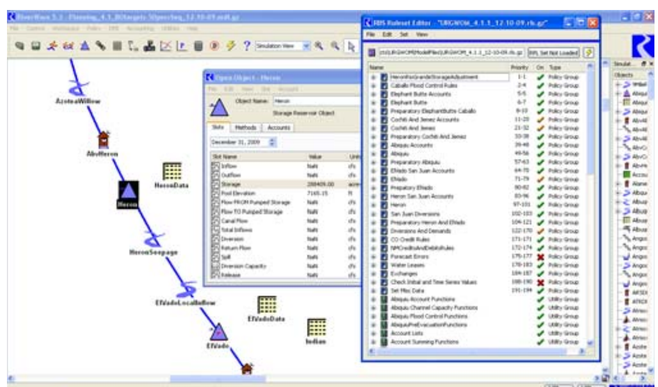
URGWOM
Planning Model User Manual
version 4.1.2

prepared by

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Table of Contents

I. Introduction

The Upper Rio Grande Water Operations Model (URGWOM) is a computational model developed through an interagency effort to simulate processes and operations of facilities in the Rio Grande Basin in New Mexico. Four separate URGWOM modules are utilized for modeling exercises and decision support: Planning, Water Operations, Forecast, and Accounting. The Planning Model is used to complete daily timestep rulebased simulations for different operation scenarios to evaluate subsequent long-term impacts of a proposed action on various indicators including deliveries to water users, river flows, interstate Compact deliveries and Compact status, and the overall water budget. The Water Operations Model is used to complete daily timestep rulebased simulations to forecast operations, deliveries, and resulting flows through the end of a calendar year for Annual Operating Plans (AOP) with forecasted inflows computed using the Forecast Model. The Accounting Model is used to complete model runs up to the current date using actual data and simulate the status of accounts for different water users. This user manual focuses on use of the Planning Model.

The Planning Model is used to complete daily timestep rulebased simulations for long-term planning studies. Physical processes and operations of facilities from the Colorado state-line to El Paso, Texas (flood control operations only below Caballo Dam) are simulated at a daily timestep. Policy for setting dam releases along with diversions and other demands are represented in coded rules in an URGWOM ruleset. Various methods are included to represent processes such as floodwave travel times; reservoir evaporation and seepage; conveyance losses to deep percolation, evaporation, and transpiration; surface water-groundwater interaction; and irrigation return flows. Refer to the physical model documentation prepared by the URGWOM Technical Team (2005) for more details on methods and assumptions for representing the physical processes in the basin.

The Planning Model is used to complete simulations for different operation scenarios to evaluate subsequent long-term impacts of proposed actions on various indicators in the Rio Grande system including deliveries to water users, river flows, interstate Compact deliveries and Compact status, and the overall water budget. Studies may entail completing a model run with a baseline model and ruleset and comparing results to output from an alternate simulation completed with a proposed change to policy for operating a specific facility. This user manual provides background information on numerous modeling assumptions represented in the current model and instructions for setting up a model with initial conditions and inflows for a historical period or for one of five 10-year synthetic hydrologic sequences developed with reference to paleo-data. The Planning Model has been used to evaluate alternatives for the Upper Rio Grande Water Operations Environmental Impact Statement (Corps, Reclamation, and ISC, 2007) and to complete analyses for the Middle Rio Grande Endangered Species Collaborative Program and for preparing Biological Assessments.

Simulations include accounting for tracking the delivery of water allocated to specific users. Note that the primary difference between the planning and water operations modules of URGWOM is that accounts for several contractors for San Juan-Chama

Project water are lumped into one Combined account in the Planning Model. This allows for simulations to be completed more efficiently as needed for longer-term planning studies. The Planning Model and ruleset are often slightly adjusted to incorporate proposed system components or proposed water agreements for a particular study. If a planning study is to be completed that includes new water agreements or significant changes to operations that require model and ruleset development, model development would need to be conducted through coordination with the URGWOM Technical Team. This user manual provides instructions for setting up model runs utilizing all capabilities included in the current version of the Planning Model and ruleset. The current version of the model is noted on the title page for this user manual. Note that any adjustments made to any parameters in the current model for a planning study should be documented thoroughly as part of the study report.

1.1. Disclaimer

This user manual is written for model users that have received RiverWare training and are able to navigate through RiverWare fairly efficiently. This user manual is not meant to serve as a manual for using the RiverWare software application.

All users of URGWOM are advised that the model was developed with numerous assumptions about standard operations and the policy for operating all the facilities in the basin as documented in this user manual. Analyses completed with the model will reflect these assumptions, and the developers of URGWOM are not responsible for any erroneous model results due to changes to key parameters or inputs to the model as established in the database.

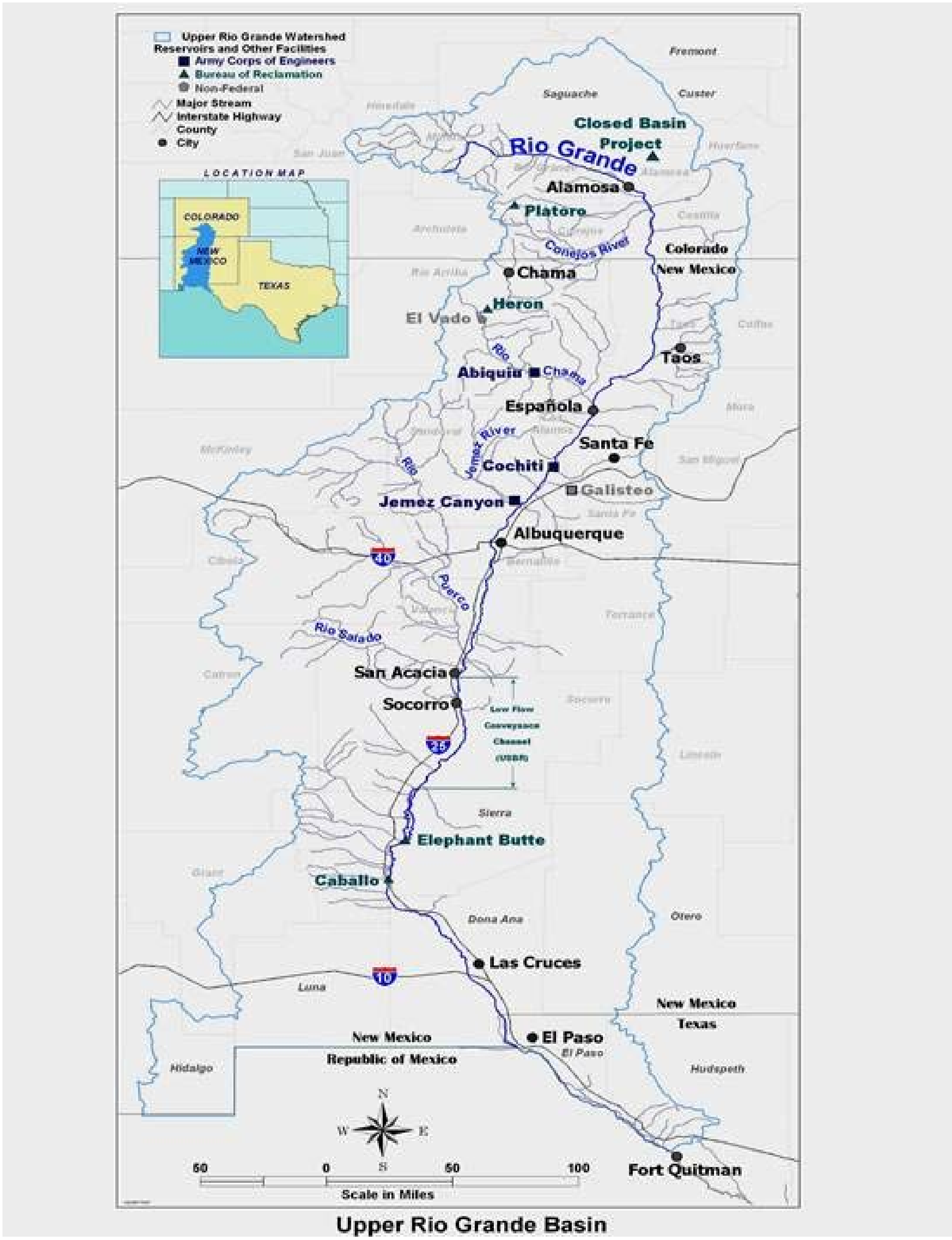


Figure 1.1. Rio Grande Basin Map

II. Modeling Assumptions

Several details and modeling assumptions need to be identified before setting up URGWOM for a planning study. URGWOM is set up to model standard operations for meeting demands and the storage of water allocated for different users. While these assumptions may likely all be maintained for a planning study, details on the assumptions for the demands and standard policy for storage and releases at reservoirs in the system should be reviewed at the beginning of any study. Assumptions for several previously analyzed water agreements and proposed actions are also presented. Some of these actions may be considered to be part of standard operations as some specific actions have actually been implemented for several years, but assumptions about these water agreements and proposed actions in the future need to be reviewed in detail for any planning study.

2.1. Demands

Basic assumptions are presented about four primary demands: Middle Rio Grande Conservancy District (MRGCD) diversions, Albuquerque Bernalillo County Water Utility Authority surface water diversions, letter water deliveries for contractors for San Juan-Chama Project water to payback the river for depletions, and target flows as documented in the current Biological Opinion (Service, 2003). Notes about deliveries of Prior and Paramount (P&P) water to the six Middle Valley pueblos are included with the discussion of MRGCD diversions.

2.1.1. MRGCD Diversions and Demand at Cochiti

Synthetic diversion schedules have been developed for each of the four main MRGCD diversions: Cochiti, Angostura, Isleta, and San Acacia. Separate schedules are input for each of these diversions as input to series slots in the MiddleRioGrandeDiversionData data object. These values are set, during simulation, for separate Diversion Requested series slots in the aggregate diversion site objects used for each of the four diversions. Two separate schedules are used for the Sili Canal and East Side Main canal at the Cochiti diversion, and two schedules are used for the Albuquerque Main Canal and Atrisco Feeder at the Angostura diversion. Five separate schedules are used for the Chical Lateral, Chical Acequia, Peralta Main Canal, Cacique Acequia, and Belen High Line Canal. Separate diversion schedules are included for the Low Flow Conveyance Channel and main canal at the San Acacia diversion; however, actual diversions from the river at the San Acacia diversion to the main canal are reduced based on the contribution from the unit 7 drain. Diversions to the Low Flow Conveyance Channel would likely be set to zero for a planning study, but gains from groundwater seepage result in flows in the Low Flow Conveyance Channel.

Rio Grande water or San Juan-Chama Project water may be released from storage to provide flows for the diversions if needed. These releases are made to meet an identified total demand at Cochiti. Since some return flows to the river are available for diversion downstream, the total demand is less than the sum of the diversions. This demand curve (Figure 2.1) was developed based on historical demands and is input to the MRGCD series slot in the Middle Valley Demands data object.

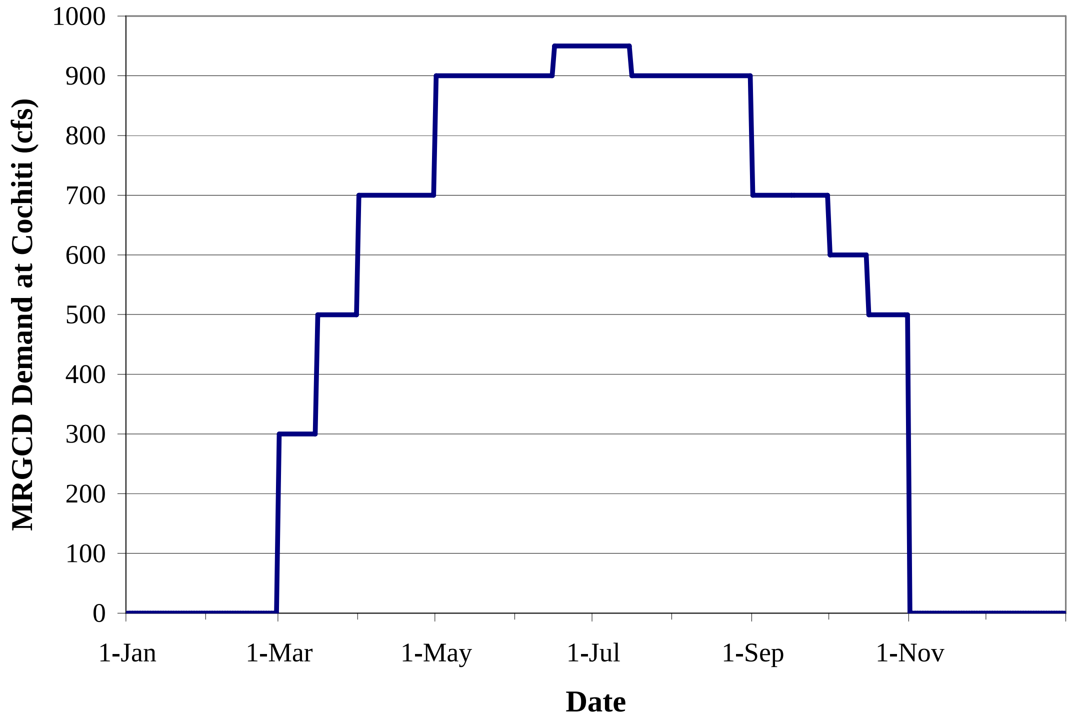


Figure 2.1. MRGCD Demand at Cochiti

2.1.1.1. Diversions for the Six Middle Valley Pueblos

Irrigated acreage for the six Middle Valley pueblos (Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta) is not represented separately from MRGCD land in URGWOM and diversions to the pueblos are included with MRGCD diversions; however, the storage and release of P&P water to assure the P&P demand is met is tracked separately in URGWOM. The methodology in URGWOM for computing a P&P storage requirement each year and the subsequent releases from P&P storage match the actual approach used in recent years and are tracked in the IndianStorage account on the El Vado level power reservoir object. Releases are made as needed if the natural flow would not meet the demand for the pueblos as input to the IndianDemand series slot in the MiddleValleyDemands data object. Unused water is reverted back to the Rio Grande account at El Vado Reservoir at the end of the year as an accounting transfer. The MRGCD Demand curve actually represents the full demand at Cochiti for both MRGCD and the pueblos, and releases of native Rio Grande water or MRGCD San Juan-Chama

Project water at El Vado Reservoir designated to meet the full MRGCD demand curve are reduced to account for any releases of P&P water.

2.1.1.2. Increased Angostura Diversions

When MRGCD is in a shortage situation which is indicated when the MRGCD Demand at Cochiti cannot be met with available water in storage for MRGCD, diversions at Angostura are increased from the regular diversion requested values to the total canal capacity of 400 cfs. These increased diversions assure water is delivered to the pueblos and reflect adjustments in MRGCD operations during shortage situations such that the limited supply is used most efficiently. The capacity at Angostura is input as two separate values of 260 cfs and 140 cfs to the MaxCapacityAtAngosturaAlbMainCanal and MaxCapacityAtAngosturaAtriscoFeeder scalar slots, respectively, in the MiddleRioGrandeDiversionData data object.

2.1.2. Albuquerque Surface Water Diversions

Albuquerque began surface water diversions in 2009, and URGWOM is currently set up to model full diversions with consideration for a preemptive cutoff to diversions before actual permit restrictions would result in curtailed diversions. The preemptive cutoff during low flows represents the assumption that Albuquerque would cease surface water diversions before diversions would be curtailed per the permit and rely entirely on groundwater. A preemptive cutoff may also occur during high flows when it may be unsafe or impractical to operate the diversion dam or when flood control operations at Abiquiu or Cochiti might prevent Albuquerque from receiving a delivery of their allocated San Juan-Chama Project water. The high flow thresholds for a preemptive diversion cutoff are input as 1800 cfs out of Abiquiu or 4500 cfs out of Cochiti as input to the ThresholdHighAbiquiuOutflowForAlbPreemptiveCutoff and ThresholdHighFlowCochitiForAlbPreemptiveCutoff scalar slots in the MiddleValleyDemands data object. The threshold low flow for a preemptive cutoff is 200 cfs as input to the ThresholdCentralFlowForAlbPreemptiveCutoff and diversions will not restart until at least two weeks after any preemptive cutoff criterion is not satisfied and the flow at Central is greater than 250 cfs as input to the ThresholdCentralFlowForAlbRestart scalar slot.

The year 2009 is input to the AlbuquerqueStartYear table slot in the MiddleRioGrandeDiversionData data object as the year when diversions would begin. Depending on the run time used for a study, this input should be reviewed. Full Albuquerque diversions are set to 130 cfs where 65 cfs is provided by delivered San Juan Chama Project water and the other 65 cfs is native Rio Grande water that will be returned. Releases of Albuquerque’s San Juan-Chama Project water are set to provide the 65 cfs with loss rates applied. The loss rate is based on the input San Juan-Chama loss rate from Abiquiu to Cochiti input to the Losses table slot in the

SanJuanChamaRules data object and a monthly loss rate from Cochiti to the diversion as input to the CochitiToAlbuquerqueDiversionLosses periodic slot in that same data object.

2.1.3. Letter Water Deliveries

Contractors for San Juan-Chama Project water may cause depletions in the basin and then use allocated San Juan-Chama Project water to offset these depletions. These paybacks are set up as inputs in URGWOM based on an assumed future delivery schedule for the payback. Actual paybacks are determined by the Office of the State Engineer, and the deliveries are requested as letters from the State to the Bureau of Reclamation (Reclamation), hence the name “letter water deliveries.” Within URGWOM, the Exchanges Manager is used to establish a debt for contractors to deliver water to the location of the Otowi stream gage object in the model based on the input delivery schedule. Deliveries during the irrigation season contribute toward meeting the MRGCD demand and effectively payback MRGCD for the effect of contractors’ depletions to the river during the irrigation season. The remaining portion delivered during the non-irrigation season contributes to Compact deliveries at Elephant Butte Reservoir and effectively payback the Compact for depletions caused during the non-irrigation season.

If a contractor does not have water in storage at the time of a delivery request, the debt is maintained until the contractor has the water to make the payback, so within the model, actual releases from storage may not exactly match the input schedules. It is rare during Planning Model simulations that a delivery cannot be made because a contractor does not have water, but it does occasionally occur (Note that input delivery schedules are usually checked for Water Operations Model runs for preparing AOPs to verify that contractors have the water to make paybacks). Numerous contractors are combined into one account in the Planning Model, so only two delivery schedules are input for the Albuquerque account and Combined account as input to the Albuquerque and Combined series slots in the DeliveryRequests data object. Annual volumes for Albuquerque deliveries include paybacks for the impact of past pumping and vary from year to year. The annual payback volume is split between a constant delivery rate through July and August and a constant delivery through November and December. Refer to Figure 2.2 for a sample annual letter water delivery schedule for Albuquerque and Figure 2.3 for projected annual delivery volumes for ten years starting in 2010. A constant annual letter water delivery volume of 2790 acre-ft is currently used for the Combined account which consists of separate deliveries for the different contractors for San Juan-Chama Project water as listed in Table 2.1. A sample plot of the delivery schedule for the payback for the Combined account is displayed in Figure 2.4 where the entire payback for Santa Fe and the Pojoaque Valley Irrigation District (PVID) is represented in a delivery in November through December and the remaining deliveries are split between July and November through December. **Note that letter water delivery schedules are input in the model in units of acre-ft/day as opposed to cfs.**

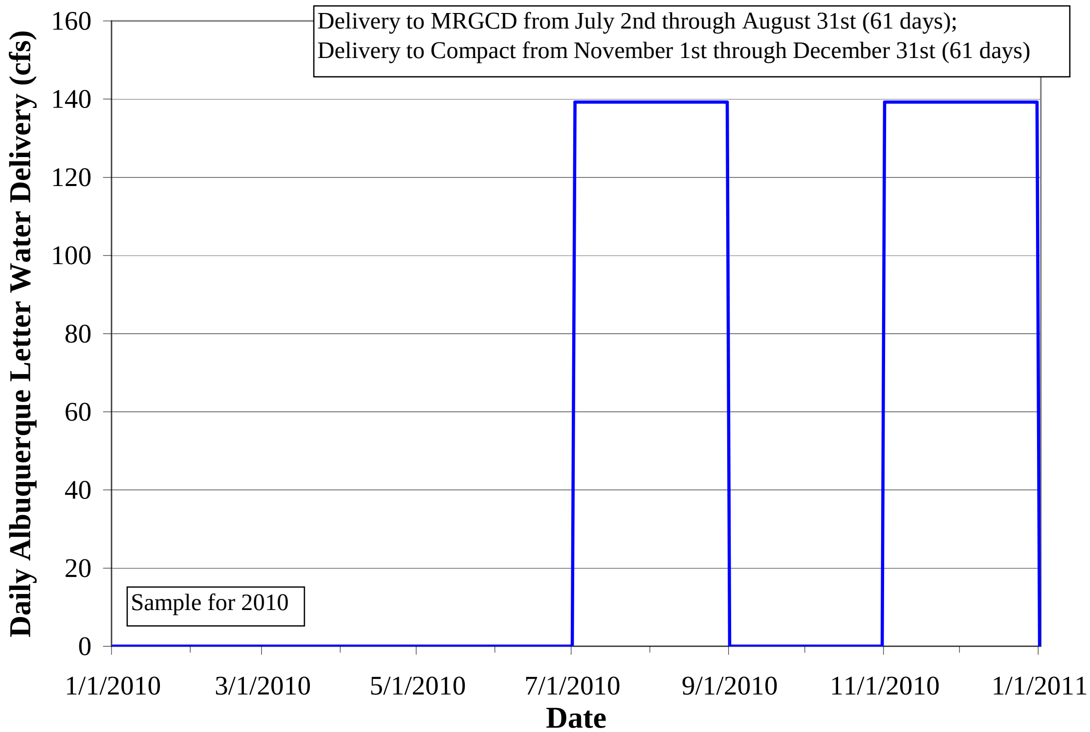


Figure 2.2. Sample (2010) Schedule for Albuquerque Letter Water Deliveries

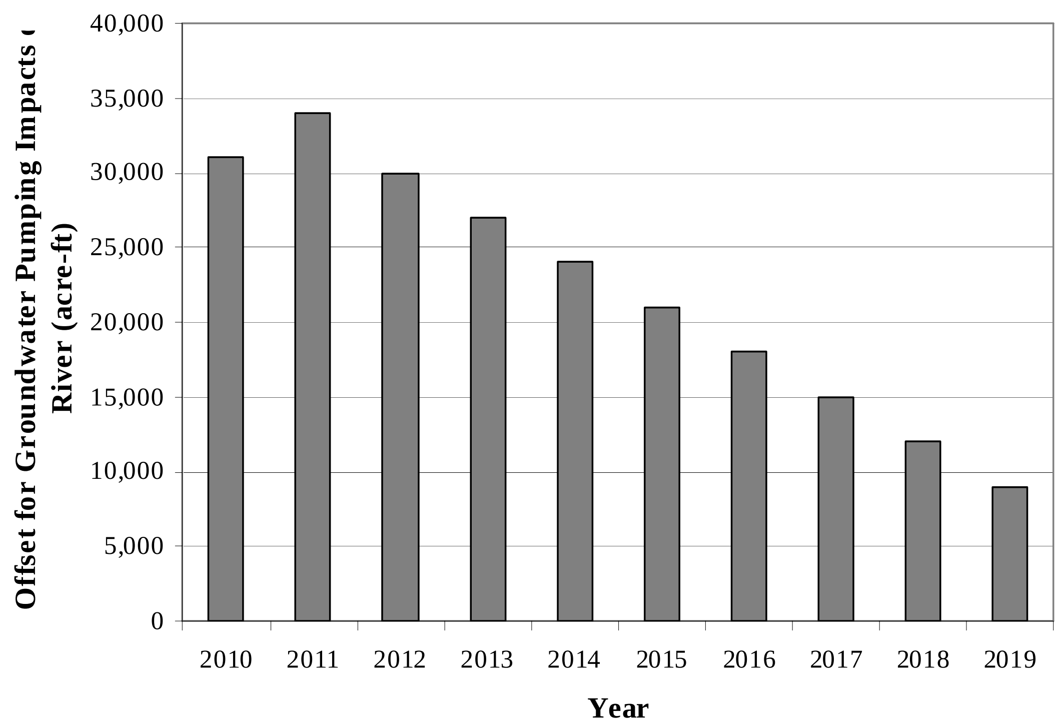


Figure 2.3. Projected Annual Paybacks for Albuquerque Starting in 2010

Table 2.1. Current Assumed Annual Letter Water Delivery Volumes for Contractors for SJC Water – Combined Account

Contractor	Annual Delivery (acre-ft)
Santa Fe	1000
Nambe/PVID	1000
Bernalillo	380
Espanola	200
Los Lunas	130
Belen	50
Taos	30
Jicarilla	0
Los Alamos/DOE	0
Red River	0
Twining	0
San Juan Pueblo	0
NMISC	0
Uncontracted	0
TOTAL	2790

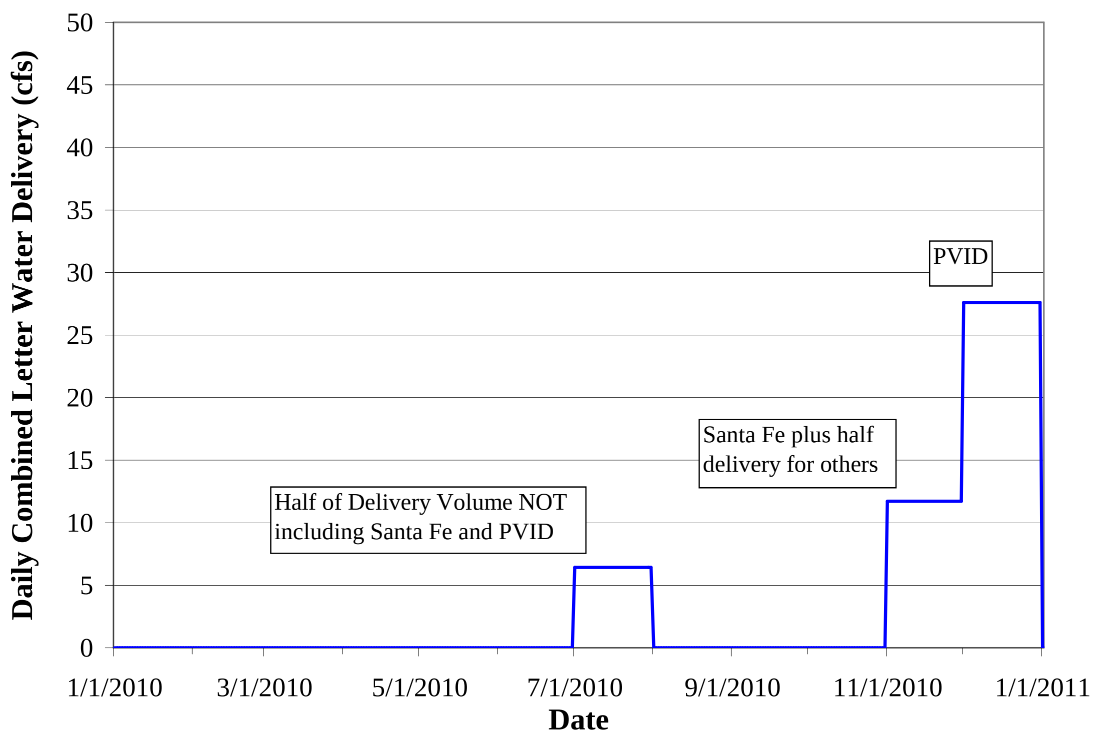


Figure 2.4. Sample Delivery Schedule for Combined Letter Water Delivery

2.1.4. Target Flows

The current model is set up to model releases of supplemental water for targets as documented in the Biological Opinion (Service, 2003). Supplemental water consists of leased San Juan-Chama Project water or Emergency Drought water stored at El Vado Reservoir that is specifically designated for targets. More details on these two sources of supplemental water are presented in sections 2.3.1 and 2.3.2. Daily needed releases from Abiquiu Dam to meet targets at Central, Isleta, San Acacia, and San Marcial are computed in the model using hypothetical simulations, or separate side simulations in RiverWare to iterate on the flow needed to meet the targets. The locations of these targets in the model match the following slots: Central.Gage Outflow, IsletaDiversionDam.Outflow, SanAcaciaFloodway.Gage Outflow, and SanMarcialFloodway.Gage Outflow. Targets are defined in the MinTargetFlows periodic slot in the MiddleValleyDemands data object where targets are a function of defined hydrologic conditions. (The last four columns with targets that are independent of a year classification are not currently used.)

A step down in flow targets following the winter continuous flow requirement is included in the target table in the current model. This step down in targets is needed to represent the use of supplemental water to control the rate of drying after the winter continuous flow requirement. This operation is specific to cases when the runoff ends before the instituted winter continuous flow requirement and a step down is specifically needed after the continuous flow requirement. A separate step down in targets to manage recession after the runoff is triggered as part of discretionary operations as discussed in section 2.1.4.3.

2.1.4.1. Hydrology Year Type

The year classification for setting targets in the model is set based on a March through July forecasted flow volume at Otowi, calculated with reference to the input upstream flows at Lobatos and input tributary inflows and ungaged local inflows above Otowi. The year will be classified as dry, average, or wet based on the forecasted flow volume relative to threshold volumes computed as a percentage of the average Otowi flow. These percentages are input to the ForecastFactorsForHydYearType table slot in the MiddleValleyDemands data object, and the average March through July Otowi flow volume is input to the AverageOtowiForecast scalar slot in the Indian data object. The determined year classification on May 1st is maintained for the remainder of a calendar year. A year is classified as dry if stipulations of Article VII of the Compact are in effect, but since the year classification is set for the remainder of the year on May 1st, the year classification will not change if the Article VII status changes after May 1st.

2.1.4.2. Safety Factor

A safety factor can be included that will increase targets by a percentage (i.e. a target of 100 cfs will increase to 125 cfs with a 25% safety factor). A 25% safety factor is currently applied to targets because the model can set releases from Abiquiu to hit targets in the Middle Valley with much better precision than can be done in actual operations. Uncertainty about conveyance losses, MRGCD returns, local inflows, etc. combined with the travel time from Abiquiu to target locations and other physical operational constraints prevent actual releases from being adjusted with such precision, so a safety factor is applied to targets in the model such that modeled supplemental water releases more accurately reflect actual release volumes. Values for the safety factor are input to the MinTargetFlowsSafetyFactor periodic slot in the Middle Valley Demands data object. The value of 25% included in the current model was identified as an appropriate safety factor based on a comparison of historical supplemental water use from 2003 through 2006 and model results for supplemental water needed for a run using historical 2003 through 2006 hydrology.

2.1.4.3. Discretionary Operations

URGWOM is set up to simulate discretionary operations as part of the Biological Opinion which entail using supplemental water to manage recession after the runoff and control the rate of drying after river rewetting. This operation entails implementing a 30-day step down in targets at the end of the runoff and 7-day step down in targets thereafter following each river rewetting event. This aspect of operations can be turned off by setting the value in the TriggerImplementStepDownInTargets scalar slot to zero. The operation will be included as modeled policy if the input value in this scalar slot is 1.

Trigger flows for establishing if river rewetting has occurred are input to the RiverWetThresholds table slot in the MiddleValleyDemands data object where river wetting is defined by the threshold flows being exceeded at all three locations. River drying is then defined when the flow drops below one of the trigger flows in the RiverDryThresholds table slot. The step down target range for each location is established in the StepDownTargetRange table slot, and the duration and number of steps in a step down are defined in the DurationNumberStepsForStepDownInTargets table slot. Separate inputs for the duration and number of steps are established for the step down to manage recession after the runoff and the subsequent step downs in targets to control the rate of drying after each river rewetting event.

2.1.4.4. Shorted Diversions

If MRGCD is in a shortage situation and does not have the supply to meet their full demand, it is possible that full requested diversions would not be met. Requested diversions at MRGCD diversions may be shorted if MRGCD is in a shortage situation to prevent released supplemental water from being diverted that is specifically designated for targets. This adjustment is implemented in a simulation by completing additional side simulations in the model to iterate on what the diversions would be without supplemental water, and requested diversions at the main MRGCD diversions are reset from the full requested diversions to the determined shorted diversion. **This adjustment is only applied if there are downstream targets.** If there are no downstream targets, it is assumed that any supplemental water still in the river is available for diversion. For example, if supplemental water is released to meet a target flow at Central, diversions may be shorted at Cochiti or Angostura if MRGCD would not have received their full requested diversion at those locations without supplemental water, but if there were no targets below Central, remaining supplemental water in the river may be diverted at the Isleta diversion during a shortage situation.

2.2. Reservoir Storage and Releases

Demands in the Middle Valley are met with specific sources of water. The MRGCD Demand at Cochiti is first met with natural flows including any letter water deliveries plus any releases of P&P water. Available native Rio Grande water in storage at El Vado is released from storage to augment flows if needed to the meet the full demand at Cochiti. If no native Rio Grande water is available, MRGCD San Juan-Chama Project water is released to meet the demand. (If no San Juan-Chama Project water allocated to MRGCD is available, MRGCD is in a shortage situation and requested diversions likely will not be made).

Albuquerque's demand for surface water diversions and letter water deliveries is met by releasing Albuquerque's available San Juan-Chama Project water from storage at Abiquiu Reservoir. Letter water deliveries for the Combined account are made from available storage for the Combined account at Abiquiu Reservoir. Releases of supplemental water as needed to meet targets are made from the Reclamation account at Abiquiu Reservoir where supplemental water may be available from leases for contractor's San Juan-Chama Project water or Emergency Drought water at El Vado that is passed through Reclamation's account at Abiquiu Reservoir in the model.

2.2.1. San Juan-Chama Project Water

Diversions from the San Juan basin through San Juan-Chama Project facilities to Heron Reservoir are computed with rules using input values for the flows in the San Juan tributaries and with consideration for diversion restrictions including an annual limit, ten-year diversion limit, and available space at Heron Reservoir. San Juan-Chama Project water at Heron is first tracked in the model with the FederalSanJuan storage account on the Heron storage reservoir object. Water is allocated to contractors for San Juan-Chama Project water on January 1st of each calendar year based on the annual allocations input to the SanJuanContractorAllocations table slot (Figure 2.5) on the HeronData data object

(Additional allocations are made on July 1st in the model with available water in the FederalSanJuan account if full allocations cannot be made on January 1st).

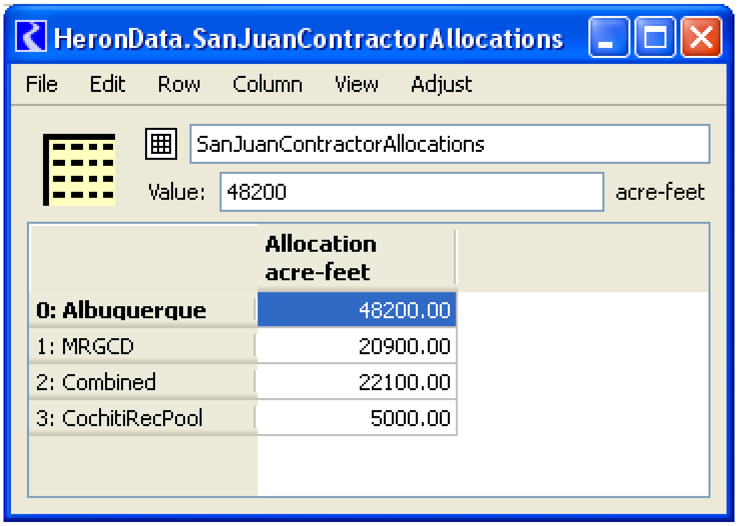


Figure 2.5. HeronData.SanJuanContractorAllocations Table Slot

2.2.1.1. Allocated Storage Space

Contractors have allocated storage space for San Juan-Chama Project water as input to the MaxAccountStorage periodic slots in the ElVadoData and AbiquiuData data objects (Figures 2.6 and 2.7). In the current model, MRGCD has all available storage space at El Vado Reservoir, but it could be assumed that MRGCD would allow other contractors to store water at El Vado as part of a planning study. The limit for MRGCD storage of San Juan-Chama Project water is currently set to 183,000 acre-ft to approximately match the storage capacity at the maximum El Vado pool elevation of 6901 ft. Albuquerque has historically had the most significant amount of allocated storage space at Abiquiu Reservoir, but with Albuquerque using more of their allocated San Juan-Chama Project water for surface water diversions to the new drinking water plant and increased letter water deliveries for historic and current groundwater pumping impacts, assumptions about future allocated storage space at Abiquiu should be reviewed for a planning study. Storage is allowed at Abiquiu Reservoir up to a pool elevation of 6220 ft (Easement approvals from land owners are needed for storage above 6220 ft). In the current model, the space is allocated to the Albuquerque, Combined, and Reclamation accounts as 128,256, 23,000, and 30,000 acre-ft, respectively, with 2000 acre-ft allocated for MRGCD, primarily to provide operational flexibility to MRGCD for moving water from El Vado Reservoir through Abiquiu Reservoir.

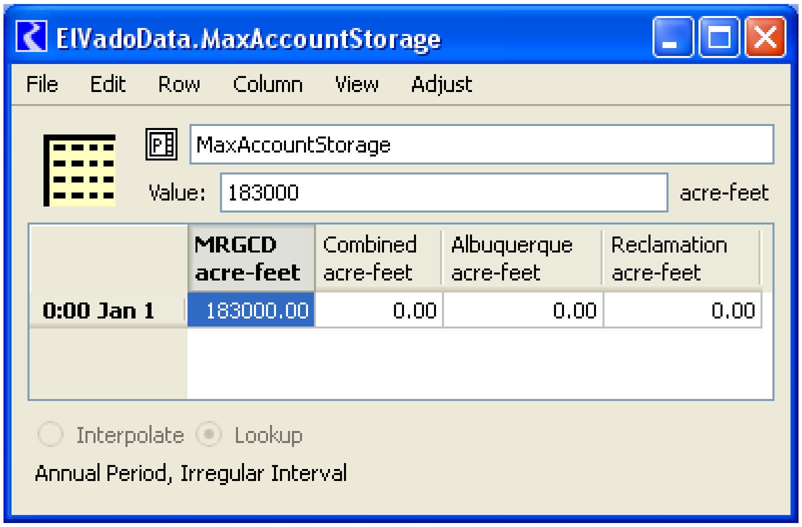


Figure 2.6. ElVadoData.MaxAccountStorage Period Slot

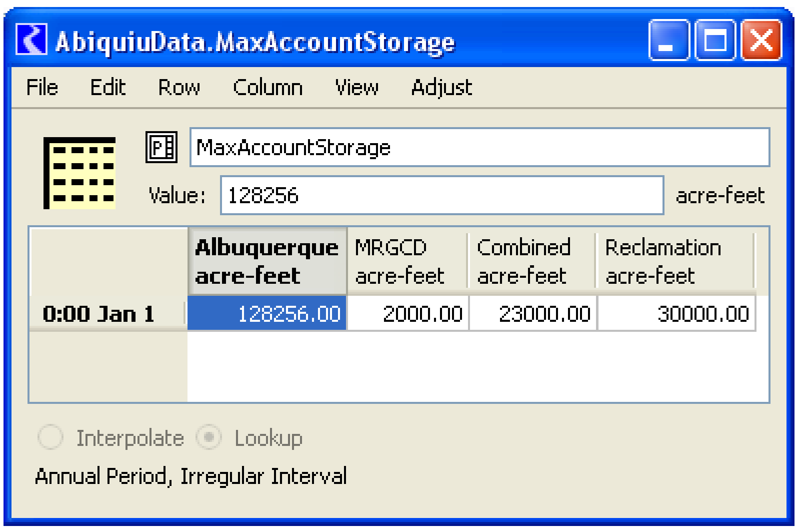


Figure 2.7. AbiquiuData.MaxAccountStorage Period Slot

2.2.1.2. Waivers

URGWOM is set up to allow contractors for San Juan-Chama Project water to retain current year allocated water, as discussed in section 2.2.1, that is still in storage at Heron Reservoir at the end of a calendar year, into the following year until an input waiver date. The current authorized waiver date of September 30^{th} is input to the WaiverDate table slot in the HeronData data object in the current model. Coded policy entails releasing waiver water as soon as possible during the following year such that available downstream allocated storage space for the contractor is filled by the waiver date or all waiver water at Heron Reservoir is released by the waiver date. Note that some current year allocated water may also be delivered at the same time to fill downstream allocated storage space as discussed in section 2.2.1.3. Also, note that Reclamation is not currently set up to store leased water at Heron into the year following when the water was originally allocated to the contractors that leased the water to Reclamation. The waiver option is turned on for a year during a simulation if the value in the annual HeronData.WaiverSwitch slot is set to 1.0. Waivers could be turned off by setting this switch to zero.

2.2.1.3. Deliveries to Allocated Storage Space

Allocated San Juan-Chama Project water for contractors as discussed in section 2.2.1 is periodically delivered to allocated storage space as discussed in section 2.2.1.1. Total delivery amounts from Heron to specifically fill allocated storage space for all contractors are input for set periods. Releases are made at an average rate to make the total release by the end of the period. The values for the total release amounts for set periods are input to the AccountFillMaxVolume periodic slot (Figure 2.8) in the HeronData data object and can be used to control the timing and amount of water that is moved from Heron to allocated storage space at El Vado and Abiquiu Reservoirs. Deliveries are made sequentially for individual contractors by setting the separate supplies that have a release type of AccountFill based on input priorities as set in the AccountReleasePriority periodic slot (Figure 2.9) in the HeronData data object. Note that waiver water, which is delivered gradually up to the waiver date, may be delivered at the same time which will impact the timing for when allocated storage space is filled.

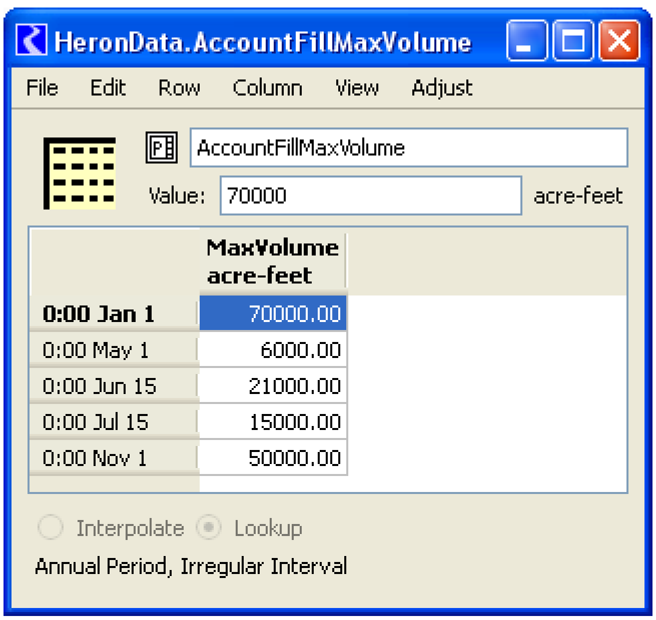


Figure 2.8. HeronData.AccountFillMaxVolume Periodic Slot

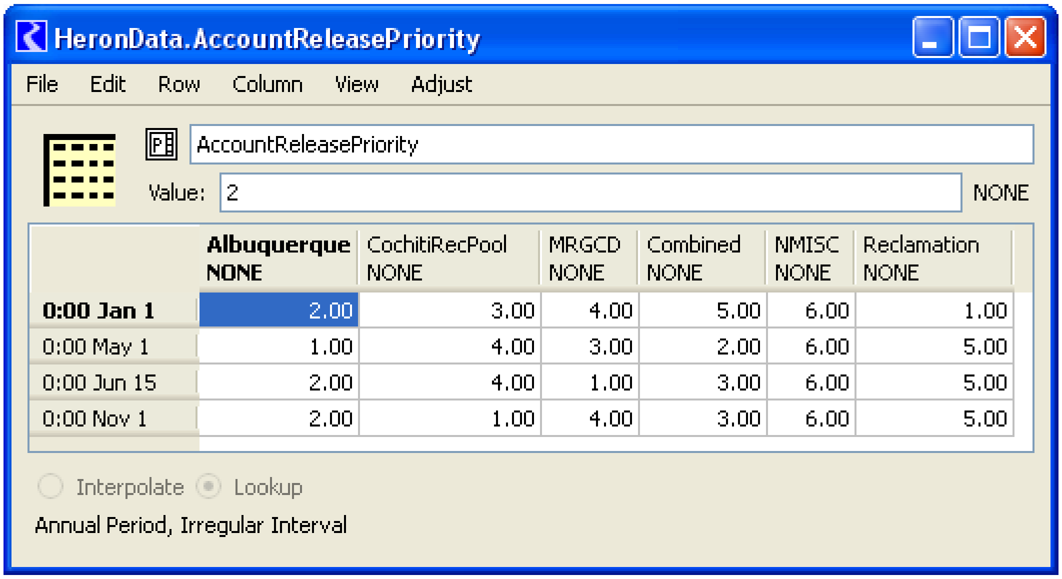


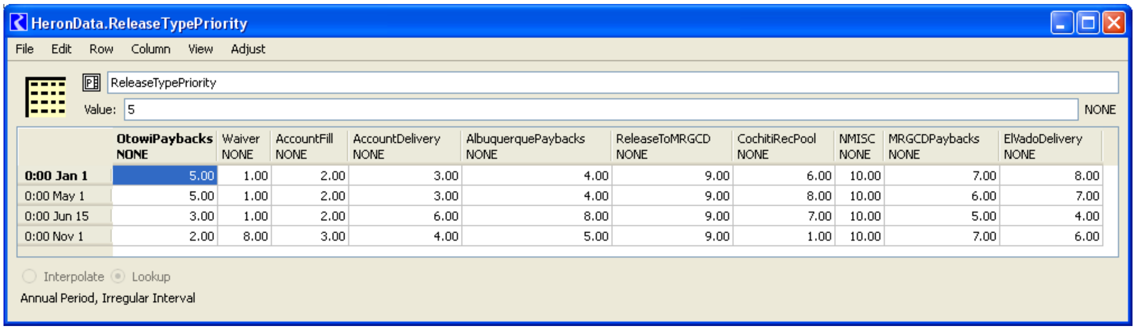
Figure 2.9. HeronData.AccountReleasePriority Periodic Slot

2.2.1.3.1. Cochiti Lake Recreation Pool

Releases of San Juan-Chama Project water for the Cochiti Recreation Pool are set in a similar manner to the AccountFill releases but are tracked separately in the model from the other AccountFill releases. Releases are made to fill the allocated rec pool space at Cochiti which is input as a storage value in the Permanent Sediment Content table slot in the Cochiti storage reservoir object. The current input value of 49,370 acre-ft provides the Cochiti rec pool surface area of 1200 acres based on the input elevation-area-capacity tables. With sediment accumulation at Cochiti Reservoir modeled during a simulation, the reservoir storage for maintaining the rec pool gradually increases during a simulation. Releases of San Juan-Chama Project water allocated for the Cochiti rec pool are made from Heron Reservoir to release set volumes over set periods as input to the HeronData.CochitiRecPoolMaxVolume periodic slot. Releases from Heron Reservoir are made at an average rate to release the input volume by the next date in the table. The timing for these deliveries may also be affected by the input priority for accounting supplies that have a release type of CochitiRecPool as set in the account release priority table as discussed further in section 2.2.1.3.2.

2.2.1.3.2. Priority Tables for Releases

Deliveries from Heron Reservoir to fill allocated storage space are made with accounts that have a release type of AccountFill and are made based on the priority for this release type in the ReleaseTypePriority periodic slot (Figure 2.10) in the HeronData data object. Accounts for other deliveries have different release types such as OtowiPaybacks for letter water deliveries as discussed in section 2.1.3. Initial demands for moving water are computed and then deliveries are made based on the input priorities. Assuming the initial computed release to meet different demands could be made and was not restricted to operational constraints and accounts have water in storage to make the designated deliveries, all initial computed demand should be met. Deliveries from El Vado are set in a similar manner with reference to the corresponding periodic slots in the ElVadoData data object.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File Edit Row Column View Adjust
ReleaseTypePriority
Value: 5 NONE

	OtowiPaybacks NONE	Waiver NONE	AccountFill NONE	AccountDelivery NONE	AlbuquerquePaybacks NONE	ReleaseToMRGCD NONE	CochitiRecPool NONE	NMISC NONE	MRGCDPaybacks NONE	ElVadoDelivery NONE
0:00 Jan 1	5.00	1.00	2.00	3.00	4.00	9.00	6.00	10.00	7.00	8.00
0:00 May 1	5.00	1.00	2.00	3.00	4.00	9.00	8.00	10.00	6.00	7.00
0:00 Jun 15	3.00	1.00	2.00	6.00	8.00	9.00	7.00	10.00	5.00	4.00
0:00 Nov 1	2.00	8.00	3.00	4.00	5.00	9.00	1.00	10.00	7.00	6.00

Interpolate Lookup
Annual Period, Irregular Interval

Figure 2.10. HeronData.ReleaseTypePriority Periodic Slot

In addition to the AccountFill releases, the current model is set up with specific accounts designated with a release type of AccountDelivery that will override original computed deliveries to assure MRGCD's allocated storage space is filled. The URGWOM Tech Team is reviewing the current set up for setting accounts for moving water to fill allocated storage space to assure water is delivered at appropriate times and to also incorporate policy for using such deliveries to provide rafting releases below El Vado Dam. Accounts with a release type of ReleaseToMRGCD also work in a similar fashion to the AccountDelivery accounts in that the ReleaseToMRGCD accounts override initial estimates for deliveries to assure water is moved to MRGCD's account. The current model contains a specific account with a release type of ReleaseToMRGCD that will move water from the Combined account to MRGCD's account if this release type is set as higher priority but this release type should be designated as lower priority unless such a transfer is desired.

2.2.1.4. Loans between Contractors

URGWOM is currently set up to allow Albuquerque to loan unused San Juan-Chama Project water to other contractors, but with the startup of surface water diversions, this policy, that had been modeled in the past, is likely no longer relevant for future studies. A minimum Albuquerque storage at Abiquiu Reservoir before water would be loaned is input to the AbiquiuData.MinPoolAlbuquerqueLoan table slot, but the value is currently set to 200,000 acre-ft which effectively prevents any loan from ever occurring because Albuquerque storage would never be so high (Total reservoir storage at the current maximum pool elevation of 6220 ft is 183,882 acre-ft.) If policy for Albuquerque to loan water to other contractors were to be simulated, the details of the policy would likely need to be reviewed against the current coded rules through coordination with the URGWOM Tech Team.

The Planning Model is also set up to model loans from MRGCD to either Reclamation or Albuquerque. Schedules for these loans are input to the ReclamationFromMRGCDLoan and AlbuquerqueFromMRGCDLoan series slots in the HeronData data object. Loans would be made, if MRGCD has the water in storage to loan, based on these input schedules and paid back to MRGCD when Reclamation or Albuquerque has available water for the payback. These loans would be tracked with the Exchanges Manager in RiverWare. This policy allows for specific agreements to be modeled, but if any future loans between these contractors were to be modeled, the details of the policy would likely need to be reviewed against the current coded policy through coordination with the URGWOM Tech Team. All values are set to zero for these series slots in the current database files.

2.2.2. Native Rio Grande Water

Native Rio Grande water is effectively bypassed at Heron Reservoir. There is a restriction that the Heron pool elevation cannot change by more than one foot a day (Input to the HeronData.maxDeltaPoolElev table slot); however, with no storage of native Rio Grande water at Heron Reservoir, this operation would primarily impact storage and releases of San Juan-Chama Project water. Rio Grande water may be stored at El Vado as discussed further below, and native Rio Grande water may be stored at Abiquiu Reservoir and Cochiti Reservoir for flood control operations. Policy for making stepped releases at Abiquiu and Cochiti Dams is included in the URGWOM ruleset. Inflows are bypassed at Jemez Dam unless storage is needed for channel capacity restrictions through coordinated operations with Cochiti Dam.

2.2.2.1. Channel Capacities

Water may be stored at Abiquiu to assure the downstream channel capacities are not exceeded as input to the AbiquiuData.ChannelCapacities table slot. The capacity of the Rio Chama between Abiquiu Dam and the Chamita gage is input as 1800 cfs, and the capacities for the Chamita to Espanola and Espanola to Otowi reaches are input as 3000 and 10,000 cfs, respectively. Channel capacities below Cochiti Dam are input to the CentralChannelCapacity and SanMarcialChannelCapacity periodic slots in the CochitiData data object. In the current model, the Central channel capacity is set to 7000 cfs and the San Marcial channel capacity is input as 5000 cfs. (A San Marcial channel capacity of 5000 cfs will prevent the Central channel capacity of 7000 cfs from being reached.) Different channel capacities for different periods within a calendar year could be established. A series slot called ChannelCapacityOpsFlag is set up in the CochitiData data object to indicate which channel capacity controlled with a value of 1 indicating the Central channel capacity controlled and a value of 2 indicating the San Marcial channel capacity controlled (a NaN value in this slot indicates that channel capacities did not control the release for that timestep). Channel capacities below Elephant Butte and Caballo Dams are input to the ChannelCapacities table slot in the ElephantButteData and CaballoData data objects. The channel capacity below Elephant Butte Dam is input as 5000 cfs, and the channel capacity below Caballo Dam is set to 3500 cfs with a capacity of 11,000 cfs at El Paso.

2.2.2.2. Carryover Storage

Water stored at Abiquiu and Cochiti Reservoirs during flood control operations will be subsequently released as possible, but any water still in storage after July 1st and after the natural flow at Otowi drops below 1500 cfs, as input to the MinLockinFlow table slot in the FloodCarryOverData data object, will be retained in storage if 212,000 acre-ft of space is available in Cochiti Lake. Carryover storage will be released starting in November at a determined constant rate such that the water is evacuated by March 31st.

2.2.2.3. Article VII of the Compact

Inflows of native Rio Grande water at El Vado Reservoir will be stored if not needed to meet downstream demands and if the stipulations of Article VII of the Compact are not in effect. Article VII of the Compact (States of New Mexico, Colorado, and Texas, 1938) stipulates that water may not be stored in post-Compact Reservoirs if there is less than 400,000 acre-ft of usable water in project storage, where project storage is calculated as the sum of storage at Elephant Butte Reservoir, not including any San Juan-Chama Project water or New Mexico credit water, plus storage at Caballo Reservoir. Usable storage is computed in the model and recorded to the CompactVIIUsableWater series slot in the RioGrandeCompact data object, and the resulting Article VII status is recorded to the ArticleVIISwitch series slot in that data object where a value of 1 indicates that Article VII is in effect and a value of 0 indicates that the provision is not in effect.

2.2.2.4. Storage at El Vado Reservoir

If the stipulations of Article VII of the Compact are in effect, inflows of native Rio Grande water will be bypassed after water has been stored to meet the computed P&P storage requirement as discussed in section 2.1.1.1 and water has been stored to fill any allocated space for Emergency Drought water as a result of relinquished Compact credits (Refer to section 2.3.2). Releases may include the release of P&P water as needed and any available native Rio Grande water to meet the MRGCD demand as needed.

If Article VII is not in effect, native Rio Grande water will be stored as not needed to meet the MRGCD demand to ultimately meet a target elevation by a target date as input to the TargetElevation periodic slot in the ElVadoData data object (Figure 2.11). During a calendar year, all available native Rio Grande inflows are stored *during the runoff*, prior to the May 25th input target elevation, until the storage reaches <u>65% of the storage</u> corresponding with that target elevation where the 0.65 fraction is input to the FractionOfTargetElevToStartPercRGRel scalar slot in the ElVadoData data object. The current input value of 65% of target storage yields an elevation of 6878.35. This elevation is approximately at the crest of the spillway. A computed percentage of native Rio Grande inflows are bypassed thereafter such that the reservoir will reach the target fill date on May 25th based on forecasted inflows. This computed percentage is recorded to the ElVadoData.PercentRGRelease series slot in the ElVadoData data object.

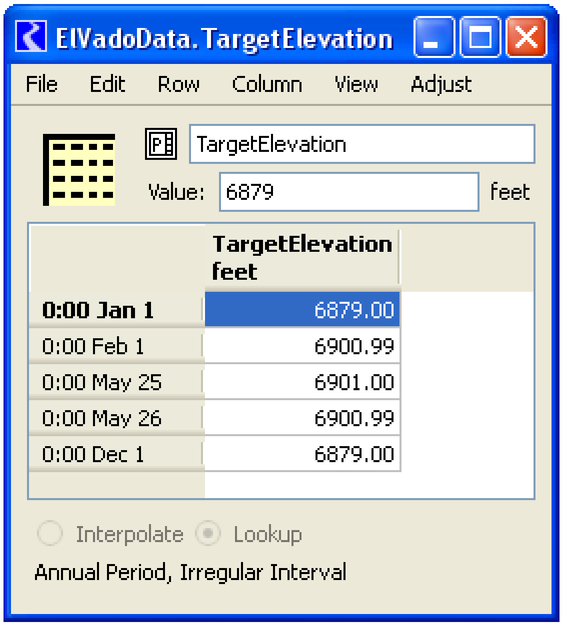


Figure 2.11. ElVadoData.TargetElevation Periodic Slot

After the reservoir has filled, water will gradually be evacuated to target the input elevation of 6879 on December 1st if Article VII is NOT in effect. This operation entails evacuating water as needed before the winter to prevent icing on the spillway gates but is not implemented if the pool elevation exceeds this winter target elevation and Article VII is in effect with the assumption that all water in storage should be retained as possible if Article VII is in effect. Also, storage of San Juan-Chama project water is not evacuated even if the pool elevation exceeds this target winter pool elevation. Heaters have recently been installed to prevent icing on the gates but the operation is still included in the current model to reflect El Vado Reservoir standard operating procedures that are still in place.

2.2.2.4.1. Article VIII of the Compact

URGWOM is set up to model El Vado Dam releases that would be made based on a call by Texas per Article VIII of the Compact which essentially states that Texas may call for a release, starting in January, of water in storage from post-Compact reservoirs to the amount of an accrued Compact debt to bring the usable water in project storage up to 600,000 acre-ft. A switch to identify whether this policy should be modeled is included as the TriggerImplementArticleVIIIOps scalar slot in the RioGrandeCompact data object. This policy will be modeled if a value of 1 is entered in this scalar slot but will not be included if the value is set to 0. A threshold debt for when a call would actually be made is input to the ThresholdCompactCreditToStartArticleVIIIOps scalar slot in the RioGrandeCompact data object which is set to -20,000 acre-ft in the current model based on the assumption that Texas would not actually make a call until the debt accrued to exceed 20,000 acre-ft. Releases are made in the model by establishing a new minimum release of Rio Grande water for an Article VIII release season as set in the ArticleVIIIReleaseSeason table slot in the RioGrandeCompact data object. Releases are set to a computed average rate to release a volume equal to the Compact debt over the Article VIII release season, but no release will be made if there is no RioGrande water in storage. P&P water in storage is not released for Article VIII releases.

2.2.2.5. Releases from Elephant Butte and Caballo Dams

Releases from Elephant Butte Dam are set to provide an input full demand if the supply is available based on the storage at Elephant Butte and Caballo Reservoirs plus a forecasted Elephant Butte Reservoir inflow volume from the runoff. The full demand for a year is input to the AverageDemand periodic slot in the ElephantButteData data object. If the full demand cannot be provided, a percentage of the demand that can be met is computed monthly based on the ratio of the available supply to the remaining demand for the year. This percentage is recorded monthly to the DownstreamDemandPercentage series slot in the ElephantButteData data object. The resulting daily demand from Elephant Butte Reservoir is recorded to the DownstreamDemand series slot in that data object. The demand from Caballo Reservoir is set with reference to the same computed DownstreamDemandPercentage value and a separate full demand schedule for Caballo Reservoir as input to the AverageDemand periodic slot in the CaballoData data object. Releases from Elephant Butte and Caballo Dams are set to the releases to provide the corresponding computed DownstreamDemand with consideration for flood control operations. Refer to the rules documentation for all the details on policy for flood control operations at Elephant Butte and Caballo Dams (Boroughs, 2010).

2.3. Water Agreements and Proposed Actions

For any planning study, assumptions need to be identified in regards to potential water agreements or other proposed actions that have been implemented or studied previously and are currently incorporated into URGWOM including the following: Reclamation leases of San Juan-Chama Project water from contractors, relinquished Compact credits and storage of Emergency Drought water, Cochiti deviations to provide recruitment or overbank flows, reregulation storage at Abiquiu Reservoir, alternate timing for letter water deliveries, and pumping from the Low Flow Conveyance Channel.

2.3.1. Reclamation Leases

For this user manual, supplemental water is defined as water designated to be released to meet target flows in the Middle Valley. There are two sources for supplemental water: water may be leased by Reclamation from contractors for San Juan-Chama Project water or native Rio Grande water may be stored as Emergency Drought water at El Vado to be used for targets (Refer to section 2.3.2 for more details on Emergency Drought water). Leases of San Juan-Chama Project water by Reclamation from contractors are set up as transfers from account storage for the other contractors to Reclamation's account. These transfers are made as input to the AlbuquerqueWaterLease, CombinedWaterLease, and MRGCDWaterLease series slots in the each of the HeronData, ElVadoData, and AbiquiuData data objects. Transfers for water leases occur exactly as input at the reservoir corresponding with the data object where the transfer is input – from the source storage account, designated in the slot name, to Reclamation's storage account. (Series slots are also included in these data objects for individual contractors for San Juan-Chama Project water as opposed to just the Combined account, but these additional slots are not used in the Planning Model. These slots must be maintained in the Planning Model such that the single ruleset that is also used with the Water Operations Model will work with the Planning Model.) Assumptions about the magnitude and timing for future leases will need to be reviewed before any planning study.

2.3.1.1. Threshold YTD Otowi Flow Volume for Conserving Lease Water

A sample policy for conserving leased San Juan-Chama Project water during wet periods is currently established in URGWOM where lease water will not be used for targets after a threshold year-to-date Otowi flow volume has been reached. This threshold volume is input to the ThresholdOtowiVolumeHoldLeaseWater scalar slot (Figure 2.12) in the MiddleValleyDemands data object. A value of 1,000,000 acre-ft has been analyzed previously. To turn off this policy, the value could be set to a threshold that would never be met such as 999,999,999 acre-ft. This policy only applies to leased water. Available Emergency Drought water would still be used to meet targets regardless of the year-to-date Otowi flow volume.

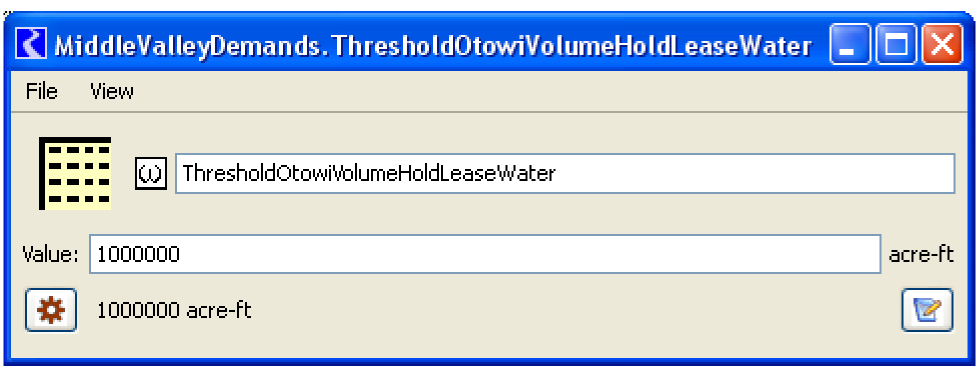
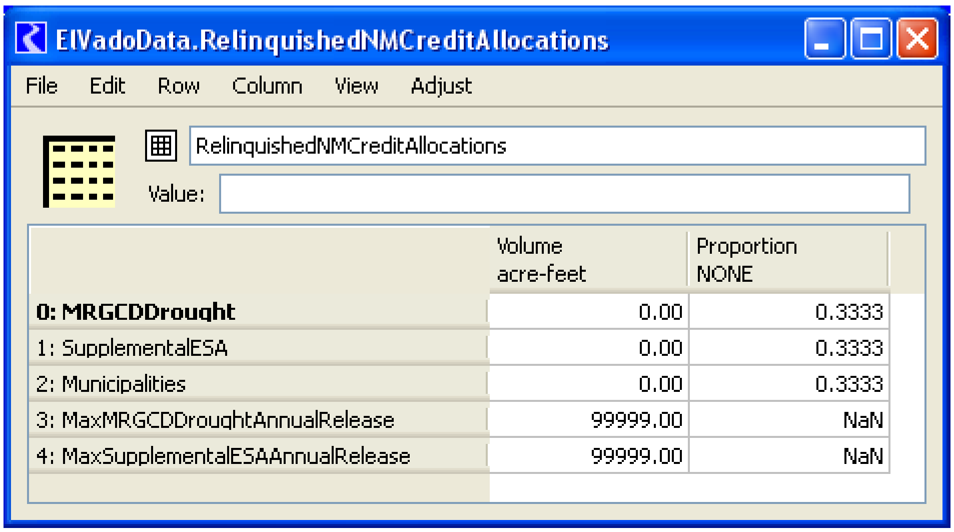


Figure 2.12. MiddleValleyDemands.ThresholdOtowiVolumeHoldLeaseWater Scalar Slot

2.3.2. Relinquished Credits and Emergency Drought Water

URGWOM is set up to model relinquished Compact credits and the subsequent storage of Emergency Drought water at El Vado Reservoir when stipulations of Article VII of the Compact are in effect (Refer to section 2.2.2.3 for more details on Article VII). A trigger is set if Relinquished credits are to be modeled. That is, if a value of 1 is input to the TriggerModelRelinquishedCredits scalar slot in the ElVadoData data object, the policy will be modeled; whereas, relinquished credits will not be modeled if a value of 0 is input to this scalar slot. Compact credits will be relinquished each year on the date input in the DateOfRelinquishment column in the RelinquishedCreditsTriggers table slot in the ElVadoData data object.

Credits are relinquished if the Compact credit exceeds the value input to the ThresholdForRelinquishment column in the RelinquishedCreditsTriggers table slot to reduce the credit to the value in the CreditAfterRelinquishment column. Allocations for subsequent storage of Emergency Drought water at El Vado Reservoir are set based on the input fractions in the Proportion column of the RelinquishedNMCreditAllocations table slot in the ElVadoData data object for each of three purposes: MRGCD, ESA, and municipalities. Initial allocations for Emergency Drought storage, from past relinquished credits, are input to the Volume column of the RelinquishedNMCreditAllocations table slot (Figure 2.13).



	Volume acre-feet	Proportion NONE
0: MRGCDDrought	0.00	0.3333
1: SupplementalESA	0.00	0.3333
2: Municipalities	0.00	0.3333
3: MaxMRGCDDroughtAnnualRelease	99999.00	NaN
4: MaxSupplementalESAAnnualRelease	99999.00	NaN

Figure 2.13. ElVadoData.RelinquishedNMCreditAllocations Table Slot

Allocations are tracked in the MRGCDDroughtAllocation, SupplementalESAAllocation, and MunicipalitiesAllocation series slots in that data object. Any water in storage for the corresponding account contributes to the allocation (These initial allocations should be greater than or equal to any initial storage in these accounts on the El Vado level power reservoir object). When water is released, the allocation has been used and is reduced. Maximum annual releases for MRGCD or ESA could be input to the last two rows of the Volume column in the RelinquishedNMCreditAllocations table slot, but values of 99,999 acre-ft are currently input to effectively represent no annual release limit.

Inflows of native Rio Grande water to El Vado Reservoir when Article VII is in effect are stored to separate accounts for Emergency Drought water *after* any storage requirement for P&P needs is met first. Storage accumulates in the Emergency Drought accounts with the actual inflow of native Rio Grande water. Available inflows of native Rio Grande water for Emergency Drought storage are split between the MRGCDDrought and SupplementalESA accounts based on the ratio of available allocation for the accounts. An allocation for storage of Emergency Drought water for municipalities is tracked in

URGWOM but water is not currently stored for use by municipalities since exact policy for how such water would be used by municipalities has not been defined.

Water for MRGCD is tracked in an MRGCDDrought account at El Vado reservoir and is used to meet the MRGCD demand when native Rio Grande water is no longer available to meet the MRGCD demand at Cochiti but before any of MRGCD's San Juan-Chama Project water would be used. Emergency Drought water for meeting targets is tracked in the SupplementalESA account at El Vado Reservoir and is used to meet targets before leased San Juan-Chama Project water in the Reclamation account at Abiquiu is used. A specific season for using SupplementalESA water can be defined in the ESAReleaseDates table slot in the ElVadoData data object; however, the entire calendar year is designated in the current model. A maximum release of SupplementalESA water can also be defined in the MaxESARelease table slot in the ElVadoData data object, but this value is effectively not used in the current model as it is set to 9999 cfs.

Within URGWOM, releases from the SupplementalESA account are effectively bypassed through Reclamation's account at Abiquiu (Water is first released from the Reclamation account to meet targets and water in the SupplementalESA account is released to replenish the storage in the Reclamation account if SupplementalESA water is available). Values for relinquished credits can be input to the RelinquishedNMCredits annual series slot (Figure 2.14) as an override to the calculation with rules. If relinquished credits are not modeled, any Emergency Drought water in storage at the beginning of the run as an initial condition would still be used to meet targets.

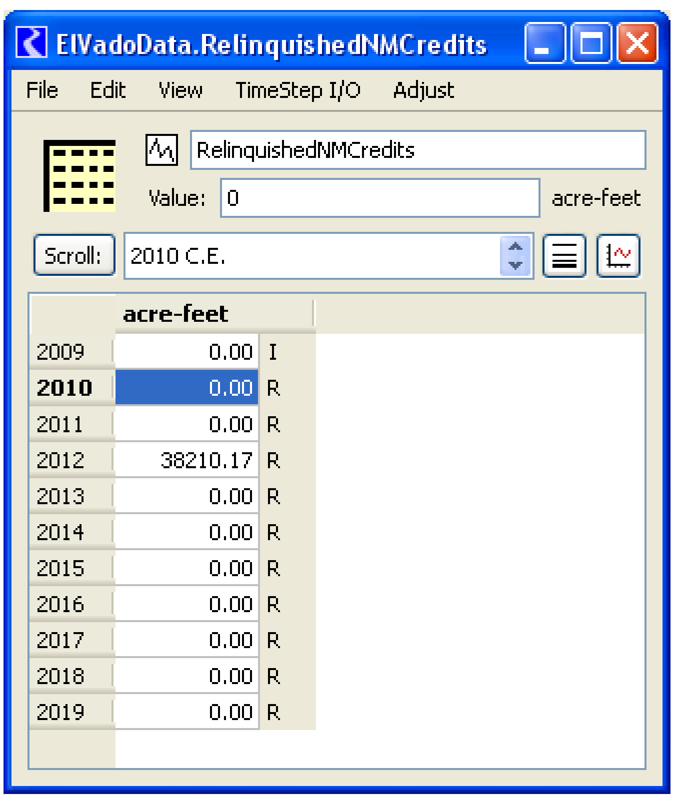


Figure 2.14. ElVadoData.RelinquishedNMCredits Annual Series Slot

2.3.3. Cochiti Deviations

Cochiti deviations are authorized through 2013 where the Corps may temporarily store native Rio Grande water to be released at the time of the peak and augment flows to provide recruitment flows in the Middle Valley (Corps, 2009). Specific criteria are coded for identifying whether the runoff is sufficient to enact Cochiti deviations to provide recruitment flows (or overbank flows) but the runoff is insufficient for providing the needed hydrograph by just bypassing inflows at Cochiti Reservoir. Operations entail providing overbank flows if conditions support providing the higher flows. A primary input to review is the year for suspending this aspect for operations as input to the table slot called LastYearCochitiDeviationsAuthorized in the MiddleValleyDemands data object (Refer to Figure 2.15 for a screen capture of this slot in the model). Cochiti deviations can easily be turned off for a model run by setting this value to a year prior to the run period. Current coded policy for deviations could be modeled for a period after 2013 by simply resetting this input to a later year.

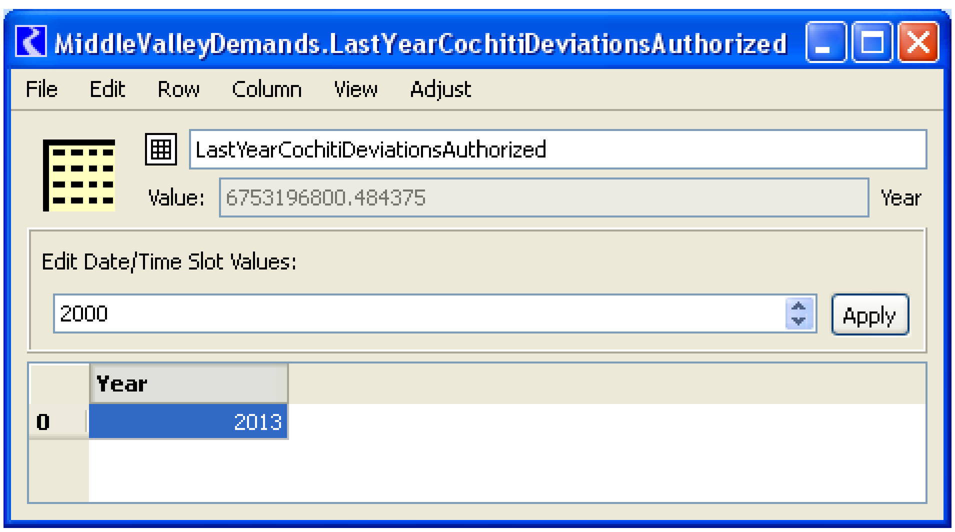


Figure 2.15. MiddleValleyDemands.LastYearCochitiDeviationsAuthorized Table Slot

Deviations will be implemented to provide *recruitment* flows if the March through July Otowi flow forecast is between 50% and 80% of average and the projected peak inflow to Cochiti Reservoir during the recruitment or overbank season is between 1800 and 5000 cfs or the March through July forecast is greater than 80% of average but the projected peak inflow is less than 3500 cfs. The recruitment or overbank season is defined by the dates input to the RecruitmentOrOverbankSeasonDates table slot in the MiddleValleyDemands data object, and the projected peak inflow to Cochiti is determined during a simulation.

Deviations will be implemented to provide *overbank* flows if the Otowi forecast is between 80% and 120% of average and the projected peak inflow to Cochiti is between 3500 and 10,000 cfs or the Otowi forecast is between 50% and 80% of average but the projected peak inflow is greater than 5000 cfs. These referenced fractions for the Otowi forecast as a percentage of average for identifying whether deviations should be implemented to provide recruitment or overbank flows are input to the EnvironmentalPercentages table slot in the MiddleValleyDemands data object. The average March through July Otowi flow volume is input to the AverageOtowiForecast scalar slot in the Indian data object (This average Otowi flow volume is also referenced in a similar manner for evaluating whether the hydrology year type for setting target flows is dry, average, or wet as discussed in section 2.1.4.1). The threshold peak Cochiti inflow rates referenced when determining whether deviations should be implemented to provide recruitment or overbank flows are input to the EnvironmentalMinMaxPeakFlows table slot in the MiddleValleyDemands data object.

The date to start storage at Cochiti Reservoir for deviations can be input to the PresetDayForCochitiDeviationsStorage table slot. Note that the value in the companion UsePresetDayForCochitiDeviationsStorge scalar slot must be set to 1 if an input date for storage is to be used. No preset date is input in the current model in which case the date to begin storage is set to 24 days before the projected date of the peak inflow to Cochiti Reservoir. The value for the number of days before the peak to begin storage is input to the DaysOfCochitiDeviationsStorageBeforePeak scalar slot in the MiddleValleyDemands data object.

Target flows to provide recruitment or overbank flows are input as 30-day target hydrographs in the EnvironmentalTargets table slot in the MiddleValleyDemands data object. If deviations are implemented, targets at Central are reset such that day five in the appropriate target hydrograph matches the date of the projected peak inflow to Cochiti Reservoir.

Water in storage for Cochiti deviations will be evacuated by the end of a deviations period which lasts for 45 days as input to the DurationCochitiDeviationsPeriod scalar slot in the MiddleValleyDemands data object. Water will begin to be evacuated 15 days before the end of the Cochiti deviations period at a constant rate if that constant rate is greater than the flow needed to meet the target in the established recruitment or overbank target hydrograph. A value of 3000 acre-ft is input to the LowStorageToEndDeviationsTargets scalar slot to shift Central targets back to original targets if storage at Cochiti for deviations drops below this threshold. This adjustment is needed to prevent other sources for supplemental water (i.e. leased San Juan-Chama Project water or Emergency Drought water for ESA) from being used to meet the recruitment or overbank targets.

2.3.4. Reregulation Storage

Reregulation storage (referred to as Conservation storage within the model) at Abiquiu is not currently authorized but has been modeled with URGWOM for planning studies. Reregulation storage entails allowing storage at Abiquiu Reservoir above the current maximum easement pool elevation of 6220 ft as input to the SJCEasement column in the

PoolLevels table slot in the AbiquiuData data object. If the total storage with reregulation storage was to be increased for a study, this SJCEasement value should be adjusted accordingly (e.g. a value of 6277.18 would be input for a total storage of 500,000 acre-ft based on the elevation-capacity table). The value in the RGConservationSpaceAvailable table slot should then also be adjusted to the total allowable storage to be modeled (e.g. 500,000 acre-ft). No additional conservation storage is allowed after that storage level has been reached.

Resulting reregulation storage allows storage of native Rio Grande inflows not needed to meet the MRGCD demand and is tracked with the Rio Grande Conservation storage account on the Abiquiu level power reservoir object in URGWOM. Reregulation storage is then released as needed for targets and is used before water in the Reclamation account based on the input priorities in the AccountReleasePriority periodic slot in the AbiquiuData data object. Reregulation storage still in storage within the dates input to the RGConservationReleaseDays table slot is completely evacuated at a computed constant rate (Past studies have also included an alternate coded policy to only evacuate reregulation storage as needed to keep the Compact credit whole). Assumptions for reregulation storage at Abiquiu to be modeled for a future planning study would likely need to be reviewed with the URGWOM Technical Team against current coded policy.

Reregulation storage at Cochiti Reservoir is currently simulated as part of Cochiti deviations. The URGWOM Tech Team is working on setting up URGWOM to simulate reregulation storage at Jemez Reservoir but this capability has not implemented into the current version of the model.

2.3.5. Alternate Timing for Letter Water Deliveries

A proposed action that has been analyzed with URGWOM entails modeling alternate schedules for letter water deliveries if specific conditions are satisfied for the portion of deliveries made to payback the Compact. The alternate delivery schedules have been studied to evaluate benefits of the alternate delivery timing on augmenting flows needed for recruitment, targets and to prevent river drying, or to help manage recession after the runoff.

Letter water deliveries from Albuquerque to payback the Compact would be used to provide a 7-day spiked release at the timing of the peak (Figure 2.16) if Cochiti deviations are not implemented and the Compact credit is greater than 70,000 acre-ft as input to the CompactCreditForSwitchToScenario2 scalar slot in the Delivery Requests data object. As a second but lower priority alternate schedule, Albuquerque letter water deliveries to payback the Compact would occur during September and October as opposed to November and December if the Compact credit is greater than 70,000 acre-ft and the flow at San Acacia is greater than 150 cfs for the last seven days of August as input to the SevenDaySAFlowForAlbScenario2 scalar slot in that data object. This second alternate delivery schedule is input to the AlbuquerqueScenario2 series slot (Figure 2.17), and the original no action delivery schedule (Figure 2.2) is input to the

AlbuquerqueScenario1 series slot. The first alternate delivery to provide a spiked release is computed in the model. Each year, conditions are evaluated to determine if an alternate delivery schedule should be simulated.

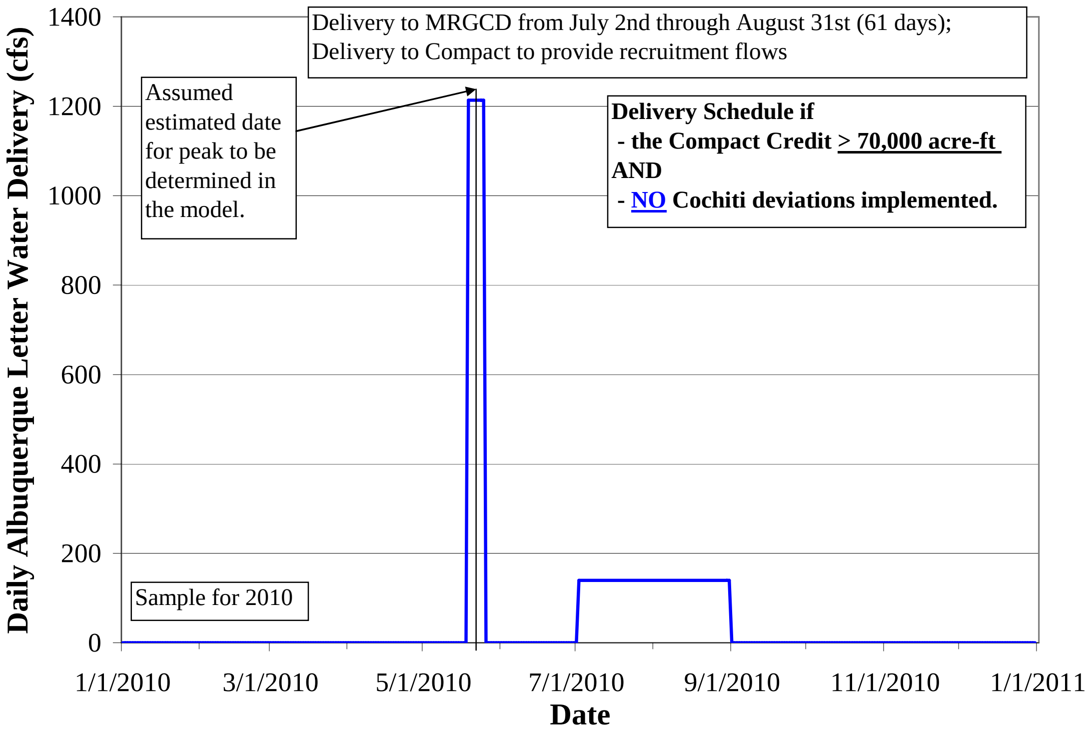


Figure 2.16. Sample (2010) *Alternate* Schedule for Albuquerque Letter Water Deliveries to Provide Spiked Release

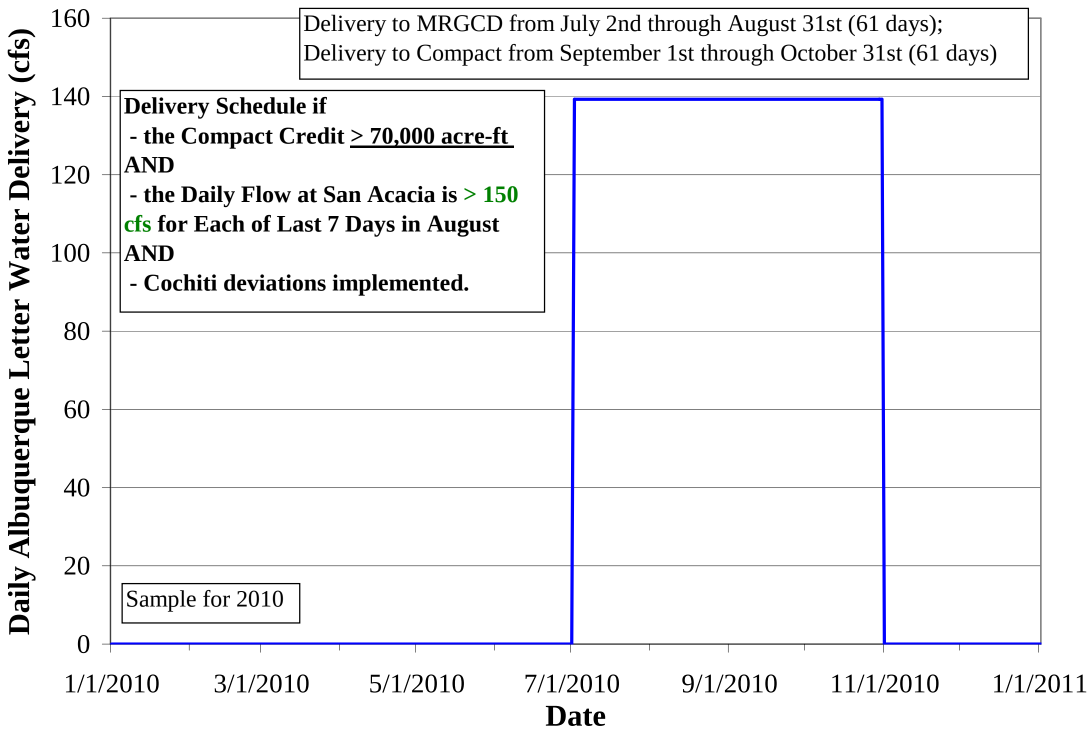


Figure 2.17. Sample (2010) *Alternate* Schedule for Albuquerque Letter Water Deliveries

Letter water deliveries for Santa Fe and half of the amount for other contractors not including PVID will be delivered at an alternate time if the Compact credit is greater than 70,000 acre-ft. That portion will be delivered in a 7-day spike around the peak (Figure 2.18) if Cochiti deviations are not implemented or as a constant release from June 15th through June 30th to help manage recession if the Compact credit is greater than 70,000 acre-ft but Cochiti deviations were implemented. The second alternative presented in Figure 2.19 is input to the CombinedScenario2 series slot in the DeliveryRequests data object with the original no action delivery schedule (Figure 2.4) input to the CombinedScenario1 series slot.

Note that if values are directly input to the Albuquerque or Combined series slots in the DeliveryRequests data object, those delivery schedules will always be utilized and alternate deliveries will not be made, and the inputs to the corresponding scenario 1 and 2 series slots in that data object are inconsequential.

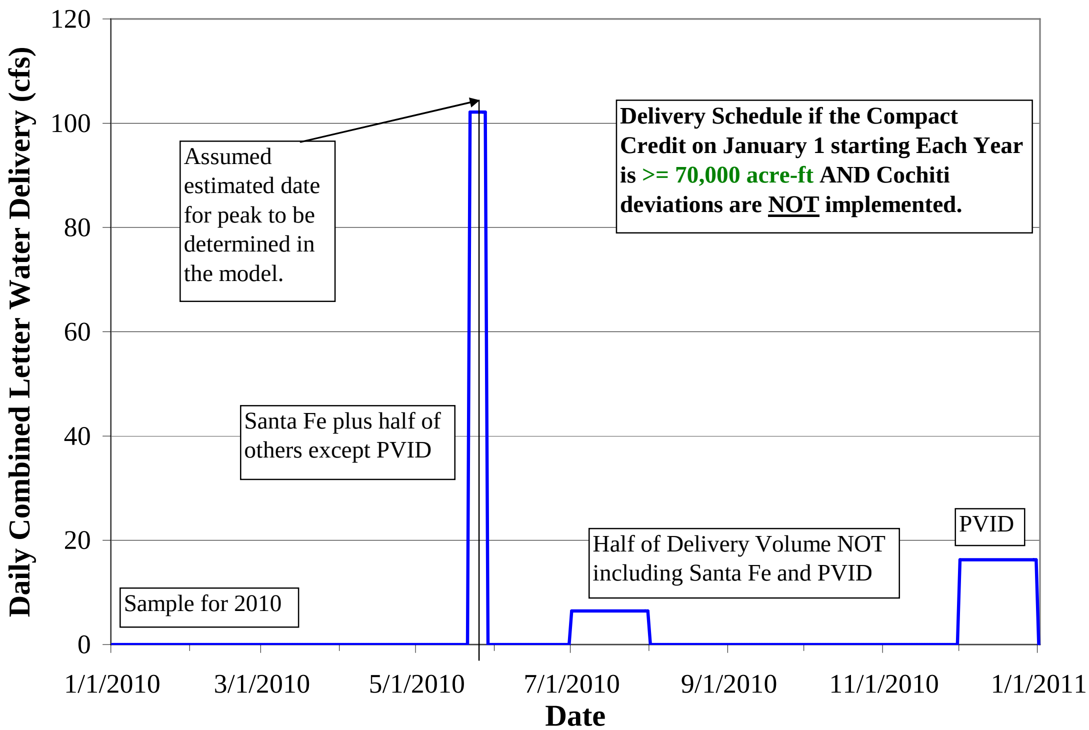


Figure 2.18. Sample *Alternate* Schedule for Combined Account Letter Water Deliveries to Provide Spiked Release

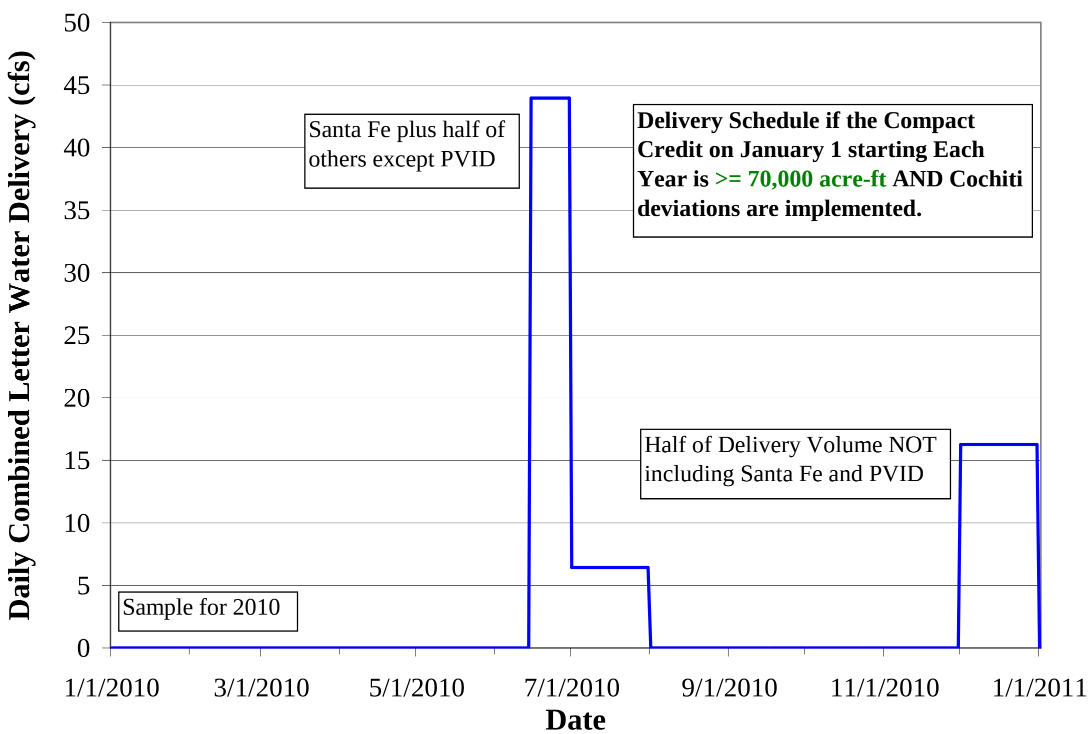
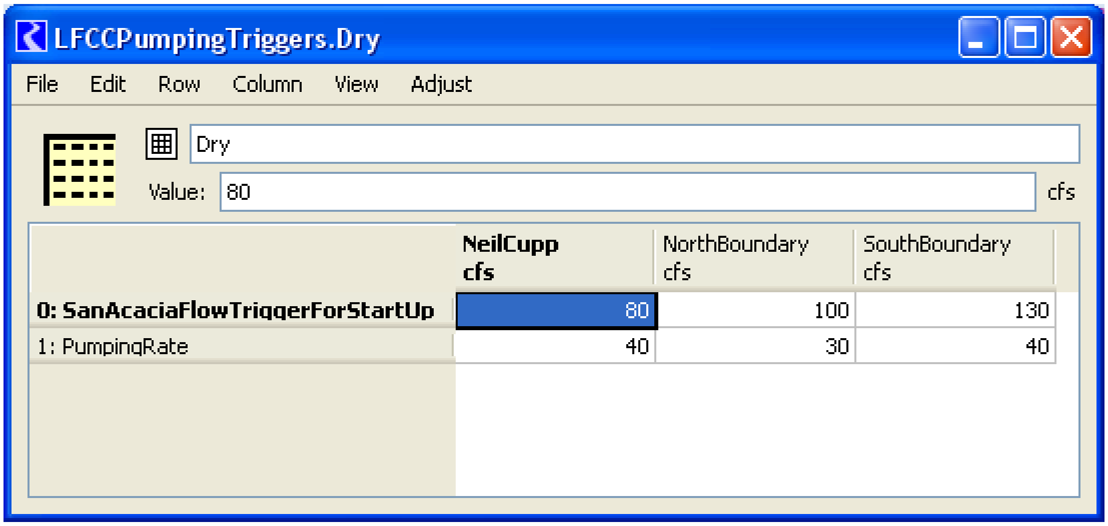


Figure 2.19. Sample *Alternate* Schedule for Combined Account Letter Water Deliveries

2.3.6. Pumping from the Low Flow Conveyance Channel

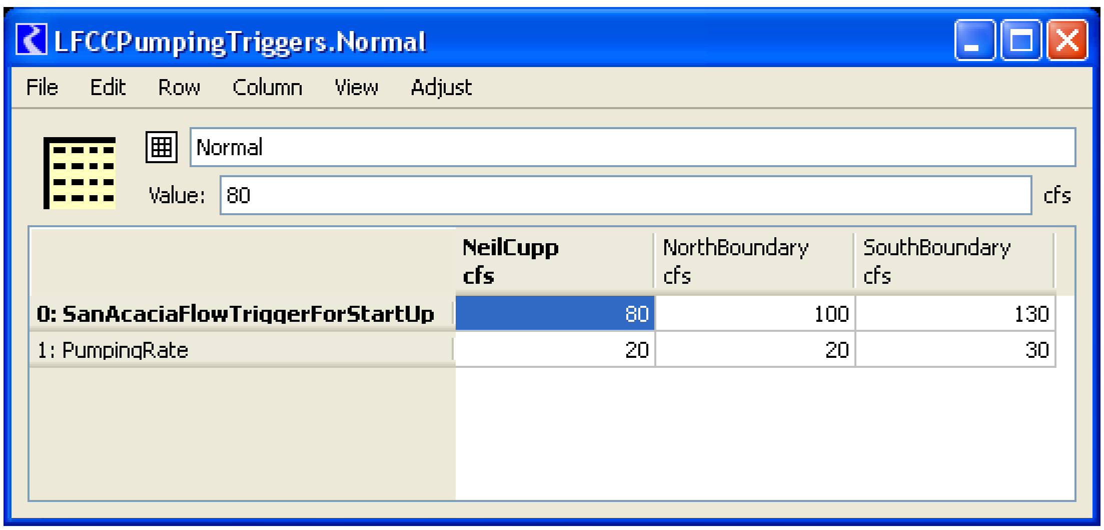
URGWOM is set up to model pumping of flows from the Low Flow Conveyance Channel (LFCC) to the river to prevent river drying. Refer to Figure 2.20 for a picture of pumps used to pump from the LFCC. Diversions at the Neil Cupp site, North Boundary of the Bosque del Apache National Wildlife Refuge, and South Boundary are simulated (Pumping at the Fort Craig site was determined to be inconsequential to the simulation results and is not included). Water that seeps into the Low Flow Conveyance Channel is pumped to the river where pumping begins based on specific river flow triggers. Different triggers could be established as a function of the year classification for setting targets (section 2.1.4.1); although, the threshold low San Acacia flow triggers for initiating pumping at each site is the same in the current model regardless of the year type. The rate of pumping does vary based on year type. Values are input to the Dry, Normal, and Wet table slots (Figures 2.21 through 2.23) in the LFCCPumpingTriggers data object. Different values are set up for the winter of wet years as defined by dates input to the WetSanMarcialWinterTargetSeasonDates table slot. After pumping has initiated at a site, pumping will continue for a minimum of one week and until the flow at San Acacia has exceeded 150 cfs as input to the SanAcaciaFlowTriggerForShutDown scalar slot in the LFCCPumpingTriggers data object. Pumping will cease for the year at each site after the dates for each site input to the DateToShutDownForYear table slot. It is assumed in the current model that pumps at the Neil Cupp site and North Boundary would not be used after June 30th. **Note that the dates in the DateToShutDownForYear table slot could all be set to January 1st to not model any pumping from the Low Flow Conveyance Channel for a simulation.**

Figure 2.20. Low Flow Conveyance Channel Pumps



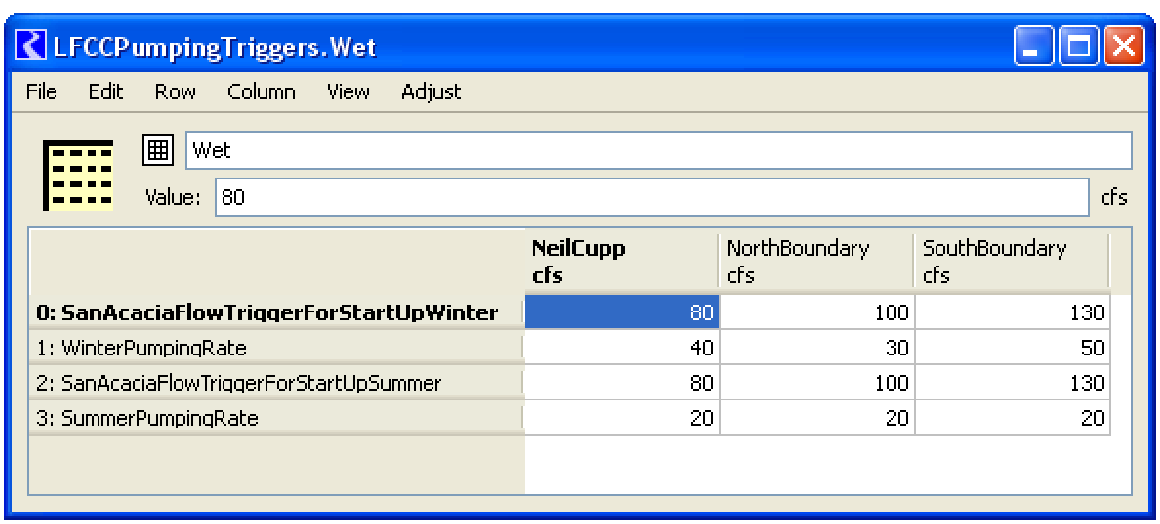
	NeilCupp cfs	NorthBoundary cfs	SouthBoundary cfs
0: SanAcaciaFlowTriggerForStartUp	80	100	130
1: PumpingRate	40	30	40

Figure 2.21. LFCCPumpingTriggers.Dry Table Slot



	NeilCupp cfs	NorthBoundary cfs	SouthBoundary cfs
0: SanAcaciaFlowTriggerForStartUp	80	100	130
1: PumpingRate	20	20	30

Figure 2.22. LFCCPumpingTriggers.Normal Table Slot



	NeilCupp cfs	NorthBoundary cfs	SouthBoundary cfs
0: SanAcaciaFlowTriggerForStartUpWinter	80	100	130
1: WinterPumpingRate	40	30	50
2: SanAcaciaFlowTriggerForStartUpSummer	80	100	130
3: SummerPumpingRate	20	20	20

Figure 2.23. LFCCPumpingTriggers.Wet Table Slot

III. Inputs and Model Set Up

Model files are maintained by the URGWOM Tech Team. Copies of the RiverWare Planning Model file and URGWOM ruleset are occasionally posted on the URGWOM website (Corps, 2010), http://www.spa.usace.army.mil/urgwom/default.asp, but the latest model files can be obtained from the Team Team. Contact information for Tech Team representatives from lead agencies is provided on the website. Database files are also maintained by the Tech Team along with the template spreadsheets that can be used to set up initial conditions and post-process model output as discussed further below.

Needed inputs to complete URGWOM simulations include initial conditions and numerous series for an identified simulation period. Series inputs are imported using the database data management interface (DMI) capability in RiverWare. An Excel template spreadsheet is set up for setting values for all needed initial conditions. Macros in the Excel template are used to create ASCII files with the initial conditions and a control file DMI is set up in the Planning Model for importing the initial conditions. The Excel template also includes a macro for creating the control file needed for the DMI in the model. A database DMI is also available for importing historical values for initial conditions which would be used for a calibration run. Series inputs include inflows at numerous nodes in the system, climate data, and assumed diversion and demand schedules. Series inputs are maintained in the URGWOM database in files that have the format of the Corps of Engineers Hydrologic Engineering Center's Data Storage System (DSS). Historical data are maintained in separate DSS files from the data for synthetic hydrologic sequences where historical data are sorted by different years to represent wet spells and drought spells evident in paleo-data. Database DMIs are set up for importing either a historical hydrology or the synthetic hydrologic sequences. The database DMIs include datasets with slot names and name maps to locations in DSS files.

3.1. Database

The URGWOM database is maintained in DSS files. Separate dss files are maintained with the model inputs for the five synthetic hydrologic sequences versus data files with historical data. Separate data files are used for either historical data or the synthetic sequences but note that the files have the same names. A list of filenames for the dss files used to maintain the historical database are presented in Table 3.1, and filenames for the dss files used to store input data for the synthetic sequences are listed in Table 3.2. Metadata files for the historical database are available in Excel format that have details on the source for all the historical data.

RiverWare environmental variables must be established on a computer for the DMIs to identify the location of the database files. The paths are established by going to the Control Panel – Performance and Maintenance – System – Advanced tab – and clicking on the Environment Variable button. Two new environment variables may be needed for

URGWOMHistoricalDSS and URGWOMPlanningSequenceDSS. The path with the location of the corresponding database files on a computer being used should be input as the value for each variable.

Table 3.1. DSS Files Used to Maintain the *Historical URGWOM Database*

Agriculture.dss
Calculated.dss
Deliveryrequests.dss
Demands.dss
Diversions.dss
ETrate.dss
Ettool.dss
Gagecaldata.dss
GWObject.dss
Localinflow.dss
Mrgcddemand.dss
Nambefalls.dss
questionableMVdataupdate.dss
Reach.dss
Reservoir.dss
Rivleak.dss
Sjaccount.dss
Streams.dss
Typicaldemands.dss
Wastewater.dss

Table 3.2. DSS Files Used to Maintain the *Synthetic Sequence* Inputs

Agriculture.dss
Calculated.dss
Deliveryrequests.dss
Demands.dss
Diversions.dss
ETrate.dss
GWObject.dss
Localinflow.dss
Nambefalls.dss
Reservoir.dss
Sjaccount.dss
Streams.dss
Wastewater.dss
Waterlease.dss

3.2. Setting Simulation Period

Before running DMIs to import the needed inputs to complete a simulation, the Run Control must be set to the period for the simulation. To set up a model to simulate the hydrology for a portion of the historical record, dates in the Run Control dialog in the Planning Model should be set to match the historical period to be modeled. For example, if the hydrology for the period from 1980 through 1989 is selected for a study, the Initial timestep should be set to December 31, 1979 and the Finish timestep should be set to December 31, 1989. Memory limitations associated with running URGWOM may prevent simulations much over 10-years from completing (If the RiverWare windows disappear during a simulation, this may be a signal that memory limitations are an issue and a shorter simulation period may need to be established).

If one of the existing synthetic sequences is to be simulated, the simulation period should be set with an Initial timestep of December 31, 2009 and a Finish timestep of December 31, 2019. The current DSS files with the data for the synthetic sequences are currently set up with these specific dates for each ten year sequence. The DSS files would need to be adjusted to use the synthetic sequences with a different period in the RiverWare Run Control dialog.

After the Run Control period has been input, check the box for Synchronize Slots with Run Parameters. On the Synchronize Slots window, select the box to Resize Simulations Slots, and under Accounting slots, select the box to Synchronize With Simulation Slots. Time series ranges for slots in the model can also be synchronized with the Run Control by selecting Workspace – Objects – Synchronize Objects.

3.2.1. Setting Annual Time Series Slots

After objects are synchronized with the run control, four slots will need to be reset back to have an annual timestep: Indian.OtowiForecast, ElVadoData.RelinquishedNMCredits, SanJuanDiversions.AnnualDiversion, and HeronData.WaiverSwitch. This is done by selecting View – Time Series Range when the slot is opened and choosing Yearly for the timestep. The time series range for the SanJuanDiversions.AnnualDiversion slot should then also be reset for twenty years and extended 10-years before the initial timestep (e.g. if the Run Control is set to December 31, 2009 through December 31, 2019), the time series for the annual timestep SanJuanDiversions.AnnualDiversion slot should be set to 2000 C.E. to 2019 C.E. Ten initial values are needed for this slot for checking the diversions from the San Juan basin against the ten-year diversion limit for San Juan diversions. If waivers are to be modeled for a planning study, all annual values for the waiver switch should be set 1.0. A value of 0 would indicate that waivers are not allowed for that year. Reference section 2.2.1.2 for more information on waivers.

3.3. Initial Conditions

Initial conditions for a simulation generally may not be related to the hydrology chosen for a simulation and will likely be set independently of the hydrology for a planning study (e.g. if a simulation is to be completed using historical inflows, initial conditions may be based on current conditions as opposed to historical initial conditions). Initial values are required for storage at each reservoir, storage in storage accounts at each reservoir, and accruals for each storage account. Initial flows are needed for several locations in the model (Initial flows have little impact on the results but are simply needed for the model to start solving). Initial values for storage and elevation in each groundwater object are also needed. Values are required for the initial timestep before the start timestep. For a simulation that begins on January 1st, the initial timestep would be December 31st of the previous year.

3.3.1. Excel Template

An Excel file called InitialValues_DMIInputFileCreator_Planning_4.1.1.xls is set up for inputting all needed initial conditions. Initial conditions are set on the “inputs” sheet. As indicated in the Excel template, initial values are needed for two timesteps for the CochitiData.EstimatedInflow: the initial timestep and the timestep before the initial timestep. Values are also needed for two initial timesteps for the ElephantButte.Outflow and CerroToTaos.Inflow. Initial values are needed for eight timesteps for the Caballo.Outflow.

If a simulation entails completing a planning study using assumed hydrology for upcoming years and assuming that initial conditions for the study match actual current conditions in the system, actual current data could be referenced to obtain information on the current state of the system. The latest accounting module of URGWOM maintained by Reclamation would be the best reference for obtaining the current status of account storage at each reservoir. The Accounting Model may also be the best reference for obtaining values for needed initial flows. The initial storage for all accounts at a reservoir should sum to equal the initial total storage. The URGWOM Tech Team should be consulted for appropriate initial values for storage and elevation at each groundwater object. Initial Accrual and initial Gain Loss values can all likely just be set to zero. If a simulation start timestep is January 1st, the initial waiver balance is inconsequential as the rules will set the waiver balance on January 1st equal to the December 31st initial storage for the corresponding account.

After all needed initial conditions have been identified and entered to the “inputs” sheet in the Excel template, the setup on the Macros sheet should be updated. The path name for outputting the input files and the control file should match the path input for the RIVERWARE_DMI_DIR environment variable on a computer being used. This path can be identified by going to the Control Panel – Performance and Maintenance – System – Advanced tab – and clicking on the Environment Variable button. The path entered to the Excel template should match the Value corresponding with the RIVERWARE_DMI_DIR Variable under System variables. If a Variable is not entered for RIVERWARE_DMI_DIR, this environment variable will need to be established to run the initial conditions DMI.

All the separate ASCII files created for each slot that needs an initial value are stored to the path entered to the “Path name for input files” cell in the spreadsheet plus a subdirectory with the name entered to the Model Simulation Name & Input File Folder Name. Dates for the simulation are entered on the Macros sheet in the columns labeled as Initial condition Timestep as set in RW and Run End Date as set in RW. These dates are then used when the initial values are imported to URGWOM. If a simulation is being completed using the hydrology for a historical period, the date for the initial conditions will depend on the start timestep for the historical period being modeled. If a simulation is being completed with one of the five available 10-year synthetic sequences, these sequences are set up for the run period from 2010 through 2019, so the initial condition date is 12/31/09.

Detailed instructions for using the Excel template are included in the Excel file on the Macros page. Press the button to Create Input Files after the path, file folder name, and simulation dates have been updated. Press the Create Control File button to create the needed control file and put it in the directory to be referenced from URGWOM based on the RIVERWARE_DMI_DIR environment variable. The step to create the control file does not have to be repeated once the control file has first been created.

A version of this Excel template should be archived as part of completing any planning study. Assumptions in regards to initial conditions can be entered to the Notes column on the inputs sheet.

3.3.1.1. Initial Conditions DMI

Within the Planning Model, the PHVAModelInitialConditions input DMI is set up to import all the initial conditions after the ASCII files have been created using the Excel template as discussed in section 3.3.1. After opening this DMI, notice that the control file created with the Excel template needs to be referenced as the entry under Control File. If needed, browse to reference the control file in the directory set up with the RIVERWARE_DMI_DIR environment variable. Invoke this DMI to input the initial conditions. This DMI may take a minute to fully execute. A window with a few warnings in reference to the end_date may display, but these warnings are okay – hit OK.

3.3.2. Historical Initial Conditions DMI

If a simulation is to be completed using historical hydrology while also using the historical conditions for initial conditions, the HistoricalInitialDataDSSDMI and the HistoricalMiddleValleyInitializationDSSDMI database DMIs could be used to import the historical initial conditions. Historical values may be used for initial conditions for a calibration model or validation model. This database DMI for inputting initial conditions had not been thoroughly reviewed at the time this user manual was prepared, so inputs should be checked in the model if this DMI is utilized.

3.3.3. Annual Timestep Slots

Initial values may need to be hand entered for the annual timestep slots: Indian.OtowiForecast, ElVadoData.RelinquishedNMCredits, and SanJuanDiversions.AnnualDiversion. The initial Otowi forecast and initial relinquished credit can just be set to 0.0. Ten initial values are needed for Annual Diversion. These values should match that actual annual diversion from the San Juan basin for the ten years before the simulation period. All values in the annual timestep HeronData.WaiverSwitch slot need to be set (Reference section 3.2.1).

3.4. Hydrology

A planning study could be completed while assuming future inflows will match the historical hydrology or will match a developed synthetic hydrologic sequence. The URGWOM database includes historical data for 1975 through 2006 (The URGWOM Tech Team is working on updating the database for more recent years). Due to memory limitations, simulations are typically completed with the Planning Model for 10-year periods. To utilize either option for assumed hydrology involves setting the correct simulation period in the Run Control in RiverWare and running the corresponding DMI.

3.4.1. Historical Inflows - DMI

After the Run Control has been established for the historical period to be modeled, two database DMIs are used to import all the series historical data: HistoricalTimeSeriesDataDSSDMI and HistoricalMiddleValleyInputDSSDMI. By invoking these DMIs, the model now has all the needed inputs to run the established historical period. The Middle Valley DMI may take several minutes to complete due to all the needed crop consumption information. This Middle Valley DMI for importing Middle Valley data is also split into two DMIs which could be used separately if needed: HistoricalMiddleValleyInputETRateDSSDMI and HistoricalMiddleValleyInputWOETRateDSSDMI.

Separate database files are established for simulating synthetic sequences as the assumed hydrology for the next ten years. Numerous inputs are established based on expected future conditions. For example, deep aquifer heads in the database files are based on projected heads from separate regional groundwater model simulations. Synthetic diversion schedules are used for assumed future diversions. If the historical database DMI is used to import historical values for an assumed future hydrology, some key inputs need to be reviewed to determine whether historical values or some other assumed values should be used for the future. These include the MRGCD demand and diversions, letter water delivery schedules, Albuquerque demand for surface water diversions, Rio Chama diversions, and Low Flow Conveyance Channel diversions.

3.4.2. Synthetic Hydrologic Sequences - DMI

Synthetic hydrologic sequences were developed for past analyses completed for the Middle Rio Grande Endangered Species Collaborative Program with reference to paleo-data. These sequences represent a 10-year hydrology with a cumulative Otowi flow volume that would be exceeded 10%, 30%, 50%, 70%, or 90% of the time based on the paleo-data. The process for developing these sequences is documented by Roach (2009).

Separate DSS files have been developed with the data for all these sequences and separate DMIs in the model are used to import the time series data for these sequences. For the 10 percent exceedence sequence, the Planning10PercentSequenceInputDSSDMI and PlanningMiddleValleyETRateInputDSSDMI-10% database DMIs would be invoked to import all the series data that are sequence dependent. A third database DMI needs to be invoked to import all the time series data that is not dependent on the sequence: PlanningNONClimateInputDSSDMI. Groups in the DMI Manager are established for each sequence and the corresponding DMIs that need to be invoked. The ET Rate database DMI takes several minutes to fully execute.

IV. Model Run

After all inputs are established in a model run, a simulation is initiated by hitting the Start button in the Run Control dialog. A 10-year simulation with the Planning Model may take three hours to complete. Run times vary slightly depending on the amount of hypothetical simulation during a run. Hypothetical simulation for targets does not fire if there are no targets or if there is no supplemental water to actually meet targets, so run times may be shorter if either of those conditions result in a reduced amount of hypothetical simulation. A 10-year simulation with no targets may complete in 30 minutes.

4.1. Errors

The model is set up to abort if a Rio Grande supply does not get set. This allows for the source of a problem to be identified by backtracking through the assignments made with the rules from the time the run aborted. Warnings may post noting that RiverWare could not converge on a solution within a set number of iterations. If these warnings are only posted for a few timesteps within a run, these warnings could probably be neglected.

The Run Analysis dialog in Windows is a very useful tool for identifying the source for any problems. The dispatch information for all the objects in the model can be sorted based on the "position" of the objects on the work space, and it is then possible to scroll from upstream objects to downstream objects to see the location where the dispatching could not continue at the first timestep the full system did not execute. The exact location of a potential missing input or other problem can often be identified using this approach.

4.2. Output

Numerous tools are included in RiverWare for reviewing output. Plots can be prepared and saved in the RiverWare Output Manager. Output DMIs could be set up to export results for different slots to DSS or HDB files for reviewing details of the results or just for archiving the output. Reclamation has also previously set up a tool called Pisces for reviewing output. Output for this tool is provided using a RiverWare data file (rdf file) created with the SlotForPiscesDatabase tool in the RiverWare Output Manager in the model.

4.2.1. Template Output Spreadsheets

Template spreadsheets have also been prepared for preparing numerous plots and summary tables of simulation results. These spreadsheets are useful for stakeholders and parties that do not have access or experience using RiverWare and also have not worked with the other available database applications. Values of particular interest are exported from a model using the BAEffectsAnalysisOutput DMI (The model may have an extended DMI name for a particular run that was completed). ASCII files with all output are exported to a subdirectory having this name within the directory established for the aforementioned RIVERWARE_DMI_DIR environment variable. **The name for this DMI should be changed for different runs such that the output is saved to different directories with names that identify the scenario modeled.** Otherwise, output from the previous time this DMI was invoked will be overwritten.

Two template spreadsheets are available. One provides output for numerous indicators of interest in the Middle Valley and the other focuses on resulting status for Storage and Accounts. Both spreadsheets are set up to compare results between two model runs with dummy labels of “Scenario” and “Control” used for the two runs in the spreadsheets. Each spreadsheet has a button labeled Import Values on the Scenario-Heron sheet for importing all the data. All plots and summary tables automatically update.

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Appendix A – Checklist for Setting Up Planning Model

Questions to be answered for defining assumptions and setting up URGWOM for a planning study are presented:

Hydrology and Initial Conditions

Which hydrology will be used?

- Hydrology for a historical period?
- Available synthetic hydrologic sequences? 10, 30, 50, 70, and 90 percent exceedence sequences?

What are the initial conditions?

- Current initial conditions? What exact date?

Standard Operations (current assumptions are likely appropriate)

Waiver date maintained at September 30th?

Use the current schedule for the full demand below Elephant Butte?

Assume full Albuquerque diversions with reference to current preemptive cutoff criteria?

What are the projected future letter water delivery volumes for Albuquerque and all other contractors (i.e. the Combined account)? Are the current assumed standard delivery schedules appropriate?

Use current assumed MRGCD demand at Cochiti and diversion schedules at each diversion? Storage and release of P&P water modeled?

Model potential releases from El Vado per Article VIII of the Compact?

Use a channel capacity of 7000 cfs at Central and 5000 cfs at San Marcial?

Scenarios

How many scenarios will be analyzed?

for each scenario,

What are the Middle Valley targets?

- Are targets dependent on a year classification? If so, is the current approach for setting a year classification appropriate?

- What safety factor should be applied to targets?
- Will discretionary operations be included (i.e. step downs in targets to manage recession and to the control rate of drying after river rewetting)?
- Assume MRGCD diversions are shorted, when MRGCD is in a shortage situation, but only if there are no downstream targets (i.e. MRGCD can divert supplemental water if there are no downstream targets)?

What are the assumed Reclamation leases of San Juan-Chama Project water?

- From which contractors? Albuquerque, MRGCD, or Combined?
- Transfers to Reclamation are made at which reservoir? Heron, El Vado, or Abiquiu?
- Should Reclamation's leased water be conserved when the year-to-date Otowi flow volume reaches a threshold? 1,000,000 acre-ft?

Should Relinquished Compact credits and subsequent storage of Emergency Drought water at El Vado Reservoir be modeled?

Should Cochiti Deviations be included?

- What is the assumed last year that Cochiti deviations would be authorized?

Should the proposed policy, as represented in the current model, for implementing alternate timing for letter water deliveries be included?

Should pumping from the Low Flow Conveyance Channel to the San Acacia reach be simulated?

Should potential reregulation storage at Abiquiu Reservoir above the current easement pool elevation of 6220 ft be modeled?