

Southeastern Colorado Water Conservancy District Board of Directors Meeting

COLORADO RIVER ISSUES STATUS

Monthly/Quarterly Report

Date: August 19, 2021

Agenda Item: VI.D

STAFF RECOMMENDATIONS:

Information

BUDGET IMPLICATIONS:

Information

PREVIOUS BOARD ACTION AND/OR ACTIVITY:

Information

ISSUE SUMMARY DESCRIPTION:

Following nearly two years of stakeholder discussions and input from Coloradans across the state and from various sectors, the Colorado Water Conservation Board (CWCB) released a draft Demand Management Framework. The Framework captures threshold issues; implementation options; and proportionality, fairness, and equity considerations. A copy of the framework was attached to the May 20, 2021, Colorado River Issues Status Report.

During May and June 2021, the CWCB scheduled several virtual events to ask questions and provide input on the Framework, culminating in a Demand Management Public Listening Session on June 29, 2021. CWCB staff tracked the input received and presented findings to the Board during the July 21, 2021, CWCB meeting. CWCB Staff's memo and summary findings are attached. CWCB staff has scheduled a CWCB Member workshop for August 18, 2021, as follow up to this presentation.

Discussions in the Colorado Water Congress Colorado River Project Executive Committee have focused principally on funding for the recovery program in the post-2023 time frame. The 2000 original authorizing legislation included capital funding by the four states of \$17 million and \$17 million by the power customers. The states propose to re-examine their monetary capital contributions in 10 years. Reclamation has not commented on the states' proposal to date.

The states have proposed to deal with each proposed capital project to determine if sources of nonfederal funding can be identified for the project that would reduce the amount needed from congressional appropriations. This has occurred over the last 20 years, wherein the states of Colorado and Utah have contributed funds beyond their commitment in the authorizing legislation and nongovernmental organizations have also contributed funds to at least one project. Other contributions that will be considered and brought to the attention Congress are

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the very substantial non-monetary contributions to the recovery programs by the nonfederal partners, including, for example, the substantial contributions water by water users to the 15-mile reach. There are many other non-monetary contributions by states, water users and NGOs.

Regarding annual funding, the recovery programs' staffs propose an increase in annual funding of \$3.8 million per year over above current levels. The states have proposed all annual funding, except for continuing approximately \$450,000 per year from Colorado, Utah, and Wyoming, be provided by congressional appropriations to Reclamation, given the unreliability of hydropower funding in the future. There has not been a federal response to the states' proposal. Given concerns regarding the success of this proposal, the Executive Committee has indicated an interest in further discussions of proposals to make voluntary contributions. Tom Pitts, who manages the CWC Colorado River Project, said that contributions by the Executive Committee or other water users could not make up the lost funding from hydropower revenues but believe that it would be looked upon very favorably by Congress and the federal participants as nonfederal cost sharing contributions. District staff is participating in these discussions, and at an appropriate time will provide information to the Finance Committee and the Colorado River and Water Supply Committee on these discussions.

The Colorado River and Water Supply Committee has set a schedule to meet following the Board meeting every three months. The next meeting is scheduled for October and appears on the District's master calendar.

SUGGESTED MOTION:

Information

ATTACHMENTS:

 Memo to Colorado Water Conservation Board Members from Amy Ostdiek dated July 21, 2021, regarding Demand Management Feasibility Investigation Update

Attachment 1



COLORADO Colorado Water Conservation Board Department of Natural Resources 1313 Sherman Street, Room 718 Denver, CO 80203

P (303) 866-3441 F (303) 866-4474 Jared Polis, Governor Dan Gibbs, DNR Executive Director Rebecca Mitchell, CWCB Director

TO: Colorado Water Conservation Board Members

FROM: Amy Ostdiek

DATE: July 21, 2021

SUBJECT: Agenda Item 14: Demand Management Feasibility Investigation Update

Staff recommendation:

Staff recommends that the Board adopt the Demand Management decision-making roadmap attached hereto as Exhibit A.

Background

The Upper Basin States of the Colorado River Basin are currently investigating the feasibility of a potential Demand Management program. Demand Management is the concept of temporary, voluntary, and compensated reductions in consumptive use. The conserved water would be used to ensure ongoing compliance with the 1922 Colorado River Compact. The Demand Management Storage Agreement, one element of the 2019 Drought Contingency Plan (DCP), provides the authorization for the Upper Division States to store water created pursuant to a Demand Management program in Lake Powell. The water would only be used for Compact compliance purposes at the direction of the Upper Colorado River Commission. Whether a program is established and how such a program would operate are still open questions. Each Upper Division State must make an initial determination that Demand Management is feasible before moving forward with creating a potential program.

The mission of the Colorado Water Conservation Board is to conserve, develop, protect, and manage Colorado's water for present and future generations. In carrying out this mission, CWCB is the agency authorized to determine whether Demand Management is feasible for Colorado. Following adoption of the DCP in March 2019 and after significant discussion by the Board and key stakeholders, the CWCB Board adopted the 2019 Work Plan to help guide the initial stage of the feasibility investigation. This work was focused on identifying key threshold issues associated with a potential Demand Management program. Pursuant to the 2019 Work Plan, staff convened workgroups that met throughout the 2019-2020 Fiscal Year. Staff provided regular updates to the Board and received guidance and input throughout the implementation of the 2019 Work Plan. A summary of work completed pursuant to the 2019 Work Plan is available in the July 2020 update to the Board.



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Following Board discussion through workshops and Board meetings, the Board adopted the Step II Work Plan in November 2020. In this Work Plan, the Board directed staff to develop a framework of a Demand Management program, to be used to generate discussion about potential Demand Management program design and a range of potential implementation options. Staff developed the draft framework in early 2021, then engaged a wide range of stakeholders to solicit feedback on the framework, including through workshops, updates, and other outreach as detailed in the Step II Work Plan. Staff has provided regular updates to the Board throughout implementation of the Step II Work Plan.

Additionally, during this time the literature review was completed pursuant to Board guidance both through the 2019 Work Plan and pursuant to the Step II Work Plan direction to "[a]nalyze and learn from existing, ongoing, and/or new programs and projects." The process was designed to collect as much information as possible to inform the Board's discussion and process for the Demand Management Feasibility Investigation in July 2021 and beyond.

Status Update on Implementation of Step II Work Plan

The framework was released in March 2021, and from March - June 2021, staff conducted public outreach regarding the framework, including:

- Six workgroup meetings: Staff conducting meetings with six of the workgroups previously convened pursuant to the 2019 Work Plan to receive input on whether workgroup members' input is adequately captured in the framework.
- *Nine Basin Roundtable meetings:* Staff presented to and requested input from the nine Basin Roundtables.
- *IBCC meetings and input:* Staff presented to the Interbasin Compact Committee on the framework and solicited specific input on the Framework. Staff plans to facilitate continued discussion at the October IBCC meeting.
- *Three public workshops*: Staff hosted three public workshops to receive input on the framework, each focused on specific subject matters.
- *Public listening session:* Staff hosted a public listening session to receive additional input on the framework.
- EngageCWCB Survey: Staff developed an informational website and a survey soliciting feedback on the framework.
- Demand Management informational video (to be released): Staff worked with a consultant to develop an informational video regarding Demand Management to reach those who may be interested but have been unable to attend previous meetings or may not otherwise be involved in the discussion at this time. This yet-to-be-released video directs viewers to CWCB's website for more information and to learn how to engage.
- Additional presentations as requested: In addition to the above-referenced items, staff also presented the framework and provided opportunities for discussion and input upon request.
- Written input: Staff also invited written comments relating to the framework.

All input received on the Framework to date is provided in Exhibit B to this memo. Note that input received through workshops and public meetings is captured in summaries, as well as directly in the attached framework through comment bubbles.



Additionally, throughout this process, staff has worked with a team of consultants to achieve the following public outreach and engagement tasks, pursuant to the Step II Work Plan:

- Developed a communications toolkit designed to assist Demand Management messaging, provided electronically to the Board members previously.
- Developed strategies to make better use of various communications networks, including but not limited to social media, improved graphics and informational documents, and use of informational videos.
- Developed a database of stakeholders who have provided input, attended meetings, or otherwise shown interest in the Demand Management Feasibility Investigation, which will be used going forward to distribute information and solicit feedback on the ongoing feasibility investigation.
- Ongoing and continued engagement with Tribal Nations regarding Demand Management and the Framework on a sovereign-to-sovereign basis.

Context for Decision Making

In the Step II Work Plan, the Board adopted a lens through which to make decisions relating to Demand Management feasibility. The Work Plan breaks the feasibility question into three subquestions:

- (1) Achievability: The focus of this inquiry is whether it is technically possible to achieve a functioning Demand Management program within Colorado, and contemplates questions such as whether it is possible to verify and track water conservation, whether there are mechanisms available to track environmental benefits and impacts, whether it is possible to develop an appropriately robust outreach plan for a potential Demand Management program, and whether a funding source may be available.
- (2) Worthwhile for Colorado: The focus of this inquiry is whether even if a program is technically achievable it is worthwhile from Colorado's perspective. The scope of this question includes whether a Demand Management program may be established in a way that is proportional and equitable and avoids or mitigates unacceptable adverse impacts within the state.
- (3) Advisability: The focus of this inquiry is whether it is advisable for Colorado to make a feasibility determination within the broader context of Colorado River issues and strategy. This is a determination that will likely incorporate input from other states and the Upper Colorado River Commission, and therefore will be an evolving analysis. Given the quickly changing circumstances and ongoing investigation by the Upper Colorado River Commission, this determination would likely be made at the point in time after the first two questions are considered.

Next Steps

Roadmap for decision making

Within this context, the purpose of this agenda item is to discuss a potential roadmap for Board decision making to assist the Board in progressing in the Demand Management feasibility investigation. Staff suggests that the Board adopt the decision-making roadmap



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attached as Exhibit A. As shown in this roadmap, staff suggests the questions relating to achievability be considered first, followed by questions relating to whether a Demand Management program may be worthwhile from Colorado's perspective, noting that answers to the "achievability" questions may help to frame and inform the analysis of whether Demand Management may be advisable.

In considering the attached roadmap for decision making, the Board may consider the following questions:

- (1) Does this roadmap adequately capture and organize the key milestones you envision in board decision making relating to Demand Management?
- (2) In considering the categories of decisions to be made relating to achievability, what are some specific questions you believe need to be answered relating to each subject in order to determine whether Demand Management is achievable for Colorado?
- (3) In considering the potential decisions to be made in the future, what are your thoughts on appropriate timing of decision-making?

Resources to support decision making

In addition to information and resources previously provided, the following items are attached hereto, designed to assist the Board in its decision-making process:

Input received to date on the Framework (Exhibit B) Literature review completed by the consultant team (Exhibit C)



Colorado Water Conservation Board Demand Management Feasibility Investigation Exhibit A - DRAFT Roadmap for Decision Making July 2021

Achievability

[Tentatively to begin September 2021; subject to change]

- Monitoring & Verification: is it technically possible to monitor and verify conserved consumptive use within Colorado as required for a potential Demand Management program? - Tentatively September 2021
- Environmental Considerations: is it technically possible to track and monitor potential environmental impacts and benefits? - Tentatively September 2021
- Education & Outreach: is it possible to develop an outreach plan for a Demand Management program that would increase general water education, motivate participation in the program, and help to inform program design? - Tentatively September 2021
- Funding: given the above determinations, is it possible to secure a funding source to pay for a Demand Management program? - Pending

Worthwhile for Colorado

[Tentatively to begin November 2021; subject to change]

- Proportionality considerations: Can Colorado establish a Demand Management program that prioritizes avoidance of disproportionate negative economic or environmental impacts to any single subbasin or region within Colorado while protecting the legal rights of water rights holders, consistent with the Board's November 2018 Support and Policy Statement? Pending IBCC input to be received in October 2021, informing Board discussion in November 2021 and beyond
- Analyses and findings of UCRC and other states: Based on information gained from the UCRC feasibility investigation and those ongoing in the other Upper Division States, would a Demand Management program be worthwhile from Colorado's perspective? -Investigation ongoing

EXHIBIT B

Input Received, Spring – Summer 2021

This Exhibit includes various input received on the Framework and the Demand Management Feasibility Investigation generally in Spring-Summer 2021, including meeting summaries, survey responses, letters, and other feedback received. In addition, the final document is the draft Framework with comment bubbles that correspond with specific input heard at public meetings.



Stakeholder Input

CWCB Demand Management Feasibility Investigation

Spring - Summer 2021

Contents:

Demand Management Workgroup Workshop Meeting Summaries

Economics and Local Government Workgroup

Funding Workgroup

Agricultural Impacts Workgroup

Environmental Considerations Workgroup

Monitoring & Verification Workgroup

Education & Outreach Workgroup

Public Workshop Meeting Summaries

Demand Management Public Workshop #1

Demand Management Public Workshop #2

Demand Management Public Workshop #3

Public Listening Session Meeting Summary

EngageCWCB Survey Responses

Stakeholder Letters

Meeting summaries prepared for CWCB by Emily Zmak, CDR Associates. This document is intended to summarize stakeholder input and does not necessarily represent the views or opinions of CWCB staff or Board.



Demand Management Workgroup Workshop Meeting Summaries

DEMAND MANAGEMENT FRAMEWORK MEETINGS

Spring 2021



Economics and Local Government Workgroup

DEMAND MANAGEMENT FRAMEWORK MEETING

April 20, 2021 | 12:00 - 1:30p

Version 1 of the draft demand management framework is available for review here.

Discussion Highlights

Following presentations on the demand management framework ("framework") by Amy Ostdiek, CWCB, and Mark Smith, Colorado College, the Economics and Local Government Workgroup ("workgroup") had a facilitated discussion on the content within the workgroup's focus area.

The overall discussion focused on:

- The framework and the elements, trade-offs, and considerations captured within it; and
- Informing the CWCB Board's decision-making process.

Framework Feedback

- □ It is difficult to present both details and an uncomplicated overview in the same framework.
- □ The right-hand column could be clarified with a title along the lines of "considerations" or "interconnected issues." Issues should be captured in a consistent and accurate way.
- □ The A-B-C columns should better illustrate the escalation in complexity.
- [□] "Do no harm" is a guiding principle that should be captured as fundamental to all topics / sections.
- □ Additional clarity around municipal participation would be helpful.
- □ Impacts to local government are closely connected to agriculture. The consultation category should capture that agriculture is a key component in addressing community impacts.
- □ Water efficiency programs may be more disruptive than currently captured in the framework.
- Green spaces are an important consideration to capture.
- □ Mitigation funds should be directly linked to the sector impacted.
- □ Iterative mitigation would allow communities to incorporate lessons-learned and/or unexpected impacts into mitigation measures.

- Does surplus water count as consumptive use?
- □ What criteria should be used to judge whether or not demand management is a good idea?
- What does proportionality mean?
- □ How much would other agencies be involved in a demand management program?



Funding Workgroup

DEMAND MANAGEMENT FRAMEWORK MEETING

April 21, 2021 | 10:30 - 12:00

Version 1 of the draft demand management framework is available for review here.

Discussion Highlights

Following presentations on the demand management framework ("framework") by Amy Ostdiek, CWCB, and Brett Bovee, Westwater Research, the Funding Workgroup ("workgroup") had a facilitated discussion on the content captured within the workgroup's focus area.

The overall discussion focused on:

- The framework and the elements, trade-offs, and considerations captured within it; and
- Informing the CWCB Board's decision-making process.

Framework Feedback

- □ Consider clarifying the budgets' inclusion of one-time costs and early investments.
- □ Both fees and taxes should be considered as funding sources.
- □ Federal investments could be captured in the commentary as a potential funding source.
- The current presentation of costs begs the question, "Why would you pay more for the same amount of water?" The framework could articulate that the B- and C-columns fund worthwhile secondary benefits, such as consistency and mitigation. Attractive program components may have additional costs.
- □ There should be an expansive consideration of financing and funding, such as looking towards supply chains to broaden the pool of fee-payers.
- □ Costs should be considered on a perpetual basis, not solely an annual or near-term basis.
- □ Municipal participants would need to consider revenues and possible rate pressures, which would have impacts on low income communities and raise issues like bill affordability and customer assistance.
- □ Cost equity could be captured. There are different impacts and benefits to different geographies, water consumers, and economies.
- □ The framework could capture opportunity costs. Understanding opportunity costs could help clarify whether an entity should participate or not.

- □ How expansive are the references to "water users"? Direct users, secondary users?
- □ What is the optimum program? Defining that would be helpful in considering financing.
- □ Can the demand management model be built in a way that it is transferable to other Basins?
- □ What is the benefit for the cost and effort of the program?



Agricultural Impacts Workgroup

DEMAND MANAGEMENT FRAMEWORK MEETING

April 22, 2021 | 10:00 - 11:30a

MEETING PURPOSE: To ensure that the framework responds to workgroup members' initial feedback, and to solicit additional input on framework elements.

Version 1 of the draft demand management framework is available for review <u>here</u>.

Discussion Highlights

Following presentations on the demand management framework ("framework") by Amy Ostdiek, CWCB, and Brett Bovee, Westwater Research, the Agricultural Impacts Workgroup ("workgroup") had a facilitated discussion on the content captured within the workgroup's focus area.

The overall discussion focused on:

- The framework and the elements, trade-offs, and considerations captured within it; and
- Informing the CWCB Board's decision-making process.

Framework Feedback

- Communicate the range of options' pros and cons, as well as financial and opportunity costs
- Consider addressing holistic sustainability and resiliency to future impacts within the framework
- □ A demand management program should treat producers fairly
- □ Consider intra-system impacts to ensure that nonparticipants are unaffected
- Pre-existing procedures, operations, and governance requirements for irrigation providers are constraints that a program would work within; for example, not all systems have individual water rights
- □ System compensation is an important consideration, although is only represented in Column C
- □ Soil health is a potential secondary benefit. The state could provide optional techniques or technical services to producers for improving soil health during fallowing. This could be a participation incentive.
- While the framework recognizes legal damages, it does not mention inconveniences. Someone will always be inconvenienced; early engagement could mitigate non-damaging impacts.
- Local benefit will stem from farmer compensation. Development funds could build and support agricultural economies, although the majority of the money should go to the program participants.
- □ Not all potential participants will be appropriate participants.

- □ Will there be a mandatory crop type to prevent further landscape damage?
- □ How much will be paid to producers?
- □ Who pays for technical assistance offered to program participants?



Environmental Considerations Workgroup

DEMAND MANAGEMENT FRAMEWORK MEETING

April 26, 2021 | 2:00 - 3:30p

MEETING PURPOSE: To ensure that the framework responds to workgroup members' initial feedback, and to solicit additional input on framework elements.

Version 1 of the draft demand management framework is available for review here.

Discussion Highlights

Following presentations on the demand management framework ("framework") by Amy Ostdiek, CWCB, and Jordan Dimick and Bailey Leppek, SGM Engineering, the Environmental Considerations Workgroup ("workgroup") had a facilitated discussion on the content captured within the workgroup's focus area.

The overall discussion focused on:

- The framework and the elements, trade-offs, and considerations captured within it; and
- Informing the CWCB Board's decision-making process.

Framework Feedback

- □ The framework is a useful tool for evaluating trade-offs
- A successful program would provide resilience for the environment and recognize holistic environmental benefits
- □ Proportionality and fairness should be linked to discussions about water and costs
- □ Assessing net benefit should work within existing local environmental rules and guidance
- A long-term program will evaluate environmental benefit / impact through a different lens than a short-term program; for example, the timing of flows matters more in a long-term program
- □ Review language for implications or assumptions of adverse risk caused by some participants
- □ The value of water will factor into the proportionality discussion, and the more complicated the program, the more financially difficult it will be to launch the program

- □ What long-term programmatic options exist outside of the drought contingency plan timeframe?
- How can a demand management program be linked to other state programs to achieve win-win outcomes for environmental benefit?



Monitoring & Verification Workgroup

DEMAND MANAGEMENT FRAMEWORK MEETING

April 30, 2021 | 12:00 - 1:30p

MEETING PURPOSE: To ensure that the framework responds to workgroup members' initial feedback, and to solicit additional input on framework elements.

Version 1 of the draft demand management framework is available for review <u>here</u>.

Discussion Highlights

Following presentations on the demand management framework ("framework") by Amy Ostdiek, CWCB, and Jordan Dimick, SGM Engineering, the Monitoring and Verification Workgroup ("workgroup") had a facilitated discussion on the content captured within the workgroup's focus area.

The overall discussion focused on:

- The framework and the elements, trade-offs, and considerations captured within it; and
- Informing the CWCB Board's decision-making process.

Framework Feedback

- □ Interconnected issues include potential environmental benefits, transmountain diversion projects, and agricultural techniques like deficit irrigation.
- □ The purpose of monitoring and verification is to accurately quantify what wet water has been added to the system, so functionality, accuracy, and efficacy are key themes.
- The references to time are not as accurate when referring to historical diversion rates. Consider taking out the "or" in the cell discussing bypass diversions, because of the potential disconnect between CCU on the west slope and historical diversion rates.
- □ Terms benefit from careful definitions. For example, conserved consumptive use may mean different things when discussing CCU in the Colorado River system or on the East Slope.
- Monitoring and verification in multiple systems is complex, and considerations include historic canal losses, potential telemetry, and field return flows.
- □ There are a variety of tools and resources available to potential DM participants.
- Grounding the A-B-C columns in hypotheticals would help to build more detail and illustrate a program.
- Equity considerations are less applicable to monitoring and verification than other workgroup topics.
- Consider building options for future participation from other sectors, like industry or environmental.
- Column A approaches to monitoring and verification may be too simplistic for many DM programs.

Open Questions

□ How will pilot programs inform the framework?



Education & Outreach Workgroup

DEMAND MANAGEMENT FRAMEWORK MEETING

May 3, 2021 | 1:30 - 3:00p

MEETING PURPOSE: To ensure that the framework responds to workgroup members' initial feedback, and to solicit additional input on framework elements.

Version 1 of the draft demand management framework is available for review here.

Discussion Highlights

Following presentations on the demand management framework ("framework") by Amy Ostdiek, CWCB, and Emily Zmak, CDR Associates, the Education and Outreach Workgroup ("workgroup") had a facilitated discussion on the content captured within the workgroup's focus area.

The overall discussion focused on:

- The framework and the elements, trade-offs, and considerations captured within it; and
- Informing the CWCB Board's decision-making process.

Framework Feedback

- □ Clarify messaging around purpose, motivation, and objectives.
- Outreach should give a clearer sense of the options to illustrate what implementation would look like.
- □ With a statewide program, messaging outside of Column C would be difficult because of the scale.
- Consider adding additional detail to capture the increasing complexities for message development. The range could capture the basic process for message development; and at a higher level, message specificity for certain geographies or target demographics.
- □ Education and outreach should identify target audiences for different messages. This process could include co-developing messages with the target audiences.
- □ A feedback loop will build trust and develop a better program.
- □ While the general public could benefit from general water education about curtailment and drought, targeted audiences should be DM program participants and other impacted stakeholders.
- □ Simplifying the framework's presentation would assist with engagement and interpretability.
- □ The framework does not capture the "why" (advisability) nor climate change.
- □ Frame issues around shared values, such as individual agency and the program's facilitation of choice.

- □ How are impacts being communicated? To what level of detail?
- □ How do messages change by audience and geography?



Public Workshop Meeting Summaries

DEMAND MANAGEMENT FEASIBILITY INVESTIGATION

June 2021



Demand Management Public Workshop #1

PUBLIC WORKSHOP MEETING #1

June 1, 2021 | 1:00 - 2:30p

Discussion Highlights

Following presentations on the Demand Management Framework ("Framework") by Amy Ostdiek, CWCB; the Monitoring & Verification section by Jordan Dimick, SGM; and the Environmental Considerations category by Bailey Leppek, SMG; the Public Workshop #1 had a facilitated discussion on the Framework categories Monitoring & Verification ("M&V") and Environmental Considerations.

Framework Feedback

- Participants' priority considerations included: creating a truly voluntary program; ensuring effectiveness; balancing accuracy and implementability; and maximizing benefits to environment
- Concern that M&V is complicated enough without combining it with the issue of proportionality
- □ Consider clarifying the language regarding municipalities on the West and East Slopes
- Broad concern for understanding how this framework is going to inform the CWCB decision-making and implementation processes
- □ Shift to hypotheticals to illustrate what requirements might be for each category
- Broaden the lens to include West Slope municipalities and industrial water users
- Concern about the significant costs of issues-management
- Define what shepherding water from remote and/or rural locations to the state line looks like
- Consider other options for incentivizing environmental benefits
- □ The state could consider a minimum and more robust requirement for environment
- □ Considering equity and proporitionality in M&V adds an additional, complicated layer
- □ Gaps in the framework include the state's process for shepherding water; clarity on state measurement rules or mechanisms; and pilots to address transmountain projects and environmental impacts
- □ Incorporate relative time, accuracy, and costs into the Framework's A-B-C options
- Concern that incentives are shifting away from compact compliance and toward environmental benefit

- □ How to connect the Framework to decision-making and implementation at the CWCB?
- □ How does the Demand Management program work in different locations and elevations?
- □ How will the Board make decisions about the A, B, and C columns? And how does the Framework inform feasibility?
- □ How could a program incentivize a C-column approach to the environment without or beyond money?
- □ What does the cost look like? Where does the funding come from?
- □ What is the process for shepherding water to the state line?



Demand Management Public Workshop #2

PUBLIC WORKSHOP MEETING #2

June 14, 2021 | 11:30 - 1:00p

Discussion Highlights

Following presentations on the Demand Management Framework ("Framework") by Amy Ostdiek, CWCB; the Economic Impacts & Local Governments section by Brett Bovee, WestWater Research; and the Agricultural Impacts section by Angie Fowler, SGM; the Public Workshop #2 had a facilitated discussion on the Framework categories Economic Impacts & Local Governments and Agricultural Impacts.

Framework Feedback

- Provide technical details about what Demand Management would encompass and look like in application, specifically for farmers and ranchers in the Colorado River Basin
- □ Interest in exploring the legal details of Demand Management in the Framework
- Concern about how to address claims of injury and how to prevent injury
- Consider defining alternative or innovative incentives for Demand Management participants beyond money, especially for municipalities
- Define the long-term implications for rural communities and the impacts to the agricultural sector
- □ Consider storing water in reservoirs within the state, rather directly in Lake Powell, to provide more internal control
- Develop clear direction for next steps and approach
- If participants are going to give up water for a few years, they need assurance that the program will provide insurance from curtailment
- Desire for a program to align with growing season schedules and ranch operations
- Impacts will likely be very localized and specific, so the Framework should include a process to evaluate and resolve local impacts in a responsive manner
- Consider secondary impacts of a program, such as health care

- □ How to ensure that one sector or region doesn't bear all the burden?
- □ How best to prepare water users for the new normal of water scarcity?
- □ What are the considerations and agreements that must be reached with the other Upper Basin states that are not encompassed by the Framework?
- □ Would the Demand Management program work with other state agencies?
- □ How is Demand Management different from existing programs like the ATM program?
- □ How is CWCB considering abandonment or speculation issues of water rights?
- □ Can other people object to an applicant's Demand Management application?
- □ How will the pricing of water work?
- □ What does "temporary" entail (years, months)?



Demand Management Public Workshop #3

PUBLIC WORKSHOP MEETING #3

June 14, 2021 | 1:30 - 3:00p

Discussion Highlights

Following presentations on the Demand Management Framework ("Framework") by Amy Ostdiek, CWCB; and the Education & Outreach and Process Consideration sections by Emily Zmak, CDR Associates, the Public Workshop #3 had a facilitated discussion on the Framework categories Education & Outreach and Process Considerations.

Framework Feedback

- Foster broader understanding for water providers and users about Demand Management's purpose and goals
- □ Turn the Framework into action through clearly-defined next steps and process clarity, and push up the contingent decision
- Define and articulate the problem of compact curtailment as the alternative to Demand Management
- □ Engage actual water users to better understand problems and obstacles for potential participants, which may require making the process more clearly defined
- □ Be intentional in special engagement with the Ute Tribe
- □ Create Spanish-language newsletters and informational documents about Demand Management, and partner with Latino organizations to assist with translation and messaging
- Add specificity about the audiences that should be targeted for outreach to better define the goals
- □ Stakeholder education needs to be informed by a real process, data, and programmatic information
- Group consensus that Column C in Process Considerations is needed to mitigate user concerns and ensure program success
- □ Incorporate process transparency with the public, especially around lessons-learned and successes
- □ Include a technical state role or service to help water users apply and develop applications

- □ Where are the other Upper Basin States in their processes?
- □ What is the worst-case scenario without Demand Management?
- Who are the key audiences, and what are the messages those audiences need to hear?
- □ How to engage water users to inform the planning process?
- □ How to reach stakeholders who have not shown up to CWCB's engagement opportunities?
- How do we communicate water and water challenges with diverse and historically underserved populations?



Public Listening Session Meeting Summary

DEMAND MANAGEMENT FEASIBILITY INVESTIGATION

June 29, 2021

Discussion Preface

Following brief presentations on the Demand Management process by Greg Johnson, CWCB, and Emily Zmak, CDR Associates, meeting participants provided comment about the Demand Management framework; the work done to date; organizational positions pertaining to the proposed Demand Management program; and/or personal thoughts and reactions to the concept of Demand Management. Comments were limited to five minutes per participant, and were otherwise unrestricted.

Participants were encouraged to submit written comment in addition to the statements summarized below.

Comment Summaries

Aaron Citron, The Nature Conservancy

- Recognizing the ongoing bad hydrology and need for cohesive Colorado River policy, he encourages CWCB to pursue Demand Management as a critical piece in a suite of tools to address Colorado River issues
- Encourages CWCB to capture trade-offs in the framework document and to include sideboards to benefit rivers, protect communities, and ensure proportionality
- Advocates for advancing policies that would build a Demand Management program, which could include pilots and demonstrations to illustrate how a program could function

Mark Harris, Grand Valley Water Users

- He believes that the process to-date and the Demand Management framework have adequately captured the concept of Demand Management
- Now that the initial work is done, it is time to answer questions like, "So what?" and "What now?" Encourages CWCB to try a compensated, voluntary, and temporary program.
- Believes that many farmers, ranchers, and their organizations are willing to find solutions
- Supports CWCB's identification of practical solutions, and believes that trying something new is the best way to answer the important questions
- Urges CWCB to articulate the next steps in the Demand Management process and develop a timeline

Tom Gray, Yampa/White/Green Basin Roundtable

- Are there hard parameters or sideboards about what Demand Management would look like and, if not, when will the hard parameters begin to be established? Encourages the development of hard statements for people to grapple with and respond to.
- Will staff make a recommendation to the Board about next steps?



Don West, Colorado Water Exchange

- Regarding the Monitoring and Verification section of the Framework, he advocates for a combination of the A and B Columns
- Is comfortable with the state's Lease Fallow tool, probably in Column B
- Encourages transparency around crop coefficients; in particular, taking a statement like, "For this program, the state will use X crop coefficient with Y elevation adjustments."
- What is the role of municipalities in conserved consumptive use? The framework focuses on the agricultural aspect.

Alden Vanden Brink, White River

- He believes that Demand Management adds to the crisis, and that it adds a target on agriculture
- The White River has depended on flood irrigation and artificial recharge for more than 100 years
- Encourages developing more reservoir space to alleviate compounding pressures on the White
- Would like a no-injury clause to protect White River users

Jeff Meyers, Yampa/White/Green Basin Roundtable

- He believes that motivation to deal with the drought is strong
- The framework document is valuable; however, the detail, complexity, and presentation means it is not the most accessible document
- Encourages CWCB to include language in the framework that defines equity as a means of ensuring all Colorado basins participate on an equitable basis
- A key issue is return flow, namely the ecosystem benefits of flood irrigation
- Feels that there is not a lot of knowledge about what Demand Management might mean or how seriously the hydrology is, so sees education and outreach as critical in this process
- Would be helpful to know from the State Engineer what curtailment might look like

Abby Burk, Audubon

- Both birds and people dependent on the Colorado River have been impacted by water supplies
- Demand Management is an alternative to curtailment and provides flexibility for Colorado
- Audubon is supportive of a Demand Management program to protect Colorado and other water users, and to yield environmental benefits; encourages CWCB to move forward and avoid delays
- Believes the framework is a good start: the next step is to evaluate the trade offs and develop a program that can be one tool in the toolbox

Austin Vincent, Colorado Farm Bureau

- Agriculture is one of the state's largest economies, especially on the West Slope and in rural areas
- Wants to help find the solution to western water supplies and to avoid risk of curtailment
- Colorado Farm Bureau supports temporary, voluntary, and compensated programs that share the load with municipal, in-stream, environmental, and recreational flows
- Wants to have attainable goals that supports producers and creates a practical program
- Encourages CWCB to use existing programs and state agencies in a Demand Management program
- Encourages CWCB to expand education and outreach with farmers / producers on the West Slope

Orla Bannan, Western Resource Advocates

- Has submitted written comments to CWCB
- Sees the need for urgent action because of the bad hydrology
- Encourages CWCB to look for next steps and find win-win environmental benefits



Chris Treese, ret. Colorado River District, consulting with Southwest Colorado River District

- Has submitted written comments to CWCB from the Southwest Colorado River District Board
- Characterizes the Southwest guidelines as skeptical-but-constructive, and articulates a commitment by their Board to remain engaged in Demand Management discussions
- Principally concerned with protecting agriculture and ensuring that a Demand Management program not target agriculture, nor encourage speculation in Western Colorado's agricultural waters
- Remains mindful of the consequences of both a Demand Management program and compact administration, which is not equitable, compensated, nor voluntary



EngageCWCB Survey Responses

DEMAND MANAGEMENT FEASIBILITY INVESTIGATION

Survey Responses

Engage CWCB Survey Responses					
What river basins are you interested in?	Southwest River Basin	Southwest River Basin	Yampa-White-Green River Basin	Colorado River Basin	Arkansas River Basin Colorado River Basin Gunnison-Uncompahgre River Basin North Platte River Basin Rio Grande River Basin South Platte River Basin Southwest River Basin Yampa-White-Green River Basin
From your perspective, Demand Management (select all that apply):					
Would benefit agricultural water users overall.	x	x		x	
Would hurt agricultural water users overall.			x		
Would benefit urban water users overall.	х	х			
Would hurt urban water users overall.			Х		
Is an opportunity for the entire state to collaborate for the benefit of the Colorado River.		х	x	x	X
Is an opportunity for Colorado to insure itself against mandatory curtailment in the Colorado River Basin.	x			х	x
Is an opportunity to build resilience in rural communities.			х		X
Is a program that individual producers should be able to choose to participate in.	x	x	x	х	X
Is a program that communities should be able to provide feedback on.	Х	Х	Х		x
Is a program that municipalities should be able to choose to participate in.	Х	X	Х	Х	X
How might a Demand Management program potentially benefit or impact you individually?	To avoid the potentially devastating economic impacts of a Colorado River water curtailment on the west slope.	Probably not much effect	Increased likelihood of low stream flows in the summer, fall, and winter months reducing ability for irrigation (rising food cost), recreased in (angling, canoeing, waterfowl), community water restrictions, degrades drinking water quality (water aesthetics, increased water treatment cost passed to the consumer), increase of nuisance aquatic vegetative species, increased tax burden risk due to seasonal low impacts on threatened and endanger species that live in our rivers (successes and dollars expended, invested, from protecting these species), increase concentration of wildlife to lands for available food, forage, water, winter range security, private land owner wildlife impacts and conflicts, loss of productive ag lands, create great dependence upon purchasing outside livestock feed source to maintain herd, livestock herd reductions due to loss of feed, secondary economic impacts from loss of agriculture, recreation, community water conservation losses to personal income (car washes, lawn care, plumbers), increased utility rates, increased to NPDES water quality standards and community waste water treatment processes	Colorado Basin, including agriculture, from climate change, hydrologic volatility, and related pressures. Waiting for the train wreck, slow or fast is a poor choice.	
How might a Demand Management program potentially benefit or impact your community?	Avoiding the economic impacts of a curtailment.	Perhaps excess water could be dinted from city supplies for compensation. Protection from a call.	[Ditto]	See #6	See response above.

Survey Responses

What topics or concerns would you like addressed in the next phase of the feasibility investigation?

Piloting the use of auctions to determine who gets paid and Value of water under this scenario how much.

How to maintain the Colorado River system when water reserves are depleted due to continued drought and or aridification. Impacts to alluvial storage and agriculture return flows. Impacts to basins and water users dependent upon alluvial storage and return flows from agriculture. Quantify the injury to water users when storage is depleted. Quantify how basins without storage are impacted. Why does Colorado not want to use the states full Colorado Compact allocation? Why is Colorado anti-water storage for compact protection purposes? What risk are there and there valuable time being lost to get critical projects done to offset or lessen drought and ardification impacts while the growing while Colorado continues to vet DCP and DM? Is water political world vets DCP and DM? What will happen to an area, community, region should water not be available? What is the States plan for areas that lack adequate drought resiliency? What legal risk is the state opening if a DM program is developed and people run out of water due to a Colorado Approved or Sponsor DM program? Does "no-jury" come into the DCP/DM equation?

We know how to create CCU, programmatic pilots

How will flows be shepherded to Lake Powell (or any other storage bucket)? Is storage in Lake Powell the best alternative (in light of tremendous evaporation loss); should storage in Colorado reservoir be explored as a first alternative, with delivery to Powell on an as needed bases? These matters are not included in the Framework.

Survey Responses

way the potential program is being considered?

I have previously commented to the CWCB that it needs to pilot the use of auctions. Auctions are a fair and equitable means to determine who gets naid and by how much. It is also fair to who pays the bill. The attached concept paper outlines the use of auctions. Attached is a water auction design document recently co-authored by Dr. Bonnie Colby from the University of Arizona and the Colorado River Research Group. https://climas.arizona. edu/publication/report/water-auctions-designimplementation-and-evaluation Additionally, below are a couple of opinion pieces that I co-authored regarding the use of auctions to reduce Colorado River Water use. Fresh Water News, August 19, 2020 Opinion: Use auctions to set Do you have any additional thoughts or feedback prices for Colorado River drought pool https://www. on the Demand Management Framework and the watereducationcolorado.org/fresh-water-news/opinionuse-auctions-to-set-prices-for-colorado-river-drought-pool/ The Colorado Sun, September 14, 2020 Opinion: Colorado needs a water market to reduce Colorado River water use https://coloradosun.com/2020/09/13/colorado-rivercompact-denver-water-opinion/? utm_source=ActiveCampaign&utm_medium=email&utm_co ntent=A+fragile+foundation+for+vaccines+% 2F+Lauren+Boebert+s+rise+% 2F+State+sues+USPS+over+voting+misinfo+% 2F+After+Suncor+settlement&utm_campaign=Sunriser+-

+9%2F14%2F2020&vgo_ee=NoyTwJ1V3BKXqMdyi2gTAw% 3D%3D I will be happy to help the CWCB think through how to design water auctions and the market structures required

to implement any Demand Management Program.

I think the market should determine price. Mostly excess storage will be the best source

secondary impacts to other water users. Each basin is different and should be treated as such. "No-injury" should be implemented. Yampa/White/Green Basin Roundtable Recommended Draft Demand Management Statement Executive Summary Context In the face of persistent drought and anticipated long-term growth in demand for water, Colorado and the other 6 Colorado River Basin states have prepared a Drought Contingency Plan (DCP). One element of that plan is to investigate the feasibility of Demand Management (DM). If implemented, DM will become a future program which, on a voluntary, temporary, and compensated basis, will reduce water use by individual. public, and commercial water rights holders, to avoid administration of the Colorado River Compact on the Colorado River, Statement of Principles Given the context for DM in Colorado, the Yampa/White/Green River Basin Roundtable considers the following concepts to be important in the development of a DM program: 1. Preservation of Quality of Life in the Y/W/G River Basin: Any DM program must preserve and enhance agriculture, local communities, and economies in our basin, while protecting municipal delivery, addressing environmental needs as well as recreational water use, and offering locally accepted methods to reduce consumptive use without injury. 2. Equity of Responsibility and Opportunity: A DM program must be structured to ensure that no river basin nor single water user group (i.e, Ag, M&I) bears a disproportionate share of DM responsibility, and to provide DM opportunities to all water right holders on a reasonably equitable basis. To ensure equity, some form of inter-basin apportionment is required. 3. Guided Market: The State of Colorado should establish a marketplace for DM water transactions that is structured to ensure/mandate fairness and transparency. 4. Recreation and Environment: Any DM program must consider/analyze its impacts on environmental and recreational needs, including those resulting from changes in water supply and/or timing of flows, and must not adversely impact these water uses and their contributions to local economies. 5. Rural Communities: Any DM program must evaluate and address all impacts that could result to rural communities, including negative economic, cultural, or social impacts. 6. Compensation for Value of Water Conserved: Any DM program must fairly compensate a participant who foregoes use of a water right. Compensation must be based on all economic impacts to the participant and not solely on the loss of income from the crop or product not produced. 7. Trans-Mountain Diversions (TMDs): Basins which benefit from water diverted from the Upper Colorado River must be considered as part of the CRS, with applicable DM responsibilities and opportunities, and subject to equitable apportionment for DM purposes. Any DM program must prohibit trans

Very dangerous program that opens up unintended

We need to consider lower case demand management, that being water conservation, learning what we can, as we wrestle with upper case DM as a part of DCP; dm is coming ready or not.

The Framework does a good job summarizing the threshold issues and alternatives discussed in each DM workgroup, but it is still too abstract and vague. I think it is time to put one or more strawmen out there so people can react. And by strawman, I mean an outline of a potential program with specific components.



Stakeholder Letters Submitted to CWCB

DEMAND MANAGEMENT FEASIBILITY INVESTIGATION

Grand Valley Water Users Association Comments to CWCB DM Framework Listening Session June 29, 2021

I am Mark Harris General Manager of GVWUA in the Grand Valley

Thanks to all of you inside and outside the CWCB that have worked diligently to get us to this DM Framework to this point.

I am not going to make specific comments on the contents of the Framework or discuss the process by which it has been developed, but we do believe the process and the resulting document provides an adequate exploration of the appropriate issues and provides a place from which to continue the search for real time and real world solutions to the use of DM as a part of DCP and perhaps on what we call lower case dm....productive approaches to water conservation that are a part of all our futures.

What I do want to share briefly is what I am being asked by the Board I serve and the farmers and other water users we deal with every day.

What folks want to know is the "so what" and "what now"....

We hear a pretty clear concern with the state of the River, compounded by weather concerns, and by extension the fate of the GVWUA and the Grand Valley in the face of these challenges. People are asking us what we managers, the CWCB, organizations like the River District, and other organizations are doing to effectively deal with the outcomes of worsening trends and increased volatility, not just for this year and the very near term, but for the longer term as well.

They wonder how these DM explorations address the very real problems they see coming?

Our organization knows that many farmers and ranchers know how to create CCU, and even perhaps how to deal with it within their own organization or on their ditch. But the larger question I am asked is SO HOW move on and WHERE is the vehicle by which we do something productive with that water potentially made available in a voluntary, temporary, and compensated basis in several geographies by various methods.

Who is working on that they ask? And when? What's next after all this talk they ask? Can't we try something?

Well the GVWUA submits that the time to work on answering those challenges is upon us. We recognize, acknowledge, and respect the very real differences in opinion that many of our peers and partners have regarding these difficult issues. But we also believe that many farmers, ranchers, and the organizations that serve them remain willing to find a productive way forward for agriculture and the State of Colorado, if for no other reason than it is in our best interest to do so.

Agriculture will be as heavily impacted by the solutions to the water problems we face as we are from the problems themselves.

Finally, we support CWCB's identification and funding of appropriate, practical, PROGRAMMATIC PILOT PROJECTS that help understand how to administer the CCU that many people already know how to create.

I know I am not telling you anything new when I say that the only way to really raise the important questions and to identify the positive and negative consequences of our actions is to try something.

You have heard me use his analogy before, but here it is one more time.

You can sit in the coffee shop all winter and talk about, cuss and discuss, and second a new crop for next spring. **But sometime you just gotta take the planter to the field....** and you may get a few blanks, and you may abandon the plan in favor of another one next year, but you know you have to be trying something every year. Embracing the past too tightly does not help us deal with the future.

There is no other way to advance the agenda without taking some well-considered risk. And all those involved in creating the FRAMEWORK have done that. We urge the CWCB to take aggressive action toward putting this time and effort to continued good use, clearly articulating the next steps in the DM process, and creating a projected schedule by which it can be accomplished.

It doesn't look like the water and the weather are not going to wait for us.

Thanks for time this afternoon and good luck.



July 6, 2021

Colorado Water Conservation Board of Directors 1313 Sherman Street, Room 718 Denver, Colorado 80203

RE: Colorado Drought Contingency Plan - Demand Management

Dear Honored Member of the Colorado Water Conservation Board of Directors

The Rio Blanco Water Conservancy District (RBWCD) would like to say it is a pleasure to provide comment on Demand Management however recognizing our present state of drought and continued aridification this is proving to push a level of conversation not many are fully prepared for nor comfortable with. There is more gratifying task we all would rather be doing in our water world but here we are today in our drought-stricken region formulating a plan for a better tomorrow. Evidently all of us were chosen in one fashion or another to be part of this crucial topic in preparation for our future generation's water security. Changing times for sure.

The winds of change are upon us, and we recognize the need for adaption to our changing environment. Being such, the RBWCD believes it is imperative for the CWCB to understand the function of the White River Basin with respect to Drought Contingency Planning (DCP) - Demand Management (DM). We believe no other Colorado water basin in our great state functions as we do nor has done so for such an extend period.

Our White River community is cultivated around areas of alluvial gravel deposits that have been washed out from the Flat Tops and high desert plains over the millennium recharged by snow, rains, and flood irrigation. The combination of these is what keeps the water available for our community needs. With the reduction in snowpack and seasonal rains not to forget increased temperatures, this has impacted our ability to put water to full beneficial use due to the lack of directly available supply from the stream or retiming of water while also reducing the alluvium storage.



Under normal years with average precipitation, flood irrigation plays an immense role "toppingoff" our White River alluvial aquifers but with the loss of direct flows and seasonal precipitation less water is available to be applied shorting the alluvial aquifer storage not to forget the natural recharge occurrence which our White River basin is dependent upon. Once the alluvium is full water eventually migrates back to the stream as return flows for other later in the season beneficial water reuse. Typical return flow season is from late summer to late winter months.

For DM discussion purposes, the White River basin has: 2 municipalities, Meeker (ground water supply) and Rangely (direct diversion surface water supply) supporting a population of about 6,400 citizens; limited industry that continues to be sequestered; recreation; and agriculture. A DM program imposed upon the municipalities will have limited conserved consumptive use with the small population, industrial water use is an incredibly small quantity, recreation is non-consumptive, so that leaves agriculture to take care of the lion's share of water for a White River DM program. As the DM program is rolling out with uncertain side boards, we must presume any Conserved Consumptive Use will be primarily sacrificed by agriculture which is the life blood of our basin hydrology. Take away or restrict flood irrigation and we eat away at the primary drought insurance policy of our community and stream ecology shorting alluvial recharge and return flows, which has been encountered during previous drought-stricken years.

Unlike other Colorado basin's, the White River is void of any real storage for drought or contingency protections hence part of the purpose and need for RBWCD along Yellow Jacket Water Conservancy District, Town of Rangely, and Rio Blanco County to aggressively push for Wolf Creek Reservoir. Our community is progressing with our Drought Contingency Plan that includes physical storage because we understand the vulnerability to our present system and how storage provides water user flexibility. White River constituents currently face an imminent municipal, agricultural, environmental, and economic catastrophe without a resilient water supply then add DM on top of our already tasked and limited water resources? The picture is grim for our community to say the very least. What happens to our towns if there is over conservation as part of a DM program and our water supply is eliminated or injuriously reduced due to the dry up of agriculture or another DM alternative? Where do we turn to then to carry us through these water short times? Critical storage is not here yet and as DM is evolving there will become more need and reliance upon storage. We ask, what are the states



plans to carry our district water needs through when water is already past the state line as part of a state Drought Contingency Plan and basins lack critical components for drought resiliency?

By keeping water in the stream and out of our alluvium by reducing flood irrigation what affect will this have upon stream ecology or the threatened and endangers fishes that reside here later in the season with reduced alluvium storage and return flows? What happens to the considerable investments made for the protection and recovery of our threatened and endangered species or recreational fishery species? Modeling completed for the White River demonstrates low to no stream flow risk to be very real.

Proponents for a DM program express climate change as a purpose and need for such a program yet are they taking into consideration the impacts to drying areas up removing green belts from playing a roll in carbon sequestration and the associated atmospheric cooling these areas provide? Perhaps in place of drying areas up we should be wetting areas using the plants and soils for what they have to offer. How does a browned pasture or field aid or play into a warming climate? Are we treating a symptom as opposed to implementing part of a cure by not wetting and activating these carbon bioreactors?

Part of the DM discussion includes conserved water to be stored downstream in Lake Powell. The district finds this approach unique since once the water has exited Colorado the multiple beneficial uses of our precious resource are no longer possible to Colorado water users. Has the state completed a Cost/Benefit analysis quantifying the benefits to our state by keeping the conserved consumptive use within our boarders? Our analysis has shown the financial benefits keeping water within our basin with the short list detailing; increased economic diversity, healthier municipalities, greater agriculture security, more recreation, stronger healthier stream ecology, and increased carbon sequestration. The White River, while not having formal representation to the DM framework development, is unaware of any attempt by the state to quantify such an analysis. Seeing this, the RWBCD recommends the state quantify these benefits as part of the DM process in a truly representative, open, and transparent means without prejudice including entities or individuals having a truly vested stake in any DM program. This includes entities statutorily created for water conservation such as water conservancy and conservation districts who have additional concepts for DM yet not part of the conversation.



"The Colorado Water Conservation Board's mission is to conserve, develop, protect, and manage Colorado's water for present and future generations." We understand and agree with this complex mission also realizing the state has a legal obligation to meet the Colorado River Compact. Not a simple task. In the instance of DCP and DM is the state truly looking for the wellbeing of our White River community? We see DM evolving around continued or expanded trans-mountain diversions, restrict less-developed basins/regions, and benefit the lower Colorado River basin states all of which is elated to in the DM Framework.

Through a public process created by HOUSE BILL 05-1177 "COLORADO WATER FOR THE 21ST CENTURY ACT" the Yampa-White-Green Basin Round Table unanimously created seven (7) Principles specific to Demands Management. The RBWCD believes these principles are important and MUST be an essential part of any DM program. The principles are: <u>https://drive.google.com/file/d/1YpIQhFCnzzK5FgZ5mQO0Eo8Y19kmDak6/view</u>

- 1. Preservation of Quality of Life in the Y/W/G River Basin: Any DM program must preserve and enhance all aspects of quality of life in our basin, including agriculture, local communities, and local economies, while protecting municipal delivery, addressing environmental needs as well as recreational water use, and offering locally-accepted methods to reduce consumptive use without injury.
- 2. Equity of Responsibility and Opportunity: A DM program must be structured to ensure that no river basin nor single water user group (i.e, Ag, M&I) bears a disproportionate share of DM responsibility, and to provide opportunities for all water right holders to participate on a reasonably-equitable basis. To ensure equity, some form of inter-basin apportionment is required.
- 3. Guided Market: The State of Colorado should establish a marketplace for DM water transactions that is equitable and transparent.
- 4. Rural Communities: Any DM program must evaluate and address all impacts that could result to rural communities, including negative economic, cultural, or social impacts.
- 5. Recreation and Environment: Any DM program must consider/analyze its impacts on environmental and recreational needs, including those resulting from changes in water supply and/or timing of flows. Any DM program should strive to benefit, and must not adversely impact, environmental and recreational water uses and their contributions to local economies.
- 6. Compensation for Value of Water Conserved: Any DM program must fairly compensate participants. Compensation should be based on all economic impacts to the participant and not solely on the loss of income from the crop or product not produced.



7. Trans-Mountain Diversions (TMDs): Basins which benefit from water diverted from the Upper Colorado River must be considered as part of the CRS, with applicable DM responsibilities and opportunities, and subject to equitable apportionment for DM purposes. Any DM program must prohibit trans-mountain diverters from purchasing Western Slope water to meet a DM responsibility.

The Rio Blanco Water Conservancy District unequivocally believes in water conservation and the overlaying rationale for DM but we question the looming injury such a program will have to our basin water users. We continue progressing our locally driven drought planning efforts that includes considerable water conservation imploring upon the CWCB and other state water agencies part of the DM development framework to keep the intricacies and lack of drought resiliency of our White River community in mind as the states DCP evolves. We must reiterate, significant desire to participate in a DM type program is evident in our White River basin however, we lack critical tools necessary for drought and over conservation resiliency. Basin storage is a vital component of our drought planning and must be part of any successful DM program.

Thank you for the opportunity to provide comment.

Wade Cox Board President Rio Blanco Water Conservancy District

Wade Klow



June 30, 2021

Ms. Amy Ostdiek Colorado Water Conservation Board 1313 Sherman Street, Suite 718 Denver, Colorado 80203

Delivered via electronic mail to amy.ostdiek@state.co.us

Re: <u>Comments on Demand Management Feasibility Investigation</u>

Dear Ms. Ostdiek,

On behalf of Trout Unlimited ("TU"), I am pleased to offer these comments on the Demand Management Feasibility Investigation (the "Investigation") and the Demand Management Framework (the "Framework"). TU appreciates the hard work of the Colorado Water Conservation Board ("CWCB") and its staff in leading the Investigation and in developing the Framework, and we appreciate the opportunity to provide input on these important issues.

As you will recall, in August of 2020, TU sent you a letter commenting on a number of issues related to demand management and the CWCB's Demand Management Feasibility Investigation. A copy of TU's 2020 letter is attached for your reference. Many of the issues we discussed in our 2020 letter remain outstanding or unresolved. While we recognize that demand management is complex and while we appreciate that development of the Framework has been time-consuming for CWCB staff, as an overriding matter we would have liked to have seen more progress towards resolution of demand management issues over the past year. Going forward, as we discuss in more detail below, it is important that the CWCB increase the pace of the Investigation.

Declining Climatic Conditions Require Swift Action

As you know well, climatic conditions across the Colorado River basin are in decline. Another year of hot and dry conditions has dramatically reduced runoff into an already-low Lake Powell, which is now approaching the lowest level since its filling in the early 1960s. The U.S. Bureau of Reclamation ("Reclamation") recently declared a Stage 1 shortage on the Colorado River, and Reclamation is projecting a further decline in water availability by 2022, which would trigger harsh curtailment measures under the 1922 Colorado River Compact. The need for action is urgent, and the CWCB must act now to advance the development of a demand management program, even if there is not 100% consensus across the state regarding the parameters of a demand management program.

Failure to Act Could Have Devastating Consequences

Failure to take action to address the declining hydrological conditions in the Colorado River basin could lead to severe economic disruption, litigation, or federal intervention. In other words, delays make it more likely that Colorado will suffer negative consequences or lose local control over shaping how to respond to the worsening climatic conditions in the Colorado River basin. Such a loss of control is not in the state's best interest. While there may be some hard choices in structuring a voluntary demand management program, the consequences of not acting could be significantly more disruptive to Colorado.

Demand Management is Critical

Reducing Colorado's risks under the 1922 Colorado River Compact will require a multitude of responses, with demand management likely being the most important. The upper Colorado River basin states' plan to release water from several upper basin reservoirs to bolster Lake Powell levels is an important tool, but it is a temporary fix that will not on its own prevent declines in Lake Powell elevations. Other solutions, including expanded water conservation and reuse, land use planning, infrastructure improvements, and investments in healthy watersheds will also be required. Demand management may be the most powerful risk-reduction response available.

A Pilot Program Would Help Advance the Investigation

The 2019 Drought Contingency Plan ("DCP"), which provided the upper basin states a seven-year opportunity to test demand management and store the conserved water in Lake Powell, expires in 2026. If the upper basin states are going to learn how a demand management program can work, it is imperative to launch a pilot program as soon as possible. Otherwise, we would be missing the opportunity to learn as much as we can during the DCP window. The CWCB should commit to initiating a new, multi-year pilot program with projects across different water use sectors and geographies as soon as possible. Given our past involvement in the System Conservation Pilot Program and other on-the-ground demonstration projects in the years since then, TU looks forward to working actively with our partners in the agricultural community to develop projects under a pilot program.

Conclusion

Trout Unlimited urges the State of Colorado to act quickly and decisively towards the development of a demand management program, and we look forward to continuing to work with the Colorado Water Conservation Board towards this goal. Thank you for the opportunity to provide these comments.

Sincerely,

Salt_11

Drew Peternell



June 28, 2021

Colorado Water Conservation Board 1313 Sherman St., 7th Floor Denver, CO 80203 Via: <u>demandmanagement@state.co.us</u>

RE: Response to Request for Input on Demand Management Feasibility Decision

Dear Members,

The Theodore Roosevelt Conservation Partnership is a coalition of 60 hunter, angler, science and outdoor recreation groups working to ensure all Americans have quality places to hunt and fish. The TRCP has worked for most of its 20 years primarily with federal agencies but also with state governments on water issues of importance, including trying to correct the water demand-supply imbalance in the Colorado River Basin because of the importance of the Basin's habitat for fish and wildlife. We have been following the Colorado Water Conservation Board's efforts to determine the feasibility of a Demand Management program closely, including by serving on the Environmental Values Work Group in 2020.

Because TRCP staff will not be able to attend the Demand Management Framework Public Listening Session June 29th from 5-7 pm, we ask the Board to consider our comments below as it determines Colorado's next steps.

Context:

As the Board is well aware, this year's extreme drought conditions come on top of a 20 year mega-drought. The hydrology for the Basin's rivers and reservoirs is simply dire. If the Bureau of Reclamation's most recent <u>24-month study</u> projections are true, Lake Powell may decline to elevation 3525 during the 2022 water year, triggering reductions in hydropower production at Glen Canyon Dam and putting Upper Basin cities, ranches and recreational water users at real risk for compact curtailment.

As a result, time is of the essence for the Board to identify and implement tools to help Colorado's water users collectively, including those who value our rivers for recreational benefit. Absent state solutions, individual water users will take individual action that may not help the State, its fish and wildlife, or even downstream water users. And, while the TRCP is aware of the Upper Colorado River Commission is also evaluating the feasibility of demand management, its process cannot answer state-specific questions, so Colorado must find answers to its own issues rather than waiting for that investigation to conclude.

Delay will make it more likely that Colorado loses control to shape the responses best for its community of water users. Without action, Colorado's water users are at ever greater risk of severe economic disruption and potentially even litigation or federal intervention. Compared to those risks, which only grow with each dry year, it is worth the Board taking a leadership role to structure a demand management program, along with other tools (like the one-time reservoir releases current under discussion) to address the Basin's water challenges.

Further delay of pilots and a full demand management program in Colorado will also add to the existing burdens for Latino communities in Colorado and the Colorado River Basin. One third of U.S. Latinos live within Colorado River Basin states, including ours. As a group, Latinos are more likely to face health impacts from climate change than others. And, one cannot imagine a demographic more supportive of building resilient water systems that serve people, fish and wildlife. An astonishing 96% of Latinos in the West support funding to modernize water infrastructure and restore natural areas in ways that improve drought resilience, while 93% agree that, notwithstanding state budget shortfalls, it is imperative to fund protection of states lands, water and wildlife. Without adequate responses to drought and climate change – which is primarily expressed in terms of drought and fire in the West, including Colorado – Latinos will continue to feel the disproportionate adverse health impacts and other effects of climate change and drought. It is therefore incumbent on the CWCB to act expeditiously to stand up programs like demand management and others, that can build climate and drought resiliency without delay.

The Board, with its staff of policy, technical and legal experts, and having conducted several years of public outreach regarding demand management and other tools, is best positioned to act in a way that will best serve Colorado's people and water resources, including the fish and wildlife that resource supports. The Board must lead on demand management but also work with other agencies, water users and communities of interest to expand water conservation and reuse, promote land use plans that fosters efficient water use, fund upgrades to aging less efficient water infrastructure and invest in healthy forests and watersheds.

Framework Comments and Next Steps

The draft framework does a good job of laying out the many factors, and thus decisions that the Board would have to make to set up and implement an equitable, voluntary and effective demand management program. But the framework does not provide a way to evaluate the tradeoffs – costs and benefits – amongst those decisions. For example, with knowing the financial cost of choosing a simple, more complex or robust alternative for any one factor, the CWCB cannot know how that choice may constrain what other choices would be available based solely on their cost. While a more sophisticated decision support tool, along with more complete data, e.g., on the cost of various choices, would help the Board, given the need for quick action, there is not the time available to optimize a program at inception.

If the Board is going to set up a demand management program, not only the hydrology, but the seven-year timeline of the 2019 Drought Contingency Plan, demands action within the year. The States, Reclamation, and others have begun renegotiating the 2007 Interim Shortage Guidelines, which must also be completed in 2026. If the Upper Basin states are going to learn anything from a demand management program, they must launch that program and implement associated projects as soon as possible. A demand management program cannot help in a practical matter, or provide lessons useful for the renegotiation unless it is in place before the crisis, not after the horse is out of the barn.

We encourage the CWCB to be practical and focus on moving quickly beyond the Framework to seek solutions and implement a pilot program that incorporates a diverse range of pilot projects. There are too many additional complex questions that will also take time to answer. We encourage the CWCB staff to focus on identifying and answering key questions and supporting additional pilot projects, including hypothetical exercises in certain circumstances, as a good approach. A range of pilots is needed, incorporating diverse geographies and project types, including not only agricultural projects, but also transmountain diversion, industrial, and other projects. The conceptual proposal for a programmatic pilot from the Agricultural Impacts Demand Management Workgroup can be a starting point.

Because of the State's interests in, and in some respects, responsibilities for maintaining fish and wildlife habitat, as well as the economic benefits of recreational water use, the Board's next steps should include an analysis of potential environmental co-benefits in pilot project design or a full demand management program. Such co-benefits only become more critical in the face of changing hydrology and increasing aridification, which affect native and important non-native game species alike. Pilots as well as a full program both have the potential to impact recreational and environmental flows, either positively or negatively. We urge the state to incorporate an analysis of environmental and recreation needs and potential benefits and impacts, as well as quantitative monitoring and verification of those, in pilots and any DM program.

Thank you in advance for your consideration,

Melinda Kassen, Sr. Counsel Jared Romero, Director of Strategic Partnerships

Feedback on the CWCB Demand Management Framework

By the Y/W/G Basin Roundtable Big River Committee June, 2021

The Framework and Review Process

The CWCB DM Framework document contains a great deal of detailed information about DM issues and solutions, primarily gleaned from and organized around the DM Work Group discussions. The conceptual framework, based on 3 levels of solutions to address issues, is a well-thought-out approach to presenting the issues that have surface and some proposed solutions for them.

Members of the Y/W/G BRC have reviewed the Framework document in detail, and summarized their comments, suggestions, and questions in the brief that follows. The BRC chose to review the Framework document by comparing it to the Y/W/G Executive Summary of DM Principles ("Principles") published in March of this year. For each Framework topic and subtopic, members of the BRC reviewed solutions to determine whether or not those solutions aligned with or were counter to the Principles. Note that several subtopics in the Framework document are not addressed, as they do not appear to intersect with the Principles.

Comments and questions are generally divided into 2 parts; an initial section that highlights high-level comments and suggestions, and a more detailed discussion of several important topics and sub-topics contained in the Framework.

High-Level Issue Discussion

Following is a summary of high-level comments and suggestions:

1. Purpose and Goal of DM. The DM Framework should state clearly that the overarching purpose of any DM program is to reduce consumptive water usage in order to avoid a Compact call (Y/W/G Context). Although the idea of yielding conserved consumptive use and the goal of placing 500KAF in a pool in Lake Powell are discussed in the Underlying Assumptions of the doc, these were both missed by several reviewers, and it would be helpful if they were more clearly stated at the outset.

2. Shared Responsibility/Opportunity and Apportionment. The DM Framework should also state clearly that all CRS basins and water rights holders will share in responsibility and opportunity of the DM program (Y/W/G Principles 2, 7.) Specifically, no discussion of projects from Industrial water users is provided, while Municipal subtopics emphasize 'support'; several reviewers commented that the document is focused on Ag. While TMD projects are discussed, nowhere does the Framework indicate the requirement that TMD diverters participate in DM. Finally, no discussion of inter-basin apportionment, or some other means of ensuring shared responsibility/opportunity between and among basins, is offered.

Detailed Issue Discussion

Each of the topics and subtopics that intersect with the Y/W/G DM Principles was discussed to determine whether and to what degree each was aligned. Following is a summary of that review:

Major Topic 1: Monitoring and Verification (Agricultural DM Project)

Subtopic: Maintain Return Flows

Option A – (Y/W/G Principles 1, 4, 5): Does not align. Failure to maintain return flows will be detrimental to ag, urban/suburban water users, and recreation in our basin during the late summer/fall season.

Option B – (Y/W/G Principles 1, 4, 5): Could align, provided that adequate storage was available.

Option C – (Y/W/G Principles 1, 4, 5): Would align by providing locally-sourced return flow. However, the solution seems impossibly complex and costly.

Major Topic 1: Monitoring and Verification (Transmountain DM Project)

Subtopic: Measure Water Returned to Stream

Option A – (Y/W/G Principle 7): Does not align. Absent some form of accounting validation (as provided for in the next subtopic), a simple estimate provided by the TMD operator would leave room for a range of harmful outcomes. For example, the TMD operator could simply overestimate the amount of water to be diverted at that diversion point, and take credit for a greater DM impact than was actually earned.

Option B – (Y/W/G Principle 7): Does align. This approach, to which an auditable provision should be added, would help to ensure that the conserved consumptive use claimed is not simply replaced by other Western Slope waters in a 'shell game'.

Option C – (Y/W/G Principle 7): Does align. This approach is the most thorough, but probably is impractical to implement.

Subtopic: Verify Conserved Consumptive Use Occurs on the East Slope

Option A – (Y/W/G Principle 7): Does align. An auditable provision should be added to this statement, but this approach would prevent the 'shell game' tactic that allows a TMD operator to simply switch one West Slope source for another while claiming a DM contribution.

Option B – (Y/W/G Principle 7): Does align, slightly better than Option A but an auditable provision should be added.

Option C – (Y/W/G Principle 7): Does align, but seems overly complicated and expensive.

** Note: This subtopic title could be considered misleading; perhaps a better name would be: 'Verify Accuracy of Accounting for Foregoing TM Diversion and that Conserved Consumptive Use Occurs on the East Slope'. Subtopic: Coordinate Environment and Other Benefits

Option A – (Y/W/G Principles 1, 4, 5, 7): Does align. Option A does not provide any additional benefit, but it does not involve negative impact.

Option B – (Y/W/G Principles 1, 4, 5, 7): Does align. The provision for temporary storage in a Western Slope reservoir helps to mitigate environmental and other impacts.

Option C – (Y/W/G Principles 1, 4, 5, 7): Does align (see comments for Option B) but is too complex and costly for actual implementation.

Major Topic 3: Environmental Considerations

Subtopic: Assessing Net Benefit or Impact

Option A – (Y/W/G Principles 1, 2, 4, 5): Does align, provided that benefits to Y/W/G basin and communities are part of the consideration.

Option B – (Y/W/G Principles 1, 2, 4, 5): Does align, provided that benefits to Y/W/G basin and communities are part of the consideration.

Option C – (Y/W/G Principles 1, 2, 4, 5): Does align, provided that benefits to Y/W/G basin and communities are part of the consideration.

Subtopic: Strategies to Incentivize Benefits

Option A – (Y/W/G Principles 2, 4): Does align. Ensures that all DM contributors have equal opportunity to participate.

Option B – (Y/W/G Principles 2, 3, 4): Does not align. Given hydrology, this option prioritizes participation by main stem users over tributary users.

Option C – (Y/W/G Principles 2, 3, 4): Does not align. Given hydrology, this option prioritizes participation by main stem users over tributary users.

Subtopic: Strategies to Avoid, Offset or Mitigate any Potential Negative Impacts

Option A – (Y/W/G Principles 2, 4): Does not align. Provides no benefit to Y/W/G basin users or communities.

Option B – (Y/W/G Principles 2, 4): Does align. Solutions provided would help to mitigate return flow issues and community impacts.

Option C – (Y/W/G Principles 2, 4): Does align, but seems too complex and costly.

** Note: This subtopic is very broad; some reviewers needed more context.

Major Topic 4: Economic Impact and Local Government (All DM Projects)

Subtopic: Support for Municipal Participants

Option A – (Y/W/G Principle 2, 7): May align, depending on implementation. Accounting verification required; as many municipals have conservation plans, it will be necessary to distinguish between permanent programs and CCU for DM.

Option B – (Y/W/G Principle 2, 3, 7): Does not align. Comments under Option A apply. But beyond those accounting factors, support for municipal project development provided in addition to DM compensation would constitute a large advantage for municipal projects, resulting in inequitable solutions.

Option C – (Y/W/G Principle 2, 3, 7): Does not align. Comments under Options A and B apply. And in addition to those considerations, this Option would potentially require the state of CO to make subjective decisions regarding the applicability secondary and tertiary impacts to DM, then to fund those which are deemed applicable. Ultimately, this Option is unsustainable.

Subtopic: Municipal Sector Mitigation

Option A – (Y/W/G Principle 1, 2, 4, 7): May align, depending on implementation. While this Option does not provide DM-based funding mitigation, it does allow for locally-accepted methods and decision-making.

Option B – (Y/W/G Principle 1, 2, 3, 4, 7): Does align, but involves complexities and subjective, bureaucratic judgements that would render it non-operational.

Option C – (Y/W/G Principle 1, 2, 3, 4, 7): Does align. This Option improves on the previous one by asserting non-subjective protocols. However, it would be complex and costly to implement, and very likely would not be sustainable.

Major Topic 5: Agricultural Impacts

Subtopic: Agricultural Mitigation

Option A – (Y/W/G Principle 1, 6): Does align, provided that compensation for participation is equitable. The goals for Ag Impacts (equitability, mitigating non-farm impacts, guided market, alignment with growing seasons) can and should met through appropriate funding for participants.

Option B – (Y/W/G Principle 1, 3, 6): Does align, but involves complexities and bureaucracy that would be difficult to sustain, and are unnecessary if compensation for participants is equitable.

Option C – (Y/W/G Principle 1, 3, 6): Does align, but involves complexities and bureaucracy that would be difficult to sustain, and are unnecessary if compensation for participants is equitable. Would likely be too costly to implement.

Subtopic: Agricultural Participant Field Requirements

Option A – (Y/W/G Principle 6): Does align. The operating principle asserted here is that the individual landowner holds a property right about which he/she is entitled to make decisions.

He/she has incentive to protect the value of that property through appropriate weed and pest control.

Option B – (Y/W/G Principle 3, 6): May align, depending on implementation. Providing assistance or support at the request of the individual landowner is appropriate. Enforced regulations for private property should not be implemented.

Option C – (Y/W/G Principle 3, 6): May align, depending on implementation. Providing assistance or support at the request of the individual landowner is appropriate. Enforced regulations for private property should not be implemented. Additional staffing may add cost that is unsustainable.

Yampa/White/Green Basin Roundtable Demand Management Statement

Executive Summary

Context

In the face of persistent drought and anticipated long-term growth in demand for water, Colorado and the other six Colorado River Basin states have prepared a Drought Contingency Plan (DCP). One element of that plan is to investigate the feasibility of Demand Management (DM). If implemented, DM will become a future program which, on a voluntary, temporary, and compensated basis, will reduce water use by individual, public, and commercial water rights holders, to avoid administration of the Colorado River.

Statement of Principles

Given the context for DM in Colorado, the Yampa/White/Green River Basin Roundtable considers the following concepts to be important in the development of a DM program:

- 1. Preservation of Quality of Life in the Y/W/G River Basin: Any DM program must preserve and enhance all aspects of quality of life in our basin, including agriculture, local communities, and local economies, while protecting municipal delivery, addressing environmental needs as well as recreational water use, and offering locally-accepted methods to reduce consumptive use without injury.
- 2. Equity of Responsibility and Opportunity: A DM program must be structured to ensure that no river basin nor single water user group (i.e, Ag, M&I) bears a disproportionate share of DM responsibility, and to provide opportunities for all water right holders to participate on a reasonably-equitable basis. To ensure equity, some form of inter-basin apportionment is required.
- 3. Guided Market: The State of Colorado should establish a marketplace for DM water transactions that is equitable and transparent.
- 4. Rural Communities: Any DM program must evaluate and address all impacts that could result to rural communities, including negative economic, cultural, or social impacts.
- 5. Recreation and Environment: Any DM program must consider/analyze its impacts on environmental and recreational needs, including those resulting from changes in water supply and/or timing of flows. Any DM program should strive to benefit, and must not adversely impact, environmental and recreational water uses and their contributions to local economies.
- 6. Compensation for Value of Water Conserved: Any DM program must fairly compensate participants. Compensation should be based on all economic impacts to the participant and not solely on the loss of income from the crop or product not produced.
- Trans-Mountain Diversions (TMDs): Basins which benefit from water diverted from the Upper Colorado River must be considered as part of the CRS, with applicable DM responsibilities and opportunities, and subject to equitable apportionment for DM purposes. Any DM program must prohibit trans-mountain diverters from purchasing Western Slope water to meet a DM responsibility.



The Nature Conservancy in Colorado 2424 Spruce Street Boulder, CO 80302 tel (303) 444-2950 fax (303) 444-2985

nature.org/colorado

June 28, 2021

Submitted by email

RE: Demand Management Framework Comments

Dear Colorado Water Conservation Board members and staff:

The Nature Conservancy (TNC) appreciates the Colorado Water Conservation Board (CWCB) request for feedback on the Demand Management (DM) framework. We opted to send a letter rather than fill out the survey due the complexity of the issue and desire to provide more information than the survey could provide.

TNC is a global environmental nonprofit working in Colorado for over 55 years to create a world where people and nature can thrive. Our mission is to conserve the lands and waters on which all life depends. TNC has over one million members and works in all 50 states and impacts conservation in 72 countries and territories across the world.

Reservoirs in the Colorado River Basin, filled to the brim at the end of the 20th century, are at historic lows. By 2060, demand for water from the Colorado River may exceed supply by more than 3.2 million acre-feet. Coming up short could put at risk the drinking water supplies of almost 40 million people in the Southwest, agricultural production, endangered species, the health of our rivers, and future economic growth, as well as the Colorado River's \$26 billion outdoor recreation economy with its quarter-million jobs. With so much at stake, we have been following CWCB efforts to determine the feasibility of a Demand Management program closely, and four TNC staff members served on the CWCB's demand management work groups.

Now, another year of hot and dry conditions have dramatically reduced run-off into an already low Lake Powell, which is now approaching the lowest level since its filling in the early 1960s. The U.S. Bureau of Reclamation recently projected that by early 2022, Lake Powell is likely to decline to elevation 3,525 feet—a level that would result in reduced hydropower production at Glen Canyon Dam and would put the Upper Basin at risk of triggering harsh curtailment measures under the 1922 Colorado River Compact. These unprecedented conditions require that Colorado decision-makers act swiftly and decisively to develop and implement a plan and tools to protect and manage Colorado's water and rivers for present and future generations.

Existing conditions require a multitude of responses, and demand management is a vital tool to address the Upper Basin's water challenges. The Upper Basin states' plan to release water from

several Upper Basin reservoirs to bolster Lake Powell levels is one important tool, but it is a temporary fix that won't prevent risky declines in Lake Powell on its own. Other solutions, including expanded water conservation and reuse, land use planning, infrastructure improvements, and investments to improve the health of forests and watersheds will also be required. Demand management, based on the bedrock principles of "temporary, voluntary, and compensated," and with sideboards to avoid disproportionate impacts and ensure environmental protection, may be one of the most useful risk-reduction responses available.

With hydrology rapidly degrading, the longer we wait to develop effective tools to collectively mitigate risk the more likely we are to lose local control in shaping how Colorado will respond and what tools will be available to us.

The CWCB draft framework is a good start in laying out the many decisions needed to set up and implement an equitable, voluntary, and effective demand management program. The Framework is a good summary of the State of Colorado's demand management feasibility evaluation, but it does not provide a way to evaluate tradeoffs and benefits to aid in decision-making. The framework is very detailed, which can be useful in understanding the State's process to date; however, its complexity may also be confusing to many stakeholders. As is, it provides a concise high-level summary of key workgroup concepts and issues. However, it cannot be used as a decision-making tool because it lacks a way to evaluate or consider tradeoffs and benefits between the various components of one category and the implications of that component choice on other categories.

We believe that CWCB decision-makers must evaluate trade-offs, make the hard calls, and develop a demand management program that can be in place as one tool if the situation continues to decline. The state should not let the desire for the perfect be the enemy of the workable—the current and projected hydrology doesn't allow Colorado to wait for 100 % consensus. Now is the time for the CWCB to move forward so it has a plan and a program in place *before* a crisis.

Inaction or undue delay could lead to severe economic disruption, litigation, and even federal intervention. While there may be some hard choices in structuring a voluntary demand management program and no one wants to reduce their water use, the consequences of not having a plan to address the crisis will be severe and costly. The decision to proceed or delay needs to be made in the full context of what can happen if dry years continue. There won't be any do-overs and curtailment without any siderails seems like a risky path for Colorado. The CWCB, with its staff and legal experts and the benefit of extensive public outreach, is positioned to make good decisions that best serve Colorado's people and water resources.

Many states in the Upper Basin are deferring to the UCRC feasibility process. That process is important but will not answer state-specific questions. Colorado must find answers to its own issues and concerns rather than waiting for the UCRC investigation to conclude.

The 2019 Drought Contingency Plan, which provided the Upper Basin States with a seven-year opportunity to test demand management and store the water conserved in Lake Powell, expires in 2026. The States, Reclamation, and others have begun renegotiating the 2007 Interim Shortage

Guidelines, which must also be completed by 2026. If the Upper Basin states are going to learn how a demand management program can work, it seems that we are missing the opportunity to learn as much as we can during the DCP window to experiment with different approaches and pilot programs.

We encourage the CWCB to focus on moving quickly beyond the Framework to seek solutions and implement a program that incorporates a diverse range of pilot projects. We hope that the State will not linger on the process of finalizing or improving the Framework. We encourage the CWCB staff to focus on identifying and answering key questions and supporting additional pilot projects, including hypothetical exercises in certain circumstances, as a good approach. A range of pilots is needed, incorporating diverse geographies and project types, including not only agricultural projects, but also transmountain diversion, industrial, and other projects. The Agricultural Impacts Demand Management Workgroup shared a conceptual proposal for a programmatic pilot that offers opportunities for systematic exploration of the multiple objectives identified by the State and other interested parties.

The State has interests in and responsibilities for maintaining environmental, fish and wildlife, and recreational water uses and values. These only become more critical in the face of changing hydrology and increasing climate change driven drought. A demand management program has the potential to positively or negatively impact recreational and environmental flows, including target flows for endangered species. We urge the state to create a demand management program that benefits rivers and that incorporates in program and project development and implementation an analysis of environmental and recreation needs and potential benefits and impacts, as well as quantitative monitoring and verification of project benefits and impacts.

We thank the CWCB staff for their work in developing the framework and commend them on their efforts to ensure a robust and open conversation about demand management in Colorado.

Sincerely,

Cadual

Carlos E. Fernandez Colorado State Director

CC: Becky Mitchell Lauren Ris Dan Gibbs Jonathan Asher Kelly Romero-Heaney

Laylor d

Taylor Hawes Colorado River Program Director

DEMAND MANAGEMENT: Preliminary Guiding Principles

Adopted June 10, 2021

The principles outlined below are intended to guide Southwestern Water Conservation District (SWCD) in its evaluation of and input to any Demand Management (DM) program the state of Colorado, in cooperation with the other three Upper Basin states, may advance.

SWCD has not adopted a position of support, opposition or neutrality on the feasibility or development, let alone implementation, of a DM program within the Upper Basin. There are simply too many unknowns at this point. DM is an evolving concept; accordingly, this is a living policy document that will be reviewed periodically to reflect changing program elements, evaluations, and goals of DM in Colorado and the Upper Basin.

SWCD was created by the General Assembly in 1941 to lead in the conservation, use and development of the water resources of the San Juan and Dolores river basins, both of which are tributary to the Colorado River. SWCD's organic act also includes the charge "to safeguard for Colorado, all waters to which the state of Colorado is equitably entitled." Demand management is a novel concept that, if implemented, has the potential to alter water use and administration within the Upper Basin and, on a more local level, within SWCD's boundaries. Accordingly, SWCD will remain involved in the evaluation and potential formation and implementation of any DM program Colorado may pursue.

Colorado River Basin Drought Contingency Plans:

At least since the turn of this century, the security and sustainability of Colorado River water supply has been in question. The basin is currently experiencing one of the worst hydrologic cycles in recorded history. Continuing drought, resulting in worsening water supply and storage conditions, increases the risk of curtailment in the Upper Basin.

To reduce the risk of Lake Powell and Lake Mead declining to critically low levels, the United States Department of the Interior (Interior) and the seven Colorado River basin states agreed to develop and implement plans to overlay the 2007 Interim Guidelines addressing forecasted low reservoir elevations if the drought continued. The resulting Colorado River Drought Contingency Plans (DCP) were submitted to Congress on March 19, 2019. On April 16, 2019, then President Trump signed the Colorado River Drought Contingency Plan Authorization Act into law. This bill requires Interior to execute the Colorado River Drought Contingency Plans without delay and to operate applicable Colorado River System reservoirs accordingly.

For its part, the Upper Division states of Colorado, New Mexico, Utah and Wyoming committed to three primary strategies to address the impacts of continued drought in the basin. The first strategy, weather modification, was already being implemented across the basin and needed no federal legislation so was not included as part of the legislation passed in the Upper Basin's Drought Contingency Plan (DCP). The other two strategies focus directly on the goal to minimize the risk of water levels at Lake Powell falling below target elevations: an immediate response and a multi-year plan. The second strategy, articulated in the Drought Response Operations Agreement of the Upper Basin's DCP, is an immediate response measure designed to utilize operational adjustments or releases from the Colorado River Storage Project Act (CRSPA) Initial Units to bolster storage levels at Lake Powell when Lake Powell approaches a critical low elevation of 3,525' MSL. The Drought Response Operations Agreement also provides mechanisms for recovering storage at those same CRSPA Initial Units in subsequent years.

The Upper Basin's longer-term strategy is to explore the feasibility of developing and implementing a new demand management program that could generate water savings by either temporarily reducing existing water use within the Upper Basin or augmenting supplies with imported water. Under the Upper Basin's DCP, up to 500,000 acre-feet of DM water savings can be stored in the CRSPA Initial Units to help assure continued compliance with the Colorado River Compact under certain circumstances.

Most of the investigations and discussions pertaining to DM to date, have been focused on generating DM "water savings" through the voluntary, compensated and temporary reduction of historically consumptively used (HCU) water within the Upper Basin in order to assist with Colorado River Compact compliance. As a result, the guiding principles set forth below are based on the assumption that DM water will be generated in this manner.

Guiding Principles:

The foundational elements of any DM program must be voluntary, temporary, and compensated reductions in use of water that was being beneficially used under existing rights that otherwise would have depleted Colorado River basin flows within the Upper Basin.

SWCD believes DM is not a panacea. Additional options and alternatives (e.g., forest management, groundwater storage, weather modification, non-native phreatophyte removal, importing water from outside of the Colorado River basin) should be equally and fully explored as we work towards the goal of supply security and sustainability in the Colorado River basin.

Exploration of DM must be just one part of the comprehensive, basin-wide strategy for addressing shortand long-term water supply and demand imbalance that may be included in the next set of Interim Guidelines currently in negotiations regarding the operations of Lake Mead and Lake Powell for future Colorado Compact compliance.

SWCD pledges to evaluate DM as one of many possible strategies to provide flexibility and reduce the risk of curtailment in the Upper Basin.

SWCD will participate in the exploration and potential formation of any Colorado DM program to ensure any proposed program is capable of achieving its stated objectives and that adverse consequences are avoided, minimized, or fully mitigated.

Any DM program must operate within Colorado's Prior Appropriation Doctrine. The creation, storage, delivery and use of DM water must not injure any existing water right within Colorado.

Before deciding whether it would be feasible to adopt, let alone implement, a DM program within Colorado, the State must commit to developing the technical platform necessary to demonstrate that a program can be accomplished without injury to other users within Colorado, at a sufficient scale, and that any conserved water can be conserved, protected, and ultimately delivered for Compact compliance.

Any DM program must ensure equitable and proportional participation from all basins consuming Colorado River water as well as all regions and sectors of Colorado's economy. SWCD acknowledges that "equity" and "proportionality" are critical but undefined terms within the context of demand management. Both are currently the subject of statewide focus. Transmountain diverters of Colorado River water must participate in DM using water that was historically diverted and beneficially used under decreed transmountain water rights. Transmountain diverters must not be allowed to purchase or otherwise rely upon other water supplies that originate in the Colorado River Basin in order to accomplish their proportional participation in DM.

A successful DM program can help ensure the safety and economic health of all Coloradans. Accordingly, the considerable funding required for DM must not target water right holders, water users, or other specific groups.

Colorado's DM program, if any, must be designed and implemented to support and aid sustaining Colorado's predominantly family- and locally-owned agriculture.

Storage of DM "savings" should be in CRSPA Initial Units that are located as high in the system as practicable.

Releases of DM water from storage should only be made by the Upper Colorado River Commission for the purpose of helping the Upper Division States assure continued compliance with Article III of the Colorado River Compact without impairing the right to exercise existing Upper Basin water rights in the future. Such releases should be timed, to the extent practicable, to provide the greatest economic, environmental, and recreational benefits.

Any DM program must not encourage or reward speculation in Colorado water resources.

Any DM program must recognize there will be impacts resulting from implementation of DM, and that impacts, both positive and negative, will be neither equally nor equitably distributed. Therefore, any DM program must include adequate mitigation for those individuals, water districts and ditch and reservoir companies, and communities impacted by implementation of a DM program. Additionally, DM mitigation should be designed to provide a net benefit to participating individuals, water projects, and their communities.

The evaluation of DM's feasibility, appropriateness, and whether DM is a timely and worthwhile pursuit must be approached without prejudice. In other words, a determination of infeasibility, inappropriateness or unworthiness must be honestly evaluated.

In order to 'test' DM and to allow for incremental implementation and accrual of meaningful DM savings, SWCD recognizes that initial implementation of DM may be required at a pilot or demonstration scale. However, any pilot or demonstration DM program must be conducted in conformance with Colorado water law, without injury to other water users and without prejudice regarding its conclusions or consequences.

As it continues to evaluate the appropriateness of DM, SWCD will remain mindful of the severe consequences of Compact Administration, which could force involuntary, and uncompensated water curtailments that could, in turn, result in disproportionate impacts to certain water users, economic sectors and geographic regions.

SWCD appreciates the CWCB's outreach and inclusivity in its evaluation process to date. SWCD pledges its continued, constructive participation with the state in its DM investigations.

Future Process:

SWCD will continue to explore demand management, including by proactively identifying and communicating its concerns regarding disproportionate and negative impacts potentially resulting from implementation of DM.

SWCD will continue to reach out to water districts, Tribes, and other interested parties in its on-going evaluation and assessment of DM.

SWCD will continue to evaluate water supply, water rights, and water uses and their respective relationships to Compact compliance.

SWCD will collaborate closely with the Colorado River District in order to maintain, to the greatest extent possible, harmony on DM between the two districts.

SWCD will continue to engage in all appropriate Colorado River Compact discussions.

COLORADO WATER CONSERVATION BOARD Protecting Colorado Water DEMAND MANAGEMENT FRAMEWORK

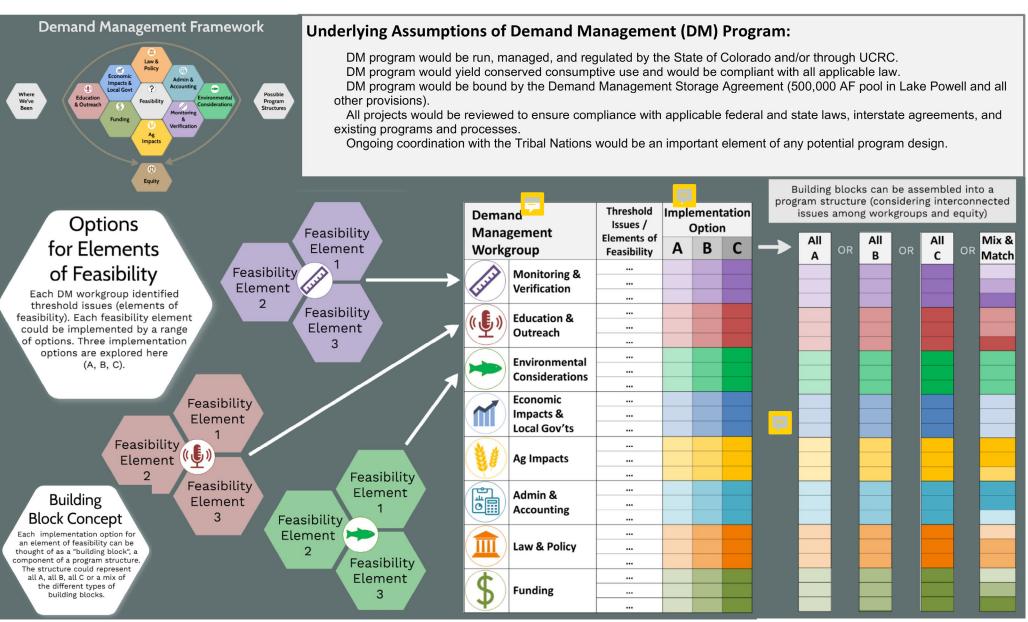
As part of Colorado's <u>Demand Management</u> Feasibility Investigation (see <u>Work Plan</u>) led by the Colorado Water Conservation Board (CWCB), this document includes a Demand Management Framework focusing on various issues associated with a potential Demand Management program.

While reviewing, note that the following Demand Management Framework draft is:

- For a potential Demand Management program that would involve temporary, voluntary, and compensated reductions in consumptive water use pursuant to the <u>Demand Management Storage Agreement</u>.
- Not a Demand Management program, but rather a tool for discussion regarding a potential program, which is not a foregone conclusion.
- Designed to be iterative, and there will likely be multiple updated versions released as the discussion progresses.
- Designed to show a broad range of implementation options, without showing preference for any given option.
- Set up using a range from A to C, designed to roughly correlate with level of complexity for the various implementation options. These designations do not correlate with any value judgments about which option may be best.
- Not intended to represent any commitments or guarantees regarding viability of a program design. For example, some options presented may have budgetary or other constraints.
- Intended to be used as a tool for discussion across Colorado about what may work and what may not work in a potential Demand Management program from varying perspectives, and any information gathered throughout this process is intended to assist CWCB in determining whether Demand Management may be achievable, worthwhile, and advisable from Colorado's perspective.
- Not intended to represent any position of the CWCB or the State of Colorado regarding the feasibility of Demand Management.

To provide feedback on this Framework document, please email <u>demandmanagement@state.co.us</u> or visit <u>engagecwcb.org</u>.





*Note that Law & Policy and Administration & Accounting elements are not included in this analysis.

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DM Program Structure Matrix of Building Blocks

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DM Threshold Issues / Interconnected Issues, T 🗧						
Workgroup Guiding Principles 	Elements of Feasibility	А	В	С	Considerations	
Timeframe and scale of	of DM Program	All potential op	tions may impact or be impacted by the timefr	rame and scale of a DM Program.		
Monitoring & Verification (Agricultural DM Project) • Honest, accurate, transparent, and defensible	Measure water returned to stream	Bypace of diversions (streamflow an <i>fer</i> eservoir releases, if applicable) if the physical and legal availability can be easily determined; or estimate the amount of conserved consumptive use through moderate engineering estimates (such as reducing historical diversion rates) to protect downstream users.	Diversion of the irrigation supply (streamflow and/or reservoir releases, if applicable) into a ditch at a flume with a stage/discharge recorder, after which would be returned to the stream.	Diversion of the irrigation supply (streamflow b)/or reservoir releases, if applicable) into a ditch with multiple real-time recording devices and a telemetry system to remotely monitor diversions and the measured returns of the irrigation supply to the stream.	Simplifying the measurement and verification requirements may underestimate the amount of the generated for a DM project based on the need to use cons setimates. Increasing the measurement and verification requirements may result in increased instrumentation requirements, longer review and/or enrollment periods, and may increase program costs, but could result in greater amounts of credits/water generated for individual DM projects.	
 Protective of other water users As simple, easy, and flexible as possible Participation adds water to the Colorado River 	Conduct a consumptive use analysis Estimate the residual field consumptive	Use the Division of Water Resources' Lease Fallow To estimate historical consumptive use (conservatively underestimating to protect downstream users). Complete fallowing, removal of deep-rooted crops, and management practices to prevent inadvertent irrigation with visual	Complete a general site-specific potential consumptive use analysis, similar to a Substitute Water Supply Plan (SWSP), to estimate consumptive use, while considering the available diversion data and/or historical remote sensing data and/or aerial photographs. Full or split fallowing with ongoing measurement of groundwater levels and/or visual soil moisture inspections.	Complete a detailed site-specific engineering analysis, similar to a water court change case, with parcel specific representative data to determine historical consumptive use and return flows. Split fallowing, irrigation of lower consumptive crops, or deficit irrigation with ongoing measurement of applied irrigation supplies, soil moisture, and remote sensing.	Equity considerations include participation across diverse geographic areas, wide-spread locations within a stream system, wide-ranging ditch system complexities, and agricultural sectors/markets.	
Basin – not solely a retiming of depletions	use Maintain return flows	Bypass of diversions Sett immediate delivery or both the consumptive use and return flow portions of the irrigation supply back to the stream after measurement.	Develop unit response functions (URFs) to determine the timing of delayed return flows to the stream and replace in time from legally available contracted supplies (reservoir releases or augmentation credits).	Determine the historical return flow patterns through a site-specific study and then construct and equip a recharge or infiltration pond with measurement devices near the fallowed field to maintain historical return flows in time, location, and amount.	Simplifying the monitoring and verification requirements for return flow maintenance may increase participation in a DM program, but could decrease streamflow absent a supply to replace lagged irrigation return flows. Increasing the monitoring and verification requirements for return flow maintenance may reduce participation in a DM program, but could be more protective of streamflow by identifying a supply to replace lagged irrigation return flows.	
Monitoring & Verification (Transmountain DM Project)	Measure water returned to stream	Bypass of diversions if the physical and legal availability can be easily determined; or estimate the amount of conserved consumptive use using moderate engineering estimates (such as reducing historical diversion rates) to protect downstream users.	Diversion of the transmountain supply for measurement in a flume with a stage/discharge recorder, after which would be returned to the stream OR measurement of reservoir release.	Diversion of the transmountain supply with real- time recording devices and a telemetry system to remotely monitor measured returns/releases of the transmountain supply to the stream.	Simplifying the measurement and verification requirements may underestimate the amount of credits/water generated attributable for a DM project based on the need to use conservative assumptions and/or estimates. Increasing the measurement and verification requirements may result in increased instrumentation requirements, longer review and/or enrollment periods, and may increase program costs, but	

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 Honest, accurate, transparent, and defensible Protective of other water users As simple, easy, and flexible as possible Participation adds water to the Colorado River Basin – not a retiming of depletions 	Verify conserved consumptive use occurs on the East Slope	Water user provides accounting demonstrating the reduction of West Slope deliveries for a DM activity did not result in additional West Slope diversions from another of its transmountain systems or contractual supply.	Water user provides accounting demonstrating the reduction of West Slope deliveries for a DM activity was offset by another East Slope supply or through a reduction in the overall demand of its customers.	Water user maintains double accounting records for several years to confirm that a DM activity in one year wasn't offset by retiming of future Colorado River depletions in subsequent years. This includes all reservoir accounting records and the reconciliation of carryover storage of West Slope supplies in East Slope reservoirs.	could result in greater amounts of credits/water generated for individual DM projects. Equity considerations include participation across diverse East Slope geographic areas, wide-spread locations of individual TMD projects, wide-ranging TMD system complexities, and ability to share conserved consumptive use impacts across all users within a DM participant's system.
Monitoring & Verification (Process considerations for all projects)	Coordinate environmental and other benefits	Qualitatively demonstrate an increase in streamflow after bypassing a transmountain diversion and/or divert, measure, and return flows to the stream. No additional measurement structures are required above what is deemed necessary to verify measurement of water returned to the stream.	Qualitatively demonstrate that temporary storage in a West Slope reservoir for a planned release bolsters non-consumptive, environmental and flow related benefits. Impacts and benefits evaluated qualitatively only. No additional measurement structures are required above what is deemed necessary to verify measurement of water returned to the stream and reservoir operations.	Quantitatively demonstrate that temporary storage in a West Slope reservoir for multi-benefit planned releases bolsters non-consumptive, environmental, and flow related benefits. Impacts and benefits evaluated quantitatively. Measurement needs could include flumes for measuring bypass of diversions and/or return flows; additional stream gages; measurements of water quality, etc. Accounting required to monitor a project's net effect (e.g. lagged return flow accretion timing, etc.).	Foregone agricultural and TMD diversions could provide additional benefits for non-consumptive uses and environmental flow needs both immediately after release and/or after temporary storage. Incorporating West Slope storage to manage releases of foregone agricultural and TMD diversions could maximize flexibility and bolster non-consumptive and environmental flow needs, but would result in additional evaporative losses and would reduce water generated by an individual DM project. Incorporating West Slope storage could also increase the requirements for measuring, verifying, and quantifying environmental benefits and/or impacts.

DM Program Structure Matrix of Building Blocks

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		DRAFT	DM Program Struc	ture Matrix of Building Blocks	DRAFT
 Fducation & Outreach Transparent and inclusive stakeholder engagement to shape the 	Water education (to engage broad audiences)	State creates detailed website resources, issues press releases, conducts interviews, and delegates many education tasks to PEPO, WEco, and other partners.	State partners with groups such as WEco, PEPO, educators, cooperative extension or similar entity, and universities to implement a series of education activities; implements a targeted communications plan; offers webinars to partner organizations; some new audience engagement.	State brings on the staff of runds education to travel statewide for strategic teaching efforts rooted in drought and water shortage k and edge; partners extensively; communicates broot and (i.e. radio, billboards, TV) to new water audiences.	"Change management" is an ongoing and resource-intensive effort to evolve both the program design and the state's attitudes towards water use.
 program Address communication gaps with message consistency, partner networks, and virtual engagement Water education 	Stakeholder engagement (to inform the program)	State builds upon successes of preexisting programs. Utilizing Board and IBCC input, and updated website comment functionality, the state develops a DM program with assistance from consultants or others as needed and appropriate.	Leveraging the Board, Roundtables, IBCC, CWC, conservation districts, and public meetings, the State leads a public input process to inform a DM program and geography. As the program is developed, stakeholders are invited to address the CWCB Board to proactively identify and discuss how the program is working from varying perspectives and geographies.	The state engages a broad and diverse range of stakeholders over an extended period. As the program is developed and implemented, stakeholders are invited to address the CWCB Board to proactively identify and discuss how the program is working from varying perspectives and geographies. Based on this input, elements of the DM program are appropriately tailored to local needs across the state. An iterative process with evolving program options.	More localized programs may mean that some programs cost the state more, and other programs cost the State less. Stakeholders would need to determine whether it is fair for taxpayer dollars to be ibuted inequitably for the sake of equity. While an evolving program structure may be desirable as a mechanism to proactively avoid or mitigate potential negative impacts, it may make it more difficult to ensure a clear, predictable process is in place. If a DM program is established, CWCB will coordinate with other state agencies relating to conflict resolution processes available.
at the state, regional, and local levels Include an equity lens in all engagement and communication 	Program marketing (to ensure participation)	State remains active in water forums like CWC; implements marketing plan as needed to target audiences; maximizes pre-existing participants. No active solicitation. Assumes participants would approach state.	State partners with local actors to assist with program marketing; implements proactive marketing plan to target audiences using annual allocated funds.	State opens local offices to be liaisons between the state and program participants; extensive marketing; maximizes new program participants. State has a role in co-developing applications with new applicants.	The "bang for the buck" considerations would need to be weighed by decision makers and stakeholders regarding the extent to which additional efforts yield increased program participation. Lower levels of marketing would limit the State's ability to educate / market for increased participation in certain geographies / sectors. Smaller operations, non-English speakers, and nontraditional participants such as mining or food industry would benefit from higher levels of implementation.
Environmental Considerations • Achieve a net environmental benefit over time, and across hydrologic conditions and geographies	How potential environmental benefits and impacts are considered	Environmental benefits and impacts (flow needs, affected habitat, and/or species, alignment with other plans or efforts, etc.) considered through existing review processes and frameworks.	Identify potential environmental benefits and impacts and associated risks for potential projects. Evaluate possibility of realizing potential benefits and mitigating potential impacts. Coordinate with other agencies to identify and track potential benefits and impacts, including CPW and others as appropriate.	Consider each item in a comprehensive list of potential benefits and impacts. Public stakeholder engagement could be required for large projects. This may include consultation with local entities or with a committee of experts to assess local needs and impacts. Evaluate possibility of realizing potential benefits and mitigating potential impacts. Coordinate with other agencies and local entities to identify and track potential benefits and impacts, including CPW and others as appropriate.	

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 Provide opportunities for projects with net environmental benefits 	Assessing net benefit or impact	Environmental benefit or impact of a given project is assessed through existing review processes and frameworks.	List of environmental considerations evaluated qualitatively for benefits or impacts. Net benefit or impact of a project is evaluated qualitatively based on evaluation of considerations.	List of environmental considerations evaluated quantitatively for benefits or impacts. Net benefit or impact of a project is evaluated quantitatively and qualitatively based on the evaluation of considerations. Evaluate risks and tradeoffs.	More comprehensive environmental assessments could be burdensome to potential applicants as well as the State. However, greater risk of adverse impacts or lost opportunities if these assessments are not conducted.
 Not harm the environment Evaluate project environmental benefits/impacts without creating an unnecessarily burdensome process for 	Strategies to incentivize benefits Strategies to avoid, offset, or mitigate any negative imports	No incentives provided for projects with potential environmental benefits. No additional strategies implemented to avoid, offset, or mitigate any potential negative impacts.	Preference and/or additional monetary or program incentive given to projects with net environmental benefits. Evaluate the program as a whole for opportunities for partnership(s) to add environmental value (enhance benefits or avoid, offset, and or mitigate negative impacts). Examples: potential storage and	Preference and/or additional monetary or program incentive given to projects with greater net environmental benefits. Potential partnerships with NGOs and/or local organizations to support the assessment of potential benefits. Evaluate specific projects for opportunities for partnership(s) to add environmental value (enhance benefits or avoid, offset, and or mitigate negative impacts). Examples: Potential partnerships with NGOs and/or local organizations to help in	Coordinate efforts on incentivizing benefits with local governments to streamline approval. Opportunities for collaboration on a county/local level.
applicants Identify project impacts/benefits to environmer resources, including flow, water quality, affected habitats, etc.	impacts		retiming of return flows in an upstream reservoir to increase benefits and/or mitigation measures.	realizing benefits and mitigating potential impacts and provide additional funding, programs, or opportunities. Potential projects could include watershed restoration work, diversion structure improvements, etc.	benefits and/or impacts would have monitoring and verification components or requirements (see Monitoring & Verification).
Economic Impacts & Local Governments • Any program participation must be voluntary • Initial ge and program 7 Id be to do no harm	Support for municipal participants	Existing programs and funding sources are used to support municipal participants.	State consults with and provides support for municipal participants in developing projects.	State identifies other programs that may be coordinated to support municipal participation and assists in facilitating more significant conservation programs. State consults with local governmental entities to identify appropriate mitigation opportunities.	A water efficiency program is not temperary. However, it is likely to be the least disruptive option.
 Program should seek to create net benefits for water users Program operations should 	Municipal sector mitigation	Existing programs and funding sources are used relating to municipal sector mitigation. Municipalities may take steps to avoid secondary impacts to their customers.	State more actively works to identify and track potential secondary impacts to municipalities resulting from participation in the program. A portion of project compensation spent on mitigation efforts. Mitigation payments are made to municipalities or communities.	State sets specific protocol and mechanisms for identifying and tracking potential secondary impacts resulting from municipal participation. A larger portion of compensation spent on mitigation with a defined list of required mitigation actions dependent upon type of project activity. State partners with local governmental entities to identify appropriate mitigation opportunities.	Potential impacts to system reliability depending upon type of municipal participation. Mitigation measures taken by municipalities may have impacts outside their municipal boundaries. Municipalities with fewer resources may be less able to mitigate potential impacts on their own, resulting in areas of low
operations should be transparent & collaborative				identify appropriate mitigation opportunities.	CHICKNERS CONTRACTOR REPORT CONTRACTOR CONTR

DM Program Structure Matrix of Building Blocks

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	Consultation with local governments to track impacts and develop mitigation measures	General education and outreach to inform local governmental entities, water boards of DM program. State does not consult with municipal participants or local governments to identify, track, or mitigate potential impacts and identify potential benefits to local economies resulting from a DM Program.	State consults with program participant and/or local governmental agencies to identify potential impacts and mitigation strategies, for all types of project activity, and to identify potential benefits to local economies and communities relating to a DM Program, as well as strategies to increase benefits.	Inter-governmental Agreement (IGA) or similar framework developed to facilitate robust and iterative consultation process with local governments and other entities to address local concerns and mitigate local impacts, with specific strategy and focus on mitigating or avoiding potential adverse impacts and increasing potential benefits, for all types of project activity.	Less consultation with local governments may result in increased se impacts that are not adequately tracked and mitigated. There is a varying level of resources and capacity available for local governments to facilitate coordination and mitigation efforts. This variation may affect the extent to which impacts are tracked and mitigation measures implemented across the state. Consultation with the Colorado Municipal League and Regional Councils of Governments may be helpful in determining appropriate parties and mechanisms for engagement.
Ag Impacts Equitable & proportional across state Minimize & mitigate off-farm impacts Program should be a structured & guided market Program operations need to align with growing season 	Agricultural sector mitigation	Existing programs and funding sources are used to promote agricultural viability.	Fund is established to provide compensation to local entity for community economic development fund. Grant program established to assist with local agricultural and economic viability.	State and partners make efforts to identify potential secondary impacts. Fund established that potentially provides compensation for mitigation, some of which is distributed to water management entity servicing property, while a portion is distributed to local/rural economic development or other appropriate organization. Additional staff time targeted at mitigating agricultural sector impacts to non-participants. Dependent on funding availability and identification of appropriate funding source.	Limiting the community development fund to verifiable DM impacts would present additional complexity, but would perhaps the ver costs or avoid reimbursement of economic impacts beyond it a State's control; alternatively a community fund that supports projects regardless of verifiable impact would be easier to manage and generate positive community outcomes. State verification of generate positive community outcomes. State verification of generate impacts could be costly and difficult to accomplish. Assess impacts to tenant farmers and land rental prices through community outreach efforts, noting it may be challenging to the suish DM-related impacts. Community impacts in sovereign Tribal Nations may require alternative structure.
schedules	Agricultural participant field requirements	No field requirements	State works with cooperative extension, other local agencies to establish guidelines for cover crops (for annual crops) and weed and pest control measures (for perennial crops). State partners/contracts with cooperative extension or similar entity for technical assistance and limited monitoring of compliance.	State works with cooperative extension, other local agencies to establish guidelines for cover crops (for annual crops) and weed and pest control measures (for annual and perennial crops). State provides staffing for technical assistance and monitoring of compliance.	Cover cropping could add complexity to monitoring and verification of consumptive use; soil health practices such as conservation tillage could reduce Monitoring & Verification complexity; development of any mitigation guidelines would likely require input from the United States Department of Agriculture, Colorado Department of Agriculture, and cooperative extension. Cover cropping could provide additional environmental benefits; select cover crops could help offset impacts to livestock feed complexity and provide additional revenue for the participant. Producers may lack knowledge of cover cropping techniques. Though cover crops may create additional costs, state may work

DM Program Structure Matrix of Building Blocks

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*Note that implementation options A through C do not reflect the relative value or preference of any particular approach. They roughly align with varying levels of complexity, and are designed to encourage discussion about various tradeoffs relating to potential program designs.

with USDA NRCS to offset participant cost of any on-farm mitigation requirements. There may be federal crop insurance

implications.

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DM Program Structure Matrix of Building Blocks

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	Agricultural	Existing programs and resources in	State creates a grant or cooperative	State creates additional staff capacity responsible	Participants would likely need technical assistance in both
	participant	place are utilized to facilitate	contracting program with the university	for assisting in fully realizing benefits of	navigating any potential DM in-take process and in
	assistance	agricultural participant assistance	cooperative extension service, conservation	participation or mitigation of impacts from the DM	selecting/implementing mitigation measures (e.g. cover cropping);
		to help fully realize potential	districts, or similar technical service	program to the participants. Position manages a	providing the ability to grant or contract with third parties would
		benefits of participation or	providers, to offer technical assistance and	budget for technical assistance and mitigating	likely reduce programs costs and address state capacity concerns.
		mitigate potential impacts.	help fully realize potential benefits of	impacts.	
			participation or mitigate agronomic		Producer participants familiar with working with agricultural
			impacts from the DM program to the	=	service providers may be more willing to work with a trusted
			participants.		concert versus state staff.
					In addition to direct technical assistance, online information
					regarding any DM sign-up process or agronomic impacts and best
					management practices would be helpful and more accessible
Process	Soliciting	No state solicitation	Annual grant funding for entities to identify	State staff support & grant funding for identifying &	
Considerations	projects		& develop project applications	developing project applications	<mark>戸</mark>
	Application	Participants are not required to	Select mitigation & monitoring elements	Select mitigation & monitoring elements must have	
	requirements	submit information regarding	must have been completed or substantially	been completed or substantially planned for	
	-	mitigation, monitoring, or other	planned for application.	application. A certification process ensures that	
		elements with their application. No		project applications meet minimum requirements.	
		certification program due to open			
		enrollment process.			
	Project	Open enrollment (first come, first	Annual RFP process without any	Annual RFP process with certification required.	Care should be taken to ensure that the timing of the application,
	selection	serve) for projects of any duration.	certification process. Coordination with	Clear protocol developed, incorporating	review, and approval process align with when agricultural
	process	No certification processes. Review	local governments, entities, others to	coordination with local governments, entities,	participants make operational decisions
	process	is done on a project-specific basis.	facilitate a "guided market" approach	others, to establish a "guided market" approach	
			aimed at ensuring a program aligns with	designed to ensure the program aligns with specific	
			specific goals and does not create	goals and values and does not create unacceptable	
			unacceptable adverse impacts (see	adverse impacts (see Economic Impacts and Local	
			Economic Impacts and Local Governments	Governments and Agricultural Impacts sections).	
			and Agricultural Impacts sections).		
	Localization and	No additional protocol put in place	Review of DM program put in place at	Regular review of the DM program to consider	Depending on the level and scale at which programs evolve, there
	program	to localize and/or evolve a	specific milestone to consider successes,	successes, lessons learned, and stakeholder	may be program differences (perceived as inequity) over time at
	evolution	program to local needs.	lessons learned, and stakeholder feedback.	feedback. The review directly informs program	the Basin levels.
			The review directly informs future program	management at local level. The review is public,	
			management across the state.	transparent, and available for comment.	Local agencies / entities have different statutes, capacity,
					jurisdictions, resources, knowledge, and mobilization. Different
				7	basins can engage at different levels.

		DRAFT	DM Program Struc	ture Matrix of Building Blocks	DRAFT
Funding Portfolio of funding sources should be considered Costs would be influenced by many factors	Range of annual costs	\$3M - \$16M Example Cost Breakdown: 10% Program Costs 90% Compensation Cost	\$5M - \$20M Example Cost Breakdown: 30% Program Costs 70% Compensation Cost	\$12M - \$30M Example Cost Breakdown: 65% Program Costs 35% Compensation Cost	Payment offered may impact who is interested and able to participate, which may affect proportionality in terms of sector and region.
including program design, scale, and participation	Funding Sources	Compensation paid by State through budget reallocation	Compensation paid by State through free	Compensation paid by State through blend of multiple sources.	Ţ

EXHIBIT C Literature Review

Demand Management Feasibility Investigation Literature Review July 2021



Consultant Team CDR Associates SGM WestWater Research / Colorado College



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Introduction

In 2019, the consultant team was retained to conduct a literature review relating to topics that correlate with the workgroups convened pursuant to the 2019 Work Plan adopted by the Colorado Water Conservation Board. The consultant team was directed to conduct a literature review and to identify key data gaps in the literature to help inform Colorado's Demand Management Feasibility Investigation.

The consultant team conducted the literature review, as well as additional research and interviews in some cases to inform their findings. This report summarizes the consultant team's findings in the following topic areas:

- Agricultural Impacts
- Economic Impacts and Local Governments
- Education and Outreach
- Environmental Considerations
- Funding
- Monitoring and Verification

Each section of this report captures:

- A summary of the literature review
- A summary of work completed in addition to the literature review
- Key takeaways
- Data gaps

The Administration and Accounting and Law and Policy workgroups were not associated with the Consultant Team's scopes and therefore not included in this report.



SECTION 1 – FEASIBILITY INVESTIGATION BACKGROUND

Colorado is currently investigating the feasibility of a potential Demand Management (DM) program. Demand Management is the concept of temporary, voluntary, and compensated reductions in the consumptive use of water in the Upper Colorado River Basin. Each of the Upper Colorado River Basin States (also referred to as the Upper Division States) are conducting their own investigations to determine whether a potential program would be feasible from their states' perspectives.

It is beyond the scope of this document to provide an overview of the minimum requirements to establish a Demand Management Program. However, more information relating to the Drought Contingency Plan (DCP) and associated agreements can be found at the following website: https://www.usbr.gov/dcp/index.html.

Investigation Background

The DM Feasibility Investigation (Investigation) follows direction of the CWCB Board in the Support and Policy Statements adopted in November 2018, the 2019 Work Plan (Step I), and the most recent Step II Work Plan approved in November 2020.

2019 Work Plan

The 2019 Work Plan (Step I) had three primary components:

- 1. Establish **workgroups** comprised of subject-matter experts and key Colorado River stakeholders, which were directed to meet publicly at least four times in Fiscal Year 2019-20, and to identify key threshold issues for board consideration
- 2. **Regional workshops** designed to facilitate the public discussion around DM and provide opportunities for CWCB staff updates on the Investigation; and
- 3. Continued education and outreach.

In addition, the CWCB Board directed staff to facilitate a literature review, completed by the Consultant Team.

The July 2020 Board meeting included a presentation of the summary of workgroup discussions and other work found at the following website:

https://dnrweblink.state.co.us/cwcb/0/edoc/212695/8_Demand%20Management%20Update.pdf?searchid =a1d2b86a-6aab-4b53-b5dc-e3dd570b71fb

Step II Work Plan

Following the 2019 Work Plan, the Board adopted the Step II Work Plan, which contemplates exploration of potential program design options through development of a Framework. Figure 1 shows how information gained in the 2019 Work Plan has helped to inform the Framework, which shows a range of implementation options and program design options.



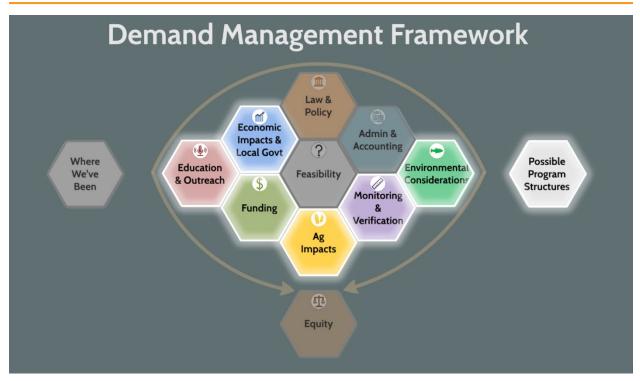


Figure 1. Demand Management Framework. The white highlighted tiles depict the Consultant Team's focus workgroups.

Consultant Team

The DM Consultant Team is comprised of three consultant firms that were responsible for different tasks. Each team member reviewed information from the workgroups, conducted a comprehensive literature review, and some conducted additional analyses and interviews. A list of each team member and their specific focus-area(s) are:

- CDR
 - Education and Outreach (E&O)
- WestWater Research & Colorado College
 - o Agricultural impacts
 - Economics and Local Governments
 - Funding
- SGM
 - Monitoring and Verification
 - o Environmental Considerations



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Conservation Board

A comprehensive list of the documents reviewed by the Consultant Team is included in **Exhibit A**. The following sections summarize the literature reviews and analyses of the Consultant Team. While compiling the individual components of the literature review, the Consultant Team identified interconnected issues that were relevant across specific workgroup topics. Pertinent areas of overlap were included in each applicable section.

SECTION 3 – AGRICULTURAL IMPACTS - LITERATURE REVIEW & ANALYSES

WestWater Research led the Agricultural Impacts literature review. The tasks associated with their work specifically included:

- Participation in the final meeting of the Agricultural Impacts workgroup as a listener.
- Compilation and review of past studies and research regarding the agricultural impacts of water conservation and reduced irrigation projects in the Western U.S.
- Analysis of design elements of a DM program as they relate to agricultural impacts.
- Identification of knowledge or data gaps in the ability to understand and evaluate agricultural impacts of a DM program and individual DM project activities in the agricultural sector.

This report section provides a summary of the literature review research findings.

Literature Review

There is an extensive body of knowledge and library of past research studies on the impacts of reduced irrigation activities. This section summarizes some high-level summary points from the literature review.

What we know

Demand management is the reduction of consumptive water use. The types of activities that can be undertaken in the agricultural sector to reduce consumptive water use are focused on reduced irrigation, which can take on a variety of forms such as: full-season fallowing, split-season fallowing, rotational fallowing, deficit irrigation, and crop switching. Each demand management activity will have different economic effects which depend upon the existing water use and crop and livestock production on a farm or ranch property. It is also important to distinguish demand management activities as those resulting in water conservation or conserved consumptive use, and not activities that result in greater water use efficiency which do not generally result in a reduction in consumptive use. The following two sections (below) expand upon the on-farm and off-farm impacts of agricultural demand management activities.

On-Farm Impacts

All demand management activities that may be implemented in the agricultural sector will reduce the irrigation water supply to the crop. Various types of irrigation reduction are possible for a given operation, but the primary (expected) methods are listed in the above paragraph. On-farm impacts of demand management activities are described in the points below.

• **Crop Yield**. In the Colorado agricultural sector, a reduction in consumptive water use is expected to result in a reduction of crop yield. This is the most direct impact of reduced irrigation and will result in

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reduced income for the producer. The extent of yield reduction depends on the crop type, extent of water stress, and timing of water stress.

- **Crop Quality**. The quality of the harvested crop or grazed pasture is often influenced by reduced irrigation, with both positive and negative quality changes documented. Particularly for alfalfa and grass hay cut for sale, quality influences price and therefore has an impact on producer income.
- **Management Impacts**. A variety of management impacts exist for reduced irrigation activities. For hay and pasture fields, there are expected to be significant and multi-year management impacts from large-scale reduced irrigation. Hay fields and pastures can take several years to establish and reduced stand density and quality changes from reduced irrigation can result in disruptions to operations. For cattle ranchers, reduced pasture production can impact herd sizes, health, and genetics, particularly if supplemental feed is not easily acquired. These impacts are expected to scale down with reduced demand management activity and forage crops are unique in their ability to scale with various irrigation inputs. For annual crops, full-season fallowing and crop switching are the most likely activities to be implemented and disruptions to operations are expected to be less than multi-year forage crops. Also, specialty annual crops are likely to see greater operational and management impacts compared to commodity crops. One aspect that is universal is the negative impact to business relationships that comes with not producing (or producing less of) a crop or agricultural product, which forces customers (buyers) to look elsewhere. The temporary reduction in agricultural production could impact the long-term business plans for producers.

Off-Farm Impacts

The off-farm impacts of reduced irrigation and agricultural production that come with demand management can touch upon multiple economic sectors in a community. Additional information on off-farm impacts is provided in the Economics & Local Government section of this report. For this report section, off-farm impacts will focus only on the agricultural sector. Off-farm impacts are organized into the following three categories: (1) hydrologic, (2) economic, and (3) agronomic.

Hydrologic Impacts

Irrigation activities change the natural hydrologic flow patterns in a watershed. These changes are often documented in the engineering studies that accompany water right change of use applications in water court. Cessation or reduction of irrigation results in a similar but reversed change to flow patterns. For many areas in Colorado, irrigation has been occurring for well over a century, such that both natural and human reliance on the irrigation flow patterns has occurred. Reduced irrigation due to demand management may result in the following hydrologic impacts:

- Increased annual streamflow volumes due to reduced crop consumptive use and reduced losses in the conveyance and application systems. Annual volume increases are the underlying reason for conducting demand management activities.
- A shift in the timing of streamflow with increases during the spring snowmelt period and reductions during the late summer and fall seasons. This shift results from not holding back spring runoff flows through irrigation diversion and land application.
- Reduction in canal flows serving multiple producers, such as irrigation districts and mutual ditch companies, which can negatively impact canal operations. Less carriage or "push" water can create hydraulic problems on ditch systems, particularly affecting neighboring producers needing elevation head in the canals and those located at the tail-end of ditches.
- A shift in the timing and volume of streamflow may result from changes in groundwater pumping for irrigation. Aquifer water levels may also increase with reduced pumping across a large area.



Economic Impacts

The off-farm economic impacts are tied to the flows of money into agricultural production and out of agricultural sales. In other words, off-farm economic impacts relate to an agricultural producer's typical spending habits and his/her modified spending habits under demand management. For production inputs, it is common to look at crop enterprise budgets developed by university extension offices to understand input types and values. The dollar value of operating costs (per acre) in the crop budget tables provide an indication of the relative economic impact resulting from reduced purchases by the producer because of demand management. For example, the 2018 budgets indicate that alfalfa hay has operating costs totaling \$334 per acre or \$86 per ton of hay production. Most of these operating costs will scale down with reduced production (yield) under demand management. Fixed costs identified in the crop budgets are not expected to change significantly under demand management activities.

The economic impact of modifications to spending that typically results from agricultural net income is more difficult to quantify and predict. Demand management activities will be compensated, and compensation amounts will need to be greater than the expected loss in agricultural net income to incentivize participation from agricultural producers. The off-farm economic impact from spending depends upon the source of compensation funds and whether the compensation income is spent locally or not. Limited data from two surveys indicate that approximately half to nearly all of the compensation payments will be spent locally.

The two money flows described above (inputs to and spending from agricultural production) are based on an owner-operator farm system. Many farms and ranches in Western Colorado have absentee landowners and are farmed by long-term lease tenants. An additional economic impact results to tenant farms if the landowner decides to participate in demand management activities without collaborating with the lease tenant. Demand management can disrupt the owner-tenant relationship because compensation payments to the owner may not be shared with the tenant, who will experience lost production and income. Landowners are incentivized to work with their lease tenants before participating in demand management activities to maintain a beneficial relationship with the tenant and to maintain market lease rates for the property.

Agronomic Impacts

The off-farm agronomic impacts relate to weeds, pests, and dust. A field that is participating in demand management can be a nuisance to neighboring fields due to these issues and therefore weed, pest, and dust management are often required as part of short-term and permanent fallowing plans. The extent of impact if such management actions are not taken is site dependent, based on field location, soil types, and localized infestation issues. Many of these agronomic impacts can be mitigated through cover crop establishment on fallowed fields and weed & pest controls on perennial forages.

The following illustration in **Figure 3** provides a conceptual model for thinking about the agricultural impacts of demand management and captures many of the themes identified in the literature review.

COLORADO Colorado Water Conservation Board Department of Natural Resources

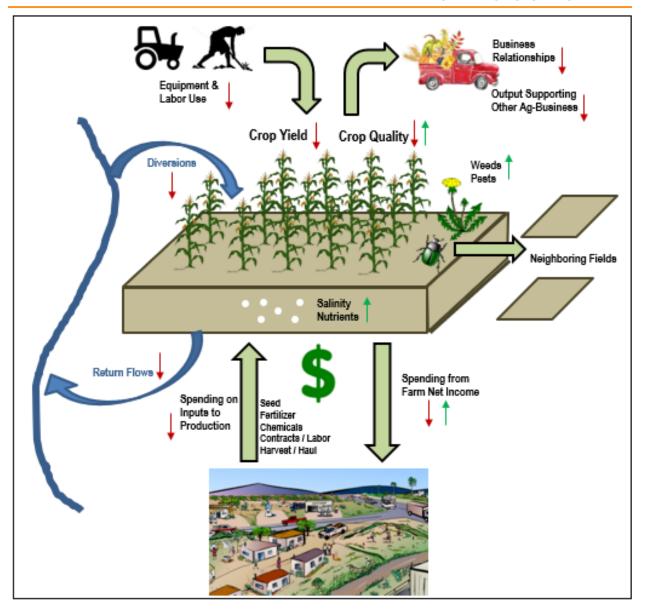


Figure 2. Conceptual Model of Agricultural Impacts from Demand Management Activities.

Key Takeaways

- **Develop Educational Resources for Producers**. The CWCB may work with the Colorado Department of Agriculture, Colorado State University Extension, Natural Resource Conservation Service, and other land management groups to develop a guide for agricultural producers on how to apply for and conduct demand management activities while minimizing on-farm and off-farm impacts. The guide may be organized by crop type and demand management activity and may present best management practices (BMPs) for reduced irrigation. In addition, technical staff support may be funded and supported to assist producers in designing their demand management programs.
- Ensure Contracting Aligns with Seasonal Cycles. The CWCB may ensure that the application, review, and approval process is timed to align with when producers make decisions and investments each growing season. For example, project contracts by October 1 of the preceding year would be best, by January 1 of the activity year would be good, and by approximately March 1 of the activity year is



necessary. If a rolling application process is used, then a demand management program may build in sufficient time to allow the producer to adjust investments and business commitments prior to activity implementation.

- Limit Demand Management Activity Duration. The available research suggests that partial-season reduction in irrigation on perennial forage crops, particularly alfalfa, can be achieved without significant and lasting damage to the forage stand. Full-season fallowing can be conducted on perennial forages but is best suited to the latter years of a stand when re-establishment is planned. For annual crops, multiple continuous years of demand management will require diligent management of weeds and pests. In general, agricultural impacts are less if specific fields do not participate in complete full-season fallow activities for multiple consecutive years.
- **Develop a Guide for Compensation Calculations.** This review identifies multiple on-farm and offfarm elements that compensation payments may consider. The CWCB may develop a simple guidance worksheet that helps producers understand the various costs that are likely to be incurred in demand management activities. Compensation payments are expected to be customized by each producer and operation, but general guidelines may be helpful to ensure that producers do not experience unforeseen costs as part of the program.
- Limit Concentration of Activities. An important tool in program design to minimize significant offfarm impacts of demand management activities is to limit the geographic concentration of projects. Demand management will be structured as a voluntary program and therefore the program may place maximum limits on the number of irrigated acres approved for participation in demand management by river basin or county.
- **Mitigate Off-Farm Impacts**. This review identifies hydrologic, economic, and agronomic impacts from demand management activities that the program may be designed to minimize and/or mitigate, and the following mitigation elements may be considered by CWCB. It is difficult to quantify the off-farm impacts for each specific project such that a program may look to implement standardized policies and payments that will apply to all projects.
- **Hydrologic Impacts**: Hydrologic impacts to off-site water users can be evaluated using standard engineering techniques such as those applied in Substitute Water Supply Plan (SWSP) applications. In addition, the CWCB may consider including mitigation payments to the managing ditch company, irrigation district, or other water user association as part of project costs (as applicable) to mitigate impacts to canal operations on larger systems.
- Economic Impacts: The on-farm economic impacts are expected to be fully addressed through compensation payments determined by the producer. Program design may be more concerned with off-farm economic impacts, which can partly be minimized through project selection. Mitigation payments to local governments may be a consideration of a demand management program, and these payments can be used for grant or loan programs for qualifying businesses or other economic development initiatives. The need for mitigation payments to local governments has not been definitively determined based on our research. It will be difficult to customize economic impact mitigation for each project due to uncertainty and privacy concerns with producer finances, such that a program may look to develop mitigation approaches applied uniformly to certain categories of demand management projects.
- Agronomic Impacts: Both on-farm and off-farm agronomic impacts can be minimized with a requirement that all farms and ranches participating in demand management conduct weed and pest control measures as part of the proposed projects. For perennial forages, this is likely to consist of various integrated approaches to maintaining a healthy forage stand. For annual crops, this is likely to require the establishment of a cover crop. A program may consider a requirement for field management techniques, such as cover cropping and weed & pest controls. CWCB may consider the compilation and



development of information resources to assist producers in determining the best cover crop and weed & pest control measures for their operation.

Data Gaps

There are two types of data gaps associated with the assessment of agricultural impacts: (1) those currently present in evaluating the feasibility of a demand management program, and (2) those that are likely to be present when evaluating the impacts of specific demand management projects.

Data Gaps in Evaluating the Feasibility of Demand Management

No major data gaps concerning agricultural impacts are identified that would significantly benefit an evaluation of demand management feasibility. Significant resources have been applied in studying demand management concepts for the past 8 years. Additional studies that are presently underway or near completion will also add to our understanding of agricultural impacts. Most of the data gaps identified during our analysis were focused on other subject areas, such as quantification of consumptive use savings and facilitation of program activities. The following data gaps related to agricultural impacts were identified:

- The costs, benefits, and impacts of crop switching and deficit irrigating as demand management activities. Most of the research we reviewed focused on partial and full-season cessation of irrigation on perennial forage stands. There are several outstanding questions about how (and if) crop-switching and deficit irrigation would work as demand management activities.
- The impact of demand management activities on the availability of hay for livestock operations. Demand management activities at a small scale will result in reduced hay production locally may require local purchase of supplemental hay. At a large scale, there are uncertainties about how the hay market would respond and how hay availability would be impacted. It is possible that demand management impacts would mirror past drought periods with a similar reduction in hay production.
- Additional information on specific best management practices for managing a field that is experiencing reduced irrigation, particularly a full-season fallowing. It is well-established that cover crop establishment for annual crops and various weed and pest control measures for perennial forage crops are critical to mitigating impacts, but specific information on practices relevant to different Western Slope agricultural zones would be beneficial. This information could form the basis for guides assisting producers in project implementation.

Further research and information on the above topics would be beneficial but is not likely to significantly change the existing knowledge base on agricultural impacts of demand management activities. Agricultural impacts will often be site-specific. The CWCB may consider additional pilot projects to expand the diversity of project examples. The pilots are not expected to provide definitive findings but rather improved perspective on likely impacts.

Data Gaps in Quantifying Impacts of Specific Demand Management Projects

The agricultural impacts associated with specific demand management projects will need to be addressed as part of compensation payments and program design. On-farm impacts will be site specific and standardized impact metrics are unlikely to be useful across operations. Each producer may evaluate the expected impacts, with available information resources and technical assistance, and incorporate impacts into proposed compensation terms. Off-farm impacts are a greater concern for program design, and program design is anticipated to mitigate off-farm impacts more than information gaps addressed during the application and review process.



SECTION 4 – ECONOMICS & LOCAL GOVERNMENTS -LITERATURE REVIEW & ANALYSES

WestWater Research worked with Dr. Mark Smith from the Colorado College Economics Department to lead the Economics & Local Governments processes for the Investigation. The tasks associated with these efforts specifically included:

- Participation in the final meeting of the Economic Impacts & Local Governments workgroup as a listener.
- Compilation and review of past studies and research regarding the economic impacts of water conservation projects in the agricultural and municipal water use sectors.
- Analysis of design elements of a DM program as they relate to economic impacts.
- Identification of knowledge or data gaps in the ability to understand and evaluate economic impacts of a DM program and individual DM project activities in the agricultural and municipal sectors.
- Implementation of a survey of 19 municipal water providers in Colorado to better understand the municipal perspective on a DM program and anticipated DM activities.

Literature Review

There is an extensive body of knowledge and library of past research studies on the impacts of reduced irrigation activities, or demand management types of projects in the agricultural sector. There is also an extensive knowledge base on municipal water conservation; however, there is a general lack of information on voluntary, compensated, and temporary reduction of water use in the municipal sector. This section summarizes key points from the literature review on economic impacts.

What we know

To evaluate the economic impacts of demand management, it is necessary to consider both the direct impacts of reducing water use through demand management activities, and the indirect effects of reduced water use. These are often referred to as the primary and secondary impacts of an action or decision. An expanded discussion on the primary and secondary impacts of agricultural and municipal demand management is provided in subsequent sections. In brief they are:

- Agricultural Demand Management. Irrigation water is one of many inputs to crop production. Reduced water use results in less production as the primary impact of demand management. Secondary impacts reflect the other economic sectors that are affected by both reduced water use and reduced production. Backward-linked impacts result from the producer spending less on production inputs, such as seed, fertilizer, labor, and other items. Forward-linked impacts result from less harvested crop feeding into agri-businesses and other industries.
- **Municipal Demand Management**. Municipal water providers provide a service which allows their customers to live and work, enjoy a good quality of life (health, safety, and happiness), and allows businesses to function. Direct water uses in a municipal system are varied and diverse. Reduced water use results in less service, which can be reflected in various ways in a community as the primary impact depending on how both the water utility and individual customers choose to implement demand reduction. Secondary impacts reflect the nature of conservation activities and can include impacts to urban vegetation, property values, and wildlife habitat, among others. It is important to acknowledge



that there remains significant uncertainty on how demand management will be achieved in the municipal sector and if demand management activities will impact municipal water use customers.

Economic Impacts of Reduced Agricultural Water Use

The economic impact of reducing water use in the agricultural sector has been studied in many locations and was previously reviewed for the Colorado Water Bank Working Group and for the Colorado River District. In addition, there are active studies occurring on the West Slope that will aid in the understanding of secondary economic impacts. The secondary or regional economic impacts of demand management activities primarily depends on the type of agricultural operation (crop type, farm size, location) and the type of activity to reduce water use. This section provides a high-level summary of economic impacts from reduced agricultural water use. Additional information on agricultural impacts is provided in a separate review for the Agricultural Impacts in the preceding section of this report.

Actions to Reduce Agricultural Water Use

Demand management is the reduction of consumptive water use. The types of activities that can be undertaken to reduce consumptive water use are focused on reduced irrigation, which can take on a variety of forms such as: full-season fallowing, split-season fallowing, rotational fallowing, deficit irrigation, and crop switching. Each demand management activity will have different economic effects which depend upon the existing water use and crop and livestock production on a farm or ranch property. It is also important to distinguish demand management activities as those resulting in water conservation or conserved consumptive use, and not activities that result in greater water use efficiency which do not generally result in a reduction in consumptive use.

Direct On-Farm Impacts

All demand management activities that may be implemented in the agricultural sector will reduce the irrigation water supply to the crop and will be compensated. The net income to the producer under demand management is expected to be positive to motivate participation, with compensation payments exceeding the on-farm costs associated with demand management activities. Compensation payments need to consider the following on-farm impacts of demand management activities:

- **Reduced Crop Yield**. In the Colorado agricultural sector, a reduction in consumptive water use is expected to result in a reduction of crop yield. This is the most direct impact of reduced irrigation and will result in reduced income for the producer. The extent of yield reduction depends on the crop type, extent of water stress, and timing of water stress.
- **Modified Crop Quality**. The quality of the harvested crop or grazed pasture is often influenced by reduced irrigation, with both positive and negative quality changes documented. Particularly for alfalfa and grass hay cut for sale, quality influences price and therefore has an impact on producer income. For annual crops, reduced irrigation may result in an unmarketable product.
- Negative Farm Management Impacts. A variety of management impacts result from reduced irrigation and reduced production. One universal impact is the negative impact to business relationships that comes with not producing (or producing less of) a crop or agricultural product, which forces customers (buyers) to look elsewhere. The temporary reduction in agricultural production could impact the long-term business plans for producers. For hay and pasture fields, there are expected to be significant and multi-year management impacts. For cattle ranchers, reduced pasture production can impact herd sizes, health, and genetics. The on-farm impacts on cattle ranches are a function of location and scale of reduced production. In remote areas where access to supplemental hay is limited and associated replacement costs are high, the on-farm impact of reduced forage is expected to be relatively high. For areas that have access to hay for maintaining herds, a smaller on-farm impact is expected and can be estimated as the cost of acquiring supplemental hay for feed. For annual crops, full-season



fallowing and crop switching are the most likely activities to be implemented and disruptions to operations are expected to be less than multi-year forage crops.

• **Costs of Mitigation Activities.** In addition to changes in irrigation practices, the producer will likely need to invest in certain on-farm projects to reduce the off-farm impact of the demand management activities. These mitigation activities and projects are anticipated to include: (1) cover crop establishment on fallowed fields, (2) new weed and pest control measures on perennial forage stands, and (3) replacement water sources to prevent injury to downstream water users.

The positive net income to the producer results in positive on-farm economic impacts of demand management. An important point is that positive on-farm impacts will only result if the compensation paid for demand management activities exceeds the combined cost of the on-farm impacts listed above. A premium above these on-farm costs is expected to motivate participation and to address risk and uncertainty to agricultural operations.

Off-Farm Impacts

The off-farm impacts of reduced irrigation and agricultural production that come with demand management can touch upon multiple economic sectors in a community. Off-farm impacts can also be positive and negative depending on the economic sector and location. For this review, off-farm impacts are divided into two broad categories below.

Costs / Negative Impacts

Secondary economic effects of reduced irrigation involve all sectors of the regional economy that directly or indirectly transact with irrigated agriculture. Some of the secondary impacts considered likely to occur include:

- Loss in the value of output, personal income, and employment resulting from reduced spending in industries that provide inputs and support services to agriculture (referred to as backward-linked industries),
- Loss of output, personal income, and employment in sectors that use agricultural outputs as inputs to production (referred to as forward-linked industries),
- Effects caused by changes in net income spending in the region, and
- Changes in local tax revenues.

When agricultural production declines in a region, the reduced crop production results in a lower expenditure on agricultural inputs (first round effect). As a result, workers, stores, and support services directly related to agriculture reduce spending within the economy (second round effect) and the businesses that they buy from reduce their spending (third round effect), and so on. In addition, reduced agricultural production can lead to reduced activity for agri-businesses that rely on harvested crop inputs, resulting in further economic loss. These impacts are sometimes referred to as the multiplier effect.

The results of the recent 2020 economic study of demand management in Western Colorado indicate an indirect effect multiplier of approximately 0.34 and an induced effect multiplier of approximately 0.40, resulting in a total backward-linked economic impact equal to approximately 0.74, equal to 74% of reduced agricultural on-farm production. Additional forward-linked effects on the livestock industry were estimated to have a multiplier of 0.3, or 30% of direct agricultural output. In total, the secondary economic impacts of demand management were estimated to have a multiplier of 1.04 relative to the lost agricultural production value. This study indicates that secondary economic impacts of demand management are roughly equal to the primary on-farm economic impacts of lost production value.

The impact on businesses and economic sectors that utilize farm output (forward-linked industries) depends largely on the crop type and presence of food products and food processing industries in the region. For

most of the Western Slope, irrigation is practiced producing forage crops in support of the livestock industry. Hay trucking and slaughter facilities are two forward-linked industries that may be impacted by reduced forage production. The 2020 economic analysis of demand management indicated potential forward-linked impacts equal to approximately 30% of lost agricultural output.

The economic impact of modifications to spending that typically results from agricultural net income is more difficult to quantify and predict. Demand management activities will be compensated, and compensation amounts will need to be greater than the expected loss in agricultural net income to incentivize participation from agricultural producers. The off-farm economic impact from spending depends upon the source of compensation funds and whether the compensation income is spent locally or not. The 2020 economic analysis of demand management in Western Colorado indicated that compensation payments may or may not offset secondary economic impacts, depending on the extent to which payments are spent locally within the region.

The two money flows described above (inputs to and spending from agricultural production) are based on an owner-operator farm system. Many farms and ranches in Western Colorado have absentee landowners and are farmed by long-term lease tenants. An additional negative impact results to tenant farms if the landowner decides to participate in demand management activities without collaborating with the lease tenant. Demand management can disrupt the owner-tenant relationship because compensation payments to the owner may not be shared with the tenant, who will experience lost production and income. Landowners are incentivized to work with their lease tenants before participating in demand management activities to maintain a beneficial relationship with the tenant and to maintain market lease rates for the property.

In addition to the negative effects associated with changes to agricultural production, there are several environmental and recreational impacts to consider that result from a change in the timing of water flows. Irrigation, and specifically flood irrigation from surface water sources, slows the movement of water across the landscape through soil infiltration and return flows back to the stream channel. The result is that snowmelt runoff peak flows are reduced through irrigation diversion and late-summer low-flows are increased from return flows. The long-term presence of irrigated agriculture across much of the Western Slope has resulted in an environment and recreational economies that are built on this altered hydrology. Modifying the timing and magnitude of streamflow may cause additional negative economic impacts. In particular, the following are noted:

- Wetland and Wet Meadow Habitat. Many irrigation ditch and canal systems have wetlands and wet meadow habitat that have been formed by irrigation practices. In addition, the canals may also provide important riparian habitat. The inefficiency of surface conveyance and flood irrigation often results in habitat development down-gradient from irrigated parcels and ditch systems. A reduction in irrigation could result in negative impacts to these habitats and environmental resources. Wetland mitigation bank credits on the Western Slope have varied values depending on location and type of wetland credit.
- Decreased Late-Season Flows for Recreational Activities. Water-based recreation activities, and particularly fishing and boating, could be negatively impacted by a reduction in late-season streamflow. Negative effects are only anticipated to be noticeable on smaller tributary creek and river systems. The effects are also dependent on the relative scale of reduced irrigation and streamflow impact. The methods and concepts presented in previous research for recreational benefits of improved streamflow could be modified to consider the recreational costs of reduced late-season flows.

Benefits / Positive Impacts

The possible economic benefits of demand management activities are derived from two sources: (1) higher net income to the producer resulting in greater spending, and (2) modified hydrology resulting in greater streamflow annual volume and changes to streamflow timing. In addition, previous research on off-farm benefits identified possible salinity control benefits resulting from not leaching salts in the soil profile.



The benefit of higher net income to agricultural producers has an uncertain benefit to the surrounding economy that is largely dependent on how the additional income is spent. As stated previously, limited survey data indicate that past water conservation projects have seen half to nearly all of the compensation payments spent locally. The off-farm benefits of compensation spending may be significantly reduced if projects have absentee landowners located out of the local region. The temporary nature of demand management activities helps to ensure that project participants will maintain their properties and agricultural operations, which helps to ensure local benefit of the compensation payments.

The off-farm benefits of modified hydrology are specific to a location and project, as modified hydrology may also result in off-farm costs (see above). Downstream of the project site, annual streamflow volume will be greater based on the demand management activities. The timing and magnitude of increased streamflow is critical to understanding whether a benefit results from water conservation activities. Previous research on two System Conservation Pilot Program (SCPP) projects in Colorado and Wyoming found that these two water conservation projects resulted in nominal off-farm benefits besides salinity control. The research does indicate that off-farm benefits are expected to increase with larger volumes of water conservation activity. The following points summarize benefit concepts by various end uses:

- **Recreation**. The recreational benefit of modified hydrology is most likely to impact fishing and boating activity. The benefit can be estimated as a combination of: (1) the increase in number of visitor days, and/or (2) the increased value (enjoyment) of each visitor day. For both boating and fishing, the timing of additional streamflow needs to indicate a significant improvement to result in a measurable benefit.
- **Environment**. The environmental benefit is typically evaluated based on the presence of threatened or endangered species. The benefit may represent reduced recovery program costs or societal benefits of improved species habitat. Similar to recreation, environmental benefits are expected to be most significant if the modified hydrology represents a significant improvement in streamflow and the timing of flow increase is critical to realizing an environmental benefit.
- **Hydropower**. Run of river hydropower facilities are likely to see a direct benefit of larger streamflow volume as long as diversion capacity is not a limiting factor. Dam hydropower facilities are less likely to see a hydropower benefit unless the modified hydrology results in significant flow volume increases or the timing of flow increase occurs outside of the snowmelt period.
- Salinity. Reduced irrigation results in less deep percolation below the crop root zone and less leaching of salts in the soil profile into subsurface flows. In areas of the Colorado River Basin where active salinity reduction projects are in place, the benefit of reduced leaching can be significant.
- **Municipal**. Municipalities may enjoy benefits of reduced risk of Compact administration, since the goal of a potential Demand Management program would be to ensure ongoing compliance by the Upper Division States with the Colorado River Compact. This benefit is significant and is a primary driver of current efforts.

Mitigation of Negative Economic Impacts

Mitigation of negative economic impacts associated with water supply development projects and large water transfers is most often accomplished through federal and state environmental permits and is usually motivated by legal requirements to provide mitigation. For small and localized water transfers from agriculture to other uses, mitigation is not typically a legal requirement besides ensuring non-injury to other water right holders. Water right transfers often have negative economic impacts that are not mitigated. For a demand management program, mitigation may be evaluated and categorized based on on-farm and off-farm impacts. On-farm economic impacts are expected to be fully mitigated through compensation payments defined by the producer. Program design may be more concerned with off-farm impacts. Potential off-farm economic mitigation measures include:



- **Mitigation Payments to the Affected Community**. Mitigation payments, in addition to producer compensation, could be a component of a demand management program. The payments would be utilized for local community investments, which might take the form of grant and loan programs administered by county or other local governments, capital investment in specific economic development projects or infrastructure needs, and/or direct payments to local governments. Previous research identified three water transfer programs that provided explicit mitigation payments to local communities, ranging from 4% to 30% of producer compensation. These mitigation payments were provided primarily as a lump sum payment at the start of a multi-year water transfer program which probably would not be applicable under a demand management program. Two challenges with mitigation payments have been identified: (1) distributional challenges caused by mitigation efforts not targeting the most impacted sectors of the local economy, and (2) geographic challenges associated with dispersed project sites and impacts across the West Slope. These challenges may be addressed through a combination of mitigation payment rules and local oversight of mitigation payment spending.
- Alternative Cropping & Land Uses on Participating Properties. Creating an economic use of the participating lands during the period of demand management activities is a possible mitigation tool. Alternative cropping with a low water use requirement is a possibility but will reduce the conserved consumptive use benefits of demand management activities. Dryland grazing is a widely applicable alternative land use that may provide some limited economic activity. The types of alternative land uses are likely to be site-specific but investments could be made on properties to generate alternative economic activity, particularly if the property is intending to conduct demand management activities over multiple years.
- **Compensation Payments as Mitigation**. Most of the water transfer programs previously reviewed did not include any additional mitigation payments or policies to offset negative secondary (off-farm) impacts. Many programs may consider the compensation payments to the producer to be sufficient mitigation of local economic impacts. As stated previously, the suitability of compensation payments as mitigation for off-farm impacts is directly tied to the spending habits of producers in demand management years.

The economic effects of modified hydrology due to demand management activities are previously noted as potentially: (1) environmental impact of lost wetland and riparian habitat, and (2) recreational impact of modified streamflow for boating and fishing activities.

Economic Impacts of Reduced Municipal Water Use

This section first provides examples of reduced water use in the municipal sector, followed by a discussion of direct and indirect economic impacts of municipal conservation activities. There remains uncertainty as to how municipal demand management will be quantified, particularly for trans-basin diversions diverting from the Colorado River Basin to the Front Range. It is possible that a municipal utility could accomplish verifiable demand management through operations and management without requiring a modification in water use at the customer level. For this analysis, municipal demand management is evaluated assuming that water use reductions occur. The economic impacts described in this section provide context but may or may not be applicable to demand management in the municipal sector depending on how a potential program gets vetted and what demand management activities are implemented.

Context of Municipal Water Conservation in Colorado

Over the past 30 years both the Federal government and State of Colorado have enacted laws that have impacted both water conservation and water use efficiency for municipal water providers. These laws now guide municipal water use in three critical areas: (1) plumbing fixtures, (2) landscaping and outdoor water use, and (3) motivating municipal planning for efficient water use and effective drought response.



Context is critical in understanding the operating space for future efficiency and conservation efforts in the municipal sector. Past municipal water efficiency efforts have significantly reduced per capita water consumption. Colorado statewide municipal water use rate (per person) has declined from about 240 gallons, per-capita, per-day (gpcd) in 2000 to about 160 gpcd in 2015. In the future, these municipal water conservation savings and efficiency benefits have become "hardened" into baseline consumption, such that they will likely not be available to provide for future demand management. The greatest potential for additional conservation and demand reduction is expected to be in the following five areas: (1) further limiting water use in residential and commercial landscaping, (2) extending low-flow plumbing fixture requirements into older homes and commercial properties, (3) extending efficiency requirements to smaller water providers, (4) adopting smart metering to reduce losses and inefficiencies in the distribution system and in-home, and (5) modifying water use habits and practices.

Actions to Reduce Municipal Water Use

Actions to reduce municipal water use have often been divided into two categories: (1) water conservation and (2) water use efficiency. Water conservation temporarily reduces water use in response to drought or supply disruption and may be scaled back once the supply disruption ends. Water use efficiency, on the other hand, aims at maximizing the water end use benefit while minimizing waste, and efficiency practices often continue indefinitely and may be expanded. Both water conservation and water use efficiency can be achieved by policies and programs designed by municipal water providers.

Cities such as Denver, Fort Collins, and Colorado Springs, where water conservation and efficiency programs have existed for over 20 years, have seen a significant reduction in per capita water use through implementing many practices. These actions have also resulted in demand hardening. The implications for hardened water demand and past conservation efforts might be considered when establishing a baseline municipal water use for demand management. In evaluating and selecting conservation and efficiency activities, municipalities have a range of criteria that could be applied.

Municipalities also have the option to make conservation activities mandatory through policy changes. Research shows that mandatory strategies yield more water savings than those that are voluntary. However, if well implemented and tied to attractive rebates, voluntary options can be effective as well.

Direct Economic Impacts

Water conservation programs directly impact water providers in three ways:

- **Revenue loss from selling less water**. Water supply has high fixed costs. Dams, reservoirs, tunnels, pipelines, treatment plants and distribution systems are all major capital investments. Once these investments have been made, the variable cost of moving an added cubic foot through the system is low. Given these high capital costs, it is more cost-efficient to have one provider serving a broad geographic area to distribute these costs over a larger customer base. Therefore, water utilities are either municipally owned or regulated by a water district. Municipal water providers have several ways of recovering their fixed cost including tap fees for new construction, monthly service charges on existing customers, and the unit charge on the volume used (water rate). Where fixed costs are covered by tap fees and the monthly service charge, water conservation activities will have less impact on utility revenues. If these costs are allocated to the water rate, conservation may result in reduced operating revenue. Rates are often adjusted periodically to offset the impact of water conservation, and to respond to inflation and other cost increases associated with capital projects and operations.
- **Costs of running conservation programs.** Program costs will vary significantly with the size of the provider and the ambition of the conservation program. Water conservation programs range from public awareness and education to subsidies for turf removal and replacing landscape irrigation. Cost efficiency requires that suppliers begin with the lowest unit cost activities. Equity implies that water conservation

opportunities are not denied to low-income households that may lack the resources to adopt more efficient water use practices.

• **Impacts on wastewater treatment**. Wastewater treatment is affected when the influent flow to the treatment plant becomes more concentrated and thus more difficult to treat to the desired effluent standard. The problem is particularly acute when effluent is reused in either potable or non-potable systems.

These direct economic impacts may be a component of the compensation or benefit sought by an individual municipal water utility seeking to conduct demand management (water use reduction) activities. Like the agricultural sector, the balance of compensation (or direct benefit) versus direct economic impact will determine the overall net impact to municipal water utilities.

Indirect Economic Impacts

Indirect impacts on urban areas are largely livability and quality of life effects. The business effects are likely to be somewhat isolated as relatively few commercial activities depend upon water. It is possible that landscaping businesses will see a decline, and heavy water use industries may struggle if pricing is used to encourage conservation. The livability impacts may be considerable and widespread, especially if conservation actions result in the die off of established trees and the desolation of parks and other urban green spaces. Unlike the indirect impacts in agriculture, these municipal impacts are not anticipated to result in reduced commercial activity and reduced profits. Nevertheless, Colorado attracts and retains both people and industry because it is a desirable place to live, both for its abundant natural beauty as well as its pleasant towns and cities with a high quality of life. These attributes that attract and retain economic activity are put at risk if significant municipal water conservation activities were to occur. A municipal water utility may incorporate some indirect impacts that are within municipal control.

Mitigating Negative Economic Impacts

Demand management in the municipal sector may require new levels of both conservation and efficiency, and these activities may result in economic impacts as described above. Direct economic impacts to the municipal utility are expected to be evaluated by the utility and incorporated into any requested compensation to conduct demand management. Indirect impacts may or may not be included as part of the requested compensation and are a greater concern for demand management program administration and design. The following mitigation activities are targeted at both direct and indirect impacts of municipal demand management activities.

- Colorado's Water Plan. The state's 2015 water plan, "...sets forth the measurable objectives, goals, and actions by which Colorado will address its projected future water needs and measure its progress all built on our shared values." The plan was developed to address supply gaps resulting from a possible doubling of the state's population by 2050. Section 6.3 identifies many actions under (1) municipal water conservation, (2) water reuse, (3) land use, (4) agricultural conservation, efficiency, and reuse, (5) self-supplied industrial conservation and reuse, and (6) state agency conservation. The conservation and efficiency measures identified in the Plan provide a foundation for future demand management efforts.
- **Regionalization**. Front Range municipalities could examine the potential benefits of regionalizing supplies to improve reliability by taking advantage of a more diversified portfolio of water supplies. It is possible that future droughts will differentially impact streamflow conditions across the state. In addition, some metro Denver suppliers are primarily dependent upon Denver Basin groundwater. By jointly managing both surface and groundwater supplies, cooperating utilities may be able to firm up supplies under demand management.



- Water conservation extension programs. Current CWCB water conservation guidelines apply only to utilities that serve over 6,000 accounts. The state's largest suppliers have already instituted a range of programs to conserve water. The state could fund extension programs that enable large utilities to provide the same programs to smaller utilities which could take advantage of conservation options that are both proven and lowest cost. For example, smart meters could be installed by small utilities who then contract for data support from a utility that has already set up a system. An extension program represents a knowledge transfer to smaller water utilities to help ensure that demand management activities are effective and cost-efficient.
- Conservation pricing. Raising prices and/or implementing an increasing block rate structure on customers are both used to reduce water demand. In contrast to mandatory water restrictions, the effectiveness of using higher prices to reduce demand is less certain. Conservation pricing is also utilized to respond to successful water conservation to cover fixed costs with less water sales. Raising prices has a disproportional impact on low-income households. When using conservation pricing, utilities may establish low-income assistance programs and consider rebates for additional revenue to avoid these negative impacts. Approximately 85 percent of Front Range and eastern slope water providers, and 77 percent of western slope water providers, have such tiered rate structures.
- Xeriscape assistance programs. Municipal demand management is expected to fall heavily on outdoor water uses by residences, businesses, and institutions. Large-scale water use reduction may involve turf removal and many indirect impacts results from the loss of tress and green spaces. Some of these indirect impacts can be mitigated by replacing turf with xeriscape plants and landscaping. Several Colorado communities provide education and financial assistance for water users to modify their landscaping to a xeriscape design.
- Urban Forestry. Many indirect impacts from water conservation result from loss of trees and urban green spaces that provide many community benefits that enhance the livability of towns and cities. Demand management may provide options for cities to maintain existing trees and even expand urban forests into low-income neighborhoods that often have fewer trees. Tree canopy mapping often reflects income inequality and Colorado is no exception. The tree canopy in Colorado Springs neighborhoods, for instance, ranges from less than 5% in low-income to more than 50% in high-income neighborhoods. Planting trees in low-income neighborhoods would both reduce inequality and increase air and water quality benefits for all. Targeted investments for tree health, such as direct irrigation and fertilization, is a way to reduce stress on the urban trees.
- **Turf Conversion in Parks**. Demand management may involve redesign of urban parks to reduce water use. Vast green spaces may give way to more selective green spaces, artificial turf on playing fields, and more extensive use of xeriscape. In addition, continued irrigation of trees in parks when turf is removed is an important consideration. In general, municipalities may consider maintaining parks and outdoor green spaces even if residential and commercial irrigation is reduced because of the community benefits.
- **Project vs. Programmatic Demand Management**. A demand management program may anticipate supporting both project (i.e., single entity) as well as programmatic (e.g. universal smart metering) as strategies for creating conserved consumptive use. Establishing a baseline, monitoring, and verifying savings generated over many users will be critical for any programmatic approach.
- Water Energy Nexus. Colorado has 25 operating thermal power plants that all require water for cooling. Retiring these plants and replacing them with wind and solar farms will reduce both consumptive water uses and greenhouse gas emissions a double-dividend.



Additional Work Completed

WestWater performed interviews with municipalities across the State to investigate demand management related to municipal operations. A memorandum summarizing municipal interviews is available upon request.

Key Takeaways

These key considerations are based on the literature review summarized in previous sections. The following activities and policy elements are key considerations related to the specific purpose of reducing and/or mitigating economic impacts of demand management activities.

- **Mitigation Payments in Program Design**. The feasibility investigation may consider a program that includes mitigation payments to offset indirect economic impacts, particularly for agricultural demand management projects. Mitigation funding requirements might be established as part of program design and should likely be standardized across all projects. Standard mitigation payments would avoid the process of evaluating economic impacts of each proposed project and will provide certainty to the program participants and funders. The mitigation funding might be given to local governments to make local decisions on spending the money.
- Ensure that the Program is Voluntary. From an economic perspective, it is important that demand management remain a voluntary program without any requirement or mandate to participate and reduce water use. In both the agricultural and municipal sectors, there is a large amount of diversity in risk, ability to pay, direct and indirect impacts, and required compensation related to demand management. A voluntary program ensures that significant direct economic impacts do not occur to specific water users and communities.
- Include Environmental and Recreational Benefits and Impacts in Project Review. The process of soliciting and evaluating demand management projects is not yet determined. The CWCB might consider some form of analysis and reporting on the environmental and recreational benefits of proposed demand management projects as part of the review process. It is important to distinguish that this type of analysis is not part of informing mitigation requirements but instead for supporting projects that may provide a specific benefit.
- Leverage Other Funding Sources. Reduced water use may result in other benefits and there may be other programs established to provide funding resources for reducing water use and/or realizing these indirect benefits. A demand management program could look to develop and publish (online) a reference list of complementary funding programs and sources for consideration by project participants. Example and possible funding sources include the Environmental Protection Agency (EPA), U.S. Bureau of Reclamation (USBR), Natural Resources Conservation Service (NRCS), and U.S. Fish and Wildlife Service (USFWS).
- Indirect Impacts of Reduced Municipal Water Use. Our literature review did not provide definitive findings on the scope or scale of indirect impacts related to reduced municipal water use, particularly for: (1) environmental impacts of reduced outdoor water use, (2) social and community impacts of reduced outdoor water use, and (3) equity implications of reduced water use. The CWCB may consider developing a work plan to better understand these impacts. Consider potential benefits and impacts for east slope agriculture (supplemental sources of water).



Data Gaps

This section provides a discussion of two types of data gaps: (1) those currently present in evaluating the feasibility of a demand management program, and (2) those that are likely to be present when evaluating the impacts of specific demand management projects.

Data Gaps in Evaluating the Economic Feasibility of Demand Management

The economic feasibility of demand management can be better evaluated when demand management activities are better defined, particularly for the municipal sector. Most of the data gaps identified during our analysis were focused on other subject areas, such as definition of qualifying activities and program administration. The following data gaps related to economic impacts were identified:

Agricultural Sector

- Further research may consider the definition of standard economic multipliers specific to West Slope agriculture for informing mitigation payments. Further work could be done to generate one or more standard multipliers which would be used to define mitigation payments for agricultural demand management projects. These multipliers may be used to determine the full costs of each project and make equivalent comparisons between projects. The 2020 economic analysis for Western Colorado provides an information basis to define these multipliers.
- Additional data gaps are identified in the Agricultural Impacts section of this report that should be incorporated into this economic review.

Municipal Sector

- Further research may be done to better define municipal demand management activities. The impacts of municipal demand management activities stem from a better definition of those activities, and impacts are difficult to evaluate without this definition. The municipal sector may not have to or be willing to reduce end uses of water to achieve demand management.
- Additional research could evaluate the ability to reduce municipal water use. It is expected that the municipal utilities will propose to conduct demand management activities based on system-specific analysis. In terms of understanding feasibility of demand management, the state might consider an analysis looking at the broad feasibility of additional water use reductions in the municipal sector. The following elements might be included in such an analysis:
 - Evaluating the existing water efficiency practices across the state to identify the potential water savings from: (a) retrofitting pre-compliance homes and commercial buildings with low flow fixtures; (b) extending proven water efficiency programs into smaller water providers; (c) reducing non-revenue water lost through systems leakage. Such efforts can generate consistent, long-term water savings.
 - Evaluating the effectiveness and experience of Colorado water providers with water pricing strategies. Water providers have used a range of conservation pricing strategies to reduce water use. These include tiered rates, seasonal pricing, conservation surcharges, and tap fees. These strategies could be assessed for effectiveness, revenue impact and fairness. Water managers may find the experience of other utilities, within Colorado and with which they are likely to have some familiarity, more compelling than experience from other states and countries.
 - Evaluating the impacts of reduced outdoor watering. The major savings in municipal water uses will likely come from reductions in outdoor water use. Practices to reduce outdoor water use have been widely applied, but we have limited understanding of the impacts on urban livability and options to mitigate these impacts.



• Further evaluate the indirect impacts of reduced municipal water use. This literature review provides information on past research related to the indirect impacts of reduced water use in the municipal sector. Our review indicates that more information is needed on the impacts of water efficiency and conservation efforts on inequality and on environmental resources beyond urban landscaping. Academic papers and utility reports note the importance of these indirect impacts; however, studies that attempt to measure or quantify such impacts have not been identified.

Data Gaps in Evaluating Economic Impacts of Specific Demand Management Project

The economic impacts associated with specific demand management projects will need to be addressed as part of compensation payments and program design. Direct impacts will be site specific for farm operations and municipal water systems. Each demand management applicant or participant is likely to evaluate the expected direct impacts, with available information resources and technical assistance, and incorporate impacts into proposed compensation terms. Indirect impacts are a greater concern for program design, and program design is anticipated to mitigate indirect impacts more than information gaps that are addressed during the application and review process. Project-specific economic analyses will be difficult to conduct due to cost and timing.

SECTION 5 – EDUCATION AND OUTREACH – LITERATURE REVIEW & ANALYSES

CDR Associates led the Education and Outreach (E&O) and Statewide Engagement processes for the Investigation. The tasks associated with these efforts specifically included:

- Participating in the Education and Outreach workgroup meetings.
- Conducting a literature review that analyzed and summarized the existing knowledge of education and outreach strategies, lessons learned, and data gaps.
- Conducting program manager interviews that collected first-hand data on education and outreach for existing water conservation and efficiency programs.
- Supporting CWCB with Statewide Engagement planning and facilitation.
- Developing a summary of the key considerations and practical education and outreach strategies relating to a potential DM program that integrates the findings from the literature review and feedback from the Education and Outreach workgroup and other key stakeholders.

The education and outreach findings detailed in this report align with the CWCB's additional policy goal statements to work with water rights holders and stakeholders in determining the feasibility of DM in Colorado:

(6) Prioritize avoidance of disproportionate negative economic or environmental impacts to any single subbasin or region within Colorado while protecting the legal rights of water rights holders. The Board **will work with water rights holders and stakeholders** to assess the feasibility of and promote mechanisms for obtaining roughly proportionate contributions of water consumptively used from the Colorado River System to a Demand Management program over a given timeframe from participants on each side of the Continental Divide.

(8) Consider and be fully informed by the input and considerations of water rights holders and stakeholders potentially impacted by application of demand management strategies within Colorado, and institute a public review process for any such proposed demand management program.

Literature Review

CDR's literature review aimed to:

- Identify education and outreach lessons learned from similar policy efforts.
- Develop key considerations and/or engagement toolkit (strategies and tactics) for consideration in next steps of the Investigation.
- Identify decision milestones and tradeoffs for future consideration.

The key findings informed the E&O goals and parameters for a potential DM program, as well as considerations linked to messaging, trust building, and program localization / evolution.

The literature review evaluation examined the literature through the following thematic questions:

- What would motivate people to participate in the Demand Management program?
- What components of a DM program excite potential participants? How do you build support for change? How do you build interest in a program like this?



- What disincentivizes people?
- How do you build trust in a low-trust environment? How do you build regional cooperation in a context of competition?
- Who was the target audience of the program? How familiar were people / do people need to be before adopting the program? How was the program messaged or marketed? How do you tailor messages (benefits, impacts) to different audiences?

Overall, the literature was vague in specific detail around E&O efforts, although general themes have proved to be informative for the exploration of the feasibility of a hypothetical DM framework. The literature reviewed for education and outreach themes included:

- Summary of "Lessons Learned" from UCRC's "Final Report: Colorado River System Conservation Pilot Program in the Upper Colorado River Basin", by UCRC & Wilson Water Group, 2018
- Lessons Learned from the System Conservation Partnership Program, by The Nature Conservancy, February 2016
- GVWUA Final Report on the Conserved Consumptive Use Pilot Projects, by GVWUA and J-U-B Engineers, 2019
- TNC Briefing Paper: Upper Basin Demand Management and Water Banking, by The Nature Conservancy, 2019
- Exploring Perceptions of a Voluntary Agricultural Water Conservation Program on the Western Slope of Colorado by MacIlroy, Colorado State University, 2019
- Towards Regional Sustainability Assessment Utilizing Community Based Participatory Research, Sustainability Indicators, and Future Scenario Modeling, by Dubinsky, CU Denver, 2019
- Urban Water Conservation in the Sacramento, California Region during the 2014-2016 Drought, by Talbot, UC Davis, 2019
- The Poudre Water Sharing Working Group: A Report to the CWCB, by The Poudre Water Sharing Working Group, 2015
- Appendix C: 2018 System Conservation Pilot Program Update, by the Upper Colorado River Commission, 2018

What we know

Education, outreach, and engagement is critical to the success of a program. The most perfectly designed program, without willing participants, will not accomplish the goals of a demand management program.

There is no one-size-fits-all solution: we know that each of Colorado's distinct sub-basins will need a contextualized approach, and an approach that keeps Colorado's residents at the heart of the solution.

Based upon the literature review and program manager interviews, the overarching E&O principles for designing and implementing a demand management program are:

- Engagement to develop and tailor the program to community needs: outreach prior to and during the exploration into the feasibility of a program to ensure it represents the potential participants.
- Motivate participation in a demand management program: following the establishment of a demand management program, marketing and outreach to program participants may align with local values, motivations to apply, and messages that resonate with community identities.



• Water education on broad policy impacts and benefits of the program: to inform and educate the broader public on the risks of inaction and the statewide benefits that justify the State's investment in a demand management program.

Additional Work Completed

Program Manager Interviews

Program manager interviews were conducted by CDR Associates following the literature review to fill in data gaps around education and outreach. In particular, the goal was to supplement the Investigation with information about how water conservation programs undertake education, outreach, communication, and marketing efforts.

Program Managers Interviewed

Program managers were selected because of their experience designing, managing, and/or evolving water efficiency programs for agricultural or municipal audiences. Program managers were from organizations including:

- Palo Verde Irrigation District
- San Luis Valley Subdistrict 1
- Colorado River Water Conservation District
- Central Platte Natural Resource District (NRD)
- North Platte NRD
- Tri-Basin NRD
- Twin Platte NRD

Methodology / Interview Approach

The goal of the interviews was to better understand successes, lessons learned, and techniques linked to education and outreach on water conservation programs. Interviewees were promised that quotes and comments would not be directly attributed to them. Meetings were not recorded to encourage candidness. The interviews ran approximately 45 to 60 minutes via Zoom or telephone.

The following questions guided the interview discussions:

- 1. Please describe your conservation / efficiency program.
- 2. Was extensive outreach conducted before the program was established?
- 3. If the program was voluntary, what motivated participation in the demand management program?
- 4. What were the general outreach strategies and specific tactics implemented?
- 5. What would you have done differently if you had a chance?
- 6. Who else would you recommend we speak with for more information?

Interview Key Themes

The following description of seven key themes represent topics and sentiments heard in two or more interviews. The intent is to identify and describe themes for further discussion with stakeholders, and not to prescribe solutions or remedies. The rural designation includes agriculture and small municipal perspectives. The urban perspective captures dense areas.

<u>Rural Themes</u>

- Idaho Snake River
- NRCS CREP Programs
- Metropolitan Fallowing Program
- Denver Water
- City of Westminster
- Republic River Conservation District
- Resource Central



- 1. Localization and evolution of the program
- 2. Proactive and hardcopy outreach
- 3. Trust-building with stakeholders
- 4. Inclusion in process

Localization and evolution of the program

A program that remains reflective of community needs results in higher participation. Several of the interviewees reported that by engaging with farmers about their needs, the co-developed program led to participation that exceeded expectations. One interviewee from the San Luis Valley takes a farm-by-farm approach to ask, "What do you need? What isn't good about the current program? What works for you?" By applying a variety of soft skills, the interviewee links input to programs.

This approach is evident in the San Luis Valley's half-usage pilot program. The program started with discussions with farmers, grew with Board input, and then our interviewee aligned the concept with timelines and budgets. The pilot was originally budgeted at \$120,000; it surpassed that in the first week of enrollment, and in total a pool of \$1,000,000 funded pilot participation.

Proactive and hardcopy outreach

Whereas some communities are familiar and comfortable with digital outreach and marketing, many of the agricultural-oriented interviewees emphasized that their outreach prioritizes tried-and-true methods. In part, this approach works because of the average age of producers (in some communities, interviewees estimated the average age was 50 years old). The interviewee from Nebraska's Central Platte NRD used outreach like mailed quarterly newsletters; newspaper articles; radio advertisements in the spring and fall to target farmers on tractors listening to market updates and farm news; annual information meetings; and the development of an NRD radio jingle.

Trust-building with stakeholders

Interviewees with agricultural audiences emphasized that implementing a program in ag communities takes time. "If you're going to do something like this, you've got to be in it for the long term," said one of the NRD interviewees, "There's no better PR than a satisfied customer." Producers are risk averse. In the interviewee's case, his conservation program's first year had poor participation; the following years benefited from local talk, trust, and evidence of the program's benefit.

Similarly, the San Luis Valley interviewee credited programmatic success to personal relationships. When communication can go both ways, particularly in getting questions answered, then individuals feel more confident in making a well-informed decision.

Inclusion in process

A theme echoed throughout the agricultural interviews was the importance of process inclusion for producers, farmers, ranchers, and rural water users. Ideally, decisions are made at a local level by local program managers or, even better, by potential program participants.

Urban Themes

- 5. Defining motivation for participation
- 6. Ease of application and program management
- 7. Engaging water managers and local government leaders

Defining motivation for participation

For urban residents and water providers, interviewees linked successful programs to marketing aligned with participants' motivations. For household users, participants in water efficiency and conservation programs typically identified water savings as the primary motivator. As a Front Range interviewee said, "The target audience is people who want to do the right thing. They understand that Colorado is semi-arid and that

they're putting too much water into their landscape." And, in a City of Westminster survey, customers identified the top two reasons for promoting water efficiency as: "It ensures long-term water supply security" and "Water is a limited resource."

For municipalities and water providers, motivators are efficiency, impact, and adaptation to the local context. One interviewee highlighted that "blanket solutions" for reducing consumptive use are difficult, as water providers have a strong sense of identity for their customers and organization. Additionally, most municipalities and water providers run lean organizations: few have dedicated staff to developing and implementing water efficiency programs. Programs need to be efficiently managed to align with capacity and need to have tangible impact to make the resources worthwhile.

Ease of application and program management

The ease of application to a program was a motivator at both the household- and water provider-levels, and the ease of program management was a motivator for water providers. Interviewees felt that complex processes would not be successful due to reasons including household attention spans, the level of effort to maintain a program, and the staff needed to run complex programs.

Engaging water managers and local government leaders

Two interviewees found success in implementing programs via water managers and local government leaders. Buy-in from local government leaders increases the likelihood of program implementation, because it provides visibility about a program and, often, elevates the prioritization and timeline of a program's implementation.

Outreach Strategies and Tactics

Interviewees pointed to a spectrum of strategies and tactics to increase participation, raise awareness, and market a program. The tactics have been divided into two categories (municipalities / urban water users and agricultural / rural water users), because approaches varied widely depending on the local context of the interviewee.

Municipalities / Urban Water Users

Messaging

• Simplify and tailor messaging: for example, consider urban programs Cash for Grass or Slow the Flow

Internal Communication Methods

- Reduce barriers to marketing and program management for staff unfamiliar with outreach, such as premade marketing toolkits:
- Flyer templates
- Sample social media posts separated out by month, with corresponding photos
- Editable text that can be used in micro-, medium-, or long-form media
- Ads for local newspapers
- Customer-service trainings for staff

External Communication Methods

- Create opportunities for in-person engagement and relationship-building
- For example, offer free audits to get a water expert into someone's home, educate that customer, build relationships, and trust, and connect them to pre-existing programs
- Outreach in consistent and audience-appropriate places.



- Strategies include:
- Utility bill inserts
- Direct mail
- Targeted social media promotion
- NextDoor posts and ads
- Posts in small local papers
- Joint press releases, often with a customer testimony
- E-news lists
- A customer survey asked: "What's the best way to reach you about water efficiency programs?"
- 42% flyers and inserts in my bill
- 40% messages on my bill
- 10% social media
- 15% website
- Advertise incentives to target audiences like developers, HOAs, and hot development areas

Leveraging Values

- Use data-based decision-making to inform and urban programs
- Define goals around scale and geography to help program managers have an equitable, balanced, and efficient approach to simplify applications for target participants

Agricultural / Rural Water Users

Messaging

- Codefined messaging: ask potential users what they need, and what would or wouldn't work. Then shape a message based on their input.
- Relationships are more important than words. Messaging may follow rapport and trust with the community.
- One-size won't fit all. Farmers have diversity in operations; different crop types have different needs.

Internal Communication Methods

- Training program employees
- Calls with the State on possible program changes

External Communication Methods

- Consider timing of outreach, such as radio ads during harvest season and newsletters in off-seasons
- Having a participant-centric approach is important for long-term participation in the program
- Outreach in consistent and audience-appropriate places. These include:
- Radio
- Radio ads in spring and fall to correlate with the timeframe that farmers are listening to market updates on their tractors

- Customized radio jingle
- Radio interviews
- Town halls, producer meetings, symposiums, and webinars
- Have included features like guest speakers and presentations about new innovations
- Provide updates on programs, aquifer levels, hydrology changes
- Newspaper updates, articles, and newsletter postings
- Newsletters and information bulletins
- Fact sheets and flyers
- Website content
- Blog to provide narrative about key issues
- Guest writers
- Press releases
- Social media, although not as successful because of age of producers
- Board member marketing, word-of-mouth marketing
- School water education on a variety of issues; best interaction with 4th, 5th, 6th graders
- Text (SMS) communication between program managers and participants for quick updates
- Local office locations allow people to come learn about conservation programs for their area

Leveraging Values

- Trust and relationships between a program manager and local communities, which could look like:
- Co-learning: host opportunities for producer / farmer roundtables to inform programmatic decisions
- Upfront time commitments: state how long a pilot or program will be around, and then be consistent.
- Long-term strategy: "There's no better PR than a satisfied customer."

Key Takeaways

The following statements capture overarching takeaways from the Education and Outreach literature review and interviews conducted, and represent common considerations for establishing buy-in for a future potential DM program.

- **Motivations to participate.** Motivation to participate is connected to information, clarity, and education about the program objectives and larger economic / social / environmental issues. Addressing these motivations includes: ensuring the protection of water rights and confirming that participation in compact security is a beneficial use under Colorado Water Law; defining short- and long-term financial benefits for participants, especially to reduce risk and increase profitability; and educating potential participants on the process, goals, and program details, to provide the context needed to relate a program to personal situations.
- **Build Support for a Demand Management Program.** Develop local communication strategies and partner with local, established networks to communicate messages. Involve communities as early as possible in program design. Inclusion of trusted local and state representatives will result in a program with higher agricultural water user participation. Additionally, align a program with producer values



like free-market economies and flexibility in operation and production schedules. Institutionalize into the program benefits for sustainable agriculture and rural communities. Create general policy parameters and rules to facilitate flexibility for the program to fit local stakeholder needs, maximize community benefits, and respond to local concerns.

- **Disincentives.** Primary reasons for nonparticipation include misconceptions about program purpose, local attitudes towards water conservation / fallowing, and concern about impacts to the economy and community. Potential participants are hesitant about overly public information about specific projects. Perceptions about whether a demand management program is necessary or unnecessary is closely linked to how an individual perceives Colorado River Basin water issues.
- **Build Trust and Regional Cooperation.** Local outreach builds trust, relationships, and community buy-in, especially when outreach results in impact and influence. Prioritize face-to-face meetings, ranging from town halls to door-to-door messaging within sub-basins. Develop clear, well-defined scenarios to help communities understand potential benefits or impacts of policy choices. Facilitate opportunities for communities to participate and/or access in research methods, datasets, reporting, and models. Enlist local key stakeholders and non-governmental organizations (NGOs) to participate in program outreach. Communicate with stakeholders, landowners, ditch and reservoir companies, and general irrigators before, during, and after projects. Define decisions that can be made at the local level, instead of the state or federal levels.
- **Defining and Communicating with Target Audiences.** Audiences with preexisting relationships with CWCB and/or partner organizations are more likely to participate in conservation programs. Use communication channels that are appropriate to the target audience. Consider the timing of messages, so the target audience has the bandwidth to engage on potentially applying to a program. Be clear and consistent in messaging so that potential participants receive one message. Develop a multi-pronged approach so that messaging to rural and urban audiences happens at state, regional, and local levels. Build upon existing water messaging platforms, such as Water Efficiency Plans and communications related to drought.

In addition to the literature review, CDR has helped facilitate the stakeholder engagement process relating to the Demand Management Framework and Demand Management more generally. Therefore, in lieu of an analysis of data gaps relating to Education & Outreach, the following section provides key observations relating to Colorado-specific issues and values. Further engagement can continue to inform what elements of a potential Demand Management program are acceptable to different sectors and communities, what elements or areas need further exploration or discussion, and what elements have buy-in or support.

Coloradan Values: A Commentary

Following the Statewide Engagement effort to engage diverse perspectives, CDR Associates provided the following anecdotal commentary to articulate Colorado-specific values. The following commentary is in no way comprehensive nor universal. However, an understanding of Colorado-specific values can help inform the advisability of a program.

Individual Choice

Coloradans appreciate individual choice and discourage government oversight. This value was articulated in rural and urban contexts; for example, producers participate in fallowing programs when it suits their financial objectives or personal lifestyles, and homeowners participate in municipal conservation programs to beautify yards or protect the environment.

Any potential demand management program may align with the value to participate when and where Coloradans choose to. Similarly, messaging and motivation for a demand management program might



recognize that individual choice applies to demand management but does not apply to Compact administration, which would not be voluntary or compensated.

Local Control

Colorado's government is designed to support and empower local control, and this is a value shared by many in the state. Many Coloradans support decision-making made at the lowest level of government possible, including town councils and county commissions. This value seems especially true on the West Slope.

Any potential demand management program may incorporate the role of local government and local decision-making into its decision-making. Inclusion from the start, such as in shaping the program framework and in designing mechanisms to protect against unintended impacts, would likely build local trust and buy-in.

Agricultural Participation in Decision Making

Agricultural communities--including many who would be eligible participants for a potential demand management program--value participation in decision-making. Agricultural stakeholders want to shape the decisions that would impact their ways of life, income, community well-being, and local economies.

Any potential demand management program may proactively include agricultural communities in the process. This includes program development, program implementation, and any changes to the program after its launch. Agricultural participants would be critical to the success of a demand management program in achieving conserved consumptive use.

SECTION 6 – ENVIRONMENTAL CONSIDERATIONS – LITERATURE REVIEW

SGM led the Environmental Considerations processes for the Investigation. The tasks associated with these efforts specifically included:

- Review and develop environmental criteria for assessing impacts of potential demand management activities.
- Identify data gaps, tradeoffs, and interrelated topics relevant to the Environmental Considerations workgroup and assist in determining methods to address data gaps as directed, as identified in the literature review.
- Summarize instream flow, environmental and recreational issues relating to past water conservation programs.

Literature Review

SGM reviewed various types of water savings, water banking, pilot projects and/or water conservation reports (listed in **Exhibit A**) and information to understand how environmental considerations, impacts and net benefits, were considered or how they influenced projects to balance these needs. Like the Monitoring and Verification literature review, SGM reviewed this information to understand how future projects could inform the integration of environmental considerations for a potential DM program, including:

• Current methodologies, data, and information to measure environmental attributes both in the agricultural and municipal contexts.



- Details associated with consumptive use and conservation estimation and monitoring, verification methods, and related issues.
- Data gaps and methods for being able to consider and measure environmental attributes within the DM monitoring and verification process.

SGM took the direction of the Environmental Considerations workgroup and summarized key topics, criteria, and considerations relating to previous conservation projects (**Exhibit B**). Summary information included:

- Primarily purpose/goal of the project.
- Key takeaways.
- Project location.
- Program name, administration, structure, nature and duration of project practice.
- Tools uses to assess environmental impacts.
- Impacts to streamflow including magnitude, frequency, duration, timing, rate of change in hydrologic conditions, and return flow impacts.
- Impacts to species including critical stream reaches, critical land or riparian habitat, and list of species impacted.
- Impacts to water quality including salinity, temperature, and other constituents.
- Environmental considerations tradeoffs predicted outcome from activities, and proportionality.
- Ability to offset losses to environmental services and opportunities to incentivize environmental components for CCU projects.
- Evaluation of impacts (positive or negative) to instream flows, stream or watershed management plans, critical habitat, state species of concern, basin roundtable environmental values, conservation strategies, and other community goals and/or projects.

What we Know

Overall, the literature review concluded that most projects and studies did not consider nor measure how conserved consumptive use impacts or benefits environmental attributes. However, there was recognition in some studies that the environment benefits with increased streamflows due to lower diversions. In general, these streamflow impacts were correlated to better fish habitat due to higher instream flow and lower temperatures.

There was recognition that the following key elements might influence environmental impacts or benefits, and in some instances, offered suggestions for integrating potential mechanisms for measuring these benefits and impacts.

Streamflow Impacts

Generally, the literature found increased streamflow could benefit the environment. "Environmental Water Transactions in the Colorado River Basin: A Closer Look" (Stanford Woods Institute for the Environment, 2018, Exhibit A) reviewed instream flow projects including the SCPP projects. Notably, the report found that "although the total amount of water restored by these transactions is very small compared to the overall water budget of the basin, in certain watersheds, transactions have provided significant benefits for local streamflow." Specifically, these were the Price River watershed in Utah and the Green River watershed in Wyoming.



Another report, "Salmon recovery in the Columbia River basin: analysis of measures affecting agriculture" (Aillery et al, 1999, Exhibit A) focused on the impact of diverted water and the impact of decreased streamflow on salmon species. Specifically, it found "flow alterations have significantly increased travel time for juvenile fish migrating to the ocean, a primary factor in reduced survival rates." The report investigates different methods to increase streamflow in the Columbia River basin. As this relates to a DM program, increased streamflow to move water to Lake Powell could have positive impacts on fish species.

Modeling

The literature identified the importance of modeling to be able to fully predict changes in streamflow during a demand management program. Currently, the models do not handle extra pools of water in the reservoirs and would need to be updated to help appropriately drive reservoir operation. In "Considerations for Modeling a Water Bank at the Aspinall Unit with Current Environmental Flows," (Hydros Consulting, 2011, Exhibit A), StateMod could be most easily reconfigured to simulate environmental flow targets (through Black Canyon and at Whitewater), including base flow and peak flow targets. However, modeling was not done in this analysis, so there are no results to share on how the water banking project would impact flows.

Species

Throughout the literature, different fish species are discussed with a focus on trout and salmon populations in the Western United States. One of the secondary benefits of the SCPP projects included increased streamflow in the Middle Piney Creek. As streamflow decreases, water temperature tends to rise, "often beyond ideal thresholds and also reduces available habitat." The GV CUPP (J-U-B Engineers Inc., 2017, Exhibit A) found "increased water in the river resulted in \$23,000 of estimated savings not spent on endangered fish programs." More broadly in the United States, adding minimum flow requirements for the Snake River at Lower Granite Dam, and for the Columbia River at McNary Dam has improved salmon and steelhead populations (Aillery et al, 1999, Exhibit A).

Water Quality

Salinity impacts were discussed in four of the reports reviewed, mostly reviewing projects in the Grand River Valley. During the SCPP, it was estimated that the "2017 Grand Valley water conservation project is estimated to have reduced salt loading to the Colorado River by 4,960 tons." (UCRC, 2018, Exhibit A). In the Colorado River District's "Colorado River Water Bank Feasibility Study: Phase 2," (MWH, 2013, Exhibit A) water quality impacts are discussed with focus on salinity and selenium. "Salinity and selenium issues may make fallowing or deficit irrigation more attractive to Project farmers, as impacted lands might be taken out of production with less impact on overall yields. In addition, reduced irrigation of these lands may have benefits in improved quality of return flows." In this study, salinity effects (not affected or marginally affected) were a screening criterion used to select candidate systems representing a broad range of characteristics. In the "Infographic: Grand Valley Pilot Project Secondary Benefits," (TNC, 2019, Exhibit A) reduced irrigation "on salty soils improved water quality and resulted in an estimated savings of \$282,720 from money not spent on other measures to reduce salinity." However, another review, "Research Synthesis: Agronomic Impacts of Reduction Irrigation," (Culp and Kelly, 2019, Exhibit A) raises the concern that "salt will move to the surface of the soil during periods of fallowing." If this occurs, "a preplanting leaching irrigation" may be required which could "reduce the water savings from fallowing."

Additional Considerations

A summary of additional project considerations from the literature suggested the following to promote the inclusion of environmental attributes. These considerations are also discussed in the M&V section.

• Using streamflow station data helps understand the impacts to streamflow from foregone diversions.



- Increasing water in the river could result in savings due to less spending on endangered fish programs in studies.
- Reducing irrigation on salt soils could improve water quality and save money on salinity reduction programs.
- Maintaining historical return flows may be a challenge and may require storage and timed releases or construction of recharge basins but could offer net environmental benefits.
- Reducing irrigation on salty soils may improve water quality and reduce costs for salinity reduction programs. However, salty soils should be monitored as extra irrigation may be needed in subsequent years to perform leaching irrigation reducing the long-term water savings.
- Increasing streamflows keeps temperatures low, improving fish habitats.

Key Takeaways

The key takeaways relating to a potential DM Program that support Environmental Considerations aligns with the need to ensure ongoing Compact compliance, however, there is a strong need to fill in the data gaps to be able to measure the potential impacts or benefits associated with the streamflow impacts.

List of key things that would support measuring impacts or benefits include:

- Local Support and Participation. Enlist local key stakeholders and non-governmental organizations (NGOs) to partner and realize opportunities to provide a net environmental benefit.
- Alternatives Analysis. Initiate a high-level assessment of environmental impacts of all recommended and alternate water management strategies considered.
- **Expand Project Purpose to Consider Additional Objectives**. The literature review revealed that many of the demand management programs did not have an environmental focus.

Data Gaps

The following data gaps were identified in the Environmental Considerations literature review:

- **Data**. Measured data on the impacts on fallowing and deficit irrigation on downstream streamflow and environmental resources due to changes in return flows.
- Modeling. The actual timing and reduction in depletions will require return flow modeling
- **Instrumentation and Monitoring Equipment**. There will be a need for cost effective flow monitoring to gage the environmental benefits in specific locations

The Environmental Considerations workgroup identified specific issues of interest to be considered in the literature review. SGM looked for mentions of these items and the following issues were not addressed in the 54 documents reviewed:

- Stream Management Plan/Watershed Management Plan objectives.
- Basin Round Tables environmental values lists/mapping.
- Colorado River Cutthroat Trout conservation strategy.
- Other known community/entity project.
- Environmental specific tradeoffs.
- Other known community/entity projects.



SECTION 7 – FUNDING – LITERATURE REVIEW & ANALYSES

WestWater Research led the Funding processes for the Investigation. The tasks associated with these efforts specifically included:

- Participation in the final meeting of the Funding Workgroup as a listener.
- Compilation and review of past studies and research regarding the costs and funding structures for other water conservation programs in the Western U.S. like a DM program.
- Analysis of design elements of a DM program as they relate to costs and beneficiaries.
- Identification of knowledge or data gaps in the ability to understand and evaluate the costs and funding options for a DM program.

Literature Review

There was found to be a lack of literature and past research on the costs and funding structures for demand management types of water conservation programs. WestWater compiled data and conducted original research on other water conservation programs in the Western U.S. to support the funding analysis.

What we know

Cost Components of Example Demand Management Programs

This section provides an inventory and analysis of other "demand management" programs in the Western U.S. In identifying comparable programs, the following selection criteria and loose definition were applied: (1) voluntary, (2) compensated, (3) consumptive water use reduction that is (4) temporary for any piece of land and is distinguished from two-party transactions because it is (5) operated by a single entity as a program over multiple years, often with a (6) regulatory or policy driver. Pilot projects were included. The costs of demand management vary by the type of water use (demand) being managed and reduced. Costs are significantly different between the agricultural and municipal sectors.

Agricultural Demand Management

Most of the demand management programs identified in the Western U.S. have been programs to reduce agricultural water use in order to utilize the savings for an alternative water use, such as municipal or environmental. A total of 17 example agricultural demand management programs were identified in more than 6 different states. A range of entities have developed and administered the agricultural demand management programs, including municipal water agencies, state government agencies, local / regional water districts, and others. The following cost components were identified in reviewing the example agricultural demand management programs:

- Water Costs. As defined above, all example demand management programs were compensated and therefore all had a water cost associated with agricultural conservation activities. The water costs reflect various factors: (1) the foregone agricultural value, or lost net revenue, (2) the program compensation structure and term, and (3) the type of demand management activity. A more expansive discussion of agricultural economic impacts from conducting demand management activities is provided in a previous section of this report. The water costs for agricultural participants in a Colorado demand management program are likely to reflect the predominance of perennial forage crops on the Colorado West Slope.
- Administration Costs. All of the example demand management programs had administrative costs, with an average annual cost \$40 per acre-foot. Administration costs include regulatory approvals to



initiate projects and annual monitoring and verification activities. In one example, these costs were paid by the participating landowners and were covered as part of the compensation (water cost). With the exception of the Catlin Canal Pilot Project on the Lower Arkansas River, administration costs ranged from \$4 to \$48 per annual acre-foot (AF) of demand reduction. The Catlin Canal Pilot Project had estimated administration costs of \$167 per AF, per year which reflects the attributes of this project and relatively stringent administrative requirements found in Colorado and particularly along the Front Range.

• **Mitigation Costs**. Only 5 of the 17 example demand management programs included mitigation payments to offset economic and related secondary (indirect) impacts from reduced agricultural water use. For the 5 programs that include mitigation as part of the program, the mitigation payments ranged from \$2 to \$86 per annual AF of water use reduction, with an average annual payment of approximately \$50 per AF.

Municipal Demand Management

The activities to achieve demand management in the municipal sector remain uncertain, and it is likely that municipal water providers will take different approaches to implement demand management within their systems. This funding analysis considers municipal demand management through water conservation as one potential method, but it is recognized that it may not be broadly applicable. Water conservation was selected because most Colorado municipal water providers have a water conservation program or plan of activities that can be evaluated for example costs of demand management. Unlike the agricultural examples described in the previous section, municipal programs are typically not intended to produce a transferable water supply to another use. Municipal demand management programs are typically targeted at one of the following objectives:

- 1. Permanently reducing individual customer water use through a variety of indoor and outdoor water conservation and efficiency activities, including public outreach, rebate programs, tiered or water budget rate structures, home water audits, and others.
- 2. Temporarily reducing both individual customer and municipal-scale water use in response to a potential water supply shortage due to drought, infrastructure damage, or other emergencies. Regulatory measures are often applied to achieve demand management, such as every other day outdoor watering, bans or limitations on certain water uses, and temporary increases to water billing rates.

Any potential Demand Management program in Colorado would be voluntary, temporary, and compensated. Municipal demand management examples do not necessarily align with all three characteristics. Water conservation program activities in the first category above have associated direct costs (compensation) and are voluntary actions but are often intended to result in permanent water use reduction. The second category of regulatory actions are intended to be temporary but are often not voluntary or compensated. For this analysis, the cost of municipal demand management references observed costs of permanent municipal water conservation programs, but it may be recognized that temporary demand management can be achieved in the municipal sector and historically has been more likely to occur through regulatory (policy) actions at little to no direct cost. In addition, many municipal water providers may look to implement demand management activities with no water service impact to their customers and therefore with no water conservation actions by their customers.

The costs of municipal demand management were evaluated using two approaches and datasets:

• **Municipal Conservation Activities**. Municipal demand management is achieved through a combination of activities, such as those listed above. These activities each have an estimated water demand reduction and cost. Previous research indicates that indoor residential conservation activities have costs that are roughly 50% of the outdoor conservation activities. The costs also increase with greater degrees of water demand reduction. In total, past research indicates municipal conservation



activities having total direct costs of \$500 per AF or more. This cost is likely to represent a permanent water use reduction, and the annual equivalent cost is estimated at approximately \$20 per AF based on a 4% discount rate over an indefinite period.

• **Municipal Conservation Programs**. Many municipal water providers have annual water conservation programs with associated budgets to achieve demand reduction. Instead of looking at the cost of individual activities, it is helpful to look at the overall costs of municipal water conservation programs to understand the administrative costs, the inefficiencies in program spending, the effects of program activities that do not have associated costs, and the impact of growth in the number of service customers. A historical analysis of municipal demand management over the period 2000-2020 was completed for 9 example municipal water providers who utilize Colorado River Basin supplies. The average unit cost was found to be approximately \$1,500 per AF of demand reduction, which is considered to better reflect the total cost of achieving overall volume reductions in municipal demand, as opposed to reductions in per-person water use rates.

Municipal demand management costs in Colorado may consider two important factors:

- **Trans-Basin Diversions**. Most municipal water use in the Colorado River Basin in Colorado is sourced from trans-basin diversions to the Front Range. These trans-basin diversions have historically not had any return flows to the Colorado River system from municipal effluent, and therefore any municipal diversion demand reduction from these trans-basin diversions is effectively a reduction in consumptive use from the Colorado River Basin. This contrasts with municipal water users located in the Colorado River Basin, who would mostly realize consumptive use savings only from a reduction in outdoor watering uses.
- Water Supply Portfolio. Most Front Range municipal water providers, particularly the largest volume users, have a water supply portfolio that sources water from a variety of river systems and projects. The composition of municipal water supplies that are sourced from the Colorado River system as a portion of the overall supply portfolio influences how total municipal demand management activities relate to water diversion reductions in the Colorado River Basin. Available data indicates that municipal water utilities in Colorado that are reliant on the Colorado River Basin for a portion of their water supply have 50% to 60% of their water supply sourced from other water systems. Therefore, municipal water providers would need to specifically reduce Colorado River Basin sources commensurate with demand management activities, otherwise the unit costs per volume of Colorado River water use reduction would potentially double.

Cost Factors for Demand Management Program

Cost estimates of a DM program are inherently uncertain because the costs can vary significantly depending on the following factors (among others):

- **Funding**. The funding structure of a demand management program is expected to influence costs, and particularly the amount of state government funding required. Decisions about who pays for demand management influences who bears the costs but also impacts the cost itself.
- Scale / Volume. Costs are directly a function of scale, or the annual volume of demand management being implemented. At the present time and for the near term, the scale of demand management in Colorado will be limited by volume of the conservation pool in Lake Powell created by the DCP. The annual volume of demand management will depend on how much space within the conservation pool is available to Colorado and how fast that space is intended to be filled.
- **Timing**. Costs escalate under emergency action, which has long motivated planning efforts in various subject areas. Demand management activities in the agricultural and municipal sectors may be more difficult and more costly to achieve during a drought, or if activities are required due to pending water

shortages or Compact administration. A multi-year consistent demand management program is expected to carry lower costs than a program that is reacting to stressful conditions.

- **Project Selection Process & Equity Policies.** The process for selecting demand management projects may influence program costs, depending on what type of process is established, how applicants are identified and evaluated, and how projects are compared. Several of the Workgroups have had discussions supporting equity in a demand management program, including water use sector equity between agricultural and municipal water users and spatial equity to limit the concentration (and associated impacts) of demand management activities. Implementing regulatory limits to provide for equity is expected to increase costs, due to a reduction in the pool of potential projects and deviation from a lowest-cost system of project selection.
- Administrative Process. The process established to conduct an upfront review of each project application, and the process established for monitoring and verification of project activities are both significant factors in overall project costs. It will be important to establish a review and monitoring process for the demand management program that is not cost prohibitive. Another aspect of approval is any environmental review and mitigation that is required as part of the program.
- **Participant Requirements.** Compensation payments are expected to reflect any lost economic opportunity associated with reduced water use, and any costs associated with meeting program requirements. As described in a separate section of this report, participant requirements may include cover crops, weed and pest controls, and other elements to reduce off-farm impacts.
- **Mitigation**. In addition to compensation paid to participants, there may be mitigation payments paid to offset economic and environment impacts resulting from the projects. Example mitigation includes: (1) payments to the larger ditch company or irrigation district for operational impacts, (2) payments to the county to offset economic impacts, (3) payments to an environmental organization to offset wetland or riparian impacts.
- Economic Factors. The multi-year and potentially multi-decade timeline of a demand management program results in various economic factors influencing costs. Some examples include: (1) agricultural commodity market prices influencing compensation payments, (2) interest rates influencing the cost of capital outlays, (3) inflation influencing all prices & costs, (4) population and economic growth influencing water supply & demand imbalances and water transaction values. There are other factors to consider, but the underlying point is that a variety of factors outside of the program's design and control will influence program costs.

Key Takeaways

The takeaways provided in this section are crafted to advance the demand management discussion and feasibility analysis in Colorado.

- Activity & Scale. Proactive programs that aim for annual demand management activities over a longer period of time are a more cost-effective method, as opposed to a surge of activity during a drought or other stressor. Therefore, funding sources may be structured to be reliable and consistent. Costs of demand management activities are a primary consideration if the program is publicly funded.
- Certification Process. Several of the time-intensive and costly aspects of project review and approval can be completed upfront and remain valid for many years. Therefore, other successful demand management programs have been designed with a certification process for projects that can allow each project to be thoroughly reviewed but also allow annual flexibility in participation.
- Minimize Seller Costs. To encourage participation in the demand management program, program design might avoid a significant cost burden for participants, or entities conducting demand



management activities. Monitoring and verification activities (and proving non-injury) may require the installation of equipment and annual data collection efforts. In addition, there may be mitigation costs associated with the ditch organization, local community, and environment. Upfront capital costs and mitigation costs could be incorporated into annual compensation payments. The program design may also consider state agency staff to conduct the initial reviews of applications and to assist in project administration. With these program design elements, the participant costs may be limited to developing application materials.

• Incorporate Monitoring & Verification Costs into Project Selection. The process of comparing and selecting project proposals requires that the full cost of the project be quantified. The compensation aspects of each proposal are expected to be defined by the participant. Monitoring and verification components of each project will be more difficult for the applicant to define. The costs of monitoring, verification, and administrative approval (to ensure non-injury) are expected to vary significantly across projects. Monitoring and verification costs could be evaluated with DNR assistance as part of a certification process and costs may be considered as a required element of each project application. An accurate evaluation of project proposals requires an "apples to apples" comparison of full project costs.

Data Gaps

This section provides a discussion of two types of data gaps: (1) those currently present in evaluating the feasibility of a demand management program, and (2) those that are likely to be present when structuring specific demand management funding options.

Data Gaps in Evaluating the Feasibility of Demand Management

The costs of demand management remain uncertain because of multiple variables and decision-points affecting the program. The preliminary estimates on cost feasibility may continue to be revisited by CWCB staff as the program design is explored. As continued analysis occurs, the following data gaps related to funding are identified:

- **Process Considerations**. Preliminary ideas on a program process are identified in the form of a single conceptual framework. The costs of a demand management program are inherently tied to the application and selection process, requirements for monitoring and verification, and project evaluation. It is expected that many of the data gaps involving process will be filled if, and as decisions are made regarding program structure.
- **Program Requirements.** Costs are also a function of program requirements, such as mitigation for local economic impacts and augmentation of stream depletions. Program costs can rise significantly depending on how program and participant requirements are defined.

Data Gaps in Structuring Specific Funding Options

The data gaps listed above for evaluating feasibility also apply to structuring specific funding options for demand management. Specific funding options can be developed once these data gaps are addressed.



SECTION 8 – MONITORING & VERIFICATION LITERATURE REVIEW

SGM led the Monitoring and Verification literature review for the Investigation. The tasks associated with these efforts specifically included:

- Participation in the final two meetings of the Monitoring and Verification workgroup as a listener.
- Compilation and review of past studies and research regarding M&V considerations and practices detailed in previous CCU and ATM pilot projects, as well as western states water banking programs.
- Analysis of design elements for a potential DM program as they relate to M&V activities.
- Identification of knowledge or data gaps for consideration of the implementation of M&V requirements in a potential DM program, along with individual DM M&V project requirements.

Literature Review

SGM reviewed various types of water savings, water banking, pilot projects and/or water conservation reports and information that had similar goals and could inform the feasibility of a DM program, including:

- Current methodologies, data, and information to measure DM and water conservation both in the agricultural and municipal contexts.
- Details associated with consumptive use and conservation estimation and monitoring, verification methods, and related issues.
- Data gaps and methods for being able to continue advancing the DM monitoring and verification process.

Overall, the reports captured a summary of pilot project, such as the System Conservation Pilot Program (SCPP), and water conservation activities in Colorado and other areas across the Rocky Mountain West. The literature review considered a wide array of documents including research papers, demand-side vs supply-side municipal studies, state-mandated water conservation programs in California, crop rotations, energy-water benefits, and ATM research. The reports (shown in **Exhibit A**) generally analyzed off-farm benefits, conserved consumptive use, lessons learned and environmental impacts.

To better record the breadth and depth of information available in the literature, SGM summarized key topics, criteria, and takeaways relating to previously completed projects within a table. Summary information included:

- Primarily purpose/goal of the project.
- Key takeaways.
- Project location.
- Program name, administration, structure, nature and duration of project practice.
- Source and amount of water conserved.
- Monitoring and verification requirements, equipment, and processes:
 - Measurement of water returned to the stream.
 - Consumptive use analyses.
 - Estimate of residual field consumptive use.



- Return flow maintenance.
- Verification of conserved consumptive use.
- Coordination of benefits.
- Municipal considerations.
- Implications for storage, hydropower, recreation, and environmental considerations.
- Program lessons learned, successes and/or challenges, tradeoffs, proportionality, and alignment with M&V workgroup guiding principles.
- Project data gaps, keys to success, identified challenges, and overall findings and lessons learned.

See Exhibit B for the comprehensive tables documenting the overall M&V literature review findings.

What we know

Overall, few of the reports focused on the specific methods, instruments, or techniques used for monitoring and verification activities. Almost all the literature identified that projects need to be evaluated at the individual field level, as no two projects are alike. Generally speaking, the measurement devices commonly used by irrigators and municipalities are adequate to monitor and verify demand management project activities. The challenge often identified in the literature wasn't inadequate devices, but a lack of measurement devices physically installed near the project area. At the project level, a combination of existing measurement devices and field visits were used to verify conservation projects were operating as planned. However, the literature often cited that detailed measurement and verification of the achieved conservation amount wasn't completed, rather that the conservation practices were implemented. As an example, the Grand Valley Water Users Association Conserved Consumptive Use Pilot Project (GV CCUPP) relied on an independent contractor to perform site visits throughout the project to verify fallowed fields, give advice for weed control, as needed, and document compliance. The reports and lessons learned from the project emphasized the importance of utilizing an independent contractor to the success of the project. Ultimately, this increased trust between the participants and the program administration. The literature also identified that widespread and readily available remote sensing may help with monitoring and verification practices in the future, as well as to understand the historical irrigation practices and potential conservation benefits at a proposed site.

Consumptive Use Analysis

There are multiple computer programs available that can reasonably estimate the amount of historical consumptive use of agricultural operations. Each program is slightly different and requires a certain amount of input data. The ability to estimate the historical consumptive use is predicated on the availability of adequate climate data, water diversion records, cropping information, and soil characteristics. For instance, the CU analyses of SCPP projects focused on the specific amounts and associated cost of conserved water. Overall, the SCPP resulted in an estimated consumptive use reduction from all 45 projects in 2015 through 2017 of 22,116 acre-feet (AF). Additionally, projects complete in 2018 increased the reduction of consumptive use by 25,097 AF for a total of 47,213 AF over the entire SCPP timeframe.

The System Conservation Pilot Program also considered the difference between estimated consumptive use reduction on the applications and the reduction calculated during the subsequent analysis. Overall, the application estimates underestimated the reduction by 2,728 AF (approximately 7%). The SCPP identified that in order to accurately calculate the actual CU conserved in a project, thorough on the ground measurements are needed. In addition, the GV CCUPP pilot program analyzed the conserved consumptive use compared to the number of acres enrolled in the project. They found in 2017 with 1,069 acres enrolled in the pilot project resulted in 2,715 AF of water conserved. Similarly, in 2018, 1,252 acres were enrolled



which conserved 3,178 AF with both years yielding approximately 2.5 AF of conserved water per acre enrolled in the GV CCUPP pilot program.

It is important to note that the purpose of the System Conservation Pilot Program was not to create quantifiable water savings in Lake Powell, but rather to test the concept of a program incorporating temporary, voluntary, compensated reductions in conserved consumptive use.

Lessons Learned

Three primary lessons learned from the SCPP include:

- Outreach & communication is essential.
- Operational & legal issues must be addressed at ditch company/irrigation district level.
- Simplifying the process allows for greater efficiency.

Multiple participants voiced concerns about "broader economic impacts and social issues for" their communities – emphasizing the necessity of outreach and communication. For monitoring and verification purposes, the SCPP literature emphasized the importance of supporting efforts to estimated conserved consumptive use and the independence of verification work from the local administrators (such as ditch company/irrigation district staff). Additionally, The GV CCUUP found there was an increased interest in participation after the first year of the program and similarly indicated the importance of independent monitoring and verification-built trust within the pilot program.

Secondary Impacts

The SCPP literature described the benefits of a DM-type program increased environmental flows, decreased cost of alternative habitat flow restoration projects, improved societal benefits from habitat flows for endangered species, reduced salinity loading in the Colorado River, and increased municipal and hydropower benefits. Other pilot projects in Colorado observed that increased flows contributed minimal improvement to the overall recreational flow needs. Some documents did consider temporary water transfers and the associated impact to instream flows (ISF). These transfers without legally changing the water rights resulted in irrigators conserving water through a variety of means and leaving some portion of that water instream, which generally bolstered flows during the irrigation season, but may have reduced non-irrigation season return flows within a stream segment. The SCPP was documented to have the added effect of enhancing streamflow, and it was further determined that the availability of consistent funding would be crucial to success of long-term demand management efforts, whether for streamflow, water security or (most likely) multiple objectives.

SCPP Overview and General Findings

- Focused on the general administration and process of running a demand management system rather than the specifics of monitoring and verification.
- Attempted to streamline the process for participants (irrigators) and keep the barriers to entering a program/project minimal.
- Concluded that the size of the ditch and its governance/bylaws greatly influenced how conserved water projects could be operationally achieved and accounted (for).
- Realized that the size of the ditch company changed how water was managed.

For example, large ditch companies diverted supplies and ran through their system; medium ditch companies diverted supplies and ran through their system or reduced their river headgate diversions; and small ditches reduced their river headgate diversions or closed it.



- Systems with multiple shareholders will likely require management participation (i.e., water users association or ditch company board) for success.
- The SCPP return flow maintenance practices were considered, but generally not adequately.
- Modelling considerations will need to be updated to handle water storage for potential demand management project operations.
- Flexibility to allow for locally driven solutions can drive higher engagement.

ATM Pilot Project Overview and Findings

- Avoided the need to go through a water court application process. However, complex monitoring and verification requirements may require a legal process that complicate the implementation of projects (historical consumptive use, change of use cases, etc.).
- Existing legal platforms to avoid water court are limited to instream flows leases, Substitute Water Supply Plan, and Interruptible Water Supply Agreement.
- These existing options have limitations and may not apply to every case or be useful in all projects so other options may need to be developed to avoid water court.
- Protection of vested water rights along with a flexible delivery schedules for M&I stakeholders are key for agricultural producers so they can keep growing crops/livestock.
- Guaranteed supplies are paramount for M&I water providers.
- An overall pilot project goal may be to reduce costs for M&I stakeholders such that ATMs are more affordable or more beneficial than buy-and-dry.
- The cost of installing new and/or highly accurate monitoring and verification equipment may be a participation barrier, depending upon the accounting and administration requirements.

Additional Findings

- Integrating local issues/sentiment was critical to the successful launch of conserved consumptive use pilot projects.
- Independent verification of project compliance helped maintain a level of trust and eliminated many interpersonal issues between irrigators, districts, and ditch companies.
- Sources of funding could cause contention if irrigators perceived a Front Range entity was paying for an area to be fallowed.
- Models worked well for estimating conserved consumptive use, though without on-farm analyses, the calculation of actual water savings was difficult to determine.
- Calculated estimate consumptive use and verification of conserved consumptive use in agriculture is improved with nearby climate stations.

Themes

The following statements capture overarching themes from the Monitoring and Verification literature review and represent common considerations for establishing buy-in for a future potential DM program.

Local data and input

Local focus was identified as one of the most crucial components for obtaining buy-in, finding project participants, and addressing misconceptions or apprehensions, etc. This theme cannot be emphasized

enough, as nearly every report highlighted this as contributing factor to the success of projects. Additional information surrounding the need for local data and input included:

- Generally, standard measurement equipment available and used by many irrigators and municipalities is adequate to monitor and verify conserved consumptive use projects. Locally, challenges may occur due to a lack of measurement devices, or with antiquated devices in poor condition.
- The availability of local data and equipment will inform the monitoring and verification needs and/or requirements for conserved consumptive use projects.
- A local presence is helpful to address any technical monitoring and verification needs. As a result, costs associated with local technical services for monitoring and verification could be significant.
- Regarding proportionality, M&I participants could more likely afford the engineering and legal costs than agricultural participants.
- Regarding proportionality, costs to support local technical services could prevent agricultural participation.
- Drought messaging can significantly influence a customer's response to whether or not they will conserve.

For instance, the Drought Monitor could indicate conditions that are too regional and general and not reflect site-specific conditions. This develops a lack of trust in the regional information and represents an opportunity to change practices.

Flexible program

- Each conserved consumptive use project is different. Therefore, a flexible program structure could be more attractive to prospective applicants, especially by considering local and regional needs.
- However, a flexible program structure could require more administrative coordination and effort and could take longer to develop.

Infrastructure

• Potential participants in future pilot projects may need significant investment in infrastructure to accurately monitory and verify the conserved water and to ensure that return flows are maintained to avoid injury to downstream users.

Key Takeaways

The key takeaways relating to a potential DM Program that support M&V activities were largely based on the observed themes and may be used to fill the identified data gaps. In summary they include:

- Utilize Local Resources. The literature indicated obtaining local data and input to drive a monitoring and verification implementation was key to building public trust in the program, as discussed in the Education and Outreach section. Local resources were instrumental to support efforts to estimate conserved consumptive use, address any technical monitoring and verification needs for participants, as well as to provide independence for verification work from the local administrators (such as ditch company/irrigation district staff).
- **Develop a Flexible Program.** Projects in different geographic regions will require different implementation methods, project operations and local support. A project in one area will have different soil conditions, crops, ditch operations, community relations, etc. than another project. Allowing program flexibility for different implementation options increased participation in the literature reviewed.



- **Provide Funding to Support Investment in Measurement Infrastructure.** The literature highlighted it is not uncommon to have good potential projects in areas which lack the infrastructure to be able to monitor and verify the project. The initial capital costs and ongoing operations and maintenance costs required to install the measurement structures needed for accurate monitoring and verification of conservation projects needs to be addressed to promote participation in those projects.
- Communicate with stakeholders, landowners, ditch, and reservoir companies before, during, and after projects. The literature highlighted the importance of working directly with the program participants and those whose operations were directly impacted by participant participation (i.e. ditch companies, reservoir companies, etc.) throughout the process to future participation and trust in the monitoring and verification process.
- Numerous takeaways from the E&O section, would support an effective M&V program implementation. The SCPP literature highlighted the importance of a local project champion to reach out to potential project stakeholders and then work through implementation challenges, including building trust in the monitoring and verification processes.

Data Gaps

- More data would need to be collected to fully monitor and verify project yields and the resulting system increases, impacts to downstream water users, and ultimate benefit to Lake Powell.
- While standard irrigation and municipal measurement devices will likely be adequate, there is not detailed information regarding equipment or measurement instrumentation recommendations and/or data processing methods.
- There is a need for significant investments in infrastructure to accurately account for any conserved water and to ensure that return flows are maintained to avoid injury to downstream users.
- Fallowing projects are easier for monitoring and verification purposes, as general techniques include site visits to document that a field isn't being irrigated, as well as to observe the growth of any vegetation along with a review of careful accounting practices.
- Verification requirements will likely be more challenging and detailed for non-fallowing projects, as producers will seek to reduce the consumptive use of plants, while still obtaining a harvest.
- Accurately assessing the CCU from deficit irrigation or alternative crops will be harder to quantify/verify, requires more monitoring and data collection, and ultimately relying on more rigorous technical analyses.
- There may be a need for improved coverage of climate stations in regions of Colorado to support M&V activities for some future pilot projects.
- ET estimation methods vary regarding the necessary data, processing techniques, and resultant accuracy. Generally, the more plentiful the data and rigorous the analyses, the greater the cost and accuracy. Future pilot projects may explore various technical options and the resultant CCU.



ACRONYMS

AF	Acre-Feet
AFY	Acre-Feet/Year
ATM	Alternative Transfer Methods
Basin	Colorado River Basin in Colorado
BMP	Best Management Practice
CCU	Conserved Consumptive Use
CCUPP	Conserved Consumptive Use Pilot Program
CRWCD	Colorado River Water Conservation District
CFS	Cubic Feet per Second
CRCA	Colorado River Cooperative Agreement
CU	Consumptive Use
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWP	Colorado Water Plan
DCP	Drought Contingency Plan
DM	Demand Management
DMSA	Demand Management Storage Agreement
DNR	Department of Natural Resources
DWR	Division of Water Resources
E&O	Education and Outreach
EPA	U.S. Environmental Protection Agency
GPCD	Gallons Per-Capita per-Day
IBCC	Interbasin Compact Committee
Investigation	Demand Management Feasibility Investigation
ISF	Instream Flow
MAF	Million Acre-Feet
M&I	Municipal and Industrial
M&V	Monitoring and Verification
NGO	Non-governmental organization
NRCS	Natural Resources Conservation Service
PMT	Project Management Team



SB	Senate Bill
SEO	State Engineer's Office
SWSP	Substitute Water Supply Plan
TMD	Transmountain Diversion
UCRC	Upper Colorado River Commission
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service

Demand Management Literature Review

EXHIBIT A



Exhibit A. Summary of Literature Review Reports and Documents.

Title	Year Published	Publisher/Authors
System Conservation Pilot Program Secondary Benefits: Final Report with Case Studies	2019	WestWater Research for TNC
Infographic: Grand Valley Pilot Project Secondary Benefits	2019	TNC
Research Synthesis: Agronomic Impacts of Reduction Irrigation	2019	Culp and Kelly for TNC
Final Report: Colorado River System Conservation Pilot Program in the Upper Colorado River Basin	2018	Upper Colorado River Commission
Final Report: Appendix C: 2018 System Conservation Pilot Program Update	2018	Upper Colorado River Commission
Pilot Program Funding Agreement	2014	Bureau of Reclamation
Colorado River Water Bank Feasibility Study: Phase 1	2012	Colorado River Water Conservation District
Colorado River Water Bank Feasibility Study: Phase 2	2013	For Colorado River District. By MWH.
Colorado River Compact Colorado water bank feasibility study: water supply technical memorandum. (Appendix B to Colorado River Water Bank Feasibility Study: Phase 1)	2012	Natural Resources Consulting Engineers, Inc
Exploring Perceptions of a Voluntary Agricultural Water Conservation Program on the Western Slope of Colorado	2019	MacIlroy, Colorado State University
Briefing Paper: Upper Basin Demand Management and Water Banking. Addressing Risk and Creating Certainty: Exploring Options for an Upper Basin Demand Management Program	2019	TNC
Colorado River Water Bank Work Group: An Overview of Previous Studies & Reports	2018	Colorado River Water Bank Working Group
GVWUA Final Report on the Conserved Consumptive Use Pilot Projects	2019	GVWUA and J-U-B Engineers
Lessons Learned from the System Conservation Partnership Program	2016	The Nature Conservancy



	T	
Title	Year Published	Publisher/Authors
Considerations for Modeling a Water Bank at the Aspinall Unit with Current Environmental Flows	2011	Hydro Consulting for TNC
Environmental Water Transactions in the Colorado River Basin: A Closer Look	2018	Stanford Woods Institute for the Environment
Lower Colorado River Basin Pilot Program	NA	Bureau of Reclamation
System Conservation: a collaborative approach to drought contingency planning the Upper Colorado River Basin	2017	Wyoming SEO Callaway, AWRA Impacts magazine
SNWA Water Resource Portfolio	2019	Southern Nevada Water Authority
Colorado River Basin Water Bank: Framework & Financial Analysis	2017	WestWater Research for TNC
Salmon recovery in the Columbia River basin: analysis of measures affecting agriculture	1999	Aillery et al, Marine Resource Economics
Feasibility of water efficiency and reuse technologies as demand-side strategies for urban water management	2017	Berhanu et al, Journal of Industrial Ecology
Response to water crisis: How do Iranian farmers think about and intent in relation to switching from rice to less water-dependent crops?	2019	Boazar et al, Journal of Hydrology
Temporary water transfers for urban water supply during drought	1992	Clark, CSU
Flexible water allocations and rotational delivery combined adapt irrigation systems to drought	2018	Cody, K.C., Ecology and Society
Water trading innovations: reducing agricultural consumptive use to improve adaptation to scarcity	2017	Colby (Ch. 3.1.4), Book eds Ziolkowska & Petersen
Towards regional sustainability assessment utilizing community based participatory research, sustainability indicators, and future scenario modeling	2016	Dubinsky, CU Denver
Economic viability of deficit irrigation in the Western US	2018	Manning et al, Agricultural Water Management.
The role of groundwater trading in spatial water management	2014	Palazzo and Brozovic, Agricultural Water Management



Title	Year Published	Publisher/Authors
Evaluating the potentials of cropping adjustment for groundwater conservation and food production in the piedmont region of the North China Plain	2019	Ren et al, Stochastic Environmental Research & Risk Assessment
Opportunities for saving and reallocating agricultural water to alleviate water scarcity	2017	Richter et al., Water Policy
Urban water conservation in the Sacramento, California region during the 2014-2016 drought	2019	Talbot, UC Davis
Remote sensing assessments of consumptive use of agricultural water in western slope of Colorado	2016	Vashisht, Colorado State University,
Deficit irrigation and surface residue cover effects on dry bean yield, in-season soil water content, and irrigation water use efficiency in western Nebraska high plains	2018	Yonts et al, J. of Agricultural Water Management
Irrigation Efficiency and Water Balance of the Little Wind Unit on the Wind River Indian Reservation in Wyoming	2017	Rosado, U of Wyoming
Standardizing Temporary Water Transfer Procedures in Colorado	2020	Nicols, Peter D, et al, University of Denver Water Law Review
Use of Alternative Transfer Methods to Increase Water Supplies for Conejos Basin Agriculture, Municipal, and Environmental Purposes	2017	DiNatale Water Consultants
Development of Land Fallowing-Water Leasing in the Lower Arkansas Valley	2011	Trout, Raley, Montano, Witwer & Freeman, P.C.
Little Thompson Farm ATM Grant Completion Report	2018	Larimer County Natural Resources
HB13-1248 Catlin Canal Company Rotational Land Fallowing-Municipal Leasing Pilot Project	2018	The Lower Arkansas Valley Water Conservancy District, Ber Hill Greenleaf Ruscitti, LLP, & Martin and Wood Water Consultants, Inc.
Yampa Basin ATM Study	2014	TNC, Trout Unlimited & CDM Smith
Grand Valley Water Users Assn Conserved Consumptive Use Pilot Project Development: Process, Procedure, and Lessons Learned: Water Banking-Next Steps Part II	Mar- 17	J-U-B Engineers, Inc.



Title	Year Published	Publisher/Authors
Grand Valley Water Users Assn 2017 CCUPP In-Season Verification	2017	J-U-B Engineers, Inc.
Power Canal Capacity Report, Grand Valley Water Users Assn	Dec- 2015	Olsson Associates
Completion Report: Development of Practical Alternative Agricultural Water Transfer Measures for Preservation of Colorado Irrigated Agriculture	May- 2011	Brown and Caldwell
Final Project Report: Implementation of Deficit Irrigation Regimes: Demonstration & Outreach	May- 2016	Chavez, CSU
The Poudre Water Sharing Working Group: A Report to the CWCB	May- 2015	The Poudre Water Sharing Working Group
FLEX Water Market: Education and Implementation Phase	Dec- 2015	Brown and Caldwell, Ducks Unlimited, Aurora Water and LJCG
Alternatives to Permanent Dry Up of Formerly Irrigated Lands	Jun- 2013	DiNatale Water Consultants & CSU
Water Partnerships: an evaluation of alternative agricultural water transfer methods in the South Platte basin.	Mar- 2012	DiNatale Water Consultants, Inc.
Project Report: Lake Canal alternative agricultural practices and in-stream flow demonstration project	Jun- 2013	Colorado Water Innovation Cluster
Final Report of the Lower South Platte Irrigation Research and Demonstration Project	Jun- 2014	Hansen, Chavez, Garcia & Lytle

Demand Management Literature Review

EXHIBIT B

Exhibit B

This Exhibit includes 12 different tables that summarize the findings from the SGM Literature Review. There were 3 sets of documents [SCPP, Lit (General Literature), and ATM] considered across 4 different evaluation criteria (ATM, Environmental, General, and Monitoring & Verification). The following table provides a map of these exhibits.

Exhibit	Document Category	Criteria
B-1	SCPP	ATM
B-2	Lit (General Literature)	ATM
B-3	ATM	ATM
B-4	SCPP	Environmental Criteria
B-5	Lit (General Literature)	Environmental Criteria
B-6	ATM	Environmental Criteria
B-7	SCPP	General
B-8	Lit (General Literature)	General
B-9	ATM	General
B-10	SCPP	Monitoring & Verification
B-11	Lit (General Literature)	Monitoring & Verification
B-12	ATM	Monitoring & Verification

Criteria Category	Specific Areas to Identify
	Identified Local Impacts
	Identified Regional Impacts
	Operational Type of Project
	Types of Crops
ATM	Agronomic Impacts
	• Yield
	• Quality
	• Recovery
	• Water Quality Effects
	Soil Health Effects Stream flow Immedia
	Streamflow Impacts
	• Magnitude
	• Frequency
	• Duration
	Timing Data of sharpes of hydrologic conditions
	Rate of change of hydrologic conditionsReturn Flow Impacts
	Species Impacts
	Return Flow ImpactsCritical Stream Reaches Impacted
	 Critical Land or Riparian Habitat Impacted
	Species Impacted
	Water Quality Impacts
	Salinity
Environmental	• Temperature
Criteria	• Other
	Data Gaps, Questions for Future Projects
	• Tradeoffs – Resource Impacts
	• Predicted outcome for applying "avoid, mitigate, offset" hierarchy
	Program Level Goals
	• No net loss to environmental services, recognizing tradeoffs
	• Build incentives for projects with net environmental benefits
	For Proposed Future Transactions, Need to Evaluate Impacts (Positive or Negative) to:
	• ISFs (or other flow targets)
	• Stream Management Plan (SMP) or Watershed Management Plan (WMP) objectives
	Critical Habitat & Flow Recommendations
	State Species of Concern
	Basin Roundtable (BRT) Environmental Values Lists/Mapping
	CRCT Conservation Strategy
	Other Known Community/Entity Projects

This table lists the various areas considered for each criterion.

	Document Title							
	Publisher/Author(s)							
	Document Description							
	General Notes							
	Story Map (hyperlink)							
	Primary Purpose/Goal of Report or Study							
	Key Takeaways							
	Project Location Information							
	Project Location Description							
	• Latitude							
	• Longitude							
	Elevation							
	Demand Management Program Basics							
	DM Program/Activity Name							
	DM Program Structure							
General	• Nature of DM Practices							
	 Duration of DM Practices Implementation (Duration and Frequency) 							
	Source and Amount of Conserved Water							
	Source of Water Conserved							
	Amount of Water Conserved – Conserved Consumptive Use							
	High Level Program Information							
	DM Program Administration							
	DM Program Monitoring and Verification Considerations							
	DM Program Education and Outreach Efforts							
	Tools Used to Measure General Outcomes							
	DM Program Funding Considerations							
	DM Economic Considerations							
	DM Agricultural Impacts Considerations							
	• Recreation							
	Program Effectiveness							
	Lessons Learned							
	Program Successes and/or Challenges							
	Pros/Cons							
	Methodologies and/or Processes							
	Measurement of Water Returned to the Stream							
	Consumptive Use Analysis							
	Estimated Residual Field Consumptive Use							
Monitoring and	Return Flow Maintenance							
Verification	Verify Conserved Consumptive Use							
	Coordination of Benefits							
	Necessary Data and Equipment for Agricultural Participants							
	Representative Crop ET Data							
	Verification of Conserved Consumptive Use							

Sub-irrigation
Reservoir Operations
 River Diversions & Foregone or Bypassed Diversions
 Lateral Delivery and Ditch Loss
 Irrigation and Non-irrigation Season Return Flows
 Resulting Streamflow
Necessary Data and Equipment for Municipal Participants
Reservoir Operations
 River Diversions
 Foregone or Bypassed Diversions
 Ditch or Pipeline Delivery
 Overall Collection Systems
 Monitor System-wide Operations to Verify Conserved Consumptive Use
 Detailed System-wide Accounting Records
Program Level Considerations
• Tradeoffs – Value and/or Cost Implications for More Precise Data
Proportionality M&V Workgroup Guiding Principles
Honest, Accurate, and Defensible
Protective of Other Water Users
• Simple, Easy, and Flexible
Resulted in Added Water, rather than a Retiming of Depletions
Lessons Learned
Key Takeaways
Data Gaps
• Keys to Success
Identified Challenges
Overall Findings and Recommendations

Exhibit B-1 SCPP Documents with ATM Criteria

				Additional ATM Specific Components									
								Agronomic Impacts (How long d	oes it take for a crop to	fully return to pre-fallowi	ng productivity?)		
Title	Date	Publisher/Authors	Description	Notes	Identified Local Impacts	Identified Regional Impacts	Operational Type of Project	Types of Crops	Yield	Quality	Recovery	Water Quality Effects	Soil Health Effects
System Conservation Pilot Program Secondary Benefits: Final Report with Case Studies	2019	WestWater Research for TNC	reduction in consumptive use in SCPP projects also generated off-arm benefits by applying setti- methods to quantify off-arm benefits to two case studies in Colorado and Wyoming. Note from TNA An executive summary is also available, along wit a more detailed report that outlines the framework for assessing secondary impacts/benefits and the associated methodology for quantifying or evaluating each impact/benefit.			Not discussed.	Annual projects.	Not discussed.	Not discussed.	Not discussed.	Not discussed.		Not discussed.
SCPP-02 Infographic: Grand Valley Pilot Project Secondary Benefits	2019	TNC	This infographic summarizes the results of secondary been effits analysis as applied to the Grand Valley Pilot Project Case Study.	Grand Valley Pilot Project paid farmers to voluntarly reduce their irrigation water use in order to keep more water in the river to help increase water security within the Colorado River Basin in the face of ongoing drought. While focus was on water security several off-farm benefits occurs because of the project.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
SCPP-03 Research Synthesis: Agronomic Impacts of Reduction Imgation	2019	Culp and Kelly for TNC	limited irrigation to highlight key findings related to agronomic impacts of limited irrigation or other methods to reduce consumptive use of irrigation water in the Upper Colorado River Basin. The concluding section also identifies remaining research questions and suggests potential	Reviews methods and findings of existing research on agronomic impacts of limited irrigation in the following categories: yield, quality, water use efficiency, recovery, soil health, weeds/diseases/pests, and ag operations Next steps and identified research needs include understanding impacts over a variety of geographies and crops, as well als iong-term recovery. Management and operations needs include understanding the benefits of rotational failowing, deficit irrigation, and crop switching. Finally, there are many needs in the verification of conserved consumptive use.	-Potentially prolonged recovery periods. Possibility for both positive and negative soil health changes. -Increased chance of weeds, pests, erosion, and loss of topsoil.			corn, barley, wheat, sunflowers, beans, and tuber/root crops.		increase with moderate water stress. - Other crops can have similar qualities to fully irrigated crops. See yield comments (left).	generally shows full recovery when irrigation is returned following		 Salt will move to the surface of the soil during periods of fallowing. Some fields may need a pre- planting leaching irrigation, reducing the water savings. Recovery from limited irrigation may be affected by micronutrient availability. Deep rooted crops (affalfa and corn) will use moisture deeper in the soil; potentially reducing the groundwater level. No-till increased the amount of water stored in this soil dure to reduced evaporation, improved infiltration, reduced runoff, and increased snow catching. Fallowing is often an overall benefit to soil health.
<u>SCPP-04</u> Final Report: Colorado River System Conservation Pilot Program in the Upper Colorado River Basin	2018	Upper Colorado River Commission	Full SCPP report from UCRC; project list; Lesson learned; administration & implementation, operational, coeb/denefit/risk, legal constraints, outreach & education.	List of future questions to be answered p4	Not discussed.	Not discussed.	Fallow, split season deficit irrigation, alternative cropping and deficit irrigation - Combination of fallow and split season deficit irrigation - Municipal foregone diversions and irrigation conservation project	winter wheat, alfalfa, beans, clover, triticale, small grains,	Not discussed.	Not discussed.	Not discussed.	Not discussed.	- There can be benefits to agriculture through soil resting.
SCPP-05 Final Report: Appendix C: 2018 System Conservation Pilot Program Update	2018	Upper Colorado River Commission	2018 update to UCRC full report, including Appendices C (2018 update), D (2017 CU analysis), and E (2018 CU analysis)	Document includes Appendices C (2018 update), D (2017 CU analysis), and E (2018 CU analysis)	Not discussed.	Not discussed.	-fallow, split season deficit irrigation, and combination of fallow and split season deficit irrigation	alfalfa, corn, and a	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
SCPP-06 Pilot Program Funding Agreement	2014	Bureau of Reclamation	2014 SCPP funding agreement between CRB entities	Reviews history of compacts, storage allowances, demand management efforts by signatories. Defines goals and parameters of SCPP. Identifies NRCS programs that might support on-farm conservation improvements: EQIP and SWEP & ensures that projects will coordinate with respective NRCS State Conservationists.	Not applicable for the pilot program agreement.	Not applicable for the pilot program agreement.		Not applicable for the pilot program agreement.	Not applicable for the pilot program agreement.		Not applicable for the nt pilot program agreement		Not applicable for the pilot program agreement.
<u>SCPP-07</u> Colorado River Water Bank Feasibility Study: Phase 1	2012	Colorado River Water Conservation District	Water bank planning phase; conservative estimat of potential WB supplies, and demand for those supplies.	elincludes potential WB uses, supply, magnitude & frequency of need, supply-use scansios. App. A: categories of WE slope water uses, App. B: CRC WB Feasibility Study Water Supply Technical Memo, App. C: Eval of CRC WB Hydrologic Scenarios w/UCRB model, App. D: Basic supply & use comparison scenarios for CRC WB technical memo	irrigation practices will impact local and	irrigation practices will impact loca	and pasture grass.	small grains, corn,	 Deficit irrigation on orchards and vineyards impacts yields and often has negative impacts the subsequent year's production. Fallowing is feasible for small grains and grain corn. Deficit irrigation is possible for all crops, but best suited for perennial forage crops of alfalfa and pasture. Pasture can be deficit irrigated every year without significant long-term impacts, including minimized stand reduction. Alfalfa and pasture enter a stressed or dormant condition without significant loss of plant population or long-term crop damage. In some instances pastures and alfalfa are grown successfully for many years without irrigation. Officit irrigation or no irrigation results in a significant decrease in yields. 	provide an adequate water supply to grasse for maintaining a health crop is in the early spring through the first harvest.	pasture not be over- s grazed during stress periods to protect the crowns of grasses which	Not discussed.	Not discussed.
<u>SCPP-08</u> Colorado River Water Bank Feasibility Study: Phase 2	2013	For Colorado River District. By MWH.	on-farm impacts for representative irrigation		diminished aesthetics, reduced groundwater recharge for residential use reduced baseflows to streams for fisheries and wildlife, and impacts to wetlands. - The need to reduce local cattle herds. - Depress the local economy.	economy. = Potential long-lasting effects on regional cattle herds. = Impacts to regional streamflows, water and wildlife, aquifer recharg = Increase regional prices for feed crops if a large number of producers participate. = Weaken the regional agricultural infrastructure.	fallowing, spilt-season irrigation, spilt-field irrigation, longer-term rotational fallowing, permanent fallowing, changes to crop type, and water efficienty projects.	and row crops.	This was identified as a long-term study need, especially for high elevation pasture systems		Not discussed.	In areas underfain by the Mancos Shale, fallowing land will helj the water quality of return flows to the receiving stream.	
SCPP-09 Colorado River Compact Colorado water bank feasibility study: water supply technical memorandum. (Appendix B to Colorado River Water Bank Feasibility Study: Phase 1)	2012	Natural Resources Consulting Engineers, Inc	Technical analysis for water bank feasibility study included in 2012 WB planning phase 1 report .pdf	Data section includes analysis, irrigated areas, water rights categories, and climate stations. Examined CU requirements (wiStateCU & Blaney- Criddle), ET verification (Penman-Monteith w4 CoAgMet stations), and HCU (StateCU values for elevation bands in each division multiplied by irrigated acres). Water bank supply and cost: "fallowing suitable for small grains, grain corn, & dry beans." Deficit Irr available for all crops but best suited to alfafa & pasture. "These crops combined account for over 98% of the acreage, irr CU, and supply-limited CU." Discusses split-season irrigation.	irrigation practices will impact local and	irrigation practices will impact loca	and pasture grass.	small grains, corn, and dry beans	Deficit irrigation on orchards and vineyards impacts yields and often has negative impacts of the subsequent year's production. Fallowing is teasible for small grains and grain corn. -Deficit irrigation is possible for all crops, but best suited for perennial forage crops of alfafa and pasture. -Pasture can be deficit irrigated every year without significant long-term impacts, including minimized stant reduction. -Afafa and pasture enter a stressed or dormant condition without significant loss of plan population or long-term crop damage. In some instances pastures and falfa are grown successfully for many years without	provide an adequate water supply to grasses for maintaining a health crop is in the early	pasture not be over- s grazed during stress	Not discussed.	Not discussed.
SCPP-10 Exploring Perceptions of a Voluntary Agricultural Water Conservation Program on the Western Slope of Colorado	2019	Macilroy, Colorado State University	and better understanding the socio-cultural components of a potential demand management program. The research, completed in Spring 2015 explored perceptions of demand management among stakeholders on the Western Slope throug- individual interviews and focus groups. The findings sheal light on the barriers and opportunitie for a demand management program, including ideas and feedback on what a successful program would look like, and why water users may or may	This is an interview-based report that covers perceptions of DM, definitions of voluntary, compensated, temporary, and equity (their words are proportional/party)-and fitnds that these definitions are not straight- floward and must be carefully communicated. Explores relationships with water and landscape, as well as "sacred values of the Western Slope." Inderesses perceptions of DM in context of 2007 Interim Guidelines and broader basin-to-basin policies. Many interviewees doubt the viability of a voluntary compensated program, and even suggest that a mandatory uncompensated call would work better, avoid equity issues, and cosi less overail. Compensation was a very challenging topic, with different role water plays for imigators vs Front Range residents. Who bears responsibility to pay-who is responsible for the shortage problems (many dont see the Upper Basin at fault). Temporary program vs temporary participation-faught discussion. Discussion of Western Slope Sacred Values, how water and farming is part of identify. Numerous people suggested every water user curtail use and respect vater and that we should make water conservation part of being a Coloradan.	Not discussed	Not discussed	Not discussed	Not discussed	Intraction.	Not discussed	Not discussed.	Not discussed.	Not discussed.

							-	-1	Additional ATM Specific Components					
									Agronomic Impacts (How long does it take for a crop to fully return to pre-fallowing productivity?)					
Title	Date	Publisher/Authors	Description	Notes	Identified Local Impacts	Identified Regional Impacts	Operational Type of Project	Types of Crops	Yield	Quality	Recovery	Water Quality Effects	Soil Health Effects	
SCPP-11 afing Paper: Upper Basin Demand lanagement and Water Banking. essing Risk and Creating Certainty: Joring Options for an Upper Basin Demand Management Program	2019		the key issues to address in evaluating a demand management program and is offered in the spirit o promoting discussion and decision-making on how	Briefly evaluates Upper Basin risk based on drought hydrology, and discusses how to reduce that risk. Asks many questions about Dm, program gowennace and structure, cost and funding, policy, measurement and verification. Identifies many of the key issues being addressed by CWOB DM workgroups. Key successes from SCPP are locally-driven solutions, minimizing impacts & maximizing benefits, e.g., through local coordination of projects. Tabulates past options considered for a voiding compact curtainent.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	
SCPP-12 rado River Water Bank Work Group: n Overview of Previous Studies & Reports	2018		completed by the Colorado River Water Bank Work Group in their effort to provide information about what types of solutions may be available to preserve communities, agriculture, power production and the river itself.	This work includes a two-phase feasibility study, an assessment of how reduced irrigation for compact purposes would work with different irrigation systems on Colorado's West Slope, economic work on pricing and payments, and scientific research on the agronomic impacts of reduced irrigation.		Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed.	Not discussed.	Not discussed.	
SCPP-13 /UA Final Report on the Conserved Consumptive Use Pilot Projects	2019	GVWUA and J-U-B Engineers	This report provides a summary of the 2018 and 2019 Conserved Consumptive Use Pilot Projects completed by the Grand Valley Water Users Association (GWWUA). The initial part of the repor provides a good summary of both the 2017 and 2018 pilots. Appendix H provides the details of the	Land management contract: manage weeds & plant growth, soil erosion (leave plant residue, tillage for closs, tillage for crust), w/mid-season visi to confirm mgmt. activities are consistent w/contract, interviewees concerned wiDM externatities including local economy & aesthetics; CCU verification procedures (Exhible J) ont specify methods to verify CCU on failowed land, but does include sites visits to verify land mgmt. and explicitly prohibits any active plant growth on failowed land	t L	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	
SCPP-14 essons Learned from the System onservation Partnership Program	2016	The Nature Conservancy		Top 3 lessons: outreach & communication is essential, operational & leg issues must be addressed at ditch company/irrigation district level simpli the process for efficiency.		Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	
SCPP-15 siderations for Modeling a Water ik at the Aspinal Unit with Current Environmental Flows	2011	Hydro Consulting for TNC	River to assess their ability to simulate a potential water bank in the basin using the Aspinall Unit	StateMod, Aspinall PBO/EIS Model, and CRSS are evaluated for their capabilities to simulate Aspinall Unit operations, environmental flows, an potential water-banking. Specifically, this modeled the Black Caryon wai right, new ESI/PBO requirements at the Whitewater gage, and a water- banking option at Aspinall. Modifications to the Gunnison StateMod are necessary to simulate environmental flows and enhance reservoir accounting options.	C te	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	
SCPP-16 onmental Water Transactions in the orado River Basin: A Closer Look	2018	Stanford Woods Institute for the Environment	Reviews CRB environmental transfers to track extent of activity. Examines SCPP projects by thit lens, given the ISF benefits of SCPP. Found that SCPP-funded projects had the effect of enhancing streamflow.		Not discussed.	Not discussed.	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed.	Not discussed.	Not discussed.	
SCPP-17 ower Colorado River Basin Pilot Program	NA	Bureau of Reclamation		"Although the Pilot Program will be ongoing until 2035, as of 2019, future announcements of funding opportunities and requests for additional project proposals are not being contemplated."	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	
SCPP-18 tem Conservation: a collaborative pproach to drought contingency ing the Upper Colorado River Basir	2017	Wyoming SEO Callaway, AWRA Impacts magazine	Description of Wyoming SCPP, how it works, participation, and future efforts.	Notifier extensive nor technical, but includes some description of proces: & participation.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	
SCPP-19 NWA Water Resource Portfolio	2019	Southern Nevada Water Authority	Chapter from SNWA's water plan	Addresses temporary supplies including different aspects of Intentionally Created Surplus, recharge and banking, DCP, and conservation tools.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed	Not discussed.	
SCPP-20 Solorado River Basin Water Bank: Framework & Financial Analysis	2017	WestWater Research for TNC	to scale up operations of the Water Bank and provides comparative costs and other factors to consider in different approaches to developing a water bank. The information is intended to provide	Evaluates 4 frameworks of a Colorado Basin water bank sufficient to address 250,000 AF of CCU: annual water bank leases, option leases in critical years, no-option critical year leases, and response to a 1922 compact call. WestWater Research developed a cost-estimation spreadsheets based on the volume of water leases, number of associate acres, and number of farms or ranches leasing water.		Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	

Exhibit B-2 Lit (Gen. Literature) Documents with ATM Criteria

								Addit	ional ATM Specific Comp	onents			
Title	Date	Publisher/Authors	Description	Notes	Identified Local Impacts	Identified Regional Impacts	Operational Type of Project	Types of Crops	Ag Yield	ronomic Impacts (How In Quality	ong does it take for a cro Recovery	op to fully return to pre-fallowing pr	roductivity?) Soil Health Effects
Lit-01 Salmon recovery in the Columbia River basin: analysis of measures affecting agriculture	1999	Aillery et al, Marine Resource Economics	Analysis of ag impacts from salmon-recovery-related flow alterations in Columbia River	Investigates ag impacts of fish recovery measures "such as modified timing for dam releases, reservoir drawdown, and flow augmentation in the Columbia River basin, on the regional agricultural sector are evaluated [] Results suggest that drawdown and/or minor reductions in irrigation water diversions would reduce producers' profits by less tha 1% of baseline levels. However, the most extreme scenario- a long drawdown period combined with a large reduction in irrigation diversionswould reduce producers' profits by \$35 million (2.5%) annually."		Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-02 Feasibility of water efficiency and reuse technologies as demand-side strategies for urban water management	2017	Berhanu et al, Journal of Industrial Ecology	Economic model of water cost provided by above-code water efficiency and reuse technologies, including variation & uncertainty analysis.	Estimates that efficiency and reuse can meet 85% of 50yr projected needs to the Lower Colorado River Authority service area (central TX)	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-03 Response to water crisis: How do Iraniar farmers think about and intent in relation to switching from rice to less water- dependent crops?	2019	Boazar et al, Journal of Hydrology	Study of farmer response to gov't demand management, switching crops.	"Structural equation modeling showed that farmers' intention to change from rice cultivation to another crop is determined by personal norms, beliefs about their role and emotional considerations."	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-04 Temporary water transfers for urban water supply during drought	1992	Clark, CSU	PhD dissertation modeling options for temporary water transfers	"This research develops a water right option agreement (WROA) model, methods of analysis, and legal implementation strategy under Colorado law." Interviewed professionals, estimates costs, identified that WROA "can b superior in terms of cost, reliability, and operational flexibility to both water-right purchases and construction of additional reservoir storage.	information to support the No Action	The paper recognized the need to quantify local drought conditions (as opposed to making the decision to have a temporary transfer on a statewide decision). The need for the transfer and benefits are locally driven	storage, which could be	There is ,mention of Federal Water systems on page 24.	Not discussed.	Not discussed	Not discussed	Included a discussion on the Senate Bill 89-181 and the rulemaking by the SEO to implement water quality standards in review of water transfers Mentioned the use of the mass balance method or the mixing zone method to estimate the influence of flow on water quality standards	Not discussed
Lit-05 Flexible water allocations and rotational delivery combined adapt irrigation systems to drought	2018	Cody, K.C., Ecology and Society	Water allocation experiment in San Luis Valley, Colorado fo self-governing irrigation systems.	Examines relationships between rules and physical context of water supplies; specifically the outcomes of water allocations between members and how they rotate water delivery.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-06 Water trading innovations: reducing agricultural consumptive use to improve adaptation to scarcity	2017	Colby (Ch. 3.1.4), Book eds Ziolkowska & Petersen	Chapter from book "Competition for Water Resources: Experiences and Management Approaches in the US and Europe" collecting global examples/discussion of approaches and solutions to water supply scarcity, includin western US	Ch 2.1.1: Challenges for US irrigated ag in the face of emerging demands and climate change, Ch 3.1.4: Water trading innovations: reducing agricultural consumptive use t improve adaptation to scarcity (reviews online trading systems to reduce transaction costs, methods for cost- effective verification of CCU, and other breakthroughs facilitating temporary & intermittent trading more feasible. Examples from AZ and CA (IID), NE, Australia, CO-Big Thompson.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-07 Towards regional sustainability assessment utilizing community based participatory research, sustainability indicators, and future scenario modeling	2016	Dubinsky, CU Denver	PhD dissertation that identified San Luis Valley sustainabilit indicators and modeled future scenarios, developing a CU indicator for 1980-2010. Conducted scenario modeling to guide decision-makers towards desired outcomes from policy decisions. Coupled sustainability indicators with future scenario modeling to inform the SLV stakeholders about a variety of social and environmental issues. Results indicated that through specific shifting of cropping rotations and minimal land fallowing, SLV could reduce water use and Greenhouse Gas Emissions while increasing soil carbon and improving soil health. In addition, the solar energy development pathways investigated by this study showed that the potential exists to offset most or all of the region's GHG emissions.	groundwater-dependence of SLV, suggests irrigation water use could be decreased 10% with shifts in crop regime and minimal fallowing.		Not discussed.	Fallowing, Crop shifting	Potato, alfalfa, small grain	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Used a green manure cover crop to promote soil health
Lit-08 Economic viability of deficit irrigation in the Western US	2018	Manning et al, Agricultural Water Management.	Research on agro-economics of deficit irrigation.	Deficit irrigation (DI) can be optimal during late growth and maturation stages given elevated water prices (depending o output price and production costs).	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-09 The role of groundwater trading in spatia water management	2014	Palazzo and Brozovic, Agricultural Water Management	Republican River Basin assessment of coupling surface- groundwater management.	Geospatial dataset of RRB irrigation wells modeling crop choice, land, and water use decisions by well. "Our analysis highlights the importance of the initial distribution of permits and the institutional context in which trading occurs." Cost savings from trading groundwater pumping are distributed unevenly between wells, counties, and groundwater management institutions.		Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-10 Evaluating the potentials of cropping adjustment for groundwater conservation and food production in the piedmont region of the North China Plain	2019	Ren et al, Stochastic Environmental Research & Risk Assessment	Evaluation of different cropping patterns (including fallowing & water supply scenarios.	Framework for using a crop model & regression to predict effects of cropping adjustments on groundwater sustainability & crop production	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-11 Opportunities for saving and reallocating agricultural water to alleviate water scarcity	2017	Richter et al., Water Policy	 Review of literature & internet to identify water-saving strategies in irrigated agriculture. Review of case studies in which water savings have been successfully transferred to other uses. 	 Catalogs water savings opportunities, claims of irrigation- efficiency savings potential, logistics of reallocating due to other ag diverting savings. Findings suggest considerable potential to reduce irrigation CU and that savings can be reallocated when proper consideration is given to water budget accounting. 	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-12 Urban water conservation in the Sacramento, California region during the 2014-2016 drought	2019	Talbot, UC Davis	UC Davis Master's Thesis cataloging/analyzing supply & demand management actions under CA's drought policies.	Evaluates outdoor watering, public outreach, media role, water-related energy savings. Makes recommendations for urban water suppliers on revenue recovery, reducing use of rebates as demand management, and scaling drought response tasks for different levels of govt. Summarizes & analyzes CA legislation establishing approval for long-term budget-based efficiency targets.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.

						I		Addit	ional ATM Specific Compo	onents			I
									Agr	onomic Impacts (How lo	ong does it take for a cro	p to fully return to pre-fallowing p	roductivity?)
Title	Date	Publisher/Authors	Description	Notes	Identified Local Impacts	Identified Regional Impacts	Operational Type of Project	Types of Crops	Yield	Quality	Recovery	Water Quality Effects	Soil Health Effects
Lit-13 Remote sensing assessments of consumptive use of agricultural water in western slope of Colorado	2016	Vashisht, Colorado State University, Colorado	estimating monthly consumptive use (CU) and conserved CU (CCU) on the West Slope	Used evapotranspiration (ET) observations at experimental plots of traditional irrigation and water-banking irrigation practices to evaluate methods of verifying CCU. Reviews methods for measuring and monitoring CU, discusses limitation and potential for ReSET remote sensing CU model.					Not discussed.	Not discussed.			Not discussed.
Lit-14 Deficit irrigation and surface residue cover effects on dry bean yield, in-seasor soil water content, and irrigation water use efficiency in western Nebraska high plains	2018	Yonts et al, J. of Agricultural Water Management	crop yield	"Reducing irrigation water by 25% caused no significant yiel reduction and improved irrigation water use efficiency by 26%." Applying 50% Etc. resulted in 30% yield reductions, and planting directly in crop residue did not improve bean yield under deficit irrigation. Ample early season rainfall is a boon to pre-flowering deficit irrigation yields, but under normal-to-dry conditions post-flowering deficit yields more.		Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
Lit-15 Irrigation Efficiency and Water Balance of the Little Wind Unit on the Wind River Indian Reservation in Wyoming	2017	Rosado, U of Wyoming	Unit	Uses ag water balance & geophysical techniques to quantify & locate water losses. "Large errors and data gaps associated with the inflows, outflows, diversions, and precipitation data, [which] identified specific needs for better data."									
<u>Lit-16</u> Standardizing Temporary Water Transfer Procedures in Colorado	2020	Nicols, Peter D, et al, University of Denver Water Law Review	consolidation and standardization.	This article will describe the barriers in existing law to temporary transfers and the various approval mechanisms available under existing Colorado law. It will provide an assessment of the strengths and limitations of the existing transfer methods and make a recommendation for consolidation and standardization.	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed

Exhibit B-3 ATM Documents with ATM Criteria

									Additional ATM Specific Components				
									Agronomic Im	pacts (How long does it t	ake for a crop to fully ret	urn to pre-fallowing p	productivity?)
Title	Date	Publisher/Authors	Description	Notes	Identified Local Impacts	Identified Regional Impacts	Operational Type of Project	Types of Crops	Yield	Quality	Recovery	Water Quality Effects	Soil Health Effects
<u>ATM-01</u> Use of Alternative Transfer Methods to Increase Water Supplies for Conejos Basin Agriculture, Municipal, and Environmental Purposes	2017	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=20533 3&dbid=0	Trujilio Meadows Reservoir ATM Study (TMR Study): "The primary objective of the TMR Study is to investigate the feasibility of a unique ATM that involves enlarging Trujilio Meadows to provide intra-year regulation of water supplies including direct flow storage and storage of other agricultural and augmentation water rights for agricultural users diverting from the San Antonio.	ATM w/ recreational and environmental benefits for municipal augmentation wienlargement of Trujillo Meadows Reservoir. Stakeholder meetings for federal & state agencies, ag, and town aug needs. Model of ATM, details of benefits, recommended path fwd. Appendix A estimates of monthy inflows to reservoir. Water rights include USFS Reserved Rights decreed as ISF, interstate shepherding for flow through NM.	Improved Ag Deliveries, flood minimization, mid-summer streamflow, recretaional benefit,	Compact and river administration benefits	Storage expansion	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-02 Development of Land Fallowing-Water Leasing in the Lower Arkansas Valley	2011	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=19573 3&dbid=0	The goal of this report is to "report on the development from 2002 through mid-2011 of rotational land fallowing-water leasing (fallowing-leasing) in the Lower Arkansas Valley of Colorado (Lower Valley) by the Lower Arkansas Valley Water Conservancy District (Lower Ark District) and the Lower Arkansas Valley Super Ditch Company, Inc. (Super Ditch)."	unnecessary at times due to trans-basin supply; considers monthly return flow "factors"; analysis	More water supply benefit to northern Munis, less water supply benefit to Lower Ark communities but \$\$ benefit to Lower Ark communities	Benefits farmers by giving them an option to not sell water/land and move out		Not discussed	Potential benefit to reduced upstream irrigation	Not discussed	Not discussed	Improved due to reduced overall irrigation and improved irr. efficiency	Potential improvements to selenium, TDS, salinity, and hardness from reduced irrigation
<u>ATM-03</u> Little Thompson Farm ATM Grant Completion Report	2018	/citec/default/filec/uploa	Study funded through CWCB 2015 ATM Grant. The Little Thompson Farm receives supply from Handy Dich and Reservoir Company shares and 240 C-BT units. The consultant team found that 'It was feasible for Lariner County to afford, from a water supply perspective, to sell some C-BT units (115) and share some other units (80) in some years, while still having sufficient water on the farm for corm and sugar beets, as well as crops that require less water." The study looks at aspects of feasibility, including: Economics, Farm Financial Viability under wet, dry, and very dry year scenarios; dry year water value. The report also investigates potential partnerships, and outlines the final water sharing agreement. Turatimer County sold 115 C-BT units to Broomfield and retained a first right of refusal to lease back these units for assessment cost plus 10%, when available." The report also discusses Lessons Learned and Future Considerations: Legal Hurdles/Barriers to Replication (Northern Rulemaking, Direct Flow Rights, Delivery Efficiency impacts from Water Transfers); Public Perception & Political Vill (Educating and Obtaining Struport of Leadership, Publis Support, Out of County Partners, Continued Education); Negolating an ATM: Successful Tips, Tricks, and Tools (Establish and Pursue Goals with an Open Mind About Implementation, Minimize the Cooks and Trust Your Team).	erosion by forming large soil clods & enhancing infiltration; Class II and III soils, slopes 0-5%, not high enough for severe erosional problems; no/low-till also recommended to reduce direct evap, improve soil health; reduce fuel & costs; irrigation efficiency via contour farming, drip irrigation. SM & ET monitoring, drough tolerant	Reduced return flow from C-BT water to Little Thompson Creek; Overall, keeps farm viable, Helps shore up water security for Broomfield		Interruptable Water Supply Agreement	Corn, sugar beets	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-04 HB13-1248 Catlin Canal Company Rotational Land Fallowing-Municipal Leasing Pilot Project	2018	https://dnnweblink.state. .co.us/owch/0/edoc/210 320/19%2001%2015% 202018%20Annual%20 Report%20- %20Catlin%20Pilot%2 0Project%20FINAL.pdf ?searchid=3856cf32- c475-4163-840c- 5361fa65041f1	The Catlin Pilot Project was the first rotational land fallowing- municipal leasing pilot project under HB 13-1248: Irrigation Water Leasing Municipal Pilot Projects. This project aims to makes available up to 500 acte-feet of water for lease to three municipal water providers – the Torwo of Fowler, the City of Fountain, and the Security Water District (Municipal Participants) – from rotational fallowing of lands located on six farms irrigated under the Catlin Canal in the Arkansas River Basin.	Huge emphasis on return flows; using Lease Fallow Tool from DWR to calc available water & word returns; "Pay As You Go' target deliveries for return flow; use of recharge structures supported well:mieme feturn flows; augmentation station used for faster return flows and consumptive use water delivered to municipal participants; ersoin & weed control included herbicide, disk tilling, cover crops (winter wheat, hay)	Not discussed	Not discussed	Lease-Fallow	Not discussed	Possibly no change but inconclusive due to 2018 being low water year and all-around reduced crop yield	Not discussed	No major issues found	Not discussed	No erosion, no noxious weeds
<u>ATM-05</u> Yampa Basin ATM Study	2014	https://dnrweblink.state .co.us/wcb/0/edoc/199 193/Yampa%20U %20NC%20Ues%20of %20NTM%20Ues%20of wfx20Nor%20%20Con sumpt%20Needs_FINA LReport%203-28- 14_with%20apps.pdf	Study conducted by Trout Unlimited (TU) and funded by CWCB's Alternative Agricultural Water Transfers Grant Program. The purpose of the study was to identify locations in the Yampa Basin where potential ATM transactions could help to meet multiple uses (nonconsumptive needs and agricultural shortages), and identify types of ATM transactions most suitable for meeting multiple purposes. Ideal candidate reaches, as specified by project proponent TNC and its partners, would involve the following scenario: - Upstream agricultural water user with full or surplus irrigation supplies and transferable CU water - Downstream agricultural water user with an irrigation CU shortage (consumptive need) - A need for water in the reach between to improve flows for trout (including Colorado cutthroat trout) or warmwater fish (nonconsumptive need)	Used StateMod delay table to estimate historic return flows; more efficient irrigation improves water quality by lowering return flow contaminant transport, fewer excess nutrients due to fertigation indrp systems; TNC/TU partnership to support instream flows for habitat w/ATM loans used when downstream ISF right is not satisfied & to provide flow in a reach without ISF right		Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-06 Grand Valley Water Users Assn Conserved Consumptive Use Pilot Project Development: Process, Procedure, and Lessons Learned: Water Banking-Next Steps Part II	42795	waterusers.com/upload	The Conserved Consumptive Use Pilot Project (CCUPP) is a pilot demand management project intended to test the mechanisms necessary for a Western Slope irrigation water provider to intentionally reduce consumptive use in a voluntary and compensated manner. This report summarizes the process of developing the CCUPP, the procedure used, and lessons learned.	Land management contract: manage weeds & plant growth, soil erosion (leave plant residue, illiage for cloads, illiage for cloads, illiage for cloads, illiage for cloads, illiage for cloads, weather wicontract; interviewees concerned w/DM externalities including local economy & aesthetics; CCU verification procedures (Exhibit B) don't specify methods to verify (Cu on fallowed land, but does include sites visits to verify land mgmt. and explicitly prohibits any active plant growth on fallowed land		Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-07 Grand Valley Water Users Assn 2017 CCUPP In-Season Verification	2017	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=20514 4&dbid=0	Field compliance and payment summary for the 2017 CCUPP, including verification forms for each program participant for 2017.	Includes 2017 verification documentation including photographs, recommendations, comments/notes	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
<u>ATM-08</u> Power Canal Capacity Report, Grand Valley Water Users Assn	12/1/2015	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=20181 3&dbid=0	Very brief report on "one potential mechanism through which water associated with CCU could be protected and returned to the Colorado River under a pilot project water bank." to convey CCU via unused capacity within the Orchard Mesa Power Canal (power canal) to deliver water to the Grand Valley Power Plant (GVPP). The report investigated the potential unused capacity within the Power Canal, including the potential for additional water to generate hydroelectric power.	temporary, voluntary. Lists current operations, water rights, data. Incomplete file in link, merged with 2017 Next Steps Part II	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-09 Completion Report: Development of Practical Alternative Agricultural Water Transfer Measures for Preservation of Colorado Irrigated Agriculture	5/1/2011	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=19570 9&dbid=0	An extensive evaluation to: 1) To identify barriers to implementation of alternative transfers and to describe potential strategies for overcoming barriers. 2) To develop tools for agricultural producers to evaluate the viability of potential alternative transfers. 3) To further actual alternative transfers by evaluating three demonstration projects that include owners of agricultural water rights and potential end users of the temporarily transferred Water.	risk/uncertainty, lack of supply, reluctance, power dynamic), needs and means to address barriers, Lease Evaluation Tool (AgLET) ag economics evaluator, exchange capacity analysis, flex markel	outside of irrigation practices and M&I use	Overall tone that keeping ag is good and that buy-and-dry by M&I should be avoided	Flex Market w/ rotational fallowing, IWSA	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed

									Additional ATM Specific Components				
									Agronomic Impa	acts (How long does it	take for a crop to fully re	urn to pre-fallowing p	roductivity?)
Title	Date	Publisher/Authors	Description	Notes	Identified Local Impacts	Identified Regional Impacts	Operational Type of Project	Types of Crops	Yield	Quality	Recovery	Water Quality Effects	Soil Health Effects
ATM-10 Final Project Report: Implementation of Deficit Irrigation Regimes: Demonstration & Outreach	May-16	co.us/cwcb/Flectronic	Evaluation of different methods of monitoring crop water stress and consumptive use (CU) under deficit irrigation. Demonstrations, workshops, educational outreach on crop stress monitoring.	Demo project to evaluate different methods of monitoring crop water stress and CU under deficit irrigation & demo educational outreach on crop stress monitoring.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
ATM-11 The Poudre Water Sharing Working Group: A Report to the CWCB	May-15	and the factor is defined as the second as	Final report of Poudre Water Sharing Working Group - a prototype ATM water sharing group between agricultural users (North Poudre Irr Co, Water Supply & Storage Co, New Cache la Poudre Irr Co, and Laimmer/Weld Irr Co) and municipal users (Fort Collins, Greeley, and Tri-Districts) on the Poudre River, facilitated by the Colorado Water Institute at Colorado State University. The report focuses on the formation of the working group, relationship building, lessons learned, survey of ag users, development of prototype agreements, and regional cooperation strategies.	Final report of prototype ATM water sharing group between ag (North Poudre Irr Co, Water Supply & Storage Co, New Cache la Poudre Irr Co, and Larimer/Weld Irr Co) and muni (Fort Collins, Greeley, and Tri-Districts) on the Poudre River. Identified CCU calculation methods as a large barrier.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
ATM-12 FLEX Water Market: Education and Implementation Phase	December-15	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=19791 6&dbid=0	Investigation of FLEX water market implementation: engagements, index based pricing, theorizing on large-scale implementation, meetings between willing shareholders. The goal of this project was to successfully implement the FLEX Water Market concept through education, facilitation, and consultation, with specific focus on developing FLEX markets in Water Division 1 with municipal, industrial, adjuctuitizal, and environmental/conservation partners. The team consulted with multiple potential partners, but in the end this project did not result in a water sharing agreement.	Investigation of FLEX water market implementation: engagements, index based pricing, theorizing on large-scale implementation, meetings between willing shareholders.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.
ATM-13 Alternatives to Permanent Dry Up of Formerly Irrigated Lands	June-13	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=19920 8&dbid=0	Review of benefits and issues of two alternatives to buy and dry that maintain some continued level of agricultural production: 1) Dry land farming, and 2) limited irrigation.	Review of benefits and issues of buy and dry and alternatives. Potential for conversion of ag land to dry land or deficit-irrigation, economic & maintenance issues w/dry land & deficit.	Limited irrigation may or may not be economically feasible depending on climate, precip, water supply issues; localized approach to evaluate benefits / Reveg can reduce tax values of adjacen properties / Dry-land farming is likely to result in economic loss	Same as previous column <	Feasibility study: comparison of full irrigation to limited irrigation, and revegetatior	Wheat corn, sorghum, alfalfa, pasture grass/hay, native grass, millet	Limited irrigation for Front Range (South Platte) parcels wouldn't typically have high enough yields to justify cost of farming due to lack of precipitation / Dry land farming results in very low yields but is cheaper than revegetation	Not discussed	Not discussed		Improper planning ahead of dry-up can lead to high residual N. high compaction, poor drainage, low organic matter, noxious weeds
ATM-14 Water Partnerships: an evaluation of alternative agricultural water transfer methods in the South Platte basin.	March-12	https://dnrweblink.state .co.us/cwcb/Electronic File.aspx?docid=19921 5&dbid=0	Water market experiment, survey of municipal & industrial providers on ATM practices, leases, evaluation of shared water bank scenarios on South Platte, focused on FRICO shareholders.	Water market experiment, survey of municipal & industrial providers on ATM practices, leases, evaluation of shared water bank scenarios on South Platte	From lab experiment results, shared water bank concept doesn't necessarily increase the efficiency of water usage in ag, but impacts are lessened by comparison to typical buy-and-dry	M&I still gets water but ag gets to use more than it would during buy- and-dry	Feasibility study, survey, and some experiments to vet ATM concept called Shared Water Bank	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-15 Project Report: Lake Canal alternative agricultural practices and in-stream flow demonstration project	June-13		Proof of concept project planning for ATM/ISF program on Lake Canal. Monitoring/verification based on deliveries, surface returns, inflow to recharge pits, and soil moisture sensors to verify return flows by lack/presence of moisture movement below the root zone. Project was not implemented due to ongoing water scarcity at the time (2012-2013) and inability to agree on a price. Describes extensive legal work to arrive at proof of concept.	Proof of concept project planning for ATM/ISF program on Lake Canal. Monitoring/verification based on deliveries, surface returns, inflow to recharge pits, and soli moisture sensors to verify return flows by lack/presence of moisture movement below the root zone. Project was not implemented due to ongoing water scarcity at the time (2012-2013) and inability to agree on a price. Describes extensive legal work to arrive at proof of concept.	Potential for enhanced flows in the river for environmental benefits	Potential for added water throughout season to a long reach of Cache La Poudre River (Lake Canal Diversion to Greeley No. 3 Diversion)	IWSA for deficit irrigation, with some fallowing	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-16 Final Report of the Lower South Platte Irrigation Research and Demonstration Project	Jun-14	.co.us/cwcb/Electronic	Technical research paper with three tasks. Task 1. Develop calculation & verification of consumptive water use and water savings, such that water court requirements can be satisfied uses a stress coefficient, the crop water stress index CWSI, and the ReSET model of remote sensing. ReSET showed accuracy of 92-98% for fields under normal growing conditions and successfully detected abnormal growing conditions to accordingly reduce ET estimates. Task 2. Simplify the administrative burden of maintaining return flows. Task 3. Estimates uppy delivery potential. Project on Lower South Platte Irrigation Research Farm near lliff.	consumptive water use and water savings, such that water court requirements can be satisfied- uses a stress coefficient, the crop water stress index CWSI, and the ReSET model of remote sensing. ReSET showed accuracy of 92-98% for fields under normal growing conditions and successfully detected abnormal growing conditions to accordingly reduce ET estimates. 2.	Not really, this report primarily focused on the science, data, and accuracy of ET modeling	Not discussed	Deficit Irrigation	Com	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
<u>ATM-17</u> RGWCD Net Annual Replacement Plans	Reports exist for each year Reviewed report for April 13, 2020	https://rgwcd.org/sd-1- annual-replacement- plan	Rio Grande Water Conservancy District plan to meet interstate compacts through forbearance agreements, leases for exchanges to meet streamflow criteria, temporary fallowing agreements, etc. Reviewed the 2020 Annual Replacement Plan (ARP), to meet requirements for the Plan Year under the provisions of the PWM for Subdistrict No. 1 decreed by the Division No. 3 Water Court in Case Nos. 2006/V64 and 2007CW52. This report describes a plan to remedy injurious stream depletions caused by the withdrawal of groundwater from Subdistrict Wells. This ARP includes a series of tables created by Subdistrict No. 1 staff and the RGDSS modeling team tabulating stream replacement quantities and locations resulting from Subdistrict No. 1 well groundwater withdrawals and a water portfolio to be used to replace such stream depletions.	Rio Grande Water Conservancy District plan to meet interstate compacts through forbearance agreements, leases for exchanges to meet streamllow criteria, temporary fallowing agreements, etc.	Agriculture is still holding on to water rights and maintaining irrigation practices at limited capacity / More water in the stream and marginal improvement in aquifer	Agriculture is still holding on to water rights and maintaining irrigation practices at limited capacity / More water in the stream and marginal improvement in aquifer	Fallowing, forbearance	Alfaffa, grain, and potatoes primarily; also oats, sudan grass hay, grass; other various crops	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed
ATM-18 Alternative Water Transfers in Colorado: A Review of Alternative Transfer Mechanisms for Front Range Municipalities	2016	https://www.edf.org/site s/default/files/alternativ e-water-transfers- colorado.pdf	studies for a more detailed analysis of ATM, found 35 municipal water providers based on water source and demand size criteria. Two case study participants were identified: City of Fountain and	Municipalities. The report conducted a screening analysis to identify potential case studies for a more detailed analysis of ATM, found 35	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed	Not discussed

Exhibit B-4 SCPP Documents with Environ. Criteria

										Environmental Resources th	at May be Affected								Data Gaps	Next Steps	ojects			
Title	Date Publis	sher/Authors	Description	Notes			Streamflow (Hydrology) Impacts			Species Impacts			Water Quality Impacts		Predic	cted	Program level goals	s For	r proposed future transacti		cts (positive or negative) to		
1100				10000	Magnitude	Frequency	Duration	Timing	Rate of change of hydrologic conditions	Return Flow Impacts	Critical Stream Reaches Impacted/where)	Critical Land or Riparian Habitat Impacted	Species Impacted	Salinity	Temperature Other	Tradeoffs - Resource mitiga Impacts hierar	ing "avoid, ate, offset" rchy Proportional	env. services, Bu recognizing pro tradeoffs be	uild incentives for rojects with net env. ISF enefits.	s (or other flow propose gets)	es/ flow	State species of values lis concern mapping	nental CRCT sts/ conservatio strategy	Other known community / entity projects
System Constraints Pflogram System Constraints Pflogram Secondary Bendles Case Budies	2019 WestWat for TNC	ter Research for	quantifying or evaluating each impact/benefit.		stmantflow benefits at the upper end of the 15ABR React WY: See Table 7 Konchryf How Comparison: CCU and Middle Phery Creek Estimated Flow. "The streamflow benefit of the project is the estimated CU savings."	Assessed monthly for 1 years (CO) and 2 years (MY).	Flow Comparison: CCU, River Flows at top of 15-mi reach, BIOp Flow Recommendation for 15- mile Reach. WY: See Table 7 for Month Flow Comparison: CCU an	b) CO. See Table 4 for Monthy Flow Comparison: COL Rev Flows at too et al. 5-nei reach, BCD Flow WW. See Table 7 to Meehby Flow WW. See Table 7 to Meehby Flow Comparison: COL and Mode Prings Comparison: COL and Comparison:	d Not discussed		15 Mile Reach. "Environmental benefits of adual 2020 diverse stimulation actions of the management program for EXE (In species in the 15-bill reach directly block the project diversion point." <i>International Conference on International Conference on International International Conference on International Conference on International International Conference on International Conference Reage and existing a statistical conference on International Reads and a statistical and a statistical conference on International Conference on International Conference Distribution Reads and a statistical and the International International Conference on International International International Conference on International International International Conference on International International International Conference on International International International International International International International International International International International International International International International</i>	Not discussed.	Wyoming: Irout: increases in streamflow made possible by the Middle Piney Creek conservation projects would likely increase the quality of trout fishing, particularly if streamflow is a factor limiting trout productivity."	Safety Termination of the second seco	equality of that stamp), equality of that stamp), a factor intring trout productivity. Specifically, from streams/tem-points to stam beyond ideal thresholds and also reduces available habitat."	Net discussed. Net di	Sourced. Not discussed.	Not discussed. No	ot discussed. Not	discussed. Not docu	Not discussed.	Not discussed. Not discu	ssed. Not discuss	L Not discussed.
SCPP-02 Infographic: Grand Valley Pilot Project Secondary Benefits	2019 TNC	sec Gra	is infographic summarizes the results of condary benefits analysis as applied to the and Valley Pilot Project Case Study.	Grand Valley Pilot Project paid farmers to voluntary reduce their ingation water use in order to keep more water in the river to help increase water security within the Colorado Rive Basin in the face of ongoing drought. While focus was on water security several off-farm benefits occurs because of the project.	Increased water in the river resulted in \$23,000 of estimated savings not spent on endangered fish program:	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Nof discussed.	"increased water in the river resulted in \$23,000 of estimated savings not spent on endangered fish programs."	Not discussed.	"Increased water in the river resulted in \$23,000 of estimated savings not spent or endangered fish programs."	(after treatments)." Reduced impairs on safety soils improved water quality and resulted an estimated savings of \$282,720 from money not spent on other measures to reduce salinity."	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	ussed. Not discussed.	Not discussed. Not discu	issed. Not discussi	 Not discussed.
SCPP-43 Research Synthesis: Agronomic Impact of Reduction Irrigation	a 2019 Culp and	d Kelly for TNC res mp ma ma hte All	ter in the Upper Colorado River Basin. The toluding section also identifies remaining earch questions and suggests potential allocations and nossible pert steps for a demand	Evices methods and throling at classifier and an approved equation of imited implements of the second second second quality water use efficiency, recovery, soit hash, equality water use efficiency, recovery, soit hash, and the second second second second second second waters of operaphilism and coperations. Next helps and waters of operaphilism and coperations water and approximate the second second second second second methods of relations and another water and operations devention of relations and another and an applement access devention of relations of laboring, solid registers, and cope personal of relations of laboring second second second second constanted consumptive use.	Impacts to flow not discussed.	Not discussed.	Not discussed.	Net discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	"Satu el more to he surface of he sol during periods of tablowing. When netwring from chaloring, some felste networks y more al 2 pro-jatoring leaching imgation, which could reduce the water savings from fallowing."	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	issed. Not discussed.	Not discussed. Not discu	ssed. Not discuss	ed. Not discussed.
SCPP-04 Final Report: Colorado River System Conservation Pilot Program in the Uppe	2018 Upper Ci Commiss	Colorado River Les Ision imp	II SCPP report from UCRC; project list; soons learned: administration & olementation, operational, cost/benefit/risk,	List of future questions to be answered p4	Impacts to flow not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	ussed. Not discussed.	Not discussed. Not discu	issed. Not discussi	d. Not discussed.
Colorado River Basin		201 Api	al constraints, outreach & education. 18 update to UCRC full report, including pendices C (2018 update), D (2017 CU	Document includes Appendices C (2018 update), D (2017 CU analysis), and E (2018 CU analysis)	Impacts to flow not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Report addresses return flows as a data gap / legal constrai / issue: "Addressing the impacts of reduced return flows.	Not discussed	Not discussed	Not discussed.	Not discussed.	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	ussed. Not discussed.	Not discussed. Not discu	ssed. Not discuss	d. Not discussed.
SCPP.46 Final Report. Appendix C: 2018 System Conservation Pilot Program Update	2018 Upper Cr Commiss	an Colorado River Islon	aysa), ano E (2018 UU analysis)			Not discussed.		Not discussed.	Not discussed	Changes in Impacton and diversion practices reduce the availability of late access reterm More-which in Lippe Blass mathe-doubly programs and the search of the search of the search of the Market Search and the search of the search of the search of the lates of the search of the project selection process, there was no metamine to account for addres address the impacts. In a larges-scale program, these impacts will need be considered to prevent injury to other water right holders and non-program participants."							scussed. Not discussed.					Not discussed. Not discu		
SCPP-05 Pilot Program Funding Agreement	2014 Bureau o	20 ent of Reclamation	14 SCPP funding agreement between CRB Itles	Reviews history of compacts, storage allowances, demand management effects by signatoria. Defines goals and parameters of SCPP. Identifies NRCS programs that might support on-farm conservation improvements. EQIP and SWEP 8 ensures that projects will coordinate with respective NRCS State Conservationists.	Impacts to flow not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed	Not discussed	Not discussed.	Not discussed.	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	issed. Not discussed.	Not discussed. Not discu	issed. Not discusse	L Not discussed.
<u>SCPP-07</u> Colorado River Water Bank Feasibility Study: Phase 1	2012 Colorado Conserva	of p sup lo River Water vation District		need, supply-use scenarios. App. A: categories of WE slope water uses, App. B: CRC WB Feasibility Study Water Supply Technical Memo, App. C: Eval of CRC WB Hydologic Scenarios wUCRB model, App. D: Basic supply & use comparison scenarios for CRC WB technical memo	The report describes "evaluation of the magnitude and frequency of Water Bank need based on demand shortager" but does not discuss flow magnitude and frequency.	Not discussed	Not discussed	The report acknowledges "the actual timing and reduction in depletions would likely require some kind of return flow modeling."	Not discussed. d	Return flow timing is recognized as a data gap. "The actual timing and reduction in depletions would likely require some kind of return flow modeling."		Not discussed.	Not discussed.	Not discussed.	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	ussed. Not discussed.	Not discussed. Not discu	issed. Not discuss	1 Not discussed.
BCREAR Colorado River Wainr Feasbailty Bludy: Phase 2			der bank jurkenning phaser, tiet cause auseaung dem impacts for representative irrigation terms		Implementation of fallowing or deficit irrigation practices could affect return flows that are a source of inflow to		Not discussed.	Next steps Size 5.2 pg. 41 strendtem hr a questionnext per Strendte her pateral impacts of failowing or default and the strendtem of the strendtem of the pateral impacts of failowing or default in return from success due to therapy in return from success due to therapy of failowing or default impactor and affect of thim for the data as a work and affect of thim for the data as a set and affect of thim for the data as a set and a set to the strengthem of the case implication systems were based on patterns were also adopted from the data table and model.	d	Ideal a genues that return News are a concent risk aga, and the accurate of the second secon		Not discussed	Not discussed:	Stahly and advances incurs may make filtering or deficit ingoods one stractive to Projectimes, as impacted one simplifies tables out of protocols will loss impact on even will jeich, in addito. Stahly effects of all ficted or marginally addited by as a screening stratum hose. "Solid and the stratum of the	7	Ner discussed. Ner dis	scussed. Not discussed.	Not discussed. No	Not	t discussed. Not discu	assed. Not discussed.	Not discussed. Not discu	ssed. Not discuss	nd Not discussed.
Colorado River Compact Colorado water bank fasability study, water suppl back of the study of the study of the study Colorado River Water Bank Fesability Study: Phase 1)	Natural F 2012 Consultin Inc	Ind Resources Ing Engineers,	luded in 2012 WB planning phase 1 report.pdf	Data section includes analysis, irrigated areas, water rights categories, and climate stations. Examined CU requirements (VBIscuc) LB allows/Code), ET windschoor (Persum-Altoration bands in each division multipated by irrigated areas). Water bank parts and division multipated by irrigated areas. Water bank and and division multipated by irrigated areas, VBI areas, and banks. The clinic threads and the parts gain const. and banks are an experiment of the second bank of the areage, in CU, and supply-limited CU." Discusses split- eases in rigation.	efficiencies. - The actual timing and reduction in depletions would like) require some kind of return flow modeling."	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Recognized as a data gap / new step: "The actual timing and reduction in depletions would likely require some kind o return flow modeling."			Not discussed.	Not discussed.		Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	issed. Not discussed.	Not discussed. Not discu	issed. Not discusse	1. Not discussed.
ECP2-18 Exploring Perceptions of a Voluntary Aptionalizat Water Conservation Program Colorado Colorado	2019 MacIhoy State Un	anc cor pro 2011 ma Sio gro pro pro pro	mponentro o a poderalia diemand management 19. explored perceptions of demand magement among submiolations of the Western per Brough Institutual Interviews and Isous submitted and Egister on the Jonates and supram, including diases and feedback on whoth a supram, including diases and feedback on whoth a supram, including diases and feedback on whoth and supram, including diases and feedback on whoth and supram, including diases and feedback on whoth and the suprame of the suprame of the suprame suprame of the suprame of the suprame of the suprame suprame of the suprame of the suprame of the suprame suprame of the suprame of the suprame suprame of the suprame of the suprame suprame of the suprame of the suprame of the suprame suprame of the suprame of	This is an interview-based report the covers perceptions of QLI interview-based report that covers perceptions of QLI per works are proportionally anyly - and frash that these distributions of white the covers of the term of the covers of the covers of the covers of the covers of the covers of the covers of the covers of the covers of the covers as will an interview of the covers of the cove	ingada is flow not discussed.	Not discussed.	Not discussed.	Not discussed	Not discussed.	Net decisiend.	Net discussed.	Not discussed.	Not discussed.	Net discussed.	Not discussed. Not discussed	Not discussed. Not di	scussed. Not discussed.	Not discussed. No	Not	f discussed. Not discu	ussed. Not discussed.	Not discussed. Not discu	Not discusse	L Not discussed.
<u>BCPP-11</u> Briefing Paper: Lipper Basin Demand Management and Water Banking. Addessing Risk and Creating Catalyn Exploring Opton for an Upper Basin Demand Management Program	2019 TNC	ma of p hov suc	nagement program and is offered in the spirit symmetry for the spirit who structure, govern, finance, and implement th a program.	anding notations (typer Batin nich tassed en dirought hyritologi) and discusses how how diversition in the structure, cast and hoffing- ablacd Din, program governance and shorture, cast and hoffing- lings, measurement and verification. Isoffier from of the key measurement of the structure of the structure of the struc- ments of the structure of the structure of the struc- ments of the structure of the structure of the struc- ments of the structure of the structure of the struc- phone. The structure of the structure of the structure projects. Tabulates para cycline considered for avoiding compart of trainings.	water managers on water administration methods that div water savings in at sama at strategic locations and/or strategic times."	Net discussed.	Not discussed.	Not discussed.	Not discussed.	Return forward scientified as a data gar/ rent data, from a log ord organizent gardanyot for a program to protect water rights holders. "Water users, state and folderal agencies, and other stateholders will need accurate data on any state of the state of the state of the state of the special topon methods for calculating water savings and question, policy may be needed to help traviate these questions, policy may be needed to help traviate these questions, policy may be needed to help traviate the questions policy may be needed to help traviate the question and the state for the state of the state of the approach to estimating and addressing return flow impacts.	Not decused.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	iot discussed. Not	t discussed. Not discu	ussed. Not discussed.	Not discussed. Not discu	ssed. Not discusse	1. Not discussed.
<u>BCPP-12</u> Colorado River Yilaris Bank Work Group: An Over and Physical Studes & Reports		We abc pre pro pro lo River Water lo River Water	vk Group in their effort is provide information to shartly post of characteristic may be available to a shartly post of characteristic may be available to a shart of the shart is a shart of the shart duction and the river itself.	The work findules a two-place flambility study, an execution of how reduced high-balance study and the study of how reduced high-balance study and the study of t	Implementation of a demand management program to headble and detailed for water users in Colonado.*	mon discussed.	wd ascussed.	Colorado River Water Bank Resulting Bauly Frasac 2: Hone of the systemic Bauly Frasac 2: Hone of the systemic progenic CLI thready a mass balance. "Dene treamts of inspirator could be response to thread inspirator could be within baking some of one space" of fallowing or detail impaird on details and the state the potential impaird of fallowing or detail impaird on details and the state of the state of the environmental resources due to change in return flows."	Hot ascussed.	Made and defaults systems have eaching the discrimina- tion of the system share eaching the discrimination and an experimental impacts of discrimination allowing on status. How and download the system and the system shares and download the system is the system share and download the system is the system shares and an experimental impacts. If the system is the adaptive measurement of the system shares and adaptive system is the system shares and adaptive system shares and system shares and adaptive system shares and shares and system shares and system shares and adaptive system shares and system shares and shares and shares and shares and a share and shares and and shares and shares and a share and shares and and shares and shares and a share and shares and and shares and shares and a share and shares and and shares and shares and a share and shares and and shares and shares and a share and shares and and shares and shares and shares and shares and shares and and shares and shares and shares and shares and and shares and shares and	ma analifiidi.	"Other benefits of impacted (late-season return flows, wildlife habitat, scenic open space)"	(no. dicuised.	me sociado	Not discussed.	mer asoussee. Net di	sousea. Not discussed.	not discussed. No	Not	Net discu	need. per discussed.	Inver discussed. Not discu	nord. Not discusse	 put discussed.
SCPP-13 GVWUA Final Report on the Conserved Consumptive Use Plick Projects	2019 GVWUA Engineer	20' cor rep A and J-U-B and srs par the pro thir ma	19 Conserved Consumptive Use Pilot Projects protectory by Grand Valley Water Users sociation (GWVLA). The initial part of the out provides a good summary of both the 2017 2018 pilots. Appendix H provides the details titipating producers, gathering their input on it experience and perspectives on the pilot eler. Appendix Lammatrizes GWVLA's wirking more broady on the pilot and demand nagement.	and management contact manage week & pinit growth, col residen (kare pinit resides), tillage for contact within season viait to confirm might, activities are consident involved to the season of the season of the season of the season of the season of the season of the season of the B) don't peoply methods to verify CU on fallowed land, but does native plant growth on failowed land.	impact to fammers.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Return four impacts not discussed. More focused on CCU and impact to farmers.		Not discussed.	Not discussed.	Net decosed	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	issed. Not discussed.	Not discussed. Not discu	essed. Not discusse	I. Not discussed.
ECPP.14 Lessons Learned from the System Conservation Partnership Program	2016 The Nati	ind Col	Cs losson learned in heat SCPP involvement lang leasons from Trout Unlimited and lorado Water Trust	To p3 tesens coments 4 communication in exentral, presentand & legit and small a database and a data companying alon data's level amplify the process for atticiancy.	Impacts to flow not discussed.	Not discussed.	Not discussed.	When you focus on consumptive use reductions, what about network from issue fore do you prevent injury and keep oft water right holders and non-participants whole?"	Not discussed.	Another as a data gap has they maked to water rights. The current program where the source rights with the program must protection for conserved water. A successful program must be able to administ and account for conserved water is an additional to a successful the source of the s		Not discussed.	Not discussed.	Net disconsed	Not discussed. Not discussed.	Not discussed. Not dis	scussed. Not discussed.	Not discussed. No	ot discussed. Not	t discussed. Not discu	issed. Not discussed.	Not discussed. Not discu	ssed. Not discuss	I. Not discussed.

																	_					Next Steps				
-		-								Environmental Resources th	t May be Affected			r							Data Gaps, G	Questions for Future Pro	ojects			
						1	Streamflow (H	ydrology) Impacts	1		Species Impacts	1		Water Quality Impacts			-			Program level goals	For p	roposed future transacti	ions, need to evaluate	impacts (positive or n	egative) to:	
Title	Date	Publisher/Authors	Description	Notes	Magnitude	Frequency	Duration	Timing	Rate of change of hydrologic conditions	n Return Flow Impacts	Critical Stream Reaches Impacted/where)	Critical Land or Riparian Habitat Impacted	Species Impacted	Salinity	Temperature	Other	Tradeoffs - Resource Impacts	Predicted outcome from applying "avoid, mitigate, offset" hierarchy		No net loss to env. services, Bui recognizing pro tradeoffs ber Not discussed. Not	Id incentives for jects with net env. ISFs (refits. target	SMP or 1 objective or other flow propose s) projects	es / flow d recommenda	at & ation State species of concern	mapping stra	CT Other known nservation community / ategy entity projects
SCPP.15 Considerations for Modeling a Wat Bank at the Agnual Unit with Characteria Environmental Pows	ter 2011		River to assess their ability to simulate a potenti water bank in the basin using the Aspinal Unit reservoirs and the effect on reservoir operations including environmental flows	Statebook, Append PROCE Models and CHSS are evaluated to be capabilities to instance Asynahl Unit operation, many the models of the Black Caryon water cpt, fore SLPPO many memory and the Minker spage, and a water bandling option al Appent. Modifications to the Currinov Blackbod are accounting options.	to simulate environmental flow targets (through the Black Canyon and at Whitewater), including base flow and peak flow targets. However, modeling was not done in this smalysis, so there are no results to share on how the water banking project would impact flows.	configuration could be change to simulate environmental flow largets (through the Black r Canyon and at Whitewater), including base flow and peak flow targets. However, modeling was not done in this analysis, so there are no results to share on how the water banking project would	edconfiguration could be w changed to simulate environmental flow targets (through the Black Canyon and at Whitewater), including base flow and peak flow s targets. However, modeling was not done in this analysis so there are no results to	could be changed to simulate environmental flow targets (through the Black Canyon and at Whitewater), including base flow and peak flow target However, modeling was not done in this analysis, so there are no results to share on how the water banking project would	ts i	refam flows. However, modeling was not done in this analysis, to the was not result to alknow on the water banking polycit would impact return flows.	considered:	Not discussed.	Endangend Fish Species in the Upper Colonad River Basin, in the Gunnison River	Not discussed	Not discussed	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not	discussed. Not di	scussed. Not disc.	ussed. Not discussed	 Not discussed. 	Not discussed. Not	Not discussed
SCP.18 Environmental Water Transactions & Golanab Priver Boarn A Closer Lo		Stanford Woods Institute for the Environment	Neveral CRB environmental trackets to task and of a darky Generalise SCPP enjoice) has a COP provide a second second second second trackets and the second second second second second environmental second second second second second second environmental second second second second second second second second s		transactions is very small compared to the overall water budget of the basis, in certain watershock, stransactions have provided significant benefits for local streamfore. Thi is particularly true in the Price River watershed in Utah and the Green River watershed in Wyoming. ¹ "Tu defics on the Price River with the Cachon Canal Company are worth specific mention. SCPP deals with imparts that receive water from the Cachon Canal Company have both been able to focus benefits for flows i the Price River, and increases the chances that conserved	multiple benefits, including improving water eccentry, plicting water conservation tools, supplementing farm ani- ranch revenue and improving ecceptatems. There is obvious premy behaves and aquadic ecceptatems. There is obvious premy behaves and approve that have one of these goals also full the others. Program each broused on one of these goals can benefit from support for the other goals."	id s r, r, s s s y y y	Net discussed	Not discussed.		In Actions, Third Scale Sense serving with the Classical Scale Scale Scale Scale Scale Sca		Not discussed	Nel discussed	Net thoused	Not discussed	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not	discussed. Not di	Net disc	Not discussed	 Not discussed. 	Not discussed. Not	He discussed
<u>SCPP-17</u> Lower Colorado River Basin Pilo Program	r NA	Bureau of Reclamation	phase .	Although the Pitel Fregram will be engine until 2005, so of 2019, faure anoncements of funding-optominates and requests for additional project proposals are not being contemplated.*		Not discussed	Not discussed	Not discussed		Return flow impacts not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed	Not discussed.				Not discussed. Not						t discussed. Not discussed.
SCPP-18 System Conservation: a collaborati approach to drought contingency planning the Upper Colorado River E	y 2017	Wyoming SEO Callaway, AWRA Impacts magazine	participation, and future efforts.	Neither extensive nor technical, but includes some description of process & participation.		Not discussed.		Not discussed.			Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed	Not discussed.				Not discussed. Not						t discussed. Not discussed.
SCPP-19 SNWA Water Resource Portfolio	2019	Southern Nevada Water Authority	Chapter from SNWA's water plan		senses that the Drought Contingency Plan "keeps more water in the river for the benefit of all water users and the environment."		Not discussed.	Not discussed.		Return flow impacts from temporary supplies not discussed. Does generally mention that SNWA heavily relies upon retur flow credits (such as from waskwater treatment plants). Direct water reuse will reduce the amount of return-flow credits (which are reused indirectly).		Not discussed.	Not discussed.	Not discussed.	Not discussed		Not discussed.			Not discussed. Not						t discussed. Not discussed.
SCPP-20 Colorado River Basin Water Ban Framework & Financial Analysis	ic 2017 s	. WestWater Research for TNC	concepts to scale up operations of the Water Bank and provides comparative costs and other factors to consider in different approaches to developing a water bank. The information is	sufficient to address 250,000 AF of CCU: annual water bank leases, option leases in critical years, non-option critical year leases, and response to a 1922 compact call. WestWater Research developed a cost-estimation spreadsheets based on the volume of water leases, number of associated acces, and number of fams or ranches leasing water.	Impacts to flow not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Return flow impacts not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not	discussed. Not di	scussed. Not discu	issed. Not discussed	1. Not discussed.	Not discussed. Not	t discussed. Not discussed.

Exhibit B-5 Lit (Gen. Literature) Documents with Environmental Criteria

																Next Steps				
				Environmental Resources that May be Affected	St	reamflow (Hydrology) Impacts		Species Impacts			Water Quality Impacts				Program	Data Gaps, Questions for Future Projects evel goals	For proposed future transaction	s, need to evaluate impacts (posit	ive or negative) to:	
Title Dat	e Publisher/Autho	Description	Notes			Rate of change								Predicted outcome from applying "avoid, mitigate, offset"	No net la env. ser		SMP or W objective	#P Critical habitat & / flow	BRT environmental	CRCT Other kn
		Analysis of ag impacts from salmon-recovery-related flow	Investigates ag impacts of fish recovery measures "such as: modified	Magnitude Policy scenarios focus on alternative strategies to increase flow velociti	Frequency Duration esNot discussed. Not discussed.	Timing conditions Not discussed. Not discussed.	Return Flow Impacts Return flow impacts not discussed.	Critical Stream Reaches Impacted (where) It Minimum flow objectives for Snake River at N Lower Granite Dam, and for the Columbia	ritical Land or Riparian Habitat npacted ot discussed.	Species Impacted (what) Endangered species act:	Salinity Temperat Not discussed. Not discus	ture Other ssed. Not discussed.	Tradeoffs - Resource Impac Not discussed.	mitigate, offset" ts hierarchy Pr Not discussed. No	portional tradeoff discussed. Not discu	1g Build incentives for projects with net env. benefits. sed. Not discussed.	ISFs (or other flow targets) projects Not discussed. Not discus	s concern s Not discussed. Not disc	ecies of values lists/ mapping used. Not discussed.	strategy entity pro Not discussed. Not discur
Lit.01 Salmon recovery in the Columbia River		alterations in Columbia River	timing for dam releases, reservoir drawdown, and flow augmentation i the Columbia River basin, on the regional agricultural sector are evaluated. [] Results suggest that drawdown and/or minor	Magnitude Policy seaminiss focus on alternative strategies to increase flow velocition in the Columbia-Snake system" "Forw alterations have significantly noreased travel time for jurenise find migrating to the cosan, a primary factor in reduced survival rates."				Lower Granite Dam, and for the Columbia River at McNary Dam		Endangered species act: "Formal ESA listings for Columbia-Snake River salmon and steelhead populations triggered formation of a										
Salmon recovery in the Columbia River basin: analysis of measures affecting agriculture	Allery et al, Marine Resource Economic		by less than 1% of baseline levels. However, the most extreme scenario-a long drawdown period combined with a large reduction in ingation diversions-would reduce producers' profits by \$35 million	3						recovery program." Minimum flow objectives for Snake River at Lower Granite Dam, and for										
			(2.5%) annually.*							the Columbia River at McNary Dam.*										
Lit-02 Feasibility of water efficiency and reuse	, Berhanu et al, Jourr	Economic model of water cost provided by above-code water efficiency and reuse technologies, including variations mail & uncertainty analysis.	Estimates that efficiency and reuse can meet 85% of 50yr projected needs to the Lower Colorado River Authority service area (central TX)	Impacts to flow not discussed. Focuses more on costs-benefits of variou municipal efficiency practices.	is Not discussed. Not discussed.	Not discussed. Not discussed.	Return flow impacts not discussed.	No assessment for environmental impacts associated with this specific study for the 2012 State Water Plan for Texas includes a	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Not discussed	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discuss
technologies as demand-side strategies for urban water management	of Industrial Ecology	V Study of farmer response to gov't demand management,					Return flow impacts not discussed.	high-level assessment of environmental impacts of all recommended and alternate water management strategies for Texas												
Lit-03 Response to water crisis: How do Iranian farmers think about and intent in relation to switching from rice to less	Boazar et al, Journa Hydrology	switching crops.	"Structural equation modeling showed that farmers' intention to chang from rice cultivation to another crop is determined by personal norms, beliefs about their role and emotional considerations."	elmpacts to flow not discussed. Report focuses instead on farmers' attitudes and believes around crop switching.	Not discussed. Not discussed.	Not discussed. Not discussed.	Return flow impacts not discussed.	Not discussed.	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	eed. Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	4ot discussed. Not discuss
relation to switching term rice to tess water-dependent crops?	, ,,	PhD dissertation modeling options for temporary water	This research develops a water right option agreement (WROA)	Impacts to flow are not discussed. Focus is more on technical, legal, operational framework and costs of temporary transfers.	Not discussed Not discussed	Not discussed Not discussed	Notes that for any agreement, historical consumptive use and return	Not discussed N	of discussed	Not discussed.	Not discussed. Not discus	ssed. Included a discussi	n on the If the temporary transfer has	Not discussed. No	discussed. Not discu	sed. Not discussed	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discur
		transiers.	model, methods of analysis, and legal implementation strategy under Colorado law "Interviewed professionals, estimates costs, identified that WROA "can be superior in terms of cost, reliability, and operational flexibility to both water-light purchases and construction of	operational inamework and costs or temporary paintiers.			records that to any agreement, insorced consumptive use and recurs flows must be quartified. Use to existing claims on the return flow portion of the water by downsteam interests such as junice water- rights holders and instream flow consider-ations, only a portion of the impation water can be made available to the city by the final transfer					Senate Bill 80-181 rulemaking by the 3 implement water qu standards in review	nd the significant depletion effects, EO to deductions from the lesses's ality available credits may be nego for mitigation of instream impo	fiated cfs or						
Lit-04 Temporary water transfers for urban water supply during drought	2 Clark, CSU		additional reservoir storage.				process." Discusses considerations for determining location and calculating timing and amount of return flows, both surface and groundwater. "Location of the existing use relative to the proposed					transfers Mentioned the use	other effects f the mass A plan of augmentation and a							1
							temporary use determines the return flow requirements and impacts the transfer on other partiesReterring to Table 6.2.1, columns (1) a (2), if the transfer has significant depixtion effects, deductions from th tessee's available credits may be negotiated for mitigation of instreas	16				balance method or zone method to est influence of flow on quality standards	he mixing exchange agreement may yie mate the more water for the user water	a much						
		Water allocation experiment in San Luis Valley, Colorado fo self-governing intigation systems.	Examines relationships between rules and physical context of water supplies; specifically the outcomes of water allocations between members and how they rotate water delivery.	Impacts to streamflow from DM practices were not discussed. Appendix discusses Long-term climate change in the SLV.	I Not discussed. Not discussed.		impacts and other effects."	A la familia de la familia	ot discussed.	Not discussed.	Not discussed. Not discus		Not discussed.	Not discussed. No	discussed. Not discu	sed. Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	ussed. Not discussed.	Not discussed. Not discus
Lit-05			members and how they rotate water delivery.	Impacto to streamfore from LM platicities we'ri not assusset. Appendio discussies Long-term climate change in the SLV. Appendio Harlow a stream a stream a stream a stream a stready impacto environnenial considerations: Unique return flow dynamics ca laad to externalise when transfers occurs in water market (hrow et al., 1952), in addiscu, PA has no histernet place to environmental uses of	n	climate change in the SLV, including timing of runoff.	The those inside the second se	ter .												
Lit-05 Flexible water allocations and rotational delivery combined adapt irrigation systems to drought	Cody, K.C., Ecology and Society	a.		1952) in addition, VA has no interest place to environmental uses of water, posing challenges for ecosystem integrity under a water constrained future; only in the past 40 to 20 years have in stream flows and non-consumptive recreational uses been incorporated into Coloradi and non-consumptive recreational uses been incorporated into Coloradi			drought, regardless of the original onteria used to allocate water (uan owned, private rights held, historical use, etc.)) In extreme shortage, tail-indexs should be the most streased due to seepage losses, depressed hydraulic head, and decreased return flows.	a												
				water law." Prior Appropriation may therefore be working against risk mitigation and may exacerbate inequalities and vulnerabilities in the ove agricultural sector.	nal		сертиално правила тнака, апа сестивно техат потех.													
		Chapter from book "Competition for Water Resources: Experiences and Management Approaches in the US and Exempt - orderation of Mahal examples/liseurspin of	Ch 2.1.1: Challenges for US intigated ag in the face of emerging demands and climate charge, Ch 3.1.4: Water trading involutions: retrieving activity that consumptive use to immove adaptation to scand	Emphasizes the need for cost effective flow monitoring to gage environmental benefits in specific locations: "Cost-effective verification	Not discussed Not discussed	Acknowledges in a general sense that CU Not discussed trading programs have a goal of "real-time reductions in agricultural consumption to	Addresses return flow impacts primarily as a date gap / next step. "Generally discusses the difficulties of data availability for determining naturn flows and historical consummines use	9 Not discussed N	ot discussed	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	1) CPNRD. The Central Biotra Natural Resources District (CBNRD) in 2007 assessed a Water Reaking Balance to end at a set	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discuss
		Europe [*] collecting global examples/discussion of approaches and solutions to water supply scarcity, including western US	for cost-effective verification of CCU, and other breakthroughs facilitating temporary & intermittent trading more feasible. Examples	stream flow changes linked to trading and low transaction cost procedures to negotize and implement trades have made temporary an intermittent amangements to reduce CU feasible in many areas. This is porticulate build it is explained from the content of the product of for	d	reductions in agricultural consumption to produce a dealer dimprovement in sufface flows at specific locations and seasons." The regions where busings programs must achieve sharemflow and lake-lovel mandates, change in water also of narmo must achieve sharemflow and seaso frammodates busing and the seaso frammodates and measurements and the momentum of the destination of the model to incomvate of the	return flows and historical consumptive use. Lower Colorado River Accounting System (LCRAS): In the Lower Colorado River Basin (LCRA), water use within glication districts receiving water under confacts with Reclamation is tracked through									regulate irrigators while returning Platte River flows in its area to mandated levels. CPNRD acquires water rights from landowners through the bank. For every acce-foot river flow improvement from banked water, there is that much less sounders the CPBNPD has to inspect." "CPMRP have been provide momentary form within each test that the composite formulate the composite formulation accessible. In composite formulation accessible to composite formulation accessible to composite formulation accessible to composite formulation accessible.				ı
			from AZ and CA (IID), NE, Australia, CO-Big Thompson.	periodicity respect to detuning the write writes significantly with specific locations and seasons. ¹ Addresses in which water's value values significantly with specific locations and seasons. ² Addresses inportance of measuring CCU rather than diversion or acrea reductions: "A program that accounts solely for changes in diversion or biomene in exercision biotic diversion for the sole of biomene in exercision biotic diversion or the biot or diversion or the biotexes in exercision biotic diversions on the biot or diversion or the biotexes in exercision biotic diversions on the biot or diversion or diversion of the second biot or the former or the biot of diversion or diversion of the biotic diversion of the biot or diversion or diversion of the biot of diversion or diversion of the biotic diversion of the biot or diversion or diversion or diversion of the biotic diversion of the biot or diversion or diversion or diversion of the biotic diversion of the biot or diversion or diversion of the biot or diversion or diversion of the biot of diversion or diver		achieve streamflow and lake-level manates, changes in water use on farms must result in measurable increases in water availability at	covering wave tophisticated water accounting systems in the world, the Lower Colorado River Accounting System (LCRAS). This system requires detailed records of diversions, return flows, CU, etc. and provides a baseline from which to quantify change in CU. However, not account provides a constraint on accounting systems. and									regards acress (and other use) and convert to use that this have leaser impacts on niver flows. The program incentificates reference to the second s				1
Lit-06				reductions in diversions or acreage) will encounter problems such as		loss, return flow lagging etc. : "Various	accounting systems are lacking in most basins of the western United									'in a 2012 effort to compete against private individuals looking to buy water rights, the CPNRD directors doubled the ra that they will pay for water rights to 8000 per acrockot of deplation of the river, up from \$3750. At the end of 2013, CPNRD had a balance of 2464 acro-facet of water rights available for offster in the over-appropriated area."	25			1
Water trading invovations: reducing agricultural consumptive use to improve adaptation to scarcity 201	Colby (Ch. 3.1.4), B eds Ziolkowska & Petersen	Book		detrimental effects on surface flows and downstream water rights, as we as on groundwater in storage. A farmer paid to cut back on the basis of reducing inigated acres may change crop mix, irrigation technology, and water management on remaining acreage*	1	programs have devised strategies, such as designated trading zones with different trading ratios and multiyear trading, to address	States and elsewhere in the world. Acknowledges the need to incorporate ditch loss, return flow lagging etc. : "Various programs have devised strategies, such as designate trading zones with different trading ratios and multiyear trading, to	d								2) TPMRD: In 2013-2014, Nebraska's Twin Platte Natural Resources District (TPNRD) created and implemented a mechanism "to help agricultural producers put gloundwater to its best use by facilitating the transfer of certified implated acres." An entre mechanism operated by a neutral market amager, Mammod Trading, matches buyers and selects anonymoust				1
				need management of minimum gasterings		variations in hydrologic connectivity and time lags between reduced water consumption on a farm and improved surface flows at the desired location. Differences in conveyance	address variations in hydrologic connectivity and time lags between reduced water consumption on a farm and improved surface flows at									indicate difficulties (justime or y it assesses interfs toward), with the starting instants and the starts as any within and confidentially, similationally comparing lots and offers. The trading system ensures that transfer comply within TPNRD rules (such as flow lines, stream depletion factors, slope), manages the approval process with TPNRD, understands site searches, and works with itemates on finalizing paparvork and transferring funds.	,			1
						losses and aquifer characteristics can be incorporated into trading rules to ensure that decreased water use on a specific farm will	the desired location. Differences in conveyance losses and aquifer characteristics can be incorporated into trading rules to ensure that decreased water use on a specific farm will improve surface flows at target location and time period. "									 Collaborations: "In 2012, four NRDs in western Nebraska boucht nearly 20,000 acres of farmland in southern Lincoln County: the 				1
						improve surface flows at a target location and time period. "										Educational Telecommunications, 2014). Crops on over 19,000 acres of purchased lands are taked, the tand is seeded in graise, and the imgains water is sent to the South Platte and Republican rivers to high the NRDs and Nebraska meet legal obligations. The participating NRDs plan to pipe water from the farm's inigation wells to the Platta and Republican	n			
		PhD dissertation that identified San Luis Valley sustainabilit	Utilized Community Based Participatory Research to engage	Discusses declining SLV aquifer levels due to diversions compared to runoff. Pg. 66.	Not discussed. Not discussed.	Acknowledges climate change impacts on Not discussed. runoff (shift from June to May) pg. 66.	Return flow impacts not discussed.	Not discussed.	iscusses the importance of flood inigat	ion Not discussed.	Not discussed. Not discus	ssed. Not discussed.	*On the other hand, through the	is Not discussed. No	discussed. Not discu	Rivers. The project enhances stream flow with water that otherwise would have irrigated acres owned by N-CORPE in Lincolo County and is the largest grassland restoration project in Nebraska.* Not discussed.		ed. Not discussed. Not disc	ussed. Not discussed.	Not discussed. Not discus
		Indicators and modeled roune scenarios, developing a CO indicator for 1980-2010. Conducted scenario modeling to quinte decision-makers	stakeholders & keep research relevant. Highlighted groundwater- dependence of SLV, suggests irrigation water use could be decreased 10% with shifts in crop regime and minimal fallowing.	iunoii. rg. do. I		runon (anni rom June o swy) pg. oc.			socialises the importance of thood imgals in five valleys, regarding wetland habita of also impacts to compared compliance this is a complex system and solely creasing efficiency may not be the ans long the ipatian conidons, diverted well as for growing meadows of pasture suntains a variety of wetlan- de that are impacting and the interval lidifie, recreation, and other ecosystem varies.	ia L			analysis, we see that naïve vegetation consumes significa amounts of water, which affect reninn's shifty to maintain a	nt Is the						
		Conducted scenario modeling to guide decision-makers towards desired outcomes from policy decisions. Coupled sustainability indicators with future scenario modeling to inform the SLV stateholders about a variety of social and informative futures.						A 1	long the riparian corridors, diverted wat sed for growing meadows nd pasture sustains a variety of wetlan:	ter d			region's ability to maintain a sustainable aquifer. It will be important for future regional w use analyses to allocate wate	ater						
Lis.47 Towards regional sustainability assessment utilizing community based 2019	B Dubinsky, CU Denv								pes that are invaluable for waterfowl, idlife, recreation, and other ecosystem arvices." While flooding land during the growing				towards ecosystem services a environmental flow requireme Much work has been done in	nd 1ts. he area						
assessment utilizing community based 2016 participatory research, sustainability indicators, and future scenario modeling		rotations and minimal land fallowing, SLV could reduce water use and Greenhouse Gas Emissions while increasing soil carbon and improving soil health. In addition, the solar reserve development optimum increation of the solar	2					s	Whee flooding land during the growing eason may not appear to be an efficien ae of water, it provides an important arvice, as these lands provide habitat fo	t			of quantifying ecosystem serv and these methodologies cou applied to river basins such as (Costanza et al. 1998, 2014, 2	SLV						
		energy development pathways investigated by this study showed that the potential exists to offset most or all of the region's GHG emissions.							ative species, as well as grazing land fo	or /			Costanza 2014)."							
								d 5	If vier considor zones were permanently fied by change of use, it would cause a ubstantial challenge to the State's abilit set compact requirements."	y 10										
Lit-48 Economic viability of deficit irrigation in the Western US	Manning et al, 3 Agricultural Water Management.	Research on agro-economics of deficit irrigation.	Deficit irrigation (DI) can be optimal during late growth and maturation stages given elevated water prices (depending on output price and production costs).	Impacts to flow not discussed. Focuses more on costs.	Not discussed. Not discussed.	Not discussed. Not discussed.	Return flow impacts not discussed.	Not discussed. N	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discuss
		Republican River Basin assessment of coupling surface- groundwater management.	Geospatial dataset of RRB irrigation wells modeling crop choice, land, and water use decisions by well. "Our analysis highlights the	Acknowledges that groundwater pumping impacts surface water flows, and how that impacts Republican River Basin interstate compacts (NE coligation to KS). "The effect of pumping a well on instream flows is a function of the glistance of that well to the nearest stream."	Not discussed. Not discussed.	Not discussed. Not discussed.	The study found that in general, trading tends to result in applied wat moving farther away from streams (a result of the specific well distribution in the study area in Nebraska). This also impacts return	ter Not discussed.	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Not discussed	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discus
			importance of the initial distribution of permiss and the institutional context in which trading occurs. ¹² Cost savings from trading groundwater pumping are distributed unevenly between wells, countie and groundwater management institutions.	congation to KS). "The effect of pumping a well on instream flows is a function of the distance of that well to the nearest stream." "Attraction do not model the second dispersion import of tradices on			flows. "Moving the location of pumping further from the river will	of												
L8-09	Palazzo and Brozov	win	and groundware management metadolate.	"Although we do not model the spatial, dynamic impact of trading on instream flows, our results show that on average, pumped water moves away from streams after trading relative to the base-line regulation. This suggests that a simple trading scheme with a single pemit price may			decrease stream depletion, but if will also decrease the contribution of team flows is balance subscripted from all that is stream baseflow. Irrigation is initiatively efficient overall, the net impact of moving the average location of pumping water way from the river should reduce stream depletion in the long run. ² in the stably are, reducing stream depletion rather than reducing agained depletion is the primary goal of regulation. This implies that where in halos the interferent from advicent pages of the plate that the stream stream is the stream stream depletion rather than reducing agained depletion is the primary goal of regulation. This implies that													
The role of groundwater tracting in spatial 201- water management	4 Agricultural Water Management			simultaneously reduce both abatement costs to farmers and damages to instream flows. Our results imply that where there is very little unused allocation and water moves away from streams after trading – such as in	5 1															
				the Upper Republican Natural Resources District – a restricted trading scheme canthus generate both economic and stream flow benefts. Because the groundwater pumping estematity on stream flow is spatial, dynamic, and legged, a dynamic model with detailed hydrology is needs			relatively less efficient wells. As a result, for a random distribution of efficiency, water trading results in a decrease in consumptive water u and an increase in returnflows All else equal, wells with a higher (meen) technical efficiency will have a lower (higher) increasization of the output of the second seco	256												
				ophamic, and aggled, a dynamic model wan dealed injuriology is needs to analyze the exact impact of trading on stream flow, as well as to estimate the optimal trading ratio between wells closer to streams and further from streams."	52		(over) sechrical electricy will have a lover (regner) unconsistend water use, a lower (higher) marginal abatement cost at their current allocation, and will thus be more likely to sell (buy) water permits."													
Lit-10 Evaluating the potentials of cropping adjustment for groundwater conservation 2019	Ren et al, Stochasti Environmental	Evaluation of different cropping patterns (including fallowing & water supply scenarios.	Framework for using a crop model & regression to predict effects of cropping adjustments on groundwater sustainability & crop production	Impacts to flow not discussed. Focuses more on nexus between food an water.	d Not discussed. Not discussed.	Not discussed. Not discussed.	Not discussed.	Not discussed.	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discus-
adjustment for groundwater conservation 2019 and food production in the piedmont region of the North China Plain	Research & Risk Assessment																			
		 Review of literature & internet to identify water-saving strategies in imgated agriculture. Review of case studies in which water savings have been 	 Catalogs water savings opportunities, claims of irrigation-efficiency savings potential, logistics of reallocating due to other ag diverting savings. Findings suggest considerable potential to reduce irrigation C 	"This paper focuses on the potential water savings that might be realize in ingland agriculture without loss of orep production, as well as Upportunities to redirect saved water toward environmental restoration on the other uses."	d Not discussed. Not discussed. r	"Unfortunately, until recently most water conservation efforts on farms, and claims of water-aaving potential, have focused solely on changes in the volume of water withdrawn or	Acknowledged as a data gap that most reports and papers fail "to properly account for key elements of water budgets such as return forws." "most water conservation efforts on farms, and datims of wate saving potential, have focused solely on changes in the volume of w withdrawm or conclust to form failed draws orman in Essaw 31.	Recognizes a need to show flow benefits are h being provided to reaches purportedly r-receiving benefits.	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Paper recognizes enabling in in agricultural production throu use of water-saving programs	could	discussed. Not discu	sed. Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discusr
		successfully transferred to other uses.	and that savings can be reallocated when proper consideration is give to water budget accounting.	no other uses." "Accurate determination of potential water savings in irrigation requires estimation of the volume of water associated with each of the water flow			saving potential, have focused solely on changes in the volume of wi withdrawn or applied to farm fields (large arrows in Figure 2), neglecting the volume and fate of return flow back into the original water source, creating misleading impressions of water benefits within						allow consumptive water use and river flows or groundwate will be further depleted, often point of conselecte device, with							
Lit-11 Opportunities for saving and reallocating agricultural water to alleviate water 2011	7 Richter et al., Water Policy	e		estimation of the volume of water associated with each of the water tow pathways illustrated in Figure 2 so that the net change in 'water availabil for subsequent use' (including environmental uses) can be properly evaluated."	•	appead to tarm heads subge airclean in Higure 2), neglecting the volume and that do freturn flow back into the original water source, oreating misbacking impressions of water benefits within the overall imgation network within which water practices have been modified. This insufficient accounting can head to recorder air the order the sources.	water source, creating materiality impressions of water benefits with the overall impation network within which water practices have been modified." Report describes the importance of return flows to downstream users						and river tows or groundwate will be further depleted, often point of complete drying, with attendent loss of biodiversity i social and economic benefits riverine fisheries.	nd such as						
agricultural water to alleviate water scarcity	, and					modified. This insufficient accounting can lead to counter-intuitive outcomes, or a water efficiency paradox' (Scott et al., 2014), in	and the fact that some increased efficiency practices can even increase crop consumptive use and therefore increase water scarcity.	256												
						to courter-intellitive outcomes, or a "water efficiency paradox" (Socti et al., 2014), in which seemingly more efficient impation application can result in greater net consumptive use, uttimately lessening the setting particulation for enhancement use ¹														
		UC Davis Master's Thesis cataloging/analyzing supply &	Evaluates outdoor watering, public outreach, media role, water-related	Impacts to flow not discussed.	Not discussed Not discussed	volume available for subsequent use." Not discussed Not discussed	Noted when municipal efficiency practices were enacted, wastewater	r Not discussed N	ot discussed	Discusses importance of	Discusses importance of keeping water in storage for Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Energy savings were realized through the water conservation efforts (OHO emission reductions and reduced kWh of	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discur
Lit-12 Urban water conservation in the		demand management actions under CA's drought policies.	energy savings. Makes recommendations for urban water suppliers on revenue recovery, reducing use of rebates as demand management, and scaling drought response tasks for different levels of govt. Summarizes & analyzes CA legislation establishing approval for long-				treatment plant effluent discharge was also reduced. Other than that brief mention, return flow impacts or implications are not discussed.			keeping water in storage for environmental flows to keep sait water from moving up river from the oneon (on 20) and to	environmental flows to keep salt water from moving up river from the ocean (fresh water releases to push back seawater), (pg. 22) and to "minimize the impacts of reduced flows from Fotsom Lake on faih and widdlife." (pg. 74).					wearing)				1
Lit-12 Urban water conservation in the Sacramento, California region during the 2014-2016 drought	Talbot, UC Davis		Summarizes & analyzes CA legislation establishing approval for long- term budget-based efficiency targets.							from the ocean, (pg. 22) and to "minimize the impacts of reduced flows from Folsom Lake on fish and wildlife." (pg.	n somen save on nen and withins. (pg. 74).									1
Lit-13 Remote sensing assessments of 2011	Market Only -	CSU Master's Thesis evaluating remote sensing for estimating monthly consummine use (CII) and expressed C	Used evapotranspiration (ET) observations at experimental plots of traditional initiation and water-bankion initiation wartings to contests.	Impacts to flow not discussed. More about the technology used to verify any DM practice.	Not discussed. Not discussed.	Not discussed. Not discussed.	Briefly mentioned as a data gap, in that many methods for quantifyin CU do not allow measurement of return flows.	g Not discussed.	ot discussed.	74). Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	ased. Not discussed.	Not discussed. Not discus
Remote sensing assessments of consumptive use of agricultural water in western slope of Colorado	Vashisht, Colorado State University, Colorado	(CCU) on the West Slope	traditional irrigation and water-banking irrigation practices to evaluate methods of verifying CCU. Reviews methods for measuring and monitoring CLJ, discusses limitation and potential for ReSET remote sensing CU model.																	
	Yonta et al. J. of	2010-2015 study in Nebraska of efforts to decrease ag	Penturing indication water by 25% caused no significant yield reduction and improved intigation water use efficiency by 26%. Applying 50% Etc. resulted in 30% yield reductions, and planting directly in complex resistue did not improve beam yield under deficit imigation. Ample early	Impacts to flow not discussed. More focused on impacts to crop yield.	Not discussed Not discussed	Not discussed Not discussed	Return flow impacts not discussed.	Not discussed N	ot discussed	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Not discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discus-
Lit-14 Deficit irrigation and surface residue cover effects on dy bean yield, in- season soil water content, and irrigation water use efficiency in western Nebraska high plains	Yonts et al, J. of Agricultural Water Management		Etc. Healaised in Solvs yaids healaidenis, and planning directly in Orop residue did not improve bean yield under deficit irrigation. Ample early season rainfall is a boon to pre-flowering deficit irrigation yields, but under normal-to-dry conditions post-flowering deficit yields more.																	1
high plains L8-15 Intigation Efficiency and Water Balance of the Little Wind Unit on the Wind River 201		Master's thesis on irrigation system efficiency in Little Wind Unit	Have an uniter balance & excelosioni techniques to support & locato	Paper not found																
of the Little Wind Unit on the Wind River Indian Reservation in Wyoming	7 Rosado, U of Wyon	Review of strengths and challenges of existing legal	Data any white bases. "Large errors and data gaps associated with the inflows, outflows, diversions, and precipitation data, [which] identified specifi needs for better data." This article will describe the barriers in existing law to temporary		Not discussed. Not discussed.	Not discussed. Not discussed.	The difficulty of calculating and challenge of maintaining historical ret	turNot discussed.	ot discussed.	Not discussed.	Not discussed. Not discus	ssed. Not discussed.	Not discussed.	Not discussed. No	discussed. Not discu	sed. Nd discussed.	Not discussed. Not discus	ed. Not discussed. Not disc	issed. Not discussed.	Not discussed. Not discuss
Lit-16	Nicols, Peter D, et a	mechanisms for ATMs and recommendations for	This areas we observe the barries in tecomy and to importanty transfers and the various approval mechanism available under existin Colorado law. It will provide an assessment of the strengths and limitations of the existing transfer methods and make a recommendation for consolidation and standardization.	Not accreased, corer man accreasing the rise to inclusive among a seeamined approach to calculating and maintaining return flows.		The second	flows is recognized as part of the "No Injury Rule" barrier and "Coloribles of MCLP" barrier to invite metation. The Lease Fallow Te	201			+eot concuts	Contraction of the second second		·						
L8:15 Standardizing Temporary Water Transfer 202 Procedures in Celorado	Water Law Review		recommendation for consolidation and standardization.				Cancerated of metal solution to simplify and stream mine the evaluation process, described as a "bansparent, simple, and streamlined approach." Also recommends the state engineer rulemaking address a streamlined approach to determine HCU and													1
L	1	1	1	1	1 1	1 1	return Tows.	1		1	1	I	1			1	1		1	

Exhibit B-6 ATM Documents with Environmental Criteria

				Environmental Resources that May be Affect	ted													Next Steps Data Gaps, Questions for Future Projects				
						Streamflow (Hydrology) Impacts		Species	is Impacts			Water Quality Impacts				Predicted	Program level goals	For proposed future transactions, need to				
Title	Date Publisher/Authors	Description	Notes	Mannituria	Frequency	ion Timing	Rate of change of hydrologic conditions Retu	turn Flow Impacts	I Stream Reaches Imnanted (whore) Crit	itical Land or Rinarian Habitat Imnartad	Speries Imparted (shat)	Ralinity	Temnerature	Other	Tradeoffs - Resource Impacts	outcome from applying "avoid, mitigate, offset" hierarchy Proportional Not discussed. Not discussed	No net loss to env. services, Build incentive recognizing projects with r tradeoffs benefits.	es for net env. ISFs (or other flow targets)	SMP or WMP Critical habit objectives / flow proposed recommenda projects s	at & BRT environm tion State species of concern mapping . Not discussed. Not discu	nental CRCT ats/ conservation	Other known community / entity projects
ATEAL Liko of Analysis Tanins for Onejo Inseam Vitalian Tanins for Onejo Basis Agriculture, Marciga, and Enveronmental Purposes			NM or recational and environmental landfus for markingle augmentation antivipagement of Traffold Machine Stearch and Stearch and Stearch and Stearch Stearch and an ends. Note of Traffold Stearch and and stearcommentic path and Appendix A statistical of contify index to search Water (b) is tooldo 10 ¹⁵ Machine (B) fold Stearch and B ¹ , interaction and particles for the stronge MR.	also be used to evaluate streamfow, leading to analysis of riparian, environmental, commutional, and economic benefite."	Potential benefite Potential benefite Potential benefite Potential Benefite Potential Benefite Potential Benefit Potenti	All sources Program has index assigned have the barrelit of operation of the index assigned have the barrelit of program of the index assigned have the barrelit of the index assigned have barrelit of the index assigned have provide have barrelit of the index assigned have provide have barrelit on the index assigned have barrelit on the last sector of the index assigned have barrelit on the index assigned have barrelit on the index provide have barrelit on the index assigned have barrelit on the index assigned have barrelit on the index provide have barrelit on the index assigned have barrelit on the index assigned have barrelit on the index provide have barrelit on the index assigned have barrelit on the index assigned have barrelit on the index provide have barrelit on the index assigned have barrelit on the index assigned have barrelit on the index provide have barrelit on the index assigned have barrelit on the index assigned have barrelit on the index provide have barrelit on the index assigned have barrelit on the index assigned have barrelit on the index provide have	ad to	v patimum to protect other water rights, Return Row are lifet of the right of the right of the right of the right of the Result of the right of the right of the right of the brotten flactor, and are legged tack to the river." 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Not discussed	entiance stream and ipparian values through additional flow after the peak rundt. This will improve aquatic habitat quality and species diversi downstream due to peological stream volume, peological s	normane dissolved organ as a result of higher from and choose temperatures from summer releases.	Not discussed.	Net discussed. Not discussed	Not discussed Not discussed Not discussed	Not discussed.	projects in the second	Not discussed. Not discu		Not discussed.
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<u>ATR48</u> Vanya Basi ATM Budy	htpp://drwebbink.doi or.sofeweb/like.org/ https://drwebbink.doi https://drwebbink.doi https://drwebbink.gov amministrationen.com/ org/sofewebbink.gov bink.doi.net.gov bink.doi.	ChOChe Alexandre Argonizard Viter Transletio Check ChoChe Alexandre Argonizard Viter Transletion Check In orace in naging uses (incrementary filter senses) and grant and an and an and an and an and an and an and an and senses and an and an and an and an and an and and	and M	environmental bandit, "The data available thomas and the second second second second second second control of a based of seath from a while and control of a based of seath from a while the second se		Mandal Kaloy nations for the self-field provides an extension type with these Cocycles and addings, there may also a sension type manual for most bioindings. We may adding a filter manual for most bioindings. We approximate in the manual for the participant and the sensitivity and that it methods and the participant and the sensitivity and that it has a sensitivity and the sensitivity and the sensitivity for and the cockets and at its participant and the filter and the filter and the cockets and the cockets and the filter and the filter and the cockets and the cockets and the filter and the cockets and the filter and the cockets and the cockets and the filter and the cockets and the filter and the cockets and the cockets and the cockets and the filter and the cockets and the cockets and the filter and the cockets	γ ματό κατά κ κ κ κ κ κ κ κ κ κ κ κ κ		ge registron trachings within meaning, the analysis generation registry of their strength of their strength generation registry of their strength as their strength their strength of their strength as the strength of the strength environment of the strength of the strength of the strength of the strength of the strength of the strength of the strength of the strength of the strength of the strength of the strength of the streng		when a TN one speech the MGST leader the MGST	Regard autority method somethod somethod to be a somethod to be a somethy of the source of the sourc	non Ant the	Net decorated	Ne decome	No decense. No decense	ionnais in suos per al anticorrespondent sea anticorrespondent beautif.	and the state of t	dy gr uchowskie Adv uchowskie Adv uchowski Adv uchowski Adv uchowskie Adv uchowskie Adv uchowskie Adv u	es, epidemic locations, expensional controls of the second address of the second address of the second address is the second address in the second address is the second address of the second addr	and Not decrement.	Net discussed
ATM-05 Grand Valley Waler Users Ason Conserved Consumptive Use Plot Project Development Process, Procedure, and Lessons Learned: Water Banking-Next Steps Part II		Field compliance and payment summary for the 2017 CCU	a Eard management contract: manage weeks & plant growth, soll wrokin (leave plant reaklus, tatage for close), tatage for crust), in winni-season with confirm mgrt. activaties are considered tage/actoritizet, interviewes concented wDM externatives including local economy & externatives. Col un failowed land, to does include site with workfully. Col un failowed land, to does include site with workfully can deploy problems, and active plant growth on failowed land.	Impacts to flow not discussed. 81 Impacts to flow not discussed.	Not discussed Not d	Incursed Nd discussed	Not discussed Not o	discussed Not disc	cussed Not	t discussed	Not discussed	Not discussed. Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not discussed	L Not discussed. Not discussed.	Not discussed.	Not discussed. Not discussed	. Not discussed. Not discu	ussed. Not discussed.	Not discussed.
ATM-07 Grand Valley Water Users Assin 2017 CCUPP In-Season Verification	https://dnrweblink.stat .co.us/eweb/Electronic File.aspx?docid=2051 4&dbid=0	including verification forms for each program participant for 2017.	r secommendations, commentainoles												Although not discussed in the report, using					Not discussed - Not discu	ussed Not-figuresed	
ATM 48 Power Cranal Capacity Report, Grand Valley Water Users Assn 12:	https://dnrweblink.stat .co.us/owcb/Electronic File.aspx?docid=2018 3&dbid+0	water associated with CCU could be protected and returne to the Colorado Rever under a pilot project water bank." to convey CCU via unused capacity within the Crchard Meas Power Canal (power cinal) to deliver water to the Grand Valey Power Pilett (CVPP). The report investigated the potential unused capacity within the Power Canal, includin the potential for additional water to generate hydroslectric power.	d associated with CCU costs be protected and returned to the Colorado River under a pilot project water bank". Compensated, hemporary, voluntary, Lists current openations, water right, data, homotopiate file in link, merged with 2017 Next Steps Part II 9	report, but it is important to note that if CCU water were diverted and delivered by means of excess acpacity in the Power Canal, that water would not be available in stream for biological needs. However, as it would be delivered at the power plant, that water would be available in th 15-mile reach.	a a	is the descentifier culotic second flam will be	Not discussed Not o	discussed Not disc	cussed Not	t discussed Tercial benefits of using recharge wellands as	Not discussed.	Not discussed.	Not discussed.	Net discussed.	CCU for hydropower generation present tradeoff with keeping water in the river for biological needs.	a r	Not discussed. Not discussed.	Net discussed.	Not discussed. Not discussed	. Not discussed. Not discu		Not discussed.
ATE-02 Complete Research of Protect and Research Detrollar and Water Transfer Neurosci de Preservation of Colorado Irligited Agriculture	https://driveeblink.state co.ux/eveblink.state File.aspr/docid=1957 p&docid=1957	1) To identify harries to implementation of alternative methods.	Printe compression (and and and and and and and and and and	will be no inpact to magnitude of thematine use is achieved with the two being cardinal card and the meritained through verbage functions.	In the demonstration damo demonstration damo production, there associate the term of the term of the term will be no investment will be to streamflow as to a historical return histor flows have been flows geantified and will quant be maintained be maintained by through recharge through facilities.	notation impact to timing of absentions as historical intum flows to have been quantified (including a logging analysis) an will be maintained through necharge facilities. and/our a landback and a landback and a linking and will included	ws Cinco and watur dever the fit support altriv correct 3) D Agree HCU AVM facilit watur patient patie	Laplouse Yeard (b) The Year Mark Mark (b) Section 2014 The Section 2014 of the Section and Section 2014 Heart where the Section 2014 of the Section 2014 Heart where signalion is permanently or transporting models. Heart the section and section 2014 in the Sec- et anounce, the section 2014 of the Section 2014 of the Section 2014 of the Section 2014 of the Sec- ted anounce, the section 2014 of the Sect	a co disc hub	component of alternative branches see	ATMs provides habitat for improves, in waterfore and other species.			watantos as a component of atmostree mandres are discussed of Section 4.3. Water quality banditis industre industre integration of the section of the matches and the section of the matches to subfield, subjective disclosed solids that and the section of the subject of the section of the matches removal.	with an environmental benefit and reduci the CCU generated.							Piot chicultane.
ATM-10 Final Project Report: Implementation of Deficit Impation Regimes: Demonstration & Outreach			water stress and CU under deficit irrigation & demo educational outreach on crop stress monitoring.	Impacts to flow not discussed.	Not discussed Not d	Not discussed			cussed Not	c discussed	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not discussed.	I. Not discussed. Not discussed.	Not discussed.	Not discussed. Not discussed		ssed. Not discussed.	Not discussed.
ATE-11 The Poule Vision Sharing Working Group: A Report in the CWCB	https://drivesbilink.state .co.uuk/woht/Electronic ay-15 Fike.aspr/docid=1980 7&dbid=0	prototopa ATM water sharing rougo between agricultural area Rytork Provide 10: on Valuet Elegol & Boringa Ca. N multicipal users (ForT Collins, Drewley, and Tri-Daricitopa neuros) and the Collins, Drewley, and Tri-Daricitopa and Poude Reis, Ensistendi og her Collins Water Institut at Collarado Statu University. The strept Rosease in the samend, sawer og al sums, diversitient of prototype agreements, and regional cooperation strategies.	Develop, and Tri-Diatich) on the Product River, Meet/Med CCU advantation methods as a large barrier.	general metrions of needing to replace return flow obligations.			Sover storas For is weath wood i neoch heave inflaa comp Note	In oper tacking in the water is mainten instruction starts for 6 days and models the basis and an advanced in the start grant and advanced in the start start and the start of the start instruction is any start and the start and the start and start and the start and the start and the start and start and the start and the start and the start and start and the start and the start and the start and start and the start and the start and the start and start and the start and the start and the start and start and the start and the start and the start and and start and start and the start and the start and a days and start and the start and the start and a days and start and the start and start and the start and start and start and start and the start and the start and a days and start and start and start and start and a days and start and start and start and start and a start and start and start and start and start and start and start and start and start and start and start and start and start and start and start and start and start and start and start and		vokida by inglated agriculture) souches on the met agriculture powides to widdle healtit p. migrating waterfload and songlevids). The of does not however tilk about impacts souches the however tilk about impacts souched to habitat from ATM activities.	Migrating selaritori and songirids, resident and singli de angle de angle de angle de angle de angle de angle de		Not discussed.	Not discussed.	Not discussed.		Not discussed. Not discussed.			. Not discussed. Not discu		
FLEX Water Maded Education and Dear Implementation Phase	https://dnweblink.stab mber-15 File.aspr?docid=1979 68.dbid=0	Investigation of FLEX seek in marks implementation- insequences, how the advices, therefore on implessous paid of the spectra of the spectra of the spectra paid of the spectra of the spectra of the spectra data with the spectra of the spectra of the spectra consultation, with spectra factor and spectra of the spec- tra of the spectra of the spectra of the spectra consultation of the spectra of the spectra of the spectra consultation of the spectra of the spectra of the consultation of the spectra of the spectra of the consultation of the spectra of the spectra of the consultation of the spectra of t	x	 Impacts to flow non discussed, other than a free perivarial matchines of needing to neplace return flow obligations. 	Not discussed Not d	Not discussed	usia e delivy alao apon The NPP sech sech sechig flows	FLEX Years in constraints, the second secon	Not	d daansed	Net discussed	Ned discussed	Not discussed.	Net discussed	Examples discussed that may effect index based priority The WPE's may off a baseline to which potential allers (or based on the standard transaction in the based on historical transaction in the staffend from several defects that vicitate based on the several defects that the several defects that the several defects that the several based on the several defects that the several based of defects that the several defects that the based of defects that the several defects the several based of defects the several defects that the several based of defects the several defects the several based of defects the several defects that the several based of defects that the several defects the several based of defects the several defects that the several defects that the several defects that the several defects the several defects that the several defects the several defects that the several defects the several defects that the several defects the several	er for sis -	 Not discussed. Not discussed. 	Not discussed.	Not discussed. Not discussed	. Not discussed. Not discu	seed. Not discussed.	Not discussed.

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					Environmental Resources that May be Affe	ected		Streamflow (Hydrology) Impacts			Quarias Impacts			Water Quality Impacts					Read	ear hund made	Data Gaps, Questions for Future Projects For proposed future transactions, need to ex-	hate impacts (nositive or)	manative) to:			
								Screamnow (Hydrology) Impacts	Ι		opecies impacts			water quarty impacts				Predicted		ram level goals	For proposed tuture transactions, need to ex		negeove) to:			
Title	Date	Publisher/Authors	Description	Notes					Rate of change									outcome from applying "avoid,	env.	et loss to services, Build incen	ves for	SMP or WMP Crit objectives / flow	itical habitat & w	BRT environ	mental CRCT	Other known
					Magnitude	Frequency	Duration 1	iming	of hydrologic conditions	Return Flow Impacts	Critical Stream Reaches Impacted(where)	Critical Land or Riparian Habitat Impacted	Species Impacted (what)	Salinity	Temperature	Other	Tradeoffs - Resource Impacts	mitigate, offset" hierarchy Prop	ortional trade	gnizing projects wi offs benefits.	ISFs (or other flow targets)	proposed rec projects s	commendation State conce	species of values I ern mapping scussed. Not disc	lists/ conser ig strateg cussed. Not dis	vation community / entity project
Alternative ATRASI Alternative Promosens Day Up Formuly Implied Lands	f June-13	https://downsblick.ddde .co.uk/awd/Electronic File.aspr?docid=19020 88.ddid=0			ingents is an endow not document	Net discussed	Not discussed 9	of discussed	Not discussed	Support solar and the layers hardness with the source of the solar solar solar solar and the solar and the solar solar solar matcher ingrism, resonance to the solar the solar solar matcher ingrism, resonance to the solar the solar solar matcher ingrism, resonance to the solar solar matcher ingrism, resonance to the solar solar matcher ingrism, resonance to the solar solar matcher ingrism. The solar solar test matcher and the solar solar solar solar solar test and solar solar test and solar solar solar test and solar test and		Naport Index discusses environment lavertie discussification (see the second se		Processing impacts that have to to be adding of watery in the large sector of the sector of the sector of the sector of the sector of the water weath from sector of the sector of the sector of the sector weath from sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the sector of the secto		where only it Proop) prior (values, file) of encodered and the Proop) prior (values, file) of Another expected in a state N to be an unary Another expected in a state N to be an unary analysis of the state of the state of the state of another expected in the state of the state of the state caution.	The waits out standard of a potion. If the matrix out the standard standard standard standard to store and advanced to be called the store and advanced to be standards of the standard standard standards of consumptions was to the water whet for instand impation."	a	Not d	Iscussed. Not discuss	1 Pad disconnel.					Not discussed
ATM-14 Water Partnerships: an evaluation alternative agricultural water transf methods in the South Platte basin	d r March-12	https://dnrweblink.state .co.us/oveb/Elsetronic File.aspr/docid=19021 S&dbid=0	providers on ATM practices, leases, evaluation of shared water bank scenarios on South Platte, focused on FRICO shareholders.	scenarios en South Plate			Not discussed		Not discussed	quantified. The 403 Decree [Case No. 02C/W033] and the resulting dish-ubs change is dentifies commonlytic use, storage decreas and capacities, recharge capabilities, and the timing of return loss, providing schnick and water transfer information that is not typically available on impation delivery systems in Colorado.	question assied if respondents are willing to sign a base in which the water is used to maintain instream flows for river system recreation: 24.1% are willing, 48.3% are not willing. One question asked if respondents are willin to sign a base in which the water is used to maintain wildfiel habitat: 23.3% are willing, 37.9 % are not willing.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	Not discussed.	The report notes the costs of storge for delayed network more may deter municipalities from leases (they would save perminent agreements due to the high overhead costs).	et -		iscussed. Not discuss	akked if respondents are willing to sign a lease which the water is used to mainten instrament for system necessitor: 24.1% are willing. 48.39 not willing.	s for ane				sussed. Not discussed
ATM-15 Project Report Lake Canal alternat agricultural practices and in-stream f demonstration project	re June-13 ow	https://dnrweblink.state .co.us/owob/Electronic	sufficie returns, inflore to recharge plis, and soli moisture searces to verify result more by indepension of moistance momentary before the not zone. Project was not implement the solid plasma and a price. Describes extensive legal work arrive at proof of consept.	Inflow to scalarge pile, and sall molicute sensors to sverify nuture howe by lack/greaced of molicute movement tables the not observation of how by lack/greaced of molicute movement tables the not observation of policit and an and implemented due to long/origin water sales/origin at the molicute of the sense of the notion of the sense of the sense that the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense that the sense of the sense of the sense of the sense of the sense the sense of the sense the sense of the sense the sense of the sense the sense of the sens	would yield consumptive use that would be our for stream flow enhancement in the Cache la Poutre River between the Lake Canal Co. ¹ wirer diversion (north of Fort Collina) and the Greeley No. 3's river diversion (west of Greeley). An agreement was not reached. Impact: It was understood that return flows would be replaced in time, amount, and locati thereby causing no negative impact to streamflow.	sed return flows would be replaced in time, amount, and location, thereby causing no negative impact to streamflow.	return flows would to be replaced in time, amount, and location, thereby	ning of the delivery to the Poude River.	Not discussed	measurement of return flows and transferrable consumptive use was proposed rather than relying exclusively on the results of a historical use analysis to determine transferrable consumptive use and return flow obligations.	Interruptible woahr supply agreement that woahd yield consumptive use that would be used for steam flow enhancement in the Lache la Pousler Nerbetweenet the Lake Canal Los In inter diversion (north of Fort diversion (nossi of Carselay). The transferent diversion (nossi of Carselay). The transferent obligation and the Develop No. 3% for obligation that the Develop No. 3% for obligation that the Carsela is the transferentiate consumptive use woahr to pass through Fort Collins. An agreement we in transfere	Not discussed.	Not discussed.	Not discussed.	Not discussed.		Participanto meet to outine all their meduleaptimems at the onate of the megotiation process otherwise it could have unitandiad consequences. For example, it is it is negatized process, thus discours the interpret on the second second second second value added for some participants. These elements were near ever considered in the init discussions. These elements added another all your of complexion to the weather transfer an miningement.	a ala ad ad ar		Social Not discuss	behalf of the CVXCB. INF Sector State that it as upported the efforts and there in the VIXBs proposal but had for any other than the VIXBs proposal but had for 1. Use of the them 'n-shares the them's photoentally protected and the them instruments the photoentally and production emphasizes and photoentally are the reaches of the 'Pounder Rever unless. CVXCB the instruments for the photoental the the them and the restrates for the photoental the them and the restrates for the photoental the them and the the restrates for the photoental the them and the share and the restrates for the photoental the them and the restrates for the photoental the them and the them the restrates for the photoental the them and the them and the share and the method of concurrenge to use the share and the them the of concurrenge to use the them and them and the them and them and the them and the them and them and the them and them and them and them and the them and them and them and th	ms and 55 ghts				
ATM-19 Final Report of the Lower South Pie Infigation Research and Demonstrat Project	te Jun-14	https://dnweblink.state .oo.uk/weblink.state file.asga?docid=19921 88dbid=0	calculation & verification of consumptive water use and wate samings, such that water court requirements can be satisfied uses a stress coefficient, the crop water stress index CVR3, and the ReSET model of remote semaing. ReSET showed momenter of 00 RMIs for finally under moment amounts	Deals werk in Deweldy catalation & Monfaulton of consumption what are and werk annually such that wait own consequences has be balanced and a strates confined. The crays wait are strat- ted to an experiment of the strate of the strategies of the balanced ansatzer of 2018 for finite start around growing conditions and successfully detailed alcohand growing conditions and successfully detailed alcohand growing conditions and successfully detailed alcohand growing conditions and the strategies and the strategies and the strategies and postform and strategies and the strategies and the postform and the strategies and the strategies and the postform and the strategies and the strategies and the postform and the strategies and the strategies of the strategies and the strategies and the strategies and the strategies and the postform and the strategies and the str	The return flow assumptions are conservative and additional return flows may provide benefito to rivers and downstream users.	n fina	Not discussed b	of discussed	Not discussed	In goal of the althoution appoints in to remefy and thanks the cost bit submitted ar damage use as and practic Tolesci that there are not while medicating goans that the cost of the submitted are the submitted and practic Tolesci that the submitted are the submitted and and the submitted are the submitted are the submitted the constructed weaking or rehology provide (and the construction submitted are the submitted are the submitted that the submitted are the submitted are the submitted are constructed and the submitted are the submitted are the disease of the submitted are the submitted are the submitted that the submitted are the submitted are the submitted are submitted and the submitted are submitted and the submitted are the submitted are devided for finguing in sub- maphement. This provides a net banded to the submit fi- abilition risk the submitted are submitted in the submit fi- abilition risk the submitted in the submit field and the submitted are submitted and the submitted in the submit field and and the submitted are submitted and the submit field and the submitted are submitted and the submitted in the submit field and the submitted are submitted are submitted and the submit field and the submitted are submitted and the submitted in the submit field and the submitted are submitted and the sub	Not discussed.	Not discussed.	Net discussed	Not discusse.	Not discussed.	Not discussed.	Not discussed.	Not discussed. Not e		Not discussed. Not discuss		Net discussed. Not		scussed. Not disc		Not discussed
<u>ATM-17</u> RGWCD Net Annual Replacement P	Reports exis for each year. Reviewed report for April 13, 2020	t https://rgwod.org/sd-1- annual-replacement- plan	Islaving agreements, etc. Reviewed the 2020 Annual Regularement Film, Allery 1, to water requirements for the Part Vala under the provisions of the PAVM for Subcificit No. Vala Under the provisions of the PAVM for Subcificit No. SubCiVII end 2020/NNN. This sport foreables a gins to be remedy higher than the provision of the PAV induces a selection of these created by Subcificit No. 1 suff and the selection of these created by Subcificit No. 1 suff and the groundwater from selecting how Subcificit No. Subcificit No. 1 suff and the selection of the PAV induces a groundwater with the avails and a water portSelect No. 1 suff and the selection of the Subcific No. 1 suff and the groundwater with divandes and a water portSelect No. 1 suff and the Subcific No. 1 sufficience No. 1 sufficience No. 1 sufficience No. 1 sufficience No. 1 suf		Not discussed in report.	Not discussed	Not discussed	discused	Not discussed	Net discussed	Net discussed.	Not discussed	Not discussed.	Not discussed	Not discussed.	Net discussed.	Net discussed.	Not discussed. Not	iscussed. Not d							Not discussed
Attenuity Water Attenuity Water A Review of Assarding Transfer Machinism So Frost Range Municipalities	do: 2016	https://www.edf.org/sit	The report conducted a screening analysis to identify potenti case studies for a more detailed analysis of ATM, found 35 municipal water providers based on water source and demand size oriteria. Two case study participants were identified: City of Fountain and Town of Windsor. The report	t Town of Windsor. The report conducted a financial analysis of or water supply alternatives for the two case studies: findings include	general is "to maintain or improve streamflow which support environmental and recreational activities" and that environmental interests ca be involved in water transfers. "The instream flow benefits from diversion reductions are tw	n 10- 10- 10- 10- 10- 10- 10- 10- 10- 10-	Not discussed 1	et discused	Not discussed	The topic methods has a given, if we wait right holds or experimental states and the second states and the percending of where right holders are not impacted by the second right wait right holders are not impacted by the second rest damps.	general is "to maintain or improve streamfor which support environmental and recreation	Ne discarie	Net discussed	Nord discussed.	Not discussed.	Not discussed.	Not discutional	Not discussed. Not	iscussed. Not d	Iscussed. Not discuss	In the discussion of different transfer methods, method made of the diverse with plan may be large provide to introduce the discussion of the discussion provide to interest that a discussion of the discussion provide to interest the discussion of the discussion provide to interest the discussion of the discussion provide to interest the discussion of the discussion of the discussion of the laters, and the discussion of the discussion of the laters, and the discussion of the discussion of the discussion of the discussion with the discussion of the discussion of the method in the discussion of the discussion of the discussion of the method in the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of the discussion of th	arity d to sees Phe rds sees	Not di	Interface	Not dis	Not discussed

Exhibit B-7 SCPP Documents with General Criteria

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Exhibit B-8 Lit (Gen. Literature) Documents with General Criteria

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Exhibit B-9 ATM Documents with General Criteria

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Exhibit B-10 SCPP Documents with M&V Criteria

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Exhibit B-11 Lit (Gen. Literature) Documents with M&V Criteria

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Exhibit B-12 ATM Documents with M&V Criteria

				Mattaching	ogies and/or Processes					Necessary	y Data and Equipment				Monitoring and Verification			Prog	ram Level Considerations					Коу Таколичун	
Title Dat	PublisherAuthors Description	Notes	Measurement of water returned to	1		a Coordination of Results	Representative Crop ET Verification of consumptive	esserved Subjection Reser	Agricultural Participants Proof River diversions & francess or homesed	I shared delivery and divis loss	trigation and non-	easting River Forego	one or Reservoir	Municipal Participants Dittch or pipeline Overall code	Monitor system- wide operations to sector	d Tradeoffs - Value and/or cost ide implications for more precise data	Properticeality	Monitoring & Monest, accurate, and defective of other water stars	Welfication Workgroup dualing Principle		Lessons learned	Data gaps	Keys to success	Identified challenges	Overall findings and recommendations
			the shears	e g analytical processes and whether or nor b	MEV activities were measured, estimated, or not considered		e g feid specific date or e g visuel verification, regional date? or specific date?	regional data, e.g. welts e.g. stating or a manifored or reading or a	auge e g flame or pump, regular outer or continuous madinge?	er, e.g. regular or continuous flume Readings?	eg measured and eg ave	itable é g fume or é g estin low pump, fom stre	nated e.g. configurge earthou wading or outer	e.g. futte or pump. e.g. futte or pump. e.g. monitor of degular or continuous devention from	conserved account conserved record record ar 4.0 company 4.0 av 2y Te overall basin wide	Tradicatific - Value analysis cost Implications for mana precise data Implications for mana precise data Implications for mana precise A a salara defauerar calimating a lawaryse A analysis and analysis	with with geographic diversity?	e g accuracy of e g consideration of		than a retiring of depletions • g. activity resulted in a ret increase in water in the steam?	e.g. critical items, or considerations for future projects?	eg, date and/or information necessary for facers projects?	e g. cruciel pathe and/or processes that should be replicated?	e.g. matteles that should be avoided?	e g. comments on the feasibility of CM activities?
ATTRO1	Foglio Mesadowa Mesanice ANM attady (1MM Shody) "The Ropic/International values of the TMS Shody in a to investigate the mesadowa discussed in the standard of a standard of an explanation of standard Shottane procedes intra-pare regulation of mater explana- tional and standard in the standard and standard of the approximation (2018) August 2018 of the standard and standard of the standard Standard Shottane Annual Annual Annual Annual Annual Annual Standard Annual Annual Annual Annual Annual Annual Standard Annual	NTM wir recleationsa and environmental beerdes for municipal augmentation electragement of Trujto blackase Reserveir. Statumbater meetings for factoral & state agencies, eig, and trave aug reads. Model of agencies, and trave aug reads. Model of path feet Appendix A estimates of modely attrave seemics: Water rights reclaude CDFS Reserve.	cke takin netholology strig tealby basin with stream measurement – Conejce River basin selected	2004 Ris Grands Markel Joon 1905 Net decrease. 2002 for debids 20-02, 24-07, and 35	Loonanated measure Not decused tom Parara Reservoir and Trujito Meadows	NOT GROUPERS	REDUCE and REDUCE OF Propulse and REDUCE OF Propulse of REDUCE OF	CU Reference means and plander vice- plander vice- plander vice-	lage, and that decusied. Insuranters ended to	study appred sore combined aton too and intigation efficiency for demand edimates.	Alabary Healow Hot decused. Colline ander H	manungan Punjung Diyug te manungan Punjung Diyug te manungan punjung bilangan satu punjung bilangan separata bilangan separata bilangan	Interest of Paraler?	Addings? Later Salary Recommended Rot declared Conveyance from Conveyon River to San Antonio River	Brendenin ID Accounting Rot decusard Pumping records an augmental requirement	and the second s	Rege adevate Ho transe Congast origination of and distribute custalments throughout been	ectivates and/or and solected? downstream water user? A 7 proper measurement downstream water user? downstream installed to determine statings & outgoins are big driver bottow solitow	No, No, and Kinda	No this would only result in the dening of depletions and/or augmentation	entropenent would be baselike is holp TownetMunopolities with augmentation	Distant fire measurement, storage feasurement on Trujilo Meadows	Rot discussed	Nel decuted	evanues consignment of toyloo as wet as processor of additional reasons of taken
Lise of Attentitive Transfer Methods to increase Water Supplex for Conejos Basin Agriculture, Manigual, and Environmental Purposes	E.D. Latowith/Electron Infection Lotsuburdle Eleberative Eleber	rat agencies, ag, and town aug needs. Model of ATM, details of benefits, recommended path fed. Appendix A estimates of monthly influes meanors. Water rights include USFS Reserve Boths decread as 105 interative standarding.	e									etides "	econicies.												
ATM-02 Development of Land Fallowing-Mater Leasing in the Lower Atlantian Valley	The goal of this report is to "report on the development the IDOD Through nod-2011 in containual land behavior, weare https://driveduk.acti examp [Balowing beaking in the Lower Attainas Valley WI is Fab augu/Stocid+19 Lower Attainas Valley William Attainas Valley Subar Charles Company, Inc. (Studie Charles Attainas Valley Subar Charles Company, Inc. (Studie Charles Attainas Valley Subar Charles Company). Inc. (Studie Charles Attainas Valley Subar Charles Charles Charles Valley Charles Charles Attainas Valley Subar Charles Charles Charles Charles Valley Charles Attainas Valley Subar Charles Charles Charles Valley Charles Charles Attainas Charles	Rights decreed as 15F, interstate shepherding Return flow needs may require additional motarge ponds & stations; Return Sows unnecessary at times due to trans-basin aber supply, considers monthly return flow "factors"	Raturn flow stations, ponds, flumes	Hydrologic-Institutional (H-1) Mitchel, Nett discussed. Discunderater Accounting Model (DINAM)	Not discussed. Not discussed.	Not discussed	Nordiscussed. Nordiscussed.	Not discussed. Most etcrag at Pueblic F and convey munic through	ge included fort docussed. Reservair yed to ugh SIDS	All-or-none approach with Super Oton - lateral users will have to follow Super Dist.	h Ca - Noz discussed. Noz disc If	used. Not Not deale decused.	used Not decised	Not discussed. Not discussed	Not decreased. Not decre	and Marine were worsed about another entity buying up water rights during base and making Marin high and dry after tease tem expires.	Munix want protections, lease failow is generall attractive to farmers m	ty tas	No, no, and kind of	No this would only result in re-dening of depletions and/or augmentation	Not discussed	Not declared	thoreasing storage for farmers to use as basis water, simple tools and admin process to help farmers batence economic choices	hit discussed	Continue developing and piloting lease-follow programs
Leasing in the Lower Astantian Valley			Analysis from an fam for evenue	Internal Parkins Second Constantia, Mcdanusat	interface what Call Reviewand	And a serie strengthen should upon the	for many and ET	No decimal and decima	100 (00 (00 (00))	Distri loss was calculared as 10% conveyance, 63% integritor efficiency	and destructures from the to	d antara fina na Manda (Meria Mandalan	the second	Noti acistica	Arr decared when meth	in the designed	Not derived	Tat Tat			and markations to allow choose of use to be faultie accords for mode and adding	No. decised	Francisco control mana in data for faith		Ferrirade alter descentrations the first ray hadr an over the first-state "state
	Bearly funded Francy, COVCR 2014 AND doard. The Life Thompson Family markets singly from Hanky 2016 and Hearder Coverse (Hanky Hanky Yang) and Hanky 2016 and Hanky 2016 and Hanky Hanky 2016 and Hanky 2016 Covers for afflict, 5 min a water singly presidence, to all soliton GUT units (15) and doars more and even with (2016 in Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 2016 Hanky 2016 and Hanky 201	wind erosion, maintains sol fartility, controls eeeds; non-intgated cover crops; dryland mild sorghum/Sudan-grass for soil health, reduce eeeds, potential sevenae; who cover crop.	Parabali furne on Sam fur normal Intgelon, Dath company vales dictore International of difference water types for Internation (difference action), C-BIT()	Dia model (DSCU)	Samatineer, when C-BT Mot discussed. Dedda kot Sandhimed to Broandheit	Farmhaveps impading most years (it or 10 out of 11) and gets cash for sold credits	Sol mosture and kT Not decusived. monitoring station recommended, not implemented			By Creek Lateral of the Handy Dish, of-doch users assid lose out if too mus ATM water transferred out. Dish loss was calculated as 25-50% conserver.	ch Little Thompson River Little Th as a result of ATM as a res	angeon River Congany alt of ATM cosely tecks when in dish	used Disch company folds shares in reservoirs and determ them to manifeers through Hany Disch	Both, existing Accounting in Infrastructure on Farm Inservoirs whe Distriction Company Marine	e place at Di cents Co.	a		-	-	_	Anguit mechanisms to allow change of user to be finable enough for music and dable whough for famous is an insue for the ATML (Booking with Dato Company Jo-manisms) official mass of flows in Handy Dath-was important for burying public perception was used and publicate enoughement from County was essentiate locality document on person, flow-to-face, tableved to music concerns; develop-clear goals, but stay willing to person, flow-to-face, tableved to music concerns; develop-clear goals, but stay willing to the start of the star		Keeping critical taxes in dich for Dach Company buy-in work with water conservancy district closely, limited legal mechanisms through water court fusion shrings be conservative in dick efficiency to beep countritism users whole; identify class goals with establish as ATM but stay fiscills about details	Linded legal mechanisms; identifying and engaging with best fit for municipal parties' to estillance shares	Rescape plate demonstrations, the Solar can help encourage "swissholds" and "barly adopters" each as Laineer County and Broofield to consider adopting ATMs to meet their goals.
	terms of the state of the phase state terms of the state	for induce excess by forming large act clock & enhancing infitution); Class II and III solis, slopes 5-5%, not high enough for severe ery excessed problems; notice-68 also accessed to the first even. Increase								un vegana			nany Linco								сопротока, опаская как се рофије изиская се си рофи, доне, песи и рак и		whole, identify char goals with establish as ATM but stay feelble about details		
Little Thompson Farm ATM Grant 201 Completion Report	bet data in the second seco	Incommended to induce dend evap, improve and health, induce fail & com; intigation efficiency via contaur familing, dop intigation, SM & ET monitoring, dooght tolerant crops, in GPS intigation guidance; no intum-flow																							
	available. "The report also descense Lescon and Future Considerations: Legal Haudes/Bartient to Replicati (Northan Researching, Desc Non Rights, Delivery Ethios Impacts from Water Taxwelers), Public Peoception & Patie Witt Bocame and Octomics Support of Lesderwise, Public	 Offit impation particular: no instant-flow impainments due to CRT water, so no effort to opuratify deepter opponents. Anno 																							
			finast Creek autometation station	LFT No docume.	FT and usordinated Accounting for exchanges and water det	iveries Not discussed	Not discussed. Accounting for exchange	ons and worker. Not discussed. Not discuss	and Field visits to task	Not document.	Accounting for the day	used. Kaletina Kaletina	AWCD	Exeting etructures, Existing etruct diversion records diversion reco	res, NZ discussed. Yes very bit	CU Water edmutes based on LFT and H	H4 Not documed	Tes ves	No. urs. and urs		aroly accessful project water delivates were made, return for obligations met.	None identified or stated in record	Cocowation and communication among	Conservative excitatope rates for delivaries meant that munis had reduced CD credits available	Successful operation of pilot proper; COMMENT: no discussion of public angagement or parceptions, so more research into public take on pilot project
H813-1248 Colfin Cana Company Rotational Law Factoring Municipal Leasing Plat Project	Experimentation and the second s	Ng- Huge emphasis on return flows: using Lease hattow Tool form DWR to calc available water and the send returns; "Pay An Your Go" target belowing to return tow, use of nottage etructures supported web fined return tows; a screamber professional for flows return.			ET and coordinated schargeniteleases in to munic Timper Creak Augmentation Station and nearby recharge scott		deliveries to munic		condition of failowed areas.	•	Accounting for the Bold day exchanges and deliveries to Timpas Creek Aug Station	disension diversion records	s, conditates integrals eleases from Pueblo Resenvoir	diversion records diversion reco	is detailed	CU Water estimates based on UFT and the models differ dramatically and may limit water available to munic excessively.					Lapply accessful project water defended ware made, indue for objectors and, former gar pair, maning gar ware a medicate it can phone a ware ware to bounce task, with n-intigation, to issues with ecosion or noticus weeds.		Cooperation and communication among etabe(ii), denicity, munic, SEC, recommend as "over the river" storage account at participating reservoirs to allow for more precise exchange account at participating reservoirs to	munis had reduced CU credits available	or perceptions, so more research into public take on pilit project
Leasing Pluz Project	OProjech/20FINAL.pd Participants) - from rotational failowing of lands located on freearchis/3556022 - six famile imgated under the Cablin Canal in the Ananaas 4075-1155-8160- 53611465011	encohures supported web timed niture trace; augmentation estriction used for factors return fores and consumptive use water delivered to manippat participants; encours & weed control included betablish; data tilling, cover crops twinter wheat, bas)																					CU and B		
	(c) Pri 10 Price (10) Pri 10 Price (10) Pri 10 Price (10) Pri 10 Pri	Intern Sower more efficient ingation improves eather quality by lowering return Sow icontaminant transport, fewer excess nutrients due to fertigation in drip systems, TNOTU		para secondo. Her una seno.	NA URUERINA. PRA URUERINA.	NUT WILLIAM OF	ner unconstante. Per unconstante.		and another			discussed.	and manage					Para sensa de la construcción de la			CVCB GF could be a very which to if to protecting insteam from for downlinaer same to cannot protect against immunoing exercit diversions, rate cata is useful to the instability, and ground cata all is exercised, shaphending is why challenging; childraction among all water uses will be key.	teo much, need to get in elso data	b) Excel participation through ag organizations, roundtables, conservancy districts, etc.	The second	Figh Millionny
ATM 05 Yanga Jindo ATM Study 201	Hyper/Developing and Trans angel some winner plannar Art is an addation to an example of the source of the source of the source of the source of the councement of the source of the source of the source of the termination of the source of the source of the source of the termination of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the emiliant source of the source of the source of the source of the source of the emiliant source of the	due to finitigation in olio systems; "NOTU partnership to support insteam float for subtra with Tel tasks used when downstream t die right is not earliched & to provide flow in a seach without the right																							
	entryDosen/sproze comprocessing (Texa de la partenis, veada involve ne bitainer, parameter comprocessing) (Texa de la partenis autoritation de la compro- ticationer) (Texa de la partenis autoritationale Cor autor NAUReport/200 de 10 - comprocessing and comprocessing and an implicitor. CO entry of the last of the last of the last of the last texa de la partenis and the last of the last of the last texa de la partenis and the last of the last of the last texa de last of the last of the last of the last texa de last of the last of the last of the last of the last texa de last of the last texa de last of the last o																								
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Grand Valley Water Users Ason Conserved Consumptive Use Pict Project Development Process, Procedure, and Lessons Learned Water Bestimolitics Other Bert II	yearwases.com/pb volumely and compensand manner. This report summaria ads/8/26/5/26/26/27 the process of developing the CCLIPP, the procedum use 8/26/5- and leases to developing the CCLIPP, the procedum use advanced from of	and provide set assistants, the tage version, and the provide set assistants, the tage for cluck, things for cluck, things for cluck, things for cluck, the set constants with the set of the set o																			This Four Range Frighters gaining for at least one year cut from any receivance or generative, located and permanders downsch in ourschner for gaining and advance register response of one search programmer or the transmission advance register response of one search programmer or the transmission advance register response of one search programmer or the transmission advance register and the transmission of participations, engage ag produces early and after is program process.				
ATMAY	Adjust Addressed in a state of the second state and payment summary for the 2017 A count output State output CCUPP, including welfcation forms for each program a count output State output of 2017.	to verify land ingest and explicitly prohibits any lactive plant growth on fallowed land Petitoles 2017 verification documentation ecologies photographs, recommendations, commentationedes	Not decurred.	Not declared.	ex delatera. Not decueed	Not discussed	Not decurse. Not decursed	Not decused. Not decus	and Mit docusted.	Not decused.	Not decusied. Not de	Not and Arrange		Not decursed. Not decursed	RX decised. RX decis	#1 Not decument	Ra decenso	NEX decused	fix decreased	Not discussed	Red discussed	NX GALLAND	Not discussed	NIZ GROUNNE	for decused
ATM-07 Grand Valley Index Libers Asso 2017 CCUIPP In-General Vertication			AZ 261.462	Not decused Not decused	ALT DESIGNARED. MAY DISCUSSED	NOT BECLESAS	Aut-boursed. Pox decused	Net datual and datua	ue for scores	NOT DECURING	M2 SIGNAL M2 SU	Salahi Mar Mar Jaka	1841 WX 243.684	Not declared	NX DECISED NX DECIS	#1 N27 Dolland	NZ DELLERG	Not decused that decused	62 dillius	Rot Backage	Rot Encland	63 BELLAND	Rot declared	Not decused	for decused
ATM OD Power Canad Capacity Report, Grand Valley Water Dawn Asso	Middlalide Phy lost report to that patients restaurum invage of every associated with CCC and a patients restaurum invage of every associated with CCC and a patients and every patient of the CCC and a patient of the CCC and a constraint of the CCC and a patient of the CCC and a constraint of the CCC and a patient of the CCC and a constraint of the CCC and a patient of the CCC and a constraint of the CCC and a constraint of the CCC and a constraint of the CCC and a constraint of the CCCC and a constraint of the CCC and a constraint of the CCCC in the CCCC and a constraint of the CCCC and a constraint of the International and a constraint of the CCCC and a constraint of the patient of the constraint of the CCCC and a constraint of the patient of the constraint of the CCCC and a constraint of the patient of the CCCC and a constraint of the CCCCC and the patient of the CCCCC and a constraint of the CCCCC. International constraints of the CCCCC and a constraint of the patient of the CCCCCCCCC and the CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	cit. Very brief report on the potential microarcement through which water associated with CCU bound be protected and resurred to the Colorade Revenued a policy and resurred to the Colorade Revenued a policy and resurred to tasks." Compensates, benposity, voluntary, Lists connect operations, water right, data genouplate the initial, merged with 2017 Next Bage Part II.																							
	An extensive evaluation to: 1) To identify barriers to implementation of abenative	Extensive final report on ATM investigation & plot on NE South Plate covering barriers	Potentially new flumes in talwater adentis; massumment devices at moturoe stations or wetlandviconds	Standard methods Not discussed.	Accounting at recharge depends on the ATM program failuring dations primula, or defort ingation, etc.	vs. Not discussed	Standard methods For fallowing SEO ve directing field is not in	rifes by Not discussed. Not discuss righted; For	and 2000	Not documed.	Depends on which Not dis portions of land are	Sussed. Not These for discussed not account	avs are Not discussed unded in	Common crue of issue Not discussed for potential ATMs -	Not decused. Not decus	ad. Potential lejury to senior water rights hold based on historical consumptive use	iden: Doscens of ag users that benefits outweighed to the pain of implementation, reporting, mantaning	by Not discussed Not discussed	Nor depused	Not discussed	Legal mechanism is coucial to get buy-in on both sides. 1) protections for aguses from devisionment of rights or risk of abandonment (2) Munis know buy-and-day and	Most discussion relied on CDSSI data that is jublicly available and leverage existing	in Programs that can address the barriers fitted in the next cell>	Prive barriers identified from interviews with MM and ag users: 1) High Tankactional cost, equal to or greater than typical buy and dry process; 2) Risk and Uncertailty for ag users readed to MCD analysis potentially	Not discussed
Completion Report Development of Practice Alternative Agricultural Since	Dartiers. Discretion and 2) To develop tools for agricultural producers to evaluate th	reluctance, power dynamic), needs and mean te to address barriers, Lease Evaluation Tool	recharge stations or wetlandslponds		Antone primarly, of defact inguino, etc. excitation from inguino efficiencies and diversion incodes (with DUN Kessel)		checking field is not in deficit ingator: sector to quartity aspects of not been tested in title	ctogy available CU but have air Court			portions of tend are followed, may need additional pipeline/ditches or pumping to git water to the historical patients, may need historical industructure	the availate supply to	urlied in able ir Tanschr	Mari is upstwam of the impation point of- use so actually banchering water, himmiding wolfance		analysis - some recent Water Court case (£5.1.3) "telk associated with any process that quantifies a serior right based on teleprocess, in light of recent decisions cutrains use of serior water rights based	dee: Soncers of ag users that tends convergined to the pair of ingeneration, supporting monitors as a program that isn't easier, funder, or cheaper that buy and dry. 6 d	-			This derivative entropy of the of all advancements of Marine know boy-index of any program that the potential yles as this context provide impress security is context that the total of the only option that shakes for ATM without able count change can and "signer" approval process through SICs too participation in MSA in indicates that the protection to water rights will present theorem to advance and a signer protection to water rights will present theorem to advance and the signer approximation to water rights will present theorem to advance and the signer and the signer and the signer and the signer approximation to the size of the signer and the size of the si	ingation and recharge infractucture / climited discussion of equipment and infractucture needs for 1) delivery of bandlened water (usually upstheam to &) and 2) measurement of CUINetum Sources		That typical buy and dry process; 2) fixes and Uncertainty, for agreems metado to HCD analysis potentially, diminishing values of right based on unlawful historical practices, for MB unless the unlessed values of anne ATMs is too risky; 3) Lack of Capabites for believey, tack of informations can be a major barrier; 4) Opposing situations between MB and Agreems (ed. br).	
Completion Report Development of Product Assessment Application Water Transfer Measures for Preservation of Colonado Intigand Aplication	1 do autoristitiscon viabili of postala atenane tradeire. 478a agr.com 1000000000000000000000000000000000000	akusia.									pathemic, may need multiple inflashructure changes to re- establish timing			dry-sp. etc. cas be chatterging and more to the Suther the inigened land is them the Marci		on tandur sensus turtandur hisioicai use.	r.				economediation that SEO should have more authority regarding rule-making for temporary water transfers under the understa of ATMs.			of inflattucture can be a major barrier; 4(Opposing relactance barreen Mall and Ag users meed for permanent supplies and dealer to mmain finable year-to- year, separatively 5) Power Initialization, related to access to technical and logal semicons to	
A7815	Revariation of different institute comparison of monitoring using water stops and consumptive are (C2) under defact ingation. Ingo:/converting.comparison.comparison.comp do.actional/Stitution of instea monitoring.	Demo project to a valuate different methods of monitoring crop water direct and CU under deficit intgation & demo educational outwach on crop stress monitoring.	ишала небазирек	Shuty Kosses Sh comparing Not Secure. Insecurement techniques to estimate crop coefficients (and thereafters ET and	NOT DESCRIPTION OF A DESCRIPTION	Not discussed	Sor mastere sensors, intered flot decused thermometers (RTs), landuit images	Not decused. Not decuse	and for decusing.	Not decused.	Not decusive. Not de	Calend Pol Not dealer Decused	24842 952 CK3.6941	Not declared. Not declared	NX decised. NX decis	ed Concusion is that Landau-MDN based o coefficient estimates are just as accurate expensive and lator intensive ground-bar	LICP NOT DECLEDED a de beed	744 Aut Becueland	Reading, is all open-source data and indices provided by USGS from Landait satisfies	Not discussed	Processing the second s	NDM is a useful four to extende cop coefficients and ET for targe, dtth-scale analysis; SWR could be a good atternative		International subsequences (LIME), March 11 Lake annual of annue accuracy compared to satellite-based techniques. For estimating MDV, Ground based techniques are lator densive and require investment in sesarch-grade equipment, Landack NDV from LIMES is Processor Construction.	Church Stated Schlepes (2005), Holds 1) have sinter or works accuracy companies to satisfile-based techniques for estimating NDM. Ground based techniques are later transies and require investment in research-grade equipment. Landad NDM from hom a consecuciencement.
Final Project Payots: Inglementation of Deficit Inglementation Regimes: Demonstration & Outward	10178alia-0			naacument tochniques 1% estimate org- conficients (and towarden ET and therefore CU). Cop coefficient (KL), soit aster todance, trifuned thermicinates, top tother fitters holes, Lancat M2VII, ground based M2VII and RedET methode												(maggarants					This is upone catacitors and measur-lipidae instruments dance serveral housed where the located datas, convention that the RFL request extensions catacitors and separate instrumentation to popely measure catego surportanew, CRIST tests, to underestimate EFL resultae background importance measurements can contaminate RFL measurements, DMM with cole sensors is interview, operative pipcardy covers interview categories sensing MDM are just as accurate as other provide datas RFL/ME	to enall applications		ndensen and regime streetheid in seaarch galde explorent - Lander NOVI fam USGS is Processessesses	COCC & PROMARKANA
4700-11	Participant of Poulan Issue Pouling Relating Gauge and setting of VII and Relating Pouland Pouland Con- tent of Pouland Pouland Pouland Pouland Pouland Pouland Carlor Is Works CC, and Lancementer III Col and a Contract Relation I Col and Contenting III Collarition of Pouland Pouland Pouland Pouland Pouland Pouland Relationary Contention Content Pouland Pouland Relationary Contention Content Pouland Pouland Relation of Pouland Pouland Pouland Pouland Relation of Markowski Pouland Relation of Markowski Pouland Relation of Markowski Pouland Relation of Markowski Pouland Relation of Pouland Pouland Relation of Pouland Relation of Pouland Pouland Relation of Pouland Relation o	Final inport of protutype ATM water sharing group between ag (North Poude III Co, Mate and Storage Co, New Caster is Poude II Co, and Latimer/Weld III Co) and muni (Fort Codes, Greeley, and Ti-Colsticut) on the	Standard methodologies	Not decused. Not decused.	Not discussed. NEE discussed.	Not discussed.	Not decursed. Not decursed.	Not declared. Not declare	and. Not documed.	Not decused.	Not discussed. Not disc	useed. Not Net-deau discussed.	used Not discussed	Not discussed. Not discussed	Not decused. Not decus	ed. Not discussed.	NaX discussed.	Not decused. Not decused.	Nit deliverd	Not discussed	Not discussed	Not decused	Personalized approach to ag about alternative options	NEE decuesed	Proposed buy and supply hybrid ATM: "1- planes tand and water that a famor seeduwarm to see its purchased by a conservation entry (typically with multiple planes) that places a universitial on assessment on the family and insists or each back to an agricultural producer. A public of the water is meaned for issues to doneed classes involves for droublet finnion, exceed a water is 1, or your for base and/or where
ATM 11 The Poudle Water Shaling Working Group: A Reportsortie CWCB	¹⁵ LFBe appr/Maid/11 MIM/Maid/01 MIM/	 Poudre River. Identified CCU calculation methods as a large barrier. 																							possible.
ATM-12 FLEX Water Market Education and Implementation Phase	Investigation of FLEX water market implementation: Intercharweblak.ass Implementation, meetings between willing shareholders. T	nvestigator of FLEX water market implementator: engagements, index based pricing, theotoing on implements X implementation, meetings between willing	drandard methodologies	Standard methodologies Nort-Broussed	Not discussed. Not discussed.	Not discussed	Not decused. Not decused.	Not discussed. Not discuss	and Not document.	Not decused.	Nit decuesed. Not dec	oussel. Not Not deale discussed.	used Not discussed	Not discussed. Not discussed	Not discussed. Not discus	ed. Not discussed	Not discussed	Not discussed Not discussed	Not declared	Not discussed	Not discussed	Not declared	Not discussed	Market volatility and changing priorities for private industry market 3 bach to work out dealer, contamined approach for industructure needs on a case by case back to assess needed influenceurse. Pipelines to deliver doestneam ag water openant to MMI and have the influenced consequence that intensitiate had – of you're	Consumptive use quantification could partertially be used to substitute the need for a shange-in-use with end-users to be determined – Exercevork for Water Court case??
Implementation Phase	PPP - Changer between the project was to according implement the FLC of the project was to according implement the FLC of the PPP - PPP	and Neview of benefits and asses of buy and dry	inandard methodologies	Standard methodologies Not-discussed.	Not desursed. Depends on familing practice. Permane up is she watts to write no infoation and	t dry- transe decusion where limbed reveal initiation could benefit both MBI and	None - standard E-maked intradion is diff methodologies applied guantify using standar methodologies ().e. or	ficult to Not discussed. Not discuss	and for decusied.	Not docussed.	Difficult to maintain Not dev during limited imparton	used. Not Not deale	used Not discussed	Not discussed. Not discussed	Not decused. Hecharge	Potentially costly to serify CU on Smithed	Not discussed	Not discussed	Not discussed	Revegetation of sites could lead to increased water in steams rather	Restrictly ingated field have poor solt teath and personial and/or native vegetation are it-equipped to handle occr solts thich contaction, occr structure, two strainic	Bol physiochemical analysis, organic math sometricate helps indicate inflation and	w Description shared of fact following or dra-	full able to access the pipeline. Then your water will be	Mater court has legal authority to allow limited intgation in an ATM but it hasn't been watering of a tended in any case ver/
Attenutives to Permanent Dry Up of June Formerly inigated Lands	reportation to Dry land terming, and 2) limble impation. A Distribution to Dry land terming, and 2) limble impation. A Distribution to Dry land terming, and 2) limble impation. In Distribution to Dry limble impation. In Distribution to Dry limble impation.	and alternatives. Protectial for conversion of a pand to dry land or deficit-intigator, economic & maintenance issues withy land & deficit.			process in underway; Limbad Imigation is complicated to track amount of water be applied to faird perfamily partial CUI for a -	weight of the second benefit both MBI and those by case: when there are surgice water is their supply portfolio that cannot be devely used or stand, as this can be asseed back to impact, which are second to impact, which are second to impact of the second or attacks and any surgice cedits. The	nethodologies (i.e. co	un accepted)							Accounting Accounting	an uld ry ed				than just a retining but it would depend on the crop type	are it-equipped to handle poor solit (high compaction, poor structure, low organic matter, and possible high nutrient residuals).	cruding issues), and soil texture analysis can help determine best path to revegetatio shateges	establishment of rative non-intigated on vegetation. Minimize carryover of Nitrogen. Weed curroot commund for 3- 5 after planting/seeding rative veg	projections, and tening to achieve best results. Long-term project timeline of 5+ years to achieve good results. Significant cost to familier (No: ong insurance or bestance variable for inshed inspiration / spicolay 0.585 across of water is none valuable than timebal inspiration and insure it time instant instants funds inspiration and in times. It time instant instants for solidant to	
Formerly trigated Lands						Itations and any surplus credits. The locharge credit transwork takes care of lagged return flow fining issues and allows better coordination between									kato-bad agreenen between h and ag									yeld gayout from timbed intgation faming unleave to putify cost of continued forming efforts)	
	Water markat superiment, survey of municipal & industrial providers on ATM practices, means, evaluation of shared water bank scenarios on South Plates, Sourced on FRICD shareholders.	Roter market experiment, survey of municipal & industrial provident on ATM practices, essese, evaluation of charand water bank scienarios on South Ptatte	Not discussed.	Not decused. Not decused.	Nit desired. Not discussed.	Report details an economic toperinent where volunteers played a pame to test-out ecenarios of a	Not decused Not decused	Not discussed. Not discuss	and for docusted.	Not discussed.	Not decused. Not dec	Succession Not dealer	used for discussed	Not discussed. Not discussed	Not decused. Not decus	ed. Not discussed	Economic taboratory separiment to tech water scaling market results: - Aq users will relate more water rights and more abler than it typical boy mod day pactices and thus add benefit to runar communities over boy- set	Not discussed Tes	Yes - leasing markets allow MMI to buy eases from termine during day years with buy-and-day impacts but them's not much benefit to formers in wet years.	Not discussed	Lots of Ag and MBI survey results about willingness to participate in ATMs/Water Sharing lanks: - Ag users willing to work with MBI but wart short-term agreements with feability for	None identified or stated in report. The hypothetical scenarios that were modeled a relied on publicly available data from the	Incentives that assuage concerns of both farmers and MAI, but primarily MAI feeds	Inherently opposing goats of individual impatton and MBJ	Findings: - Engance are relucted of ATMs due to 1) concerns over ability to set their water rights in the faces, 2) relacance as go through water court for two of consequences within to Care Not 2012(NHS).
	et and class.	exercision built Palle				Shared water back" to see whether MBI or Ag users benefit the most by tracking who gets more water under different market conditions and legulations.											eater than in Spical buy-and-dry practices and four add benefit to nate communities over buy- and-dry - Leasing mathets do not necessarily lead to efficiency gains in water usage or ag production		Second in terminal in wat years		And of A and MBI survey results about willingness to participate in ATMIN/Water Intering Sarase. - Ag uness willing to and/s with MBI but water short-term agreements with fiscalibility for Saybert parts - MBI sarate generating do not an ATMIs as great solution, they are still planning on log-grand-by for the fullist, they see blane-back to ag as best attenuative to bup-and- by back its not their first shores.	DBR.	Not parting cost burden entirely onto ag and MBI but perhaps State sharing some cost		ME users plan to acquire ag-water rights as part of their long-term supply planning & development
AFM 14 Water Partnersbjer all evaluation of abstrative agricultural water baselin methods in the South Platte basis.	12 konstruktiva ale konstruktiva konstrukti konstruktiva konstruktiva konstruktiva konstruktiva																India and amines in state communities there dogs and dogs and any advantage do not accessibly state to a state of the state of the state of the state of the state of the state of the state in the state of the state of the state of water rights will be be a state of the state of water rights will be a state with introduction of water inseting the	64E							Millioners are related of any ATM method unless they can be assured 1) permanent supply, 2) overship of easier rights used in their supply, 3) certainly if instability, 4) they can have a permanent supply at the end of an agreement period for an ATM. Recommendations:
																									Automatications Servery MB andress of the Delations to use if they share concerns of B. Pathe MB/s. Refere and educate MB about ATMs Warks with MB is construct ATMs that address their primary concerns Candra additional like experiments like - detailed in the reports or wrATM concepts Develop formatic models that help inclusion inplant of bury addry or ATMs.
	Proof of clonage property prevengs for ANMONE program of tank Canad. Monitoring/wet/foldow Takad on ballwise, antonics to verify what is face by producement of monitore moments them for an 2004 Project was not in planteen	 Ploat of concept project parameters for A11600 program on Lake Canal. Monitoring/vertification caned on deliverines, excition instants, inflore to recharge pts, and doit instantere encousts to desity relations for the Statisticements of missian encourter. News Statisticements of missian 	This project was not actually implemented	HCU to quantify water right and another Transformation CU analysis based on logic used for defact impairs	Inst GD Sance This project acts for Analysis properties of the project acts for " Strategrade SCAA system to called a partice strategrammeter of activity implemented strategrammeter of activity implemented strategrammeter of activity strategrammeter of activity provided SCAA system to called a strategrammeter of activity provided SCAA system to activity of the strategrammeter of activity provided SCAA system to activity of the strategrammeter of activity provided SCAA system to activity of the strategrammeter of activity provided SCAA system to activity of the strategrammeter of activity provided SCAA system to activity of the strategrammeter of activity provided SCAA system to activity of the strategrammeter of activity of the strategrammeter of t	 Application of the second secon	ACSE-PM and Markey-Criddle Approx. \$23,000 html Actionated for periods where data for ACSI-PM was Retailation of new fun	indeclinent in and includure angle capa iding flumes, sensor vertically- and water is nes, soil sciented array fleasurement	any curve Wet was at turne with level pressure transducers for in ers 60x 50x data logaina	excelling flurnes at dech furniouts in-maintained and recorded by dibd. Company need to be outfitted with	Proposed turned to be extend Installed strategically at collecte Bartice runsifi cuttate,	ed Ton data Rod Not Second		No 313.462 No 313.463	RAT DECLARED. NOT DECLA	and automated \$20,000 per property for restrumentation and equipment required to set up integrated SCADA	relepandent appraisant of water make rates, provide the second second second second second tests were the plaquing facts for negotiations between intigator and trial	Poligerober appraisant Feb of water lease rates, agricultural production	Fee, INSA aboved to deed for credits to be counted towards conservation-goals are will as tide season storage releases.	 Rightmetically, yes, this project was bit actually implemented 	The project was not actually implemented for some important associatives classified from the progress that the project made:	The project was not actually implemented but some important questions were posed i the report	Water Mass rate was the root attack point of discussion for the project - opportunity used to fammers forecome	See LEGIOR LEBIES	Incertivide preservation of agriculture by ensuing that costs are not borne entirely by encoded of ABU encoderation was not regenerated, the project was able to demonstrate/accomption terms takes. Journal of the product supply for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the Castle La Pouche Row for a reach including the control of the production upper for the castle La Pouche Row for a reach including the control of the production upper for the castle La Pouche Row for a reach including the control of the castle La Pouche Row for the castle La Pouche Row for a reach including the control of the production upper terms the control of the castle La Pouche Row for a reach including the control of the castle La Pouche Row for a reach including the control of the castle La Pouche Row for a reach including the control of the castle La Pouche Row for a reach including the control of the castle La Pouche Row for a reach including the control of the castle La Pouche Row for a reach including the control of the
	sensors to verify nature flows by laddpresense of monitore non-ment being the rule court of the rule of the rule of the rule due to organize water accord at the rule of the rule of the rubbity to agree or a price. Describes extended inget wor to arrive at model of content.		By-pass of diversions from the Lake Canal headgate on the Cadhe La Evouble River	This project was not actually implemented form this project was not actually implemented form this project was not a moderneeted	paring actually implemented second data from measurement structure participating from a Clusterian Flows: in-ritues in-ritue mail-time measurements at execting Parchail form grown-owner of Parks and the	a.e. in maintaining environmental flows for larger reach through Fort Callins code/ve been achieved is into This project was not achaily explanation.	Insufficient Indistum sensor array integrated SCADA systemplemented This project was not actually triplemented	s, and down to 7-feet below surface scheatly This project was scheatly imp	z was not. This project was not plemented actually implemented	pressure transducers for continuous measurements. This project was not actually implement	outlined with continuous data Rogging and integration to SICADA	(ect was not explormented				This project was not actually implemented	ed This project was not actually implemented	opportunity uset would help even the playing field for regulations between ingenur and MBJ	Hen, Mitch allowed for direct flow credit is to counted branchs conservation-goals and well as tate season storage releases, though the Borawer's platture Consensation and City of PCC Califory Valued laberaaco flows more than excess peak flows for environmental goals.	ey a	The part of the second	Does there need to be a direct connection between the timing of the conserved consumptive use and the delivery of water the ruler?	sales of profibile crops was a function and oil & gas sector was willing to pay more than Maria in the end to - DMR was a willing participant in planning the implementation of mo		Incention preservation of agricultural by executing that costs as not bone winding by detailing of additional sets of employments, the properties also to benerational association of the set of t
Project Report Lake Calual atternative agricultural project diversion project	International Sectors	x implemented due to ongoing water locarchy at the time (2010) d0113) and inability to agree on a price. Describes extensive legal work to arrive at proof of concept.	 Project goal was to allow conserved CL to flow past Fort Colline, but that could only be directly accomplished for in- 		 An integrated SCRDA systems -Surback Return Property in reductions from the mean form manuscreaments at proposal fluences at all active runnifig cardinal to proposality for a propagately hydrology -Sort Notation: cognitizations will exercise active propagations will exercise active and the second second			inglemented			This project was not actually implemented							This project was not actually implemented	This project was not actually implemented		Notes for water and your the value of water to an economic lodes was agreeded. Finalized by in the timing of detenties is circular Needs, subset, and preferences need to be established early and communicated dearly from both sides	Does CU need to be "saved" before it can be "spent"? Could an unintended consequence of this type of ATM be that this is another tool to g	 project with respect to river framagement, instrumentation, and how is to monitor and report on return flows pet - Some project participants had 		dawrdinam righti - Lawrdfy factors that contribute or prevent participation from Ag and MBI
four demonstration project	30658-80-0		priority diversions from Cache La Roude sta Lake Canat, scored conserved use had to be exchanged upstream with C-RT water based on agreement with VIC and Lake Canat Ca		Exposure that a second seco	arays anno															 That building to oversime ecces and point at barries was time consuming and comparing measurements. Other industrial sectors can influence perceived price of water and that needs to be considered in approximate, particularly any demand from oil & gas -Characteristics of the projectarriver disensions are important to ensure honest 	water out of the rows and vito the theatment plant thereby decreasing river flows in the end? -Does it make sense to try and limit the number of agreements or does this kind of	E Regative interactions and the social/professional history was difficult to overcome		
					Recharge pits maintained with long third formes Weekly and all imagery captured for participating terms to include RGM, NR, feast expranse (R)																nanny o suiteivel seller	exact make this too complicated to be a visible option in other projects?			
	Fectivical research paper with three tasks. Task 1: Develo calculation & verification of consumptive water use and we savings, such that water course explorements can be satisfie uses a treas coefficient, the orgs water convertings.	boats uses 1 Develop satisfation 8, env writesation of unneurophyse water use and water satisfation, scoth Tau water out out 8, equipments can be attached-uses a three coefficient programmer more mana coefficient pro- lated the Rodolf model of ensuits earning, add the Rodolf model of ensuits earning, haddelf showed abounding symphysic concelleding spraining conditions and successfully developed about any symphy.	 Assumption is that return flow obligations are met through sugmentation to measured measure of timed water are applied to over CCU and Return flows (i.e. no surface return flow from deficit imgated Selds) 	Nost zone water balance (K2WE) to get edmands of stress coefficient (Ka) and ET for cam in webvingsted vs. defice rigitated plots	g ET Name advantation and in sppraach – diversions are limbed to what is needed for additional model, which or the regulation for regulations for the FAC-bit model, which or the regulation of the regulation of the regulation of the needed for addition.	lings Not discussed Social et	A control field, clearly in the same project to prevent to instructional provide the second second second project to evaluate the second second second second project to evaluate the second second second second the same nethod used to quarty CCU (gen Redist) control second second second second second control second second second second second to state nethod used to provide the second second second second control second second second second second to second second second second second second to second second second second second second to second second second second second second second second to second second second second second second second second to second second second second second second second second second to second second to second	idination Not discussed. Not discuss neutron probe sits study to	and: Allocation approach to beaus flow maintenance uses normal river diversion flows are met by a court- approved augmentation	Not discussed.	Allocation approach to Inturn flaw Inaliterance uses via ET i Inornal river diversion	Not Set desce underestimated discussed. askulations to evaluated at	vesed. Yes potentially need to install additional exchange for	Tes the report evaluated installation of a new pipeline to bring exchange water	Not decused. Not decus	ad. Depends on the ET methodology. Stress coefficient — detailed Insequentents are needed at the beginn of intgation season (soil study and neutro	Aboution method for mandataning influent from the second	Pes at these \$1" Pes, allocation method for administrative peet- intern flow maintenance as nethodologies success of here willinges to these to establish an access of here willinges	Fire, the objects coefficient method is destified in report as being the econimended approach for property tennes involved in deficit impation project	tes, less water is diverted from the liver and consumed by crops	The and CoL can be estimated by the direct conflictent method (Fredd Bill, and Tanasa). The Managing can be also as the set of the Managing and Filt means. A standard part of the project area methods that the set of the project to the Managing and the project area methods that the standard during the project to set of the set of the se	None identified in this report - it was scient based and relied heavily or actual climate and project-like data for comparing tree offerent ET estimation methods	 Reducing administrative burden on verifying intum flow maintenance by implementing the adlocation method, which can be summarized as: 	It's estimation methods can have accuracy issues and are highly dependent upon the accuracy of the data being input into the models (gatage in + gatage cut). The sport identifies the stress coefficient method (FAC 64)	If estimator methods can have accuracy issues and are highly dependent upon the sourcey of the data being input into the models (galange in + galange out. The sport dentifies the stress coefficient method (FAD-46) as the most coefficient entrol for estimating IT and COUT which inguing more and accuracy similar to the control sectors.
Final Report of the Lower South Plans Integration Research and Demonstration Project	circulation & welf-circle of consumption water uses and we weight, such that were count requisered and the same well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field of the well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the scalar field means and the scalar field means well as the s	coefficient, the crop water stress index CMSI, and the RedSET model of remote sensing. RedSET showed accuracy of 90 MMs for fields under normal growing conditions and successfully detected abnormal growing	and Heturn flows (i.e. no surface return flow from-deficit imgeted fields)	- Crop Water Stress In (CVRs) - RedistY mode (useful based method)	b) § E7 Mater advocation	ade rep with	the same method used to quantity CCU (dtress coefficient, CWSII, or RecIET). thermometer and lots- for background tempe teadings and local clin	on parameters ade infrand of conscions estare nate data	flows are net by a court- approved augmentation plan as opposed to project specific measurements of sail moniture		Instant flow CCU is numeration uses fractional diservices of the temporal financial diservices of the temporal financial diservices of the temporal figure restriction plane as opposed to project section to project	underectinate	spelines and surface storage to smooth out differences			probe measurements) to establish initial conditions for FAO-66 model - Crup Water Stress Index - More use of specialized equipment (informed thermometer) deployed to the proiect site	CCU depends on ST methodology: f Steas coefficient – one time measurements needed at project site prior to impation easien e - Cop Water Steas Index – continual	sources or have willingnee to invest in establish an augmentation structures			extenses "normal" wer-inigation conditions and calculate conserved CJ by deficit inigation - Allocation method for initian flow maintenance allows for simple conservative estimates of nature flows that are activised through suggestration and the ETE istimates under gender CHC, therein a not been for the immathem and downsmann		 diset the minimum required volume at the headgate to meet estimated deficit ingation target 2) assume that no flow from the project sits is instanted to the stream 	as the most cost-effective method for estimating ET and CCU in deficit engation projects with accuracy similar to from intensive methodologies like Crup Nater Strees Index (CWSI) and Redict model.	nore intensive methodologies like Crop Water Stress Index (CWSI) and Radal T model.
Demonstration Project	CFIe agrichodor19 foreit, Taox 3. Extinute suppy delenny potential. Project o D1586/bioHo Lower Studt: Platte Engation Research Fam near BE	n conditions to accordingly reduce ET estimates 2. Simplify the administrative burden of maintaining return flows, and 3. Estimate supply delivery potential. Project on Lower III from the transform Simparch Lower VIII			cots of complicated sumections of the infi termination data. - PeddST Model - assette imagery is that over impation seasons and the RedST in applied to extende ST	and Red off is	 ReSET — to equipm technical knowledge a to analyze satellite inu 	ent but specific end computers ageny	-Chromitine are limited to the target deficit impation ansure and the remainder stays in the river, return fixes are maintained		specific measurements of eait moleture		between excitang scamping rates and existing pipeline capacities	5		throughout irrigation easaws for no significant improvement in ST extinute - RedST - Requires specialized analysis no major investment in project-specific informations.	beautements with specialized research-gade equipment required at the project-site and a but additional table to QAQC the data - RedST - special bechnical separate required of hear same the force model in the scientificant				uses Delivery of databingeton COJ is site and region-specific, depending on where along the fiver the COJ oradis are being exchanged from and exchanged to, and additional storage, inchange, and/or pipetnee might be required to make deliverse form ag-able to main is		4) augment required return flows from		
	Na Grande Water Conservancy Datact plan to meet		Well meters and diversion records	Assumed pumped goundwater used for intigation with an IDTs efficiency for genotes and diffs efficiency for pumpels and diffs for float. pumpels	2020. Met through Cher than using mater and downloar te back an have been been added in the region memory and the out ready addeneed in the region memory foo Canada		Not decused. Not decused	Not discussed. Not discuss	fores are maintained forough augmentation and. Not document.	for document.	Not document. Not do	used. Not Not des	used for discussed	Not decreased Not decreased	Detailed Not discus providentier pump refer data analysis	Interview Color P Interview	in other investment is influence, our or oppingent needs other than local weather data (could be from exciting dimage stations) in various terms, data companies, etc. are pitching in fair the project, so lots of "beamson".	ed Ig fes fes, a big seson for the project is there interests compart obligations	Tas.	7+4	Significant gains will have to be made in order to mach program goals by 2020	Nit delated	agrintator to so	Not enough curtainnertRobascancertaiowing to reach program guais, eigefficant gains will be needed to meet 2010 target	Not discussed
Perports Scr 44	Kin Grader Water Conserving Datic parts from the Hometex compacts from \$2 Theorem 2014 and the heatest for exchanges to meet disearching and the hashest for exchanges to meet disearching and the hashest for exchanges to meet disearching and the hashest for exchanges and the hometex an	ry Agreements, leaves for exchanges to meet Breamfow criteria, temporary following as agreements, etc.		spinkless and 62% for floor. pumpingdverting	eleanes from optimient exercises (Ro Grande Reservor)	evel of the aquifer and task it over line									neter data analysis.	manufactory and an other an additional	an an property of the or manifold."	compact obligations						Depit tapper	
ATM-17 RGWCD Net Arnul Replacement RGWCD Net Arnul Replacement Plans 200	the considering of the Distance No. 3 Mather Claute II clause No. 4 Mather Claute II claute II clause No. 4 Mather Claute II claute II clause No. 4 Mat	a a a																							
	groundwater withdrawals and a water portfolio to be used to veolace such stream depletions.																								
Alternative Water Transfers in	Review of ATMs in Catalosis for Frank Review The report conduced a sciencing analysis is biteredly constant cases which for a more detailed analysis of ATM product and the results for a more detail analysis of ATM https://www.att.op/interesting.com/or analysis/op/interesting.com	Review of ATMs in Catorado for Frust Range Burcopatilies. The input conducted a screening analysis is blently posted catal todaes for a more detailed analysis of ATMs. Noted 35 increasing aware procedure based on transmission and demonstration. The com- tent of the screen and demonstration that com- tent and posted and screening the Complex community and posted and screening the Complex bases and plasma of analysis of name complex presentiates of the next case includes. Follow	rea ultitutited	ren unsonliki	nuc distanted Not discussed	NEX DECLESED	reconcilial. Not decaded	pair decused. Not decus	ere. Not docussed.	me decused.	nut documed. Not do	orona Not Not data Datumed	enel Witdiscoul	nex decursed. Not decursed	fox decuesed. Not decue	ers. mit distatied	end dolution	www.dmcumed Not documed	Non-shilling	end datumed	no source and	Non ultituded	Print Childrafield	no woliki	and annual and
Alleringbe Water Taksbes in Colorado: A Pervise of Alternative Transfer Mechanisms for Front Range Municipalities	Mpertanee ad: organized in diminate last clinits, their case study participants were excellent intercupants and lower of Workson. The work Workson. The International Control of the Control of the Control of the Control of the colorado pdf. In the Control of Control of the Control of Control of the for the Control of Control o	ort water course and demand size orbits. Two case study participants were identified: City of Fourtain and Town of Window. The report conducted a francial analysis of water supply alternatives for the two case studies; findings include recommendations for best ATM																							
		include recommendations for best ATM practices to suit those municipalities.	1																	1					