Water Supply Reserve Fund
Water Activity Summary Sheet
September 16-17, 2020
Agenda Item 19(k)

Applicant & Grantee:	Colorado State University
Water Activity Name:	Sustaining Plains Aquatic Ecosystems using an Integrated Ecological and Social Approach
Water Activity Purpose:	Environmental/Education & Outreach-Study
County:	Sedgwick, Phillips, Yuma, Logan, Washington, Morgan, Weld, Larimer, Adams and Arapahoe
Drainage Basin:	South Platte
Water Source:	South Platte River
Amount Requested:	$40,000 South Platte Basin Account $94,015 Statewide Account $134,015 Total Request
Matching Funds:	Basin Account Match = $40,000 • 43% of statewide request (meets 10% min) Applicant Match (cash) = $67,012 • 71% of the statewide request (meets 10% min) Total Match (Basin request & Applicant Match) = $107,012 • 113% of the statewide request (meets 50% min)

Staff Recommendation:
Staff recommends approval of up to $40,000 from the South Platte Basin Account and up to $94,015 from the Statewide Account to help fund the project: Sustaining Plains Aquatic Ecosystems using an Integrated Ecological and Social Approach.

Water Activity Summary: WSRF Funds, if approved will assist Colorado State University: evaluate ecological impacts of non-native mosquitofish on select native fish species under different flow and salinity conditions in the laboratory; assess land managers' and owners' perceptions regarding aquatic ecosystems, values related to these ecosystems, and evaluate factors affecting their attitudes toward environment-relevant water use practices, and; develop digital public outreach materials that document aquatic species, habitat and people working towards aquatic sustainability. Information from this study will inform future efforts to maintain both water supplies and non-consumptive needs.

Streams in the South Platte and Republican Basin are home to approximately 30 native fish that are non-consumptive priorities in the South Platte Basin Implementation Plan. Surface water diversions and groundwater pumping have decreased flow in these streams. Less water results in less habitat, while also affecting water quality (e.g., salinity), resiliency to climate change, and species composition. An invasion of non-native mosquitofish (*Gambusia affinis*; Fig. 1), one of the most invasive species in the world, is an emerging threat to native plains fish.. Little if known about how reduced streamflow, altered water quality, and invasive species, in concert, affect native species. On top of ecological

dynamics, people's knowledge, values, and decision-making at multiple levels (land managers, municipalities, other actors in the State Water Plan) interact to drive aquatic sustainability in the plains. CSU proposes an ecological study of non-native mosquitofish paired with an assessment of water managers' and landowners' perceptions regarding aquatic ecosystems, values related to these ecosystems, and factors affecting attitudes toward environment-relevant water use practices.

Discussion: This effort will assist the South Platte Basin Roundtable achieve several goals as called for in the South Platte Basin Implementation Plan and Education Action Plan, such as: Promote restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic, riparian and wetland dependent species and plant communities (Section 1.9.7); Protect and enhance environmental and recreation attributes through collaborations with other water use sectors (Section 5.5.5); and Facilitate South Platte communications and outreach programs (Section 5.5.9). In addition, this efforts assists the state in achieving the following goals as called for in Chapter 10 of Colorado's Water Plan, such as: Enhance Environmental and Recreational Economic Values, and; Protect Healthy Environments; Promote Protection and Restoration of Water Quality.

Issues/Additional Needs: None.

Eligibility Requirements: The application meets requirements of all eligibility components.

Evaluation Criteria: Staff has determined this activity satisfies the Evaluation Criteria.

Funding Sources/Match	**Cash**	**In-kind**	**Total**	**Status**
Colorado State University	$67,012	$0	$67,015	Secured
WSRF South Platte Basin Account	$40,000	$0	$40,000	Secured
Sub-total	$107,012	$0	$107,012	
WSRF Statewide Account	$94,015	n/a	$94,015	
Total Project Costs	**$201,027**	**$0**	**$201,027**	

CWCB Project Manager: Craig Godbout

South Platte Basin Roundtable

Garrett Varra, Chair

July 15, 2020

Craig Godbout
Water Supply Planning Section
Colorado Water Conservation Board
1313 Sherman Street, Room 718
Denver, CO 80203

VIA EMAIL to craig.godbout@state.co.us

RE: Approval Recommendation for "Sustaining plains aquatic ecosystems using an integrated ecological and social approach" Application

Dear Craig,

I am writing to express strong support for the WSRF project proposal submitted by Dr. Kanno and his colleagues at Colorado State University titled "Sustaining plains aquatic ecosystems using an integrated ecological and social approach". On July 14, 2020, the South Platte Basin Roundtable met virtually, and a quorum of the membership voted to approve funding the proposal fully for the requested amount of $40,000 from the basin account. The proposal seeks additional $94,015 from the statewide account. We found the proposal complete with required documents, and it will address some key objectives identified in the South Platte Basin Implementation Plan.

This proposal combines an ecological and social study of plains aquatic sustainability with an outreach activity. We consider that this project falls under at least two categories of water activities, namely "Nonconsumptive (Environmental)" and "Education & Outreach", and it is a multi-purpose project in nature. The project addresses Roundtable priorities with its three key objectives:

(1) Evaluate ecological impacts of non-native mosquitofish (*Gambusia affinis*) on select native fish species under different flow and salinity conditions in the laboratory;
(2) Assess land managers' values and actions regarding aquatic ecosystems, and evaluate the broader stakeholder decision-making network that structures how water needs are interpreted and met, and
(3) Develop digital public outreach materials that document aquatic species, habitat and people working towards aquatic sustainability.

Information from this study will inform future efforts to maintain both water supplies and non-consumptive needs in line with South Platte Basin Implementation Plan and Colorado Water Plan priorities. Specifically, the proposed project will:

(1) Promote restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic, riparian and wetland dependent species and plant communities by supporting Colorado Parks and Wildlife and other agencies responsible for aquatic species management (CWP p.6-157; SP BIP Measurable Outcome #1 p.1-28);
(2) Provide information that can help identify opportunities to protect and enhance environmental and recreation attributes through collaborations with other water use sectors (BIP Section 5.5.5, p. S-14) and support the development of multipurpose projects and methods that benefit environmental and recreational water needs as well as water needs for communities and agriculture (CWP p. 6-157).
(3) Facilitate South Platte communications and outreach programs that complement the State's overall program (BIP Section 5.5.9 p. S-15) and provide 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 (CWP p. 9-53).

While activities address issues in the South Platte and Republican basins, balancing water supply and aquatic environmental protection is a common theme statewide. Therefore, it is a project appropriate for consideration of funding by the statewide account, as well as the basin account.

Sincerely,

Garrett Varra
Chair
South Platte Roundtable

Last Update: July 31, 2018

Colorado Water Conservation Board

Water Supply Reserve Fund
Grant Application

Instructions

All WSRF grant applications shall conform to the current 2016 WSRF Criteria and Guidelines.

To receive funding from the WSRF, a proposed water activity must be approved by a Roundtable(s) **AND** the Colorado Water Conservation Board (CWCB). The process for Roundtable consideration and recommendation is outlined in the 2016 WSRF Criteria and Guidelines. The CWCB meets bimonthly according to the schedule on page 2 of this application.

If you have questions, please contact the current CWCB staff Roundtable liaison:

Arkansas	**Gunnison | North Platte | South Platte | Yampa/White**	**Colorado | Metro | Rio Grande | Southwest**
Ben Wade	Craig Godbout	Megan Holcomb
ben.wade@state.co.us	craig.godbout@state.co.us	megan.holcomb@state.co.us
303-866-3441 x3238	303-866-3441 x3210	303-866-3441 x3222

WSRF Submittal Checklist (Required)	
✓	I acknowledge this request was recommended for CWCB approval by the sponsoring roundtable.
✓	I acknowledge I have read and understand the 2016 WSRF Criteria and Guidelines.
✓	I acknowledge the Grantee will be able to contract with CWCB using the Standard Contract.(1)
Application Documents	
✓	Exhibit A: Statement of Work(2) *(Word – see Template)*
✓	Exhibit B: Budget & Schedule(2) *(Excel Spreadsheet – see Template)*
✓	Letters of Matching and/or Pending 3rd Party Commitments(2)
✓	Map(2)
	Photos/Drawings/Reports
	Letters of Support
Contracting Documents(3)	
	Detailed/Itemized Budget(3) *(Excel Spreadsheet – see Template)*
	Certificate of Insurance(4) *(General, Auto, & Workers' Comp.)*
	Certificate of Good Standing(4)
	W-9 Form(4)
	Independent Contractor Form(4) *(If applicant is individual, not company/organization)*
	Electronic Funds Transfer (ETF) Form(4)

(1) Click "Grant Agreements". For reference only/do not fill out or submit/required for contracting
(2) Required with application if applicable.
(3) Additional documentation providing a Detailed/Itemized Budget maybe required for contracting. Applicants are encouraged to coordinate with the CWCB Project Manager to determine specifics.
(4) Required for contracting. While optional at the time of this application, submission can expedite contracting upon CWCB Board approval.

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Schedule		
CWCB Meeting	**Application Submittal Dates**	**Type of Request**
January	December 1	Basin Account; BIP
March	February 1	Basin/Statewide Account; BIP
May	April 1	Basin Account; BIP
July	June 1	Basin Account; BIP
September	August 1	Basin/Statewide Account; BIP
November	October 1	Basin Account/BIP

Desired Timeline	
Desired CWCB Hearing Month:	September
Desired Notice to Proceed Date:	October

Water Activity Summary	
Name of Applicant	Colorado State University
Name of Water Activity	Sustaining plains aquatic ecosystems using an integrated ecological and social approach

Approving Roundtable(s)	Basin Account Request(s)(1)
South Platte Basin	$ 40,000.00 (approved by SP Roundtable)
Basin Account Request Subtotal	$ 40,000.00
Statewide Account Request(1)	$ 94,015.00
Total WSRF Funds Requested (Basin & Statewide)	$ 134,015.00
Total Project Costs	$ 201.027.00

(1) Please indicate the amount recommended for approval by the Roundtable(s)

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Grantee and Applicant Information	
Name of Grantee(s)	Colorado State University
Mailing Address	Sponsored Program, CSU, Fort Collins, CO 80523-2002
FEIN	84-6000545
Grantee's Organization Contact(1)	Carmen Morales
Position/Title	Senior Research Administrator
Email	carmen.morales@colostate.edu
Phone	970-491-6684
Grant Management Contact(2)	Jenny Harding
Position/Title	Research Administrator
Email	jenny.harding@colostate.edu
Phone	970-491-4330
Name of Applicant (if different than grantee)	Yoichiro Kanno
Mailing Address	1474 Campus Delivery, Fort Collins, CO 80523-1474
Position/Title	Assistant Professor
Email	yoichiro.kanno@colostate.edu
Phone	970-491-5145

(1) Person with signatory authority

(2) Person responsible for creating reimbursement invoices (Invoice for Services) and corresponding with CWCB staff.

Description of Grantee
Provide a brief description of the grantee's organization (100 words or less).
Colorado State University is the state's land grant university and the flagshipe university of the Colorado State University System.

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Type of Eligible Entity (check one)	
✓	**Public (Government):** municipalities, enterprises, counties, and State of Colorado agencies. Federal agencies are encouraged to work with local entities. Federal agencies are eligible, but only if they can make a compelling case for why a local partner cannot be the grant recipient.
	Public (Districts): authorities, Title 32/special districts (conservancy, conservation, and irrigation districts), and water activity enterprises
	Private Incorporated: mutual ditch companies, homeowners associations, corporations
	Private Individuals, Partnerships, and Sole Proprietors: are eligible for funding from the Basin Accounts but not for funding from the Statewide Account.
	Non-governmental organizations: broadly, any organization that is not part of the government
	Covered Entity: as defined in Section 37-60-126 Colorado Revised Statutes

Type of Water Activity (check one)	
✓	Study
	Implementation

Category of Water Activity (check all that apply)		
✓	Nonconsumptive (Environmental)	
	Nonconsumptive (Recreational)	
	Agricultural	
	Municipal/Industrial	
	Needs Assessment	
✓	Education & Outreach	
	Other	Explain:

Location of Water Activity	
Please provide the general county and coordinates of the proposed activity below in **decimal degrees**. The Applicant shall also provide, in Exhibit C, a site map if applicable.	
County/Counties	Sedgwick, Phillips, Yuma, Logan, Washington, Morgan, Weld, Larimer, Adams and Arapahoe
Latitude	
Longitude	

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Water Activity Overview
Please provide a summary of the proposed water activity (200 words or less). Include a description of the activity and what the WSRF funding will be used for specifically (e.g. studies, permitting, construction). Provide a description of the water supply source to be utilized or the water body affected by the activity. Include details such as acres under irrigation, types of crops irrigated, number of residential and commercial taps, length of ditch improvements, length of pipe installed, area of habitat improvements. If this project addresses multiple purposes or spans multiple basins, please explain. The Applicant shall also provide, in Exhibit A, a detailed Statement of Work, Budget, and Schedule.
Streams in the South Platte and Republican Basin are home to approximately 30 native fish that are non-consumptive priorities in the South Platte Basin Implementation Plan. Surface water diversions and groundwater pumping have decreased flow in these streams. Less water results in less habitat, while also affecting water quality (e.g., salinity), resiliency to climate change, and species composition. An invasion of non-native mosquitofish (*Gambusia affinis*; Fig. 1), one of the most invasive species in the world, is an emerging threat to native plains fish. We know little about how reduced streamflow, altered water quality, and invasive species, in concert, affect native species. On top of ecological dynamics, people's knowledge, values, and decision-making at multiple levels (land managers, municipalities, other actors in the State Water Plan) interact to drive aquatic sustainability in the plains. We propose an ecological study of non-native mosquitofish paired with an assessment of water managers' and landowners' perceptions regarding aquatic ecosystems, values related to these ecosystems, and factors affecting attitudes toward environment-relevant water use practices.Our objectives are: (1) evaluate ecological impacts of non-native mosquitofish on select native fish species under different flow and salinity conditions in the laboratory, (2) assess land managers' and owners' perceptions regarding aquatic ecosystems, values related to these ecosystems, and evaluate factors affecting their attitudes toward environment-relevant water use practices, and (3) develop digital public outreach materials that document aquatic species, habitat and people working towards aquatic sustainability. Information from this study will inform future efforts to maintain both water supplies and non-consumptive needs.

Measurable Results		
To catalog measurable results achieved with WSRF funds please provide any of the following values.		
	New Storage Created (acre-feet)	
	New Annual Water Supplies Developed or Conserved (acre-feet), Consumptive or Nonconsumptive	
	Existing Storage Preserved or Enhanced (acre-feet)	
	Length of Stream Restored or Protected (linear feet)	
	Efficiency Savings (indicate acre-feet/year OR dollars/year)	
	Area of Restored or Preserved Habitat (acres)	
	Length of Pipe/Canal Built or Improved	
√	Other	Explain: This study will support aquatic sustainability state-wide, and its impacts can be measured numerically by number of people at whom outreach activities were aimed, habitat restoration and species reintroduction projects informed by the project results, students trained in the project, professional presentations and peer-reviewed publications.

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Water Activity Justification

Provide a description of how this water activity supports the goals of Colorado's Water Plan, the most recent Statewide Water Supply Initiative, and the respective Roundtable Basin Implementation Plan and Education Action Plan [(1)]. The Applicant is required to reference specific needs, goals, themes, or Identified Projects and Processes (IPPs), including citations (e.g. document, chapters, sections, or page numbers).

For applications that include a request for funds from the Statewide Account, the proposed water activity shall be evaluated based upon how well the proposal conforms to Colorado's Water Plan criteria for state support (CWP, Section 9.4, pp. 9-43 to 9-44;) (Also listed pp. 4-5 in 2016 WSRF Criteria and Guidelines).

This study consists of research and outreach to balance human and environmental protection needs for water. Our proposal is collaborative and action-oriented with the following notable strengths:

- **Multi-purpope:** We study both ecology and human dimensions related to water sustainability, and disseminate findings through outreach and education activities (Section 5.5.8 South Platte BIP). Outreach will be conducted by Colorado State University faculty and students (graduate students and American Fisheries Society undergraduate students) to integrate research, education, outreach and engagement sustainably. The project addresses both Non-consumptive (Environmental) and Education & Outreach objectives.
- **Partnership:** This project represents collaborative efforts among Colorado State University, Colorado Parks and Wildlife, and The Nature Conservancy, and will involve local stakeholders (farmers, ranchers, Water Conservancy Districts, South Platte Basin Roundtable) in eastern Colorado in understanding their attitudes and motivations for water conservation. These partnerships and participatory approach assist in transferring knowledge into management actions effectively (page 5-27 South Platte BIP).
- **Knowledge gap**: Despite high biodiversity in the plains streams, previous and existing fish programs in Colorado have targeted disproportionately native trout, Upper Colorado River endangered fish, and "Three Species" (Section 6.6 Colorado's Water Plan). South Platte Round Roundtable has not yet funded a similar project that focuses on native plains fish and human dimensions surrounding water use and aquatic protection (Section 4 South Platte BIP). Knowledge on native plains fish has lagged behind, but is much needed for the sustainable future of Colorado. We consider that outreach is critical for plains fish, which may not bear immediate recreational or economic values. Thus, communicating what they are and what issues they face is a perquisite to garnering public support for the South Platte BIP (page 5-27) and Colorado's Water Plan (page 2-9, Vol. 2 Section 12 of 2019 Analysis and Technical Upate [formerly SWSI]).
- **Informing management**: As populations of aquatic speices decline, species reintroduction is increasingly gaining importance as a management tool (Section 4.5.2.4 South Platte BIP). However, reintroduction efforts do not always succeed because species are reintroduced into unsuitable habitats or conditions. So, when and where do they fail? Do they fail depending on flow and salinity condtions (i.e., physical and chemical habitat conditions) and the presence of invasive species such as mostuitofish? Providing answers to these questions is critical and saves money and resources in planning future reintroduction projects. In addition, why does the attitude towards willingness to conserve water differ so much among farmers and ranchers in eastern Colorado? By identifying socioeconomic drivers, we can reach out to policy makers and elected officials to inform how to promote and incentivize water conservation (Section 5.5.9 South Platte BIP).
- **State-wide implications**: We will assess the ecological effects of invasive mosquitofish on 2-3 state-listed species (brassy minnow [threatened], plains minnow [endangered]) or those declining rapidly (plains killifish, plains topminnow) under different flow and salinity conditions. Findings will inform aquatic prioritization and management actions at the state level as Colorado works to reduce a water supply gap and adapt to changing climate that affects stream temperature and flow (Vol. 2 Sections 6 and 14 of 2019 Analysis and Technical Upate [formerly SWSI])). Additionally, outreach materials will be disseminated outside South Platte

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Water Activity Justification
Republicatn Basin, particularly municipalities along the Frong Range to educate the largest water consumption group in the state on water sustainability and social issues (i.e., water allocation, environmental justice). • **Proactive**: It is typically too late and cost prohibilitive to take management actions after species suffered a drastic decline in their populations and habitats (e.g., ESA listed species such as greenback cutthroat trout, humpback chub, and razorback sucker). Plains fish may not have reached there yet, but time is dwindling for proactive actions and planning to take place (Section 6.6 Colorado's Water Plan; Page 5-27 South Platte BIP). Our activities support an range of goals/activities listed below. 1. Goals of Colorado's Water Plan • Promote restoration, recovery, sustainability, and resiliency of endangered, threatened, and imperiled aquatic- and riparian-dependent species and plant communities (page 6-157). • Support the development of multipurpose projects and methods that benefit environmental and recreational water needs as well as water needs for communicaties or agriculture (page 6-157). • Colorado's Water Plan provides technical land 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 (page 9-53). 2. 2019 Analysis and Technical Update to the Water Plan (formerly Statewide Water Supply Initiative) • Colorado Environmental Flow Tool Documentation (Volume 2; Section 6). • Observations Regarding Public Perceptions on Water (Volume 2; Section 12). • Temperature Offsets and Precipitation Change Factors Implicit in the CRWAS-II Planning Scenarios (Volume 2; Section 14) 3. South Platte Roundtable Basin Implementation Plan and Education Action Plan • Promote restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic, riparian and wetland dependent species and plan communicaties (Section 1.9.7). • Protect and enhance environmental and recreation attributes through collaborations with other water use sectors (Section 5.5.5). • Facilitate South Platte communications and outreach programs (Section 5.5.9)

(1) Access Basin Implementation Plans or Education Action Plans from Basin drop down menu.

Matching Requirements: Basin Account Requests	
Basin (only) Account grant requests require a 25% match (cash and/or in-kind) from the Applicant or 3rd party and shall be accompanied by a **letter of commitment** as described in the 2016 WSRF Criteria and Guidelines (submitted on the contributing entity's letterhead). Attach additional sheet if necessary.	
Contributing Entity	Amount and Form of Match (note cash or in-kind)
See below for statewide account match	$
Total Match	$
If you requested a Waiver to the Basin Account matching requirements, indicate the percentage you wish waived.	

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Matching Requirements: Statewide Account Requests	
Statewide Account grant requests require a 50% match as described in the 2016 WSRF Criteria and Guidelines. A minimum of 10% match shall be from Basin Account funds (cash only). A minimum of 10% match shall be provided by the applicant or 3rd party (cash, in-kind, or combination). The remaining 30% of the required match may be provided from any other source (Basin, applicant, or 3rd party) and shall be accompanied by a **letter of commitment.** Attach additional sheet if necessary.	
Contributing Entity	Amount and Form of Match (note cash or in-kind):
South Platte Roundtable	$ 40,000.00 (cash)
Colorado State University	$ 67,012.07 (cash)
Total Match	$ 107,012.07 (cash)
If you requested a Waiver to the Statewide Account matching, indicate % you wish waived. (Max 50% reduction of requirement).	

Related Studies

Please provide a list of any related studies, including if the water activity is complimentary to or assists in the implementation of other CWCB programs.

Field studies on the impacts of flow alterations on native plains fish in Colorado (These studies provide the background for our proposed laboratory studies);

- Falke et al. (2011) The role of groundwater pumping and drought in shaping ecological futures for stream fishes in a dryland river basin of the western Great Plains, USA. Ecohydrology 4:682-697.
- Falke et al. (2012) Colonization and extinction in dynamic habitats: an occupancy approach for a Great Plains stream fish assemblage. Ecology 93:858-867.
- Fitzpatrick et al. (2014) Water availability strongly impacts population genetic patterns on an imperiled Great Plains endemic fish. Conservation Genetics 15:771-788.
- Perkin et al. (2017) Groundwater declines are linked to changes in Great Plains stream fish assemblages. PNAS 114:7373-7378.

A field study documenting an expansion of mosquitofish in Republican River basin;

- Kanno (2019). Survey of native plains fish assemblages after a recent discovery of invasive mosquitofish in Arikaree River. Competition report submitted to the Greater Denver Audubon Society (https://www.denveraudubon.org/wp-content/uploads/2019/11/2019-LWF-Plains-Native-fish.pdf).

Laboratory studies on invasive mosquitofish impacts on other fish (None in Colorado, and none addresses how streamflow conditions affect the outcome of competitive interactions);

- Alcaraz et al. (2008) Salinity mediates the competitive interactions between invasive mosquitofish and an endangered fish. Oecologia 155:205-213.
- Laha & Mattingly (2007) Ex situ evaluation of impacts of invasive mosquitofish on the imperiled Barrens topminnow. Environmental Biology of Fishes 78:1-11.

A salinity study funded by the South Platte Basin Roundtable that documents spatiotemporal variability in salinity in the basin (We will use a range of salinity values reported in our laboratory experiments to extend and translate this study in a biological context);

- O'Brien (2020) South Platte River salinity: sources, trend, and concerns – 1995-2018. Neirbo Hydro Geology (www.neirbo.com).

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Previous CWCB Grants
List all previous or current CWCB grants (including WSRF) awarded to both the Applicant and Grantee. Include: 1) Applicant name; 2) Water activity name; 3) Approving RT(s); 4) CWCB board meeting date; 5) Contract number or purchase order
None.

Tax Payer Bill of Rights
The Tax Payer Bill of Rights (TABOR) may limit the amount of grant money an entity can receive. Please describe any relevant TABOR issues that may affect the applicant.
None.

Last Update: January 9, 2018

Colorado Water Conservation Board	
Water Supply Reserve Fund	
Exhibit A - Statement of Work	
Date:	**January 2021 – August 2023**
Water Activity Name:	**Sustaining plains aquatic ecosystems using an integrated ecological and social approach**
Grant Recipient:	**Colorado State University**
Funding Source:	**South Platte Basin Roundtable**

Water Activity Overview: (Please provide brief description of the proposed water activity (no more than 200 words). Include a description of the overall water activity and specifically what the WSRF funding will be used for.

Streams in the South Platte and Republican Basin are home to approximately 30 native fish that are non-consumptive priorities in the South Platte Basin Implementation Plan. Surface water diversions and groundwater pumping have decreased flow in these streams. Less water results in less habitat, while also affecting water quality (e.g., salinity), resiliency to climate change, and species composition. An invasion of non-native mosquitofish (*Gambusia affinis*; Fig. 1), one of the most invasive species in the world, is an emerging threat to native plains fish. We know little about how reduced streamflow, altered water quality, and invasive species, in concert, affect native species. On top of ecological dynamics, people's knowledge, values, and decision-making at multiple levels (land managers, municipalities, other actors in the State Water Plan) interact to drive aquatic sustainability in the plains. We propose an ecological study of non-native mosquitofish paired with an assessment of water managers' and landowners' perceptions regarding aquatic ecosystems, values related to these ecosystems, and factors affecting attitudes toward environment-relevant water use practices. Information from this study will not only inform future efforts to maintain both water supplies and non-consumptive needs but our own education and outreach effort along the Front Range and eastern Colorado. We will use the WSRF funding to buy supplies for laboratory experiments, travel to survey water users, develop outreach materials, and support graduate and undergraduate students at Colorado State University.

Objectives: (List the objectives of the project)

(1) Evaluate ecological impacts of non-native mosquitofish on select native fish species under different flow (Task 1) and salinity (Task 2) conditions in the laboratory;
(2) Assess land managers' and owners' perceptions regarding aquatic ecosystems, values related to these ecosystems, and evaluate factors affecting their attitudes toward environment-relevant water use practices (Task 3); and
(3) Develop digital public outreach materials that document aquatic species, habitat and people working towards aquatic sustainability (Task 4).

Fig. 1. Gravid female mosquitofish collected in May 2019 at TNC's Fox Ranch on Arikaree River, Yuma County, where the species has invaded in the last few years.

Tasks

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Tasks

Provide a detailed description of each task using the following format:

Task 1 – Evaluating invasive mosquitofish impacts on native plains fish under different flow conditions

Description of Task:

This task will evaluate whether the impacts of invasive mosquitofish on native plains fish depend on flow volumes (i.e., flowing versus standing waters). Mosquitofish is listed by the International Union for Conservation of Nature as one of the 100 worst invasive species globally and they prefer habitats with standing waters. Mosquitofish have been spreading in the South Platte and Republican basins and other Front Range and plains streams in Colorado (Kanno 2019). Their invasion poses a major threat to protection and management of native plains fishes state-wide. We will test a hypothesis that reduced flows, which convert flowing rivers to standing waters, facilitate invasion of mosquitofish in Colorado by providing them with a competitive edge in their assumed preferred habitat conditions. The hypothesis will be tested by manipulating flow rates in experimental streams (Fig. 2) and assessing the effects of invasive species on behavior and body growth rates of 2 or 3 native species (brassy minnow [state threatened], plains minnow [state endangered], plains killifish, and plains topminnow) that are similar ecologically to mosquitofish (i.e., high likelihood of niche overlap and competition). Outcomes of this task will inform state-wide planning for native plains fish reintroduction and efforts to suppress mosquitofish. This task will be led by a graduate student at CSU.

Method/Procedure:

This task will be conducted using experimental stream systems (Fig. 2) at CSU. Three replicated, recirculating systems have been just installed on the main campus of CSU ($100,000), and each system can contain up to 800 gallons of water with capabilities to control temperature (4-28°C) and flow rates that mimic flowing and stagnant flow conditions using a pump and bypass/valve system that circulates 40 gallons of water per minute. Study fish will be sourced from the wild or CPW's Native Fish Hatchery in Alamosa. In each experimental stream system, 40-60 individuals each of invasive mosquitofish and a native species of choice will be housed for up to 3 months to monitor the effects of mosquitofish on behavior and growth of the native species under different flow conditions, which vary by stream system. Body growth of native species will be quantified by marking each individual with a passive integrated transponder (PIT) tag for identification and measures changes in body length and weight over time, in addition to their survival rates.

Fig. 2. An experimental stream system at CSU. Three replicates of the system are available.

Grantee Deliverable: (Describe the deliverable the grantee expects from this task)

- Study report in the form of a Master's thesis (graduate student) and peer-reviewed publication.
- Use of study findings and photos in outreach materials (Task 4).

CWCB Deliverable: (Describe the deliverable the grantee will provide CWCB documenting the completion of this task)

In addition to the deliverables above, we will use research findings to coordinate with Colorado Parks and Wildlife in planning their future native species reintroduction and invasive mosquitofish control efforts. This task will identify (1) which native species is most vulnerable to invasion by mosquitofish, (2) whether maintaining flows can offset invasion of mosquitofish to some degree, and (3) the need for heightened control effort of mosquitofish, depending on the magnitude of their impacts on native species. We will also give an oral presentation on the task summary at a South Platte Roundtable meeting, and elsewhere (e.g., The Nature Conservancy and Larimer County; see their support letters).

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Tasks

Provide a detailed description of each task using the following format:

Task 2 - Evaluating invasive mosquitofish impacts on native plains fish under different salinity conditions

Description of Task:

This task will evaluate whether the impacts of invasive mosquitofish on native plains fish depend on salinity levels. High salinity reduces crop yield and affects drinking water, thus is a concern in the South Platte and Republican River basin. In the meantime, invasiveness of mosquitofish may be lower under high salinity conditions because a study in Europe shows that in saline water they become less aggressive towards native species (Alcaraz et al. 2008). If a similar pattern holds true in the South Platte basin, efforts to decrease salinity in water for agricultural and municipal use may facilitate mosquitofish invasion. We need to understand whether this trade-off exists between beneficial use and environmental protection for water sustainability, and if so, the range of salinity levels and locations that may satisfy both objectives. In this task, we plan to mimic three different salinity levels observed in the South Platte River basin (O'Brien 2020) and assess if aggressive behavior of mosquitofish changes across the salinity levels. Based on findings of Task 1, we will select one native species most negatively affected by mosquitofish for use in Task 2. Outcomes of this task will inform state-wide planning of native plains fish protection and management as well as salinity control. This task will be led by undergraduate students in the CSU American Fisheries Society Sub-unit under the supervision of their advisor (Dr. Kanno).

Method/Procedure:

This task will be completed using an annular chamber at CPW (Fig. 3). We used the chamber (125 cm in diameter) in a previous study to evaluate how different water temperature affects behavioral interactions between mosquitofish and a state-endangered native fish (northern redbelly dace). Using this proven system, we propose to simulate salinity levels observed in South Platte River basin (high = 1,000, medium = 500, low = 100 mg/L; O'Brien 2020) and assess if interactions between mosquitofish and a select native species depend on salinity levels. Similar to Task 1, fish will be sourced from the wild or CPW's Native Fish Hatchery in Alamosa, but each trial (with 10 replicates per salinity level) will house fewer individuals (1-3 individuals per species) to avoid overcrowding in this smaller arena and facilitate observations of behavioral interactions for 2 hours per trial, which will also be video recorded. We will record number of aggressive behavior and species which initiated aggression (i.e., winners and losers). Given the small physical size of the annular chamber, we will focus on behavior and will not measure growth and survival, unlike Task 1.

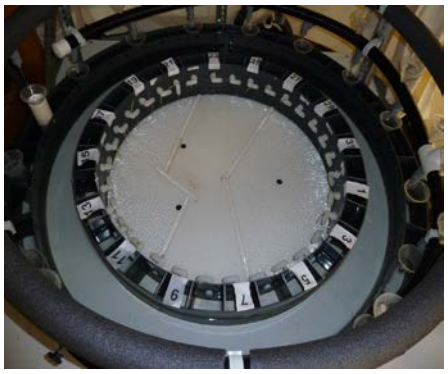


Fig. 3. An annular chamber at CPW.

Grantee Deliverable: (Describe the deliverable the grantee expects from this task)

- Study report in the form of an undergraduate thesis and peer-reviewed publication.
- Use of study findings and photos in outreach materials (Task 4).

CWCB Deliverable: (Describe the deliverable the grantee will provide CWCB documenting the completion of this task)

In addition to the deliverables above, we will use research findings to coordinate with Colorado Parks and Wildlife in identifying priority habitats and populations of native plains fish for protection, restoration, and reintroduction. Outcomes of this task will also provide a numeric range of salinity criteria, which can be used as a guideline in monitoring water quality and serve as a critical linkage that unites water users and stakeholders towards planning a sustainable aquatic future in South Platte and Republican basins. We will also give an oral presentation on the task summary at a South Platte Roundtable meeting, and elsewhere (e.g., The Nature Conservancy and Larimer County; see their support letters).

Last Update: January 9, 2018

Tasks
Provide a detailed description of each task using the following format:
Task 3 – Understanding stakeholder decision-making regarding water use, instream flows, and plains aquatic ecosystems in the South Platte and Republican Basins
Description of Task:
This task will focus on multiple levels of stakeholder decision-making to evaluate the opportunities for native fish protection and management. Due to the complex institutional context surrounding water use, there may be decision or leverage points that allow for sustaining native fish while also sustaining consumptive water use. However, it is not clear how policy or education measures might be targeted most effectively to promote such win-wins, particularly across both South Platte and Republican systems. In addition, key water users (i.e., land owners and managers) may be engaged with this institutional context in varying ways, and with different priorities related to streamflow and water quality relevant to aquatic species. We will implement this task through two research efforts, targeting the (1) stakeholder institutional network and (2) South Platte and Republican Basin rural water users. First, informal stakeholder interviews and social network analysis will enable us to describe and analyze how decisions are made and implemented to specifically impact habitat, instream flows, and salinity in the two basins. We initially define our stakeholder network as individuals and institutions engaged with CWCB, the South Platte Basin Roundtable, and the Lower South Platte and Republican River Water Conservancy Districts. We will engage with and expand this network, informed by our collaborators with CSU Extension, CPW, and TNC. Second, we will conduct a structured survey of rural landowners and managers to determine how they value plains aquatic ecosystems in their decisions and evaluate what factors affect their attitudes toward environment-relevant water use practices. Outcomes of this task will help design how and through what pathways strategies should address social behavior change, for example through outreach, education, or regulatory action. This task will be led by the CSU graduate student under the supervision of Dr. Salerno.
Method/Procedure:
The stakeholder institutional network will focus on actors (i.e., people and groups) engaged with decisions affecting South Platte and Republican Basin instream flows and water quality. Stemming from key informant interviews, we will conduct a census of representatives of relevant institutions comprising our network. A snowball approach will allow for all relevant institutions to be identified and queried (i.e., each interview will identify additional institutions until saturation is reached). From these data, we will construct a network representing relationships among actors and associated decision processes. To understand individual land manager decisions, we will conduct a structured survey among South Platte and Republican water users (~100 individuals). Surveys will measure respondent attitudes toward aquatic ecosystems and land management decision impacts on instream and habitat conditions, as well as their ideas for how to implement environment-relevant strategies on their land.
Grantee Deliverable: (Describe the deliverable the grantee expects from this task)
• Study report in the form of a Master's thesis (graduate student) and peer-reviewed publication. • Use of study findings and photos in outreach materials (Task 4).
CWCB Deliverable: (Describe the deliverable the grantee will provide CWCB documenting the completion of this task)
Task 3 will analyze our basins' water decision-making context as it relates to stream ecosystems and native fish. We will co-produce specific research priorities with SPBRT and CWCB partners. This approach allows our research framework to be adapted to the two basin's systems and the needs of the roundtable partners. For example, how do water providers make decisions to expand or reduce their water programs, and what are the implications of these agency decisions for water decisions in other parts of the system? How do decision-makers and agricultural water users perceive irrigation and water storage impacts on streamflows? How might water and salinity management intersect with opportunities for habitat restoration, for example, as is being planned for the South Fork Republican River? What are competing incentives that motivate water use decisions for landowners, and what are the opportunities for plains fish species protection? We will apply this co-production approach toward identifying a solution space for win-win outcomes, which can be communicated to different stakeholders through Task 4.

Last Update: January 9, 2018

Tasks
Provide a detailed description of each task using the following format:
Task 4 – Developing outreach materials on water sustainability in plains streams in eastern Colorado
Description of Task:
Using findings from Tasks 1-3 and other relevant information available, we will develop outreach materials geared towards the general public and policy makers to communicate native aquatic biodiversity, their status and threats, management activities and people that depend on plains streams (farmers and ranchers) in eastern Colorado. We will disseminate materials via the South Platte Basin Roundtable and through outlets at CSU, e.g., "fact sheets" available through CSU Extension. We share that public understanding of and perceptions on water sustainability are critical for the success of the Colorado's Water Plan and South Platte Basin Implementation Plan. However, water sustainability in eastern Colorado may be "hidden" from the general public and media. How many people know those beautiful native plains fish in dryland streams (Fig. 4)? We don't need to go to coral reefs to see these colorful fish! Are Coloradans on the Front Range aware that their water use may come at the cost of less water for agricultural production (environmental justice) and aquatic biodiversity loss downstream? Do they know farmers that work hard to use modern irrigation technology to minimize water use on their lands? Given how little information is disseminated on these topics, we believe that developing and delivering outreach materials can garner public understanding efficiently.     Fig. 4. Breeding orangethroat darter (above) and brassy minnow (below) collected at Arikaree River in 2019.
Method/Procedure:
We will develop and deliver outreach materials by working with Colorado Water Center, Water Education Colorado, and CSU Warner College of Natural Resources' Communication Team, and involving CSU undergraduate and graduate students. A Facebook or Twitter account will be opened at the beginning of the project to provide regular updates on our tasks (1-3) and other relevant information. We will also develop a short video documenting native plains fish, their habitat and management activities. This material may be used online (e.g., youtube) and in-person; the latter may involve showings at middle and high schools, colleges and public events along the Front Range communities. We will also summarize Task 3 results (socioeconomic drivers of farmers' and ranchers' willingness to conserve water) for reaching out to policy makers and elected officials in the South Platte and Republican basins and Colorado, in consultation with South Platte Basin Roundtable.
Grantee Deliverable: (Describe the deliverable the grantee expects from this task)
• Increased educational opportunities for CSU undergraduate and graduate students who integrate research and outreach in their learning. • Regular updates of social media contents by CSU students (Facebook or Twitter). • A video for on-line and in-person outreach activities. • Engagement with policy makers and elected officials.
CWCB Deliverable: (Describe the deliverable the grantee will provide CWCB documenting the completion of this task)
In addition to the deliverables above, we will monitor and report the number of people that our team has reached out. We will locate outreach partners in addition to those listed above, and additional funding will be sought from elsewhere to continue our outreach activities. These quantifiable measures will be reported to the South Platte Roundtable.

Last Update: January 9, 2018

Tasks
Provide a detailed description of each task using the following format:
Task 5 – Grant administration
Description of Task:
This task is related to managing the CWCB contracting process and the grant administration. Colorado State University will invoice the project and prepare reporting as appropriate. The invoices will be sent to the CWCB project manager for payment. Progress reports, as required by the CWCB, will be prepared and delivered to the CWCB project manager.
Method/Procedure:
• Prepare an accounting of project related expenses to generate invoices. • Submit invoices to the CWCB. • Prepare and submit project reports to the CWCB.
Grantee Deliverable: (Describe the deliverable the grantee expects from this task)
• Invoices related to the project
CWCB Deliverable: (Describe the deliverable the grantee will provide CWCB documenting the completion of this task)
• Progress reports will be prepared to document activities and outcomes of each project task. • Invoices related to the project

Last Update: January 9, 2018

Budget and Schedule

Exhibit B - Budget and Schedule: This Statement of Work shall be accompanied by a combined Budget and Schedule that reflects the Tasks identified in the Statement of Work and shall be submitted to CWCB in excel format. A separate excel formatted Budget is required for engineering costs to include rate and unit costs.

Reporting Requirements

Progress Reports: The grantee shall provide the CWCB a progress report every 6 months, beginning from the date of issuance of a purchase order, or the execution of a contract. The progress report shall describe the status of the tasks identified in the statement of work, including a description of any major issues that have occurred and any corrective action taken to address these issues. The CWCB may withhold reimbursement until satisfactory progress reports have been submitted.

Final Report: At completion of the project, the grantee shall provide the CWCB a Final Report on the grantee's letterhead that:

- Summarizes the project and how the project was completed.
- Describes any obstacles encountered, and how these obstacles were overcome.
- Confirms that all matching commitments have been fulfilled.
- Includes photographs, summaries of meetings and engineering reports/designs.

Payments

Payment will be made based on actual expenditures, must include invoices for all work completed and must be on grantee's letterhead. The request for payment must include a description of the work accomplished by task, an estimate of the percent completion for individual tasks and the entire Project in relation to the percentage of budget spent, identification of any major issues, and proposed or implemented corrective actions.

The CWCB will pay the last 10% of the entire water activity budget when the Final Report is completed to the satisfaction of CWCB staff. Once the Final Report has been accepted, and final payment has been issued, the water activity and purchase order or contract will be closed without any further payment. Any entity that fails to complete a satisfactory Final Report and submit to CWCB within 90 days of the expiration of a purchase order or contract may be denied consideration for future funding of any type from CWCB.

Performance Requirements

Performance measures for this contract shall include the following:
(a) Performance standards and evaluation: Grantee will produce detailed deliverables for each task as specified. Grantee shall maintain receipts for all project expenses and documentation of the minimum in-kind contributions (if applicable) per the budget in Exhibit B. Per Grant Guidelines, the CWCB will pay out the last 10% of the budget when the final deliverable is completed to the satisfaction of CWCB staff. Once the final deliverable has been accepted, and final payment has been issued, the purchase order or grant will be closed without any further payment.
(b) Accountability: Per the Grant Guidelines full documentation of project progress must be submitted with each invoice for reimbursement. Grantee must confirm that all grant conditions have been complied with on each invoice. In addition, per the Grant Guidelines, Progress Reports must be submitted at least once every 6 months. A Final Report must be submitted and approved before final project payment.
(c) Monitoring Requirements: Grantee is responsible for ongoing monitoring of project progress per Exhibit A. Progress shall be detailed in each invoice and in each Progress Report, as detailed above. Additional inspections or field consultations will be arranged as may be necessary.
(d) Noncompliance Resolution: Payment will be withheld if grantee is not current on all grant conditions. Flagrant disregard for grant conditions will result in a stop work order and cancellation of the Grant Agreement.

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Water Supply Reserve Fund

EXHIBIT B - BUDGET AND SCHEDULE - Direct & Indirect (Administrative) Costs

Date: May 1, 2020

Water Activity Name: Sustaining plains aquatic ecosystems using an integrated ecological and social approach

Grantee Name: Colorado State University (Yoichiro Kanno, Jonathan Solerno, John Sanderson)

Task No.[1]	Description	Start Date[2]	End Date	Matching Funds (cash & in-kind)[3]	WSRF Funds (Basin & Statewide combined)[3]	Total
1	Evaluating invasive mosquitofish impacts on native plains fish under different flow conditions	01/01/2022	06/30/2021	$20,377	$40,752	$61,129
2	Evaluating invasive mosquitofish impacts on native plains fish under different salinity conditions	01/01/2022	12/31/2022	$7,237	$14,473	$21,710
3	Understanding stakeholder decision-making regarding water use, instream flows, and plains aquatic ecosystems in the South Platte and Republican basins	06/01/2021	08/31/2023	$22,539	$45,075	$67,614
4	Developing outreach materials on water sustainability in plains streams in eastern Colorado	07/01/2022	08/31/2023	$8,118	$16,234	$24,352
5	Grant administration	01/01/2021	08/31/2023	$8,741	$17,481	$26,222
			Total	$67,012	$134,015	$201,027

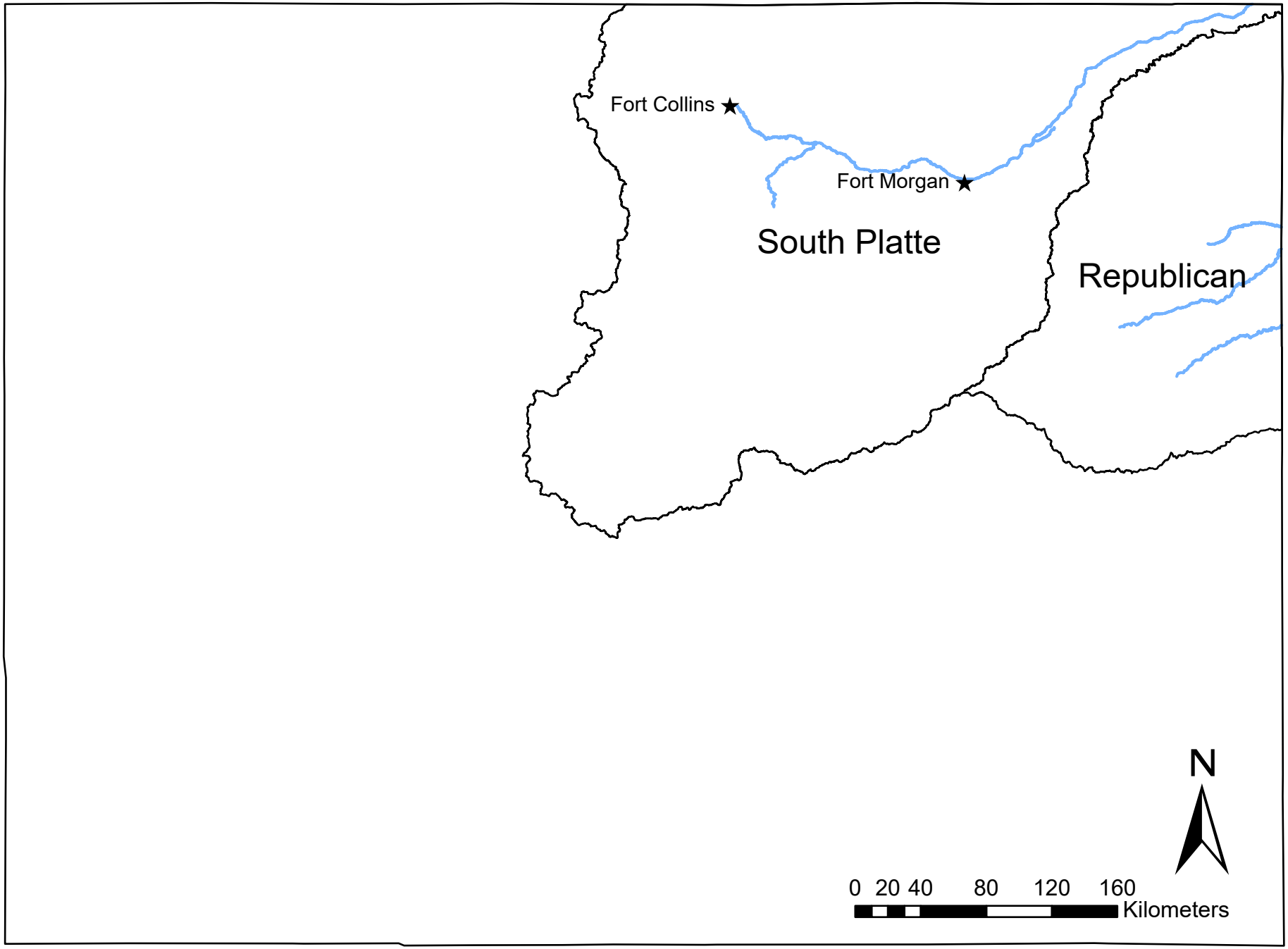
(1) The single task that include costs for Grant Administration must provide a labor breakdown (see Indirect Costs tab below) where the total WSRF Grant contribution towards that task does not exceed 15% of the total WSRF Grant amount.

(2) Round values up to the nearest hundred dollars.

• Additional documentation providing a Detailed/Itemized Budget may be required for contracting. Applicants are encouraged to coordinate with the CWCB Project Manager to determine specifics.

The CWCB will pay the last 10% of the entire water activity budget when the Final Report is completed to the satisfaction of the CWCB staff project manager. Once the Final Report has been accepted, the final payment has been issued, the water activity and purchase order (PO) or contract will be closed without any futher payment. Any entity that fails to complete a satisfactory Final Report and submit to the CWCB with 90 days of the expiration of the PO or contract may be denied consideration for future funding of any type from the CWCB.

• Additonally, the applicant shall provide a progress report every 6 months, beginning from the date of contract execution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