COLORADO
Colorado Water Conservation Board
Department of Natural Resources

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John Hickenlooper, Governor

Robert Randall, DNR Executive Director

Rebecca Mitchell, CWCB Director

TO: Colorado Water Conservation Board Members

FROM: Lauren Ris, Deputy Director
Steve Biondo, Finance Manager

DATE: May 23 - 24, 2018, Board Meeting

AGENDA ITEM: Agenda Item 10 – Severance Tax Operational Fund Grants

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Introduction

CWCB is entitled to an amount up to a 5% share of the Severance Tax Operational Fund. In April 2018, CWCB received internal requests and outside applications for funding that becomes available from the Operational Fund in July 2018 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). This year Staff has included a ranking of High, Medium and Low for each project in the event that CWCB's share of the Severance Tax Operational funding is reduced prior to July 1, 2018.

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 – 25 and projects not recommended are numbered 26 - 30.

Table 1
SEVERANCE TAX OPERATONAL FUND PROJECTS
FOR FUNDING FROM JULY 1, 2018 TO JUNE 30, 2019

No.	Applicant	Project Name	Funding Recommended	Priority
1	CWCB	Work related to Recreational Projects	$ 40,000	High
2	CWCB	Colorado River Modeling	$ 75,000	High
3	CWCB	CSU Water Resources Archive	$ 20,000	High
4	CWCB	Decision Support System – Colorado River Technical Services	$ 99,000	High
5	CWCB	Bear Creek Lake Water Rights Engineering	$ 98,000	High
6	CWCB	Traveling Colorado River Museum Exhibition	$ 25,000	High
7	Colorado Geological Survey	Colorado Groundwater Atlas Update	$ 50,000	High
8	Colorado Geological Survey	County Groundwater Resource Series, Year 7	$ 40,000	Medium
9	Open Water Foundation	StateDMI Web Services	$ 25,000	Medium
10	Open Water Foundation	StateMod Software Next Generation Evaluation	$ 50,000	Medium
11	DWR	Dam Safety Inundation Mapping Grant Program	$ 20,000	High
12	DWR	Comprehensive Dam Safety Evaluation Program	$ 30,000	High
13	CWCB	Agency Case Management and Litigation Support	$ 65,000	High
14	CWCB	Stream and Lake Protection Section Outreach and Education	$ 15,000	High
15	CWCB	R2Cross Program Modernization	$ 100,000	High
16	CWCB	Flood Mitigation and Project Compliance	$ 100,000	High
17	CWCB	Community Assistance Program	$ 45,000	High
18	CWCB	Target Control Evaluation of North Platte Basin Cloud Seedinge Program	$ 35,000	Medium
19	CWCB	Water Project Planning and Implementation	$ 80,020	High
		Total	**$1,012,020**	

No.	Applicant	Project Name	Funding Recommended	Priority
HIGHER EDUCATION RESEARCH PROJECT REQUESTS:				
20	CSU	Investigating Major Influences on Groundwater Levels in the LaSalle/Gilcrest Area	$ 47,610	High
21	CWI/CSU	Assessing Temporal and Spatial Crop Water Consumptive Use with Unmanned Aerial Systems	$ 49,999	High
22	CWI/CSU	User-Friendly Web Application for Water Data Statistical Analysis and Visualization	$ 36,626	High
23	CSU	Streamflow Estimation in Colorado Ungauged Basins	$ 49,963	High
24	CWI/CSU	Review of Published Studies of Floodplain Storage Capacity and Changes Associated Flooding	$ 29,295	High
25	CSU / MSU	Successional Trajectories of the Riparian Forest Along the South Platte River	$ 49,987	High
		Total	**$ 263,480**	
		Grand Total	**$1,275,500**	

PROJECTS NOT RECOMMENDED:			**Requested**	
26	CWCB	DWR Division 2 Acreage Verification Partnership	$ 25,000	Low
27	Colorado Geological Survey	Cascading Direct Uses of Deep-well Hydrothermal Resources as a test Case for Diversified Deep Direct Geothermal Use Study	$ 50,000	Low
28	U. S. Geological Survey	Groundwater Level Monitoring Network	$ 16,200	Low
29	U. S. Geological Survey	Rural Douglas County Water-Level Monitoring Extension	$ 13,450	Low
30	Open Water Foundation	StateMod Dataset Web Publishing	$ 35,000	Low

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2018 – 2019

Project No. 1

Applicant: Brent Newman, IF&WI Chief

Project Title: Work related to Recreational Water Projects

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

Description of Project: Staff has typically requested funds each year to either: 1) fund work associated with the litigation of Recreational In-Channel Diversions(RICDs); or 2) fund projects that have benefits to water based recreational interests. In the next fiscal year, CWCB is anticipating that it may receive requests to assist local governments (i.e. Town of Delta, Town of Eagle, and the City of Fort Collins, etc.) in the design, construction or repair of their whitewater courses. Products may include: 1) design drawings and permitting for these communities to move toward building and/or repairing their whitewater courses, and/or 2) construction or repair of these structures.

Project Manager(s): Erik Skeie

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. To the extent that recreational uses of water and the associated 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, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 2

Applicant: Brent Newman, IF&WI Chief

Project Title: Colorado River Modeling

Recommended Amount: $ 75,000
Requested Amount: $ 100,000

Description of Project: Model possible Colorado River drought contingency actions and coordinated reservoir operations.

Project Manager(s): Brent Newman / Michelle Garrison

Program: Interstate, Federal, and Water Information

Purpose: Coordinate with the Upper Colorado River Commission to model and evaluate possible drought contingency actions and reservoir operations. Modeling will explore drought contingency options, coordinated reservoir management options, and opportunities to improve short-term and mid-term forecasting of reservoir operations and storage levels.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 3

Applicant:	Brent Newman, IF&WI Chief
Project Title:	CSU Water Resources Archive - Digitization of Water Resources Archive Materials
Recommended Amount:	$20,000
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 Kemp
Program:	Water Information

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

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 4

Applicant: Brent Newman, IF&WI Chief

Project Title: Decision Support System - Colorado River Technical Services

Recommended Amount: $99,000
Requested Amount: $99,000

Description of Project: To provide technical services and modeling efforts relative to the Colorado Decision Support System and Colorado River water supply planning. This will include in-depth training for the Decision Support System and to finalize Phase II of the Colorado River Water Availability Study.

Project Manager(s): Michelle Garrison / Brent Newman

Program: Colorado River Water Information

Purpose: To fund technical services and modeling efforts associated with recent and past Colorado River initiatives. A series of trainings will be conducted for new staff with CWCB and DWR regarding the in-depth operations and use of the Decision Support Systems and technical services will be provided to members of the public with queries about the model and its use. Additionally, this scope will cover the finalization of the Colorado River Water Availability Phase II technical documentation, assist with Colorado River Compact technical deliverables and review, provide review of ongoing intrastate Upper Colorado River drought planning efforts, and assist with Endangered Species recovery issues.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 5

Applicant: Brent Newman, IF&WI Chief

Project Title: Bear Creek Lake Water Rights Engineering

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

Description of Project: To continue to provide engineering and technical support as required for the application covering a new storage right at Bear Creek Lake.

Project Manager(s): Erik Skeie

Program: Interstate, Federal, and Water Information

Purpose: In anticipation of the reallocation of Bear Creek Lake, the Board declared its intent to appropriate a new storage water right for Bear Creek Lake at the March 2016 CWCB Meeting. Funds are needed to provide additional engineering and planning work to support the water right application in Water Court.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 6

Applicant: Brent Newman, IF&WI Chief

Project Title: Traveling Colorado River Museum Exhibition

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

Description of Project: To support the implementation of a Traveling Museum Exhibition focused on the Colorado River.

Project Manager(s): Erik Skeie / Carolyn Kemp

Program: Colorado River - Public Education and Outreach

Purpose: To educate the public on Colorado River issues in each of the Basin States. The exhibit will tour for five years, with three month slots ineach of the selected museums. The project will also potentially tour in states outside of the Colorado River Basin based on the success of the initial five years.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 7

Applicant: Peter Barkman, Colorado Geological Survey

Project Title: Colorado Groundwater Atlas Update

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

Description of Project: To create a web-based fully interactive update to the 2003 Colorado Groundwater Atlas. The project will also include the collection of new water quality and aquifer vulnerability data to be funded by CDPHE.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: To provide valuable groundwater resource information and data to the public. To assist researchers and water managers with geologic reference data in order to guide research projects and decision making. To incorporate water quality and aquifer characteristic data into an Atlas that in the previous iteration focused primarily on water quantity.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 8

Applicant: Lesley A. Sebol, Colorado Geological Survey

Project Title: County Groundwater Resources Series, Year 7

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

Description of Project: To perform a groundwater assessment of La Plata County with an alternate location of Bent County. The assessment will include geology and groundwater information for all aquifers utilized in the county. A web-based application will be produced to share the data publicly.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: To build off previous efforts including the county-wide groundwater resource series of the 1960s and 1970s and the Colorado Groundwater Atlas of 2003 with a more detailed analysis of counties. To assist the public, planners, and policy-makers with decision making, focusing on rural domestic wells, pressure from development and natural gas production, and water quality from historic mining activities.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 9

Applicant: Steve Malers, Open Water Foundation

Project Title: StateDMI Web Services

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

Description of Project: To enhance the CDSS StateDMI software to use new HydroBase REST web services to read data where web services exist, which will allow modelers to access HydroBase over the web.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: The StateDMI software is used to read data from HydroBase and other sources and format model data files for StateCU and StateMod models. StateDMI currently requires using a local HydroBase. However, installing HydroBase locally can be a challenge. DWR has recently created REST web services to provide remote access to HydroBase data. StateDMI commands will be updated to use these web services where available.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 10

Applicant: Steve Malers, Open Water Foundation

Project Title: StateMod Software Next Generation Evaluation

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

Description of Project: To evaluate options for moving StateMod from Fortran to a new language with the intent of improving sustainability of the software.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: StateMod is written in Fortran, which is an older programming language that limits options for support and maintenance. There are few Fortran programmers, which severely limits the pool of resources available to support StateMod. The Fortran language and development environment also limit progress that can be made to integrate StateMod with other tools. This project will evaluate options for migrating StateMod to another programming language and provide recommendations to the State.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 11

Applicant: Colorado Division of Water Resources, Dam Safety Branch

Project Title: Dam Safety Inundation Mapping Grant Program

Recommended Amount: $20,000
Requested Amount: $30,000

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: Dam Safety Inundation Mapping

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, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 12

Applicant: Colorado Division of Water Resources, Dam Safety Branch

Project Title: Comprehensive Dam Safety Evaluation (CDSE) Program

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

Description of Project: The CDSE program objectively identifies risk driving failure modes for existing dams. That information will be used to make risk-informed decisions for setting the safe storage level as an interim risk reduction measure, working with partners to reduce the potential for consequences downstream, and supporting dam owners in making decisions to modify or rehabilitate their dams where necessary. Colorado Dam Safety engineers have completed a number of CDSE process at dams and is committed to integrating the CDSE process into its regulation of high hazard dams. The CDSE process is time intensive and Colorado Dam Safety is seeking support to enable outside consultants, under the direction of Colorado Dam Safety Engineers, to conduct this process at selected dams across the state to enable CDSE's to be completed at the largest number of high hazard dams statewide in the shortest period of time

Project Manager(s): Jonathan Hernandez

Program: Comprehensive Dam Safety Evaluation

Purpose: To aid risk informed decisions for the safety of public, landscape, and water storage in Colorado.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 13

Applicant(s): Linda Bassi, S&LP Chief
Brent Newman, IF&WI Chief
Kevin Houck, W&FP Chief

Project Title: Agency Case Management and Litigation Support

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

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/Kaylea White/Rob Viehl
Brent Newman/Erik Skeie
Kevin Houck/Chris Sturm/Joe Busto

Program: Instream Flow and Natural Lake Level;
Interstate, Federal, and Water Information; and
Watershed and Flood Protection

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

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 14

Applicant: Linda Bassi, S&LP Chief

Project Title: Stream and Lake Protection Section Outreach and Education

Recommended Amount: $15,000
Requested Amount: $15,000

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 historically has been 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 implementation of Colorado's Water Plan. This year, the Stream and Lake Protection Section is becoming more involved in stream management plans in an effort to address the goals of the Colorado Water Plan to have these plans in place on 80% of Colorado's important rivers and streams.

It is estimated that $15,000 of supplemental funding will be required to address travel associated with meetings, field work, and other outreach activities related to over 70 new ISF appropriation recommendations, increased acquisitions due to Request for Water, and stream management plans.

Project Manager(s): Linda Bassi / Rob Viehl

Program: Instream Flow and Natural Lake Level

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, 2018 – June 30, 2019

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2018 – 2019

Project No. 15

Applicant: Linda Bassi, S&LP Chief

Project Title: R2Cross Program Modernization

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

Description of Project: Since the inception of the Instream Flow and Natural Lake Level Program in 1973, the CWCB has used the R2CROSS program as one of its primary standard techniques to model instream hydraulic parameters and develop instream flow recommendations in Colorado. In 1996, staff updated the program towork with modern Excel spreadsheets, incorporating numerous imbedded macros to perform the calculations.

It has been over 20 years since this last update of the R2Cross program and staff believes that an update is necessary in order to: 1) modernize the R2Cross programming, and 2) incorporate state of the art hydraulic knowledge to enhance accuracy of model results, and (3) incorporate field measured hydraulic parameters toreduce the need for multiple site visits, which in turn will result in cost savings and staff efficiency.

Project Manager(s): Brandy Logan

Program: Instream Flow and Natural Lake Level

Purpose: Hire hydraulic modeling experts and programmers to update and modernize the Board'sR2CROSS program.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 16

Applicant: Kevin Houck, W&FP Chief

Project Title: Flood Mitigation and Project Compliance

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

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. Finally, additional funding may be needed to perform tasks associated with monitoring and closeout activiites associated with the NRCS Emergency Watershed Protection (EWP) program that are necessary to perform, but ineligible to be reimbursed by the NRCS. 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**:** Kevin Houck

Program: Watershed and Flood Protection

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

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 17

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): Stephanie Dibetitto

Program: Watershed and Flood Protection

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, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 18

Applicant: Kevin Houck, W&FP Chief

Project Title: Target Control Evaluation of North Platte Basin Cloud Seedinge Program

Recommended Amount: $35,000
Requested Amount: $40,000

Description of Project: The North Platte Basin Round Table and water users will partner with the State of Wyoming and its contractor on aerial wintertime cloud seeding in the Sierra Madre, Medicine Bows and in Colorado in the Never Summer Range. As required by the 2012 Colorado Weather Modification Rules and Regulations, a target control evaluation for each program must be developed.

Project Manager(s): Joe Busto

Program: Watershed and Flood Protection

Purpose: Funding will support the North Platte Water users, the State of Wyoming, and the Wyoming based aerial seeding contractor to be in compliance with Colorado Rules and Regulations by developing a target control evluation at the start of the program and reporting on those values each year. Target control is reporting on snow data relationships from seeded and non seeded areas. It is a trend analysis over time.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 19

Applicant: Lauren Ris, Deputy Director

Project Title: Water Project Planning and Implementation

Recommended Amount: $80,020
Requested Amount: $80,020

Description of Project: CWCB needs funding to meet immediate needs for water planning and implementation. CWCB is implementing a number of water planning efforts 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.

Project Manager(s): Kirk Russell

Program: Water Project Planning and Implementation

Purpose: To provide technical and administrative assistance to water providers in the state for planning or implementation of small and urgent water project issues.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 20

Applicant: Reagan Waskom, Colorado State University

Project Title: Investigating Major Influences on Groundwater Levels in the LaSalle/Gilcrest Area

Recommended Amount: $47,610
Requested Amount: $47,610

Description of Project: To use the recently developed and tested MODFLOW groundwater model of the Gilcrest/LaSalle area to investigate reasons for high groundwater in the area, explore the effect of best management practices on groundwater elevation, and to monitor water table elevation fluctuations using a network of existing observation wells. To present findings in a technical report.

Project Manager(s): Erik Skeie, CWCB (See Attached)

Program: Water Information Program

Purpose: To study the causes of high groundwater in the Gilcrest/LaSalle area including reduced pumping, deep percolation from irrigation water and rainfall, seepage from earthen canals, and seepage from augmentation plan recharge ponds. To numerically test best management practices such as increased pumping, curtailment of surface water irrigation, decreased canal seepage, and decreased recharge pond infiltration, which may help alleviate the high groundwater issue.

Funding Available: July 1, 2018 – June 30, 2019

Investigating Major Influences on Groundwater Levels in the LaSalle/Gilcrest Area

Dr. Ryan Bailey, Assistant Professor, 970-491-5045, rtbailey@colostate.edu
Department of Civil and Environmental Engineering, Colorado State University

Location of the Work. LaSalle/Gilcrest Area, Colorado

Purpose of the Research. The LaSalle/Gilcrest area in the South Platte River Basin of Colorado has experienced extremely high groundwater levels during the past 3-4 years resulting in flooded basements, waterlogged crop fields, and damages to the Gilcrest wastewater treatment plant. The area, which lies on alluvial deposits interspersed with pockets of clay, relies on both surface water and pumped groundwater to sustain irrigation practices. Since 2006 all non-exempt wells have been required to have a decreed augmentation plan that replaces 100% of their estimated stream depletion, potentially resulting in the rising groundwater levels in the LaSalle/Gilcrest area. Major hydrologic features that add or remove groundwater from the aquifer system include pumping, deep percolation from irrigation water and rainfall, seepage from earthen canals, and seepage from augmentation-plan recharge ponds. The influence of each of these features on groundwater levels must be quantified to 1) determine reasons for high groundwater levels and 2) identify management practices that can sustain agriculture while maintaining a sufficiently deep water table. Due to the highly complex interaction of hydrology and geology in the area, a numerical modeling approach is useful in determining the impact of these groundwater sources and sinks.

Project Objectives. This project will use a recently developed and tested MODFLOW groundwater model for the LaSalle/Gilcrest area to:

(1) Investigate reasons for high water table elevation in the area

(2) Explore the effect of best-management practices (BMPs) on water table elevation

(3) Monitor water table elevation fluctuations using network of existing observation wells

Work on constructing the MODFLOW model began in July 2016 and has resulted in a multi-layer, refined model that currently is being tested against observation well data, with excellent results. The model uses data from over 400 boreholes, resulting in a three-dimensional aquifer material map that includes 10 layers of different unconsolidated material. Due to this detailed representation of subsurface material, including the clay lenses that prevent downward flow of groundwater, the model is able to capture the high water table conditions in the area. The model will be run for the time period 1990-2012, thereby assessing groundwater flow dynamics and water table fluctuation patterns before and after the 2006 well curtailment. We anticipate that the model will be fully tested and initial scenarios run by the end of the current year's project (June 30 2018). Completing Objectives (1) and (2) will require one additional year of funding. Objective (3) will be used to provide insights into groundwater response to sources and sinks and to further constrain model results.

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

Task 1: Complete Model Testing
The MODFLOW model currently is being tested for the years 1990-2012, with model results compared against measured water table elevation from many observation wells

in the region. Values of spatially-varying hydraulic conductivity of materials (gravel, sand, silt, clay) are modified within acceptable ranges to provide an acceptable match between simulated and observed water table elevations over the 23-year period. This task is expected to be completed before the project start date, but is included here in the event that further testing is required during the first weeks of the projects.

Task 2: 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 influence and also identify the source/sink that has 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, decreased surface water delivery for irrigation, decreased canal seepage, and decreased recharge pond infiltration. For each scenario simulation, the volume of streamflow depletion from the South Platte River also will be estimated and compared with results from analytical models (e.g. Glover, Hunt solutions).

Task 3:

Water level data will be collected from 9 existing monitoring wells in the Gilcrest area. These wells have been installed in the past 2.5 years using funds provided by the CWCB. Data from these wells have demonstrated the rapid response of groundwater levels to pumping and precipitation events. Data are recorded by pressure data loggers, with data downloaded monthly for analysis. Water levels will be used to constrain the MODFLOW in regards to response time of pumping and recharge events.

Deliverables. At the end of the project period (June 30, 2019), a final technical report describing project activities, analysis results, and findings will be submitted to the CWCB. In addition, Dr. Bailey will meet with CWCB representatives at least twice during the project period, either at the CSU campus or at CWCB offices to best coordinate projects activities and discuss project progress and future directions.

Completion Date. This project will be completed by June 30, 2019.

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

0.50 Month Faculty Salary (includes 25% fringe)	$6,600
12 Month PhD half-time Salary (includes 5.5% fringe)	$23,000
1 semester tuition and fees for PhD student	$6,200
12 Month Undergraduate Research Assistant (8 hrs/week)	$5,600
Indirect Cost (15% rate)	$6,210
Total	**$47,610**

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

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2018 – 2019

Project No. 21

Applicant: Reagan Waskom, Colorado State University

Project Title: Assessing Temporal and Spatial Crop Water Consumptive Use with Unmanned Aerial Systems

Recommended Amount: $49,999
Requested Amount: $49,999

Description of Project: To collect unmanned aerial vehicle (UAV) multispectral imagery, flow, and soil water content data from corn fields near Rocky Ford, CO. To calculate actual and modeled CU from corn fields. To develop methodology to synthesize and integrate UAV data into CU data models as a tool to improve irrigation water management. To develop a manual and factsheet on the use of UAVs to map actual consumptive use.

Project Manager(s): Alexander Funk, CWCB (See Attached)

Program: Interstate, Federal, and Water Information

Purpose: To develop methodologies to reduce and integrate unmanned aerial vechicle data with actual consumptive use models as a tool to improve irrigation water management and an manual for producers on the use of UAVs.

Funding Available: July 1, 2018 – June 30, 2019

Project No. 21

Assessing Temporal and Spatial Crop Water Consumptive Use with Unmanned Aerial Systems

P.I.: José L. Chávez, Associate Professor, Civil and Environmental Eng. Dept., CSU
Email: jose.chavez@ colosate.edu Phone: (970) 491-6095
Collaborators: Huihui Zhang, Jon Altenhofen, Allan Andales, Tim Gates and Ashish M.
Location: Field data collected at CSU ARDEC (Fort Collins), USDA ARS Limited Irrigation Research Farm (LIRF in Greeley) and near Rocky Ford will be used.

Purpose of the research:
In the United States, irrigated agriculture produces about half of the total value of crop sales despite comprising only 17 percent of U.S. cropland. However, irrigated agriculture also represents the largest share of consumptive water use in the nation (IA, 2017). Efficient irrigated agriculture has the potential to supply food and fiber for a growing population worldwide while protecting the environment that is experiencing climate change. According to IA (2017) publication entitled “Principles of Efficient Agricultural Irrigation,” the key to success for using any of the irrigation management technologies is making it practical for the grower to use. For instance, obtaining plant canopy reflectance and thermal imagery in different radiometric spectrums from instruments on unmanned aerial vehicles (UAVs) can affordably survey an entire crop so that a grower or a consultant/advisor can make better and quicker management decisions and document CU. The difficulty lies in synthetizing the spatial data (data reduction) and in the integration of that data into crop water consumptive use (CU) algorithms for fully and limited (regulated) irrigation. Therefore, the purpose of the proposed research is to develop a methodology to reduce and integrate UAV data with actual CU models as a tool to improve (and document) irrigation water management.

Objectives
To use unmanned aerial systems’ multispectral imagery to map actual CU for fully and regulated irrigation (irrigated with sprinkler, drip, and surface systems) in CO.
To evaluate CU maps using in-situ measurements of actual crop water use.
To develop a manual on the use of UAVs to map actual CU for irrigated crops in CO.
To prepare a factsheet on the use of UAVs to map actual CU.

Methods:
A fixed-wing and a multi-rotor unmanned aerial systems (UASs) were used in 2015, 2016, and 2017 over corn fields near Fort Collins and Greeley, CO. These fields were irrigated using sprinkler and drip irrigation systems, respectively. Flow meters recorded the gross amount of water applied to the fields. While soil water content sensors recorded the actual water use per treatment. There were two irrigation treatments, fully irrigated and deficit irrigated, for both locations/irrigation methods. In 2018, UAS multispectral imagery will be collected over corn fields near Rocky Ford, CO, irrigated with furrows. Flow will be measured with flumes and soil water content sensors (SWCS) will measure the soil root zone water content change during the growing season.
The following CU models will be applied using the UASs data: reflectance based crop coefficients (Kcr), thermal Infra-red based coefficients (TIc) and energy balance (EB).

Procedures detailed in Kullberg et al. (2016), DeJonge et al. (2016) and Chávez et al. (2005) will be followed. Resulting CU maps will be evaluated with actual crop water use values derived from soil water content sensor networks. In order to "measure" actual CU, data from a number of soil water content sensors will be used. These sensors are installed at different locations in the field and along the crop soil root "zone" profile. Data from the SWCS are entered in a soil water balance to calculate actual CU on a daily, weekly and monthly time scales. Thus, maps of crop consumptive use will be evaluated spatially and temporally. The CU model that consistently performs well, for fully and deficit irrigation regimes, will be identified. The performance of CU models will be assessed using the Nash-Sutcliffe model efficiency method, as well as using the least squares regression method and through the calculation of mean error bias and root mean square errors. The procedure to acquire, pre- and post- process UAV imagery and their application in the suitable CU model will be detailed in a manual.

Timeline and Completion date: From July 1st, 2018 through June 30th, 2019,
Summer of 2018: field data collection, existing and new data processing,
Fall of 2018: data reduction, CU model application, documentation, reporting,
Spring of 2019: CU model application, evaluation, manual, reporting and factsheet.

Budget: Funds are requested for:

Graduate student salary ($1,800/mo, 12 mo) and fringe benefits:	$23,436
Tuition and differential tuition (2 semesters):	$11,980
PI partial summer salary (0.55 mo) and fringe benefits:	$ 8,642
Multiple field trips:	$ 982
Indirect costs (15%):	$ 4,959
Total project cost:	$49,999

Budget Justification:
The graduate student will process field data, reduction, analysis and manual write up.
The PI will guide the graduate student and will write the factsheet.
Multiple trips to the field to collect data during the summer of 2018.

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Office of Sponsored Programs Team Leader Contact information: Jeniffer Strange, jennifer.strange@colostate.edu, 970.491.2083

References:

Chávez J.L., C.M.U. Neale, L.E. Hipps, J.H. Prueger, and W.P. Kustas. 2005. Comparing aircraft-based remotely sensed energy balance fluxes with eddy covariance tower data using heat flux source area functions. J. of Hydrometeorology, AMS, 6(6):923-940. DOI:10.1175/JJ,467.1

DeJonge K., Mefford, B.S., and J.L. Chávez. 2016. "Assessing corn water stress using spectral reflectance," International Journal of Remote Sensing. Volume 37, Issue 10, 2016, pages 2294-2312. DOI:10.1080/01431161.2016.1171929

Kullberg, E.G., DeJonge, K.C., and J.L. Chávez. 2016. "Evaluation of thermal remote sensing indices to estimate crop evapotranspiration coefficients." Agricultural Water Management, 179, 64-73.

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 22

Applicant:	Reagan Waskom, Colorado State University
Project Title:	User-Friendly Web Application for Water Data Statistical Analysis and Visualization
Recommended Amount:	$36,626
Requested Amount:	$36,626

Description of Project: To create a web-based application that will run the R statistical/programming framework in order to output statistical analysis and visualization of CDSS's groundwater level and streamflow data. To provide the CWCB a technical report and online tool to be hosted on a State Linux server.

Project Manager(s):	Brian Macpherson, CWCB (See Attached)
Program:	Water Information Program

Purpose: To support the Colorado Decision Support System (CDSS) by providing to state authorities, other stakeholders, and the general public, a user-friendly web application that will be able to analyze water state data trends in a robust way. Statistical and visual representation of the data will be prioritized in order to convey trends and big-picture status.

Funding Available: July 1, 2018 – June 30, 2019

Project No. 22

User-Friendly Web Application for Water Data Statistical Analysis and Visualization

Dr. Panagiotis Oikonomou, Postdoctoral Fellow, poikon@colostate.edu

Colorado Water Institute, Colorado State University

Location of the Work: Development of the online tool will take place at Colorado Water Institute, Colorado State University, Fort Collins, CO.

Purpose of the Research: The current proposal falls under the research priority topic "Advance the Colorado Decision Support System". The main goal of the proposed online tool is to advance the capabilities of the Colorado Decision Support System by providing to state authorities, other stakeholders, and, the general public, a user-friendly web application that will be able to analyze water state data trends, in a robust way. At the same time it will have a visualization capability both in point and area scale. The State of Colorado has world-class water data in terms of availability compared with other regions and it has been a priority to investment on data availability and transparency through open data and the online tools in terms of data retrieval, visualization. Currently though, there is a lack of statistical data analysis for water data (groundwater level and streamflow) that would transform the data to useful information aiding in decision making process. Data without the appropriate analysis can be misconstrued resulting to misinformation. The tool will be running the R statistical/programing framework (open source) at the background, without the need for the user to be expert in any software nor programming/statistical language. Such a tool will be able to answer frequently asked questions about water data and be used by interest parties and public authorities.

Project Objectives: The objectives of this project are:

1. Determine locations for both groundwater level and surface water flow collected measurements, within the South Platte basin, in order to be included in the list of sites of interest for analysis. The criterions will be the quality, frequency and the span of the measurement record.
2. Develop the statistical analysis framework and code, which will be robust for the studied time series, for performing basic statistical analysis and also for determining if systematic trends exist. The statistical trend analysis will be done by utilizing non-parametric methods that avoid pitfalls impacting accuracy of statistical results (e.g. serial correlation).
3. Design and develop the web application, through which the user will interact for accessing and retrieving the statistical analysis (including explanation in layman terms) for each point of interest. This will also include an interactive trend map for the South Platte basin that would give the pig-picture of the status of water resources.
4. Design and develop the web application that will retrieve datasets from data.colorado.gov using Socrata Open Data API (SODA) for current groundwater levels and USGS streamflow gage conditions, and compare each site of interest current conditions with its statistics.

Methods: The methods and tools that will fulfill the proposal's objectives are all open source. The online tool that will be utilizing the capabilities of R an open source statistical/programing language and environment. RStudio will be employed as the developing user interface and the "Shiny Web Application Framework for R" will be the framework for building the interactive online tool. To perform the specific project objectives, which entail data retrieval, analysis and visualization, R packages will be used. The main ones will be the Shiny, Leaflet, RSocrata, dataRetrieval, statistical and other map related available libraries. At the final stage of the project the web application will be hosted in a "Shiny Server Open Source" which provides a web hosting platform for Shiny applications.

From the beginning of the project, a crucial aspect for its efficacy is the involvement of pertinent DNR personnel. A meetings during the first month of the project life will give the chance to lay out in person the proposed project and ensure that important elements for DNR personnel will be included in the web application. Throughout the life of the project two progress briefing meetings will be organized giving also the opportunity for constructive feedback.

Completion Date: This project will be completed by June 30, 2019. All deliverables will be provided to the CWCB on or before that date.

Deliverables: At the end of the project, a final technical report describing project activities, analysis methodology, and findings will be submitted to the CWCB. Alongside to that, the online-tool will be delivered, in a ready to use form and to be hosted to an appropriately configured Linux Server. For dissemination purposes, a Colorado Water short article will be written and a peer-reviewed publication will be pursued.

Budget: The amount requested for the proposed project is $36,626 that will be used for supporting the PI as a postdoctoral fellow to perform the aforementioned tasks during the period of the project. Open source technologies (no cost) will be used for the project (programming languages, software, and libraries).

Budget Justification: The requested amount was calculated with a base salary per month of $4,160.

12 months (07/01/2018 - 06/30/2019) @ 50% effort	$24,960
Fringe for 2nd Year Postdoc @ 27.6%	$ 6,889
Total Personnel Salary	$31,849
Indirect Cost (15% rate)	$ 4,777
Total	$36,626

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

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 23

Applicant: Reagan Waskom, Colorado State University

Project Title: Streamflow Estimation in Colorado Ungauged Basins

Recommended Amount: $49,963
Requested Amount: $49,963

Description of Project: To assess performance of streamflow estimation methods. To build a stream monitoring network of small watersheds to improve streamflow estimates for intermittent and low snow streams.

Project Manager(s): Brandy Logan, CWCB (See Attached)

Program: Stream and Lake Protection

Purpose: To develop a data product that improves estimates of streamflow in ungaged streams throughout the State.

Funding Available: July 1, 2018 – June 30, 2019

1. Title: Streamflow estimation in Colorado ungauged basins

2. Principal Investigators: S. Kampf[a], B. Livneh[b], G. Richard[c], A. Bhaskar[d]

3. Location: all Colorado, with focus monitoring locations shown in Figure 1

4. Purpose of the research: Colorado has over 600 active stream gauges (Fig.1), which are primarily located on large streams and rivers used for water supply. While this is a large number of gauges, it is a small fraction of the >100,000 miles of stream length in the state. Water managers often need to estimate flow on ungauged streams to determine water supply availability and aquatic habitat or to manage flood risk. The long-term goal of our research is to develop a spatial data product that estimates flow for ungauged stream segments throughout the state (e.g. Fig. 1).

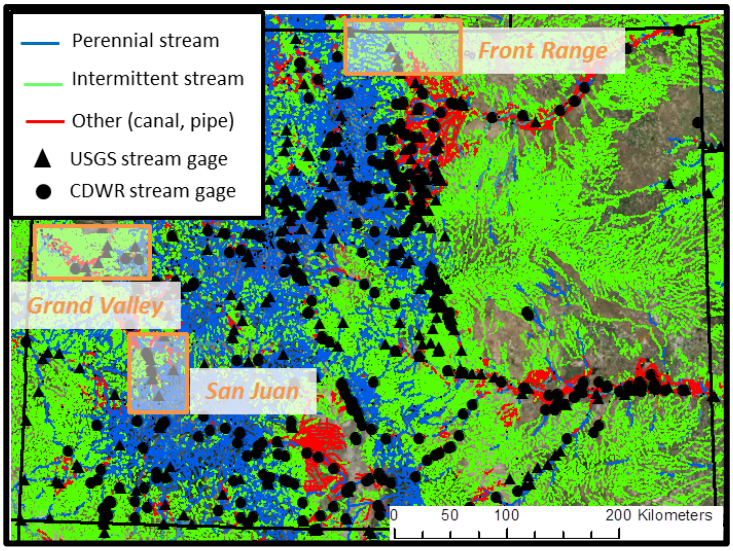

Fig.1.Colorado stream network showing stream types classified by the National Hydrography Dataset (NHD) and active USGS and CDWR stream gauges. Boxes indicate areas of small watershed monitoring for the proposed research; these areas include a wide range of snow zones and land cover types.

5. Objectives, methods, timeline: As part of this long-term goal, the research proposed here focuses on two **objectives**: (1) validate performance of a diverse set of streamflow estimation methods in reference gauged basins, and (2) build a new stream monitoring network of small watersheds that span the wide range of snow zones and land cover types in the state.

Methods, O1: We will review all gauged Colorado streams (Fig. 1) and select those with drainage areas <1000 km^2, limited upstream flow modifications, and at least 10 years of high quality streamflow data. The drainage area size restriction removes the largest rivers of the state, which are already extensively monitored. The flow modification restriction limits the current scope of the study to examining effects of climate and land cover on streamflow. The effects of water diversions and impoundments on streamflow will be addressed in separate research. For the selected gauges, we will compute frequency statistics for annual and seasonal water yields, peak flows, and 7-day low flows. We will also compile geophysical information on contributing watersheds including area, slope, aspect, and land cover and climate information including precipitation, temperature, and snow persistence. Using these data we will test three diverse methods of streamflow prediction:

[a]Assoc.Prof., CSU, 970-491-0931, stephanie.kampf@colostate.edu; [b]Asst. Prof., CU Boulder, 303-735-0288, ben.livneh@colorado.edu; [c]Prof., CMU, 970-248-1689, grichard@coloradomesa.edu; [d]Asst. Prof, CSU, 970-491-8339, aditi.bhaskar@colostate.edu

a. Regional regression equations[1]. These empirical regression equations were developed by the USGS for Colorado streams to predict water yield and peak flow/low flow values for fixed return intervals. We will test these on stations not originally used for regressions.

b. Snow empirical model[2]*.* This method is an empirical relationship between snow persistence and annual water yield in semi-arid watersheds. We will evaluate this relationship against streamflow observations for watersheds at middle-high elevations.

c. Variable Infiltration Capacity (VIC) model. This is a state-of-the-art process-based distributed hydrologic model for which simulations of daily runoff are available for a 6 km resolution grid from 1950-2013[3]. We will test modeled seasonal and annual streamflow against streamflow observations for watersheds with areas >50 km^2. We will also use VIC results to test method b throughout the state.

Other methods such as NOAA river forecast center streamflow predictions may be added to the testing depending on time and data availability.

Methods, O2: Our ongoing research indicates that the current stream gauge monitoring network is not a representative sample of all Colorado stream types. 70% of the mapped stream length is intermittent, yet these streams represent only 10% of the active stream gauges (Fig.1). We have therefore begun to establish a small watershed monitoring network that samples different snow zones on west and east slopes[4]. This work is supported by current CWCB funding. Here we request funding to support ongoing precipitation and streamflow data collection in these sites (Fig.1) and four additional urban and grassland sites in low snow areas. New sites have existing stream stage monitoring; funding requested here would support developing stage-discharge rating curves for these locations, so they can be used for streamflow statistics.

Timeline and completion date: O1, site selection in 1st quarter; method testing in 2nd quarter; method comparison in 3rd quarter; conference presentation and reporting in 4th quarter. O2, Monthly site visits for data collection and discharge measurements. Completion at end of study time period (June 30, 2019, as indicated in RFP).

6 & 7. Budget + justification: $49,963 ($43,446 direct; $6,517 IDC @ 15%)

Item	*Justification*	*Cost*
GRA	4 months @ CSU for O1a,b; 4 months at CU for O1c	$19,395
Student hourly	4 months @ CSU and 4 months @ CMU for O2	$16,951
Travel	$3,000 for meetings; $3,000 for field	$6,000
Supplies	$500 for field; $600 for computing	$1,100

8. Department head: John Moore, 970-491-1796, john.moore@colostate.edu
9. Department accountant: Kim Melville-Smith, 970-491-7715,kimberly.melville-smith@colostate.edu; **10. OSP team leader:** Carmen Morales, 970-491-6684, Carmen.Morales@colostate.edu

[1]Capesius JP, Stephens VC 2009. Regional regression equations for estimation of natural streamflow statistics in Colorado. USGS Scientific Investigations Report 2009-5136.
[2]Hammond J, Saavedra F, Kampf S, in review. How does snow persistence relate to annual streamflow in mountain watersheds of the western U.S. with wet maritime and dry continental climates? WRR
[3]Livneh B, et al. 2015. A spatially comprehensive, hydrometeorological data set for Mexico, the US, and Southern Canada 1950–2013. Scientific data, 2.
[4]Hammond J, Moore C, Kampf S, Richard G 2017. Watershed monitoring across the intermittent persistent snow transition zone. Colorado Water. May/June

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 24

Applicant: Reagan Waskom, Colorado State University

Project Title: Review of Published Studies of Floodplain Storage Capacity and Changes Associated With Flooding

Recommended Amount: $29,295
Requested Amount: $29,295

Description of Project: To review and extract relevant data which can be translated into layman's terms to be used by the public and water planners related to flood storage capacities.

Project Manager(s): Kevin Houck, CWCB (See Attached)

Program: Watershed and Flood Protection

Purpose: The Colorado Watershed Restoration Program of the Colorado Water Conservation Board is working to protect and restore the physical and ecological processes that connect land and water while protecting life and property. Many of the projects that the program funds are designed to reconnect channels with geomorphic floodplains. Among the benefits to be gained from such reconnection are enhanced water storage and the associated attenuation of peak flows, hyporheic and groundwater recharge, and increased base flows during drier periods of the year. The CWCB and the Colorado Department of Natural Resources worked with the Colorado Water Institute to list a literature review of floodplain storage in relation to flooding as one of the primary research topics for funding from the CWI. The results of the literature review will be used to inform river management in Colorado.

Funding Available: July 1, 2018 – June 30, 2019

Title: Review of Published Studies of Floodplain Storage Capacity and Changes Associated with Flooding

PI: Ellen Wohl, Professor of Geology, (970) 491-5298, ellen.wohl@colostate.edu

Location of work: Colorado State University

Purpose of research: The Colorado Watershed Restoration Program of the Colorado Water Conservation Board is working to protect and restore the physical and ecological processes that connect land and water while protecting life and property. Many of the projects that the program funds are designed to reconnect channels with geomorphic floodplains. Among the benefits to be gained from such reconnection are enhanced water storage and the associated attenuation of peak flows, hyporheic and groundwater recharge, and increased base flows during drier periods of the year. The CWCB and the Colorado Department of Natural Resources worked with the Colorado Water Institute to list a literature review of floodplain storage in relation to flooding as one of the priority research topics for FY 2018 funding from the CWI. The results of the literature review will be used to inform river management in Colorado.

Objectives, method, timeline, completion date: The primary objective is to develop a comprehensive and detailed white paper that reviews existing knowledge of floodplain storage capacity and changes in storage capacity associated with flooding. In this context, floodplain storage capacity is interpreted to include: surface water, subsurface water in the hyporheic zone and groundwater; mineral sediment; organic matter, from fine particulate organic matter to large wood; and solutes. An abundant literature documents how lateral connectivity between channels and floodplains attenuates downstream fluxes of these materials. The details of what facilitates connectivity (e.g., obstructions in the channel), as well as the spatial extent of the floodplain; thickness, grain-size distribution, and stratigraphy of floodplain sediment; riparian vegetation; channel planform and lateral channel mobility; spatial heterogeneity of surface and subsurface floodplain environments; flow regime; and human modifications of the channel, floodplain, and flow and sediment regimes will all influence the details of floodplain storage and the resiliency (resistance to disturbance and recovery following disturbance) of floodplains. The literature review will start with a basic overview of floodplains, including processes by which floodplains are created, maintained, and changed through time. Floodplain classifications will be reviewed, along with studies of floodplain stability (sometimes described via floodplain turnover time or residence time of diverse materials within floodplains). The literature review will continue with a discussion of factors that promote or retard connectivity between channels and floodplains, and a discussion of the factors that influence all of the forms of floodplain storage listed above. Finally, the literature review will discuss how floodplain form and storage of diverse materials changes in relation to the occurrence of floods or the absence of floods (e.g., where flow regulation strongly limits flooding) and the factors that enhance or limit floodplain response to floods. The emphasis will be on the range of channels and floodplains present in Colorado, ranging in size from headwater channels

to the South Platte River at the state boundary, and varying in channel geometry and floodplain extent from lowland channels of the Great Plains to mountain streams and western canyon rivers. Despite this emphasis, studies from other systems will be included in the literature review when these studies illustrate or explain phenomena relevant to the primary objective.

Methods will involve directed literature searches using Google Scholar and queries to state water and resource management agencies (to help locate unpublished technical reports and case studies). Published material and unpublished reports will be read and relevant information will be extracted for the literature review. The white paper that constitutes the final report will be written in a manner that ensures accessibility for readers without training in the natural sciences or civil engineering.

I anticipate that the literature search, synthesis, and report writing for this literature review will require the equivalent of two months of working time, although I will carry out these tasks over a period of several months. Assuming that this project is funded with CWCB funds, the completion date – submission of the final white paper – will be 30 June 2019. I anticipate submitting a complete draft to CWCB at least two months before that date, to allow time for comments and revisions.

Budget: $29,295

Budget justification: The two months of summer salary will allow me to focus on this extensive literature review. Breakdown is $19,964 for salary ($9982/month), $5510 (27.6%) for fringe benefits, and $3821 (15%) for indirect costs.

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Department accountant contact information: Tracey Trujillo, (970) 491-8280, tracey.trujillo@colostate.edu

OSP team leader: Carmen Morales, (970) 491-6684, carmen.morales@colostate.edu

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 25

Applicant: Reagan Waskom, Colorado State University

Project Title: Successional Trajectories of the Riparian Forest Along the South Platte River

Recommended Amount: $49,987
Requested Amount: $49,987

Description of Project: Follow-up study of the growth of native and non-native phreatophyte species to provide guidance for future riparian forest management in the South Platte River Basin.

Project Manager(s): Erik Skeie, CWCB (See Attached)

Program: Interstate, Federal, and Water Information

Purpose: The project is a follow-up to the recently completed SB14-195 phreatophyte study wherein extensive field inventory work was accomplished in 2015 to measure impacts of the 2013 flood. That work identified the need for continued monitoring to better understand the dynamics of the riparian forest and ecosystem. Due to a shortage of funds last year it was felt that the re-inventory work could be delayed until 2018. In addition we have begun working with the South Platte BRT to identify management strategies to address phreatophytes in the basin, and a long-term monitoring plan will be developed through that process.

Funding Available: July 1, 2018 – June 30, 2019

Successional Trajectories of the Riparian Forest Along the South Platte River

Andrew Norton[1] and Gabrielle Katz[2]
[1]Professor, Colorado State University, Fort Collins. Andrew.Norton@Colostate.edu (970)-491-7421; [2]Assistant Professor, Metropolitan State University of Denver, gkatz@msudenver.edu, (303) 615-0771

Location: The South Platte River and its lower tributaries from Fort Lupton – Julesburg.
Purpose: The present day cottonwood forest on the South Platte River in eastern Colorado became established ~1900-1930, as the historically wide river channel became narrower in response to anthropogenic hydrologic alterations. Prior to this, the river had a wide, braided form. **The current forest is valued as a natural resource, providing a variety of ecosystem services including wildlife habitat, recreation, and flood mitigation.** The persistence of a cottonwood forest on the South Platte River depends on dynamic processes of flooding, erosion and sediment deposition that create suitable conditions for seedling establishment and long term survival. **However, we do not know if these conditions commonly exist within the study area.** Future changes in flow amounts and timing due to additional diversions or climate change are likely to alter forest trajectories as well. A better understanding of the successional trajectory of this forest is of great importance to managers and policy makers, as the possible alternative future pathways have vastly differing implications for water use by riparian vegetation and value of the river system for wildlife habitat and recreational use.

In 2015 we undertook a study of the phreatophytic vegetation along the South Platte River for the Colorado Water Conservation Board. The Board wanted us to determine the impact of the 2013 flood on phreatophyte persistence and establishment. In our report[1] we found that the 2013 flood and high spring flows in 2014 and 2015 resulted in substantial erosion and deposition along portions of the river, and that large areas of newly exposed substrate contained abundant cottonwood seedlings and saplings. However, in a single field season we were not able to determine seedling and sapling survival. **We propose to study the recruitment dynamics and current age structure of the riparian forest along the South Platte River in order to generate predictions about the future trajectory of this forest.** By re-sampling sites we surveyed in 2015, we will determine whether and where phreatophyte recruitment has occurred and estimate historical recruitment patterns for each of the 5 dominant riparian tree species.

Objectives

a) Estimate the proportion of cottonwood seedlings present in 2015 that have survived to summer 2017.

b) Determine the proportion of saplings present in summer 2015 that have survived to summer 2017.

c) Determine the relationship between diameter, height and tree age for cottonwood, peachleaf willow, Russian olive, green ash and Siberian elm.

d) Use these data, in combination with 2015 forest survey data, to develop descriptive models of lower South Platte River basin riparian forest recruitment.

Methods and Timeline: In summer 2015 we surveyed 15 sites on the South Platte River and its lower tributaries. Sites were located between Fort Lupton and Julesburg, CO. Sites were selected with the assistance of South Platte Basin Roundtable members. At each site we measured trees, saplings and seedlings along transects perpendicular to the river and across the entire existing floodplain. We measured the height, diameter (dbh) and canopy condition of >2,500 saplings and trees and quantified seedling densities in 873 20 x 20 m plots. All individuals were recorded by species. Importantly, the location of each plot surveyed was recorded using a precision GPS system so that we can return to the same locations for future data collection.

In this project, we will re-survey each site to determine the survivorship of seedlings first recorded in 2015 (germinated in 2014 or 2015), and if any new seedlings have emerged (germinated in summer 2016 or 2017). We will use the same design to determine the survivorship of saplings. For all dead saplings we will determine the likely source of mortality. We will determine the relationship between dbh and age for each tree species using tree ring analysis and use these data to estimate forest age structure and recruitment history. Data will be collected in summer, 2018 and analyzed that fall.

DRAFT Budget

Personnel G. Katz 1 mo @ $5,512 per mo.	$5,686
Masters Student, 12 mo. @ $1,870 per mo.	$22,764
Student Hourly, 200 hours @ $10.00 per hour	$2,000
Fringe (varies by positions, total)	$3,345
In state tuition	$9,628
Travel to field sites	$1,300
Total direct	$44,723
CSU indirect @15%	$5,264
Total Requested	$49,987

Budget Justification:

We are requesting salary ($1,897 per month) and tuition ($9,628 for 1 year) for a full-time master's level student. The student will be co-advised by Dr. Katz and Dr. Norton and will be enrolled at CSU. The student will collect seedling and sapling field data, and will collect and process tree cores, and conduct tree ring analysis. We request 200 hours of undergraduate research assistance at $10.00 per hour. The undergraduate will assist with field data collection and processing tree cores. We are requesting 1 month of Dr. Katz's salary ($5,686). Dr. Katz will co-advise the graduate student and will assist in developing the data collection protocols and report writing. We request $1,300 to cover costs of travel to the 15 field sites.

Department Head Contact Information: Dr. Amy Charkowski. Amy.charkowski@colostate.edu, (970) 491-8586.

Department Accounting: Pre award: Cliff Shulenberg, (970) 491-0926; Post award: Paul White, 491-0488. **Sponsored Projects Contact:** Marilyn Morrissey, (970) 491-2375

1. Norton, A., Katz, G., Eldeiry, A., Waskom, R., Holtzer, T. 2016. SB14-195 Report to the Colorado Legislature: South Platte Phreatophyte Study . Colorado Water Institute Special Report 30.

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 26

Applicant: Brent Newman, IF&WI Chief

Project Title: DWR Division 2 Acreage Verification Partnership

Recommended Amount: $0
Requested Amount: $25,000

Description of Project: To assist the Department of Water Resources (DWR) Division 2 Water Commissioners and Division 2 Engineers with the acreage verification process and technical records keeping.

Project Manager(s): Brent Newman

Program: Interstate, Federal, and Water Information

Purpose: To provide easily accessible and technologically up-to-date acreage verification processes and equipment for Division 2 Water Commissioners and Division Engineers. This will make the acreage verification more efficient and instantly communicated to the Division 2 office, for the purposes of water administration and data collection related to ongoing compliance with the Arkansas River Compact.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 27

Applicant:	Paul Morgan, Colorado Geological Survey
Project Title:	Feasibility Study for Cascading Deep-Well Hydrothermal Resources in the Upper Arkansas River Valley for Diversified Direct Geothermal Uses
Recommended Amount:	$0
Requested Amount:	$50,000

Description of Project: To perform a feasibility study that investigates geothermal water resource for possible electrical power generation, direct-space heating and cooling, and hot-water use near Buena Vista, Colorado. The geologic formation targeted is approximately 6,500 to 10,000 feet below ground surface.

Project Manager(s):	Brian Macpherson
Program:	Water Information

Purpose: To investigate an alternative energy resource that has the potential to replace fossil fuel use at an existing facility that has an energy bill of nearly $1,000,000/yr. The same renewable energy source could also be used for new construction including houses and schools.

Funding Available:	July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 28

Applicant: Judith Thomas, U.S. Geological Survey

Project Title: Groundwater-Level Monitoring Network, Lower Gunnison River Basin

Recommended Amount: $0
Requested Amount: $16,200

Description of Project: To monitor groundwater levels from 29 monitoring wells in the Lower Gunnison River Basin. The funds will be used for collection of water-level data, data processing, and network maintenance.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: To provide ground water level data to decision makers through the USGS National Water Information System (NWIS) database. Selenium is present in the underlying Cretaceous Mancos Shale and is leached into groundwater through irrigation pumping. Monitoring of groundwater levels may provide a proxy for Selenium contamination.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 29

Applicant: Suzanne Paschke, U.S. Geological Survey

Project Title: Rural Douglas County Water-Level Monitoring Extension

Recommended Amount: $0
Requested Amount: $13,450

Description of Project: To monitor water level and perform data processing of 33 domestic wells in Douglas County. Results will be publicly available.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: Excessive groundwater pumping from the Denver Basin Aquifer in the South Metro Denver area poses potential risk to rural Douglas County residents who rely on self-supplied domestic wells. The USGS has worked with the Rural Water Authority of Douglas County and the Colorado Water Conservation Board since 2011 to monitor groundwater wells. Data from these wells aids in decision making for rural well owners.

Funding Available: July 1, 2018 – June 30, 2019

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Proposed Project for Fiscal Year 2018 – 2019

Project No. 30

Applicant: Steve Malers, Open Water Foundation

Project Title: StateMod Dataset Web Publishing

Recommended Amount: $0
Requested Amount: $35,000

Description of Project: To prototype a static website and a process to automate publishing of StateMod datasets on the web in order to facilitate review and access without having to run the model.

Project Manager(s): Brian Macpherson

Program: Water Information

Purpose: The StateMod water allocation modeling software is used to implement planning models that help users understand water resources. The datasets have traditionally been published as a download from the CDSS website, but this typically only includes input files and users are required to run the model on a computer. This can lead to issues if the person does not install the proper software or run StateMod correctly. This project will implement a prototype to explore utilization of cloud storage and static websites to publish output files and make recommendations for a full implementation of a web application.

Funding Available: July 1, 2018 – June 30, 2019