LeonardRice ENGINEERS, INC.

Integrated Water Resources Engineering
Innovative Solutions for Water and Land

Willow Creek Ranch – Daily Surface Water Hydrology Model Documentation and Results Summary

Prepared for:

United States Bureau of Reclamation on behalf of Donala Water and Sanitation District

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The technical material in this report was prepared by or under the supervision and direction of the undersigned, whose seal as a Professional Engineer is affixed below.

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1 MODEL PURPOSE

Leonard Rice Engineers, Inc. (LRE) is assisting the Donala Water and Sanitation District (Donala) in preparing an Environmental Assessment (EA) to meet NEPA requirements that accompany proposed contracts with the Bureau of Reclamation (Reclamation). The contracts would allow Donala to convey and store Willow Creek Ranch (WCR) water and Pueblo Board of Water Works (PBWW) leased water in Pueblo Reservoir and deliver this water through the North Outlet Works (NOW). A daily hydrologic spreadsheet model was developed to simulate the possible impacts of rerouted flow.
In the hydrologic model, historic daily gage flows are used to model gage flows under existing baseline conditions, the no action alternative, and the proposed action alternative (with four operational scenarios). The simulations of each operational scenario include accounting for changes in the routing of **WCR consumptive use (CU) water**, **WCR historical return flows (RF)**, **PBWW return flow (RF) lease water** and **PBWW excess lease water**. Schematics in Appendices A through G illustrate the system and flow routing for each model simulation. Throughout this documentation and the model, consistent color coding is used for convenient distinguishing between each type of water including:

- **WCR CU Water** – Consumptive use is the portion of water that was historically diverted and consumed by irrigation. The historical consumptive use for Willow Creek Ranch (WCR) has been quantified and decreed in case 09CW73 and is now available for use by Donala. This water is only available during the historical irrigation season (May through August)
- **WCR Historical RF Water** – As a term and condition of case 09CW73 the WCR historical return flow obligations have also been quantified. When Willow Creek Ranch was actively irrigated, these flows would have returned to the stream during the non-irrigation season (September through April). Without ranch irrigation, these flows reach the stream without a seasonal delay. To cover these obligations, Donala will leave this water in the stream to flow to its storage account in Pueblo Reservoir for exchange into PBWW's storage account, and then PBWW will retime the return flows by releasing an equivalent amount of water during the historical non-irrigation period (September through April).
- **PBWW RF Lease Water** – Donala leases 250 AF from PBWW to retime and meet non-irrigation season return flow obligations from September through April. After PBWW receives the historical return flow water from WCR during the irrigation season (May through August), PBWW releases an equivalent amount of leased water from Turquoise Lake to meet Donala's return flow obligations from September through April.
- **PBWW Excess Lease Water** – Donala's return flow obligations will never exceed the total 250 AF leased from PBWW. The excess lease water above the return flow obligations is available for use by Donala and is released at Turquoise Lake by PBWW during the non-irrigation season (September through April). The quantity of excess lease water depends on that year's return flow obligations, which varies due to hydrologic conditions.

2 MODEL ASSUMPTIONS

2.1 Model Extent

The system schematic in Appendix A illustrates the geographic extent of the hydrologic model. The model includes the Arkansas River from Leadville to Pueblo as well as Lake Fork Creek below Turquoise Lake, Lake Creek below Twin Lakes, Pueblo Reservoir and neighboring conveyance infrastructure. This model does not consider any basin operations below Pueblo. Waste water return flows in Fountain Creek are not modeled as they are unaffected by the proposed contract as this is only a proposed alternate source of water for existing uses (not additional water delivery). Waste water flows in Fountain Creek will return with the same timing and in the same amount as present.

2.2 Model Study Period

The study period includes 28 years from water year 1982 through water year 2009 and is representative of when the ranch was actively irrigated. This period of record also matches the Arkansas Valley Conduit (AVC) Environmental Impact Statement (EIS) modeling effort's study period and contains a variety of hydrologic conditions including low, average and high flow years. As irrigation at the ranch ceased in 2009, gage flows after water year 2009 already include Donala's operations and therefore are not included in the model study period.

2.3 Year Type Classification

The hydrologic year type classification governs the magnitude of WCR flows, PBWW deliveries, and return flow obligations for each year in the hydrologic model. To determine year type, the total annual streamflow (AF) at ARKSALCO (Arkansas River at Salida, Co) between water year 1982 and water year 2009 were sorted. Each year was given a percentile ranking calculated as that year's integer rank divided by the total number of years in the study period. All years below the 15th percentile were classified as dry years while all years above the 85th percentile were classified as wet years. All remaining years are considered average years. Of note, five average years (1986, 1987, 1988, 1996 and 1999) are hydrologically distinct because Fry-Ark imports were curtailed in those years because east slope storage reservoirs were too full. This year type analysis is included in the hydrologic model on the *Year Type* tab. Note that the representative wet (WY 1985), dry (WY 2003), and average (WY 1998) years were selected as the 89th, 11th, and 50th percentiles respectively.

- Dry Years: 2002, 2003, 2004, and 2005

- Average Years: 1982, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1996, 1997, 1998, 1999, 2000, 2001, 2006, 2007, 2009
- Wet Years: 1983, 1984, 1985, 1995 and 2008

2.4 Model Time Step

The hydrologic model uses a daily time step with average daily inputs (e.g. average daily gage flow) and average daily outputs (e.g. scenario specific average daily streamflow change from baseline).

3 MODEL SOURCE DATA AND METHODOLOGY

3.1 Willow Creek Ranch Flows

From Willow Creek Ranch (WCR), we estimated the total depletions as well as the split between **available consumptive use (CU)** and **historical return flow (RF)** water for each year type (wet, average, or dry). In the hydrologic model, the monthly Willow Creek Ranch flow values are summarized and described below (included in the *WCR & PBWW Monthly* tab of the hydrologic model) are further divided into equal daily flows that are then used in the model (see the *WCR Daily* tabs). Table 1

Table 1 - Willow Creek Ranch Flows

Willow Creek Ranch Monthly Flows [AF]										
		Dry			Average			Wet		
Month	Month #	WCR Total CU [AF]	WCR Historical RF [AF]	WCR Available CU [AF]	WCR Total CU [AF]	WCR Historical RF [AF]	WCR Available CU [AF]	WCR Total CU [AF]	WCR Historical RF [AF]	WCR Available CU [AF]
October	10	0	0	0	0	0	0	0	0	0
November	11	0	0	0	0	0	0	0	0	0
December	12	0	0	0	0	0	0	0	0	0
January	1	0	0	0	0	0	0	0	0	0
February	2	0	0	0	0	0	0	0	0	0
March	3	0	0	0	0	0	0	0	0	0
April	4	0	0	0	0	0	0	0	0	0
May	5	0	0	0	39	23.61	15.39	170	47.5	122.5
June	6	122.4	24	98.4	147	23.61	123.39	207	47.5	159.5
July	7	68.8	24	44.8	118	23.61	94.39	172	47.5	124.5
August	8	0	0	0	70	23.61	46.39	143	47.5	95.5
September	9	0	0	0	0	0	0	0	0	0
Annual		191.2	48	143.2	374	94.42	279.58	692	190	502

For a wet year:

- The monthly total depletions for a wet year came from the maximum monthly inflow to storage listed in Table 1 of Exhibit C in the 2016 Temporary Excess Capacity Water Storage Contract No. 16XX650016 (TECWSC). The annual total depletion for a wet year is 692 AF.
- The **annual RF** obligation for a wet year is listed on page 6 of Exhibit C in the TECWSC as 184 AF (maximum possible return flow obligation). However, to end up with 184 AF of return flow, an additional 3.26% must be added to account for transit losses, meaning that the total return flow obligation is 190 AF (as noted on page 6 of Exhibit C in the TECWSC). This obligation is split proportionally over the four months of the historical irrigation season (May through August).
- The total annual **available CU** is the difference between the total annual depletions and RF obligation. For a wet year, this is 502 AF. The monthly available CU is simply the difference between the total monthly depletion and the monthly RF obligation during the four months of historical use.

For a dry year:

- The annual total depletion of 191.2 AF used for a dry year in the hydrologic model is equivalent to the total depletions in 1968 (the driest year within the study period used for the WCR water court case). During 1968, irrigation only took place during a limited season (June and July). This limitation is retained in the hydrologic model, such that dry year depletions are assumed to only take place during June and July.
- The **annual RF** obligation for a dry year is listed on page 14 of the WCR Decree (Case No. 09CW73) as 48 AF. An additional 3.26% is added to account for transit losses (as noted on page 6 of Exhibit C in the TECWSC) for a total annual obligation of 49.57 AF. This obligation is split proportionally over the two months (June and July).
- The total annual **available CU** is the difference between the total annual depletions and RF obligation. For a dry year, this is 141.63 AF. The monthly available CU is simply the difference between the total monthly depletion and the monthly RF obligation during the two months of historical use.

For an average year:

- The annual total depletion of 374 AF for an average year comes from the WCR Water Rights and Regional Contract Operation Model created in 2011.
- The **annual RF** obligation of 94.42 AF for an average year comes from the WCR Water Rights and Regional Contract Operation Model created in 2011. An additional 3.26% is added to account for transit losses (as noted on page 6 of Exhibit C in the TECWSC) for a total annual obligation of 97.50 AF. This obligation is split proportionally over the four months of historical use (May through August).

- The total annual **available CU** is the difference between the total annual depletions and RF obligation. For an average year, this is 276.50. The monthly available CU is simply the difference between the total monthly depletion and the monthly RF obligation during the four months of historical use.

3.2 Pueblo Board of Water Works Leased Water

Donala has a lease with the Pueblo Board of Water Works (PBWW) for 250 AF to meet return flow obligations during the non-irrigation season (September through April). These return flow obligations are expected to range from 49.57 AF to 190 AF annually. The PBWW lease water will be released from Turquoise Lake (above WCR on Lake Fork Creek).

For both average and wet years, the **leased return flow** water will be delivered by PBWW over the eight months (September through April) following the pattern established in Table 2 on page 6 of Exhibit C in the TECWSC. For dry years, the leased return flow water will be delivered by PBWW following the eight month pattern of return flow deliveries from the driest year within the study period used for the WCR water court case (1968).

Excess leased water (any portion of the 250 AF not obligated to return flows) is delivered to Donala alongside the available CU water. The delivery of this excess leased water will be split evenly over the same eight month non-irrigation season (September through April).
In the hydrologic model, the monthly PBWW delivery values (included in the *WCR & PBWW Monthly* tab of the hydrologic model) are further divided into equal daily flows that are then used in the model (see the *PBWW Daily* tabs).

Table 2 – PBWW Lease Deliveries

PBWW Lease Delivery Monthly Flows [AF]										
		Dry			Average			Wet		
Month	Month #	PBWW Lease Pattern	PBWW RF Lease [AF]	PBWW Excess Lease [AF]	PBWW Lease Pattern	PBWW RF Lease [AF]	PBWW Excess Lease [AF]	PBWW Lease Pattern	PBWW RF Lease [AF]	PBWW Excess Lease [AF]
October	10	0.11	5.40	25.25	0.11	10.26	19.45	0.11	20.65	7.50
November	11	0.27	12.82	25.25	0.26	24.30	19.45	0.26	48.90	7.50
December	12	0.19	8.88	25.25	0.18	16.95	19.45	0.18	34.11	7.50
January	1	0.14	6.72	25.25	0.13	12.65	19.45	0.13	25.46	7.50
February	2	0.11	5.40	25.25	0.11	10.34	19.45	0.11	20.80	7.50
March	3	0.10	4.61	25.25	0.10	8.99	19.45	0.10	18.09	7.50
April	4	0.05	2.16	25.25	0.05	4.49	19.45	0.05	9.03	7.50
May	5	0	0	0	0	0	0	0	0	0
June	6	0	0	0	0	0	0	0	0	0
July	7	0	0	0	0	0	0	0	0	0
August	8	0	0	0	0	0	0	0	0	0
September	9	0.04	2.02	25.25	0.07	6.45	19.45	0.07	12.97	7.50
Annual		1	48	202.00	1	94.42	155.58	1	190	60.00

3.3 Streamflow Data

Daily average streamflow from 10/1/1981 to 9/30/2009 at each of the 13 DWR and USGS gages listed in Table 3 were pulled from HydroBase using TSTool. HydroBase is a central database that houses real-time, historic and geographic data related to water resources in Colorado including republished USGS streamflow. Most gage records required some data estimation and filling as discussed in section 3.3.4. Command files used to compile, review, and fill streamflow records were developed using TSTool.

3.3.1 Locations

Flows at thirteen DWR and USGS gages and one synthetic gage (estimated flows using data from five gages) are modeled in this study. In Table 3, each gage's DWR abbreviation is listed with its description and location. Four gages of primary interest (as determined by the Bureau of Reclamation) are **bolded**: ARKLEACO, ARKBGNCO, ARKPARCO and ARKPUECO.

Table 3 – Name and location of all gages used in the creation of the hydrologic model

DWR Abbreviation	Gage Description	Latitude	Longitude
ARKLEACO	Arkansas River near Leadville, CO	39.249°	-106.348°
LFCBSLCO	Lake Fork Creek below Sugar Loaf Dam near Leadville, CO	39.251°	-106.374°
BLWROCK*	*Synthetic* – Rock Creek at Confluence with Lake Fork Creek	39.212°	-106.374°
ARKEMPCO	Arkansas River Below Empire Gulch near Malta, CO	39.169°	-106.324°
LAKBTLCO	Lake Creek below Twin Lakes Reservoir	39.076°	-106.310°
ARKGRNCO	Arkansas River at Granite, CO	39.043°	-106.266°
ARKBGNCO	Arkansas River below Granite, CO	38.995°	-106.220°
ARKNATCO	Arkansas River near Nathrop, CO	38.652°	-106.051°
ARKSALCO	Arkansas River at Salida, CO	38.546°	-106.011°
ARKWELCO	Arkansas River near Wellsville, CO	38.503°	-105.940°
ARKPARCO	Arkansas River at Parkdale, CO	38.487°	-105.374°
ARKCANCO	Arkansas River at Canon City	38.434°	-105.257°
ARKPORCO	Arkansas River near Portland, CO	38.388°	-105.016°
ARKPUECO	Arkansas River above Pueblo, CO	38.272°	-104.718°

** This gage is a synthetic gage compiled for this hydrologic model, therefore its abbreviation was created to match DWR format*

3.3.2 Transit Losses

Transit losses are estimated from each point of origination to downstream gages as shown in Table 4 below. Transit losses are calculated using the Colorado DWR Division 2 office methodology as 0.07% per mile. Transit losses from Willow Creek Ranch (WCR) apply to both the **WCR Available Consumptive Use** (CU) and the **WCR Historical Return Flows** (RF). Transit losses from Turquoise Lake via Lake Fork Creek only ever apply to **PBWW RF Lease** water. Transit losses from Turquoise Lake via the conduit to Twin Lakes only ever apply to **PBWW Excess Lease** water.

Table 4 – Transit losses calculated from origination to downstream gages

Abbreviation	Transit Loss from Willow Creek Ranch	Transit Loss from Turquoise Lake via Lake Fork Creek	Transit Loss from Turquoise Lake via Twin Lakes
ARKLEACO			
LFCBSLCO		0.00%	
BLWROCK	0.17%	0.27%	
ARKEMPCO	0.57%	0.67%	
LAKBTLCO			0.00%
ARKGRNCO	1.29%	1.39%	0.32%
ARKBGNCO	1.65%	1.75%	0.68%
ARKNATCO	3.66%	3.77%	2.69%
ARKSALCO	4.48%	4.58%	3.51%
ARKWELCO	4.88%	4.98%	3.90%
ARKPARCO	7.92%	8.02%	6.95%
ARKCANCO	8.52%	8.62%	7.55%
ARKPORCO	9.63%	9.73%	8.66%
ARKPUECO	11.20%	11.30%	10.23%

3.3.3 Ungaged Flow Representation

To quantify and understand potential impacts on Lake Fork Creek below the Rock Creek confluence streamflow was estimated using a mass balance approach. A four step process was use to estimate the flow on Lake Fork Creek below Rock Creek (BLWROCK).

Step 1 – Reconstruct streamflow's on Halfmoon Creek flows below the diversion dam ($\text{HALFMOON}_{\text{COMBO}}$). The upstream Halfmoon gage (USGS 07083000 (Halfmoon Creek near Malta)) was discontinued in May of 2009 and the replaced with USGS 07083200 (Halfmoon Creek below Halfmoon Diversion near Leadville, CO) located below the Halfmoon Diversion Dam. To represent flows below the diversion dam flows historical diversions were subtracted from the upstream station, then after May 1 2009 the new station was used. Note Halfmoon diversions filled prior to 1997 with average monthly diversion.

Between 10/1/1981 and 5/1/2009: $\text{HALFMOON}_{\text{COMBO}}$ = USGS07083000 – USBR Diversion Records
Between 5/1/2009 and 9/30/2009: $\text{HALFMOON}_{\text{COMBO}}$ = USGS 07083200

Step 2 – Calculate the remaining flow by subtracting Arkansas River Below Empire Gulch near Malta, CO (ARKEMPCO),
Lake Fork Creek below Sugar Loaf Dam near Leadville, CO (LFCBSLCO), and HALFMOONCOMBO from Arkansas River near Leadville, CO (ARKLEACO).

$(ARKEMPCO - ARKLEACO - HALFMOON_{COMBO} - LFCBSLCO) = Remaining\ Flow$

Step 3 - Prorate remaining flow based on contributing watershed area. Of the watershed area that contributes to flow on the Arkansas River between *ARKEMPCO and ARKLEACO; 40.60% comes from Lake Fork Creek.* Of the watershed area that contributes to flow *on Lake Fork Creek* 93.14% *comes from t*he area between the Lake Fork Creek below Sugar Loaf Dam near Leadville (LFCBSLCO) station and the confluence of Rock Creek. Therefore, the total contributing area accounts for 37.82 % of the area

$0.3782 \times (ARKEMPCO - ARKLEACO - HALFMOON_{COMBO} - LFCBSLCO) = Remaining\ Flow$

Step 4 – Add the prorated Remaining Flow to the Lake Fork Creek below Sugar Loaf Dam near Leadville (LFCBSLCO) station to represent the estimated flows on Lake Fork Creek below Rock Creek (BLWROCK).

Remaining Flow + LFCBSLCO = BLWROCK

The calculation of The daily average streamflow at the gages used in this calculation were pulled from HydroBase using TSTool and filled as needed using the method described in Section 3.3.4. A summary of the results is for the synthetic gage BLWROCK is included in Table 8**.**

3.3.4 Data Estimation and Filling Methods

Of the 16 DWR and USGS gages used (the 13 gages described in Table 3 plus the additional 3 gages used only in the estimation of BLWROCK flows), 13 required some amount of data estimation and filling. A variety of methods were used based on the data characteristics of each individual gage including filling missing data via interpolation, regression, and pulling data from alternative time-series. All methods were performed using the CDSS time-series tool (TSTool). The complete TSTool scripts used for data collection and estimation are included in Appendix H. Table 5 below summarizes the percent complete for each streamflow station during the study period, whether the station is seasonal, and the filling methods used. For a detailed summary of the filling algorithms used for each gage see Appendix I.

Table 5 – Streamflow Data Filling Summary

Station	Station Name	Seasonal Station	% Complete	Filling Method		
				CDWR Admin Station	Fill Interpolate	Fill Regression
ARKLEACO	Arkansas River near Leadville, CO		76.5%	X		X
LFCBSLCO	Lake Fork Creek below Sugar Loaf Dam near Leadville		96.4%	X	X	
ARKEMPCO	Arkansas River below Empire Gulch near Malta, CO	X*	19.7%	X		X
LAKBTLCO	Lake Creek below Twin Lakes Reservoir		89.3%	X		X
ARKGRNCO	Arkansas River at Granite, CO		100.0%			
ARKBGNCO	Arkansas River below Granite, CO	X**	19.7%	X		X
ARKNATCO	Arkansas River near Nathrop, CO	X***	48.6%	X		X
ARKSALCO	Arkansas River at Salida, CO		100.0%			
ARKWELCO	Arkansas River near Wellsville, CO		99.7%	X		X
ARKPARCO	Arkansas River at Parkdale, CO	X****	73.6%	X		X
ARKCANCO	Arkansas River at Canon City		100.0%			
ARKPORCO	Arkansas River near Portland, CO		100.0%			
ARKPUECO	Arkansas River above Pueblo, CO		100.0%			

* ARKEMPCO is seasonal starting 05/01/2004, intermittent record prior
** ARKBGNCO is seasonal starting 04/01/1999, no record prior
*** ARKNATCO is seasonal starting in 11/01/1993, intermittent record prior
**** ARKPARCO is seasonal starting in 10/01/1994, complete record prior to 10/01/1995

3.4 Minimum Flows and Flow Management Programs

In the model's area of interest, there are multiple instream flow (ISF) rights as well as a voluntary flow management program agreement:

- ISF at Lake Fork Creek above Rock Creek: 15 CFS
- ISF at Lake Fork Creek below Rock Creek: 20 CFS
- ISF at Lake Creek Below Twin Lakes: 15 CFS
- Minimum Flow at Salida WWTP: Varies seasonally from 240 CFS to 260 CFS
- Minimum Flow at Fremont WWTP: 190 CFS
- Minimum Flow at Wellsville: Varies seasonally from 250 CFS to 700 CFS

We evaluated each minimum flow to determine which would impact the model and how. Both ISF rights on Lake Fork Creek are <u>not</u> affected by model operations since all possible simulations (including baseline, the no action alternative, and all alternative operational scenarios) never cause a decrease in flow on Lake Fork Creek. The Salida, Fremont and Wellsville minimum flows do not affect the model operationally since these are already taken into account in the WCR decree and in how Donala will operate the WCR water right. Only the ISF at Lake Creek below Twin Lakes impacts the model operations as it is decisive in determining whether a Lake Creek exchange (included in alternative operational scenarios B and C) can occur. The exchange potential on Lake Creek is the excess of flows recorded at LAKBTLCO above the 15 CFS instream flow.

3.5 Pueblo Reservoir

The Bureau of Reclamation provided historical end-of-day storage data for Pueblo Reservoir as well storage-elevation relationships based on measured surface areas and reservoir survey data (see Appendix I). These relationships were then used to estimate historical end-of-day surface area and elevation throughout the study period of water years 1981 through 2009. During this study period, three different area-capacity relationships were in use during different years as summarized in in Table 6 below to evaluate the surface area and elevation of Pueblo Reservoir potentially utilized.

Table 6 – Summary of Pueblo Reservoir Elevation-Area-Capacity Relationship Use Periods

Year of Area-Capacity Estimation	Water Years in Use
1963	WY 1963 through WY 1985
1984	WY 1986 through WY 1994
1993	WY 1995 through WY 2015

Doanla's total storage capacity is limited to 499 AF at any given time (as noted on page 5 of Exhibit C in the TECWSC). To model the worst case operational scenario of 499 AF being delivered to Pueblo Reservoir for storage in a single day, 499 AF were added to the end-of-day storage for each day in the period of record to determine the maximum impacts to reservoir surface area and elevation during different year types. While this is not likely to ever occur, it does demonstrate the maximum possible impacts of the Proposed Action Alternative at Pueblo Reservoir. This analysis was completed in a spreadsheet outside of the hydrologic spreadsheet model, but is included with this documentation.

4 MODEL SIMULATIONS

The hydrologic model compares both a No Action Alternative and a Proposed Action Alternative (with multiple operational scenarios) to existing baseline conditions using historic flow data at points within the Arkansas River Basin. Sections 4.3 through 4.5 describe each alternative as well as the baseline conditions in detail.

4.1 Model Structure

In the hydrologic spreadsheet model, each gage listed in Table 3 has its own tab for simulations. On each gage tab, the first five columns summarize the date, model year, water year and hydrologic year type. The sixth column is populated with the original flows recorded at that gage (pulled and filled using TSTool).

Following the original gage data, all gage model tabs below Twin Lakes have information (with the header *ISF Conditions)* on whether the Lake Creek decreed exchange is allowed for each day (depending on Lake Creek stream flow). Then there are columns that look up each day's WCR flows and PBWW deliveries based on year type and the appropriate transit losses depending on the point of origination.

The next columns (with blue headers) include the calculation of each scenario's modeled streamflow and the change in streamflow. Scenarios are grouped together when they are identical in operation at each gage (e.g. all scenarios at ARKEMPCO are grouped together). The top four rows above these model calculation columns include the summary guide color coding described below in Section 4.2 (color coded **+** and **–** showing how each "color" of water is handled for that scenario at that gage).

The final columns in each tab (with gray headers) show the daily percentage difference from baseline flow caused by each scenario. A cell at the top of the column provides a summary of the max percent change in flow caused by that scenario throughout the entire period of record, the average percent change caused, the number of days with a greater than a 5% change in flow and the number of days with a greater than 10% change in flow.

4.2 Model Guide

Table 7 below summarizes the hydrologic model operations at each gage for each scenario. This summary visual guide is also included on the *Model Guide* tab in the hydrologic model. For each of the four "colors" of water described in Section 1, it shows whether that flow is added or subtracted at each gage (or neither). This color coding is maintained throughout the model, this documentation and the operational schematics in Appendix A through Appendix G. Scenarios are grouped together when they are identical operationally at each gage (e.g. baseline and the no action alternative affect every gage identically).

Table 7 – Summary visual guide of the hydrologic model operations at each gage for each scenario

Model Operations Guide	Arkansas River near Leadville, CO	Lake Fork Creek below Sugar Loaf Dam near Leadville	*Synthetic - Rock Creek at Confluence with Lake Fork Creek*	Arkansas River near Malta, CO	Lake Creek below Twin Lakes Reservoir	Arkansas River at Granite, CO	Arkansas River below Granite, CO	Arkansas River near Nathrop, CO	Arkansas River at Salida, CO	Arkansas River near Wellsville, CO	Arkansas River at Parkdale, CO	Arkansas River at Canon City	Arkansas River near Portland, CO	Arkansas River above Pueblo, CO
Baseline & NAA	*ARKLEACO*	*LFCBSLCO*	*BLWROCK*	*ARKEMPCO*	*LAKBTLCO*	*ARKGRNCO*	*ARKBGNCO*	*ARKNATCO*	*ARKSALCO*	*ARKWELCO*	*ARKPARCO*	*ARKCANCO*	*ARKPORCO*	*ARKPUECO*
WCR Historical RF			+	+		+	+	+	+	+	+	+	+	
WCR Available CU			+	+		+	+	+	+	+	+	+	+	+
PBWW RF Lease		+	+	+		+	+	+	+	+	+	+	+	
PBWW Excess Lease					+	+	+	+	+	+	+	+	+	+
Op Sc A	*ARKLEACO*	*LFCBSLCO*	*BLWROCK*	*ARKEMPCO*	*LAKBTLCO*	*ARKGRNCO*	*ARKBGNCO*	*ARKNATCO*	*ARKSALCO*	*ARKWELCO*	*ARKPARCO*	*ARKCANCO*	*ARKPORCO*	*ARKPUECO*
WCR Historical RF			+	+		+	+	+	+	+	+	+	+	
WCR Available CU			+	+		+	+	+	+	+	+	+	+	
PBWW RF Lease		+	+	+		+	+	+	+	+	+	+	+	
PBWW Excess Lease					+	+	+	+	+	+	+	+	+	
Op Sc B & C *	*ARKLEACO*	*LFCBSLCO*	*BLWROCK*	*ARKEMPCO*	*LAKBTLCO*	*ARKGRNCO*	*ARKBGNCO*	*ARKNATCO*	*ARKSALCO*	*ARKWELCO*	*ARKPARCO*	*ARKCANCO*	*ARKPORCO*	*ARKPUECO*
WCR Historical RF			+	+	-	-	-	-	-	-	-	-	-	
WCR Available CU			+	+	-	-	-	-	-	-	-	-	-	
PBWW RF Lease		+	+	+		+	+	+	+	+	+	+	+	
PBWW Excess Lease					-	-	-	-	-	-	-	-	-	
Op Sc D	*ARKLEACO*	*LFCBSLCO*	*BLWROCK*	*ARKEMPCO*	*LAKBTLCO*	*ARKGRNCO*	*ARKBGNCO*	*ARKNATCO*	*ARKSALCO*	*ARKWELCO*	*ARKPARCO*	*ARKCANCO*	*ARKPORCO*	*ARKPUECO*
WCR Historical RF			+	+		+	-	-	-	-	-	-	-	
WCR Available CU			+	+		+	-	-	-	-	-	-	-	
PBWW RF Lease		+	+	+		+	+	+	+	+	+	+	+	
PBWW Excess Lease					-	-	-	-	-	-	-	-	-	

** Operational scenarios B & C are dependent on the availability of the Lake Creek exchange. When unavailable, these scenarios revert back to operational scenario A.*

4.3 Baseline Existing Conditions

The system schematic in Appendix A illustrates the components of Donala's Arkansas River system. The baseline scenario presumes current conditions, meaning that the system is modeled as if Willow Creek Ranch has been dry throughout the study period (WY 1982 through WY 2009) and the terms and conditions of the decree relating to maintenance of return flows have been implemented. Therefore, **WCR historical return flows (RF)** and **consumptive use (CU)** water (as well as **PBWW RF lease water**) flow from WCR down to Pueblo Reservoir (Appendix B). In the hydrologic model:

- **WCR RF** and **CU water** are added back to each gage (less transit losses) below Willow Creek Ranch.
- **PBWW RF lease water** is added back to each gage (less transit losses) below Turquoise Lake.
- **PBWW excess lease water** flows from Turquoise Lake to Twin Lakes through the conduit (no transit losses) and then is added back to each gage (less transit losses) below Twin Lakes.
- Without a federal storage and conveyance contract, no amount of **WCR CU** or **excess PBWW leased water** is delivered to Donala and instead passes through Pueblo Reservoir. Note, during days with no historically observed releases there are no **WCR CU** or **excess PBWW leased water** releases.
- The **PBWW RF leased water** is held in winter water storage in Pueblo Reservoir until being released from that account. Note, during days with no historically observed releases there are no **PBWW RF leased water** releases.

4.4 No Action Alternative

The No Action Alternative (NAA) is would involve a willing buyer purchasing Donala's water rights and transmitting these water rights into the new buyer's system without the need for a federal action. That user would most likely use the WCR water rights in a manner similar to Donala and the terms of the associated water court case (Appendix C). Without a federal contract, this alternative assumes that the municipal water user would be capable of diverting and using flows below Pueblo Reservoir. In the hydrologic model, this alternative does not differ from the baseline existing conditions scenario operationally:

- **WCR RF** and **CU water** are added back to each gage (less transit losses) below Willow Creek Ranch.
- **PBWW RF leased water** is added back to each gage (less transit losses) below Turquoise Lake.
- **PBWW excess lease water** flows from Turquoise Lake to Twin Lakes through the conduit (no transit losses) and then is added back to each gage (less transit losses) below Twin Lakes.
- **WCR CU** and **excess PBWW leased water** are assumed to pass through Pueblo Reservoir and would be diverted by the municipal water user further downstream. . Note, during days with no historically observed releases there are no **WCR CU** or **excess PBWW leased water** releases.

- The **PBWW RF leased water** is held in winter water storage in Pueblo Reservoir until being released from that account. Note, during days with no historically observed releases there are no **PBWW RF leased water** releases.

In an additional NAA considered, Donala could sell the WCR water rights, but retain the PBWW lease contract. As long as this PBWW lease water were still delivered to Pueblo Reservoir (no change in operation), there would be no impacts on streamflow or on Pueblo Reservoir storage. However, this alternative has been determined to be infeasible because without a federal contract for storage and conveyance, there isn't a means for Donala to use the PBWW lease water.

4.5 Proposed Action Alternative

The sections below describe the operational variants to the proposed action alternative. Operational scenario B is the primary system setting preferred by Donala. As operational scenario requires the use of the Lake Creek exchange, operational scenario A is the back-up system setting when the exchange is not available. Similarly, operational scenario C also requires the Lake Creek exchange. Operational scenarios C and D will only be available when this method of delivery using the Otero pipeline is more convenient for Colorado Springs Utilities (CSU) than use of the Southern Delivery System.

4.5.1 Operational Scenario A

Operationally, Scenario A is very similar to both Baseline and the NAA, except that the **WCR CU water** and **PBWW excess lease water** are stored in Pueblo Reservoir and delivered to Donala via the North Outlet Works (NOW), Southern Delivery System (SDS), and Northgate Road Interconnect (Appendix D).
In the hydrologic model:

- **WCR RF** and **CU water** are added back to each gage (less transit losses) below Willow Creek Ranch (but above Pueblo Reservoir).
- **PBWW RF leased water** is added back to each gage (less transit losses) below Turquoise Lake (but above Pueblo Reservoir).
- **PBWW excess lease water** flows from Turquoise Lake to Twin Lakes through the conduit (no transit losses) and then is added back to each gage (less transit losses) below Twin Lakes (but above Pueblo Reservoir).
- **WCR CU water** and **PBWW excess lease water** are stored in Pueblo Reservoir and then delivered to Donala via the North Outlet Works (NOW), Southern Delivery System (SDS), and Northgate Road Interconnect.
- The **PBWW RF leased water** is held in winter water storage in Pueblo Reservoir until being released from that account. Note, during days with no historically observed releases there are no

PBWW RF leased water releases.

4.5.2 Operational Scenario B

In Operational Scenario B, Donala utilizes the Lake Creek native exchange when available as well as a transfer to route the WCR and PBWW flows to Pueblo Reservoir (Appendix E). In the hydrologic model:

- **WCR RF** and **CU water** flow from WCR to the junction of the Arkansas River with Lake Creek and are added back to each gage (less transit losses) between Willow Creek Ranch and the Lake Creek junction. As long as flow at the Lake Creek gage (LAKBTLCO) is greater than 15 CFS (the decreed instream flow obligation), these flows are then exchanged up to Twin Lakes via the Lake Creek decreed exchange. When flow in Lake Creek prohibits the exchange, this operational scenario reverts back to Operational Scenario A in the hydrologic model.
- **PBWW RF leased water** is added back to each gage (less transit losses) below Turquoise Lake (but above Pueblo Reservoir) as it follows the same path as in previous scenarios down the Arkansas River to Pueblo Reservoir.
- **PBWW excess lease water** would flow from Turquoise Lake to Twin Lakes through the conduit (no transit losses).
- A transfer of the **WCR RF**, **WCR CU**, and **PBWW excess lease** water then takes place between Twin Lakes and Pueblo Reservoir using CSU's account.
- The use of the Lake Creek native exchange and transfer between Twin Lakes and Pueblo Reservoir means that the **WCR RF**, **WCR CU**, and **PBWW excess lease** flows are subtracted from each gage (less transit losses) below Twin Lakes because an equal amount of water that would have been released from Twin Lakes is now held as part of the exchange.
- **WCR CU water** and **PBWW excess lease water** are stored in Pueblo Reservoir and then delivered to Donala via the North Outlet Works (NOW), Southern Delivery System (SDS), and Northgate Road Interconnect.
- The **PBWW RF leased water** is held in winter water storage in Pueblo Reservoir until being released from that account. Note, during days with no historically observed releases there are no **PBWW RF leased water** releases.

4.5.3 Operational Scenario C

In Operational Scenario C, Donala utilizes the Lake Creek native exchange when available as well as the Otero Pipeline and a transfer of WCR return flows to Pueblo Reservoir (Appendix F). In the hydrologic model:

- **WCR RF** and **CU water** flow from WCR to the junction of the Arkansas River with Lake Creek and are added back to each gage (less transit losses) between Willow Creek Ranch and the Lake Creek junction. As long as flow at the Lake Creek gage (LAKBTLCO) is greater than 15 CFS (the decreed instream flow obligation), these flows are then exchanged up to Twin Lakes via the Lake Creek decreed exchange. When flow in Lake Creek prohibits the exchange, this operational scenario reverts back to Operational Scenario A in the hydrologic model.

- **PBWW RF leased water** is added back to each gage (less transit losses) below Turquoise Lake (but above Pueblo Reservoir) as it follows the same path as in previous scenarios down the Arkansas River to Pueblo Reservoir.
- **PBWW excess lease water** flows from Turquoise Lake to Twin Lakes through the conduit (no transit losses).
- **WCR CU water** and **PBWW excess lease** water are then delivered to Donala via the Otero Pipeline and Northgate Road Interconnect.
- A transfer of the **WCR RF** water takes place between Twin Lakes and Pueblo Reservoir using CSU's account.
- The use of the Lake Creek native exchange, Otero Pipeline, and transfer between Twin Lakes and Pueblo Reservoir means that the **WCR RF**, **WCR CU**, and **PBWW excess lease** flows are subtracted from each gage (less transit losses) below Twin Lakes because an equal amount of water that would have been released from Twin Lakes is now held as part of the exchange.
- The **PBWW RF leased water** is held in winter water storage in Pueblo Reservoir until being released from that account. Note, during days with no historically observed releases there are no **PBWW RF leased water** releases.
- This scenario is less likely than Operational Scenarios A or B, but it provides operational flexibility for CSU and increases water efficiency and quality (by taking it upstream). CSU cannot promise this operational flow path on a reliable basis.

4.5.4 Operational Scenario D

In Operational Scenario D, Donala utilizes the Otero Intake and a transfer of the WCR historical RF flows to Pueblo Reservoir (Appendix G). In the hydrologic model:

- **WCR RF** and **CU water** flow from WCR to the Otero Intake. This means that these flows are added back to each gage (less transit losses) between Willow Creek Ranch and the Otero Intake. Once these flows reach CSU through the Otero pipeline, a transfer of the **WCR RF** water takes place between CSU and Pueblo Reservoir using CSU's account.
- **PBWW RF leased water** is added back to each gage (less transit losses) below Turquoise Lake (but above Pueblo Reservoir) as it follows the same path as in previous scenarios down the Arkansas River to Pueblo Reservoir.
- **PBWW excess lease water** flows from Turquoise Lake to Twin Lakes through the conduit (no transit losses) and then through the Otero Pipeline (no transit losses) and joins the **WCR CU water** before both flows are delivered to Donala via the Northgate Road Interconnect.

- The use of the Otero Pipeline means that the **PBWW excess lease** flow is subtracted from each gage (less transit losses) below Twin Lakes because an equal amount of water that would have been released from Twin Lakes is now held as part of the exchange.
- The use of the Otero Intake and transfer between CSU and Pueblo Reservoir means that the **WCR RF** and **WCR CU** flows are subtracted from each gage (less transit losses) below the Otero Intake since this is a physical removal of flow from the Arkansas River.
- The **PBWW RF leased water** is held in winter water storage in Pueblo Reservoir until being released from that account. Note, during days with no historically observed releases there are no **PBWW RF leased water** releases.
- This scenario is less likely than Operational Scenarios A or B, but it provides operational flexibility for CSU and increases water efficiency and quality (by taking it upstream). CSU cannot promise this operational flow path on a reliable basis.

5 MODEL RESULTS

5.1 Summary

In sections 5.2 through 5.5 below, we provide detailed analysis of the modeling results for the gages of primary interest (as requested by the Bureau of Reclamation): ARKBGNCO, ARKPARCO and ARKPUECO, as well as Lake Creek below Twin Lakes Reservoir (LAKBTLCO). For each of these gages, there are two types of results presented: maximum day and representative year maximum day. The maximum day results display the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in each year type. The representative year maximum day results display the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in the representative year selected for each year type. The representative years were selected as the 11th (dry), 50th (average), and 89th (wet) percentiles and corresponded to WY 2003, WY 1998, and WY 1985 respectively.

None of the proposed action alternative operational scenarios cause any change from baseline flows at ARKLEACO (Arkansas River near Leadville) for any day during the modeling period because ARKLEACO is located upstream of Willow Creek Ranch on the Arkansas and no exchanges or other activities in the operational scenarios will affect this location. For ARKLEACO and the remaining nine gages modeled, Table 8 summarizes the maximum and average daily percent changes in flow modeled between baseline and the proposed action alternative throughout the study period:

Table 8 – Summary of proposed action alternative impacts modeled for gages of secondary interest

Gage Abbreviation	Max % Decrease in Flow from Baseline	Average % Decrease in Flow from Baseline
ARKLEACO	0%	0%
LFCBSLCO	0%	0%
BLWROCK	0%	0%
ARKEMPCO	0%	0%
ARKGRNCO	3.3%	0.3%
ARKNATCO	2.6%	0.2%
ARKSALCO	2.7%	0.2%
ARKWELCO	2.2%	0.2%
ARKCANCO	2.5%	0.2%
ARKPORCO	1.7%	0.2%

As shown, none of these gages ever experience a modeled impact larger than 3.3%. Similar to ARKLEACO, the first three gages in Table 8 (LFCBSLCO, BLWROCK, and ARKEMPCO) experience 0% differences from baseline for all days for all alternative operational scenarios because these gages are not impacted by the proposed alternative rerouting of flow from Willow Creek Ranch (as shown in the Model Operations Guide in Table 7). For further analysis, the daily percent change in flow modeled between baseline and each alternative operational scenario for every day in the study period is provided on each modeled data tab for each gage (in the columns furthest to the right).

5.2 Lake Creek below Twin Lakes Reservoir (LAKBTLCO)

At low flows (below 20 CFS), Lake Creek below Twin Lakes Reservoir (LAKBTLCO) experiences minor impacts, particularly due to Operational Scenario D. Table 9 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in each year type. As shown, the overall maximum daily impact modeled at LAKBTLCO is a 41.1% decrease in flow from baseline associated only with Operational Scenario D (on December 13th, 1985 when the baseline gage flow was only 1.51 CFS). The average modeled daily impact at LAKBTLCO for the proposed action alternative for all year types by operational scenario:

- 0.0% average daily decrease in flow from baseline under Operational Scenario A
- 0.7% average daily decrease in flow from baseline under Operational Scenarios B & C
- 1.4% average daily decrease in flow from baseline under Operational Scenario D

Under operational scenarios B and C, when the gage flow at LAKBTLCO is below 15 CFS, the scenario automatically reverts to operational scenario A (which always has 0.0% impacts on flow) because the

Lake Creek exchange is not available. However, in the hydrologic model, operational scenario D can still operate when the flow in Lake Creek is below 15 CFS (as it does not require the native exchange).

Table 9 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in each year type. In Appendix K, Figure 1 is a graph of the maximum daily impact (change in flow) modeled at LAKBTLCO for the proposed action alternative from baseline conditions in each month for all dry years. Figure 2 is a graph of the maximum daily impact (change in flow) modeled at LAKBTLCO for the proposed action alternative from baseline conditions in each month for all average years (Appendix K). Figure 3 is a graph of the maximum daily impact (change in flow) modeled at LAKBTLCO for the proposed action alternative from baseline conditions in each month for all wet years (Appendix K).

Table 9 – Maximum daily impact modeled at LAKBTLCO in each month for each year type

	Maximum Day of Dry Years (2002, 2003, 2004, 2005)					**Maximum Day of Average Years (1982, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1997, 1998, 1999, 2001, 2006, 2007, 2009)**					**Maximum Day of Wet Years (1983, 1984, 1985, 1995,2008)**				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	14.4	14.4	13.6	-0.8	**-5.7%**	10.1	10.1	9.5	-0.6	**-6.1%**	14.1	14.1	13.9	-0.2	**-1.7%**
Feb	12.4	12.4	11.6	-0.9	**-7.0%**	10.3	10.3	9.7	-0.7	**-6.4%**	11.1	11.1	10.9	-0.3	**-2.3%**
Mar	14.4	14.4	13.6	-0.8	**-5.7%**	10.3	10.3	9.7	-0.6	**-6.0%**	11.1	11.1	10.9	-0.2	**-2.2%**
Apr	14.4	14.4	13.6	-0.8	**-5.8%**	7.6	7.6	7.0	-0.6	**-8.4%**	16.1	16.1	15.9	-0.3	**-1.6%**
May	15.0	15.0	15.0	0.0	**0.0%**	20.0	20.0	19.4	-0.6	**-3.2%**	21.0	21.0	18.2	-2.8	**-13.2%**
Jun	83.0	83.0	80.9	-2.1	**-2.5%**	94.0	94.0	91.5	-2.5	**-2.6%**	72.0	72.0	68.5	-3.5	**-4.8%**
Jul	35.0	35.0	33.9	-1.1	**-3.2%**	27.0	27.0	25.1	-1.9	**-7.1%**	173.0	173.0	170.2	-2.8	**-1.6%**
Aug	13.0	13.0	13.0	0.0	**0.0%**	16.0	16.0	14.9	-1.1	**-7.1%**	33.0	33.0	30.7	-2.3	**-7.0%**
Sep	12.4	12.4	11.6	-0.8	**-6.8%**	11.3	11.3	10.7	-0.6	**-5.7%**	15.1	15.1	14.9	-0.3	**-1.7%**
Oct	12.4	12.4	11.6	-0.8	**-6.6%**	11.3	11.3	10.7	-0.6	**-5.5%**	6.1	6.1	5.9	-0.2	**-4.0%**
Nov	13.4	13.4	12.6	-0.8	**-6.3%**	8.2	8.2	7.6	-0.6	**-7.8%**	18.1	18.1	17.9	-0.3	**-1.4%**
Dec	14.4	14.4	13.6	-0.8	**-5.7%**	1.5	1.5	0.9	-0.6	**-41.1%**	18.1	18.1	17.9	-0.2	**-1.3%**

X > 10% decrease

Table 10 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in the representative year selected for each year type. In Appendix L, Figure 4 is a graph of the maximum daily impact (change in flow) modeled at LAKBTLCO for the proposed action alternative from baseline conditions in each month of the representative dry year, 2003. Figure 5 is a graph of the maximum daily impact (change in flow) modeled at LAKBTLCO for the proposed action alternative from baseline conditions in each month of the representative average year, 1998 (Appendix L). Figure 12 is a graph of the maximum daily impact (change in flow) modeled at LAKBTLCO for the proposed action alternative from baseline conditions in each month of the representative wet year, 1985 (Appendix L).

Table 10 – Maximum daily impact modeled at LAKBTLCO in each month for each representative year

	Maximum Day of a Representative Dry Year (2003, 11th Percentile)					Maximum Day of a Representative Average Year (1998, 50th Percentile)					Maximum Day of a Representative Wet Year (1985, 89th Percentile)				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	14.4	14.4	13.6	-0.8	**-5.7%**	65.3	65.3	64.7	-0.6	**-0.9%**	78.1	78.1	77.9	-0.2	**-0.3%**
Feb	14.4	14.4	13.6	-0.9	**-6.0%**	23.3	23.3	22.7	-0.7	**-2.8%**	347.9	347.9	347.6	-0.3	**-0.1%**
Mar	14.4	14.4	13.6	-0.8	**-5.7%**	17.3	17.3	16.7	-0.6	**-3.6%**	120.2	120.2	120.0	-0.2	**-0.2%**
Apr	43.4	43.4	42.6	-0.8	**-1.9%**	14.3	14.3	13.7	-0.6	**-4.5%**	163.0	163.0	162.8	-0.3	**-0.2%**
May	66.0	66.0	66.0	0.0	**0.0%**	20.0	20.0	19.4	-0.6	**-3.2%**	288.4	288.4	285.7	-2.8	**-1.0%**
Jun	173.0	173.0	170.9	-2.1	**-1.2%**	279.0	279.0	276.5	-2.5	**-0.9%**	542.9	542.9	539.4	-3.5	**-0.6%**
Jul	237.0	237.0	235.9	-1.1	**-0.5%**	200.0	200.0	198.1	-1.9	**-1.0%**	308.6	308.6	305.8	-2.8	**-0.9%**
Aug	46.0	46.0	46.0	0.0	**0.0%**	36.0	36.0	34.9	-1.1	**-3.2%**	157.4	157.4	155.1	-2.3	**-1.5%**
Sep	12.4	12.4	11.6	-0.8	**-6.8%**	12.3	12.3	11.7	-0.6	**-5.2%**	57.4	57.4	57.2	-0.3	**-0.4%**
Oct	13.4	13.4	12.6	-0.8	**-6.1%**	13.3	13.3	12.7	-0.6	**-4.7%**	86.7	86.7	86.4	-0.2	**-0.3%**
Nov	14.4	14.4	13.6	-0.8	**-5.8%**	14.3	14.3	13.7	-0.6	**-4.5%**	68.5	68.5	68.2	-0.3	**-0.4%**
Dec	14.4	14.4	13.6	-0.8	**-5.7%**	15.3	15.3	14.7	-0.6	**-4.0%**	65.9	65.9	65.7	-0.2	**-0.4%**

X > 10% decrease

5.3 Arkansas River below Granite, CO (ARKBGNCO)

The Arkansas River below Granite (ARKBGNCO) experiences negligible impacts due to the proposed action's rerouting of flow. Table 11 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in each year type. As shown, the overall maximum daily impact modeled at ARKBGNCO is a 2.5% decrease in flow from baseline (in May of a wet year, 1983). The average modeled daily impact at ARKBGNCO for the proposed action alternative for all year types is a 0.3% decrease in flow from baseline. In Appendix M, Figure 7 is a graph of the maximum daily impact (change in flow) modeled at ARKBGNCO for the proposed action alternative from baseline conditions in each month for all dry years. Figure 8 is a graph of the maximum daily impact (change in flow) modeled at ARKBGNCO for the proposed action alternative from baseline conditions in each month for all average years (Appendix M). Figure 9 is a graph of the maximum daily impact (change in flow) modeled at ARKBGNCO for the proposed action alternative from baseline conditions in each month for all wet years (Appendix M).

Table 11 – Maximum daily impact modeled at ARKBGNCO in each month for each year type

	Maximum Day of Dry Years (2002, 2003, 2004, 2005)					Maximum Day of Average Years (1982, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1997, 1998, 1999, 2001, 2006, 2007, 2009)					Maximum Day of Wet Years (1983, 1984, 1985, 1995,2008)				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	66.2	66.2	65.4	-0.8	**-1.2%**	92.5	92.5	91.9	-0.6	**-0.7%**	99.1	99.1	98.9	-0.2	**-0.2%**
Feb	53.1	53.1	52.2	-0.9	**-1.6%**	92.5	92.5	91.9	-0.7	**-0.7%**	105.6	105.6	105.4	-0.3	**-0.2%**
Mar	55.7	55.7	54.9	-0.8	**-1.5%**	92.5	92.5	91.9	-0.6	**-0.7%**	112.1	112.1	111.9	-0.2	**-0.2%**
Apr	125.5	125.5	124.6	-0.8	**-0.7%**	84.5	84.5	83.8	-0.6	**-0.8%**	111.6	111.6	111.4	-0.3	**-0.2%**
May	171.0	171.0	171.0	0.0	**0.0%**	145.6	145.6	144.4	-1.2	**-0.9%**	215.9	215.9	210.4	-5.4	**-2.5%**
Jun	224.0	224.0	220.0	-4.0	**-1.8%**	650.3	650.3	645.5	-4.9	**-0.7%**	612.3	612.3	605.5	-6.8	**-1.1%**
Jul	144.1	144.1	141.9	-2.2	**-1.5%**	241.5	241.5	237.7	-3.8	**-1.6%**	676.8	676.8	671.2	-5.5	**-0.8%**
Aug	146.0	146.0	146.0	0.0	**0.0%**	136.1	136.1	133.9	-2.2	**-1.6%**	244.3	244.3	239.7	-4.6	**-1.9%**
Sep	101.5	101.5	100.6	-0.8	**-0.8%**	122.5	122.5	121.9	-0.6	**-0.5%**	164.3	164.3	164.1	-0.3	**-0.2%**
Oct	108.3	108.3	107.5	-0.8	**-0.7%**	118.8	118.8	118.2	-0.6	**-0.5%**	142.4	142.4	142.2	-0.2	**-0.2%**
Nov	79.5	79.5	78.7	-0.8	**-1.1%**	117.7	117.7	117.1	-0.6	**-0.5%**	125.8	125.8	125.6	-0.3	**-0.2%**
Dec	66.3	66.3	65.5	-0.8	**-1.2%**	97.9	97.9	97.2	-0.6	**-0.6%**	119.0	119.0	118.7	-0.2	**-0.2%**

X > 10% decrease

Table 12 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in the representative year selected for each year type. In Appendix N, Figure 10 is a graph of the maximum daily impact (change in flow) modeled at ARKBGNCO for the proposed action alternative from baseline conditions in each month of the representative dry year, 2003. Figure 11 is a graph of the maximum daily impact (change in flow) modeled at ARKBGNCO for the proposed action alternative from baseline conditions in each month of the representative average year, 1998 (Appendix N). Figure 12 is a graph of the maximum daily impact (change in flow) modeled at ARKBGNCO for the proposed action alternative from baseline conditions in each month of the representative wet year, 1985 (Appendix N).

Table 12 - Maximum daily impact modeled at ARKBGNCO in each month for each representative year

	Maximum Day of a Representative Dry Year (2003, 11th Percentile)					Maximum Day of a Representative Average Year (1998, 50th Percentile)					Maximum Day of a Representative Wet Year (1985, 89th Percentile)				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	66.2	66.2	65.4	-0.8	**-1.2%**	199.0	199.0	198.2	-0.8	**-0.4%**	151.7	151.7	151.5	-0.2	**-0.2%**
Feb	53.1	53.1	52.2	-0.9	**-1.6%**	120.1	120.1	119.3	-0.9	**-0.7%**	651.2	651.2	650.9	-0.3	**0.0%**
Mar	55.7	55.7	54.9	-0.8	**-1.5%**	114.8	114.8	114.0	-0.8	**-0.7%**	230.4	230.4	230.2	-0.2	**-0.1%**
Apr	125.5	125.5	124.6	-0.8	**-0.7%**	116.3	116.3	115.4	-0.8	**-0.7%**	329.8	329.8	329.5	-0.3	**-0.1%**
May	224.0	224.0	224.0	0.0	**0.0%**	267.7	267.7	267.7	0.0	**0.0%**	673.8	673.8	668.3	-5.4	**-0.8%**
Jun	726.0	726.0	722.0	-4.0	**-0.6%**	814.3	814.3	810.2	-4.0	**-0.5%**	1343.5	1343.5	1336.7	-6.8	**-0.5%**
Jul	615.1	615.1	612.9	-2.2	**-0.4%**	620.6	620.6	618.4	-2.2	**-0.4%**	738.6	738.6	733.1	-5.5	**-0.7%**
Aug	187.0	187.0	187.0	0.0	**0.0%**	287.9	287.9	287.9	0.0	**0.0%**	395.1	395.1	390.5	-4.6	**-1.2%**
Sep	133.5	133.5	132.6	-0.8	**-0.6%**	174.2	174.2	173.4	-0.8	**-0.5%**	187.0	187.0	186.8	-0.3	**-0.1%**
Oct	110.9	110.9	110.1	-0.8	**-0.7%**	183.2	183.2	182.4	-0.8	**-0.4%**	329.1	329.1	328.8	-0.2	**-0.1%**
Nov	88.7	88.7	87.9	-0.8	**-0.9%**	159.8	159.8	158.9	-0.8	**-0.5%**	204.7	204.7	204.4	-0.3	**-0.1%**
Dec	75.5	75.5	74.7	-0.8	**-1.1%**	159.6	159.6	158.8	-0.8	**-0.5%**	145.3	145.3	145.0	-0.2	**-0.2%**

X > 10% decrease

5.4 Arkansas River at Parkdale, CO (ARKPARCO)

The Arkansas River at Parkdale (ARKPARCO) experiences negligible impacts due to the proposed action's rerouting of flow. Table 13 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in each year type. As shown, the overall maximum daily impact modeled at ARKPARCO is a 1.9% decrease in flow from baseline (in May of a wet year, 1983). The average modeled daily impact at ARKPARCO for the proposed action alternative for all year types is a 0.2% decrease in flow from baseline. In Appendix O, Figure 13 is a graph of the maximum daily impact (change in flow) modeled at ARKPARCO for the proposed action alternative from baseline conditions in each month for all dry years. Figure 14 is a graph of the maximum daily impact (change in flow) modeled at ARKPARCO for the proposed action alternative from baseline conditions in each month for all average years (Appendix O). Figure 15 is a graph of the maximum daily impact (change in flow) modeled at ARKPARCO for the proposed action alternative from baseline conditions in each month for all wet years (Appendix O).

Table 13 – Maximum daily impact modeled at ARKPARCO in each month for each year type

	Maximum Day of Dry Years (2002, 2003, 2004, 2005)					**Maximum Day of Average Years (1982, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1997, 1998, 1999, 2001, 2006, 2007, 2009)**					**Maximum Day of Wet Years (1983, 1984, 1985, 1995,2008)**				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	221.9	221.9	221.2	-0.8	**-0.3%**	299.5	299.5	298.9	-0.6	**-0.2%**	319.5	319.5	319.3	-0.2	**-0.1%**
Feb	218.5	218.5	217.7	-0.8	**-0.4%**	273.5	273.5	272.9	-0.6	**-0.2%**	324.5	324.5	324.2	-0.2	**-0.1%**
Mar	191.1	191.1	190.3	-0.8	**-0.4%**	263.6	263.6	263.0	-0.6	**-0.2%**	316.4	316.4	316.2	-0.2	**-0.1%**
Apr	235.4	235.4	234.6	-0.8	**-0.3%**	222.4	222.4	221.8	-0.6	**-0.3%**	303.3	303.3	303.0	-0.2	**-0.1%**
May	238.0	238.0	238.0	0.0	**0.0%**	284.6	284.6	283.4	-1.2	**-0.4%**	274.5	274.5	269.5	-5.1	**-1.9%**
Jun	358.9	358.9	355.1	-3.8	**-1.1%**	843.3	843.3	838.7	-4.5	**-0.5%**	1283.2	1283.2	1276.8	-6.4	**-0.5%**
Jul	229.0	229.0	227.0	-2.1	**-0.9%**	441.8	441.8	438.2	-3.5	**-0.8%**	1012.6	1012.6	1007.4	-5.2	**-0.5%**
Aug	236.0	236.0	236.0	0.0	**0.0%**	308.0	308.0	306.0	-2.1	**-0.7%**	467.1	467.1	462.9	-4.3	**-0.9%**
Sep	187.4	187.4	186.6	-0.8	**-0.4%**	288.4	288.4	287.8	-0.6	**-0.2%**	354.3	354.3	354.1	-0.2	**-0.1%**
Oct	118.9	118.9	118.1	-0.8	**-0.6%**	242.1	242.1	241.5	-0.6	**-0.2%**	336.3	336.3	336.1	-0.2	**-0.1%**
Nov	188.4	188.4	187.7	-0.8	**-0.4%**	334.7	334.7	334.1	-0.6	**-0.2%**	358.9	358.9	358.6	-0.2	**-0.1%**
Dec	226.0	226.0	225.2	-0.8	**-0.3%**	234.6	234.6	234.0	-0.6	**-0.2%**	340.6	340.6	340.4	-0.2	**-0.1%**

X > 10% decrease

Table 14 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in the representative year selected for each year type. In Appendix P, Figure 16 is a graph of the maximum daily impact (change in flow) modeled at ARKPARCO for the proposed action alternative from baseline conditions in each month of the representative dry year, 2003. Figure 17 is a graph of the maximum daily impact (change in flow) modeled at ARKPARCO for the proposed action alternative from baseline conditions in each month of the representative average year, 1998 (Appendix P). Figure 18 is a graph of the maximum daily impact (change in flow) modeled at ARKPARCO for the proposed action alternative from baseline conditions in each month of the representative wet year, 1985 (Appendix P).

Table 14 – Maximum daily impact modeled at ARKPARCO in each month for each representative year

	Maximum Day of a Representative Dry Year (2003, 11th Percentile)					Maximum Day of a Representative Average Year (1998, 50th Percentile)					Maximum Day of a Representative Wet Year (1985, 89th Percentile)				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	221.9	221.9	221.2	-0.8	**-0.3%**	433.9	433.9	433.3	-0.6	**-0.1%**	319.5	319.5	319.3	-0.2	**-0.1%**
Feb	218.5	218.5	217.7	-0.8	**-0.4%**	342.7	342.7	342.1	-0.6	**-0.2%**	660.5	660.5	660.2	-0.2	**0.0%**
Mar	191.1	191.1	190.3	-0.8	**-0.4%**	335.1	335.1	334.5	-0.6	**-0.2%**	316.4	316.4	316.2	-0.2	**-0.1%**
Apr	235.4	235.4	234.6	-0.8	**-0.3%**	289.4	289.4	288.8	-0.6	**-0.2%**	434.3	434.3	434.0	-0.2	**-0.1%**
May	238.0	238.0	238.0	0.0	**0.0%**	288.6	288.6	287.4	-1.2	**-0.4%**	840.5	840.5	835.5	-5.1	**-0.6%**
Jun	956.9	956.9	953.1	-3.8	**-0.4%**	1072.3	1072.3	1067.7	-4.5	**-0.4%**	2153.2	2153.2	2146.8	-6.4	**-0.3%**
Jul	745.0	745.0	743.0	-2.1	**-0.3%**	824.8	824.8	821.2	-3.5	**-0.4%**	1572.6	1572.6	1567.4	-5.2	**-0.3%**
Aug	345.0	345.0	345.0	0.0	**0.0%**	525.0	525.0	523.0	-2.1	**-0.4%**	520.1	520.1	515.9	-4.3	**-0.8%**
Sep	250.4	250.4	249.6	-0.8	**-0.3%**	320.4	320.4	319.8	-0.6	**-0.2%**	427.3	427.3	427.1	-0.2	**-0.1%**
Oct	118.9	118.9	118.1	-0.8	**-0.6%**	424.5	424.5	423.9	-0.6	**-0.1%**	521.4	521.4	521.2	-0.2	**0.0%**
Nov	188.4	188.4	187.7	-0.8	**-0.4%**	545.7	545.7	545.1	-0.6	**-0.1%**	444.9	444.9	444.6	-0.2	**-0.1%**
Dec	226.0	226.0	225.2	-0.8	**-0.3%**	447.1	447.1	446.6	-0.6	**-0.1%**	367.6	367.6	367.4	-0.2	**-0.1%**

X > 10% decrease

5.5 Arkansas River Above Pueblo, CO (ARKPUECO)

The Arkansas River above Pueblo (ARKPUECO) experiences negligible impacts due to the proposed action's rerouting of flow during average and wet years. However, between August 28th, 2002 and January 15th, 2003 (dry year type), there were extreme low flows recorded at ARKPUECO (under 2 cfs). This causes very small changes in flow (on the order of 0.4 cfs) due to the proposed re-routing to simulate very large impacts to flow in comparison to baseline (between 15% and 40%). This occurred on four days: one day in September of 2002, when baseline flows were 0.96 cfs and the flow reduction was 0.38 cfs (39.5%); two days in October of 2002, when baseline flows were 0.92 cfs and the flow reduction was 0.37 cfs (39.9%); and one days in February of 2005, when baseline flows were 2.59 cfs and the flow reduction was 0.39 cfs (15.1%). In terms of duration, these impacts occurred on only four days, over a 28 year period (10,277 days), or 0.04% of the total days modeled).

Table 15 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in each year type. The average modeled daily impact at ARKPUECO for the proposed action alternative for all year types is a 0.5% decrease in flow from baseline. In Appendix Q, Figure 19 is a graph of the maximum daily impact (change in flow) modeled at ARKPUECO for the proposed action alternative from baseline conditions in each month for all dry years. Figure 20 is a graph of the maximum daily impact (change in flow) modeled at ARKPUECO for the proposed action alternative from baseline conditions in each month for all average years (Appendix Q). Figure 21 is a graph of the maximum daily impact (change in flow) modeled at ARKPUECO for the proposed action alternative from baseline conditions in each month for all wet years (Appendix Q).

Table 15 – Maximum daily impact modeled at ARKPUECO in each month for each year type

	Maximum Day of Dry Years (2002, 2003, 2004, 2005)					Maximum Day of Average Years (1982, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1997, 1998, 1999, 2001, 2006, 2007, 2009)					Maximum Day of Wet Years (1983, 1984, 1985, 1995,2008)				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	8.7	8.7	8.3	-0.4	**-4.2%**	51	51	51	-0.3	**-0.5%**	71	71	71	-0.1	**-0.2%**
Feb	2.6	2.6	2.2	-0.4	**-15.1%**	21	21	21	-0.3	**-1.4%**	77	77	77	-0.1	**-0.2%**
Mar	16.4	16.4	16.0	-0.4	**-2.2%**	67	67	67	-0.3	**-0.4%**	82	82	82	-0.1	**-0.1%**
Apr	91.4	91.4	91.0	-0.4	**-0.4%**	34	34	34	-0.3	**-0.8%**	205	205	205	-0.1	**-0.1%**
May	37.0	37.0	37.0	0.0	**0.0%**	103	103	103	-0.4	**-0.4%**	318	318	316	-1.8	**-0.6%**
Jun	174.4	174.4	173.0	-1.4	**-0.8%**	583	583	581	-1.6	**-0.3%**	306	306	304	-2.2	**-0.7%**
Jul	47.7	47.7	47.0	-0.7	**-1.5%**	195	195	194	-1.3	**-0.6%**	1222	1222	1220	-1.8	**-0.1%**
Aug	0.6	0.6	0.6	0.0	**0.0%**	231	231	230	-0.7	**-0.3%**	292	292	291	-1.5	**-0.5%**
Sep	1.0	1.0	0.6	-0.4	**-39.5%**	57	57	57	-0.3	**-0.5%**	139	139	139	-0.1	**-0.1%**
Oct	0.9	0.9	0.6	-0.4	**-39.9%**	62	62	62	-0.3	**-0.4%**	169	169	169	-0.1	**-0.1%**
Nov	52.4	52.4	52.0	-0.4	**-0.7%**	54	54	54	-0.3	**-0.5%**	63	63	63	-0.1	**-0.2%**
Dec	72.4	72.4	72.0	-0.4	**-0.5%**	50	50	50	-0.3	**-0.6%**	54	54	54	-0.1	**-0.2%**

X > 10% decrease

Table 16 displays the maximum day's change in flow for the proposed action alternative from baseline conditions for each month in the representative year selected for each year type. In Appendix R, Figure 22 is a graph of the maximum daily impact (change in flow) modeled at ARKPUECO for the proposed action alternative from baseline conditions in each month of the representative dry year, 2003. Figure 23 is a graph of the maximum daily impact (change in flow) modeled at ARKPUECO for the proposed action alternative from baseline conditions in each month of the representative average year, 1998 (Appendix R). Figure 24 is a graph of the maximum daily impact (change in flow) modeled at ARKPUECO for the proposed action alternative from baseline conditions in each month of the representative wet year, 1985 (Appendix R).

Table 16 – Maximum daily impact modeled at ARKPUECO in each month for each representative year

	Maximum Day of a Representative Dry Year (2003, 11th Percentile)					Maximum Day of a Representative Average Year (1998, 50th Percentile)					Maximum Day of a Representative Wet Year (1985, 89th Percentile)				
	Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference		Baseline Condition	No Action	Proposed Action	Difference	
	cfs	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*	*cfs*	*cfs*	*cfs*	*cfs*	*%*
Jan	8.7	8.7	8.3	-0.4	**-4.2%**	51.3	51.3	51.0	-0.3	**-0.5%**	117.1	117.1	117.0	-0.1	**-0.1%**
Feb	20.4	20.4	20.0	-0.4	**-1.9%**	62.3	62.3	62.0	-0.3	**-0.5%**	655.1	655.1	655.0	-0.1	**0.0%**
Mar	27.4	27.4	27.0	-0.4	**-1.3%**	98.3	98.3	98.0	-0.3	**-0.3%**	535.1	535.1	535.0	-0.1	**0.0%**
Apr	91.4	91.4	91.0	-0.4	**-0.4%**	332.3	332.3	332.0	-0.3	**-0.1%**	770.1	770.1	770.0	-0.1	**0.0%**
May	37.0	37.0	37.0	0.0	**0.0%**	697.4	697.4	697.0	-0.4	**-0.1%**	905.8	905.8	904.0	-1.8	**-0.2%**
Jun	860.4	860.4	859.0	-1.4	**-0.2%**	683.6	683.6	682.0	-1.6	**-0.2%**	2022.2	2022.2	2020.0	-2.2	**-0.1%**
Jul	176.7	176.7	176.0	-0.7	**-0.4%**	788.3	788.3	787.0	-1.3	**-0.2%**	1521.8	1521.8	1520.0	-1.8	**-0.1%**
Aug	135.0	135.0	135.0	0.0	**0.0%**	398.7	398.7	398.0	-0.7	**-0.2%**	347.5	347.5	346.0	-1.5	**-0.4%**
Sep	40.4	40.4	40.0	-0.4	**-0.9%**	190.3	190.3	190.0	-0.3	**-0.2%**	296.1	296.1	296.0	-0.1	**0.0%**
Oct	0.9	0.9	0.6	-0.4	**-39.9%**	310.3	310.3	310.0	-0.3	**-0.1%**	570.1	570.1	570.0	-0.1	**0.0%**
Nov	82.4	82.4	82.0	-0.4	**-0.5%**	328.3	328.3	328.0	-0.3	**-0.1%**	93.1	93.1	93.0	-0.1	**-0.1%**
Dec	0.5	0.5	0.5	0.0	**0.0%**	50.3	50.3	50.0	-0.3	**-0.6%**	105.1	105.1	105.0	-0.1	**-0.1%**

X > 10% decrease

5.6 Pueblo Reservoir

Pueblo Reservoir experiences negligible impacts due to the proposed action's rerouting of flow, even under the scenario of a maximum delivery of 499 AF to Pueblo Reservoir in a single day. Table 17 displays the maximum daily change in reservoir surface area with the maximum addition of 499 AF to storage in a single day for each month in each year type. As shown, the overall maximum daily impact to surface area modeled is a 0.88% increase in surface area from baseline (in October and November of WY 1982 when the ACAP used was less refined than the modern ACAP relationship). The average modeled daily impact to surface area for all year types throughout the study period is a 0.2% increase in surface area from baseline.

Table 17 – Maximum daily impact to Pueblo Reservoir surface area modeled in each month for each year type when maximum delivery of 499 AF is added to the historical reservoir end-of-day-storage

	Maximum Day of Dry Years (2002, 2003, 2004, 2005)					Maximum Day of Average Years (1982, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1997, 1998, 1999, 2001, 2006, 2007, 2009)					Maximum Day of Wet Years (1983, 1984, 1985, 1995,2008)				
	Baseline Condition Acres	No Action Acres	Proposed Action Acres	Difference Acres	Difference %	Baseline Condition Acres	No Action Acres	Proposed Action Acres	Difference Acres	Difference %	Baseline Condition Acres	No Action Acres	Proposed Action Acres	Difference Acres	Difference %
Jan	2,403.9	2,403.9	2,412.6	8.74	**0.36%**	1,688.4	1,688.4	1,699.1	10.73	**0.64%**	2,917.0	2,917.0	2,924.3	7.26	**0.25%**
Feb	2,919.9	2,919.9	2,926.7	6.79	**0.23%**	2,262.1	2,262.1	2,271.4	9.34	**0.41%**	4,252.7	4,252.7	4,260.8	8.18	**0.19%**
Mar	3,089.8	3,089.8	3,096.6	6.74	**0.22%**	4,328.7	4,328.7	4,336.8	8.04	**0.19%**	4,406.2	4,406.2	4,414.1	7.90	**0.18%**
Apr	3,089.0	3,089.0	3,095.7	6.74	**0.22%**	4,242.2	4,242.2	4,250.4	8.20	**0.19%**	4,389.5	4,389.5	4,397.4	7.93	**0.18%**
May	2,451.6	2,451.6	2,460.1	8.57	**0.35%**	2,262.1	2,262.1	2,271.4	9.34	**0.41%**	4,240.8	4,240.8	4,249.0	8.21	**0.19%**
Jun	2,210.0	2,210.0	2,219.1	9.06	**0.41%**	2,262.1	2,262.1	2,271.4	9.34	**0.41%**	4,268.7	4,268.7	4,276.9	8.15	**0.19%**
Jul	2,167.8	2,167.8	2,177.0	9.23	**0.43%**	2,262.1	2,262.1	2,271.4	9.34	**0.41%**	4,243.6	4,243.6	4,251.8	8.20	**0.19%**
Aug	2,243.0	2,243.0	2,251.9	8.93	**0.40%**	2,277.2	2,277.2	2,286.0	8.88	**0.39%**	4,196.5	4,196.5	4,203.5	6.98	**0.17%**
Sep	2,218.1	2,218.1	2,227.1	9.03	**0.41%**	2,217.1	2,217.1	2,226.4	9.30	**0.42%**	4,553.5	4,553.5	4,561.1	7.64	**0.17%**
Oct	2,205.2	2,205.2	2,214.3	9.08	**0.41%**	1,352.6	1,352.6	1,364.5	11.9*	**0.88%**	2,034.9	2,034.9	2,043.7	8.78	**0.43%**
Nov	2,204.0	2,204.0	2,213.1	9.08	**0.41%**	1,352.6	1,352.6	1,364.5	11.9*	**0.88%**	2,262.1	2,262.1	2,271.4	9.34	**0.41%**
Dec	2,171.4	2,171.4	2,180.6	9.22	**0.42%**	1,688.4	1,688.4	1,699.1	10.73	**0.64%**	2,917.0	2,917.0	2,924.3	7.26	**0.25%**

X > 5% Increase   X > 10% Increase

* These maximums occurred in WY 1982 and were calculated with the 1964 ACAP, which has lesser resolution

Table 18 displays the maximum daily change in reservoir elevation with the maximum addition of 499 AF to storage in a single day for each month in each year type. As shown, the overall maximum daily impact to elevation modeled is a 0.52% increase in elevation from baseline (in October and November of WY 1982 when the ACAP used was less refined than the modern ACAP relationship). The average modeled daily impact to elevation for all year types throughout the study period is a 0.14% increase in elevation from baseline.

Table 18 - Maximum daily impact to Pueblo Reservoir elevation modeled in each month for each year type when maximum delivery of 499 AF is added to the historical reservoir end-of-day-storage

	Maximum Day of Dry Years (2002, 2003, 2004, 2005)					Maximum Day of Average Years (1982, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994, 1996, 1997, 1998, 1999, 2001, 2006, 2007, 2009)					Maximum Day of Wet Years (1983, 1984, 1985, 1995,2008)				
	Baseline Condition Ft	No Action Ft	Proposed Action Ft	Difference Ft	Difference %	Baseline Condition Ft	No Action Ft	Proposed Action Ft	Difference Ft	Difference %	Baseline Condition Ft	No Action Ft	Proposed Action Ft	Difference Ft	Difference %
Jan	78.1	78.1	78.3	0.21	**0.27%**	85.5	85.5	85.8	0.28	**0.33%**	97.1	97.1	97.3	0.17	**0.18%**
Feb	83.2	83.2	83.4	0.19	**0.23%**	95.3	95.3	95.5	0.24	**0.25%**	102.5	102.5	102.7	0.15	**0.15%**
Mar	86.2	86.2	86.4	0.18	**0.21%**	105.1	105.1	105.3	0.20	**0.19%**	107.5	107.5	107.6	0.14	**0.13%**
Apr	84.7	84.7	84.9	0.19	**0.22%**	105.1	105.1	105.3	0.20	**0.19%**	110.5	110.5	110.6	0.14	**0.12%**
May	79.2	79.2	79.4	0.20	**0.26%**	96.1	96.1	96.3	0.24	**0.25%**	111.0	111.0	111.1	0.13	**0.12%**
Jun	73.3	73.3	73.5	0.23	**0.31%**	96.1	96.1	96.3	0.24	**0.25%**	140.2	140.2	140.3	0.13	**0.09%**
Jul	69.9	69.9	70.1	0.24	**0.34%**	90.1	90.1	90.4	0.26	**0.28%**	117.0	117.0	117.1	0.13	**0.11%**
Aug	68.5	68.5	68.8	0.24	**0.35%**	90.1	90.1	90.4	0.26	**0.28%**	110.6	110.6	110.8	0.14	**0.12%**
Sep	67.8	67.8	68.1	0.25	**0.36%**	90.1	90.1	90.4	0.26	**0.28%**	108.4	108.4	108.5	0.14	**0.13%**
Oct	67.1	67.1	67.3	0.25	**0.37%**	73.8	73.8	74.2	0.38	**0.52%**	90.1	90.1	90.4	0.26	**0.28%**
Nov	67.2	67.2	67.5	0.25	**0.37%**	73.8	73.8	74.2	0.38	**0.52%**	96.1	96.1	96.3	0.24	**0.25%**
Dec	70.7	70.7	70.9	0.24	**0.33%**	75.0	75.0	75.4	0.34	**0.46%**	105.1	105.1	105.3	0.20	**0.19%**

X > 5% Increase   X > 10% Increase

6 CONCLUSIONS

Of the gages modeled (thirteen DWR & USGS gages and one synthetic gages), twelve experienced negligible impacts due to the proposed action alternative's rerouting of flow. For these twelve gages, the maximum impacts experience on any single day throughout the period of record was 3.3% (ARKGRNCO on May 3rd, 1983). On average, these twelve gages experienced an average daily 0.3% decrease in flow or less between the proposed action alternative and baseline conditions. Below is a summary analysis of the modeling results for the four primary gages (LAKBTLCO, ARKBGNCO, ARKPARCO, and ARKPUECO) and Pueblo Reservoir.

Lake Creek below Twin Lakes Reservoir (LAKBTLCO) - Lake Creek below Twin Lakes Reservoir (LAKBTLCO) experiences minor impacts due to the proposed action's rerouting of flow. The largest single maximum daily impact modeled at ARKBGNCO is a 41.1% decrease in flow from baseline (December 13th, 1985). There are a total of three days in December when the maximum daily flow decrease exceeded 10%. In terms of duration, these impacts occurred on only three days, over a 28 year period (10,277 days), or 0.03% of the total days modeled.

Arkansas River below Granite (ARKBGNCO) - The Arkansas River below Granite experiences negligible impacts due to the Proposed Action's rerouting of flow. The largest single maximum daily impact modeled at ARKBGNCO is a 2.5% decrease in flow from baseline (May 3rd, 1983). During the 28 year period there are no days when the maximum daily flow decrease exceeded 10%.

Arkansas River at Parkdale (ARKPARCO) - The Arkansas River at Parkdale (ARKPARCO) experiences negligible impacts due to the proposed action's rerouting of flow. The maximum daily impact modeled at ARKPARCO is a 1.9% decrease in flow from baseline (May 8th, 1983). During the 28 year period there are no days when the maximum daily flow decrease exceeded 10%.

Arkansas River above Pueblo (ARKPUECO) - The Arkansas River above Pueblo (ARKPUECO) experiences negligible impacts due to the proposed action's rerouting of flow during average and wet years. The maximum daily impact modeled at ARKPUECO is a 39.9% decrease in flow from baseline (October 1st, 1985). There were four total days in September and October of 2002 and in February 2005 when the maximum daily flow decrease exceeded 10%. In terms of duration, these impacts occurred on only four days, over a 28 year period (10,277 days), or 0.04% of the total days modeled).

Pueblo Reservoir - Pueblo Reservoir also experiences negligible impacts to reservoir surface area and elevation due to the proposed action's rerouting of flow, even under the scenario of a maximum 499 AF delivery to storage in a single day. The maximum daily impact to reservoir surface area was 0.88% (11.9 acres) and the maximum daily impact to reservoir elevation was 0.52% (0.38 ft). The average daily impact to reservoir surface area was a 0.2% increase and the average daily impact to reservoir elevation was a 0.14% increase. Again, this is for the scenario of maximum delivery, so actual operational impacts will be much smaller since typical operational deliveries will only be a portion of the maximum 499 AF delivery.

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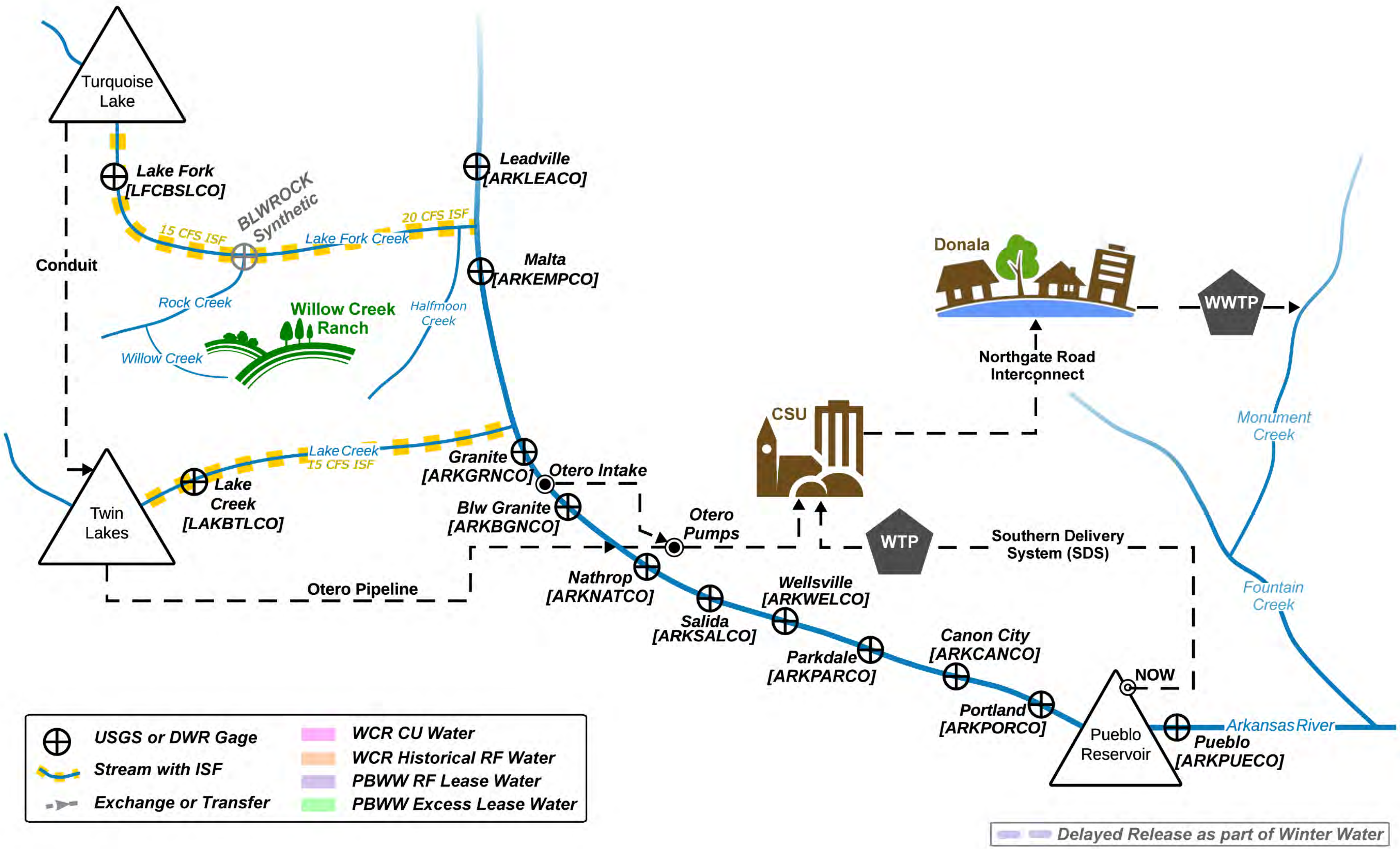
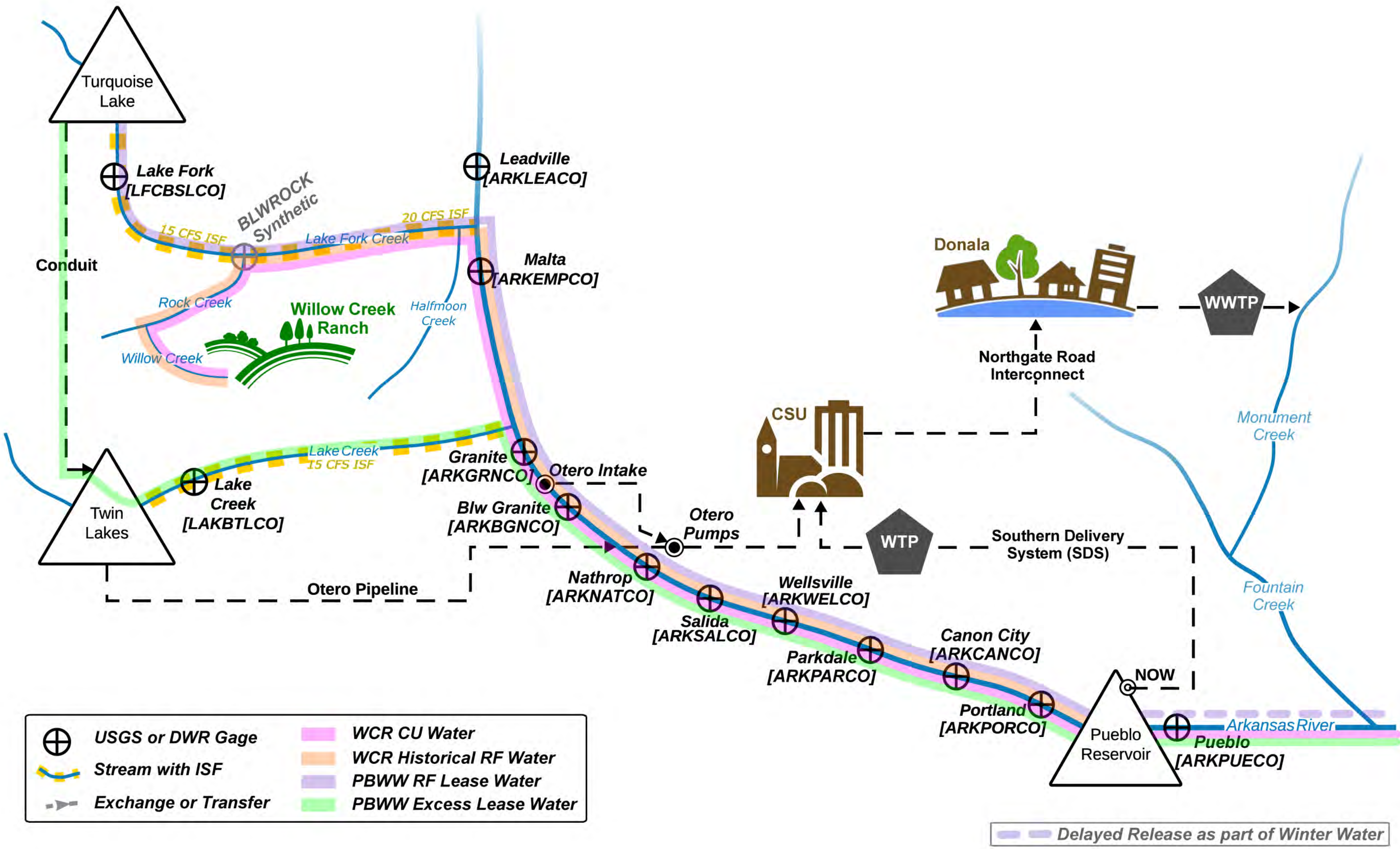
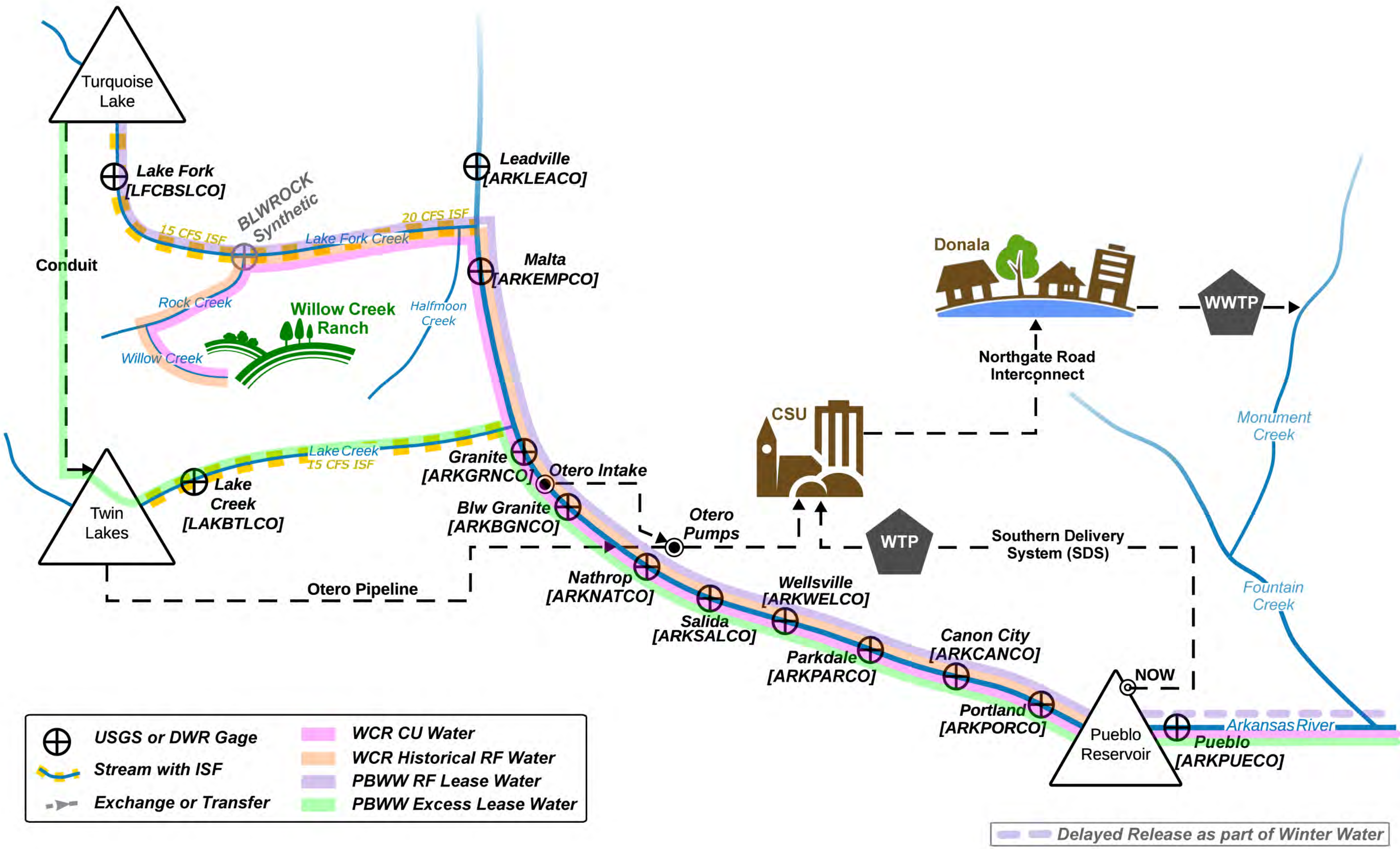
APPENDIX A SYSTEM SCHEMATIC



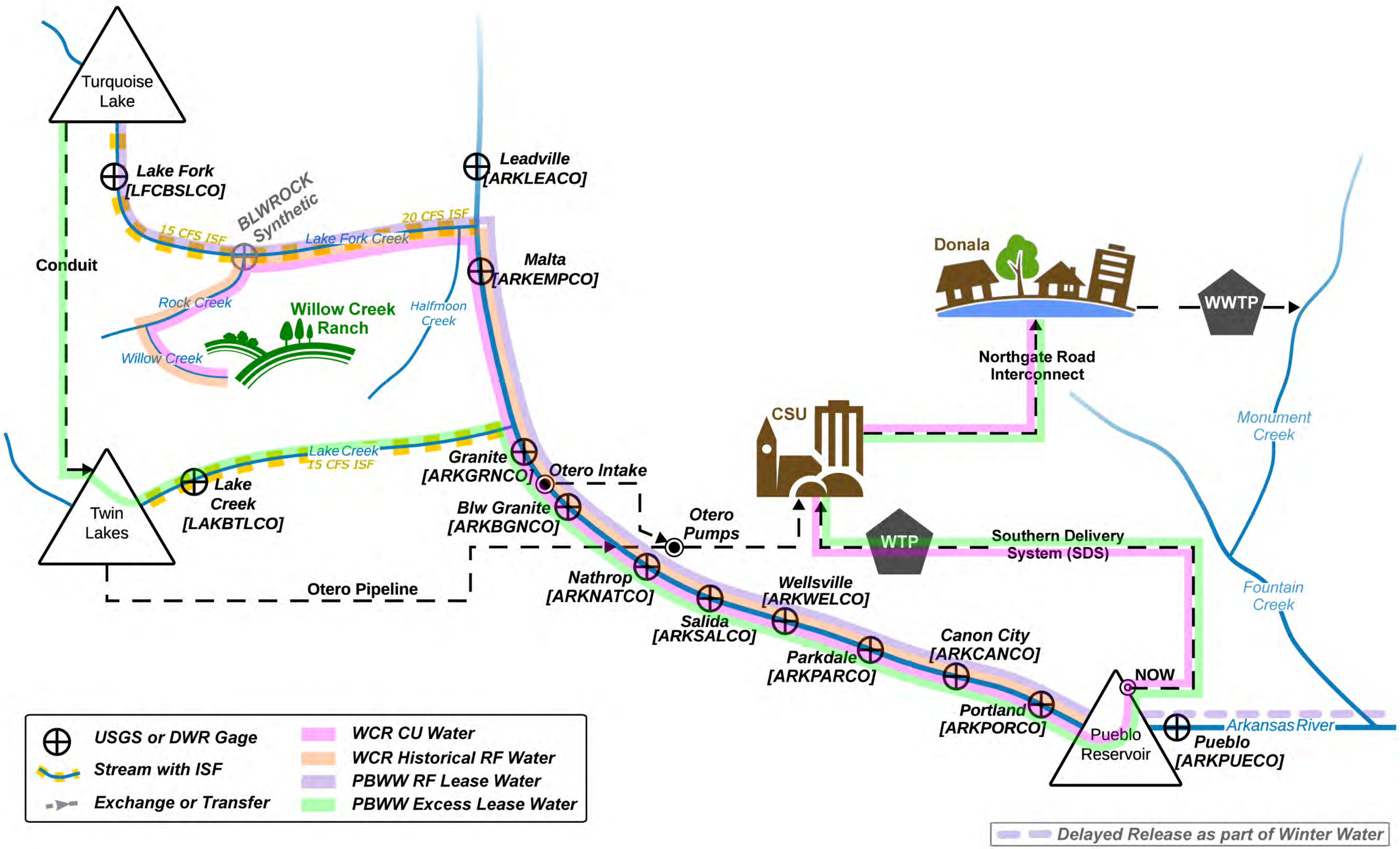
APPENDIX B BASELINE EXISTING CONDITIONS SCHEMATIC



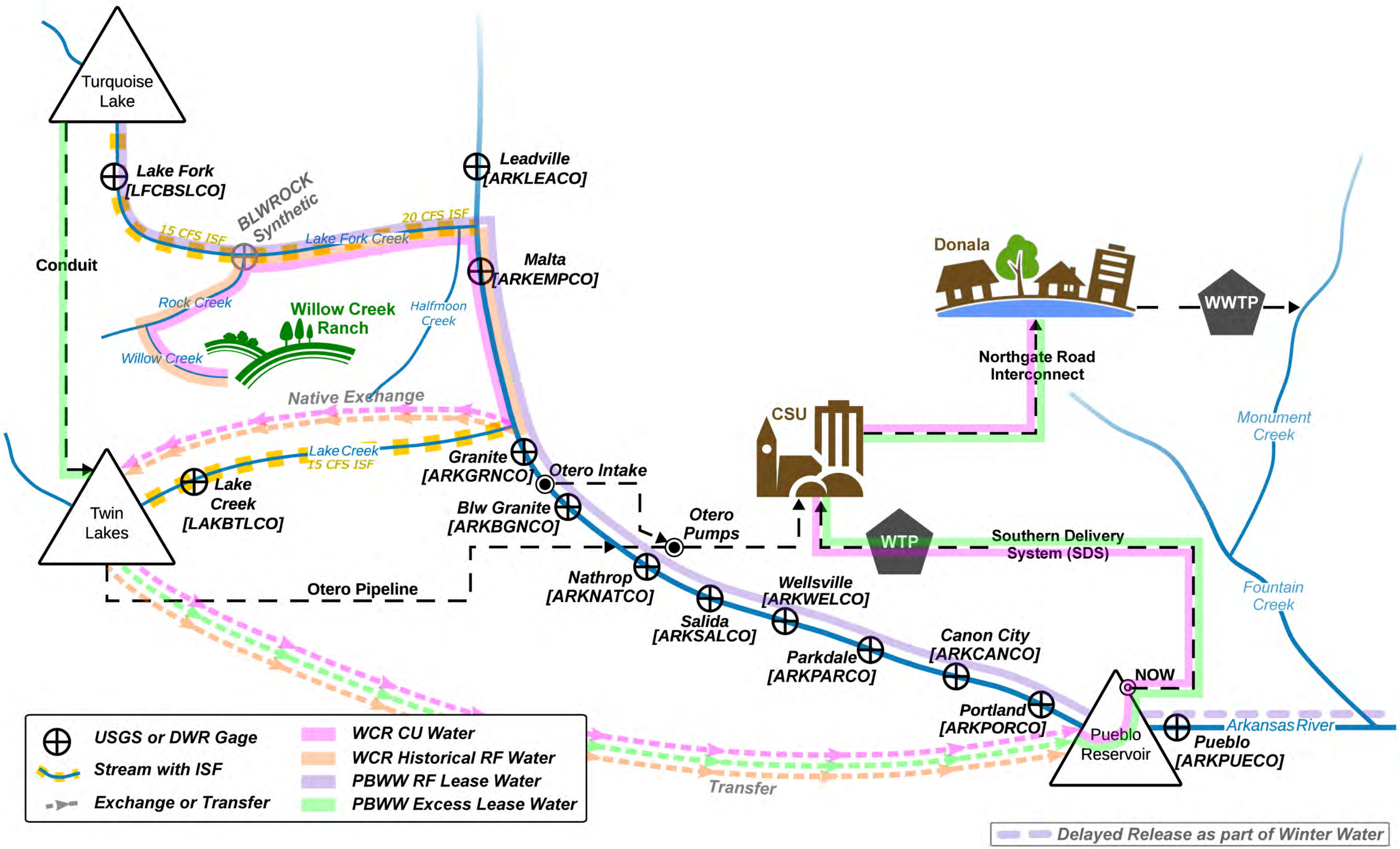
APPENDIX C NO ACTION ALTERNATIVE SCHEMATIC



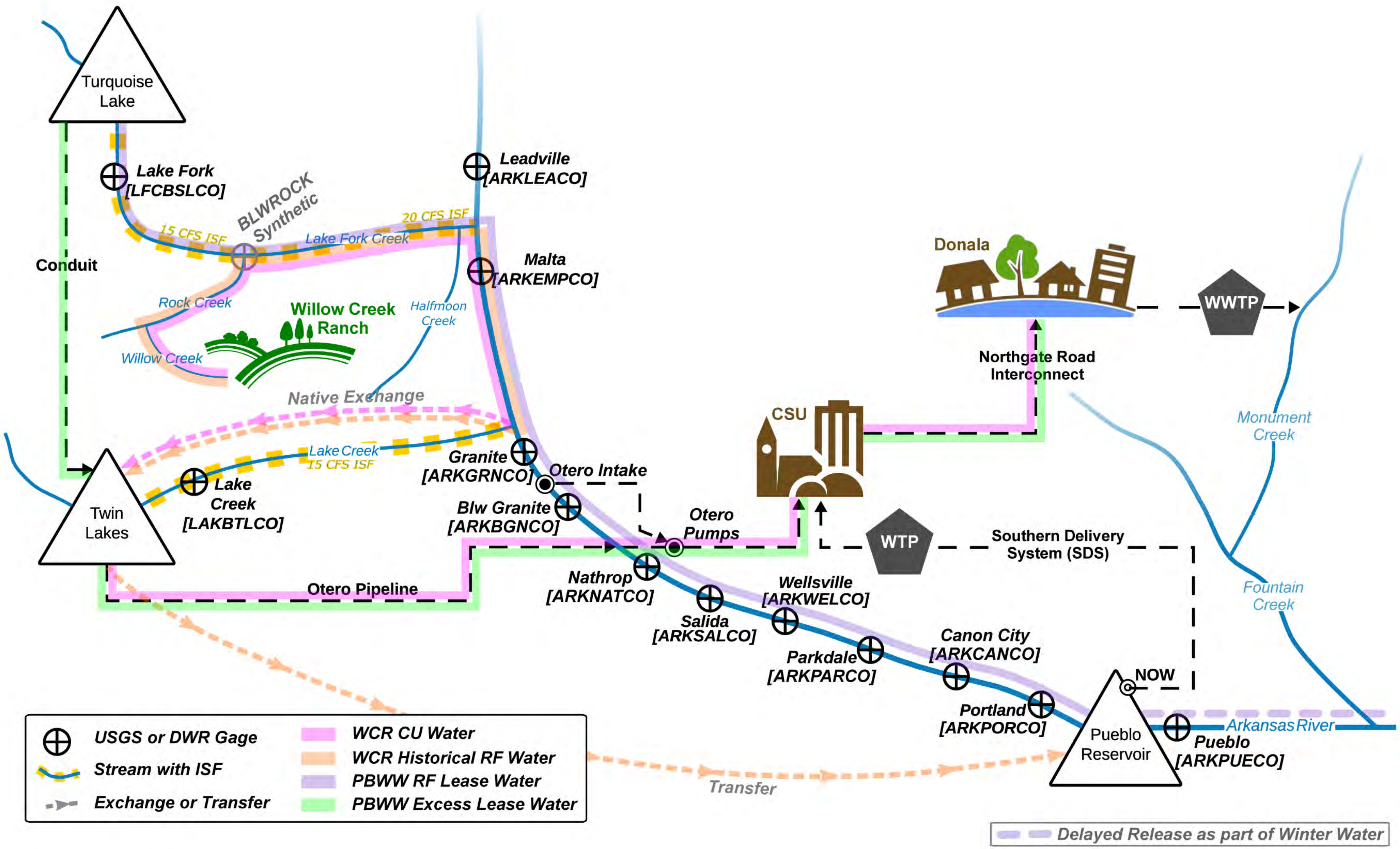
APPENDIX D PROPOSED ALTERNATIVE *OPERATIONAL SCENARIO A* SCHEMATIC



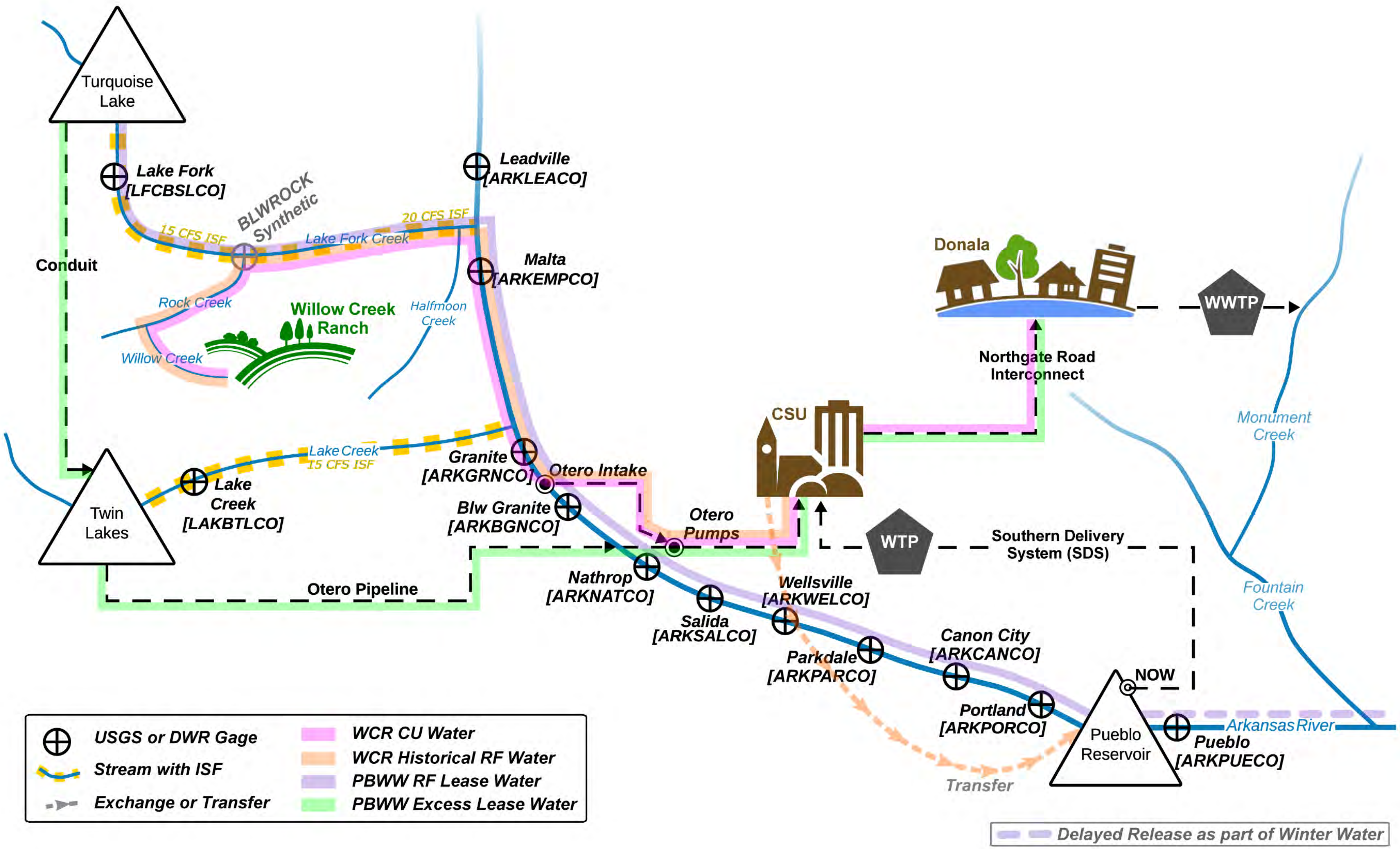
APPENDIX E PROPOSED ALTERNATIVE *OPERATIONAL SCENARIO B* SCHEMATIC



APPENDIX F PROPOSED ALTERNATIVE *OPERATIONAL SCENARIO C* SCHEMATIC



APPENDIX G PROPOSED ALTERNATIVE *OPERATIONAL SCENARIO D* SCHEMATIC



APPENDIX H TSTOOL COMMAND FILES

TSTool Command File (WCR_Streamflows_AppendixH.TSTool) Used to compile, review, and fill streamflow

```
SetInputPeriod(InputStart="10/01/1981",InputEnd="09/30/2009")
SetOutputYearType(OutputYearType=Water)
#---------------------------------------------------------------------------------
------------------------------------------
# 07082500 - LAKE FORK CREEK BELOW SUGAR LOAF DAM NEAR LEADVILLE
07082500.DWR.Streamflow.Day~HydroBase
# 07082500 - LAKE FORK CREEK BELOW SUGAR LOAF DAM NEAR LEADVILLE
07082500.DWR.AdminFlow.Day~ColoradoWaterHBGuest
FillFromTS(TSList=AllMatchingTSID,TSID="07082500.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="07082500.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="07082500.DWR.AdminFlow.Day")
FillInterpolate(TSList=AllMatchingTSID,TSID="07082500.DWR.Streamflow.Day",MaxInter
vals=5)
#---------------------------------------------------------------------------------
------------------------------------------
Halfmoon...DAY~StateMod~Halfmoon_Filled.stm
#---------------------------------------------------------------------------------
------------------------------------------
# 07083000 - HALFMOON CREEK NEAR MALTA, CO
07083000.USGS.Streamflow.Day~HydroBase
# Read USBR Halfmoon Diversion Records and Subtract from Halfmoon Creek Nr Malta
Subtract(TSID="07083000.USGS.Streamflow.Day",SubtractTSList=AllMatchingTSID,Subtra
ctTSID="Halfmoon...DAY",HandleMissingHow="IgnoreMissing")
ReplaceValue(TSList=AllMatchingTSID,TSID="07083000.USGS.Streamflow.Day",MinValue=-
10000000,MaxValue=0,NewValue=0)
#---------------------------------------------------------------------------------
------------------------------------------
# 07083200 - HALFMOON CR BL HALFMOON DIVERSION NR LEADVILLE, CO
07083200.USGS.Streamflow.Day~HydroBase
# Fill Halfmoon Creek Blw Halfmoon Diversion with Calculated Halfmoon Creek Nr
Malta
FillRegression(TSID="07083200.USGS.Streamflow.Day",IndependentTSID="07083000.USGS.
Streamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
FillRegression(TSID="07083200.USGS.Streamflow.Day",IndependentTSID="07083000.USGS.
Streamflow.Day",NumberOfEquations=OneEquation,Intercept=0)
FillFromTS(TSList=AllMatchingTSID,TSID="07083200.USGS.Streamflow.Day",IndependentT
SList=AllMatchingTSID,IndependentTSID="07083000.USGS.Streamflow.Day")
Free(TSList=AllMatchingTSID,TSID="Halfmoon...DAY")
Free(TSList=AllMatchingTSID,TSID="07083000.USGS.Streamflow.Day")
#---------------------------------------------------------------------------------
------------------------------------------
```

```
# Salida Regression R2 = 0.81, Salida used as Wet/Dry/Avg Basis for the model and
provides good correlations to Alta and Leadville Gages
# 07091500 - ARKANSAS RIVER AT SALIDA, CO.
07091500.DWR.Streamflow.Day~HydroBase
#---------------------------------------------------------------------------------
-------------------------------------------
# 07081200 - ARKANSAS RIVER NEAR LEADVILLE, CO
07081200.USGS.Streamflow.Day~HydroBase
FillRegression(TSID="07081200.USGS.Streamflow.Day",IndependentTSID="07091500.DWR.S
treamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
#---------------------------------------------------------------------------------
-------------------------------------------
# 07083710 - ARKANSAS RIVER BELOW EMPIRE GULCH NEAR MALTA, CO
07083710.USGS.Streamflow.Day~HydroBase
# 07083700 - ARKANSAS RIVER NEAR MALTA, CO.
07083700.USGS.Streamflow.Day~HydroBase
FillFromTS(TSList=AllMatchingTSID,TSID="07083710.USGS.Streamflow.Day",IndependentT
SList=AllMatchingTSID,IndependentTSID="07083700.USGS.Streamflow.Day")
Free(TSList=AllMatchingTSID,TSID="07083700.USGS.Streamflow.Day")
FillRegression(TSID="07083710.USGS.Streamflow.Day",IndependentTSID="07091500.DWR.S
treamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
Free(TSList=AllMatchingTSID,TSID="07091500.DWR.Streamflow.Day")
#---------------------------------------------------------------------------------
-------------------------------------------
# Calculate Flows at Confluence with Rock Creek and Mouth of Lake Fork Creek
Copy(TSID="07083710.USGS.Streamflow.Day",NewTSID="Total_G_L.CALCULATED.GAIN_LOSS.D
ay",Alias="%L")
Subtract(TSID="Total_G_L",SubtractTSList=SpecifiedTSID,SubtractTSID="07081200.USGS
.Streamflow.Day,07082500.DWR.Streamflow.Day,07083200.USGS.Streamflow.Day",HandleMi
ssingHow="IgnoreMissing")
Copy(TSID="Total_G_L",NewTSID="LK_FK_TOTAL.CALCULATED.GAIN_LOSS.Day",Alias="%L")
Scale(TSList=AllMatchingTSID,TSID="LK_FK_TOTAL",ScaleValue=0.4060)
Copy(TSID="LK_FK_TOTAL",NewTSID="BLW_ROCK_CRK.CALCULATED.GAIN_LOSS.Day",Alias="%L"
)
Scale(TSList=AllMatchingTSID,TSID="LK_FK_TOTAL",ScaleValue=0.9314)
Free(TSList=AllMatchingTSID,TSID="Total_G_L")
ReplaceValue(TSList=AllMatchingTSID,TSID="BLW_ROCK_CRK",MinValue=-
111111111111111111,MaxValue=0,NewValue=0)
Free(TSList=AllMatchingTSID,TSID="LK_FK_TOTAL")
Add(TSID="BLW_ROCK_CRK",AddTSList=AllMatchingTSID,AddTSID="07082500.DWR.Streamflow
.Day",HandleMissingHow="IgnoreMissing")
Free(TSList=AllMatchingTSID,TSID="07083200.USGS.Streamflow.Day")
#---------------------------------------------------------------------------------
-------------------------------------------
# LAKBTLCO - LAKE CREEK BELOW TWIN LAKES RESERVOIR
LAKBTLCO.DWR.Streamflow.Day~HydroBase
# LAKBTLCO - LAKE CREEK BELOW TWIN LAKES RESERVOIR
LAKBTLCO.DWR.AdminFlow.Day~ColoradoWaterHBGuest
```

```
FillFromTS(TSList=AllMatchingTSID,TSID="LAKBTLCO.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="LAKBTLCO.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="LAKBTLCO.DWR.AdminFlow.Day")
#---------------------------------------------------------------------------------
-------------------------------------------
# 07086000 - ARKANSAS RIVER AT GRANITE, CO.
07086000.DWR.Streamflow.Day~HydroBase
# 07086000 - ARKANSAS RIVER AT GRANITE, CO.
07086000.DWR.AdminFlow.Day~ColoradoWaterHBGuest
FillFromTS(TSList=AllMatchingTSID,TSID="07086000.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="07086000.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="07086000.DWR.AdminFlow.Day")
FillRegression(TSID="LAKBTLCO.DWR.Streamflow.Day",IndependentTSID="07086000.DWR.St
reamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
#---------------------------------------------------------------------------------
-------------------------------------------
# 07087050 - ARKANSAS RIVER BELOW GRANITE, CO
07087050.USGS.Streamflow.Day~HydroBase
FillRegression(TSID="07087050.USGS.Streamflow.Day",IndependentTSID="07086000.DWR.S
treamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
FillRegression(TSID="07087050.USGS.Streamflow.Day",IndependentTSID="07086000.DWR.S
treamflow.Day",NumberOfEquations=OneEquation,Intercept=0)
#---------------------------------------------------------------------------------
-------------------------------------------
# 07091200 - ARKANSAS RIVER NEAR NATHROP, CO
07091200.USGS.Streamflow.Day~HydroBase
#---------------------------------------------------------------------------------
-------------------------------------------
# 07091500 - ARKANSAS RIVER AT SALIDA, CO.
07091500.DWR.Streamflow.Day~HydroBase
# 07091500 - ARKANSAS RIVER AT SALIDA, CO.
07091500.DWR.AdminFlow.Day~ColoradoWaterHBGuest
FillFromTS(TSList=AllMatchingTSID,TSID="07091500.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="07091500.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="07091500.DWR.AdminFlow.Day")
FillRegression(TSID="07091200.USGS.Streamflow.Day",IndependentTSID="07091500.DWR.S
treamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
FillRegression(TSID="07091200.USGS.Streamflow.Day",IndependentTSID="07091500.DWR.S
treamflow.Day",NumberOfEquations=OneEquation,Intercept=0)
#---------------------------------------------------------------------------------
-------------------------------------------
# 07093700 - ARKANSAS RIVER NEAR WELLSVILLE, CO.
07093700.DWR.Streamflow.Day~HydroBase
# 07093700 - ARKANSAS RIVER NEAR WELLSVILLE, CO.
07093700.DWR.AdminFlow.Day~ColoradoWaterHBGuest
SetConstant(TSList=AllMatchingTSID,TSID="07093700.DWR.AdminFlow.Day",ConstantValue
=-999.0,SetStart="11/29/2014",SetEnd="11/30/2014")
```

```
FillFromTS(TSList=AllMatchingTSID,TSID="07093700.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="07093700.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="07093700.DWR.AdminFlow.Day")
FillRegression(TSID="07093700.DWR.Streamflow.Day",IndependentTSID="07091500.DWR.St
reamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
#--------------------------------------------------------------------------------
-------------------------------------------
# 07094500 - ARKANSAS RIVER AT PARKDALE, CO.
07094500.USGS.Streamflow.Day~HydroBase
#--------------------------------------------------------------------------------
-------------------------------------------
# 07096000 - ARKANSAS RIVER AT CANON CITY
07096000.DWR.Streamflow.Day~HydroBase
# 07096000 - ARKANSAS RIVER AT CANON CITY
07096000.DWR.AdminFlow.Day~ColoradoWaterHBGuest
FillFromTS(TSList=AllMatchingTSID,TSID="07096000.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="07096000.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="07096000.DWR.AdminFlow.Day")
#--------------------------------------------------------------------------------
-------------------------------------------
# 07097000 - ARKANSAS RIVER AT PORTLAND, CO.
07097000.DWR.Streamflow.Day~HydroBase
# 07097000 - ARKANSAS RIVER AT PORTLAND, CO.
07097000.DWR.AdminFlow.Day~ColoradoWaterHBGuest
FillFromTS(TSList=AllMatchingTSID,TSID="07097000.DWR.Streamflow.Day",IndependentTS
List=AllMatchingTSID,IndependentTSID="07097000.DWR.AdminFlow.Day")
Free(TSList=AllMatchingTSID,TSID="07097000.DWR.AdminFlow.Day")
#--------------------------------------------------------------------------------
-------------------------------------------
FillRegression(TSID="07096000.DWR.Streamflow.Day",IndependentTSID="07097000.DWR.St
reamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
FillRegression(TSID="07094500.USGS.Streamflow.Day",IndependentTSID="07096000.DWR.S
treamflow.Day",NumberOfEquations=MonthlyEquations,Intercept=0)
#--------------------------------------------------------------------------------
-------------------------------------------
# 07099400 - ARKANSAS RIVER ABOVE PUEBLO, CO
07099400.DWR.Streamflow.Day~HydroBase
#--------------------------------------------------------------------------------
-------------------------------------------
WriteDelimitedFile(TSList=AllTS,OutputFile="USGS_Streamflows.csv")
```

APPENDIX I STREAMFLOW DATA FILLING SUMMARY

ARKLEACO - ARKANSAS RIVER NEAR LEADVILLE, CO

- Filled with regression from 10/01/1983 to 05/01/1990 using Colorado Division of Water Resources gage ARKSALCO - ARKANSAS RIVER AT SALIDA, CO (R^2 = 0.81)

LFCBSLCO - LAKE FORK CREEK BELOW SUGAR LOAF DAM NEAR LEADVILLE

- Filled 10/01/1990 to 09/30/1991 with Colorado Division of Water Resources Administrative Records
- 06/08/1991 and 06/09/1991 filled with linear interpolation from 06/07/1991 to 06/10/1991

ARKEMPCO - ARKANSAS RIVER BELOW EMPIRE GULCH NEAR MALTA, CO

- Filled 10/01/1981 to 09/30/1984 with USGS gage 07083700 - ARKANSAS RIVER NEAR MALTA, CO
- Filled with regression from 10/01/1984 to 06/01/1990, 10/01/1993 to 04/30/2004, and 10/01 to 04/30 of water years 2005 through 2009 using Colorado Division of Water Resources gage ARKSALCO - ARKANSAS RIVER AT SALIDA, CO (R2 = 0.89)

LAKBTLCO - LAKE CREEK BELOW TWIN LAKES RESERVOIR

- Filled 10/01/1990 to 09/30/1992 with Colorado Division of Water Resources Administrative Records.
- Filled with regression from 10/01/1984 to 09/30/1985, 06/08-06/09 1991, 12/29/1991, and 2/28-2/29 1992 using Colorado Division of Water Resources gage ARKGRNCO - ARKANSAS RIVER AT GRANITE, CO (R2 = 0.91)

ARKGRNCO - ARKANSAS RIVER AT GRANITE, CO

- No data filling required

ARKBGNCO - ARKANSAS RIVER BELOW GRANITE, CO

- Filled with regression from 10/01/1981 to 03/31/1999, and 10/01 to 3/31 for water years 2000 through 2009 using Colorado Division of Water Resources gage ARKGRNCO - ARKANSAS RIVER AT GRANITE, CO (R2 = 0.98)

ARKNATCO - ARKANSAS RIVER NEAR NATHROP, CO

- Filled with regression from 10/01/1982 to 05/01/1989, and 11/01 to 03/31 for water years 1994 through 2009 using Colorado Division of Water Resources gage ARKSALCO - ARKANSAS RIVER AT SALIDA, CO (R2 = 0.99)

ARKWELCO - ARKANSAS RIVER NEAR WELLSVILLE, CO

- Filled with regression from 09/01/1989 to 09/30/1989 using Colorado Division of Water Resources gage ARKSALCO - ARKANSAS RIVER AT SALIDA, CO (R2 = 0.99)

ARKPARCO - ARKANSAS RIVER AT PARKDALE, CO

- Filled with regression from 10/01 to 03/31 for water years 1995 through 2009 using Colorado Division of Water Resources gage ARKCANCO - Arkansas River at Canon City, CO (R2 = 0.98)

ARKCANCO - Arkansas River at Canon City, CO

- No data filling required

ARKPORCO - Arkansas River near Portland, CO

- No data filling required

ARKPUECO - Arkansas River above Pueblo, CO

- No data filling required

APPENDIX J PUEBLO RESERVOIR AREA-CAPACITY DATA

1963 Area Capacity Curve Data for Pueblo Reservoir

Provided by the Bureau of Reclamation

Adopted water year 1963 (10/01/1962) through water year 1985 (09/30/1985)

PUEBLO RESERVOIR
Area - Capacity Data

Elev. ft.	Area Acres	Capacity A.F.	Elev. ft.	Area Acres	Capacity A.F.
4725 a/	0	0	4830	2427	90545
4730	1	2	4835	2598	103124
4735	2	8	4840	2743	116479
4740	2	18	4845	2915	130608
4745	9	36	4850	3135	145721
4750	66	203	4855	3369	161981
4755	178	800	4860	3597	179399
4760	302	1996	4865	3826	197953
4765	440	3860	4870	4070	217679
4770	530	6291	4875	4365	238767
4775	649	9228	4880	4618	261237
4780	788	12818	4885	4856	284920
4785	930	17114	4890	5131	309879
4790	1075	22126	4895	5431	336274
4795	1232	27893	4900	5767	364252
4800	1388	34447	4905	6162	394066
4805	1528	41737	4910	6540	425809
4810	1681	49752	4915	7005	459654
4815	1872	58635	4920	7481	495853
4820	2024	68376	4925	8027	534583
4825	2210	78950			

EXPLANATION

Coordinates for Assumed Vertical Plane, Dam Axis:

	Left Abut.	PI	Right Abut.
Northing	588,425	585,460	578,415
Easting	2,221,045	2,222,815	2,222,495

Source of Data: Pueblo Reservoir Topography, Scale 1" = 400', Drawing 382-706-1032 through 382-706-1051, by International Aerial Mapping Company, Invitation No. DS-6005, Contract No. 14-06-D-5009, Schedule III. Streambed elevation at dam axis by U. S. Bureau of Reclamation, July 31, 1964.

This Drawing supersedes Drawing No. 382-706-320.

a/ Approximate streambed elevation at dam axis.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
FRYINGPAN-ARKANSAS PROJECT-COLORADO

PUEBLO RESERVOIR
AREA-CAPACITY DATA

DRAWN PHO SUBMITTED [signature]
TRACED WCB RECOMMENDED [signature]
CHECKED GJS APPROVED [signature]

PUEBLO, COLORADO JAN 13, 1965 382-706-1649

1984 Area Capacity Curve Data for Pueblo Reservoir

Provided by the Bureau of Reclamation

Adopted water year 1986 (10/01/1985) through water year 1994 (09/30/1994)

United States Department of the Interior

BUREAU OF RECLAMATION
REGIONAL OFFICE, LOWER MISSOURI REGION
BUILDING 20, DENVER FEDERAL CENTER
P.O. BOX 25247
DENVER, COLORADO 80225

IN REPLY REFER TO: LM-730
511.

MAY 10 1984

Memorandum

To: Project Manager, Pueblo, Colorado

From: Regional Planning Officer

Subject: Area-Capacity Tables and Equations - Fryingpan-Arkansas Project

Enclosed for your information and use are the equations you requested in your memorandum of March 13, 1984. These mathematical equations relate elevation to capacity for each control elevation in the reservoirs of the Fryingpan-Arkansas Project. The form of the equation is as follows:

$$X_c = A1 + A2(Y) + A3(Y^2) \qquad (1)$$

where: X_c = Capacity in acre-feet
Y - Elevation - elevation base
$A1$ = Intercept
$A2$ = Coefficient first term
$A3$ = Coefficient second term

Taking the first differential of the capacity curve equation:

$$dx = (A2)dy + 2(A3)(Y)dy$$

The area equation then becomes:

$$X_A = A2 + 2(A3)(Y) \qquad (2)$$

where: X_A = Area in acres
$A2$ = Coefficient first term
$A3$ = Coefficient second term
Y = Elevation - elevation base

For example, using equation No. 30 for Ruedi Reservoir at elevation 7674:

where: $Y = (7674 - 7670) = 4$

$Y^2 = 4^2 = 16$

then: $X_C = 32348.5 + 499.0(4) + 1.9(16)$

$= 34374.9$ acre-feet

Then using equation No. 2:

where: $Y = (7674 - 7670) = 4$

then: $X_A = 499.0 = 2(1.9)(4)$

$= 514$ acres

In order to generate the equations, it was necessary to recreate area-capacity tables for Ruedi Reservoir, Turquoise Lake, Mt. Elbert Forebay, Twin Lakes Reservoir, and Pueblo Reservoir. This was done using the least-squares fitting technique where a second-degree polynomial is fitted to as many points as permitted by the error term epsilon. To accomplish this interpolation, a number of discontinuous second-degree polynomials have been created.

We have compared the capacity information generated from these equations with the present in-use capacity data. Changes in computational procedures have caused slight differences.

A preliminary copy of the new area-capacity tables for each reservoir have been included. When finalized, Ruedi Reservoir, Turquoise Lake, and Mt. Elbert Forebay will be published and copies will be sent to you.

If you need further explanation, please contact Dave Kutner at FTS 234-4418.

William J Steele

Enclosures

PUEBLO RESERVOIR
FRYINGPAN-ARKANSAS PROJECT

EQUATION NUMBER	ELEVATION BASE	CAPACITY BASE	COEFFICIENT A1(INTERCEPT)	COEFFICIENT A2(1ST TERM)	COEFFICIENT A3(2ND TERM)
1	4725.00	0	.0000	-.0000	.1000
2	4735.00	9	10.0000	2.0000	.0000
3	4740.00	19	20.0000	2.0000	1.3000
4	4745.00	62	62.5000	15.0000	6.3000
5	4750.00	294	295.0000	78.0000	12.1000
6	4755.00	987	987.5000	199.0000	11.9000
7	4760.00	2279	2280.0000	318.0000	12.9000
8	4765.00	4192	4192.5000	447.0000	2.7000
9	4770.00	6494	6495.0000	474.0000	22.1000
10	4775.00	9417	9417.5000	695.0000	11.8000
11	4780.00	13187	13187.5000	813.0000	12.1000
12	4785.00	17554	17555.0000	934.0000	13.1000
13	4790.00	22552	22552.5000	1065.0000	16.3000
14	4795.00	28284	28285.0000	1228.0000	15.9000
15	4800.00	34822	34822.5000	1387.0000	14.5000
16	4805.00	42119	42120.0000	1532.0000	15.7000
17	4810.00	50172	50172.5000	1689.0000	19.3000
18	4815.00	59099	59100.0000	1882.0000	15.0000
19	4820.00	68884	68885.0000	2032.0000	20.7000
20	4825.00	79562	79562.5000	2239.0000	20.3000
21	4830.00	91264	91265.0000	2442.0000	19.4000
22	4835.00	103959	103960.0000	2636.0000	13.6000
23	4840.00	117479	117480.0000	2772.0000	15.3000
24	4845.00	131722	131722.5000	2925.0000	20.6000
25	4850.00	146862	146861.5903	3131.9319	22.8500
26	4860.00	180464	180465.0000	3588.0000	24.8000
27	4865.00	199024	199024.9999	3836.0000	23.4000
28	4870.00	218789	218789.9999	4070.0000	28.8000
29	4875.00	239859	239859.9999	4358.0000	25.8000
30	4880.00	262294	262294.9999	4616.0000	23.7000
31	4885.00	285967	285967.4999	4853.0000	27.4000
32	4890.00	310917	310917.4999	5127.0000	29.7000
33	4895.00	337294	337294.9999	5424.0000	33.4000
34	4900.00	365249	365249.9999	5758.0000	39.6000
35	4905.00	395029	395029.9999	6154.0000	37.8000
36	4910.00	426744	426748.3353	6528.5829	47.1500
37	4920.00	496752	496752.4999	7475.0000	55.2000

1993 Area Capacity Curve Data for Pueblo Reservoir

Provided by the Bureau of Reclamation

Adopted water year 1995 (10/01/1994) through water year 2015 (09/30/2015)

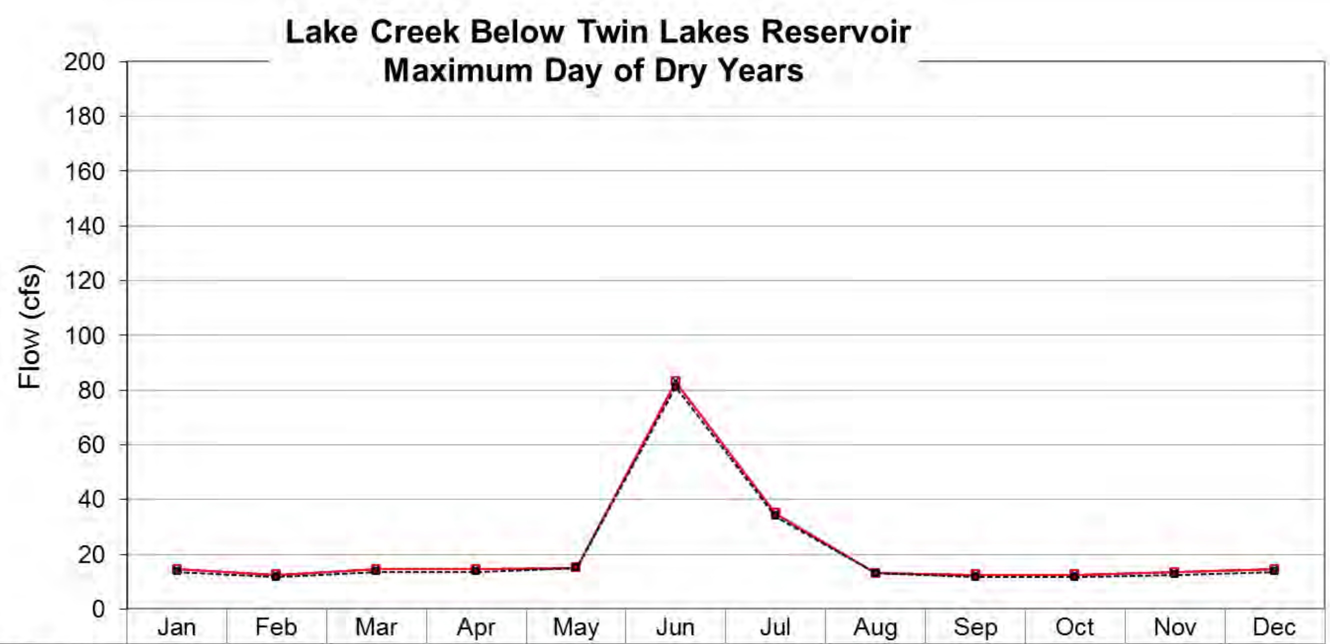
The tables for Pueblo Reservoir were generated by means of the area-capacity program ACAP85, using the least squares method of curve fitting developed by the Reclamation Service Center. This program computes area at 1.0-, 0.1-, and 0.01-foot increments by linear interpolation between basic data contours. The respective capacities and capacity equations are then obtained by integration of the area equations. The initial capacity equation is tested over successive intervals to check whether it fits within an allowable error term. At the next interval beyond, a new capacity equation (integrated from the basic area equation over that interval) begins testing the fit until it too exceeds the error term. The capacity curve thus becomes a series of curves, each fitting a certain region of data. The final area equations are obtained by differentiation of the capacity equations. Capacity equations are of the form $y = a_1 + a_2x + a_3x^2$, where y is capacity and x is the elevation above an elevation base. The capacity equation coefficients for the reservoir are shown below (ε = 0.000001).

PUEBLO RESERVOIR 1993 AREA-CAPACITY TABLES

EQUATION NUMBER	ELEVATION BASE	CAPACITY BASE	COEFFICIENT A1 (COEFFICIENT)	COEFFICIENT A2 (1st TERM)	COEFFICIENT A3 (2nd TERM)
1	4752.80	0	-0.0000	0.0000	3.6364
2	4755.00	17	17.6000	16.0000	30.2000
3	4760.00	852	852.6000	318.0000	12.7700
4	4765.00	2761	2761.8500	445.7000	2.6100
5	4770.00	5055	5055.6000	471.8000	21.9600
6	4775.00	7963	7963.6000	691.4000	10.2600
7	4780.00	11677	11677.1000	794.0000	11.0300
8	4785.00	15922	15922.8500	904.3000	10.2700
9	4790.00	20701	20701.1000	1007.0000	15.2000
10	4795.00	26116	26116.1000	1159.0000	12.1000
11	4800.00	32213	32213.6000	1280.0000	15.1000
12	4805.00	38991	38991.1000	1431.0000	21.2000
13	4810.00	46676	46676.1000	1643.0000	17.0000
14	4815.00	55316	55316.1000	1813.0000	19.2000
15	4820.00	64861	64861.1000	2005.0000	16.2000
16	4825.00	75291	75291.1000	2167.0000	20.1000
17	4830.00	86628	86628.6000	2368.0000	21.1000
18	4835.00	98996	98996.1000	2579.0000	15.8000
19	4840.00	112286	112286.1000	2737.0000	17.3000
20	4845.00	126403	126403.6000	2910.0000	19.9000
21	4850.00	141401	141401.1000	3089.0000	20.9000
22	4855.00	157368	157368.6000	3298.0000	23.2000
23	4860.00	174438	174438.6000	3530.0000	23.3000
24	4865.00	192671	192671.1000	3763.0000	22.9000
25	4870.00	212058	212058.5999	3992.0000	24.6000
26	4875.00	232633	232633.5999	4238.0000	34.9000
27	4880.00	254696	254696.0999	4587.0000	23.6000
28	4885.00	278221	278221.0999	4823.0000	29.2000
29	4890.00	303066	303066.0999	5115.0000	30.9000
30	4895.00	329413	329413.5999	5424.0000	33.4000
31	4900.00	357368	357368.5999	5758.0000	39.6000
32	4905.00	387148	387148.5999	6154.0000	37.8000
33	4910.00	418863	418863.5999	6532.0000	46.6000
34	4915.00	452688	452688.5999	6998.0000	47.7000
35	4920.00	488871	488871.0999	7475.0000	55.2000

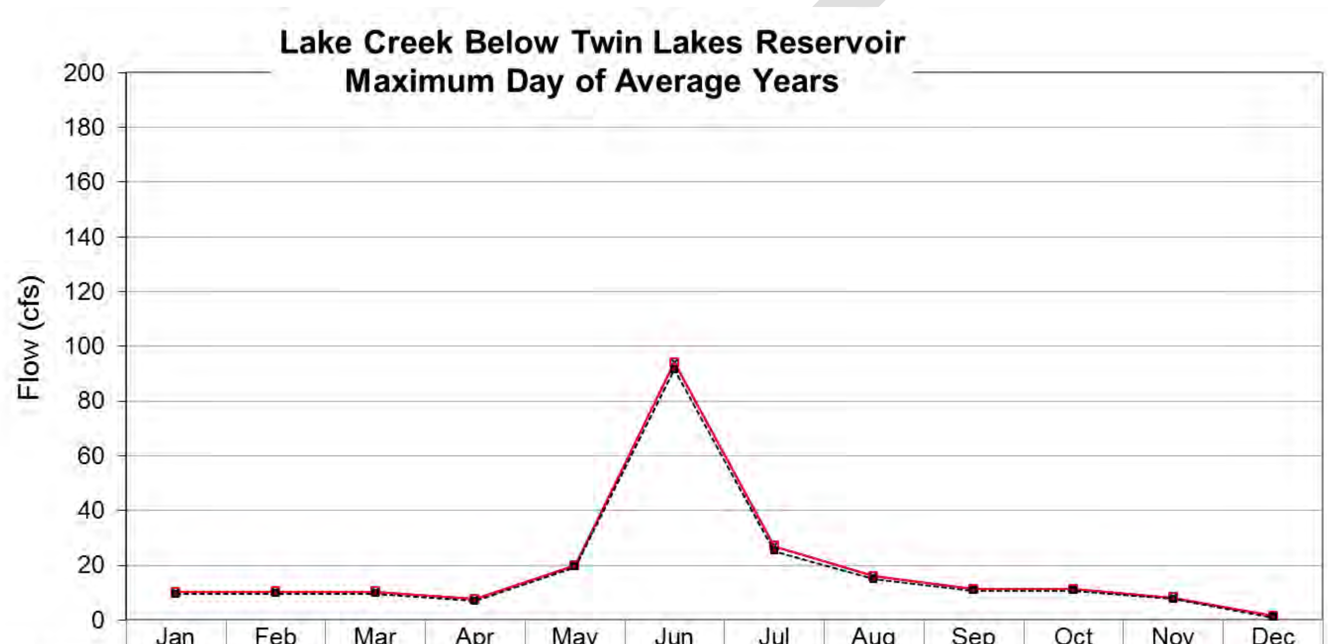
The Pueblo Reservoir survey in May 1993 used the range method to obtain the basic data for these tables. Ranges were profiled by standard surveying techniques. The survey was run by personnel from the Reclamation Service Center and Great Plains Region. Reduction of the field data was completed at the Reclamation Service Center in Denver, Colorado.

APPENDIX K LAKBTLCO – MAXIMUM DAY RESULTS



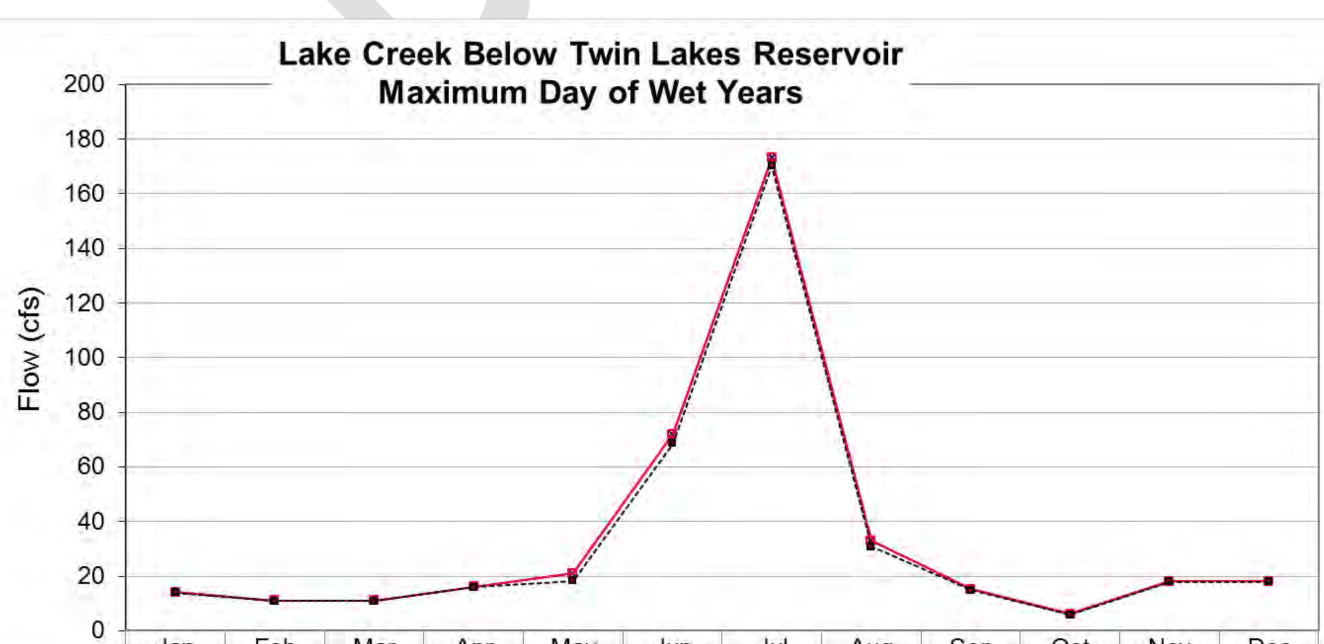
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	14.4	12.4	14.4	14.4	15.0	83.0	35.0	13.0	12.4	12.4	13.4	14.4
No Action	14.4	12.4	14.4	14.4	15.0	83.0	35.0	13.0	12.4	12.4	13.4	14.4
Proposed Action	13.6	11.6	13.6	13.6	15.0	80.9	33.9	13.0	11.6	11.6	12.6	13.6

Figure 1 – Maximum daily impact (change in flow) modeled at LAKBTLCO in each month for all dry years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	10.1	10.3	10.3	7.6	20.0	94.0	27.0	16.0	11.3	11.3	8.2	1.5
No Action	10.1	10.3	10.3	7.6	20.0	94.0	27.0	16.0	11.3	11.3	8.2	1.5
Proposed Action	9.5	9.7	9.7	7.0	19.4	91.5	25.1	14.9	10.7	10.7	7.6	0.9

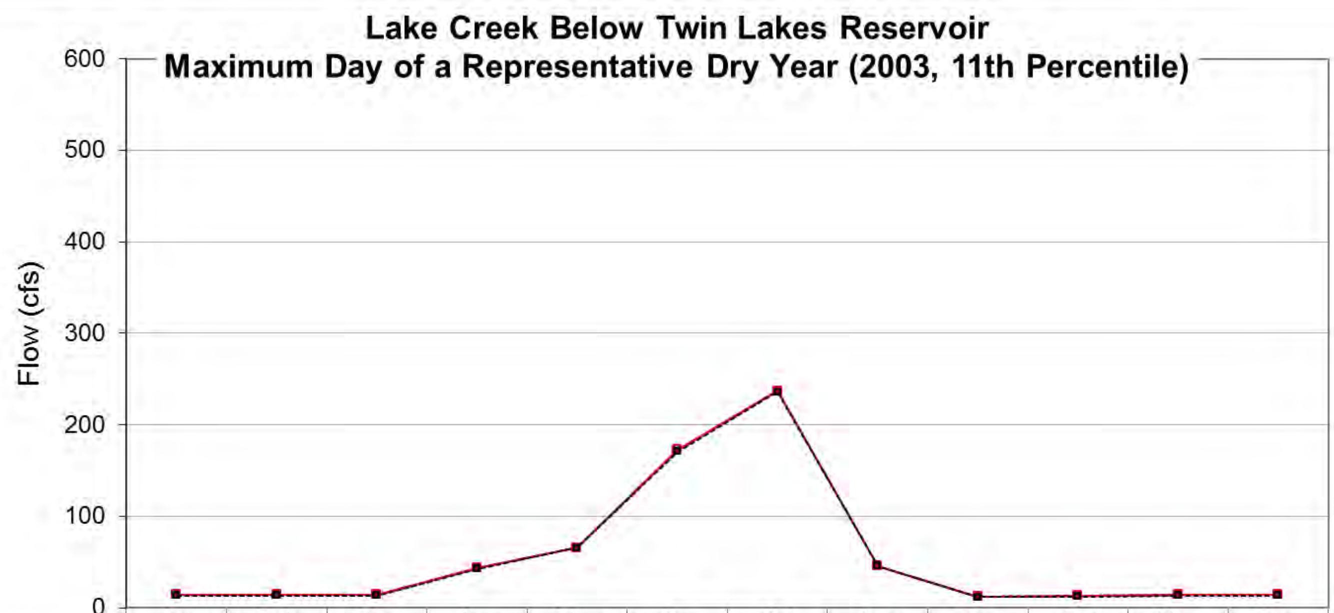
Figure 2 – Maximum daily impact (change in flow) modeled at LAKBTLCO in each month for all average years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	14.1	11.1	11.1	16.1	21.0	72.0	173.0	33.0	15.1	6.1	18.1	18.1
No Action	14.1	11.1	11.1	16.1	21.0	72.0	173.0	33.0	15.1	6.1	18.1	18.1
Proposed Action	13.9	10.9	10.9	15.9	18.2	68.5	170.2	30.7	14.9	5.9	17.9	17.9

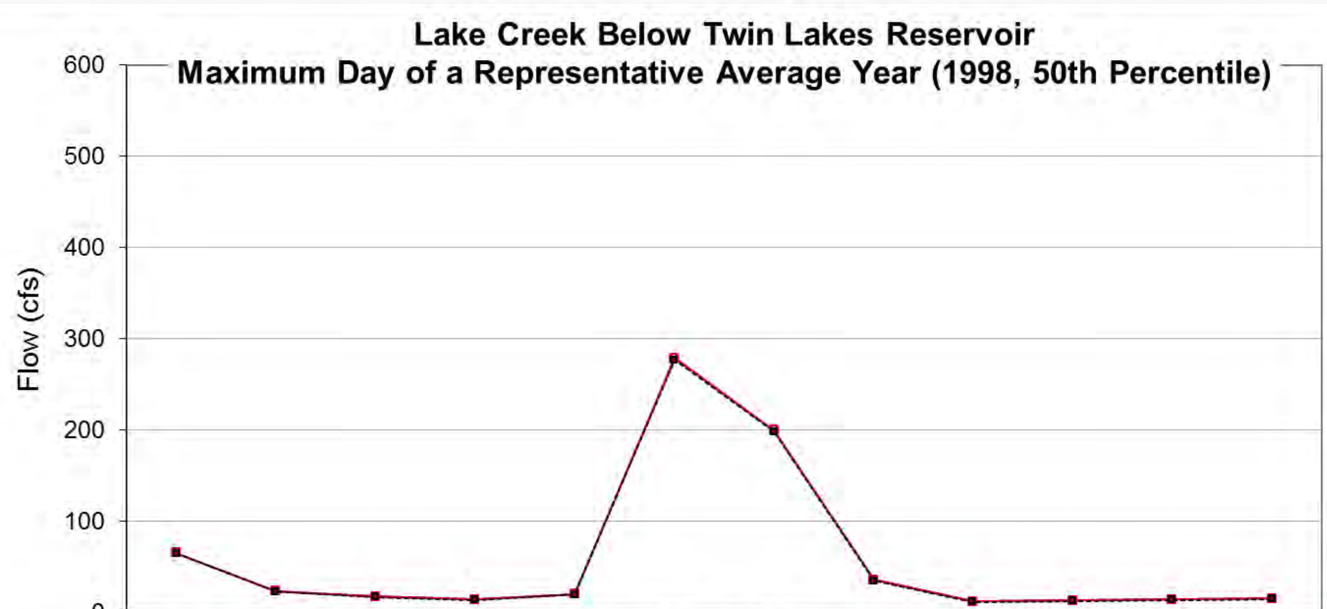
Figure 3 – Maximum daily impact (change in flow) modeled at LAKBTLCO in each month for all wet years

APPENDIX L LAKBTLCO – MAXIMUM DAY OF REPRESENTATIVE YEAR RESULTS



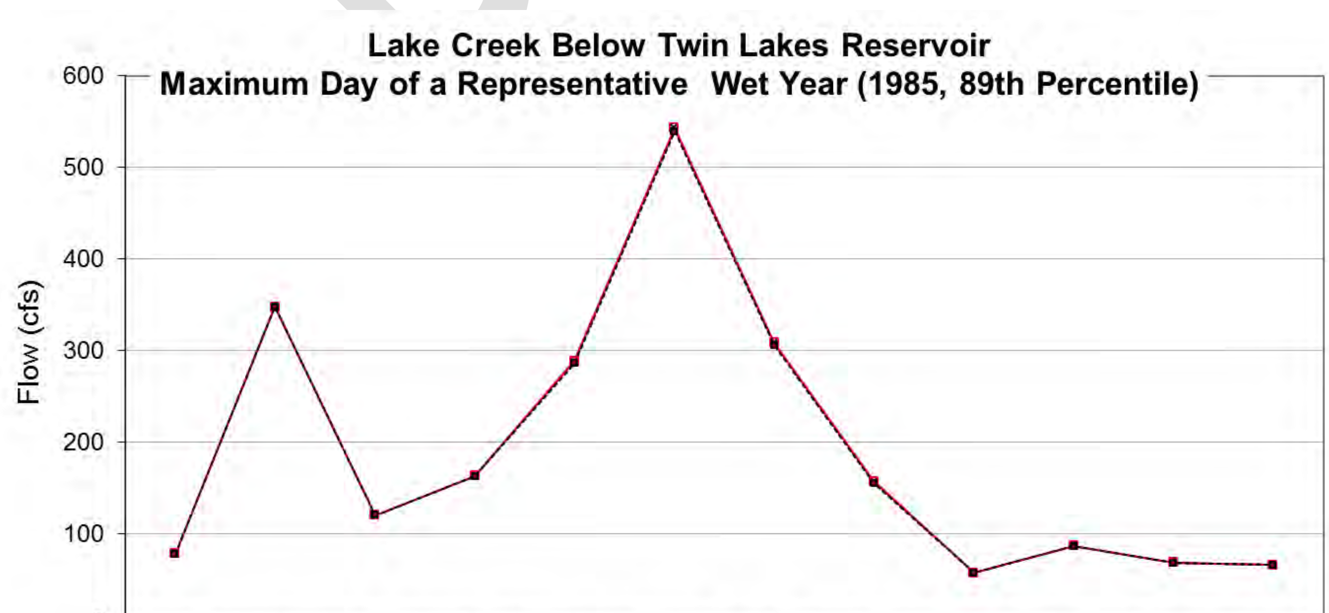
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	14.4	14.4	14.4	43.4	66.0	173.0	237.0	46.0	12.4	13.4	14.4	14.4
No Action	14.4	14.4	14.4	43.4	66.0	173.0	237.0	46.0	12.4	13.4	14.4	14.4
Proposed Action	13.6	13.6	13.6	42.6	66.0	170.9	235.9	46.0	11.6	12.6	13.6	13.6

Figure 4 – Maximum daily impact (change in flow) modeled at LAKBTLCO in each month of the representative dry year (2003)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	65.3	23.3	17.3	14.3	20.0	279.0	200.0	36.0	12.3	13.3	14.3	15.3
No Action	65.3	23.3	17.3	14.3	20.0	279.0	200.0	36.0	12.3	13.3	14.3	15.3
Proposed Action	64.7	22.7	16.7	13.7	19.4	276.5	198.1	34.9	11.7	12.7	13.7	14.7

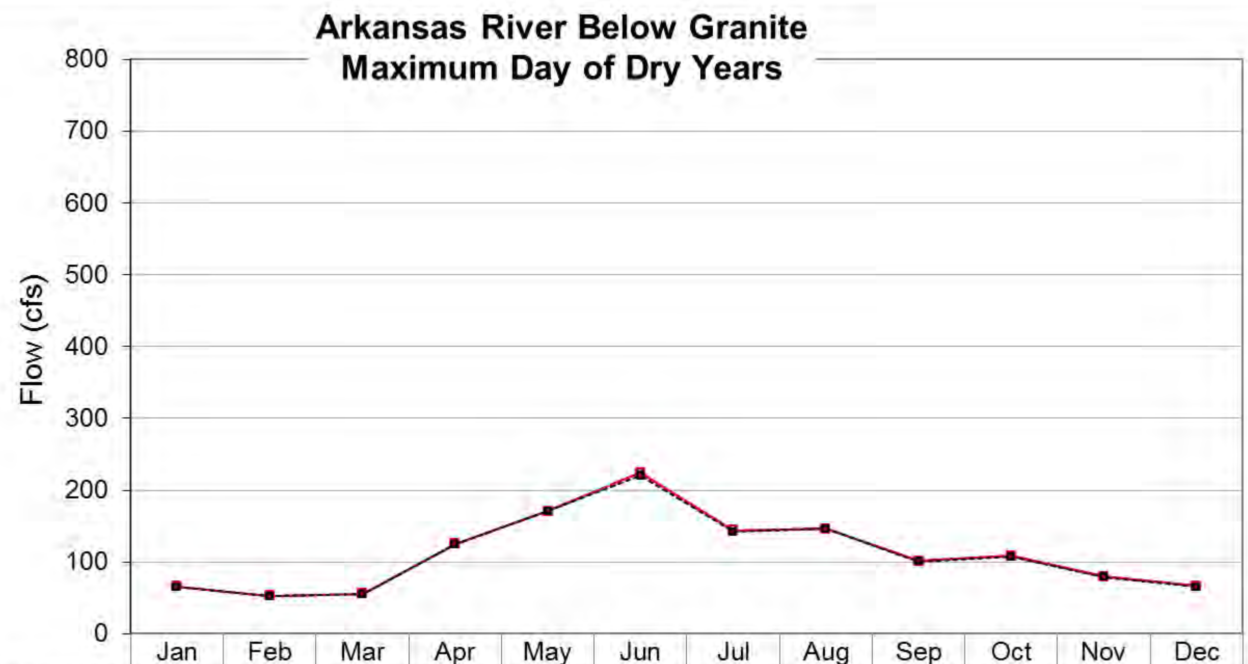
Figure 5 – Maximum daily impact (change in flow) modeled at LAKBTLCO in each month of the representative average year (1998)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	78.1	347.9	120.2	163.0	288.4	542.9	308.6	157.4	57.4	86.7	68.5	65.9
No Action	78.1	347.9	120.2	163.0	288.4	542.9	308.6	157.4	57.4	86.7	68.5	65.9
Proposed Action	77.9	347.6	120.0	162.8	285.7	539.4	305.8	155.1	57.2	86.4	68.2	65.7

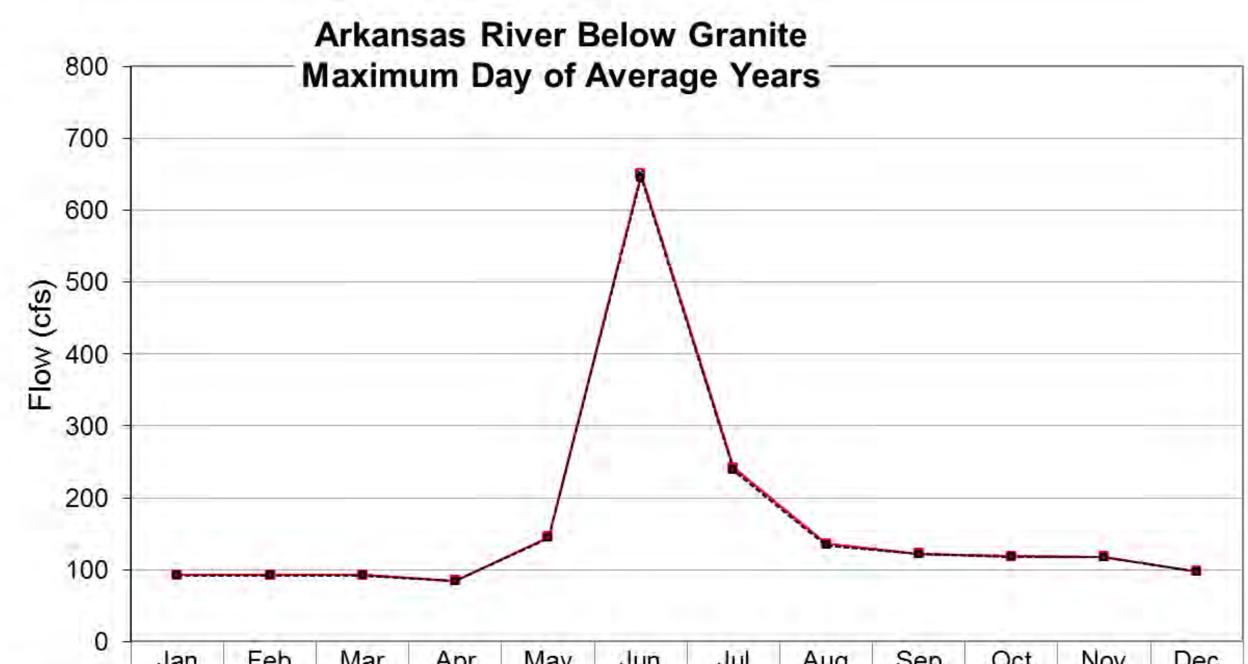
Figure 6 – Maximum daily impact (change in flow) modeled at LAKBTLCO in each month of the representative wet year (1985)

APPENDIX M ARKBGNCO – MAXIMUM DAY RESULTS



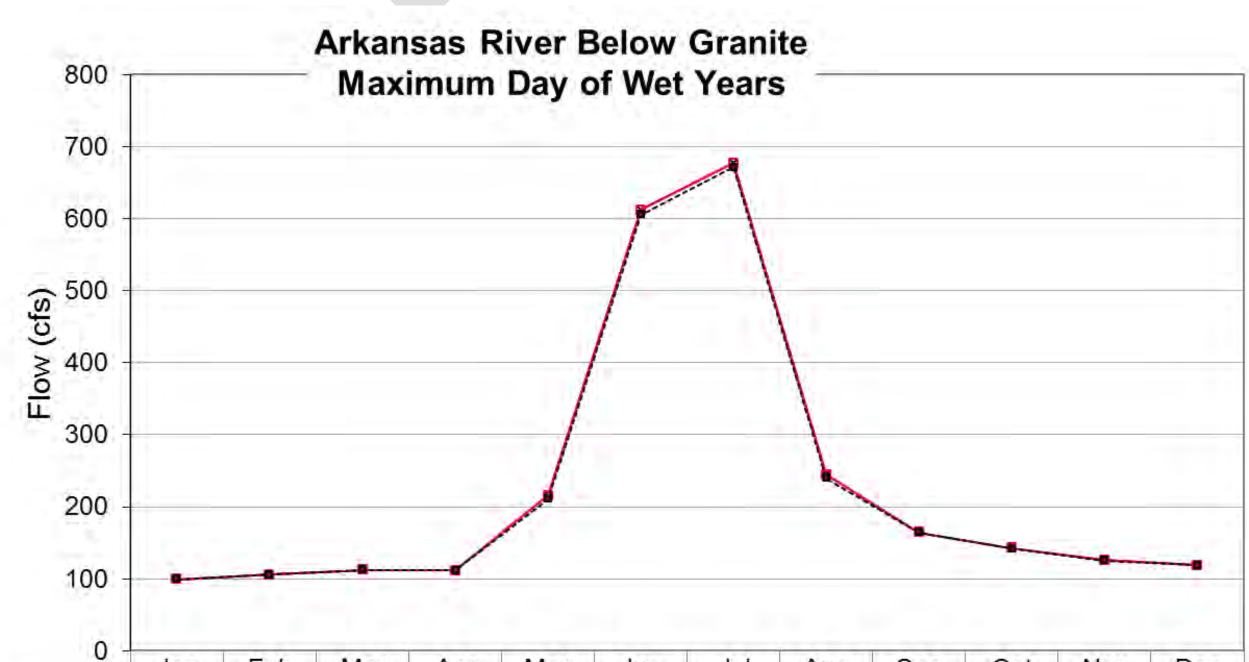
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	66	53	56	125	171	224	144	146	101	108	80	66
No Action	66	53	56	125	171	224	144	146	101	108	80	66
Proposed Action	65	52	55	125	171	220	142	146	101	107	79	65

Figure 7 – Maximum daily impact (change in flow) modeled at ARKBGNCO in each month for all dry years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	93	93	92	84	146	650	241	136	122	119	118	98
No Action	93	93	92	84	146	650	241	136	122	119	118	98
Proposed Action	92	92	92	84	144	645	238	134	122	118	117	97

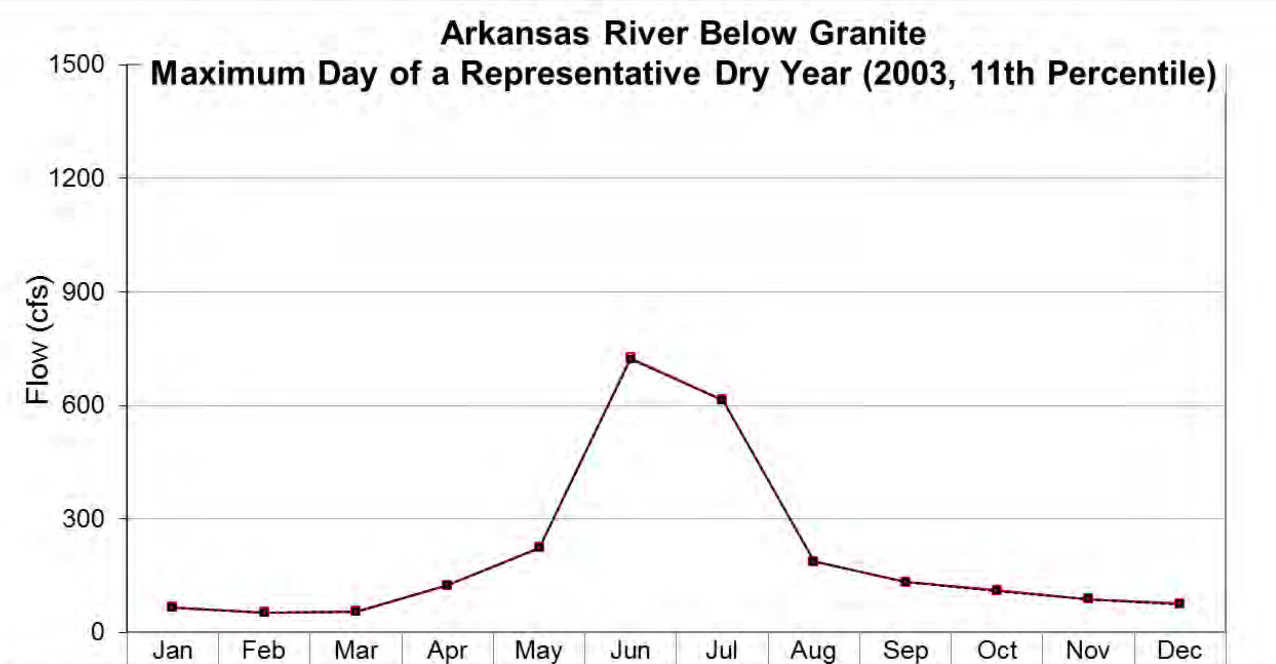
Figure 8 – Maximum daily impact (change in flow) modeled at ARKBGNCO in each month for all average years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	99	106	112	112	216	612	677	244	164	142	126	119
No Action	99	106	112	112	216	612	677	244	164	142	126	119
Proposed Action	99	105	112	111	210	605	671	240	164	142	126	119

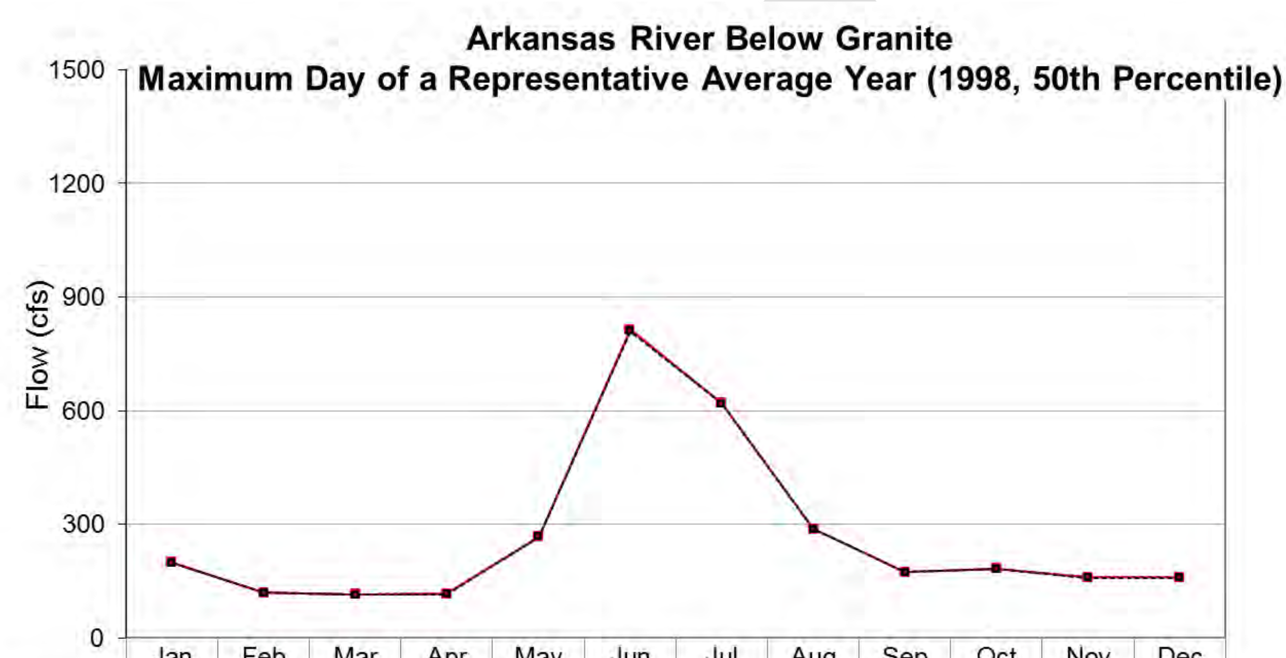
Figure 9 – Maximum daily impact (change in flow) modeled at ARKBGNCO in each month for all wet years

APPENDIX N ARKBGNCO – MAXIMUM DAY OF REPRESENTATIVE YEAR RESULTS



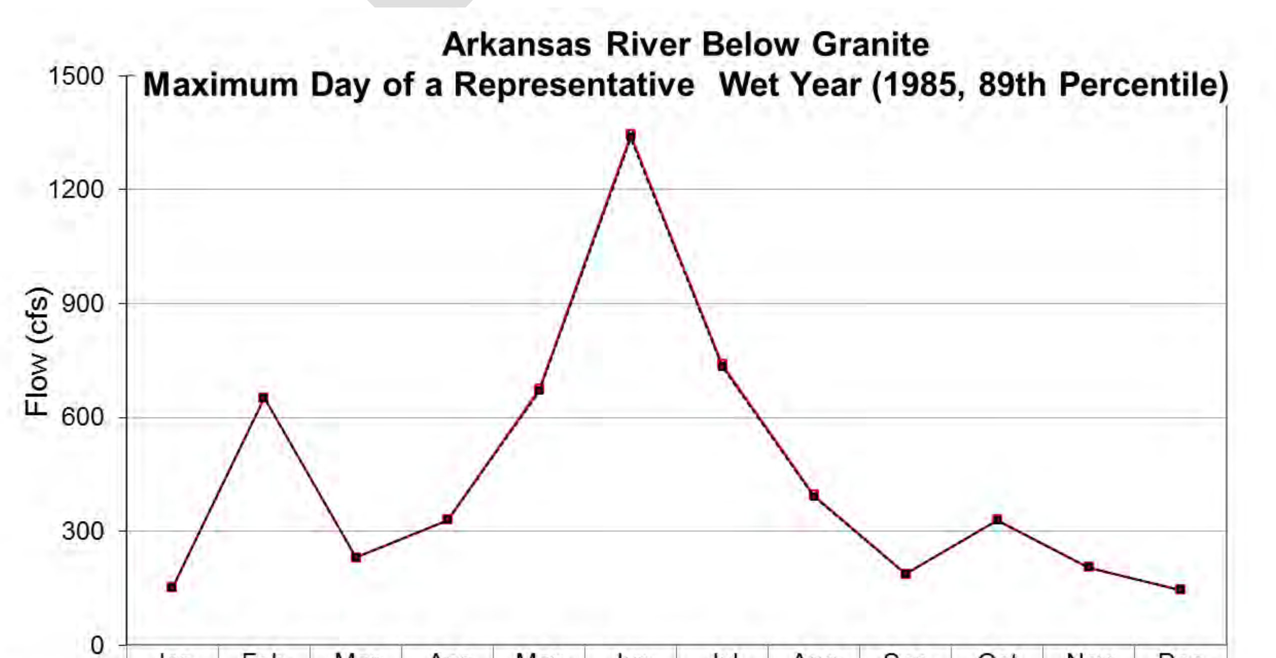
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	66	53	56	125	224	726	615	187	133	111	89	75
No Action	66	53	56	125	224	726	615	187	133	111	89	75
Proposed Action	65	52	55	125	224	722	613	187	133	110	88	75

Figure 10 – Maximum daily impact (change in flow) modeled at ARKBGNCO in each month of the representative dry year (2003)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	199	120	115	116	268	814	621	288	174	183	160	160
No Action	199	120	115	116	268	814	621	288	174	183	160	160
Proposed Action	198	119	114	115	268	810	618	288	173	182	159	159

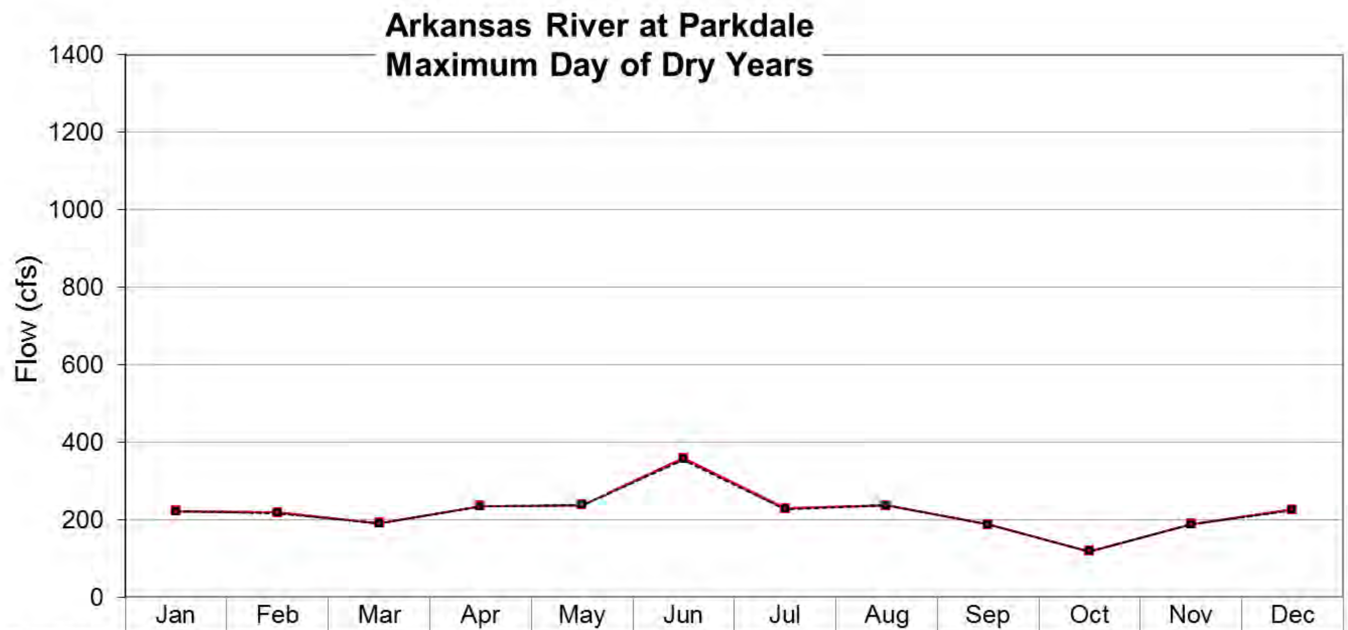
Figure 11 – Maximum daily impact (change in flow) modeled at ARKBGNCO in each month of the representative average year (1998)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	152	651	230	330	674	1343	739	395	187	329	205	145
No Action	152	651	230	330	674	1343	739	395	187	329	205	145
Proposed Action	151	651	230	330	668	1337	733	391	187	329	204	145

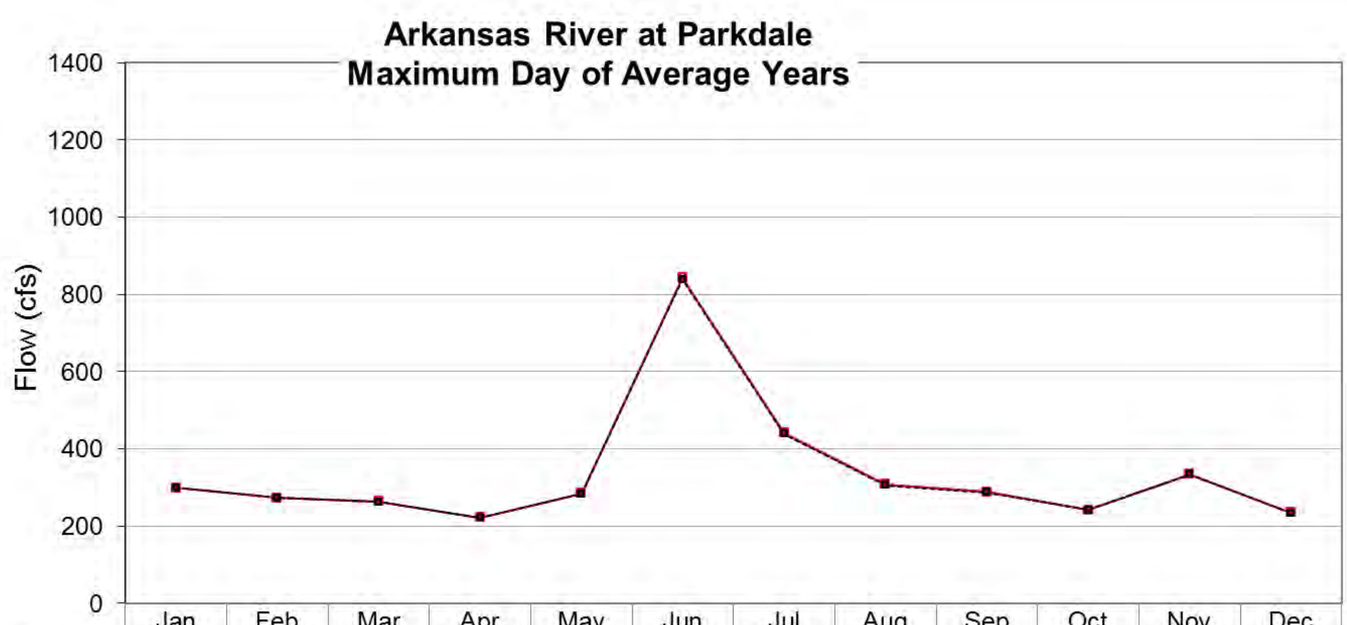
Figure 12 – Maximum daily impact (change in flow) modeled at ARKBGNCO in each month of the representative wet year (1985)

APPENDIX O ARKPARCO – MAXIMUM DAY RESULTS



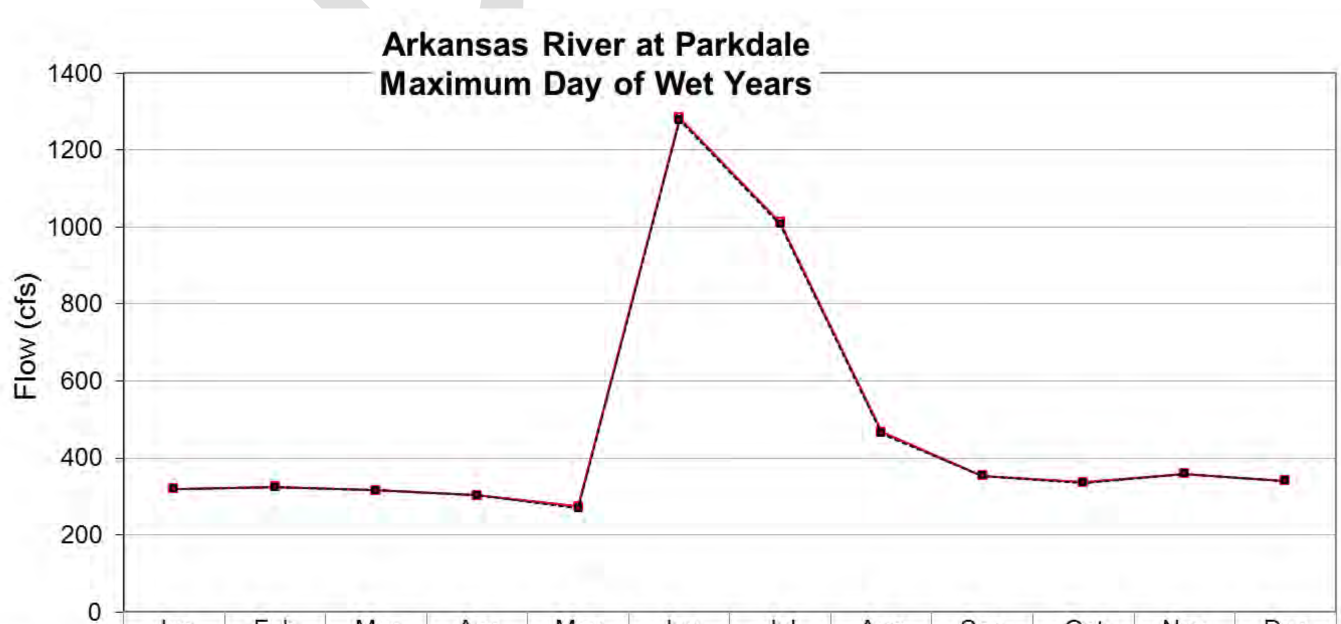
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	222	219	191	235	238	359	229	236	187	119	188	226
No Action	222	219	191	235	238	359	229	236	187	119	188	226
Proposed Action	221	218	190	235	238	355	227	236	187	118	188	225

Figure 13 – Maximum daily impact (change in flow) modeled at ARKPARCO in each month for all dry years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	299	273	264	222	285	843	442	308	288	242	335	235
No Action	299	273	264	222	285	843	442	308	288	242	335	235
Proposed Action	299	273	263	222	283	839	438	306	288	241	334	234

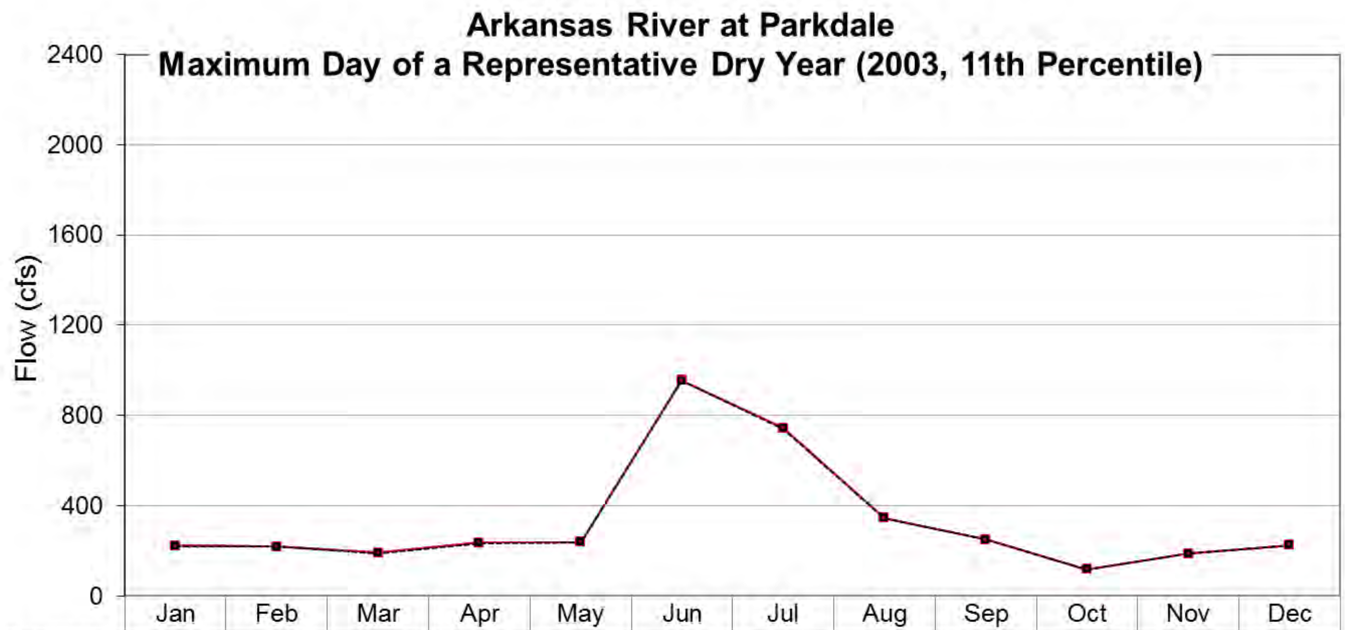
Figure 14 – Maximum daily impact (change in flow) modeled at ARKPARCO in each month for all average years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	319	324	316	303	275	1283	1013	467	354	336	359	341
No Action	319	324	316	303	275	1283	1013	467	354	336	359	341
Proposed Action	319	324	316	303	269	1277	1007	463	354	336	359	340

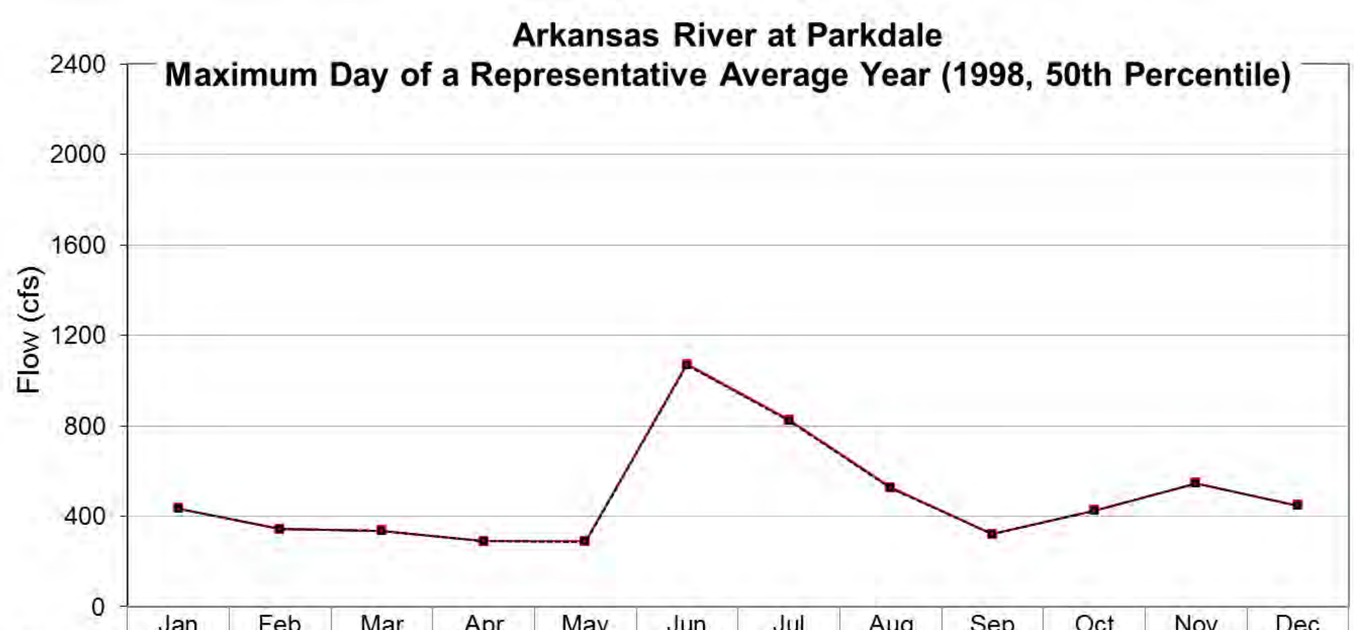
Figure 15 – Maximum daily impact (change in flow) modeled at ARKPARCO in each month for all wet years

APPENDIX P ARKPARCO – MAXIMUM DAY OF REPRESENTATIVE YEAR RESULTS



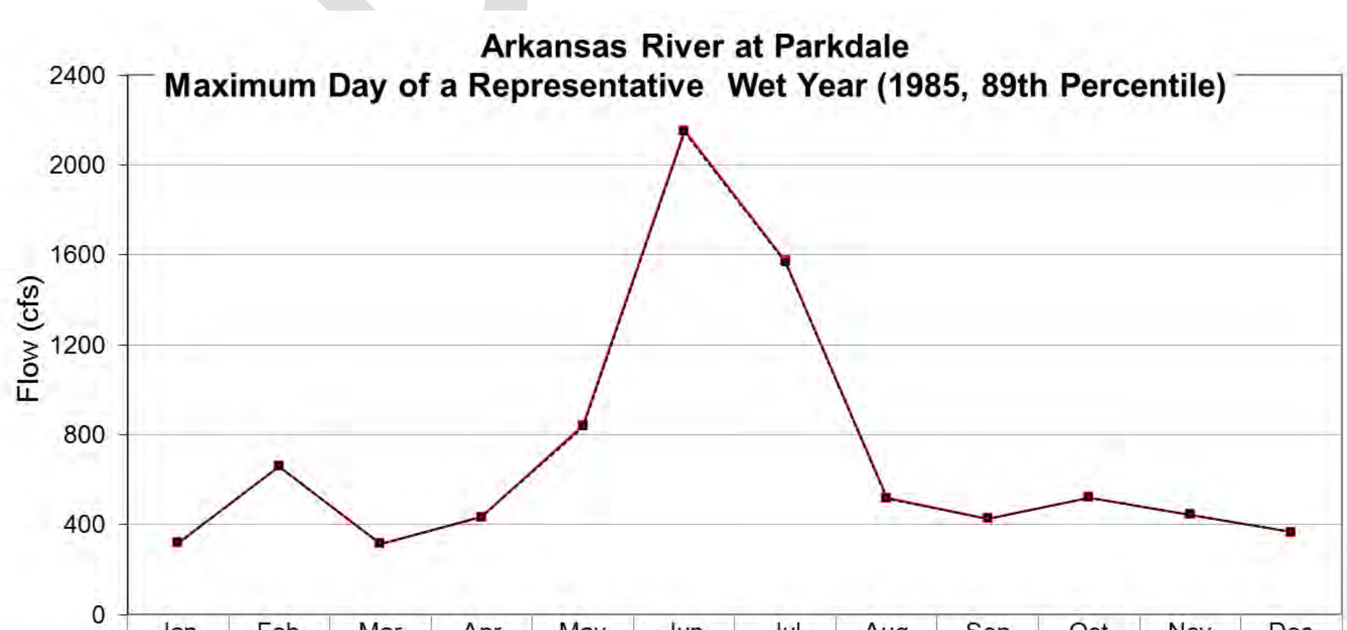
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	222	219	191	235	238	957	745	345	250	119	188	226
No Action	222	219	191	235	238	957	745	345	250	119	188	226
Proposed Action	221	218	190	235	238	953	743	345	250	118	188	225

Figure 16 – Maximum daily impact (change in flow) modeled at ARKPARCO in each month of the representative dry year (2003)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	434	343	335	289	289	1072	825	525	320	424	546	447
No Action	434	343	335	289	289	1072	825	525	320	424	546	447
Proposed Action	433	342	334	289	287	1068	821	523	320	424	545	447

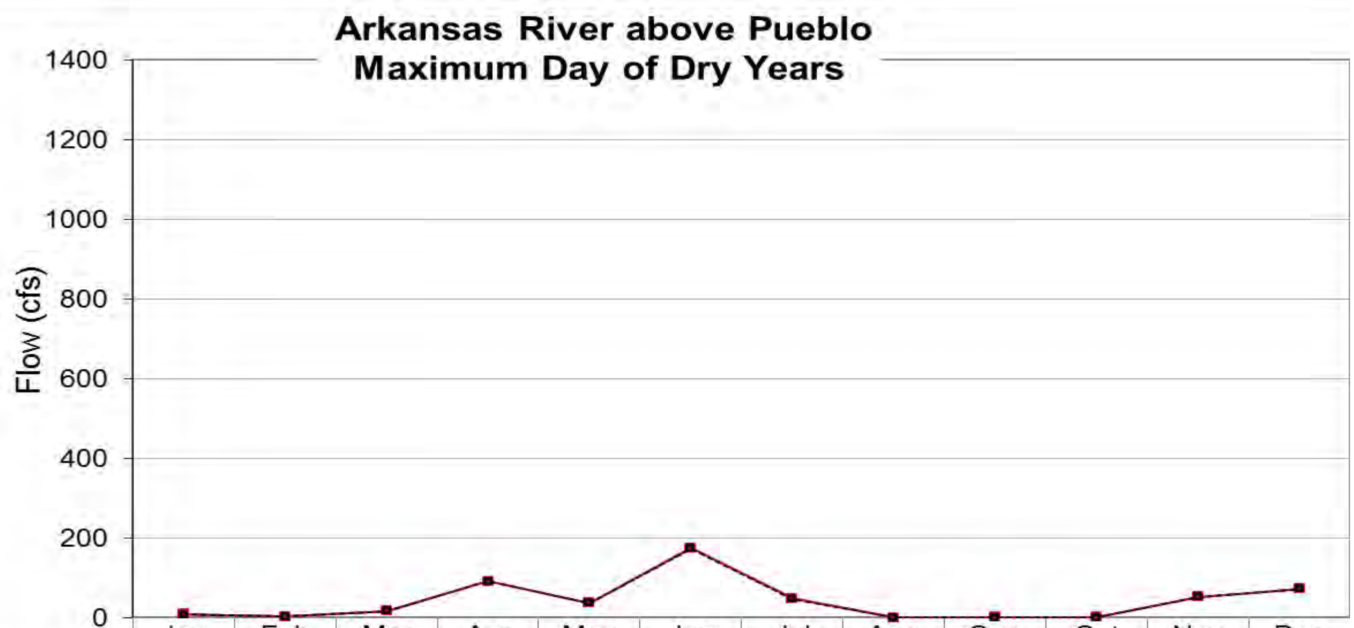
Figure 17 – Maximum daily impact (change in flow) modeled at ARKPARCO in each month of the representative average year (1998)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	319	660	316	434	841	2153	1573	520	427	521	445	368
No Action	319	660	316	434	841	2153	1573	520	427	521	445	368
Proposed Action	319	660	316	434	835	2147	1567	516	427	521	445	367

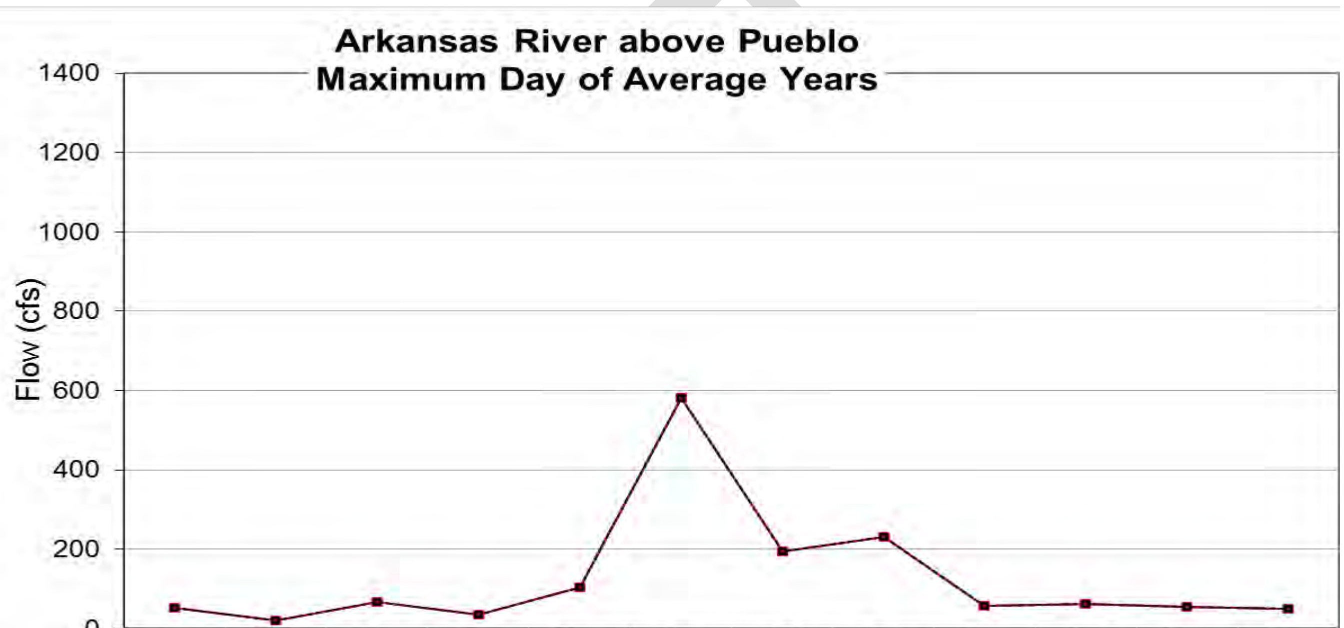
Figure 18 – Maximum daily impact (change in flow) modeled at ARKPARCO in each month of the representative wet year (1985)

APPENDIX Q ARKPUECO – MAXIMUM DAY RESULTS



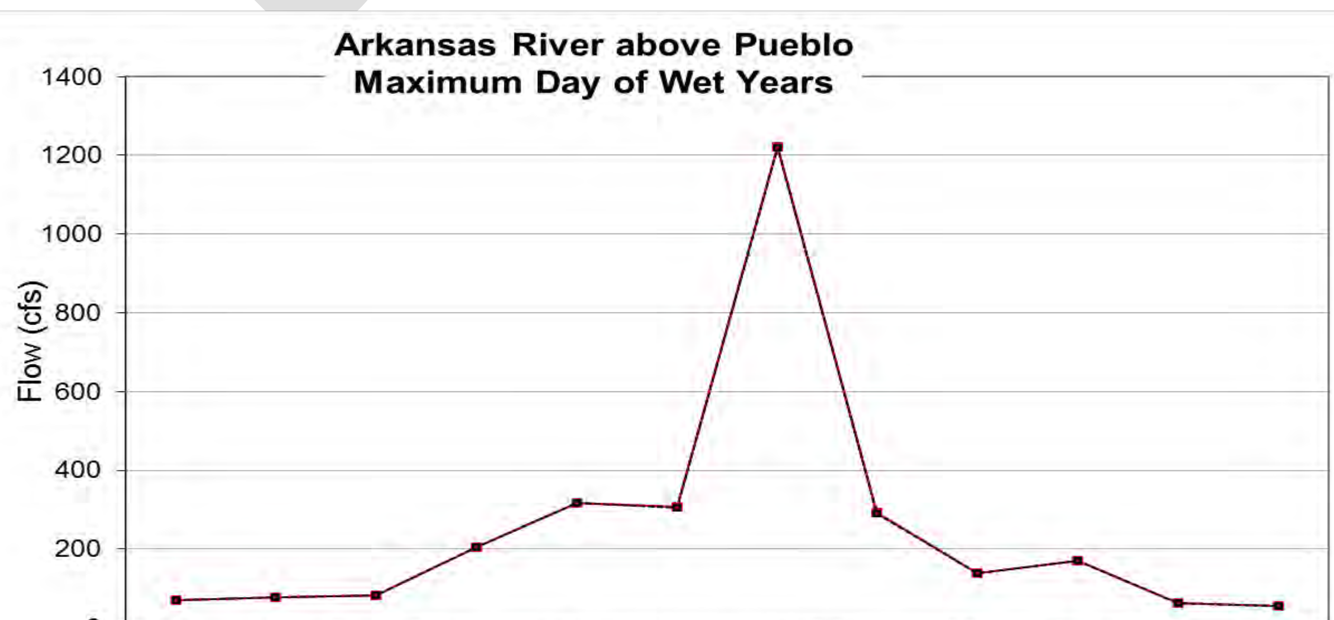
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	9	3	16	91	37	174	48	1	1	1	52	72
No Action	9	3	16	91	37	174	48	1	1	1	52	72
Proposed Action	8	2	16	91	37	173	47	1	1	1	52	72

Figure 19 – Maximum daily impact (change in flow) modeled at ARKPUECO in each month for all dry years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	51	21	67	34	103	583	195	231	57	62	54	50
No Action	51	21	67	34	103	583	195	231	57	62	54	50
Proposed Action	51	21	67	34	103	581	194	230	57	62	54	50

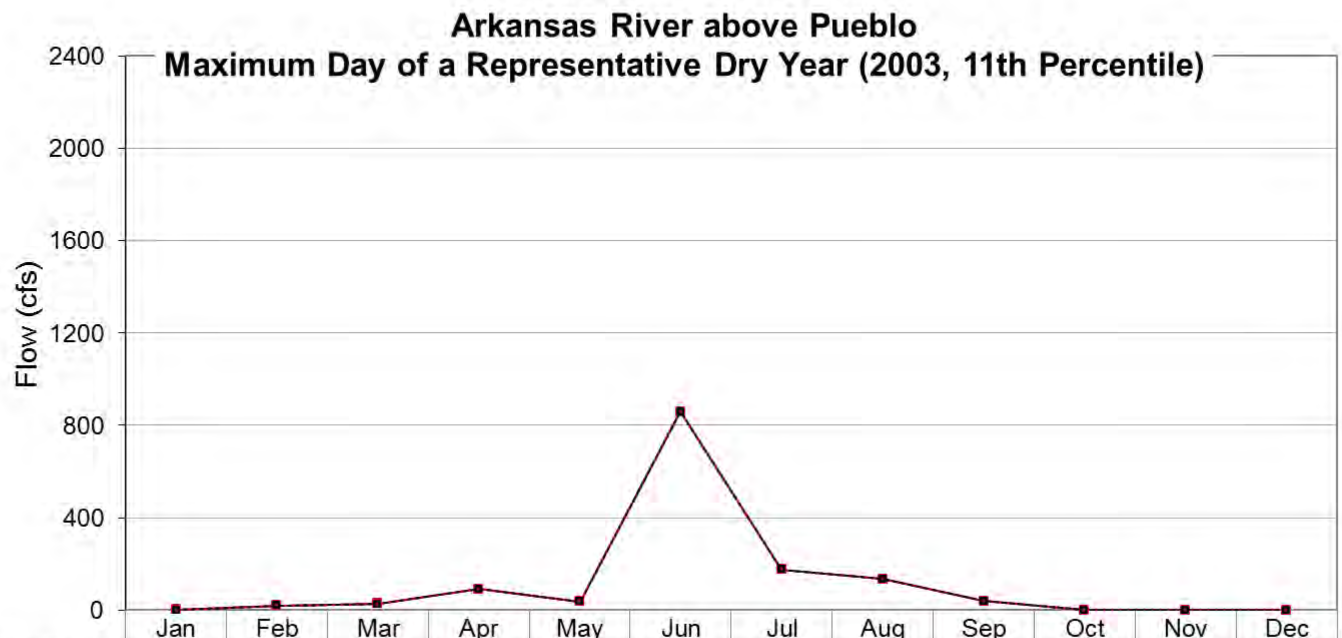
Figure 20 – Maximum daily impact (change in flow) modeled at ARKPUECO in each month for all average years



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	71	77	82	205	318	306	1222	292	139	169	63	54
No Action	71	77	82	205	318	306	1222	292	139	169	63	54
Proposed Action	71	77	82	205	316	304	1220	291	139	169	63	54

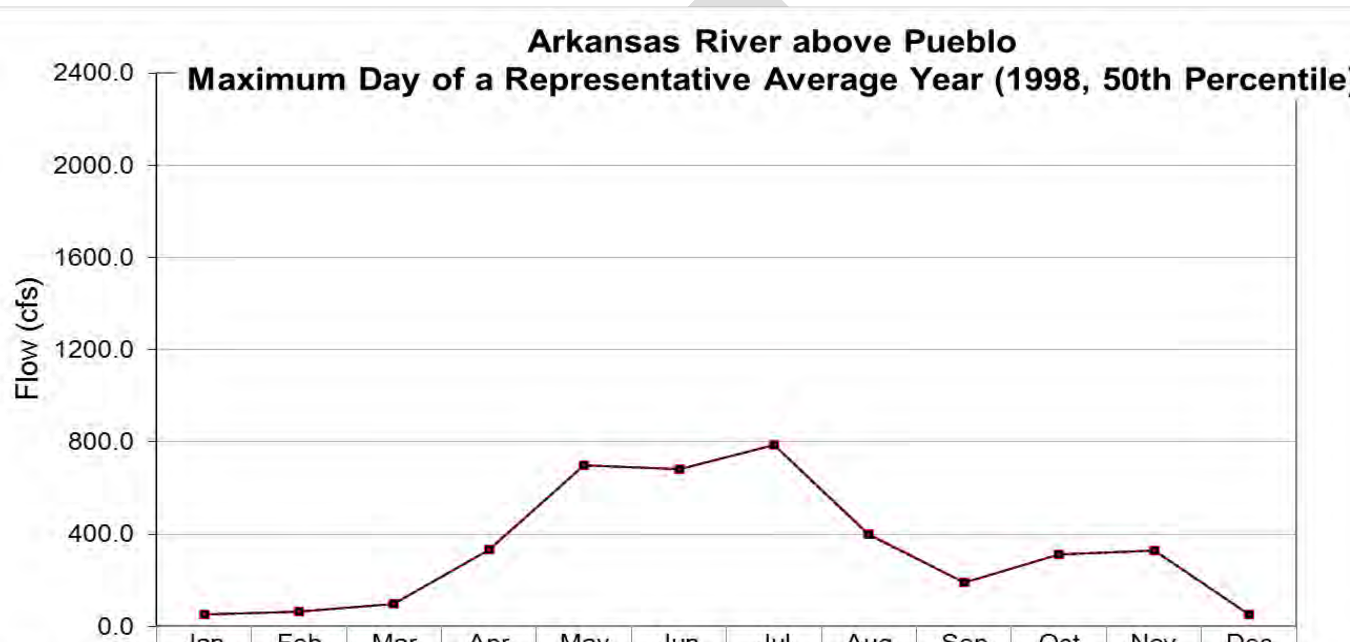
Figure 21 – Maximum daily impact (change in flow) modeled at ARKPUECO in each month for all wet years

APPENDIX R ARKPUECO – MAXIMUM DAY OF REPRESENTATIVE YEAR RESULTS



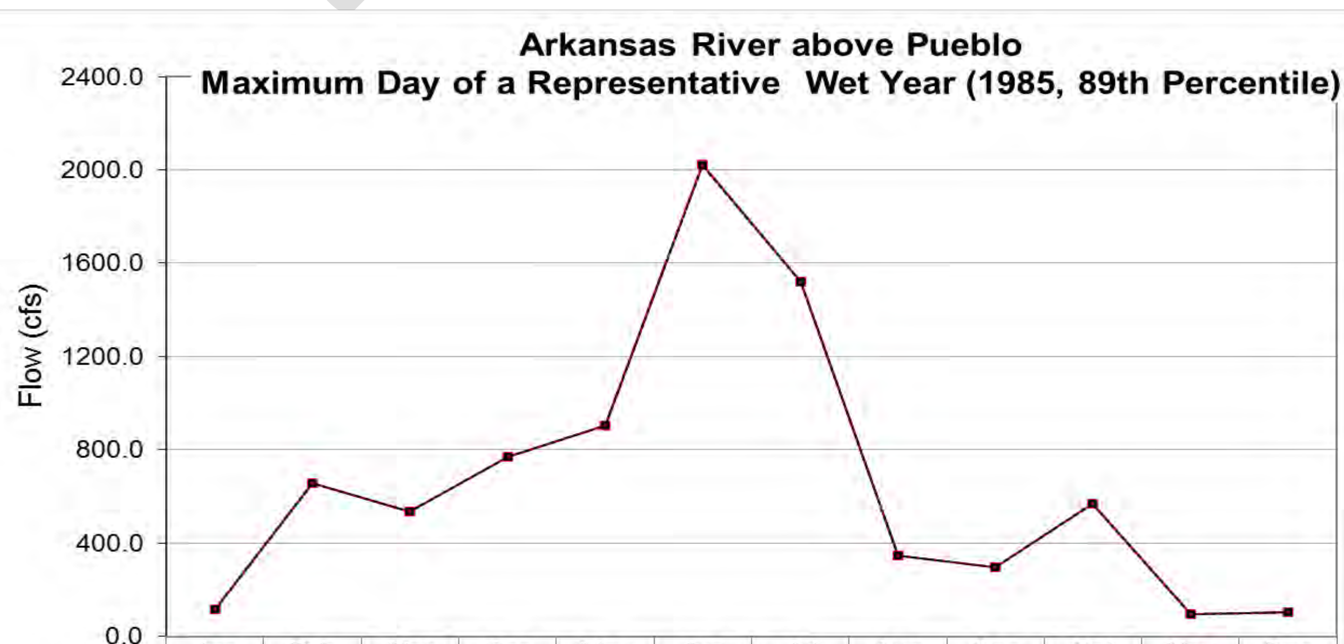
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	1.6	20	27	91	37	860	177	135	40	0.92	0.83	0.82
No Action	1.6	20	27	91	37	860	177	135	40	0.92	0.83	0.82
Proposed Action	1.2	20	27	91	37	859	176	135	40	0.55	0.45	0.45

Figure 22 – Maximum daily impact (change in flow) modeled at ARKPUECO in each month of the representative dry year (2003)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	51.3	62.3	98.3	332.3	697.4	683.6	788.3	398.7	190.3	310.3	328.3	50.3
No Action	51.3	62.3	98.3	332.3	697.4	683.6	788.3	398.7	190.3	310.3	328.3	50.3
Proposed Action	51.0	62.0	98.0	332.0	697.0	682.0	787.0	398.0	190.0	310.0	328.0	50.0

Figure 23 – Maximum daily impact (change in flow) modeled at ARKPUECO in each month of the representative average year (1998)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline Condition	117.1	655.1	535.1	770.1	905.8	2022.2	1521.8	347.5	296.1	570.1	93.1	105.1
No Action	117.1	655.1	535.1	770.1	905.8	2022.2	1521.8	347.5	296.1	570.1	93.1	105.1
Proposed Action	117.0	655.0	535.0	770.0	904.0	2020.0	1520.0	346.0	296.0	570.0	93.0	105.0

Figure 24 – Maximum daily impact (change in flow) modeled at ARKPUECO in each month of the representative wet year (1985)