Statement of Work

WATER ACTIVITY NAME – The use of excess storage capacity in Blue Mesa Reservoir to avoid or reduce the impact of a Colorado River Compact curtailment in Colorado.

GRANT RECIPIENT –Southeastern Colorado Water Conservancy District (Fiscal) & Co-managed by the Upper Gunnison River Water Conservancy District

FUNDING SOURCE - Statewide Account (80%), Arkansas Basin Account (10%), Gunnison Basin Account (10%).

INTRODUCTION AND BACKGROUND

This project provides an evaluation of the potential use of excess capacity in Blue Mesa Reservoir, under different hydrological scenarios, to avoid, reduce or forestall a Colorado River Compact curtailment in Colorado. The use of Blue Mesa Reservoir for this purpose has been identified by several roundtables as having significant potential for reducing the threat of curtailment of Colorado River diversions in Colorado, and this project will provide important technical information and an analysis of that concept. It is prudent for the Basin Roundtables, in cooperation with the State, to examine whether excess capacity in Blue Mesa Reservoir can be part of the State water planning efforts to reduce risk associated with existing water uses in Colorado.

One risk management option currently being explored by the Colorado Water Conservation Board (CWCB) and other interested stakeholders is water banking. A Water Bank Group has been formed and that group is evaluating how a water bank might work in Colorado. The Water Bank Group consists of representatives of the Colorado River Water Conservation District, the Southwestern Water Conservation District, the Nature Conservancy, the Front Range Water Council and the CWCB.

Water banking concepts raise interesting and very difficult legal and political issues in the Colorado River Basin. While Lower Basin water banking arrangements exist for storing unused allocations in groundwater basins and in Lake Mead, no explicit banking arrangements currently exist in the Upper Basin. Such banking arrangements could be beneficial to the State of Colorado, but there are significant legal, policy, and political issues that would have to be overcome. Nevertheless, it is important for the State of Colorado to develop the best information about how the Aspinall Unit could be used to reduce curtailment risk in order to make informed decisions about whether water banking concepts ought to be considered as part of an overall Compact Curtailment mitigation strategy.

This project will support the work of the Water Bank Group and the work of the CWCB related to the Compact Compliance Study and will be coordinated with the Basin Study currently being performed by Reclamation. Because of the potential for overlap among these projects, this work will be performed in close consultation with the CWCB, Reclamation staff and Blue Mesa Subcommittee (Subcommittee). The Subcommittee is a joint subcommittee with representatives

from the Arkansas Basin Roundtable and the Gunnison Basin Roundtable. The project will be coordinated with the work performed for the three studies listed above, as appropriate.

In order to appropriately examine the Colorado River system, this study must make certain assumptions about a number of factors, including demand growth, hydrology, Upper Basin states' approach to a potential curtailment, Lower Basin states' response to shortages and related curtailment and the ultimate Federal response. The assumptions used for analyzing the effectiveness of Blue Mesa Reservoir excess storage capacity will also be developed in close consultation with the CWCB Staff, the Subcommittee and Reclamation, as appropriate.

A significant asset of the Upper Colorado River Basin is the storage capacity of the major reservoirs of the Colorado River Storage Project (CRSP), including Blue Mesa Reservoir of the Wayne N. Aspinall Unit. The three reservoirs of the Aspinall Unit were constructed between 1963 and 1977. The storage reservoir of the Aspinall Unit is Blue Mesa Reservoir, the largest reservoir that exists completely within the State of Colorado. The total storage capacities of the Aspinall Unit reservoirs are shown in the table below.

Total Storage Capacities

Reservoir	Total Storage Capacity
Curecanti (now named Aspinall)	
• Blue Mesa	940,000 AF
• Morrow Point	117,200 AF
• Crystal	25,200 AF

OBJECTIVES

The objectives of this project are to assess the effectiveness of using excess capacity storage in Blue Mesa Reservoir to avoid, forestall and/or mitigate the magnitude and duration of potential Colorado River Compact curtailment in Colorado. A principle objective is to evaluate the use of Blue Mesa Reservoir as a potential storage location for a Colorado water bank. The analysis may also consider and use the potential output of the Water Banking Study to be conducted by the Water Bank Group as input (to the extent that information is available from this work) reflecting the likely available supplies (e.g., pre-compact consumptive use credits) which might be deposited in a water bank. The project will contribute to better understanding of circumstances surrounding a potential curtailment of Colorado River diversions in Colorado and the effectiveness of utilizing excess storage capacity in Blue Mesa Reservoir as a water bank. The project will provide a draft report that will include conclusions and recommendations based upon the findings.

The draft report will include potential water banking operations and guidelines in Blue Mesa Reservoir. The intent of this study is to create a feasible operational framework for a water bank that could be the basis for an excess storage capacity contract at Blue Mesa Reservoir.

TASKS
It is anticipated that this work will be conducted in close coordination with the CWCB Staff, the Water Bank Group, and the sponsoring Roundtables. The consultant will coordinate with the Subcommittee. Following are the tasks that would be completed under this proposal:

TASK 1 – Scenario Development – (Not to exceed $20,000)
Description of Task
The purpose of this task is to develop the assumptions and scenarios that would be incorporated into a hydrologic model to explore how the Aspinall Unit could respond to different hydrologic conditions in a compact curtailment situation. These assumptions will be based on historic flow and reservoir content data. The task will use specific assumptions regarding curtailment relative to the quantity, duration and frequency as advised and provided by the Water Bank Group, the CWCB Staff and invited Reclamation technical staff.

Method/Procedure
The consultant will review and identify several scenarios using historical hydrologic conditions representing periods with the wettest, driest (e.g., 2000-2010 drought), average, or other combinations and couple them with beginning Aspinall Unit reservoir contents derived from the record (e.g., full system, 50 percent capacity, lowest historic capacity, etc.). Paleo-hydrology records will also be investigated to determine applicability for this study. These scenarios will be developed in close consultation with CWCB and USBR staff and the Subcommittee.

Deliverable
Deliverables for the task will include:

- A Technical Memorandum summarizing the assumptions used and the scenarios developed to be used to evaluate water banking management options in subsequent tasks.

TASK 2 – Model Tool Evaluation – (Not to exceed $20,000)
Description of Task
The purpose of this task is to evaluate existing and potential hydrologic models in order to identify the most appropriate model to evaluate how the Aspinall Unit could respond to different hydrologic conditions in advance of, and in response to, compact curtailment situation. The task will include coordination with the State (StateMod) and Bureau of Reclamation (RiverWare) modelers to review the strengths and limitations of each model, in consultation with the Subcommittee

Method/Procedure
The consultant will review available and applicable models to identify the preferred modeling tool to evaluate how the Aspinall Unit could be used to as part of water banking management option. The consultant will work with the modelers from the State and Bureau of Reclamation to identify the strengths and limitations of existing hydrologic models, as well as to evaluate the use of new modeling tools such as STELLA or Microsoft Excel in consultation with the Subcommittee.

STELLA is an intuitive object-oriented program allowing models to be built as simple or complex as necessary. STELLA can be configured to use a dashboard interface to change model

parameters quickly allowing the ability to perform "what if" scenarios in real-time. Figures and tables of model input and output are generated as the model runs.

An additional option is to develop a model using Microsoft Excel. The familiar Microsoft Excel environment enables developers and users alike to easily add output displays and reports, adjust model parameters and relationships, and readily use output in other spreadsheet programs. This could make the optimization model a very flexible and easy-to-use tool.

Deliverable

Deliverables for the task will include:

- A Technical Memorandum summarizing the available hydrologic models with a recommendation of the model to be used to evaluate management options in subsequent tasks. Selection of the model will be made by the Subcommittee.

TASK 3 – Hydrologic Simulations — (Not to exceed $90,000)

Description of Task

The purpose of this task is to evaluate each scenario (up to ten) to determine the response of the Aspinall Unit, and the potential for use of excess capacity in Blue Mesa Reservoir, to offset or mitigate the curtailment amounts and durations scenarios developed in Task 1. This will be done using the modeling tool selected in Task 2. In this task the scenarios will use existing demands and allow for outreach, coordination and refinement.

The outreach, coordination and refinement component listed above shall include the following requirement. An initial scenario evaluation shall be presented for review by representatives from the CWCB and roundtables. The review will assess the appropriateness of the modeling methods, inputs, assumptions and anticipated end product. Suggested refinements will be a product of this review. The review shall be completed within 15 business days of receipt of the scenario and modeling tool evaluation. Approval of this initial scenario evaluation by the CWCB and the Subcommittee must take place prior to continuation of the project.

Method/Procedure

The consultant will use or develop a high-level operational model of the Aspinall Unit reservoirs using the model selected in Task 2. The selected model will be used to simulate the scenarios identified in Task 1. The model will be developed using operational parameters and constraints based on Aspinall Unit new operations (e.g., EIS guidelines, BCNP decree).

Risk Assessment Using the Optimization Model: The consultant will work with the Arkansas and Gunnison Basin Roundtables and the CWCB staff to prioritize which aspects of system performance should be monitored, evaluated and assessed in a risk analysis and optimization framework.

Risk Indicators: Identifying risk indicators, using companion models/knowledge will be part of the optimization model output. The user will be notified when any of a number of risk indicators, such as a minimum or maximum level in a surface water reservoir (i.e., Blue Mesa) is reached. This will help define important threshold values to determine how water banking strategies might be implemented.

Stochastic Input: Develop an algorithm (or set of user instructions) to repeat the optimization process multiple times with systematically or randomly changing input. The benefit of this approach is that output is viewed as a distribution of objective values based on broad input ranges. This will help define frequency of when important threshold are reached to determine how water banking strategies might be best implemented. The use of paleo-conditioned approach to stochastic input (Prairie et al.; USBR) shall be considered.

Sequential Optimization – Simulation: The model could be programmed so that it optimizes one or two years, then simulates the following one or two years under various hydrologic conditions to evaluate potential future impacts of the optimized schedule. This approach addresses the difficulty of accurately predicting climate two or three years into the future. This will help define auto-correlation characteristics. Similar work has been initiated by the USBR as part of the Aspinall EIS and shall be considered.

Translate Input Probability to Output Probability: Correlating the probability of hydrologic input with probability of various types of output. A model that relates potential hydrologic water availability with outputs such as unmet demands, shortages and/or total consumptive use credits to be needed for an optimal-sized water bank is a desired outcome of this task.

Deliverable

Deliverables for the task will include:

- The consultant will prepare modeling output for each scenario and present results to the Arkansas and Gunnison Basin Roundtables, and the CWCB staff, and other interested parties as part of the outreach and coordination process; and,
- Model output and results will be summarized in a draft report format delivered to the Subcommittee and CWCB staff. This will include tabular results that identify important threshold values, event frequencies (recurrence intervals) and optimal water bank size.

TASK 4 – Scenario Sensitivity Analysis – (Not to exceed $32,500)

Description of Task

The purpose of this task is to use the scenarios developed in Task 1 and the modeling in Task 3 to evaluate the sensitivity of how the Aspinall Unit simulation model responds to different hydrologic conditions and under different operational scenarios.

Method/Procedure

The procedure for evaluating the sensitivity of different demands on Colorado River supplies will be similar to the process used in Task 3. Specific model inputs will be modified to assess and quantify how the model behaves under different hydrological inputs (water availability, consumptive and non-consumptive demands under different Colorado River supply scenarios, and under different associated Aspinall Unit operations).

The option to modify model inputs to evaluate the effects of different demands is at the discretion of the Arkansas and Gunnison Basin Roundtables.

Deliverable

Deliverables for the task will include:

- The consultant will prepare modeling output for each scenario and a report of model sensitivity to significant input parameters and will present these results to the Arkansas and Gunnison Basin Roundtables, the CWCB staff, and other interested parties as part of the outreach, coordination and collaboration process

TASK 5 – Evaluate Management Options Focused on Aspinall Unit Reservoir Banking – (Not to exceed $57,500)

Description of Task

The purpose of this task is to define potential water banking management options for each scenario with careful attention to avoiding injury to existing water rights and authorized purposes of the Aspinall Unit. Water banking management options will include the different types of water bank (top water bank, bottom water bank), contract options with Reclamation for vacant space at Blue Mesa, operational releases from the water bank with differing timing and volumes to meet downstream obligations while maximizing benefits to other Blue Mesa uses, and compact curtailment mitigation scenarios (i.e., quantity, frequency and duration) as provided in Task 1.

In this task the selection and evaluation of management options will allow for outreach, coordination and refinement. This outreach, coordination and refinement component shall include the following requirement. Management options shall be presented for review by representatives from the CWCB and the Subcommittee. The review will assess the appropriateness of the modeling methods, inputs, assumptions and anticipated end product for this task. Suggested refinements will be a product of this review. The review shall be completed within 15 business days of receipt of the management option evaluation plan. Approval of this task evaluation by the CWCB and the Subcommittee must take place prior to continuation of the project.

Management options focused on Blue Mesa Reservoir banking will be evaluated using the model developed in Task 3 to identify viable management alternatives that might limit the magnitude and duration of a potential compact curtailment of Colorado River diversions in Colorado. The amount of water available for proposed water banking of pre-compact and post-compact water rights (as determined by the water bank study being conducted by the Water Bank Group and/or from the CWCB Staff through their work on the Compact Compliance Study) will be integrated into the management options.

Method/Procedure

The model developed and utilized will include a "banking" function to implement and evaluate banking concepts. The model inputs and parameters will be modified to simulate a water bank in Blue Mesa Reservoir. The consultant will coordinate with the Water Banking Study to determine complimentary but not overlapping "banking" concepts. The model with "banking" function will be used to simulate the Aspinall Unit operations to determine the reductions that might be possible to the magnitude and duration of compact curtailments under each of the selected scenarios.

Deliverable

Deliverables for the task will include:

- The consultant will prepare modeling output for each scenario and present results to the Arkansas and Gunnison Basin Roundtables, the CWCB staff, and other interested parties as part of the outreach process;
- Model output and results will be summarized in a draft report format delivered to the Arkansas and Gunnison Basin Roundtables and CWCB staff;
- Model output and results will be summarized and analyzed in a draft report format delivered to the Arkansas and Gunnison Basin Roundtables and CWCB staff. This report will include a set of proposed water bank operations. The desired outcome of this task is a defensible basis (including a description of parameters) for a proposed contract request to Reclamation for excess storage capacity to implement a water bank;
- The developed simulation model, including the applicable code, logic and data (including both relevant input and output data) will be archived and made available via appropriate mass storage products (e.g., CD, DVD and/or portable hard drive).

TASK 6 – Reporting – (not to exceed $25,000)

Description of Task

The purpose of this task is to develop a report describing the modeling and results performed in Tasks 3 though 5. The report will summarize study findings and provide conclusions and recommendations.

Method/Procedure

The consultant will develop draft and final reports. The draft report will be provided to the Arkansas and Gunnison Basin Roundtables and CWCB staff to review. Upon formal review and comment, input received will be incorporated in the final report.

Deliverable

Deliverables for the task will include:

- A draft and final report summarizing the management options using Blue Mesa Reservoir to avoid or mitigate a curtailment of Colorado River diversions in Colorado which will include: description of the model, results, conclusions and recommendations
- Meeting summaries documenting action items from coordination meetings
- Presentation for use at Basin Roundtable Meetings

REPORTING AND FINAL DELIVERABLE

Reporting: The consultant will coordinate with the Subcommittee via monthly progress reports. In addition, the consultant shall provide the Arkansas and Gunnison Basin Roundtables and the CWCB staff a summary progress report every 6 months, beginning from the date of the executed contract. The progress report shall describe the completion status of the tasks identified in the statement of work including a description of any major issues that have occurred and any potential corrective actions taken to address such issues.

Final Deliverable: At completion of the project, the consultant shall provide the Arkansas and Gunnison Basin Roundtables and the CWCB staff a final draft report that summarizes the project

and documents how the project was completed. This report may contain photographs, figures, charts, tables and summaries of meetings and engineering reports/designs. In addition, the archived model, data and results will be provided.

PERSONNEL

The following staff will be available to work on this project: Susan Morea, Rick Gold, Hal Simpson, Nicole Rowan, Seth Turner, Mark McCluskey, Rick Parsons, Kirk Westphal, Tim Cox, Mark Hoener. Brief staff bios for each available staff member follow.

Susan Morea: With more than 25 years of water supply planning and water quality experience, Sue Morea has been involved in the analysis and planning of a broad range of projects for federal, state, municipal, and private sectors. As CDM's Project Director for Phases 1 and 2 of the Statewide Water Supply Initiative, she is responsible for helping guide the technical roundtables of state water, agriculture, and environmental interests toward developing solutions for meeting Colorado's water supply needs. Her ongoing work on the Interbasin Compact Roundtable Technical Support project for the Colorado Department of Natural Resources involves completing consumptive and nonconsumptive needs assessments. Sue is also leading several integrated water resources planning projects in the West and recently directed SWSI 2010—an update of the Statewide Water Supply Initiative that extends the planning horizon to 2050.

Rick Gold: Rick Gold has 41 years experience in the area of civil and environmental engineering. His extensive career includes 3 years as a Senior Consultant to CDM with a principle focus of Colorado River issues, and 38 years with the United States Bureau of Reclamation. He was the projects manager for Reclamation Office in Durango, Colorado, and the regional planning officer in Utah for the Upper Colorado Region. He became the Deputy Regional Director prior to serving as the 10th Regional Director of the Upper Colorado Region in Salt Lake City, Utah, from 2000 until his retirement in 2007. Rick was involved in the support of all the Reclamation Projects within the Upper Colorado River Basin and on all the critical issues dealing with water rights, interstate compacts, land acquisition, litigation, project planning, NEPA and ESA compliance, hydro power development, water conservation projects, title transfer, and water contracts. Since joining CDM in 2008 he has maintained his Colorado River focus and works on developing strategies and perspectives for several clients within the Colorado River Basin. Most recently he was the principle author of a White Paper on the Colorado River Storage Project prepared for the Front Range Water Council.

Hal Simpson: A Senior Consultant for CDM and a past Colorado Division of Water Resources State Engineer, Hal Simpson is an expert on issues related to the water basins in Colorado. While at CDM, Hal has worked on a variety of water supply studies and basin wide investigations in the South Platte, Arkansas, Rio Grande, Gunnison, North Platte and Yampa/White River basins. During his tenure as State Engineer, he was responsible for the direction and management of the Division of Water Resources. His responsibilities included the distribution and administration of water in accordance with statutes and interstate compacts; the implementation of a statewide dam safety program; the permitting of the use of groundwater and construction of wells; the collection and dissemination of data on water use and streamflow; and conducting various studies concerning water resources and the availability of water supplies.

Nicole Rowan: Nicole Rowan has 15 years experience, specializing in water supply and water quality planning projects. She is a senior project manager and leads projects focusing on water supply, watershed and water quality management, and natural resources projects. Currently, Nicole is the project manager for Colorado's Division of Natural Resources and Colorado Water Conservation Board's Interbasin Compact Roundtable process. She is responsible for leading efforts to develop strategies for Colorado's water supply future and is providing technical support to nine basin roundtables throughout the state in completing their consumptive needs assessments, nonconsumptive needs assessments, water supply availability analysis and identification of projects and methods to address water needs. Additionally, she was the Project Manager for Colorado's Statewide Water Supply Initiative Phases 1 and 2 and SWSI 2010 where she oversaw all of the aspects of the projects.

Seth Turner: Seth Turner specializes in water supply planning studies and other projects involving hydrologic modeling and water. Seth is proficient in using the MODSIM model and the STELLA decision support tool. He is providing technical assistance for a number of updates to the Statewide Water Supply Initiative. Seth is also providing technical support for the investigation of alternative agricultural water transfer methods and for the development of a statewide water supply portfolio evaluation tool. In addition, Seth provided technical support for the evaluation of bedrock aquifer sustainability in the mountainous regions of four counties near Denver, on the Upper Mountain Counties Water Needs Assessment project.

Mark McCluskey: Mark McCluskey is a water resources engineer with 12 years experience and expertise in hydrologic and groundwater modeling. He has worked on several Colorado water supply and water rights investigations, including the development of basin water supply and demand projections. He is also an expert in the following Colorado Decision Support System (DSS) modeling tools: StateCU, StateMOD, StatePP and the South Platte DSS Alluvial Groundwater Model. Recently, Mark developed basin water supply and demand projections basins to support the State of Colorado Inter Basin Compacts (HB 1400) Water Needs Assessment. He worked with the Basin Roundtables to revise and update their water supply and demand projection through 2050, and served as a project engineer on the SB06-193 Aquifer Recharge Study for the State of Colorado. Mark investigated the potential for underground water storage area in the South Platte and Arkansas River Basins in Colorado and was responsible for characterizing each of the potential sites based upon hydrogeologic, environmental and implementation criteria.

Rick Parsons: Rick Parsons, of *Parsons Water*, has been intimately involved with Colorado's Decision Support Systems (CDSS) for a variety of projects. He will lead our surface water hydrology effort, applying extensive knowledge of the basis and application of the CDSS tools and data for decision-making.

Kirk Westphal: Mr. Westphal has managed and directed projects involving water supply planning and management and river basin planning. He has developed and employed numerous computer models for clients with interconnected reservoir systems. The models have been developed to evaluate yield, reliability, drought resistance, operational plans, regionalized supply, capital improvements, and instream flow regulations.

Tim Cox: Specializing in water resources engineering and water quality and quantity modeling, Dr. Cox has extensive experience in the development and maintenance of surface water quality and quantity computer models, as well as the application of many published models. Dr. Cox also has significant experience in stream ecology and ecosystem modeling, water quality and ecology field and laboratory research, and engineering software development. Prior to joining CDM, Dr. Cox served as a water resources research assistant at the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) in Boulder, Colorado. His primary responsibility at CADSWES was maintaining and developing water resource engineering algorithms and code for *RiverWare*, a large-scale hydrologic decision support software package. Dr. Cox was instrumental in redesigning and upgrading the reach routing options in this model, as well as implementing new reach routing and reservoir sedimentation algorithms. He also provided user support and training to RiverWare users, including Tennessee Valley Authority and Bureau of Reclamation staff.

Mark Hoener: Mr. Hoener offers experience in statewide water supply planning and hydrologic modeling. He is currently assisting the Yampa Basin in performing its project and methods analysis utilizing CRDSS. He has assisted in the water planning gap analysis for the Oklahoma Comprehensive Water Plan and has experience conducting consumptive use and irrigation modeling.

SCHEDULE AND BUDGET

Although there is no formal performance schedule by task included, it is anticipated that the project will not exceed two years in length. The project timeline and budget will be actively managed by the CWCB, roundtable participants and fiscal agent. Progress will be closely tracked via task memos, progress reports and submitted comments.

Total Cost: $245,000
Statewide Account: $196,000
Arkansas Basin Account $24,500
Gunnison Basin Account: $24,500

Aspinall Study Budget and Schedule
Updated: 3/14/2012

BUDGET

Tasks	Labor	Other Direct Costs	Total Project Costs
Task 1 - Scenario Development[1]	$ 19,340.00	$ 660.00	$ 20,000.00
Task 2 - Model Tool Evaluation[1]	$ 19,930.00	$ 70.00	$ 20,000.00
Task 3 - Hydrologic Simulaitons[2]	$ 89,900.00	$ 100.00	$ 90,000.00
Task 4 - Scenario Sensivity Analysis[2]	$ 31,345.00	$ 1,155.00	$ 32,500.00
Task 5 - Evaluate Management Options[1]	$ 55,800.00	$ 1,700.00	$ 57,500.00
Task 6 - Reporting[1]	$ 22,600.00	$ 2,400.00	$ 25,000.00
Total	$ 238,915.00	$ 6,085.00	$ 245,000.00

[1]Tasks granted to Southeastern Water Conservancy District

[2]Tasks grated to Upper Gunnison Water Conservancy District

SCHEDULE

Tasks	Start Date	End Date
Task 1 - Scenario Development	Upon NTP	NTP + 60 Days
Task 2 - Model Tool Evaluation	NTP + 60 Days	NTP + 150 Days
Task 3 - Hydrologic Simulaitons	NTP + 150 Days	NTP + 240 Days
Task 4 - Scenario Sensivity Analysis	NTP + 240 Days	NTP + 300 Days
Task 5 - Evaluate Management Options	NTP + 300 Days	NTP + 410 Days
Task 6 - Reporting	Upon NTP	NTP + 410 Days
NTP = Notice to Proceed		