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Pecos River Decision Support System: Application for Adjudication Settlement and River Operations EIS

McCord

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Pecos River Decision Support System: Application for Adjudication Settlement and River Operations EIS

Jim McCord[1], P.E., Ph.D. (505-835-2569; jtm@hydrosphere.com), John C. Carron[2], Ph.D. (jcc@hydrosphere.com); Beiling Liu[3], Ph.D. (bliu@ose.state.nm.us); Sara Rhoton[3], P.E. (srhoton@ose.state.nm.us); Miguel Rocha[4], P.E. (mrocha@uc.usbr.gov); Tomas Stockton[5] (tomas-stockton@tetratech.com); Laura Belanger[2] (lmb@hydrosphere.com)

ABSTRACT

As part of a water rights adjudication settlement in the lower Pecos River Basin (Adjudication Settlement) and the Carlsbad Project Water Operations and Water Supply Conservation EIS (Carlsbad Project EIS), the Pecos River Decision Support System (PRDSS), a suite of linked groundwater and surface water management models, is being used to evaluate and refine proposed management actions. This paper describes application of the PRDSS to these conjunctive-use water management problems.

On the one hand, the Adjudication Settlement anticipates a combination of land retirement and groundwater pumping with the objectives of: a) permanent compliance with the U.S. Supreme Court's Pecos River Compact Amended Decree, and b) avoiding the need for issuance of a priority call in the basin, curtailing exercise of junior water rights. Central to achieving these objectives is maintaining the surface water supply for the Carlsbad Irrigation District (CID). Because of the seniority of CID water rights and due to CID's proximity to the New Mexico-Texas stateline, CID water use directly impacts stateline flows, and hence Pecos River Compact compliance. On the other hand, the Carlsbad Project EIS evaluates river system re-operations intended to: a) conserve the threatened Pecos bluntnose shiner (PBNS), and b) conserve the CID water supply. Maintaining river flows to conserve the PBNS will result in depletions to the CID water supply, thus the actions for the EIS include development of a water acquisition program to offset depletions to CID. It is desirable for the state of New Mexico and the federal government to adopt policies that result in an optimal solution for both the Adjudication Settlement and the Carlsbad Project EIS; this goal is facilitated through use of the PRDSS.

Model scenarios developed for evaluation included a Baseline scenario and several action alternatives. The Baseline scenario represents operational conditions in the basin prior to adoption of ongoing temporary actions that have been undertaken to comply with U.S. Fish and Wildlife Service Biological Opinions issued to protect the survival of the PBNS. The action scenarios simulate the operation of the system under the proposed Adjudication Settlement terms, also for a variety of river operations intended to conserve the PBNS for the Carlsbad Project EIS. Simulation of the scenarios using the PRDSS provides an estimate of the changes in water supply that would be expected if the Adjudication Settlement terms, river re-operations, and water acquisition program were implemented.

Preliminary model results indicate that implementation of the Adjudication Settlement will:

1) Increase the annual water supply available to CID irrigators, and increase it's resiliency in dry years.

1. Hydrosphere Resource Consultants, 115 Abeyta Street Suite A, Socorro, New Mexico 87801
2. Hydrosphere Resource Consultants, 1020 Walnut Suite 200, Boulder, Colorado 80302
3. New Mexico Interstate Stream Commission / Office of the State Engineer, P.O. Box 25102, Santa Fe, NM 87504-5102
4. U.S. Bureau of Reclamation, Albuquerque Area Office, 555 Broadway N.E. Suite 100, Albuquerque, New Mexico 87102
5. TetraTech, Inc., One Town Center, 6121 Indian School Rd. NE, Suite 205, Albuquerque, New Mexico 87110

2) Eliminate the chances of a priority call by CID and the U.S. under certain conditions, through augmentation pumping to meet supply targets to CID.
3) Provide for the direct delivery of water from Avalon Dam to the stateline to help the State of New Mexico meet its Pecos River Compact obligations.

Implementation of the Carlsbad Project EIS alternatives can:
4) Ensure more reliable flows in PBNS critical habitat reaches.
5) Offset depletions to the CID water supply due to re-operations intended to conserve the PBNS.

1.0 INTRODUCTION

This paper describes the structure of the Pecos River Decision Support System (PRDSS), a set of linked surface water and groundwater models, and its application to two current water resource management projects on the Pecos River in southeast New Mexico. This section provides an overview of the PRDSS and its component models, as well as a summary of the framework of the settlement agreement for the adjudication of water rights in the Carlsbad Project Offer Phase of the *Lewis Case* (the Adjudication Settlement) and the Carlsbad Project Water Operations and Water Supply Conservation Environmental Impact Statement (Carlsbad Project EIS).

1.1 The Pecos River Decision Support System

The PRDSS is a set of coupled surface water, river operations, and groundwater models that simulate system behavior in response to changes in reservoir operations and/or hydrological inputs. The Pecos River Hydrology Work Group of the Carlsbad Project EIS, jointly led by the New Mexico Interstate Stream Commission (ISC) and the U.S. Bureau of Reclamation (Reclamation) has generated a series technical reports that provide detailed background on the PRDSS and each of its component models (Hydrosphere, 2002, 2003a,b; Tetra Tech, 2000; Tetra Tech, 2003; Barroll, 2002). Here we provide a high-level summary of the PRDSS.

The PRDSS simulates the groundwater and surface water hydrology and operations associated with major reservoirs and diversions on the river from Santa Rosa Reservoir to the New Mexico-Texas Stateline. The suite of models consists of:

- The Pecos River RiverWare surface water and reservoir operations model, which is critical in understanding how modified reservoir operations to meet ESA requirements may impact surface water supplies (Tetra Tech, 2003, 2000);
- Two MODFLOW groundwater models:
    - the Roswell Artesian Basin Groundwater Model (RABGW), which is critical for understanding how changes in groundwater pumping in the Roswell Basin impact base inflows to the Pecos River and aquifer storage levels (Daniel B. Stephens and Associates, 1995; Eric Keyes, 2002; Papadopulos & Associates, 2003);
    - the Carlsbad Area Groundwater Model (CAGW), which is vital to helping understand impacts of Carlsbad Irrigation District (CID) diversions and supplemental well pumping on return flows to the Pecos River below Avalon Dam and consequently Pecos River flows at the New Mexico – Texas stateline. The return flows and base inflows from the Carlsbad region are critically important to

the State in meeting its water delivery obligations under the Pecos River Compact (Barroll, 2002); and

- The Red Bluff Accounting Model (RBAM) that provides a monthly and annual analysis of Pecos River, tributary, and groundwater base inflows from Avalon Dam to the New Mexico-Texas stateline.

In addition to these discreet model components, there are several pre- and post-processing and analysis tools, including the Data Processing Tool (DPT) (Hydrosphere Resource Consultants, 2002). The DPT provides input/output data processing capabilities between the RiverWare, CAGW, and RBAM models. It also provides an archiving facility that tracks data and model results through the scenario evaluation process. A map of the approximate spatial domains of the models is shown in Figure 1. A schematic illustration of data flow between the component models is provided in Figure 2.

1.2 The Carlsbad Project Offer Phase Adjudication Settlement and the Consensus Plan

Since the U.S. Supreme Court's 1988 Amended Decree ruling on the Pecos River Compact, New Mexico has achieved compliance largely through short-term leasing of irrigation water rights. In 2001, faced with the prospect of a potential compact delivery shortfall and the possibility of a priority call, the New Mexico ISC formed an *ad hoc* committee comprised of water users and stakeholders in the Pecos River basin to develop a long-term solution to the Compact compliance problem. These discussions led to development of the "Consensus Plan," which resulted in a settlement agreement for the adjudication of water rights in the Carlsbad Project Offer Phase of the *Lewis Case*, signed in March 2003.

The goals of the Adjudication Settlement terms are to supply water to the CID, a senior water rights holder at the lower end of the Pecos River, comply with the Pecos River Compact and U.S. Amended Decree ("Compact"), and to avoid the need for a priority call. With regard to the Compact, the U.S. Supreme Court determined that on average, New Mexico had under delivered in its delivery obligations of water to the stateline by about 10,000 acre-feet annually between 1952 and 1983. The U.S. Amended Decree to the Pecos River Compact is explicit in its prohibition of an accrual of debt, but does allow an accrual of credit. Delivery obligations of water must be paid for with water, not monetary compensation. The Adjudication Settlement will allow New Mexico to bypass water past CID to accumulate a credit to "buffer" against future drought situations, during which the threat of under-delivery may be heightened. Following the U.S. Supreme Court adopted the Amended Decree in 1988, the ISC retired water rights appurtenant to 9,316 acres in the Roswell Basin, but has largely been avoiding net shortfalls via short-term water leases. The Settlement will provide a more permanent solution to this problem.

CID's surface water rights are among the most senior in the Lower Pecos River Basin, while groundwater pumpers in the just-upstream Roswell Basin (members of the Pecos Valley Artesian Conservancy District, PVACD) hold relatively junior rights. Unit response functions for pumping in the Roswell Basin indicate it can take decades for a reduction in groundwater pumping to accumulate to the river (Fig. 3). Thus in a surface-water short year, a priority call that curtails the use of junior water rights from approximately 100,000 acres of groundwater-supplied agriculture in the PVACD would not supply the senior water right holder downstream, nor provide flows to comply with the Compact in a timely fashion to alleviate a potential shortfall.

The Adjudication Settlement incorporates key components of the Consensus Plan listed below that were evaluated using the PRDSS:

- The NMISC purchases up to 18,000 acres of irrigated land and retires appurtenant surface and ground water rights (distributed 1/3 from CID lands and 2/3 for PVACD and other lands to the north);
- Groundwater pumping of a portion of the retired PVACD water rights to augment Pecos River flows, subject to an annual limit of 35,000 acre-feet and 5-year accounting-period limit of 100,000 acre-feet; and
- Release of the ISC's shares of water appurtenant to CID lands it acquires from Avalon Dam directly to the stateline for Compact compliance, subject to limits described in 2.3.

Besides addressing the priority administration issue, the actions in the second component that help keep CID "whole" are important because of the interdependence of CID surface and groundwater supplies and their impacts on Compact compliance. CID irrigators receive surface water deliveries based on an allotment, determined from existing surface water supplies in CID reservoirs. In periods of low surface water supply, CID irrigators may pump Carlsbad Basin groundwater to supplement their surface water supplies. The combination of reduced surface water delivery plus increased groundwater pumping has a direct and significant impact on return flows and base flows into the Pecos River below Avalon Dam, adversely affecting New Mexico's annual Compact deliveries.

1.3 Carlsbad Project Water Operations and Water Supply Conservation EIS

In 1987, the Pecos bluntnose shiner (henceforth referred to as the PBNS or "shiner") was listed as federally threatened under the Endangered Species Act (ESA). In 1991, a Biological Opinion ("BO") was issued by the U.S. Fish & Wildlife Service in regards to the effects of water operations of the Pecos River on continued existence of the shiner. In response to the 1991 BO, Reclamation has undertaken a variety of temporary actions, including water acquisitions and dam re-operations in an effort to conserve the shiner. To develop a long-term solution to this problem, Reclamation began work on an EIS to evaluate its Pecos River operations.

As described in the Notice of Intent for the Carlsbad Project Water Operation and Water Supply Conservation EIS ("Carlsbad Project EIS"), the purposes are: (i) to conserve the federally threatened PBNS, and (ii) to conserve the Carlsbad Project ("the Project") water supply, and the underlying need is to comply with the ESA and Reclamation's responsibility to conserve the Project water supply. It is this purpose and need statement that guides how the hydrological impact assessment using the PRDSS will proceed. The ultimate objective of the Carlsbad Project EIS is to allow decision-makers to select a preferred alternative for operating Project facilities to meet the purpose and need.

Several alternatives have been identified to meet the Carlsbad Project EIS purpose and need. To conserve the PBNS, most of the alternatives contemplate reservoir operations tailored to meet in-stream flow requirements for the upper critical habitat reach of the Pecos River; in practice this is accomplished by operating the reservoirs to meet target flows. These types of operations cause depletions to the CID supply; so achieving the second purpose will require some sort of water acquisition program to offset depletions to the CID supply caused by operations to conserve the

PBNS. Numerous water acquisition options have been identified, including some that mimic the Consensus Plan water right retirement and augmentation pumping scheme.

2.0 PRDSS APPLICATION TO PECOS WATER MANAGEMENT ISSUES

Clearly, there is significant overlap between the problems and potential solutions for the Adjudication Settlement and the Carlsbad Project EIS. As designed and implemented, the component models of the PRDSS explicitly account for the hydrological features in the basin that can help quantitatively describe basin response to management actions contemplated by the Adjudication Settlement and the Carlsbad Project EIS. For the Adjudication Settlement, the PRDSS is being used to demonstrate that the Consensus Plan can indeed meet its goals under a broad range of hydrological conditions, and to refine details of Consensus Plan operations. For the Carlsbad Project EIS, the PRDSS is the tool being used to evaluate the potential impacts of the water management alternatives proposed to conserve the PBNS and the Project water supply.

2.1 Resource Indicators

To evaluate, compare, and contrast the relative benefits of the various management alternatives, we have identified several resource indicators that will be computed for each model run, including:

1. Pecos River flows at the Taiban and Acme gages, located above and below the PBNS critical habitat reach, respectively, which is the reach most susceptible to flow intermittency; this resource indicator relates directly to PBNS habitat maintenance;
2. Annual CID supply, which directly relates to the CID supply conservation purpose of the Carlsbad Project EIS and the Adjudication Settlement; and
3. Stateline flows, which relate directly to New Mexico's ability to comply with the Compact.

Below we present model evaluation results for each of these three resource indicators.

2.2 Baseline Model

Again, to compare model predictions to each other, you need to first identify a baseline, or a "No Action," model, against which all "Action" models will be evaluated. The PRDSS models are driven by two classes of model inputs: anthropogenic stresses and natural hydrological inputs.

Regarding anthropogenic stresses, reservoir operations prior to the 1991 BO together with groundwater pumping in the Roswell Basin between 1991 and 2000 were selected to represent baseline management conditions in the Lower Pecos River Basin for a variety of reasons, including:

- Prior to the 1991 BO, reservoirs on the river were operated in the most efficient way to minimize losses and depletions, and
- In response to the U.S. Supreme Court's Amended Decree in 1988, New Mexico permanently retired water rights in the Roswell Basin; the 1991-2000 pumping rate is assumed to account for the retired rights.

For the natural hydrological variability we have chosen to utilize the Pecos River inflows, both main stem at Santa Rosa as well as all tributaries. An historical period was selected to represent natural groundwater recharge and evapotranspiration stresses to the system.

2.3 Action Model: Adjudication Settlement

For the Adjudication Settlement, the three key components listed in Section 1.2 were evaluated in the PRDSS. The third component listed, release of ISC water to the stateline, was governed by a set of operating criteria set forth in the terms of the Adjudication Settlement. The disposition of the ISC's water rights rights appurtenant to lands ISC acquires in the CID is conditioned on two important objectives: 1) to reduce the threat of under-delivery according to the Compact, and 2) to maximize water available for agricultural production in New Mexico. The Adjudication Settlement terms are designed to meet both objectives, guided by targets goals for building credit under the Compact and providing water to the senior water right holder, CID. Thus, the distribution of water from the 6,000 acres of CID land purchased by the ISC is based on a tiered schedule of delivery and redistribution as follows:

- If Compact credit is less than 50,000 acre-feet, ISC water is delivered to the stateline on each of the five CID allotment dates.
- If CID supply is less than 50,000 acre-feet on March 1 and Compact credit is at least 50,000 acre-feet, ISC water is reallocated to other CID members.
- If Compact credit is between 50,000 and 115,000 acre-feet, and the CID supply is less than 90,000 acre-feet, ISC will make its CID water available for re-distribution to CID irrigators.
- If Compact credit is between 50,000 and 115,000 acre-feet, and the CID supply is greater than 90,000 acre-feet, ISC's share of water will be turned directly into the river from Avalon Dam for delivery to the stateline.
- If Compact credit is greater than 115,000 acre-feet, ISC will make its water available for re-distribution to other CID irrigators up to the decreed limit (3.697 acre-feet/acre); if CID irrigators have full allotment, excess water is to be held in storage for future years.

Tables 1 through 3 provide a summary of PRDSS prediction for each of the resource indicators listed above (Section 2.1) for both the Baseline and Adjudication Settlement models.

Table 1. Resource indicator: flows at Acme.

Acme Flow Statistics (cfs)		
	Baseline	Settlement
Maximum	6,306	6,845
Mean	103	106
Minimum	0.0	0.0
Exceedence Values (cfs):		
	Baseline	Settlement
50%	6.00	6.00
75%	0.21	0.21
90%	0.00	0.00
95%	0.00	0.00
99%	0.00	0.00

Table 2. Resource indicator: average CID Supplies

	Baseline	Settlement	Net Increase
CID Delivery (af/yr)	67,731	75,801	8,070
Equiv. Allotment (af/acre)	2.51	2.95	0.44

Table 3. Resource indicator: average Pecos River flows at New Mexico – Texas stateline.

	Baseline	Settlement	Net Increase
PR at Stateline (af/yr)	81,100	89,600	8,500

2.4 Action Model: Carlsbad Project EIS Instream Flow Targets

For the Carlsbad Project EIS analysis (Section 1.3), most of the Action alternatives intended to conserve the PBNS contemplate operations at Sumner Reservoir, which is upstream of the upper critical habitat, that are designed to meet in-stream target flows at either the Taiban or Acme gages. Figure 4 shows the predicted flow frequency curves for the Pecos River at Acme gage under both the Baseline scenario, as well as for several target-flow scenarios. Figure 5a shows the preliminary results if the target-flow operations are limited to bypassing flows through Sumner Dam just upstream of the critical habitat reach (bypassing is the only operation that is authorized under the current water rights). Figure 5b shows the preliminary flow exceedence curves if water is released from storage in Sumner Reservoir to meet the flow targets; establishment of a "fish conservation pool" in Sumner is one of the alternatives currently being considered in the EIS. Biologists working on the project note that the most severe adverse impact to the species occurs during flow intermittencies in the upper critical habitat reach of the Pecos. Table 4 summarizes the predicted intermittencies for the Baseline and Action scenarios.

As noted in Section 1.3, these types of operations geared at conserving the PBNS cause depletions to the CID supply, which need to be offset to meet the second purpose of the EIS. Figure 5 shows preliminary estimates of net depletions to the CID supply (not counting for spills), for both the bypass and take-from-storage methods from Sumner Reservoir to meet the flow targets. Finally, Figure 6 presents the preliminary impact of the operations to conserving the PBNS on the New Mexico – Texas stateline flows.

Table 4. Resource indicator: Flows at Acme, frequency of intermittency for both the bypass and take-from-storage methods to meet the flow targets.

Frequency of Intermittency at Acme (Intermittency = 0.0 cfs)

Number of Days	No Action	Release from Storage			Bypass Flow		
		10 cfs	35 cfs	71 cfs	10 cfs	35 cfs	71 cfs
1	21	1	1	3	13	14	14
2 - 5	40	2	2	8	18	24	24
6 - 10	41	0	3	6	15	8	13
11 - 20	54	0	1	6	9	11	13
21 - 30	22	1	0	3	6	8	8
> 30	44	0	0	4	3	1	1
% of Time Intermittency Occurred	17.6	0.1	0.2	1.7	2.6	2.5	2.9

3. RESULTS AND CONCLUSIONS

The preliminary results presented above illustrate the beneficial hydrologic impacts of the Adjudication Settlement Agreement, both to CID supplies and stateline flows. They also show that the operations designed to benefit the threatened PBNS can lead to significant depletions to the CID supplies. Future model runs will include analyses of the water acquisition options being contemplated as part of the Carlsbad Project EIS, to determine which will be able to offset the depletions caused by the operations to conserve the PBNS.

Through the use of the linked groundwater and surface water models of the Pecos River Decision Support System, the management scenarios under consideration for EIS, ESA, and interstate compact issues can be evaluated for both potential effectiveness in meeting stated purposes and needs, and resulting impacts on key resource indicators.

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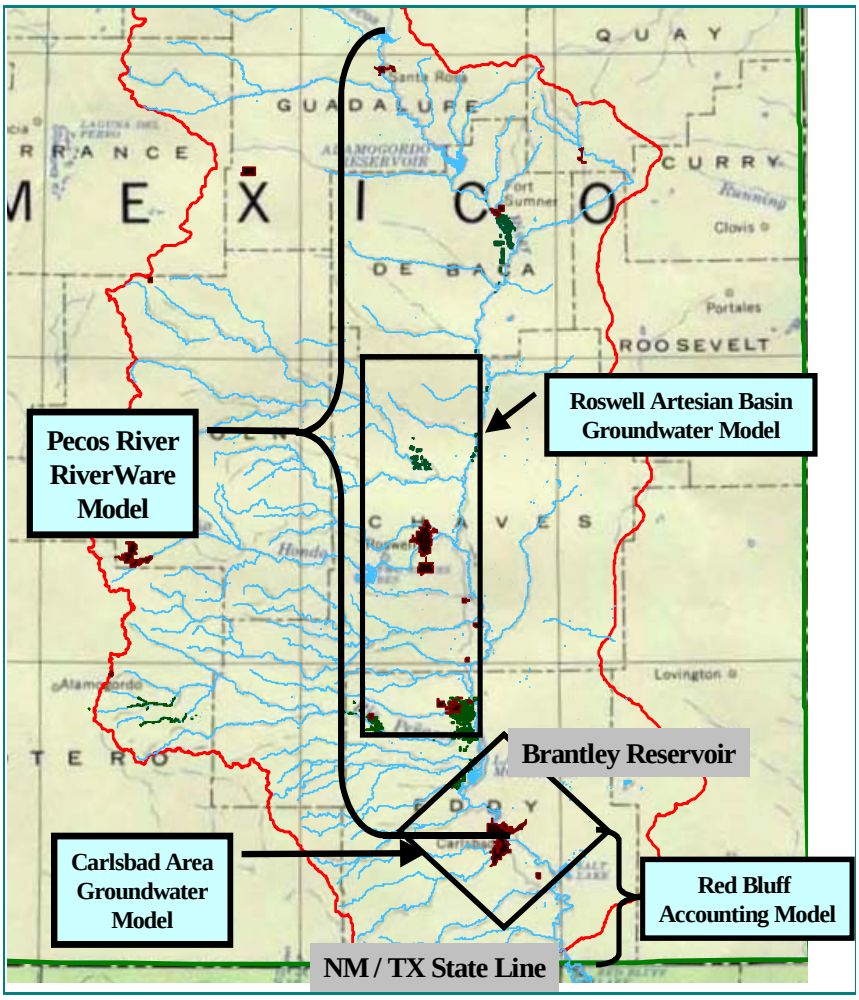


Figure 1. Geographic extent of region considered by each of the models that comprise the PRDSS.

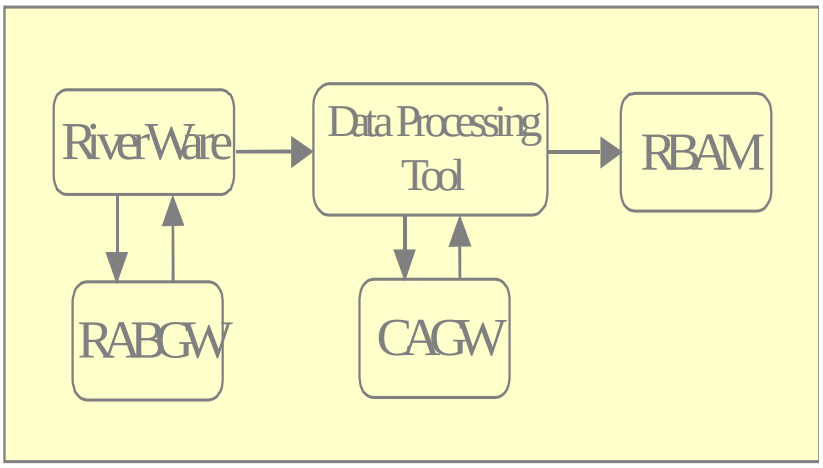


Figure 2. Schematic diagram illustrating data flow between each of the models that comprise the PRDSS.

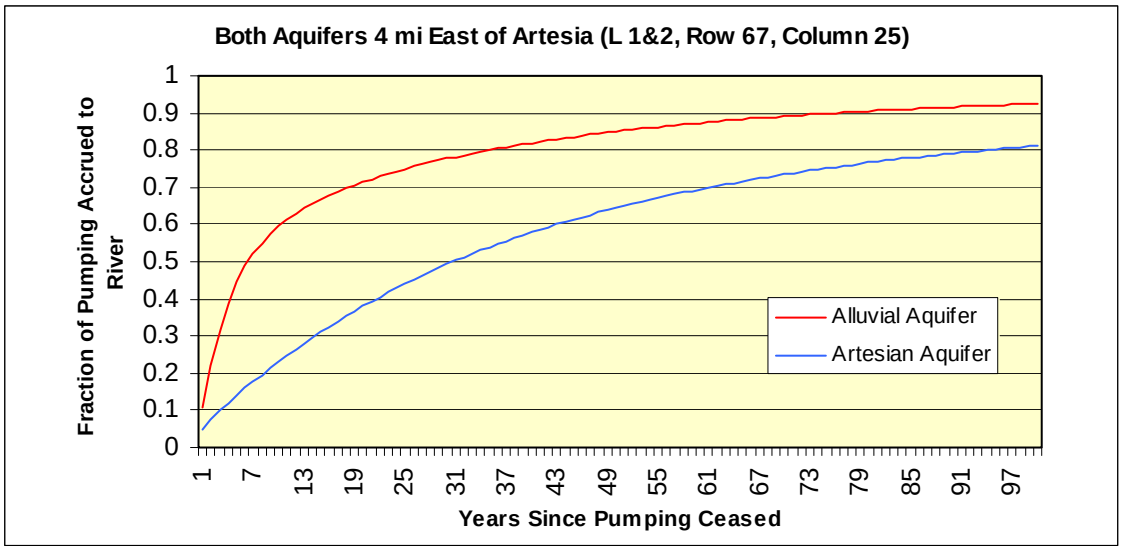


Figure 3. Unit response functions showing time that it takes for a unit of pumping in the artesian and alluvial aquifers in the Roswell Basin to accrue to Pecos River baseflows.

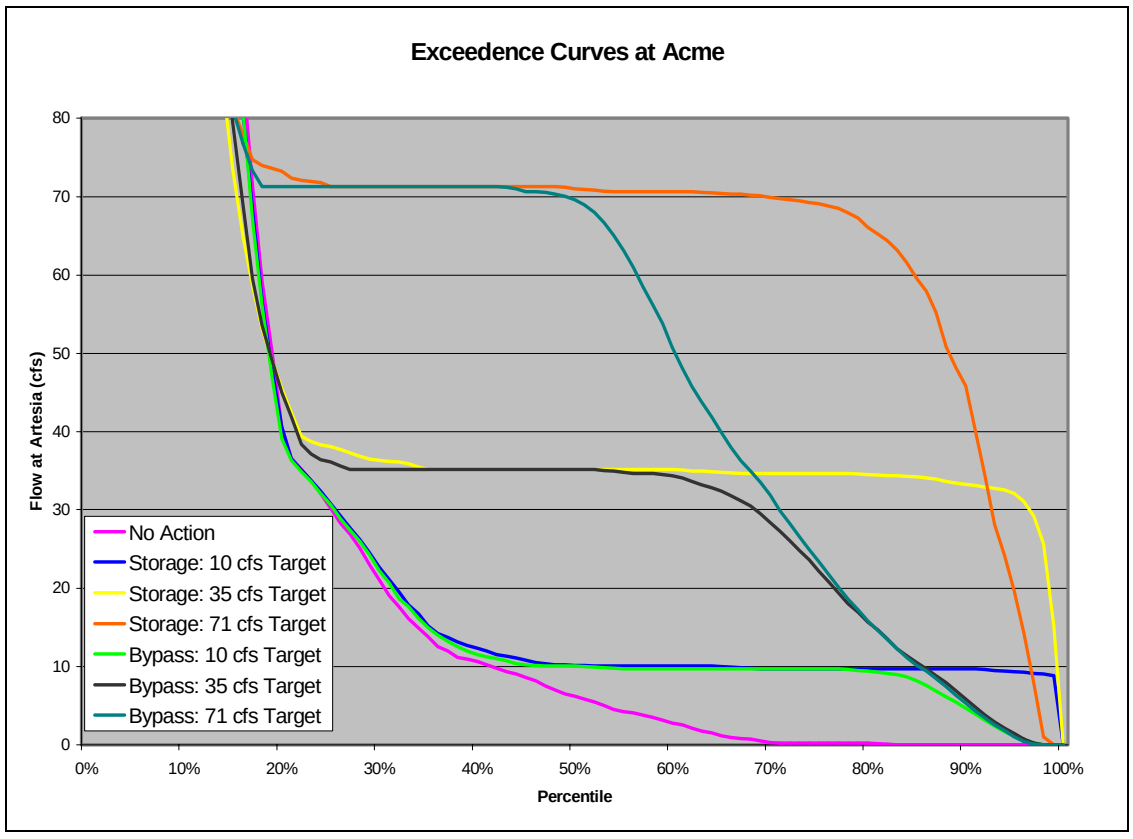
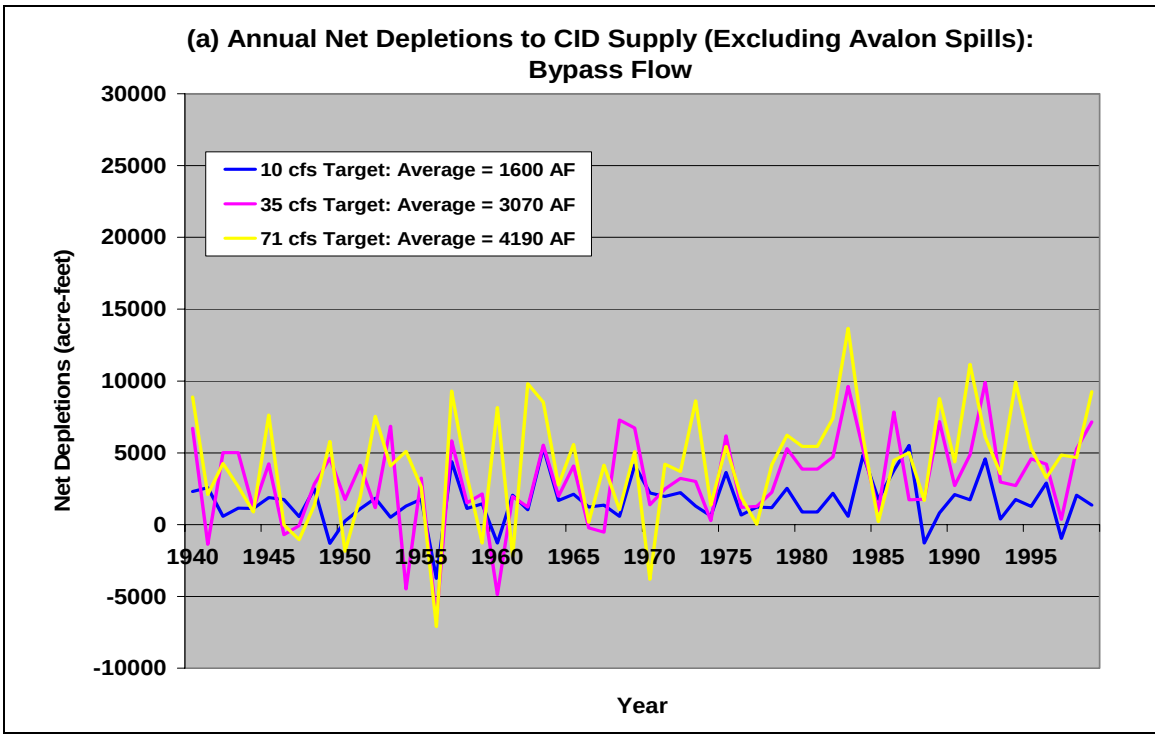


Figure 4. Flow frequency curves for the Pecos River at Acem gage, for Baseline (No Action) and various flow target Actions met by both flow-bypass operations at Sumner Reservoir, and release-from-storage operations at Sumner Reservoir.

Figure 5. Net depletions to the CID supply caused by "fish operations", for both the (a) bypass, and (b) take-from-storage methods to meet the flow targets.



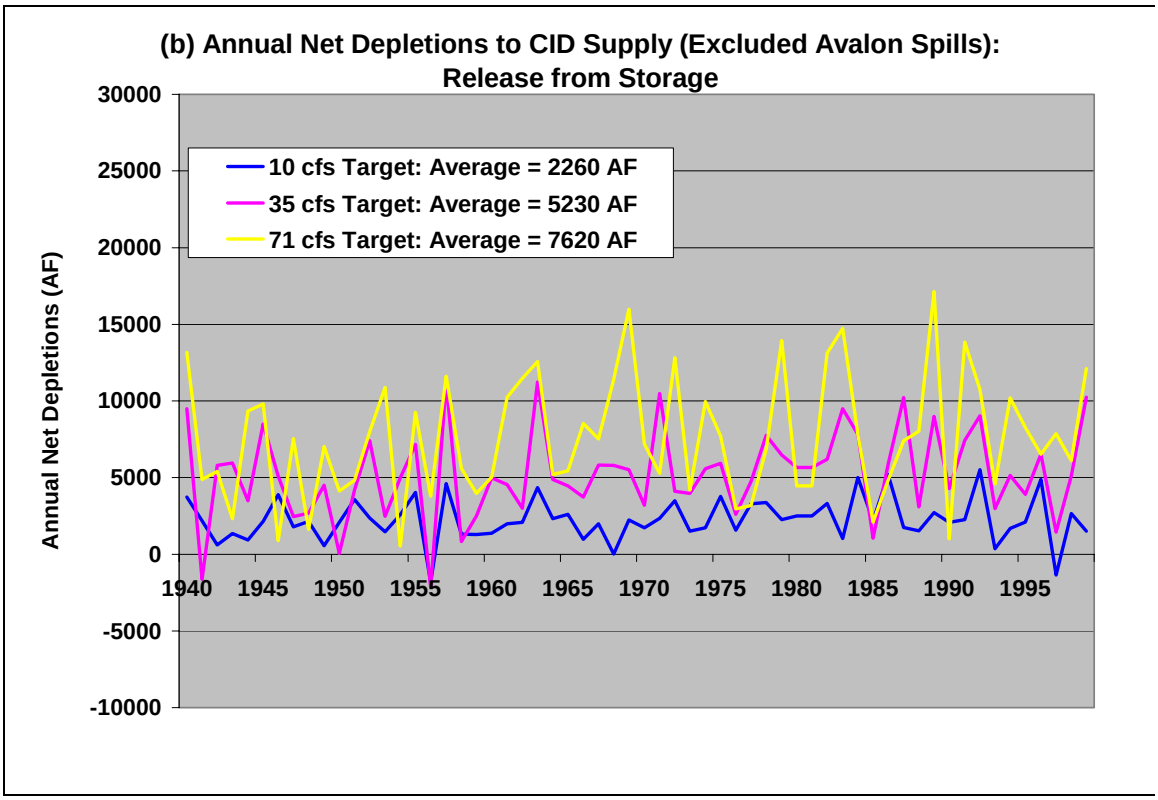


Figure 6. New Mexico – Texas state line flows for Baseline (No Action) and "fish operations" for the take-from-storage methods to meet the flow targets.