COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Last Updated: May 2021

Colorado Water Conservation Board

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Water Plan Grant Application

Instructions

To receive funding for a Water Plan Grant, applicant must demonstrate how the project, activity, or process (collectively referred to as "project") funded by the CWCB will help meet the measurable objectives and critical actions in the Water Plan. Grant guidelines are available on the CWCB website.

If you have questions, please contact CWCB at (303) 866-3441 or email the following staff to assist you with applications in the following areas:

Water Storage & Supply Projects	Matthew.Stearns@state.co.us
Conservation, Land Use Planning	Kevin.Reidy@state.co.us
Engagement & Innovation Activities	Ben.Wade@state.co.us
Agricultural Projects	Alexander.Funk@state.co.us
Water Sharing & ATM Projects	Alexander.Funk@state.co.us
Environmental & Recreation Projects	Chris.Sturm@state.co.us

FINAL SUBMISSION: Submit all application materials in one email to *waterplan.grants@state.co.us* in the original file formats [Application (word); Statement of Work (word); Budget/Schedule (excel)]. Please do not combine documents. In the subject line, please include the funding category and name of the project.

Water Project Summary	
Name of Applicant	Regents of the University of Colorado
Name of Water Project	Urban Agriculture and Soil Health Management as a Water Conservation Strategy in Colorado

Last Updated: May 2021

CWP Grant Request Amount	$150,000
Other Funding Sources	$tbd
Other Funding Sources	$
Other Funding Sources	$
Applicant Funding Contribution	$50,000
Total Project Cost	$200,000

Last Updated: May 2021

Applicant & Grantee Information
Name of Grantee(s) Regents of the University of Colorado
Mailing Address
FEIN
Organization Contact
Position/Title
Email
Phone
Grant Management Contact Jody Beck
Position/Title Associate Professor
Email jody.beck@ucdenver.edu
Phone 303.815.9935
Name of Applicant (if different than grantee)
Mailing Address
Position/Title
Email
Phone
Description of Grantee/Applicant
Provide a brief description of the grantee's organization (100 words or less).

Last Updated: May 2021

We are the only public urban research university in Colorado. Our campus in downtown Denver enables our faculty and students to work on groundbreaking research, often focused on solving urban issues. Our academic programs bring together current research, creative work, and civic engagement.

Type of Eligible Entity (check one)	
x	**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: Private parties may be eligible for funding.
	Non-governmental organizations (NGO): Organization that is not part of the government and is non-profit in nature.
	Covered Entity: As defined in Section 37-60-126 Colorado Revised Statutes.

Type of Water Project (check all that apply)

X	Study
X	Construction
	Other

Category of Water Project (check the primary category that applies and include relevant tasks)	
	Water Storage & Supply - Projects that facilitate the development of additional storage, artificial aquifer recharge, and dredging existing reservoirs to restore the reservoirs' full decreed capacity, multi-beneficial projects, water sharing agreements, Alternative Transfer Methods, and those projects identified in basin implementation plans to address the water supply and demand gap. *Applicable Exhibit A Task(s):* ***Note:** For Water Sharing Agreements or ATM Projects - please include the supplemental application available on the CWCB's website.*
X	Conservation and Land Use Planning - Activities and projects that implement long-term strategies for conservation, land use, water efficiency, and drought planning. *Applicable Exhibit A Task(s):*
X	Engagement & Innovation - Activities and projects that support water education, outreach, and innovation efforts. *Applicable Exhibit A Task(s):*
X	Agricultural - Projects that provide technical assistance and improve agricultural efficiency. *Applicable Exhibit A Task(s):*

	Environmental & Recreation - Projects that promote watershed health, environmental health, and recreation. *Applicable Exhibit A Task(s):*	
	Other	Explain:

Location of Water Project	
Please provide the general county and coordinates of the proposed project below in **decimal degrees**. The Applicant shall also provide, in Exhibit C, a site map if applicable.	
County/Counties	Denver, Jefferson, Broomfield, Arapahoe, Adams, Douglas
Latitude	
Longitude	

Water Project Overview
Please provide a summary of the proposed water project (200 words or less). Include a description of the project and what the CWP Grant funding will be used for specifically (e.g., studies, permitting process, construction). Provide a description of the water supply source to be utilized or the water body affected by the project, where applicable. 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, and area of habitat improvements, where applicable. 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, Other Funding Sources/Amounts and Schedule.

Last Updated: May 2021

This project will provide base-line data on several issues pertinent to the water-efficient growth of food in cities in Colorado. First, we will provide a comparison between raw, potable, and recycled water with regard to their impact on soil health, crop yields, and nutritional content of produce grown. This work will be undertaken through the construction of a series of parallel growing beds which will be managed side by side with different water sources. We will also map potential reclaimed watersheds within the city to indicate potential water savings. The second major component of this project will be to establish baseline water usage by commercial growers and home gardeners in the urban and peri-urban areas of the Denver Metro area. This work will generate high quality data useful to evaluate the effectiveness of the promotion of urban agriculture as a water conservation strategy in Colorado. Lastly, we will compare different soil amendment strategies in new gardens with regard to their impact on water consumption over the span of two growing seasons. This will further guide future programs that are aimed at reducing the water usage of food production in Colorado's cities, and in particular indicate what strategies will reduce total water usage within our region and within our cities.

Measurable Results	
To catalog measurable results achieved with the CWP Grant funds, please provide any of the following values as applicable:	
	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)

Last Updated: May 2021

	Quantity of Water Shared through Alternative Transfer Mechanisms or water sharing agreement	
X	Number of Coloradans Impacted by Incorporating Water-Saving Actions into Land Use Planning	
X	Number of Coloradans Impacted by Engagement Activity	
X	Other	Conversion of grass lawns to food production Data generated about the efficient use of water in agricultural production in Colorado's climate and about water conservation achievable through conversion of grass lawns to productive gardens in the same.

Water Project Justification
Provide a description of how this water project supports the goals of Colorado's Water Plan, the Analysis and Technical Update to the Water Plan, and the applicable Roundtable Basin Implementation Plan and Education Action Plan. 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). The proposed water project shall be evaluated based upon how well the proposal conforms to Colorado's Water Plan Framework for State of Colorado Support for a Water Project (CWP, Section 9.4, pp. 9-43 to 9-44;)

Last Updated: May 2021

The Colorado Water Plan, which provides a policy roadmap for addressing state water resource challenges, highlights the Colorado Department of Public Health and Environment's (CDPHE) commitment to expand "safe and environmentally friendly water reuse" that protects stakeholders' health and the environment and, notably, shares the need for additional funding to research recycled water's use for food production. (p. 6-76)

The Colorado Water Plan also proposes a reduction in non-beneficial water consumption. (p. 6-91) Demonstrating the value and water savings of converting grass lawns into small scale agricultural production meets this goal. In addition, we will be evaluating the value of different soil-health building techniques with relation to irrigation efficiency and water conservation. (p. 6-93)

Related Studies

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

There are many related studies, but none tie into our climate in particular.

Previous CWCB Grants, Loans or Other Funding

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; 6) Percentage of other CWCB funding for your overall project.

The applicant has no current or past CWCB funding, institutional research is needed to establish the scope of CWCB funding to the University as a whole.

Taxpayer Bill of Rights

The Taxpayer Bill of Rights (TABOR) may limit the amount of grant money an entity can receive. Please describe any relevant TABOR issues that may affect your application.

None known.

Last Updated: May 2021

Submittal Checklist	
	I acknowledge the Grantee will be able to contract with CWCB using the Standard Contract.
Exhibit A	
	Statement of Work(1)
	Budget & Schedule(1)
	Engineer's statement of probable cost (projects over $100,000)
	Letters of Matching and/or Pending 3rd Party Commitments(1)
Exhibit C	
	Map (if applicable)(1)
	Photos/Drawings/Reports
	Letters of Support (Optional)
	Certificate of Insurance (General, Auto, & Workers' Comp.) (2)
	Certificate of Good Standing with Colorado Secretary of State(2)
	W-9(2)
	Independent Contractor Form(2) (If applicant is individual, not company/organization)
Water Sharing Agreements and Alternative Transfer Methods ONLY	
	Water Sharing Agreements and Alternative Transfer Methods Supplemental Application(1)

(1) Required with application.
(2) Required for contracting. While optional at the time of this application, submission can expedite contracting upon CWCB Board approval.

Last Updated: May 2021

ENGAGEMENT & INNOVATION GRANT FUND SUPPLEMENTAL APPLICATION

Introduction & Purpose

Colorado's Water Plan calls for an outreach, education, public engagement, and innovation grant fund in Chapter 9.5.

The overall goal of the Engagement & Innovation Grant Fund is to enhance Colorado's water communication, outreach, education, and public engagement efforts; advance Colorado's water supply planning process; and support a statewide water innovation ecosystem.

The grant fund aims to engage the public to promote well-informed community discourse regarding balanced water solutions statewide. The grant fund aims to support water innovation in Colorado. The grant fund prioritizes measuring and evaluating the success of programs, projects, and initiatives. The grant fund prioritizes efforts designed using research, data, and best practices. The grant fund prioritizes a commitment to collaboration and community engagement. The grant fund will support local and statewide efforts.

The grant fund is divided into two tracks: engagement and innovation. The Engagement Track supports education, outreach, communication, and public participation efforts related to water. The Innovation Track supports efforts that advance the water innovation ecosystem in Colorado.

Application Questions

*The grant fund request is referred to as "project" in this application.

Overview (answer for both tracks)
In a few sentences, what is the overall goal of this project? How does it achieve the stated purpose of this grant fund (above)?
Project Objectives RESEARCH OBJECTIVES: 1. Identify potential barriers and confirm or negate presumed benefits of wide use of recycled water irrigation for food production in Colorado.

2. Investigate recycled water irrigation compared to potable and raw water irrigation for food production and determine relative effects on soil nutrients, soil sodicity and salinity, produce nutrient content and potential contamination, and crop yields.
3. Holistically compare economic costs and returns of using recycled water irrigation for food crops by conducting side-by-side comparisons with potable and raw water irrigation using two water delivery methods: drip and spray.
4. Support the conversion of grass lawns to agricultural production and measure the benefits of different soil management techniques on water consumption, and the water use impacts overall of growing food in comparison to lawns.

EDUCATION & OUTREACH OBJECTIVES:

5. Collaborate with the Colorado agricultural community - from urban and peri-urban market gardeners to large commercial operators - to inform and assess recycled water irrigation opportunities for food production in Colorado.
6. Synthesize information, communicate key outcomes, and engage with a broad coalition of interested partners and stakeholders.
7. Provide resources for producers and the general public to understand and compare the relative natural resource benefits of using raw, potable, and recycled water for irrigation of food production in Colorado and other semi-arid climates, while building trust and confidence in utilizing recycled water for growing food crops.
8. Provide water consumption data and yield data to homeowners to help them make decisions about the conversion of lawns to food production.

Who is/are the target audience(s)? How will you reach them? How will you involve the community?

Describe how the project is collaborative or engages a diverse group of stakeholders. Who are the partners in the project? Do you have other funding partners or sources?

Last Updated: May 2021

The following stakeholders have been vocal in listing the study of expanding and diversification of uses for recycled water as an important research topic, particularly for agricultural applications in Colorado, and will be engaged throughout this project:

- Denver Water
- Denver Botanic Gardens
- Colorado Department of Natural Resources, Colorado Water Conservation Board (CWCB)
- Colorado Fruit and Vegetables Growers Association (CFVGA)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado State University
- WateReuse Association Colorado Chapter
- Colorado Food Systems Advisory Council (COFSAC)
- Colorado Department of Agriculture
- One World One Water Center (OWOW), Metro State University of Denver
- Colorado Water Quality Control Division (WQCD)

Describe how you plan to measure and evaluate the success and impact of the project?

What research, evidence, and data support your project?

Colorado is a drought- and fire-prone Western state where, according to the Colorado Water Conservation Board, agriculture accounts for 89% of the state's water consumption. Colorado producers often cite long-term access to water as a significant limiting factor to their ongoing success and note that their agricultural needs are often in direct competition to increasing municipal water demands. As climate change reduces supply, and as water rights transfer from agricultural to municipal use, irrigated agriculture will face a severe shortage of access to water, one of agriculture's most precious and necessary resources, and this shortage will have far-ranging impacts on Colorado's economy, food security, and rural communities. However, recycled water resources increase in volume as population increases. Recycled water is a drought-resistant, significant water resource with little diurnal and seasonal variation. Of more immediate importance for agriculturalists, it often costs less than municipal water sources.

Additionally, recycled water has a lower embodied energy intensity than most other water sources, resulting in reduced atmospheric greenhouse gas emissions. It also boasts the ability to reduce pressure on environments and habitats by limiting withdrawal of water from surface and groundwater sources. (Water Research Foundation, 2019)

The term "recycled" (also "reclaimed") water refers to water produced as a result of treating municipal wastewater to a level that makes it fit for specific uses allowed by regulation. In 2013, Colorado expanded recycled water use under Regulation 84 – Reclaimed Water Control Regulation to include Agricultural Irrigation, yet excluded irrigation of food crops intended for direct human consumption. In a 2015 issue brief titled *Use of Reclaimed Water for Food Crops*, the Colorado Food Systems Advisory Council (COFSAC) advised the removal of recycled water irrigation's use limitation to non-edible crops. In 2016, efforts to amend Regulation 84 to include the use of recycled water for food crop irrigation culminated in a hearing before the Colorado Water Quality Control Commission (WQCC). Even with ample support from farmers, ranchers, agricultural trade groups, water utilities, academic institutions, a public health department, and a hospital, the WQCC ultimately determined the need for more comprehensive study of risk and impacts before approving edible food crops as a use for recycled water. However, since this time, Colorado's General Assembly passed HB18-1093, which compelled the expansion of Regulation 84 to include edible crops as a new, allowed use for recycled water as of December 2019.

Despite authorization to utilize recycled water for edible crop irrigation, concerns remain that food safety would be compromised if recycled water came in contact with the edible portion of the crop. Recycled water is a highly treated, monitored water

source that has been shown to be food-safe with precedents for food production use in Arizona, California, Texas, and Washington states. It is important to note that no adverse health effects have been associated with or caused by recycled water's use on edible crops in any of these places. (Colorado WaterWise, 2016) Yet, there remains an underlying question of public health and food safety that necessitates more comprehensive study of potential risks and impacts of recycled water as a use for edible food crops to help garner acceptance by producers and their consumers. The study will also assess potential agronomic impacts and benefits of using recycled water for irrigation of edible crops for producers and provide a better understanding of the potential operational tradeoffs for producers that are interested in transitioning to a recycled water supply.

Previous studies, such as the comprehensive and long-term Monterey Wastewater Reclamation Study for Agriculture (MWSRA) (Sheikh et al., 1998), confirm that recycled water does not compromise public health when used to irrigate edible crops in full compliance with proper treatment techniques and water management practices. There has not yet been a similar comprehensive study of this scale conducted on recycled water in Colorado.

While other states' experiences would allow Colorado to leverage outside expertise, Colorado's climate, soils, and rainfall are considerably different from areas where recycled water is currently in wide agricultural use. Local agriculturalists and consumers find greater confidence and assurance from studies conducted in familiar conditions similar to their own operational and climatic situations. Producers who elect to use recycled water for irrigating edible crops could potentially realize important cost savings as well. For example, Denver Water "provides recycled water at approximately 25% of the price of potable water" and higher nutrient (N) levels of recycled water could possibly reduce fertilizer application amounts and associated labor/ energy costs.

"In aggregate and under idealized conditions, existing effluent could supply an average of about 17% of the irrigation water needed in the west and more than 75% of demand in the eastern states . . . 80% of irrigated croplands in the United States (44.4 million ac, 18 million ha) are located within 10 miles (16 km) of" Publicly Owned Treatment Works (POTWs) that produce nearly 33,000 MGD of treated effluent, with "only a small fraction" going to beneficial use. (Water Research Foundation, 2019, pg 115)

The Colorado Water Plan, which provides a policy roadmap for addressing state water resource challenges, highlights the Colorado Department of Public Health and

Environment's (CDPHE) commitment to expand "safe and environmentally friendly water reuse" that protects stakeholders' health and the environment and, notably, shares the need for additional funding to research recycled water's use for food production. (pg. 6-76) This project seeks to evaluate the use of recycled water for edible crops commonly grown in Colorado to provide an evidence-based assessment of its use in side-by-side comparisons with potable and raw water demonstration applications at Denver Water's Water Recycling Plant and at Petrocco Farms, a rural commercial farm. This study further supports the CDPHE's commitment by expanding recycled water's safety inquiry and, additionally, would inform future updates to the Colorado Water Plan alongside future efforts to scale the application of recycled water in the agriculture sector.

Describe potential short- and long-term challenges with this project.

As a state that faces ongoing drought conditions and regular water-resource challenges, Colorado agricultural stakeholder groups are hopeful for recycled water's potential to provide a more constant, reliable supply of water for irrigation that enhances drought resiliency and reduces nitrogen inputs that would allow producers to save money, time, labor, and energy. According to the Water Research Foundation's 2019 report titled *Agricultural Use of Recycled Water,* "impediments and incentives to use recycled water in irrigated agriculture are not uniformly distributed across stakeholder groups." (pg. 57) Stakeholder interests can be broadly categorized into six different classes: 1. Water Quantity, 2. Water Quality, 3. Government Regulations, 4. Economic/ Business/ Financial, 5. Technical, and 6. Social/ Health.

Under the heading Recommendations for Future Research," the Water Research Foundation states that:

"It is critical to identify and characterize emerging opportunities for reuse and/or resource recovery where nutrient management for environmental protection is a growing issue. . . Research is needed to better quantify this practice and unify the risk assessment frameworks in the new Food Safety Modernization Act with existing recycled water regulations." (Water Research Foundation, 2019, pg 118)

Typical households in Colorado use approximately 0.4-0.5 acre-feet of water each per year. Approximately 50% of that is used to water grass. (https://extension.colostate.edu/topic-areas/family-home-consumer/water-conservation-in-and-around-the-home-9-952/) Converting significant amounts of this

water use into agricultural production would have many benefits for water usage in the state. Outlining soil management strategies which would reduce this water usage while growing food at the same time would be an even greater improvement.

Please fill out the applicable questions for either the Engagement Track or Innovation Track, unless your project contains elements in both tracks. If a question does not relate to your project, just leave it blank. Please answer each question that relates to your project. Please reference the relevant documents and use chapters and page numbers (Colorado's Water Plan, Basin Implementation Plan, PEPO Education Action Plan, etc.).

Engagement Track
Describe how the project achieves the education, outreach, and public engagement measurable objective set forth in Colorado's Water Plan to "significantly improve the level of public awareness and engagement regarding water issues statewide by 2020, as determined by water awareness surveys."
This project is largely geared to a producer audience to demonstrate the benefits of using recycled water and address any producer concerns. Our secondary audience is the State of Colorado, Denver Water, and other water providers and our goal is to encourage them to increasingly consider this delivery mechanism. This could include feedback on current regulatory requirements, cost-incentives necessary to be developed for incentivizing recycled water use, and to understand needs associated to scale the use of recycled water more broadly. We expect that producers will adopt the use of recycled water as a cost-saving, safe, and reliable water source based on the results of this study. In addition, it is our hope that agricultural producers will begin to initiate conversations with other local water providers about the possibility of

accessing recycled water. Our primary means of distribution will be through electronic formats and through presentations at stakeholder gatherings and conferences. In addition, we will prepare the results for publication in peer-reviewed journals. A critical component of all our presentations and electronically distributed materials will be a demystification of the existing regulations around the use of recycled water.

We will also be promoting the results of the lawn conversion component of this project to neighborhood and homeowner associations. We will host demonstrations and staff tables at local events once we have information to share with homeowners. As much as possible, we will have homeowners who have converted their lawns be the spokespeople for this component of the project.

Describe how the project achieves the other measurable objectives and critical goals and actions laid out in Colorado's Water Plan around the supply and demand gap; conservation; land use; agriculture; storage; watershed health, environment, and recreation; funding; and additional.

This project will address the supply and demand gap in Colorado through demonstrating the value of using recycled water in food production and by mapping the potential recycled water network within the Denver Metro area. It will address conservation, land use, and agriculture by providing local data and case studies that promote the conversion of grass to food production.

Describe how the project achieves the education, outreach, and public engagement goals set forth in the applicable Basin Implementation Plan(s).

Describe how the project achieves the basin roundtable's PEPO Education Action Plans.

Last Updated: May 2021

Innovation Track
Describe how the project enhances water innovation efforts and supports a water innovation ecosystem in Colorado.
This study compares potable, raw, and recycled water irrigation used in food crop production for the relative impacts on soil health and produce quality, as well as examines the safety and benefits of using recycled water as a sustainable water resource for growing edible crops in Colorado. Colorado state Regulation 84 defines recycled water as, ". . . domestic wastewater that has received secondary treatment by a domestic wastewater treatment works (centralized system or a localized system) and such additional treatment as to enable the wastewater to meet the standards for approved uses." The terms reclaimed and recycled are synonymous and interchangeable. Water availability in Colorado's semi-arid climate is a barrier to food production. Colorado producers often cite long-term access to water as a significant limiting factor to their ongoing success and note that agricultural needs are often in direct competition with increasing municipal water demands. Recycled water is a drought-resistant water resource with little diurnal and seasonal variation and is the only water resource that increases in volume as population increases, thus enabling producers to overcome looming issues of water scarcity and urbanization pressures. Furthermore, recycled water often comes at a lower cost. For instance, Denver Water charges 75% less for recycled water than it does for potable water – a significant savings for agriculturalists. This project proposes a side-by-side model for a comparative study of recycled, potable, and raw water sources for edible crop irrigation with two types of water delivery: drip and spray. Our proposed research will investigate effects on soil health, produce

quality, and crop yields. The project team will grow common Colorado crops at two sites: Denver Water's Water Recycling Plant and at Petrocco Farm's rural, commercial growing site. These demonstration operations will allow researchers to study and share findings with the agricultural community and general public regarding the use of recycled water as a sustainable option for food production.

This study seeks to build on and amplify vigorous research programs happening throughout Colorado academic institutions investigating the impacts of recycled water irrigation. Overall, the findings from these studies have consistently shown safe use of recycled water. However, most studies are focused on landscape irrigation sites in parks and golf courses rather than in agricultural applications and thus avoid the question of public safety related to food production. Our hope is to extend these findings to the agricultural community and, in doing so, provide awareness around a more dependable and predictable source of water for edible crops in Colorado.

Water Research Foundation's 2019 report titled *Agricultural Use of Recycled Water,* notes substantial interest from growers and water utilities to use recycled water for irrigation of food crops, however, cites the inadequacy of available scientific evidence specific to Colorado and considers the long-term field experiences of other states as non-transferrable to Colorado's unique situation. Concurrently, the Colorado Water Plan highlights the imperative to meet Colorado's supply-demand gap induced by staggering population growth. (Colorado Water Plan, 2015)

As of December 2019, the use of recycled water for food production is an allowable use under Regulation 84. Yet, there remains an underlying question of public health and food safety that necessitates more comprehensive study on the risks and impacts of recycled water for edible food crops irrigation to help garner producer and consumer acceptance.

Furthermore, higher nutrient content (N) of recycled water may allow growers to reduce the amount of fertilizer used on their crops, thus saving time, money, and labor. A typical Denver area farming operation applies 3 ft of water (3 acre feet/ acre) during an irrigation season, with an equivalent of 122 lb of N delivered per acre, representing half the nitrogen demand for crops (Denver Water, 2015). Knowing the soil nutrient makeup and chemical characteristics of irrigation water, as this study seeks to do, would provide growers with the knowledge and tools to adjust their practices.

The second component of the proposal will engage home producers in the statewide water conversation by illustrating the value to Colorado as a whole of growing food with water that is currently used to grow grass. Not only does this reduce non-beneficial water use, but it also engages people in the conversations around water conservation

and responsible use through personal experience and through engagement with an environment they can control.
Describe how the project engages/leverages Colorado's innovation community to help solve our state's water challenges.
Describe how the project helps advance or develop a solution to a water need identified through TAP-IN and other water innovation challenges. What is the problem/need/challenge?
Describe how this project impacts current or emerging trends; technologies; clusters, sectors, or groups in water innovation.

Last Updated: May 2021

Colorado Water Conservation Board
Water Plan Grant – Exhibit A

Statement Of Work	
Date:	**7/1/2021**
Name of Grantee:	**Jody Beck, University of Colorado Denver**
Name of Water Project:	
Funding Source:	**CWCB**

Water Project Overview:

This project will provide base-line data on several issues pertinent to the water-efficient growth of food in cities in Colorado. First, we will provide a comparison between raw, potable, and recycled water with regard to their impact on soil health, crop yields, and nutritional content of produce grown. This work will be undertaken through the construction of a series of parallel growing beds which will be managed side by side with different water sources. We will also map potential reclaimed watersheds within the city to indicate potential water savings. The second major component of this project will be to establish baseline water usage by commercial growers and home gardeners in the urban and peri-urban areas of the Denver Metro area. This work will generate high quality data useful to evaluate the effectiveness of the promotion of urban agriculture as a water conservation strategy in Colorado. Lastly, we will compare different soil amendment strategies in new gardens with regard to their impact on water consumption over the span of two growing seasons. This will further guide future programs that are aimed at reducing the water usage of food production in Colorado's cities, and in particular indicate what strategies will reduce total water usage within our region and within our cities.

Project Objectives:

Last Updated: May 2021

The objective of this research and outreach is to establish parameters for the more efficient use of water to grow food in urban and peri-urban settings. There are two parts to this objective. The first is to provide local case studies that illustrate the value of using recycled water for growing food. The second is to demonstrate how water can be better used in our state through the conversion of grass lawns into food production. Both of these components to our research will result in advocacy and information resources that can be used to grow awareness of water concerns within urban populations in Colorado and encourage a reconsideration of how we use water.

Tasks

Task 1: Identify potential barriers and confirm or negate presumed benefits of wide use of recycled water irrigation for food production in Colorado.

Description of Task:

Focus group discussions at events with producers and producer representatives.

Host field days and on-site demonstrations, conduct virtual webinars.

Method/Procedure:

Discussions will be focused on three questions: 1) What are the producer concerns about using recycled water? 2) What should we test soil and produce for in order to address those concerns, and 3) What crops should we test?

Make on-site tour times available through the team's networks.

Deliverable:

Share preliminary results in focus group discussions at events with producers and producer representatives.

Publicize the study in progress more formally and seek feedback on crop selection and growing methods for second season.

Host on-site tours and publicize the ongoing study as appropriate.

Task 2: Investigate recycled water irrigation compared to potable and raw water irrigation for food production and determine effects on soil nutrients, soil sodicity and salinity, produce nutrient content and potential contamination, and crop yields.

Description of Task:

Last Updated: May 2021

Construct beds in study locations, install soil and test for all soil quality baseline data.

Irrigation systems will be installed and initial seeding will take place.

Growing season 1. Plant material will be managed and harvested for testing at appropriate times.

Irrigation system will be repaired as necessary and initial seeding will take place.

Growing season 2. Plant material will be managed and harvested for testing at appropriate times.

Method/Procedure:

Raised beds will be built with a drainage layer to isolate test soil from soil in place and for soil and growing method consistency between site locations.

Seeds will be selected based on producer focus groups. There will be two beds each for raw water, potable water, and recycled water (six beds total). In these two beds, one will test drip and the other will test spray water delivery.

Soil moisture will be kept consistent across all beds and optimized for produce health. Produce will be tested when harvested and soil will be tested at appropriate points. Bed maintenance protocols will be kept consistent.

Seeds will be selected based on producer focus groups and results from growing season one. Water sources and irrigation types will be kept consistent.

Soil moisture will be kept consistent across all beds and optimized for produce health. Produce will be tested when harvested and soil will be tested at appropriate points. Bed maintenance protocols will be kept consistent.	

Deliverable:

Task 3: Holistically compare economic costs and returns of using recycled water irrigation for food crops by conducting side-by-side comparisons with potable and raw water irrigation using two different delivery methods: drip and spray.

Data from the first growing season will be used alongside other completed studies.	Comparisons will be made between beds by irrigation type and water source.
Data from the second growing season will be used alongside other completed studies.	Comparisons will be made between beds by irrigation type and water source.

Task 4: Collaborate with the Colorado agricultural community - from urban and peri-urban market gardeners to large commercial operators - to assess and inform recycled water irrigation opportunities for food production in Colorado.

Description of Task:

Focus group discussions at events with producers and producer representatives. *(This is both a research objective and an outreach objective.)*

Host field days and on-site demonstrations, conduct virtual webinars. *(This is both a research objective and an outreach objective.)*

Share preliminary results in focus group discussions at events with producers and producer representatives. *(This is both a research objective and an outreach objective.)*

Host on-site tours and publicize the ongoing study as appropriate. *(This is both a research objective and an outreach objective.)*

Method/Procedure:

Discussions will be focused on three questions: 1) What are the producer concerns about using recycled water? 2) What should we test soil and produce for in order to address those concerns, and 3) What crops should we test?

Hold open houses to share and discuss ongoing study findings on site or online with interested parties. Make on-site tour times available through the team's networks.

Deliverable:

Publicize the study in progress more formally and seek feedback on crop selection and growing methods for second season.

Last Updated: May 2021

Task 5: Synthesize information, communicate key outcomes, and engage with a broad coalition of interested partners and stakeholders.
Description of Task:
Identify engaged group of advisory stakeholders. Prepare final distribution materials and publications. Apply for positions to present material in all relevant conferences and symposia.
Method/Procedure:
Conduct quarterly outreach calls with key stakeholders. Host Annual Statewide meeting. Attend and present at existing stakeholder meetings.
Deliverable:

Distribution materials will be primarily digital. Publications will be aimed at relevant and impactful journals, to include but not limited to the following:

- Water Education Colorado
- Water Reuse Colorado
- CSU Water Center Research Newsletter
- Agricultural Management Journal
- Colorado Water Plan

Conference attendance and potential presentation to include but not limited to the following:

- Colorado Water Congress
- CSU Water in the West Symposium
- The Watershed Summit (at Denver Botanic Gardens)
- South Platte Forum
- Rocky Mountain Land Use Institute Summit
- Governor's Forum on Colorado Agriculture
- Colorado Fruit and Vegetable Growers Association Conference
- Rocky Mountain Water Conference
- Metro Basin Roundtable

Task 6: Provide resources for producers and the general public to understand and compare the relative natural resource benefits of using raw, potable, and recycled water for irrigation of food production in Colorado and other semi-arid climates, while also building trust and confidence in utilizing recycled water for growing food crops.

Description of Task:

Prepare preliminary information in digital and presentation form from first growing season. Data from the second growing season will be used alongside other completed studies.
Method/Procedure:
While seeking feedback on process and information gathered after the first growing season, we will also seek feedback on and evaluate effectiveness of communication materials.
Deliverable:
Final materials will be produced based on feedback and evaluation of communication material effectiveness from first season.

Task 7: Map potential recycled water availability
Description of Task:

In order to be able to project total water conservation impacts of using recycled water in urban and peri-urban areas, we will need to map the potential availability of recycled water.
Method/Procedure:
A series of maps will be produced that overlay the potential availability of recycled water in the Denver Metro area with current and potential agricultural areas. These maps will necessarily be based on a series of assumptions and projected infrastructure investments. These assumptions and projections will be clearly identified on each map.
Deliverable:
A series of maps based on assumptions and projections, each of which will also project the water conservation and food production impacts.

Task 8 – Identification of prospective home gardeners for lawn conversion study
Description of Task:

We will first determine how best to select the areas for lawn conversions including the mix of institutional and residential, the distribution across the Denver Metro area, and the range of socio-economic characteristics of the participants. This work will be undertaken with an eye toward both social and environmental justice and the potential to demonstrate a viable expansion strategy.

Method/Procedure:

We will begin by establishing a sense of the available grass lawns by type in the Denver Metro and understand the proportions of ownership that make up the easiest targets for production. We will then reach out through home-owner groups, neighborhood groups, and professional connections to establish a group of people who will be committed to work with this program for two years. They will receive both material, labor, and technical assistance in exchange for recording water usage and yield data.

Deliverable:

Twenty sites committed to work with the proposal.

Task 9 – Establishment of soil amendment research protocol

Description of Task:

We will be generating data on how different home soil amendment strategies impact water consumption and yield.
Method/Procedure:
These strategies will be developed in collaboration with the identified individuals who will be managing the sites of this study. In order for the strategies to be viable and demonstrably expandable after the study, we need to obtain buy-in from the people who will be managing the sites.
Deliverable:
Soil amendment strategies will be identified and attached to particular sites.

Task 10 – Install gardens
Description of Task:

The twenty sites will need to be installed including removing grass, initial soil amendment to bring sites to as near a uniform baseline as reasonable, and installing water and soil moisture meters.
Method/Procedure:
The grass will be removed and the soil worked to a gardenable state. Each site will have a uniform installation of water meters, soil moisture meters, and watering controls.
Deliverable:
Twenty gardens ready for the first growing season.

Task 11 – Support gardeners and track water usage / yields
Description of Task:

In order to obtain the best data possible, we will be providing technical support throughout the two growing seasons of the study. We will also be supporting the gardeners in their collection of water usage and yield data.
Method/Procedure:
Each gardener will be able to contact our garden support personnel as they need. In addition, the garden support personnel will make a regular rotation of visits to the gardens at which point they will check that all metering equipment is working correctly as well as collect water usage and yield data.
Deliverable:
This will deliver high-quality data on garden production and water usage.

Tasks
Task 12 – Provide an advocacy resource regarding the conversion of grass lawns to food production.
Description of Task:

Last Updated: May 2021

The data from the gardening component of this study will be put into a publication which details the costs and benefits of garden installations in terms of yield and water savings. This publication will be usable for both encouraging those who control spaces with grass lawns to consider conversion and also to encourage the public support of these efforts.
Method/Procedure:
This publication will be comprised of data as well as case studies. We expect that it will be primarily an electronic resource, though limited promotional materials that can be handed out at neighborhood events may be printed.
Deliverable:
Materials directed at and differentiated for the general public, elected and administrative officials, and academic audiences.

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.

Reporting Requirements

Progress Reports: The applicant 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.

Final Report: At completion of the project, the applicant shall provide the CWCB a Final Report on the applicant'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.

The CWCB will pay out the last 10% of the 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 purchase order or grant will be closed without any further payment.

Payment

Payment will be made based on actual expenditures and must include invoices for all work completed. 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.

Costs incurred prior to the effective date of this contract are not reimbursable. The last 10% of the entire grant will be paid out when the final deliverable has been received. All products, data and information developed as a result of this contract must be provided to as part of the project documentation.

Last Updated: May 2021

Performance Measures

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 Water Plan Grant Guidelines, the CWCB will pay out the last 10% of the 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 purchase order or grant will be closed without any further payment.

(b) Accountability: Per Water Plan 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 Water Plan 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

Water Plan Grant
Budget and Schedule - Exhibit B

Prepared Date: 07/01/2021
Name of Grantee: Jody Beck
Name of Project: Urban Agriculture and Soil Health Management as a Water Conservation Strategy in Colorado
Project Start Date: January 2022
Project End Date: December 2023

Task No.	Task Description	Task Start Date	Task End Date	CWCB Grant Funding Request	Match Funding	Total
1	Identify potential barriers and confirm or negate presumed benefits of wide use of recycled water irrigation for food production in Colorado.	January 2022	December 2023			$0
2	Investigate recycled water irrigation compared to potable and raw water irrigation for food production and determine effects on soil	January 2022	December 2023	$11,429	$3,143	$14,572
3	Holistically compare economic costs and returns of using recycled water irrigation for food crops	Sept. 2022	December 2023	$857	$286	$1,143
4	Collaborate with the Colorado agricultural community to assess and inform recycled water irrigation opportunities for food production in Colorado	January 2022	December 2023			$0
5	Synthesize information, communicate key outcomes, and engage with a broad coalition of interested partners and stakeholders.	Sept. 2022	December 2023	$857	$286	$1,143
6	Provide resources for producers and the general public to understand and compare the relative natural resource benefits of using raw, potable, and recycled water	Sept. 2023	December 2023	$857	$286	$1,143
7	Map potential recycled water availability	May 2022	August 2022	$6,286	$1,428	$7,714
8	Identification of prospective home gardeners for lawn conversion study	January 2022	May 2022	$10,857	$3,286	$14,143
9	Establishment of soil amendment research protocol	January 2022	May 2022			$0
10	Install gardens	May 2022	May 2022	$24,143	$7,714	$31,857
11	Support gardeners and track water usage / yields	May 2022	Sept. 2023	$52,500	$17,142	$69,642
12	Provide an advocacy resource regarding the conversion of grass lawns to food production.	Sept. 2023	December 2023	$857	$286	$1,143
13	Grant management	January 2022	December 2023	$41,357	$16,143	$57,500
			Total	$150,000	$50,000	$200,000

NOTE TO APPLICANTS: Below are two "detailed budget" examples

Prepared Date:
Name of Applicant:
Name of Water Project:

EXAMPLE A: Coordination

Task 1 - [TASK NAME]

Sub-task	Item	Hourly Rate	# Hours
Focus Groups			
	Participant Stipend		
	Catering		
	Feedback Survey		
	Staff Time	$ 40.00	10
Exhibit			
	Exhibit Designer	$ 50.00	100
	Staff Time	$ 40.00	30
	Film Production		
TOTAL			

EXAMPLE B: Construction/Engineering

Task 1 - Engineering			**Water Consulta**
Sub-task	Senior Principal Engineer	Senior Water Resources Engineer/ Consultant	Water Resources Engineer
	$ 190	$ 160	$ 130
	Estimated Hours		
Project Initiation / Stakeholder Ident	12	32	
Water Rights Evaluation	24	24	80
Engineering Evaluation	24		
Environmental Analysis	8	8	
Flood Mitigation		32	
Funding Opportunities	4	24	
Cooperative Partnership	16	60	
Project Management	20	30	

Report, Conclusions and Recommen	40	54	16
Task 2 - ?			
Subtotal Hours	148	264	96
Subtotal Labor/ Subcontractor cost	$28,120	$42,240	$12,480
Subcontractor Administration Fee @ 5%			
Other Direct Costs (see below)			
TOTAL			

Other Direct Costs

Item:	**Copies & Printing (Black & White)**	**Copies & Printing (Color)**	**Materials and Final Report Production**
Units:	**No.**	**No.**	**Lump Sum**
Unit Cost:	**$0.10**	**$0.50**	
Project Initiation	400	100	
Water Rights Evaluation	40	30	
Engineering Evaluation	60	40	
Environmental Analysis			
Flood Mitigation			
Funding Opportunities			
Cooperative Partnership		60	
Project Management	60		
Report, Conclusions and Recommendations	150	60	$ 1,900
Total Units:	710	290	1,900
Total Cost:	$71	$145	$1,900

s. Detailed budgets will vary between all projects, so these examples can be used as a helpful guid

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Water Plan Grant - Detailed Budget Estimate

Subtotal			Item Cost	Item Quantity	Subtotal	Total	
$	**-**		$ 50.00	20.00	**$ 1,000.00**	$	1,000.00
$	**-**		$ 15.00	20.00	**$ 300.00**	$	300.00
$	**-**		$ 0.50	20.00	**$ 10.00**	$	10.00
$	**400.00**					$	400.00
$	**5,000.00**				**$ -**	$	5,000.00
$	**1,200.00**				**$ -**	$	1,200.00
$	**-**		$ 5,000.00	1.00	**$ 5,000.00**	$	5,000.00
						$	**12,910.00**

nts							Subcor
Geologist/ Water Resources Analyst				Geotechnical	Environmental and Cultural Resources	Water Rights and other Legal	
$	100	**Subtotal**		Lump sum	Lump Sum		
				Estimated Cost			
	16	**$ 9,000**					
	30	**$ 21,800**				$	12,000
	36	**$ 8,160**		$ 27,000			
	12	**$ 4,000**			$ 12,000		
	40	**$ 9,120**					
	8	**$ 5,400**					
		$ 12,640					
	24	**$ 11,000**					

40	$ 22,320				$	3,000
206	714					
$20,600	$103,440		$ 27,000	$ 12,000	$	15,000
			$ 1,350	$ 600	$	750

Lodging and Meals Per Diem $ 100.00	Travel Expenses (Airfare and Car Rental) Lump Sum	Mileage Miles $0.535	Total
4		400	
2		550	
2		550	
4		400	
		300	
4		800	
		550	
4		600	
20		4,150	
$0	$0	$2,220	$4,336

le rather than required template.

CWCB Funds	Other Matching Funds

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Technical editing and proofing Lump Sum	Report Word Processing and Graphic Design Lump Sum	Subtotal		Total	CWCB Funds	Other Matching Funds
		$	-	$9,000		
		$	**12,000**	$33,800		
		$	**27,000**	$35,160		
		$	**12,000**	$16,000		
		$	-	$9,120		
		$	-	$5,400		
		$	-	$12,640		
		$	-	$11,000		

$	1,500	$	4,000	**$**	**8,500**	$30,820	
$	1,500	$	4,000	**$**	**59,500**	$162,940	
$	75	$	200	**$**	**2,975**	$2,975	
						$4,336	
						$170,251	