Revised June, 2005

M E M O R A N D U M

April 17, 2000

To: URGWOM Technical Team
From: William J. Miller, Consulting Engineer
Subject: Technical Review Committee Comments on January 26, 2000 URGWOM Physical Model Documentation.

This Memorandum compiles and summarizes the major comments of some of the members of the Technical Review Committee on the January 26, 2000 URGWOM Physical Model draft Document. Minor editorial comments were make in a marked-up version of the document and are not included in this Memorandum. A brief description of how the comment was addressed or otherwise disposed of is provided following the comment. Page numbers in this document refer to pages in the January 26, 2000 document. Changes in addition to these have been made to the model and the documentation. The entire 2nd draft should be reviewed to determine current content of the document.

Document Organization

It is difficult to find major sections of the text document. For the sake of providing for more easy reference to parts of the document, it would be helpful to number each section, or utilize a chapter system.

The geographic scope of area covered by the document should be more fully described in the introduction. *The document has been revised to address this suggestion.*

Include a copy of the RiverWare topology or workspace layout at the beginning of each reach section for use in describing that section. *A copy of the RiverWare workspace showing the URGWOM river reaches has been added to the document.*

Page 1, streamflow routing methods. Provide additional basis or discussion for placing the "Routing and Losses" Section at the beginning of the document. *The routing and loss computation are major computations needed for the proper functioning of all of the River Ware models being developed for URGWOM.*

Include a description of the different types of models and data bases available within URGWOM. *The January 26, 2000 Documentation describes the URGWOM physical model documentation. The relationships developed in the physical model are also used in other URGWOM models, the accounting model, the planning model, and the water operations model. Discussion of these models is beyond the scope of this Document.*

Show the Sevilleta National Wildlife Refuge and the Bosque del Apache National Wildlife Refuge in Figure 6. Maps have been revised to incorporate these features.

Page 23, section "Description of Physical …" In the text, dams were used for Table 31, however, reservoirs were used in the title of Table 31. Should the Table title be written as " Table 31. General information about dams in the Rio Chama Basin"? *The document has been revised in accordance with this suggestion.*

Ensure that the format for all references is consistent. *The references section of the Document has been reviewed and revised for consistency.*

It would be helpful to include in the Maps on pages 8, 25,29, and 30, some sort of indicator that would show the boundaries of the URGWOM reaches. The map features have been modified to reflect URGWOM river reach boundaries.

Technical or numerical

Page 2, Table 1, delete the units descriptor “(cfs x 10^3)” from the column headed “Flow Rate”. *This heading has been edited in accordance with this suggestion*.

The time lag in Figure 2 to the nearest 0.00 hours is not appropriate for a log-log plot. *The graph has been edited as suggested*.

It is probably not necessary for all tables and graphs to show four significant figures in the coefficient of determination. *The Tables have been edited to show this value using two significant figures.*

Page 21, paragraph below Table 27, the meaning of the sentence “January data show a 27-percent loss of flow…” is not clear. Is there really a loss of flow? Please clarify and make the reference to the value in the Table. Make similar clarification for the latter sections. *In this instance, the flow arriving at the downstream station has been reduced by 27%, which is called a loss in this document. The language of the document has been reviewed and revised as suggested.*

The elevations listed for El Vado Dam in Table 31 are not consistent with the elevations in Table 33. *These data have been reviewed and corrected*
.

Are the data in Table 36 monthly or daily leakage rates? Does the information below Table 36 agree with the table? *The data in Table 36 are daily rates. The text has been clarified to avoid this confusion. The discussion following Table 36 describes the development of an estimate of the amount of the gross seepage that is returned the Rio Grande via the riverside drains.*

It is probably not appropriate to show discharge data in Table 39 to the nearest 0.0001 cfs. *Data in this table has been reviewed and revised as suggested.*

Page 48, Jemez Reservoir. The graphs referred to on this page, nos. 121 and 122, do not appear be the correct representation of the Jemez River reach. On these two graphs, the measured discharges reach up to 6,000 cfs, while the time lags in Table 50 do not consider flows in that range. Also, the peak instantaneous discharge recorded at this station was 5900 cfs, Graphs 121 and 122 appear to show many measurements at a discharge of about 6000 cfs. *The data used to develop the equations in these graphs have been reviewed and revised to correct these equations.*

Page 49, first paragraph. The last sentence in this paragraph is unclear, and it is suggested that this sentence be reviewed. A reference to specific graphs may help the explanation. *The R^2 values for non-zero intercepts for other months are also somewhat similar to zero intercept R^2 values. In addition to the R^2 values the slope of the trend line better represented the distribution of the data for the non-zero intercept trend lines. The text has been modified to better explain using non-zero intercepts.*

Page 50. Table 52 shows canal seepage rates increasing over time from 1975-1993 for the Angostura to Albuquerque reach. At some point, these rates will level off. What is the relationship being used in RiverWare? If canal seepage for this reach is based on a linearly increasing relationship, the canal seepage rates should be reviewed. Canal seepage rates have been reviewed and revised.

Page 56, San Acacia to San Marcial routing. What is the rational or basis for using the 1970-1984 period for determining travel times, but a different period, 1987-1996 for monthly loss coefficients. Is this an inconsistency? The data have been revised to use consistent periods of record.

The RiverWare workspace layout for this reach of the floodway (San Acacia to San Marcial) shows a channel seepage or groundwater loss, yet there is no mention of this in text. The workspace layout also shows modeling for the LFCC and the Socorro main canal, which is not discussed in the documentation. RiverWare modeling for this reach has been revised and expanded, and the text has been revised.

Page 57, second paragraph. Is it possible that the time lag had to be adjusted from the lag determined using the standard method because the period used to establish the time lags is not representative of channel conditions during the 1987-1996 period? Channel aggradation in this reach during the 1987-96 period may have reduced the stream velocity from those experienced during the 1970-84 period. Also, it is not clear if the time lags shown in Table 59 are the adopted time lags used by RiverWare. *The methods used to develop travel times for this reach has been adjusted and now includes a hydrograph adjustment technique based on an evaluation of the standard error of the estimate.*

Page 57-58 – San Marcial to Elephant Butte Reservoir. The period of record used to determine travel times (1970-1984) is not the same as the period of record used to determine monthly loss rates. The monthly losses were determined during a period of nearly full reservoir stage, while the routing parameters were developed using data from a period of widely fluctuating water levels. This inconsistency should be addressed, or a basis provided for using different periods of record. *The period of record used in the development of loss rates and travel times has been made consistent*.

A description of the methods used to estimated sediment inflow to Abiquiu, Cochiti and Jemez Reservoirs between sediment surveys should be added to the documentation. *A detailed description of the sediment inflow equations and their application may be found in the accounting model documentation.*

Page 61, It is suggested that the equation

$$“S_t - S_{t-1} - I - P_t - E_t + O = 0”$$

be rewritten as

$$“S_t - S_{t-1} – I_t*1 - P_t *1 - E_t *1+ O_t*1 = 0”,$$

where “1” is one day, and inflow (I_t) and outflow (O_t) vary with time. *The equation as written has been reviewed and has shown to be correct.*

Page 61, it is suggested that the equation

$$“P_t = R_t/(A_{res})”$$

be rewritten as

$$“P_t = R_t*A_{res}/12”.$$

The Document will be changed in accordance with this suggestion.

Page 61, it is suggested that the equation

$$“E_t=E_p/12(coeff)(A_{res})”$$

be rewritten as

$$"E_t=E_p*coeff*A_{res}/12"$$

to avoid confusion. *The Document will be changed in accordance with this suggestion.*

Methods and procedures

The document notes that data point outliers were removed from some data sets. The document should provide a basis for determining which data points are outliers and subject to exclusion. *All data were reviewed and if, in the judgment of the individual working in that reach that the departure is obviously erroneous, the data point was removed from the analysis. The Document will be edited to include this discussion*.

Page 6, section "Reach loss …", item 1, what is included in the overall data set? Can some data be listed as examples? *The text of the Document will be revised to include as more complete discussion of the data sets used and how they were selected. In general, for the reaches above Cochiti Dam, the entire available record (in electronic format) was used to develop travel times. This same period was used in the determination of monthly loss rates. This is a valid approach because most of the channel sections above Cochiti Dam are relatively stable, and travel times and loss rates will not be significantly impacted by using any specific period of time. For the reaches below Cochiti Dam, the channel is unstable and has changed since the construction of Cochiti Dam, and is continuing to change. Using data from the period prior to construction of Cochiti Dam for travel times and loss rates would not be valid for application outside of the period used to develop the parameters.*

The validation period has not been used as yet for the comparison outside of the calibration period. For the URGWOM reaches through the middle valley, the data set selection should include a discussion of the period of record used for the calibration period and the validation period. *Model verification has been undertaken using the 1998-1999 period, and the results of the verification are included in the Documentation.*

Page 22, travel time lags, Otowi to Cochiti (graph 95). Is reservoir operation accounted for in developing travel times for this reach? *The effects of the construction and operation of Cochiti reservoir preclude the use of an additional (downstream) gage to develop travel times. Since the travel time for this reach is based on one gage upstream, the operation of Cochiti Reservoir is not relevant.*

In the development of the monthly loss coefficients in the various reaches, the decision as to use the loss equation with the y-intercept, or to use the loss equation with y=0 intercept should be based on the confidence intervals of the intercept and the slope; that is $p<.05$. Based on work done by others, regression equations will give an intercept value, but because of the large number of values that fall outside the 95% confidence intervals (± two standard deviations), the intercept is not significantly different that zero. *The document has been revised to show only the y=0 intercept in the various loss equations.*

Channel shifting at the gages Rio Grande below Taos Junction Bridge and Rio Grande at Embudo over a period of measurements impacts the travel times of the reach. Identify years in the data plot to determine when channels shifts took place, and develop regression equations for a specific period of years. This will eliminate the effects of channel shifting on travel time. *This exercise could improve calibration of the model, by using separate travel times for specific periods of time. The improvement of the precision this would bring to the model may not justify the work. Since the model cannot predict the location or the nature of future channels, there would be no guidance as to which regression curve to use. Given enough time, future channel location and characteristics will mimic the historic conditions. See also the discussion on page 17 of the text. In some instances, travel times are calibrated by changing reach lengths where differences between computed and observed are significant.*

Page 36, second paragraph (graphs 100-107). How was this data obtained? Width of measurement minus non-flowing (sand bars) should be used to determine average flow depth. The equation in graph 103 should not predict less depth with stage increase from gage height = 1.5 to 3.0. *Flow depths for gage heights less than 3.0 feet will be set equal to the flow depth for 3.0 feet.*

Because these plots reflect continuous shifting and aggradation and degradation, plotting channel change with time is probably necessary. The binomial fitting curves of depth versus stage is not reasonable. *This method of curve fitting was utilized because it produced the best regression equation (highest value of R^2)*.

Page 56 – 59 (graphs 126-137,138,149). Use the regression that has both slope and /or intercept significance ($p<.05$). Better relationships between sites will be realized if total flow at one cross-section is related total flow at another without regard to where the water is conveyed to: the floodway, the conveyance, and/or the main canal. *The Floodway only is used to route flows between San Acacia and San Marcial because there is not adequate data to route and account for loss in flow in the low flow conveyance channel in this reach. Routing methods used for routing flows in the Floodway are the same as used in upstream and downstream reaches.*

M E M O R A N D U M

July 31, 2001

To: Members, URGWOM Technical team
From: William J. Miller, Consulting Engineer
Subject: Proposed Responses to Comments on February 27, 2001 URGWOM Documentation

This Memorandum contains suggested changes to the February 27, 2001 URGWOM Technical Review Committee documents and related Appendices. These changes are being suggested as the result of comments received following the April 26, 2001 Technical Review Committee meeting as well as the result of routine review by Technical Team members. Short editorial changes to correct the documentation are included in this Memorandum; lengthier changes are contained in documents attached to this Memorandum. Minor changes made to correct errors in grammar, punctuation or for the sake of clarity are not identified here. This Memorandum also contains proposed responses to comments made on URGWOM documentation that may not result in changes to the documentation.

Changes to documentation made in response to comments

An introduction that describes all of the model documentation, including the appendices, should be included. See attached document entitled “Model Document Introduction”.

The model limitations must be assessed, clearly identified, stated in the model documentation and strongly communicated to potential model users and to the water management community. The following language has been included in the introduction to the URGWOM documentation to address this comment:

> URGWOM is intended to be developed and operated with accuracy sufficient to represent all significant influences to the extent that available data will allow. Lack of adequate physical data or poor data in many areas precludes the precise, reliable simulation of many physical features operating in the Rio Grande basin. In these cases, URGWOM uses the best available data, which in some cases is the only available data, to simulate physical processes. Some of the simulations require data extrapolations that but for the lack of other suitable data, would not normally be done. URGWOM development serves as a tool for identifying areas where additional data or investigations are needed.
>
> URGWOM is not a water supply model, a climate simulation model, a water rights model, a rainfall/runoff model, a hydraulics model or a groundwater model, although some of these things may be used as input to URGWOM or receive output from URGWOM. The user of the data and relationships developed in this model and documentation is cautioned against applying the relationships outside of the range of data upon which the relationships were developed. Care should also be exercised in the use of applications involving high or low-flow extremes. For example, see Graph 145 in appendix A. In this instance, the lack of reliable low-flow measurement data has resulted in computed travel times varying between 25 hours and 60 hours for the flow of 300 cfs.

<u>Physical Model Document (02/27/01 Draft):</u>

Page 1. Introduction. Add new Figure 1, a map of the Rio Grande basin between Lobatos and Ft. Quitman that shows the entire geographic extent of URGWOM in one location. Re-number subsequent figures.

Page 1. Add a fourth paragraph under the INTRODUCTION as follows:

Data sets used to determine travel times and loss rates for the reaches above
Cochiti Dam and travel times for the reaches between Cochiti Dam and Elephant Butte Dam are from USGS stream-gage calibration data and Bureau of Reclamation and Corps of Engineers' reservoir records. Data from gages at the upstream and downstream ends of URGWOM reaches that are available in electronic format, which is generally the most recent 30-year period, were used in these calculations. Data sets used to determine loss rates and travel times for reaches between Elephant Butte Dam and El Paso are based on stream-gage calibration and reservoir data collected by the USGS, Bureau of Reclamation and Elephant Butte Irrigation District during the 1984-99 period.

Page 3, fourth paragraph, fourth sentence. Delete this sentence and insert the following sentence in lieu thereof: "First, the variable time lag method is fairly easy to develop if measurement data are available. Second, it can be developed throughout the model for reaches with differing geomorphic and hydrologic conditions."

Page 5, Figure 1. Edit (if possible) the equation in the graph to read: $A = 9.5789Q^{0.517}$.

Page 5. In the last equation on this page, add units of miles (mi) after 28.8, and add units of velocity (ft/sec) after 3.25.

Page 8, RIO CHAMA REACHES. Prior to the single sentence referring to figure 3, insert the following:

A 73.4-mile section of the Rio Chama is divided into two reaches. The first reach begins at the gage Rio Chama below El Vado Dam and extends to the next downstream gage Rio Chama above Abiquiu Reservoir The second reach is from below Abiquiu Dam downstream to the Chamita gage, which is considered the confluence of the Rio Chama and Rio Grande. The San Juan-Chama Project water diversion and delivery into Heron Reservoir is included in the physical model. The transport of San Juan-Chama Project water from the Azotea Tunnel portal to Heron Reservoir is not based on physical gains/losses and lags, but is based on an approved loss rate of 0.002 with no travel time lag.

Page 13, After the heading UPPER RIO GRANDE REACHES, add the following new paragraph:

The 132-mile reach of the Rio Grande between the Colorado-New Mexico stateline and Cochiti Dam is divided into six reaches. The first reach begins at the gage Rio Grande near Lobatos, CO, the second at the gage near Cerro, NM, the third at the gage below Taos Junction Bridge, the fourth at the gage at Embudo, the fifth at the Rio Chama confluence and the sixth at the gage at Otowi Bridge. The discontinued gages Rio Grande above San Juan Pueblo and the Rio Grande near Arroyo Hondo were used to help estimate travel times and loss rates in the reaches where the gages formerly operated.

Page 29, last sentence. After the word "topology" add "(Appendix B)".

Page 32, Delete paragraph number 11.

Page 38, Table 36. Delete the word "monthly" from the caption of this table.

Page 53-54, Table 53. Middle Rio Grande Conservancy District total irrigated-crop acreage, 1975-99. Data errors were found in the miscellaneous fruit, miscellaneous vegetables and hay columns of this table and have been corrected.

Page 56, San Acacia to San Marcial routing. What is the rational or basis for using the 1970-1984 period for determining travel times, but a different period, 1987-1996 for monthly loss coefficients. Is this an inconsistency? The data have been revised to use consistent periods of record

Page 60, first paragraph found at the bottom of the page, third sentence. More recent data about irrigated acreage for the La Joya Community Acequia provided by the NM Interstate Stream Commission indicates that up to 250 acres may have been irrigated in 2000. As a result of this new information, an agricultural depletions object to the Bernardo to San Acacia reach will be added to account for agricultural depletions associated with 250 acres of irrigated farmland served by the La Joya Community Acequia. The third sentence in this paragraph will be revised to read as follows: “Based on 2000 NMISC GIS irrigated acreage data, irrigable acreage in this reach was assumed to be 250 acres.”

Page 63, under the heading **Computation of Local Inflow**. Delete this paragraph in its entirety and insert the following in lieu thereof:

> The local inflow, which represents the gains or losses within the reach, is determined by subtracting the routed with losses flow from the downstream observed or recorded flow (exact local inflow). Assuming proper modeling techniques and accurate stream gaging, the routed with losses hydrograph should be contained within the observed hydrograph and the difference between the two is an estimate of the local inflow occurring between the upstream and downstream stream gages. The resulting accepted local inflow data set is intended for use as input in the planning and water operations models. The following items are represented in local inflow which could not otherwise be accounted for:
>
> - Ungaged diversions and return flows;
> - Precipitation;
> - Ungaged tributary inflow;
> - Streamflow measurement errors;
> - Modeling errors;
> - Ground-water interaction

Page 69, PHYSICAL DESCRIPTION OF MODEL REACHES. In the first sentence, delete “Courchesne Bridge” and insert in lieu thereof “stream gage Rio Grande”.

Page 71, under heading **Reach Travel Time and Loss Analysis**. Paragraph number one, second sentence. Insert “and loss rates” after “travel times”.

Page 77, Table 76. The Adopted loss coefficients for the flow range above 2,000 cfs should be 0.05.

After page 79. Insert attached write-up entitled “Reservoirs in the Lower Valley.”

Appendix B

Delete this copy (dated 7/06/00) of URGWOM RiverWare workspace layout and insert in lieu thereof the most recent version of the workspace layout that includes URGWOM reaches between Elephant Butte Dam and El Paso.

URGWOM Physical Accounting Model Documentation

Page 1, Table 1. The loss rates for the reach Cochiti to Elephant Butte should be corrected to read as follows:

Month	Loss (%)
January	3.30
February	3.80
Mar	5.20
April	6.50
May	7.20
October	4.60
November	3.70
December	3.30

Proposed responses to comments not resulting in changes to URGWOM documentation.

The following comments, along with proposed responses, have not resulted in changes to URGWOM Documentation and are made to document the response to the comment. The comments are summarized prior to providing the proposed response. Responses are given in *italics*.

Key long-term transient impacts relate to climate cycles and population growth, both of which impact groundwater withdraws and recharge conditions, cannot be modeled in URGWOM. *This is indeed a limitation of the URGWOM physical model as well as other physical surface water models. URGWOM is based upon historical physical data, which in some cases includes the effects of long-term (30-year) climate influences and population growth. The basic assumption used in this instance is that future hydrologic conditions will reflect historic conditions. URGWOM is not a climate change forecast tool. At such time as a better understanding of climatic dynamics is reached, or better data or tools become available, these factors may be included in river simulation models such as URGWOM.*

The model needs to improve representation of parameters that impact water conveyance in the middle valley.
One of the benefits of developing the URGWOM physical model is that the model complexities have resulted in the identification of areas of data limitation which has resulted in the identification and prioritization of additional data needs. Data parameters, such as irrigation drain return flows from irrigated lands in the middle valley, are now being measured for the first time in some instances. When a sufficient database of drain returns become available for use in URGWOM , improvements in the model's reliability can be expected. This type of data enhancement will be incorporated in future URGWOM enhancements.

Page 2, Table 1 implies the use of the Muskingum K value of 0.1, but the text above the table uses a value of 0.3. *The Muskingum X value of 0.3 was tried in RiverWare, resulting in negative flows. Because of the instability of the method for short routing reaches (travel times less than 24 hours), the X value was adjusted to 0.1 so that negative values would not be computed. See text on page 2 located immediately above Table 1 in 02/27/01 draft*.

The text and the graphs found in appendices should use the same number of significant figures in the equation coefficients and R^2 values. *Coefficient of determination values (R^2) used in the text in the tabulation of stream-gage and calibration data and for the loss rate correlations for the various reaches are presented in two significant figures. The number of significant figures used in the R^2 values found in the graphs in Appendix B are "hard wired" in the MS Excel spreadsheet program.*

Many figures and tables in the text have different period of record than suggested for the calibration period of 1985-1996. *In the reaches above Cochiti Dam, stream-gage calibration data and related loss rate correlations are based on the period of record defined by gage calibration data available in electronic format. This is generally the most recent 30-year period, depending upon the individual stream-gage. The gages above Cochiti Dam used to determine loss rates and travel times are located in stable channel sections and provide the largest amount of data* *that is considered reliable during the calibration and validation period, and travel times and loss rates are not substantially affected by the use of any specific period of time. For those reaches below Cochiti Dam, the channel is unstable: the channel has changed since the construction of Cochiti Dam and continues to change*.

Outliers have been removed in some sets of data. Was there a method to select them? Should other data be outliers? *Data points removed from the data set were points that, in the judgment of the modelers working on that analysis, were clearly based on erroneous data and were not located close to the remaining data points or the "line of best fit." In general, data to be used in an analysis were plotted using a log-y axis. This allowed plots of the outliers to be exaggerated and selected for removal.*

What does the information in table 6 really describe? Graphs 11 through 22 in Appendix C have two sets of lines in them. *In all of the tables describing the loss rate correlations, the "n" value is the number of days that remained after application of the screening process, the "slope (y=0)" column is the slope of the "line of best fit" based on a regression equation with a zero y-intercept. The R^2 value is the coefficient of determination from the "line of best fit" equation using a zero intercept, which is the percentage of the variance of the dependent variable that is explained by the regression equation. The "Adopted monthly loss coefficient" is the result of the equation [{slope (y=0)} – 1.0]. Some of the graphs show two lines of best fit, those with a y-intercept and those without. Based on comments received during the January 26, 2000 technical review, it was determined that there is no significant difference between the with and without y-intercept relationships, so the y=0 relationship was adopted for simplicity. In the Lower Valley reaches, the y=0 and the y-intercept equations showed significant differences in some reaches in some months. Equations with non-zero intercepts were adopted when they improved the relationship (as described by R^2) by 4% or more over the zero-intercept relationship.*

Tables 7 through 12 use different periods of time. *The period of record used in determination of the loss rate correlations are different from the period of record used in the travel time determination because the days that remain after the application of the 3-consecutive day screening period may result in varying periods of time for each reach, depending upon the results of the application of the screening process.*

The stream-gages Rio Chama near Chamita and Rio Grande above San Juan Pueblo have been assumed to be the same position on the river. *There are no gages on the Rio Chama at is mouth or on the Rio Grande at the confluence with Rio Chama. For the purposes of determining travel times and loss rates, the gage Rio Chama near Chamita (2.8 miles above mouth) was assumed to be at the confluence, and the gage Rio Grande above San Juan Pueblo (1.8 miles above Rio Chama confluence) was assumed to be located at the confluence of Rio Chama and Rio Grande.*

What was the recognized acceptable R^2 value? *No criteria have been established for which an R^2 value was determined to be acceptable or not. The R^2 value is presented to allow for the evaluation of how good the relationship predicts the dependant variable. In the development of these relationships, it was found that although there may be a poor (low) R^2, the relationship is based on the only data available.*

Is the definition of "standard error" found anywhere in the documentation? *The MS Excel spreadsheet software was used to compute the standard error. The MS Excel spreadsheet software defines the standard error as the measure of the amount of error in the prediction of y for an individual value of x.*

Does the information below Table 36 agree with the table? *The text located below Table 36 is not discussing the data in Table 36. Table 36 discusses estimates of the total amount of water seeping through the bed of the river, the text below the table discusses the derivation of the amount of seepage that is intercepted by the riverside drains.*

What is the variable time lag method? *The description of the variable time-lag method is found on page three, and development of the method is found under the heading "Time Lags Base on Wave Velocity".*

Does standard error relate to R^2 throughout the document? *The standard error is not always related to R^2. The standard error is related to confidence intervals on the regression line. MS Excel spreadsheet software was used to compute the R^2 value. The MS Excel software* *spreadsheet as uses the correlation coefficient (R^2) to determine the relationship between two values.*

What criteria are used to drop data points to decrease the "standard error". *No data points are lost in the process of minimizing the standard error. Some data points may have been dropped in the initial development of travel times using the variable time lag, if in the judgment of the modeler, there were obvious errors. The standard error is minimized by multiplying the travel time lags by various multipliers greater than or less than one.*

Why do the estimates of canal seepage not change between 1975 and 1999 except for the San Felipe to Central reach? *These data are derived from Bureau of Reclamation data and reports. (1997 Middle Rio Grande Water Assessment – Supporting Documents 6, 12 and 15) These documents present the data used in the RiverWare model, but do not provide any information about the variations in canal seepage rates. Table 52 has been reformatted to try to make the information presented easier to follow.*

Use of a pan coefficient of 0.7 is not valid for use at all reservoirs during all months and its source should be referenced. *Agreed, however, water accounting is based on the use of pan coefficient of 0.7 as approved by the Rio Grande Compact Commission. Evaporation pan coefficients used to compute water surface evaporation may be varied by reservoir for use in the Water Operations or Planning models.*

There is no written description of the hydrogeology of the Lower Valley (as found in the Middle Valley section) *Only simplified modeling of flood flows is done in the Lower Valley reaches of the Rio Grande, which does not require a section on descriptive hydrogeology. When the Lower Valley is modeled in detail a corresponding description of the Lower Valley hydrogeology will be written and included in the report.*

TECHNICAL MEMORANDUM

November 18, 2002

To: URGWOM Technical Team
From: William J. Miller, Consulting Engineer
Subject: Proposed Responses to Technical Review Committee Comments on the June, 2002 URGWOM Documentation

This Memorandum contains suggested responses and changes to the June, 2002 URGWOM Technical Review Committee documents and related appendices. The changes proposed herein are in response to comments received following the August 22, 2002 Technical Review Committee meeting as well as the result of routine review by Technical Team members. Each review comment is summarized and followed by the proposed response. Minor changes in the documents to correct errors in grammar, punctuation or for the sake of clarity are not identified here.

Model Document Introduction

The text of this section has been re-written and updated to reflect the current status of model documentation

Clarify the meaning of the fourth sentence of the second paragraph on page one. *The sentence has been edited to clearly state the meaning of this sentence, which is that in some cases, the model uses data that are based on a relationship projected outside of the range of data that established the relationship.*

Physical Model Documentation

The documentation should include a discussion of the geohydrology of the upper and lower sections of the river. *A description of the groundwater hydrology has not been prepared for these areas because the impact of the groundwater development in these areas is not specifically addressed in these models. Future URGWOM investigation may include the simulation of seepage from the river channels in these reaches, at which time a detailed description of the geohydrology will be prepared.*

Some values of coefficients in the text do not agree exactly with the supporting values in the appendix. The number of significant figures is not consistent through the documentation. *In those cases where the error resulting from the lack of exact agreement between the two values of coefficients affects the reliability of the relationship, the values were corrected. The documentation is not always consistent in the number of significant of figures because the displays of significant figures in coefficients in the graphs are fixed by the software.*

The pan to lake coefficient used to compute lake surface evaporation should not be the same for all reservoirs and all basins. *The Technical Team recognizes that the pan to lake coefficient will vary seasonally and in accordance with elevation, and the use of an average annual value of this coefficient may not be appropriate in all cases. However, the use of an average pan to lake coefficient of 0.70 has been accepted and is commonly used. The Rio Grande Compact accounting is based on the use of this coefficient*.

The travel time values shown in Table 2 do not seem to agree with values determined using the line on the graph in Figure 3. *The logarithmic scale used in figure 3 makes it difficult to estimate* *values directly from the line. Computing travel times using the equation shows that the values in table 3 are correct.*

The streamflow period of record used in development of data in Table 9 is not the period of record used to develop the data in Table 7 even though they are for the same reach. *The Technical Team does not believe that using non-concurrent periods of record reduces the reliability of the results of using these relationships, in this instance. The relationships do not appear to exhibit any change over the years in the period of record used.*

Why is there no period of record listed for the data in Table 27 and Table 30? *Loss rates for these reaches were not based on data specific to that reach. They are based on the application of loss rates developed for similar, upstream reaches. See text on Page 24-25.*

A definition of the term standard error as used in the documentation and how it differs from the coefficient of correlation should be included in the early portion of the document. Does standard error relate to R^2 throughout the document? *The standard error is not always related to R^2. The standard error is related to confidence intervals on the regression line. MS Excel spreadsheet software was used to compute the R^2 value. The MS Excel spreadsheet software uses the correlation coefficient (R^2) to determine the relationship between two variables. The standard error method was not applied to reaches in the upper section. The MS Excel spreadsheet software was used to compute the standard error. The MS Excel spreadsheet software defines the standard error as the measure of the amount of error in the prediction of y for an individual value of x.*

How is evaporation used at the middle valley reservoirs? *The evaporation is used to estimate losses from the reservoir water surface which can then be used in a mass balance equation to determine reservoir inflow.*

Physical Accounting Model

Has the Rio Grande Compact Commission approved the travel time lags shown in Table 1? *It is not necessary to have the approval of the Commission for use of these travel time lags. The text has been edited to clarify this point.*

Explain why the Heron Reservoir seepage value is set to zero as used in the SEEPAGE METHOD section. *The seepage discharge from Heron Reservoir has been measured and calibrated with Reservoir elevation. When the Reservoir elevation declines to about elevation 7064, the rate of seepage from the reservoir is reduced to zero.*

Page 7, discussion above Table 2, the elimination of the effective precipitation may be resulting in negative end-of month storage. *The effective precipitation term is removed from this equation in order to account only for Rio Grande water, which does not include San Juan-Chama Project water gain through inclusion of the effective precipitation.*

Why are the losses computed in the equations on page 12 multiplied by the percent of open-water surface area? *This term is added in the event that the losses are to be reduced due to ice cover on all or part of the reservoir.*

Why are the arrows used on Figure 1 for the Hypothetical Condition different from the arrows used in the Present Condition? *The direction that the arrow points does not have any special significance; they intend to show the loss from that surface.*

What is the meaning of the term “N/A” used in Table 3? *This term means that the loss computation is not applied in the condition in that particular reservoir.*

What is the purpose of the value of the number 2,000 in the sediment deposition computation equations? *This value represents the number of pounds in a ton of sediment and is used to compute the volume of sediment.*

Why do the sediment deposition equations use different coefficients for different reservoirs? *Abiquiu Reservoir sediment computation uses the suspended fraction only (Sed_s) and Cochiti Lake and Jemez Canyon Reservoir use an equation that uses the total sediment load (Sed_t).*

Forecast Model

Explain why some of the runoff forecasts are based on the March-July forecast period, and others use the April-July period. *The Forecast Model is designed for developing daily snowmelt-runoff hydrographs for portions of the Rio Grande Basin; these hydrographs are based on March-July (April-July for San Juan River) volumetric forecasts developed by the NRCS for various points within the basin. See section 2.2.*

Include the date that the URGWOM Steering Committee adopted the RiverWare model for the development of URGWOM*. The document has been edited to reflect that the Steering Committee adopted the recommendation of the Technical Team to utilize RiverWare in April, 1998.*

Could the functionality of the rules sets be demonstrated through the use of a flow chart to help explain the process? *The RiverWare rule set developed for URGWOM does not lend to the use of flow charts to demonstrate the rules functions. The best way to demonstrate rule functionality is based on model results of simulated scenarios evaluated on a case-by-case basis*.

Page 20, last sentence. This sentence seems like a conclusion and should be placed in the conclusion section. *This is a concluding statement regarding the test method and it seems appropriate it its current location.*

Middle Valley Channel Leakage Documentation.

The text of the document has been edited to reflect suggested changes and then inserted into the Physical Model Document (PHYMOD) at page 43.

The data in graphs 97-104 use power curves and linear curves to develop similar relationships. Should they be consistent? *The relationship that yielded the best coefficient of correlation was used to determine which type of relationship to use.*

The data for some of the figures showing depth of flow versus gage height have overlapping data months. *The data are daily and some of the data from one month may be used in one relationship and data for the remainder of the month may be used in another relationship.*

The inclusion of a sketch that shows the layout of the flow from the drains to the river would help understand the differences between the assumptions behind the USBR groundwater gradient and the FORTRAN computed groundwater gradient. A graphic to help explain this process will be included in the next draft documentation.

What is the reason that the number of days of gradient measurements at the Interstate 40 site (page 9) is much lower than the number of days at the other sites? *The number of days of available data is not the same for each site.*

Model Calibration and Validation

Will the dry-day calibrated model underestimate the flow during wet days; if so, by how much? *The model calibration method is based on only dry days, periods of time when there is no precipitation that might produce unmeasured inflow. It is expected that this method would underestimate the flow on wet days, but this difference can be identified as or assumed to represent tributary inflow. Analyses performed by the Technical Team indicate that the unmeasured inflow, that might be the result of a dry-day calibration method, is not significant when compared to the total flow in each reach.*

In the calibration and validation of the model, the absolute value of 0.1 cfs was used in evaluation of the residuals. Will this error accumulate and result in less accuracy downstream than the upstream reaches? The Technical Team should consider a calibration based on a relative error allowance (such as % of total flow) to gain a better simulation. *The error (and unmeasured inflow) would tend to accumulate in a downstream direction when the flow is routed through each reach consecutively. This may be in part attributable to the reliability of the stream gage that was used to calibrate the model, which generally deteriorates in a downstream direction. The Team will consider the use of a relative error allowance in the next model calibration.*

Add a footnote to Table 1 to clarify the meaning of the variables used in this table. *A footnote has been added to help clarify the meaning of the table.*

Please clarify if the models discussed on the last paragraph on page nine are currently included in the model of if they will be included in a future application of the model. *The text of the document has been revised to clarify the fact that the models mentioned here are not currently part of the URGWOM models, but that these models could provide input data for use in URGWOM.*

Please explain the statement on the top of page 16 that states that the difference between historic and modeled flow will be greatest between Cochiti and San Marcial. *The document text has been revised to indicate that this reach will result in the greatest difference because of the accumulation of model error in a downstream direction and because of the difficulty in obtaining reliable streamflow record at the lower gages as opposed to the gages in the upper reaches.*

M E M O R A N D U M
February 4, 2004

To: URGWOM Technical Team
From: William J. Miller, Consulting Engineer
Subject: Technical Review Committee Comments on October 13, 2003 Draft Base Run Start-Up and Initial Conditions Assumptions Documentation

This Memorandum summarizes the Technical Review Committee review of the October 13, 2003 Base Run Start-up and Initial Conditions documentation. Included in this Memorandum are responses to comments made at the November 13, 2003 Technical Review Committee meeting, responses to written comments received and a brief description of changes made to the document as suggested by the review.

In addition to changes made to the model documentation as a result of comments received in the course of the Technical Review Committee review, a brief discussion of the introduction of a historic forecast error and its development has been included in the document and portions of the document have been rearranged or revised for the sake of clarity and for continuity. Following are responses to questions raised during the Technical Review Committee review process:

What is the basis for the 40-year hydrologic sequence used in the planning model? *The data used for the develop the hydrologic sequence used in URGWOM are based on the period from 1975 to 1999, the period for which the URGWOM Technical Team has assembled complete model input files. Because the period from 1975 to 1999 is a wetter-than-average period, a simple random sampling from this period would not generate a sample representative of long-term conditions. To obtain an appropriate sequence from this available hydrologic record, a sampling procedure was developed that normalizes the recent record to a long-term climate record. With this procedure, the drier years within the 1975 to 1999 period are sampled more frequently to obtain a sequence that is representative of the range of conditions reflected in the long-term climate record (the past 300 years). Based on an analysis of climate data for the past 300 years developed from tree-ring data, a "typical" 40 year period would consist of:*

- *14% very dry, 15% dry, 39% average, 18% wet, and 14% very wet years;*
- *One 10-year drought, two 7-year droughts, or 3 to 4 4-year droughts;*
- *One 11-year wet period, two 7-year wet periods, or 3 to 4 4-year wet periods;*
- *About 19 average years*.

Multiple 40-year synthetic flow sequences were constructed based on the above criteria for a 40-year period. The goal was to meet the criteria specified above and to obtain an average flow for the 40-year sequence of near 950,000, the equivalent of the average Otowi index flows for 1950-1998. The result is the following 40-year flow sequence for the URGWOM Planning model. *Dark-shaded regions are multi-year droughts (average flow < 710,000); light-shaded regions are multi-year wet periods (average flow > 1,100,000). Average flow for the entire sequence is 933,573 acre-feet per year*.

Year #	Year	Flow	Year #	Year	Flow	Year #	Year	Flow	Year #	Year	Flow
1	1982	1183500	11	1996	449100	21	1978	699000	31	1978	699000
2	1988	726500	12	1996	449100	22	1998	892500	32	1998	892500
3	1992	1067800	13	1977	296500	23	1999	1103200	33	1976	682500
4	1976	682500	14	1988	726500	24	1986	1805900	34	1991	1239000
5	1989	713400	15	1987	1662400	25	1999	1103200	35	1989	713400
6	1996	449100	16	1975	1185800	26	1991	1239000	36	1984	1343100
7	1977	296500	17	1998	892500	27	1980	1392200	37	1992	1067800
8	1989	713400	18	1976	682500	28	1992	1067800	38	1988	726500
9	1989	713400	19	1975	1185800	29	1985	2169100	39	1982	1183500
10	1981	416900	20	1978	699000	30	1998	892500	40	1991	1239000

How can the EIS alternatives be fairly compared if run on only a single hydrologic sequence? Typically alternatives are run on ensembles of forecasts, producing a probability density function or similar metric for determining the likelihood of the alternative meeting or violating various criteria. A single sequence can introduce responses that are not indicative of probabilistic outcomes*. The goal of the Planning Model is not to predict the next 40-years of climate, but to provide the framework for assessing environmental and resource responses to a range of climatic events. Therefore, to support the alternatives analysis, a single 40-year sequence of years was developed that represents a broad range of climatic conditions based on the period from 1975 to 1999.*

What loss rates does URGWOM use for the delivery of Albuquerque San Juan-Chama water to the proposed diversions? *The URGWOM model applies the same San Juan-Chama Project water loss rates that are used for delivery of all contractors' water as far as Cochiti Dam (2.33% from Heron Dam to Cochiti Dam). No losses are charged against Albuquerque San Juan-Chama Project water between Cochiti Dam and the proposed point of diversion because San Juan-Chama Project loss rates have not been approved for this reach during the summer months. When the loss rates are approved, they will be implemented in the model.*

In the development of the relationships between the amount of water diverted at the upstream end of an URGWOM reach and the gaged flow below the bifurcation, is the use of 1985-1997 data period suitable for representing the relationship during drought years? *The reason for determining the relations below the bifurcations was specific for the 40-year scenario required by the EIS. Even though the minimum flow used in the scenarios was data from 1977 when the Otowi Index was 296,500 acre feet, the URGWOM Technical Team did not have a complete data set before 1985 to complete the analysis. There were only two years used in the 40-year runs that were out of the range of the analysis, 1977 and 1981. The 1981 flow was very close to the minimum used for the analysis.*

With reference to figures 3-7 showing the relationships between the flow at the head of a reach and the drain return flow at the bottom of the reach, are these trend lines "best-fit" or the "best-fit" straight line? Add the correlation coefficient to these line equations. *The trend lines displayed in these figures are best-fit straight lines. Correlation coefficients have been added to the figures.*

Does the model adjust storage releases from upstream reservoirs to take into account tributary inflow to the middle valley that is available for diversion for irrigation purposes? *Modeled tributary inflows to the middle valley do not result in the change in the amount of water diverted from the river or the amount of water released from upstream conservation storage. Flood inflows from middle valley tributaries may result in the change in operation of upstream flood control reservoirs.*

It is suggested that a map of gaging stations discussed in the report be included in this document. *Maps showing the locations of gaging stations are included in the Physical Model documentation.*

After the planned recompilation of model documentation, these maps will be accessible for more convenient reference by the reader.

The value used to estimate the projected inflow to Elephant Butte Reservoir (35% of the March-June forecasted flow of the Rio Grande at Otowi gage) looks extremely low. *The language of the draft document was in error, and the 35% value represents the amount of the Otowi flow lost in transit to Elephant Butte Reservoir. The draft document has been revised to indicate that 65% of the March-June forecasted flow of the Rio Grande at Otowi gage will be used as the estimated runoff into Elephant Butte Reservoir during the same period.*

What is the 2001 MRGCD crop acreage used in determining the irrigation diversion demand used in the planning model? *Data for the 2001 MRGCD cropping pattern are not available. Based on the most recent data available from the MRGCD (1999) the best available data for the current MRGCD cropping pattern (not including fallow lands) is as follows:*

Crop	Irrigated Acreage
Alfalfa	26,700
Pasture	15,600
Corn	3,800
Hay	1,400
All other crops	3,200
Total	50,700

Are the San Juan-Chama Project contractor release demand priority schedules for releases from Heron Reservoir? Will the release priority change when Albuquerque begins diverting surface water from the Rio Grande? *The San Juan-Chama Project release priority schedule applies to all of the three Rio Chama reservoirs. Albuquerque is set as the highest priority to take into account the proposed release schedule expected to be implemented when the Albuquerque Drinking Water Project diversions begin. At a point in time in the future all San Juan-Chama Project contractors will have equal priority of releases to reflect actual demands as they occur.*

What period of record was used in developing the schedule of releases from Elephant Butte Reservoir? *Period of record used is 1975-2000. The record was not extended through 2002 because final data were not available at the time the analysis was performed*.

With respect to the modeling of the operation of Elephant Butte Reservoir, how is water flowing through the spillway simulated, such as occurred in 1987 and 1988? *If the water surface elevation in Elephant Butte Reservoir exceeds the spillway crest elevation, the model will route water over the crest and through the spillway using the Elephant Butte spillway rating curve.*

The following revisions have been made to the most recent version of the Base Run Star-Up and Initial Conditions Assumption document and model rules:

The URGWOM rules used to account for credit water loss in Elephant Butte Reservoir reduce the New Mexico (and Colorado) credit water in storage on a daily basis based on the proportion between the total amount of credit water in storage and the total amount of water in storage. The model distributes the total credit water loss between the Colorado and New Mexico credit water on a proportional basis. However, it is the amount of credit water in storage at the beginning of the year (if any) that is used to determine the amount of usable water in Project Storage at any time during the year.

The documentation has been revised to include a discussion of the use of historic forecast error algorithm in the planning model. This was incorporated to allow the planning model, which uses historical data, to accurately portray operating decisions by “looking ahead”. In this manner, model results will as accurately as possible reflect the information available to the operator when the actual reservoir operating decisions were made.

Revised June, 2005

TECHNICAL MEMORANDUM

September 13, 2004

To: URGWOM Technical Review Committee
From: URGWOM Technical Team
Subject: Technical Review of URGWOM Modifications

This Memorandum summarizes the major modifications to the URGWOM model since the last Technical Review. Changes have been made to the physical model layout and rules to improve simulation of the groundwater surface water interaction in the San Acacia to San Marcial reach. This simulated interaction depends upon the use of a groundwater flow model constructed for this reach. Methods and rules for El Vado Reservoir were modified to allow multiple Rio Grande storage accounts, and additional methods were developed to simulate the operation of the system to meet minimum flow targets at locations in the middle valley.

These modifications will be the subject of presentations that will be made at the October 14, 2004 meeting of the Technical Review Committee. Additional details and explanation about these modifications will be provided at that time.

Changes to the San Acacia to San Marcial Reach

Reason and Concept for change

It was clear to the Technical Review Committee and the Technical Team that the middle valley portion of the Physical Model needs to be upgraded for several reasons. In the initial calibration of the "Physical Model", the San Acacia to San Marcial reach was calibrated with zero diversion to the low-flow conveyance channel at San Acacia. Some of the scenarios simulated by the planning model had diversions to the Low Flow Conveyance Channel. This use of the model fell outside of the initial calibration of the model.

The initial calibration also used a feed back loop that needed the downstream actual-flow data to be entered to have the model solve for this reach. Due to the use of a feedback loop, the simulation of the reach had to have a bifurcation object which posed problems during the initial hypothetical simulation at the start of model runs. The goal for the middle valley part of the URGWOM is to have the model solve completely in a downstream direction from Cochiti Lake to Elephant Butte Reservoir. This allows more functionality for the model to solve more complex simulations in a more efficient manner.

The concept for the upgrade of the middle valley part of the Physical Model is to upgrade the model in a multiple stages that would depend on the development of solution methods in RiverWare. The first phase is to use a calibrated ground/surface-water simulation model of the San Acacia to San Marcial reach to develop two look-up tables. The look-up tables would be used to determine the losses or gains in the floodway and the low-flow conveyance Channel based on the upstream flows at both upstream gages. Since the losses or gains in the reach are dependent on the amount of flow at the top of the reach (San Acacia), the look-up tables incremented by flow. The increments use in the look-up table for the floodway flow at the gage at San Acacia are 0, 250, 500, 1000, 2000, 4000, 8000, and 12000. The increments for the Low Flow Conveyance Channel flow at the gage at San Acacia are 0, 250, 500, 1000, and 2000.

Look-up tables

Preparation of look-up tables

In the development of the look-up tables the result of the GW/SW interaction simulation was the flow of water at each of the downstream gages given the flow at both of the upstream gages.

This type of input could not be used in the Physical Model because the model upstream of the reach would be physically separated from the model downstream of the reach. If this were the case, the accounting portion of the URGWOM would not work. To alleviate the problem of a disconnect in the model, the monthly result from the GW/SW interaction simulation was modified by subtracting the simulated flows at the San Marcial gages for both stations by the corresponding upstream flow at San Acacia. This resulted in the monthly gain or loss in the reach by the flow in both the floodway and the Low Flow Conveyance Channel. The gain or loss was put into twelve monthly three-column table slots in the two data objects FloodwaySanAcaciaToSanMarcialLoss and LFCCSanAcaciaToSanMarcialLoss.

Rules created for look-up tables.

In RiverWare, there is no reach method to look up gains or losses from a three dimensional table. To set the loss or gain to the reach objects in the San Acacia to San Marcial reach two rules were needed to use the look-up tables. The rules looked at the previous days flows at the San Acacia gages on the Rio Grande Floodway and the Low Flow Conveyance Channel and used the three-dimension table look-up function to determine the loss or gain for each of the reaches and set the local inflow on the reach object to the loss or gain value. The two rules were placed in a rule group named “Middle Valley Loss”.

Calibration and verification of the gain or loss

Computational verification and calibration was completed on the new San Acacia to San Marcial reach. To ensure that the Physical model would perform the simulation of the gains or losses in the reach properly, a test model was used that included only the San Acacia to San Marcial reach and the adjacent Socorro Main Canal irrigation area. The actual flows for both the Low Flow Conveyance Channel and the Rio Grande Floodway were used for the initial verification. After the simulation of the calendar year 1968 was completed, the results were compared to the actual flows for the two gages at San Marcial. There appeared to be a constant difference between the actual and the simulated gains or losses over the range of flows in June and July. After some analysis, a constant was added to the gain and loss values in the look-up tables for these two months. A verification simulation was then run for three additional years (1969, 1973, and 1975). The results for the verification simulation indicated that the results of the simulation were very close to the actual flows at both San Acacia gages for all three years. Additional calibration work can be done to fine tune the look-up tables.

Modification of the San Acacia to San Marcial Reach

As part of the upgrade of the San Acacia to San Marcial reach and the use of the look-up tables, the RiverWare objects in this reach were either moved, replaced, or deleted. The first change to the model was the move of the SocorroWastewater data object. Further investigation of the location of the outflow of the Socorro Waste Water Treatment Plan indicated that the data object was located in the wrong place in the model and linked to the wrong reach object. The treatment plant effluent was actually put into one of the drains that flowed into the Low Flow Conveyance Channel. Because of the issue with the location, the object was moved near and linked to the Return Flow slot of the SanAcaciaToElephantButteCropDeepPercLosses object.
In the San Acacia to San Marcial reach many objects were removed or replaced by the look-up table design. The objects removed from the model are:

1) SanAcaciaLFCCToSanMarcialLFCCGWGains reach object
2) LFCCBifurcation bifurcation object
3) SanAcaciaToSanMarcialSeepageCalibration reach object
4) SanAcaciaToSanMarcialSeepageLag reach object
5) BlwSocorroWastewaterReach reach object
6) SanAcaciaToSanMarcial reach object
7) SanAcaciaToSanMarcialLocalInflow reach object.

The SanAcaciaToSanMarcialLosses reach object was used in the new setup but the methods used in reach calculations were changed. The seepage calculations were removed and the routing method was set to time lag routing. A new reach object was added to the Low Flow Conveyance Channel part of the reach, LFCCSanAcacia ToSanMarcialLosses. The new object was set up the same as the SanAcacia ToSanMarcialLosses reach object. These two reach objects have there slot for local inflow set to the loss or gain from the look-up table by rules.

Multiple Rio Grande Accounts in El Vado

In 2003, an Emergency Drought Water Agreement (EDWA) was implemented that allows Rio Grande storage in El Vado (other than for Indian Storage requirements), even though operations of Rio Grande basin reservoirs are under Article VII of the compact. Article VII states that Rio Grande water cannot be stored in reservoirs constructed after 1929 when Rio Grande Project water storage in Elephant Butte and Caballo reservoirs drops below 400,000 acre-feet. The EDWA allowed for storing several types of Rio Grande water (based on relinquishing some of New Mexico's credit water under the compact) for use by the Middle Rio Grande Conservancy District (MRGCD) and supplemental water for endangered species needs.

This agreement necessitated accounting for both of the EDWA types of water, along with separating the Indian Storage requirement and a generic Rio Grande account, in the URGWOM accounting, water operations and planning models. This required a modification to the Storage Account Gain Loss method for El Vado to allow for more than one Rio Grande account and proportion the loss to each account. Rules also needed to be developed (for the water operations and planning models) to move water into the accounts and release the water for uses downstream. A number of rules and functions were created or modified to model these new accounts.

There are now four Rio Grande accounts in the El Vado object (in the accounting, water operations and planning models); IndianStorage, MRGCDDrought, RioGrande and SupplementalESA. Water is placed into the accounts based on the following; the Indian Storage pool is the first to be filled up to its required amount, then the MRGCDDrought and SupplementalESA pools are proportionally filled simultaneously up to the EDWA allowance for each account. Releases from the MRGCDDrought account are delivered to help meet MRGCD demands in the middle valley. Releases from the SupplementalESA account are used to meet target flows in the middle valley (i.e., at Central and San Acacia). The IndianStorage water is released to meet Indian demand when the natural flow at Otowi is not adequate to meet the demand and needs to be supplemented from storage.

When operations are not restricted by Article VII of the compact, Rio Grande water is stored in the RioGrande account for use by MRGCD, as has typically been done in the past. The IndianStorage account is treated the same as always as mentioned above (is filled first and released for Indian demand). The other two Rio Grande pools would not have any storage under normal conditions (when not under Article VII).

Minimum Target Flows in the Middle Valley

Upon implementing meeting minimum target flows at locations in the middle valley (e.g., at Central, San Acacia, etc.), it was noted that too much Rio Grande Conservation (stored in Abiquiu) or SupplementalESA (stored in El Vado) was delivered to meet the desired target. The model was meeting not only the target, but also meeting the forecasted (based on historical diversions) MRGCD diversion requests. The diversion requests need to be kept at the amount that could be diverted (available from the river) prior to delivering water to meet the targeted flow. This required new rules, to in effect, short the diversion requests when they could not be met by natural flows in the river and any supplemental San Juan-Chama water or any stored Rio Grande water for MRGCD purposes.

Another problem cropped up at the bifurcation objects (see Figure 1) in the middle valley where they are linked to downstream gage objects (at each canal/drain cross section), which are set by rules (based on historical flows at given cross-sections of the drain/canal system. The flows at these gages may need to be reduced when the original diversion request at an upstream diversion is not met (i.e., there is not enough water to meet the diversion request), using a relationship between the amount of water diverted upstream and the gaged flow below the bifurcation. These relationships were presented in a previous Technical Review (November 2003) and were set using rules (based on historical diversions). The gages at each canal/drain cross section (below the bifurcation objects) need to be set 5-10 days in advance (depending on the target location) for the hypothetical simulation (a predefined function in the RiverWare Policy Language) to be able to estimate required releases to meet the given target flow at the downstream location. Because the hypothetical simulation needs data 5-10 days out, a method (Stream Gage Conditional Flow Method) was required to set the values at the gage locations below bifurcation objects to replace previously used rules. The method replaces the rules that were developed to set the gage values based on the relationship between upstream diverted flows to what flows show up at the canal/drain gage location. CADSWES's document describing the Stream Gage Conditional Flow Method is in Appendix A.

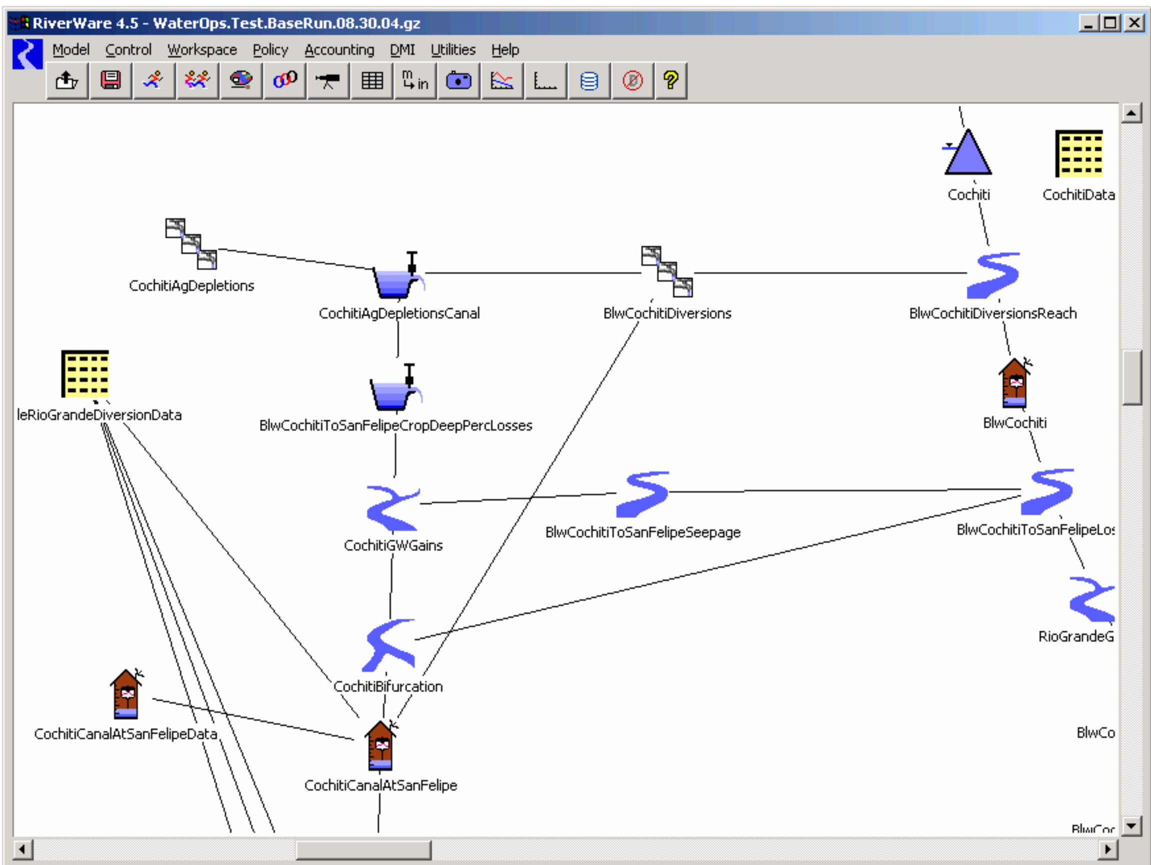

Figure 1 - Example of drain/canal x-section stream gage linked with bifurcation object.

APPENDIX A

Stream Gage Conditional Flow Method

1.0 Purpose

The URGWOM team has requested a RiverWare method to calculate and set conditional flow on a gage object. Currently in the URGWOM model, the gage object's Inflow slot is set by a rule. The URGWOM team would like the capability of setting the gage Inflow during hypothetical simulation mode, however, it is not possible to set slots via rules in the middle of a hypothetical simulation run. A method will be added to the gage object so that it may calculate a conditional flow dependent on shortages in upstream diversions.

2.0 Design Details

A new method category Conditional Flow Calculation will be added to the gage object. The new method category will contain two methods: Fractional Flow and None. The None method is the default method and will perform no calculations. The Fractional Flow method will have four new slots: Condition One, Condition Two, Normal Flow, and Loss Factor. The two slots Condition One and Condition Two are linkable or can be set via rules or user input. These slots are dispatch slots and will provide the gage object with the information necessary to calculate the gage Inflow slot. The Loss Factor slot is a scalar slot used to calculate the conditional Inflow

In the Fractional Flow method, gage inflow is conditional, determined through a comparison between the two sets of values in the slots Condition One and Condition Two. If the slot Condition Two is greater than slot Condition One, the Inflow slot will be set to Condition One multiplied by the Loss Factor. Otherwise, the gage Inflow slot will be set to the Normal Flow.

The following pseudocode displays the logic of how the gage Inflow slot is calculated:

```
IF ("Condition One" (e.g., diversion) < "Condition Two" (e.g., diversion requested))
        gage.Inflow=ConditionOne x Loss Factor        Eq. 1
ELSE
        gage.Inflow=Normal Flow        Eq. 2
```

3.0 Methods and Method Slots

3.1 "None"

The "None" method is the default method in the Conditional Flow Calculation method category. This method does nothing. No slots are instantiated or set as a result of this method.

3.2 "Fractional Flow"

The "Fractional Flow" method is available in the Conditional Flow Calculation method category. The following slots are activated when this method is selected:

"Normal Flow"
Type: SeriesSlot
UNITS: FLOW
Description: timeseries of values of Inflow if condition is not met
Information: When slot Condition One is equal to or greater than slot Condition Two, the gage Inflow is set to Normal Flow.
I/O: Required Input
Links: Not linkable

"Condition One"
Type: SeriesSlot
UNITS: FLOW
Description: a slot for comparing two conditions that will affect the gage Inflow slot
Information: This slot is a dispatch slot which will trigger the object to resolve if its value changes. Values are received one of three ways: linked with another object, provided via user input, or set by rules.
I/O: Required Input
Links: linkable

"Condition Two"
Type: SeriesSlot
UNITS: FLOW
Description: a slot for comparing two conditions that will affect the gage Inflow slot
Information: This slot is a dispatch slot which will trigger the object to resolve if its value changes. Values are received one of three ways: linked with another object, provided via user input, or set by rules.
I/O: Required Input
Links: linkable

"Loss Factor"
Type: ScalarSlot
UNITS: NONE
Description: factor specifying fraction of water remaining after conveyance losses upstream of the gage object.
Information: This factor is a fraction between 0 and 1 and will be multiplied by Condition One.
I/O: Required Input
Links: Not linkable

4.0 Implementation Concerns

The addition of this method is a work-around for the issue that hypothetical simulation does not permit rules to fire in the middle of a hypothetical simulation run. Implementation of this method may cause the model to appear cluttered as additional links are added between the gage object and other objects. This later problem will be alleviated in the future when the workspace is redesigned to allow links to be "hidden".