COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Water Plan

Water Project Summary

Name of Applicant	Colorado School of Mines	
Name of Water Project	Project-01909 Direct Potable Reuse (DPR) Demonstration – Phase II	
Grant Request Amount		**$297,715.00**
Primary Category		$297,715.00
Engagement & Innovation Activities		
Total Applicant Match		**$369,833.00**
Applicant Cash Match		$369,833.00
Applicant In-Kind Match		$0.00
Total Other Sources of Funding		**$0.00**
Total Project Cost		**$667,548.00**

Applicant & Grantee Information

Name of Grantee: Colorado School of Mines
Mailing Address: 1500 Illinois St Golden Colorado 80401
FEIN: 6,000,551

Organization Contact: Tzahi Cath
Position/Title:
Email: tcath@mines.edu
Phone: (720) 722-3343

Organization Contact - Alternate: Liz Sanders
Position/Title: Contract specialist
Email: evsanders@mines.edu
Phone: (303) 384-2302

Grant Management Contact: Tzahi Cath
Position/Title:
Email: tcath@mines.edu
Phone: (720) 722-3343

Engineering Contact: Tzahi Cath
Position/Title:
Email: tcath@mines.edu
Phone: (720) 722-3343

Description of Grantee/Applicant

Public university

Type of Eligible Entity

- [x] Public (Government)
- [ ] Public (District)
- [ ] Public (Municipality)
- [ ] Ditch Company

- ☐ Private Incorporated
- ☐ Private Individual, Partnership, or Sole Proprietor
- ☐ Non-governmental Organization
- ☐ Covered Entity
- ☐ Other

Category of Water Project

- ☐ Agricultural Projects
  Developing communications materials that specifically work with and educate the agricultural community on headwater restoration, identifying the state of the science of this type of work to assist agricultural users among others.
- ☐ Conservation & Land Use Planning
  Activities and projects that implement long-term strategies for conservation, land use, and drought planning.
- ■ Engagement & Innovation Activities
  Activities and projects that support water education, outreach, and innovation efforts. Please fill out the Supplemental Application on the website.
- ☐ Watershed Restoration & Recreation
  Projects that promote watershed health, environmental health, and recreation.
- ☐ 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 and Multi-beneficial projects and those projects identified in basin implementation plans to address the water supply and demand gap.

Location of Water Project

Latitude	39.761667
Longitude	104.853611
Lat Long Flag	Water provider location: Coordinates based on address of water provider
Water Source	Reclaimed water
Basins	Arkansas; Metro; Colorado; South Platte
Counties	Denver; Larimer; Jefferson; Douglas
Districts	8-South Platte Cheesman to Denver Gage

Water Project Overview

Major Water Use Type	Municipal
Subcategory	Education
Scheduled Start Date - Design	
Scheduled Start Date - Construction	

Description

Colorado School of Mines (Mines) in partnership with Colorado Springs utilities and funded by CWCB, have designed, fabricated, and built a mobile laboratory to demonstrate proven and novel technologies to practice Direct Potable Reuse (DPR) using municipal wastewater, or other impaired waters. Phase 1 of that project was successful in educating over 1000 individuals from various backgrounds on that role DPR can play in future water supplies.

Phase II goals include DPR education and research to further demonstrate carbon-based advanced treatment (CBAT) processes. Specifically, we will:

Build upon CWCBs initial investment in the mobile lab, to help achieve the Colorado Water Plan, Basin Implementation Plan, and help CDPHEs with DPR regulatory rule making with continued education and research.

Leverage CWCB funds to support continued operation of the mobile lab at various utilities in Colorado, optimize maintenance needs, students/staff, analysis of water quality, public education/outreach, and technical support (Carollo Engineers).
Develop an interdisciplinary program between Mines, Carollo, and utilities to enhance data science integration into water reclamation and reuse.
Use as a sensory tool for DPR education and outreach to the public, operator/employee/leadership, and regulatory/government groups.
Provide a resource and pilot opportunity for other entities, industry, and communities investigating DPR viability for individual/regional water systems.

Measurable Results

	New Storage Created (acre-feet)
	New Annual Water Supplies Developed or Conserved (acre-feet), Consumptive or Nonconsumptive
	Existing Storage Preserved or Enhanced (acre-feet)
	New Storage Created (acre-feet)
	Length of Stream Restored or Protected (linear feet)
	Efficiency Savings (dollars/year)
	Efficiency Savings (acre-feet/year)
	Area of Restored or Preserved Habitat (acres)
	Quantity of Water Shared through Alternative Transfer Mechanisms or water sharing agreement (acre-feet)
1,000,000	Number of Coloradans Impacted by Incorporating Water-Saving Actions into Land Use Planning
1,000,000	Number of Coloradans Impacted by Engagement Activity

Water Project Justification

Proposed project demonstrate development of new drinking water resources for Colorado

Related Studies

Direct Potable Reuse (DPR) Demonstration (https://dnrweblink.state.co.us/CWCB/0/edoc/210315/Colorado%20Springs%20Utilities-Direct%20Potable%20Reus ?)

Taxpayer Bill of Rights

NA

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: (1) Summarizes the project and how the project was completed. (2) Describes any obstacles encountered, and how these obstacles were overcome. (3) Confirms that all matching commitments have been fulfilled. (4) 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.

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 the Budget & Schedule 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
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Department of Natural Resources

Last Updated: May 2021

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:

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	Colorado School of Mines
Name of Water Project	Direct Potable Reuse (DPR) Demonstration – Phase II
CWP Grant Request Amount:	$297,715
Other Funding Sources: Aurora Water (LOS pending)	$45,000
Other Funding Sources: Castle Rock (LOS pending)	$45,000
Other Funding Sources: Dominion (LOS pending)	$45,000
Other Funding Sources: South Platte Renew (LOS pending)	$45,000
Other Funding Sources: Fort Collins (LOS pending)	$45,000
Other Funding Sources: Coors/Ball/IBM (LOS pending)	$45,000
Applicant Funding Contribution	$99,833
Total Project Cost	$667,548

Last Updated: May 2021

Applicant & Grantee Information
Name of Grantee(s): Colorado School of Mines, a public research university
Mailing Address: 1500 Illinois St., Golden, CO 80401
FEIN: DUN#010628170 and TIN# 84-6000551
Organization Contact: Tzahi Cath
Position/Title: Professor and Center Director
Email: tcath@mines.edu
Phone: 720-722-3343
Grant Management Contact: Elizabeth V. Sanders, MBA
Position/Title: Contract Administrator
Email: evsanders@mines.edu
Phone: 303-384-2302
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).
The Colorado School of Mines (Mines) is a public research university in Golden, Colorado, founded in 1874. The school offers both undergraduate and graduate degrees in engineering, science, and mathematics, with a focus on energy, natural resources, and the environment. In 2021, the school had close to 7,200 students enrolled, with more than 5,500 in undergraduate programs and the rest in graduate programs. In every QS World University Ranking (2016-2020), the university was ranked as the top institution in the world for mineral and mining engineering. It is classified among "R2: Doctoral Universities – High research activity".

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

X	Other: Direct Potable Reuse Demonstration (mobile unit) – Phase II

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.*	
	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):* Task 1 – General Project Management Task 2 – Operation Task 3 – Optimization and Research of New Treatment Technologies Task 4 – Outreach	
	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	Aurora (Arapahoe), Castle Rock (Douglas), Colorado Springs (El Paso), Dominion (Douglas), Fort Collins (Larimer) , South Platte Renew (Denver)
Latitude	Multiple Locations
Longitude	Multiple Locations

Last Updated: May 2021

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.

Colorado School of Mines (Mines) in partnership with Colorado Springs utilities and funded by CWCB, have designed, fabricated, and built a mobile laboratory to demonstrate proven and novel technologies which can be used for Direct Potable Reuse (DPR) - the treatment of municipal wastewater to potable standards. Phase 1 of that project was successful in educating over 1000 individuals from various backgrounds on the role DPR will play in future water supplies.




Phase II goals include DPR education and research to further demonstrate carbon-based advanced treatment (CBAT) processes. Specifically, we will:

- Build upon CWCBs initial investment in the mobile lab (Phase I), to help achieve the Colorado Water Plan, Basin Implementation Plan, and provide continued education and research in support of CDPHE's DPR rule making.
- Leverage CWCB funds to support continued operation of the mobile lab at various utilities in Colorado, optimize maintenance needs, students/staff, analysis of water quality, public education/outreach, and technical support (Carollo Engineers).
- Develop an interdisciplinary program between Mines, Carollo, and utilities to enhance data science integration into water reclamation and reuse.
- Use as a sensory tool for DPR education and outreach to the public, operator/employee/leadership, and regulatory/government groups.
- Provide a resource and pilot opportunity for other entities, industry, and communities investigating DPR viability for individual/regional water systems.

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 or water sharing agreement	
	Number of Coloradans Impacted by Incorporating Water-Saving Actions into Land Use Planning	
Initial Engagement 1000-2500 directly through education and outreach and > 400,000 indirectly (entire Colorado Springs Utilities' customer base and the customers of other utilities that will deploy the mobile lab) *Note: many more are anticipated to be impacted over the expected life of the mobile lab*	Number of Coloradans Impacted by Engagement Activity	
	Other	Explain:

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;)

This project will provide further evidence to support DPR as a viable alternative water source in addition to supporting education, engagement, outreach and innovation goals outlined in Colorado's Water Plan, Statewide Water Supply Initiative, the Arkansas Basin Roundtable Basin Implementation Plan, the South Platte River Basin and the Basin Education Action Plan.

Colorado's Water Plan (2015)

Chapter 3 – Basin Challenges (pp. 3-4, and 3-14)

1. *"Replacement of municipal water supplies that depend on the non-renewing Denver Basin aquifer..."*
2. *"Regional solutions are emerging...to address the needs of the Arkansas Basin."*
3. *"The South Platte Basin is leading the state in municipal and industrial water-use efficiency. Efficient use of the basin's resources through water reuse and conservation is a critical step toward meeting future water needs"*

While our proposed project will not address these technical goals as written in the CWP, our project will directly promote their objectives. The mobile DPR lab will allow Mines and its partner utilities to pilot-test viable DPR technologies for the region and test associated messaging in different service areas. This approach should provide greater value to the water community as a whole and that of the utilities' customers, allowing broad public engagement and education for that utility.

Section 6.2 – Goals (p. 6-21, p. 6. 26)

1. *"Support regional infrastructure development for cost-effective solutions to local water supply gaps."*

2. *"Reduce or eliminate Denver Basin groundwater dependence for municipal users."*
3. *"The roundtable identified a critical gap as the need to replace nonrenewable groundwater and augment the sustainability of designated basins."*
4. *"Enhance current levels of municipal water reuse and consider studies to quantify effects of: 1)...conservation on water available for reuse; 2)...water reuse in relation to water available for exchanges: 3)...reuse and successive uses of water downstream including effects on agricultural water shortages"*

Mines diversified deployment of the PureWater Colorado DPR mobile lab will have two primary focuses: education/outreach for Coloradoans and utilities operators to learn about advanced reuse opportunities, and research to inform utilities and regulations on the viability and sustainability of advanced technologies to achieve various water treatment goals.

DPR is one approach to water reuse, but systems developed for DPR can produce water of targeted quality for other beneficial reuse at a lower cost (e.g., irrigation, industrial, etc.). The education component of our proposed project will target non-industry and industry participants, and will focus on the DPR processes and their potential financial, resiliency, and environmental benefits. As the mobile lab is being used by the water providers partnered on this proposed project, it will improve the likelihood that other entities adopt a DPR supply strategy to reduce the use of nonrenewable water sources (e.g., Denver Basin).

Section 6.3 – Goal (p. 6-59)

1. *"Promote water efficiency ethic throughout Colorado."*
2. *"Explore additional water reuse options."*

Mines and its partners on this proposal recognize that these goals were intended to address traditional ideas for water conservation and reuse, but we believe that the DPR demonstration project will assist Colorado utilities and other entities in exploring and promoting a new viable reuse option--DPR. Furthermore, tailored water reuse (fit-for-purpose) is another option that can be explored with the new mobile lab, as well as side-by-side comparison of DPR with or without reverse osmosis purification. With education and research as the project's primary goals, this demonstration is uniquely suited to address DPR as an option alongside current water efficiency practices to close the statewide water supply gap, while answering critical questions about the technology and strategies to optimize the implementation specifically for Colorado-based utilities.

Section 6.5 – Goal (p. 6-127)

1. *"Meet community water needs during periods of drought."*

This mobile demonstration will educate water providers and local, regional, and state policymakers throughout Colorado on the benefits associated with pursuing DPR, especially in preparation for years when Colorado experiences mild and severe drought. DPR can provide an operationally and cost-effective means for water utilities to fully utilize their reusable water supplies; thereby creating a higher level of water supply security in times of drought. Increasing DPR of reclaimed and other unconventional water sources during times of drought can also decrease utilities' first or single use withdrawals from surface and groundwater sources. Reduced withdrawals can accelerate drought recovery, maintain adequate water storage, and mitigate water quality treatment issues and operational challenges during drought and/or wildfire conditions.

Section 6.5 – Actions (p.6-155)

1. *"While the right to buy or sell private property, water rights must not be infringed upon, and the State will encourage the innovation and creativity by agricultural producers and research institutions to maximize the productivity of every drop of water."*

2. *"Multipurpose project funding: The CWCB will prioritize support for multipurpose projects and those that modernize, make more efficient, or lead to the building of new critical infrastructure for agricultural purposes, M&I uses, and hydropower production."*

In Phase I of the DPR project, which was funded in part by CWCB, it was established that upon the completion of the DPR demonstration period in Colorado Springs, the trailer ownership will transfer to Mines, who will then partner with other water providers to further demonstrate how DPR may be implemented with their unique water sources, which may ultimately lead to building of new, more efficient water supply infrastructure. During Phase I we also partnered with technology providers, national labs, and other universities to study enhanced water recovery, reduced energy costs, and optimization of unit processes utilization.

With this proposal we aim to act on this planned vision by partnering with small and large utilities across the Front Range in helping communities educate their residents and regulators on the role and benefits of DPR, now and into the future. With the support of business and economics professors at Mines, results from this project will help water utilities understand the costs and implications of adopting DPR strategies to create new drinking water supplies.

This proposal builds upon the investment already made by CWCB, Colorado Springs Utilities, and Mines in the mobile demonstration lab and all of the education materials developed for the mobile DPR demonstration in Phase I.

Section 10.2 – Measurable Objectives and Adaptive Management (pp. 10-5 and 10-7)

1. *"B. Conservation: Colorado's Water Plan sets a measurable objective to achieve 400,000 acre-feet of municipal and industrial water conservation by 2050.*

2. *"H. Education, Outreach and Innovation: Colorado's Water Plan sets a measurable objective to significantly improve the level of public awareness and engagement regarding water issues statewide by 2020, as determined by water awareness surveys." "Colorado's Water Plan will expand outreach and education efforts that engage the public to promote well informed community discourse and decision making regarding balanced water solutions."*

As stated previously the intent of the Mines and its DPR demonstration project partners is to educate multiple stakeholder groups on the viability of DPR as a conservation measure and a way for water providers to maximize the use of fully consumable water supplies, while also filling critical research gaps around DPR in Colorado. Over the summer and fall of 2021, Phase I of the project, we have conducted a major public education campaign in which we have demonstrated that more than half a million gallons of treated wastewater water could be converted into drinkable water. In Phase I the mobile DPR lab has been leveraged for the following public engagement:

- 49 tours in the DPR lab
- 945 people attending (85% of them tasted the purified water),
- 3 community events in which we served 760 soda tastings (soda made of the reclaimed water),
- 4 public presentations with 101 public attendees,
- 11 school and college tours
- 2 media events
- 10+ media stories and 2 videos.

Section 10.3 – Critical Goals and Actions (p. 10-14)

1. "Encourage Reuse: Encourage the development of reuse solutions to maximize fully consumable water supplies.

See section 10.2.

<u>Statewide Water Supply Initiative (2010)</u>

Section 8 – Recommendations (p. 8-1)

1. *"Support meeting Colorado's non-consumptive water needs by working with Colorado's water stakeholders to help: (1) Protect or enhance environmental and recreational values that benefit local and statewide economies; and (2) Encourage multi-purpose projects that benefit both water users and native species."*

The intent of this project is to initiate, and in some cases, continue the discussion of DPR as an alternative potable water source. DPR by design leaves water in natural systems, with potential use for non-consumptive water needs. Multiple stakeholders will be involved as the mobile DPR lab moves between utilities/communities, so each entity using and demonstrating the lab would have the opportunity to involve stakeholders specific to their area.

2. *"Actively encourage projects to address multiple purposes, including municipal, industrial, environmental, recreational, agricultural, risk management, and compact compliance needs."*

Although this project is a demonstration rather than a full implementation of DPR, it provides an excellent opportunity to illustrate the potential benefits and viability of DPR for a broad range of regional stakeholders. Mines and its partners believe that this outreach will lead to heightened awareness and acceptance of the technology, helping to pave the way for future DPR implementation both locally and statewide.

DPR can help address municipal, industrial, environmental, recreational, and risk management needs simultaneously. The water produced by this process can meet all state and federal drinking water regulations and is consequently suited for municipal potable use. Furthermore, due to its unique design, this DPR paradigm can produce water for other uses at slightly lower quality and at reduced cost, demonstrating a flexible multi-purpose use of a single infrastructure.

DPR can be a cost and operationally effective means to utilize reusable water supplies and can reduce the amount of water that must be supplied from other water sources to meet demands. It can also reduce water supply risks during challenging hydrologic cycles, providing a higher level of water supply security. For Mines and its partners, this means a more efficient use of regional water supplies can be achieved, if DPR is implemented, generally allowing for reduced transmission and demand of regional water supplies. This provides the environmental benefits of reduced energy consumption as well as increased habitat for aquatic species and the recreational benefit of a decreased risk for boat ramp closures due to low water levels (as was the case with Rampart Reservoir in 2018). Finally, DPR can provide a stabilizing effect to utilities water portfolios, helping to mitigate risk.

3. *"Identify and utilize existing and new funding opportunities to assist in implementing projects and methods to meet Colorado's consumptive and non-consumptive water supply needs."*

It's intended that a significant portion of the project cost will be funded by one or more grants, which occured in Phase I (e.g., National Science Foundation, Water Reuse Colorado, etc.). In this case Mines will be able to leverage funds from a Department of Energy grant that is investigating Machine Learning of water systems, with the DPR trailer being a major focus of that project. In addition, Mines and its partners will leverage existing relationships and potentially build new relationships with entities interested in providing funding and/or in-kind support to this project (e.g., technology providers such as Hach (a Colorado entity), national labs (e.g., NREL, ORNL), and industrial entities that will test the DPR lab in their facilities (e.g., Ball, Coors)).

4. *"Evaluate multi-purpose projects or packages of projects to develop new water supplies for use on the West Slope and Front Range."*

The implementation of DPR can serve as an alternative to development of new water supply projects meeting municipal, industrial, environmental, and risk mitigation needs as described in Item 2. The mobile nature of the DPR demonstration lab will allow it to be used across the state of Colorado, as proposed here.

5. *"Help safeguard Colorado's water supply during times of drought by incorporating drought mitigation and response in statewide and local water supply planning."*

The majority of Colorado's population is on the east slope (Front Range), and many of them rely on water transferred from the west slope of the continental divide. To harden water supplies against severe drought, communities on the east slope will have to rely on reuse infrastructure, most of which currently does not exist. The mobile DPR demonstration helps to inform multiple water utilities and policymakers throughout Colorado on the benefits associated with implementing DPR, especially during times of drought. DPR will decrease utilities' dependence on withdrawing water from traditional sources such as aquifers or reservoirs and transmountain diversion. Especially during drought or wildfire conditions, reduction in withdrawals can mitigate water quality changes and operational challenges due to low water levels in aquifers and reservoirs.

6. *"Support local water supply planning."*

This phase of the project build on Phase I and will continue to help support local water supply planning for partner utilities as well as throughout Colorado. Water providers stand to benefit from DPR in a variety of ways and may be interested in the demonstrated technology for different reasons.

The education and outreach opportunities that this mobile demonstration unit offers should serve to increase public acceptance of DPR. With this acceptance, water providers throughout the state should have an easier time incorporating DPR into future water supply planning.

Arkansas BRT Basin Implementation Plan (April 2015) and South Platte Implementation Plan (April 2015)

Section 1.6.2.1 (Arkansas)– Goals (p. 14)

1. *"Meet the municipal supply gap in each county within the basin"*
2. *"Support regional infrastructure development for cost effective solutions to local water supply gaps"*

Assuming that water rights are met, gaps in water supplies can be bridged with enhanced reuse of water. While water nonpotable reuse has been practiced in Colorado for decades, indirect potable reuse is much less common (Aurora Water is the most notable utility indirect potable reuse system). For efficient use of funding for infrastructure development and improvements, piloting of DPR is needed in multiple locations, for different types and sources of water. Our DPR mobile lab can help communities in various basins to evaluate existing and novel technologies time to help them with the planning and design processes before investing many millions of dollars in projects to secure new water resources. This mobile approach is the most efficient way to leverage invested funds to benefit numerous utilities.

Section 1. (South Platte) - Goals and Outcomes (p. 1-9, p. 1-20)

1. "*...seek to tap Colorado collaboration and innovation in addressing our water challenges"*
2. *"Our vision for meeting the east slow municipal supply gap is statewide support for: 1. Reaching enhanced levels of municipal conservation and reuse..."*

Specifically, Mines and its proposal partners seek to demonstrate the technical and economical feasibility, and educate multiple stakeholders on the viability of repurposing treated/reclaimed water for additional consumptive use and to close a potential future supply gap. The DPR mobile lab will be achieving the Phase I goal of moving to other utilities and regions around Colorado's front range. The role of reuse in both Basin plans is clear, that reuse must play a role in meeting future demands, and this project aims to help lay that foundation with education and research utilizing the DPR mobile lab. Additionally, the mobile lab will also investigate the technical feasibility of using mixed treated wastewater effluents and even industrial wastewater, providing unique locations and impaired waters to evaluate the DPR unit processes.

Section 3.1.6.1 – [Arkansas River Basin] Constraints (p. 108)

1. *"The Arkansas River Basin is highly over-appropriated due to unmet demands of senior water rights and the Compact. Therefore, new water projects are not feasible because the yield of existing conditional or new water rights would be very limited. The unmet demands for both municipal and agricultural future demands will have to be met from better management of existing supplies including reuse of transbasin water supplies to the maximum potential along with consideration of new transbasin diversions from an IBCC approved project."*

and… ***Section 3. - [South Platte River Basin] Challenges and Opportunities (p. 3-1)***

1. *"Key points... -Needs for water in the South Platte Basin have long exceeded the native water supplies of the South Platte and Republican river systems. - Limitations on additional water reuse. -Vulnerability to water service disruptions."*
2. *"The South Platte is fully appropriated - any remaining water is available during spring runoff in wetter-than average years.."*

Full-scale DPR would directly address these constraints by reusing legally-reusable water, a substantial portion originating from transbasin water supplies, to maximize the potential "use to extinction" criteria of the transferred water. Maximizing efficiency of transbasin water use is key. This small-scale DPR demonstration project will help Colorado utilities to evaluate the feasibility and benefits of future full-scale implementation with their source waters and patrons; providing critical education and research needed to plan for full-scale DPR projects in the future.

Section 3.1.6.2 – [Arkansas River Basin] Opportunities (p. 109)

1. *Additional water management programs may be feasible to increase the use of reusable water sources. These programs need to be carefully evaluated using the best water resources engineering and modeling available to determine feasibility.*

and… ***Section 3. - [South Platte River Basin] Challenges and Opportunities (p. 3-1) and Projects and Methods (p.4-27)***

1. *"….the limited native water supply to serve future needs is a constraint in identifying projects and methods that are easy to implement, but it also serves as an opportunity to drive water use efficiency and collaboration among water supply agencies"*
2. *Potable Reuse "Promoting and monitoring research of non-RO treatment of recycling water suitable for DPR."*

Although the primary objective of Phase II of the project is to educate stakeholders, including water/wastewater treatment operators, on the feasibility of DPR, the mobile lab was designed with flexibility in-mind, allowing for alternative configurations to help facilitate research of the overall process and its individual steps. This flexibility will help provide proof of concept research, and the role of each unit process, while demonstrating the potential of the process and its contribution to regional water supply and resiliency.

<u>Arkansas BRT Education Action Plan (Work Years 2016-2019)</u>

The Arkansas River Basin PEPO workgroup has stated that; "Our goal is to inform, involve, and educate the citizens of the Arkansas River Basin about local water resources."

Section 3. - [South Platte River Basin] Challenges and Opportunities (p. 4-27)

1. *"Improving public understanding of advantages of potable reuse"*

The design of the mobile demonstration DPR lab had a long-term investment strategy in mind and carefully considered urban and rural communities and water providers statewide. The DPR mobile lab allows Mines, its partners, and water providers to initially test DPR and address specific messaging in their

service areas. The mobile lab allows water providers the ability to engage and educate the public and other stakeholders in a small group setting in a variety of manners: viewing active treatment during the demonstration, observation of treatment processes when not treating in unique settings, such as community events, or travel of participants to schools for educational interactions with students.

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.

RECENT STUDIES (Mines involved as stakeholder)

- Current project (Phase I), in which the mobile demonstration lab was designed, constructed, and deployed at the JD Phillip wastewater reclamation plant in Colorado Springs (continuously operating since June 2021).
- PureWater Colorado project (2018 demonstration hosted by Denver Water)
- WateReuse Colorado DPR projects (Phases 1, 2, and 3)

The listed studies address water supply, water treatment and reuse, and management issues. This includes efficiencies, planning watershed protection, and addressing future/current impacts of climate change.

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.

Colorado School of Mines

1. Colorado Springs Utilities (Colorado School of Mines is a co-PI)
2. 2020 Direct Potable Reuse (DPR) Demonstration (total: $835,374, CWCB share: $350,000)
3. N/A
4. November 2019
5. N/A (maybe #PSKGWVXC0D5HS4v1)
6. 42%

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

Last Updated: May 2021

Submittal Checklist	
X	I acknowledge the Grantee will be able to contract with CWCB using the Standard Contract.
X	Statement of Work(1)
X	Budget & Schedule(1)
NA	Engineer's statement of probable cost (projects over $100,000)
X	Letters of Matching and/or Pending 3rd Party Commitments(1) **Colorado School of Mines**
NA	Map (if applicable)(1)
NA	Photos/Drawings/Reports
NA	Letters of Support (Optional)
X	Certificate of Insurance (General, Auto, & Workers' Comp.) (2)
NA	Certificate of Good Standing with Colorado Secretary of State(2)
X	W-9(2)
NA	Independent Contractor Form(2) (If applicant is individual, not company/organization)
Water Sharing Agreements and Alternative Transfer Methods ONLY	
NA	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)?
In a current project funded by CWCB, we have designed, constructed, and deployed a mobile lab (in a 35' long customized cargo trailer) to demonstrate proven and future water treatment technologies to enable direct potable reuse (DPR) of reclaimed water -- methods to secure drinking water for Colorado, enable population and economic growth, and provide testbed to demonstrate drought-proof water infrastructure. The next Phase of this study, for which we are seeking funding from CWCB, will enable communities in Colorado to deploy the mobile lab in their water/wastewater treatment facilities and demonstrate for an extended time the feasibility and viability of DPR for the specific community.

Project goals include:

- Build upon CWCBs initial investment in the mobile lab, to help achieve the Colorado Water Plan, Basin Implementation Plan, and help CDPHEs DPR regulatory rule making with continued education and research.
- Leverage CWCB funds to support the Mines effort of continued operation of the mobile lab at various utilities. These funds will be used to maintain the mobile lab, fund students/staff for start-up and operations at new locations, oversight of research, analysis of water quality samples, community

outreach efforts, and provide support to Carollo Engineers for assistance with education, outreach, and technical support.

- Develop an industry-academia program between Mines, Carollo, water utilities, and other universities in Colorado to explore new technologies for water treatment and potable water reuse, enhance data science integration into water reclamation and reuse, and improve our understanding of optimizing DPR treatment trains and the removal of contaminants of public health concern.
- Use as a sensory tool for DPR education and outreach to the public, utilities' employees and leadership, and regulator and government groups.

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

- Communities' decision makers, general public/ratepayers, and students (to include college, high school, middle school, and 4th-5th grade elementary school students).
- Decision/policy makers – invitation only. Tours to include water tastings
- General public/ratepayers – a beverage contest featuring local businesses. Mines and the utility partners will also be either transporting the mobile unit (post production) and/or setting up booths at community events. Events may include local and regional conferences, professional workshops, utility open-house, etc.)
- School outreach will be conducted through participating utilities, with assistance from Mines students, by an already developed teacher/education outreach programs.

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?

- Mines has entered into cooperative discussions with a number of front range utilities that include Aurora Water, Castle Rock, Dominion, South Platte Renew, Fort Collins, and potentially Denver Water. Mines is also engaged in discussions with industry partners such as Bal Industries and Hach. For the utilities, this project will provide education and outreach on DPR, and for Mines it allows students/faculty to participate in a unique pilot DPR research opportunities, providing both entities the chance to leverage professional contacts and/or build new contacts and utilize a sustainable resource for other water providers within the state to use.
- Currently project partners are Mines, Carollo, a list of utilities provided above, with pending partners including Aqua Aerobic Systems and WateReuse Colorado. Additionally, Mines and the partner utilities have and will be reaching out to local key partners for letters of support. Mines also has plans to work closely with the beverage industry(s) in beverage contests, which would be part of the project scope for each utility.
- Existing funding partners that have already committed funding to support research activities around the mobile DPR lab include:
  - DOE/NAWI (National Alliance for Water Innovation): committed funding to support research on advanced control systems for autonomous water treatment systems
  - NSF/HDR-Mo(Wa)^{2}TER (Modernizing Water and Wastewater Treatment through Data Science Education and Research): enhanced data science education for student and professional engineers
- Proposal under review:
  - EPA: National Priorities: Water Innovation, Science, and Engagement to Advance Water Reuse: Unlocking the Nationwide Potential of Water Reuse (WRF lead)

- EPA: National Priorities: Water Innovation, Science, and Engagement to Advance Water Reuse: Reinventing the Nation's Urban Water Reuse Systems (ReNUWeRs) (UC Berkeley lead)

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

- Continuous and autonomous operation of the mobile lab: we would strive to continue operating the mobile lab continuously for at least 30 between maintenance stops.
- Target water quality and removal of regulated and unregulated contaminants: water quality that meets federal and local quality levels at least 90% of the time.
- Achieving higher than 90% water recover during continuous operation
- Surveys will be conducted before and after community events and group visits to the DPR lab. A post project survey will also be conducted to compare public knowledge and potential shift in acceptance.
- Demonstration outreach numbers will also be tracked (in some cases estimated) to evaluate success of event participations.
- Involvement of operators and utility personnel: the ability of local operators to learn and operate the system will be measured and results will be used to update and improve SOPs and deployment procedures at the next site.

What research, evidence, and data support your project?

- PureWater Colorado demonstration project and the ongoing DPR demonstration in Colorado Springs
- WateReuse Colorado Advancing Direct Potable Reuse to Optimize Water Supplies and Meet Future Demands
  - Technical Memorandum 1 Development of Direct Potable Reuse Regulation in Colorado
  - Technical Memorandum 2 Communications and Outreach Plan for Direct Potable Reuse in Colorado
  - Technical Memorandum 3 Potable Reuse Planning Tools and Case Studies
- WRCO "Colorado Guidelines for Direct Potable Reuse" project (released Dec 2019)
- Numerous published AWWA, WEF and WRA reports, studies and projects support this project

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

Short term:

- Obtaining firm commitments from potential partners
- Ensuring that all prerequisite agreements are in place to ultimately fulfill project goals.
- Continuous operation during severe winter conditions. That said, the mobile lab was designed to operate in cold temperatures.

Long term:

- Ensuring that utilities are able to engage the community in a manner that maximizes education and outreach.

The overall biggest challenge this project faces is the limited funding available from individual utilities and Mines, this project must receive grant monies to make it viable.

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 being designed to be a sensory tool to educate project visitors in water reuse, specifically DPR. The project will include water tastings and product development using the DPR water (e.g., water, beer, and soda). Additionally, informational materials will be developed for both student education and public information. YouTube videos will be included in the outreach package to have a wider public outreach, with many already available from Phase I, as listed below: Colorado School of Mines: https://www.youtube.com/watch?v=M2c2cpNAUf0 Colorado Springs: PureWater Colorado: recycling water to drinking water standards Carollo: https://www.youtube.com/watch?v=xosC9jAimMM
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 addresses the supply/demand gap by addressing replacement of non-sustainable groundwater sources with the reuse of the sustainable surface water source. Outreach materials will include discussions on good water habits (conservation) and how the use of the right water for the right use must become part of water conversation.
Describe how the project achieves the education, outreach, and public engagement goals set forth in the applicable Basin Implementation Plan(s).
(Intentionally left blank as per instructions. BIP does not directly address engagement activities..)
Describe how the project achieves the basin roundtable's PEPO Education Action Plans.
The mobile DPR lab was carefully designed with considerations around the needs of surrounding communities and water providers statewide. This mobile unit will allow other utilities and water providers to initially test DPR and associated messaging in their service areas. The mobile unit allows water utilities/providers the ability to engage and educate the public and other stakeholders in a variety of manners; viewing active treatment in the demonstration, observation of treatment processes when not treating in unique settings, such as community events, or potentially even travel to schools for student interaction.

Innovation Track
Describe how the project enhances water innovation efforts and supports a water innovation ecosystem in Colorado.

The mobile lab was equipped with treatment technologies that are not commonly installed in wastewater treatment plants in Colorado. We also installed numerous, novel water quality sensors that help collect continuous information on the performance and efficiency of the process to transform reclaimed water to drinkable water.

In Phase II of the project we will engage with additional companies and researchers in Colorado and beyond to test new treatment and monitoring technologies. These include, for example, new disinfection and oxidation technologies such as UV-LED, new water quality sensors , reverse osmosis purification comparison to the current non-RO DPR, and more. We will also utilize analytical tools to improve biological processes and optimize /minimize the use of chemicals in the process.

Describe how the project engages/leverages Colorado's innovation community to help solve our state's water challenges.

The project team will collaborate with the following entities:

- CU Boulder on new oxidation processes
- CDPHE on developing DPR regulations
- Hach on developing and implementing new water quality sensors
- Oak Ridge National Lab and Baylor University on development of new advanced control systems and integration of machine learning
- Brewer Science on developing new water quality sensors (nitrate, lead)

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?

In 2019, TAP-IN Colorado migrated to The Water Connection, the water resources and policy arm of The Greenway Foundation (TGF). TGF advances a sustainable water future, focusing primarily on Colorado and the western United States. TGF protects and revitalizes watersheds, promotes water stewardship, champions environmental education, and stimulates innovative policies and practices. All of these objectives well-aligned with the objectives of our DPR demonstration project, which explores innovative approaches to reclaim and reuse high-quality water, preparing small and large communities in Colorado to be ready with water sources and solutions during drought years.

Describe how this project impacts current or emerging trends; technologies; clusters, sectors, or groups in water innovation.

Colorado is among very few states in the US (and around the world) to adopt potable reuse, to secure water for the future (Aurora Water, The Prairie Waters project). While Aurora Water adopted full scale adoption of indirect potable reuse (IPR), both Denver Water and Colorado Springs Utilities were pioneers in piloting and demonstrating direct potable reuse (DPR). Our mobile DPR demonstration lab ensures that every community in Colorado can evaluate DPR and every company (and especially Colorado businesses) can use the mobile DPR lab to test new technologies. We will enable continuous operation of the mobile lab to enable these opportunities, while demonstrating to the public that DPR is viable, feasible, and sustainable.

Last Updated: May 2021

Colorado Water Conservation Board
Water Plan Grant - Exhibit A

Statement Of Work	
Date:	**12/1/21**
Name of Grantee:	**Colorado School of Mines**
Name of Water Project:	**Direct Potable Reuse (DPR) Demonstration, Phase II**
Funding Source:	**CWCB Water Plan Grant, Colorado School of Mines and Partner Utilities**

Water Project Overview:

Mines aims to continue the Direct Potable Reuse Demonstration project around the state with the primary objective of educating our community, customers, staff, leadership and government officials on not only the viability but the potential financial, resiliency, and environmental benefits of direct potable reuse (DPR). For example, in the first phase of the study (ongoing and tested in Colorado Springs) we are testing the applicability of DPR for Colorado Springs Utilities (CSUt). And while Utilities does not believe that DPR in Colorado Springs is imminent, they do believe and prepare for it to be a likely component of their long-term strategy for efficient and cost-effective use of their reusable water supplies. The proposed project will allow us to explore and better understand the potential benefits and constraints of DPR, including but not limited to:

- Raw water quality for potable treatment
- Potable water quality
- Reduced conveyance pumping and associated energy consumption
- Reduced conveyance infrastructure
- Reduced transit losses
- Presence of emerging contaminants and the ability of the DPR treatment train to continuously remove them

Mines, in partnership with CSUt and Carollo Engineers designed and built a mobile treatment unit to demonstrate proven technologies associated with DPR using secondary treated wastewater. The proposed Phase II project will allow more communities in Colorado to contribute to the long-term advancement of DPR research and technologies by improving the mobile, reusable asset that CWCB has invested in, further investigating site/utility specific viability and benefits of DPR. The mobile DPR treatment system has been operating continuously for 5 months (since early July 2021) at an average rate of 5 gallons per minute, with a flexible treatment train that includes (1) ozonation, (2) biologically active filtration (BAF), (3) microfiltration (with a novel ceramic membrane), (4) granular activated carbon, (5) ultraviolet (UV) with advanced oxidation (AOP), and (6) chlorination. During this proposed Phase II of the study we will use CWCB and cost sharing funds to further improve these technologies, optimize them (energy, chemical use, biological performance) and test new treatment technologies and water quality sensors to advance the autonomous capabilities of such systems. While not yet finalized, we will strive to include small and rural communities in the testing plans, ensuring that underserved communities can have clean and safe water for future generations.

Last Updated: May 2021

Project Objectives:

Project goals include:

- Building upon the Colorado Springs DPR demonstration and PureWater Colorado's momentum to continue the advancement of DPR and associated technologies, we will continue to operate and test the mobile DPR lab in diverse locations and source waters
- Optimise existing water treatment technologies in the mobile DPR lab
- Test new treatment and sensor technologies in the mobile DPR lab
- Build a mutually beneficial relationship with front range and Arkansas basin utilities, and use the DPR lab as a sensory tool for DPR education and outreach to public, employee/leadership, and regulator/ government groups.
- Create numerous local DPR "conversations" by hosting and participating in various community events around the DPR trailer's location.
- Provide a resource for other entities investigating DPR viability for individual/regional water systems.

The original vision of Colorado Springs Utilities and Mines was that the mobile unit will benefit other entities interested in exploring DPR as a supply alternative. This vision is currently ongoing in the Springs and has demonstrated the benefits of strong utility-academia relationships, the strength of right and customize messaging for advanced water reuse, and the benefits of focused operator training on processes for specific target water quality.

Tasks

Task 1 – General Project Management

Description of Task:

Provide general oversight and coordination of tasks between all parties for the timely completion of the proposed Phase II DPR demonstration project.

General

- Prepare and submit a brief project plan and baseline schedule for review and approval by the first utility to host the mobile DPR lab (AUrora Water, Sand Creek Water Reclamation Plant) for Direct Potable Reuse Demonstration Engineering Design and Operations Support Services within fifteen (15) business days of Notice to Proceed (NTP). The baseline schedule shall meet the requirements set forth in Exhibit A - Attachment A3 Schedule Requirements.
- Provide monthly updates of project progress, schedule, and budget reports for services and activities. Provide monthly cash flow projection submittals for budgeting purposes. Projections must be re- forecast with each monthly submittal. Schedule reports shall be prepared in accordance with Exhibit A - Attachment A3 Schedule Requirements.
- Develop a communication plan to coordinate and communicate with project team members.
- Prepare a project quality management plan detailing quality assurance (QA) and quality control (QC) processes and procedures to be used throughout the entire lifecycle of the project.
- Organize and facilitate an Initial Project Meeting/Kickoff with appropriate test sites representatives to review project requirements, and establish roles and responsibilities for each project component/site.
- Submit all project deliverables, contract administration documents (invoices, amendments, meeting agendas, meeting minutes, etc.) and all project correspondence through the Colorado School of Mines' reporting system.
- Prepare a comprehensive list of deliverables and submittals with scheduled submission dates.
- Organize and conduct deliverable review meetings as necessary to facilitate Mines deliverable review and approval.
- Prepare monthly invoices in accordance with the agreement terms and conditions for the project.

Last Updated: May 2021

Method/Procedure:

Mines will be responsible for the overall project management of the DPR demonstration. Mines staff will manage the project in accordance with the applicable portions of its standardized project management practice.

Mines and its partner utilities will be engaging with Carollo as our third-party engineering firm for operational support services for the mobile lab.

We will use knowledge, skills, tools, and techniques to meet or exceed the needs and expectations of partner utilities for this project.

Deliverables:

The project shall include, but is not limited to, the deliverable items outlined below.

Electronic Files: Spatial data files must be compatible with ESRI ArcGIS standards for retrieval purposes. Map and drawing files shall be completed in SolidWorks with electronic copies provided in AutoCAD format in addition to searchable PDF files. All drawings files shall be modeled in 3D. Text and spreadsheet files shall be completed in Microsoft Word and Excel respectively, with electronic copies provided in Word/Excel format in addition to searchable PDF files. Input and output files for any engineering software used in the analysis must also be provided in addition to searchable PDF files of the results. All electronic files and project documents will be managed within a Google Docs folder system.

Project Plan and Schedule: Provide one (1) electronic copy of the overall project plan and schedule, including a work breakdown with corresponding dates and milestones and cash flow projections within thirty (30) calendar days of Notice to Proceed (NTP). Include all of the tasks and subtasks included in Exhibit A – Statement of Work Attachments A and B. Prepare a detailed Critical Path Method (CPM) schedule for the project. The schedule shall specify the proposed start and finish dates along with total float for each activity for all phases of the work.

Monthly Status and Schedule Updates and Cash Flow Projections: Provide monthly updates of project progress, schedule, budget reports, and cash flow projections throughout the life of the project. Provide one (1) electronic copy on or before the 5th day of each month.

Project Quality Management Plan: At the beginning of the project, provide one (1) electronic copy of the overall project quality management plan.

Project Health and Safety Plan: At the beginning of the project, provide one (1) electronic copy of the overall project health and safety plan for field activities.

Meeting Agendas and Minutes: Meetings must be scheduled at least two (2) weeks in advance to ensure availability of required Mines, Carollo, and partner utility personnel and appropriate meeting space. Organize and facilitate meetings with appropriate Mines, Carollo, and the specific utility representatives. Provide draft agenda to project distribution list at least two (2) days prior to scheduled meetings. Provide sufficient physical copies of meeting agenda for face-to-face meetings for anticipated attendees. Submit electronic copies of minutes to all attendees within five (5) days of meeting.

List of Deliverables: At the beginning of the project, provide one (1) electronic copy of the deliverable list. Provide monthly updates in electronic format throughout the life of the project.

Invoices and Payment Applications: Submit monthly payment applications on or before the 5th day of each month. Provide two (2) physical copies and one (1) electronic copy.

Last Updated: May 2021

Tasks
Task 2 – Operation
Description of Task:
Following the successful demonstration of the mobile lab in Colorado Spring, the mobile DPR demonstration system will be deployed at several Colorado utilities to demonstrate DPR of their reclaimed water. The mobile DPRlab will be first deployed at the Sand Creek Wastewater Reclamation Plant (Aurora Water) in April 2022, and will be operated there for 6 months. Following this deployment, the mobile lab will be deployed at other facilities for testing for at least 4 months per location. At this time, committed utilities include Aurora Water, Castle Rock Water (Plum Creek Wastewater Authority), South Platte Renew, Dominion Water & Sanitation District, and Ball Industries). Expected completion of Phase II of the project is on 3/31/2024.
Method/Procedure:

The following sections provide further detail for the operational tasks and activities including proposed responsibilities:
 	
Demonstration Site Set up and Administration – Each partner utility will provide a site for the proposed demonstration operational period. Site provisions will include electricity (2x 120V/100A), effluent from a secondary or tertiary wastewater treatment plant to feed the mobile lab, appropriate mobile lab effluent management, and and internet connection. Provisions will also include the utility's standard site security and appropriate access controls.
 	
Mobile Lab Operations – the utility will provide staff to assist with operating the mobile demonstration lab for the planned operating period, with technical support from a contract engineering consulting firm (Carollo Engineers) and Mines. A graduate student and Mines faculty will be responsible for the management of the research component and will assist with public events.
 	
Sampling and Analysis – Mines in collaboration with staff from the hosting utility will prepare an overall project Sampling and Analysis Plan to inform and document compliance, as well as performance evaluation sampling and analysis requirements for the project. The hosting utility will provide staff, equipment, and laboratory analysis for all Colorado Department of Public Health and Environment (CDPHE) required operating period compliance sampling and analysis.
 	
The hosting utility and Mines will provide staff, equipment, and laboratory analysis for evaluating and investigating demonstration lab performance during commissioning and start-up activities and throughout the operational period as coordinated and agreed to with Mines.
 	
Mobile Unit Decommissioning – Upon completion of the planned demonstration period, the hosting utility , in collaboration with Mines, will decommission (shut down, drain and clean) the mobile lab and prepare it for transport to the next hosting/testing location.
 	
The following excerpt from the Engineering Support Services Statement of Work (SOW) defines the third-party (Carollo) engineer's operation task requirements:
 	
<u>Commissioning and Start-up</u>
 	
• Prepare a *Commissioning and Start-up (C&S) Plan* that includes the following elements:
  ○ Commissioning plan that includes all Components, Devices, and Equipment specified in the Final Design. The commissioning plan shall define and sequence any installation and functional testing required for each Device, Component, and piece of Equipment as specified in the Final Design.
  ○ Start-up plan includes the following:
  ▪ Pre-start-up activities including but not limited to:
  • Start-up sequence review
  • Temporary testing arrangement finalization
  • Start-up testing including but not limited to:
  • System testing with water (no treatment)
  • Control system tuning

- Start-up
- Global control testing

- Performance testing including but not limited to:
  - Performance tests that cannot be performed during the commissioning work element
  - Process performance tests to prove mobile unit performance
  - Detailed schedule of commissioning and start-up activities that includes durations, and sequencing requirements with the following activities identified:
    - Manufacturer's services (purchased equipment only)
    - Certificates of Proper Installation (purchased equipment only)
    - Operator training
    - Submission of Operation and Maintenance Manual (purchased equipment only)
    - Installation testing (as specified in Final Design)
    - Functional testing (as specified in Final Design)
    - Pre-Start-Up activities
    - Start-Up testing
    - Performance testing (as specified in Final Design)
    - Operational testing (as specified in Final Design)
- Testing and witness forms required to properly document the performance of required tests demonstrating individual unit functionality and performance to complete system functionality and performance.
- Testing plan with test logs and forms for each Component, Device, Equipment, Subsystem and each System when specified. Include testing of alarms, interlocks, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

- Hazardous Materials Management Plan (HMMP) – plan for how any commissioning and start-up and/or long term operations hazardous materials will be managed to comply with regulatory, code, and the hosting utility safety requirements
- Hazardous Materials Inventory Statement (HMIS) – a list of any commissioning and start- up and/or long term operations hazardous materials that will be used on site. Any waste generated from the demonstration will be handled appropriately.
- Provision of training and informational resources necessary for operations staff to operate the mobile unit.
- Operations Period Engineering Support

Deliverable:

Hosting utility and Mines:
- Sampling and analysis plan
- Demonstration summary report third-party engineer:
  - Start-up and Commissioning Plan: Provide one (1) electronic copy of the Start-up and Commissioning Plan.
  - Operator Training Material: Provide one (1) electronic copy of the Operator Training Material

Last Updated: May 2021

Tasks
Task 3 – Optimization and Research of New Treatment Technologies
Description of Task:
Over the first year of the DPR demonstration, Mines, Colorado Springs Utilities, and Carollo Engineers have deployed the mobile lab and started operating it in mid June 2021. Over the last 5 months we made several modifications to the system to enable continuous, 24/7 operation, we fine-tuned and upgraded the control system, we installed and calibrated numerous water quality sensors, and we started monitoring and analyzing the plentiful data generated in the mobile lab to identify areas that need additional research and optimization. Under Task 3 we will optimize individual unit processes to both increase performance and reduce energy and other operating costs. We will also focus our efforts on maximizing water recovery of individual processes and the overall system. We will also upgrade the ceramic microfiltration system to enable operating with a variable speed feed pump, which will enable reduction in energy cost and increase in water recovery and the sustainability of the process (less chemicals and membrane fouling). We will also test new treatment technologies that can better suit water sources of specific utilities. These include, but not limited to, testing of ion exchange columns for removal of nitrate and other specific contaminants (metals, radionuclides, PFAS, etc.), reverse osmosis and nanofiltration for the removal of salts and low molecular weight organic compounds, and UV-LED as a replacement to currently used medium pressure mercury lamps. In addition, and in collaboration with the industry, we will test new and novel in-line water quality sensors that will enable improved control of the treatment train, and support our DOE effort on machine learning for autonomous operation of water treatment systems.
Method/Procedure:
Optimization of ozone delivery and dosing - ozonation is the first process in the treatment train and it is used to oxidize and break down organic compounds, and especially recalcitrant organic micropollutants before biological treatment in biologically active filters (BAF). In the next year we will optimize dosing of ozone to reduce energy demand, reduce production of disinfection byproducts, and optimize ozone utilization in the BAF columns. Optimization of BAF performance - BAF is the second and more sensitive process in the treatment train. Cultivating the microorganisms and ensuring that they have the best conditions to oxidize and remove organic contaminants is critical to downstream processes and to the overall quality of the finished water. We will explore operating conditions that promote biological activity and simultaneous adsorption in the BAF columns, alongside techniques to regenerate the adsorption capacity of the BAF columns on the fly. Optimization of the ceramic microfiltration (MF) system - MF is the third process in the treatment train and responsible for removing any solids and microorganisms from migrating into the activated carbon columns or other downstream processes. The MF system requires frequent backwashing and constant chemical feeding (coagulants); therefore, it is one of the larger contributors to the lower water recovery of the entire system. We will explore techniques to increase filter runs and the time between backwashing. This will be done through optimization of coagulant dose and simultaneous hydraulic conditions. Optimization of granular activated carbon (GAC) adsorption - GAC is the fourth process in the train and responsible for adsorption and removal of organic micropollutants that were able to escape the upstream processes. We will explore different GAC products and their ability and efficiency to remove emerging contaminants of concern (PFAS, 1-4 dioxin, etc.). We will also explore mixed media in the GAC columns to include ion exchange for removal of nitrate and radionuclides. Optimization of UV/AOP - the fifth process in the train is UV/AOP oxidation. It is responsible for final destruction of any micropollutants that escaped upstream treatment. We will explore optimization of UV dose and UV sources (UV-LED instead of UV from mercury lamps), to demonstrate reduced energy

consumption and improved contaminant destruction. We will also explore substitutes to peroxide as a source of oxidant.

In parallel to these optimizations, we will explore and test new and novel water quality sensors to enhance the datasets generated in real time by the DPR system and enhance the accuracy and reliability of existing sensors in the system.

We will also test additional treatment processes such as reverse osmosis (RO) or nanofiltration (NF) under a novel closed-circuit desalination (CCD) mode to explore and demonstrate very high water recovery of CCD-RO DPR vs. non-RO DPR.

Deliverable:

- Reports for each testing site will summarize the efficiency of each unit process to achieve the treatment goal for the specific water tested, and the overall ability of
  - Results will determine if any additional pretreatment is needed to achieve the treatment goal
  - Results will determine the most efficient operating conditions for each subsystem in the DPR train
  - Results will help develop techno-economic model for each location/water tested

Tasks

Task 4 – Outreach

Description of Task:

Performing multiple outreach activities during the planned operating period (April 2022 – April 2024) and post operation as deemed beneficial. Outreach initiatives will encompass programs for the public (including school programs), government officials, and industry personnel engagement.

Method/Procedure:

Mines, the collaborating utilities, and Carollo Engineers will collaborate to develop and provide a successful DPR outreach program based on the successful programs developed and executed by Colorado Springs Utilities during the summer of 2021.

Communications and Public Relations – Staff of the participating utilities, with support from Mines and Carollo, will be responsible for developing and distributing all project communications and promotional materials (written and oral, traditional and social media, and advertising)

Education and Outreach Events – Mines, Carollo and the participating utilities will be responsible for planning and executing all proposed outreach events including but not limited to:

- Public tours
- Private tours (government, City, and the participating utilities officials)
- Educational institution tours
- Community events “DPR booth”
- Beverage production contest(s)
- Beverage tasting event(s)
- Project presentation at water industry symposiums/conferences/workshops

Last Updated: May 2021

Deliverable:
Participating utilities: • Promotional materials • Survey results • Number of individuals reached (actual and/or estimated)

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 as part of the project documentation.

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 C. 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

Last Updated: May 2021

Dr. Tzahi Y. Cath, Professor
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ReNUWIt: http://urbanwatererc.org/

November 30, 2021

Re: Letter of Matching - DPR Demonstration Project Phase II

The Colorado Center for a Sustainable WE²ST at the Colorado School of Mines (Mines) is applying for funding from the Colorado Water Conservation Board (CWCB) to continue conducting a demonstration study of direct potable reuse (DPR) of reclaimed water.

Mines is a public teaching and research university in Colorado, devoted to engineering and applied science, with special expertise in the development and stewardship of the Earth's natural resources—water being a of them. The WE²ST Water Technology Hub is Mines' new research center focusing on industry-academia partnerships to promote research and development treatment and reuse of water in energy- and water-intensive industries. WE²ST was established to promote the joint sustainability of energy and water resources through education of energy-water literate graduate and undergraduate students, and by conducting world-class research on both the economic feasibility and community acceptance of water resource development reuse.

Mines will commit cost share for the proposed project in the estimated amount of $99,833 in cash contribution. This includes:

1.	Tzahi Cath, PI (8% AY effort)	$27,705
2.	Fringe benefits (40.6%* of 1)	$11,845
3.	Student support (ZOMA - CASH), Water Technology Hub (Denver)	$50,000
4.	Indirect costs (26% of 1 and 2)	$10,283
	TOTAL COST SHARE	$99,833

Mines will work collaboratively with committed Colorado water utilities to ensure that our goals are aligned with the goals of the award proposal, including efforts to track and report on outcomes. I believe that our support and commitment will significantly improve the impact that this project will have on increasing water reclamation and reuse in Colorado, thereby improving water sustainability in Colorado and reducing drought impacts on Colorado's communities, economy, and environment. We are looking forward to playing a major role and ensuring the success of this project.

Sincerely,

Dr. Tzahi Y. Cath

Tzahi Cath

Professor of Environmental Science & Engineering
Director, WE²ST Water Technology Hub
Director, Advanced Water Technology Center (AQWATEC)

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Colorado Water Conservation Board

Water Plan Grant - Exhibit C
Budget and Schedule

Prepared Date: November 30, 2021

Name of Applicant: Colorado School of Mines, Prof. Tzahi Cath

Name of Water Project: Direct Potable Reuse (DPR) Demonstration, Phase II

Project Start Date: April 1, 2022

Project End Date: March 31, 2024

Task No.	Task Description	Task Start Date	Task End Date	Grant Funding Request	Match Funding	Total
1	General Project Management	1-Apr-22	31-Mar-24	$63,000	$50,000	$113,000
2	Operation	1-Apr-22	31-Mar-24	$146,000	$300,000	$446,000
3	Optimization and Research of New Treatment Technol	1-Apr-22	31-Mar-24	$83,715	$7,833	$91,548
4	Public Outreach	1-Apr-22	31-Mar-24	$5,000	$12,000	$17,000
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
			Total	$297,715	$369,833	$667,548

PROPOSED BUDGET
April 2022 - March 31, 2024

		Year 1	Year 2	Total	Banner Codes
A.	SALARIES AND WAGES				
1.	Tzahi Cath, Co-PI - 1 summer days	4,549	4,686	9,235	5210
2.	James Rosenblum - Research Faculty - Co-PI - 0.25 months per year	7,725	7,957	15,682	5211
3.	Technician (Mike Veres) - 0.25 months per year	6,925	7,133	14,058	5211
4.	Technician (Nathan Rothe) - 1 month per year	0	0	0	5211
5.	Graduate Research Assts. @ $24,720/year	24,720	25,462	50,182	5214
6.	1 Undergraduate Research Assistant @ $25/hr.	4,000	4,000	8,000	5218
	Subtotal	$47,919	$49,237	$97,156	
B.	FRINGE BENEFITS				
1.	42.5%* of A1	$1,933	$2,015	$3,948	5130
2.	30.5%* of A2	2,356	2,467	4,823	5138
3.	42.2%* of A3	2,922	3,046	5,968	5138
4.	30.5%* of A4	0	0	0	
5.	GRA Tuition, fees & health insurance	22,677	23,130	45,807	5118
	Subtotal	$29,889	$30,657	$60,546	
C.	OTHER DIRECT COSTS				
1.	Expendable supplies	$5,000	$5,000	$10,000	5416P
2.	Travel - domestic	15,000	15,000	30,000	5501P
3.	Education Materials	1,500	1,500	3,000	5304
4.	Lab analysis	12,000	12,000	24,000	5306
5.	Lab use (Denver WE2ST)	0	0	0	
6.	Publications	0	0	0	5317
	Subtotal	$33,500	$33,500	$67,000	
D.	Subcontractors				
1.	Carollo Engineers	$10,000	$10,000	$20,000	5906
	Subtotal	$10,000	$10,000	$20,000	
E.	TOTAL DIRECT COSTS	$121,308	$123,394	$244,702	
F.	MODIFIED TOTAL DIRECT COSTS**	$88,631	$90,264	$178,895	
G.	INDIRECT COSTS - 26% of F	29,544	23,469	53,013	5985
H.	**TOTAL PROJECT COST (Line E + G)**	**$150,852**	**$146,863**	**$297,715**	

*Rates are increased .50 annually

**Line E not including B4 or D

I.	**COST SHARE**				
1	*Tzahi Cath, PI - 3% AY effort*	*13,648*	*14,057*	*27,705*	297,715
2	*Fringe benefits - 40.6%* of H1*	*5,800*	*6,045*	*11,845*	45,000
3	*Student suppo Water Technology Hub (Denver)*	*25,000*	*25,000*	*50,000*	45,000
4	*Indirect costs - 26% of I1 and I2)*	*5,056*	*5,226*	*10,283*	45,000
	TOTAL COST SHARE	*49,504*	*50,328*	*99,833*	45,000
					45,000
		24.7%	25.5%	25.1%	45,000
					99,833
					667,548
					369,833
					0.4460

COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

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Mines will commit cost share for the proposed project in the estimated amount of $99,833 in cash contribution. This includes:

1	*Tzahi Cath, PI - 5% AY effort*	*$27,705*
2	*Fringe benefits - 40.6%* of H1*	*$11,845*
3	*Student support (ZOMA - CASH), Water Technology Hub (Denver)*	*$50,000*
4	*Indirect costs - 26% of I1 and I2)*	*$10,283*
	TOTAL COST SHARE	*$99,833*

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Sincerely,

Tzahi Cath

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