


# Turf Replacement Program Impacts on Households and Ratepayers:

## An Analysis for the City of Los Angeles




UCLA Luskin School *of* Public Affairs

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# Executive Summary

## *Introduction*

Ongoing severe drought and climate change continue to strain the Los Angeles region's water supply and have forced the City to institute water savings goals (Garcetti, 2014). Turf replacement programs, which aim to encourage residents to replace their lawn with less water intensive landscaping, may offer benefits as part of a larger package of conservation measures. More than half of residential water use is allocated for outdoor watering (approximately 54%) (Firestone, 2015). Outdoor water use is typically considered discretionary while indoor water use is generally considered essential, making outdoor water use a good target for conservation efforts. In order to encourage turf replacement, the city launched a turf replacement program in 2009. Commercial and residential customers can receive a rebate from the utility when they replace their lawns with less water intensive landscaping. Currently, the city is offering a rebate of $1.75 per sq. ft. up to 1,500 sq. ft.

This report seeks to answer two questions regarding the turf replacement program. First, under what conditions does participation in the turf replacement program provide financial benefits to households? Second, is the turf replacement program a reasonably cost effective investment for utilities and ratepayers?

## *Where Are We Today?*

This report uses data accumulated from 2009 until 2015, over which time the City of Los Angeles spent more than $42 million on the turf replacement program (Reicher, 2015). In partnership with the Metropolitan Water District (MWD), they issued rebates for 15 million square feet of turf (Mac & Coral, 2015). As of March, 2015, 4,994 households (1.53% of all single family households in Los Angeles)[1] had participated in the program. Participating households replaced, on average, 1,600 sq. ft. of turf,[2] and are now saving approximately 66,000 gallons of water per year (LADWP, 2016).[3] As of today, 23,730 of the Los Angeles Department of Water and Power's (LADWP) residential customers have participated in the turf replacement rebate program (LADWP, 2016). One of the likely reasons for this large increase in participation since March, 2015, was the temporary increase in the available rebate. In 2014, LADWP raised the turf rebate from $1.00 per sq. ft. of turf replaced to $1.75 per sq. ft. MWD also offered rebates, making the total amount LA City residents received for lawn replacement $3.75 per sq. ft. (MWD offered $2.00 while DWP offered $1.75). As of July 2015, MWD had exhausted their funds. This lowered the rebate total for Los Angeles residents from $3.75 to the current level of $1.75 per sq. ft.

1 Using the Los Angeles Solar Atlas from the UCLA Luskin Center for Innovation (DeShazo et al., 2011), there are 464,325 potential sites but only 70.1% of these sites are single family. Therefore, this report uses 325,492 as the number of possible conversion sites.

2 Although the actual average of turf replaced per household is 1,600 sq. ft., this report uses 1,500 sq. ft. because of complications relating to LADWP's tiered water rate structure and their cut off for rebate offers. The additional 100 of average square footage should not impact the findings in this report.

3 Participants save 66,000 gallons of water per year if we assume they are saving an annual 44 gallons per sq. ft. of turf replaced.

## Household Financial Benefit

In order to assess the economics of lawn replacement from the household perspective we measure the impact of different rebate levels, turf replacement costs, climate zones (determined by different evapotranspiration rates across the city[4]), and future expected water pricing on household benefit as measured by the payback period. We found that varying the replacement cost had the most significant impact on household financial benefits, followed by different rebate levels. For example, increasing the cost of turf replacement from $3 to $8 per sq. ft.[5] (which represents ~2.7x increase) yields a ~138x increase in the payback period (rising from 0.08 to 11 years). Variations in the future cost of water and the household's climate zone had lesser impact on household financial benefit. We found that when the utility offers a rebate of $1.75 per sq. ft. of turf replaced, typical households make back their initial investment in the program and start saving money in less than 10 years, a timeframe considered to be the policy status quo and comparable to other investments such as solar panels (Reid & Wynn, 2015).

## Ratepayer and Utility Cost-Effectiveness

Our analysis suggests that the current level of lawn replacement rebates is also cost effective from the ratepayer[6] and utility perspective. When the utility offers a rebate of $1.00 per sq. ft., ratepayers see savings start to accrue after approximately 10 years. When the rebate increases to $1.75 per sq. ft. of turf replaced, the typical ratepayer does not see savings for 14-20 years depending on the rate at which MWD increases the cost of water. Ratepayers face a 14 year payback period when we assume higher increases in water rates (10%) and face a 20 year payback period when we assume lower increases (6%).

We expect the cost of purchasing water from MWD to increase in the future. Today, MWD sells their water to DWP for approximately $900 per acre ft. (Urban Water Management Plan, 2011). We compared the rising cost of purchasing water to the cost of saving water and found that in almost all scenarios (considering different lifetime benefit timeframes for turf replacement and rebates of either $1.00 per sq. ft. or $1.75 per sq. ft.), the cost of purchasing water from MWD is higher than the cost of saving water. While the cost of saving water assuming a **10 year lifetime** of turf replacement benefits is more expensive than purchasing water from MWD (with a rebate of $1.75 and typical MWD rate increases), the cost of saving water assuming a **20 year lifetime** of benefits for turf replacement is half the cost of an acre ft. of purchased water (with the same rebate of $1.75 and typical MWD rate increases).

## Summary

To balance household and ratepayer needs, an optimal rebate level may be between $1.00 and $1.75 per sq. ft. of turf replaced. Lawn reconversion is a concern. Policies that could decrease the likelihood of reconversion would make the lifetime benefit of turf more secure and could increase the financial benefits to ratepayers even with a rebate of $1.75 per sq. ft.

4 Evapotranspiration (ET) rates are the rate at which water is lost due to evaporation.

5 These levels were determined based on interviews with professionals, online calculators, and other sources to represent the range of household preferences. These preferences may vary depending on aesthetics, ease of maintenance, home value and environmental concerns.

6 *Ratepayers* refer to the general LADWP customer base. Ratepayers are responsible for financing utility-run conservation programs

# 1. Introduction

Ongoing severe drought and climate change continue to strain the Los Angeles region's water supply and have forced the city to institute water savings goals (Garcetti, 2014). Turf replacement programs, which aim to encourage residents to replace their lawn with less water intensive landscaping, may offer benefits as a conservation measure. Extreme drought has led to the City of Los Angeles' dependence on a significant amount of imported water, approximately 80% (Garcetti, 2015). Imported water is costly and potentially vulnerable to climate change impacts, such as a reduction in the Sierra snowpack (Garcetti, 2015). Earthquakes are also a major risk to Los Angeles' water supply, threatening to incapacitate the aqueducts that deliver water to the city (Davis, 2010).

Decreased dependence on imported water through reduced water use could help to alleviate water insecurity in Los Angeles. Therefore, the city has set ambitious water conservation goals. However, conservation programs can only successfully help the city meet its targets if residents decide to participate in the programs and if such programs are reasonably cost effective for ratepayers. As a public utility, LADWP has a responsibility to treat all of its customers fairly. Therefore, the turf replacement program must ultimately provide savings for all of its ratepayers[7], not just to the participants who save money by reducing their individual water use.

Currently, the turf replacement program offers rebates that intend to incentivize homeowner participation.

This report seeks to answer two questions:

1. Under what conditions does participation in the turf replacement program provide financial benefits to households?
2. Is the turf replacement program a reasonably cost effective investment for utilities and ratepayers?

## *Financial Benefits of Turf Replacement to Households*

In this report, we focus on single family households. Thirty nine percent of Los Angeles' potable water use is attributed to single family households (Firestone, 2015). And more than half of residential water use is allocated for outdoor watering (approximately 54%) (Firestone, 2015). Outdoor water use is typically considered discretionary while indoor water use is generally considered essential, making outdoor water use a good target for conservation efforts.

Single family households may decide to participate in the turf replacement program for multiple reasons, but financial benefit is most likely the major determinant. One component of financial benefit to households is the rebate that they receive for replacing their lawn with less water intensive landscaping. We want to identify the financial benefit for households who participate and the factors which impact the potential benefit. Some of these factors are determined by the household, such as the amount that homeowners decide to spend on replacing their turf with alternative landscaping, while other factors are driven by outside entities, such as the rebate amount and the future cost of water, both of which are decided by government agencies.

7 *Ratepayers* refer to the general LADWP customer base who may reap the benefits of reduced costs for the utility. Ratepayers finance LADWP conservation programs, such as the turf replacement program.

## Ratepayer Cost-effectiveness of Turf Replacement

This report explores the cost effectiveness of the turf replacement program for utility ratepayers. Ratepayers make up the LADWP customer base and are responsible for financing conservation programs. However, only a subset of the community will participate in these programs, thereby reaping the direct benefits. The turf replacement program may reduce overall water costs for the utility, which would reduce costs for all ratepayers providing them with some amount of financial benefit.

We calculate the potential ratepayer financial benefits of the turf replacement program. We also determine what factors might impact these benefits. We further explore the impact of different rebate levels on ratepayer financial benefits. We also analyze how the future cost of imported water might affect ratepayer financial benefits. Finally, we amortize the utility's investment in the turf rebate program over 20 years. Amortization gives us a different perspective on the financial benefit to ratepayers as it allows us to look at the program as an investment (and compare it to other water supply investments) considered over a period of time.

## The History of Rebates

Rebates for turf replacement have been offered by the Metropolitan Water District (MWD) and city utilities like the Los Angeles Department of Water and Power (LADWP). MWD has offered their rebates to customers on top of any rebate those customers receive from their city utility.[8] The rebates have changed rapidly over the past few years and it is unclear what the future holds.

At the end of 2014, Los Angeles Mayor Eric Garcetti passed Executive Directive #5 which dictated, among other water conservation policies, an increase in the turf replacement rebate offered by LADWP. The increase changed the rebate from $1.00 per sq. ft. of turf replaced to $1.75 per sq. ft. of turf replaced. This 75 cent increase raised the total rebate for participants to $3.75 per sq. ft. of turf replaced (including the rebate from both LADWP and MWD). However, in July, 2015, MWD announced that their funds for providing the rebate were exhausted. Just one month after approving $350 million for the turf rebate program, MWD had run out of money (Stevens & Morin, 2015). This lowered the rebate total for Los Angeles residents from $3.75 to $1.75 per sq. ft. The differences in rebate levels have an impact on both the household financial benefit of participating in the turf replacement program and the financial impacts on ratepayers. In fiscal year 2014/2015, LADWP reportedly spent $17.8 million on turf rebates (Goldenstein & Stevens, 2015).

## Report Roadmap

This report examines the financial impact of the turf replacement program on both households and ratepayers. In order for the turf replacement program to be successful, it must be both appealing enough to incentivize households to participate as well as sufficiently cost-effective so that ratepayers also see financial benefit from the program. Therefore, we consider 1) will households participate in the program?, and 2) is the program cost effective for the utility and ratepayers?

8 LADWP customers have historically received a rebate from both MWD and LADWP.

## Household Impacts

To evaluate the financial proposition for households, we test a range of conditions that are likely to impact their financial benefit from the turf replacement program. This report uses payback periods, the time it takes to recoup an investment, to estimate financial benefits to households (the lower the payback period, the higher the financial benefit). We also calculate the gross savings that households can expect if they participate in the rebate program.

**Replacement Costs:** To participate in the turf replacement program, households first face decisions regarding turf replacement: How will they remove their lawn and what will they replace their lawn with? We calculate the impact of the replacement cost on household financial benefit using three different cost levels. These levels were determined based on interviews with professionals, online calculators, and other sources to represent the range of household preferences. These preferences may vary depending on aesthetics, ease of maintenance, home value and environmental concerns.

**Rebate Levels:** Once homeowners have replaced their turf with less water intensive landscaping, they can receive a rebate based on the square footage of turf that they have replaced. This report analyzes the impact of different levels of rebates on household financial benefits. We model three different potential rebate levels based on historic rebates and possible future rebate options. We compare households living in the same climate zone, spending a medium amount on turf replacement, but receiving different levels of rebate.

**Climate Zone:** The climate in which people live affects their financial benefit from the turf replacement program because it impacts the amount of water they use. Households located in warmer climates require more water to maintain turf and therefore will save more water when participating in the turf replacement program than households in cooler climates. We examine how much different climate zones affect household financial benefit when the rebate level and replacement costs stay the same.

**Future Cost of Purchasing Water:** Currently, the Los Angeles Department of Water and Power (LADWP) purchases a significant portion of their water from the Metropolitan Water District (MWD).[9] Historically, MWD has raised its rates every year and these costs are passed on to LADWP ratepayers. As California continues to face droughts and the impacts of global warming, we expect water prices to continue to rise, potentially at a higher rate than usual. Using expected water rate increases, we calculated the amount that households can expect to save over time if they participate in the turf replacement program.

## Ratepayer Impacts

Financial benefits for ratepayers are determined by the amount of rebate offered by the utility and the expected future cost of purchasing water from MWD (is it cheaper for the utility to spend the money upfront on the rebate program or to buy water from MWD indefinitely?). This report calculates the payback periods for ratepayers based on varying levels of household participation in the turf replacement program and different levels of rebates. We use participation levels that are consistent

9 According to data.lacity.org, LADWP purchased 39% of their water from MWD in 2012 (3 month moving average). (https://data.lacity.org/dataset/DWP-Percentage-Of-Water-Purchased-From-MWD-3-Yr-Av/8yaq-2fpu)

with meeting water conservation goals for the City of Los Angeles. We also consider the potential financial benefits to ratepayers over time. For this analysis, we use amortization, allocating the cost of the turf replacement program over a period of time. The timeframe during which we expect the benefits of turf replacement to last has a large impact on ratepayer financial benefit. We examine a 10, 20, and 30 year potential lifetime of benefits. While 20 years is the typical planning horizon for water supply projects, 10 years is the timeframe typically used by other researchers to analyze the turf replacement program.

Finally, we calculate the cost of saving water based on the amount of expected water savings due to turf replacement. Unfortunately, the exact amount of water saved when converting from lawn to less water intensive landscaping is unknown. We use MWD's predictions for expected water savings for most of this report. However, we also do a sensitivity analysis to test the impact that different levels of water savings from turf replacement would have on the cost of saving water.

There are a multitude of additional questions we could ask regarding the turf replacement program. These include what are the additional environmental impacts of replacing turf? What have been the impacts of turf replacement on home resale values? However, we leave these questions to future research.

# 2. Benefits of Household Participation

Homeowners may be motivated to participate in the turf rebate program for a variety of reasons, including a desire for greater environmental protection, communal resource stewardship, or water conservation. The most influential motivation for households, however, is likely to be the magnitude of the financial benefit which they may receive from participation. Therefore, in this section, we first identify the factors which determine the household financial benefits of turf replacement. Second, we explore how variations in these factors can change the size of financial benefits which households receive.

## *The Financial Proposition for Households*

Because financial benefits are likely the biggest motivator for households to participate in the turf replacement program, homeowners will want to know what type of financial benefit they can expect. The financial benefit varies depending on a few factors, some of which are determined by household preferences and some of which are shaped by outside factors, such as policy decisions. To understand the benefits, homeowners may ask the following questions:

***How much does it cost to switch from lawn to something else?***

The first step in the replacement process is also the biggest upfront cost to participants: removal of the lawn, and installation of replacement landscaping. Consumers can decide how to remove their turf, and the type of turf replacement. For example, they can hire a company to remove the lawn or they can remove the lawn themselves; they can use expensive products to re-landscape their yard or they can use inexpensive options; they can hire a landscape architect or design the yard themselves. These decisions will be made based on consumer preference. Regardless of the customer's decision, the replacement process will incur time and monetary costs , but the amount of cost will vary depending on what choices the homeowner makes.

The cost of lawn replacement is offset by two things: 1) the size of rebate which homeowners receive, and 2) future savings from avoided water usage. This leads to the next homeowner inquiries.

***What proportion of the cost of replacement does the rebate cover?***

Participants will receive a rebate if they remove their lawn and replace it with drought tolerant landscaping. This rebate may offset some or all of what the homeowner has spent upfront on the replacement of their lawn. The rebate amount received by the homeowner is typically determined based on how much money the utility is offering per square foot of turf removed and the total square footage of turf removed by the homeowner.

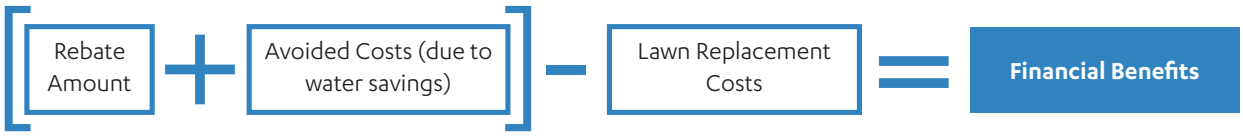
***How much water will we save? How much would we have spent on that water? And, how many years will it take to recoup the extra costs not covered by the rebate?***

In addition to the offset provided by the rebate, households will offset the upfront cost of lawn replacement with future savings from not purchasing as much water. With less thirsty landscaping,

households will not need to use as much water in the future. Homeowners will want to know how much water they are saving by replacing their lawn with an alternative option because this will impact their financial benefit of participation in the program. Outside factors such as the climate zone in which the homeowner lives and the future water rates charged by utilities will impact the amount of cost savings experienced over time by the homeowner.

Figure 1 connects both the costs to homeowners who participate in the turf replacement program and the offsets to these costs with the final determination of household financial benefit:

**Figure 1: Household financial benefit from participation in the turf replacement program**




As displayed in the figure, the rebate amount received by households and the amount of money households save over time due to avoided water usage are combined to offset the cost of lawn replacement. If the offsets are greater than the cost of lawn replacement, households will see financial benefits.

The following sections outline each step of the customer decision-making process and conditions that might impact a resident's desire and willingness to participate in the rebate program.

## *The Replacement Decision*

Before moving forward with turf replacement, households will likely consider what landscaping they might use to replace their lawn. This is an important decision which will impact their final financial benefit from participation in the rebate program. Replacement costs vary greatly depending on household preferences (Nordrum, 2015) and homeowners must make tradeoffs between quality and cost.

There are four main criteria for household consideration associated with replacement landscaping.

1. **Aesthetics:** Plantings and fill (groundcover) usually make up the post removal landscape, and can range from sparse to lush and colorful. Many participants have opted to use fruit bearing bushes and trees, succulents, native grasses, perennials, shrubs, and cactus, among other California-native and drought-resistant plants. Some yards have bright flowers and rich textures while others are simple and monotone. Fill is usually some form of permeable paving such as, gravel, mulch, stone, decomposed granite or even a combination including flagstone paths and boulders.[10]

2. **Home Value:** Attitudes have been changing about lawn desirability (Brenner, 2013). Generally, the more aesthetically pleasing the landscaping, which potentially requires costlier investment, the more likely it is to have a positive impact on property value. In addition, the water savings attributed to lawn-free yards may render higher home values.[11]

3. **Ease and Cost of Landscape Maintenance:** Participants will likely consider the ease and cost of the replacement landscape maintenance.[12] Yard alternatives to lawns often require significantly less watering and less upkeep. For example, California-native plants usually need weekly watering when first planted. Then the necessary frequency is reduced to monthly or even bi-monthly watering after the first couple of months. Most drought-resistant plants only require pruning every three or so months and native grasses only need mowing one or two times per year.[13]

4. **Environmental Impact:** Residents may consider the environmental impact of their replacement landscaping. For example, a lush California-native plant yard is likely more expensive to install than something more sparse, but will increase the supply of appropriate local habitat which could in turn increase biodiversity.[14] Also, storm water infiltration will vary depending on fill and plantings.

10 Sunset Magazine and other publications have published photos, plant and landscape fill lists, and how-to guides for less water intensive yards (Sunset Magazine, 2015).

11 According to a study done by Dastrup et al. in 2012, solar panels increased home value by about 3.5% (Dastrup et al., 2012). While this is not an overwhelming percentage, it is notable. Alternative yards can provide value in a similar fashion to solar panels. However, in California, due to public awareness about the drought, it is possible that water savings may affect home value even more significantly (Hurd, 2006).

12 A household survey performed in Phoenix found that residents rank ease of maintenance highly in terms of landscape preferences (Larson et al., 2009).

13 Plant maintenance is based on conversations with plant specialists at Matijila Nursery, Simi Valley.

14 Urban environments are responsible for many environmental problems including loss of biodiversity. Increasing natural habitats for birds, insects, and other animals can help to combat this problem (McKinney, 2002).

As figures 2 – 5 illustrate, there is a wide continuum of options available to households.

**Figure 2: Turf Terminators Landscape**

*Source: International Business Times*

**Figure 3: Green Pros Landscape**

*Source: Green Pros*

**Figure 4: DryStoneGarden Landscape**

*Source: DryStoneGarden: Plants and Stones for California Gardens*

**Figure 5: PCHSA Landscape**

*Source: Pacific Coast Home Solutions*

In this report, we use different replacement cost levels to represent different consumer preferences. These cost levels help to determine the potential household benefits, testing the variability in benefit based on different upfront costs. The next section examines the cost components that determine the underlying cost of turf replacement.

## *Replacement Costs*

The first financial impact on homeowners who decide to participate in the turf rebate program is the upfront cost of lawn replacement. Replacement refers to the process of uprooting a lawn and then replacing it with new plants and groundcover. The initial cost of lawn replacement can be high and may be a strong deciding factor for homeowners when they consider whether to participate in the rebate program.

While the Los Angeles Department of Water and Power (LADWP) turf replacement program has some requirements for households to qualify for the rebate, such as plant coverage of at least 40% in the final replaced turf area, the customer has flexibility and the decisions they make will affect the final cost of turf replacement. There are a number of choices that customers can make regarding replacement: how they will remove their turf, what they will replace their turf with, and whether they will add an irrigation system.

There are four components that vary in cost and affect the total cost of lawn replacement:

1. **Turf Removal:** The removal of the preexisting lawn.
2. **Plant Coverage:** Plants used after lawn removal. A homeowner can choose from many types of plants and landscaping options/designs. While the written regulations require 40% planting, in practice, there seems to be a lot of variability.
3. **Landscape Fill:** The ground coverage surrounding the plants. Most often, homeowners opt to use mulch but they could use other permeable groundcovers such as, river, gold or brown stones (Turf Terminators, 2015), gravel, or decomposed granite (Sunset Magazine, 2015).
4. **Drip Irrigation:** Not required, but many homeowners choose to have it installed in order to support their chosen plantings. Homeowners can decide to use drip irrigation or hand watering.

At each step of the process, the cost of labor can also impact the cost of turf replacement. If homeowners opt to hire a company to perform the lawn replacement, the cost will likely be higher than if the customer decides to implement the project on their own. Homeowners can decide to hire a company to do one portion of the lawn replacement, for example the removal of the lawn, or they can choose to have a company do the entire replacement including removal, landscaping, and irrigation installation. New companies have emerged to fill the burgeoning market of turf replacement and they can provide households with a full range of replacement options (Nordrum, 2015). One Los Angeles company, Turf Terminators, offers their services for free if homeowners sign over their rebates to the company.

In order to analyze the financial benefit of the turf rebate program, we need to estimate what homeowners can expect to pay for specific components of turf replacement. We used information gleaned from industry professionals, commercial websites with cost information, and online turf replacement calculators to come up with a range of possible replacement costs (Medina et al, 2015). On average, households can anticipate paying $1.92 per sq. ft. to have their lawn removed if they opt

to hire an outside company. The cost includes lawn removal labor, lawn removal debris disposal, and lawn removal equipment. The cost of replacement plantings vary greatly. Our sources indicate that a typical household spends about $4.14 per sq. ft. on plantings.[15] For landscape fill, homeowners will usually spend $1 per sq. ft. for mulch installation.[16] With respect to irrigation, we assume the upfront cost of choosing to hand water is $0. If a household decides to install drip irrigation, it will cost an average $0.92 per sq. ft.[17]

Based on the estimates above, this report evaluates three replacement cost option levels – low, medium, and high – to capture the variability in potential consumer choices.[18] The low cost option is $3 per sq. ft., and is only achievable assuming a household opts to carry out the replacement of the lawn as well as installation of plants and landscape fill on their own, a much less expensive option than hiring professionals (Medina et al. 2015). The medium cost option is $5.50 per sq. ft., and accounts for a moderate level of investment in planting and no drip irrigation. The high cost scenario is $8 per sq. ft., and assumes a household has opted to cover the minimum of 40% of the yard with premium plants and will install drip irrigation. The following table outlines the turf replacement cost options we have modeled.

**Table 1: Turf Replacement Cost Options for Homeowners**

| Turf Replacement Cost Options |
|---|
| **Low: $3/sq. ft.**<br>• Turf removal<br>• 40% of yard covered in low cost plants<br>• Low cost landscape fill |
| **Medium: $5.50/sq. ft.**<br>• Turf removal<br>• 40% of yard covered in moderate cost plants<br>• Moderate cost landscape fill |
| **High: $8/sq. ft.**<br>• Turf removal<br>• 40% of yard covered in higher cost plants<br>• High cost landscape fill<br>• Drip irrigation installed |

15 A report by UC Davis calculated the cost of three low water need native plants as well as the typical size these plants would eventually grow to be (Shapiro et al., 2012). They estimated that the average buyer spent $30 per 7.25 sq. ft. of California-friendly plants (including installation). We use their cost estimates for our analysis assuming plant costs are not significantly higher in Los Angeles than in Davis where the study was conducted.

16 Depending on the vendor, other landscape fill, such as decomposed granite or stone, can cost from $3-$9 per sq. ft. We use $1 per sq. ft. assuming most participants use mulch.

17 According to Homewyse Calculator, an online tool for homeowners to estimate landscaping and other home improvement project costs.

18 See Appendix A for a list of variables, assumptions, and sources used throughout the report.

## Turf Rebate Level

The upfront cost of turf replacement is offset by rebates which homeowners can receive from the local water utility. In L.A. City, this amount is determined by both LADWP and the Metropolitan Water District (MWD). Households, however, are unlikely to make decisions based on the source of the rebate. Rather, they are more likely to decide based on the total amount of the rebate available to them. The total rebate level has recently been volatile and it is unclear what the rebate for participants will be going forward. Therefore, it is important to examine how increases and decreases might affect the financial benefit to participants in the program, thereby impacting whether households will be incentivized to participate.

In order to replicate and test the effect of potential future rebate rates, we look at a range of rebate levels. On the low end, we investigate the financial effect of a $1.75/sq. ft. rebate. We also look at $2.75/sq. ft., $3.75/sq. ft., and $4.75/sq. ft. rebate levels. These levels represent both possible future cuts in the rebate dollar amount as well as possible expansion to the program.

## Climate Impacts on Water and Cost Savings

The financial benefit to homeowners who participate in the turf rebate program is also determined by future cost savings. Due to less thirsty landscaping, homeowners can use less water and therefore save money over time. These savings help to offset the upfront cost of turf replacement.

However, there are a multitude of factors, such as climate variation, local temperature, and precipitation variation, which can impact avoided water use and thus the magnitude of household savings. Climate affects evapotranspiration (ET) rates, which in turn affect the amount of water a household requires to maintain its lawn.[19] In high temperature zones, water evaporates more quickly. High temperature zones cause higher household water use to compensate for the higher ET rate. Low temperature zones, on the other hand, have lower ET rates and lower associated water use (LADWP Presentation, 2015). Households in high temperature zones that participate in the turf replacement program therefore experience the largest reduction in per capita water use and the biggest long-term savings.[20]

To model the variation in climate across Los Angeles, we test varying levels of ET rates by designating a low, medium, and high climate zone.[21] However, exact ET rates are unknown. For this report, we use the average ET rate that has been documented for the South West as the medium ET rate. This assumes that households in the medium climate zone (citywide average) see water savings of 44 gallons per sq. ft. per year.[22]

19 ET rates are the rate at which water is lost due to evaporation.

20 Even when assuming households in the higher temperature zones pay slightly less for a larger portion of their water than do low climate zone households, they still experience higher long-term savings from switching their lawns to less water intensive landscaping options.

21 LADWP assigns each zip code a "high," "medium," or "low" temperature zone classification (LADWP, 2015). These classifications are reflected in water pricing. Households in the higher temperature zones are allotted more water in LADWP's tier 1 (less expensive) pricing rate to compensate for the fact that they will need more water than households located in the lower temperature zones.

22 MWD determined the amount of water savings from turf replacement within their service area by using data from two different studies, one analyzing water savings in Marin (Nelson, 1994), a cold and damp climate, and one analyzing water savings in Nevada (Sovocool, 2005), a warmer and more arid climate.

We hypothesize that the difference in rates is around 20%. Therefore, we use a 20% climate differential to test the sensitivity of household financial benefits based on different climate zones. We assume households in the high climate zone save 20% more gallons per year than households in the medium climate zone, while households in the low climate zone save 20% fewer gallons of water per year.

## *Trends in the Future Price of Water*

The cost of purchasing water impacts how much households will save and the total financial benefit to households that participate in the turf rebate program. LADWP and MWD generally raise water prices each year, which means households should consider the growth rate of water pricing when calculating their possible future savings from reduced water usage. In typical weather conditions, LADWP and MWD are likely to increase rates respectively by 4% and 6% each year. These percent increases are estimated based on water pricing history. However, in drought conditions, LADWP is expected to increase its water price at a rate of 8% per year and MWD is expected to increase its water price at a rate of 10% per year (See Figures 6 and 7).

**Figure 6: LADWP expected water rate increases over the next 20 years (cost per hundred cubic foot (HCF) during drought and non-drought years)**

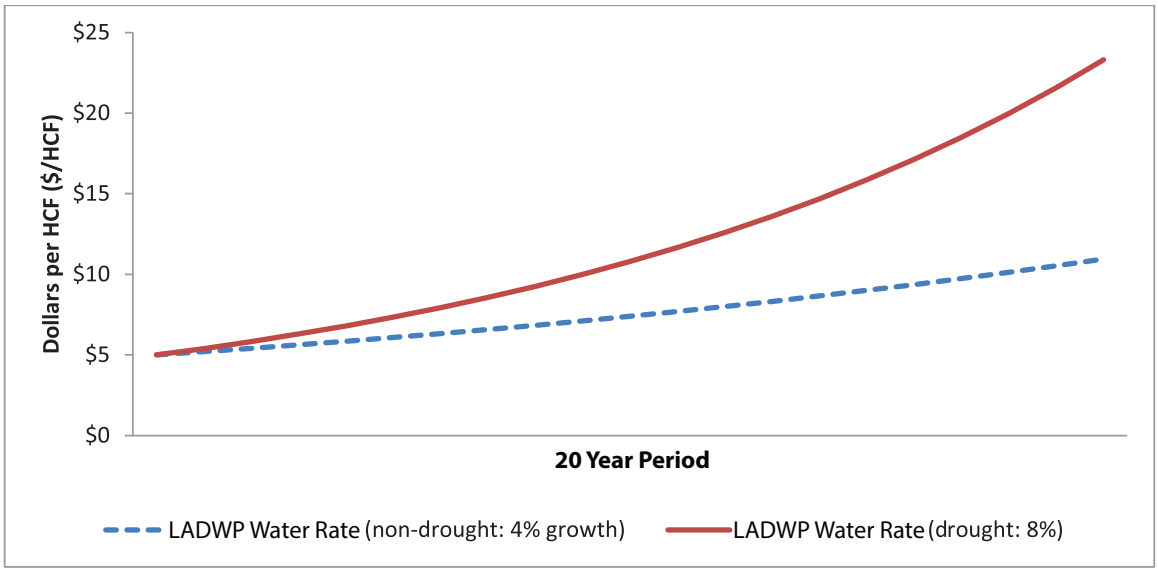
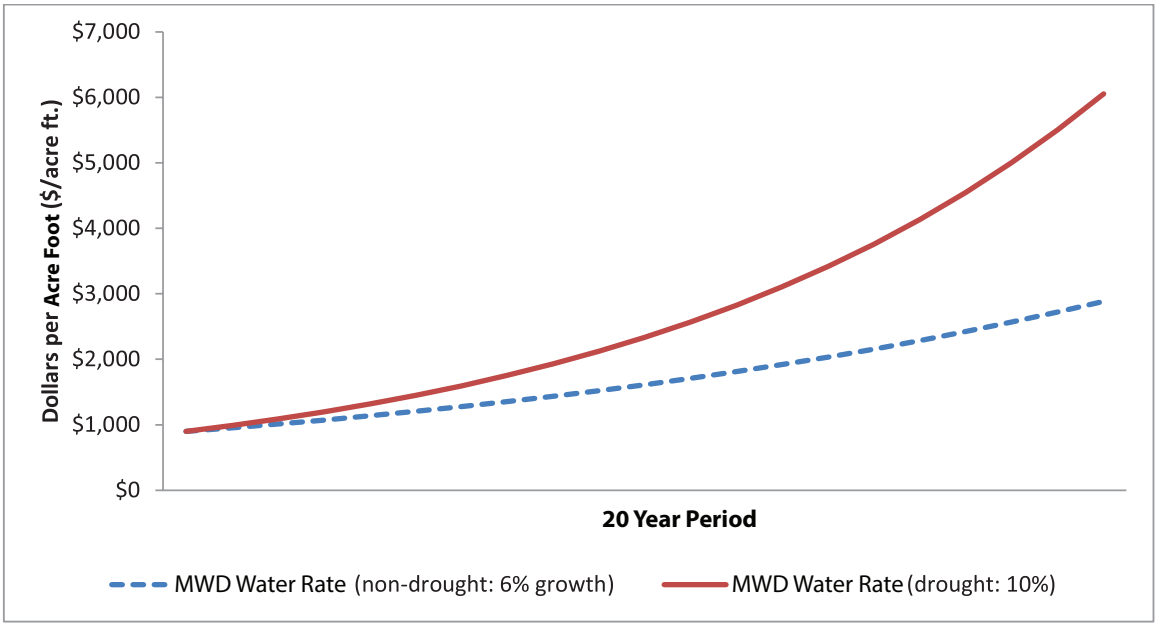


**Figure 7: MWD expected water rate increases over the next 20 years (cost per HCF) during drought and non-drought years**




The next section examines the potential household financial benefit for participants in the turf rebate program. We test the sensitivity of conditions that are likely to have the greatest impact on household financial benefit.

## *Analyzing Household Financial Benefits from Turf Replacement Scenarios*

We evaluate how alternative scenarios involving replacement costs, rebate levels, and climate zones affect the financial benefit to households who participate in the turf rebate program. A motivating question is which factors have the biggest impacts on household financial benefit. We use the payback period— the time it takes for a household to recoup the funds they expended on turf replacement— as a means to quantify household financial benefit from the program (shorter payback periods mean more financial benefit to program participants).

Consumer willingness to accept payback period length varies. Higher-income residents are typically willing to accept longer payback periods than low-income residents (Cunningham & Joseph, 1978). This is relevant because many of the single-family home potential conversion sites (sites that currently contain lawn with possibility to convert to an alternative) belong to higher income households (Mini, 2014).

The sensitivity analysis explained in the next section is performed by modeling a range of values for a given variable while holding all of the other variables at the medium level. For example, we test different levels of turf replacement cost while holding the climate zone and rebate level constant at the medium level in order to calculate possible payback period lengths.  Each calculation accounts

for both a typical discount rate (accounting for how consumers value future gains less than gains in the present) and inflation rate. The analysis is performed using two possible scenarios – drought and non-drought. This difference in potential weather patterns is reflected in LADWP and MWD projected water rates. Finally, we assume that households save 20 cents per sq. ft. on maintenance for alternative landscaping instead of turf.[23]

The payback periods we find are relatively short when we consider a rebate level of $3.75 per sq. ft. (the total rebate households would receive with a $1.75 per sq. ft. rebate from LADWP and a $2.00 per sq. ft. rebate from MWD). In fact, on average, the payback periods are shorter than the time a typical homeowner will stay in their home.[24] This makes the investment in turf replacement likely more appealing because homeowners can expect to experience financial benefits from the rebate program before leaving the home in which they invested. The payback periods for almost all of the scenarios we test are ten years or less. This timeframe is typically considered acceptable for similar investments, such as solar panels (Reid and Wynn, 2015).

When we decrease the total rebate to $1.75 per sq. ft. of turf replaced, assuming no additional rebate from MWD, the payback periods increase in all scenarios. But only in two cases does the payback period jump to higher than 10 years, 1) in a medium climate with the highest level of replacement costs (the payback period is just under 19 years), and 2) with medium replacement costs in the lowest climate zone (the payback period is just over 11 years).

In terms of relative importance, we find that replacement costs have the largest impact on household financial benefit, followed by alternative rebate levels. Different climate zones appear to have the smallest effect on household financial benefit. Therefore, consumer decision-making regarding the replacement process has the biggest effect on financial benefit for households. This may result in customers choosing the cheapest replacement options. This decision may also have consequences for the City. In this report, we do not explore what the impacts of replacement options might be other than the financial impacts on households and ratepayers, but the City may want to consider all potential factors when making decisions regarding rebate levels. For example, turf replacement programs may impact a range of environmental factors, such as plant and animal biodiversity and heat island effects.[25]

## *Replacement Cost*

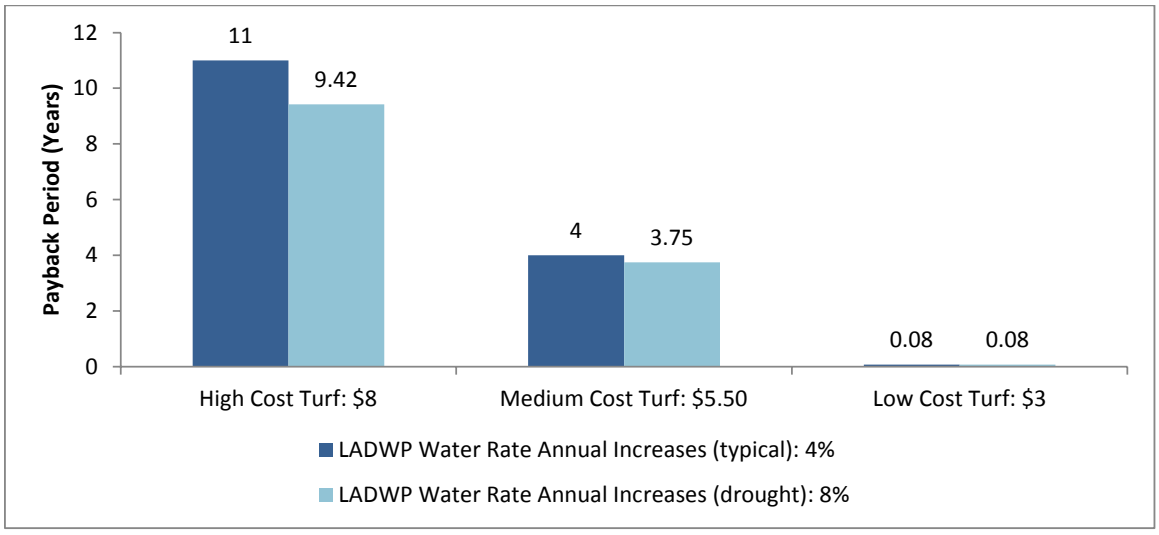
We first examine how differing turf replacement costs impact homeowner financial benefit. Because of the array of landscaping options, a homeowner's cost for turf replacement can vary widely. Three possible levels for the replacement cost were first modeled at the rebate rate of $3.75 per sq. ft. for a household located in a medium climate zone (Figure 8).

23 We determined the $0.20 savings for alternative landscaping maintanence based on data from EPA's Greenscapes Program (2005). See the archived EPA website at https://archive.epa.gov/wastes/conserve/tools/greenscapes/web/pdf/landscape.pdf for more information.

24 According to an article published by the National Association of Home Builders, homeowners typically stay in their houses about 13 years (NAHB, 2013). Most of our results show payback periods of less than 13 years, implying large financial benefits for households.

25 "Heat island" describes a built up area that is significantly warmer than its surrounding rural areas. The main cause of the heat island effect is from the modification of land surfaces.

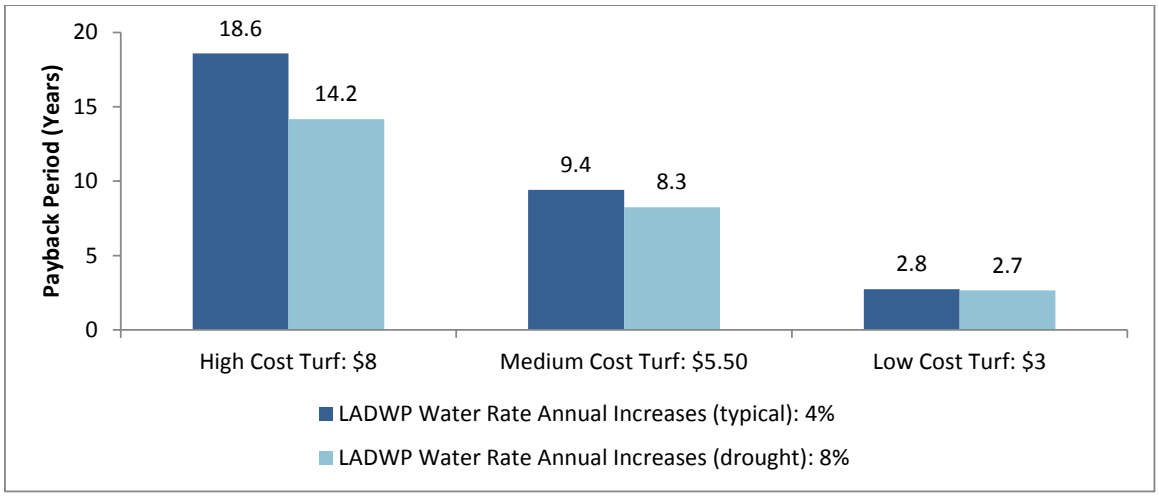
**Figure 8: Household payback period for different replacement costs and expected water rate annual increases ($3.75 rebate in medium climate zone)**




As shown in Figure 8, the cost for turf replacement can have a significant effect on the payback period. For example, increasing the cost of turf replacement from $3 to $8 per sq. ft. (which represents ~2.7x increase) yields a ~138x increase in the payback period (rising from 0.08 to 11 years).

Next, we modeled the same conditions with a rebate rate of $1.75 per sq. ft. of turf replaced.

**Figure 9: Household payback period for different replacement costs and expected water rate annual increases ($1.75 rebate in medium climate zone)**

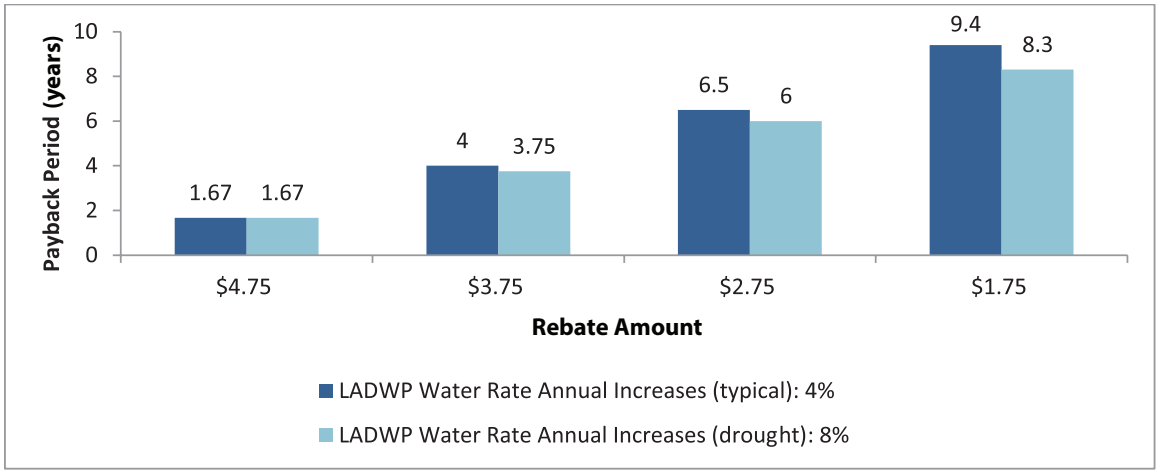



In this scenario, the payback periods increase overall because the rebate level is significantly lower. Only at the highest replacement cost level, however, is the payback period more than 10 years. When a customer spends $8 per sq. ft. on replacement costs instead of $5.50 on replacement costs, their payback period doubles when the water rate increases annually at 4% per year.

## Rebate Rate

By contrast, to examine the effect of different rebate levels on participating households, the payback period was modeled with a total rebate to participants of $1.75/sq. ft., $2.75, $3.75, or $4.75 assuming households are located in a medium climate zone and paying a medium replacement cost of $5.50 per sq. ft. (Figure 10).

**Figure 10: Household payback period for different rebate levels and expected LADWP water rate annual increases ($5.50 per sq. ft. replacement costs in medium climate zone)**

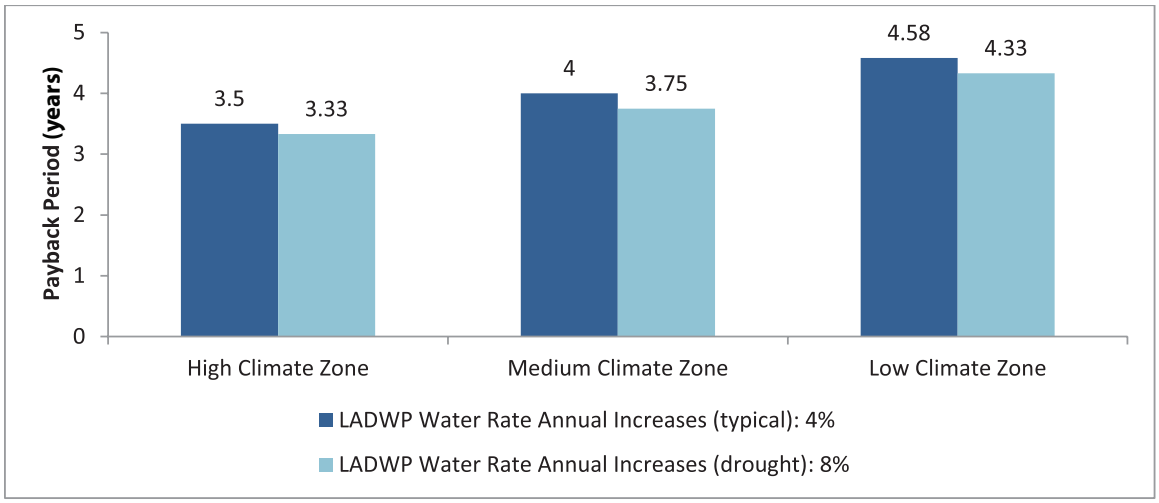



As the amount of rebate decreases, the payback period predictably increases. However, even at the lowest rebate level ($1.75/sq. ft.) in a medium climate zone, the average payback period is less than ten years for households which spend a moderate amount on turf replacement ($5.50/sq. ft.).

## Climate Zone

Assuming a rebate amount of $3.75 per sq. ft. and a medium level of turf replacement costs ($5.50 per sq. ft.), households located in different climate zones can expect to experience different payback periods (Figure 11). However, we find that the difference is minimal.

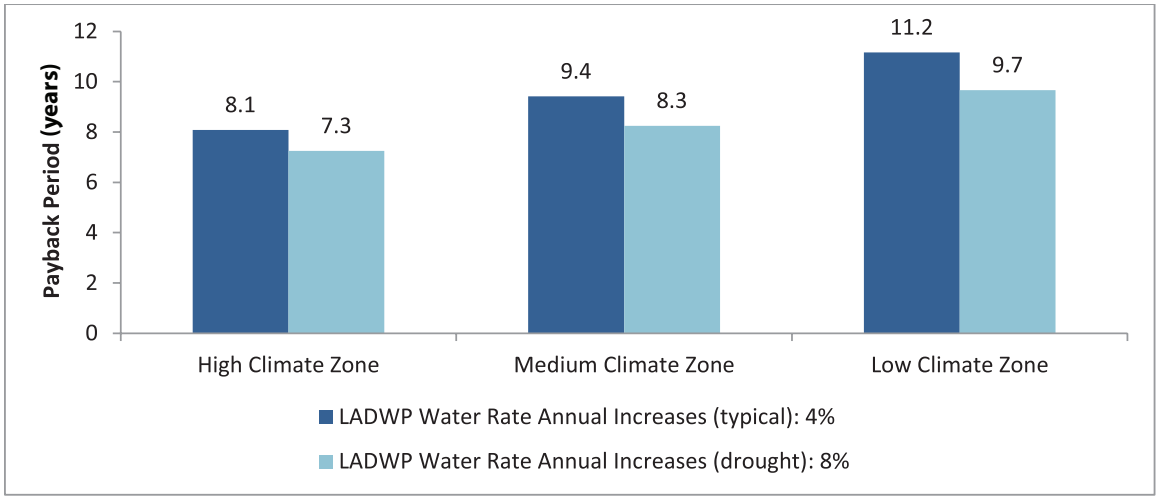
**Figure 11: Household payback period for different climate zones and expected water rate annual increases ($3.75 rebate with $5.50 per sq. ft. replacement costs)**




Average households in all three climate zones recoup their investment for turf replacement in 3.5 – 4.6 years at a typical LADWP annual water rate increase of 4%. During a drought, LADWP's expected annual water rate increase rises to 8% and the payback period for each climate zone is reduced by an average of roughly 5.5% (higher avoided costs equals shorter payback periods).

When the rebate is decreased to $1.75 per sq. ft. of turf replaced, the payback periods for all three climate zones almost double. Similar to when the rebate is $3.75 per sq. ft. of turf replaced, the difference in payback period based on the climate zone is minimal.

**Figure 12: Household payback period for different climate zones and expected water rate annual increases ($1.75 rebate with $5.50 per sq. ft. replacement costs)**




As seen in the graph above, even in the lower rebate scenario ($1.75 per sq. ft. of turf replaced), the payback periods are still less than 10 years.

## *Household Savings*

Another way to evaluate household financial benefit is to calculate it in terms of gross and net household savings (in terms of dollars saved or gallons of water saved due to avoided purchase of water) after 5, 10, and 20 years. This timeframe allows us to look beyond payback periods for homeowners in order to investigate what they could expect to save if they replace their turf with less water intensive alternatives. Savings vary dependent on weather conditions due to different expected annual water rate increases – drought (expected annual water rate increases of 8%) versus non-drought (expected annual water rate increases of 4%) (Table 2). The monetary savings account for inflation and discount rates (the savings are listed as present value). We assume households are saving 44 gallons of water per sq. ft. of turf replaced with less water intensive landscaping. Gross household savings do not account for upfront replacement costs or the rebate received by homeowners.

**Table 2: Gross Household Savings over Different Time Periods for a Representative LA Household**

| Time Period | 5 years | 10 years | 20 years |
|---|---|---|---|
| Current Pricing | $3,308 | $5,960 | $9,853 |
| Short-term Drought Pricing | $3,524 | $6,791 | $12,980 |
| Gallons of Water Saved | 330,000 | 660,000 | 1,320,000 |

These savings are not insignificant. In fact, the gross household savings in 10 years during short-term drought pricing are equivalent to paying more than five years of water bills. The gross savings in 20 years are equivalent to paying almost eleven years of water bills.[26] The figure below shows a visualization of these water savings. A train of 11 tankers carries approximately 330,000 gallons of water; an Olympic size swimming pool holds about 660,000 gallons of water; and a water tower carries slightly less than 1,320,000 gallons of water.

26 To calculate average water bills and potential yearly savings, this report assumes 54% of water use is directed outdoors (Firestone, 2014) and that 74% of outdoor water use is saved when lawns are replaced by less water intensive landscaping (Sovocool, 2005). We assume customers are replacing 1,500 sq. ft. of turf with less water intensive landscaping, and we use water rate averages from LADWP's website based on recent water rate increases: http://www.myladwp.com/2016_2020_rate_request. For more details on calculations, see Appendix B.

Figure 13: Water Savings


We also examined the net present value (NPV) of household savings from the turf replacement program over different periods of time assuming a rebate of $3.75 in the first scenario and $1.75 in the second scenario. We incorporated the cost of turf replacement, the rebate amount[27] and the water savings associated with turf replacement to analyze household savings. We found the NPV of the turf replacement program for households by looking at a range of potential water savings over different time periods. Table 3 shows the net present value for a household saving 26.4, 35.2, or 44 gallons of water per sq. ft. per year. We examine time periods of 5, 10, 15, and 20 years, representing the amount of time a person may stay in their home after they have replaced their lawn (assuming they keep the replacement landscaping while they are in the home).

For the first case, we assume current water pricing conditions (water prices increasing at an annual rate of 4%) and that households receive a rebate of $3.75 and spend $5.50 per sq. ft. of turf replaced. In the second case, we adjust the rebate to $1.75 per sq. ft.

27 In the first scenario, we use a rebate amount of $3.75.This was the rebate amount available to households when MWD and LADWP both offered rebates in 2014. In the second scenario, we use a rebate of $1.75 per sq. ft. of turf replaced, assuming MWD will not offer its $2.00 per sq. ft. rebate.

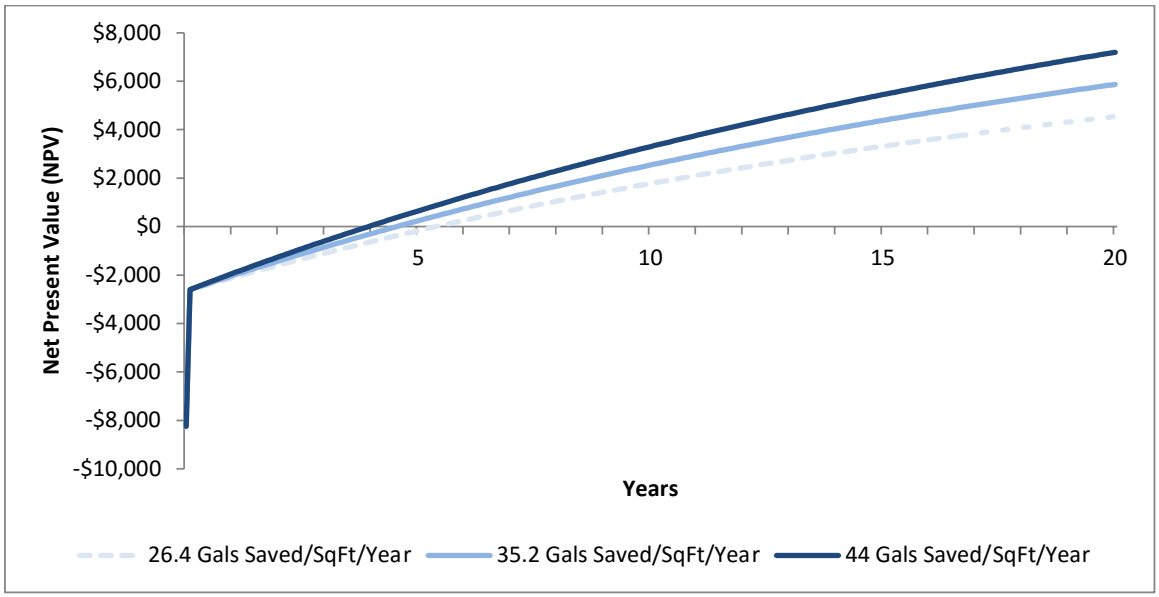
**Table 3: Net present value (NPV) for households in current water pricing scenario, receiving a rebate of $3.75 and spending $5.50 per sq. ft. of turf replacement**

| Years | 26.4 Gallons Saved/SqFt/Year | 35.2 Gallons Saved/SqFt/Year | 44 Gallons Saved/SqFt/Year |
|---|---|---|---|
| 5 | -$168 | $242 | $651 |
| 10 | $1,779 | $2,541 | $3,302 |
| 15 | $3,317 | $4,382 | $5,447 |
| 20 | $4,543 | $5,869 | $7,195 |

In the table above, we see that households in almost all scenarios receive some amount of financial benefit from the turf replacement program. Only in the lowest water saving scenario assuming a five year time period does a household lose money by participating in the program.

Even with low water savings and relatively short time horizons (10 years), households experience financial benefits when they replace their lawn. Figure 14 displays the net present value for households dependent on water savings level and time period.

**Figure 14: Net present value (NPV) for households over 20 years with different expected water savings from turf replacement (assuming $3.75 rebate, $5.50 per sq. ft. replacement costs and current drought pricing rate increases)**




At first, all three water savings scenarios have a negative net present value because households are required to pay upfront for replacement costs. After receiving the rebate and saving water over time, households start to make back their investment in turf replacement. All three water saving scenarios see financial benefits to participating in the replacement program after six years.

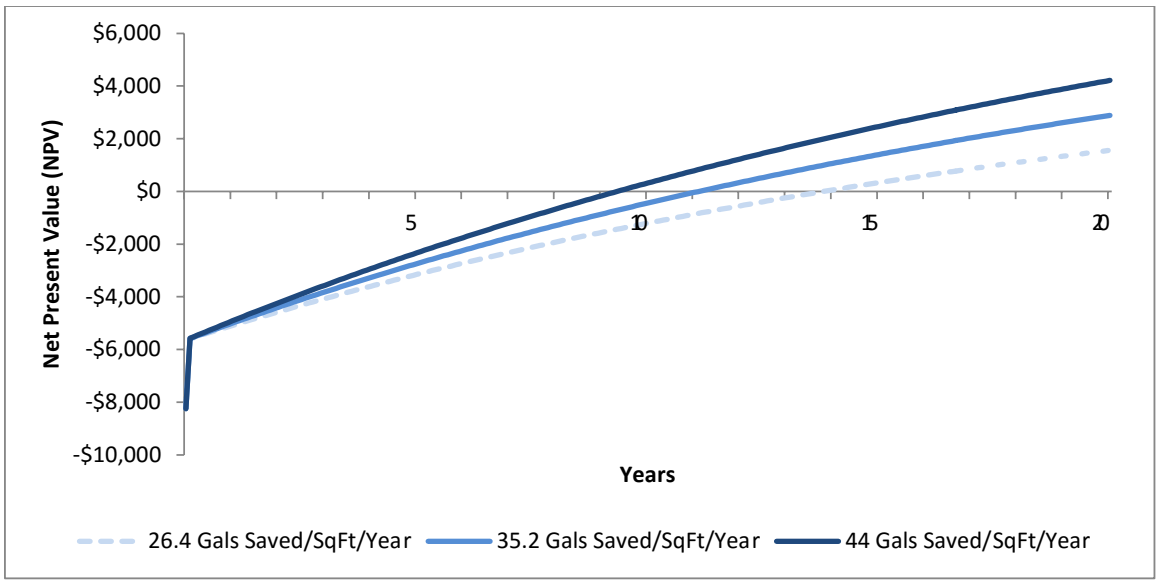
Households take longer to realize savings when we adjust the rebate to $1.75 per sq. ft. of turf replaced.

Table 4: Net present value (NPV) for households in the current water pricing scenario, receiving a rebate of $1.75 and spending $5.50 per sq. ft. of turf replacement

| Years | 26.4 Gallons Saved/SqFt/Year | 35.2 Gallons Saved/SqFt/Year | 44 Gallons Saved/SqFt/Year |
|---|---|---|---|
| 5 | -$3,150 | -$2,741 | -$2,332 |
| 10 | -$1,203 | -$442 | $320 |
| 15 | $334 | $1,399 | $2,464 |
| 20 | $1,560 | $2,886 | $4,212 |

In the table above, we see that savings for households accrue in all scenarios starting after 15 years.

Figure 15: Net present value (NPV) for households over 20 years with different expected water savings from turf replacement (assuming $1.75 rebate, $5.50 per sq. ft. replacement costs and current drought pricing rate increases)




Again, all three water saving scenarios have a negative net present value. After approximately 10 years, annual water savings of 35.2 and 44 gallons per sq. ft. result in financial benefit for households (positive net present value of their financial savings). In the lowest water saving scenario, 26.4 gallons per sq. ft. saved annually, households see positive net present value approximately 14 years after investing in the turf replacement program.

There is a significant difference in payback periods and the net present value of household savings dependent on whether the rebate amount is $1.75 or $3.75. The higher rebate is better for households, i.e. shorter payback periods and higher net present value in less time. However, even without the extra $2.00 historically offered by MWD, households see financial benefit from the rebate program in a relatively short period of time.

## *Participation Goals and Associated Costs*

If the turf replacement program is going to be successful in helping Los Angeles reach its water conservation goals, people have to participate in the program. But ***how many*** people have to participate? As of March, 2015, 4,994 households (1.53% of all single family households in Los Angeles)[28] have participated in the turf rebate program. Participating households replaced, on average, 1,600 sq. ft. of turf,[29] similar to the average of 1,500 sq. ft. replaced used as an assumption in this report. If households replace approximately 1, 500 sq. ft., they save 66,000 gallons of water per year.[30] A water tank holding 66,000 gallons of water is approximately 24 ft. high and 21 ft. in diameter (Figure 16).

**Figure 16: 66,000 Gallon Water Tank**

*Source: National Storage Tank, Inc. (www.nationalstoragetank.com)*

In this section, we calculate the number of households that would have to participate in the turf replacement program if the City of Los Angeles is going to reach its water conservation goals. We also examine how much it will cost the City to reach those targets and how the time it takes to reach those goals will impact the potential financial burden to the City.

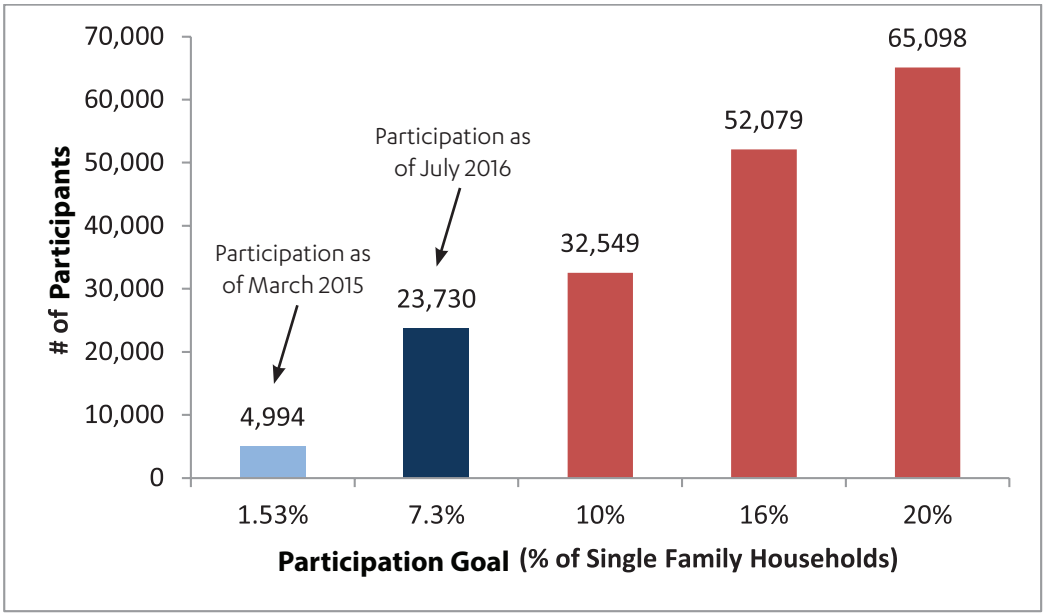
28 Using the Los Angeles Solar Atlas from the UCLA Luskin Center for Innovation (DeShazo et al., 2011), there are 464,325 potential sites but only 70.1% of these sites are single family. Therefore, this report uses 325,492 as the number of possible conversion sites.

29 Although the actual average of turf replaced per household is 1,600 sq. ft., this report uses 1,500 sq. ft. because of complications relating to LADWP's tiered water rate structure and their cut off for rebate offers. The additional 100 of average square footage should not impact the findings in this report.

30 The average participant saves 66,000 gallons of water per year if we assume they are saving an annual 44 gallons per sq. ft. of turf replaced.

Figure 17 shows the number of people that would have to participate in the turf replacement program to reach 10%, 16%, and 20% penetration rates (i.e. participation goals for the turf replacement program).[31]

**Figure 17: Single Family Household Participation in Turf Rebate Program**




The City has set a goal of reducing average per capita potable water use by 20% by 2017. As illustrated in Figure 17, 65,098 people would have to convert their lawns in order to reach 20% penetration of the single family household sector.[32] This requires a 240% increase in participation (12,021 person increase per year) over the March, 2015, participation level of 4,994 households every year over the next five years. However, as of July, 2016, 23,730 residents had participated in the program, an increase of 475% over the previous year (LADWP, 2016). The higher participation goals thus appear within reach.

The turf replacement program is one of a multitude of conservation programs offered by LADWP and the program has important longterm benefits. Water savings from replacing lawn with less water intensive landscaping will compound in value over future years as households continue to use less water and the City can purchase less water from imported sources. The City's long term water conservation goals include a 50% reduction in the purchase of imported water by 2025 and 50% locally sourced water by 2035 (Sustainable City Plan, 2015).

31 We chose to examine a range of participation rates, which were chosen in part to model the targets set at both the State and local level. Governor Brown's Executive Order B-29-15 calls for a statewide 25% reduction in potable water compared to 2013 by February 28 of 2016 but designated specific targets by city (16% reduction target for the City of Los Angeles). Locally, the City set goals in ED5 as well as the Sustainability pLAn to reach a 20% reduction in per capita potable water use by 2017, a 50% reduction in DWP's purchase of imported potable water by 2024, and 50% locally sourced water by 2035.

32 While asking all L.A. residents to reduce consumption by 16% would be the most equitable way to reach the citywide goal, it is unlikely that each person will conserve equally. To address this issue, we consider single family households as a group that needs to reduce water consumption by 16%, rather than assuming each individual within the single family household sector will reduce use by 16%. Turf replacement can be an effective way to meet the goal for single family households. The households that convert their lawns will each be reducing their water consumption by about 39% (based on 54% of water being used outdoors (Firestone, 2014) and 74% of outdoor water use being saved when lawns are replaced by less water intensive landscaping (Sovocool, 2005)). If 16% of households in this sector convert their lawns to less water intensive alternatives, the remaining 84% of households will only have to reduce their water consumption by about 10%.

Participation would have to grow substantially from the number of participants as of March, 2015, in order to meet 10%, 16%, or 20% penetration. The 475% increase between March 2015 and July 2016 indicates this is possible. If participation continues to rise, the associated water savings are significant. Figure 18 and 19 illustrate the gallons of water saved and the associated money saved if the City reaches 10% and 16% penetration rates. The financial savings are accrued based on the amount of water saved over time and therefore not purchased from MWD. We look at both a five (Figure 18) and ten year (Figure 19) timeframe for reaching the penetration goals. Overall savings will be greater if realized over the ten year timeframe due to a longer period to accumulate cost savings from avoided water purchasing. Reaching participation goals more quickly will mean more savings but will also cost the City more money upfront. Gross savings shown in figures 18 and 19 do not include the upfront rebate expenditure for the City.

**Figure 18: LADWP gross savings (gallons and dollars) over 5 year period reaching 10% and 16% participation rates - does not include the rebate expenditure**

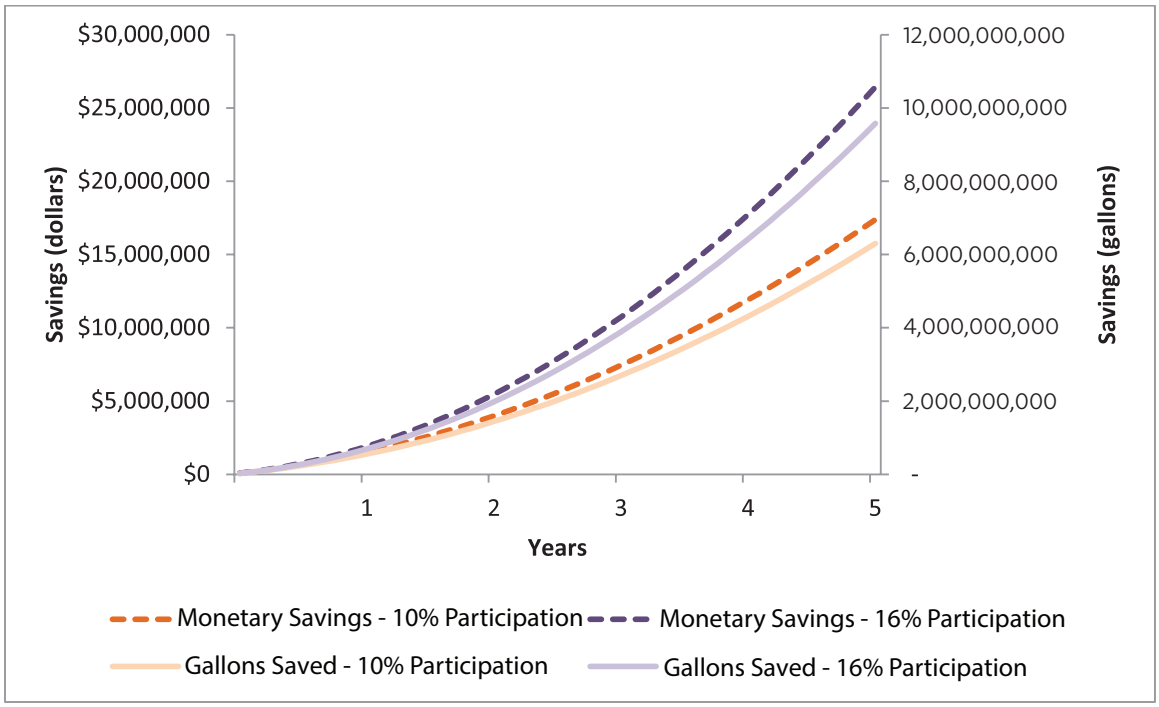
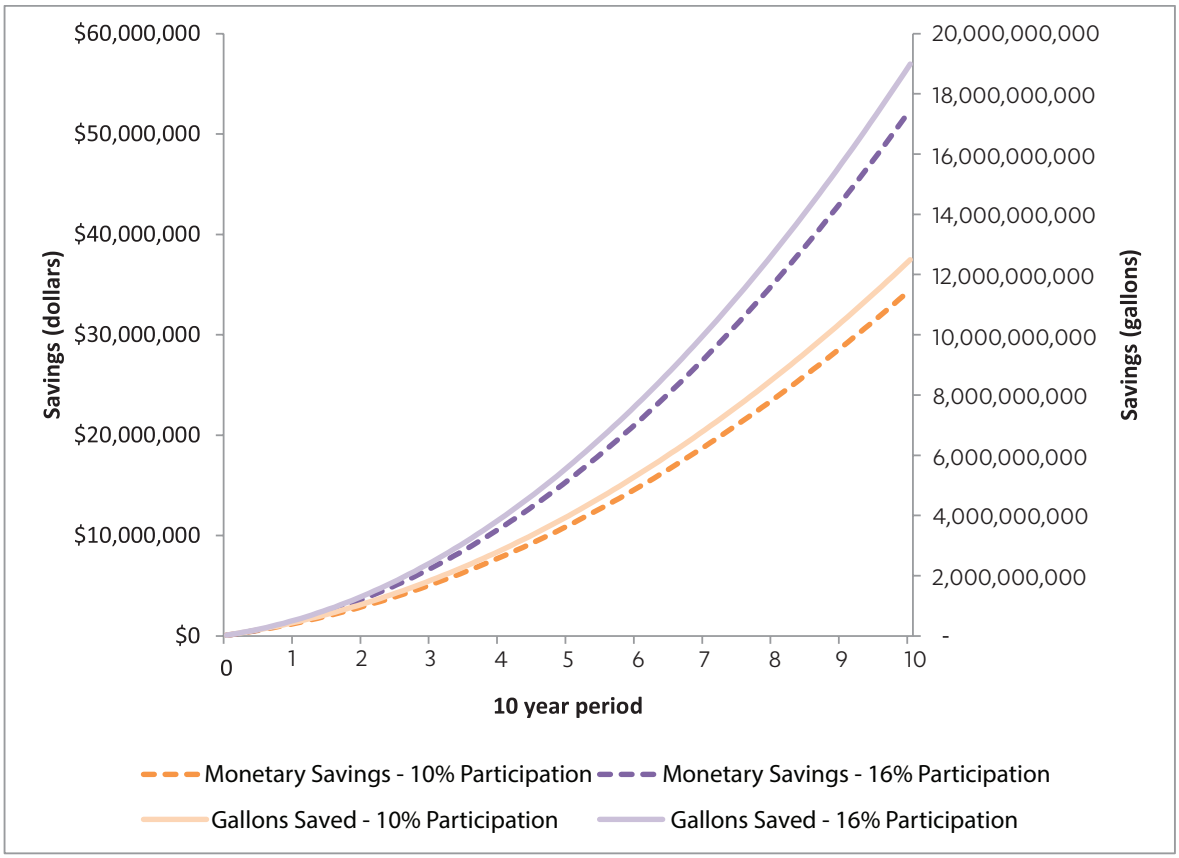


Figure 19: LADWP savings (gallons and dollars) over 10 year period reaching 10% and 16% participation rates




Next, we examine the financial implications of reaching these participation targets (Figure 20 and 21). The ten year period allows for less expenditure by the City per year. However, the five year timeframe would help L.A. reach the 2020 goal in a more timely fashion. The following figures assume the rebate is $1.75 per sq. ft. and that households are converting 1,500 sq. ft. of turf.

Figure 20: LADWP rebate expenditures reaching participation rates over 5 years (discounted and adjusted for inflation; cumulative; assuming participation starts at 4,994 households)

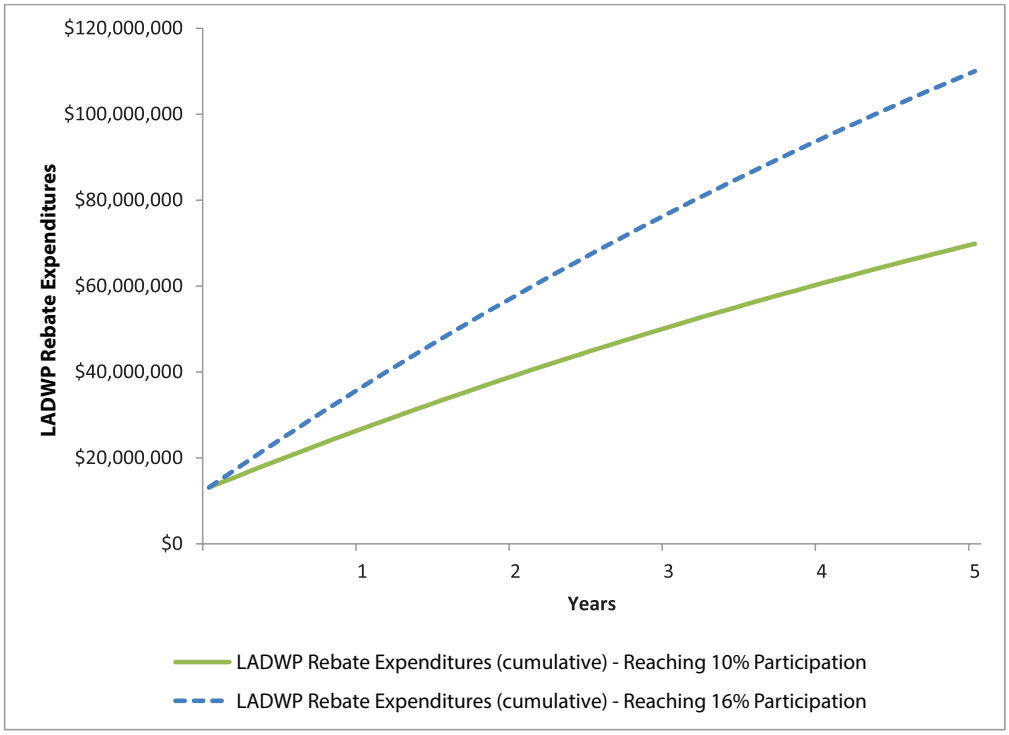
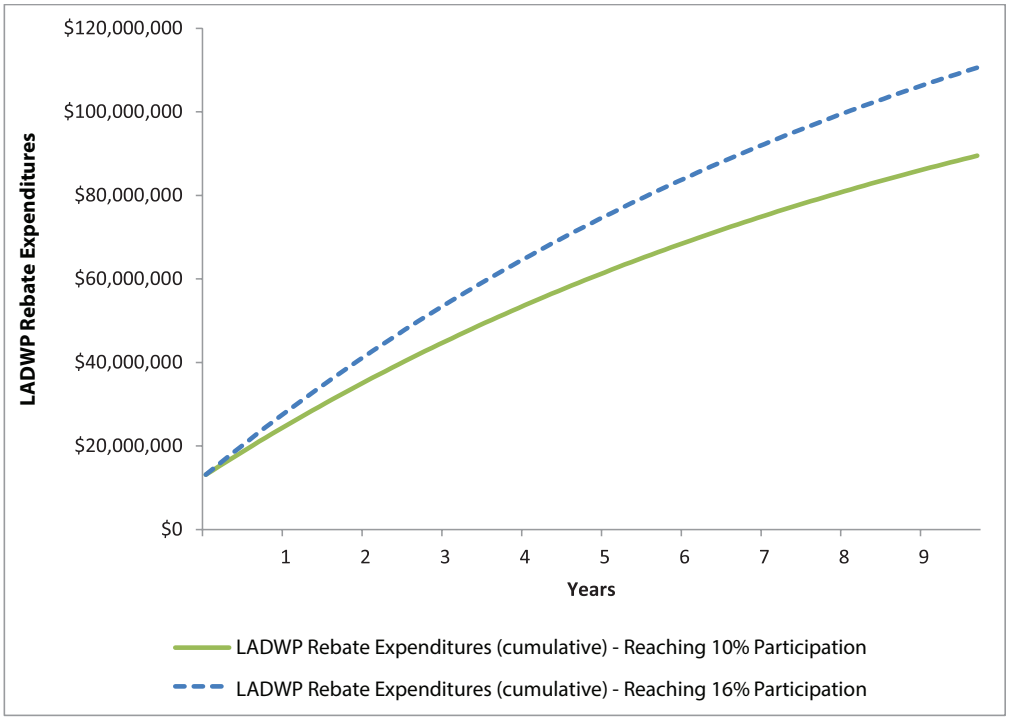



Figure 21: LADWP rebate expenditures reaching participation rates over 10 years (discounted and adjusted for inflation; cumulative; assuming participation starts at 4,994 households)



The turf replacement program may be an effective way to reach water conservation goals if the City decides to invest and incentivize program participation. However, it is worthwhile to also consider the upfront and ongoing cost to the utility and ratepayers.

## *Household Decision-Making*

Households consider many factors when deciding whether or not to replace their lawn. Understanding these decisions could help the City structure the rebate program to incentivize higher penetration rates. For example, residents have to consider a tradeoff between cost of replacement and the rebate amount. If a household is concerned with aesthetics, and home value in particular, they will be faced with possible increased investment costs. Those households may be more likely to make the investment to replace their lawn if they are offered a higher rebate amount. The City has to evaluate the quality threshold that they want to support. Not only will customers be incentivized to participate with higher rebate amounts, the replacement result may be more in line with what the City values (for example, native habitats, permeable surfaces, decreased heat island effect) if participants receive larger rebates to fund their lawn conversions. However, as noted, even with lower rebate amounts and relatively high replacement costs, households only face payback periods of approximately ten years or less. This is comparable to solar panel payback periods and often considered an "attractive" timeframe for households to consider an investment (Faiers & Neame, 2005).

The next chapter evaluates the cost effectiveness of the rebate program and analyzes the impact on ratepayers and the utility.

# 3. Ratepayer Benefits of the Turf Replacement Program

In addition to households, utilities may benefit from the turf replacement program and must pass on savings to ratepayers.[33] The analysis in this chapter aims to evaluate the potential for LADWP to save money in the future through its immediate investment in the turf replacement program, thereby making the program a worthwhile investment. LADWP's savings would be passed on to the ratepayers through lowered water costs.

To provide water for its customers, LADWP must purchase water from MWD. While Los Angeles is moving towards obtaining more water from local sources, currently, over 80% of L.A.'s water is imported (Garcetti, 2015) and a large portion is purchased from MWD. Through water conservation programs, like turf replacement, LADWP can avoid some of the high costs of purchasing imported water. Purchasing water from MWD currently costs LADWP $900 per acre foot (Urban Water Management Plan, 2011). However, water prices have historically increased every year. The table below shows MWD's expected yearly rate averages per acre foot of water over 10, 20, 30, and 40 years. The average price is expected to be higher during drought conditions.

**Table 5: Average cost per acre foot of water purchased from MWD over different time periods (present value, adjusted for inflation)**

| | 10 years | 20 years | 30 years | 40 years |
|---|---|---|---|---|
| **Typical Rate (avg/yr)** | $1,341 | $1,998 | $2,976 | $4,434 |
| **Drought Rate (avg/yr)** | $2,279 | $4,711 | $10,100 | $22,048 |

If conservation efforts are successful, and LADWP is able to purchase less water from MWD, then they will avoid costs that they would have had to pay to MWD to purchase water. Water savings from the turf replacement program[34] can be allocated elsewhere, allowing LADWP to reduce their water purchasing.

LADWP will recoup their investment in the turf rebate program after a certain period of time (the payback period). At first, LADWP's water savings from household participation in the turf rebate program are not sufficient to make up for the cost of the turf rebate program. In fact, it would initially be less expensive for the utility to buy water from MWD. However, after the payback period, LADWP will start saving money due to the water savings from household participation in the turf rebate program. These savings are passed on to the ratepayers because water is now less expensive (less

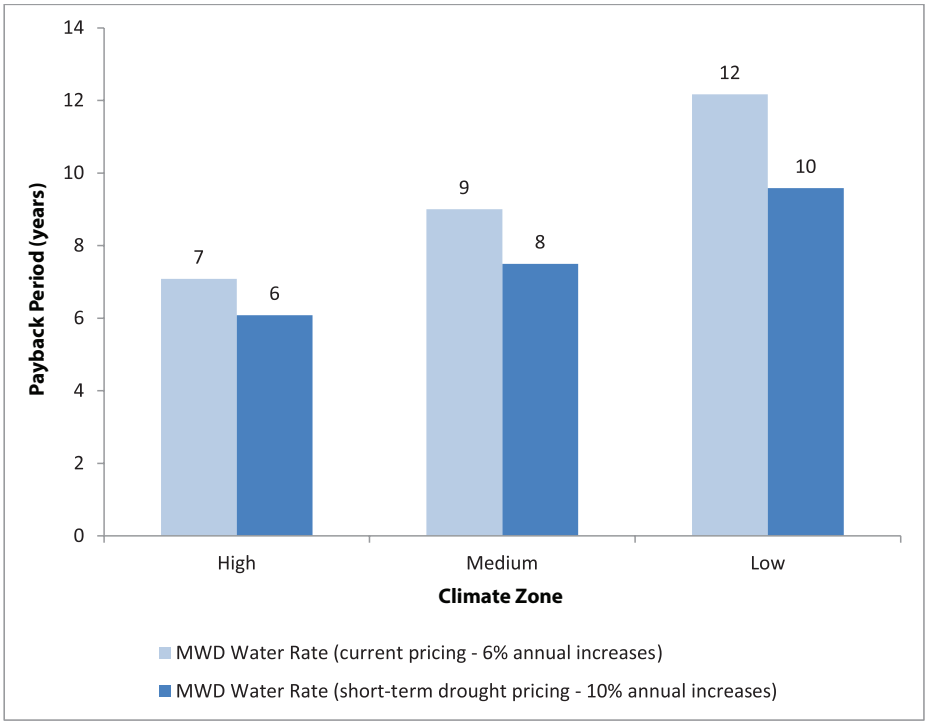
33 *Ratepayers* refer to the general LADWP customer base who may reap the benefits of reduced costs for the utility.

34 If 54% of water is used outdoors (Firestone, 2014) and 74% of outdoor water use is saved when lawns are replaced by less water intensive landscaping (Sovocool, 2005), then households that change out their lawns will reduce their water use by about 39%.

than it would have been to purchase water from MWD) and LADWP can charge their customers less for the water they consume which is supplied by less expensive local resources, such as groundwater. Increasing MWD water rates mean the savings are also compounded over time and will accelerate as time passes while the rebate expenditures will not last indefinitely (once the City has reached the penetration goal it desires, it can decide to discontinue the rebate program).

We calculated LADWP payback periods depending on different levels of rebates[35] ($1.00 per sq. ft., $1.75 per sq. ft., and $2.40 per sq. ft.).[36] The shorter the payback periods, the sooner ratepayers experience the benefits of the turf replacement program, i.e. utility-wide water savings and thus financial savings. We used a penetration rate goal of 16% over five years because this tracks most closely with citywide conservation goals. To test potential differences in payback period lengths based on household location, we modeled different climate zones at each rebate level. Finally, we use two different possible MWD water rates to account for cost increases over time – drought rates and typical year rates.

**Figure 22: LADWP payback period with a $1.00/sq. ft. rebate (16% participation over 5 year time period)**




35 This chapter does not consider any additional rebate from MWD. Only the rebates provided by LADWP will directly impact the cost effectiveness for the utility. While MWD's additional rebate may incentivize higher rates of participation thereby impacting water savings for LADWP, MWD's rebate does not directly affect the payback period to LADWP.

36 Before Mayor Garcetti raised the rebate in 2014, the rebate amount was $1.00; the current rebate amount is $1.75; and the highest rebate we could model for payback periods was $2.40. Once the rebate increased above $2.40, the payback periods were over 90 years for the low climate zones. Not only could our model not account for these high payback periods, we also decided this was too high a payback period to be reasonable for the City to consider.

Figure 23: LADWP payback period with a $1.75/sq. ft. rebate (16% participation over 5 year time period)

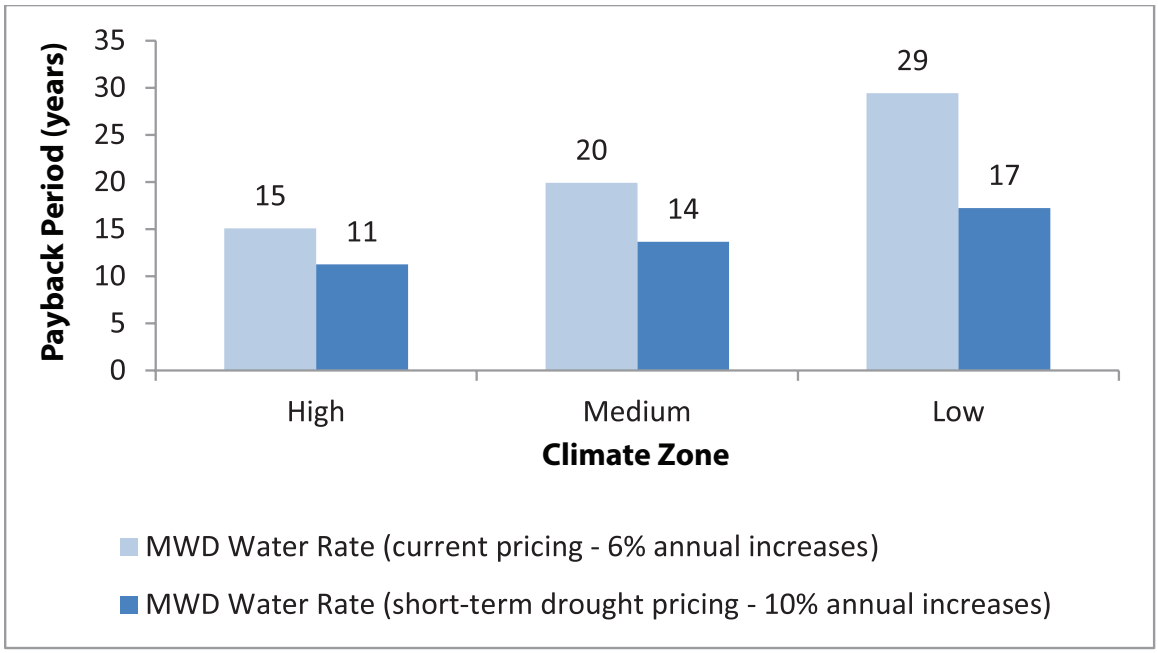
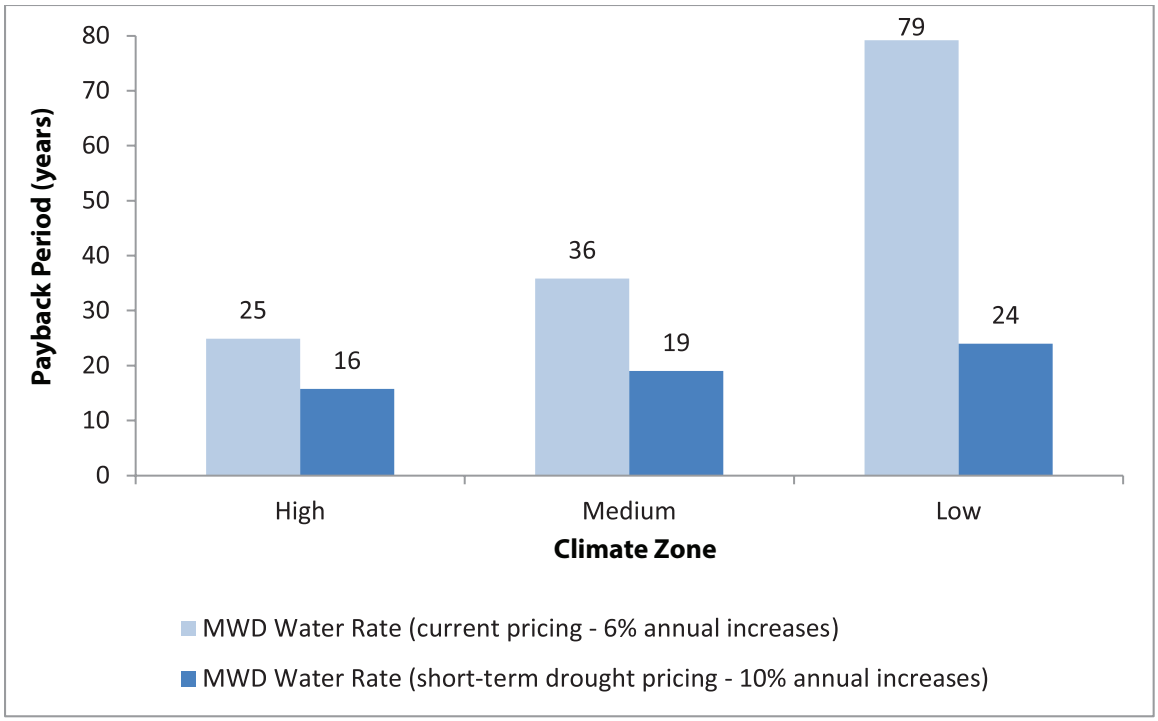



Figure 24: LADWP payback period with a $2.40/sq. ft. rebate (16% participation over 5 year time period)



As illustrated in the previous graphs, the amount of rebate provided by the utility to households has a large impact on the payback period for the utility. When the utility offers the lowest rebate amount ($1.00 per sq. ft.), the payback periods are relatively low (mostly under ten years) even considered in all three climate zones. However, when the utility offers the medium rebate level ($1.75 per sq. ft.), the payback period jumps up to periods of 15 years and more depending on the climate zone. Payback period is not the only way to consider LADWP's return on investment. In the next section, we will use amortization analysis to evaluate the cost effectiveness of the turf replacement program.

## *Amortization Analysis*

We use amortization analysis to evaluate the potential financial benefits to ratepayers. Amortization is an accounting practice referring to the allocation of the cost of an asset over a period of time. Amortization allows a company (or in this case, the utility) to consider an investment (in this case, rebates for turf replacement) spread out over the life of the asset (e.g., the new, less water intensive landscaping). While the turf replacement program requires upfront costs for the utility, the costs appear significantly smaller when amortized.

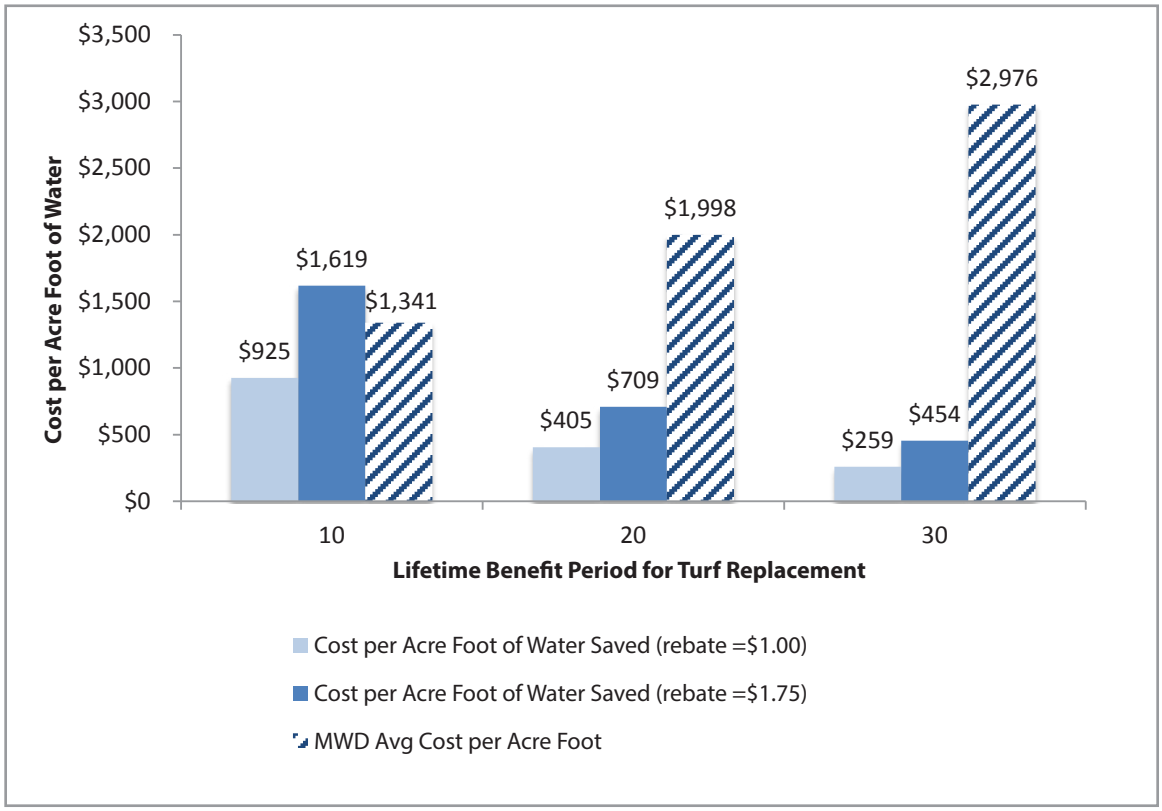
Using an interest rate of 3%, based on available rates, and amortizing the investment over 20 years,[37] we compared the cost per acre foot of water saved to the cost per acre foot of purchased water from MWD (Figure 25). We test different time periods for the lifetime of turf replacement benefits assuming a 16% participation rate (other participation rates do not change the analysis significantly[38]) as this correlates with the City's conservation goals. We use a conservative estimate of increasing MWD prices (6% every year) in the model.

MWD average water prices are significantly higher than the cost per acre foot of water saved through turf replacement when considered over a turf replacement lifetime of benefits of 20 and 30 years. Even when only considering a ten year timeframe for turf replacement benefits, MWD's cost is still higher than the cost per acre foot of water saved when LADWP issues a $1.00/sq. ft. rebate.

37 We use a 20 year amortization period because this is the typical planning horizon for water supply projects.

38 See Appendix C for complete analysis results.

**Figure 25: Cost per acre foot of water saved amortized over 20 years (comparing the cost of water saved using a $1.00 or $1.75 rebate scenario with the cost of water purchased from MWD)**



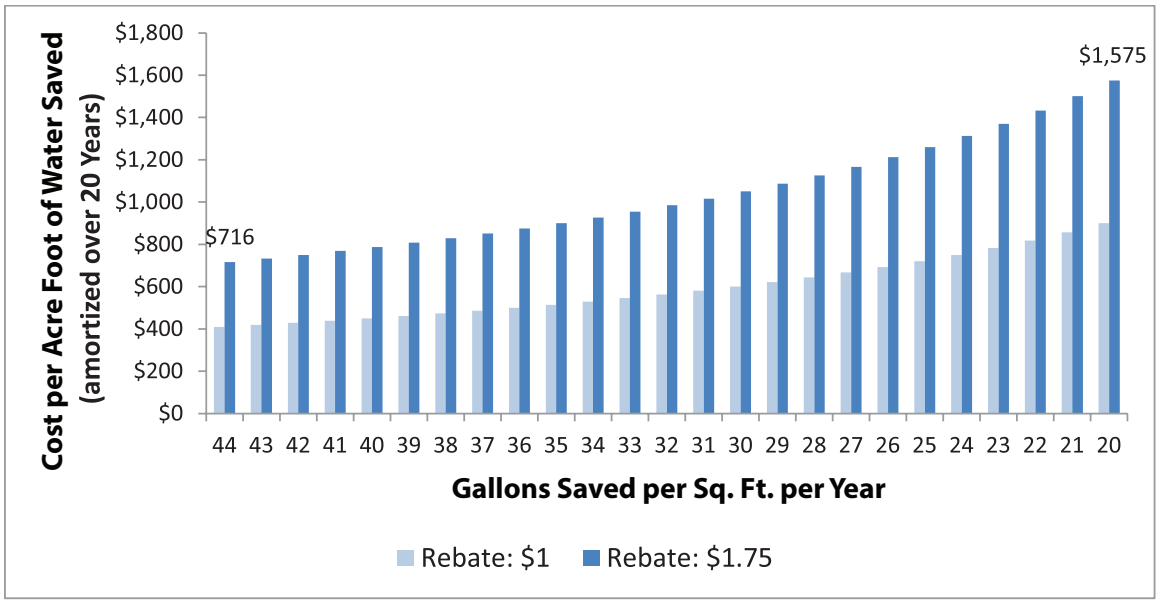

A ten year lifetime of benefits from the replacement program is typically used for allocating turf replacement costs.[39] This is based on the assumption that households will put turf back in their yards after only ten years. However, with policy changes aimed at incentivizing a longer lifetime of replacement landscaping, the lifetime benefits of turf replacement may increase (to 20 or even 30 years as modeled in the graph above). While the concern of reconversion after short time horizons is real, it is unlikely due to two factors. First, reconversion comes with a price. Households will have already spent money on converting their turf to alternative landscaping and there are large fixed costs associated with re-landscaping. Second, water prices are likely to rise. This creates an additional incentive for homeowners to keep less water intensive landscaping.

The lifetime benefit of turf replacement has a large impact on the cost per acre foot of water saved. When using a 20 year lifetime of benefits instead of a 10 year lifetime, the cost per acre foot of water saved (at the rebate level of $1.00) drops nearly 50%, making it less than a quarter of the comparable cost of purchasing water from MWD.

39 In the report "Turf Removal and Replacement: Lessons Learned," author Briana Seapy documents turf removal programs of nine agencies. These agencies all assume a ten year lifespan of the turf replacement program (Seapy, 2015).

For the analysis above, we have assumed that households will save 44 gallons per sq. ft. of water when they replace their turf with less water intensive landscape.[40] To test the variability in the cost per acre foot of water saved depending on the water savings per sq. ft. of turf replaced, we did a sensitivity analysis, assuming a 20 year amortization period. We examined the minimum extent of the water savings rate that maintains program attractiveness for households and ratepayers by examining water savings from 20 gallons per sq. ft. to 44 gallons per sq. ft. Figure 26 shows the cost per acre foot of water saved depending on how much water is saved per sq. ft. of turf replaced, and based on the rebate amount ($1.00 or $1.75) offered by the utility.

**Figure 26: Cost per acre ft. of water saved depending on gallons of water saved with turf replacement (10% penetration rate over 5 years)**




The above graph assumes that participation in the turf replacement program starts at the current number of people participating (4,994).[41] To be conservative, the model uses 10% single family household penetration within five years. With higher participation rates (for example, 16% or 20%), the cost per acre foot of water saved would decrease slightly for both rebate scenarios.

Despite the increase in cost per acre foot of water saved when we assume water savings of only 20 gallons per sq. ft. of turf replaced and a higher rebate ($1.75), the cost of the water saved ($1,575) is still lower than the average cost of purchasing MWD water over 20 years ($1,998). The cost per acre foot of water saved when only saving 20 gallons per sq. ft. of turf replaced with a low rebate ($1.00) is equivalent to the current price of purchasing water from MWD ($900/acre foot of water) (Urban Water Management Plan, 2011).

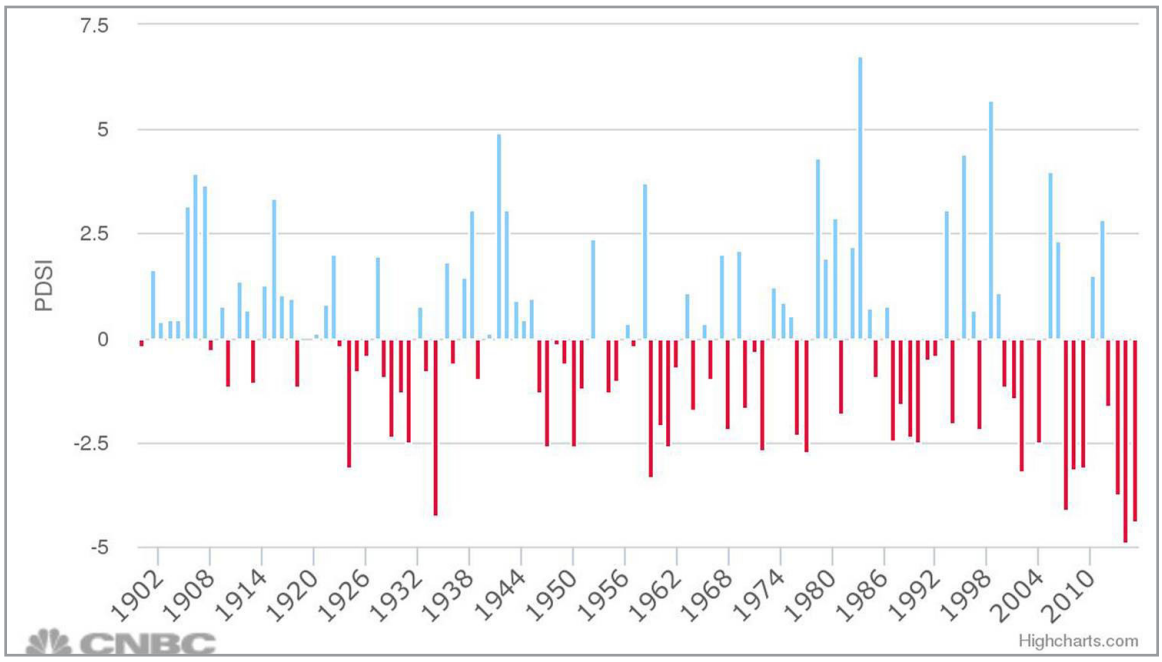
40 MWD used two studies to determine the 44 gallon savings number for households that replace turf with less water intensive landscaping. The first study (Olafson, 1994) calculated annual water savings of 33 gallons per sq. ft. in the cool climate of Marin County (Olafson, 1994). The second study (Sovocool, 2005) calculated water savings of 55.8 gallons per sq. ft. in the warmer climate of Nevada.

41 As of March, 2015 (when data was most recently available for this study).

Although the rebate program incurs an upfront cost for the utility, ratepayers see financial benefits accrue over time. When the increasing cost of MWD's water is considered, ratepayers are paying less over time for water saved than they would for water purchased from MWD, whether savings are 20 gallons per square foot of turf removed, or 44 gallons per square foot of turf removed.

The reduced water consumption leads to the public benefits of both lowered water costs and a more stable water supply. California's drought has been ongoing for approximately 4 years and it is the worst the region has experienced in the past century (Guzman, 2015). The graph below shows drought patterns in California from 1902 until 2015 using the Palmer Drought Severity Index (PDSI).[42] A PDSI recording of 0 reflects normal conditions. A reading of -4 or lower represents extreme drought (Guzman, 2015). Drought conditions are not only expected to continue in California but also to increase in severity putting ever more pressure on Los Angeles' water supply (Griffin & Anchukaitis, 2014).

**Figure 27: History of Droughts in California**




*Source: CNBC News (West Wide Drought Tracker)*

42 The PDSI recordings are a way to factor both precipitation and temperature to track soil moisture. The PDSI is used by the National Oceanic and Atmospheric Administration as its main drought index.

# 4. Conclusion

Turf replacement programs have the potential to provide conservation benefits to the City of Los Angeles. However, to be successful, the program needs to be cost effective. In this report, we calculated the potential financial benefits to both households and ratepayers. Household financial benefit is a likely indicator of participation and ratepayer financial benefit is a proxy for program cost-effectiveness. We have found that both households and ratepayers may see financial benefits from the turf replacement program.

## *Household Participation*

We assumed that financial benefit is the most likely factor to impact household participation in the turf rebate program. We found that rebates have a significant impact on household financial benefit. With turf replacement rebates of $3.75 per sq. ft., households make back their initial investment in less than 10 years. This payback period is similar to the payback periods generally considered appropriate for other investments, such as solar panels (Reid & Wynn, 2015). With rebates of $1.75 per sq. ft., payback periods increase. But typical households, households located in a medium climate zone and paying medium level replacement costs, see payback periods of less than 10 years. While the higher rebate (including a rebate from MWD and LADWP) is preferable, the lower rebate level is also beneficial. Households still face the upfront cost of turf replacement before they receive their rebate; this initial financial burden may make it difficult for lower income households to participate in the turf replacement program whether the rebate is $1.75 per sq. ft. or $3.75 per sq. ft.

While lower rebates will still likely incentivize household participation in the turf rebate program, we also recognize that a higher rebate may encourage households to make different replacement decisions. We did not analyze the impact replacement costs may have on non-financial outcomes. For example, more expensive replacement may result in lush, aesthetically pleasing, and environmentally friendly landscaping while less expensive replacement may result in bare, less desireable yards. The more expensive options could improve property values and neighborhood aesthetics.

## *Cost-effectiveness for Ratepayers*

The financial benefit of the turf replacement program to ratepayers and the utility would be realized over time. When the utility offers rebates as low as $1.00 per sq. ft., the payback period is close to 10 years; a rebate of $1.75 per sq. ft. increases the payback period to 11-29 years, depending upon other factors.

We examined the potential financial benefit for ratepayers by amortizing the utility's investment in the turf replacement program over 20 years. We found that in almost all scenarios, it is less expensive to invest in the turf replacement program and save water than to purchase water from MWD.

When considering the turf replacement program investment over time, we tested the impact of different timeframes for the expected lifetime benefits of turf replacement. We argue that the lifetime of benefits could be close to 20 years or longer. The lifetime benefit of the turf replacement program

has a signifant impact on the financial benefits associated with water conservation. Therefore, lawn reconversion is a concern. Policies that could decrease the likelihood of reconversion would make the lifetime benefit of turf replacement more secure and could increase the financial benefits to ratepayers.

## *Future Research*

We only examined the financial impacts of the turf replacement program and therefore made the assumption that financial benefit determines household participation. Future research may investigate the impact of other factors for determining household participation in turf replacement programs. For instance, we do not know what environmental effects native plants might have versus lawns, or what aesthetic impacts removing lawn might have. Future research may also investigate the relationship between property values and lawn aesthetics. We also make assumptions regarding the amount of water saved from replacing turf with less-water intensive plants, the cost of future water, and the length of time a household will keep non-turf landscaping in their yard (the lifetime benefit of the turf replacement program). More research is needed to enhance future estimates regarding these assumptions.

Finally, the turf replacement program is aimed at water conservation. Municipal incentive programs have broad reach and the potential to impact a range of environmental factors, such as plant and animal biodiversity and heat island effects. It could be worthwhile for future researchers to study other impacts from lawn conversion and best practices for incentivizing other city-wide goals.

# Bibliography


1. "Becoming a Watershed Wise Gardener." Los Angeles Department of Water and Power, Los Angeles, CA. February 7, 2015. California Friendly Landscape Workshop.
2. Brenner, Lara, et al. "The American Lawn: Examining our Cultural Commitment to an Energy-Intensive Institution." Environmental Studies Comprehensive Project. Carleton College. 2013.
3. Cunningham, William H. & Brondel Joseph. "Energy Conservation, Price Increases and Payback Periods." *NA – Advances in Consumer Research*. Kent Hunt, Ann Arbor, MI: Association for Consumer Research. 5 (1978): 201-205. Web. 25 July 2015.
4. Dastrup, Samuel, Joshua Graff Zivin, Dora L. Costa, & Matthew E. Kahn. "Understanding the Solar Home price premium: Electricity generation and "Green" social status." *European Economic Review*, 56 (2012): 961-973. Web. 28 July 2015.
5. Davis, Craig A. "Los Angeles water supply impacts from a M7.8 San Andreas Fault earthquake scenario." *Journal of Water Supply: Research and Technology*, 59, 6-7 (2010): 408-417. Web. 3 May 2016.
6. DeShazo, J.R., Ryan Matulka, & Norman Wong. "Los Angeles Rooftop Solar Atlas." UCLA Luskin Center for Innovation. 2011. Print.
7. "Drought Tolerant Garden Catalog." Turf Terminators. Web. 28 July 2015.
8. "Finances and Reports: Schedule A – Residential." *Los Angeles Department of Water and Power*. Los Angeles Department of Water and Power. Web. 27 July 2015.
9. Fairers, Adam & C. Neame. "Consumer attitudes towards domestic solar power systems." *Energy Policy*. 34 (2006): 1797-1806. Web 25 April 2016.
10. Firestone, Hilary & Jeanalee Obergfell, LA Office of Sustainability. Personal interview. 16 January 2015. (Source: Based on DWP's average annual consumption in acre feet for FYE 2010-2014)
11. Garcetti, Eric. "Emergency Drought Response – Creating a Water-Wise City." Office of the Mayor, Los Angeles. 2014.
12. Goldenstein, Taylor, & M. Stevens. "Not much bang for the buck in DWP turf rebates, city controller audit says." *Los Angeles Times*, 20 November 2015. Web. 27 April 2015.
13. "GreenScapes: Environmentally Beneficial Landscaping." Environmental Protection Agency (2005). Web. March 2016. https://archive.epa.gov/wastes/conserve/tools/greenscapes/web/pdf/landscape.pdf for more information.
14. Griffin, Daniel & Kevin J. Anchukaitis. "How unusual is the 2012-2014 California drought?." *Geophysical Research Letters*, 28 December 2014. Web. 4 may 2016.
15. "Guide to low-maintenance gardening: Water-wise garden design guide." *Sunset Magazine*. Web. 28 July 2015.
16. Guzman, Zack. "California's Drought is Worst in Over a Century, Analysis Shows." *NBC News*, 16 July 2015. Web. 4 May 2016.

17. Hurd, Brian H. "Water Conservation and Residential Landscapes: Household Preferences, Household Choices." *Journal of Agricultural and Resource Economics*, 31.2 (2006): 173-192. Web. 25 July 2015.

18. Los Angeles Department of Water and Power. Personal interviews. 24 July 2016. (Source: Based on DWP's turf replacement program data collection)

19. Larson, Kelli L., David Casagrande, Sharol L. Harlan, & Scott T. Yabiku. "Residents' Yard Choices and Rationales in a Desert City: Social Priorities, Ecological Impacts, and Decision Tradeoffs." *Environmental Management*, 44 (2009): 921-937. Web. 24 July 2015.

20. "Latest Study Shows Average Buyer Expected to Stay in a Home 13 Years." *Eye on Housing*. National Association of Home Builders, 3 January 2013. Web. 20 July 2015.

21. Medina, Edith, Jacky Guerrero, & Diego Ramirez. "Water Conservation Efforts: An Evaluation of the "Cash for Grass" Turf Replacement Rebate Program in Los Angeles City Council District 3." UCLA Luskin Center for Innovation. 2015. Web. July 2015.

22. McKinney, Michael L. "Urbanization, Biodiversity, and Conservation." *BioScience*, 52.10 (2002): 883-890. Web. 22 July 2015.

23. Mini, C., T.S. Hogue, & S. Pincetl. "Patterns and controlling factors of residential water use in Los Angeles, California." *Water Policy*, 16 (2014): 1054-1069. Web. July 2014.

24. Nelson, John Olaf, & Janae Kruta. "Water Saved by Single Family Xeriscapes." American Water Works Association. 1994.

25. Nordrum, Amy. "California Drought: Landscapers Cash In On Lawn Removal Rebates." *International Business Times* 23 April 2015. Web. 27 July 2015.

26. Reid, Gerard & G. Wynn. "The Future of Solar Power in the United Kingdom." *Energies*, 8(8), 2015. Web. 25 April 2016.

27. Seapy, Briana. "Turf Removal & Replacement: Lessons Learned." California Urban Water Conservation Council, March 2015. Web. 20 April 2015.

28. Shapiro, Kristen, Andrew Chan, Elliot Carson, & Romina Tayag. "Outdoor Water Use Conservation through Native Plants." n.p. 2012. Web. 27 July 2015.

29. Sovocool, Kent A. "Xeriscape Conversion Study." Las Vegas, Nevada: Southern Nevada Water Authority, 2005.

30. Stevens, Matt. "As rebate program ends, Turf Terminators slashes its workforce." *Los Angeles Times*, 10 July 2015. Web. 27 July 2015.

31. Stevens, Matt & M. Morin. "Southland water district ends popular lawn-removal rebate program." *Los Angeles Times*, 10 July 2015. Web. 27 April 2016.

32. "Sustainable City Plan." City of Los Angeles Mayor's Office of Eric Garcetti. April 2015. Web. July Web. 2016.

33. "Urban Water Management Plan." Los Angeles Department of Water and Power. April 2011. Web. July 2015.

# Appendix A

## *Variables, Assumptions and Justification*

| Variable | Assumptions | Source/Justification |
|---|---|---|
| Upfront cost of lawn replacement | Low: $3/sq. ft.<br>Medium: $5.50/sq. ft.<br>High: $8/sq. ft. | • Medina et al., 2015<br>• Homewyse Online Calculator available at http://www.homewyse.com/services/cost_to_remove_lawn.html<br>• Shapiro et al., 2015 |
| Ongoing landscape maintenance cost | Alternative landscaping maintenance cost is approximately 20 cents/sq. ft. less than the cost of lawn maintenance. | • Environmental Protection Agency GreenScapes program (GreenScapes, 2005) |
| Rebate level per sq. ft. of turf replaced | $1.75/sq. ft.<br>$2.75/sq. ft.<br>$3.75/sq. ft.<br>$4.75/sq. ft | • Historic rebate levels offered by LADWP and MWD |
| Climate zone evapotranspiration (ET) rates | Low climate zone: 20% below ET rate<br>Medium climate zone: Average ET rate<br>High climate zone: 20% above ET rate | • Average ET rate that has been documented for the South West is the medium ET rate (used by LADWP and MWD) |
| Gallons of water saved per sq. ft. of turf replaced | 44 gallons per sq. ft. in medium climate zone | • Nelson, 1994<br>• Sovocool, 2005 |
| Estimated cost of MWD water purchased by LADWP (2015) | $900 per acre foot | • Urban Water Management Plan, 2010 |
| Annual water rate increase | Drought scenario: 8% (LADWP), 10% (MWD);<br>Non-drought scenario: 4 % (LADWP), 6% (MWD) | • Historic levels of water rate increases (LADWP and MWD) |
| Amortization period | 20 years | • Typical planning horizon for water supply projects |
| The time period of lifetime benefit for turf replacement | Future policy may extend the lifetime benefit of turf replacement from 10 to 20 or 30 years | • Seapy, 2015 |
| Average sq. ft. of turf replaced by households in Los Angeles | 1,500 sq. ft. | • LADWP personal interviews, 2016 |

# Appendix B

## *Comparison Calculations for Average Water Bill to Average Gross Savings*

### CONSTANTS

| Variable | Value | Source | Description |
|---|---|---|---|
| $p_1$ | 0.54 | Firestone, 2014 | % of water use allocated to outdoor watering (%) |
| $p_2$ | 0.74 | Sovocool, 2005 | % of outdoor water use saved when using alternative landscaping instead of turf (%) |
| $g_1$ | 44 gallons | Sovocool, 2005; Nelson, 1994 | Average gallons saved per sq. ft. of turf replaced (gallons) |
| $f_1$ | 1,500 | LADWP* | Household average sq. ft. of turf removed (sq. ft.) |
| $b_1$ | 65.35 | LADWP website | Average monthly water bill for a typical household, which uses 12 HCF per month, over the next 5 years ($) |
| $h_1$ | 12 | LADWP website | # of HCF used per month by a typical household |
| $h_2$ | 748.05 | Online conversion calculator | # of gallons in 1 HCF |
| $s_1$ | 6,791 | Jessup et al., 2016 | Gross savings for a typical household 10 years after turf replacement during drought conditions ($) |
| $s_2$ | 12,980 | Jessup et al., 2016 | Gross savings for a typical household 20 years after turf replacement during drought conditions ($) |

* The actual average according to LADWP data is 1,600 sq. ft. but we use an average of 1,500 sq. ft. for the purpose of this report.

### DEPENDENT VARIABLES

| Variable | Value | | Description |
|---|---|---|---|
| $p_3$ | 0.4 | $p_1 \times p_2$ | % of total household water use allocated to turf (%) |
| $g_2$ | 66,000 | $g_1 \times f_1$ | Average gallons of water saved annually due to lawn replacement (gallons) |
| $g_3$ | 165,000 | $g_2 \div p_3$ | Total average gallons of water used by a typical household annually (gallons) |
| $c_1$ | 5.45 | $b_1 \div h_1$ | Cost per HCF of water used ($) |
| $c_2$ | 0.00727948 | $c_1 \div h_2$ | Cost per gallon of water used ($) |
| $b_2$ | 1,201.11 | $g_3 \times c_2$ | Average annual water bill for an average household in this report ($) |
| $y_1$ | 5.65 | $s_1 \div b_2$ | # of years of water bills accounted for in 10 years of gross savings during drought condition prices |
| $y_2$ | 10.81 | $s_2 \div b_2$ | # of years of water bills accounted for in 20 years of gross savings during drought condition prices |
| $s_2$ | 12,980 | Jessup et al., 2016 | Gross savings for a typical household 20 years after turf replacement during drought conditions ($) |

The number of years of water bills accounted for in 10 years, $y_1$, was determined using Equation 1. The number of years of water bills accounted for in 20 years, $y_2$, was determined using Equation 2.

**Equation 1:**

$$y_1 = \frac{s_1}{\left(\frac{g_1 f_1}{p_1 p_2}\right)\left(\frac{b_1 h_1}{h_2}\right)}$$

**Equation 2:**

$$y_2 = \frac{s_2}{\left(\frac{g_1 f_1}{p_1 p_2}\right)\left(\frac{b_1 h_1}{h_2}\right)}$$

# Appendix C

## *Amortization Data*

### Rebate Deployment for 5 Years, Investment Amortized Over 20 years

| Interest Rate | 3% | | | | | |
|---|---|---|---|---|---|---|
| Rebate level | $1 | | | $1.75 | | |
| Penetration Goal | 10% | 16% | 20% | 10% | 16% | 20% |
| Investment | $39,903,362 | $62,875,357 | $78,190,021 | $69,830,883 | $110,031,875 | $136,832,537 |
| Interest | $8,472,839 | $13,090,73 | $16,168,896 | $14,827,468 | $22,908,328 | $28,295,568 |
| Acre Feet Saved over 10 yrs | 52,291 | 82,123 | 102,011 | 52,291 | 82,123 | 102,011 |
| Acre Feet Saved over 20 yrs | 118,218 | 187,607 | 233,865 | 118,218 | 187,607 | 233,865 |
| Acre Feet Saved over 30 yrs | 184,145 | 293,090 | 365,720 | 184,145 | 293,090 | 365,720 |
| Investment (w/Interest) Per Acre Ft over 10 Yrs | $925 | $925 | $925 | $1,619 | $1,619 | $1,619 |
| Investment (w/Interest) Per Acre Ft over 20 Yrs | $409 | $405 | $403 | $716 | $709 | $706 |
| Investment (w/Interest) Per Acre Ft over 30 Yrs | $263 | $259 | $258 | $40 | $454 | $452 |

### Investment Analysis with Immediate Deployment and Return

| Interest Rate | 3% | | | | | |
|---|---|---|---|---|---|---|
| Rebate level | $1 | | | $1.75 | | |
| Penetration Goal | 10% | 16% | 20% | 10% | 16% | 20% |
| Investment | $39,903,362 | $62,875,357 | $78,190,021 | $69,830,883 | $110,031,875 | $136,832,537 |
| Interest | $8,472,839 | $13,090,73 | $16,168,896 | $14,827,468 | $22,908,328 | $28,295,568 |
| Acre Feet Saved over 10 yrs | 65,927 | 105,483 | 131,854 | 65,927 | 105,483 | 131,854 |
| Acre Feet Saved over 20 yrs | 131,854 | 210,967 | 263,709 | 131,854 | 210,967 | 263,709 |
| Acre Feet Saved over 30 yrs | 197,781 | 316,450 | 395,563 | 197,781 | 316,450 | 395,563 |
| Investment (w/Interest) Per Acre Ft over 10 Yrs | $734 | $720 | $716 | $1,284 | $1,260 | $1,252 |
| Investment (w/Interest) Per Acre Ft over 20 Yrs | $367 | $360 | $358 | $642 | $630 | $626 |
| Investment (w/Interest) Per Acre Ft over 30 Yrs | $245 | $240 | $239 | $428 | $420 | $417 |

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