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Technical Memorandum | Final

To:	**Blaine Dwyer (Boyle | AECOM)**
Distribution:	**Distribution List**
From:	**Erin Wilson (Leonard Rice Engineers, Inc.)**
Subject:	**CRWAS Phase I	Task 4.4	Recommend Model Refinements**
Date:	~~**June 24, 2009**~~ **January 2012 updates in red**

CRWAS Phase I included a public comment period on the draft CRWAS Phase I Report and public outreach workshops, to solicit feedback from stakeholders on the Study. CWCB and the CRWAS technical team used these forms of feedback to refine Study deliverables, such as this technical memorandum, which includes content that has been updated.

Introduction

The objective of Task 4 is to:

Facilitate an understanding/acceptance of the State's current water allocation modeling of Colorado River tributaries by interested parties, specifically the BRTs and to provide the Consultant team an opportunity to peer review the existing modeling efforts.

This memorandum summarizes recommended refinements to the Colorado Decision Support System (CDSS) water allocation models based on comments, questions, and observations noted through four Basin Roundtable (BRT) Workshops listed below.

BRT Workshop	BRT Chair	Date	Time	Location
Colorado	Jim Pokrandt	02/23/09	1 pm	Glenwood Springs
Gunnison	Michelle Pierce	03/02/09	4 pm	Montrose
Yampa / White	Tom Sharp	03/04/09	6 pm	Craig
Southwest	Mike Preston	03/11/09	3 pm	Durango

Feedback collected from each of the four BRT Workshops provided valuable insight to basin hydrology, operations, and administration. Attachments 1 through 4 provide summaries of the comments collected from each of the four BRTs including written comments from the Colorado, Gunnison, and Southwest BRTs and verbal comments from the Yampa / White BRT.

In addition, BRT members and other water users had an additional opportunity to revisit CDSS model assumptions and operations during the review of the Draft Phase 1 Report. Review comments and suggestions were included in **Colorado River Water Availability Study – Phase I September 16, 2011 Public Comment / Response Matrix – Final** available on the CWCB website. Suggestions related to CDSS model refinements, and a general description of how they were addressed, are included in this technical memorandum.

Requirements of CRWAS

As part of the CDSS project, separate StateCU (crop consumptive use model) and StateMod (water allocation model) models were developed to represent each of the five major river subbasins that contribute to the Colorado River Basin as follows:

- Colorado River Mainstem
- Gunnison River
- Dolores/San Juan/San Miguel Rivers
- Yampa/Green Rivers
- White River

StateCU and StateMod are executed in conjunction to represent each basin's hydrology, demand, water rights, and operations. StateCU generates crop requirement demand estimates that are used directly in the StateMod model. StateMod starts with hydrology then operates based on Colorado water right priorities to meet the irrigation, municipal, transbasin, and other demands.

The CDSS models have been selected for use in the CRWAS study to first quantify water availability based on historical measured hydrology and current basin water uses. The CDSS models will then be executed to estimate water availability using hydrology traces based on tree-ring data and stochastic methods, and associated climate-related crop demands, as developed in Task 6. Finally, the CDSS models will be executed to estimate water availability using alternate hydrology and demands based on climate and forest change, developed in Task 7.

Because the CDSS models will ultimately be used to provide results for other aspects of the CRWAS study, it is important that water users and interested parties have the opportunity to understand the models' operations and provide input based on their local experience.

Approach

The following approach was used to identify potential model CDSS enhancements.

1. Model briefs were developed for each basin summarizing model inflow hydrology, physical representation, water demands, and legal and administrative conditions. The model briefs outlined data sources and filling techniques for each category. The model

briefs also presented results of model calibration and described operations of the major projects modeled for each basin.

A general "Overview of the Colorado Decision Support System" document was also developed that provided context for the CDSS efforts including descriptions of the StateMod and StateCU models and the CDSS data-centered process. The overview memorandum and the model briefs were provided to each BRT chair for distribution to the members and their technical consultants. These efforts were completed under Task 4.1

2. The study team presented an overview of the CDSS and its application in each basin for each BRT. The primary focus of these meetings were to obtain specific comments and suggestions directly related to potential refinements to CDSS data and models based on the participants' knowledge of current water supply and management in the respective river basins. The presentations build on the model briefs, providing more detailed information regarding specific model operations and calibration. Areas where previous CDSS modeling efforts raised specific concerns or drew less feedback from basin water users were identified and additional information was solicited. Questions and comments during the BRT meetings were noted. Formal feedback was requested and received from three of the four BRTs within several weeks of the meetings. Comments were received from BRT members, their consultants, and other water users. These efforts were completed under Task 4.2.

3. The Boyle | AECOM team includes individuals with extensive experience developing CDSS and other crop consumptive use and water allocation models. These specialists reviewed the subbasin models and provided additional comments for potential improvements. These efforts were completed under Task 4.3.

4. Additional comments received through the Phase I Draft Report review were revised and modeling revisions incorporated, as shown in Table 1.

5. The comments and questions specifically related to the CDSS were compiled and grouped into "comments that require additional clarification to assist in model understanding," and "recommended model refinements." The recommended model refinements were then categorized by the consulting team as follows:

    - Recommended – refinements that will significantly enhance the basin representation and the understanding of the impact of alternative hydrology;

    - Desirable – if possible to implement within the Study's budget and schedule, these refinements should be incorporated;

    - Optional – the suggested changes would enhance the supporting data and/or model capabilities, but are not anticipated to have significant overall effects on the purpose or results of this Study. The State will keep these suggestions on file for potential future reference and implementation; or

    - Infeasible – the suggested changes are impractical to implement.

Model Refinements

Table 1 summarizes the recommended model refinements based on CRWAS Tasks 4.1 through 4.3 and additional comments from the Draft Phase I Report review. Each refinement is assigned a category as defined above. No infeasible model refinements were identified.

Table 1
Recommended Model Refinements

Item*	Recommended Model Refinements	Basin
1	Incorporate more current irrigation / power demands for Redlands Canal	Gunnison
2	Revise Blaney-Criddle crop consumptive use estimates for acreage below 6,500 to apply a standard recommended elevation adjustment	All basins
3	Incorporate Elkhead Reservoir enlargement, including new area/capacity curves and operations	Yampa
4	Through discussions with the Division 6 Engineer, better understand the potential for a futile call from the lower Piceance basin to the upper Piceance basin and revise model to reflect	White
5	Add High Savery Reservoir (completed in 2005 on tributary to Little Snake River, Wyoming) to reflect the decrease in available supply on the Yampa	Yampa
6	Add finalized Black Canyon of the Gunnison Federal Instream flow right	Gunnison
7	Review the final report documenting recent lysimeter studies in the Upper Gunnison and document the results compared to the high-altitude coefficients currently used	All basins
8**	Review and revise representation of 15-mile reach recommended fish flows and San Juan Recovery Implementation Program recommended flows to represent Colorado's specific obligations	San Juan Colorado
9**	Update Gunnison Model with new Blue Mesa Reservoir operating curves and hydropower demands	Gunnison
Item*	**Desirable Model Refinements**	**Basin**
10	Review specific ditch information in Upper Gunnison basin to determine if modeled efficiencies lead to underestimated irrigation shortages.	Gunnison
11	Prepare for and meet with Dolores Project and MVIC operators to better understand and enhance representation of demands and operations	San Juan
12	Prepare for and meet with operators of the Grand Mesa projects (Overland, Fruitgrowers, Fruitland, Paonia) to better understand and enhance representation of demands and operations	Gunnison

13	Review and incorporate, if appropriate, suggestions provided by Denver Water's consultant regarding StateMod representation of the Grand Valley Project Operations	Colorado
14	Prepare for and meet with Ute Water Conservancy District staff and operators of the Collbran project and to better understand and enhance representation of demands and operations. Review and adopt suggestions provided by UWCD consultants.	Colorado
15	Revise the model using new StateMod accounting plan capabilities to better represent Silt Project operations	Colorado
16	Update ownership and operations for Yamcolo and Stagecoach reservoirs based on information from the Upper Yampa Water Conservancy District	Yampa
17	Review and update the flood forecasting rules used for Lemon Reservoir	San Juan
18	Review the integrated operations of Taylor Park Reservoir and Blue Mesa Reservoir and revise, if necessary, based on the Gunnison River System Official Accounting Sheet	Gunnison
19	Review the irrigated acreage assigned to lands in Leroux Creek to identify revisions that could enhance calibration	Gunnison
20	Revise maximum system efficiency values used in StateCU and StateMod from 60% to 54% (based on a maximum conveyance efficiency of 90% and a maximum application efficiency of 60%) for flood irrigated acreage and to 72% (based on a maximum conveyance efficiency of 90% and a maximum application efficiency of 80%) for sprinkler irrigated acreage.	All basins
21	Identify / add instream flows appropriated since models were last updated	All basins
22	Review and incorporate, if appropriate, suggestions provided by Colorado Spring's consultant regarding StateMod representation of the Con-Hoosier Project	Colorado
23	Contact transbasin diversion operators to obtain and incorporate recent estimates of "current use"	Colorado
24	Update the user documentation for each basin to include model revisions and enhancements	All basins
25**	Limit USBR reservoir uses to acreage-based allocations	San Juan
26**	Revise Denver Water Moffat system bypass requirements by year type	Colorado
27**	Include new area/capacity curves Steamboat Lake, and Fish Creek Reservoir	Yampa
28**	Investigate revisions to McElmo Creek natural flows	San Juan
Item	**Optional Model Refinements**	**Basin**

29	Revise model input data, including data not available through HydroBase, so each basin model represents a consistent study period through 2008	All basins
30	Incorporate administrative transit losses from reservoir releases	All basins
31	Incorporate variable outdoor municipal demands to reflect change in landscape needs based on climate information	All basins
32	Perform and document a sensitivity analysis of estimated parameters including crop-based demands, efficiencies, headgate demands, and baseflow gain distributions (one basin example)	White
33	Review return flow locations and timing and incorporate revisions	All basins
34	Initiate discussions with the Division 6 Engineer to identify locations of pumped diversions, obtain estimated records, and to the model	Yampa
35	Update the models to reflect the standard 7-digit water district identifier (WDID, previous standard was 6 digits)	All basins

* No order of priority
** Indicates recommendations from Draft Report review

Table 2 summarizes general categories for comments or questions that required additional clarification during the BRT meeting, and that should be clarified in more detail in future BRT meetings. Table 2 also indicates the approximate occurrence of individual comments or questions in that general category.

Table 2
General Comments and Question Categories

General Comment/Question Categories	Occurrence
Consumptive use	23
Model system representation	15
Non-consumptive use	15
Representation of current and future water demands	14
Irrigation efficiency and return flows	13
Phase II	12
Model calibration and accuracy	11
Model operations	7
Hydrology	6
Computation time step	6
Climate change uncertainty and probability	5

Communication (Outreach)	5
Tree ring analysis and forest change	4
Interstate Issues	3
Water rights and administration	3
Model sensitivity	3
Overlap and duplication between Yampa studies and CRWAS	2
Groundwater	1

Conclusion and Recommendations

Following are conclusions and recommendations for StateMod model refinements:

- Model refinements identified in Table 1 as “recommended” should be incorporated into the StateMod models as part of Task 5.1 (Model Refinements).
- Model refinements identified in Table 1 as “desirable” should be incorporated into the StateMod models as part of Task 5.1 (Model Refinements).
- Model refinements identified in Table 1 as “optional” should be considered for incorporation into the StateMod models during routine CDSS updates.
- Clarification of the general comments and questions outlined in Table 2 should be incorporated as appropriate in future BRT presentations.

The model refinements made are documented in detail in the *Baseline Data Set* section of each of the basins **Water Resources Planning Model User’s Manuals**, available on the CDSS website (http://cdss.state.co.us) along with the model input files. Section 1.2 of each basin model summarizes the specific model enhancements made as part of the CRWAS study.