COLORADO
Colorado Water Conservation Board
Department of Natural Resources

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John Hickenlooper, Governor

Robert Randall, DNR Executive Director

James Eklund, CWCB Director

TO: Colorado Water Conservation Board Members

FROM: Kirk Russell, Interim Deputy Director
Steve Biondo, Finance Manager

DATE: March 22 - 23, 2017, Board Meeting

AGENDA ITEM: Agenda Item 31 – 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 January 2017, CWCB received internal requests and outside applications for funding that becomes available from the Operational Fund in July 2017 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, 2017.

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, 2017 TO JUNE 30, 2018

No.	Applicant	Project Name	Funding Recommended	Priority
1	CWCB	Work related to Recreational Projects	$ 50,000	High
2	CWCB	Colorado River Project Support	$ 75,000	High
3	CWCB	CSU Water Resources Archive and Water Tables	$ 25,000	High
4	CWCB	John Martin Reservoir Storage Account, Phase 2	$ 25,000	High
5	CWCB	Purgatoire River Irrigation Diversion Telemetry Equipment	$ 17,500	High
6	Open Water Foundation	Update CDSS Software for new HydroBase Web Services	$ 25,000	High
7	CWCB	Aquatic Nuisance Species Control	$ 100,000	High
8	CWCB	Bear Creek Lake Water Rights Engineering	$ 80,000	High
9	Pikes Peak Regional Water Authority	Fountain Creek Transit Loss Model Upgrade	$ 50,000	High
10	Rural Water Authority of Douglas County	Rural Well-Level Monitoring in Douglas County	$ 49,750	Medium
11	Colorado Geological Survey	County Groundwater Resource Series, Year 6	$ 50,000	Medium
12	DWR	Dam Safety Inundation Mapping Grant Program	$ 50,000	High
13	CWCB	Case Management, Litigation Support and Program Implementation	$ 100,000	High
14	CWCB	Stream and Lake Protection Section Outreach and Education	$ 15,000	High
15	CWCB	Agency Intern Support	$ 12,529	High
16	CWCB	Flood Mitigation and Project Compliance	$ 150,000	High
17	CWCB	Community Assistance Program	$ 45,000	High
18	Center for Snow & Avalanche Studies	Colorado Dust on Snow Program	$ 25,000	Medium

No.	Applicant	Project Name	Funding Recommended	Priority
19	Metropolitan State University	Colorado's Water Plan – Education Asset Mapping	$ 40,000	High
20	OMNI Institute	CWP Outreach, Education, and Public Engagement Baseline Survey	$ 48,760	High
		Total	**$1,033,539**	
HIGHER EDUCATION RESEARCH PROJECT REQUESTS:				
21	CWI/CSU	Constructing and Testing a Refined Groundwater Flow Model for the LaSalle/Gilcrest Area	$ 48,515	High
22	University of Colorado Boulder	Bark Beetle Impacts on Remotely Sensed Evapotranspiration in the Rocky Mountains	$ 50,000	High
23	CWI/CSU	Automated Non-Telemetered Snow Depth Monitoring for Water Supply Forecasting	$ 43,455	High
24	Colorado Mesa University	Water Yield Sensitivity to Snow Loss in Colorado Headwater Streams	$ 49,991	High
25	CWI/CSU	Mountain Basin Hydrologic Response Study	$ 50,000	High
		Total	**$ 241,961**	
		Grand Total	**$1,275,500**	

PROJECTS NOT RECOMMENDED:			Requested	
26	Open Water Foundation	StateMod Dataset Web Publishing	$ 25,000	Low
27	Open Water Foundation	Enhance CDSS StateMod Integration with GIS	$ 25,000	Low
28	Central Colorado Water Conservancy District	Walker Recharge Project	$ 100,000	Low
29	Colorado State University / Metropolitan State University	Age Structure and Seedling Survivorship of the South Platte River Riparian Forest	$ 49,795	Low
30	U. S. Geological Survey	Online Flood Inundation Maps of the South Platte River	$ 45,000	Low

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2017 – 2018

Project No. 1

Applicant: Carlee Brown, IF&WI Chief

Project Title: Work related to Recreational Water Projects

Recommended Amount: $50,000
Requested Amount: $75,000

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. Staff may also use these funds for expert testimony in the Glenwood Springs RICD case.

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. 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, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 2

Applicant: Carlee Brown, IF&WI Chief

Project Title: Colorado River Project Support

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

Description of Project: To assist in allowing Colorado to fully use its compact entitlement, and in the recovery of endangered species that have designated habitat in the Colorado River and its tributaries.

Project Manager(s): Carlee Brown

Program: Interstate Compact Compliance

Purpose: To provide assistance and resources for meeting Colorado River compact obligations and associated agreements on the Colorado River. Assistance for recovery of four endangered fish within the Colorado River and its tributaries (Humpback Chub, Bonytail, Razorback Sucker, and Colorado Pikeminnow). Assistance may also include voluntary demand management programs, conservation efforts, salinity control projects, and selenium management projects.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 3

Applicant:	Carlee Brown, IF&WI Chief
Project Title:	CSU Water Resources Archive - Digitization of Water Resources Archive Materials and Water Tables
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.b By participating in CSU's Water Tables conference, funds are leveraged from other sources to provide additonal support for the day to day operation of the Water Resources Archive.

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

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

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 4

Applicant: Carlee Brown, IF&WI Chief

Project Title: John Martin Reservoir Storage Account Study, Phase 2

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

Description of Project: This project, in cooperation with the Lower Arkansas Valley Water Conservancy District (LAVWCD), is for Phase 2 of a study of a potential new storage account for Colorado water users as an amendment to the 1980 Operating Plan for John Martin Reservoir. Phase 2 will consist of presenting the operational proposal developed in Phase 1 to Kansas for discussion, modification, and consideration of adoption by the Arkansas River Compact Administration at the 2017 Annual Meeting.

Project Manager(s): Steve Miller

Program: Interstate, Federal, and Water Information

Purpose: The new storage account will utilize unused capacity in the existing John Martin Reservoir, providing new storage opportunities not currently available and helping to meet the Arkansas Basin Roundtable's goal of providing 40,000 AF of new storage by 2030. The availability of stored water is critical to meeting several water management goals while maintaining compliance with the Arkansas River Compact. Those goals include compliance with the Division 2 well use and irrigation improvement rules as well as efforts to improve water quality in Colorado and Kansas.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 5

Applicant: Carlee Brown, IF&WI Chief

Project Title: Purgatoire River Irrigation Diversion Telemetry Equipment

Recommended Amount: $17,500
Requested Amount: $17,500

Description of Project: CWCB will use these funds to purchase and install, in cooperation with the Division 2 Engineer's Office, Sutron telemetry equipment on two diversion structures within the Purgatoire River Water Conservancy District (PRWCD) service area. This will allow real time monitoring of these remotely located downstream diversion points via DWR's Satellite Monitoring System (SMS). DWR, the PRWCD, and the two ditches will assist in the cost of installation and fully cover the ongoing annual cost of participation in the SMS.

Project Manager(s): Steve Miller, CWCB / Jeff Montoya, DWR-Div. 2

Program: Interstate, Federal, and Water Information

Purpose: Real time measurement of diversions at these locations will improve administration of the PRWCD water supply, by assuring adequate flows are passed to downstream rights without unnecessarily curtailing project diversions. This will allow maximization of the District's water supply and at the same time facillitate compliance with the Arkansas River Compact. Currently, due to the remote location of the diversion structures, there is significant lag time between measuring actual diversions and making the necessary adjustments to upstream diversions to insure adequate flows are passed downstream. This forces conservative administration and loss of water which would be otherwise useable within the District.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 6

Applicant: Open Water Foundation

Project Title: Update CDSS Software for new HydroBase Web Services

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

Description of Project: To update the CDSS TSTool software for the DWR HydroBase REST web services.

Project Manager(s): Andy Moore, CWCB / Steve Malers, OWF

Program: Interstate, Federal, and Water Information

Purpose: Open Water Foundation (OWF) will enhance the CDSS TSTool software to support the new HydroBase REST web services that are being implemented by the Division of Water Resources (DWR). REST web services allow access to data products via a unique URL, and the output uses open data formats that can be easily used by other software. This enhancement to HydroBase web services will improve access to data.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 7

Applicant: Carlee Brown, IF&WI Chief

Project Title: Aquatic Nuisance Species Control

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

Description of Project: CWCB will provide emergency financial assistance for the Aquatic Nuisance Species (ANS) Program to offset some impacts of the ANS Program's loss of funding. Short-term funding is required for the ANS Program to operate in 2017 and 2018 while a permanent replacement funding source is established.

Project Manager(s): Michelle Garrison

Program: Interstate & Federal

Purpose: To provide one-time emergency financial assistance to the Aquatic Nuisance Species program. The ANS program was financed through Tier 2 Severance Tax funds and is therefore expected to receive little to no funding for 2017 and 2018. Emergency funding is needed to maintain the program and continue boat inspections in 2017 and 2018 while a more stable funding source is identified and established. The ANS program provides vital protection from mussel infestation to water supply infrastructure throughout the state.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 8

Applicant: Carlee Brown, IF&WI Chief

Project Title: Bear Creek Lake Water Rights Engineering

Recommended Amount: $80,000
Requested Amount: $80,000

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

Project Manager(s): Suzanne Sellers

Program: Bear Creek Lake Reallocation

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 perform engineering and planning work to support the water right application in Water Court.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 9

Applicant: Pikes Peak Regional Water Authority

Project Title: Fountain Creek Transit Loss Model Upgrade - Phase II

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

Description of Project: This is the second and final phase of a project to upgrade and enhance an existing transit loss accounting model used to track and credit valuable consumptive use return flows on Fountain Creek, a major tributary in the Arkansas River Basin.

Project Manager(s): Steve Miller / Andy Moore

Program: Interstate, Federal, and Water Information

Purpose: The model upgrade will incorporate new Fortran coding as well as stream aquifer interaction algorithms to facilitate more accurate calculations and ease of model maintenance. The work is being conducted by USGS in cooperation with numerous water user partners who have invested significant financial and technical resources into the existing model and the requisite data collection to make the model functional in real time. In addition, the project is being closely coordinated with future ArkDSS development and Division 2 Staff.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 10

Applicant: Rural Water Authority of Douglas County

Project Title: Rural Well-Level Monitoring in Douglas County

Recommended Amount: $49,750
Requested Amount: $49,750

Description of Project: To continue an existing groundwater level monitoring network to collect data for planning purposes in Douglas County.

Project Manager(s): Andy Moore, CWCB / Barry Gager, RWADC

Program: Interstate, Federal, and Water Information

Purpose: The Rural Water Authority of Douglas County (RWADC) proposes to continue this groundwater monitoring effort, ongoing since 2011, until June 2018. Much of Douglas County is still reliant on nonrenewable groundwater, and it is imperative to monitor the supply status in those aquifers used primarily by the rural families pumping water from over 8000 wells.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 11

Applicant: Colorado Geological Survey

Project Title: County Groundwater Resource Series, Year 6

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

Description of Project: This effort addresses counties where development pressures are currently straining water resources and where comprehensive county-wide assessments have not been done. The Colorado Geological Survey (CGS) will develop web-based applications tailored to inform the public, planners, and policy-makers about local geology and groundwater resources.

Project Manager(s): Andy Moore, CWCB / Peter Barkmann, CGS

Program: Interstate, Federal, and Water Information

Purpose: This effort addresses counties where development pressures are currently straining water resources and where comprehensive county-wide assessments have not been done. This scope is based on preparing an assessment for a single county. Three counties have been been proposed for consideration for this effort: Elbert, La Plata, and Bent. The final choice will be made following discussions with CWCB Staff.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 12

Applicant: Colorado Division of Water Resources, Dam Safety Branch

Project Title: Dam Safety Inundation Mapping Grant Program

Recommended Amount: $50,000
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: 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.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 13

Applicant(s): Linda Bassi, S&LP Chief
Carlee Brown, 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 Interstate, Federal, and Water Information Section with recreational in-channel diversion cases; 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
Carlee Brown/Suzanne Sellers
Kevin Houck/Chris Sturm/Joe Busto

Programs: 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, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

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 Account outreach and education project, which has been historically funded at $15,000.

The Section's operating budget needs can vary significantly from year to year depending on the amount of outreach activities required to address issues associated with new appropriations, acquisitions, legal protection, and implementation of Colorado's Water Plan. This year, the Section is becoming more involved in stream management plans to help achieve the measurable objective of Colorado's Water Plan to cover 80% of Colorado's locally prioritized rivers with stream management plans.

The Section estimates that $15,000 of supplemental funding will be required to address travel and other expenses associated with meetings, field work and other outreach activities related to new instream flow appropriation recommendations (including pending recommendations from the U.S. Forest Service in Water Division 7), acquisitions of water for instream flow use, legal protection of instream flow water rights, stream management plans, and other outreach needs.

Project Manager(s): Linda Bassi / Jeff Baessler

Program: Instream Flow and Natural Lake Level

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

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 15

Applicant: Linda Bassi, S&LP Chief

Project Title: Agency Intern Support

Recommended Amount: $12,529
Requested Amount: $15,000

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 aspiring water professionals.

Project Manager(s): Linda Bassi

Program: CWCB Programs

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

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 16

Applicant: Kevin Houck, W&FP Chief

Project Title: Flood Mitigation and Project Compliance

Recommended Amount: $150,000
Requested Amount: $200,000

Description of Project: 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 the NRCS Emergency Watershed Protection (EWP) program that are necessary to perform, but ineligible to be reimbursed by the NRCS. CWCB staff is requesting this Severance Tax funding 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

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

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2017 – 2018

Project No. 17

Applicant: Kevin Houck, W&FP Chief

Project Title: Community Assistance Program

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

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.

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2017 – 2018

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, CWCB / Jeff Derry, CSAS

Program: Watershed and Flood Protection

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.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 19

Applicant: Metropolitan State University

Project Title: Colorado's Water Plan - Education Asset Mapping

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

Description of Project: Colorado's Water Plan (CWP) sets a measurable objective of significantly improving the level of public awareness and engagement on water issues statewide by 2020, as determined by water awareness surveys. In addition, the plan lays out an overarching goal to "provide technical and financial assistance for high-quality, balanced, and grassroots water education and outreach efforts that inform Coloradans about the issues so that they may engage in determining Colorado's water future." To do this, CWP lists three critical actions: 1) create a new outreach, education, and public engagement grant program; 2) conduct a water education assessment to help develop a data-based water education plan; and 3) improve the use of existing state resources and involve the innovation community in solutions. This Education Asset Mapping project will address various aspects of these critical actions, but particularly #1 and #2 above. This asset mapping will provide information about the education and outreach strengths, resources, needs, and gaps (geographically and topically) in each basin roundtable region and will include an analysis of the types of target audiences for education and outreach that need to be reached to achieve each measurable objective in CWP. This project will inform and feed into the development of a statewide education and outreach grant fund program by identifying specific target audiences and approaches needed to meet the goals of the Basin Implementation Plans and CWP. In sum, this project will gather, synthesize, and disseminate the information needed for Colorado to create a data-based water education plan and provide appropriate and critically needed funding for education and outreach programs that help achieve CWP.

Project Manager(s): Rebecca Mitchell, CWCB / Mara MacKillop, CWCB / Tom Cech, MSU

Program: Colorado's Water Plan Implementation

Purpose: This project aligns with Colorado's Water Plan and helps local communities and statewide organizations collaborate, plan, and adapt their education, outreach, and engagement efforts to meet the goals and actions in CWP.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 20

Applicant: OMNI Institute

Project Title: CWP Outreach, Education, and Public Engagement Baseline Survey

Recommended Amount: $48,760
Requested Amount: $48,760

Description of Project: Colorado's Water Plan sets a measurable objective to significantly improve the level of public awareness and engagement regarding water issues statewide by 2020, as determined by water awareness surveys. This survey is the baseline survey to gather and analyze the necessary information to determine progress, successes, and areas of priority and improvement to meet this objective. It will include questions about public knowledge, awareness, attitudes, and willingness to act. This survey will utilize and build upon past awareness surveys in Colorado and will continue this work in order to collect and analyze consistent data that is evaluated and distributed so Colorado can target efforts to meet the objective, and the other measureable objectives in the plan.

Project Manager(s): Rebecca Mitchell, CWCB / Mara MacKillop, CWCB / Sara Bayless, OMNI

Program: Colorado's Water Plan Implementation

Purpose: This project is called for in Colorado's Water Plan and will help local communities, as well as statewide organizations, plan and adapt their education, outreach, and engagement efforts to meet all measurable objectives, goals, and critical actions.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 21

Applicant:	Reagan Waskom, Colorado State University
Project Title:	Constructing and Testing a Refined Groundwater Flow Model for the LaSalle/Gilcrest Area
Recommended Amount:	$48,515
Requested Amount:	$48,515

Description of Project: To use a refined groundwater flow model to investigate high groundwater levels in the LaSalle/Gilcrest area.

Project Manager(s):	Andy Moore, CWCB (See attached)
Program:	Interstate, Federal, and Water Information

Purpose: This project is a continuation of an ongoing CWCB-funded project that aims at constructing and applying a refined groundwater flow for the LaSalle/Gilcrest area. The objectives of the model are to investigate reasons for high water table elevation in the area and explore the effects of best-management practices (BMPs) on water table elevation.

Funding Available:	July 1, 2017 – June 30, 2018

Constructing and Testing 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. This project is a continuation of an ongoing CWCB-funded project that aims at constructing and applying a refined groundwater flow for the LaSalle/Gilcrest area. The objectives of the model are:

(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.

Model construction began July 2016 and is progressing well, using data from over 400 boreholes to create a three-dimensional aquifer material map and provide a more refined representation of aquifer properties such as hydraulic conductivity. Dr. Ryan Bailey, 1 PhD student, and 1 undergraduate student are working on data collection and model construction and testing. We anticipate that a working model will be available by the end of the current project period (June 30, 2017). However, fulfilling the two outlined objectives will require one additional year of funding. 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 Construction

The refined model grid is being constructed in the software Visual MODFLOW Flex, with a digital elevation model (DEM) used for the ground surface and the data from over 400 boreholes used to define stratigraphic layers within the subsurface. Two potential additional refinements include simulating groundwater percolation in the root zone and vadose zone 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), and using the UnStructured Grid (USG) version of MODFLOW that allows refinement of grid cells around pumping wells to more accurately simulate drawdown cones. The USG version of MODFLOW currently does not include the UZF package, and so we will decide during the project which feature is more important for the successful completion of the project objectives.

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, 2018), 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, 2018. All deliverables will be provided to the CWCB on or before that date.

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

0.65 Month Faculty Salary (includes 25% fringe)	$8,125
12 Month PhD half-time Salary (includes 5.5% fringe)	$23,000
1 semester tuition and fees for PhD student	$5,462
12 Month Undergraduate Research Assistant (8 hrs/week)	$5,600
Indirect Cost (15% rate)	$6,328
Total	**$48,515**

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 22

Applicant:	Reagan Waskom, Colorado State University
Project Title:	Bark Beetle Impacts on Remotely Sensed Evapotranspiration in the Colorado Rocky Mountains
Recommended Amount:	$50,000
Requested Amount:	$50,000

Description of Project: To use remotely sensed evapotranspiration in the Colorado Rocky Mountains to evaluate the impacts of bark beetle-related forest mortality.

Project Manager(s):	Brenna Mefford, CWCB (See Attached)
Program:	Interstate, Federal, and Water Information

Purpose: Changes in climate and land cover can increase the uncertainty of water supply forecasts by altering the partitioning of precipitation and snowmelt between evapotranspiration (ET) and streamflow. In particular, bark beetle-related forest mortality represents a major ongoing disturbance, and it is shown to have the potential to supersede drought stress to forest growth with major implications for ET. Remotely sensed ET data will be used to: (1) quantify the net effect of bark beetles on ET throughout the EPA Level III Southern Rocky Mountain Ecoregion and (2) evaluate this impact within the context of the water balance and streamflow.

Funding Available: July 1, 2017 – June 30, 2018

Title: Bark Beetle Impacts on Remotely Sensed Evapotranspiration in the Colorado Rocky Mountains

Principal Investigators:
Dr. John F. Knowles, University of Colorado Boulder, Postdoctoral Research Associate, 303-492-9967, John.Knowles@Colorado.edu
Dr. Noah P. Molotch, University of Colorado Boulder, Associate Professor, 303-492-6151, Noah.Molotch@Colorado.edu

Location: The principal investigators and the requested postdoctoral research associate would be located at the University of Colorado Boulder campus. The study region is forested areas within the EPA Level III Southern Rocky Mountain Ecoregion that principally represents the Colorado Rocky Mountains, but also encompasses mountain areas in Southern Wyoming and northern New Mexico.

***Purpose of the research*:** In the western United States, effective water distribution to agricultural, industrial, and residential customers is predicated upon accurate forecasts of water supply based on estimates of mountain snowpack. Changes in climate and land cover can increase the uncertainty of these forecasts by altering the partitioning of precipitation and snowmelt between evapotranspiration (ET) and streamflow. In particular, bark beetle-related forest mortality represents the major ongoing disturbance in this area, and is shown to have the potential to supersede drought stress to forest growth with major implications for ET. Importantly, ET is a two-component flux comprised of (1) bare soil/canopy evaporation and (2) transpiration, or evaporation that is mediated by vegetation, but the aggregated effect of bark beetles on these processes is not well understood. **As a result, this proposal seeks to establish the link between bark beetle-induced tree mortality and ET in the Colorado Rocky Mountains. We hypothesize that transpiration will decrease but that evaporation will increase as a result of bark beetle infestation with a negative net effect on total ET.** The total ET is critical to water resources as it represents a major component of the water balance and thus regulates the amount of water available to streamflow. Consequently, this information is useful to both hydrological forecast models and water managers for the purpose of quantitatively evaluating the impact of land cover change on the water balance and streamflow. This proposal stems in part from previous collaboration between Dr. Molotch with Denver Water and the Western Water Assessment, and the results of this work will be widely disseminated to water management entities along the Colorado Front Range.

Objectives, methods, timeline and completion* date*: We will utilize remotely sensed ET data to: (1) quantify the net effect of bark beetles on ET throughout the EPA Level III Southern Rocky Mountain Ecoregion and (2) evaluate this impact within the context of the water balance and streamflow. To achieve this, we will primarily utilize publically available ET data from the Moderate Resolution Imaging Spectroradiometer (MODIS). These ET data are available at 1 km resolution and are based on the Penman-Monteith equation and forced by both ancillary meteorological

data and 8-day averaged MODIS-based vegetation information. For this analysis, beetle-disturbed areas will be identified using United States Forest Service Aerial Detection Survey (ADS) data, which estimate forest mortality based on aircraft observations wherein visual estimates of the number of trees killed per hectare are manually transcribed onto a base map. As ground truth, we also propose to use ecosystem-scale ET from eddy covariance measurements at several AmeriFlux sites within the study area to independently compare and contrast against MODIS-derived ET. Dr. Knowles has a background in the eddy covariance method and has previously worked with researchers and ET data from the US-NR1 (Niwot Ridge, Colorado) and US-VCM (Valled Caldera, New Mexico) sites within the study area, as well as the US-GLE (Glacier Lakes Ecosystem Experiments Site, Wyoming) site that has been heavily impacted by bark beetles. Together with Dr. Molotch's remote sensing experience, this will promote a unique multi-scale research design with which to quantify the net effect of bark beetles on ET within the larger context of water resources. Statistical analysis will consist of time series and single and multiple variable regression analyses. This project will be completed within eight months of the start date and no later than 30 June 2018.

***Budget*:**

Cost	**Amount**
Postdoc Salary (8 months @ $4167/month)	$33,333
Fringe Benefits (35% of Salary)	$11,667
Indirect Costs (15% of Salary)	$5000
Total	$50,000

Budget justification: We are requesting eight months of salary with which to recruit a postdoctoral research associate to be mentored by Drs. Molotch and/or Knowles at the University of Colorado. The requested salary is based on $50,000 per year, which is a standard salary for postdoctoral researchers at the University of Colorado Boulder. During this eight-month period, fringe benefits are requested at the University-mandated rate for research professionals and indirect costs amount to 15% of the eight-month salary and 11% of direct costs.

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 23

Applicant:	Reagan Waskom, Colorado State University
Project Title:	Automated Non-Telemetered Snow Depth Monitoring for Water Supply Forecasting by Improved Basin-wide Snowpack Water Storage Estimation
Recommended Amount:	$43,455
Requested Amount:	$43,455

Description of Project: To improve basin-wide snowpack water storage estimation using automated non-telemetered snow depth monitoring.

Project Manager(s):	Joe Busto, CWCB / Erik Skeie, CWCB (See Attached)
Program:	Watershed, Flood, Interstate, Federal and Water Information

Purpose: To enhance CWCB's efforts of collecting more snow data in order to better refine water forecasting efforts. To more accurately estimate SWE in a basin through increased spatio-temporal snow depth data collection. To develop a data collection algorithm and protocol that can be transferred to other areas.

Funding Available:	July 1, 2017 – June 30, 2018

1. Title: Automated Non-Telemetered Snow Depth Monitoring for Water Supply Forecasting by Improved Basin-wide Snowpack Water Storage Estimation

2. Principal Investigator: Steven R. Fassnacht, Professor, (970) 491-5454, <Steven.Fassnacht@colostate.edu>

3. Location: Fort Collins (CSU) and one mountain watershed in Colorado

4 and 5. Purpose, Objectives, and Methods of the Research: In the late 1970s, the Natural Resources Conservation Service (NRCS) initiated the west-wide Snow Telemetry (SNOTEL) network to provide real-time snow water equivalent (SWE) and precipitation measurements. Twenty years later, ultra sonic depth sensors began to be added. Now, simpler SNOLite stations are being installed that are less expensive (by at least a factor of five) and more environmentally sound (no glycol as there is no snow pillow). Recent research (e.g., Meromy *et al*., 2013) has shown that there can be substantial spatial variability in the snowpack about SNOTEL sensor and it is recommended to use multiple sensors about one station to have a more robust snowpack estimate (Veatch *et al*., 2009; Rice and Bales, 2010). This follows the concept of the manual snow course that uses 10+ snow cores and can also be used to provide estimates of variability or uncertainty (Fassnacht and Hultstrand, 2015).

We propose to use game cameras and five depth staffs per camera in a variety of locations across a study basin to estimate snow depth at a multitude of sites, and to establish estimates of intra-annual variability. Manual snow depth surveys will occur 2-4 times (during accumulation, at peak, and during melt). These will be sets of 20 to 40 individual snow depth measurements about each camera site over a 100 by 100 meter area to assess variability. Density can be estimated from existing SNOTEL and snow course stations (Sexstone and Fassnacht, 2014), so SWE can be estimated as well. A focus watershed could be the Conejos River; this is where the NASA Airborne Snow Observatory (ASO) is collecting snow data in conjunction with the Colorado Water Conservancy Board (CWCB) to improve the spatio-temporal estimates of snow for forecasting. The proposed camera snow depth measurements may be established in a different basin, depending on CWCB-ASO plans. It is quicker and easier to install game cameras and depth staffs than SNOTEL or SNOLite stations.

The staffs will be red, blue or green (to be easily distinguished from the snow and the canopy) and the project will develop an algorithm to automatically determine snow depth from a number of locations (staffs) across an image. Images will be taken 2-3 times per day and with a series of 10 cameras, generating a large number of depth estimates over a winter season. It is anticipated that the algorithm could be ported to the SNOTEL or similar data collection platforms. The rationale for this method is that more data can be collected at more sites and be less intrusive than SNOTEL or SNOLite stations. The proposed work with test and establish a protocol for this data collection method. The protocol will be transferable to other areas.

This first product is a robust time series of daily snow depth data (mean and variability) at 10 crucial locations across the study watershed. These locations are not currently measured and have unique terrain characteristics. These data are robust since they integrate over an area rather than being just a point estimate. The latter is the case

for SNOTEL and other stand-alone sensors. This time series can enhance the ASO spatial dataset and it is anticipated will help estimating streamflow in this river. These camera-sensors can remain in situ for subsequent years. Since a formal protocol will be developed by this work, the creation of future daily time series can be done easily.

References

Fassnacht and Hultstrand, 2015. *PIAHS*, 371, [doi:10.5194/piahs-371-131-2015].
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Veatch *et al*., 2009. *Ecohydrology*, 2, [doi:10.1002/eco.45].

5C. Timeline: It is anticipated that this project will partner with CWCB.
Basin Identification – July 2017: determine study basin and sampling locations
GIS Analysis – July and August 2017: spatial (include ASO, if available) data and metadata retrieval, evaluation of current measurement locations to find optimal locations
Field Setup – September and October 2017: camera and snow depth staff installation.
Field Surveys and Data Retrieval – November 2017 through May 2018: four bi-monthly site visits to download photo time series from each camera and manual snow surveys
Data Analysis – November 2017 through June 2018: develop and apply algorithm, compare to NRCS data, estimate basin-wide SWE improvement using new dataset
Final Reporting – June 2018: write final report and draft journal manuscript

5D. Completion Date: Data will be collected in the winter, and analysis will be concurrent. We anticipate all aspect of the project being completed by the end of 2018.

6. Budget: The budget is $43,355 including 15% in-direct.

7. Budget Justification: This is a project is the basis for a MS thesis and asks the research question: "*do multiple low cost camera-depth sensors improve our basin-wide estimates of the snowpack*?" The budget is as follows: 1) graduate research assistant for 12 months (August 15-June 30) [$25,200]. The student will build the setup, use GIS to locate the camera-depth sensors, install, download the data and analyze the results, prepare the protocol; 2) 10 camera-depth sensors (10 cameras, 5x10 staffs, T-bars, bailing wire, spray paint, etc.) [$4,000]; 3) travel to install cameras (pre-season), mid-season visits/downloads, end of season removal [$4,500]; and 4) Fassnacht supervision, and programming for 1 week [$4,000]

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 24

Applicant:	Reagan Waskom, Colorado State University
Project Title:	Water Yield Sensitivity to Snow Loss in Colorado Headwater Streams
Recommended Amount:	$49,991
Requested Amount:	$49,991

Description of Project: To Examine how snow patterns relate to water yield in Colorado Watersheds with streamflow data.

Project Manager(s):	Joe Busto, CWCB / Erik Skeie, CWCB (See Attached)
Program:	Watershed, Flood, Interstate, Federal and Water Information

Purpose: **T**o improve understanding of the relationship between snowpack and streamflow across Colorado. With a focus on improving future water yield predictions by enhancing the understanding of runoff from middle and low elevation snowpack (<8,400 ft. elev.). Middle elevations are important sources of water yield in some years, but these areas experience large changes in snow from year to year and are sensitive to other impacts such as dust deposition, beetle kill, and fire. The lack of snow and streamflow measurements at middle elevations can mean that snow and runoff changes are not detected, potentially causing problems for streamflow forecasting and downstream water supply.

Funding Available: July 1, 2017 – June 30, 2018

1. Title: Water yield sensitivity to snow loss in Colorado headwater streams

2. PIs: Gigi Richard, Prof., Colorado Mesa Univ, 970-248-1689, grichard@coloradomesa.edu & Stephanie Kampf, Assoc. Prof., Colorado State Univ., 970-491-0931, stephanie.kampf@colostate.edu.

3. Locations in Colorado: Grand Mesa, western CO; Front Range, eastern CO

4. Purpose of the research: The purpose of this proposed research is to improve understanding of the relationship between snowpack and streamflow across Colorado. We focus on improving future water yield predictions by enhancing our understanding of runoff from middle and low elevation snowpack (<8,400 ft. elev.). Middle elevations are important sources of water yield in some years[(1)], but these areas experience large changes in snow from year to year and are sensitive to other impacts such as dust deposition, beetle kill, and fire[(2-4)]. The lack of snow and streamflow measurements at middle elevations can mean that snow and runoff changes are not detected, potentially causing problems for streamflow forecasting and downstream water supply.

5. Objectives, methods, timeline and completion date: Our research has two primary objectives: (1) Examine how snow patterns relate to water yield in Colorado watersheds with historical streamflow data, and (2) Develop and maintain a small watershed monitoring network that directly links snowpack measurements to adjacent streamflow measurements at different elevations.

For obj. 1, we will compare annual water yield to snow patterns for watersheds throughout the state. We will document snow patterns using a combination of ground-based SNOTEL stations and satellite snow cover data. For example, for stations without flow modifications, there is a strong non-linear relationship between snow persistence from satellite data and runoff ratio (water yield / precipitation) (Fig.1). We will examine how this relationship is affected by flow modifications and land use change and how it can inform streamflow forecasts.

For obj. 2, we will expand on an existing small watershed network initiated with previous seed grant funding. The network includes two sets of monitored catchments along elevation and snow gradients in western CO (Grand Mesa) and eastern CO (Big Thompson and Cache la Poudre basins). Each transect contains catchments at high (persistent snow), middle (transitional snow), and low elevations (intermittent snow) (Fig. 1). At all catchments we

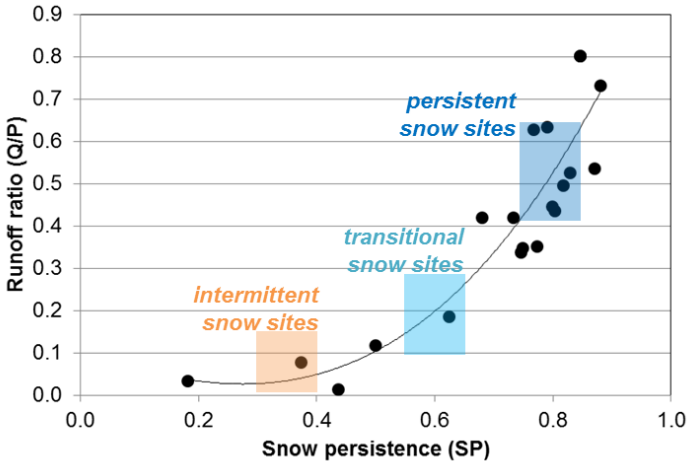

Figure 1. Relationship between mean annual water yield over mean annual precipitation (Q/P) and mean annual Jan 1 – Jul 3 snow persistence (SP) from MODIS, 2000-2010. Water yield values from CO streamflow gauging stations with no documented flow modifications.

monitor precipitation, snow depth, snow water equivalent, soil moisture, soil temperature, stream stage, and stream discharge. The high elevation locations capture snow conditions similar to those at the current network of SNOTEL sites; the middle and low elevation locations capture snow and runoff conditions that are not monitored by SNOTEL and are only minimally sampled for water yield. We use the network of catchments to quantify relative quantities of water yield generated in each snow zone.

Timeline (start date varies depending on funding source. If federal funds, shift start date to July.):

Objective	Apr-June 2017	July-Sept 2017	Oct-Dec 2017	Jan-Mar 2017
1	Compile data*	Data analysis	Publication prep.	
2	Snow survey, soil moisture, stream discharge	Soil moisture, stream discharge	Data Analysis	Publication preparation

* historical snow data and processing scripts are already available in Kampf lab

Data analysis will include data collected from March 2016 – March 2017 as part of a CWI student grant. Results will contribute to two collaborative publications for each of the two objectives. We intend to keep the monitoring network running long-term and will use the grant period to share findings with water managers, identify sources of long-term funding, and continue building partnerships with local agencies in each monitored region to help with long-term maintenance of the sites.

6-7. Budget & justification: Costs will be split between CMU (lead institution) and CSU

Item	**Description**	**Cost**
PI Salary	1-month salary + fringe for supervision + field time - Richard	$9,070
GRA Salary	6 months salary + fringe – CSU PhD student for field time, data analysis, and writing for all sites	$14,150
Undergrad student salary	4 undergrads, 20 hrs/mo - student hourly + fringe - research assistants for field work + data processing[Office1]	$14,000
Travel	travel to field sites, exchange visits between CMU and CSU researchers, and visits with potential partners and future funders	$3,600
Supplies	replacement of malfunctioning equipment, field accessories, and field computer for CMU	$2,550
Communication	Phone, printing and shipping charges	$100
Indirect costs	15%	$6,521
Total		**$49,991**

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[1]Hyd.Proc 28, 2237-2250; [2]PNAS 107(40), 17125-17130; [3]J.Hydro 523, 196-210; [4]Geomorph 273, 39-51

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 25

Applicant: Reagan Waskom, Colorado State University

Project Title: Mountain Basin Hydrologic Response Study

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

Description of Project: To determine if the Division of Water Resources Dam Safety Guidelines are adequate for runoff modeling covering extreme precipitation events in the Rockies.

Project Manager(s): Anna Mauss, CWCB (See Attached)

Program: Dam Safety

Purpose: The long-term objectives of this line of research are: (1) to determine whether the present Colorado Dam Safety guidelines for runoff modeling correctly specify the runoff production mechanisms for extreme precipitation events in Colorado's mountain basins and (2) to develop updated guidelines for runoff modeling that include the appropriate runoff production mechanisms. The immediate goal for this first phase of research is to implement a physically-based model that allows production of both infiltration-excess and saturation-excess runoff and examine in detail the mechanisms that were active for Gross Reservoir during the September 2013 event and another large event from September 1938.

Funding Available: July 1, 2017 – June 30, 2018

Project No. 25

Mountain Basin Hydrologic Response Study

Principal Investigator: Dr. Jeffrey D. Niemann, Associate Professor; Department of Civil and Environmental Engineering, Colorado State University (jniemann@engr.colostate.edu)

Background: The safety of Colorado's dams is critical for the protection of human life and prevention of economic losses. Spillway regulations are based on extreme flows that a given dam might encounter, and such flows are produced by the combination of extreme precipitation and the conversion of precipitation into runoff and streamflow. An important and long-standing problem for the Rocky Mountain region is that traditional meteorology and flood hydrology methods appear to significantly overestimate floods based on comparisons to paleoflood evidence and regional peak streamflow statistics. Solving this problem may allow higher confidence in terms of spillway safety, more efficient allocation of dam repair funds, and possibilities for additional reservoir storage in support of the Colorado Water Plan. The CWCB, DWR, and State of New Mexico are conducting a $1.5 million study to develop improved estimates of extreme precipitation for the two state region. Concurrently, DWR has been working to improve flood hydrology methods for the mountain region. Traditional flood hydrology methods utilize low infiltration rates to model flood runoff solely by an infiltration-excess mechanism. By this mechanism, runoff occurs when the rainfall intensity exceeds the infiltration capacity of the soil. However, forested basins typically have soils with high infiltration capacities that produce little infiltration-excess runoff. Recent advances by DWR indicate that flood runoff in mountain basins might be controlled by a saturation-excess mechanism. Saturation-excess runoff occurs when a relatively shallow soil is underlain by a layer with much lower permeability (usually bedrock), which is a relatively common situation in Colorado's mountain basins. Rainfall rates that are less than the infiltration capacity can still produce runoff if the precipitation continues long enough to saturate the soil column. A recent but preliminary examination of the Gross Reservoir basin suggests that saturation-excess runoff might be important for extreme precipitation events. For the September 2013 precipitation event that produced widespread flooding along the Colorado Front Range, the rainfall rate in the Gross Reservoir basin never exceeded 1.0 in/hr but continued for approximately 6 days. During that period, two distinct peaks in rainfall intensity occurred approximately one day apart. Although the first peak had a greater rainfall intensity, the second peak produced much more runoff. This behavior is not consistent with infiltration-excess runoff, which would produce higher runoff rates for higher rainfall rates, but it is consistent with saturation-excess runoff, which depends more on the accumulated depth of rainfall.

Objectives: The long-term objectives of this line of research are: (1) to determine whether the present Colorado Dam Safety guidelines for runoff modeling correctly specify the runoff production mechanisms for extreme precipitation events in Colorado's mountain basins and (2) to develop updated guidelines for runoff modeling that include the appropriate runoff production mechanisms. The immediate goal for this first phase of research is to implement a physically-based model that allows production of both infiltration-excess and saturation-excess runoff and examine in detail the mechanisms that were active for Gross Reservoir during the September 2013 event and another large event from September 1938. In a future phase, the research will be extended to other basins and extreme events to more robustly fulfill the first long-term objective. The model developed in the present study is also expected to provide the foundation for any updates to the guidelines described in the second long-term objective. The modeling method used in this study must fulfill several key requirements. First, it must be physically-based to maximize the reliability of its results. Second, it must simulate both infiltration-excess and saturation-excess runoff so the appropriate runoff production mechanism(s) can be identified and simulated. Third, the model must not require calibration because most basins above Colorado dams are ungauged. Fourth, it must be implemented in a simple and low-cost framework and

utilize existing NRCS or USFS soil survey data to allow possible future adoption by consultants that perform dam safety studies.

Methods: Unfortunately, widely-available models such as HEC-HMS do not include an infiltration model that meets these requirements. We anticipate implementing a Green and Ampt infiltration method in a spreadsheet environment that includes an impervious bedrock layer at a specified depth. The Green and Ampt model is an approximation of Richard's Equation in which the wetting front is assumed to be abrupt. A similar Green and Ampt method is available in the scientific literature but will be generalized to accept temporally varying rainfall amounts. The Green and Ampt model will be applied to the Gross Reservoir basin in a semi-distributed fashion where the number of sub-basins is determined by the heterogeneity of the basin and storm characteristics. The model will be applied to September 2013 and 1938 flood events using storm and basin characteristics provided by the Dam Safety Program. To evaluate the new Green and Ampt approach, its runoff production will be compared to that of a full Richard's Equation model for the same events. To determine whether saturation-excess runoff is occurring, the Green and Ampt approach will be applied with and without the impermeable bedrock layer. When this layer is excluded, any runoff production must be produced by infiltration excess, which is consistent with the present guidelines. When the bedrock layer is included, runoff production can be produced by both infiltration-excess and saturation-excess runoff. The appropriate mechanism will be determined in part by comparing against the observed responses of the basin. During the project, we will also interact with the U.S. Army Corps of Engineers to discuss a long-term plan for improving the infiltration models in HEC-HMS. The goal is to provide a suitable infiltration model that can be used by consultants with existing datasets for spillway studies in Colorado.

Deliverables: A spreadsheet model will be provided to DWR that implements the physically-based infiltration model and allows generation of both infiltration-excess and saturation-excess runoff. This model will be user friendly and readily applicable to basins beyond Gross Reservoir. A final report will be provided to CWCB and DWR that summarizes the comparison of the proposed Green and Ampt model to the Richard's Equation model and the relative importance of infiltration-excess and saturation-excess runoff production for the September 2013 and 1938 events at Gross Reservoir. Recommendations will be provided regarding: follow-up investigations to meet the long-term objectives, a plan for incorporating the improved model into HEC-HMS, and a strategy for possible automated acquisition of soil characteristics from existing NRCS and USFS soil surveys.

Completion Date: This phase of the project will occur from July 1, 2017 to June 30, 2018. All deliverables will be provided by June 30, 2018. It is anticipated that one or more future project phases will follow the current phase. The future phases would extend the model testing to other basins and extreme events and would develop methods and/or resources for estimating the parameters of the runoff production model. We plan to apply for additional grant funding from the FEMA National Dam Safety Program in May 2017 in order to leverage the state funds.

Budget and Justification: The estimated budget and justification is summarized below:

Faculty Salary & Fringe (*Approx. 0.59 months to allow active involvement in project*)	$9,946
Masters Student Stipend & Fringe (*Begins Aug. 15, spans 10.5 months, $1850/month stipend, student will perform the modeling described in this proposal*)	$22,323
Tuition (*2 semesters, full-time resident tuition*)	$12,478
Mileage (*2 coordination visits to DWR office in Pueblo, 352 mi round trip*)	$359
Indirect Costs (*15% of all costs except tuition per Colo. Water Institute agreement*)	$4,894
TOTAL	$50,000

Fringe rates given at: vprnet.research.colostate.edu/OSP/facilities-and-administrative-rates-fa/

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Severance Tax Operational Fund

Proposed Project for Fiscal Year 2017 – 2018

Project No. 26

Applicant: Open Water Foundation

Project Title: StateMod Dataset Web Publishing

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

Description of Project: This project will prototype publishing StateMod datasets, including input and results, on the web, to facilitate access via a web browser.

Project Manager(s): Andy Moore, CWCB / Steve Malers, OWF

Program: Interstate, Federal, and Water Information

Purpose: The StateMod water allocation model datasets that have been produced as part of Colorado's Decision Support Systems (CDSS) are typically distributed as only input files and software command files to create the input. The results must be created by downloading software and datasets and running StateMod software. This is a barrier to using the datasets by non-modelers, and limits use of StateMod by Basin Roundtables, their consultants, and others. This project will develop a prototype to facilitate the access to StateMod input and results.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 27

Applicant: Open Water Foundation

Project Title: Enhance CDSS StateMod Integration with GIS

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

Description of Project: To develop standards and a template example for creating StateMod datasets that integrate GIS.

Project Manager(s): Andy Moore, CWCB / Steve Malers, OWF

Program: Interstate, Federal, and Water Information

Purpose: The StateMod water allocation model datasets that have been produced as part of Colorado's Decision Support Systems (CDSS) typically contain limited spatial data integration, which limits use of the datasets. The Open Water Foundation (OWF) will develop guidelines and template example that integrates StateMod and Geographic Information System (GIS) files.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 28

Applicant: Central Colorado Water Conservancy District

Project Title: Walker Recharge Project

Recommended Amount: $ 0
Requested Amount: $100,000

Description of Project: The Walker Recharge Project is a $7,000,000 project that will be located in Weld and Morgan Counties. Water diverted from the South Platte River will be conveyed through a pipeline to various recharge facilities for augmentation purposes.

Project Manager(s): Andy Moore, CWCB / Randy Ray, CCWCD

Program: Interstate, Federal, and Water Information

Purpose: To assist in planning efforts for the Walker Recharge Project to better understand the local river system at the proposed site and determine the most efficient location to construct the necessary works to complete the project.

Funding Available: July 1, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 29

Applicant:	Colorado State University / Metropolitan State University of Denver
Project Title:	Age Structure and Seedling Survivorship of the South Platte River Riparian Forest
Recommended Amount:	$ 0
Requested Amount:	$49,795

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):	Andrew Norton, CSU / Gabrielle Katz, MSU Steve Miller, CWCB / Erik Skeie, CWCB
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 an anticipated shortage of funds this 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, 2017 – June 30, 2018

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Proposed Project for Fiscal Year 2017 – 2018

Project No. 30

Applicant:	U. S. Geological Survey
Project Title:	Online Flood Inundation Maps of the South Platte River through Fort Morgan area
Recommended Amount:	$ 0
Requested Amount:	$45,000

Description of Project: To build an online flood inundation map library for areas adjacent to Fort Morgan, CO based on the streamgage on the South Platte River at Fort Morgan.

Project Manager(s):	Thuy Patton, CWCB / Michael Kohn, USGS
Program:	Watershed and Flood Protection

Purpose: To provide real time flood inundation depths based on stream gage heights transmitted via the internet during flood events. This data can be used by local emergency personnel, public officials, and the general public to make decisions regarding evacuation routes and to plan for areas with most significant risk of flooding.

Funding Available:	July 1, 2017 – June 30, 2018