Group Project Brief

EVALUATING MULTIPLE BENEFITS OF URBAN RAINWATER CATCHMENT SYSTEMS IN AUSTIN, TEXAS

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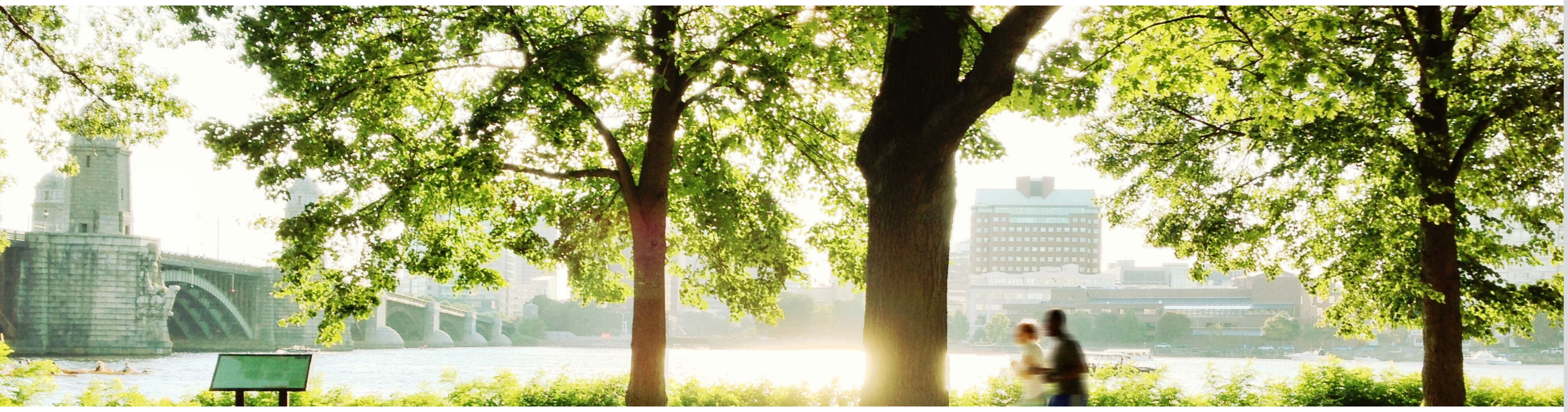
1 ENVIRONMENTAL PROBLEM

Over the next century, climate change adaptation measures will require significant investment in building, improving, and changing urban water infrastructure. These measures will require multifaceted strategies that can simultaneously address many challenges, such as flooding, impaired water quality, and lowered efficiency. Meeting these challenges allows for new opportunities to address other environmental issues, such as the urban heat island (UHI) effect and energy costs as well. This project evaluated the potential impact an urban rainwater catchment project titled the 'Rain Catcher Pilot Program (RCPP)' will have on UHI and energy costs in the Waller 3 neighborhood in Austin, Texas.



2 SIGNIFICANCE

This group project has quantified two important co-benefits associated with the RCPP: **energy savings** from reduced outdoor potable water demand and **UHI effect reductions** within the upper Waller Creek Watershed. Additionally, we have identified opportunities for participating stakeholders to ensure equitable distribution of potential benefits over the course of the RCPP implementation process. Lastly, our project has created a comprehensive “toolbox” of resources for decision-makers to apply to water projects in their own communities.

3 PROJECT OBJECTIVES

1. Quantified potential **energy savings** from reduced potable water demand resulting from scaling up the rain-catcher pilot program (RCPP) within the Waller-3 neighborhood in Austin, Texas;
2. Quantified possible **UHI effect reduction** resulting from implementation of the RCPP within the Waller-3 neighborhood;
3. Identified and evaluated potential opportunities for **incorporating equity** into the RCPP;
4. Compiled useful resources for decision-makers who will use the framework for evaluating other water projects in the future.

BACKGROUND

This project utilized the Pacific Institute's Multi-Benefit Framework, a water decision-making framework developed by researchers at the Bren School and the Pacific Institute, the group project client. The Pacific Institute's multi-benefit framework provides a systematic approach for assessing benefits and tradeoffs within water infrastructure projects, watershed improvement programs, and water policies. Two public agencies, Austin Water and Austin Department of Watershed Protection, are working to pilot a green stormwater infrastructure (GSI) project through the RCPP, within the upper Waller Creek Watershed, a residential neighborhood north of downtown Austin. The pilot project supports the installation of trees, rain gardens, and large-capacity rain cisterns in the project area.

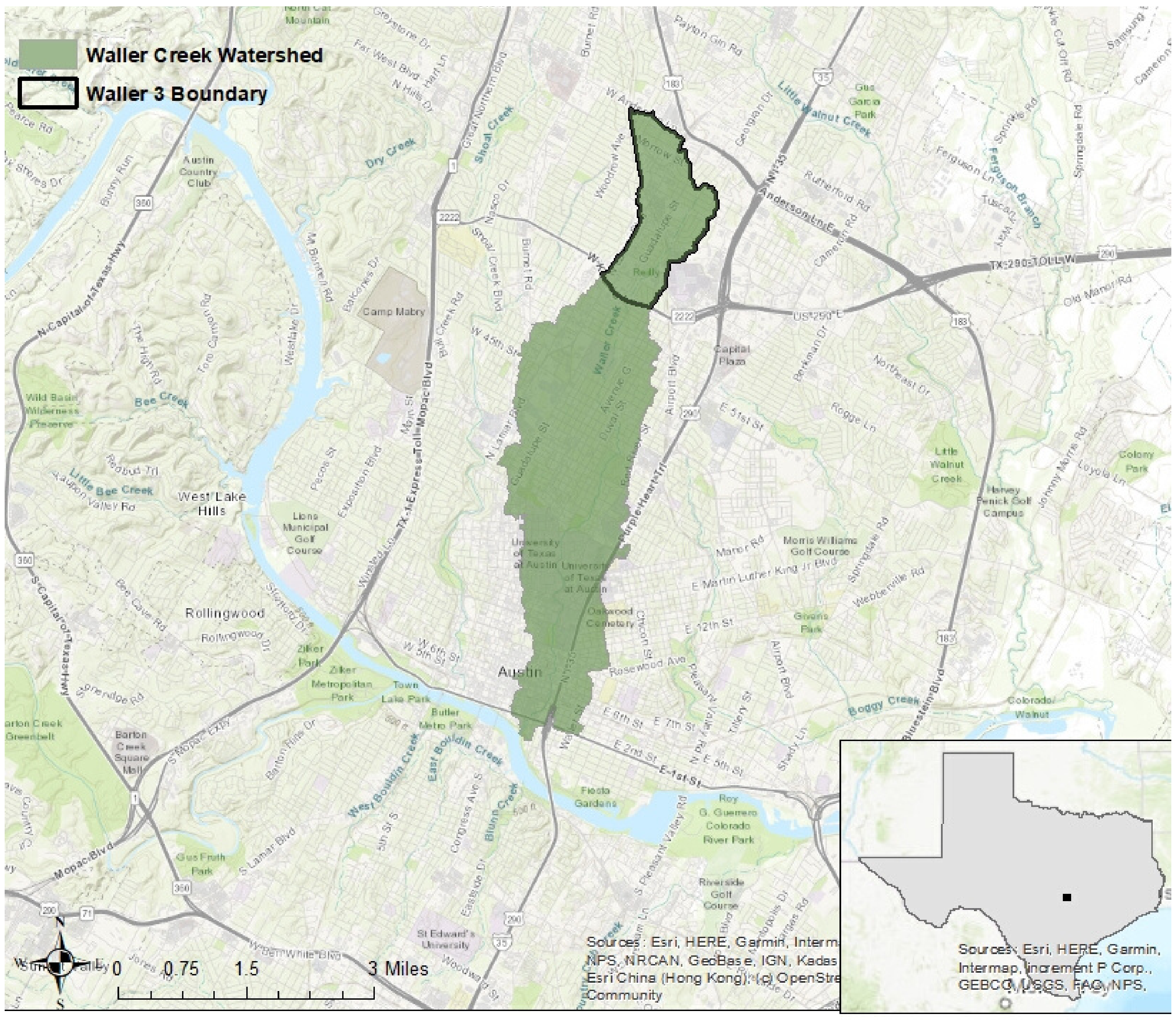


Figure 1. Map of Upper Waller Creek Watershed. The Upper Waller Creek Watershed is to the north of downtown Austin and was chosen to minimize downriver impacts during flooding events. This map shows the extent of the planned RCPP. 75 percent of homes within this area are expected to participate in the program. Source: AustinTexas.gov.

Figure 2. Large rain cistern. Cisterns used in the Waller-3 RCPP are able to hold 1,000 gallons of captured rainwater. Source: gardening.stackexchange.com.

Figure 3. Rain garden. Rain gardens in the Waller-3 RCPP are approximately 100 cubic feet. Source: U.S. Environmental Protection Agency.

MULTI-BENEFIT FRAMEWORK

In collaboration with Bob Wilkinson of the Bren School, the Pacific Institute has developed a multiple-benefits framework to help water managers quantify and evaluate all of the potential benefits of water management projects, and to incorporate these benefits into their decision-making. The framework seeks to bring diverse stakeholders together to invest in progressive water management projects that solve more than one problem.

The framework divides potential benefits into five categories: Water, Energy, Land and Environment, People and Community, and Risk and Uncertainty. Our project focused on **'People and Community'** which includes UHI, and **'Energy'**, which includes the energy intensity of water. Equity is treated as a lens all benefits should be considered through.

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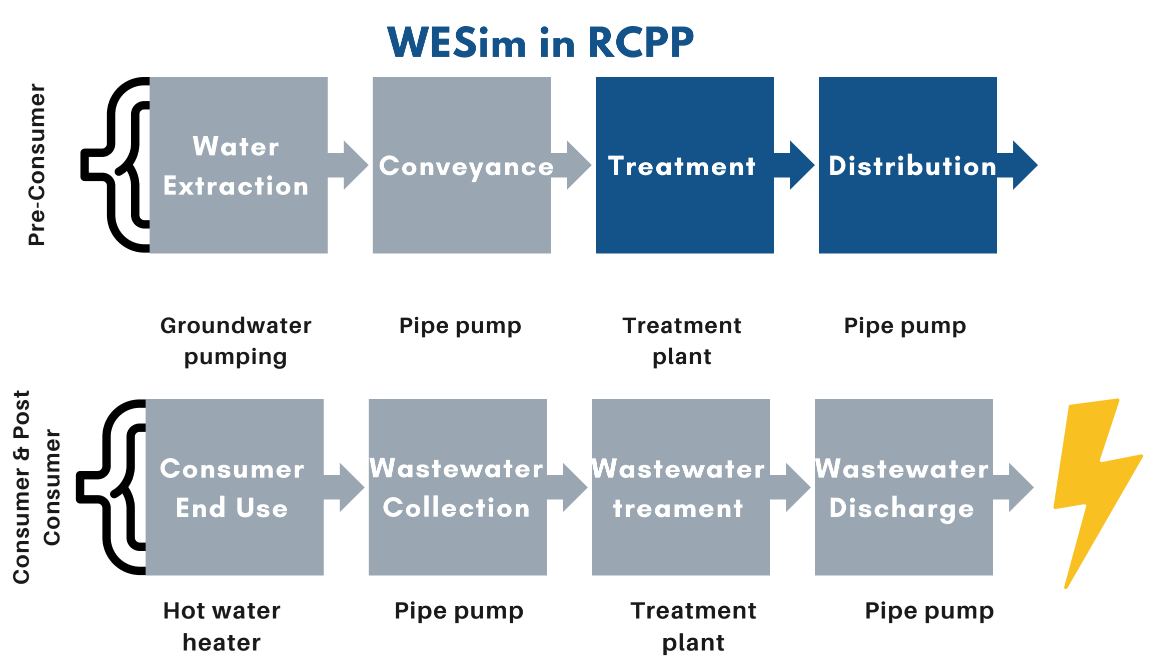
APPROACH

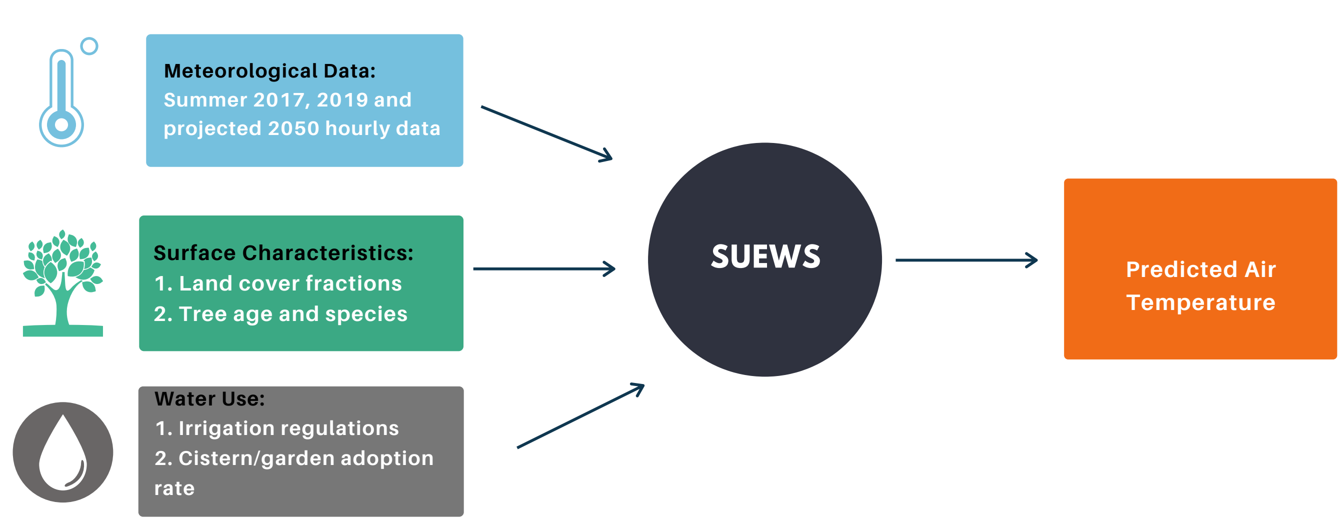
Energy

To quantify energy reduced through offsetting potable water demand in the project area, we used the Pacific Institute's **Water-Energy Simulator Model (WESim)**. The WESim model separates components of the water treatment and transfer process, and uses each part in calculating the overall energy intensity of water treatment through summing the flow through individual water treatment facilities. After finding an estimate of energy reductions, we used current electricity rates to calculate the estimated savings resulting from RCPP implementation and to be conveyed to Austin Water. We also incorporated estimated reductions in UHI from the RCPP to quantify potential reductions in energy use.



Urban Heat Island (UHI) Effect

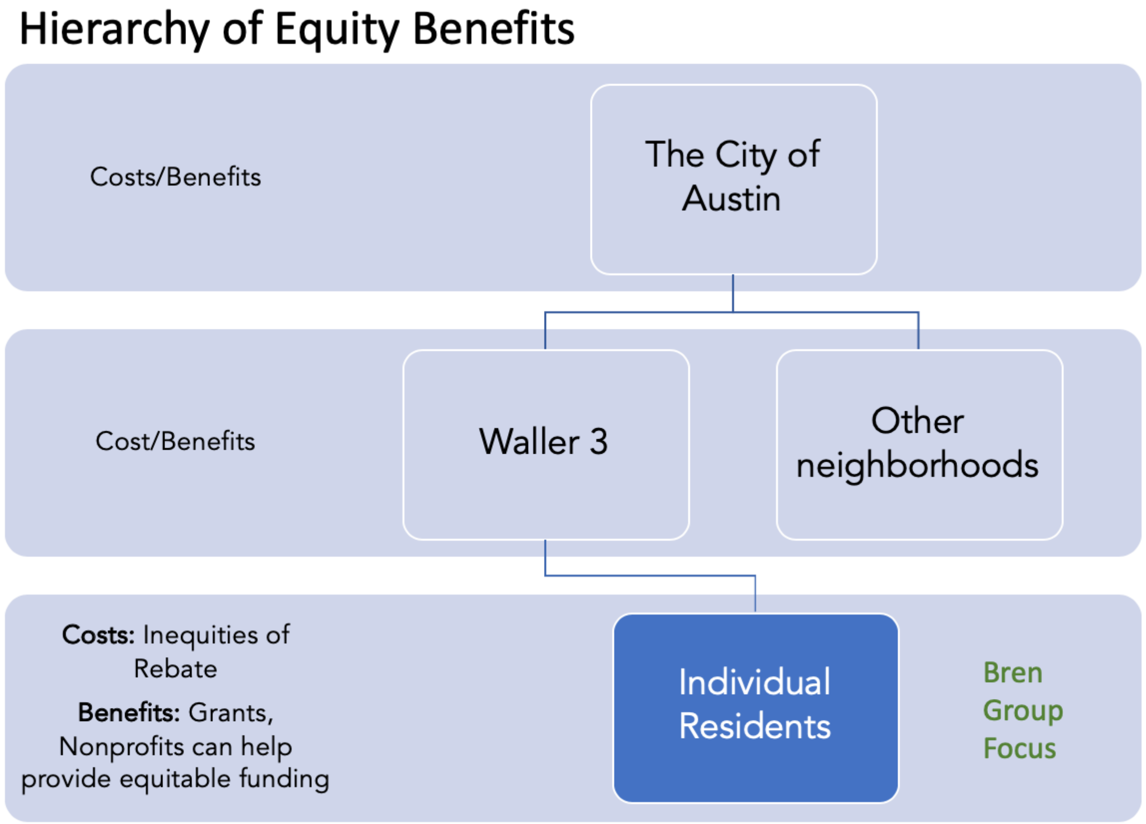
Within the UHI component of the project, we have quantified reductions in summertime temperatures in Waller-3 resulting from implementation of the RCPP. We then used these predicted temperature reductions to estimate reductions in residential energy consumption. To calculate temperature reductions resulting from increased irrigation, we selected the **Surface Urban Energy and Water Balance Scheme (SUEWS) Model**, which used meteorology, tree cover, soil moisture and other data inputs to predict sensible heat reductions. To calculate temperature reductions from additional tree cover, we compared land-surface temperatures (LST) determined from satellite imagery to estimate the effect of tree cover on temperature reductions. Once we estimated the UHI effect, we translated these reduced temperatures to energy savings using existing literature on the relationship between temperature and energy consumption in the southwest United States.



Equity

Equity should be viewed as a holistic lens through which one should view our project, rather than a discrete component. Therefore, we have identified opportunities to consider equity within each step of our project. Additionally, we have created tools to help water managers think through equitable implementation of water projects in their own communities. This "toolbox" includes (i) a mapping tool that quickly identifies areas in Austin that would benefit most from UHI and energy reductions resulting from RCPP based on UHI, environmental factors, and socioeconomic data, and (ii) a list of recommendations for more equitable rebate structures and financing that would assist low socioeconomic status residents in installing GSI on their own properties.

Hierarchy of Equity Benefits



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RESULTS

Energy Offsets

For every thousand gallons of potable water offset by RCPP implementation, we estimate that Austin Water will gain **2.15 - 2.82 kWh in energy savings**. Carbon dioxide emissions will be reduced by 0.0015 - 0.0020 tons per thousand gallons of offset potable water.

Urban Heat Island (UHI) Effect Reductions

Once new shade trees provided by the RCPP achieve maturity, this could lead to **0.17-0.33 degrees (F)** cooling. Additionally, we expect that increases in irrigation from rain cisterns and rain gardens provided by the RCPP will decrease mean temperature by **0.35 degrees (F)**. Reduction in residential energy consumption from decreased air conditioning energy use is up to 1**00,000 kWh/year** when aggregated to the neighborhood.

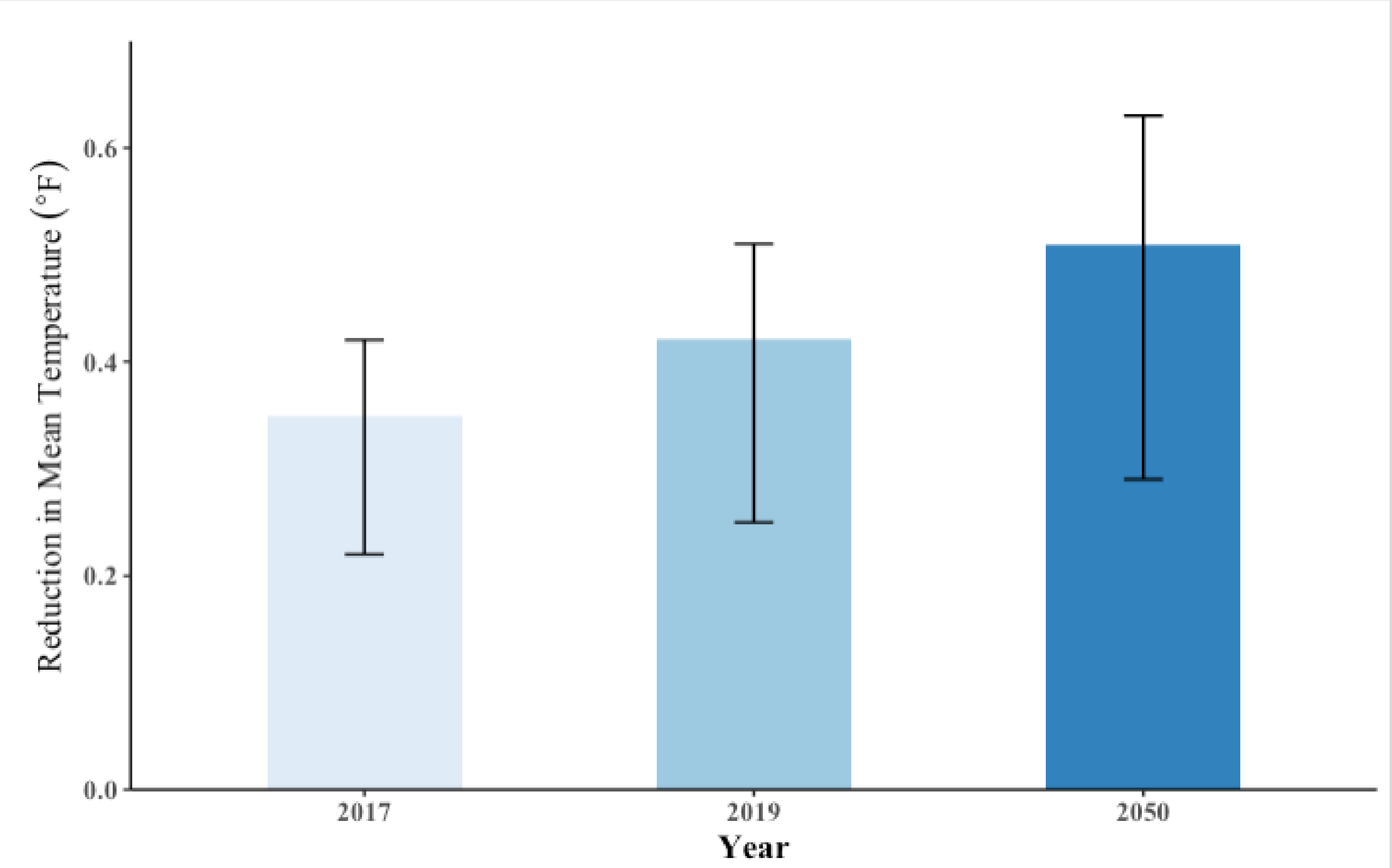


Figure 4. Average temperature reductions across 2017, 2019, and 2050 climate scenarios. Each bar corresponds to the mean reduction in average temperature between the middle implementation scenario and the status quo scenario for that year. Error bars represent the lowest and highest levels of project implementation. In 2017, the average temperature reduction was 0.35°F (range = 0.22-0.42°F). In 2019, the average temperature reduction was 0.42°F (range = 0.25-0.51°F). In 2050, the average temperature reduction was 0.56°F (range = 0.29-0.63°F).

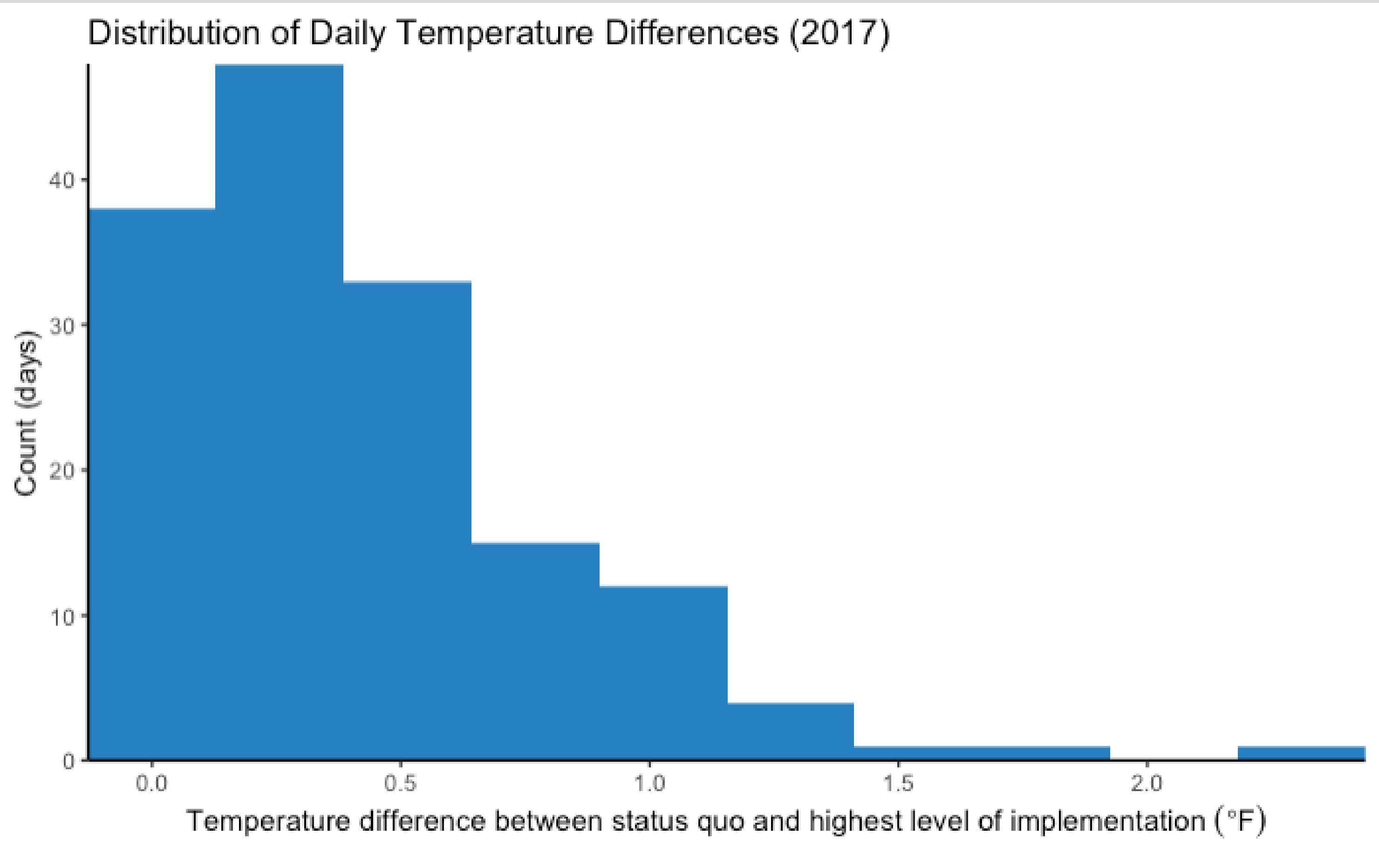
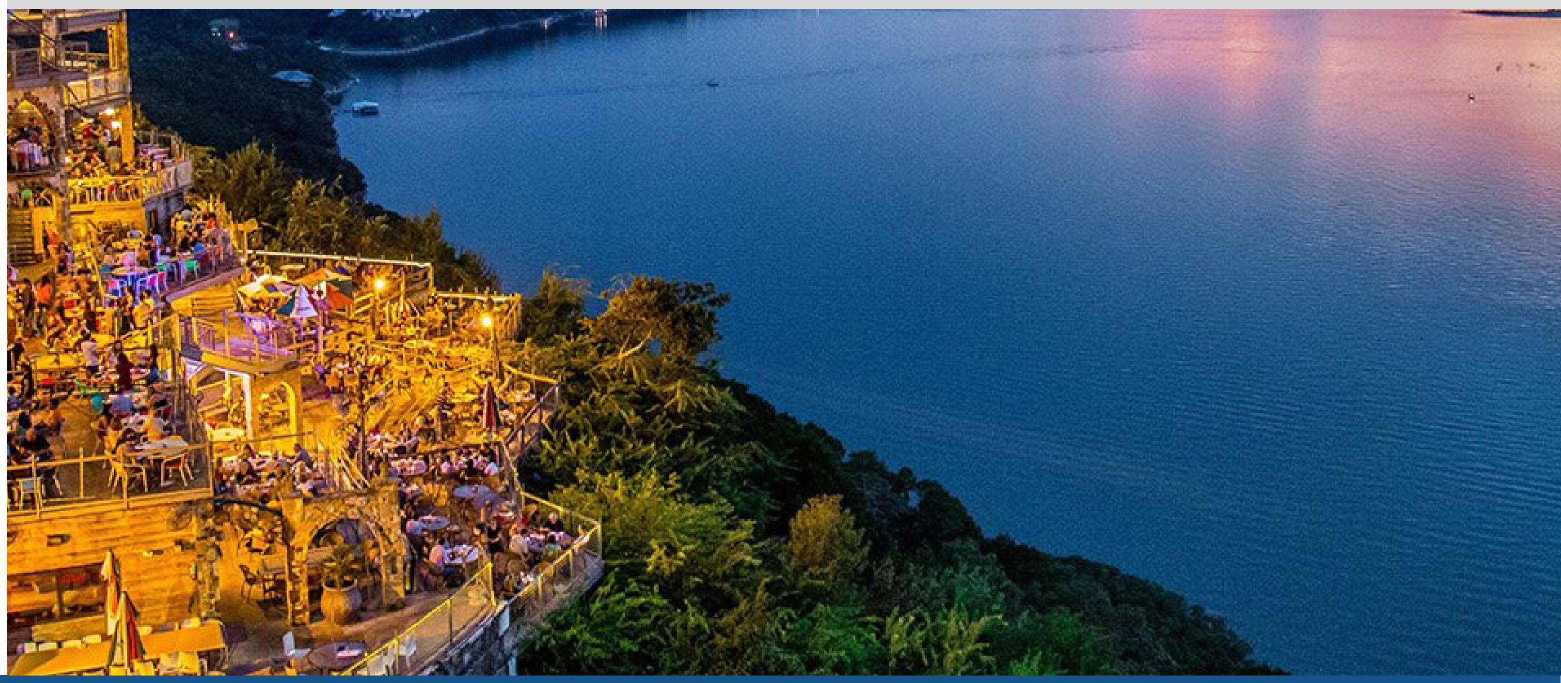


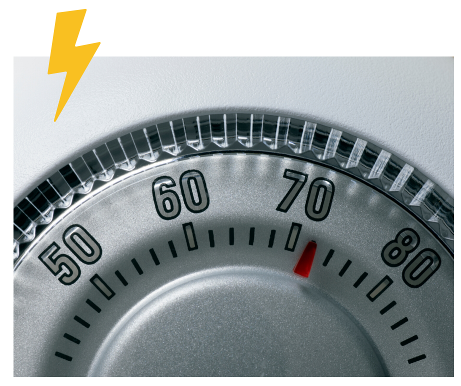
Figure 5. Distribution of daily temperature differences for the year 2017. Temperature differences ranged from zero to 2.5 degrees (F).



7 CONCLUSIONS

The reduction in energy use from potable water offsets is up to 2.8 kWh/1000 gallons.

The neighborhood-scale reduction in UHI from rain cisterns & rain gardens is an average of 0.35 F, but can be greater on individual days and for individual homeowners.



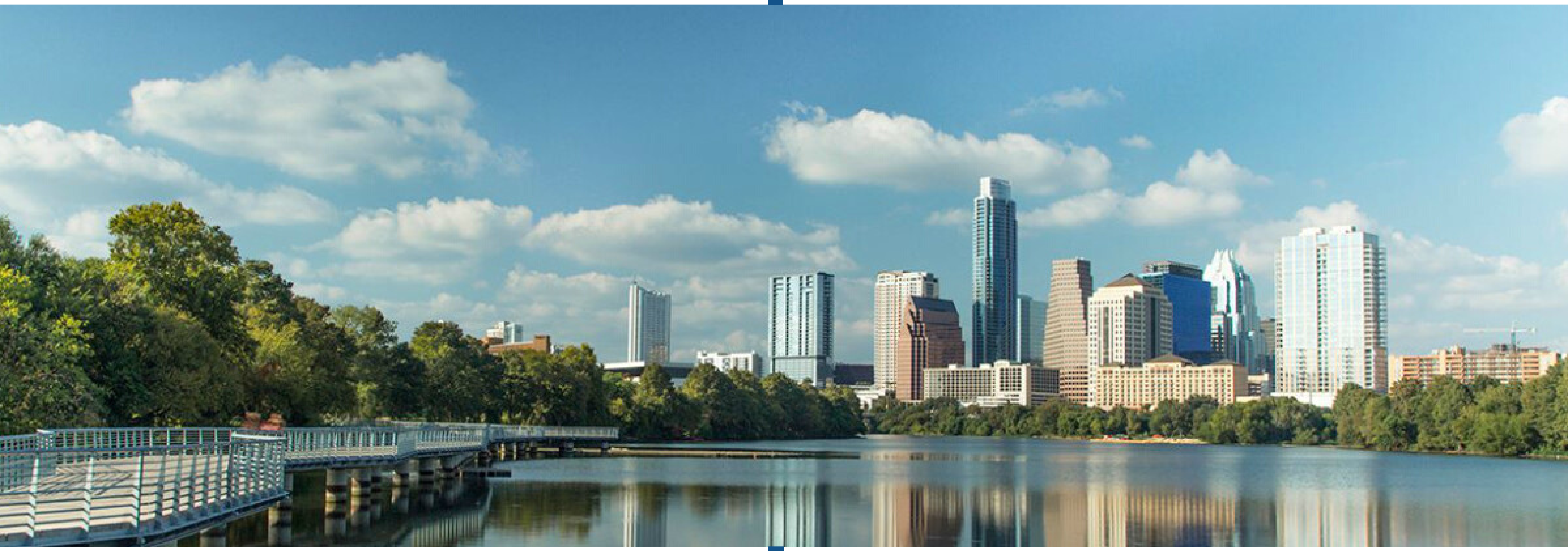
Reduction in residential energy consumption from decreased energy use is up to 100,000 kWh/year when aggregated to the neighborhood.

8 RECOMMENDATIONS

1. To maximize the benefit of UHI reductions, the City of Austin should focus on tree shading. Tree shading provides the greatest amount of UHI reduction associated with the RCPP.
2. Emphasize energy savings to residents from reduced air conditioning use.
3. Ensure afforable solutions are available for everyone.

9 FUTURE WORK

1. Continue adding data layers to decision-maker mapping tool to allow for more equity considerations with project placement.
2. Test multi-benefit framework on other urban stormwater projects.
3. Examine effect of RCPP on housing prices and gentrification.



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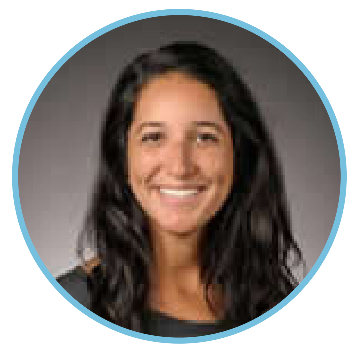

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