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**Regis University
Regis College
Master of Development Practice**

Advisor/Final Project Faculty Approval Form

Master's Candidate: **Lauren Ott**

Capstone Title: **Household Water Conservation in the Upper Colorado River Basin: A Proposed Customer Engagement Tool and Recommendations for Denver Water**

Presented in the MDP Community Forum on: **May 7, 2024**

I approve this capstone as partial fulfillment of the requirements for the Master of Development Practice.

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Household Water Conservation for the Upper Colorado River Basin: A Proposed Customer Engagement Tool and Recommendations for Denver Water

Lauren Ott

Regis University Master of Development Practice

Acknowledgements

I want to express my gratitude and appreciation for everyone who helped me develop this Capstone project. My Capstone Advisor, Professor Emily Van Houweling and Second Reader, Kelly Latham provided invaluable analysis, feedback and direction. Their passion and expertise were instrumental in shaping this paper and project.

I am also profoundly grateful to Prof. Nina Miller and the faculty of the MDP program at Regis University for providing me with the resources and encouragement to complete my degree and this paper. Their availability, flexibility and support have been an incredible source of inspiration. I would also like to thank Dr. Peter Van Arsdale for advising me and connecting me to the Rotary District 5450 who were instrumental in the early development of this research.

I am also grateful for the support of the Colorado water management and conservation community. Engagement with Denver Water, Castle Rock Water, Water Education Colorado, Colorado Water Wise, WaterNow Alliance, Colorado Stormwater Center, and the Denver Department of Transportation & Infrastructure. All interviewed participants were extremely giving of their time and expertise. Most importantly, they made me feel hopeful and empowered about the future of water conservation in the region.

Last but not least, I want to thank my family and friends for being supportive and patient these last three years. I could not have done this without you!

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Personal statement:

I was born and raised in Littleton, Colorado, a suburb of Denver with large swaths of open area, green spaces and parks. It is home to Chatfield Reservoir, a large artificial lake on the South Platte River and small streams run through parks and neighborhoods. These streams and riverbeds were often dry or low enough to be easily traversed as a child and made for great hidden play areas to spend happy hours in nature. I did not realize how abundant water could be until I began spending months of the summer with family in northern Wisconsin. Here for the first time, I saw bodies of fresh water so large I could not see to the other side. The air in the Midwest as we drove through Iowa and Minnesota into Wisconsin was damp instead of the dry heat I had grown accustomed to. I continued to spend all my hours outside but now instead of roaming dry creek beds or reservoirs, I could swim and boat on a collection of lakes that seemed to all connect and grow forever. As I got older, I looked forward to escaping the hot, dry summer months of Colorado where wildfires were becoming increasingly commonplace. The severe drought that stretched through the early 2000s along with rising temperatures meant Colorado simply did not have enough water to avoid catastrophic fires.

The drought and wildfires put stress on our community and on many days restricted how or when we could be outdoors. It also woke us to our own responsibility to protect our environment. The first time I remember hearing about water conservation was in elementary school when a guest speaker came to our classroom to tell us about how we could conserve water at home. She asked us how much water we thought would be wasted by a dripping faucet left on overnight or how much water we estimated could be saved by turning the water off while we brushed our teeth. We walked around our school and neighborhood and made a list of all the things in our environment that required water. Years later, another guest speaker came to my

High School and this time spoke to us about the beginning of our water cycle. He answered our questions about where our water in Littleton comes from, how its managed and what endangers it. We then took chemical test kits out to the small creek running behind our school and collected vials of water to see for ourselves how our own activities were changing the composition of the water around us.

Growing up in this environment and in a community the encouraged thoughtfulness and intentionality, I was always interested in learning more about climate change and environmental challenges like water scarcity. However, as I entered college and moved to the Pacific Northwest, my natural inclination toward public health took a central focus and the environmental interests of my childhood somewhat slipped away. I studied Global Health and Development and entered the Peace Corps after graduation. I arrived in the southeast African country of Malawi as a Community Health Advisor at the age of 23. As a Community Health Advisor, my stated goals when entering my village were to support in the reduction of HIV, malaria and malnutrition. Here again, across every aspect of my life and work, water became a main focus. Inequitable potable water access forced mostly women and girls to take hours out of their day traveling long distances to secure water for daily use. This removed them from educational or livelihood pursuits, elevating rates of poverty, the key driver of HIV.

I traveled to schools and community centers with healthcare workers to discuss vector control of malaria. Here again, the conversation often came down to water as stagnant water is the breeding ground for the mosquitos that spread the disease. We worked to promote a culture of covering standing water sources and integrated community water system management into our conversations. The distribution of these water sources played no bigger logistical role than when brainstorming nutritional solutions with women's groups and cooking groups. Community

kitchen gardens were popular amongst these groups, but for three of them, planting a central garden was not feasible as no functional water source was nearby. Realities such as these were shockingly commonplace as even if a water pump was nearby there was a 50/50 chance it would not be working. The maintenance required to upkeep these pumps in rural Malawi requires knowledge, tools and parts that the community members simply did not have the means to acquire. In the end, my life in Malawi and ability to act as an effective development practitioner was dictated by the victories or failings of those charged with managing the local water system.

As I returned home to Colorado in 2018, after eight years away, I was shocked to see how much Metro Denver had changed and grown in my time away. The population had boomed, and the city had stretched to accommodate but the natural environment and climate remained the same. My hyperawareness of the environment was exacerbated by reverse culture shock as I observed I returned to my childhood home and looked out my window as neighbors ran their lawn sprinklers while it rained and ardent sprinkler heads flooded sidewalks and gutters with water.

I moved to Denver and after three years finally found myself feeling settled and embedded with a desire to grow here personally and professionally. This brought me to the MDP Program at Regis with the initial goal of continuing my Development Education with a focus on health and the environment. The ensuing courses, research and interactions with professors and classmates cemented my belief that water access, security and management is at the center of every aspect of physical, societal and economic wellbeing. I feel fortunate to call Denver home as its climate, culture and history lend itself to so many lessons in water management. Water is our most valuable resource and Denverites have a rapidly growing respect for its value. For this reason, this paper seeks to provide an outline of resources and tools available for household level

water conservation. These resources exist in abundance but the sheer challenges and opportunities facing our community make it difficult for Denver residents such as myself to even know where to start. I hope that the proposed program will provide an accessible starting point for new and old residents to establish homes with water conservation top of mind.

Executive Summary:

Over the past couple decades, the world has increasingly grappled with the realities of climate change and the accompanying changes to the availability of natural resources. Fresh, clean, potable water is the most important of these resources to sustain human life. Concern over the continued, equitable and affordable access to such water is therefore top of mind for a growing percentage of the population, especially in countries of the Global South and poor, marginalized communities in the Global North. Calls for climate change mitigation practices, improved natural resource management, and enhanced attention to water conservation have therefore become increasingly prevalent. These water conservation practices require population-wide political, attitudinal and behavioral shifts and it will be especially impactful for wealthy nations and wealthy people to be mindful of instituting these changes in their own spaces.

In this project, I conduct a literature review to investigate current challenges surrounding water from a global to localized perspective focusing on the arid Upper Colorado River Basin. I draw from the knowledge and recommendations of academics and scholars in the water management field to understand the political environment, sociodemographic environment, and conservation mentality of the Upper Colorado River Basin and determine challenges and opportunities.

Building on this information, I conducted a needs assessment, holding semi-structured interviews with water system managers and educators working in Colorado and identified

Denver as the focus area for program implementation. Following this research, I completed a comprehensive analysis of the water conservation resources available to households in the Denver area. To conclude, I combined the four main findings of the needs assessment with key takeaways from the literature review to develop an engagement tool for Denver Water customers that aims to ensure residents have an effective, stream-lined means of engaging with available water conservation materials in their communities.

Literature review:

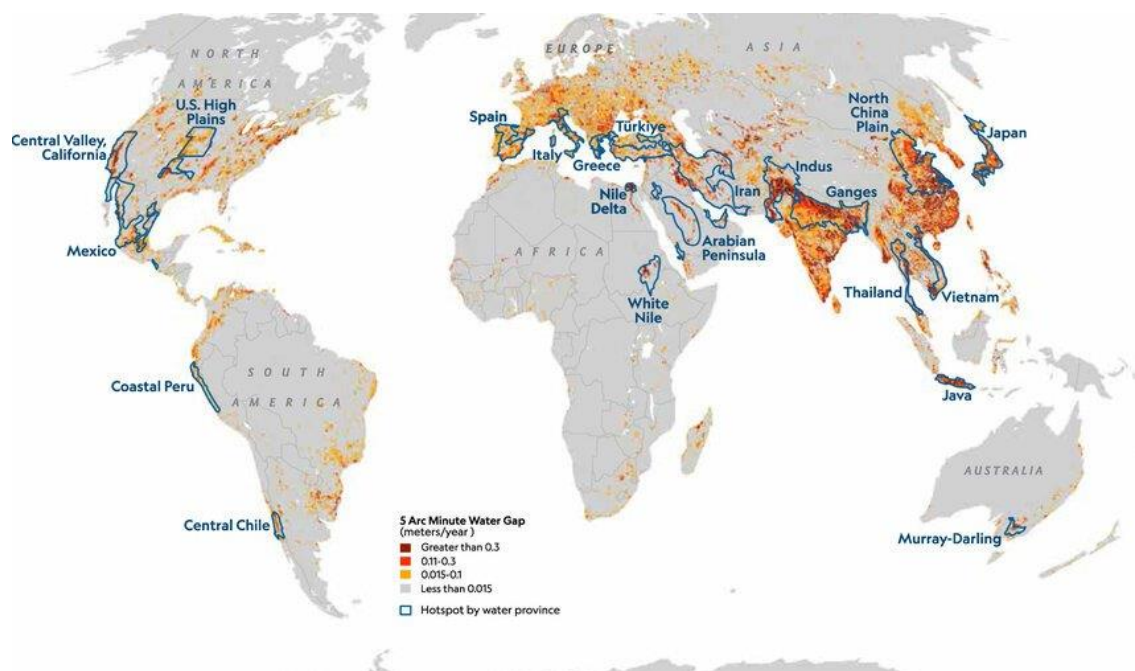
Introduction:

Water conservation refers to the practice of reducing unnecessary water usage by using water efficiently. The question of water availability and responsible water use has been closely tied to growing debates surrounding climate change and resource availability in the last decades. 100 liters of water per person per day are needed to ensure that most basic needs are met, and few health concerns arise” (World Health Organization, 2024). Additionally, Earth’s freshwater will continue to be allotted for food production to meet the nutritional needs of a growing global population with an ever-increasing standard of living. 2020 data shows that 72 percent of global freshwater extraction was for agricultural purposes, 15 percent for industry and 13 percent for municipal water use (Aquastat, 2020).

In addition to global water use patterns, the impact of climate change must also be considered. Shifting patterns of water availability, flooding, droughts and falling groundwater levels are a global challenge that will require a global response. As of 2019, “over 2 billion people already lack access to safe drinking water at home, and by 2025 over half of the world’s population will reside in water-stressed areas” (Famiglietti, 2019). A decade long study of the

Earth's climate and groundwater levels found that high-latitude regions of the world such as the northern half of the United States and low-latitude regions such as the global tropics are getting wetter while the arid to semiarid climates such as the Northwest Sahara, Middle East and Southwestern United States are getting drier.

These regions of the world constitute many of the areas defined as “Global Water Scarcity Hotspots” (areas outlined in blue as seen on the map below). This map identifies 22 water availability hotspots across the globe as part of a five-year freshwater initiative by the National Geographic Society in partnership with Utrecht University and ESRI. These hotspots are places identified as facing crisis-level water scarcity due to the gap between human water demand and renewable water availability (Kunzig, et. al, 2022). These crises are exacerbated by several factors including climate change, increased consumption, and economic development, which are straining the demand on water use for agricultural, municipal, industrial and livestock purposes.



The reduction of water availability simply from a quantity perspective is further aggravated by decreasing water quality caused by increasing and newly emerging pollutants. A 2024 article highlights pollution as an added reason why water scarcity is such a challenge despite municipal water needs being relatively small. It builds on classical water scarcity assessment mapping by further defining global sub-basins where both water quantity and water quality place human populations and nature at risk. Clean water is needed as source supplies for municipal water and “clean water scarcity assessments” show that many regions face shrinking municipal water supply from a quantity perspective and quality perspective (Wang, et. al, 2024). These patterns are in line with predictions by a series of Intergovernmental Panel on Climate Change (IPCC) reports created to provide policymakers with scientific assessments on climate change, its implications and possible and mitigation options.

Rising Water Insecurity in the Colorado River Basin:

The undeniable global pattern of wet getting wetter and dry getting drier applies to all states of the Colorado River Basin. California, for example, has experienced drought extremes that have intensified at dangerously high rates with documented droughts from 2006-2010 and 2011-2015 (Famiglietti, 2019).

The importance of this issue can be established by several academic journal articles that present the climate factors promoting the rise of water insecurity in the region. One means of measuring water levels in the Colorado River Basin is comparing levels of Lake Powell and Lake Meade year over year. Both lakes are artificial, created by large dams built by the Bureau of Reclamation for the purposes of water storage, hydroelectricity and recreation. The Glen Canyon Dam located on the Colorado River in Northern Arizona created Lake Powell and the

Hoover Dam located on the Colorado River in Arizona and Nevada formed Lake Mead. Both lakes receive most of their water from snow melt that flows into the Colorado River. Early 2023 has seen a promising amount of snowpack and the resulting snow melt into Lake Powell will provide a much-needed boost to the reservoir's levels. However, reliance upon snowmelt will mean this boost will exist only in the short-term. “Big snow years are happening half as often as they used to, while dry years are 2.5 times as common” (Hughes, 2023). The US Bureau of Reclamation, the federal agency that manages the West’s water projected that Lake Mead’s water level will fall just below 1,068 feet in January 2024. This is below the agreed upon water shortage limit of 1,075 feet. If this happens, it will trigger water restrictions and cutbacks based upon agreements written in 2007 and 2019. With these 2024 cutbacks, “Arizona will lose about 18% of its Colorado River supply and about 8% of the state’s total water use. Nevada will lose about 7% of its water allocation” (Hager, 2023). Federal officials are expected to agree on new guidelines for the river by 2026, when the current rules expire. Therefore, water levels in Lake Powell and Lake Mead will inevitably continue to be heavily monitored and consumption allotments adjusted accordingly.

Present day, an average of 1.9 trillion gallons of water is drawn from the Colorado River for annual consumption. Of this, “79 percent goes to agriculture, 12 percent to residential, 4 percent for commercial and industrial uses and 4 percent to thermoelectric power” (Shao, 2023). Therefore, it can be considered that significant water conservation will ultimately need to come from changes in the agriculture sector. However, policy limitations and water appropriation as will be explained in the challenges section, make implementing any meaningful change in the agriculture section a challenge. A bottom-up approach starting with reducing residential water use can be more quickly and easily implemented from a political, cultural and economic

perspective. Increasing public knowledge of water use and conservation will also create a policy environment where water issues are more readily prioritized.

Challenges:

The rising water insecurity of the region caused by climate change and population demand makes water conservation a more relevant issue with every passing year. However, the Colorado River Basin's antiquated water laws also greatly hamstring modern-day policymakers' ability to navigate the climate and promote meaningful solutions. Even when policies, codes or laws can be updated, a pervasive lack of general knowledge surrounding water conservation ensures they are slower to be adapted at the municipal and household levels. Literature outlining these challenges with the political environment, sociodemographic environment, and conservation mentality will be discussed in the next three subsections.

Political Environment:

Municipalities differ in their policies and strategies for water use and conservation depending on local needs and priorities. The seven states of the Colorado River Basin have been politically linked since 1922 when they agreed to the terms of the Colorado River Compact which divided river flows and annual water allotments among the states. It is worth noting that per the original verbiage of the agreement, "nothing in this compact shall be construed as affecting the obligations of the United States of America to Indian Tribes". People living on reservations were denied the right to participate in the 1922 Compact Negotiations. According to this Compact, water was divided for the river's lower-basin states of California, Arizona, and Nevada in absolute quantities instead of percentages. This means "upper-basin states are obligated to deliver 7.5 million acre-feet per year to the lower states, no matter what which "turned out to be a tragically bad design" (Smith & James, 2023). States of the Upper River

Basin – Colorado, New Mexico, Utah and Wyoming have long argued that it is unreasonable to allow its population centers to go thirsty if there comes a time when there is not enough water to go around. As this time draws closer, there have been significant commitments to conserve water across all states.

However, the question of how best to approach water conservation is being addressed differently by different political entities. Literature shows that Lower River Basin states can implement more experimental, “soft approach” techniques such as domestic Rainwater Harvesting because they are not beholden to water rights laws in the same way the Upper River Basin. Taking Colorado as an example, water laws are so strict that a doctrine entirely prohibiting rainwater collection was written into the state’s Constitution and not amended until 2016. This restrictive mentality stems from the belief that capturing rainwater prematurely removes it from the established water cycle where its natural path would integrate it into the watershed for future use. However, Other than the restrictions of the Colorado River Compact, another “principle at stake is called prior appropriation, which is legalese for first come, first served” (Guo, 2015). This prior appropriation doctrine is another bedrock of water law in the Southwestern United States. It stems from early agricultural settlers in the region being the earliest claimants to the water of the Colorado River. While academics and experts criticize the outdated nature of prior appropriation and its effects on state’s ability to regulate and conserve water, it is so deeply entrenched in regional water laws that it will not likely change anytime soon. The continued priority of seniority over need means that industries such as mining and agriculture have more water rights than urban households to this day. This helps explain why water-intensive crops such as alfalfa, wheat and hay are still a major industry in an arid Colorado

River Basin. It also provides further context for why water conservation at a household level can serve as a non-political approach by engaging citizens in attitudinal and behavioral shifts.

will be an easier political battle than at the agricultural level.

Sociodemographic Environment:

The sociodemographic side is of particular focus due to the public perception of water management and its role in water insecurity. Three urban areas (Phoenix, AZ, Denver, CO and Las Vegas, NV) were selected for a random mail survey meant to assess topics such as environmental worldview, procedural knowledge, perceived personal responsibility, trust in government and socio-economic resources. The results of this survey were assessed in a 2019 article by D.D White titled “Public attitudes toward urban water sustainability transitions: a multi-city survey in the western United States”. Key conclusions from the research found that residents in all three towns recognized water availability as a threat and were supportive of transformational strategies for water management. The key challenge remains how to address the issue. Municipal governments are hamstrung by antiquated policy and citizens can be slow to adapt to necessary changes. Diaz-Cervantes and White promote decentralizing water management as key to addressing rising water insecurity.

Water Conservation Mentality:

Decentralizing water management in the American context per Diaz-Cervantes' definition means reducing reliance on stored water from reservoirs and groundwater and transitioning toward household reuse. Cervantes-Diaz deems these approaches “soft-path strategies”. These are the softer, easier approaches that literature shows will be most easily implemented with the benefit of updated codes and policies. A 2023 article studied the adaption of such techniques by evaluating multidecadal trends in urban water use in 28 cities in the Southwest United States.

The researchers ultimately found that while large cities in the region have reduced their use by 15%, small and medium sized cities saw large increases in Colorado River Basin water use. (Richter, 2023). The key difference between these populations is outdoor watering habits. Citizens use a great deal of municipal water for nonessential grass areas. This once again suggests that a general lack of shared knowledge of household water conservation techniques and a slow adoption of new strategies will continue to play a key role in the ongoing water crisis.

The most environmentally and cost friendly solutions to urban water management are in educating citizens about how to prioritize available water. Promoting a mentality of water conservation among citizens will naturally lead to increased use of water management techniques such as Rainwater Harvesting (RWH) and greywater use. RWH, greywater use and climate appropriate landscaping were identified as the preferred approaches in the Upper Colorado River Basin. The examination of these techniques is a key focus of several articles outlined below.

Solutions:

This literature review will seek to understand the realistic impact of different methods of water management and conservation amid the documented environmental and political challenges. The two main methods of focus will be rainwater harvesting (RWH) and greywater reuse. Greywater is defined as the use of any water, other than toilet waste, draining from a residence. Harvested rainwater and greywater are often used predominantly for outdoor irrigation. Therefore, responsible, climate-adaptive landscaping will also be integrated into the proposed solutions as a key way to maximize the use of conserved water. This impact will be observed within the greater context of the water security crisis.

Why RWH and Greywater:

Arizona is a common example in many academic articles as it is at the forefront of sustainable water use policy. A 2023 article outlines the 2014 Arizona Strategic Vision for Water Supply Sustainability. At the time of publication, the Central Arizona Project (CAP), was hit the hardest by Colorado River allotment adjustments demanded by the low reservoir levels and faced “an 18% cut in their annual Colorado River allocation under normal conditions” (Megdal, 2023). Megdal sought to understand what these cutbacks mean for Arizona water users by performing a literature review of key policy options and opportunities and pulling from the 2014 Arizona Strategic Vision for Water Supply Sustainability. Megdal concluded that while central Arizona is making many necessary changes, it will need to be more proactive in the active development and installation of desalination, water reuse and rainwater capture as well as growing a market for moving or storing water for the long-term.

This conclusion by Megdal is also shared by Rolando Diaz-Cervantes in their article titled “Urban water security: a comparative study of cities in the arid Americas” which studied Tucson, AZ as well as Hermosillo, Mexico and Mendoza, Argentina to show the different recognized approaches to water resource management in these semi-arid urban areas. These cities are examined through the lens of the “Urban Water Security Framework” which looks at five domains: sociodemographic, economic, technological, ecological and governance to determine the threat of water insecurity. This analysis concluded that it is easier to speak about these locations in terms of water insecurity than security due to the multitude of threats to a secure water supply (droughts, altered ecosystems, population growth, overexploited water bodies, and obsolete infrastructure).

Rainwater harvesting is discussed as an affordable and viable option in several articles such as “Remaking stormwater as a resource: Technology, law, and citizenship” by J.J Cousins and “The Law and Policy of Rainwater Harvesting: A Comparative Analysis of Australia, India, and the United States” by Brianne Holland-Stergar. Both articles conclude that if the necessary actors (engineers, urban planners, politicians and voters) are diligent to promote change, market driven and codified RWH policies can encourage adoption of RWH technologies to decrease reliance on more traditional water sources such as municipal water supplies. Holland-Stergar references the use of a rebate program in Tuscon, AZ which was largely unsuccessful because the accompanying educational programs focused on installation of the systems instead of responsible uses for harvested water. Building codes mandating RWH systems for new commercial and government buildings may therefore be a better short-term solution as municipalities could use this rainwater while prioritizing education programs on responsible water use at the household level to overcome the common issue of water misuse and waste.

The issue of rainwater being misused when available is not the only challenge faced by Colorado. As Katie Meehan explains, policies such as “prior appropriation” dictate the amount of water the Upper Colorado River Basin of which Colorado is a part owes to the states of the Lower Basin. Therefore, water preservation such as RWH are limited by law even at the household level. While this may change in the coming years as the Colorado River Compact is renegotiated, greywater use may be a more viable immediate solution. Jerd Smith and Michael Elizabeth Sakas both examine greywater use in the context of Colorado in their articles. Smith outlines the current policies dictating greywater use and Sakas outlines deterrents to the adoption of greywater use such as high costs of things like diversion valves, costly oversight, and policies

prohibiting retrofitting old homes or buildings. Like RWH, educating the public and providing rebates or other incentives are identified as the best ways to promote the use of greywater.

Greywater and RWH promotion:

Ultimately, the realistic range for RWH and greywater's impact on water insecurity looks different in every state in the CRB. The Lower Basin states such as Arizona are less restricted by policy surrounding downstream water allotments. This is the main reason Arizona is a key focus of many articles as it has the advantage of being able to be experimental for the benefit of sustainability. For Lower River states, RWH would therefore be the ideal way to promote sustainable water management. However, in Upper River Basin states like Colorado, policy will continue to make RWH at any large scale difficult to codify and promote. Therefore, greywater use would be a more viable solution. In his article, Vitor Vinagre emphasizes the trend found in many of the outlined articles. The underlying trend that without education, both solutions will be ineffective. Therefore, all seven states in the CRB must "prioritize education around not only the supply of water but the demand and responsible use of water by urban residents" (Vinagre, 2023). As Mukherjee states in her article "Carrot or stick: what motivates urban water consumption? Evidence from Southern California", policy is important to set a benchmark for change. However, even once the policy is withdrawn, yearly water consumption rates can be expected to maintain reduced levels as adapted tools and knowledge for reducing consumption and reusing water continue to be used.

Introduction to Community and Context:

Upper Colorado River Basin:

The Upper Colorado River Basin includes Wyoming, Colorado, New Mexico and Utah. These states face stricter regulations surrounding water conservation due to the high water

demands of populations in the Lower River Basin (Arizona, California and Nevada) as outlined in the literature review. I will use Denver as a pilot community as it is the most populated urban area drawing municipal water from the Upper Colorado River Basin. It is worth noting that the city of Denver sits just east of the recognized Colorado River Basin area. However, the sources of Denver's water supply are split almost evenly with half coming from west of the Continental Divide and the Colorado River system and half from tributaries of the South Platte River outside of the Colorado River Basin system (Adams, 2021).



Graphic 1: The Colorado River

Denver Context:

According to the 2020 Census, Denver's population was 715,522 people. This is a 19.22% increase since 2010. When taking the surrounding metropolitan area into account, the population grows to 3.6 million people. Metro Denver is a relatively young region with a median age of 37 years old. 43% of the population is between the ages of 15-44 providing a concentrated workforce for a range of industries such as communication and software technology, aerospace and aviation, finance, and energy. This is a highly educated workforce with 92.3% of residents having completed high school, almost 4% higher than the national average. The political climate of Denver is strongly liberal with 79.6% of the people voting Democrat in the last presidential election. This liberal inclination sets Denver and Colorado at large apart from Wyoming and Utah which are significantly more conservative states within the Upper Colorado River Basin.

The cost of living and affordable housing topped the list of Denver resident voting concerns as voiced in a recent 2023 survey. Housing prices are high in Denver, attributing to only 49% of houses in the Denver metro area being owner-occupied as of 2021. This is well below the national average of 65.8%. This statistic may contribute to slower adaptations of water-efficient plumbing fixtures and greywater technology as renters are less likely to invest in improvements to homes, they do not own or note when maintenance to existing tools is needed.

Environmental Justice:

Another important consideration that must not go unaddressed is the impact of environmental injustices on the poorer neighborhoods in Denver. The Environmental Protection Agency (EPA) defines environmental justice as “the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the

environment”. As stated above, 49 percent of single-family houses in the Denver metro area are owner-occupied. While this number indicates people of all backgrounds struggle to secure home ownership in Denver, rates of home ownership are lower for Black and Hispanic residents than their White counterparts. According to a 2022 Colorado Sun article, “about 48% of white residents can afford to buy the typical home in Colorado, compared with 30% of Black residents and 32% of Latino people” (Flowers, 2022). The article further states that this homeownership gap has narrowed in the last decade between Colorado’s White and Latino households. However, the gap between Black and White homeownership continues to widen.

Further inequality exists in the continued historic trend of segregation seen in Denver’s neighborhoods. Denver’s 2020 Neighborhood Equity Index (Appendix 1) provides a valuable visual tool outlining the continued effects of such harmful practices as redlining. Per the City and County of Denver, “Denver, along with many other cities across the U.S., has a history of redlining. Government housing agencies assigned a grade from A to D to different neighborhoods in Denver and refused housing loans to people and families living in neighborhoods of a certain grade (namely grades C and D). Often, non-white populations lived in poor grade areas, and as a result, non-white families were not able to purchase homes.” This practice provides one reason for lower homeownership rates as well as the higher rates of concentrated BIPOC populations in Denver’s western and northern neighborhoods, neighborhoods which have less trees, fewer well-maintained green spaces and higher rates of lead contaminated residential water pipes. The North Denver neighborhoods of Globeville and Elyria-Swansea provide a good case study of the environmental injustice seen in Denver today. Local nonprofit Conservation Colorado works to “protect Colorado’s climate, air, land, water, and communities through organizing, advocacy, and elections.” In 2020, they conducted a study

mapping for environmental justice in Globeville, Elyria-Swansea (GES) compiling maps to better “visualize historic data and the present-day distribution of heavy industry and environmental hazards in Globeville and Elyria-Swansea” (Conservation Colorado). The mapping shows that the GES area continues to carry the burden of Denver’s heavy industry including agricultural refineries and smelters and toxic release sites both of which occur inappropriately close to residents exposing them to air and water pollutants with negative health outcomes. There are more government, academic and nonprofit programs than can be listed here working in these communities to address this disparity. However, progress comes slowly, and the legacy of water contamination tied to aging lead service lines and various industrial activity has many homeowners buying drinking water in bulk instead of drinking tap water. Trust in the municipal water supply must be reestablished in these neighborhoods for any program proposed here to be effective and equitable in all Denver Communities. In 2020, Denver Water launched an ambitious project to replace lead water lines in 64,000 to 84,000 properties over the next 15 years. This project was approved and continues to be monitored by the EPA who “applauded Denver Water’s approach to health equity and environmental justice” by prioritizing historically underserved communities.

This development will bring health benefits to residents, but inclusive outreach and communication will also play a role in optimizing positive outcomes of such projects. Sabrina Scherma, Programs Director of Water Education Colorado, a nonprofit providing services in GES identified the provision of Spanish materials to be a main barrier in getting information out. Nonprofits are key in filling this gap as the Colorado government does not yet disburse all information in Spanish as a standard practice. Spanish language material will be crucial in the engagement, capacity building and empowerment of Denver neighborhoods such as GES where

census reports show the majority of households are primarily Spanish speaking (63.6% of Elyria-Swansea).

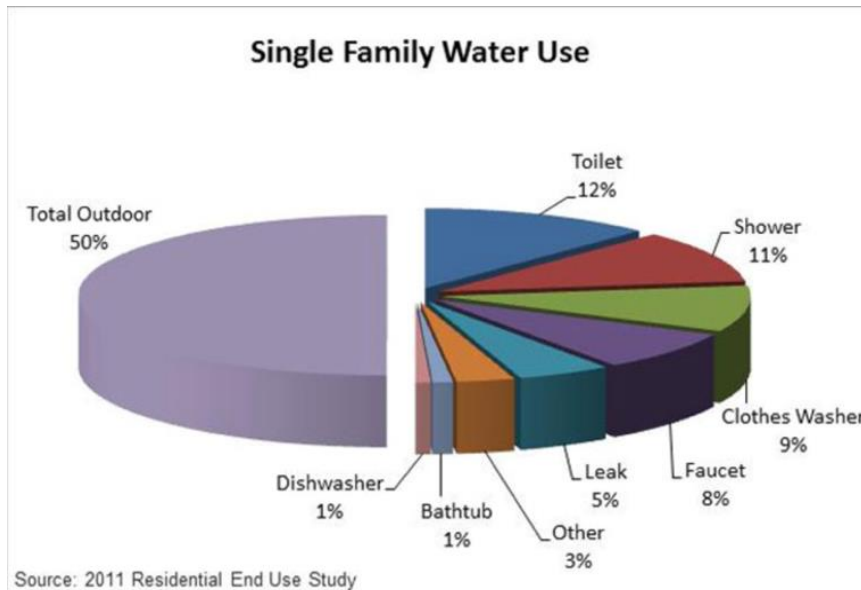
Residential water use:

Denver Water as a utility strives to keep water affordable while encouraging conservation. It therefore employs a tiered residential rate structure based on how much water single-family residences use. “Indoor water use — for bathing, cooking and flushing toilets — is essential for human life and is charged at the lowest rate. Efficient outdoor water use is charged in the second tier (middle rate), followed by additional outdoor water use in the third tier (highest rate)” (Denver Water, 2024). In addition to charges based on water use, the rate structure also includes a monthly fixed charge based on the size of the household’s water meter.

Tier	Monthly consumption (gallons)	Rate per 1,000 gallons
Tier 1	0 to average winter consumption (AWC) — see Note 3	\$2.78
Tier 2	AWC + 15,000	\$5.00
Tier 3	Greater than AWC + 15,000	\$6.67

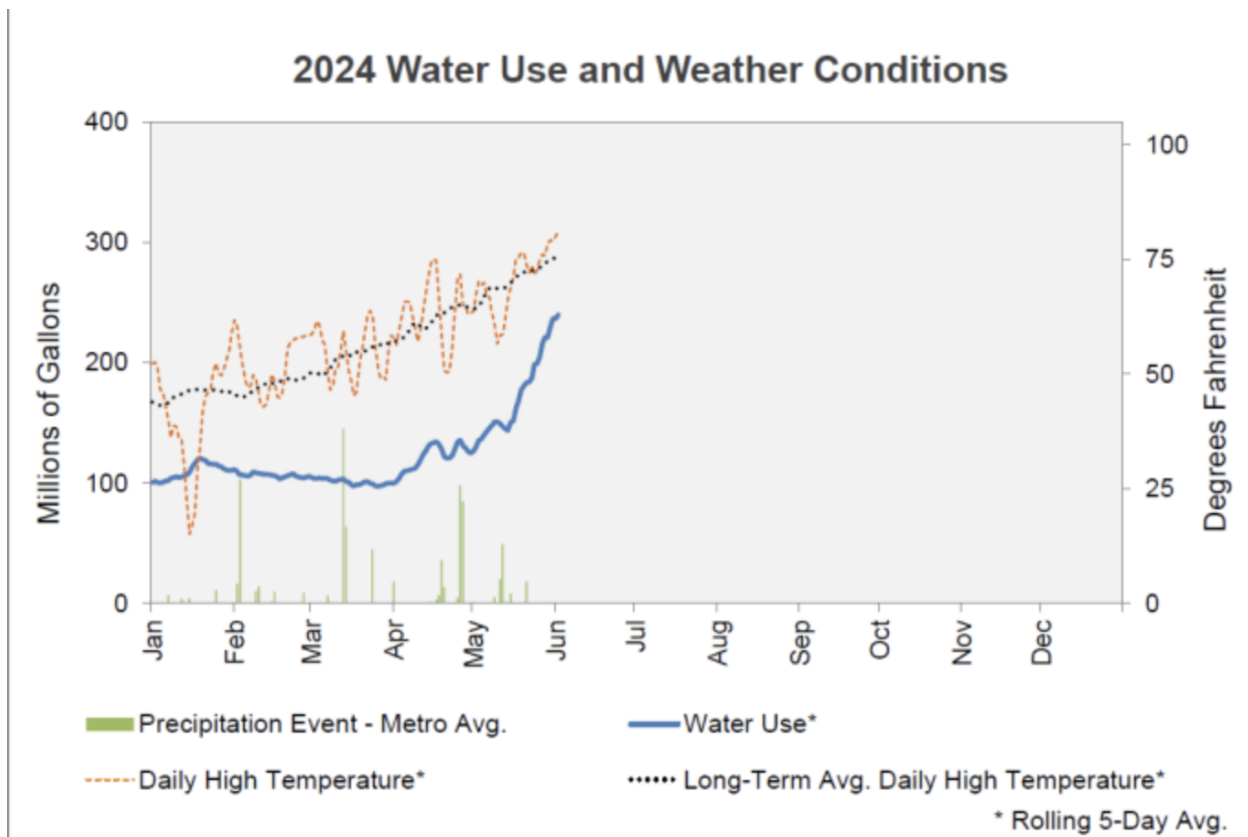
In the United States, the average in-home water use is approximately 60-65 gallons per person daily (Evolve, 2022). This estimation places Denver water users slightly below the national average. According to Denver Water, as of early 2023 on average “single-family residential customers use about 50 gallons per person per day inside the home — about 10 gallons

more per day than our efficiency experts would like to see people using”.



Graphic 2

Graphic 2 shows the average percentages of water use in single family homes as of 2011. As seen in the graphic, outdoor water use is significant. “Outdoor water use represents up to half of total urban water demand in many semi-arid and arid cities and presents a climate adaptation challenge in urban centers” (Blount, et. al, 2021). Denver is no different with outdoor water use representing 50 percent of single-family water use in 2011 and 40 percent of total annual demand in 2016 per the Colorado Water Conservation Board and single-family residential (SFR) irrigation representing approximately 23.5% of total demand.



Graphic 3

Graphic 3 shows the drastic increase in water use during the warmest months of the year (June-September). Outdoor water use is a driving factor in higher water use levels especially in the suburban neighborhoods of the Denver Metro area most of which also falls into Denver Water’s service area. In these areas, residents plant irrigated turfgrasses and other urban vegetation in private and public outdoor spaces at higher rates than in urban areas where population density, cost of living and types of homes make the maintenance of such non-functional turf grass less permissive. “Increased temperatures are projected to drive increases in demand for outdoor water use in existing developments” (Blount, et. al, 2021). This increased demand can be countered by RWH, greywater irrigation and low water use, or xeric, landscaping practices, all of which are being actively promoted by Denver Water.

Stakeholder analysis

Table 1: Broad Overview of Stakeholders

Type of Stakeholder	Title of person/ organization	Relationship to water	Incentives, motivation, risks	How to engage with project
Government	Municipal Water Managers (Denver Water, etc...), City and County of Denver, United States EPA (Office of Ground Water and Drinking Water), Colorado Dept. of Agriculture, Colorado Dept. of Public Health & Environment, Colorado Water Conservation Board	Establishing and upholding laws and policies, dictating water rates, providing high-quality safe drinking water to public	Drying municipal water supplies, public resistance/upheaval to changing water needs, challenges keeping different stakeholder groups happy, strong lobbying from agricultural associations	Research (secondary data source), connections to private sector and NGOs, apply for funding, inform and seek feedback on project
NGOs (Water management/ conservation)	Colorado Water Congress, Colorado Water Education, CSU Spur, Colorado Water Wise, Groundwork Denver, Metro Water Recovery, Resource Central, Colorado Watershed Assembly, Citizens for San Luis Valley Water, Clean Water Action, Rocky Mountain Water Environment	“Ensure prudent use of water in conjunction with agricultural, ecological, and recreational environment”, promote understanding of local water resources, and water issues, advocate for updated policies and tools for water management/ conservation	Colorado River Basic Water Compact and water laws, changing community and environment, access to public funding, economic/ political priorities	Potential funder, learn from their current water conservation curriculum, research (primary data source), share results of research

	Association, American Water Works Association			
NGOs (Environmental Justice)	Colorado Village Collaborative, Commún Denver, Globeville- Elyeria-Swansea (GES) Coalition, Denver Urban Gardens (DUG), West Denver Renaissance Collaborative (WRDC)	Through DEI and community sustainability efforts, Promotion of equitable water/environmental rights and development in Colorado	Changing community and environment, access to public funding, economic/ political priorities	Potential funder/partner in program work in disproportionately impacted neighborhoods, support in community relationship establishment, research (primary/secondary data source)
Private Sector	Local businesses, Water System Solution Companies (Greyter, Hydroloop, PureCycle) Agriculture, Large-scale farmers, Energy utility companies	Water users, adhere to local laws and policies, Partners/vendors in household level water efficiency solutions and systems, Promote, install and maintain systems	Cost of water (fees, taxes), rebates, updated plumbing and water management tools, security of water for selves and future generations, engagement with natural environment, conservation knowledge (or lack thereof)	Research (primary data source), inform and seek feedback on project proposals, main beneficiaries/subjec ts of changing policies and tools
Civil Society	Homeowners' associations, Voting organizations, Western Resource Advocates, Water for Colorado, Rotary Clubs	Connect organizations and government to people, represent local perspectives, promote clean drinking water and sustainable water management	Concern for water, environment, and ecology, narrowing of civil society space, volunteers time and resources	Engage early in research (focus group population, survey question development), funding, conservation education curriculum development

Households and Small-holder farmers	Households and Small-holder farmers	Drinking water, hygiene and sanitation, plant and pet care	Increased knowledge of household water priorities, reduced cost of water	Primary research subjects, education/conservation initiatives
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Due to the abundance of stakeholders involved in this issue, the below table further defines the narrowed list of stakeholders involved in the below proposed program plan. Their relationship to water and incentives and motivations will remain the same as outlined in Table 1.

Table 2: Stakeholders involved in program

Type of Stakeholder	Name of person/organization
Government	Denver Water, City and County of Denver
NGOs (Water Management/Conservation)	Colorado Water Education, Resource Central, CSU Spur
NGOs (Environmental Justice)	Colorado Village Collaborative, Globeville-Elyeria-Swansea (GES Coalition), West Denver Renaissance Collaborative (WDRC), Denver Urban Gardens (DUG)
Private Sector	Greyter, Hydroloop, PureCycle
Households and Small-holds famers	Denver Water customers

Needs Assessment:

To best assess the needs for improved household water conservation and identify existing resources and challenges, I conducted semi-structured expert interviews and performed a

comprehensive review of available water conservation resources available to Denver Water costumers.

In initially considering different means of community engagement, I visited a largescale community that is under development in Arapahoe County, Colorado called Sky Ranch. While this community is only about 25% developed, it is expected to be home to approximately 9,600 people upon its completion in the coming years. A January 2023 CBS News article reported that this community is set apart from other new developments because of its unique water recycling facility that will allow for 100% of its water to be recycled. My initial goal when approaching the development was to utilize residents as survey participants to better understand what drew them to the neighborhood and their perceptions and understanding of their recycled household water. However, when speaking with two real estate agents for the neighborhood it became immediately clear that even they were not aware of the water recycling facility and could not articulate the benefits it holds for the residents. This was a very interesting and indicative piece of information to come away from the visit with and one that supported key findings from later expert interviews. However, the lack of awareness coupled with large undeveloped acres of land between residences made it a challenging community to engage with further.

Expert Interview Participants (December 13, 2023-January 18, 2024)

Name	Role	Organization	Location	Area(s) of expertise
Sabrina Scherma	Programs Director	Water Education Colorado	Denver, CO.	Community engagement, educational programming, resource development
Katie Duke	Water Efficiency Coordinator Board Member	City of Golden	Golden, CO.	Graywater, Environmental Sciences, Geographic

		Colorado Water Wise		Information Systems
Theresa Worsham	Sustainability Manager	City of Golden WaterNow Alliance	Golden, CO.	City System Sustainability, Public Administration
Jessica Thrasher	Diversity, Equity and Inclusion (DEI) Coordinator Board Member	Colorado Stormwater Center Colorado Water Wise	Fort Collins, CO.	Rainwater Harvesting, DEI, Green Infrastructure, Low Impact Development
Matt Bond	Manager of Youth Education	Denver Water	Denver, CO.	Youth Education, DEI, Communication
Donny Roush	Stormwater Education and Outreach	Denver Department of Transportation & Infrastructure	Denver, CO.	Stormwater, Environmental Education, Community Engagement
Austin Krcmarik	Water Efficiency Lead	Denver Water	Denver, CO.	Indoor water use, Urban and regional planning, Analytics, Environmental Policy
Bea Stratton	Senior Planner, Conservation & Efficiency	Denver Water	Denver, CO.	Master Gardener, Landscaping, Outdoor water use, Environmental policy
Mark Marlowe	Director of Castle Rock Water	Castle Rock Water	Castle Rock, CO	Watershed management, city system management, partner collaboration

Expert interview structure:

Interviews were recorded where possible and lasted an average of 1-2 hours. Six guiding questions were asked of all participants to direct the conversation as needed and keep a sense of continuity to better define trends. Depending on individual expertise, additional technical questions about topics such as rainwater harvesting, greywater use, and community engagement methods were also integrated into the interviews. Resources and follow-up information was shared via email exchange.

Guiding Questions:

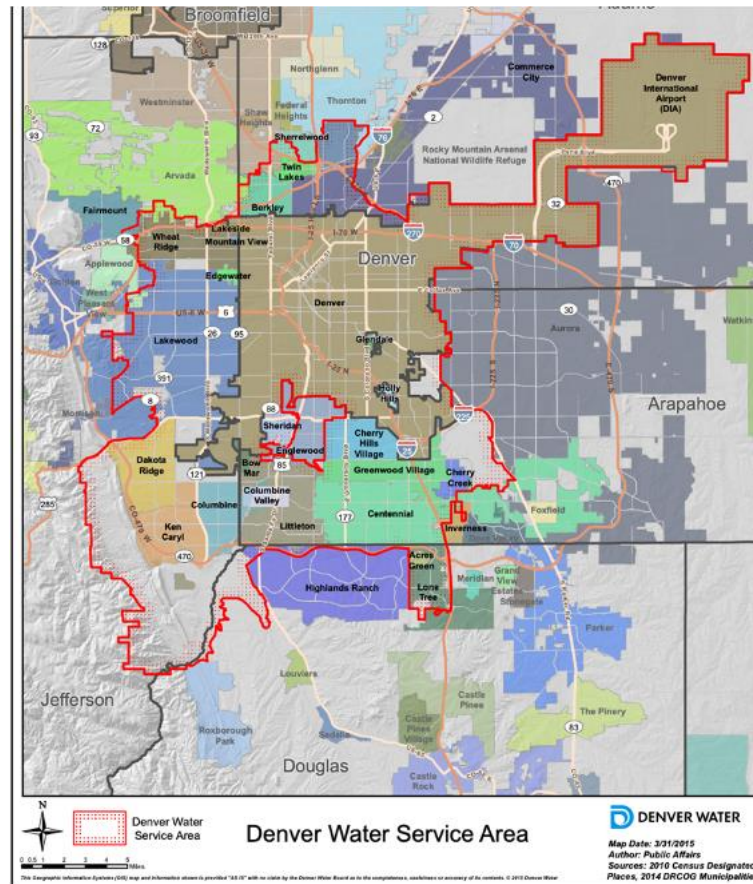
- 1) What policies/structures enable you to do your work? What policies/structures challenge your work?
- 2) What is the most important aspect of household level water management from your perspective?
- 3) How are new homes being designed with water conservation in mind? Are there any incentives (rebates, etc...) to update older dwellings?
- 4) Speak about past or ongoing education/community engagement campaigns to get citizens involved in water conservation. Have these been seen as successful?
- 5) What gaps do you see in urban water conservation initiatives in general?
- 6) Is there a project/program you wish to start or grow out further?

Key findings:

- *The importance of policy differences between municipalities/water utilities*

Speaking to a diverse geographic group of people working across different counties or under specific municipalities/utilities (Denver Water, City of Golden, City of Castle Rock, etc..) was eye-opening from a policy perspective. The means by which these different entities

receive their water dictates the “portfolio of water rights” they have and the approaches they are therefore able to take in conserving it. Consequently, when considering conservation initiatives, practitioners must be narrow in their focus to accommodate the means and needs of only one utility or municipality. It is for this reason that the following program plan and policy recommendations will be solely for Denver Water.



Graphic 4

Denver Water is the largest water provider in Colorado serving nearly one-fourth of all Coloradans. Per their website, “Denver Water is responsible for the collection, storage, quality control and distribution of drinking water to 1.5 million people”. Denver Water’s collection system is therefore very expansive, covering about 4,000 square miles and

extending into more than eight counties. The collection system is divided into two areas called the South and the North system. On average, 80% of Denver's Water supply is from the South System which includes the upper South Platte, upper Blue, and Bear Creek watersheds. The South Platte River Basin lies on the east side of the Continental Divide and therefore outside of the Colorado River Basin while the Blue and Bear Creek Watersheds are within the Colorado River Basin to the west of the Continental Divide (Adams, 2021). Denver Water owns and operates seventeen reservoirs for water storage and four water treatment plants across the South and North Systems. The vast scale of Denver Water's service area and the cost of operation and maintenance of reservoirs, treatment facilities and services lines are key challenges in developing program plans as will be addressed further below.

To best understand the unique challenges and advantages with which Denver Water is presented, I will compare its operations with that of Castle Rock Water. Castle Rock Water provides water to the town of Castle Rock (seen at the bottom of Graphic 4) located approximately 30 miles south of Denver. Castle Rock is a town frequently cited by interview participants as the best example in integrated advanced water conservation. Examining their structure and practices is therefore a good place to start when seeking to better understand how policy and governance can play an advantageous role in household level water conservation.

Vertical Integration:

When asked what policies enable Castle Rock's mentality surrounding water conservation, Director of Castle Rock Water, Mark Marlowe first stated:

"Unlike Denver Water [for example], we are a very young and new municipality that is growing very fast and so we don't have a lot of the old, senior water rights that some of the older communities have. Therefore, water is scarcer in Castle Rock so conservation becomes a really cost-effective approach. We treat conservation like a supply because as we're able to

conserve we're able to bring additional water supplies for more critical or beneficial uses than some of the past uses.”

Considering household water conservation as a cost-effective supply point for water is an important mentality Castle Rock holds that larger or older utilities like Denver Water will need to grow into as spending budgets can be reoriented slowly away from largescale storage and distribution systems to focus more on re-use and conservation.

As a young town, Castle Rock is home to many up-and-coming housing developments all guided by the town's Development Services Department. This department is responsible for the permitting, zoning and monitoring of developments and is also very closely integrated with Castle Rock Water. This close working connection between the town and water provider was referenced by one interview participant who said:

“One nice thing you might find communicating with Caste Rock is that they are a vertically integrated structure meaning their water utility is a part of their city structure. They work really well on the code side and it's all a cohesive package. Denver Water being a utility, we serve the City and County, but we are not a city and county department, so it makes that regulatory side harder” [Austin Krcmarik].

This vertical integration and the smaller size of the community allows for a more advanced, creative and faster acting planning process. As such, Caste Rock is able to be more aggressive and strategic with their water conservation than Denver including adopting a unique water budget rate structure.

Water Budget Rate Structure:

Mark Marlowe stated this rate structure, put in place in 2010, is the single most important aspect of household level water conservation from a policy standpoint. In accordance with this tiered rate structure, each water account (household) has an individual water budget that is reset annually. The indoor water budget is based on household water consumption in the winter. The

outdoor water budget is calculated based on the property's irrigated area and evapotranspiration. Owners of new homes must submit a landscape plan which further supports setting the budget for irrigable space. This early collaboration between City managers and homeowners and the ongoing communication surrounding water budgets establishes an early mentality of community-oriented conservation in Castle Rock.

The tiered rate structure further promotes this mentality through financial incentives as residents pay an "excessive use rate" should the amount of water used be over their total water budget allocation. A water conservation measure adopted by the Town Council also allows for a "conservation surcharge" to be assessed for each 1,000 gallons used once a single-family residence surpasses 40,000 gallons for the period. This rate structure does not mean that residents pay more than the average Coloradan. In fact, per the Town of Castle Rock, annual financial analysis for water rates and fees shows that Castle Rock Water's rates are mid-range compared to other water providers in the region". However, rate structures such as these along with other techniques such as Advanced Metering systems promote a culture of transparency and awareness around water use that is crucial to household water conservation.

Advanced Metering Infrastructure:

Castle Rock is currently in the process of transitioning to advanced metering infrastructure with the hope of having the new system fully functional in the next year. These household meters will allow residential customers to monitor water use daily in real time. During our interview, Marlow recognized the significant cost that comes with such an upgrade even for a town the size of Castle Rock which serves 85,000 people (56% of the amount of Denver Water's service area). However, the Town has accommodated these costs for the benefits the system will provide:

“We’re definitely proceeding with it and we think knowledge is power. All the research we see indicates that if people know how much they’re using they’re certainly much more likely to be efficient and cognizant of it” [Mark Marlowe]

As new homes have these advanced meters installed, an accompanying placard is also placed next to the water meter providing information about landscaping and the water budget for the home.

This promising development for Castle Rock is one that Denver Water has not begun to integrate likely due to the high cost, vast service area other budgetary priorities facing Denver Water and differences in water source supplies. Therefore, Denver Water continues to use residential water meters which track the gallons used since the meter was installed. The number shown on most meters in use will only be to the nearest thousandth gallon. Therefore, while curious customers can check their meter periodically and subtract the first reading from the second reading to see the amount used between readings, the amount they will see will still represent a broad range only being updated with every thousand gallons used. This makes water waste issues such as leaks harder for homeowners to quickly identify and remedy. The location of many residential meters also presents a challenge to customers wishing to check their usage or verify the monthly reading on their water bill. Denver Water explains “most Denver Water customers have outdoor meters set in pits in the front yard or in the back sidewalk”.

Additionally, a Denver Water employee explained:

“We also do not allow after the fact smart water monitoring devices that interfere or go on our meters in anyway whereas other utilities encourage that. I think there’s a huge void of that next level data or information” [Austin Krcmarik].

The effort required to locate and monitor current meters creates a further divide between residential water users and the knowledge they need to make informed decisions.

- ***Availability of community engagement and education material***

Educational material and community engagement material exist in abundance. All interview participants readily referenced resources provided by Denver Water or collaborating organizations working in environmental justice or water conservation spaces. As one interviewee stated:

“We have a really public affairs department really dedicated to communication...Denver Water is way on the front edge of things in terms of understanding the communication aspect of the information and knowing that’s important” [Matt Bond].

In reviewing recent material through Denver Water, the diverse means in which this material is made available also became clear. Websites, social media, YouTube, K-12 school curriculum and direct community engagements are all methods used by Denver Water to promote residential water conservation.

Web Communication:

Denver Water maintains websites, social media pages, and a YouTube channel. DenverWater.org first navigates visitors to information about household water use including the two graphics presented under the Community and Contexts section. The website is well organized and navigation to education or more in-depth residential materials is easily found. From the residential tab, comprehensive information can be found outlining currently offered rebates, most of which are for WaterSense products. These are products “backed by independent third-party test and certification and meet the Environmental Protection Agency’s specifications for water efficiency and performance”. WaterSense’s labeling allows consumers to identify products that will perform well and save water. Denver rules for outdoor water use, lawn watering, outdoor water use reports, indoor use self-audit guides and resources for

“Coloradoscaping” are also outlined. Among the resources for “Coloradoscaping” is a 20-page “Water Wise Landscape” Handbook produced by Denver Water and free for download. Denver Water's TAP website seeks to connect residents to their water use by telling local stories and providing up to date news. Customers can subscribe to their newsletter to receive headlines every week.

A detractor that several interviewees noted about web communications is that as a utility service, Denver Water’s website operates separately from the City and County of Denver websites. This poses a navigational challenge for customers seeking information online who may not be aware of the difference between the two entities. The layout and management of City websites is also a concern for water educators seeking to streamline communication. When interviewed, one employee stated “City and County of Denver’s website is convoluted and difficult to navigate. We are not Denver Water when it comes to the website. A lot of people can make changes to the websites so there are a lot of chefs in the kitchen. The bureaucracy of the city has been cumbersome”.

School Curriculum:

While bills are paid and households managed by adults, youth education is also a key aspect of Denver Water’s public engagement campaigns. Understanding where their water comes from, and the critical aspects of the water cycles and climate change all play a part in connecting youth to their environment and driving generational change that will ensure water conservation continues to be a priority in coming decades. Youth are also becoming increasingly more savvy communicators and consumers at every level. This observation was well stated by one interviewee:

“In the last 15 years, we have come to an understanding for better or worse sometimes that the youth population is a separate entity to be communicated with and that they are very much water users in the same way you and I are” [Matt Bond]

Engagements with K-12 schools within Denver Water’s catchment area is done very collaboratively with teachers and administrators. Conservation messaging is integrated into already established teacher goals or grade level curriculum to promote engagement and ensure educators are not diverted from their own performance metrics. Lessons are therefore often co-planned with teachers to supplement their lessons while also providing conservation and management messaging desired by the city. One interviewee, an environmental educator by background explained that “the water angle can be found pretty much anywhere” – for any subject and at any grade level. Due to this adaptability, Denver Water and its youth educators reach about 10,000 youth and adults in classrooms across the service area every year.

The classroom connection also helps youth gain an understanding of our unique watershed by providing environmental messaging in a local context. As one interviewee put it:

“With textbooks, they’re writing things at a really basic level that are going to apply generally across the board. For example, your traditional water cycle graphic with the ocean tied to whatever else, while that makes perfectly good sense in a large picture reality, it does not give you the local reality here on the front range with the Rocky Mountains, the Continental Divide, and the way climate and weather works. We are giving them information that is directly tied to the lives of those students as opposed to a more theoretical look at things” [Matt Bond].

In grounding education practices, educators are also dedicated to understanding the different living realities of K-12 students and approaching educational messaging with a Diversity, Equity and Inclusion lens. One interviewee acknowledged the challenges this can provide in bringing youth equitable, relevant information.

“Household level conversations can be tricky with the students I work with because you can’t assume they live in a single-family home. I have to go in thinking through DEI. I

will often defer to the language I hear teachers using because they know their classrooms better than me” [Donny Roush].

The consistent, equitable access to water conservation material especially for marginalized populations remains the largest gap as will be spoken about further in the coming Challenges section.

Community Education Initiatives and Citizen Engagement:

Denver Water also attempts to connect more directly with water users through mailers, events and challenges. Mailers are often more time sensitive pertaining to such information as how to request water filters, participation in the ongoing lead reduction program or winterizing plumbing to reduce leaks. Denver Water’s “Use Only What You Need” campaign ran from 2006-2016 and was hugely successful, playing a pivotal role in creating a culture of conservation in the greater metro area. This decade-long campaign was launched in response to the severe drought in 2002. It utilized humorous, eye-catching messages on billboards, park benches, bus stations, grocery store conveyor belts, stadiums and other public spaces encouraging customers to take a hard look at how much water they truly needed. Years after the campaign ended, it continues to be recognized for its effectiveness and memorability. “By the time the campaign ended in 2015, water use by Denver Water’s customers had dropped 22% compared to usage before the drought” (Proctor, 2022). Today, the messaging remains but is more individualized, making better use of the digital space.

While this campaign is the most notable example of an advertising victory in the past decade, Denver Water continues to utilize the power of online and digital spaces. However, as citizens meet the goal of using less of their services, Denver Water will continue to have less income from billing and service fees and therefore generally does not prioritize funding toward advertising. Ongoing partnerships between Denver Water and local non-profits are therefore

necessary to maximize community engagement. Sabrina Scherma, Programs Director for Water Education Colorado spoke about their contributions to this space. In 2022, Water Education Colorado spearheaded a year-long public awareness campaign and celebration of Colorado's Water replete with volunteer days, expert talks, multi-media PSAs, film screenings and a student water awareness week. "The campaign highlighted simple actions that anyone could take to conserve and protect Colorado water and asked Coloradans to take the Water '22 pledge to commit to 22 Ways to Care for Colorado Water in 2022" (Guerts, 2024). The recommendations and resources to households and individuals that Water Education Colorado and many other local non-profit organizations provide are critical in filling Denver Water's funding gap and supplementing their work. Denver Water will often partner with these organizations to provide material resources especially to disproportionately affected areas.

"Last March on World Water Day, Metro Water Recovery, CSU Spur and Groundwork Denver put together a rain barrel workshop. We had 40 barrels constructed and go out to families in Globeville, Elyria-Swansea neighborhoods that day" [Donny Roush].

Days such as these allow water management actors an opportunity to connect with different communities on their land and support in the construction of rain barrels, planters and other outdoor spaces where much attention will continue to be paid in the future.

- ***Priority on reducing outdoor water use through climate appropriate landscaping***

Counties and utilities across Colorado and the wider Colorado River basin are prioritizing programs for outdoor water use reduction. Denver Water is no different. The development of xeriscaping or "Coloradoscaping" is a key piece of household water conservation planning for

the obvious reason of reducing single-use water in outdoor spaces. However, responsible outdoor water use is also crucial to the success of programs seeking to increase the use of saved or recycled water such as rainwater and greywater.

Rainwater Harvesting (RWH):

The use of rain barrels to collect and hold rainwater in Colorado was legalized in 2016 after many years of restriction due to downstream water rights.

“In 2016, Colorado Water Center proved through research that a 110-gallon water limit is not enough to take anyone else’s water. At the time, Colorado and Utah were the only states that had Rainwater Harvesting restrictions. However, there is now an understanding that captured water will still eventually make it into the watershed” [Jessica Thrasher].

Today, no permit or other approval is required for any single-family residence to capture and use precipitation in rain barrels with a combined storage capacity of 110 gallons at any time.

Water can be collected from the roof of a residence. Therefore, connecting rain barrels to gutter downspouts is generally thought to be the best practice for rainwater collection. Tools such as “downstream diverters” are easily purchased and can be found in affordable price ranges.

However, even the small cost of installation was identified by several experts as a barrier to entry and a main reason rainwater harvesting is not more widely used by Denver residents. Interview participant Theresa Worsham provided Golden as an example of the cost/benefit analysis many residents face stating, “it is \$6 for 1,000 gallons of water in Golden but installation of rainwater systems is more than \$250”. Rain barrel workshops such as the one previously hosted in the GES neighborhoods or rebate programs to reduce the cost of installation will therefore need to be a central piece of community engagement for rainwater harvesting to have any meaningful impact. While RWH is not currently widely used, its value not only as a means of small-scale water conservation but also a tactile, tangible means of connecting homeowners to their outdoor environment is one recognized by water managers in the region. Promoting “appropriate water

for appropriate use” is an essential mentality to encourage among homeowners. Placing the impetus on rainwater users to evaluate the quality of the collected rainwater and ensure it is appropriate for proposed outdoor uses such as lawn and garden irrigation will grow citizens’ awareness of how much water goes into certain tasks and promote a culture of mindfulness and conservation.

Greywater use:

Just as Rainwater Harvesting has struggled to find a foothold among Denver Water users, so has greywater use. Per Elizabeth Sakas’ article for Colorado Public Radio, “Not a single state-approved greywater system has been built since it was legalized (in 2013). Only Denver, Castle Rock and Pitkin County have adopted the code, known as Regulation 86, that regulates how greywater gets done in the state” (Sakas, 2019). Simply explained, Regulation 86 “establishes the minimum state-wide standards for the location, design, construction, operation, installation, modification of graywater treatment works” (Colorado Department of Public Health and Environment, 2015) but places enforcement and management authority of graywater systems with the local city and county. The fact that Denver is one of the municipalities to adopt the code therefore means that residential greywater use programs can be implemented by Denver Water and integrated into new home builds or water use plans. Currently, Denver Water defines greywater as untreated wastewater from common household fixtures such as bathtubs, showers, washing machines and laundry tubs. For outdoor purposes, water from a laundry machine for example, can be connected to the exterior of the home with the addition of a y-valve that can be opened or closed seasonally by the homeowner to divert the flow of the water away from the sewer and toward the desired outdoor space.

As recycled water use for irrigation is still in its infancy in Colorado, Denver Water is currently partnering with the Colorado Water Conservation Board (CWCB) “to fund research into the impacts of using reclaimed water to irrigate edible crops with a focus on soil health, crop yield and food safety” (Denver Water, 2023). Research such as this will help inform water managers and educators on water sources supplying urban agriculture and landscapes at various scales and support in the further integration of graywater use at the residential level.

Climate Appropriate Landscaping:

As the above initiatives grow, much of the focus will continue to be on reducing the need for outdoor irrigation to ensure that this saved or recycled water does not go to waste. For generations, public and private outdoor spaces in Colorado urban and suburban areas have been built around what regional water managers deem “non-functional turf grass”. This is grass such as Kentucky bluegrass or perennial ryegrass, varieties of turf grass that are aesthetically pleasing and sturdy but more water intensive than the native plants found in the semi-arid, high-desert climate of Denver. Several experts interviewed cited legislative changes as a key driver in reducing turf grass. In August 2022, Denver Water signed an agreement to reduce turf grass by 30 percent. While the time frame for such reductions is still under negotiation, 2025 will likely be a turning point. A bill first drafted in November 2023 by the Water Resources and Agriculture Review Committee for the State of Colorado, if approved by the people in the general election in November 2024, would serve to greatly restrict turf grass in new home builds. According to the published draft summary, “on or after January 1, 2025, the bill prohibits local governments and unit owners’ associations of common interest communities from allowing the installation, planting, or placement of nonfunctional turf, artificial turf, or an invasive plant species on any commercial, institutional, or industrial property”. It is worth noting that appropriate allowances

will continue to be made for community or recreational purposes such as neighborhood parks, sports fields, and playgrounds to ensure quality of life is not adversely impacted. As several municipalities have already implemented restrictions, water resource managers feel optimistic about the approval of this bill into law.

Programs and policies supporting the transition to climate appropriate landscapes are currently most established in the neighboring cities of Aurora, Castle Rock and Golden. In Castle Rock, for example, owners of new homes are not allowed any irrigable turf in their front yard and less than 500 square feet in the backyard. The City of Aurora offers free professional water-wise landscape designs to Aurora Water customers. Per Aurora Water, customers can consult with Aurora Water staff to select designs for their space in line with themes that address specific challenges such as shade provision or pollinator support. These are important developments for residents and water managers seeking to keep pace with regional progress and policy. While legislation may be what initially ushers in the necessary changes, learned behavior and community pressure will be what cements an attitudinal and behavioral shift to climate-appropriate landscaping practices. As one expert stated:

“Denver Water has a pretty large PR wing but there is a little bit of free advertising in knowing what your neighbors are doing which is helpful for building programs. It is hard to change what is kind of the norm currently where we are on the front range” [Austin Krcmarik].

While these experts acknowledge that Denver Water is further behind than most regional municipalities in addressing this challenge, there are currently several pilot programs in the works to support in the removal of turf lawns and the growth of climate appropriate landscaping for Denver Water customers. One such program will be the first of its kind in Denver to offer financial incentives for turf removal. Denver Water will provide up to \$500 per home to go toward turf removal in partnership with a key nonprofit partner, Resource Central. The same

customers participating in this turf removal program will also receive a seed mix to replace perennial grasses with native grasses to create new low water gardens. Partnerships with nonprofits are important not only in piloting and testing solutions but also in investing in disproportionately impacted communities. Denver Water is actively seeking potential partnerships in the hope that “greater collaboration with locally based organizations will allow all homeowners (and businesses) to improve their capabilities by way of better access to landscaping options” (Koval, 2023).

These programs are increasingly utilizing the term “Coloradoscape” instead of older terminology such as “xeriscaping” in an effort to demystify the language surrounding the topic.

“Castle Rock coined the Coloradoscape term. We did that because the xeriscape term is kind of a negative term people viewed as just putting rock in your yard and doing nothing else. The concept of Coloradoscape is that it is a landscape with lots of different textures, colors and plants. Most of them are native and drought tolerant. Most of them are very beneficial for the community” [Mark Marlowe].

The continued development of these “Coloradoscaping” pilot programs in the years to come coupled with the legally imposed reduction of turf grass in new builds will be the single most important factors in reducing the outdoor water use that currently accounts for 40 percent of annual residential demand.

- ***New home builds as a focus for innovation***

The installation of water efficiency tools is seen as especially challenging in older homes. This is for the simple reason that updates are harder to introduce into old homes due to factors such as plumbing codes and home layouts. Large scale plumbing code updates are possible but require a costly, large-scale effort and a review process that often takes years to study before approval. For example, Castle Rock is currently in the middle of a study to change their

plumbing code to better reflect the efficiency of the indoor water fixtures being installed today. In Castle Rock, Denver and much of Colorado, there has been little infrastructural work done to change the size of the pipes coming into houses even though the houses are using significantly less water now than at the time of installation. Reducing the size of the lines serving homes will save additional water and also change the cost of the material for the plumbing and installation. These updates are therefore seen to be cost-restrictive, especially for a utility serving as vast an area as Denver Water.

Therefore, new residential home builds are where much of the innovation is taking place. Denver Water is taking advantage of partnerships with new developments to pilot the installation of greywater systems in homes. One such partnership began in 2020 in the Central Park (previously Stapleton) neighborhood in Northeast Denver. Through this project, “forty new homes will be equipped with (Greyter Water) systems that capture shower and bathwater and reuse it for flushing toilets – a major technology shift that will reduce a home’s indoor water consumption by as much as 25% (Hartman, 2020). A “Greyter Water” system works by sending water from showers and baths down to a device which through three different processes screens out any large solid particles, microorganisms, remaining solids, soaps and foams. That water is then stored until the toilet is flushed with any excess greywater going to the drain – its typical path without the system. For a system such as this, two showers per day will typically meet the toilet flushing needs for a four-person household. In our interview, Jessica Thrasher cited this system as well as laundry to landscape systems and the “Hydroloop” system as promising water recycling tools that can greatly reduce indoor water use. The “Hydroloop” appliance can also reduce outdoor water use by redistributing water collected from baths, showers, washing machines and even condensation from air conditioners and heat pumps to washing machines,

toilets and outdoor irrigation systems. Systems such as these which allow water to be used twice stand to transform the way we use water. However, the cost-benefit analysis for the average household user indicates that systems will not be widely installed and utilized unless they come with the house. Therefore, a company like Greyter “currently focuses its efforts on new home construction and in areas where municipal water-conservation goals provide incentives for builders to adopt” (Oswald, 2021).

Installation programs such as these offer an opportunity to assess the effectiveness of greywater systems in residential settings and promote the “appropriate water for appropriate use” mentality. However, while architects and planners are designing homes more intentionally, the information about these innovations may not reach the residents. This issue becomes even more challenging when a mechanism requires maintenance or repair. The general awareness or cost-benefit analysis for the average homeowner from a time and budgetary perspective means many mechanisms will go unfixed or under-utilized over time. For this reason, providing financial incentives such as rebates, installing accompanying leak detection devices to all fixtures, and providing relevant system information to all homeowners at the time of move-in will be crucial steps in ensuring the long-term success of such innovations for Denver Water users.

Challenges:

The following were identified through the needs assessment as the key challenges in successfully implementing desired water conservation initiatives outlined above. The proposed program seeks to be responsive to these challenges.

- *Overwhelming amount of information and other daily priorities of citizens*

The conservation educators interviewed for this needs assessment cited the internet as a significant resource in engaging citizens. It has also changed the fundamental way humans generate and receive information. According to information scientists, “in 2011, Americans took in five times as much information every day as they did in 1986 – the equivalent of 174 newspapers. During our leisure time, not counting work, each of us processes 34 gigabytes, or 100,000 words, every day” (Levitin, 2015). The human brain has not yet evolved to be able to process this unprecedented amount of data to discern its validity or significance. The question of validity is also a challenge posed by the internet as information can now be disseminated by anyone regardless of their authority on the topic.

The continued relatively low cost of water for Denver Water users is a necessity for equity and health as water is a human right. As one interview participant put it:

“The low cost of water is a double-edged sword. How do you put a price hammer on something that is a basic necessity at a certain level. You design your rate structure to ensure that the indoor, necessary water-use that we all need is affordable and then the more we use the more we pay” [Matt Bond].

As financial considerations are often one of the largest, if not the largest consideration for new homeowners, this established low-cost rate structure for water leads other more costly aspects of life to take priority.

With these factors in mind, how can Denver Water grab and hold residents’ attention and present them with the information needed to drive water management programs forward at a time when they are most ready to receive it?

- ***Denver Water’s prohibitive budget***

The low cost of water mentioned above also reduces the funding available for the utility as water fees are the main source of income for infrastructure and system updates. Current

programming surrounding large-scale service line and infrastructure updates are taking priority under the current outlined budget. One interviewee explained this stating:

“As Denver Water is currently in the middle of our largest capital expenditure ever replacing lead service lines and expanding Gross Reservoir for extra supply, there is very little bandwidth for extra programming at this time. So, how do we provide programming to engaged customers who expect us to have incentive programs similar to those of Aurora or Castle Rock?” [Austin Krcmarik].

Denver Water has a robust public affair department. However, there is a general reticence around putting larger sums toward advertising because as a rate-based utility, those costs would be passed on to the customers.

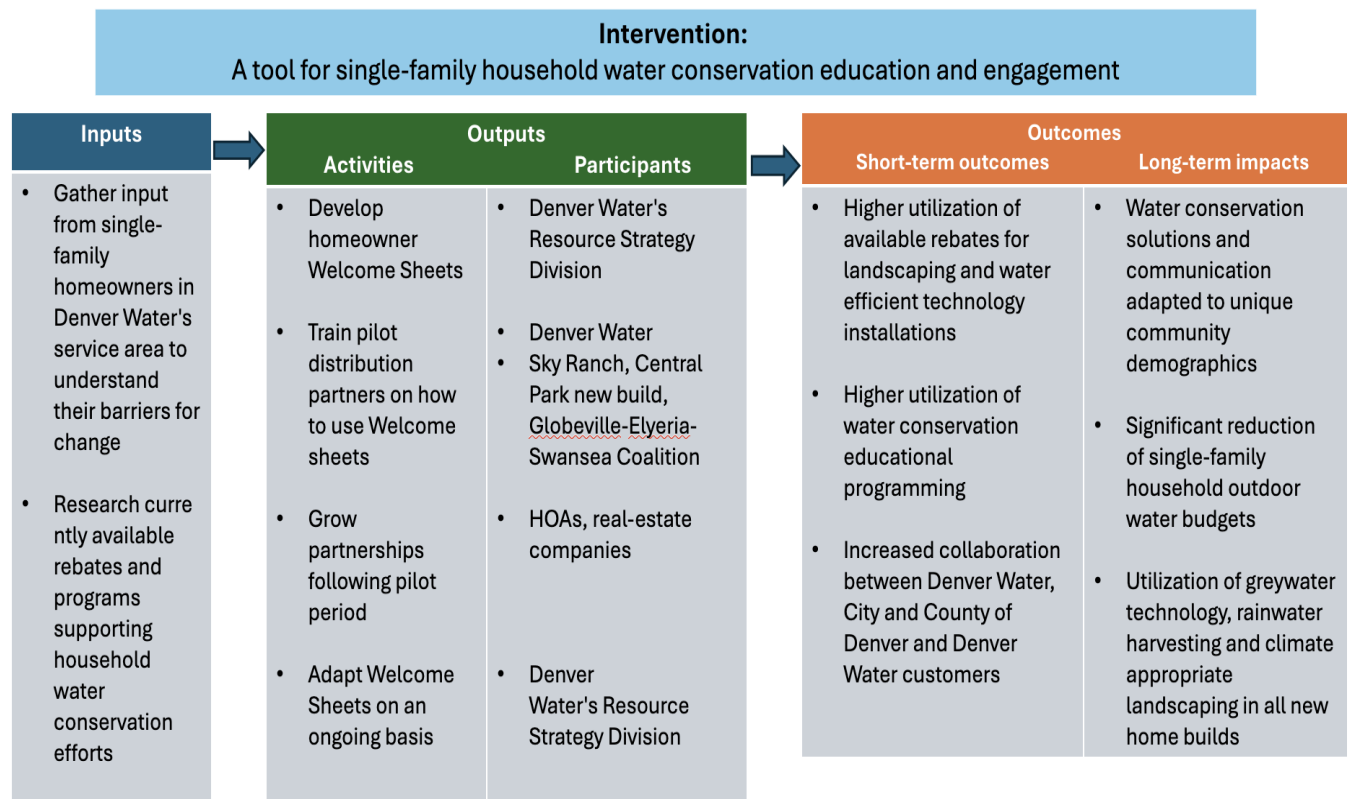
With the ongoing budgetary considerations, what is a low-cost tool for household education and engagement that can supplement already available resources?

- ***DEI concerns***

For any tool to be effective, citizens need to understand why this issue is important to them. They need to understand how they stand to benefit from partaking in the programs offered. Denver Water is working collaboratively with local, community-based, non-profits to better meet citizens where they are. However, the Colorado government does not yet disburse educational information in Spanish as a standard. This includes rebate promotions which are almost exclusively in English. This leaves the task of attempting to close the language barrier largely to people that work in the non-profit space.

What partnerships will be best to ensure the proposed education tool serves communities equitably?

Theory of change:



Assumptions:

This Theory of Change framework is based on the following assumptions:

- 1) Homeowners want to make use of knowledge and resources
- 2) The tool will not be too cumbersome for distribution partners
- 3) People will conserve the saved water instead of increasing water use in other spaces

External factors:

For the intervention outlined in the Theory of Change to be effective. The following external factors must be monitored and considered:

- 1) Codes and policies that allow for the use of recommended resources
- 2) The impact of climate change and pollutants on the fresh, clean water supply

Program Description:

This program aims to promote household level water conservation using the resources and community connections already developed by Denver Water. As mentioned under “Challenges” in the Needs Assessment, cost is a consideration for any public facing initiative as large-scale infrastructure and systems updates are currently underway. Therefore, the program intervention, as outlined in the Theory of Change, will include the development of a low-cost supplemental tool for customer education and engagement. This tool is new homeowner Welcome Sheets provided at the time of move-in to connect residents with information including:

- 1) Key tips for water conservation
- 2) Information about the water in the home (meter location, water recycling systems built into the home, etc...)
- 3) Their rights as water users in Denver
- 4) Connections to non-profits or local organizations for additional resources
- 5) Currently active rebates or financial incentives to maintain or update water systems in the home.

New homeowner Welcome Sheets

Goal: Increase immediate understanding of the resources and policies currently in place to improve household-level water conservation practices in Denver Water’s service area by providing a single-entry point to information.

Objectives:

- Residents will be able to identify existing water conservation or reuse systems in their home and understand their responsibility for monitoring and maintenance.
- Residents will know where their water meter is located and understand how to use it and their monthly bill to track water usage.

- Residents will be made aware of any currently active rebates or financial incentives offered by Denver Water to update water efficiency systems to reduce indoor and outdoor water use.
- Residents will be connected to local programs to support in furthering their water conservation capacity including programs for climate adaptive landscaping, rainwater harvesting and greywater use.

Activities:

1) Develop “pilot” homeowner welcome sheets:

I will serve as the initial developer of the homeowner welcome sheets in collaboration with Denver Water’s Resource Strategy Division. This Division includes expert interview participants Austin Krcmarik and Bea Stratton. In line with Bea Stratton’s recommendations, the initial document will be developed in the style of a “decision tree” by which new residents can identify the option which best suits their reality and track further for more information and options pertaining to them. As this will be intended to be an example to grow from, information will be kept generic to be applicable to as many single-family households as possible. Key differentiations on the Welcome Sheets will, in this first pilot phase, be limited to new builds vs. older homes. As the developer of these welcome sheets, we will seek to provide resources, tools and policies drawing from Denver Water’s online presence and context from expert interviews.

2) Host small focus group discussion(s) with sample group of Denver Water customers.

The goal of these discussions will be to:

- a. Assess receptivity to provided information
- b. Gain feedback of information provided – any gaps or points that could be refined?
- c. Gain feedback on method of delivery – paper vs. QR code for online access, mailed vs. placed in standard location in home?

- 3) Introduce Welcome Sheets to distribution partners (home developers, HOAs and realtors, community-based environment justice organizations). This period will be intended to educate them about the home Welcome Sheets. This will also be a time for them to provide feedback on the best means of dissemination.
- 4) Pilot dissemination of Welcome Sheets to home developers, HOAs, realtors and organizations in identified communities. Potential communities to establish this early presence will be outlined further in the Partners section below.
- 5) Broaden dissemination of Welcome Sheets following pilot period

Partners:

1) Denver Water:

The primary partner for this program will be Denver Water, specifically their Resource Strategy Division charged with creating adaptive plans for long term water sustainability. The idea for Welcome Sheets came about through conversations with two members of this team who identified that residents they engage with are frequently overwhelmed with options and information. The Resource Strategy Division will be involved in the creation and review of provided information and strategic planning for its dissemination. As the Welcome Sheets become more streamlined, they will be responsible for keeping information relevant and up to date.

Denver Water's incentive for participation is that it will serve as a cost-effective means to promote existing initiatives and partnerships. It will also serve to promote a culture of intentional water use by providing material to new residents at the time of resettlement. I will be a good partner for Denver Water by maintaining open lines of communication and providing the sample Welcome Sheets and recommendations for development.

2) Listed non-profit actors:

Additional partners will be any non-profit actors cited in Welcome Sheets as a resource to homeowners. The development of these partnerships and programs is not a part of this tool. Denver Water currently utilizes the resources of several non-profits to bridge cost and environmental justice gaps in service and initiative provisions. These active partnerships will be identified as part of the Welcome Sheets for homeowners to connect with as they see fit. Therefore, in the spirit of transparency and agency, the nature of the Welcome Sheets should be disclosed to any external organizations listed.

Community-based Environmental Justice non-profits will also be helpful in ensuring equitable access to the Welcome Sheets provided by supporting translation and communication. The incentive for these organizations to participate in this short-term project can be found in aligning the expected outcomes of the program with their stated missions. The Welcome Sheets also open the opportunity to potential financial savings and access to cleaner, safer water for appropriate uses.

3) Home developers, Homeowner Associations (HOAs) and Real Estate Agencies

These are the entities that will serve as key partners in the primary dissemination of Welcome Sheets to new homeowners at the time of move-in and the identification of existing systems (Greyter, Hydroloop, Rain Barrels, etc...). For home developers, building new homes could present the opportunity to establish a set location for a scannable QR code to the Welcome Sheets. HOAs and Real Estate Agencies, while not directly involved in the construction or layout of the home, do have frequent, direct access to the key beneficiaries (new homeowners). Incentivizing them to speak with new residents about water conservation and providing them either a paper copy or scannable QR code to the Welcome Sheets would therefore be the easiest place to start communication.

The incentive for developers, HOAs and real-estate agencies to participate in this program is the low-cost and effort required on their parts. As the initial developers of the Welcome Sheets and Denver Water and I will be responsible for periodic updates as new information and resources become available. Housing developers will benefit from participation because of the increased awareness the Welcome Sheets will bring to any built-in water efficiency systems. Homeowners must appreciate the value of the systems operating in their homes. If they do not, they will not monitor their performance and the associated benefits will be cut short by lack of maintenance. Additional benefits to developers and real-estate agencies can be drawn from the positive marking surrounding social responsibility that comes with documented actions to improve the state of the environment and threatened resources.

Identified Pilot Partners:

- a. Sky Ranch – Arapahoe County new build community that I visited during early Needs Assessment. This community “is being developed by Pure Cycle, a publicly-traded company that is designing both the land and water use infrastructure in the neighborhood – something that is usually done by separate entities” (Weis, 2023). In visiting this neighborhood, I noted that they have offices on site where representatives work during regular business hours. They were eager to engage in a brief conversation and I am confident they would be receptive to participation in the pilot.
- b. Central Park new build community – “a new pilot program in 40 homes in Denver’s Central Park neighborhood is testing the efficacy of a residential water-recycling system called Greyter Home, which could be a new tool in municipalities’ belts to save precious H₂O” (Oswald, 2021). As this is one of the first communities in Denver

Water's service area to integrate graywater systems, it would provide a good site to test language and maintenance recommendations for this equipment.

- c. Globeville-Elyeria-Swansea (GES Coalition) – This non-profit is well established in the GES neighborhoods. As these neighborhoods face the worst challenges with environmental injustice, Denver Water has run previous pilot programs (such as the Rain Barrel workshops referenced in the Needs Assessment). GES Coalition could serve as an advisor in the language and distribution of Welcome Sheets to new residents moving into older homes in the area.

Denver Water and I can serve as good partners to these entities by providing an initial training outlining the benefits of the Welcome Sheets and how best to disseminate them to homeowners. Once the program is established, my goal will be to have QR codes placed in every new home that can be scanned to access the information. With these QR codes in place, the need for these partnerships beyond initial agreements with developers will naturally phase out.

Sustainability:

The sustainability of this program will depend on the ongoing support from the above partners. This program is meant to be supplementary, to bolster the visibility of and engagement with other programs developed by Denver Water and partners. Although, Welcome Sheets can provide an entry point to such programs, they will cease to be useful if not regularly updated to reflect current systems, policies and recommendations. Thus, to sustain the program, I recommend Denver Water assign a team member the role of confirming listed information as relevant. Information must be updated when significant new policies, rebate incentives or household level conservation or transformation programs are introduced. I would therefore

recommend incorporating quarterly checks and updates into the assigned person's job responsibilities.

The quick transition from paper copies to a scannable QR code will further support in this sustainability. It will not only minimize waste but also provide the easiest way for updates to be made in one place that is accessible to all viewers. The use of QR codes will also deliver further savings to Denver Water as the program implementer as they will save on copying and mailing costs. QR codes can be generated quickly and easily through the user's choice of free, online websites. Once generated and linked to the corresponding website where updates are made, the most updated version of the site will be accessed when a person scans the code.

Evaluation:

Based on the outlined challenges in the Needs Assessment and the anticipated outcomes from the Theory of Change, success of this program will be measured by increased utilization of established programs and water conservation systems. Denver Water reports an underutilization of such things as rainwater harvesting and landscape transformation programs. This is due in part to the low cost of water decentivizing residents from spending their own money on system installations. However, one interview participant reported that through a recent focus group for a landscaping pilot program they "learned that customers did not know where to start and were overwhelmed with options". Therefore, direction to highlighted educational and rebate programs would improve program engagement and create a culture of learning among Denver Water users.

Measurable metrics for evaluation include:

- Increased web traffic on Denver Water residential programming websites
- Increased expressed interest in water conservation programs
- Increased installation and maintenance of residential graywater systems
- Decreased annual water use as reported on residential water meters

Implementation:

Capacity

The Welcome Sheets will be implemented with few staff or infrastructure needs.

Attention must be paid to the initial development and piloting of the Welcome Sheets with the Resource Strategy Division. The success at the piloting phase will depend on the goodwill of the established partners. Initial workshops or communication between these partners and Denver Water will promote receptivity to the project.

The success in the later phases after broader dissemination will depend on the assigned coordinator as mentioned in the Program Description section. Their role will include:

- Auditing the Welcome Sheets for updates in line with current rebates, policies and programs
- Communicating with partners as updates are made
- Overseeing monitoring and evaluation of measurable outcomes

Timeline of New Home Welcome Sheets

<i>Sequential tasks</i>			
No.	State Date Start Date	End Date	Task/activity
1	5/17/24	6/17/24	Develop "pilot" homeowner Welcome Sheets
2	6/20/24	7/4/24	Focus groups with Denver Water customers
3	7/5/24	7/9/24	Revision of Welcome Sheets
4	7/9/24	8/9/24	Pilot Welcome Sheets with distribution partners (3 trainings)
5	8/9/24	2/9/25	Pilot dissemination of Welcome Sheets
6	8/9/24	2/9/25	Ongoing monitoring and evaluation with distribution partners
7	2/9/25	3/9/25	Evaluate measurable metric outcomes
8	3/9/25	3/9/26	Widen dissemination of Welcome Sheets

****Evaluation and update of Welcome Sheets to be conducted quarterly moving forward after task 8.**

Funding

As the development of the Welcome Sheets is intended to be a low-cost initiative in line with Denver Water's budget restrictions, the funding for this project will be minimal. Ongoing collaboration with Denver Water will be incorporated into employees' workdays. An increase in the salary of the assigned Program Coordinator to accommodate their extra workload would encourage them to prioritize monitoring and updates into their work schedule. Some costs can be predicted during the pilot phase for workshops and focus groups with Denver Water customers and implementation partners.

The following table includes estimated costs for these activities:

Needs	Cost
Incentives for focus group participants (food or gift cards)	\$500
Materials for focus group(s)	\$200
Communication/travel to implementing partner sites	\$300
Materials for implementing partner workshops	\$200
Space rental (depending on location and availability of appropriate space on Denver Water property)	\$0-\$1,000
Program Coordinator added income (annual)	\$2,000
TOTAL (maximum)	\$4,200

The total estimated cost of this program will be dependent on free available space and resources. After the pilot phase of the program, costs will reduce to zero (except for the annual

pay of the program coordinator) unless additional training with new partners is required. This assumption is also based on the standard implementation of QR codes as disseminated by implementing partners. These QR codes will make Welcome Sheets updates free without the need to re-print and publish.

Additional Recommendations:

Collaboration recommendations for further growth

The following recommendations will be for partnerships outside of the New Home Welcome Sheet Program. Denver Water already has established partnerships with many local non-profits. One such partnership that I would recommend continuing to grow is Resource Central. Resource Central is a nonprofit based in Boulder striving to make conservation as simple as possible. They have established partnerships with over 50 water providers and municipalities including Denver Water. One pilot program currently in the works to provide turf removal incentives relies heavily on Resource Central. For the first time Denver Water will provide up to \$500 per home for up to 100 customers to go toward turf removal that Resource Central would provide. Those same customers that participate in the turf removal program would also be eligible to receive further support through Resource Central by receiving either a seed mix of native grasses to replace perennial plants or water gardens called “Garden in a Box” that Resource Central provides. “Garden in a Box” is another aspect of Denver Water’s Water Efficiency Plan. According to the Plan, this landscape change initiative “offers customers a 25% discount on a pre-packaged xeric garden kit and educational material.” The synopsis of the current standing with this initiative goes on to state that it has not to date shown great water savings “likely due to establishment irrigation of new landscapes and weather differences

between the baseline year and the evaluation year (the weather factor for 2016 was 16% higher than 2013)” (Denver Water Water Efficiency Plan, 2018). The analysis also points out that customers self-selected for Garden in a Box were already likely gardeners with an established interest in irrigation and landscape technology. This partnership demonstrates the need to provide funding to market to an expanded audience and capture those who can utilize rebates and educational material as an entry point to adaptive landscaping instead of those already engaged.

Funding for turf removal and “Coloradoscaping” initiatives will also need to account for “establishment irrigation” timelines. This is the time period during which a newly transplanted plant requires more frequent irrigation while its root system grows. Water savings will appear to be less during this period but will increase in the long term.

Partnership programs with Resource Central are still in their infancy. However, Denver Water estimates a savings of 30-acre feet of water in the next five years (Denver Water Water Efficiency Plan, 2018). Partnerships to supplement the material provisions further through education academic or non-profit organizations such as CSU Spur and Water Education Colorado are not currently being officially pursued by Denver Water but could serve to bolster estimated savings by providing additional content and connections to less served communities. In conducting my needs assessment, it became clear that water managers employed by Denver Water connect and engage frequently with educators and conservationists at CSU Spur, Water Education Colorado and more. They are aware of each other’s work and progress and often share space at conferences and meetings. However, an official, contracted partnership like the one established with Resource Central is lacking for these collaborators. Establishing a contracted working relationship with outlined goals and deliverables could open lines of funding such as government grants to these non-profits so they could grow a more active, tangible presence

delivering goods and resources to Denver Water customers at a reduced cost that is amenable to the average household.

Nonprofits organizing shared community garden spaces such as Denver Urban Gardens (DUG) are also partners worth pursuing. Per Denver Gardens website, the community garden plots they maintain are often in older or lower-income neighborhoods or are school-based. DUG gardens are therefore highly visible parts of the community and provide a great space for programming surrounding such things as Rainwater Harvesting. Engaging DUG community members and local neighborhoods in this way would be a cost and space efficient way of educating and changing attitudes surrounding Rainwater Harvesting.

Environmental Justice organizations listed in the Stakeholder Analysis including Colorado Village Collaborative, Globeville-Elyeria-Swansea (GES Coalition) and West Denver Renaissance Collaborative (WDRC) have already been identified by Denver Water as potential partners for further development. In Denver Water’s document, “Community Resource Organizations: Established and Potential Partnerships for Denver Water’s Turf Replacement Program”, all three organizations were identified as community-based organizations whose connectivity would support “coordination on area planning projects, investments, and opportunities” (Koval, 2023). These organizations understand the unique challenges and identities of the communities they serve. Denver Water would therefore be served well by consulting them as experts to ensure piloted and established programs are equitably tested in these spaces.

Finally, graywater system companies such as Greyter and Hydroloop are currently partnering with housing development companies as outlined in the Needs Assessment. However, graywater systems are currently listed as “new tactics” in Denver Water’s 2018 Water Efficiency

Plan for consideration in further plans as reliance on recycled water continues to grow. The lessons learned from pilot communities such as the one in Central Park will show what technology can be more widely implemented in the future. Therefore, Denver Water should monitor the systems in these homes closely to determine the feasibility of large-scale graywater system installation or financial incentives programs. As these programs are currently not well established and retrofitting older homes is generally not thought to be a cost-effective option, these partnerships will likely not be more developed until Denver Water is able to reallocate funding from their current budgeting priorities.

Additional Policy/management recommendations

- 1) Re-establish Denver Water’s water budget rate structure – Castle Rock Water’s budget rate structure would serve as a model for an updated structure.
- 2) Integrate policies surrounding maximum allowable non-functional turfgrass – The Bill proposed by the Water Resources and Agriculture Review Committee for the State of Colorado for consideration in 2025 (referenced in the Needs Assessment) would necessitate the integration of such policies. However, this bill alone would not set a precedent for municipal-wide regulations of turf-grass outside new residential and commercial builds. The Cities of Castle Rock and Aurora already restrict non-functional turfgrass. In Castle Rock, “beginning Jan, 1, 2023, any home permitted and built after this date requires the builder to install a ColoradoScape with no turf in the front yard and a landscape with 500 square feet or less in the backyard” (Caste Rock Water). Aurora has the same limitations of 500 square feet. The City and County of Denver should follow the precedent set by these two municipalities in establishing this 500 square foot limit regardless of the status of the 2025 state-wide regulation.

- 3) The institution of a “stormwater fee” to single-family residents. In our interview, Jessica Thrasher explained that other municipalities outside Colorado “have a stormwater fee that residents have to pay because with more homes, there is less ground for water absorbance”. Including this fee on bills would provide another source of income for Denver Water. However, a rebate could be provided to cover the stormwater fee for people who institute Rainwater Harvesting practices in their home. This rebate would provide a financial incentive for homeowners to consider utilizing rainwater barrels for outdoor use.

Conclusion

Through my own assessment of available information and resources, I recognize the importance of an integrated, household-level tool designed to present an immediate solution to the frequently cited challenge that citizens find it initially difficult to know where to start with all the resources and information available to them and the competing priorities of their daily lives. My hope is that the New Home Welcome Sheets will fill this gap and create further connectivity between homeowners, housing developers and their water utility.

In accordance with the remaining outputs outlined in the Theory of Change, collaboration recommendations for government, utility and nonprofit actors, and strategic policy recommendations have also been provided. These collaborations and policy recommendations will be more long-term solutions as a prohibitive budget and bureaucratic governance system will cause inevitable delays. All interventions are designed to support Denver Water customers in understanding their resources and responsibilities regarding water use and conservation. They are also meant to ensure Denver Water continues to have the political and financial support as a utility to protect and conserve a dwindling water supply.

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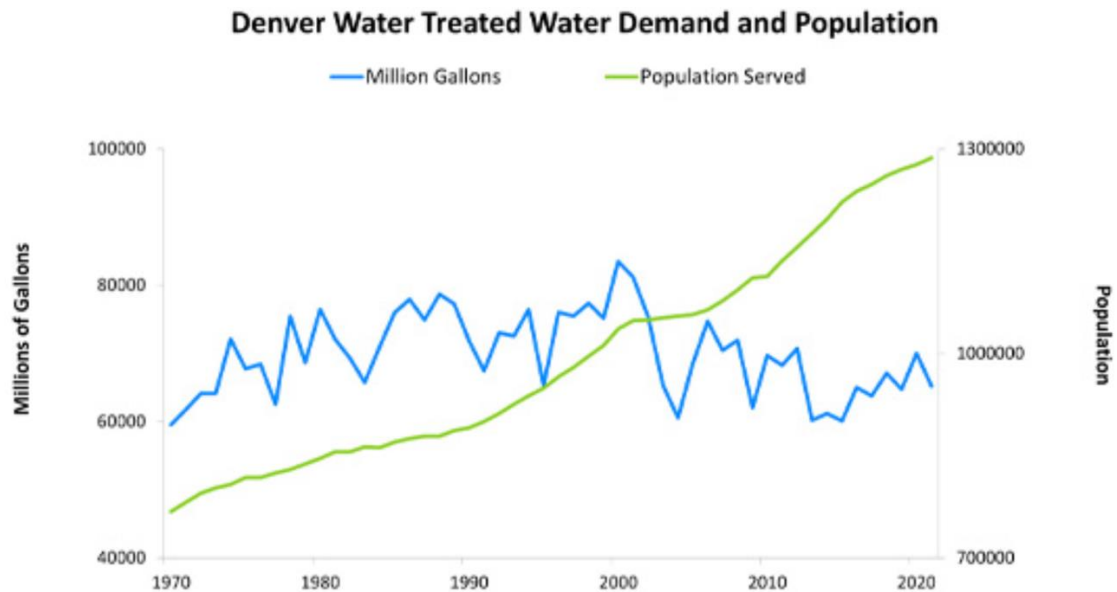
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Appendix:

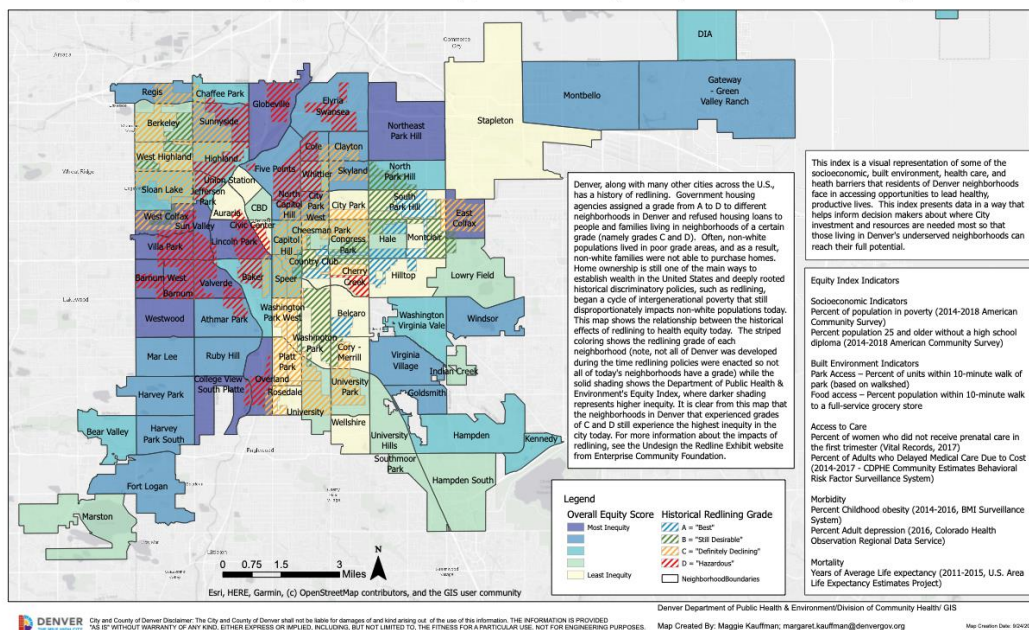
Appendix 1



Source: <https://www.denverwater.org/your-water/water-supply-and-planning/water-use#n>

Appendix 2

Denver Neighborhood Equity Index Scores (updated March, 2020) and Historic Redlining Grades



Source: <https://www.denvergov.org/opendata/dataset/city-and-county-of-denver-equity-index-2020-neighborhood>