

May 16, 2002

**San Juan River Basin
Recovery Implementation Program
Hydrology Committee
March 26, 2002
Meeting Summary**



Members/Alternates Present: _____	Representing:
Ray Alvarado	State of Colorado
Steve Cullinan	U.S. Fish and Wildlife Service
Dave Frick	Jicarilla Apache Nation
Mike Hamman	Jicarilla Apache Nation
Steven Harris	Water Development Interests
Bill Miller	Southern Ute Indian Tribe
Pat Page	U.S. Bureau of Reclamation
John Simons	U.S. Bureau of Reclamation
Bernadette Tsosie	Navajo Nation
Brian Westfall	U.S. Bureau of Indian Affairs
John Whipple	State of New Mexico
Others present: _____	Representing:
Dave King	U.S. Bureau of Reclamation
Kevin Needham	Water Development Interests
Marilyn Greenberg, Program Assistant	U.S. Fish and Wildlife Service

Welcome and Introductions by Pat Page.

Review of Agenda Items

The Biology Committee "Flexibility of Operations" memo, regarding increasing the minimum summer release from 250 cfs to 500 cfs, was added to Agenda Item #13. The agenda was approved as amended.

Review and Approval of the September 26, 2001 Draft Meeting Summary

The January 25, 2002 version of the meeting summary was approved. John Whipple had not seen the summary before today; if he has any comments he will incorporate them into the next meeting discussion.

Review and Approval of the January 15, 2002 Hydrology Committee Draft Conference Call Summary

John Whipple asked about the discussion and agreement from this conference call regarding giving deference to the states regarding what will be used for the model, in terms of depletions, in both states. New Mexico is not providing irrigation depletion amounts at this time, so the modelers are calculating the irrigation depletions for New Mexico. Whipple stated that irrigation depletions in New Mexico should be calculated using the original Blaney-Criddle method. The modelers (Reclamation and the BIA) stated that the third generation RiverWare model for the San Juan Basin will use the original Blaney-Criddle method for computing New Mexico non-NIIP irrigation depletions and that the modified Blaney-Criddle method will form the basis for computing NIIP, Arizona, Utah and Colorado irrigation depletions. Whipple raised questions as to the bases for determining baseline depletions in the past and whether the baseline depletions, including the methods used to determine them, as decided upon by the BIA and the FWS in previous ESA Section 7 consultations, are effectively binding upon other parties, including participants in the San Juan RIP, for future modeling and evaluation activities in the basin. Whipple noted that the model disclaimer adopted and placed in the Program Document by the Coordination Committee states that the model data are not binding on the Program participants, and that the charge to the Hydrology Committee includes review of baseline depletions. The discussion left off with the notion that issues of irrigation depletion methodologies and baseline depletions for modeling can be added to the agenda at the next meeting or the Committee can agree to disagree. The Committee took no action either way.

Minor revisions were made to the draft Conference Call Summary, and the Conference Call Summary was approved as amended. Marilyn Greenberg will send out the final version to Committee members when the approved revisions have been completed.

Review of Action Item Log from Jan. 15, 2002 Hydrology Committee

Conference Call *(Numbers not listed below either have no changes from the last version of the Action Item Log or have been completed and are listed on a separate "Completed Tasks" Log.)*

1. The second generation model documentation is complete. John Simons needs to incorporate changes.
3. There needs to be an annual progress report to the Coordination Committee. Pat Page will draft this report and send it out to Hydrology Committee before April 30. This

progress report is due to the Coordination Committee in July of each year.

4. Dave King indicated that the model website is currently unavailable. Public access to the website is being worked on. Reclamation hopes to add the Navajo EIS supplemental runs as official runs.

7. FY01 unused funds: FY02 Program budget issues have caused a delay in the temperature modeling. There was discussion about the need to extend the modeling development effort into FY03. There is sufficient budget available to continue the modeling work through FY 02, as has been approved, along with the changes approved on March 25 (agenda item 10).

Agenda item for next meeting: FY 03 budget draft; draft scopes of work are usually due by April 30 - June 2, each year. Have drafts ready by next meeting?

22. John Simons discussed the Navajo Reservoir Operations Low Flow Test report. Reclamation still needs to complete their internal review and approval.

27. Model Approach - see discussion on pages 4 - 5, and action item # 45.

29. The incidental loss discussion will be considered completed if approved today.

31. **Pat Page and Bill Miller will attempt to convene a Hydrology/Biology summit to sort out flexibility and other issues.** The Biology Committee meets on May 21; could it be a joint meeting?

34. The Committee agreed to wait until the new model is ready/complete to followup on the gaging error analysis.

35. Water used for other purposes would have to go through the Navajo EIS process. This is adaptive management DELETE as action item.

37. Model Progress Report duplicate. DELETE as an action item.

37. (formerly 39) How have additional trips to the gages affected the shifts? How many times have shifts had to be adjusted? **The Committee agreed that USGS be invited to the October 22 meeting to give us a report.**

38. (formerly 40) There were questions about what the Hydrology Committee budget will be once the third generation model is developed. **Reclamation will draft a long-term budget and send it out for review by April 30.**

40. (formerly 42) A budget review and progress report will be done today, March 26.

41. (formerly 43) Paragraphs regarding water rights have been removed from the

RiverWare model documentation, per page 5 of this meeting summary. Complete.

42. (formerly 44) The draft plan of approach discussion will be completed today.

Group B Consultant Tasks - Contract Status

Reclamation was directed by the Solicitor's office to use a different approach for the second group of tasks (group B). Tetra-Tech was not able to do the work, so they passed it through to Keller-Bliesner. The contract should be awarded by next week. The cost of the work for the Group B tasks totals \$90,000, plus 10% goes to Tetra-Tech for pass through, bringing the total cost to approximately \$99,000. This obligates the total amount of money that the Hydrology Committee had budgeted for contracts for this year.

Draft Key Model Input Plan of Approach

The "Key Model Input Draft Plan of Approach," dated March 22, 2002, was discussed. The Plan of Approach documents how Reclamation and the BIA are proceeding with certain aspects of the model. It was suggested that on page 3 of the draft Plan of Approach, the section on off-stream depletions should be deleted because they are not to be included in the model and therefore do not need to be quantified and listed. The effect on the river of off-stream depletions will be imbedded in the net gain or loss in the water balance between streamflow gages. Brian Westfall stated that this is an assumption about gain/loss effects by off stream depletions. Keller-Bliesner added this section to indicate that there are depletions in the basin which might be considered in an environmental baseline description although not included in the RiverWare model.

John Whipple clarified that the draft Plan of Approach involves the use of the modified Blaney-Criddle method to compute irrigation depletions, at least for NIIP in New Mexico. After some discussion on the use of the modified Blaney-Criddle method versus the original Blaney-Criddle method in New Mexico, most members of the Committee agreed that this was a New Mexico-BIA issue and that it was not an issue that this committee could or should determine or vote on.

Whipple indicated that the FWS has stated that the baseline is reviewable with each and every consultation. This suggests that the baseline can change with every consultation.

Whipple indicated that the use of the terminology "depletions" is preferred rather than "incidental losses". Regarding non-Indian irrigation, Whipple expressed concerns about taking into account changing irrigation practices in some areas from flood irrigation to sprinkler irrigation and the resulting changes in incidental loss rates and sprinkler evaporation. Dave King stated that it is hard to vary incidental losses in RiverWare because it cannot be input as a time series. This can be done with StateMod as long as it is known when changes in the incidental loss rates occur. No agreement was reached on treatment of incidental loss and sprinkler evaporation rates for non-Indian irrigation uses in New Mexico. The modelers indicated, however, that the same rates

will be used for natural flow computations as for actual runs under baseline conditions, and that the rates would not change from the historical conditions.

Steve Harris recommended that the Committee vote today to approve the draft Plan of Approach, and suggested that issues can be worked out or disclaimers developed to identify disagreements with certain methods used in the modeling. Brian Westfall stated that John Whipple has expressed to him other valid technical concerns with the draft Plan of Approach. The Committee would like to see New Mexico's technical comments in writing. Whipple stated, for example, that the La Plata River at Hesperus gage record needs to be adjusted for diversions above Hesperus before the record can be used as an index station for disaggregating flows at other gaging stations. ***John Whipple will try to get some written comments out to Keller-Bliesner and the Hydrology Committee within the next month.***

The Hydrology Committee voted to recommend that Reclamation move forward with the modeling effort in accordance with the draft Plan of Approach. New Mexico cast the only vote not in favor of the recommendation and the draft Plan of Approach.

John Whipple expressed concerns about the Committee skirting around an important issue and stated that the function of this Committee is to make recommendations to Reclamation regarding modifications needed for the model. Ray Alvarado responded that the Committee is aware that this model has shortcomings; and that there are major issues that this Committee cannot address.

Whipple added that the original Blaney-Criddle method was calibrated for field conditions in New Mexico; the modified Blaney-Criddle method was not. Some members of the Committee think that the modified Blaney-Criddle method in theory is a better tool for estimating evapotranspiration (ET). It was suggested by some that the modified Blaney-Criddle method be used for NIIP and irrigation uses in Colorado; and that the original Blaney-Criddle method be used for non-Indian irrigation in New Mexico. No vote or recommendation was made by the Committee on this issue.

Review Group A Tasks and Scope Group B Tasks Meeting (3/25/02) Report Discussion of Recommended Modeling Approach (operating criteria)

The "SJRIIP Third Generation Hydrologic Data and Model Development," dated March 23, 2002, was discussed. The document attempts to summarize a general data and model development approach that was previously approved or recommended by the Hydrology Committee. The document was meant to clarify the purpose of the different stages of model uses and development, to show how the modelers (Reclamation and the BIA) are proceeding, and to address New Mexico's concerns about where water rights are being used and where they are not being used. John Whipple asked if this document supplements or replaces the December 18th version, and stated that New Mexico's lack of response to the December 18, 2001, version (and to the January 2002 revision), does not constitute agreement by New Mexico with it. New Mexico objects to

the December 18 version and the language and discussion regarding water rights. Dave King responded that this March 23, 2002, version can be a replacement of the December 18th document. Operating criteria and water rights language have been removed from earlier versions of the document.

In response to confusion about all the different models being used by Reclamation in the modeling process, King explained that there are 2 basic models - monthly and daily. The Third Generation Data and Model Development document describes the developmental process to progress to the daily decision model. King explained that there is a monthly bridge - the migration model - that can be run with the old operating criteria to see the change in the hydrology from the old model to the new model. Then new operating criteria can be created if needed. A daily bridge model may not be used except for setting up the initial daily decision model.

Steve Harris requested that a meeting be held with interested members of the Hydrology Committee and the modelers to gain further understanding of the model options and capabilities. What the StateMod model does and does not do can be clarified also. Harris suggested that this would be a good time to get a clear understanding so that issues and concerns do not come up in the future. Those who are interested in more information and are available agreed to meet with Dave King in Denver on Tuesday, April 16, at 1 pm, and to continue into Wednesday morning if more time is needed. This meeting is open to anyone who would like more information about the model and its operation.

The Hydrology Committee agreed to review this document and get comments to Dave King prior to April 15. Dave King agreed to send out a revision for review in a couple of days, and in the future will use a redline strikeout format to document revisions.

John Whipple questioned what Dave King means when he writes about using the new RiverWare model for new proposed projects while respecting baseline water uses under current conditions and about using StateMod in conjunction with the USGS Mixed Stations Model to compute natural flows. This language was not in the December 18, 2001, version of the document.

Some members of the Hydrology Committee questioned the value of doing modeling by committee, saying that the modelers (specifically Dave King) have spent a huge amount of time on this. The same members wondered how much everyone else needed to be dragged along and bogged down in the process. Other members responded that at one time, the BIA had done their own modeling and did not adequately consult with or address concerns of the states. Some members feel that there is a need to make sure that we understand the model before we can make recommendations as to how to improve it. It was stated that we need to take these steps to be informed and to attempt to reach consensus on the modeling effort.

The draft Plan of Approach was first reviewed and discussed in November 2001. A

question was raised as to how much detail needs to be submitted to the Hydrology Committee for review, and how much modeling detail the modelers should proceed on or decide independent of Committee review. Some members expressed their opinion that the Committee would like the modelers to report to the Committee only about what model approaches have been decided, and to seek recommendations from the Committee only on matters where the modelers have a significant question as to how to proceed. The same members continued that if at any time the Committee questions the modelers' efforts, then the Committee can decide whether more information should be requested and reviewed or whether it should consider making a recommendation to Reclamation on the modeling work at question. No decision or vote was made on the issue of how much detail of the model the Hydrology Committee may want to review.

Some members of the Hydrology Committee said they would like to see documentation of forks in the road in the modeling process and the decision-making process used by the modelers, saying that the more clarification and documentation of details that is included by the modelers as the model development process unfolds, the easier it will be to update the model as we move forward. This will also create a paper trail that shows what was done to develop the Third Generation model, so that someone can go back later and know what was done or can use the same methodology to build on the previous steps to replicate, extend or update the model data. The same members also stated that this would create documentation for possible future Freedom of Information Act (FOIA) requests. In the case of a FOIA request, ongoing documentation of the process and the decision points would be needed. Dave King commented that much of this documentation is already on the website, and that decision documentation is currently being included in the monthly log. Also, final organizational documentation is scoped out in the Hydrology Committee work plan scopes of work. Some members commented that it is okay to say, in theory, that the documentation will be done as we go along, but there are usually other things that come up that take our time and attention. Other members commented that organization of the documentation is needed and that the documentation budget may not be sufficient.

Data Needs to Complete Modeling Work

Dave King still needs the final New Mexico historic irrigated acreage data. He currently has provisional data from John Whipple. Any comments on the draft New Mexico historic irrigated acreage data for 1929-2000 should be forwarded to John Whipple as soon as possible. Whipple reported that New Mexico began to work on the non-irrigation depletions data for that State in March 2002.

Dave King reported that field climate data from the second generation model has been provided to Colorado. Ray Alvarado says they will not use weather data because they do not have irrigated acreage data back to 1929 and because Colorado uses average wet and dry year irrigation depletion estimates, even for the baseline condition. Dave King suggested that the climate data could be used for baseline computations even if it is not used for historic depletions, in which case the depletions would vary with the climate variability even with a constant baseline acreage. No recommendation was

made on this matter by the Committee.

Budget and Status Report

Table 4, Status Report, shows that the Bureau of Reclamation (BOR) has expended \$92,382, or 42% the FY02 budget so far this year. Dave King's time on the modeling effort may be lagging behind what was anticipated in the work plan. The Durango portion of the costs is probably a bit ahead as compared to the work plan due to additional coordination costs. John Simons recently has not spent as much time working on the third generation model as had been anticipated because he has been involved in the Navajo Operations EIS.

Ray Alvarado suggested that the model development status reports indicate the percent of work that has been done and the percent of the money that has been spent - separately - so that we can see whether we are on track with our projects. The amounts budgeted by Reclamation for administrative time represent Pat Page (Durango) and Dave King (Denver). Separating out Pat Page's time would reflect the model work that has been done. King and Page will look at each task so as to determine project completion amounts and percentages.

The Coordination Committee asked that either letters or numbers be used in identifying work items and tasks. The Coordination Committee will want and need to see where the Hydrology Committee projects and budget are as compared to last year. A budget of \$535,500 was described for tasks A - L, so we need to make sure that the A-L tasks stay with that \$535,500. If numbers are used, we need to make sure that each number, 1 - 25, correlates to letters A - L (was previously item B, etc.). ***The Hydrology Committee decided to report in a format which uses a conversion column with the old work item letter and the new task number. Reclamation will work on this conversion.***

Reclamation will develop a revised, realistic schedule, with a bar chart, to show where it is in the model development process, which tasks can be done concurrently, and which work has to be completed in order for another piece of work to begin. Pat Page will send this information out to the Hydrology Committee prior to April 30th so that the Committee can have a good discussion about this during the conference call on May 7th.

Reclamation prepared an initial draft Long Term SJRIP Hydrology Committee Budget, dated March 26, 2002. The draft budget for fiscal year 2003 includes completing the development of the third generation RiverWare model for the San Juan Basin, operating and maintaining the model, maintaining more frequent gaging station visits, and coordination. The draft budget includes 1/4 FTE for a new/additional modeler in the Grand Junction office. An additional person is being added to learn from those who have already been involved in the model development and who are nearing retirement age. Some Committee members suggested that someone look into allocating a full FTE so that during 2003 all the modeling work can transition to one person in the

Durango office. Other members felt that it would be difficult to justify a full-time person for the amount of modeling work that will be left after this year.

Steve Harris will draft for Hydrology Committee consideration a justification for a full-time modeler to be located in the Durango office. Steve Harris and Pat Page will revise the long term budget and send it out to the Committee prior to April 30. Review by the Committee of the full-time modeler justification and revised long term budget will be placed on the agenda for the May 7 Hydrology Committee conference call.

For estimating the number of model runs that might need to be made each year by a modeler and for justifying a full-time modeler, there were questions about whether running the model for a proposed depletion of 500 acre-feet or less is necessary. Steve Harris stated that a new depletion of 1000 acre-feet would be a big project in Colorado. ***The Committee is seeking direction on this from FWS - Steve Cullinan will check on this.***

John Whipple also requested an updated list from FWS of what depletions are included in the initial 3000 acre-feet block of minor depletions approved by the FWS in about 1992, and in the second 3000 acre-feet block of minor depletions approved by the FWS in about 1999. Other Committee members concurred in that request. John Whipple expressed concern that depletions already included in the baseline of the 1991 Animas-La Plata Project Biological Opinion not be double-counted under the minor depletions accounts. ***Steve Cullinan will find out what individual depletions have been approved by the FWS under the two minor depletions accounts.***

Discussion of Plan and Outlook for Balance of FY 2002, Long Term Budget, and Long Range Plan

Bill Miller explained that the updated draft Long Range Plan (LRP) prepared by the Biology Committee reflects the ongoing process within the San Juan RIP and updates the progress of the San Juan RIP along with providing more detailed information and recommendations that are now available. The Coordination Committee members had requested more specifics in the LRP. The draft LRP would provide future direction for the San Juan RIP. It shows the Long Range Plan with the old table format first and the revised table format (Table 5.1 Revised) second.

Miller further stated that the Hydrology Committee efforts need to be added to the LRP to show where the Hydrology Committee tasks and responsibilities fit into the LRP. For instance, in looking at Program Goals and Objectives, a hydrology component might be added if and where it fits. Miller suggested that something from the Hydrology Committee might be placed in the LRP under the dual purposes of the San Juan RIP. Miller indicated that Jim Brooks is planning to add an additional column to Revised Table 5.1 to identify responsible parties for each task or milestone of the LRP.

Some Hydrology Committee members expressed their opinion that the LRP should

include any tasks on which the Hydrology Committee foresees receiving San Juan RIP funds to accomplish (for example, review of model runs). They expressed a need to determine which tasks and milestones include hydrology issues or Hydrology Committee functions and to agree as a Committee on what tasks or milestones to include in the LRP. The process for revising the draft LRP is: the Hydrology Committee may recommend to the Biology Committee addendums or revisions to the draft LRP, the Biology Committee will consider any Hydrology Committee recommendations as well as recommendations of any of the San Juan RIP participants for revising the draft LRP, and the Biology Committee will submit a revised draft LRP to the Coordination Committee for its consideration. The next meeting of the Biology Committee is May 21st.

Review by the Committee of the draft LRP and recommendations for revisions to the draft LRP will be placed on the agenda for the May 7 Hydrology Committee conference call. Pat Page and Steve Harris will take a first cut at incorporating Hydrology Committee issues into the LRP and will send to the Hydrology Committee by April 30th their recommendations on revisions to the draft LRP for the Committee's consideration.

Navajo Reservoir Operations - Discussion of Latest Forecast

John Simons invited everyone to the next Navajo Dam operations meeting on April 18th at the Farmington Civic Center. As of March 26, the snow pack in the San Juan River Basin is about 30% of average for this time of year. Inflows to Navajo Reservoir during the April through July snowmelt runoff period are forecasted to be about 37% of average. Navajo Reservoir will not fill this summer. A springtime peak release from Navajo Dam will not be made this year due to low water supply conditions and the lack of downstream habitat perturbing events as determined by the Biology Committee. The Animas River is currently flowing between 200 cfs and 300 cfs at Farmington.

Bill Miller discussed the Biology Committee memorandum regarding the flexibility of Navajo Dam operations in the context of the flow recommendations. He explained that the request of the Biology Committee for information regarding flexibility came from FWS and Reclamation, and that Reclamation had concerns regarding the impacts on trout fishery interests of Navajo Dam releases less than 500 cfs, the inability of Reclamation to affect flows in the endangered fish critical habitat reaches on one day by changing dam releases on the same day, and the need to reduce releases below 500 cfs to attempt to meet 100 percent of the time endangered fish base flow targets before such reduces are needed also for water conservation. He further stated that Reclamation requested a memorandum from the Biology Committee regarding flexibility of operations sooner than the Biology Committee minutes would be available. Miller stated that Reclamation did not inform the Biology Committee that it would include the memorandum in the Navajo Dam operations EIS.

John Whipple commented that the Biology Committee has authority only to recommend flows that might be needed to provide for the habitat needs of the endangered fish in

the San Juan River, but that the rest is up to the Coordination Committee. The flow recommendations are not inviolate and should not be dictated to Reclamation by the Biology Committee. Whipple further complained that the Hydrology Committee was not consulted on or advised of the matter. Mike Hammond suggested that the Biology Committee's recognition of operational constraints and flexibility at Navajo Dam was a good decision in the context of pertinent issues. Pat Page indicated that individual comments on the EIS, including on the flexibility memorandum, should be sent to Kathleen Ozga by March 29.

Some Hydrology Committee members suggested that a joint meeting of the Biology and Hydrology Committees might be held to address issues regarding or needing coordination and communication. Some Committee members felt that the Navajo Dam operations flexibility issue was not a Hydrology Committee issue, per se, while other members disagreed. Also, Steve Harris provided Bill Miller with a copy of Reclamation's transmittal letter and distribution list it used for sending out copies of the Biology Committee's Navajo Dam operations flexibility memorandum. ***Pat Page agreed to inquire as to why the Hydrology Committee was bypassed on this matter.***

Review of New Action Items

New action items were reviewed. These have been added to the Action Item Log.

Discuss Next Meeting (April 30, 2002) - Conference Call or Meeting?

Some Hydrology Committee members suggested that a meeting be held, rather than a conference call, for the Committee's next deliberations due to the nature of the agenda. After some discussion, the meeting date was changed and ***the Committee agreed to have a conference call on Tuesday, May 7th, 9am - noon. Marilyn Greenberg will send the number to call, and the passcode, out on the listserve.***

San Juan River Basin Hydrology Model Key Model Input Draft Plan of Approach

Background

The San Juan River Basin Recovery Implementation Program (SJRIP) Hydrology Committee has approved the revision of the San Juan River Basin Hydrology Model (model) to provide more precise modeling of river flows below Navajo Dam. Three tasks have been contracted to Keller-Bliesner Engineering: (1) Recommend methodology for and determine incidental losses in the basin utilizing existing data, (2) Recommend methodology for and determine off-stream depletions, and (3) Recommend methodology for and develop software and/or algorithms to disaggregate monthly demands, return flows, tributary flows, gains and losses into pseudo-daily values for use in the daily Navajo dam operational model. This document presents the draft plan of approach for these three methodologies.

The methodologies outlined here rely on the following assumptions:

1. Monthly natural flows will be computed utilizing consistent assumptions from 1929 to 1999 (assuming data are available through 2000) and the same assumptions will be used for model operation as for natural flow calculation. This consistency is essential for accurate modeling and to make the model and natural flows defensible.
2. The general model configuration is the same for model runs as for natural flow computation except that depletions will be adjusted to match conditions modeled (e.g. baseline, future development, etc.).
3. Daily timestep data will be required only for those activities that influence flow downstream of Navajo Dam, including operation of ALP.
4. Natural flows are computed at all the gage sites required for model calibration and operation (no spatial disaggregation required).

Incidental Losses

Incidental losses associated with water supply projects are those that are not directly accounted for in primary project demand. They occur as a result of conveyance, application and return flow system losses. For purposes of computation they are considered the consumed portion of these losses. The impact on diversion as a result of the incidental losses will be computed utilizing the calculated efficiency of the project being modeled. It is further proposed that sprinkler evaporation, while computed separately, be handled in the same manner as incidental losses. Utilizing model

terminology, the depletion and diversion requests for any project would be computed as follows:

$$\text{Depletion Request} = (\text{Irrigated Area} * \text{ET rate}) * (1 + \text{Incidental Loss Rate} + \text{Sprinkler Evaporation Rate})$$

$$\text{Diversion Request} = \text{Depletion Requested} / \text{Minimum Efficiency}$$

Presently, the model includes the sprinkler evaporation rate as a portion of diversion request, which is incorrect as it implies sprinkler evaporation is influenced by the incidental and conveyance losses, which it is not. The above change would be implemented in the model by including sprinkler evaporation rate in the overall incidental loss rate so no Riverware code change is required.

Because incidental losses and sprinkler evaporation are components of the total losses due to inefficiency, the minimum efficiency used in computing the diversion request needs to be thought of and adjusted (upward) accordingly. Since the minimum efficiency is a calibration parameter, this should happen automatically; however, when determining initial values and verifying the model calibration this needs to be recognized.

In the present USBR natural flow calculations (at least since 1973) and in the RiverWare model, Colorado incidental loss rates come from the Type I study, for which no documentation can be found. It is not known what was used pre-1973. The New Mexico incidental loss rates are typically 10% with a few exceptions. Colorado, in its modeling effort does not explicitly include incidental loss rates, but includes the net effect in efficiency calibration and stream reach gain/loss.

Since incidental losses are important in the State's accounting of depletions in the system, it is proposed that the incidental loss rates for historical projects be set by the two States, subject to review and approval of the Hydrology Committee. By using the same rates for natural flow computation as for model runs (see the above assumptions), the method of computation or the amount of incidental loss will not affect model results as both the natural flow runs and the model calibration runs close on gage flow. In this way, the model remains consistent with State depletion computations and model integrity is preserved. For projects that have changed over time, the amount of incidental loss will have a small impact on the modeled case, as the baseline condition will be assumed. If the incidental loss was over-stated during the natural flow analysis and the same rate is applied to the modeled case, an increase in depletion will result in the simulation runs during the years when the project was not in place. Since incidental losses are typically low and most projects have been on-line for a long time, the potential error is not likely to be great, even if the estimate of incidental loss is quite different from reality for a single project.

For projects that are undergoing change or that are newly introduced, the case is different. Of most significance is the Navajo Indian Irrigation Project (NIIP). Water balance data exist for the duration of NIIP with diversions accurately measured, acreages and crops

carefully recorded, phreatophyte area measured and return flow measured or estimated. It is proposed that for natural flows the time series of diversions and return flows be used. For modeled cases, the forecast losses and return flows should be utilized, considering expected time lag in return flow. Data will be provided to the committee for review and approval.

Proponents of any new project would be asked to submit their estimate of incidental losses along with other project information for review by the Hydrology Committee prior to modeling. The best available information and scientific methods should be used to estimate incidental losses for these new projects.

Off-Stream Depletion

In the present natural flow analysis and model runs, off-stream depletions (depletions that occur within a stream reach on an ungaged water supply) have been handled differently for different states and for different time periods. Quantification of these demands in terms of impact upon streamflow is always problematic. Timing is not well understood. Demands must be limited to natural gains (adjusted for phreatophyte loss) in the model to prevent a call on the reservoir, yet must numerically match the values in the natural flows to preserve gage balance. It is proposed that this process be significantly simplified.

Since assumptions in the model will also be used in computation of natural flow and both the model and natural flow will be calibrated to gage flow, we propose that off-stream depletions not be considered in either the natural flow computation or model runs. This will eliminate the need for going through complicated computation to limit depletions and will substantially improve the accuracy of the gage estimate. The computed gain-loss, which is the balance term in each reach, will account for existing off-stream depletion. This approach will be accurate as long as new off-stream depletions are not added. Even then, they would have to be quite large to have a measurable impact due to the extremely small and unreliable water supply that typically exists in these ungaged drainages.

For purposes of state depletion accounting, the anticipated depletion associated with these projects may be different than what the States' use in their water accounting practices. However, as long as assumptions are consistent in the natural flow estimate as in the model there should be minimal effect on the model results.

Tributary Disaggregation

Monthly model tributary flows of the La Plata and Mancos rivers and McElmo Creek must be disaggregated into daily flows at their confluence with the San Juan River for operation of the daily time-step main stem simulation model. It is proposed that the existing gage record on each tributary be used to calculate a time series of daily flow percentages (percent of the monthly flow that occurred on a given date). These flow percentages are based on historical gage records and will result in a fixed time series data set for the modeling period. They will be stored in the model as input data. This

facilitates the disaggregation of monthly to daily data within the model. The monthly model simulated tributary flows would be multiplied by the time series of daily flow percentages to produce a daily record.

Where daily flows are not available, a key station or gage would be used to estimate the period of missing record. Table 1 shows the gage, the missing period of record and the likely key station that may be used to fill in the missing period of record. La Plata at Hesperus has very good record since 1929 and has been used in disaggregating the monthly flows in the current model. It has the limitation of being less influenced by upstream depletions and manipulation than the locations for which disaggregation are necessary, but no better gage has been found. It may be possible to correlate the Hesperus gage to the three analysis gages during periods of overlapping records to provide an adjusted daily flow percentage that would better reflect flow distribution. It is proposed that this analysis be completed and checked against using the key gage percentages without adjustment. If there is not statistically significant improvement in the disaggregation, the key gage would be used without adjustment. Since the flows of these tributaries are typically small relative to main stem flows and the monthly flow is being maintained, the error from using the key gage will likely be small.

Table 1.

Gage	Missing	Key
LaPlata @ Farmington	10/28 to 3/38	La Plata @ Hesperus
Mancos near Towaoc	10/43 to 3/51	La Plata @ Hesperus
McElmo @ CO-UT Stateline	10/28 to 2/51	La Plata @ Hesperus

Calculation of Daily Irrigation Demands

All irrigation demands modeled in the main stem daily model must be expressed as a daily demand. The approach we recommend is to develop the daily consumptive irrigation requirement (CIR) time series for the crop mix at all irrigation nodes as follows:

1. Develop the daily CIR for the same crops included in the monthly calculation. The same climatic stations would be used for this computation as is used for the monthly computation. It is proposed that we use the Hargreaves-Samani temperature difference method as it is the least data intensive of the daily ET methods and provides reasonable accuracy. Multiple CIR time series for the same crop may be required if climate is significantly different from node to node.
2. The result of step one typically produces a saw-tooth type curve reflecting daily differences in temperature and precipitation. Since irrigation deliveries do not vary on a daily basis, the time-series data set will be smoothed using a running average (7-days is the most probable, but this will be evaluated during development).

3. A single curve for the crop mix in the node will be developed by combining the CIR curves using an area weighted average for each demand node in the model that has a different crop-mix or climatic zone.
4. Daily percent distributions will be computed by dividing the daily CIR by the sum of daily values for the month. The actual daily CIR will be the product of the daily percent time the monthly computed CIR used in the natural flow analysis or as identified for any proposed project. The result is a single time series of CIR data that is used directly in the daily model. If crop mix is an important variable to retain in the model, the process could be computed on a crop-by-crop basis and then aggregated.

Disaggregation of Return Flows and M&I Demands

In a few isolated cases return flows calculated in the monthly model will need to be fed directly into the daily model (e.g. return flow from the Pine River basin entering the Florida drainage). Since return flows are rather constant, we propose that the monthly volume be divided by the number of days in the month. This produces a constant daily flow for the month. There may be some flow discontinuities at month boundaries, but the effect on the model results will be negligible. It is proposed that M&I demands be similarly disaggregated.

Calculation of Daily Gains and Losses

In the development of natural flows, a set of gains and losses will be computed to force balance to each gage. The gains and losses are the accumulation of unknown inflows, phreatic water use, gage error and unknown diversions or other losses. Once calibrated in the natural flow development, these gains/losses are used in all future model runs. Since these gains and losses will be computed on a monthly basis in the natural flow development, they cannot be directly used in the daily time-step main stem model.

There are two possible approaches to developing daily gain/loss data. The first is to develop a process to disaggregate the computed monthly values. The other is to operate a daily time-step model to simulate historical conditions and directly compute gains and losses. The first approach is problematic since there is no reliable key location that can be used to develop a daily flow percentage as in the tributary flows. Utilizing daily gage differences for each reach is not possible since they include non-natural activities that must be accounted for. We propose the second approach as it is more straightforward and will rely on the model configuration and assumptions in implementation, making it consistent with future model operation.

We propose that the daily main stem model, configured to represent historical conditions, be used to generate the gains and losses. This requires that all diversion, and tributary daily data be in place and the daily main stem model be operational. This process

directly produces the daily gains and losses so there is no need to disaggregate a monthly value. The process is envisioned as follows:

1. The daily main stem model will be configured with the daily tributary gage flows developed in the tributary disaggregation process. The Animas River at the confluence will be set to the Animas at Farmington historical daily gage flow. The gage flow of the San Juan River at Archuleta/Blanco will be used in place of Navajo Dam releases. This takes Navajo Dam operation out of the model. All gain/loss nodes on main stem of the San Juan below Navajo Dam will be set to zero.
2. The model will then be run on a daily time step for the entire model period (1929–1999), producing a daily flow record at each main stem gage.
3. The gains/losses above each main stem gage will be calculated by subtracting the historical daily gage record from the simulated gage record produced by the model run (Actual Gage – Model Gage). This will be a cumulated gain/loss down-river. To compute the gain/loss in each reach, the upstream gain/loss will be subtracted. A daily time series of positive and negative numbers results. This time series is the gain/loss adjustment required to match gage flow.

A gain/loss node is placed in the model above each of the main stem gages. The time series calculated in step three is placed in the gain/loss node as a flow correction. This assures that the historical model will always reproduce gage flows. This same set of gains and losses will be used in Baseline runs and any run used to evaluate future projects. The only reason for the gains/losses to change would be due to a correction or modification of the historical model that would effect the generation of the natural flows. In such a case, the process described is repeated.

Gains and losses on the Animas can be done in the same manner. We would recommend that the only gain/loss node required is immediately above the Animas at Farmington gage.