San Antonio users to provide a more reliable supply and hopefully provide some reduction in peak flood flows.

The following comments and ideas were presented by the stakeholders:

- Trujillo Meadows or other storage should be developed as soon as possible.

- If there were adequate supply, agricultural users could have two cuttings of hay.

- Current DWR administration of the San Antonio during the irrigation season results in a heavy burden on agricultural users.

- The towns of San Antonio and Ortiz are not in the CWCD and could not receive agricultural users' Project Water allocation under

the ATM concept. It might be worthwhile to bring these properties into the CWCD if a supply can be delivered to them.

- If Trujillo Meadows is not feasible, another option that should be explored in the next phase is to construct a reservoir between the state line and Antonito somewhere near Ortiz.

- One other option to deliver Platoro Project Water to San Antonio users is to examine the old ditch systems that used to divert water from the Conejos southwest towards the San Antonio.

- Coordinated operations between Platoro, Trujillo Meadows, and a potential new reservoir near Ortiz could improve streamflows and agricultural yields and minimize irrigation season curtailments.

- One option is to use direct flow storage for the junior water rights and use these on the senior lands, rather than have high consumption but little benefit by short irrigation of the lands that only have junior rights.

- Gages should be installed or a study conducted to evaluate transit losses if water is retimed for release from Trujillo Meadows after peak runoff.

- It may be better to use direct flow storage during high flows to limit non-beneficial evapo-transpiration (E-T) from the river and canals flowing bankfull or overtopping.

- Santa Fe has implemented a concept similar to Cove Lake in transferring a pre-Compact storage right to another reservoir.

- Irrigation water in July is much more useful than early season water.

Coordinated operations between Platoro, Trujillo Meadows and a potential new reservoir near Ortiz could improve streamflows and agricultural yields.

6.3 : Town Augmentation Needs Meeting

Representatives of the Towns within the CWCD boundaries were invited to a meeting to discuss the Trujillo Reservoir ATM project, the pending well-replacement rules, and plans for the Towns to meet the replacement requirements. In addition, representatives from the Town of La Jara were also invited. The meeting was held at the CWCD office in Manassa on October 31, 2017. Dan Bond and Robert Bagwell from the Town of Manassa, Tim Crowther from the Town of Sanford, and Dennis R. Koenig and Raymond J. Valdez from the Town of La Jara attended.

- Nathan Coombs, CWCD manager, and Kelly DiNatale provided background on the Trujillo Meadows ATM project. All the Towns invited, except for La Jara, are in the Conejos basin and are in the

area that would be covered by Subdistrict No. 3. La Jara is just outside the Conejos basin in the Alamosa-La Jara basin and its well-pumping replacements could be made by Subdistrict No. 6.

- Nathan noted that the CWCD would prefer that the Towns avoid acquiring and transferring agricultural rights for well replacement since this would result in a loss of irrigated agricultural land. The TMR Study is examining this option.

- The CWCD is interested in assisting the Towns in developing replacement supplies that could be provided to the subdistricts to meet a portion of the Town's replacement requirements.

- Questions relating to subdistricts and replacement obligations included:

    - Were the Towns being assessed for their total well pumping as a depletion or if they were receiving credit for their effluent return flows? (Note that in Section 5.5, DWR did incorporate return flows from the Towns that physically reach the river.)

    - How would the subdistricts work?

    - When does a decision have to be made on joining a subdistrict?

        - Nathan responded that the decision is required within two years after the final court ruling on the replacement plan.

    - Whom would they contract with if they wanted to acquire replacement water?

    - Can there be swapping of replacement credits between response areas?

    - Can the Town of La Jara be included in Subdistrict No. 3 that will cover the Conejos, rather than Subdistrict No. 6, since it is at the boundary of two subdistricts?

- The Towns discussed the growth rates included in the Colorado Water Plan and Rio Grande Basin Implementation Plan.

- Raymond Valdez of La Jara noted that in the 1970s the Town had been encouraged by then State Engineer C. J. Kuiper to drill two new confined aquifer wells and have the townspeople abandon their existing individual wells. He also noted that the Town had one of the lowest water rates in the Valley and that Town residents were tired of water and sewer rate increases.

- Tim Crowther, Sanford Public Works Director, noted that many of the Town's residents have San Antonio ditch rights that they use

The CWCD would prefer that the Towns avoid acquiring and transferring agricultural rights for well replacement since this would result in a loss of irrigated agricultural land.

for early irrigation. Could this water be recharged and used for replacement credits?

- There was a discussion of the Middlemist water right, also referenced as the Taos Valley No. 3. This is a potential source of augmentation water, and the potential for storage of a portion of this right in Trujillo Meadows was evaluated as part of the TMR Study.

The consensus at the meeting was that the CWCD should continue with the follow-up to the TMR Study and work on developing supplies that could be used by the Towns for well replacement. The intent is to provide this water to the subdistricts for incorporation in the subdistricts' plan for replacement as an offset against the Town's well-pumping replacements to reduce the Towns' costs for replacement water.

Platoro Reservoir
Photo by Dick Stenzel

7. Alternative Transfer Method Model

7.1 : Model Description

We developed an operations model for this project and incorporated the model into the existing RiverWare Rio Grande Basin Planning model. The purpose of the modeling is to track reservoir use for meeting existing uses, reducing agricultural shortages, changes to streamflows below Trujillo Meadows, changes to Platoro operations to meet augmentation demands, and the impact to the Compact and CPW's obligations for replacement of Trujillo Meadows evaporation.

RiverWare is a river and reservoir modeling platform developed by the Center for Advanced Decision Support for Water and Environmental Systems at the University of Colorado (**http://www.riverware.org**). The Rio Grande Basin Implementation Plan modeling effort captures characteristics of the Basin with regards to hydrology, physical infrastructure, water rights, demands, and legal and administrative policy.

Flexibility in the RiverWare modeling platform allows for simulation of variable reservoir operations and administration of the Rio Grande Compact. The Rio Grande Basin Planning Model simulates multiple reservoir accounts in the Trujillo Meadows and Platoro Reservoirs as well as the Rio Grande, Continental, Santa Maria, and Beaver Park Reservoirs.

Flexibility in the RiverWare modeling platform allows for simulation of variable reservoir operations and administration of the Rio Grande Compact.

The following provides a description and the assumptions incorporated into the Trujillo Meadows and Platoro Reservoirs portion of the Rio Grande Basin Planning Model.

Trujillo Meadows has an assumed maximum of 4,000 AF of active storage split between three accounts: Conejos Compact, CWCD Priority, and CWCD Direct Flow. The volume of storage for each account and the total reservoir storage can be varied. Inflows to Trujillo Meadows, which are not gaged or otherwise measured, were estimated based on a watershed scaling method. The Los Pinos near Ortiz gage is the first downstream gage below Trujillo Meadows. An estimate of Trujillo Meadows inflow was determined by comparing Platoro Reservoir inflow, the area and elevation of the Platoro and

Trujillo Meadows' contributing watersheds, and the Los Pinos near Ortiz gage. This methodology is described further in Section 5.4.

Similarly, flows at the Federal Reserved instream flow right quantification point were estimated using the watershed scaling method. This water right and methodology is described further in Section 5.5.1. It was assumed that if a stream gage is installed at the quantification point and administered, any future storage operations in Trujillo Meadows would be junior to this Federal Reserved right; therefore, no storage under priority or direct flow storage was modeled when flows at the quantification point were estimated to be below the decreed instream flowrates. This was compared to a scenario where the Federal Reserved instream flow right is not administered to determine the impact of the right.

The Trujillo Meadows CWCD Priority storage account (CWCD Priority), otherwise known as Project storage, was assigned the most junior priority on the Los Pinos, San Antonio, and Conejos Rivers. The CWCD Priority account is permitted to store from November 1 to March 31 when Elephant Butte storage is greater than 400,000 AF in accordance with Compact Article VII and when inflows to the reservoir exceed five cfs. During the winter, five cfs is always passed as an environmental flow. This minimum bypass value can be adjusted monthly in the model. During the irrigation season, Trujillo Meadows project storage is permitted to store when in priority and is subject to the Conejos portion of the Compact curtailment.

The Trujillo Meadows Direct Flow Storage account stores water when the sum of the Los Pinos near Ortiz, CO and San Antonio at Ortiz, CO gages are greater than 240 cfs and there are no modeled irrigation shortages. This storage reduces available flow for all ditches below Trujillo Meadows Reservoir. Individual ditch direct flow storage accounts and associated bypass of available water at ditch headgates is not modeled. The figure of 240 cfs was chosen based on Figure 4, which shows that the average peak IWR to meet CU demand is at about 120 cfs. An irrigation and ditch efficiency of 0.5 was assumed, resulting in 240 cfs of IWR at the river headgates. The minimum flow at the Los Pinos and San Antonio gages required before direct flow storage can occur can also be varied.

Each day, diversions on the Los Pinos and San Antonio are modeled using RiverWare's water rights allocation method that allocates water based on the Prior Appropriation doctrine. Available flow is also influenced by a modeled curtailment in accordance with the Compact. Water right flowrates and priority dates are modeled for each ditch's water rights. The IWR and irrigation efficiency for each ditch service area was also obtained from the RGDSS model. Return flows are calculated as ditch diversion minus CU, minus a loss calibration factor, and are lagged back to the river. These lagged return flows are available for downstream diversion. Ditches experience IWR shortages when available flow (based on physical flow, the call on the river, and the curtailment) is insufficient to meet the IWR. The sum of the IWR shortage for the entire Los Pinos and San Antonio system each day is used to create a new demand that can be met by Trujillo Meadows releases.

The Trujillo Meadows project and direct flow storage accounts release available water to the IWR shortage demand at a maximum rate of 50 cfs. This release supplies additional water to the ditches on the Los Pinos and San Antonio when their direct flow rights are insufficient for irrigation.

Supplemental groundwater supply is not modeled in the RiverWare model.

7.2 : Model Results

Trujillo Meadows was modeled with the storage values shown in Table 11.

TABLE 11.

Assumed Storage of Trujillo Meadows for Model Runs

Run name*	Priority Storage Space	Direct Flow Storage Space	Total Active Reservoir Storage
1k pri, 1k DF, FR	1,000 AF	1,000 AF	2,000
1k pri, 1k DF, no FR	1,000 AF	1,000 AF	2,000
2k pri, 2k DF, FR	2,000 AF	2,000 AF	4,000

* Pri = priority storage, DF = direct flow storage, FR = Federal Reserved right modeled

These three Trujillo Meadows scenarios were run in RiverWare with varying storage levels for the priority storage account and direct flow storage account as well as the modeling of the Federal Reserved instream flow right on the assumption that a gage will be installed and this water right will be administered. The names and volumes of each scenario are shown in Table 11. Priority storage is modeled at 1,000 AF and 2,000 AF and direct flow storage is also modeled at 1,000 AF and 2,000 AF. Allocation for a permanent minimum storage pool is not included. Up to 6,000 AF of storage capacity is possible at the site, but that available storable inflow is minimal above 4,000 AF; storage greater than 4,000 AF for an enlarged reservoir was not modeled.

The resulting volumes of water stored in Trujillo Meadows under the various model runs are highly variable and largely dependent on high-flow events for either priority storage or direct flow storage. Given unlimited storage space (model results not shown), the priority storage account exceeded 1,000 AF in only one year (1987) with 1,688 AF stored. The largest annual diversion for the priority account is 1,141 AF, which means that water was carried over from the previous year to reach a volume of 1,688 AF. The fact that the priority account only ever reaches 1,688 AF when it is not space-limited indicates that there is very little in-priority flow on the Los Pinos, either due to physical flow into the reservoir, more senior water rights, the Federal Reserved instream flow right, the Compact curtailment, or Article VII storage limitations of the Compact.

There is very little priority water on the Los Pinos that can be stored in Trujillo Meadows.

The direct flow storage account is not subject to the priority storage account water rights limitations, but it is subject to exchange limitations through the Federal Reserved instream flow right. If the Federal Reserved instream flow right is not satisfied, direct flow storage will not be permitted. If the instream flow right is satisfied, Trujillo Meadows Reservoir is able to store water any time that downstream ditches are in priority for greater than 240 cfs and choose to store excess in-priority water in Trujillo Meadows Reservoir. This may happen during peak runoff when decreed water rights are greater than necessary, and a release of this excess water later in the irrigation season may help extend the growing season for farmers.

With 1,000 AF of direct flow storage space and 1,000 AF of priority storage space, Figure 21 shows that Trujillo Meadows fills to near 1,000 AF in many years from 1980 to 2008, but rarely fills above 1,000 AF due to storage of priority and direct flow water. The direct flow storage right was filled above 800 AF out of 1,000 AF in 12 out of 29 years while the priority storage account was filled above 500 AF out of 1,000 AF in only 4 out of 29 years. The fact that there is little water left in priority for Trujillo Meadows Reservoir to store (priority storage), yet a large amount of water modeled as available above the Basin's IWR (direct flow storage), suggests that decreed water rights are large compared to IWR. Direct flow storage may therefore be very beneficial to the Basin, as irrigators with senior water rights may choose to store direct flow water instead of diverting early in the season.

By doubling the available storage space for both the priority storage right and the direct flow storage right from 1,000 AF to 2,000 AF each, there are years in which Trujillo Meadows was able to increase its yield and supplemental releases for unmet irrigation demands. As seen in Figure 23, storage was greater than 1,750 AF in 7 out of 29 years. This increase in storage was attributable to the direct flow storage account; the priority storage account exceeded 1,000 AF only in 1987, indicating that the increase from 1,000 AF to 2,000 AF of storage space for the priority storage account did not result in greater yield. Comparing Figure 24 and Figure 26 again shows large increases in storage in the direct flow storage right in some years. On average, storage in the direct flow storage account increased from 721 AF to 969 AF per year by increasing the storage space from 1,000 AF to 2,000 AF. The yield into the priority storage account did not increase, indicating both supply and legal limitations.

In some years (such as 1995), the volume of water diverted into the direct flow storage account exceeds the available storage space, indicating fill, release, and refill of that storage space. The hydrograph on the Los Pinos and San Antonio in 1995 was unique in that it had four distinct peaks separated by severe drops in flow. This created the scenario of fill, release, and refill described above.

The Federal Reserved instream flow right on the Los Pinos, while not currently gaged or administered, has a large impact on modeled yield of the Trujillo Meadows priority and direct flow storage rights. As seen in Figure 21 and Figure 22, the reservoir would fill to at least 800 AF in 25 out of 29 years

modeled if the Federal Reserved right was not modeled as active compared to 12 out of 29 years with the Federal Reserved right modeled. Figure 24 and Figure 25 show severe declines in yield of the priority water right and storage of the direct flow water right due to the Federal Reserved right. On average, the storage into the direct flow storage account increased from 721 AF per year to 1,108 AF per year by not modeling the effect of the Federal Reserved right requirements. The yield in the priority storage account showed the largest increase on average from 212 AF per year to 617 AF per year by not modeling the Federal Reserved right. As was shown in Table 10, the flow requirements at the QP 22H quantification point are most impactful during the winter, which is typically when the priority storage right has the opportunity to store. It is important to note that this modeling of the Federal Reserved right is based on estimation of flows into Trujillo Meadows and at the Federal Reserved Right quantification point QP 22H as described in Sections 5.4 and 5.5. Actual flows, once gaged, will vary from modeled flows and may increase or decrease the ability to store in Trujillo Meadows.

As seen in Figure 21 to Figure 26, at times when priority storage space and direct flow storage space are available, the sum of the storage exceeds the direct flow storage space only one time during 1987, the wettest year modeled. This is because there are two distinct times of the year when priority storage is diverted and released and when direct flow storage is diverted and released. Priority storage tends to happen in the winter when Article VII of the Compact is not invoked and there is sufficient physical flow. Then, in early April, when irrigation season starts and the peak of the hydrograph has not yet occurred, the priority storage is typically released to unmet irrigation demand on the Los Pinos and San Antonio. Later in the irrigation season in May, when the peak of the hydrograph typically occurs on the Los Pinos and San Antonio and the flow is above the 240 cfs threshold, direct flow storage occurs. This direct flow storage is held until there are irrigation shortages in mid-to-late summer, when it is then released to unmet demand. This suggests that although a storage water right may be beneficial for winter storage, it would be best to share storage space and not have separate firm priority and direct flow storage space, since the timing of storage rarely overlaps.

Although a storage water right may be beneficial for winter storage, it would be best to share storage space and not have separate firm priority and direct flow storage space, since the timing of storage rarely overlaps.

Plots of flow retiming can be seen starting in Figure 27. With the current Trujillo Meadows pass-through of inflows and no significant change in storage level, modeled inflows and outflows would be equal except for evaporation and seepage losses. With active storage, however, flow is retimed by storing before and during the peak of the hydrograph and releasing water after the peak of the hydrograph. In Figure 29, 2,000 AF of priority storage and 2,000 AF of direct flow storage is modeled. From April 1 to 14, it can be seen that average outflow is greater than average inflow. This is because the irrigation season is modeled to start on April 1 and there is little modeled inflow to Trujillo Meadows at this time of year. On average, the hydrograph of Trujillo Meadows inflow peaks on May 21 (the hydrograph at the San Antonio River at the Ortiz, CO gage, which is more than 2,000 feet lower in elevation than Trujillo Meadows, peaks on May 5 on average). As such, there are modeled irrigation shortages on the San Antonio, and a supplemental release of water is beneficial. The water stored on April 1 is any priority

storage that was available during the preceding winter. Between April 15 and April 30, as the hydrograph rises, Trujillo Meadows on average is in direct flow storage as the flows are greater than 240 cfs on the San Antonio for diversion and there are no modeled agricultural shortages. On May 1 through June 18, the modeled inflows and outflows to the reservoir alternate between whichever is greater as inflows, irrigation demands, and flows at the Federal Reserved right instream flow quantification point all dictate whether the reservoir is in direct flow storage or releasing to unmet irrigation demands. From June 19 to July 5, the reservoir on average releases water as the peak of the hydrograph has passed and stored water is released to unmet irrigation demands. Similar trends can be seen in Figure 28 without the Federal Reserved instream flow right modeled, except that the May-to-July average outflow is always greater than the inflow because on average, a larger volume of water was stored earlier in the irrigation season, allowing for greater releases of supplemental irrigation water in mid-summer.

FIGURE 21.

Modeled Trujillo Meadows Storage from 1980–2008

- 1,000 AF Priority Pool
- 1,000 AF Direct Flow Pool
- Federal Reserved Instream Flow Right Modeled

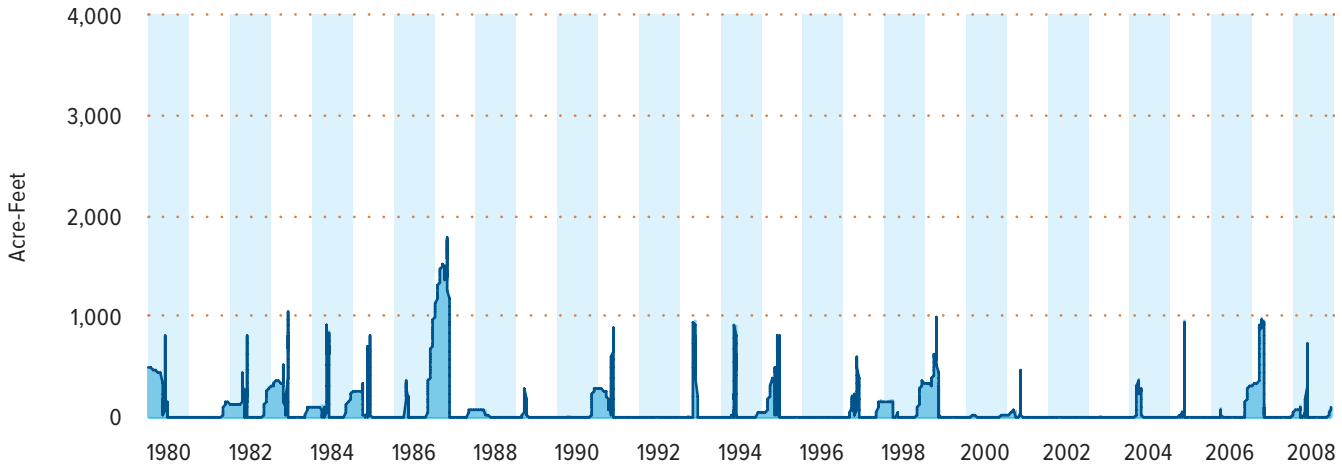


FIGURE 22.

Modeled Trujillo Meadows Storage from 1980–2008

- 1,000 AF Priority Pool
- 1,000 AF Direct Flow Pool
- No Federal Reserved Instream Flow Right Modeled

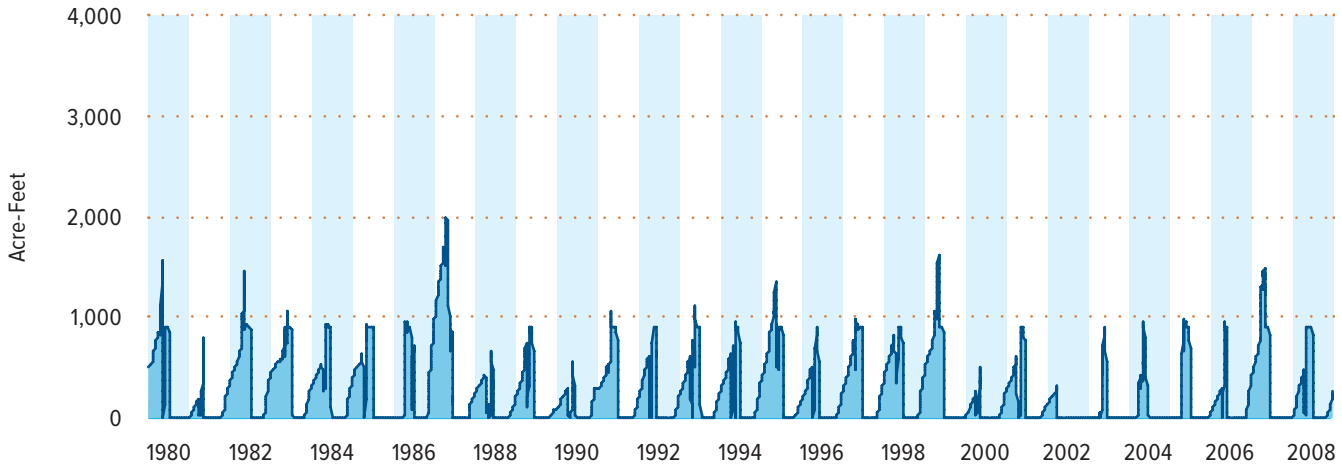


FIGURE 23.

Modeled Trujillo Meadows Storage from 1980–2008

- 2000 AF Priority Pool
- 2,000 AF Direct Flow Pool
- Federal Reserved Instream Flow Right Modeled

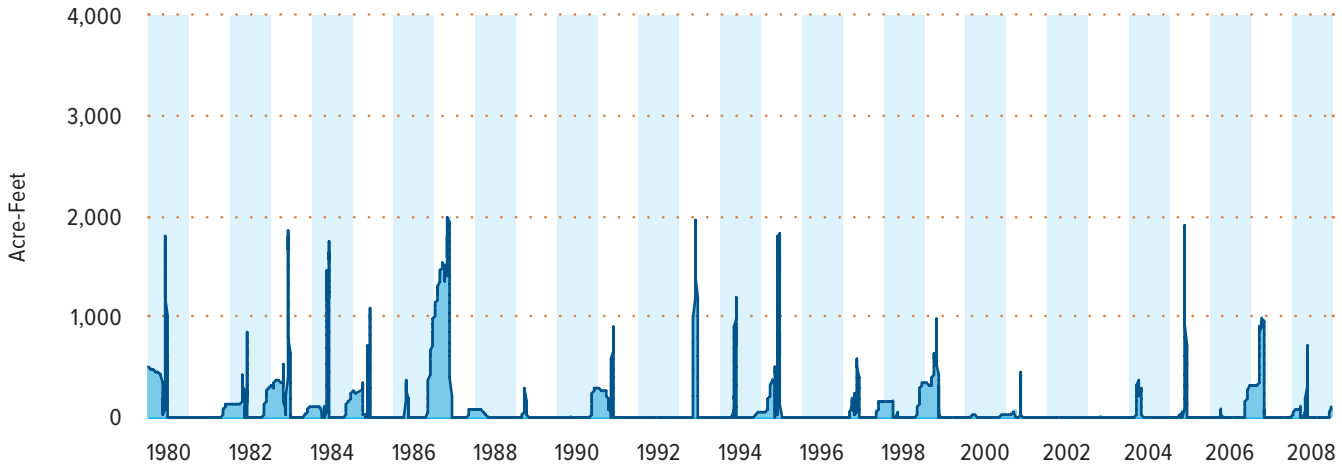


FIGURE 24.

Modeled Diversions to Trujillo Meadows From 1980–2008

- Under Priority Storage (1,000 AF of Storage Space)
- Direct Flow Storage (1,000 AF of Storage Space)
- Federal Reserved Instream Flow Right Modeled

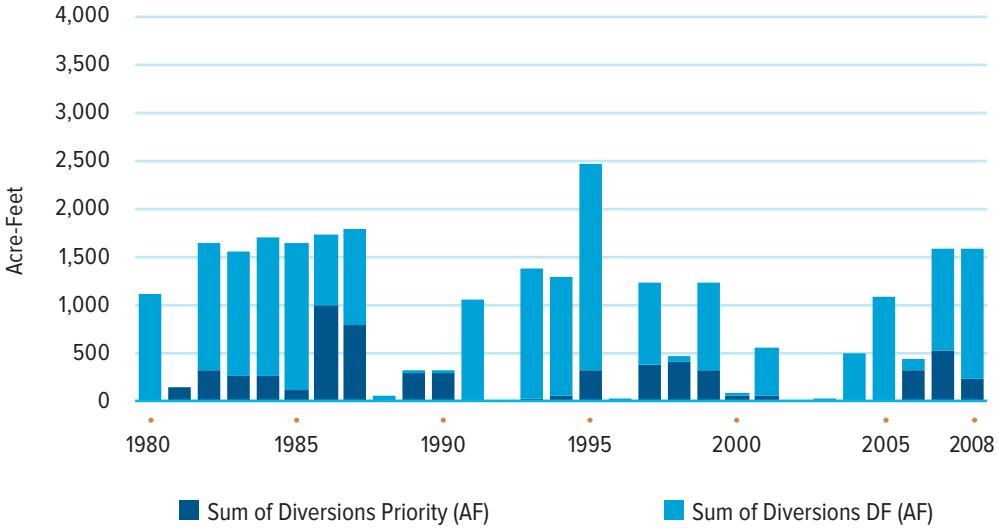
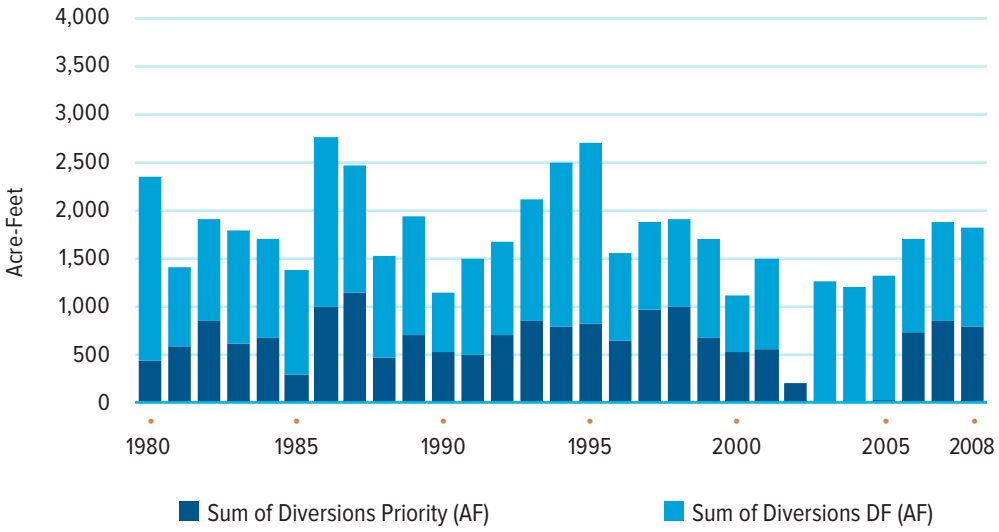


FIGURE 25.

Modeled Diversions to Trujillo Meadows From 1980–2008

- Under Priority Storage (1,000 AF of Storage Space)
- Direct Flow Storage (1,000 AF of Storage Space)
- No Federal Reserved Instream Flow Right Modeled



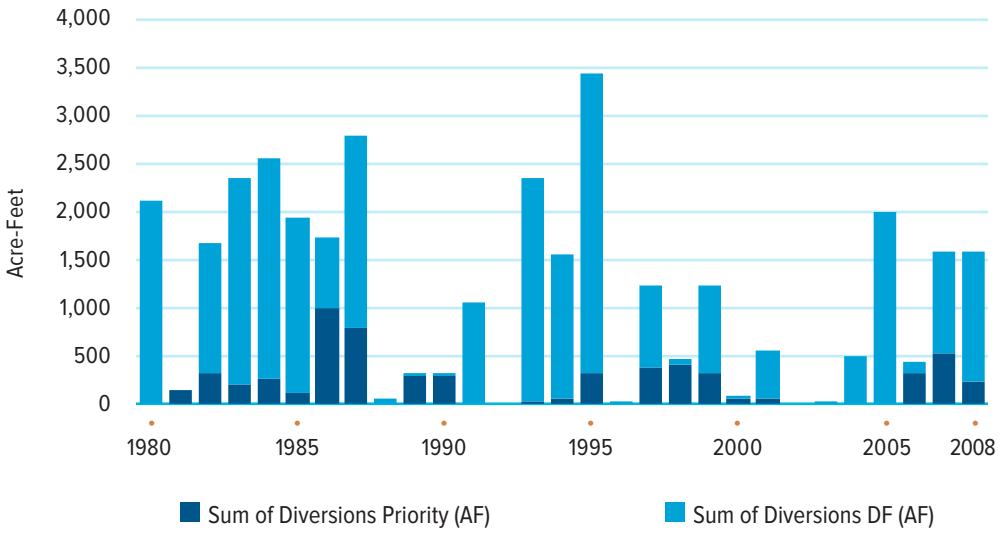


FIGURE 26.

Modeled Diversions to Trujillo Meadows From 1980–2008

- Under Priority Storage (2,000 AF of Storage Space)
- Direct Flow Storage (2,000 AF of Storage Space)
- Federal Reserved Instream Flow Right Modeled

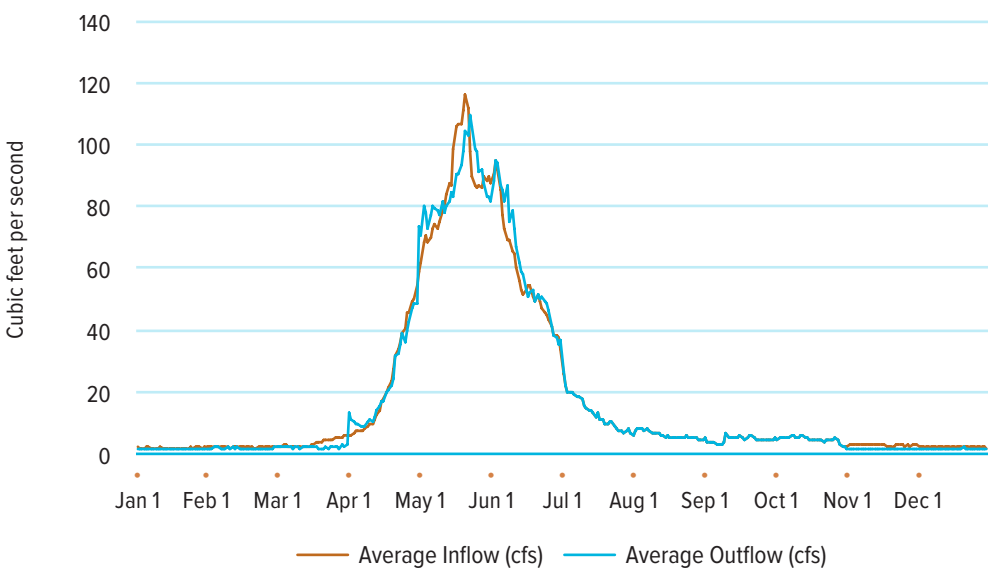


FIGURE 27.

Average Daily Inflow and Outflow to Trujillo Meadows During Irrigation Season

- 1,000 AF Priority Storage
- 1,000 AF Direct Flow Storage
- Federal Reserved Instream Flow Right Modeled

FIGURE 28.

Average Daily Inflow and Outflow to Trujillo Meadows During Irrigation Season

- 1,000 AF Priority Storage
- 1,000 AF Direct Flow Storage
- No Federal Reserved Instream Flow Right Modeled

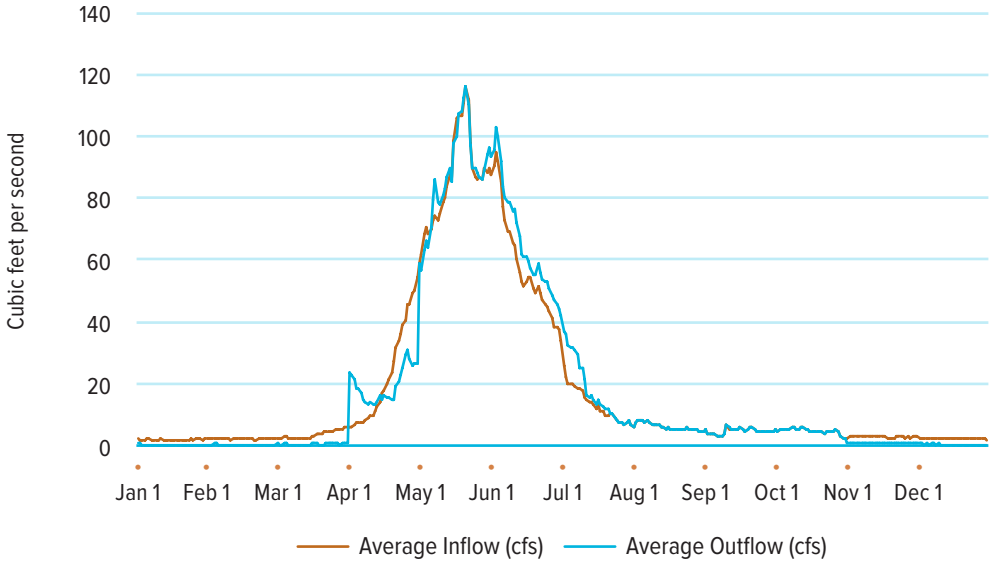
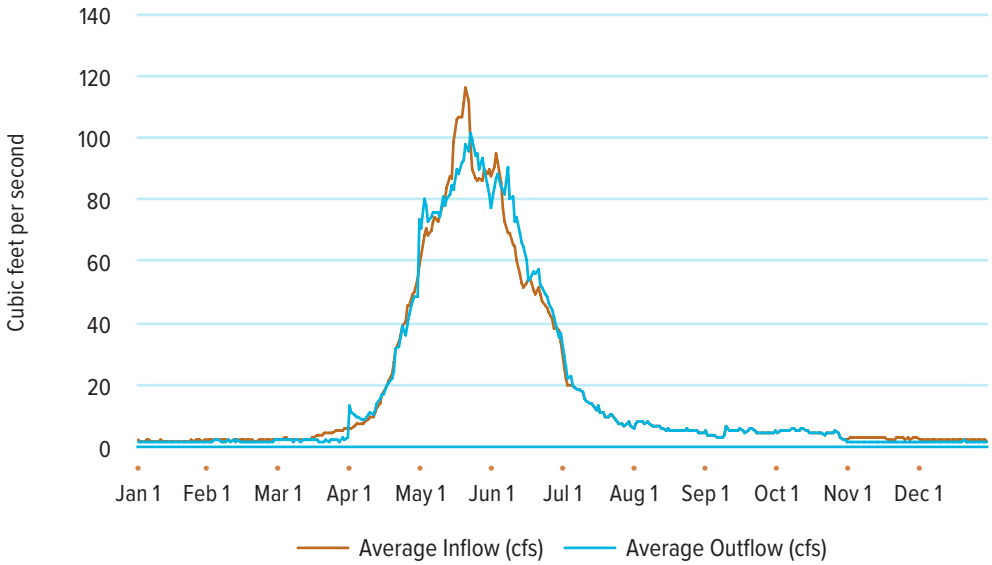


FIGURE 29.

Average Daily Inflow and Outflow to Trujillo Meadows During Irrigation Season

- 2,000 AF Priority Storage
- 2,000 AF Direct Flow Storage
- Federal Reserved Instream Flow Right Modeled



8. Multiple Benefits

The goal of the TMR Study is to evaluate if an enlargement of Trujillo Meadows could provide for an improved irrigation supply for San Antonio agricultural users and reduce the need to dry up irrigated land to meet the Towns' well-replacement requirements. The early runoff and inability to regulate flows on the Los Pinos and San Antonio Rivers has resulted in challenges in meeting irrigation water demands, managing delivery of Compact water, flood control, fish habitat, and riparian health. This report indicates that there is a potential to meet many of these goals while providing for multiple benefits.

8.1 : Improved Agricultural Deliveries

El Coda Lateral Ditch

Typically, the San Antonio and Los Pinos systems runoff much earlier in the year than is optimal for irrigation purposes, causing the peak flow to run downstream prior to about June 15 and leaving irrigators short after about June 15 (see Figure 2). For this reason, many irrigators on the San Antonio believe that they "pay the Compact" for the entire Conejos system prior to June 15 by passing a much greater amount than is required by the Division Engineer's daily curtailment percentage. Providing storage that can be filled with a new priority storage right and/or through direct flow storage would much more equitably spread the burden of the Compact to all water users on the Conejos system and allow users on the Los Pinos and San Antonio systems to much more closely follow the daily curtailment. The addition of late-summer reservoir water would help bridge the gap of agricultural shortages and potentially allow another cutting of hay, a common crop on the San Antonio and Los Pinos systems. The Federal Reserved right limits the ability to use direct flow storage in every year. A lower reservoir near Ortiz would provide better opportunities to use direct flow storage.

8.2 : Improved Compact and River Administration

Additional operational storage in the Los Pinos and San Antonio River systems offers many potential benefits to stakeholders in Colorado as well as for Compact administration. The reservoir enlargement and dynamic operation of stored water in the reservoir provides regulation to the previously unregulated Los Pinos and San Antonio River systems as well as an opportunity for water rights holders to trade water that has previously been unusable to them (Platoro Reservoir water) for storage. Many of these issues can see improvement through the development of this project. Additionally, there will be economic and agricultural benefits in Conejos County stemming from the marketing and transfer of water rights to municipalities that will soon have a need for augmentation water on the Conejos River. By facilitating this transfer, this project would result in a reduction in irrigated acres, which is the default method contemplated by well-users in the San Luis Valley to adhere to the proposed Groundwater Rules and Regulations for Colorado Division 3.

Providing Compact storage space accessible to the Division Engineer would reduce the risk of over-and under-delivery of the Compact. This type of storage space is common in other parts of the Rio Grande basin and allows the Division Engineer to store or release water specifically for the Compact at times when greater or fewer deliveries are required. It increases the beneficial use of the Rio Grande and Conejos Rivers for users in Colorado by avoiding accrual of a debt to New Mexico or high evaporation losses experienced in Elephant Butte Reservoir when Colorado over-delivers on the Compact.

During peak runoff, there have been issues with flooding in past years near San Antonio.

8.3 : Flooding Minimization

During peak runoff, there have been issues with flooding in past years near the Town of San Antonio. This problem can be exacerbated by a high curtailment and the inability to divert water out of the river upstream of the affected areas. The ability to store water in Trujillo Meadows, while situated high in the basin, could still reduce flows near San Antonio and greatly reduce the risk of flooding in the spring. A lower reservoir near Ortiz would provide better flood control benefits since it could capture more of the basin flows.

8.4 : Supply to Meet Towns' Well-replacement Requirements

Additional direct flow and priority storage for the agricultural users will improve the water supplies to the agricultural users. With support for funding for the development of additional storage, the agricultural users could lease their Platoro Project water to the Towns to meet a portion of the Towns' well-replacement requirements. This water could be provided to Subdistrict No. 3 for partial payment of the Towns' contribution for well-pumping replacement.

8.5 : Enhanced Mid-summer Streamflows

Additional releases of water in mid-summer will enhance stream and riparian values through a prolonged release of additional flow after the peak runoff. This will improve aquatic habitat quality and species diversity downstream due to prolonged stream volume, lower temperatures, and higher levels of dissolved oxygen.

Additional direct flow and priority storage for the agricultural users will improve the water supplies to the agricultural users.

8.6 : Enhanced CPW Operations

An active storage pool in Trujillo Meadows provides an additional location for CPW to store and regulate its transmountain water supplies. CPW currently has storage in Beaver Park Reservoir and Rio Grande Reservoir. Storage of CPW's transmountain supplies in Trujillo Meadows increases CPW's total usable storage in the San Luis Valley, improving the yield of these water rights and allowing CPW to directly enhance streamflows in the Los Pinos and San Antonio Rivers. An enlargement of Trujillo Meadows would also result in increased surface acres and shoreline miles that would provide benefits for wildlife use and wildlife-related recreation (fishing, hunting, wildlife watching) and boating.

9. Recommended Path Forward

We recommend an analysis of a storage site near Ortiz and comparison of the feasibility and benefits of this alternative storage site to an enlarged Trujillo Meadows. This additional analysis will implement and expand upon the recommendations of the Trujillo Meadows (ATM) project and investigate and select opportunities for development of additional storage and coordinated water operations to provide multiple benefits.

An enlargement of Trujillo Meadows and/or construction of new storage on the San Antonio upstream of Antonito or a gravity conveyance from the Conejos River to the San Antonio River, coupled with coordinated operations with Platoro Reservoir, can provide multiple benefits to agricultural water rights holders on the Los Pinos and San Antonio Rivers. Benefits from these changes in reservoir operations include enhanced riparian habitat and streamflows because of extended summer releases from Trujillo Meadows. The recommended analysis is expanded beyond the San Antonio watershed boundaries since there are benefits and cooperative measures that extend to the entire CWCD boundaries.

Feasibility studies of a new reservoir on the San Antonio between the state line and Antonito should be conducted.

Feasibility studies of a new reservoir on the San Antonio between the state line and Antonito should be conducted. This includes reconnaissance-level engineering and costs, as well as biological, wetlands, cultural, and other resource investigations. The Rio Grande Basin Plan RiverWare model should also be expanded to evaluate opportunities for maximization of the beneficial use of the Conejos' entitlement under the Compact and flood mitigation potential. The model should also be used to evaluate streamflows, leading to analysis of riparian, environmental, recreational, and economic benefits.

Los Pinos River

Appendix A: Estimated Monthly Inflows to Trujillo Meadows Reservoir

	Estimated Trujillo Meadows Inflow (AF)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	106	137	116	810	8,336	9,711	1,669	312	202	166	139	142	**21,845**
1981	116	96	87	1,066	1,998	1,137	360	297	301	465	162	127	**6,213**
1982	119	105	126	1,315	8,540	6,825	1,750	522	853	460	287	213	**21,116**
1983	160	140	181	939	6,264	8,530	1,876	551	234	334	158	172	**19,539**
1984	141	115	137	863	9,671	4,523	1,065	547	248	387	210	200	**18,109**
1985	178	125	272	3,286	11,235	8,275	1,860	663	463	791	242	222	**27,611**
1986	188	187	352	2,075	8,033	6,343	1,639	412	610	1,149	531	279	**21,798**
1987	192	196	222	2,103	6,898	4,051	645	280	185	185	180	144	**15,279**
1988	111	124	143	1,220	3,126	2,172	590	382	285	187	124	128	**8,593**
1989	106	140	429	3,103	3,610	1,227	319	246	172	301	99	50	**9,803**
1990	50	73	103	831	2,991	1,467	523	321	207	364	279	191	**7,400**
1991	168	103	148	2,378	7,318	3,751	1,059	659	429	188	165	169	**16,537**
1992	154	153	158	1,801	4,769	2,221	532	615	248	153	132	138	**11,074**
1993	119	115	238	1,235	10,284	7,702	1,411	516	346	235	182	149	**22,530**
1994	113	97	215	1,579	8,219	4,248	551	404	311	267	194	190	**16,388**
1995	150	168	345	980	7,170	10,842	3,389	571	318	222	150	153	**24,460**
1996	105	129	156	1,440	3,310	532	520	209	190	160	151	148	**7,050**
1997	123	122	376	1,218	8,075	5,593	931	601	445	393	213	204	**18,293**
1998	153	127	203	724	6,729	3,123	858	321	198	320	284	195	**13,233**
1999	137	127	371	1,169	5,173	3,570	913	916	370	201	119	90	**13,158**
2000	89	111	121	1,185	2,023	449	217	161	106	204	165	132	**4,962**
2001	97	98	213	1,348	6,875	2,145	446	278	137	136	93	87	**11,953**
2002	83	70	86	605	350	107	78	46	114	122	119	70	**1,851**
2003	80	105	144	1,051	3,942	1,556	231	153	426	178	141	137	**8,146**
2004	102	115	537	1,650	5,089	1,545	428	207	192	326	185	124	**10,501**
2005	161	169	134	1,969	9,507	4,727	847	363	168	282	130	119	**18,576**
2006	98	91	112	1,527	2,970	606	364	651	577	1,110	306	197	**8,608**
2007	152	148	543	1,945	5,126	2,368	528	252	210	207	114	169	**11,763**
2008	133	146	277	1,745	8,600	6,948	1,547	378	279	259	119	130	**20,562**
2009	125	132	244	1,776	9,047	2,741	814	224	227	284	161	102	**15,876**
2010	105	98	127	2,076	6,472	2,730	460	248	189	165	124	131	**12,926**
2011	117	113	140	930	3,996	4,394	620	321	371	377	206	149	**11,734**
2012	104	135	513	2,621	2,282	428	258	167	160	134	104	96	**7,002**
2013	87	92	116	645	2,233	702	253	312	387	296	130	112	**5,364**
2014	109	128	165	1,806	3,429	1,397	399	254	136	195	122	127	**8,267**
Min	**50**	**70**	**86**	**605**	**350**	**107**	**78**	**46**	**106**	**122**	**93**	**50**	**1,851**
Max	**192**	**196**	**543**	**3,286**	**11,235**	**10,842**	**3,389**	**916**	**853**	**1,149**	**531**	**279**	**27,611**
Avg	**124**	**124**	**224**	**1,515**	**5,820**	**3,677**	**856**	**382**	**294**	**320**	**178**	**148**	**13,661**

Appendix B: Additional Investigations

These investigations are available upon request. Contact DiNatale Water Consultants or Nathan Coombs, Manager of Conejos Water Conservancy District.

- Roy H. Spitzer, Project Manager DEERE & AULT CONSULTANTS, INC., Memo to DiNatale Water Consultants, "Reconnaissance Level Investigations, Potential for Enlargement of Trujillo Meadows Dam and Reservoir," December 18, 2013.

- Doug Loebig, General Manager, Stratified Environmental & Archaeological Services, Letter to Kerrianne Zdimal, "Trujillo Meadows Reservoir Expansion Project," November 25, 2013.

- Nathan Kirker and Sean Moore, Email, "Assessment of Special Status Species Report, including Federally-listed Species by the U.S. Fish and Wildlife and the U.S. Forest Service," December 24, 2013.

- Nathan Kirker and Sean Moore, Email, "Summary of the National Environmental Policy Act for the U.S. Forest Service," December 24, 2013.

- SME Environmental Consultants, Report to DiNatale Water Consultants, "Wetland Delineation Report: Trujillo Meadows Reservoir Project, Conejos County, Colorado," August 2014.

- Tim Funk and Kerrianne Zdimal, Email, "Assessment of Potential On-Site Mitigation — Trujillo Meadows Reservoir," August 12, 2014.

- Tim Funk and Kerrianne Zdimal, Email, "Assessment of Potential Waters of the US/Permit Scenarios for the Trujillo Meadows Reservoir Expansion," December 9, 2013.

Back cover: El Coda Lateral Canal

Llano Ditch

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Deere & Ault Consultants and SME Environmental Consultants performed investigations integral to this report.