

APPENDIX F

Gaging

Inventory and Review of Gages in Purgatoire River Basin

As part of the Water Measurement and Gaging issue addressed in the Trinidad 10-Year Review, Reclamation agreed to document the historic gages for the Trinidad Project (Project) and to assemble an ad-hoc team to examine which gages are needed to be able to document and analyze Project operations. The documentation included identifying the periods of record covered by the gages, locations, their status and the various names used for them.

During the July 10th, 2007 Trinidad 10-year Review meeting at the TSC Reclamation presented a preliminary list of gages in the Purgatoire River basin. Reclamation then solicited representation on the team from the various interested parties. The team eventually rounded out with participation from the following individuals and entities:

- Jeris Danielson, PRWCD
- Kevin Salter, State of Kansas
- Steve Witte, Colorado Division of Water Resources (CDWR), Division 2
- Bill Tyner, CDWR Division 2
- Mark Perry, CDWR Division 2
- Dennis Garcia, Army Corps of Engineers, Albuquerque Office
- Joel Fenolio, Bureau of Reclamation
- Malcolm Wilson, Bureau of Reclamation

The first step was to compile a list of gages that are currently or have been in the Purgatoire River Basin. The list of gages, presented in Table 1, was put together with the assistance of the CDWR, Division 2 staff. Once the list was compiled, each gage was checked to determine it had been identified by another name at any time. The periods of record for daily discharge according to the United States Geological Survey (USGS) and status of each gage were then identified. The State has taken over responsibility of some of the gages and the actual period of record maybe different than what the USGS listed. It is noted in the comment section if the State is now maintaining the gages and what is the actual period of record. It was also noted whether the gage had previously been identified as an historic gage for monitoring Project operations or is required by water right decree for administration of the transfer of the Model Reservoir right to Trinidad Reservoir. A preliminarily review was then conducted to determine if more or less gages are needed to evaluate the Project's effects on the Purgatoire River.

A second list of gages (Table 2) that will measure the real-time diversion of ditches within the Purgatoire River Water Conservancy District (PRWCD) in the near future was also assembled with information provided by the CRWCD. The second table is in the same format and provides the same information as the Table 1.

GIS maps were also developed to show the relative location of gages to each other, to Project and senior water right diversions, and to other Project facilities. Figure 1 shows the entire Purgatoire River basin with all the gages in Table 1 and Table 2. Figure 2 shows the Project land use, gages, and project facilities on a smaller scale from just

upstream of Trinidad Reservoir to just east of the split of U.S. Highways 350 and 160. Figure 3 is the same scale as Figure 2 and shows more downstream project facilities and gages from the highway split to just east of the PURGATOIRE RIVER NEAR THATCHER gage.

On August 30th, 2007 Reclamation hosted a conference call with representatives of the State, PRWCD, Army Corp of Engineers, and the State of Kansas. The main thrust of the meeting was to add to or eliminate the gages, and get background information on the gages. Comments and concerns that were discussed during the meeting are presented in the following paragraphs.

Upstream of Trinidad Reservoir only one of the seven gages that have been in existence is still in use, the PURGATOIRE RIVER AT MADRID gage, as noted in Table 1. The PURGATOIRE RIVER AT MADRID gage is used to measure the approximate inflow to Trinidad Reservoir and is a historic Project gage. The other six sites have been abandoned since 1981. It was noted that with the potential development of coal bed methane industry in the Purgatoire River watershed upstream of Trinidad Reservoir that these gages could allow determination of possible impacts to inflow to Trinidad Reservoir and the operations of the Project in the future.

The gages below Trinidad Reservoir, PURGATOIRE RIVER BELOW TRINIDAD LAKE and PURGATOIRE RIVER AT TRINIDAD, are both historic sites for the Project. During a release of flows in the range of 1000 cfs in 2004, the Corps found that the PURGATOIRE RIVER BELOW TRINIDAD LAKE gage became unreliable for measurement of flows of this magnitude. The Corps, with the help of the USGS, completed the installation of a secondary gaging station downstream of the existing gage. The new gage will be used for readings when releases from the reservoir exceed 800 cfs. The Corps provided an update on the second gage at the 2007 ARCA meeting.

Besides being a historic gage, the PURGATOIRE RIVER AT TRINIDAD gage is also used to measure the inflow from Raton Creek into the Purgatoire River. The PURGATOIRE RIVER AT TRINIDAD and the RATON CREEK ABOVE STARKVILLE combined can give an indication of how much water is being released from Trinidad Reservoir and the potential accretion or depletion that occurs above the City of Trinidad.

The PURGATOIRE RIVER NEAR HOEHNE gage has not been turned used since 1968 according to the USGS records but needs to be re-evaluated to see if it can be used for measuring Project depletions. The State is currently looking at a site for a new gage that would be able to measure project effects on the Purgatoire River. The PURGATOIRE RIVER NEAR HOEHNE gage was a site for this measurement but is not an ideal location for the new gage. During the conference call there was discussion about possibly locating the gage in the location where U.S. Highway 350 crosses the Purgatoire River near Patterson Crossing, as shown in Figure 3. Another possible gaging site would be in the area of the PURGATOIRE RIVER NEAR ALFALFA gage but where River

Canyon Ranch comes close to the Purgatoire River. The PURGATOIRE RIVER NEAR ALFALFA gage is a historic gage site but is not a good location for measuring the flow.

LUNING ARROYO NEAR MODEL and VAN BREMER ARROYO NEAR MODEL, CO gages are part of the Model Transfer decree but neither was used in the 1996 Trinidad 10-Year Review. The intent of these gages was to quantify the return flows from Project lands. The usefulness of these gages needs is questionable. The actual flows in the arroyo's are infrequent and do not provide reliable measurements for accounting to determine the Model Reservoir transfer impact. The two gages have not been used for measuring Project return flows to the Purgatoire River. The gage site that the State is investigating, as mentioned in the previous paragraph, would be a better measure of the overall Project effects and return flows when coupled with the PURGATOIRE RIVER NEAR THATCHER gage. It was suggested by the State and others that the single new gage site could serve the measurement needs of the Project better than the current gages at Luning Arroyo and Van Bremmer gages and be more accurate. Replacement of these two gages will require legal action to have the objectors in the Model Transfer decree agree to a new gage site.

VAN BREMER ARROYO NEAR TYRONE, CO gage and the gages from BURKE ARROYO TRIBUTARY NEAR THATCHER, CO to BENT CANYON CREEK AT MOUTH NEAR TIMPAS, CO are historical gages used by the Corps of Engineers. The gages from PURGATOIRE RIVER AT ROCK CROSSING NR TIMPAS to PURGATOIRE RIVER NEAR LAS ANIMAS in Table 1 are for State's administrative purposes but are not a measurement of the Project's effects. HIGHLAND CANAL and NINE MILE CANAL AT NINEMILE DAM NEAR HIGBEE, CO are used to measure diversions senior to the Project's and are also important for the State's administration.

In summary, based on the input from members of the technical team, the inventory and review done to date, the gages that can be used for measuring project effects can be classified as:

Project or Required for Model Transfer that can be used for accounting:

- PURGATOIRE RIVER AT MADRID
- PURGATOIRE RIVER BELOW TRINIDAD LAKE
- PURGATOIRE RIVER BELOW TRINIDAD LAKE
- PURGATOIRE RIVER NEAR THATCHER
- A future gage between the U.S. Hwy 350 crossing of the Purgatoire River and River Canyon Ranch

Project or Required for Model Transfer that need to be evaluated

- LUNING ARROYO NEAR MODEL
- VAN BREMER ARROYO NEAR MODEL

There was also interest among some team members in reestablishing gages upstream of Trinidad Reservoir that could be used to monitor future coal bed methane mining effects. Those are not addressed in this 10 year review but include:

- MIDDLE FORK PURGATOIRE RIVER AT STONEWALL
- LONG CANYON CREEK NEAR MADRID
- MOLINO CANYON NEAR WESTON
- SARCILLO CANYON NEAR SEGUNDO
- REILLY CANYON AT COKEDALE
- CARPIOS CANYON NEAR JANSEN

Table 1: List of Gages in the Purgatoire River Basin

Site ID*	Site Name	Period of Record (Based on Daily Data from USGS website)		Historic Gaging Station for Project	Gaging Station Required for Model Transfer	Gage Cooperator	Comment
		Begin Date	End Date				
<u>7124050</u>	MIDDLE FORK PURGATOIRE RIVER AT STONEWALL	5/9/1978	9/30/1981				Upstream of Trinidad Reservoir
<u>7124200</u>	PURGATOIRE RIVER AT MADRID	3/1/1972	Present	X		U.S ACOE	Upstream of Trinidad Reservoir
<u>7124300</u>	LONG CANYON CREEK NEAR MADRID	9/1/1972	7/31/1989				Upstream of Trinidad Reservoir
<u>7124100</u>	MOLINO CANYON NEAR WESTON	7/31/1979	8/10/1981				Upstream of Trinidad Reservoir
<u>7124120</u>	SARCILLO CANYON NEAR SEGUNDO	6/27/1978	8/10/1981				Upstream of Trinidad Reservoir
<u>7124220</u>	REILLY CANYON AT COKEDALE	6/15/1978	9/30/1981				Upstream of Trinidad Reservoir
<u>7124350</u>	CARPIOS CANYON NEAR JANSEN	6/8/1978	9/30/1981				Upstream of Trinidad Reservoir
<u>7124410</u>	PURGATOIRE RIVER BELOW TRINIDAD LAKE	12/17/1976	Present	X		U.S ACOE	
<u>7124500</u>	PURGATOIRE RIVER BELOW TRINIDAD LAKE	10/01/1896	9/30/1981	X		CDWR	NO RECORD WY1987 - 1993. CDWR record is continuous from WY1994 - present.
<u>7125000</u>	PURGATOIRE RIVER NEAR HOEHNE	10/1/1954	9/30/1968				
<u>7125100</u>	FRIJOLE CREEK NEAR ALFALFA	3/1/1957	9/30/1968				
<u>7125500</u>	SAN FRANCISCO CREEK NEAR ALFALFA	10/1/1954	9/30/1968				
<u>7126000</u>	PURGATOIRE RIVER NEAR ALFALFA	4/1/1905	9/30/1968				
<u>7126100</u>	LUNING ARROYO NEAR MODEL	7/1/1966	9/30/1981		X	CDWR	CDWR Provisional Record from WY1999 through present available on CDWR website.
<u>7126140</u>	VAN BREMER ARROYO NEAR TYRONE, CO	5/21/1985	11/16/2004			U.S ACOE	
<u>7126200</u>	VAN BREMER ARROYO NEAR MODEL	7/1/1966	Present		X	U.S ACOE	

* Numeric Site ID is a USGS designation, alpha Site ID is a State designation

Table 1: List of Gages in the Purgatoire River Basin

Site ID*	Site Name	Period of Record (Based on Daily Data from USGS website)		Historic Gaging Station for Project	Gaging Station Required for Model Transfer	Gage Cooperator	Comment
		Begin Date	End Date				
<u>7126300</u>	PURGATOIRE RIVER NEAR THATCHER	7/1/1966	Present	X	X	U.S ACOE	
<u>7126320</u>	BURKE ARROYO TRIBUTARY NEAR THATCHER	10/1/1984	9/30/1986				
<u>7126325</u>	TAYLOR ARROYO BL ROCK CROSSING, NR THATCHER	3/18/1983	Present			U.S ACOE	
<u>7126390</u>	LOCKWOOD CANYON CREEK NAR THATCHER	4/21/1983	Present			U.S ACOE	
<u>7126415</u>	RED ROCK CANYON CREEK AT MOUTH NR THATCHER	5/26/1983	Present			U.S ACOE	
<u>7126470</u>	CHACUACO CREEK AT MOUTH NEAR TIMPAS, CO	5/1/1983	7/16/1993				
<u>7126480</u>	BENT CANYON CREEK AT MOUTH NEAR TIMPAS, CO	10/1/1983	Present			U.S ACOE	
<u>7126485</u>	PURGATOIRE RIVER AT ROCK CROSSING NR TIMPAS	6/1/1983	Present			U.S ACOE	
<u>7126500</u>	PURGATOIRE RIVER AT NINEMILE DAM, NR HIGBEE	10/1/1924	9/30/1995			CDWR	CDWR record is continuous through present.
<u>7128000</u>	PURGATOIRE R AT HIGHLAND DAM, NR LAS ANIMAS	10/1/1931	9/30/1955			CDWR	CDWR record is continuous from May 23, 2001 through present.
<u>7128500</u>	PURGATOIRE RIVER NEAR LAS ANIMAS	1/1/1922	Present				Published as Purgatoire Creek at Las Animas in 1889 and Purgatory River near Las Animas in 1909
<u>RACRSTCO</u>	RATON CREEK ABOVE STARKVILLE	10/1/2002	Present			CDWR	
<u>HILCANCO</u>	HIGHLAND CANAL	10/1/2000	Present			CDWR	
<u>NMCHIGCO</u>	NINE MILE CANAL AT NINEMILE DAM NEAR HIGBEE	10/1/1979	Present			CDWR	

* Numeric Site ID is a USGS designation, alpha Site ID is a State designation

Gaging sites were compiled from the USGS website and cross checked with the Colorado Division of Water Resources Website

Table 2: Purgatoire River Water Conservancy District (PRCWD) Diversions Structures Gages (not in operation to date)

Site ID	Site Name	Period of Record		Gage Cooperator	Comment
		Begin Date	End Date		
PIKDITCO	PICKETWIRE DITCH			PRWCD	
MODCANCO	MODEL CANAL			PRWCD	
JOHDITCO	JOHN FLOOD DITCH			PRWCD	
HOEDITCO	HOEHNE DITCH			PRWCD	
SOUDITCO	ENLARGED SOUTHSIDE DITCH			PRWCD	
CILDITCO	CHILILI DITCH			PRWCD	

Information Provided by the Colorado Div. of Water Resources via email 7/13/2

RECLAMATION

Managing Water in the West

Diversion Gages	Picketwire Ditch	Hoehne Ditch
Gages In Use For Non-Project	Southside Ditch	Chilili Ditch
Gages Not In Use	Johns Flood Ditch	Model Ditch
Gages In Use For Project		

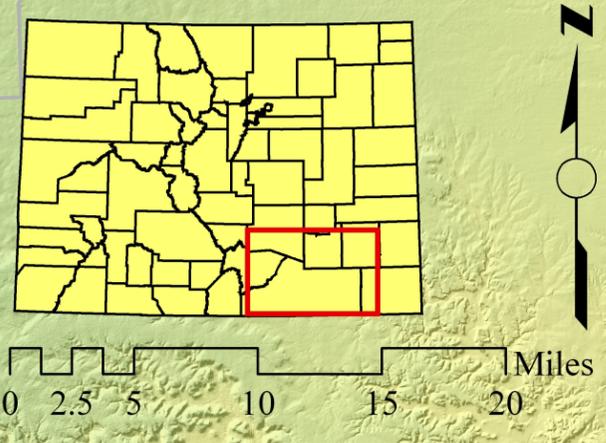
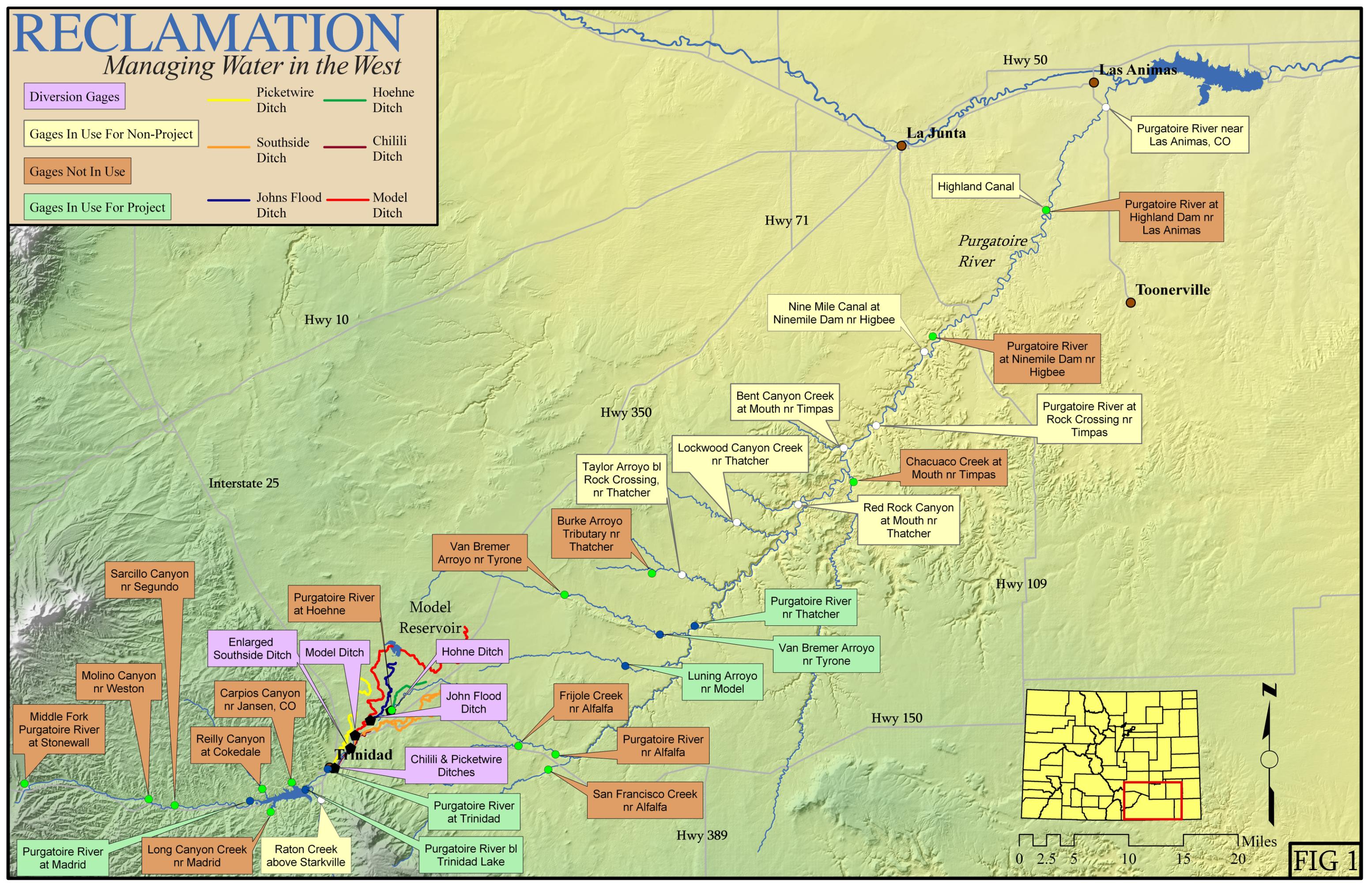


FIG 1

RECLAMATION

Managing Water in the West

Diversion Gages	Model - not irrigated	Picketwire Ditch	Hoehne Ditch
Gages In Use For Non-Project	Model - dried	Southside Ditch	Chilili Ditch
Gages Not In Use	City - dried	Johns Flood Ditch	Model Ditch
Gages In Use For Project	All Parcels		

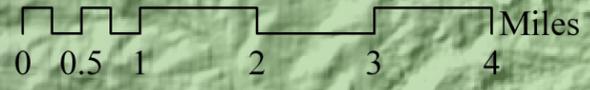


FIG 2

RECLAMATION

Managing Water in the West

Diversion Gages	Model - not irrigated	Hoehne Ditch
Gages In Use For Non-Project	Model - dried	Southside Ditch
Gages Not In Use	City - dried	Model Ditch
Gages In Use For Project	All Parcels	Johns Flood Ditch

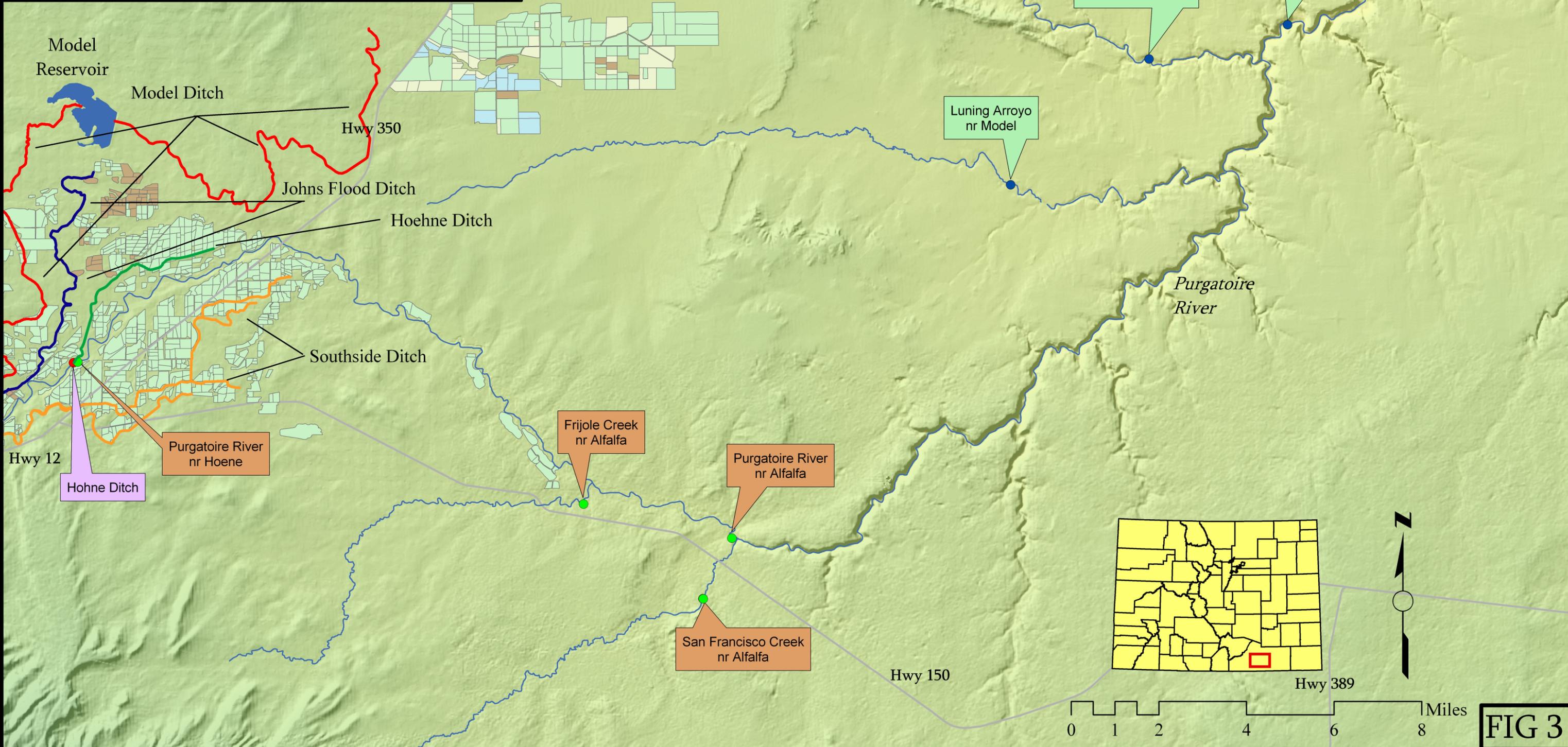


FIG 3