New Mexico Interstate Stream Commission

Pecos River Adjudication Settlement Negotiations: Model Evaluation of Proposed Settlement Terms

Final Report

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Introduction

As part of the Pecos River Adjudication Settlement Negotiations, Hydrosphere was asked to perform model simulations of the proposed Pecos River adjudication settlement terms. The parties to the adjudication negotiations were interested in understanding how the settlement terms would translate into actual water operations, and how those modified operations would impact water supply to the various water users in the Pecos River basin.

This report provides a brief background on the modeling tools, discusses how the adjudication settlement terms were translated into modeling assumptions and rules, outlines the analysis process including definition of the resources of interest, and presents the results of the analysis.

Modeling Tools and Processes

A suite of models was used to evaluate the impacts of the proposed settlement terms. 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. A schematic of the spatial extent of the Pecos basin represented by the models is shown in Figure 1.

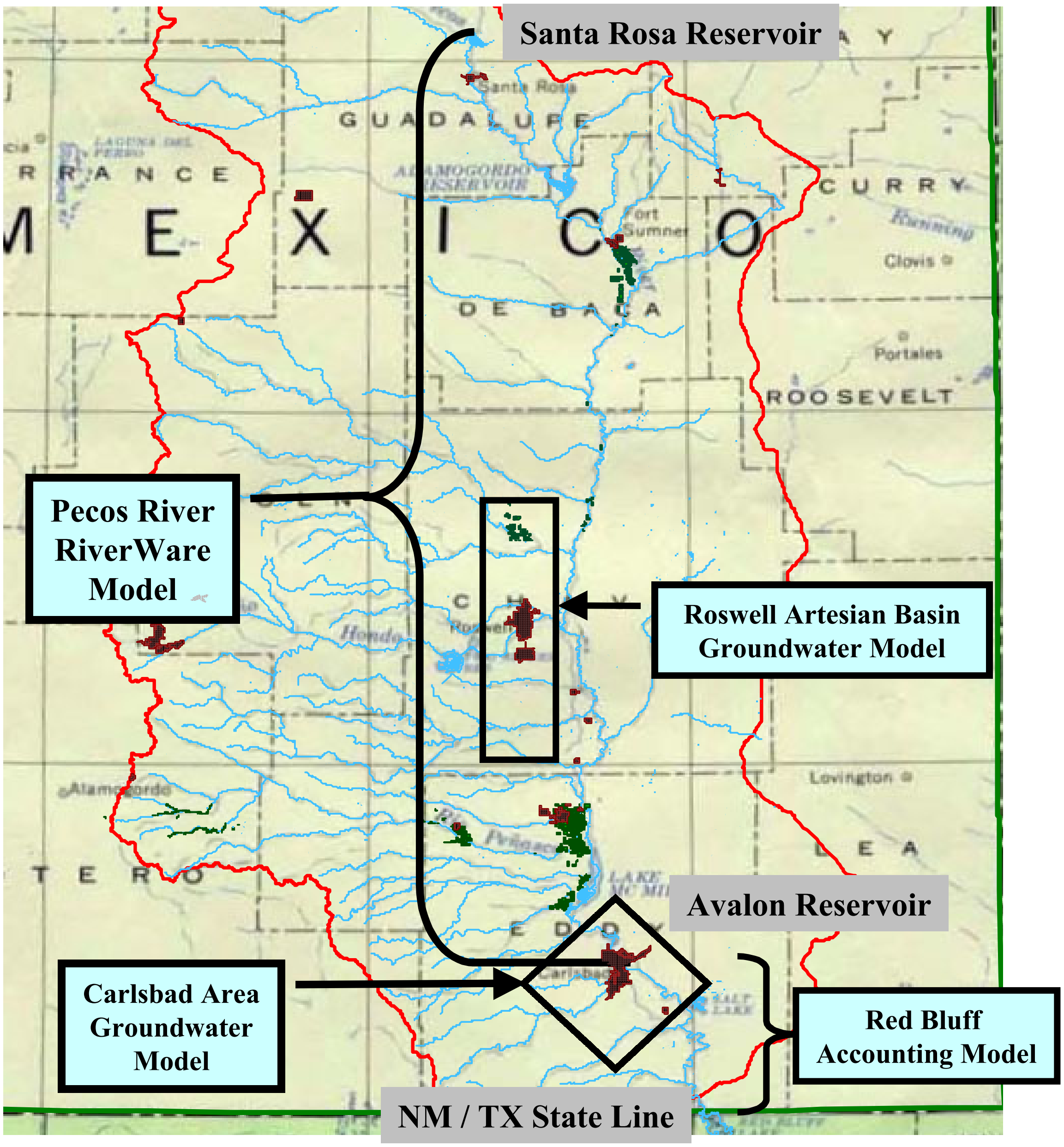

Figure 1. Spatial Extent of the Pecos River Modeling Tools.

Model Objectives and Assumptions

The purpose of this modeling exercise was to evaluate the impact of the proposed Pecos River adjudication settlement terms. The terms anticipate a combination of land retirement and groundwater pumping with the objectives of: a) permanent compliance with the Pecos River Compact Amended Decree, and, b) avoiding the need for priority administration of water in the basin. Central to achieving these objectives is maintaining a certain level of water supply for the Carlsbad Irrigation District (CID). Maintaining certain levels of water supply to CID is important because of their seniority in the basin and because water supply shortfalls have a direct impact to stateline flows, and hence Compact compliance.

Two model scenarios were developed for this evaluation. The Baseline scenario, as the name suggests, is intended to represent a baseline condition against which any proposed actions may be evaluated. However, it should only represent those conditions or activities in the basin which are permanent; thus, ongoing temporary leases of water or bypass operations for ESA compliance was not considered part of the baseline. The second scenario, which is termed the Settlement scenario herein, is intended to simulate the operation of the system under the proposed settlement terms. The Settlement scenario is essentially a translation of the Settlement Terms into model rules and data. Simulation of the two scenarios, and evaluation of their results, provides an estimate of the changes in water supply that would be expected if the settlement terms were implemented.

The models rely on historical hydrology for inputs, with current or proposed operation superimposed on the hydrologic record. The models are reliable for estimating the long-term impact of implementing a proposed action, but they should not be used in any sense to predict water supply conditions at specific times and locations.

As stated previously, the Baseline scenario is intended to reflect the current operations of the system, minus any ongoing short-term leases or modified operations. The Settlement scenario is based largely on the Baseline scenario, with certain modified operations. Model assumptions implicit to both scenarios include:

- Models are based on current / proposed operations and historical hydrology (1967-1996).
- January 1, 2000 reservoir storage levels are used as initial condition for all simulation runs.
- No augmentation / bypass flows are allocated for the Pecos Bluntnose Shiner.

- Effects of permanent land retirements previously made through the PVACD conservation program and NM ISC are included.
- Acme to Artesia base inflows are generated by the RABGW model, and are based on combinations of historical and statistically generated pumping rates.
- No FSID lands were retired or leased for model runs.
- CID allotments are based on 25,055 acres.
- CID supplemental well pumping limited to 3.0 (baseline) or 3.697 (settlement) AF per acre at farm headgate. Model assumes that ALL irrigated acreage can be irrigated by supplemental wells.
- Willow Lake, Harroun, ISC purchased River Pumpers are retired.

The Baseline scenario includes all of the above assumptions, plus:

- The baseline scenario employs 1967 - 1996 historical pumping from the artesian aquifer and 1991-2000 average pumping for the shallow aquifer.
- River Pumpers diversion rates are modified to reflect water rights currently leased by the U.S. Bureau of Reclamation (USBR). River Pumpers diversions are set at the 1990-1998 average for baseline model runs (about 4,000 af/yr), which is representative of the diversion rates immediately prior to implementation of the USBR lease program.
- CID allotments are based on 25,055 acres. Delivery of CID water to 20,000 acres of irrigated land.
- Avalon releases are due to conservation storage spills only.

The Settlement scenario is modified from the above as follows:

- The settlement scenario assumes the retirement of 11,000 acres in the Roswell Basin; 3,000 acres irrigated by shallow aquifer, and 8,000 acres irrigated by artesian aquifer.
- The settlement RABGW model uses modified stress files; retirement of 11,000 acres and augmentation pumping are distributed uniformly across both the artesian and alluvial aquifers throughout Pecos Valley Artesian Conservancy District (PVACD). Land retirement and augmentation pumping

is split between the artesian and alluvial aquifers in an 8:3 ratio (8,000 acres artesian; 3,000 acres alluvial).

- Augmentation pumping in the Roswell basin, from retired PVACD lands, up to 35,000 AF/year and 100,000 AF per 5-year accounting period, occurs when CID divertable supplies at Avalon Reservoir are less than the prescribed target supply volumes defined in the table below.

Table 1. CID Surface Water Supply Thresholds for Augmentation Pumping.

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

- The model accounts for the purchase of 6,000 acres in CID (by ISC), and delivered or redistributed based on the logical rules below.
- CID allotments are based on 25,055 acres with delivery to 19,055 CID acres.
- River Pumper diversions are set at decreed max (~4,800 AF/year).
- CID supplemental well pumping of up to 3.697 AF per acre at farm headgate (applied to all irrigated acres) occurs.

- The distribution of water from 6,000 acres of CID land purchased by ISC is conditioned on the cumulative Compact credit and current water supply (ISC water "yield" = 1.176 x allotment):
    - If CID irrigators' supply < 50,000 AF on March 1, ISC water is realloted to CID up to a total supply of 50,000 AF. Once the 50,000 AF supply level has been reached, ISC may take delivery of water (approximately 13,700 AF) until its allotment is equivalent to that of the irrigators.
    - If credit < 50,000 AF, deliver ISC water to stateline 5x annually.
    - If 50,000 AF < credit < 115,000 AF, AND current supply > 90,000 AF, ISC gets all water > 90,000 AF, up to 24,696 AF (3.5 x 1.176 x 6,000). Beyond 114,696 AF, water is alloted to all 25,055 acres equally.
    - If 50,000 AF < credit < 115,000 AF, AND current supply < 90,000 AF, ISC shall make its CID water available for re-distribution to CID irrigators up to 3.5 AF/acre (90,000 AF).
    - If credit > 115,000 AF, ISC shall make its CID water available for re-distribution to CID irrigators up to the decreed limit (3.697 af/acre); IF CID irrigators have their full allotment, excess water is held over in storage.

Model Analysis and Resource Indicators

Several resource indicators were developed to evaluate and compare the results of the various settlement scenarios. These include:

- Pecos River Flows at Acme and Artesia.
- Augmentation pumping in the Roswell Basin.
- Roswell Basin Aquifer Storage.
- Base Inflows in the Acme to Artesia Reach.
- CID Allotment and Main Canal Deliveries.
- CID Supplemental Well Pumping.
- Releases from Avalon under Settlement Terms.
- Pecos River Flow at Red Bluff Gage and Stateline Deliveries.

- Pecos River Compact Obligations and Departures.

The results of the model simulations, based on the above resource indicators, are discussed below.

Resource Indicator: Pecos River flows at Acme and Artesia

Flow statistics are generated from the RiverWare model at nodes representing the "near Acme" and "near Artesia" gages (Figures 2 and 3). Augmentation pumping is assumed delivered directly into Brantley Reservoir in the RiverWare model. However, in reality, augmentation water would be delivered into the Pecos somewhere upstream of the Artesia gage. To estimate the impacts of augmentation pumping on flows at Artesia, the augmentation pumping was distributed evenly over the period preceding each CID allotment date, and added to the modeled Artesia flow data. Losses at Artesia were assumed to be 7.5% of the pumped flows. Exceedence curves at Artesia, based on the simulation period, are shown in Figure 4.

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

Figure 2: Flow Statistics at Acme.

Artesia Flow Statistics (cfs)

	Baseline	Settlement	Settlement + Aug flow
Maximum	10,013	10,961	10,961
Mean	155	158	170
Minimum	4.9	0.0	0.0

Exceedence Values (cfs):

	Baseline	Settlement	Settlement + Aug flow
75%	42.9	41.8	47.9
90%	25.6	21.0	25.4
95%	19.4	14.8	16.6
99%	12.8	4.8	6.5

Figure 3: Flow statistics at Artesia.

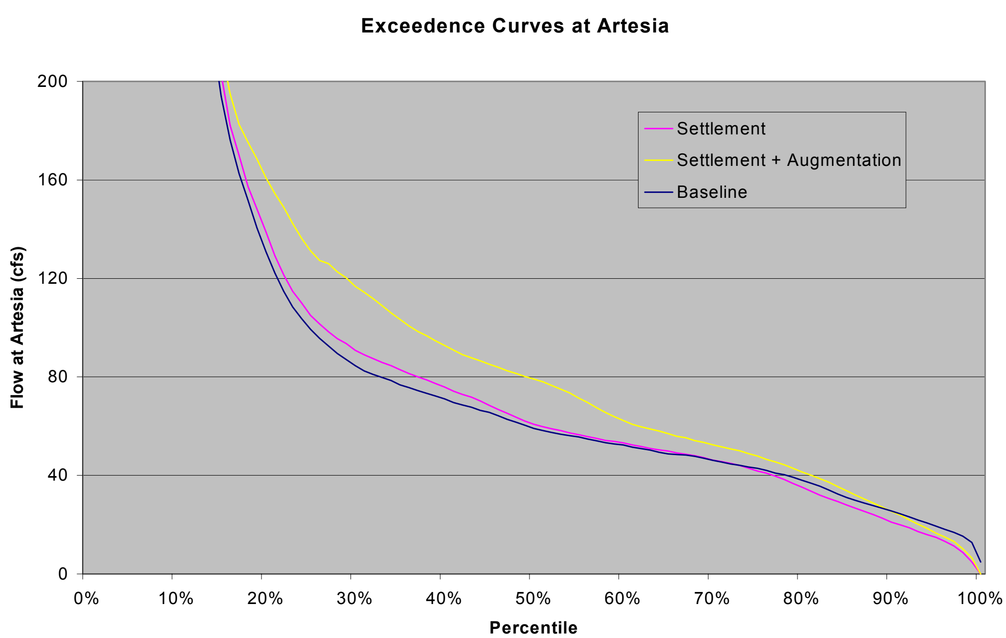

Figure 4: Exceedence Curves at Artesia.

<u>Resource Indicator: Roswell Basin Aquifer Storage</u>

Aquifer storage levels are derived from the RABGW model, and represent departures in storage from a pre-development condition. Figures 5 and 6 show the aquifer storage levels for both the artesian and shallow alluvial aquifers as a normalized percentage of the estimated pre-development aquifer storage. Note that the general trend for both aquifers is one of increasing storage throughout the simulation period, due to the combined effects of retired PVACD lands and lower augmentation pumping requirements.

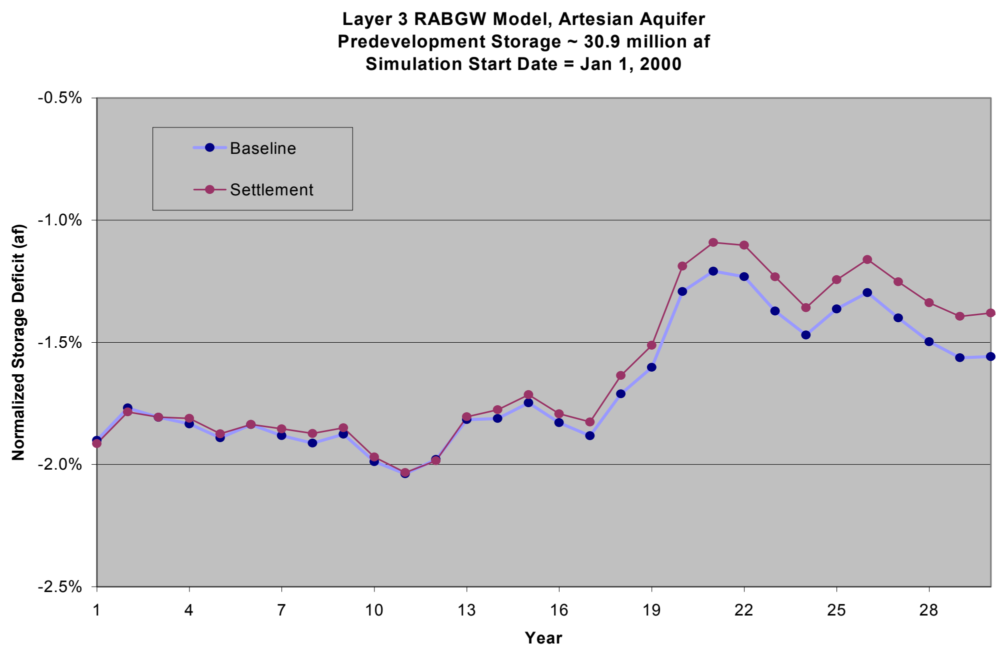

Figure 5: Artesian Aquifer Storage. (Comparison of storage deficit for the baseline and settlement scenarios, normalized against pre-development storage conditions.)

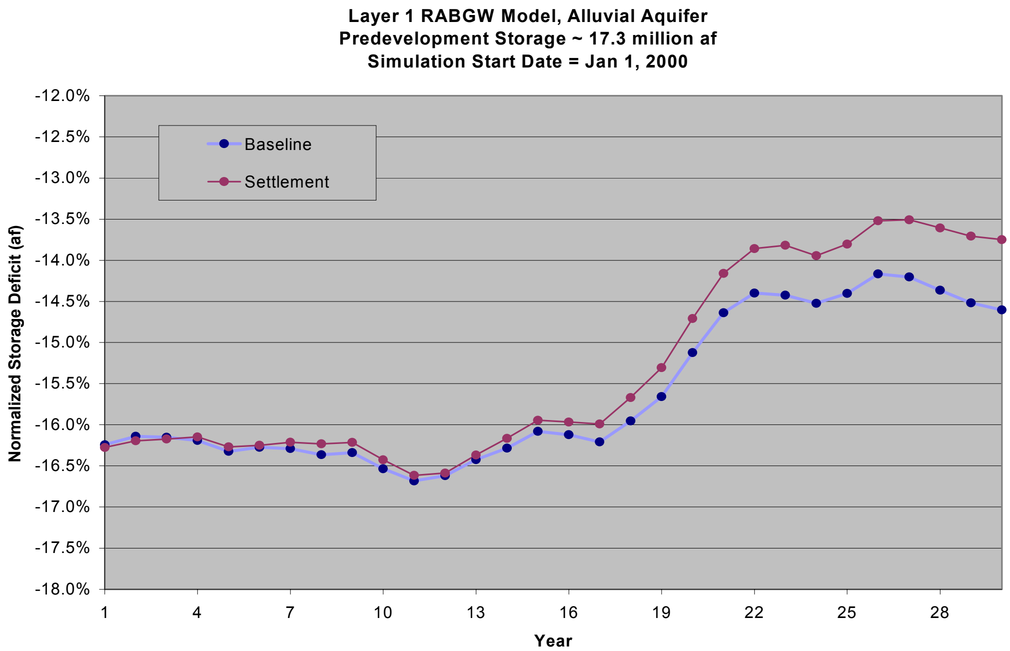

Figure 6: Alluvial Aquifer Storage. (Comparison of storage deficit for the baseline and settlement scenarios, normalized against pre-development storage conditions.)

<u>Resource Indicator: Base Inflows in the Acme to Artesia Reach</u>

Base inflows between Acme and Artesia are generated from the RABGW model and input to the RiverWare model as daily values. RABGW generates monthly average flows, which are distributed evenly over the month when converting from monthly to daily flow values. Due to land retirement in PVACD, the settlement scenario baseflow results indicate approximately 7,500 additional acre-feet of baseflow by the end of the 30-year simulation period (Figure 7).

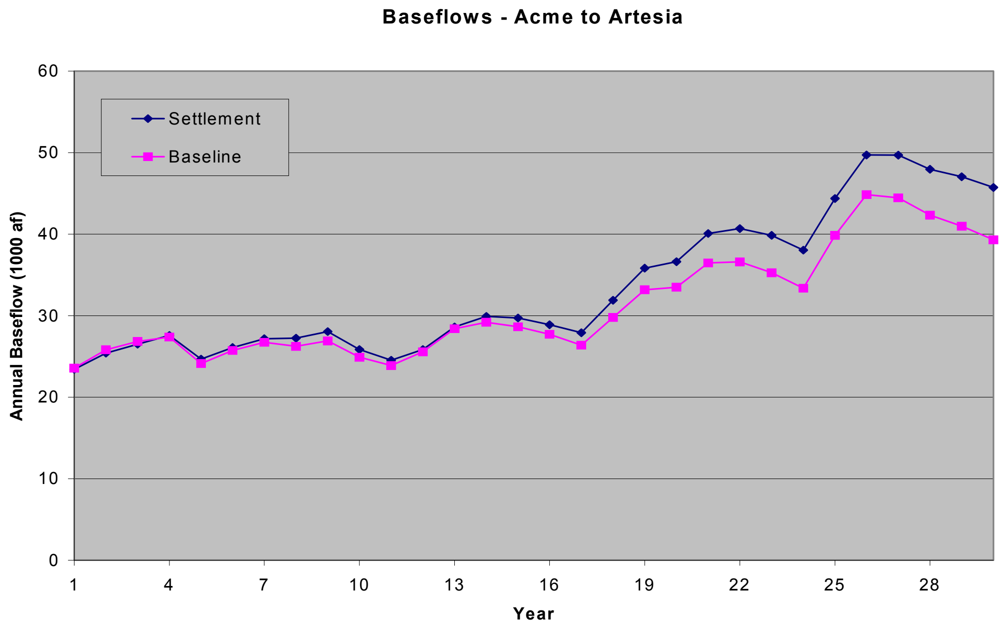

Figure 7: Acme to Artesia Base Inflows.

<u>Resource Indicator: CID Allotment and Main Canal Deliveries</u>

Under the proposed settlement, ISC would use its purchased PVACD water rights to augment CID's surface water supply it times when the natural CID surface water supply is less than certain prescribed thresholds (refer to Table 1 above). The March 1 threshold is particularly important because under the terms of the settlement, not meeting that supply level would provide a basis for CID to ask for a priority call on junior water rights in the basin. Figure 8 illustrates the amount of augmentation pumping required to provide CID with 50,000 acre-feet of water on March 1.

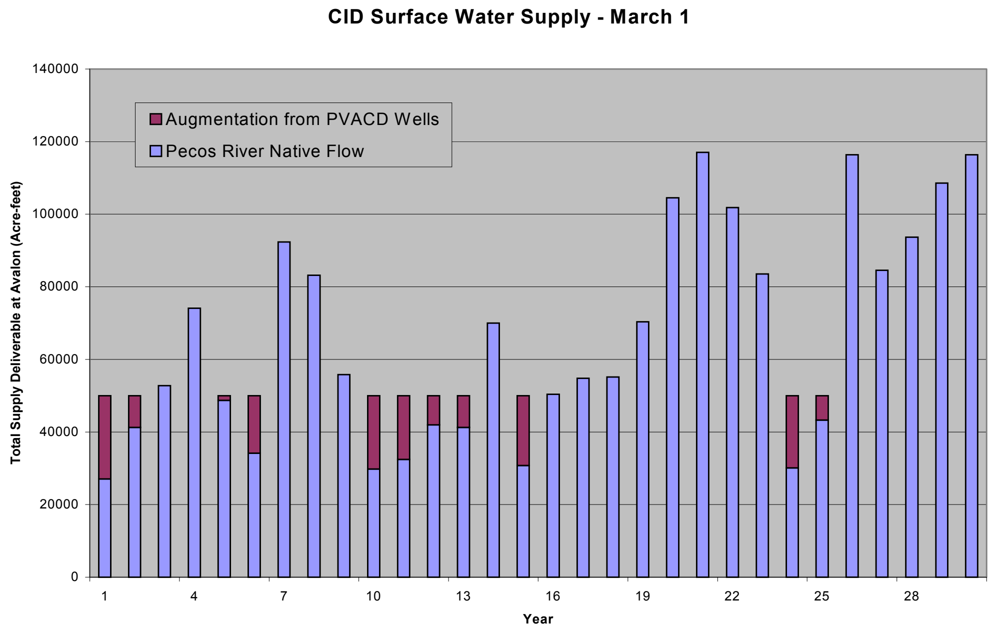

Figure 8. Augmentation Pumping required to meet 50,000 AF March 1 Supply Target.

Total annual augmentation pumping is shown in Figures 9 and 10. Note that in many years, there is augmentation pumping even when the total supply exceeds 90,000 acre-feet (Figure 9). In these years, the supply typically is low early in the year, which triggers augmentation, but later increases due to large precipitation and flood events. From the figures, the impacts of the 35,000 acre-foot annual limit and 100,000 acre-foot 5-year limit can clearly be seen. Compare the two charts in years 1 and 11, for example, where the 90,000 acre-foot supply target cannot be met due to the annual augmentation pumping limit. Also compare the values for year 10, where the total supply is well less than 90,000 acre-feet, and augmentation pumping is constrained because of the 5-year 100,000 acre-foot limitation.

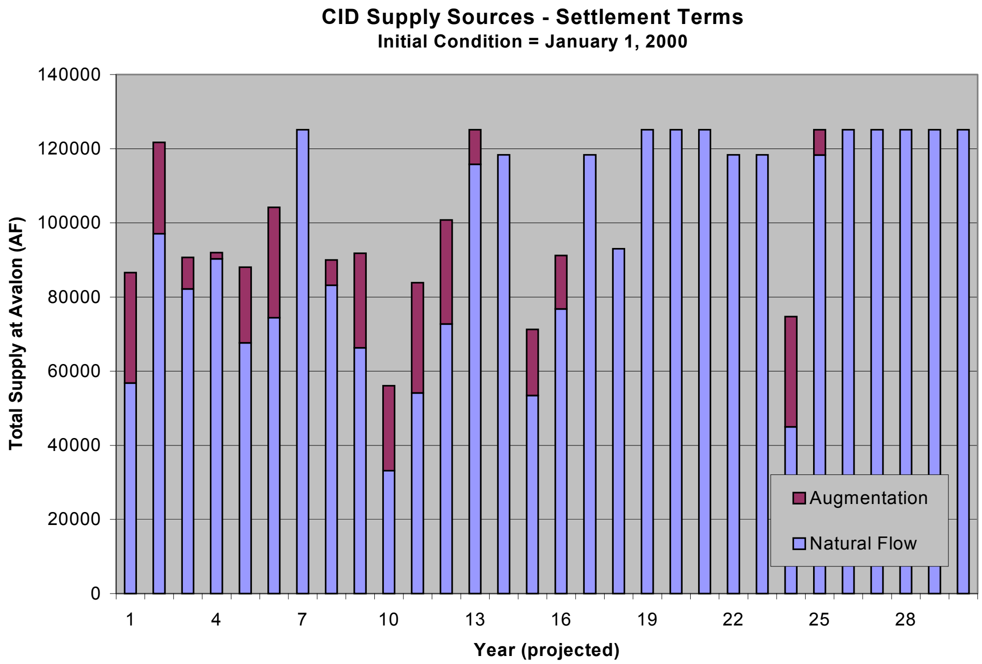

Figure 9. Total CID Supply from "Natural" and Augmentation Sources.

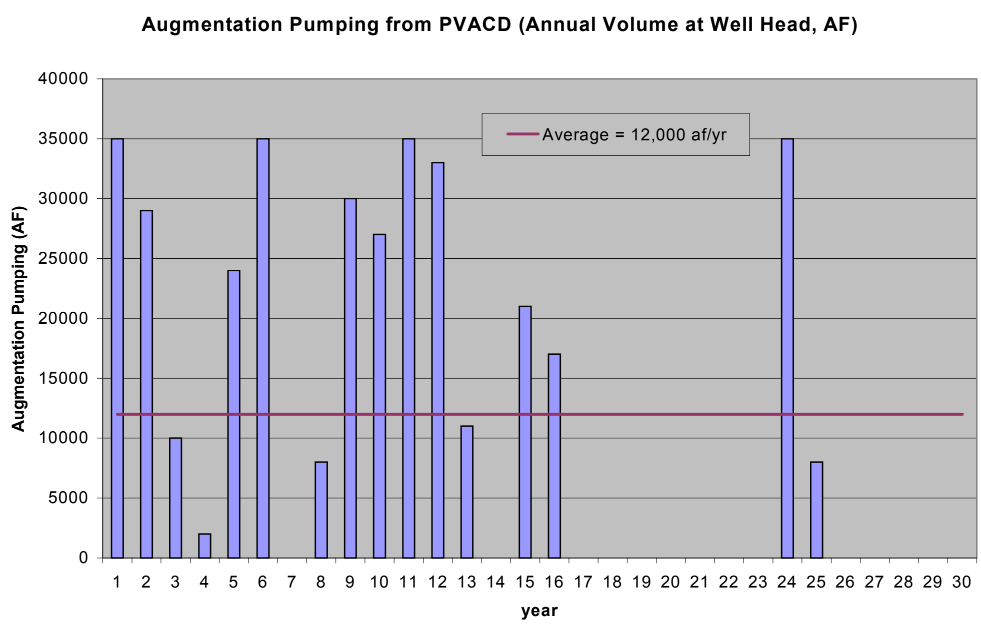

Figure 10: Settlement Scenario Augmentation Pumping from PVACD.

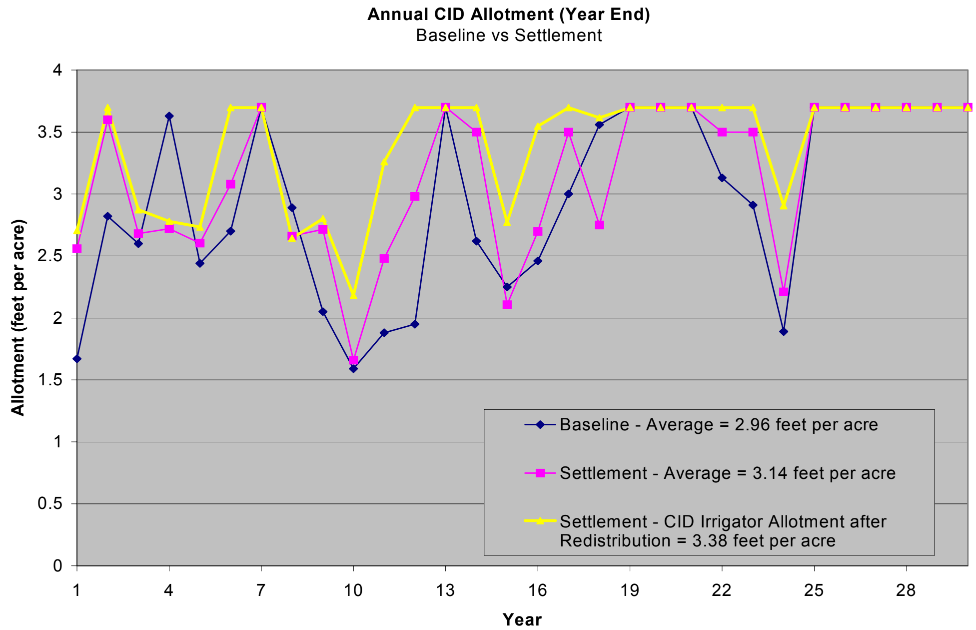

Figure 11: Comparison of CID Allotments under Baseline and Settlement Scenarios, Before and After re-distribution of ISC's CID rights.

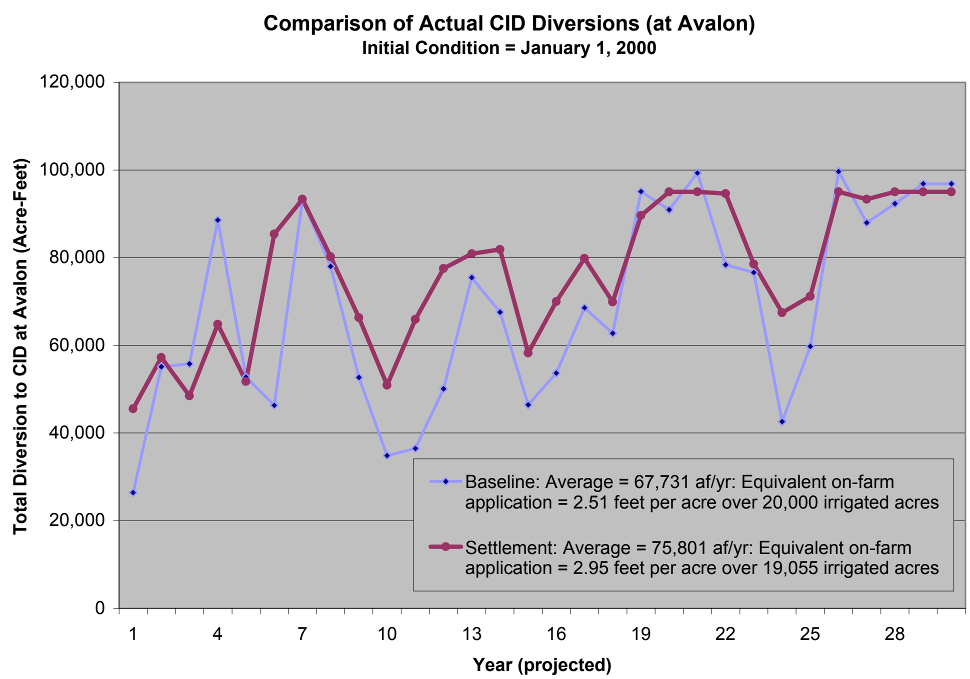

Figure 12: Comparison of Actual Diversions to CID Main Canal. (Note differences in irrigated acreage: 20,000 for the baseline and 19,055 for settlement scenario.)

Another significant feature of the proposed settlement terms is the re-distribution of ISC's CID rights under certain water supply and Pecos River Compact conditions. In Figure 11, the impacts of that re-distribution are shown. Overall, the average increase in water available for irrigators due to implementation of the settlement plan, and subsequent re-distribution of the CID allotment, is 0.42 feet per year. Even more significant, notice that in wet years the distributions change little, and in dry years, when the additional water is most needed, the redistribution benefits are greatest.

Figure 12 shows the total actual diversions from Avalon Reservoir into the CID Main Canal. The difference in total diversions, plus the difference in irrigated acreage under the settlement scenario results in an average increase in on-farm delivery of 0.44 feet per acre.

Supplemental well pumping results are shown in Figure 13. Under the proposed settlement, supplemental well pumping limits would be increased from 3.0 to 3.697 feet per acre, to offset any under-deliveries of surface water. Total supplemental well pumping increases under the settlement scenario by about 1,000 acre-feet per year. It is worth noting that the most significant increases occur in the early years of the simulation when ISC is more often making deliveries of its CID water from Avalon to the stateline.

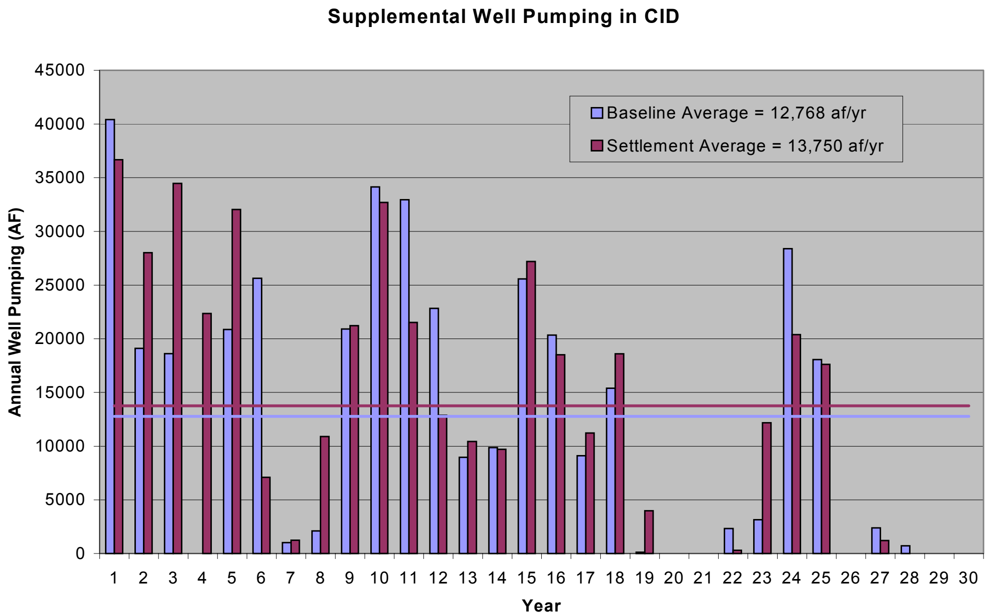

Figure 13: Comparison of CID Supplemental Well Pumping. (Increase in pumping under settlement is due to increase of pumping limit from 3.0 to 3.697 acre-feet per acre.)

<u>Resource Indicator: Releases from Avalon under Settlement Terms</u>

Under baseline operations, the only releases from Avalon dam, other than to CID, are due to conservation spills. The settlement terms include provisions that allow ISC to release its share of the CID allotment directly from Avalon dam for purposes of complying with the Pecos River Compact. Figures 14 through 16 illustrate the impacts of the proposed terms. Total releases from Avalon increase by about 4,500 acre-feet annually (Figure 14). Conservation spills are on average almost identical between the scenarios, and the additional releases are accounted for by the release of ISC's CID water (Figure 16). Notice that all of the ISC releases occur early in the simulation period, when the stateline Compact credit is small. Once this credit increases above certain thresholds, no additional releases are made (see discussion on Compact departure in the next section).

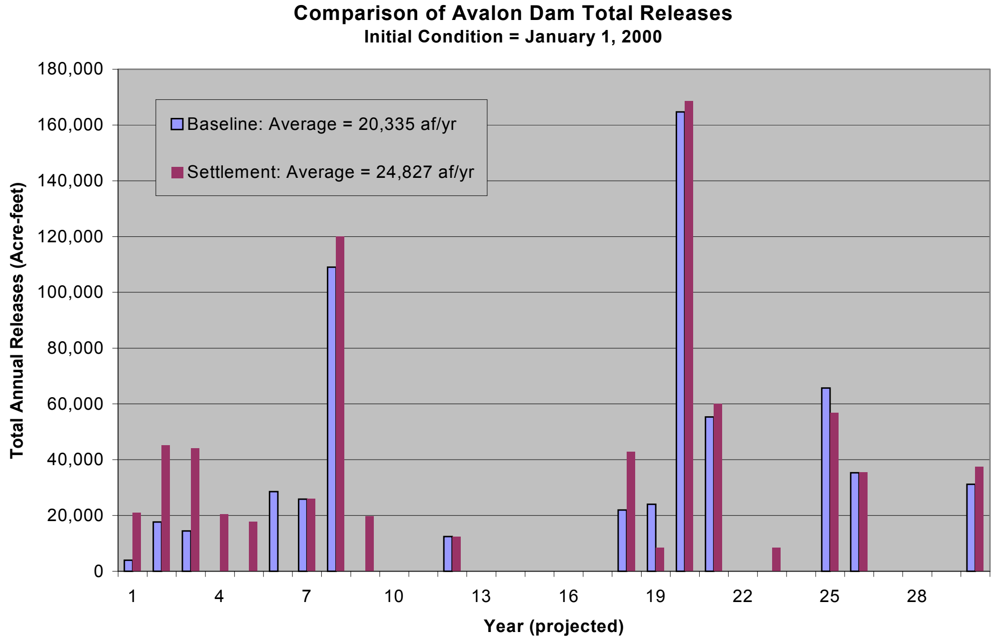

Figure 14: Total Avalon Releases to Pecos River.

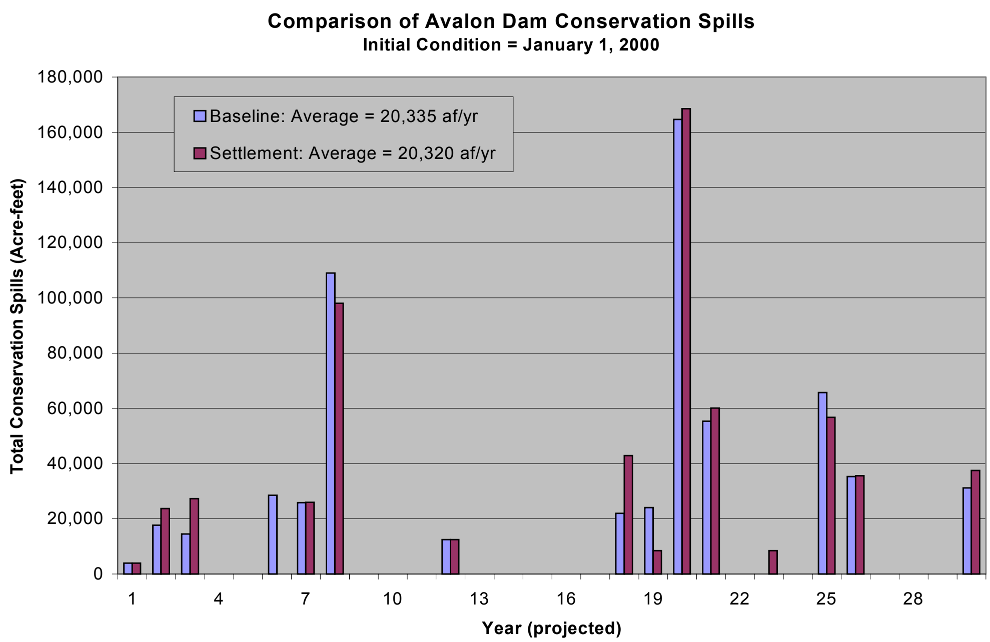

Figure 15: Avalon Releases to Pecos River due to Conservation Spills only.

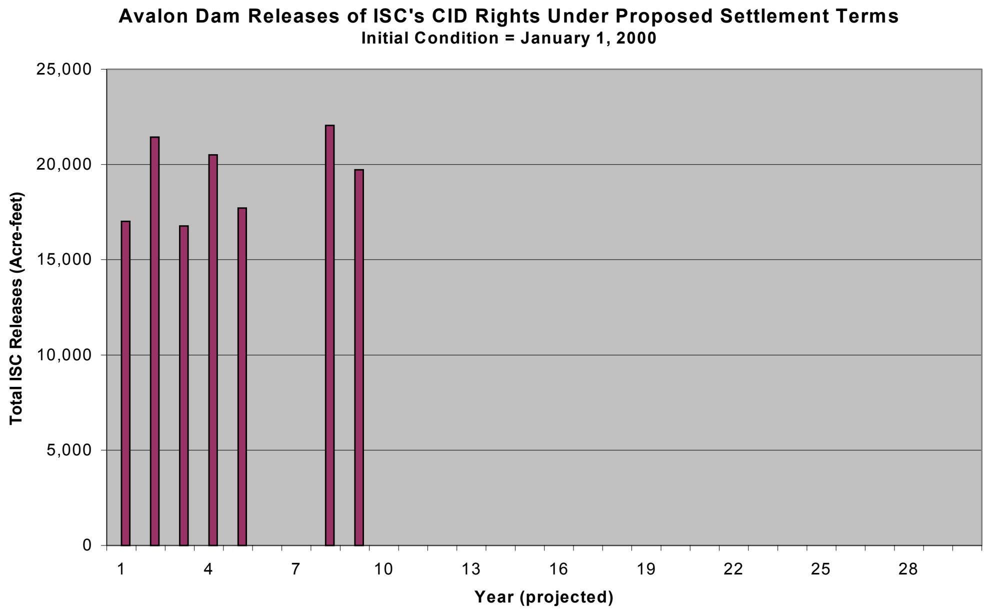

Figure 16: Avalon Releases of ISC's CID Water Rights to Pecos River.

<u>Resource Indicator: Red Bluff Flows, Stateline Deliveries, and Pecos River Compact</u>

The final set of resource indicators are all related to New Mexico's obligations under the Pecos River Compact and Amended Decree. By keeping CID's water supply whole as much as possible (which reduced supplemental well pumping and increases return flows to the Pecos River), and by direct delivery of a portion of the CID allotments which would be purchased by NM ISC, New Mexico intends to increase its Compact credit to a level that will allow it to more comfortably weather drought years without severely damaging the region's economy. The net impacts of the proposed settlement terms on stateline flows are shown in Figure 17. Average annual flows at the stateline would increase by almost 10,000 acre-feet annually based on the model simulations. Corresponding to that increase is an increase in the average annual and cumulative departure from the Compact obligation, as shown in Figure 18.

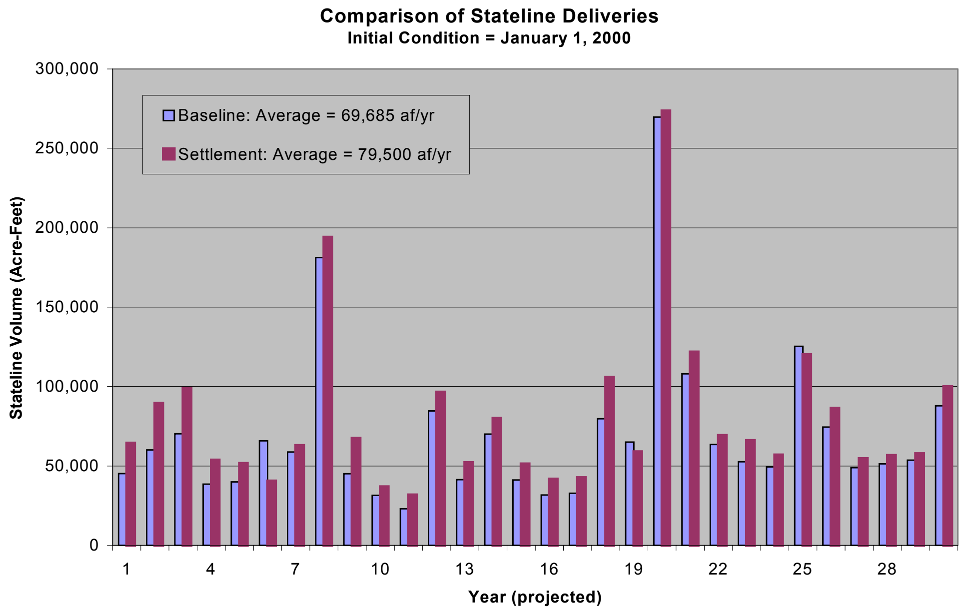

Figure 17: Total Flows at the Stateline (includes Red Bluff and Delaware).

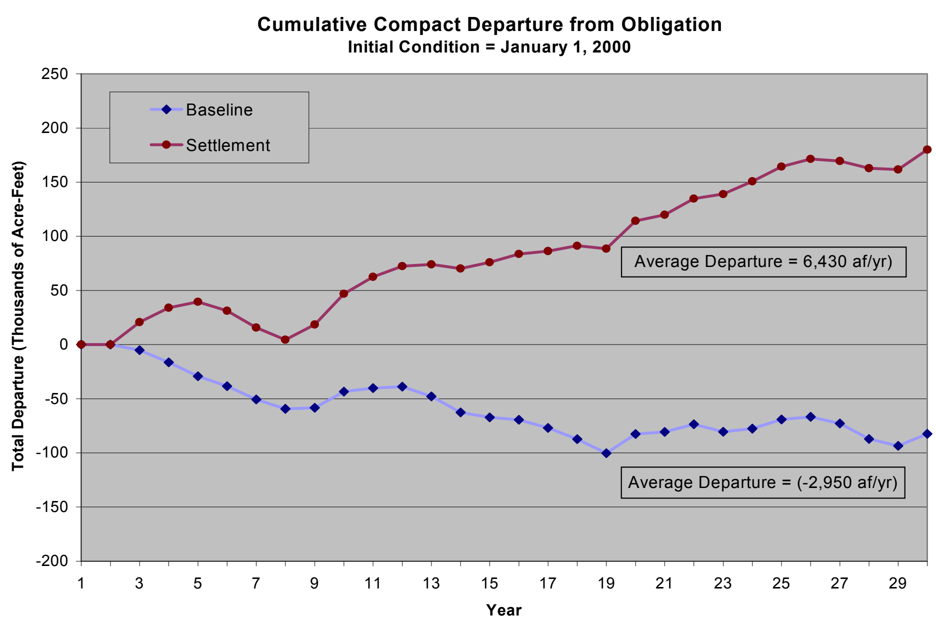

Figure 18: Comparison of Cumulative Compact Departure under the Baseline and Settlement Scenarios.

Finally, Figure 19 provides a breakdown of the additional sources of water that lead to the additional stateline flows. The graph shows the cumulative gain in stateline flows (in acre-feet) as the light blue line, using the y-axis on the right. Using the left-hand y-axis, the bars show year-by-year changes under the settlement scenario for Avalon spills, baseflow gains, and ISC releases from Avalon, as compared to the baseline scenario. Early in the simulation period, deliveries of ISC's CID water directly from Avalon account for much of the gain in stateline flow. In the later two-thirds of the period, additional return flows and baseflow gains from the CID area account for much of the gain. It is interesting to note that although the average values for conservation spills are almost identical between the runs, there are significant annual variations in these spills, cause primarily by changes in the timing of water deliveries under the settlement scenario.

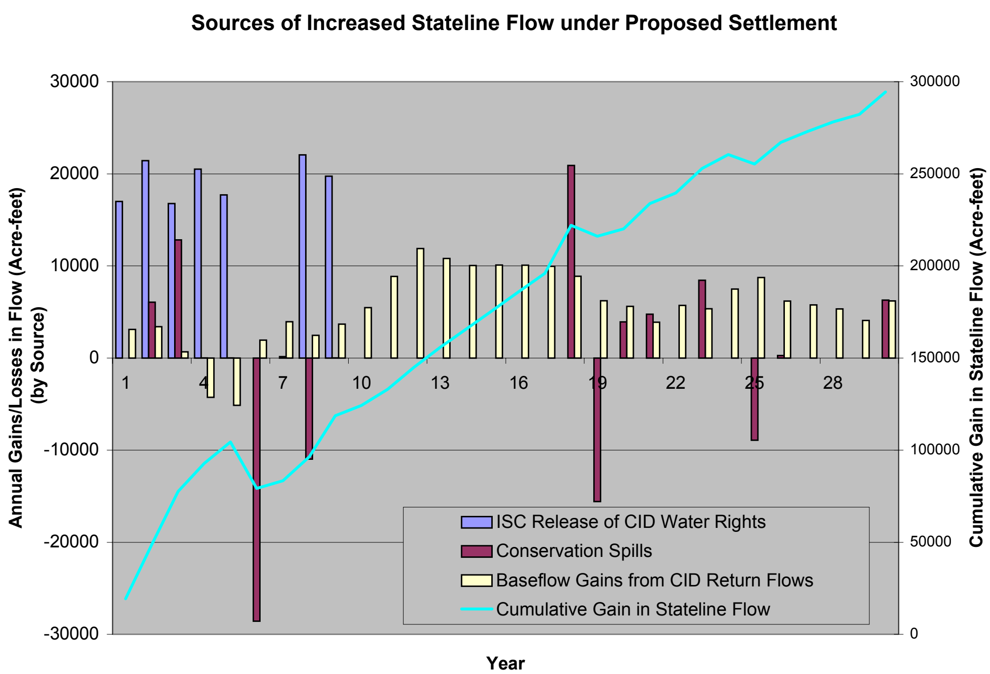

Figure 19: Sources of increased state line flow, and cumulative gain in state line Flow, Settlement scenario vs. Baseline scenario.

Summary and Conclusions

This report has presented results of two model simulations intended to evaluate the impacts of the proposed Pecos River Adjudication Settlement Terms. The model results indicate that implementation of the terms will:

1. Have no significant impact to Pecos River flows at Acme.

2. Increase the total annual surface water supply available to CID irrigators.

3. Significantly increase the CID system's resiliency to dry years.

4. Minimize the chances of a priority call by CID, through augmentation pumping to meet supply targets.

5. Increase baseflows / return flows from CID to the Pecos River.

6. Provide for the direct delivery of water from Avalon dam to the stateline.

7. Result in a cumulative credit for the State of New Mexico with respect to its Pecos River Compact obligations.