Last Updated: July 2017

Colorado Water Conservation Board

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:

Supply and Demand Gap Projects	Gregory.Johnson@state.co.us
Water Storage Projects	Anna.Mauss@state.co.us
Conservation, Land Use Planning	Kevin.Reidy@state.co.us
Engagement & Innovation Activities	Mara.MacKillop@state.co.us
Agricultural Projects	Brent.Newman@state.co.us
Environmental & Recreation Projects	Linda.Bassi@state.co.us

Applicants interested in submitting an 'Intent to Apply' in the future are encouraged to check here ☐ and fill in all sections with the best information available at the time. Exhibits may be excluded.

This "Intent to Apply" will help CWCB prioritize Projects that are not ready for fully completed Water Plan Grant Application due to the initial timeframe and required deadlines.

FINAL SUBMISSION: Submit all application materials 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.

Water Project Summary

Name of Applicant	Colorado State University
Name of Water Project	Linking urban landscape irrigation, urban growth density, and return flows

CWP Grant Request Amount	$142,536
Other Funding Sources _____	$0
Other Funding Sources _____	$0
Other Funding Sources _____	$0
Applicant Funding Contribution	$143,394
Total Project Cost	$285,930

Last Updated: July 2017

Applicant & Grantee Information	
Name of Grantee(s)	Colorado State University
Mailing Address	2002 Campus Delivery, Fort Collins, CO 80523-2002
FEIN	846000545
Organization Contact	William Moseley
Position/Title	Interim Senior Research Administrator
Email	Bill.moseley@colostate.edu
Phone	970-491-1541
Grant Management Contact	Linda Loing
Position/Title	Research Administrator
Email	Linda.loing@colostate.ed
Phone	970-491-6586
Name of Applicant (if different than grantee)	Aditi Bhaskar
Mailing Address	1372 Campus Delivery, Fort Collins, CO 80523
Position/Title	Assistant Professor
Email	aditi.bhaskar@colostate.edu
Phone	970-491-8339

Description of Grantee/Applicant
Provide a brief description of the grantee's organization (100 words or less).
Colorado State University is recognized as one of the premier research institutions and routinely ranks in the top of all American Universities in research expenditures. The Office of the Vice President for Research has overall responsibility for facilitating the research enterprise at Colorado State University. The Office works to encourage and support the development, marketing and application of Colorado State University's intellectual property and our world-renowned researchers, students and facilities. Vision: The Office of the Vice President for Research will enable the University, its faculty, staff and students to emerge as a world-class research institution complementing our learning, service and outreach missions. Mission: The Office of the Vice President for Research will lead the 21st Century Land-Grant mission of Colorado State University by fostering and supporting the research enterprise, promoting scholarship and artistry, instilling a culture of integrity, and capitalizing on opportunities to address global challenges.

Last Updated: July 2017

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
	Construction
	Identified Projects and Processes (IPP)
	Other

Category of Water Project (check all that apply and include relevant tasks)	
	Supply and Demand Gap - Multi-beneficial projects and those projects identified in basin implementation plans to address the water supply and demand gap. *Applicable Exhibit A Task(s):*
	Water Storage - Projects that facilitate the development of additional storage, artificial aquifer recharge, and dredging existing reservoirs to restore the reservoirs' full decreed capacity. *Applicable Exhibit A Task(s):*
x	Conservation and Land Use Planning - Activities and projects that implement long-term strategies for conservation, land use, and drought planning. *Applicable Exhibit A Task(s): 1-3*
	Engagement & Innovation - Activities and projects that support water education, outreach, and innovation efforts. Please fill out the Supplemental Application on the website. *Applicable Exhibit A Task(s):*
	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):*

Last Updated: July 2017

	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	Larimer
Latitude	40.588990°
Longitude	-105.080096°

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: July 2017

Water Project Overview
If the conservation goals of the Colorado Water Plan are to be met, cities must develop effective and integrated water and land use plans. This will support the CWP's goal to "support the growth of the next 5 million residents more strategically than the last 5 million" (CWP p.10-5). The proposed work will provide valuable decision information to help cities reduce future demand by quantifying the links between landscape irrigation and urban growth density. To develop and demonstrate the methodologies, landscape irrigation for vegetated residential parcels will be compared across housing densities in the service area of Fort Collins Utilities. Consumptive use by vegetation on these same residential parcels will be quantified using high-resolution optical, near infrared, and thermal aerial imagery. Combining imagery-derived evapotranspiration and irrigation rates per parcel will yield estimates of lawn irrigation return flows. The deliverables from this project will include values of seasonal irrigation in gallons per pervious square foot for various housing and landscape types, and could be used to predict water demand with future growth densities, develop water budgets, and inform land use planning decisions as they relate to water use in Fort Collins and across urban areas in Colorado.

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)
	Quantity of Water Shared through Alternative Transfer Mechanisms
	Number of Coloradans Impacted by Incorporating Water-Saving Actions into Land Use Planning
	Number of Coloradans Impacted by Engagement Activity

Last Updated: July 2017

Measurable Results		
	Other	Explain:

Water Project Justification
Provide a description of how this water project supports the goals of Colorado's Water Plan, the most recent Statewide Water Supply Initiative, 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;)
"The success of Colorado's Water Plan will ultimately be measured by whether or not the municipal water supply-and-demand gap is closed, and the choices we make to close it…In order to reduce the amount of water needed for future generations of Coloradoans and keep urban-adjacent agricultural lands in production, Colorado must support the growth of the next 5 million residents more strategically than the last 5 million" (CWP p.10-5). The proposed work addresses this need by supporting strategic future urban growth. SWSI (2010) states, "Currently there is not much data regarding the ability of denser and more sustainable developments to reduce water demand in Colorado. This data is necessary so that developers and city and county planners can understand what the best management practices and methodologies are, and reliably how much water savings they could expect" (SWSI, 2010, p. 7-14). The proposed work directly addresses this need for data by developing and demonstrating a methodology to quantify the relationship between water demand and housing density. The information provided by this project will help contribute to coordination of planning efforts between water agencies and land use planners, which is one of Colorado's vision goals (SWSI 2010, p. ES-28) and is called for in the South Platte BIP (p. S-13, 5-25). Lastly, the proposed work addresses the potential for diminishing M&I return flows with increased efficiency by considering the relationship between outdoor water use and lawn irrigation return flows (CWP, p. 3-14).

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.

Last Updated: July 2017

Related Studies
The proposed project is complementary to a number of other CWCB programs. The Colorado Water and Growth Dialogue with the Keystone Policy Center is focusing on Aurora Water and Denver Water. The proposed study area of Fort Collins will be compared to results from Aurora and Denver to see how variable the relationship between water demand and housing density is for different urban areas within Colorado. The empirical results from Fort Collins will be used to inform typical irrigation gallons per pervious square foot (GPSF) and GPSF variability in the model and tool that is being produced from the Colorado Water and Growth Dialogue.

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.

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.

Last Updated: July 2017

Submittal Checklist	
	I acknowledge the Grantee will be able to contract with CWCB using the Standard Contract.
Exhibit A	
X	Statement of Work(1)
X	Budget & Schedule(1)
	Letters of Matching and/or Pending 3rd Party Commitments(1)
Exhibit C	
	Map (if applicable)(1)
	Photos/Drawings/Reports
	Letters of Support (Support letter from Basin Roundtable encouraged)
	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)
Engagement & Innovation Grant Applicants ONLY	
	Engagement & Innovation 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: July 5, 2017

Colorado Water Conservation Board
Water Plan Grant - Exhibit A

Statement Of Work	
Date:	October 1, 2017
Name of Applicant:	Colorado State University
Name of Water Project:	Linking urban landscape irrigation, urban growth density, and return flows
Funding Source:	Conservation and Land Use

Water Project Overview: Please provide a summary of the proposed water project (200 words or less). The same summary can be used from Page 5 of the CWP Grant Application.

If the conservation goals of the Colorado Water Plan are to be met, cities must develop effective and integrated water and land use plans. This will support the CWP's goal to "support the growth of the next 5 million residents more strategically than the last 5 million" (CWP p.10-5). The proposed work will provide valuable decision information to help cities reduce future demand by quantifying the links between landscape irrigation and urban growth density. To develop and demonstrate the methodologies, landscape irrigation for vegetated residential parcels will be compared across housing densities in the service area of Fort Collins Utilities. Consumptive use by vegetation on these same residential parcels will be quantified using high-resolution optical, near infrared, and thermal aerial imagery. Combining imagery-derived evapotranspiration and irrigation rates per parcel will yield estimates of lawn irrigation return flows. The deliverables from this project will include values of seasonal irrigation in gallons per pervious square foot for various housing and landscape types, and could be used to predict water demand with future growth densities, develop water budgets, and inform land use planning decisions as they relate to water use in Fort Collins and across urban areas in Colorado.

Objectives: List the objectives of the project.

(1) Define the relationship between residential outdoor water use and parcel vegetated area in Fort Collins, Colorado.

(2) Estimate the volume of residential irrigation that is not consumptively used by vegetation.

(3) Identify characteristics of residential parcels that have above and below average outdoor water use per vegetated area.

Last Updated: July 5, 2017

Tasks
Task 1 – Define the relationship between residential outdoor water use and parcel vegetated area in Fort Collins, Colorado.
Description of Task:
Past work with a reconnaissance-level planning tool[1] showed that water use in gallons per capita per day decreases with increases in housing density. As parcels and associated vegetated areas shrink, there is less area to irrigate and outdoor water use drops. At the highest housing densities almost all water is already used indoors, and therefore decreases in outdoor water use level off. The proposed project will examine this trend empirically using residential parcels in the Fort Collins Utilities service area. The average value of outdoor water use per household per parcel vegetated area (also termed seasonal gallons per pervious square foot, GPSF) will be defined. This average GPSF will be compared to values found for other regions outside of and within Colorado. Task 3 will further examine housing and landscape characteristics that drive variations in GPSF.
Method/Procedure:
Fort Collins Utilities water billing data for the period 2012 - present will be obtained under a partnership with the Water Conservation program at Fort Collins Utilities. The minimum month method will be used to estimate outdoor water use from total water use. In the minimum month method, all water use during the minimum month (in winter) is assumed to be indoor use and constant throughout the year. Increases in use from the minimum month are therefore providing an estimate of outdoor use. The Fort Collins Utilities water billing data have previously been related to residential parcel boundary information. A high-resolution land use/land cover classification from the City of Fort Collins will be updated as required and will provide information on the area of each residential parcel that is made up of grass and trees. Combining these three datasets (water billing giving outdoor use, parcel boundaries associated with that outdoor use, and land use/land cover data giving vegetated area) together will allow estimation of the change in outdoor use per household with vegetated area.
Grantee Deliverable: Describe the deliverable the grantee expects from this task
GPSF will be calculated over time for residential parcels within the Fort Collins Utilities service area. This information will be contained within GIS data layers, maps, and analysis reports.
CWCB Deliverable: Describe the deliverable the grantee will provide CWCB documenting the completion of this task
A memorandum summarizing the findings of task 1 and the average GPSF for various types of residential landscapes will be provided to CWCB. Additional data layers will be provided to CWCB as requested.

[1] http://cwcb.state.co.us/public-information/publications/Documents/ReportsStudies/DRAFTDensityTechnicalMemo.pdf

Last Updated: July 5, 2017

Tasks
Task 2 – Estimate the volume of residential irrigation that is not consumptively used by vegetation.
Description of Task:
The Colorado Water Plan states, "the South Platte Basin is leading the state in M&I water-use efficiency. Efficient use of the basin's resources through water reuse and conservation is a critical step toward meeting future water needs. Nevertheless, increased M&I water-use efficiency will reduce the quantity of water available for agricultural and ecological practices and other uses, because M&I return flows will diminish" (p. 3-14). The interplay between increasing water-use efficiency, lawn irrigation return flows, and downstream agricultural and ecological water users needs to be explicitly considered when examining changes to urban landscape irrigation practices. The proposed task 2 considers the linkage between outdoor water use efficiency and return flows by quantifying the potential for deeper drainage in each residential parcel. The consumptive use by vegetation in Fort Collins residential parcels will be estimated using high-resolution optical, near infrared, and thermal (multispectral) aerial imagery and two vegetation water use algorithms. These algorithms are the reflectance-based crop coefficient approach and the surface energy balance approach. The evapotranspiration derived from multispectral imagery will be combined with the irrigation rates found in task 1 to yield estimates of return flows (here considered both deep drainage and surface runoff from landscape irrigation). The results from this task will inform how return flows might change with less vegetated area or lower irrigation rates.
Method/Procedure:
GPSF for each parcel from task 1 will be converted to irrigation depth per parcel per day and combined with estimates of evapotranspirative use by residential vegetated landscapes. Thermal aerial imagery (1 m) and multispectral imagery (10 cm) will be collected by Aeroptic LLC over Fort Collins during peak summer irrigation (four flights corresponding to a single water billing period will be collected). The high-resolution multispectral data will be used to quantify actual evapotranspiration for each parcel by two different approaches to yield greater confidence in the estimates. The surface reflectance approach updates landscape crop coefficients while the energy balance approach relies on scaling vegetation water use between two anchoring pixels, namely the cold and hot thermal surface temperature pixels. The difference between irrigation applied and evapotranspirative use will provide an estimate of the amount of irrigation that is consumptively used and conversely, the amount of irrigation that is not consumptively used by residential vegetation. The irrigation that is not used forms either return flows (deep drainage or surface runoff) or may be stored temporarily as soil moisture.
Grantee Deliverable: Describe the deliverable the grantee expects from this task
GIS data layers, maps, and analyses of evapotranspiration by residential landscape vegetation and return flows in the Fort Collins Utilities service area will be produced by this task.
CWCB Deliverable: Describe the deliverable the grantee will provide CWCB documenting the completion of this task
A memorandum including maps of evapotranspiration, return flows, and analysis of the spatial and temporal patterns of evapotranspiration and return flows observed will be provided to CWCB. The original evapotranspiration data will be provided to CWCB as requested.

Last Updated: July 5, 2017

Tasks
Task 3 – Identify characteristics of residential parcels that have above and below average outdoor water use per vegetated area.
Description of Task:
In task 1, an average or typical value of GPSF will be identified. This value is expected to have substantial variability with above and below average parcels for outdoor water use per household per vegetated area. Task 3 will identify the characteristics that above and below average GPSF parcels have. In task 2, the difference between irrigation and vegetative use will be identified in each parcel. Task 3 will also identify the characteristics of those parcels which are receiving excess irrigation (irrigation is greater than vegetative use) compared to those that are receiving deficit irrigation (irrigation is less than vegetative use). Identification of the key characteristics will allow classification of residential parcels into tiers of higher, average, and lower GPSF and return flows. This type of information could be used by municipalities for the outdoor component of a water budget used for setting residential water pricing. The identification of the driving characteristics of outliers in GPSF and correspondence to vegetative use will inform how outdoor municipal demand will be expected to change in different growth pattern scenarios for Fort Collins and other municipalities.
Method/Procedure:
The characteristics that will be considered for above and below average parcels are housing characteristics (development type, age of development, median income, parcel size, location) and landscape characteristics (vegetation type, amount of vegetative cover, parcel proportion of vegetative cover). Field reconnaissance and xeriscaping rebate information will also be used to observe presence of low-water using plants. These variables will be combined in a multiple linear regression to explain anomalies observed in task 1 for GPSF and the spatial pattern observed in return flows identified in task 2.
Grantee Deliverable: Describe the deliverable the grantee expects from this task
The most significant characteristics driving anomalies in GPSF and return flows will be identified in the Fort Collins Utilities service area.
CWCB Deliverable: Describe the deliverable the grantee will provide CWCB documenting the completion of this task
CWCB will be provided with a memorandum identifying the significant characteristics driving anomalies in GPSF and return flows, along with data used in the analysis as requested. This type of information could be used as decision support information to analyze different urban development scenarios and the expected resulting water use and return flow patterns.

Last Updated: July 5, 2017

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. The CWCB may withhold reimbursement until satisfactory progress reports have been submitted.

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 withhold disbursement the last 10% of the budget until 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.

Last Updated: July 5, 2017

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Water Plan Grant - Exhibit A
Budget and Schedule

Date: October 1, 2017

Name of Applicant: Colorado State University

Name of Water Project: Linking urban landscape irrigation, urban growth density, and return flows

Task No.	Task Description	Start Date[(1)]	End Date	Water Project Funding Category	Grant Funding Request	Match Funding	Total
1	Define the relationship between residential ou	1-May-18	30-Apr-19	Conservation/Land Use	$28,916	$29,524	$58,440
2	Estimate the volume of residential irrigation th	1-May-19	30-Apr-20	Conservation/Land Use	$79,810	$82,298	$162,108
3	Identify characteristics of residential parcels th	1-May-20	30-Apr-21	Conservation/Land Use	$33,810	$31,572	$65,382
							$0
							$0
							$0
							$0
							$0
							$0
							$0
							$0
							$0
				Total	$142,536	$143,394	$285,930

(1) Start Date for funding under $100K, minimum 45 Days from Board Approval; Start Date for funding over $100K, minimum 90 Days from Board Approval.

·Round values up to the nearest hundred dollars.

·Reimbursement eligibility commences upon the grantee's receipt of a Notice to Proceed (NTP)

·NTP will not be accepted as a start date. Project activities may commence as soon as grantee enters contract and receives formal NTP if prior to the listed "Start Date".

·The applicant shall provide a progress repost every 6 months, beginning from the date of contract execution.

·CWCB will withhold disbursement of the last 10% of the total grant amount until a Final Report is completed to the satisfaction of CWCB staff (2017 CWP Grant Guidelines).