COLORADO WATER CONSERVATION BOARD

ALERNATIVE AGRICULTURAL WATER TRANSFER METHODS COMPETITIVE GRANT PROGRAM

GRANT APPLICATION FORM

Colorado Water Bank: Agricultural Field Studies and Estimates of Saved Consumptive Use

Program/Project Name

River Basin Names:
Colorado
Gunnison
Southwest

$180,000

Amount of Funds Requested

$120,000 in cash, plus extensive in kind

Amount of Matching Funds

Instructions: This application form must be submitted in electronic format (Microsoft Word or Original PDF). The application can be emailed or a disc can be mailed to the address at the end of the application form. The Alternative Agricultural Water Transfer Methods Competitive Grant Program, Criteria and Guidelines can be found at http://cwcb.state.co.us/LoansGrants/alternative-agricultural-water-transfer-methods-grants/Pages/main.aspx. **The criteria and guidelines must be reviewed and followed when completing this application**. You may attach additional sheets as necessary to fully answer any question, or to provide additional information that you feel would be helpful in evaluating this application. Include with your application a cover letter summarizing your request for a grant. If you have difficulty with any part of the application, contact Craig Godbout of the Water Supply Planning Section (Colorado Water Conservation Board) for assistance, at (303) 866-3441 x3210 or email at craig.godbout@state.co.us.

Generally, the applicant is also the prospective owner and sponsor of the proposed program/project. If this is not the case, contact Craig before completing this application.

Alternative Agricultural Water Transfer Methods – Grant Application Form
October 2010

Part A. - Description of the Applicant (Project Sponsor or Owner);

1. Applicant Name(s): Colorado Water Institute

Mailing address: Colorado Water Institute
1033 Campus Delivery
Fort Collins, CO 80523-1033

Taxpayer ID#: 846000545

Primary Contact: Nancy Grice Position/Title: Assistant to Director

Email: Nancy.Grice@ColoState.EDU

Phone Numbers: Cell: Office: (970) 491-6724

Alternate Contact: Perry E. Cabot Position/Title: Research Scientist

Email: perry.cabot@colostate.edu

Phone Numbers: Cell: (719) 334-2558 Office: (970) 434-3264

2. Person to contact regarding this application if different from above:

Name:

Position/Title

3. If the Contracting Entity is different than the Applicant, please describe the Contracting Entity here.

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4. Provide a brief description of your organization. The applicant may be a public or private entity. Given the diverse range of potential applicants, not all of the following information may be relevant. Where applicable and relevant the description should include the following:

a) Type of organization, official name, the year formed, and the statutes under which the entity was formed, a contact person and that person's position or title, address and phone number. For private entities, a copy of the Articles of Incorporation and By-laws should be appended to the application.

b) For waters suppliers, information regarding the number of customers, taps, service area, and current water usage, and future growth plans, water related facilities owned or used, funding/revenue sources (existing service charges, tap fees, share assessments, etc.), the number of members or shareholders and shares of stock outstanding or a description of other means of ownership.

c) For other entities, background, organizational size, staffing and budget, and funding related to water that is relevant in determining whether the applicant has the ability to accomplish the program/project for which funding is sought.

d) A brief history of the Applicant(s).

The Colorado Water Institute (CWI), an affiliate of Colorado State University, will also participate on this project and receive project funding. The CWI is involved for the express purpose of focusing the water expertise of higher education on the evolving water concerns and problems being faced by Colorado citizens. CWI is authorized and funded by Congress and the Colorado Legislature and is accountable to Congress via its annual appropriation, a required annual report, and a thorough congressionally mandated peer review conducted every five years under the auspices of the U.S. Geological Survey. CWI is operated, by law, as a state-wide water research institute, obligated to connect all water expertise in Colorado's higher education system with research and education needs of Colorado's water managers and users

e) Please include any relevant Tabor issues relating to the funding request that may affect the Contracting Entity.

No TABOR issues are envisioned.

Part B. - Description of the Alternative Water Transfer Program/Project –

1. ***Purpose of the Program/Project***

   Please provide a summary of the proposed program/project, including a statement of what the program/project is intended to accomplish, the need for the program/project, the problems and opportunities to be addressed, the expectations of the applicant(s), and why the program/project is important to the applicant(s). The summary must include a description of the technical, institutional (i.e., how the program/project will be organized and operated), and legal elements that will and/or have been addressed by the applicant and proposed program/project. The summary should also discuss relevant project history, if applicable, and any other relevant issues.

Project History:

The recent declines in storage levels of Lake Powell and Lake Mead reflect that water supplies may be insufficient to meet water demands within the Colorado River Basin during extended periods of drought. Without a plan in place to address water shortages, there is growing concern that continued drought would negatively impact Colorado's agricultural communities, municipal and industrial water users, recreational and environmental uses, and our State's economy. To address these concerns, the Water Bank Workgroup has been evaluating several water bank concepts as a strategy to increase predictability and certainty for users of Colorado River water given unpredictable future hydrology and precipitation.

In 2011, the Water Bank Workgroup began a three phase study to determine the basic viability of a water bank to address potential future Colorado River Compact shortages within the state of Colorado. Since that time, the water bank has also been considered as a potential tool to address Lake Powell storage issues as well. The water bank would work with agricultural and other water users to implement voluntary and compensated, interruptible supply agreements, to make water available on a temporary basis to address either Lake Powell or Colorado River Compact issues.

The Workgroup has completed Phase I and Phase II of the feasibility study, which investigated questions related to potential water supply and demand, as well as water bank operations at the ditch company or water user association level. With funding from the ATM program, we are currently performing a more in-depth analysis of potential water bank operations in three different irrigation systems on the West Slope.

Need for Project:

As the Water Bank Workgroup (WBWG) continues to refine the operational aspects of a water bank program for Colorado, additional technical knowledge is required to develop approaches to reduce or curtail irrigation without adversely affecting long-term agronomic sustainability. To ensure success from the perspective of agricultural water users, irrigation reductions must be structured and scheduled such that fields can be returned to full and healthy production after the period of reduced irrigation is over. In the context of the water bank, the amount of saved water accruing from irrigation reductions on individual fields must correlate with the aggregate goals of the larger program. The practice of partial-season irrigation (also referred to as "split-season" irrigation) is one operation that could be employed to accomplish these mutual aims.

Project Summary:

Partial-season irrigation of perennial hay crops such as alfalfa and grass, which are predominant on the Western Slope of Colorado, provides an opportunity to save water while maintaining the long-term viability of crop production. There are approximately 90,000 and 620,000 acres of alfalfa and grass-pasture, respectively, on the

Western Slope (Colorado Water Divisions 4-7). Under a partial-irrigation regime, water delivery would be reduced or completely ended on hay or alfalfa fields, after a "partial season" or at a time before a typical irrigation season would finish. Study sites located throughout the Western Slope will help us understand the impact of these irrigation practices under a range of growing circumstances and variables.

The proposed project for this ATM grant has two identified purposes. One purpose is to **expand current agronomic feasibility assessments of partial and full season reductions to irrigated hay as part of a Colorado Water Bank.** By expanding the current study on alfalfa and grass hayfields, the project will help agricultural producers and the Water Bank Workgroup understand opportunities to save water through reduced irrigation, without adversely affecting long-term agronomic sustainability. The other purpose is to **measure the irrigation water management (IWM) on project fields to calculate the amount of applied water (e.g., irrigations) and saved consumptive use (CU), for comparison with similar fields across their respective regions.**

Objectives:

1. Understand the recovery period associated with bringing grass pastures and alfalfa fields back into production, after multiple (1, 2 and 3) years of reduced irrigation.
2. Determine the impacts to forage yield and quality on alfalfa and grass hayfields, after multiple years of reduced irrigation.
3. Derive estimates of saved applied water (e.g., irrigations) and saved CU that may be credited to alfalfa and grass hayfields where split-season irrigation is practiced under structured guidelines.

Timeline:

The project will begin in January 2015, in preparation for the irrigation season later that year. It is expected that a Masters-level graduate student will begin working on the project in the Spring semester of 2015 at Colorado State University, in the Department of Soil and Crop Sciences. In Year 1 (2015), the research sites will be established and instrumented. During Year 1, partial-season irrigation (alfalfa fields) or non-irrigation (grass pasture) will commence. A reference field on which for irrigation is practiced will also be established and instrumented. In subsequent years 2016, 2017 and 2018, the treatment fields will be progressively returned to full irrigation, matching the irrigation regime of the reference field. Due to the schedule of the CSU degree program, it is expected that the project will continue into 2019, to allow the student a realistic timeframe to finish their degree, but the costs in the final year (2019) will be minimal.

Please note that this proposal only addresses the first two years of the project and we anticipate seeking additional ATM grant funding for the remainder of the study.

Previous Studies

To the maximum extent possible, the results of any previous studies and investigation should be utilized and incorporated into the proposed program/project. The application for funding should include a brief summary of the results of previous studies and how they will be utilized.

This study is a continuation of the Phase 1 and Phase 2 studies, funded by a 2011 and a 2013 Alternative to Agricultural Transfers Grant, and focuses on the gaps in knowledge and understanding identified in the earlier studies. Also, in late 2009, a report was completed by Tom Iseman, then at The Nature Conservancy, in conjunction with the Property Environment Research Center and WestWater Research (Iseman Report) on behalf of a Coalition which made an initial examination of issues surrounding a compact water bank.

4. Study Area/Service Area Description

The study area/service area is generally the geographic area that is the subject of the proposed program/project (include both the source of supply and location and type of new use). The description should include the following items:

a) A narrative description of the study area/service area including: the county, the location of towns or cities, topography, and locations of major surface and ground water features.

The study area includes six agricultural properties on Colorado's West Slope outlined in Table 1 below.

Table 1: Proposed Study Areas

County Location	Delta	Gunnison	Mesa	Mesa	Montezuma	Montrose
Crop Type	alfalfa	grass hay/pasture	Alfalfa	grass hay/pasture	alfalfa	alfalfa
Irrigation Water Source	Surface Creek	Little Cimarron River	Colorado River	Colorado River	Dolores River?	Gunnison & Uncompahgre Rivers
Acres	30	40	80	30	30	80

b) An area map showing each of the items above, as well as the locations of existing facilities, proposed project facilities and boundaries of lands involved in the proposed program/project.

See attached map in Appendix A.

c) Information regarding the irrigated lands that are involved in the program/project. This must include a tabulation of total irrigated acreage, description of cropping types, crop yields, and total average annual water diversions for existing agricultural lands.

Detailed information on crop yields and annual water diversions will be developed as site selection is finalized.

d) Information regarding the location of the new water use(s) that will be served by transferred water including the estimated number of users/taps and/or uses served.

While this study aims to derive estimates of the amount of saved water that could be available to a water bank, we will not transfer any water to another use as a part of this study.

e) Socio-economic characteristics of the area such as population, employment and land use.

The study sites cover the entire West Slope of Colorado and the water bank project itself is a statewide effort. Because of this, a meaningful and brief description of the socioeconomics of such a vast area is not possible in this application.

5. Description of the Alternative Water Transfer Method

Please describe the type(s) of water transfers that will be examined/utilized (i.e., conceived transfer methods

include, but are not limited to: 1) interruptible water supply agreements; 2) long-term agricultural land fallowing; 3) water banks; 4) reduced consumptive use through efficiency or cropping changes while maintaining historic return flows; and 5) purchase by end users with leaseback under defined conditions). In addition, please describe how the transferable consumptive use will be calculated and quantified, and how return flow patterns will be addressed/maintained.

The field studies proposed for this grant will support the evaluation of the water bank concept, which would work with agricultural and other water users to implement voluntary, compensated, interruptible supply agreements, to make water available on a temporary basis to address either Lake Powell or Colorado River Compact issues. More specifically, this phase of the water bank feasibility study will examine how reduced consumptive use can be quantified. However, there will be no actual transfer of water under this project. The Water Bank Work Group is currently completing separate but related work under another ATM grant to evaluate water bank operations within three different irrigation systems that includes delivery of saved consumptive use and methods for meeting return flow obligations.

6. Program/Project Eligibility

Please describe how the proposed program/project meets each of the following eligibility requirements (please see Criteria and Guidelines for additional information regarding the alternative water transfer methods/strategies that qualify for funding). Note: If these requirements are addressed in other parts of the application you may simply reference the applicable section(s).

a) A description of how, if implemented, the proposed program/project will protect property and water rights.

A water bank would provide a market-based approach to temporarily reduce water use in order to address the risks associated with continuing water supply reductions and low water storage levels in Lake Powell. These risks could include loss of regionally important hydropower, a reduction in revenues from the sale of that power, potential federal action to ensure Lake Powell does not fall below critical levels, and increased risk associated with the Colorado River Compact. The primary purpose of the water bank is to reduce these risks and provide greater certainty to water users in Colorado. Without a water bank or similar mechanism in place, there could be a significant negative impact associated with the permanent transfer of agricultural water rights. The implementation of a water bank would allow water managers to shift water use on a temporary basis, thereby helping preserve and protect agricultural water rights and the communities and economies that rely on those rights.

The State of Colorado currently has a statute which authorizes the State Engineer's Office to promulgate the necessary rules for operation of a water bank. The statute includes language that protects water rights owners who participate in a water bank, and this would likely be reinforced with basin specific rules.

For this project, participating water right owners will be protected because they are part of a larger system that will continue to divert its full right, are continuing to irrigate a portion of their historically irrigated land, and are only engaging in a temporary reduction in their water use.

b) Identified group(s) of agricultural users that are or may be willing to transfer a portion of their water and identified entity(s), group(s) or area(s) where the transferred water could or would be put to the new use and a description of the new use.

In Phase II of the Water Bank Feasibility Study, the project team met with the water users and water managers in the Grand Valley Water Users Association, Orchard Mesa Irrigation District, Montezuma Valley Irrigation Company, Dolores Water Conservancy District, Yampa Valley, and Uncompahgre Valley Water Users Association. Generally, these senior, west-slope agricultural water users recognized the significant potential for a future disruption and indicated a willingness to consider how a water bank could help to address these impacts through willing-participant, free-market transactions. We are continuing to work with the Grand Valley Water Users Association, the Uncompahgre Valley Water Users Association, and the Southern Ute Tribe Water Resources Division on the details of how a water bank could operate within their systems.

c) The program/project must at a minimum conceptually describe the technical, institutional, and legal elements of the water transfer. Grant monies may be used to address one or more of these elements. If grant monies are not requested for all three elements, the grant applicant must describe how the applicant has or intends to address the elements, which are not included in the grant request, through other efforts.

The purpose of this grant is to better understand the agronomic impacts of reduced irrigation and gather the necessary data to begin estimating the amount of consumptive use saved through changes in irrigation practices. Separate funds from Workgroup partners and other grants will be used to continue work on addressing the many technical, institutional, and legal questions of how a water bank could operate.

d) If grant monies are proposed for use for legal assistance then the use of those funds shall be oriented toward advancing the knowledge of alternative agricultural water transfer methods and techniques; not for preparation of a specific water court case. The total requested funds for legal assistance shall not exceed 40 percent of the total grant request. In addition, grant monies proposed for use for legal assistance must be used to collaboratively address issues and concerns related to agricultural water transfer. Funds shall not be used to solely advance the cause of the project proponents.

Grant funds will not be used for legal assistance.

e) A minimum of a 10 percent cash match of total project cost (past expenditures and "in kind" can not be counted toward the 10 percent match).

Workgroup partners have each committed to contribute at total of $120,000 as cash match and individual letters of commitment are forthcoming.

7. Program/Project Evaluation Criteria

The following grant evaluation criteria will be used by the CWCB to evaluate and make recommendations to fund, partially fund or not fund a grant application. The criteria are aimed at advancing alternative transfer methods from the literature and studies to actual on the ground projects/programs that provide reliable water supply and sustain key elements of the agricultural area from which the water is transferred. The applicant should fully address and explain in detail in the application how, and the extent to which, the proposed project/program meets each of the criteria. However, it should be noted that the project does not have to meet all of the criteria to be eligible to receive funding and the criteria below are not listed in any order of important or priority.

a. The proposed project/program builds upon the work of former alternative water transfer methods efforts and addresses key areas that have been identified. For more detailed information on this work,

please refer to the draft report: Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update, November 2012.

This proposal builds on the Phase 1 and Phase 2 of the Water Bank Feasibility Study and directly addresses issues identified in those reports related to on-farm feasibility, participation from agricultural water users, and the amount of potential supply available to the water bank.

b. The proposed project addresses one or more key recommendation(s) in the report: Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update, November 2012.

This proposal directly addresses two of the three recommendations for the West Slope from the November 2012:

- Continue the study by CSU and others on the suitability of pasture grass for rotational fallowing.
- Advance the Colorado River Compact Water Banking study and its focus on rotational fallowing by integration using the results from the Aspinall Water Bank study and Yampa ATM study.

A key recommendation from the Yampa ATM study is to "Continue to create technical and legal innovations that increase the options of water right owners while protecting other water users from injury." The water bank is then described as one of the main options.

c. Preference will be given to projects that provide additional matching resources in the form of cash, past expenditures and in-kind contributions that are in addition to the required 10% cash match.

For this ATM grant, the Workgroup proposes to provide $120,000 (40% of the total) in cash to serve as matching funds. In addition, every partner is prepared to provide extensive in-kind support, as described in the attached letters of commitment (Appendix B). The Workgroup also plans to pursue matching funds through the recently announced System Conservation Program. However, because the details of this new program are not yet available, we have not reflected that request in our budget.

d. The proposed project/program has the ability/potential to produce a reliable water supply that can be administered by the State of Colorado, Division of Water Resources.

While the water bank project is not aimed at producing a new supply of water, it does seek to increase certainty for all Colorado water users and reduce the risks of Lake Powell dropping below minimum hydropower levels and the risk of a deficit under the Colorado River Compact.

e. The proposed project/program produces information that is transferable and transparent to other users and other areas of the state (i.e., would provide an example "template" or roadmap to others wishing to explore alternate transfer methods).

While some of the issues associated with developing a water bank will be unique, the project will certainly provide a template for dealing with many issues associated with temporary transfers in Colorado. These include how to quantify consumptive uses on a ditch or irrigation system, if and how Reclamation project beneficiaries can participate in a water bank, how to quantify supply and demands, how to develop the appropriate market approach for a water bank, and how to quantify and mitigate third party impacts.

f. The proposed project/program addresses key water needs identified in SWSI 2010 or as identified in a basin's needs assessment.

This project is unique in that it provides an insurance-like program in the event of extreme shortages that significantly affect Lake Powell's operations or the State's ability to meet Colorado River Compact obligations. A water bank will help increase certainty and security for all key water needs in Colorado.

g. The proposed project/program advances the preservation of high value agricultural lands. Value can be viewed as: the value of crops produced, the value the agriculture provides to the local community, and the value the agricultural area provides for open space and wildlife habitat.

Protecting agricultural land and water is one of the key objectives of the Water Bank. The proposed project will examine how agricultural water use can be temporarily reduced under a market based program that provides an alternative to permanent dry-up, and will examine the associated impacts on surrounding communities, the environment, and local economies.

h. The proposed project/program addresses water quality, or provides other environmental benefits to rivers, streams and wetlands.

In particular, the Workgroup believes it is important in that any plan to address extreme shortages in the Colorado River Basin provide some level of protection for endangered fish species at a minimum. It is also possible that a water bank or similar mechanism could provide additional environmental benefit to rivers and streams. For example, water stored for the water bank at higher elevation reservoirs on a space available basis could be released downstream at strategic times to provide flow benefits that would help preserve and protect endangered species. Another option would be to first reduce irrigation on lands that contribute to salinity and selenium loading, providing additional water quality benefits.

i. The proposed project/program increases our understanding of and quantifies program/project costs. This could include: institutional, legal, technical costs, and third party impacts.

The proposed program will add to our understanding of the technical costs, and the direct and indirect costs incurred by agricultural water users participating in a water bank. We will use a modified crop enterprise budget for each study site to track income and expenses for both the treatment and control fields. Tracking this information over the five year study period will inform program costs related to tracking saved water, lost yield, field recovery, and any unintended impacts.

j. The proposed project/program does not adversely affect access to other sources of water (not subject to/participating in the program) where owners of these water rights may wish to pursue traditional transfer of their rights to other users.

Participation in the water bank would be entirely voluntary, and the Workgroup does not believe that the project will adversely affect a water rights holder from pursuing traditional transfers. In fact, the bank is conceived with the express purpose of providing security for water rights owners.

k. The proposed project/program provides a perpetual water supply for the new and/or alternate use and preserves agricultural production and/or helps sustain the area's economy from which the transfer is occurring.

As mentioned above, the Water Bank is not meant to provide a perpetual water supply, but instead aims to increase security for all water uses in the event of extreme shortages while protecting agricultural lands and associated economies.

l. The quantity of water produced by the proposed project/program. Preference will be given to programs that can address larger water supply needs.

This proposal will not generate a large supply of water as it is intended to investigate the on-farm feasibility of water bank participation. However, the information derived from this project will facilitate the implementation of a water bank which could produce a significant amount of water on a temporary basis to deal with declining reservoir levels and/or Compact issues. The bank could also support West Slope agriculture by providing direct financial assistance for those water users willing to participate in the bank.

m. Applicants are encouraged to develop projects demonstrating participation and/or support from a diverse set of stakeholders and interests.

Formed in 2009, the Water Bank Workgroup is a representative group of stakeholders that includes the Colorado River District, Southwestern Water Conservation District, The Nature Conservancy, the Front Range Water Council, and the State of Colorado. We regularly consult with agricultural representatives, Native American tribes, and the Bureau of Reclamation. Our goal is to be fair and equitable among water user groups that may be approached to help address shortages. We pledge to be transparent and responsive to the issues facing agriculture, municipal and environmental uses throughout the Basin and in Colorado.

8. Statement of Work

Provide the proposed statement of work. On the following page there is an example format for the statement of work. You can use the example format or your own format, provided that comparable information is included. The statement of work should outline by task how the proposed program/project will be accomplished. It is important that the statement of work detail the specific steps, activities/procedures that will be followed to accomplish each individual task and the overall program/project and the specific products/deliverables that will be accomplished. The statement of work must include but not be limited to: task description, key personnel, budget, schedule and deliverables and the final report/project documentation upon completion of the water activity.

The statement of work will form the basis for the contract between the Applicant and the State of Colorado. In short, the Applicant is agreeing to undertake the work for the compensation outlined in the statement of work and budget, and in return, the State of Colorado is receiving the deliverables/products specified. Please note that costs incurred prior to execution of a contract or purchase order are not subject to reimbursement.

Please provide a detailed statement of work using the following template. Additional sections or modifications may be included as necessary. Please define all acronyms. If a grant is awarded an independent statement of work document will be required with correct page numbers.

See Appendix B attached for a detailed statement of work.

BUDGET

Table 2: Complete Itemized Budget by Year (CWCB Request)

CWCB Contribution	Year 1	Year 2	Total
PERSONNEL SALARIES			
Academic Faculty:	$4,909	$5,105	$10,014
Fringe Rate	$1,242	$1,310	$2,552
Student Hourly:	$7,560	$0	$7,560
Fringe	$76	$0	$76
GRA's:	$21,600	$22,464	$44,064
Fringe	$1,728	$1,822	$3,550
TOTAL SALARY:	$34,069	$27,569	$61,638
TOTAL FRINGE:	$3,046	$3,132	$6,178
TOTAL PERSONNEL:	**$37,115**	**$30,701**	**$67,816**
DOMESTIC TRAVEL:	**$5,328**	**$4,966**	**$10,294**
MATERIALS AND SUPPLIES	**$66,566**	**$6,000**	**$72,566**
OTHER DIRECT COSTS			
Publications:	$0	$1,248	$1,248
TOTAL OTHER DIRECT:	**$0**	**$1,248**	**$1,248**
EQUIPMENT:	**$4,598**	**$0**	**$4,598**
TOTAL DIRECT COSTS:	**$113,607**	**$42,915**	**$156,522**
Facilities & Administrative (15%):	**$17,041**	**$6,437**	**$23,478**
TOTAL CWCB Request:	**$130,648**	**$49,352**	**$180,000**

Table 3: Complete Itemized Budget by Year (Matching Funds)

Matching Contribution	Year 1	Year 2	Total
MATERIALS AND SUPPLIES	**$61,631**	**$0**	**$61,631**
OTHER DIRECT COSTS			
In-State Tuition:	$9,076	$9,757	$18,833
Crop Offset Payments:	$17,667	$18,374	$36,041
TOTAL OTHER DIRECT:	**$26,743**	**$28,131**	**$54,874**
TOTAL DIRECT COSTS:	**$88,374**	**$28,131**	**$116,505**
Facilities & Administrative (3%):	**$2,651**	**$844**	**$3,495**
TOTAL Matching:	**$91,025**	**$28,975**	**$120,000**

BUDGET

Table 4: Complete Itemized Budget by Year Total Project)

CWCB Contribution	Year 1	Year 2	Total
PERSONNEL SALARIES			
Academic Faculty:	$4,909	$5,105	$10,014
Fringe Rate	$1,242	$1,310	$2,552
Student Hourly:	$7,560	$0	$7,560
Fringe	$76	$0	$76
GRA's:	$21,600	$22,464	$44,064
Fringe	$1,728	$1,822	$3,550
TOTAL SALARY:	$34,069	$27,569	$61,638
TOTAL FRINGE:	$3,046	$3,132	$6,178
TOTAL PERSONNEL:	**$37,115**	**$30,701**	**$67,816**
DOMESTIC TRAVEL:	**$5,328**	**$4,966**	**$10,294**
MATERIALS AND SUPPLIES	**$128,197**	**$6,000**	**$134,197**
OTHER DIRECT COSTS			
Publications:	$0	$1,248	$1,248
In-State Tuition:	$9,076	$9,757	$18,833
Crop Offset Payments:	$17,667	$18,374	$36,041
TOTAL OTHER DIRECT:	**$26,743**	**$29,379**	**$56,122**
EQUIPMENT:	**$4,598**	**$0**	**$4,598**
TOTAL DIRECT COSTS:	**$201,981**	**$71,046**	**$273,027**
Facilities & Administrative:	**$19,692**	**$7,281**	**$26,973**
TOTAL CWCB Request:	**$221,673**	**$78,327**	**$300,000**

Table 5: **Project Costs associated with ATM request.**

	Personnel + Fringe	***Tuition***	***Travel Mileage***	***Materials Equipment***	***Payments to Farmers***	***Indirect Costs***	***Total***
Item Description							
Task 1. Graduate student, intern selection	$6,782	$18,833	$1,029	---	---	$1,737	$28,381
Task 2. Site selection & deployment of monitoring	$13,563	---	$2,059	$131,295	---	$14,642	$161,559
Task 3. Coordination with irrigators before season	$3,391	---	$515	---	$36,041	$1,667	$41,614
Task 4. Collection, analysis of agronomic field data	$3,391	---	$511	---	---	$586	$4,488
Task 5. Collection of irrigation water budget data	$13,563	---	$2,059	---	---	$2,343	$17,965
Task 6. Determination of saved CU estimates	$13,563	---	$2,059	---	---	$2,343	$17,965
Task 7. Documentation and reporting of data	$3,391	---	$515	---	---	$586	$4,491
Task 8. Maintenance of equipment, COAGMET	$3,391	---	$515	$7,500	---	$1,711	$13,116
Task 9. Quality analysis and quality control	$3,391	---	$515	---	---	$586	$4,491
Task 10. Extension and Outreach	$3,391	---	$515	$1,248	---	$ 773	$5,927
TOTAL Project Cost	**$67,816**	**$18,833**	**$10,294**	**$140,043**	**$36,041**	**$26,973**	**$300,000**

Matching (Colorado River District)	**$30,000**
Matching (The Nature Conservancy)	**$30,000**
Matching (Southwestern Colorado Water Conservancy District)	**$30,000**
Matching (Front Range Water Council)	**$30,000**
TOTAL FUNDS REQUESTED from CWCB Alternative Transfer Methods Program	**$180,000**

SCHEDULE

Task	Year 1				Year 2				
	Fall 2014	Winter 2015	Spring 2015	Summer 2015	Fall 2015	Winter 2016	Spring 2016	Summer 2016	Fall 2016
1. Grad student and intern interview and selection									
2. Study site selection, deployment of research equipment									
3. Coordination with irrigators/managers before irrigation season									
4. Collection and analysis of agronomic field data									
5. Collection of irrigation water budget data									
6. Determination of saved consumptive use estimates									
7. Documentation and Reporting									
8. CoAgMet station maintenance	Ongoing				Ongoing				
9. Quality Assurance and Quality Control									
10. Outreach	Ongoing				Ongoing				

PAYMENT

Payment will be made based on actual expenditures and invoicing by the applicant. Invoices from any other entity (i.e. subcontractors) cannot be processed by the State. The request for payment must include a description of the work accomplished by major task, and estimate of the percent completion for individual tasks and the entire water activity in relation to the percentage of budget spent, identification of any major issues and proposed or implemented corrective actions. The last 5 percent of the entire water activity budget will be withheld until final project/water activity documentation is completed. All products, data and information developed as a result of this grant must be provided to the CWCB in hard copy and electronic format as part of the project documentation. This information will in turn be made widely available to the public and help promote the development of alternative agricultural transfer methods.

Additional Information – If you would like to add any additional pertinent information please feel free to do so here.

The above statements are true to the best of my knowledge:

Signature of Applicant:

Print Applicant's Name: Dr. Perry E. Cabot

Project Title: Colorado Water Bank: Agricultural Field Studies and Estimates of Saved Consumptive Use

Return this application to:

Mr. Craig Godbout
Colorado Water Conservation Board
Water Supply Planning Section
1313 Sherman St., Room 721
Denver, CO 80203
craig.godbout@state.co.us

Appendix B: Statement of Work

Monitoring Consumptive Use and Agronomic Sustainability for Split-Season Irrigation of Alfalfa and Grass Hayfields under the Auspices of a Western Slope Water Bank

Phase IIC Feasibility Study

Collaborating Investigators:
Dr. Joe Brummer, CSU, Soil and Crop Sciences
Dr. Perry Cabot, CSU, Colorado Water Institute, Extension, Agricultural Experiment Station
Dr. José Chávez, CSU, Civil and Environmental Engineering

The following will also be available for consultation during the project:
Dr. Abdel Berrada, CSU, Agricultural Experiment Station – Yellow Jacket
Dr. Greg Litus, CSU, Agricultural Experiment Station – Orchard Mesa (available for consultation)
Dr. Reagan Waskom, CSU, Director, Colorado Water Institute
Mr. John Rizza, CSU, Extension Specialist, Range and Small Acreage
Ms. Wendy Ryan, CSU, Colorado Climate Center

Introduction & Background:

The Water Bank Workgroup (WBWG) is a representative group of stakeholders that is exploring the use of a voluntary and compensated market approach to temporarily reduce consumptive uses in the Colorado River Basin in Colorado. The WBWG wants to develop solutions that strike a balance between urban, agricultural and environmental needs. The group, which was formed in 2009, consists of the Colorado River District, Southwestern Water Conservation District, The Nature Conservancy, the Front Range Council, and the State of Colorado. We regularly consult with agricultural representatives, Native American tribes, and the Bureau of Reclamation. The WBWG's effort is aimed at avoiding long-term agricultural dry up and water supply disruption on the West Slope while minimizing risk for all water Colorado River users. As the Water Bank Workgroup continues to define the operational aspects of the program, there exists a need to develop approaches to reduce or curtail irrigation for a portion of the growing season, without adversely affecting long-term agronomic sustainability. This proposal will examine reduced irrigation on six study field on the West Slope to better understand agronomic impacts, recovery time, and the amount of saved water that could be available to the water bank.

Goals:

1. Continue and expand the agronomic evaluations conducted by the WBWG in Phases 1, 2A, and 2B to investigate the feasibility of partial and full season irrigation reduction of grass and alfalfa on the west slope. This project will produce on-farm, real life, information for agricultural producers and the WBWG to understand consumptive use savings through reduced irrigation and whether long-term agronomic sustainability is affected.

2. Measure the irrigation water management (IWM) on project fields to calculate saved applied water (e.g., irrigations) and saved CU, for the larger purpose of estimating these parameters on comparable fields across their respective regions.

Objectives:

1. Understand the recovery period associated with bringing grass pastures and alfalfa fields back into production, after multiple (1, 2 and 3) years of reduced irrigation.
2. Determine the impacts to forage yield and quality on alfalfa and grass hayfields, after multiple years of reduced irrigation.
3. Derive estimates of saved applied water (e.g., irrigations) and saved CU that may be credited to alfalfa and grass hayfields where split-season irrigation is practiced under structured guidelines.

TASKS

TASK 1 (GRAD STUDENTS) – Graduate student and intern interviews and selection.

Description:

There will be one (1) Masters-Level graduate student and one (1) summer intern required for the project. The graduate student will commence their degree program in Spring 2015 and complete their thesis defense in Spring 2017. Along this schedule, the grad student will complete four semesters of coursework (in-state tuition) and have an additional semester of 1.0 research credit to complete their thesis. The graduate student will be expected to relocate to Grand Junction during the summer months. The CSU Orchard Mesa Agricultural Experiment Station will provide housing free of charge. By relocating them to Grand Junction, the amount of travel time and complication of logistics will be greatly minimized.

Additionally, the first year of the project (2015) will be heavily involved in field work to establish and instrument the research sites. The budget also includes funding for an intern to be hired locally for 3.5 months. This in turn is budgeted as a non-student hourly because they may originate from a non-CSU University. Dr. Cabot is familiar with several potential intern candidates locally from his 2014 Summerfield season.

All of the Principal Investigators as well as members of the WBWG will be involved in the selection of the graduate students and interns. Graduate students will assume their Masters Degrees from the Department of Soil and Crop Sciences (Prof. Joe Brummer), or from the Department of Civil and Environmental Engineering (Prof. José Chavez). The graduate committee for the students would likely consist of Prof. Joe Brummer, Prof. José Chavez and Dr. Perry Cabot, with an outside member from the Water Bank Workgroup. Members of the graduate committee will supervise the students and interns during the course of the project; therefore some faculty time has been budgeted for the summer salaries.

Deliverables:

- Selection of graduate student by Spring 2015 and supervision through Spring 2017.
- Selection and supervision of a field intern for Summer 2015.

TASK 2 (SITE DEVELOPMENT) – Construction of research sites and deployment of monitoring equipment

Description:
In Year 1 (2015), the research sites will be established and instrumented. A reference plot on which a typical irrigation regimen is practiced will also be established and instrumented. The reference plots will be irrigated to reflect a condition that would occur on fields that do not participate in the water bank. The experimental concept, therefore, is to determine the agronomic and biophysical impacts of reduced irrigation versus irrigation to maximize yield or irrigation to fully utilize water rights throughout the season (e.g., "typical" irrigation).

During Year 1 (2015), partial-season irrigation (alfalfa fields) or non-irrigation (grass pasture) will also commence on the test plot within the research sites. This test plot is expected to comprise half the acreage of the research site. During Year 2 (2016), some decisions will have to be made on the sequence of irrigation:

- *Option 1*. The same experimental design will be imposed on the research sites to compare "typical" irrigation throughout the season versus partial-season irrigation. Under *Option 1*, the test-plots would be expected to remain under the regime of reduced irrigation, in order to determine the multi-year impacts of this practice. *Option 1* is the most preferred and likely choice, due to the goals of the Water Bank Partners, although this option depends on the availability of funding to continue the project.
- *Option 2*. The experimental design would be modified to bring the test-plots back into full production, after only one year of reduced irrigation. *Option 2* is less preferred.

Partial-season irrigation practices will vary for the alfalfa and grass/hay research sites. Partial-season irrigation is optimal for perennial crops such as alfalfa and grass, which are prevalent in western Colorado, but has not been a common practice in the region.
Grass/Hay Irrigation. One of the criterial for research site selection is the availability of gated pip, which will allow irrigation rates to be easily controlled. As explained above, the reference plots will receive irrigation at rates comparable to historic or agronomic baselines. The test-plots for grass/hay will not be irrigated, and thereby will only survive on natural rainfall or stored soil moisture. Understanding the year-over-year carryover of the soil moisture deficit will be critical.

Alfalfa Irrigation. Comparatively, summer *deficit* irrigation of alfalfa has shown potential to conserve more than 22 inches per year in the Palo Verde and Imperial Valleys (Bali et al., 2010; Bali et al., 2001). It is important to note that this project focuses on *partial-season* irrigation, which differs from deficit irrigation, in that some cuttings of alfalfa will receive water at rates equal to historic or agronomic requirements. At some point in the season, the field will be intentionally stressed during a period where

plants are deprived of irrigation water. The start of this period can be after the 1st cutting or after the 2nd cutting. Another alternative would be irrigate the 1st cutting, then eliminate irrigation during the peak CU period of the summer, and then re-initiate irrigation later in the season. Irrigation of the alfalfa test plots will be designed in manner and sequence that best represents the desired administrative structure of the Water Bank.

The sites are being selected for their rectangular or square shape, however, the collection of data will be done in specific locations (e.g., 1 m^2, randomized or strategic) within the test plots, so as to gain the most information from sampling replication and redundancy.

The *existing study* is comprised of four (4) grass/hay sites (C-Ranch in Hayden, F-Ranch in Steamboat Lake, T-Ranch in Gunnison, BV-Ranch in Kremmling) and 3 alfalfa sites (K-Farm in Eckert, Western Colorado CSU-AES in Fruita, Southwest CSU-AES in Yellow Jacket). The different locations and parameters for the *proposed* new study are detailed below in Table 1. There are six (6) research sites proposed with an optional seventh site for Garfield County in the Rifle Creek area. The primary priority used for research site selection under this proposed study was to locate the sites within the largest water user districts that would be approached first to participate in the Water Bank. The sites of greatest interest are those in the Grand Valley Water Users Association (GVWUA) and the Uncompahgre Valley Water Users Association (UVWUA), represented by the sites in Mesa and Montrose Counties. Additionally, the site in Delta County will be kept in the project due to an exceptionally good cooperative farmer. This site is close to the area served by the UVWUA. The site in the Upper Gunnison is intended to develop an understanding of high-mountain pasture sites. The CSU Agricultural Experiment Station (AES) in Montezuma County will be useful to document the impacts of reduced irrigation practices that may be practiced on in the area served by the Doctor Morrison Ditch, which is in La Plata County.

The instrumentation to be installed at each site will be designed to provide “real-time” measurements soil moisture conditions, soil electrical conductivity and temperature. Additionally, metering equipment will be deployed to measure the rates, totals and timing of irrigation water inputs tail water. Details may vary by site, but the smaller (<30 ac) reference and test plots would each consist of two (2) “sensing stations,” comprised of two (2) soil sensors and telemetric capability. The larger (>30-ac) plots would have four (4) sensing stations. The location of the sensing stations will be determined on the basis of different irrigation treatments, irrigation systems and soil types. The site locations will be instrumented with telemetric capability. This capability requires an additional “base station” that can relay data to a headquarters, which will likely be the CSU Orchard Mesa Agricultural Experiment Station in Grand Junction.

Table 1: Site Location and Info by County

County	Delta	Gunnison	Mesa (GVWUA)	Mesa (CSU-AES)	Montezuma (CSU-AES)	Montrose (UVWUA)
Crop Type	Alfalfa	Grass Hay/Pasture	Alfalfa	Grass Hay/Pasture	Alfalfa	Alfalfa
Site Size (acres)	30	40	80	30	30	80
Plot Size (acres)	10	10	40	10	10	40
No. of Plots	3	4	2	3	3	2

GVWUA: Grand Valley Water Users Association; CSU-AES: Colorado State University Agricultural Experiment Station;
UVWUA: Uncompahgre Valley Water Users Association

All of the Principal Investigators will be involved in the instrumentation of the sites, but Prof. Chavez and Dr. Cabot will take the lead. The purpose of funding summer salary for Prof. Chavez in the first two years is to avail the project of his expertise with soil sensing equipment and telemetry systems. The establishment of the research sites will be a major duty of the incoming graduate student in Year 1. Because this work is intensive and must move at a fairly rapid pace, an intern will also be hired to assist.

Deliverables:

- Identification of study sites and recruitment of participating producers.
- Installation of monitoring equipment.
- Summary reports detailing characteristics of each site.

TASK 3 (COOPERATORS) – Coordination with irrigators and land managers before each irrigation season

Description:
Before the beginning of each field season, the research team will meet with the land managers at each and establish a plan for irrigating during the year. Any surprises or challenges that were encountered in the previous year or changes to the upcoming year will be addressed. The budget includes travel funding for the graduate students to visit the Western slope a few times during the semester before they relocate to Grand Junction for the summer. Because the irrigation season typically lasts longer than August, the graduate student is also budgeted to return a couple times as the irrigation season finishes. Dr. Cabot will take the lead to facilitate these meetings between the land managers and the graduate student.

Deliverables:

- Annual irrigation plan for each study site.
- Summary document of participant experiences with reduced irrigation practices.

TASK 4 (RESEARCH - AGRONOMY) – Collection and analysis of agronomic field data

Description:

The first major goal of this project is to assess the recovery period and pattern of vegetation on fields that have undergone a period of reduced irrigation. To this end, agronomic data collection will follow a similar pattern as has been conducted under the current research supervised by Prof. Brummer in Phase IIB of the Water Bank Feasibility Study. General data being collected at the sites includes plant count and density, yield, and quality. Because the nature of the project is to understand the relationship between consumptive use (CU) and agronomic variables, there may be additional study parameters that could be useful in establishing this relationship.

When conducting research on irrigation, a reasonable concern always exists that subsurface water may affect the study through lateral inputs from adjacent irrigated plots that are not included in the study. These impacts could likely affect the reference plots as well as the test plots. The primary measure taken to avoid the intrusion of lateral flow is to select sites that are side-bound by roadways or non-irrigated areas. A secondary measure is to exclude "buffers" from sampling and measurement. These buffers are wide enough to separate the research plots dimensions from any potential intrusion. In typical research, the buffer width can be approximately 2-3 m wide or less, depending on soil types. Soil moisture levels will accurately be reflected by locating the sensing stations far enough into the plots, so as to be unaffected by lateral wicking of subsurface flows. Finally, the actual sampling design will be arrayed within the sites, so that several specific locations (e.g., 1 m^2, randomized or strategic) within the test plots. For instance, forage samples will be taken from specific locations arrayed within the plots. The data from these specific locations will be used for averaging, modeling inputs and statistical comparisons.

Prof. Brummer will take the lead on supervising the graduate student in this task. Additional input will be received from Prof. Chavez and Dr. Cabot in order to develop the CU/ET relationship with agronomic variables. Field visits will be regularly scheduled during the summer in order to collect data at the sites.

Deliverables:

- Annual and summary agronomic data for each field site, including yield, plant count, density, relative feed value.
- Annual and summary crop enterprise budgets for each field site.

TASK 5 (RESEARCH - WATER) – Collection of irrigation water budget data

Description:

Water budget data collection will be assisted through telemetric reporting systems that will be established at each site. Irrigation data will include water flow rates and totals applied to the fields under gated pipe systems. In the case on one location where gated pipe does not exist – in Gunnison County – funding has been added to the budget in order to install it.

Dr. Cabot will take the lead on supervising the graduate student in this task. Additional input will be received from Prof. Brummer and Prof. Chavez in order to develop the CU/ET relationship with agronomic variables. Ongoing storage of the data from the telemetric system will be a duty of the graduate student, who will provide assistance remotely, during the semesters, and directly, during the summer.

Deliverables:

- Annual and summary irrigation water budget data for each study site, including applied irrigation water, potential ET, field runoff, and soil moisture.

TASK 6 (DATA APPLICATION) – Determination of saved consumptive use (CU) estimates

Description:

The second major research goal of this project is to understand the change in consumptive use (CU) exhibited as a function of irrigation reductions. Accomplishment of this goal requires that a difference in CU be measured between: 1) a fully-irrigated reference condition (intended to match historic CU rates), and; 2) the "treatment" condition that represents reduced irrigation management, as would occur under the water banking strategy.

By measuring the water budget of the reference and treatment fields, the known variables of a simplified water balance equation can be determined:

$$Dc = Dp + ETc - P - Irr - U + SRO + DP \quad [1]$$

Where *Dc* is the soil water deficit (net irrigation requirement) in the root zone on the current day, *Dp* is the soil water deficit on the previous day, *ETc* is the crop-based evapotranspiration amount for the current day, *P* is the gross precipitation for the current day, *Irr* is the net irrigation amount infiltrated into the soil for the current day, *U* is upflux of shallow ground water into the root zone, *SRO* is surface runoff, and *DP* is deep percolation or drainage.

Because *U* and *DP* are difficult to estimate in the field, our approach will be to select locations where the water table is significantly deeper than the root zone and *U* can be assumed zero. The SRO parameter will be accounted for by measuring runoff using small flumes equipped with water level loggers. The *DP* parameter can be accounted for by setting *Dc* to zero whenever water additions (*P* and *Irr*) to the root zone exhibit patterns of being greater than *Dp* + *ET*c. For these purposes, *ETc* may be estimated using the Penman-Montieth or other comparable equations. Additionally, however, the instrumentation of the entire field with soil moisture and flow monitoring equipment will allow for a direct calculation of *ETc* by knowing all other parameters.

Prof. Chavez and Dr. Cabot will take the lead on supervising the graduate student in this task. Assistance will also be requested from Ben Harding (AMEC), so that such calculations can be integrated usefully with the larger Water Bank project.

Deliverables:

- Annual and summary estimates of saved consumptive use for each study site treatment plot.
- Revised estimates and description of the factors influencing the range of potential supply available to the water bank.

TASK 7 (REPORTING) – Documentation and reporting of data

Description:

Data from the project will be compiled and reported to the funding entity on a timely basis that is scheduled at the outset of the project. All of the Principal Investigators will be involved in the reporting and presentation of data, but Dr. Cabot will take the lead on this task, given closer proximity to the region being researched. The graduate student will be expected to assist with this task in the preparation of slides, graphs and concepts.

Deliverables:

- Annual progress reports.
- Final report summarizing study, key findings, and recommendations.

TASK 8 (COAGMET) – Maintenance of research equipment and COAGMET stations

Description:

All COAGMET stations require regular maintenance. A portion of the budget will be used to pay the Colorado Climate Center staff in charge of COAGMET system maintenance.

Table 2: COAGMET Station Planning and Procurement

County	Delta	Gunnison	Mesa (GVWUA)	Mesa (CSU-AES)	Montezuma (CSU-AES)	Montrose (UVWUA)
Existing Station?	No	No	No	Yes	Yes	No
Procurement	Move Existing	CWCB-ATM	CWCB-ATM	n/a	n/a	CWCB-WSRA

GVWUA: Grand Valley Water Users Association; CSU-AES: Colorado State University Agricultural Experiment Station;
UVWUA: Uncompahgre Valley Water Users Association

Deliverables:

- Development of expanded COAGMET capacity on the Western Slope

TASK 9 (QA/QC) – Quality analysis and quality control

Description:

In order to maintain data quality and address problems as they are encountered a Quality Analysis and Quality Control (QA/QC) protocol will be established. This will involve regular (weekly) compiling of data, formatting spreadsheets and generating appropriate charts in order to determine any issues arising with the data collection system. Additionally, regular interactions with the land managers will allow any unplanned changes to the irrigation schedules to be understood and reflected in the data. The graduate student will be primarily responsible for QA/QC, submitting regular updates to the Principal Investigators.

TASK 10 (EXTENSION) – Extension and Outreach

Description:

At the request of the funding entity, an extension and outreach program can be developed for the project, consisting perhaps of such approaches as field tours, video materials, fact sheets, etc. The project team will work with the funding entity to determine a schedule and structure for extension and outreach. The graduate student will be primarily responsible for coordinating the details of Extension and Outreach, as component of their degree requirements in the Department of Soils and Crop Sciences.

Deliverables:

- Annual or semi-annual field tours.
- Fact sheets/summary sheets for water bank outreach.
- Other materials as needed or requested.