EVALUATION OF THE PECOS RIVER CARLSBAD SETTLEMENT AGREEMENT USING THE PECOS RIVER DECISION SUPPORT SYSTEM

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ABSTRACT

The Pecos River Decision Support System (PRDSS) is a complex set of hydrologic models that simulates the hydrology and operations of key surface water and groundwater systems associated with the Pecos River. The PRDSS has been used in the development and evaluation of a complex water rights settlement agreement that is intended to help New Mexico achieve long-term compliance with the Pecos River Compact. The agreement anticipates that the State of New Mexico will purchase water rights, retire irrigated farmland, and operate wells to augment the flows of the Pecos River. The water rights acquired will be used to make deliveries to the state line as required by the Compact and to ensure certain water supplies to the Carlsbad Irrigation District. The PRDSS has been used extensively for evaluating the key terms of the Settlement Agreement using input data based on the historical hydrology records from 1967 to 1996 including river gages, pumping records and meteorological data. Two model scenarios were developed for this evaluation: the baseline scenario and the Settlement scenario that simulates the operation of the system under the Settlement Agreement. Several key resource indicators were identified to evaluate the results of the simulations. These include Pecos River compact obligations and departures, CID surface water allotment and supplemental well pumping and augmentation pumping in the Roswell basin.

The model results indicate that implementation of the Settlement agreement will:

1. Reduce the possibility of New Mexico defaulting on its Pecos River Compact obligations, and most likely result in credit over the long-term;
2. Increase the total annual surface water supply available to CID irrigators; and minimize the chances of a priority call by CID.

The PRDSS has proven a valuable tool for evaluating various actual or proposed management policies in the Pecos River basin.

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INTRODUCTION

The Pecos River, which is a tributary of the Rio Grande, originates at an altitude of 12,000 feet in the Sangre de Cristo Mountains of north-central New Mexico.. The river flows southward through the semi-arid high plains of southeastern New Mexico and west Texas to join the Rio Grande near the town of Langtry, Texas.. A companion paper (Carron et al., 2006) describes the physical character of the river basin and provides and overview of water operations in the New Mexico sections of the river. The waters of the Pecos River are allotted between New Mexico and Texas by the terms of the Pecos River Compact of 1947 and an amended decree issued by the U.S. Supreme Court in 1988 after Texas sued New Mexico alleging violations of the terms of the original Compact.

The Supreme Court found that New Mexico had been under-delivering an average of 10,000 acre-feet of water each year for the past several decades. Since the 1988 ruling, New Mexico has met its Compact obligation shortfalls primarily through a series of short-term water leasing agreements. In March 2003, the State of New Mexico entered into an agreement with the Carlsbad Irrigation District (CID), the U.S. Bureau of Reclamation and the Pecos Valley Artesian Conservancy District (PVACD) regarding the adjudication of the Carlsbad Project Water Rights. This "Settlement Agreement" not only resolves certain outstanding water rights adjudication claims in the basin, but also provides a permanent mechanism for the State of New Mexico to meet its Compact obligations. Key components of the Settlement Agreement include purchase and retirement of irrigated lands and use of appurtenant ground water and surface water rights to meet Compact delivery requirements and to supplement the water supply of the Carlsbad Irrigation District.

This paper provides an overview of the Settlement Agreement, focusing in particular on the operational (hydrologic) components of the agreement. We then discuss the modeling of the Settlement Agreement components by the Pecos River Decision Support System (see companion paper by Carron et al.). The PRDSS was used to evaluate the terms of the Settlement, and to investigate how the Settlement might impact river operations and water supplies for other water users in the basin.

Pecos River Basin Overview

The Pecos river basin drains an area within New Mexico of approximately 20,000 square miles (**Figure 1**). In general, the climate of the basin is semiarid to arid with moderate winters and hot summers. The average annual precipitation over the greater portion of the basin varies between 11 and 16 inches annually. Seventy five to eighty percent of annual precipitation occurs during the period from May to October. Winter precipitation annual average is one-half inch in most parts of

the basin except in the mountainous regions where it increases with elevation to over one inch.

Pecos River water has three primary sources. The first is snowmelt and runoff from the headwaters in the Sangre de Cristo Mountains, which averages about 55,000 acre-feet annually. The second source is overland flood flow, which is generated by precipitation, and on average provides between 20,000 – 300,000 acre-feet annually. The third source of Pecos River water is groundwater base inflow at three primary locations: springs located in and around Santa Rosa (36,000 – 60,000 acre-feet annually), Roswell to Artesia area (historically as high as 120,000 acre-feet annually, now approximately 15,000 to 20,000 acre-feet annually) and the Carlsbad area (20,000 – 30,000 acre-feet annually), **Figure 1**. The first two sources (snowmelt runoff and precipitation-based tributary inflows) are highly variable. The third source is less variable, although it is subject to significant impacts from ground water pumping.

There are primarily three processes that contribute to the reduction of flows in the Pecos River: natural evapotranspiration, seepage of water into the underlying ground water system, and human-induced consumptive use, mainly from irrigation. On average, approximately 110,000–120,000 acre-feet of Pecos River surface water is diverted for irrigation of crops. Two large irrigation districts, the Carlsbad Irrigation District (CID) and the Fort Sumner Irrigation District (FSID), use approximately 85 percent of the surface irrigation water. The remaining usage is by many individual irrigators who pump water directly from the river, and by small acequias, which are community operated irrigation canals. There are four primary reservoirs on the Pecos River that regulate the flow of the river (**Figure 1**). These reservoirs are used primarily to store irrigation water for CID and for flood control. They also provide recreational and environmental benefits.

Two major groundwater basins are directly connected to the Pecos River: the Roswell groundwater basin and the Carlsbad groundwater basin. The Roswell groundwater Basin consists of an extremely productive artesian (confined) aquifer that is overlain by a thick confining unit, and topped off by a shallow alluvial aquifer. In the early part of the 20th century, the artesian aquifer supported high-capacity artesian wells, from which water flowed freely at the surface without the need for pumps. Large groundwater diversions from the two aquifers support irrigation of more than100,000 acres. As mentioned earlier, the base flow from the Roswell basin is a major component of the Pecos River flow. Base inflow from the Roswell Basin has changed dramatically since the early 1900's, due in large part to the growth of ground water use for irrigation. In the Carlsbad basin there are two important aquifers: an alluvial aquifer associated with the Pecos River and its tributaries, and a karstic carbonate aquifer associated with the Permian Capitan Reef. When the surface water supply is inadequate, many CID members pump supplemental groundwater from these aquifers.

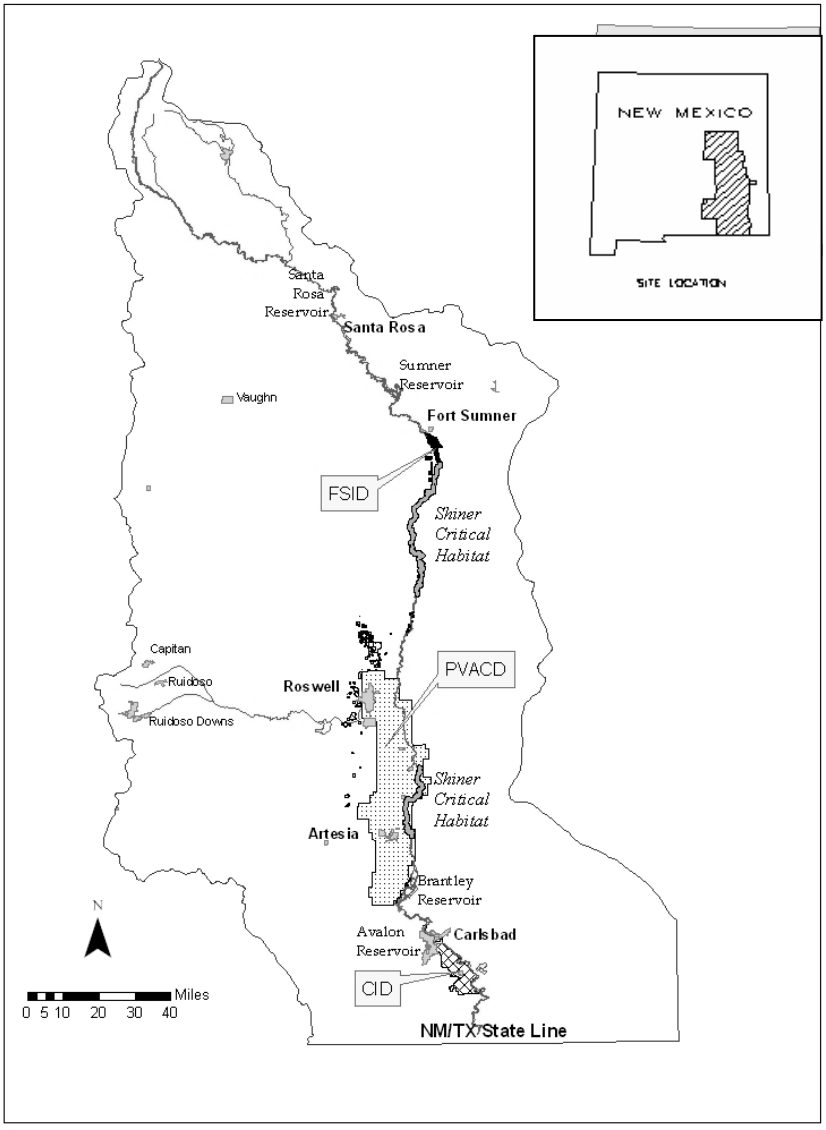

Figure 1. Map of the Pecos River Basin.

Pecos River Compact and Supreme Court Amended Decree

In 1948 New Mexico and Texas entered into the historic Pecos River Compact, and the negotiators were fully confident that the agreement would put conflicts between the states behind them (Thorson, 2003). The Pecos River Compact was intended to provide a means for dividing the surface waters of the river. However, only thirty years later, the states were before the U.S. Supreme Court to enforce and ascertain the meaning of the 1948 compact (op. cit). In 1974, Texas filed a suit in the U.S. Supreme Court complaining that New Mexico had failed to

deliver all the water required by the compact. The Supreme Court eventually ruled that New Mexico had failed to meet compact obligations and required New Mexico to pay for past under-deliveries and thereafter to meet the delivery obligation every year (**Figure 2**). The court also issued in 1988 an amended decree appointing a River Master who determines New Mexico's annual obligation and compliance. New Mexico's obligation is determined by a complex set of instructions called the River Master's Manual. The primary factor in determining New Mexico's obligation is flood inflow. Flood inflow is determined by an examination of USGS stream flow gage records combined with a series of hydrologic calculations. It includes releases from Sumner Dam and the total overland and tributary flows accumulating to the Pecos between Sumner Dam and the state line. The manual provides that roughly 50 percent of the flood inflow to the basin must be delivered to Texas over a three-year period. Therefore, each year, New Mexico is required to deliver one-sixth of the current and one-sixth of each of the previous two-year's flood inflows.

Since 1988, New Mexico has achieved compliance largely through short-term leasing of irrigation water rights (**Figure 2**). Due to a potential compact delivery shortfall in 2001, discussions on a long-term solution to the compact compliance problem began between water users and stakeholders in the Pecos basin. These discussions resulted in the "consensus plan" and ultimately led to an adjudication settlement agreement on the Carlsbad project water rights, which is known as the Pecos River Carlsbad Settlement Agreement.

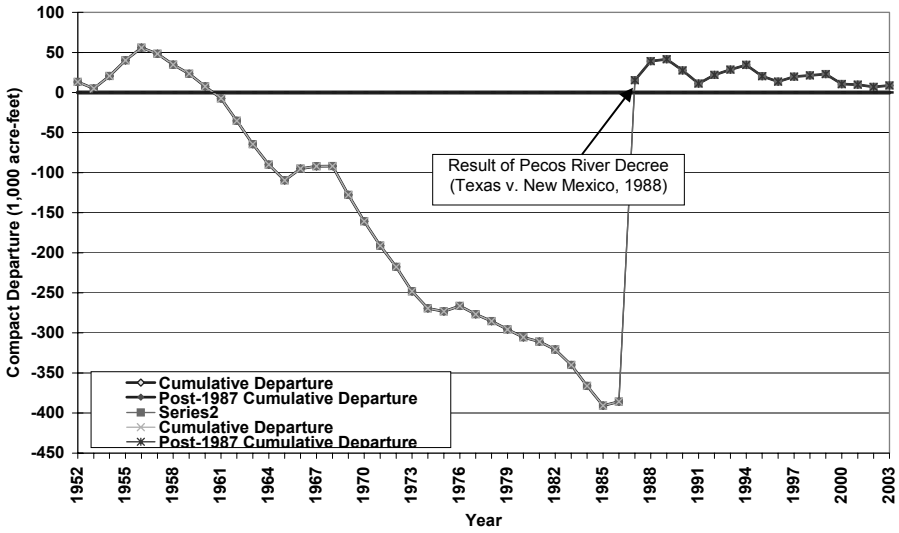

Figure 2. Pecos River Compact Cumulative Departure
1952-2003

THE PECOS CONSENSUS/ SETTLEMENT PLAN

In January 2003, the State of New Mexico entered into an agreement with the Carlsbad Irrigation District, the U.S. Bureau of Reclamation and the Pecos Valley Artesian Conservancy District regarding the adjudication of the Carlsbad Project Water Rights. The settlement adjudicates the water rights of CID, provides for an annual water allotment of 3.697 acre-feet per acre to CID members, and establishes a schedule for delivery of water to the state line. Implementation of the settlement requires satisfaction of the conditions precedent, which include: entry by the court of a partial final decree; adjudication of CID's water rights; implementation of the consensus plan which anticipates that the State of New Mexico will purchase water rights, retire irrigated farmland, and operate wells to augment the flows of the Pecos River; and completion of federal National Environmental Policy Act (NEPA) requirements.

The water rights acquired will be used to make deliveries to the state line as required by the Compact to avoid future under deliveries and to accumulate a net compact credit. These water rights will be used also to ensure certain water supplies to the Carlsbad Irrigation District to avoid future priority calls. The key components of the consensus plan include:

- Purchase and retirement of appurtenant water rights for 6,000 acres of land within CID;
- Purchase and retirement of 11,000 acres of land within PVACD;
- Delivery of the state owned CID water from Lake Avalon directly to the state line, subject to certain limits;
- Pumping from wells in the Roswell artesian basin to supplement Pecos River flows and to augment CID's surface water supply in low-supply years, up to the supply target levels shown in **Table 1**, subject to annual pumping limits of 35,000 acre-feet and a 5-year accounting period limit of 100,000 acre-feet.

Table 1. CID Surface Water Supply Thresholds for Augmentation Pumping (Effective Brantley Reservoir Storage)

Target Date	Target Supply
March 1	50,000 acre-feet
May 1	60,000 acre-feet
June 1	65,000 acre-feet
July 15	75,000 acre-feet
September 1	90,000 acre-feet

MODEL ANALYSIS AND RESULTS

Modeling Tools and Processes

The Pecos River Decision Support System (PRDSS) suite of models was used to evaluate the impacts of the terms of the Settlement Agreement. The models include a RiverWare model of river and reservoir operations between Santa Rosa Reservoir and Avalon Dam, two MODFLOW groundwater models of the Roswell and Carlsbad groundwater basins (the RABGW and CAGW models, respectively), a Pecos River Compact accounting model, and various pre- and post-processing tools for performing data input/output functions and post-run analyses. These tools are described in greater detail in a companion paper by Carron et al. (2006).

Model Input Data and Assumptions

The models used input data based on the historical hydrology records, from 1967 to 1996 including river gages, pumping records and meteorological data, with current or proposed operational rules superimposed on the hydrologic record. This period contains years of higher water supply as well as years of lower water supply. Thus it allows an evaluation of the effectiveness of the Settlement Plan under a variety of hydrologic conditions. This period was selected, in part, because some of the components of the hydrologic system, such as groundwater pumping, are better defined and stream gaging data are generally more complete. The models are reliable for estimating the long-term impact of implementing the proposed action, but they have not being used to predict water supply conditions at specific times and locations.

Two model scenarios were developed for this evaluation. The Baseline scenario, as the name suggests, represents a pre-settlement baseline condition against which proposed actions may be evaluated. The second scenario - termed the Settlement scenario herein - simulates the operation of the system under the Pecos River Adjudication Settlement Agreement (the Settlement). The Settlement scenario is essentially a translation of the Settlement agreement into model rules and data. In addition to the settlement terms described in the previous section, other key modeling assumptions used in evaluation of the scenarios include:

- Combined surface water allocation plus supplemental well pumping in CID limited to 3.0 feet per acre per annum for the baseline, and 3.697 feet per acre per annum under the settlement scenario;
- CID surface water allotments based on decreed 25,055 acres, deliveries to 20,000 irrigated acres (baseline), or 19,055 irrigated acres + 6,000 equivalent acres of state water rights (settlement);
- PVACD alluvial ground water pumping rates based on recent (1991–2000) historical use patterns, extrapolated back to 1967, artesian aquifer pumping rates use historical data 1967–1996;

• Permanent land retirements by ISC and other agencies are represented in both scenarios; and
• Temporary lease programs for Endangered Species Act (ESA) compliance and Pecos River Compact compliance are not included in either scenario.

Simulation of the two scenarios, and evaluation of their results, provides an estimate of the changes in water supply that is expected when the Settlement agreement is implemented.

Results

For evaluation of the settlement scenario, several key resource indicators were identified to evaluate the results of the simulations. These include:
• Estimated Pecos River Compact deliveries and credits;
• CID surface water allotment and supplemental pumping rates; and
• Augmentation pumping of purchased PVACD water rights.

Results of the scenario evaluation indicate that the settlement terms would likely increase state-line flows by approximately 9,500 acre-feet annually. **Figure 3** shows the estimated Pecos River Compact cumulative departure for both scenarios. Note that although the baseline results show a net deficit, this is not necessarily an indication or prediction of future non-compliance. Rather, we want to focus on the net gain in deliveries, as indicated by the difference in compact deliveries between the two scenarios.

Under the Settlement, CID, which is relatively a senior downstream water right holder, will not attempt a priority call on Pecos River basin water rights if they have at least 50,000 acre-feet of divertable supply each year.

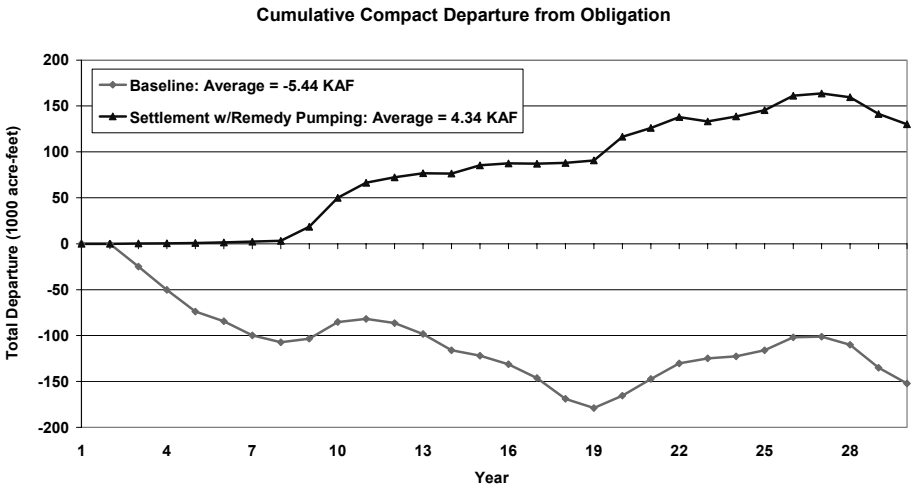

Figure 3. Comparison of Cumulative Compact Departure under the Baseline and Settlement Scenarios. (Carron, 2004)

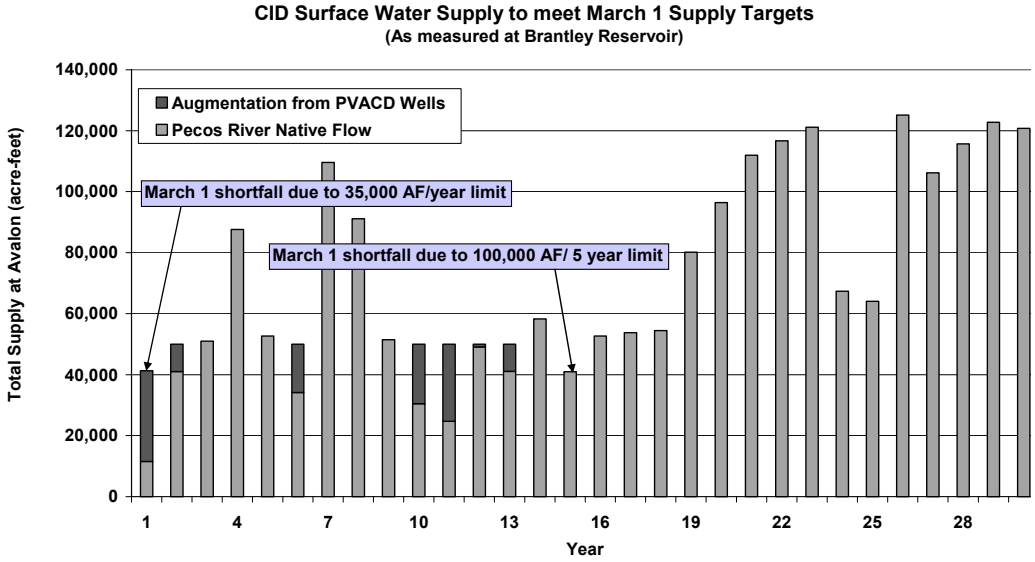

Figure 4. Augmentation Pumping required to meet 50,000 AF March 1 Supply Target (Carron, 2004).

To achieve this goal, ISC would use its purchased PVACD water rights to augment CID's surface water supply at times when the natural CID surface water supply is less than the prescribed thresholds (refer to Table 1). This means in practice that a need for a priority call is circumvented if CID's water supply reaches 50,000 acre-feet by March 1 (the beginning of the irrigation season) of each year. **Figure 4** illustrates the amount of augmentation pumping required to provide CID with 50,000 acre-feet of water on March 1 for each year under the settlement scenario and emphasizes the potential importance of augmentation pumping to the Pecos River in avoiding a priority call.

The total annual water supply available to CID under the settlement, including augmentation pumping, is shown in **Figure 5**.

The model estimated that ISC would pump an average of 12,500 acre-feet annually from its purchased PVACD water rights to augment the Pecos River flow as shown in **Figure 6**. A significant amount of augmentation pumping would occur in the first 10-15 years. During this time, the NMISC would be releasing most of its CID allotment to help build a credit at the state line. As a result, there would be less carryover water each year and a higher likelihood of additional augmentation pumping required to meet the CID target storage values. Over time, there would be fewer state line releases, more carryover, less augmentation pumping, and more aquifer recovery, which would further reduce the need for compact deliveries and augmentation pumping

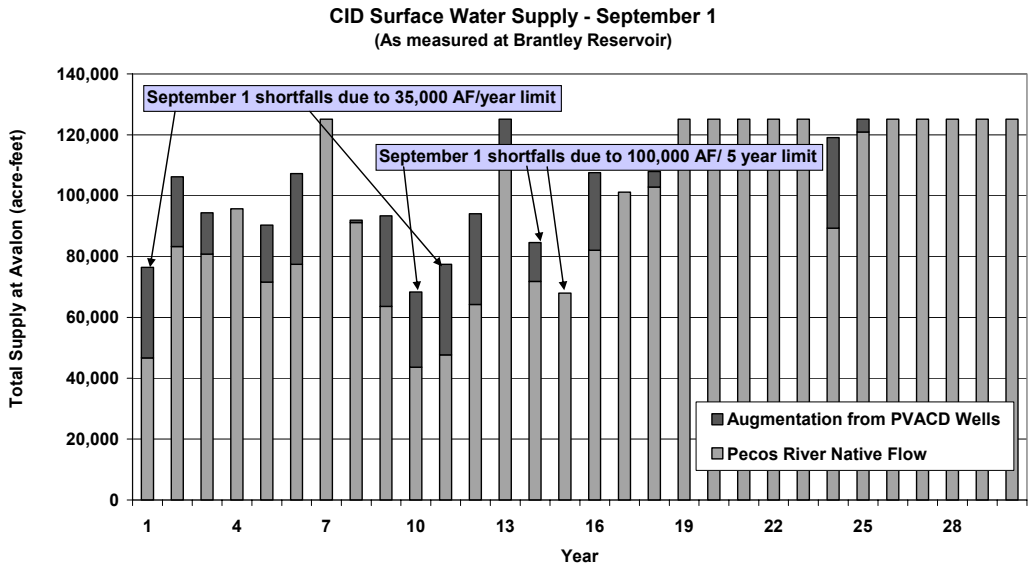

Figure 5. Total CID Supply from "Natural" and Augmentation Sources (Carron, 2004).

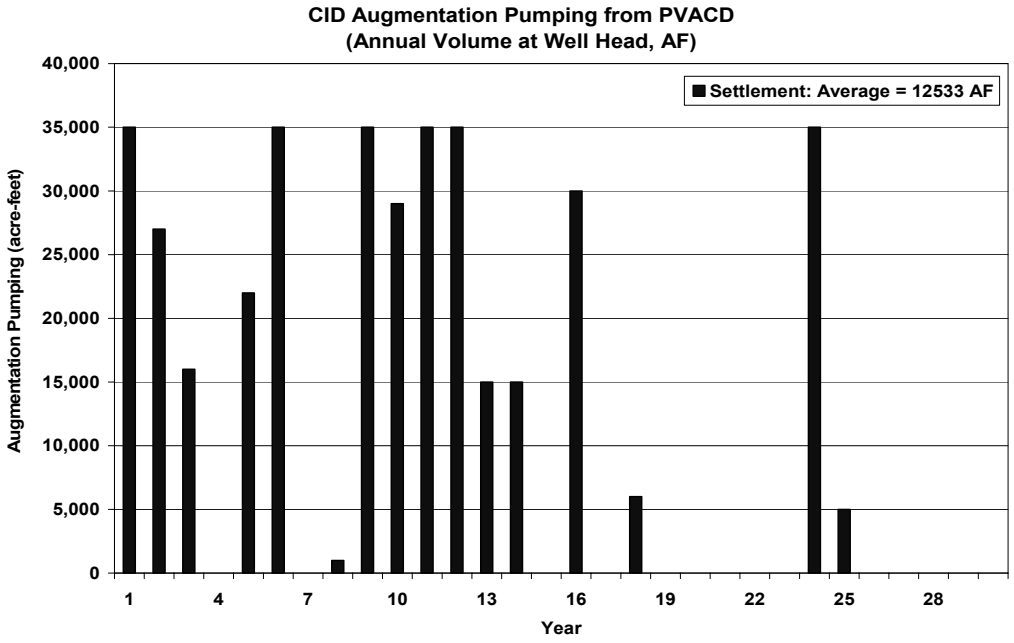

Figure 6. Settlement Scenario Augmentation Pumping from PVACD (Carron, 2004).

The average increase in water available for CID irrigators due to implementation of the Settlement is 0.22 feet per year **(Figure 7)**. Notice also that the Settlement tends to significantly benefit CID in dry years.Under the baseline scenario, the

minimum final allotment was 1.5 feet per year, while under the Settlement; the minimum was about 2.2 feet per year. This benefit extends into the early part of the irrigation season as well. The minimum March 1 allotment increased from 0.55 to 1.21 under the Settlement scenario. This increase in early-season allotment translates into a higher proportion of early-season irrigation water coming from surface supplies as opposed to supplemental wells.

The increase in water available to CID irrigators due to implementation of the Settlement will benefit PVACD farmers by minimizing the chances of a priority call by CID from three times under the baseline scenario to zero time under the settlement scenario as can be seen in **Figure 5**.

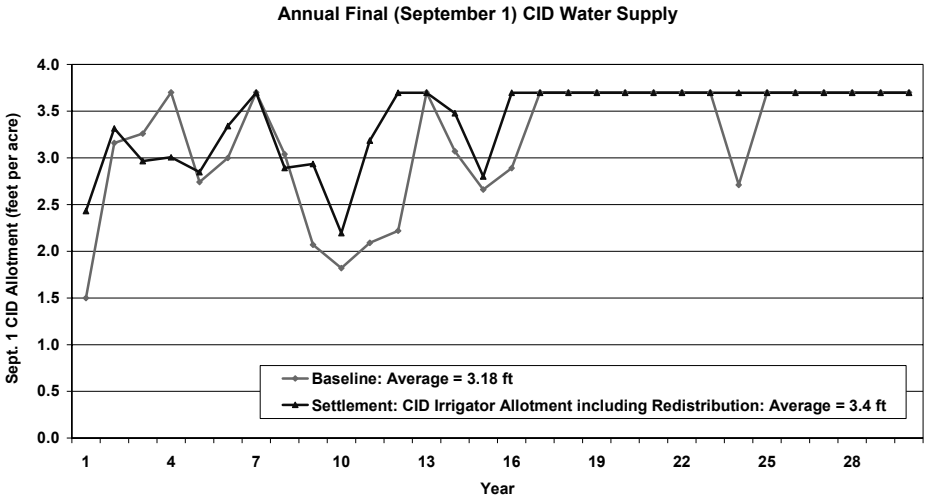

Figure 7. Comparison of CID Allotments under Baseline and Settlement Scenarios (Carron, 2004).

CONCLUSIONS

The model results indicate that implementation of the Settlement agreement will:

1. Increase the total annual surface water supply available to CID irrigators; significantly increase the CID system's resiliency to dry years and minimize the chances of a priority call by CID.
2. Over time, reduce total depletions in the Roswell basin and increase baseflows to the Pecos River; and
3. Reduce the possibility of New Mexico defaulting on its Pecos River Compact obligations, and most likely result in credit over the long-term.

The PRDSS has proven to be a valuable tool for evaluating various actual or proposed management policies in the Pecos River basin.

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