COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

TO: Colorado Water Conservation Board Members

FROM: Tim Feehan, Deputy Director
Steve Biondo, Finance Manager

DATE: March 16-17, 2016, Board Meeting

AGENDA ITEM: Agenda Item 11 – Severance Tax Operational Fund Grants

---

Introduction

CWCB is entitled to an amount up to a 5% share of the Severance Tax Operational Fund. In January 2016, CWCB received internal requests and outside applications for funding that becomes available from the Operational Fund in July 2016 via the Long Bill enacted by the General Assembly. CWCB Staff reviews the applications and then recommends to the Board the projects that should receive funding. We expect to receive $1,275,500 in funding; however, should that amount be changed, the project funding will also need to be revised. Table 1 on pages 2 through 3 provides a summary of the recommended and non-recommended projects by CWCB Staff. These projects are described in more detail following Table 1 (see each write-up by the corresponding Project Number).

Recommendation

Staff recommends that the Board approve the proposed funding for each of the projects from the Severance Tax Operational Fund as summarized as Table 1 to this memo. Recommended projects are numbered 1 – 31 and a project not recommended is numbered 32.

Table 1
SEVERANCE TAX OPERATONAL FUND PROJECTS
FOR FUNDING FROM JULY 1, 2016 TO JUNE 30, 2017

No.	Sponsor	Project Name	Funding Recommended
1	CWCB	Work related to Recreational Projects	$ 30,000
2	CWCB	Colorado River Contingency Planning Work	$ 25,000
3	CWCB	CSU Water Resources Archive	$ 25,000
4	CWCB	Colorado River Basin Climate Station Monitoring, Operation and Maintenance	$ 50,000
5	CWCB	Colorado River Interactive Museum Project	$ 25,000
6	CWCB	John Martin Reservoir Storage Account, Phase 1	$ 24,710
7	CWCB	Irrigation Well Data Collection Enhancements	$ 30,000
8	Pikes Peak Regional Water Authority	Fountain Creek Transit Loss Model Upgrade	$ 50,000
9	USGS	Water Budget Analysis of the Upper Big Sandy Alluvial Aquifer	$ 50,000
10	Upper Arkansas WCD	Lake Ranch Multi-Use Pilot Project Feasibility Study – Alluvial Aquifer Storage	$ 45,290
11	DWR	Dam Safety Inundation Mapping Grant Program	$ 40,000
12	DWR	Dam Safety Dam Records Digitization Project	$ 20,000
13	CWCB	Case Management, Litigation Support and Program Implementation	$ 100,000
14	CWCB	Stream and Lake Protection Section Outreach and Education	$ 10,000
15	CWCB	Flood Mitigation and Project Compliance	$ 100,000
16	CWCB	Community Assistance Program	$ 47,650
17	DWR	Colorado Dam Release – Floodplain Impacts Study	$ 50,000
18	Center for Snow and Avalanche Studies	Colorado Dust on Snow Program	$ 25,000

No.	Sponsor	Project Name	Funding Recommended
19	Open Water Foundation	Enhanced Snowpack Assessment Products for Colorado Water Managers	$ 50,000
20	USGS	On-line Flood Inundation Maps of the South Platte River	$ 45,000
21	CWCB	Water Planning and Operational Needs	$ 12,982
22	CWCB	Agency Intern Support	$ 30,000
		Total	**$ 885,632**
HIGHER EDUCATION PROJECT REQUESTS:			
23	MSU	2017 Watershed Summit Sponsorship, K-12 education on water use, Colorado Water Archives Internship, and to develop studies on the economics of the value of water and water efficiency	$ 41,450
24	CWI/CSU	Quantifying Pumping-Induced Streamflow Depletion in the South Platte River Corridor	$ 45,310
25	CWI/CSU	Developing a Refined Groundwater Flow Model for the LaSalle/Gilcrest Area	$ 49,234
26	CWI/CSU	Agronomic Responses to Partial and Full Season Fallowing of Alfalfa and Grass Hayfields	$ 5,000
27	CWI/CSU	Colorado Irrigation Center Design and Concept Development	$ 49,876
28	CWI/CSU	Data Collection and Analysis in Support of Improved Water Management in the Arkansas River Basin, Phase 3	$ 50,000
29	CWI/CSU	Enhanced Open Data for Colorado's Water Resources	$ 50,000
30	CWI/CSU	Investigation of the Effects of Whitewater Parks on Trout and Native Fishes in Colorado	$ 48,998
31	CWI/CSU	Aquifer Storage and Recovery – Fountain Formation in Northern Colorado	$ 50,000
		Total	**$ 389,868**
		Grand Total	**$ 1,275,500**

PROJECTS NOT RECOMMENDED:

32	USGS	Snow-depth Mapping using Small Unmanned Aircraft Systems	$ 98,400

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 1

Applicant: Ted Kowalski, IF&WI Chief

Project Title: Work related to Recreational Water Projects

Recommended Amount: $30,000
Requested Amount: $30,000

Description of Project: The Staff has typically requested funds each year to either: 1) fund work associated with the litigation of RICDs; or 2) fund projects that have benefits to water based recreational interests. In the next fiscal year, the CWCB is anticipating that it may receive requests to assist local governments (i.e. Town of Lyons, Fort Collins, etc.) in the design, construction or repair of their whitewater courses. Products may include: 1) finalization of design drawings and permitting for these communities to move toward building and/or repairing their Recreational In-Channel Diversions structures (RICD) and/or, 2) construction or repair of RICD structures. Staff may also use these funds for expert testimony in the upcoming Glenwood Springs RICD application. The funds may also be used to obtain data or information related to stream-related recreation that could be used to assure Colorado could fully use its compact entitlements and support Colorado's tourist recreation-based economy.

Project Manager(s): Suzanne Sellers

Program: Recreational Projects

Purpose: These funds will help assure that Colorado can fully use its compact entitlements while allowing mountain communities to develop water based recreational infrastructure. Wild and scenic rivers and RICD water rights, and the structures themselves, affect water planning in many important ways. The statutes and CWCB's policies on recreational use of water and on RICD's demonstrate a need to ensure compliance by local communities and to help protect Colorado's compact entitlements and to assure maximum utilization of Colorado's water resources. To the extent that recreational uses of water and RICD structures are designed and constructed in a manner that promotes maximum utilization of Colorado's water resources and that allows Colorado to fully use its compact entitlements, then CWCB's missions are being fulfilled.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 2

Applicant: Ted Kowalski, IF&WI Chief

Project Title: Colorado River Contingency Planning Work

Recommended Amount: $25,000
Requested Amount: $50,000

Description of Project: To fund activities associated with Colorado River contingency planning efforts. The Colorado River basin has been experiencing drought for the last 16 years. The Upper Colorado River Commission and the lower basin states have each been developing contingency plans for implementation should the drought continue or worsen. This funding could be used for modeling associated with drought contingency alternatives (modeling of extended operations), and it could also be used to implement activities associated with some of these alternatives (demand management/System Conservation Agreement Pilot Program).

Project Manager(s): Ted Kowalski

Program: Interstate, Federal, and Water Information Program

Purpose: To provide technical, adminstrative, and logistical support associated with the development and implementation of the Colorado River contingency planning efforts.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 3

Applicant:	Ted Kowalski, IF&WI Chief
Project Title:	CSU Water Resources Archive - Digitization of Water Resources Archive Materials
Recommended Amount:	$25,000
Requested Amount:	$25,000

Description of Project: To digitize materials in CSU's Water Resources Archive. Of highest priority are documents related to groundwater research and administration in Colorado , especially in the South Platte, Rio Grande, and Arkansas river basins.

Project Manager(s):	Carolyn Fritz
Program:	Interstate, Federal, and Water Information Program

Purpose: To provide online, public access to historical water resource related documents within CSU's Water Resources Archive.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 4

Applicant: Ted Kowalski, IF&WI Chief

Project Title: Colorado River Basin Climate Station Monitoring, Operation and Maintenance

Recommended Amount: $ 50,000
Requested Amount: $100,000

Description of Project: Provide monitoring, operation and maintenance for newly installed climate stations in the Colorado River basin.

Project Manager(s): Ted Kowalski / Michelle Garrison

Program: Upper Colorado River Compact
Interstate, Federal, and Water Information Program

Purpose: To improve consumptive use estimates throughout the Colorado River Basin within Colorado through additional clilmate data. To cooperate with the Colorado State Climatologist to monitor, operate and maintain newly installed climate stations in western Colorado. Climate stations were purchased and installed as part of a consumptive use study being conducted by the Upper Colorado River Commission. Ongoing operation and maintenance will be the responsibility of the state.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 5

Applicant: Ted Kowalski, IF&WI Chief

Project Title: Colorado River Interactive Museum Project

Recommended Amount: $25,000
Requested Amount: $40,000

Description of Project: To fund Colorado's share of a Colorado River Basin museum interactive exhibit.

Project Manager(s): Michelle Garrison

Program: Interstate, Federal, and Water Information Program

Purpose: To provide Colorado's cost share for an interactive museum exhibit that will travel aroudn the basin, and around the country to provide education and outreach opportunities to explain the importance of the Colorado River to the Southwestern United States, and to the State or Colorado.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 6

Applicant: Ted Kowalski, IF&WI Chief

Project Title: John Martin Reservoir Storage Account, Phase 1

Recommended Amount: $24,710
Requested Amount: $50,000

Description of Project: Feasibility and scoping study as Phase 1 of an engineering study to support a request to Arkansas River Compact Administration (ARCA) for approval of a new storage account at John Martin Reservoir for the use of Colorado water users.

Project Manager(s): Steve Miller

Program: Interstate, Federal, and Water Information Program

Purpose: In cooperation with the Lower Arkansas Valley Water Conservancy District (LAVWCD) conduct a fesibility and scoping study as Phase 1 of a more detailed engineering study of a new storage account at John Martin Reservoir (JMR). This new account, although in an existing reservoir, will provide new storage opportunities not currently available thereby helping to meet the Arkansas Basin Roundtable's goal of providing new storage in the Basin.

Phase 1 wil include the following tasks:

- LAVWCD will interview and select an engineering firm to conduct Phase 1 study
- Determine appropriate water user entities that could potentially use account
- Determine types of water available to those entities that would be suitable for storage at JMR
- Develop preliminary operating scenarios for account including mitigation of any new potential depletions and potential benefits of account to basin water users
- Conduct stakeholder meetings with water users and State of Kansas officials
- Collaborate with ongoing CSU study which may include proposed operational changes at JMR
- Develop Scope of Work for more detailed engineering study as may be necessary to present a final and comprehensive proposal to ARCA by December 2017.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 7

Applicant: Ted Kowalski, IF&WI Chief

Project Title: Irrigation Well Data Collection Enhancements

Recommended Amount: $30,000
Requested Amount: $50,000

Description of Project: To improve current methods for collecting and analyzing well pumping data for determination of augmentation requirements and compliance with the Arknasas River Compact and the decree and agreements in Kansas vs. Colorado. To encourage direct measurement of monthly pumping volumes, a rebate program will be offered to those users switching from the power conversion coefficient ("PCC") method to totalizing flow meters.

Project Manager(s): Steve Miller

Program: Interstate, Federal, and Water Information Program

Purpose: In cooperation with the Lower Arkansas Valley Water Conservancy District (LAVWCD), the Division 2 Engineer, and the three main well augmentation organizations in the Valley, conduct an analysis of current data collection and reporting methods. Evaluate enhanced methods that could be implemented for more timely and accurate determination of augmentation requirements. If possible try to standardize these methods across all entities. When the Division 2 well measurement rules were first enacted in 1996 the PCC method which utilizes electrical consumption data was recommended as the most practical way to assess pumping volumes. Now, 20 years later, there is widespread belief that metering of each well may provide more timely and accurate data on pumping. To minimize the impact on existing users of the PCC method a rebate program will be offered that could cover up to 50% or more of the cost of conversion (estimated at $1500-2000 per well). The LAVWCD and Div. 2 Engineer, in consultation with well users will develop standards for meter replacement and eligibility criteria for the rebate program.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 8

Applicant: Pikes Peak Regional Water Authority

Project Title: Fountain Creek Transit Loss Model Upgrade

Recommended Amount: $50,000
Requested Amount: $50,000

Description of Project: This grant is for Phase 1 of a two year project to upgrade the USGS transit loss model for Fountain and Monument Creeks by incorporating new hydrolgic algorithms and updating model coding, structure, and documentation.

Project Manager(s): Andy Moore / Steve Miller

Program: Interstate, Federal, and Water Information Program

Purpose: The improved transit loss model will provide more efficient operation and improved reliability for routing and accounting of valuable, fully consumable water in an important tributary of the Arkansas Basin. The model is utilized and relied upon by the Division 2 Engineer for daily operation and administration. The current model was written 20 years ago in an obsolete version of Fortran and does not have complete up to date documentation. It will be improved by updating the code to the current version of Fortran, improving the web based user interface, updating all model documentation, and incorporating hydrologic algotithms developed more recently by the USGS. The project sponsors currently invest over $250,000 annually to collect the required data and operate the model, indicating the importance of the water being tracked by the model. This water is used to meet a variety of augmentation and return flow obligations in a highly over appropriated basin.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 9

Applicant: U. S. Geological Survey

Project Title: Water Budget Analysis of the Upper Big Sandy Alluvial Aquifer

Recommended Amount: $50,000
Requested Amount: $65,166

Description of Project: The Upper Big Sandy Groundwater Management District (UBSGWMD) is concerned with potentially declining groundwater levels and thus available groundwater in storage of the Upper Big Sandy alluvial aquifer in eastern Colorado. The objective of this project is to evaluate changes in groundwater storage in the aquifer by comparing water-budget results from the USGS Denver Basin groundwater flow model to another aquifer water budget previously developed for UBSGWMD. Water-budget components not considered in the original study will be included in this project.

Project Manager(s): Andy Moore

Program: Interstate, Federal, and Water Information Program

Purpose: To evaluate changes in groundwater storage and estimate major water-budget components within the Upper Big Sandy Designated Groundwater Basin using results from the USGS Denver Basin model.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 10

Applicant:	Upper Arkansas Water Conservancy District
Project Title:	Lake Ranch Multi-Use Pilot Project Feasibility Study – Alluvial Aquifer Storage
Recommended Amount:	$45,290
Requested Amount:	$45,290

Description of Project: The Upper Arkansas Water Conservancy District (UAWCD) is in the process of developing two multi-use/multi-purpose storage projects in Chaffee County, CO. Multiple purpose projects are necessary for providing additional needed water supplies for municipal, industrial, agriculture, recreation and the environment. This feasibility study for alluvial aquifer storage at the Lake Ranch will give the UAWCD the insight and knowledge needed for implementation of the larger multi-use project at Trout Creek Park, while gaining vast benefits at the Lake Ranch throughout the process. The feasibility study will include drilling and monitoring test wells, a detailed topographic survey, and groundwater modeling.

Project Manager(s):	Andy Moore
Program:	Interstate, Federal, and Water Information Section

Purpose: To perform a feasibility study for the potential utilization of alluvial aquifer storage at the UAWCD's Lake Ranch in Salida, CO, and provide a demonstration of how to maximize utilization of State waters and address the "gap" with a multi-purpose approach.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 11

Applicant: Colorado Division of Water Resources, Dam Safety Branch

Project Title: CO Dam Safety Inundation Mapping Grant Program

Recommended Amount: $40,000
Requested Amount: $50,000

Description of Project: Colorado's Dam Safety Rules require owners of high and significant hazard dams to prepare and maintain an Emergency Action Plan (EAP). A key component of the EAP is an inundation map which shows the calculated extends of the flood wave that would occur in the event the dam were to fail. Beginning in 2010, Colorado established the Inundation Mapping Grant Program with a significant portion of its FEMA National Dam Safety Program grant money to assist owners of high and significant hazard dams in updating inadequate inundation mapping. A typical grant provides a 50% cost share with the dam owner. To ensure the mapping products are consistent, all work is coordinated with the Dam Safety Branch and is required to conform to the State of Colorado Rules and Regulations for Dam Safety and Dam Construction (1/1/2007), and the Dam Safety Guidelines for Dam Breach Analysis (2/10/2010). Grant funds are not disbursed until the project has been approved by the Dam Safety Branch.

Project Manager(s): Jonathan Hernandez

Program: Water Project Loan Program

Purpose: To provide additional funding to continue the current Dam Safety Branch Inundation Mapping Grant Program that has been in place since 2010.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 12

Applicant: Colorado Division of Water Resources, Dam Safety Branch

Project Title: Dam Safety Dam Records Digitization Project

Recommended Amount: $20,000
Requested Amount: $35,000

Description of Project: The Dam Safety Branch is moving toward a paperless file and archival process with most day-forward processes using a digital filing system since 2013. Dam safety files are necessary for some of the implementation plan efforts described in the Colorado Water Plan, specifically those related to exploring possible locations of englarging existing dams to increase statewide water storage capacity. The goal of the project is to allow a more efficient means of searching dam safety archives by fully digitizing dam safety files in all Water Division offices. Digitized files become part of the Laserfiche digital filing system and as such can be catalogued and queried easily and provided in digital format to approved users efficiently. All historical dam construction related files have been scanned in the Denver Office and are actively being scanned in the Division 1 Greeley Office, Division 1 and 2 Colorado Springs Office, and the Division 2 Pueblo Office.

Project Manager(s): Jonathan Hernandez

Program: Water Project Loan Program

Purpose: To acclerated the process of digitzing Dam Safety Branch paper files at Water Division office locations statewide.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 13

Applicants:	Linda Bassi, S&LP Chief Ted Kowalski, IF&WI Chief Kevin Houck, W&FP Chief
Project Title:	Case Management, Litigation Support, and Program Implementation
Recommended Amount:	$100,000
Requested Amount:	$100,000

Description of Project: Hire temporary or contract paralegal staff to (1) assist the Stream and Lake Protection Section with instream flow ("ISF") case management, including organizing and imaging case files, tracking court deadlines, prioritizing case review, and drafting pleadings, memos, correspondence and other documents as appropriate; (2) assist the Federal and Interstate Section with recreational in-channel diversion cases; the Bear Creek Lake appropriation and litigation; the Platte River Recovery Implementation Program; and Wild and Scenic River Alternative stakeholder group participation, including drafting pleadings, memos, correspondence and other documents as appropriate; and (3) assist the Watershed and Flood Protection Section with implementing the Watershed Restoration Program and Fish and Wildlife Resources Fund projects by drafting or editing documents, letters, proposals, memos, and correspondence; drafting or editing contracts, documents, letters, proposals, memos, correspondence related to the Weather Modification Program; and developing rules, regulations and legislative analyses.

Project Manager(s):	Linda Bassi/Jeff Baessler/Kaylea White Ted Kowalski/Suzanne Sellers Kevin Houck/Chris Sturm/Joe Busto
Programs:	Instream Flow and Natural Lake Level Program Interstate, Federal, and Water Information Program Watershed and Flood Protection Program

Purpose: Provide adequate staffing for legal protection of the State's ISF water rights and implementation of various agency programs.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 14

Applicant: Linda Bassi, S&LP Chief

Project Title: Stream and Lake Protection Section Outreach and Education

Recommended Amount: $10,000
Requested Amount: $10,000

Description of Project: In most years the Stream and Lake Protection Section has budgeted between $12,000 and $16,000 to fund operating expenses such as travel, telecomm, printing, equipment, official functions, and conference registrations. However, those funds have been supplemented in most years by the section's severance tax operational fund outreach and education project which has been historically funded at $15,000.

The section's operating budget can vary significantly from year to year depending on the amount of outreach activities that are required to address issues associated with new appropriations, acquisitions, legal protection and involvement in the basin roundtable process regarding non-consumptive uses. It is estimated that $10,000 of supplemental funding will be required to address travel associated with meetings, field work and other outreach activities related to multiple new appropriation recommendations, including those connected to the USFS reserved rights case in Water Division 7.

Project Manager(s): Linda Bassi / Jeff Baessler

Program: Instream Flow and Natural Lake Level Program

Purpose: Supplemental funding for the Stream and Lake Protection Section's annual operating budget to address extended outreach and education needs.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 15

Applicant: Kevin Houck, W&FP Chief

Project Title: Flood Mitigation and Project Compliance

Recommended Amount: $100,000
Requested Amount: $150,000

Description of Project: The CWCB has identified a substantial need for identification of deficiencies to flood mitigation projects throughout Colorado, a point vastly reinforced by the devastating floods of September 2013. Funds from this program will be used to develop solutions to bring these projects back into technical or regulatory compliance. In some cases, some financial assistance may be provided to smaller communities to perform required one-time maintenance activities for regulatory purposes provided that the local governments and other entities benefiting from the project expend as many local resources as available to perform the work. The focus of this work will be to address local requests as well as identification and design of projects that can be implemented or upgraded to reduce the flood risk. The best example of the use of these funds are the current nationwide focus on the condition of levees, which has already impacted some Colorado communities and is expected to impact many more in the coming years. Many of these levees and other flood control/mitigation projects are located in small or impoverished communities throughout the state that are in need of both technical and, in some cases, financial assistance. Other projects being considered include ongoing post-wildfire analysis and mitigation as well as a long overdue update to the Statewide Floodplain and Stormwater Criteria Manual, last updated in 2006. The CWCB staff is requesting this Severance Tax non-reimbursable investment to provide a means of cost-sharing with local entities and other agencies to accomplish the much needed work. Cost-sharing will be emphasized when practicable to leverage the severance tax dollars.

Project Manager(s): Kevin Houck

Program: Watershed and Flood Protection Program

Purpose: Mitigate flood hazards throughout the state by partnering with local governments in plans, studies, and minor flood projects.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 16

Applicant: Kevin Houck, W&FP Chief

Project Title: Community Assistance Program

Recommended Amount: $47,650
Requested Amount: $47,650

Description of Project: To administer the Community Assistance Program, a 75/25 partnership with FEMA for administration of the National Flood Insurance Program in Colorado.

Project Manager(s): Jamie Prochno

Program: Watershed and Flood Protection Program

Purpose: To provide technical and administrative assistance for communities in the state for administering floodplain regulations and other related issues. To assist communities in adopting updated floodplain management regulations, including the requirements promulgated in the Rules and Regulations for Floodplains in Colorado.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 17

Applicant: Colorado Division of Water Resources, Dam Safety Branch

Project Title: Colorado Dam Release – Floodplain Impacts Study

Recommended Amount: $50,000
Requested Amount: $50,000

Description of Project: The Colorado Division of Water Resources, Dam Safety Branch requests funding to evaluate the magnitude of the statewide issue of dams operating within their design limits, but releasing water through spillway or outlets that results in damaging flooding downstream. The problem is especially pronounced where large dams and constricted floodplains coincide.

Project Manager(s): Jamie Prochno

Program: Watershed and Flood Protection Program

Purpose: To provide additional funding to understand potential impacts of conditions statewide caused by flooding below a dam caused by outlets works or spillway releases. This scope entails comparing the conveyance capacity (ability to handle discharge) of the downstream channel below these dams, to the the full range of spillway and outlet releases. This will allow a quick assessment of the dams to determine where dangerous conditions exist and actions might be warranted to mitigate them. This is a screening level study that seeks to maximize the use of existing information for these comparisons. Criteria will be developed to rank the severity of the conditions as a means to prioritize the future efforts. Future studies will be scoped to obtain greater detail on impacts and potential mitigation strategies.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 18

Applicant: Center for Snow and Avalanche Studies

Project Title: Colorado Dust on Snow Program

Recommended Amount: $25,000
Requested Amount: $25,000

Description of Project: The Center for Snow and Avalanche Studies serves the mountain system science community and regional land and water managers by conducting comprehensive weather, snowpack, hydrology, soils, and plant community monitoring at multiple study plots within the Senator Beck Basin Study Area at Red Mountain Pass, by monitoring and reporting on dust-on-snow conditions there and at ten additional locations throughout the Colorado mountains, and by hosting and conducting interdisciplinary research investigating processes affecting the ecological services provided by mountain systems, most notably water supplies.

Project Manager(s): Joe Busto

Program: Watershed and Flood Protection Program

Purpose: CODOS is designed to monitor hydrologic and ecologic conditions, including dust-on-snow. The program provides operationally useful snowmelt behavior information to stakeholders and supports snow hydrology and climate change research. Recent years have highlighted the vulnerability of Colorado's snow-based water supplies to extreme variability in precipitation and drought, and to the increasingly 'constant' influence of dust-on-snow. Forest health and other watershed-scale, climate driven changes in hydrology are creating additional uncertainty in current and future water supplies.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 19

Applicant:	Open Water Foundation
Project Title:	Enhanced Snowpack Assessment Products for Colorado's Water Managers
Recommended Amount:	$50,000
Requested Amount:	$50,000

Description of Project: This project will result in statewide snow products that are produced automatically in real-time and distributed to Colorado water managers to help with compact administration, reservoir operations, and other needs.

Project Manager(s):	Joe Busto
Program:	Watershed and Flood Protection Program

Purpose: The SNODAS model provides real time snowpack information. It has een useful in the Rio Grande to provide to the Division Engineer what percentage of snowpack is left in the basin above key stream gauges. It is a better indicator of what is left than SNOTEL alone.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 20

Applicant: U. S. Geological Survey

Project Title: On-line Flood Inundation Maps of the South Platte River

Recommended Amount: $45,000
Requested Amount: $98,900

Description of Project: The objective of this study is to build a flood inundation map library for areas adjacent to the South Platte River near Fort Morgan, CO based on the USGS streamgage 06759500.

Project Manager(s): Thuy Patton

Program: Watershed and Flood Protection Program

Purpose: During a flood event, emergency personnel can use the current gage height transmitted via the internet and the predicted gage height of the crest to make decisions regarding evacuation routes and areas-at-risk.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 21

Applicant: Rebecca Mitchell, WSP Chief

Project Title: Water Planning and Operational Needs

Recommended Amount: $12,982
Requested Amount: $28,000

Description of Project: CWCB needs funding to meet immediate needs for water planning. CWCB is implementing a number of water planning efforts since the inception of the Statewide Water Supply Initiative and has the responsibility to address other water planning needs that emerge during the fiscal year, but for which no other funding source is available. These funds will also be used to supplement any operational needs of the Water Supply Planning Section.

Project Manager(s): Rebecca Mitchell / Craig Godbout

Program: Water Supply Planning Program

Purpose: To provide funding for water planning efforts and associated operational expenses not covered by any other funding. Without these funds, immediate cooperative efforts needed may be delayed or postponed.

Funding Available: July 1, 2016 – June 30, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 22

Applicant: Tim Feehan, Deputy Director

Project Title: Agency Intern Support

Recommended Amount: $30,000
Requested Amount: $35,000

Description of Project: CWCB needs funding to meet immediate needs for temporary operational support for some of its water programs. Utilizing an intern sponsorship program provides the assistance needed to fill program needs while helping to build a future for new water professionals.

Project Manager(s): Tim Feehan / Tom Browning

Program: CWCB Programs

Purpose: To provide funding for the CWCB Intern Sponsorship Program and associated operational expenses not covered by other funding.

Funding Available: July 1, 2016 – June 30, 2017

One World One Water Center
MSU Denver
CWCB Severance Tax - Potential Funding
November 9, 2015

1) Organize and host a Watershed Summit in Denver in June 2017 (this is a continuation of the Water Stewardship Conference held in Longmont, Colorado, on January 21, 2015, and the event in Denver in 2016). Sponsors would be the One World One Water Center at MSU Denver, City of Boulder Water Conservation Department, and Denver Water. Aurora Water, Colorado Springs Utilities and other groups would also be invited to be sponsors. Approximately 250 attendees –

   CWCB funding request - $10,000

2) Provide release time for MSU Denver faculty to work with the Englewood Public Schools STEM project K-12 teachers utilizing the South Platte River as a teaching tool. Focus would be on in-school and in-home water use, potential for conservation, and assessment of program effectiveness as it relates to water conservation and the value of water in the schools. The project would also include a Project WET (Water Education for Teachers) curriculum planning workshop for 20 teachers. MSU Denver Teacher Education faculty and Pre-Service teachers would help Englewood Public Schools teachers implement hands-on activities of the STEM project related to the South Platte River. This is a continuation of the work begun in 2015.

   CWCB funding request- $18,000

3) Continue the Colorado Water Archives internship program with MSU Denver.

   CWCB funding request - $10,000 (and would also like to develop ongoing Internship Agreement with CWCB)

4) A. Develop a new class in the MSU Denver Economics Department (cross-listed with the Environmental & Atmospheric Sciences Department) that studies the actual economics of the "value of water" and the interrelated nature of water efficiency and the value of water.

   CWCB funding request- $3,450 (faculty release time for course development)

   Total: $41,450

Quantifying Pumping-Induced Streamflow Depletion in the South Platte River Corridor

Dr. Ryan Bailey, Assistant Professor, rtbailey@engr.colostate.edu
Department of Civil and Environmental Engineering, Colorado State University

Location of the work. Centennial Well Field / South Platte River system (downstream of Chatfield Reservoir, south Denver)

Purpose. Stream-aquifer interaction has been studied intensively in Colorado during the last 50 years due to the important role it plays in water rights management in alluvial aquifer systems. Of prime importance is the impact of groundwater pumping on nearby streams, as streamflow is reduced due to pumping-induced infiltration of stream water into the aquifer. Typically, one-dimensional analytical models (e.g. Glover-Balmer, 1954; Hunt , 1999; Hunt, 2003) are used to determine streamflow depletion. However, these models rarely are tested against field data, in particular the actual volumes of stream water depleted from the stream channel. Furthermore, these models assume a large degree of hydraulic connection between the aquifer and the stream, which may not be the case in certain settings. For example, field work performed during a recent visit to the Centennial Well Field adjacent to the South Platte River downstream of Chatfield Reservoir indicated that indeed a strong hydraulic connection between the aquifer and the river is not present, despite an extended pumping period. As water conservation efforts continue throughout the state, a better understanding of these processes is needed.

The hypothesis motivating this project is that *available analytical and numerical groundwater models do not adequately represent pumping-induced groundwater-surface water interactions*. Using a combination of field data collection and modeling applications, the following research questions will be used to address this hypothesis: (1) What is the overall impact of high-capacity pumping on a reach of a nearby river? Specifically, what volume of river water is depleted due to the pumping? (2) What is the degree of hydraulic connection between the river and the aquifer during both long-term and short-term pumping periods? Does the hydraulic connection depend on time of pumping? Do the pumps' drawdown cones extend to the other side of the stream? (3) Can available models (analytical; numerical) account for the physical processes observed in the study region? If not, what modifications can be implemented to provide accurate processes in the models? This project provides training for a graduate student and an undergraduate student within the area of groundwater hydrology and water resources engineering.

Objective and Methods. The overall objective of this project is to determine the impact of high-capacity pumping on streamflow of a section of a major river. This will be accomplished using a combination of field data collection (streamflow, water table elevation, pumping flow rates) and model application for a reach (~300 m) of the South Platte River just downstream of Chatfield Reservoir in the south Denver area. The Centennial Well Field consists of 4 high-capacity pumping wells, with each well located within 200-400 ft of the river. Furthermore, pumping rates can be a significant fraction of streamflow during winter months, thereby allowing the effects of pumping on streamflow to be quantifiable. This project will be supplemented by Water

& Environmental Systems Technology, Inc. to install observation wells, and by Centennial Water District for site access. The objective will be accomplished by the following 4 tasks:

Task 1: Field Site Instrumentation. The monitoring system will consist of 6 observation wells on the side of the river where the pumps are located, and 1-2 observation wells on the opposite side of the river. Two observation wells will be located within 10 ft of the river, with the others located closer to the pumping wells. Stream depletion along the 300-m control volume of the South Platte River will be quantified by assessing streamflow at the upstream and downstream sections of the control volume using weirs and data loggers. Data loggers will be installed in the wells and at the gaging sites. [*Timeline*: Months 1-3; *Deliverables*: Monitoring Network]

Task 2: Data Collection and Analysis. Water level data will be downloaded from the data loggers frequently for quantifying spatial and temporal patterns of groundwater drawdown. Water level data will be used at the upstream and downstream sections of the river control volume to quantify inflows and outflows, with the difference assumed equal to stream depletion. Drawdown data in the wells immediately adjacent to the river, and also drawdown data in the wells on the opposite side of the river, will provide information regarding hydraulic connection between the aquifer and the river. [*Timeline*: Months 1-10*; Deliverables*: Data sets]

Task 3: Modeling Testing. Analytical stream depletion models will be tested against the drawdown data and estimated streamflow depletion to determine their applicability to the study site. Groundwater-surface water exchange processes in numerical models (e.g. MODFLOW) also will be assessed to determine their adequacy in representing physical processes of the study site [*Timeline*: Months 4-11*; Deliverables*: Model input files for a number of scenarios; Model results]

Task 4: Report Results: The final report will describe the methods, results of the research, and recommendations for expanding the work to larger scales. A CWI newsletter article will be written, and the results presented regionally. Peer-reviewed publication of this work will be pursued. [*Timeline*: Months 7-12*; Deliverables*: Final report, CWI newsletter article]

Budget and Budget Justification. The following table summarizes the proposed budget. Fieldwork and equipment costs include water level data loggers (Hobo Onset) for the monitoring wells and for stream gaging sites, and also travel costs for frequent trips to the study site (~180 mi roundtrip). Additional field equipment costs (observation well materials and installation, stream gaging equipment) and site access will be covered through partnership with Water & Environmental Systems Technology, Inc. and Centennial Water District.

Faculty Salary, 0.5 months	$5,200
Graduate Research Assistant, 12 months	$21,600
Tuition for GRA (1 semester)	$5,500
Undergraduate Research Assistant, 200 hours	$2,700
Fieldwork & Equipment	$4,400
Facilities and Administrative @ 15%	$5,910
Total	**$45,310**

Developing a Refined Groundwater Flow Model for the LaSalle/Gilcrest Area

Dr. Ryan Bailey, Assistant Professor, rtbailey@engr.colostate.edu
Department of Civil and Environmental Engineering, Colorado State University

Location of the Work. LaSalle/Gilcrest Area, Colorado

Background. The surface watershed of the South Platte River Basin (SPRB) lies on alluvial deposits that form an unconfined aquifer system connected with the surface water, with a thickness that reaches 200 ft in the lower SPRB. The aquifer, which sustains the base flow in the river, is recharged by infiltrations from precipitation and irrigation canals, as well as seepage from surface water bodies and streams. Conjunctive use of surface and groundwater resources in the SPRB is regulated accordingly with the 1969 Groundwater Administration Act (Senate Bill 81), which requires all non-exempt groundwater rights to come into priority. Following legislative changes that occurred in 2003-2004, water resources have been administered following strict priority rules since 2006, with all non-exempt wells required to have a decreed augmentation plan that replaces 100% of their estimated stream depletion. About 4,000 wells have been totally or partially curtailed from pumping during the last 6 years (Nettles, 2011), potentially resulting in reduced aquifer drainage and rising water table levels in several areas of the SPRB, including the LaSalle/Gilcrest area.

Project Objectives. The objectives of this project are to use a refined groundwater flow for the LaSalle/Gilcrest area to:

(1) Investigate reasons for high water table elevation in the area; and
(2) Explore the effect of best-management practices (BMPs) on water table elevation.

The model is being developed in a current project through funding from the Colorado Water Conservation Board (project ends June 30 2016), and will be further refined, calibrated, and tested in the proposed project. Potential refinements include implementing unsaturated-zone flow into the model and using the USG (UnStructured Grid) version of MODFLOW (Panday et al., 2013). The model will be run for the time period 1990-2012, thereby assessing groundwater flow dynamics and water table fluctuation patterns before and after well curtailment.

Methods. The project objectives will be accomplished by the following 3 tasks:

Task 1: Model Refinement
The model being developed in the current CWCB project is based on the SPDSS groundwater flow model, with spatial discretization (horizontal cell size, vertical layering) refined to depict spatial variations in water table elevation more accurately for the LaSalle/Gilcrest area. For the proposed project, groundwater flow in the unsaturated zone will be simulated using the Unsaturated Zone Flow (UZF) package of MODFLOW, which has been used successfully in similar agricultural regions of Colorado (e.g. Arkansas River Valley). Including the UZF package is important due to the dependence of shallow groundwater on near-surface processes

such as infiltration, evaporation, and plant transpiration. Main inputs to the UZF package are infiltration from rainfall, applied irrigation water, canal seepage, and recharge pond water. A potential refinement could be the conversion of the model to the USG version of MODFLOW, to enable locally refined grid cells near pumping wells, canals, and hydro-stratigraphic units. This conversion will take place if time allows.

Task 2: Model Calibration and Testing

Model results for the years 1990-2012 will be tested against measured water table elevation from observation wells in the region. Model parameters (hydraulic conductivity) will be modified within acceptable ranges to minimize residuals between simulated and observed values. Newly acquired pumping test data within the Gilcrest area will be used to constrain aquifer parameters.

Task 3: Assess Causes of High Water Tables and Effect of BMPs

The tested model will be used to assess the cause of water table fluctuation during the 1990-2012 time period and, most importantly, the cause of rising water table elevation during the post-2006 time period. This will be accomplished using sensitivity analysis, with each system stress (e.g. irrigation water, canal seepage, recharge pond infiltration, pumping) analyzed for its impact on water table elevation and overall groundwater storage. Results of the model simulations will yield a ranking of stress influence and also identify the source/sink that could have the largest effect on decreasing water table elevation. Using these results, a final set of simulations will be run to determine the effect of implementing single and multiple BMPs, including scenarios of increased groundwater pumping and decreased surface water delivery for irrigation. For each scenario simulation, the volume of streamflow depletion from the South Platte River will be estimated and compared with results from analytical models (e.g. Glover, Hunt solutions).

Deliverables. At the end of year (June 30, 2017), a final technical report describing project activities, analysis results, and findings will be submitted to the CWCB. In addition, the PI will meet with CWCB representatives at least twice during the project duration, either at the CSU campus or at CWCB offices to best coordinate projects activities and discuss project progress and future direction.

Completion Date. This project will be completed by June 30, 2017. All deliverables will be provided to the CWCB on or before that date.

Budget and Budget Justification. The following table summarizes the proposed budget.

0.75 Month Faculty Salary[1]	$9,656
12 Month PhD half-time Salary[2]	$27,694
1 semester tuition and fees	$5,462
Indirect Cost (15% rate)	$6,422
Total	**$49,234**

One PhD student will be hired as a Graduate Research Assistant and supported financially in this study. PhD student salary includes $1700/month during each semester and $3,500/month during the summer.

[1]Includes 25% fringe [2]Inclues 5.5% fringe

Memorandum

To: Tim Feehan (Colorado Water Conservation Board), Dr. Reagan Waskom (Colorado Water Institute

From: Dr. Perry Cabot

Date: 2/4/2016

Re: Additional funding to support continuation of CWI Project entitled "Agronomic Responses to Partial and Full Season Fallowing of Alfalfa and Grass Hayfields

This memo supplies information regarding the request for an additional $5,000 to support an additional season of data collection for research under the CWI Project entitled "*Agronomic Responses to Partial and Full Season Fallowing of Alfalfa and Grass Hayfields*." This project is embedded within the larger goals of the project partially-funded by the CWCB, entitled "*Colorado River Water Bank Feasibility Study Phase 2B*" that is administered through the Colorado River District.

The bulk of this research was conducted by Prof. Joe Brummer and his graduate student Lyndsay Jones. Ms. Jones recently received her Master's Degree from the Department of Soil and Crop Sciences for her thesis entitled "*Agronomic Responses of Grass and Alfalfa Hayfields to No and Partial Season Irrigation as Part of a Western Slope Water Bank*." Ms. Jones degree schedule did not allow time for her to finish evaluating the recovery behavior of the crops in 2015. We are pleased to say that Ms. Jones has gone on to secure employment as a Lead Feed Technician at Aurora Organic Dairy. Since the completion of her thesis, Dr. Perry Cabot has taken on a supervisory role in the project, and has utilized a graduate student (Sumit Gautam) and AES personnel to continue evaluating the recovery behavior of the stressed crops.

The first phase of project results indicates that reduced irrigation may improve forage quality slightly, but will significantly reduce yields during the stress year. When irrigation is returned after one year of partial irrigation, forages may have increased quality due to reduced fiber content, but grass yields will likely not fully recover while alfalfa yields may recover depending on length and severity of reduced irrigation. Due to its ability to recover, using partial season irrigation similar to that of the SA2 treatment on alfalfa hayfields may be the most practical approach to make water available to a Western Slope water bank.

The diminishment of yield would be offset by a compensatory structure, paying the farmer for impacts to their farming operations in return for forgone diversions of their irrigation water. Continual dialogue with farmers will be necessary in order to determine the best compensatory structure to support agricultural sustainability and profitability, while still providing a pathway for agriculture to play a role in offsetting basin-wide water shortages.

- ***Summary of Field Sites.*** Grass and alfalfa (Medicago sativa L.) hayfields may be ideal for inclusion in a Colorado Water Bank as they are the primary users of agricultural water in this region and may have a greater ability to withstand water stress in comparison to other crops. This study was conducted to determine effects of withholding irrigation for a full season from high elevation grass hayfields and implementing partial season irrigation on lower elevation alfalfa hayfields on forage yield, nutritional quality, and associated recovery period to confirm if this approach is worth pursuing.

  In 2013, grass hayfield sites at 4 locations were established and subsequently resampled in 2014 to determine crop recovery after a two year period of split-season irrigation. High-elevation, grass hayfields were selected that typically irrigated using "wild" flood irrigation and most produce 1 cutting annually. Sites were located in Kremmling, Hayden, Gunnison and Steamboat Lake. The grass hayfields were split into side-by-side plots, one of which was irrigated normally as the control while the other was subjected to total

cessation of irrigation. Both plots were fully irrigated in the second year of the study (2014). Three established alfalfa fields were subjected to irrigation treatments including normal irrigation (control), irrigation stopped after the 1st cutting (SA1), and irrigation stopped after the 2nd cutting (SA2) for 2 consecutive years. These plots were returned to full irrigation in 2015.

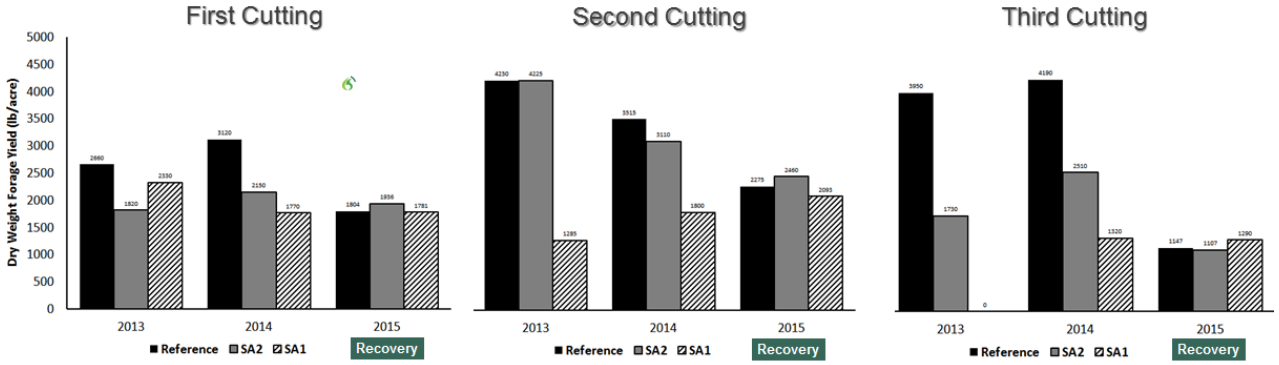
- ***Summary of Yield Data.*** In Year 1 (2013), average dry matter yields in non-irrigated grass plots were reduced to 39% (2497 kg ha-1) of the control (6377 kg ha-1). Yields of non-irrigated grass plots did not fully recover when returned to irrigation in Year 2 (2014) producing 49% (3623 kg ha-1) of the control (7442 kg ha-1). One of the grass sites that was able to be sampled after returning to full irrigation for 2 years, yields had fully recovered.

  Averaged over both years, SA2 alfalfa plots maintained production similar to the control in the 1st and 2nd cutting while SA1 alfalfa plots were reduced to 61% (2089 kg ha-1) of the control (3430 kg ha-1) by the 2nd cutting. By the 3rd cutting, SA2 and SA1 alfalfa yields decreased to 53% (1804 kg ha-1) and 30% (1013 kg ha-1) of the control, respectively. On a total season basis, both alfalfa plots receiving partial season irrigation were reduced with SA2 plots producing 72% (7880 kg ha-1) and SA1 plots producing 33% (3650 kg ha-1) of the control (11040 kg ha-1).

- ***Summary of Forage Quality Data.*** Neutral detergent fiber (aNDF) concentration - *a measure of forage quality* - in non-irrigated grass plots was 5% lower while crude protein (CP) content was 30% greater than the control. In-vitro true digestibility (IVTD) was unaffected by irrigation treatment. When returned to irrigation, aNDF concentrations were still reduced by 8% and CP contents were similar to that of the control.

  The aNDF concentrations were greatest in the control at 34.6% and lowest in SA1 alfalfa plots at 28.2%. By the 2nd cutting, SA1 plots had the highest IVTD (80%), and by the 3rd cutting, S2 and S1 plots were equally greater (80%) than the control (75%). Effects on CP content were inconsistent.

- ***Additional Research Expenses.*** Results from one of the research sites are depicted below for in Eckert, CO.



This project has been favorably received by the Colorado Water Institute Advisory Board and the partner members of the Colorado Water Bank Workgroup. Of particular interest to the CWI Board was the recovery of the forage crops during the 2015 season. In the figure above, for instance, the second cutting of alfalfa in 2015 displayed consistent yields among all field sites. The "fully irrigated" reference plot diminished in yield, whereas the most stressed field (SA1 - "stop irrigation after first cutting") gained yield each year eventually becoming consistent with the reference plots in 2015. These findings suggest value in continuing to examine the recovery of these plots through 2016. A modest research budget will enable this research to continue, as summarized below:

Description	***Cost***
○ Student Hourly (8 months @ 4.33 wk/month @ 10 hr/wk @ $12/hr)	$ 4,156.80
○ Travel Budget (60 mi @ 2 trips/mo @ 6 month @ $0.51/mile	$ 367.20
○ Laboratory Feed Analysis	$ 470.00

PROJECT TITLE: Colorado Irrigation Center Design and Concept Development

PRINCIPAL INVESTIGATORS (CO-PIs): Dr. José Chávez, Associate Professor, Civil and Environmental Engineering, Colorado State University; 970-491-6095; Jose.Chavez@colostate.edu

Dr. Reagan Waskom, Director, Colorado Water Institute and Chair of Colorado Water Center; Colorado State University; 970-491-6308; Reagan.Waskom @colostate.edu

Dr. Stephen W. Smith, Owner, Buena Vida Farm and Wade Water LLC, 970-222-9680, swsmith@buenavidafarm.com

LOCATION WHERE THE WORK IS TO BE CONDUCTED: This project will be conducted at the Colorado State University (CSU) – **Agricultural Research, Development and Education Center** (ARDEC), north of Fort Collins, Colorado.

PURPOSE OF THE RESEARCH

Current pressures on available water supplies in the western U.S. are creating unprecedented political, sociological, engineering, and management issues for practitioners in the irrigation sector. This includes both the agricultural irrigation and landscape irrigation sectors of the irrigation industry. Climate change, extended drought periods, and population forecasts portend significant future water shortages due to the combination of increased demand and probable long term reductions in water supplies. The western U.S. has experienced severe, and even exceptional-rated, drought for much of the past decade. Competition has increased for a limited water resource from agriculture, growing municipalities and the environment. Over 70% of water diverted from western rivers goes to irrigation demands, thus the irrigation industry is the primary target for change and improvement as water becomes increasingly scarce. Technology, large data, management and information systems currently exist that can significantly upgrade irrigation system efficiency, but they have not yet been widely implemented in most of the world, including the western U.S. Additionally, several state and federal water related agencies such as the US Geological Survey and USDA Agricultural Research Service / Water Management Unit have science staff located in close proximity to Colorado State University, uniquely positioning this area to be a global center of activity with respect to irrigation and water management. What is missing is a not-for-profit, non-advocacy, non-proprietary training organization that can serve as a connector and nucleus for this economic cluster. There are also strong potential synergies between Colorado State University, Colorado Water Innovation Cluster, Irrigation Association, Irrigation Foundation, and numerous irrigation equipment manufacturers with opportunities for joint collaborations in demonstrations, technology transfer, tailored workshops, certifications, and student training. In particular, CO Division of Water Resources has raised the need of an irrigation center in CO. Thus, this project will develop a 5-year business plan for the design and operation of a Colorado Irrigation Training and Demonstration Center (CITDC).

OBJECTIVES and METHODS

The main objective of this project is to develop a business plan to create and operate a Colorado Irrigation Training and Demonstration Center (CITDC) within Colorado State

University (ARDEC). A partnership is proposed between private business and the public sector to create a new Center of excellence in irrigation automation, SCADA, modernization, evaluation, management, training to enhance the economic and environmental opportunities for water sharing arrangements in CO, the U.S. and across the globe.

The CITDC concept development will revolve around the envisioned goals of the center which are listed below:

- Develop a state of the art instrumented location to showcase current irrigation technologies (hardware, software and management systems)
- Provide hands on training in the use of new irrigation technologies to diverse clientele – field days, short courses, distance education and semester long graduate and undergraduate courses
- Provide on-site evaluation of irrigation systems and technology
- Provide a clearinghouse of irrigation information for Extension, NRCS, consultants and industry personnel
- Provide training and outreach to irrigated crop producers
- Develop certification training and continuing education for professional irrigation practitioners
- Use instrumented hydraulics lab to certify and test gates and sensors, and as a training site for industry personnel, students and international visitors
- Help train the next generation of irrigation engineers and water managers

In that regard, the sub-objectives of this proposal are to: 1) establish a consortium of interested parties that will help develop a business plan for the CITDC, 2) design the center physical plans (e.g., buildings, equipment), 3) identify entities and obtain commitments (pledges) to support the creation of the CITDC (e.g., instruments, equipment).

In order to achieve the established goals the following steps will be followed:

a) (Sub-objective 1): Contact potential collaborators (listed at the end of the proposal) and hold face to face (at least 6) meetings and phone (as well as Skype) conference calls (as needed). Visit two established irrigation centers (i.e., Center for Irrigation Technology at Fresno State, and the Irrigation Training and Research Center at Cal Poly) in CA to learn about their business model and structure.
b) (Sub-objective 2): Work with an hourly student and a member of the Irrigation Association (to be contracted) based on outcomes from the previous objective.
c) (Sub-objective 3): Contact and visit federal, state and local agencies as well as the irrigation industry to obtain pledges for acquiring (or develop) irrigation equipment, instruments, sensors, teaching/training/testing material, and other needed support for the center.

Project timeline: July 1st 2016 through June 30th 2017.

Progress reports will be made available quarterly (i.e., every three months).

BUDGET AND JUSTIFICATION

This agreement is for a maximum of $49,876 budgeted as follows.

Salary (one month, co-PI Chávez; $11,344)	$11,344
Fringe benefits (@ 25.4%)	$ 2,881
Hourly student salary and fringe (1260 hrs)	$15,845
Sub-contract with Irrigation Association	$ 5,000
Travel to irrigation centers in CA (four tickets)	$ 6,000
Mileage for trips to meetings in CO	$ 1,100
Group meetings, venues, refreshments	$ 1,200
Subtotal	$43,370
Indirect cost (@ 15%)	$ 6,506
Total	$49,876

These funds will pay for 1 month salary of co-PI Chávez, hourly student 1260 hours (part time during regular semesters and full time during summer months), Irrigation Association consulting costs, trips within the state and to CA, and group meetings.

Department Head Contact: Dr. Charles D. Shackelford, Civil and Environmental Engineering, 970-491-5051, charles.shackelford@colostate.edu

Department Accountant Contact: Pre-award Valorie M. LeFebre, 970-491-6628, valorie.lefebre@colostate.edu; Post-award Rebecca (Becky) A. Burke, 970-491-3943, rebecca.burke@colostate.edu

OSP Team Leader Contact: Jennifer E. Strange, 970-491-2083, jennifer.strange@colostate.edu

Potential Collaborators: Chris Thornton (CSU, ERC), Zach Thode (Rubicon), Colorado DWR, CSU Civil & Environmental Engineering and Soil and Crop Sciences Departments (among others) irrigation related faculty, CSU ARDEC administration, CO Ag Experiment Station , CSU Extension, USDA ARS and NRCS, Aqua Engineering, Irrigation Association (IA), USCID, etc.

Pre-Proposal to Colorado Water Institute FY2016 Water Research Program
Title: Data Collection and Analysis in Support of Improved Water Management in the Arkansas River Basin, Phase 3
Principal Investigator: T. K. Gates, Prof. (tkg@engr.colostate.edu), **Co-Principal Investigator**: Jeffrey D. Niemann, Assoc. Prof.; *Civil and Environ. Engrg. Dept., CSU*

Location: Arkansas River Basin, Colorado

Purpose of the Research: The Arkansas River, drawing from Colorado's largest watershed (more than 28,000 mi^2), serves as a vital part of the State's water resource system. In the years to come, important decisions, including long-term investments in infrastructure and amended management practices, will need to be made in Colorado's Arkansas River Basin to enhance overall beneficial water use, redress serious problems of water quality degradation (e.g., salinity, selenium, uranium, and nutrients), conserve water, and find innovative ways (e.g., the Super Ditch) to address mounting pressures for increased diversions out of the Basin.

A reliable database is needed to allow characterization of the Basin's stream-aquifer system and to undergird both existing and future modeling tools, including the proposed Arkansas Basin Decision Support System (Ark DSS). Data on both surface and subsurface waters are needed in both the mountainous Upper Arkansas River Basin (UARB), above Pueblo Reservoir, and in the agriculturally-intensive Lower Arkansas River Basin (LARB). For over 16 years in the LARB and 4.5 years in the UARB, Colorado State University (CSU) has conducted extensive field monitoring to build such a database. *The project proposed herein constitutes the third phase of project that began in FY2014 (Phase 1). The purpose is to collect and analyze key field data in representative regions of the Arkansas River Basin needed to maintain and enhance a database in support of improved water management. Thereby, this project will prevent interruption of long-term data collection efforts.*

Objectives: The data-focused objectives of this one-year project are:

(1) Gather data on water table levels and water quality in existing groundwater monitoring wells distributed over representative study regions in the UARB and LARB, for characterization of the aquifer system and to support flow and solute transport models developed by CSU, the Lease-Fallowing Water Accounting Tool, and the proposed Ark DSS to be developed over the coming years by the Colorado Water Conservation Board;
(2) Gather data on water quality, water levels, and flows at selected sites along canals, tributaries, and the main stem of the Arkansas River in the UARB and LARB to characterize the stream system and to support current and future models;
(3) Conduct quality-control tests of the gathered data and enter them into the SQL database for the Arkansas River Basin developed and maintained by CSU; and
(4) Conduct a preliminary analysis of the data gathered under this project and summarize in a final report for use in system characterization and model support.

Methods: About 150 landowners provide access to water sampling sites in the UARB and LARB. *Site availability provides valuable in-kind matching support for this proposed project.* Data on groundwater and surface water quantity and quality were gathered during 4 sampling events at numerous locations in Phase 1 in the UARB between July 2014 and April 2015 and during 6 sampling events in the LARB in between May 2014 and June 2015. In Phase 2, similar field data have been gathered so far during events

in July and August 2015 in the UARB and in August 2015 in the LARB. Field data on water table depth and in-situ water quality parameters (electrical conductivity, temperature, pH, dissolved oxygen, and oxidation reduction potential) will continue to be gathered at about 18 existing groundwater monitoring wells in a study region in Chaffee County in the UARB and about 60 to 70 groundwater monitoring wells in two study regions within Otero, Bent, and Prowers Counties in the LARB. Three to four sampling events will be conducted in each of the three study regions. During one sampling event in both regions of the LARB, water samples will be extracted from 30 to 40 wells and analyzed for major dissolved ions, nutrients, selenium, and uranium. Similar water samples will be taken from UARB wells during one sampling event. Water quality samples will be analyzed by EPA-approved laboratories. In-situ water quality parameters will be measured during the sampling events at about 22 surface-water sites in the UARB and at about 30 to 50 sites in the LARB. Flow rates will be measured at about 8 of the surface-water sampling sites in the UARB. If available funds permit, pressure transducers will be installed in stilling wells to monitor water level changes (hourly intervals) near flow-measurement locations within two or three key tributaries that are not equipped with permanent stream gauges.

Standard procedures and protocols will be followed in maintaining equipment for field measurements and sample collection. Field data will be checked to ensure that values are physically reasonable and will be subjected to statistical outlier tests in comparison with previously collected data.

Data will be added to CSU's SQL database (compatible with Colorado Division of Water Resources HYDROBASE). Preliminary data analysis will describe spatiotemporal variability of measured values and basic statistical characteristics in relation to previous data gathered in the study regions. Field measurement methods, along with procedures and results of preliminary analysis, will be documented in a final project report.

Timeline, & Completion Date: Data collection under Phase 3 is planned to commence in July 2016. Two irrigation season sampling trips and one to two off-season trips are planned for each study region in the UARB and LARB. Data will be checked and entered into the database over the course of the one-year project. Final data analysis will commence on about 1 March 2017 and a final report will be prepared. The project is scheduled for completion on 30 June 2017.

Budget: An estimated budget is summarized in Table 1.

Table 1. Estimated Project Budget ($) (July 2016 – June 2017)

Salaries	18215
Travel	9338
Materials and Supplies	2375
Laboratory Analysis	13550
Indirect Costs (15%)	6522
TOTAL	50000

Budget Justification: Included are about 750 person-hours of undergraduate student effort and 0.5 person-months of faculty effort; mileage, per diem, and accommodations; parts/maintenance for multi-probes, pressure transducers, sampling pumps, acoustic Doppler velocimeters; water sample filters; sample bottles and preservatives; calibration solution; field books; and other miscellaneous supplies. Costs of laboratory analysis are based upon recent quotes from respective laboratories.

Dept. Head Cont. Info.: Chuck Shackelford, 491-5049, shackel@engr.colostate.edu.

Enhanced Open Data for Colorado's Water Resources

Principal Investigators:
Reagan Waskom, Colorado Water Institute (CSU), 970-491-6308, reagan.waskom@colostate.edu
Steve Malers, Open Water Foundation (OWF), 970-286-7462, steve.malers@openwaterfoundation.org

Location of the work and project team: The work will be performed in Fort Collins utilizing a CSU student intern in collaboration with the Open Water Foundation (OWF), a Fort Collins nonprofit that focuses on open source software and open data for water resources. OWF works with CSU on various projects and employs CSU interns on an ongoing basis.

Purpose of the Research: The proposal is being submitted under priority research topic "Developing and disseminating open source data systems for Colorado". The purpose of the project is to increase public access to State of Colorado water resources data and information, consistent with the State's desire to promote open data initiatives. There is a need to provide open data access both to increase the amount of data that are accessible, and also to increase the effectiveness and efficiency of using such data. Improved access to data will allow integration of datasets to address larger and more difficult issues such as those addressed in the Colorado Water Plan (CWP). Currently, the following barriers exist to accessing data:

- Lack of open data policies and governance
- Lack of standard data formats, and data formats that are difficult to use
- Lack of metadata and documentation explaining the data and how a dataset can be used
- Lack of software that can be used by the public to access open data

A number of State efforts, such as CWP, Statewide Water Supply Initiative (SWSI), and Basin Implementation Plans (BIPs), could benefit from improved implementation of open data protocols. Although the State has made progress (such as use of data.colorado.gov) available data are not being used in an integrated way to publish and support important efforts such as the CWP. This project will focus on developing working examples of open data for important efforts such as the CWP, SWSI, and BIPs that will demonstrate protocols for publishing data using open data standards. This will allow the public and organizations to use the data in a variety of analyses and leverage existing work as much as possible.

Objectives:

1. Determine standards and implement working examples of data sets formatted for open data (for example data products mentioned in the CWP and SWSI). The goal is to increase publishing CWP and SWSI data in open data formats and enable increased use of such datasets.
2. Expand the use of water data available on data.colorado.gov by providing documentation and working examples of how to use the data in common tools such as Microsoft Excel, Google Maps, Google Earth, and other technologies.

3. Enhance software in Colorado's Decision Support Systems (CDSS), such as TSTool, to interface with the Socrata software web services provided on the data.colorado.gov website, for example to automate reading datasets such as population, water resources, and economics data.
4. Facilitate State of Colorado staff in publishing additional datasets on data.colorado.gov, to facilitate increased use of open datasets.

Method (Approach): If awarded, one or more CSU students will be identified to work with OWF technical leadership. The following broad tasks are envisioned:

1. Review Colorado Water Plan, SWSI, and Basin Implementation Plans to identify important datasets that can benefit from an open data approach. Coordinate with CWCB staff to select datasets.
2. Determine how best to format the datasets for download from the CWCB website and/or data.colorado.gov. Develop working examples and documentation for creating and using the datasets, for example in Microsoft Excel, Google Maps, and Google Earth. These examples can serve as templates for CWCB staff and consultants who develop datasets for studies.
3. Enhance CDSS software to read data from the Socrata web services provided by data.colorado.gov using Socrata Open Data API (SODA). This capability will allow CDSS tools to automate access to open data available on data.colorado.gov, which will facilitate integrated water resources planning.
4. Present the results of the project to CWCB staff, Basin Roundtables including education subcommittees, webinars, university seminars, etc., as appropriate.

Timeline and Completion Date: The scope is expected to be substantially completed within the first eight months after signing the contract, with follow up based on feedback.

Deliverables: Deliverables will include open data documentation guidelines, and open datasets from the Colorado Water Plan, SWSI, and/or BIPs, suitable as examples for CWCB staff and consultants that may publish open data. CDSS software will also be updated. OWF recommends that deliverables be managed in open source cloud repositories such as GitHub that allow easy access by various stakeholders and users of products.

Budget: $50,000 is being requested for this project, with distribution estimated as follows (final distribution will be based on available student intern resources):

- $15,000 to $20,000 – CSU student intern for one year
- $30,000 to $35,000 – OWF technical team

Budget Justification: Budget will be used to pay for software developers and technical leadership at OWF, and CSU student(s) to perform tasks to improve open data access. The resulting work can be leveraged by State staff and consultants on efforts such as SWSI, as well as by university researchers.

Department Head Contact Information: Reagan Waskom
Department Accountant Contact Information for Pre and Post Award: Nancy Grice
Office of Sponsored Programs Team Leader Contact Information: TBD

Investigation of the Effects of Whitewater Parks on Trout and Native Fishes in Colorado

Dr. Christopher Myrick, Professor
Department of Fish, Wildlife and Conservation Biology
Dr. Brian Bledsoe, P.E., Professor
Department of Civil and Environmental Engineering
Colorado State University

Location of the work: The research involves hydraulic modeling and flume experiments that will take place at Colorado State University. Supplemental field surveys of hydraulic structures and existing conditions on one or two existing whitewater parks (e.g., the Colorado River at Pumphouse or the Uncompahgre River) will also be performed.

Purpose: An improved understanding of the fundamental hydraulic processes and potential environmental effects of whitewater parks (WWPs) is needed to inform management decisions about Recreational In-Channel Diversions (RICDs). This is the first study of its kind that integrates computational fluid dynamic (CFD) modeling and a swimming performance study of a Colorado native fish to assess how WWP structures may affect aquatic resources. Given the lack of data on the effects of WWP on fish movement, especially native fishes, this analysis of swimming performance and the physical processes affecting passage at WWPs will provide important information on the effects of WWPs and other hydraulic structures on longitudinal connectivity and how these effects on trout and native fishes can be mitigated through appropriate design. This work will provide engineers and natural resource agencies with novel species-specific guidelines for the allowable velocities for upstream movement of mottled sculpin (*Cottus bairdi*).

Objectives, methods, timeline and completion date: Our objectives are to understand the swimming performance of a representative native fish species and link those findings with modeled hydraulic changes resulting from WWPs, test the transferability of fish passage findings to different structure and river sizes, and demonstrate design techniques in an actual project. We will address current knowledge gaps regarding native fish species by utilizing a swimming performance study for mottled sculpin, as well as existing databases and measurements of fish movement in Colorado. We will link these data to detailed descriptions of hydraulic characteristics based on field measurements and CFD modeling at an existing and proposed WWP site. By analyzing fish passage at two locations (Colorado River at Pumphouse and St. Vrain River at Lyons, CO), we can test the transferability of our previous findings to different river scales. In addition, innovative fish passage designs will be demonstrated in the collaborative design of an actual whitewater park in Fort Collins. The swimming performance study and 2-d modeling of pre-construction vs. as-built WWPs will take place concurrently in months 1-7. Integration and data analysis will occur in months 8-

10. Reporting requirements, including one or more CWI newsletter articles, will be fulfilled in months 10-12. Completion date will be one year after notice to proceed.

Task 1: Swimming Performance Study: Mottled sculpin swimming performance will be measured in recirculating swimming flumes with both constant acceleration tests, where water velocity is increased at a constant rate until the fish is exhausted, and with fixed velocity tests, where the fish's endurance at a fixed water velocity is measured.

Task 2: Field Data Collection: Supplemental measurements of channel geometric characteristics are needed for 2-d hydraulic modeling. We will utilize existing surveys and topographic datasets to the maximum extent possible but anticipate that additional data will be necessary to provide the detail needed for accurate modeling.

Task 3: Hydraulic Analysis: River2D will be used to compare pre-construction and as-built hydraulic conditions of two WWPs.

Task 4: Integrate Hydraulic Modeling and Fish Swimming Studies: Link observed swimming performance of mottled sculpin and other native fish species and nonnative trout to develop improved design criteria. Emphasis will be placed on practical 2-d modeling for design.

Task 5: Report Results: A report describing the results of the swimming performance study and modeled effects of WWPs on trout and native fish passage will be provided to CWI and CWCB. Deliverables: Final report and a M.S. thesis / technical report.

Budget and Justification (For budget justification, please see detailed tasks above.)

Task	**Budget**
Task 1: Swimming Performance Study	$17,230
Task 2: Field Data Collection	$4,732
Task 3: Hydraulic Analysis	$6,185
Task 4: Integrate Hydraulic Modeling and Fish Swimming Studies	$10,760
Task 5: Report Results	$3,700
Facilities and Administrative @ 15%	$6,391
Total	$48,998

Contacts: Dr. Charles Shackelford, Head, Department of Civil and Environmental Engineering (shackel@engr.colostate.edu, 970-492-5049), Dr. Ken Wilson, Head, Department of Fish, Wildlife, and Conservation Biology (Kenneth.Wilson@colostate.edu, 970-491-5020), Cathy Smith, pre-award (cathy@engr.colostate.edu, 970-491-5914), Becky Burke, post-award (Rebecca.Burke@colostate.edu, 970-491-3943), Jennifer Strange, OSP Team Leader (jennifer.strange@colostate.edu, 970-491-2083).

Colorado Water Institute
FY 2016 Full Proposal

1. **Title. Aquifer Storage and Recovery – Fountain Formation**

2. **Principal investigator name(s) and university.**

Dr. Tom Sale
Associate Professor
Civil and Environmental Engineering, Colorado State University
970-491-8413 TSale@engr.colostate.edu

Dr. Mike Ronayne
Associate Professor
Geosciences, Colorado State University
Michael.Ronayne@colostate.edu

Dr. Sally Sutton
Associate Professor
Geosciences, Colorado State University
Sally.Sutton@colostate.edu

3. **Location** - Colorado State University and Northern Colorado

4. **Purpose of the research –**

Aquifer storage and recovery (ASR) is emerging as promising strategy for water storage in Colorado. Potential attributes of coupling ASR to existing infrastructure include reduced losses to evaporation and seepage, lower costs, and greater reliance including drought storage.

Recent research at CSU has led to the realization that the Fountain Formation in Northern Colorado could be a remarkable resource for ASR. The Fountain Formation in Northern Colorado

- Lies immediately above the crystalline rock of the Front Range.
- Is composed of approx. 800 feet of interbedded sandstones and siltstone.
- Extends along the Front Range, is largely undeveloped, and appears to be largely isolated by surrounding aquitards and structural features.
- Dips to the east providing the potential for large yields due to the potential to apply large drawdown or mounding.

- Lies in close proximity to key complementary infrastructure associated with the Colorado Big Thomson project and the cities of Northern Colorado.

The purpose of this project will be to synthesize and apply available data to assess the feasibility of incorporating ASR in the Fountain Formation into Colorado's water supply infrastructure.

5. **Objectives, methods, timeline and completion date.**

The overarching objective for this study is to investigate the feasibility of ASR in the Fountain Formation in Northern Colorado. The focus on Northern Colorado reflects favorable geologic condition in the Fountain Formation in Northern Colorado. Study elements will include:

- **Task 1 - Developing a conceptual hydrogeologic model** for the Fountain Formation in Northern Colorado. This will include synthesizing available data to describe the geologic framework (stratigraphy, major geologic structures) and estimate aquifer properties. Data sources will include the USGS, State Engineers Office (Aqua Maps), and Colorado Geologic Survey.
- **Task 2 - Applying CSU's well field superposition model** to evaluate the hydraulic performance of the two or more portions of the Fountain Formation.
- **Task 3 - Applying CSU's subsurface water storage assessment model** to evaluate the performance and cost of at least two Fountain Formation ASR projects.
- **Task 4 - Exploring water quality** issues that could affect the feasibility of using the Fountain Formation for water storage

All work will be completed in a one-year time frame. Result from all of the work will be documented in a comprehensive report

6. **Budget. - $50,000**

7. **Budget justification.** Funds will be split between a full-time master student and faculty including Drs. Sale, Ronayne, and Sutton. Complementary support will come from currently supported students including Azia Alqahtani / Civil and Environmental Engineering and Cat Cannan / Geosciences.

	Total
PERSONNEL SALARIES	
Academic Faculty:	$22,289
Fringe Rate	$5,661
Administrative Professional:	$863
Fringe	$219
GRA's:	$15,200
Fringe	$1,094
TOTAL SALARY:	$38,352
TOTAL FRINGE:	$6,974
TOTAL PERSONNEL:	$45,326
OTHER DIRECT COSTS	
In-State Tuition:	$4,674
TOTAL OTHER DIRECT:	$4,674
TOTAL DIRECT COSTS:	$50,000
TOTAL:	$50,000

8. **Department Head Contact Information.**

   Chuck Shackelford / Civil and Environmental Engineering / 970-491-5051 / shackel@engr.colostate.edu

   Rick Aster / Geosciences / 970-491-7606 / Rick.Aster@colostate.edu

9. **Department Accountant Contact Information for Pre and Post Award.**

   Cathy Smith / 970-491-5914 / cathy.smith@colostate.edu
   Heather Ihde / 970-491-3521 / Heather.Ihde@colostate.edu

10. **Office of Sponsored Programs Team Leader Contact Information.**

    Jennifer Strange / 970-491-2083 / jennifer.strange@colostate.edu
    Kristine Miller / 970-491-1552 / Kris.Miller@colostate.edu

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Robert Randall, DNR Interim Executive Director

James Eklund, CWCB Director

Severance Tax Operational Fund

Proposed Project for Fiscal Year 2016 – 2017

Project No. 32

Applicant: U. S. Geological Survey

Project Title: Snow-depth Mapping using Small Unmanned Aircraft Systems

Recommended Amount: $ 0
Requested Amount: $98,400

Description of Project: This demonstration project will test a unmanned aircraft system (UAS). The instruments aboard have been integrated into a single, operating unit capable of returning latitude, longitude, and elevation. A bare-earth topographic model will be developed based on flights during the snow-free season. Using the same flight path, multiple flights will be conducted during the snow-cover season to map snow-surface topography and calculate snow depth by difference based on a bare-earth topographic model. Snow depths will be derived by the UAS (snow depth elevations minus bare earth elevations) and will be interpolated to produce basin-wide snow depth grids with a 1 m resolution.

Project Manager(s): Joe Busto

Program: Watershed and Flood Protection Program

Purpose: Snow-depth mapping in high-elevation snow-covered basins using small unmanned aircraft systems (sUAS).

Funding Available: July 1, 2016 – June 30, 2017