

# QUENCHING LOS ANGELES' THIRST

Evaluating Policy Options for Incentive Amounts and Financial Instruments to  
Increased Cistern Installation in Single-Family Homes in Los Angeles



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## **Disclaimer**

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## **LIST OF TERMS**

MWD	Metropolitan Water District of Southern California
LADWP	Los Angeles Department of Water and Power
SITC	Solar Investment Tax Credit
NPV	Net Present Value
SCMP	City of Los Angeles Stormwater Capture Master Plan
LID	Low Impact Development

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## **EXECUTIVE SUMMARY**

The long-lasting drought in California led state officials and local agencies to find ways to take action in water conservation efforts. About 12% of Los Angeles' water demand is supplied from local sources and the majority is imported from other regions.<sup>1</sup> A potential source to increase local reservoirs is through rainwater capture. Rainwater harvesting with cistern tanks has been used effectively in other parts of world as a solution to conserve water.<sup>2</sup> TreePeople, our client, asked us to help in their efforts in increasing the number of water cistern tanks installed in single-family homes in the City of Los Angeles.

Our policy analysis determines the best policy option to increase residential rainwater harvesting through cisterns. It accomplishes this by answering the following two policy questions:


First, what incentive amount is optimal to offer in order to induce single-family households to purchase and install cisterns? Second, which methods should be used to generate the revenue needed to pay out the incentive to single-family homeowners?

Policy options for incentive amount were evaluated with the following criteria: household payback period, participation rate, ratepayer payback period, and revenue requirement. In determining policy alternatives for the incentive instrument we explored enhancing the status quo, a rebate program, and considered two other options that included a property tax credit and an avoided water utility fee. We next evaluated these options with two main criteria, equity and political feasibility, in order to help us recommend the best financial instrument.

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<sup>1</sup> "LADWP Announces Stormwater Capture Master Plan." March 28, 2014. Accessed March 16, 2017. <http://www.lastormwater.org/blog/2014/03/ladwp-announces-stormwater-capture-master-plan/>.

<sup>2</sup> Sample, D. J., & Liu, J. (2014). Optimizing rainwater harvesting systems for the dual purposes of water supply and runoff capture. *Journal of Cleaner Production*, 75, 174-194.



In deciding our final recommendations we prioritized our client's goal of inducing participation of residents installing water capture cisterns. As a result, an incentive amount of **\$1,126** provided a significant participation rate with a reasonable household payback period. As to what the most effective incentive approach should be, we determined that a **rebate program** resulted in the most equitable manner to incentivize city residents with the least political and financial constraints.

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## **SECTION I: INTRODUCTION**

### **Background**

#### *Challenges*

The recent drought affecting the State of California has increased awareness of the water dependence in metropolitan areas, particularly in the southern part of the state. The City of Los Angeles imports nearly 80% of its water supply from three main sources: Reservoirs in Northern California, the Colorado River and groundwater. This leads the City of Los Angeles to spend approximately one billion dollars annually to import water.<sup>3</sup> In addition to the drought, the expanding population and city development further complicate the issue of meeting the demand for water in Los Angeles. As a result, it is important to find effective ways in which Los Angeles can become less dependent on outside water resources.

#### *Opportunities*

Rainwater harvesting is one way to help alleviate the costly need to import water. Capturing rainwater by installing cisterns can increase more self-sufficiency in meeting the city's water needs. Also, historically droughts affect California in cycles<sup>4</sup> and residential cistern installation can be part of a long-term solution in which the public can be one step ahead. The Stormwater Capture Master Plan conducted by the Los Angeles Department of Water and Power (LADWP) indicates that the City has the potential to capture between thirty and forty-five

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<sup>3</sup> "Los Angeles Depends on Imported Water" Accessed March 16, 2017. [http://angeles.sierraclub.org/los\\_angeles\\_depends\\_imported\\_water](http://angeles.sierraclub.org/los_angeles_depends_imported_water).

<sup>4</sup> "Los Angeles Water Issue." Accessed March 16, 2017. <https://viterbi.usc.edu/water/>.

percent of LA's current water demand.<sup>5</sup> In addition, an incentive program on rainwater harvesting will also help meet the requirement that Los Angeles Mayor Eric Garcetti set to save water. The Mayor issued the Executive Directive No. 5 in 2014, mandating:

A reduction in per capita potable water use by 20% by 2017; a reduction in the Department of Water and Power's purchase of imported water by 50% by 2024; the creation of an integrated water strategy that increases local water supplies and that improves water security in the context of climate change and seismic vulnerability.<sup>6</sup>

There are several regulatory drivers that encourage rainwater harvesting with cisterns for a variety of purposes. For example, the Los Angeles County's MS4 Permit (Municipal Separate Storm Sewer Systems) requires local rainwater capture through various projects. Since stormwater carries pollutants such as oil, trash, and metals, the MS4 Permit was established to manage water discharges from the storm sewer system. Installing cisterns on residential properties is considered an effective method to reduce stormwater runoff. Also, the City of Los Angeles LID (Low Impact Development) Ordinance, established in 2012, is another regulatory driver to facilitate the installation of cisterns. This ordinance "requires all development and redevelopment projects that create, add, or replace 500 square feet or more of impervious area to capture the three quarter-inch rain event for infiltration or reuse on site."<sup>7</sup> Single-family residents can achieve compliance with the LID ordinance by installing cisterns on their properties.

### What is a Cistern?

Cisterns are tanks in which liquids can be stored. They are commonly used to store water.

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<sup>5</sup> Bloome, Deborah Weinstein, Edith de Guzman, and David Jaeckel. "Transferring Lessons from Australia's Millennium Drought to California: Accelerating Adaptation to Drought, Flood & Heat." February 2016. Accessed March 16, 2017. <https://www.treepeople.org/sites/default/files/pdf/publications/TreePeople%20-%20Transferring%20Lessons.pdf>.

<sup>6</sup> "Executive Directive No. 5-Emergency Drought Response - Creating a Waterwise City ." October 14, 2014. Accessed March 16, 2017. [https://www.lamayor.org/sites/g/files/wph446/f/page/file/ED\\_5\\_-\\_Emergency\\_Drought\\_\\_Response\\_-\\_Creating\\_a\\_Water\\_Wise\\_City.pdf?1426620015](https://www.lamayor.org/sites/g/files/wph446/f/page/file/ED_5_-_Emergency_Drought__Response_-_Creating_a_Water_Wise_City.pdf?1426620015).

<sup>7</sup> Los Angeles Department of Water and Power. *Stormwater Capture Master Plan*. Los Angeles, CA, 2015. P.15.



Rainwater can be collected in these cisterns through a catchment system that involves a roof, gutters, pipes and downspouts. This water can then be used for outdoor purposes such as irrigation, washing cars or even bathing pets. If appropriate modifications to the systems are made, such as installing treatment systems, the water can be utilized indoors to flush toilets or wash clothes. With adequate treatment, the water can be used for bathing or even be made potable. Cisterns can be placed above ground or below ground. Below ground tanks are usually larger in size and more expensive to install since it requires excavation and additional components to pump the water out.<sup>8</sup> Those that are placed above ground are less expensive and easier to maintain. Cisterns are offered in a variety of sizes ranging from 200-gallon to 50,000-gallon tanks. In determining the appropriate size, several factors are considered: collection area (roof size), purpose of and demand for stored water (indoor vs. outdoor use) and average rainfall. The amount of water a cistern can collect is greatly dependent on two main factors, roof size and amount of rainfall. From a roof that is 1,000 square feet in size, a cistern can collect approximately 600 gallons of rainwater for every inch of rainfall.<sup>9</sup> The cost of a cistern also varies and depends on the size and type of material that the cistern is made from. For example, a 200-gallon cistern made from galvanized steel or polyethylene can cost \$150-\$300. Larger cisterns (500 to 10,000 gallons) can cost anywhere from \$500 to \$3,000. You can expect to pay from \$3,000 to \$10,000 for tanks larger than 10,000 gallons in size.<sup>10</sup>

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<sup>8</sup> "Rainwater Cisterns: Design, Construction, and Water Treatment." Accessed March 14, 2017. <http://extension.psu.edu/natural-resources/water/drinking-water/cisterns-and-springs/rainwater-cisterns-design-construction-and-water-treatment>.

<sup>9</sup> "How Much Rain Can You Catch?" Accessed March 14, 2017. <https://cals.arizona.edu/cochise/waterwise/waterharvest.html>.

<sup>10</sup> "How Much does a Cistern Cost?" Accessed March 14, 2017. <http://home.costhelper.com/cistern.html#extres2>.



Figure 1. A roof-catchment cistern system

### Current State of Policy

In addition to LADWP, the Metropolitan Water District of Southern California (MWD) is another critical agencies related to water conservation in the City of Los Angeles. As a regional water wholesaler, MWD delivers water to member public agencies, municipal water districts and county water authorities.<sup>11</sup> The current cistern incentive program, funded by MWD and LADWP, provides three rebate levels depending on the cistern size: \$300 for a cistern between 200 and 500 gallons, \$400 for a cistern between 501 to 999 gallons, and \$500 for a cistern larger than

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<sup>11</sup> "The Metropolitan Water District of Southern California. Overview & Mission Home." Accessed February 17, 2017. <http://www.mwdh2o.com/WhoWeAre/Mission/Pages/default.aspx>.

1000 gallons.<sup>12</sup> Since the cistern program started in August 2016, LADWP has received approximately 207 rebate requests for 200-500 gallon cisterns and 2 rebate requests for 501-999 gallon cisterns through the end of 2016.<sup>13</sup> These two agencies determined the rebate levels to fulfill the educational component of the SoCal WaterSmart Program, a water conservation program. However, the design of the current incentive amount has had a limited effect on program participation. Based on the current participation number of 209 between August to December 2016, we estimated an annual participation number of 502. This result indicates a very low level of participation when compared to the Turf Replacement Program.

### Examples of Other Cities

There are several successful examples of municipalities or localities that have implemented cistern-related policies. The first example is the City of Seattle. The city has a goal to manage 700 million gallons of yearly runoff by 2025. As a result, the RainWise Rebate Program was launched as a countermeasure provided by Seattle Public Utilities and King County Wastewater Treatment Division. Under this program, the residents can obtain financial support when they install systems that reduce water runoff, such as rain gardens and cisterns.<sup>14</sup> Currently, homeowners can receive a rebate covering from 50% to 100% of the project costs.<sup>15</sup> This rebate program has contributed to funding almost 1,200 cistern and rain garden projects on private

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<sup>12</sup> "Rebates Start at \$35 per Barrel or \$250 per Cistern." SoCal WaterSmart. Accessed March 16, 2017. [http://www.socalwatersmart.com/?page\\_id=2973](http://www.socalwatersmart.com/?page_id=2973).

<sup>13</sup> Rodriguez, Martha. E-mail interview by author. December 22, 2016.

<sup>14</sup> "RainWise Rebates for Cisterns and Rain Gardens." Rainwise Program. Accessed March 14, 2017. <http://www.seattle.gov/util/EnvironmentConservation/Projects/GreenStormwaterInfrastructure/RainWise/Rebates/index.htm>.

<sup>15</sup> Rainwise Program: How to Get Started and What to Expect. WA: Seattle Public Utilities, 2013. [http://www.seattle.gov/util/cs/groups/public/@spu/@usm/documents/webcontent/02\\_008089.pdf](http://www.seattle.gov/util/cs/groups/public/@spu/@usm/documents/webcontent/02_008089.pdf)

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properties since 2010.<sup>16</sup>

Another example is Australia's rainwater cistern project, which could be considered one of the most successful rainwater harvesting projects in the world. Since Australia has experienced severe droughts in recent decades, Australian agencies had no choice but to take countermeasures to collect as much precipitation as possible in its cities.<sup>17</sup> The state of Victoria in Australia has achieved a 45% reduction in residential water use per capita in 2010 compared to the 1990s. The participation rate increased from 11.6 percent 31.1 percent over six years between 2007 and 2013.<sup>18</sup> This was accomplished through a facilitation of residential behavioral change around water conservation via public education and water pricing policies.<sup>19</sup> One of the countermeasures implemented by the Australian agencies was a water conservation rebate program that began in 2003. The incentive amount was high; they offered rebates of up to \$1,500 for cisterns through mid-2015.

## **The Client**

Our client is TreePeople, an environmental nonprofit organization that focuses on growing a sustainable and climate-resilient Los Angeles. TreePeople shares its vision of increasing climate resilience against flooding and drought by forming coalitions with agencies partners, including LADWP, the City's Bureau of Sanitation and the Los Angeles County Department of Public Works Flood Control District. TreePeople plays a critical role in

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<sup>16</sup> 2016 Overview & Accomplishment Report. WA: Seattle Public Utilities, 2016.

[http://www.700milliongallons.org/wp-content/uploads/2017/02/1702\\_8095m\\_2016-GSI-accomplishment-Report-pages.pdf](http://www.700milliongallons.org/wp-content/uploads/2017/02/1702_8095m_2016-GSI-accomplishment-Report-pages.pdf)

<sup>17</sup> "Australia's Rainwater Cisterns Inspire TreePeople's Lipkis." May 28, 2014. Accessed March 14, 2017.

<http://www.planningreport.com/2014/05/28/australia-s-rainwater-cisterns-inspire-treepeople-s-lipkis>.

<sup>18</sup> TreePeople, "Transferring Lessons from Australia's Millennium Drought to California: Accelerating Adaptation To Drought, Flood & Heat", February 2016, P.20

<sup>19</sup> Ibid. P. 15

promoting water conservation in Los Angeles toward a 20% reduction in water use, in support of Mayor Garcetti's Executive Directive on water.<sup>20</sup> As a key water conservation leader in Los Angeles, TreePeople has implemented lessons learned from Australia's devastating "Millennium Drought" by advancing the rainwater capture in retrofitted pilot homes.<sup>21</sup> Cisterns are the main devices these retrofitted homes adopted to collect rainwater. The recommendations in this report will offer the client insight and direction for advocating increased cistern adoption in the City of Los Angeles, helping the region achieve its goal towards climate resilience and sustainable local water supplies.

## **Policy Question**


We compared three different approaches to increase participation of cistern utilization: a voluntary (educational) approach with no financial incentive, a mandatory approach, and an incentive-driven approach. A voluntary approach would encourage the public to install cisterns by providing information on their financial benefits and positive environmental impact. The City of Los Angeles and LADWP launched campaigns such as "Save the Drop LA" to educate and advise residents on how to save water.<sup>22</sup> However, this approach may have a limited effect since it is optional and many people would not feel compelled to join the program. The mandatory option has a high political constraint due to its required legislative action, as well as the likelihood of public backlash. Due to the limited effect of an educational approach and the political barriers of a mandatory approach, we determined the incentive-driven approach as the

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<sup>20</sup> TreePeople Pledges to Help Garcetti's Water Conservation Goals. October 14, 2014. Accessed March 14, 2017. <https://www.treepeople.org/sites/default/files/pdf/press/2014/TreePeople%20Helps%20Water%20Conservation%20Goals.pdf>.

<sup>21</sup> Bloome, Deborah Weinstein, Edith De Guzman, and David Jaeckel. "Transferring Lessons from Australia's Millennium Drought to California: Accelerating Adaptation to Drought, Flood & Heat." February 2016. Accessed March 16, 2017.

<sup>22</sup> Save the Drop. Accessed March 1, 2017. <http://savethedropla.com/>.



preferred method to achieve our client's goal.

This report draws on quantitative and qualitative research to develop an incentive plan for residential rainwater harvesting with cisterns designed to address water scarcity and increase local water reliance. This report answers the following policy question:

**What are the best policy options for an incentive amount and financial instrument to increase residential rainwater harvesting (cisterns) in the City of Los Angeles?**

## **SECTION II: POLICY ANALYSIS STRATEGY**

We conducted a two-fold analysis since our policy question has two components: financial incentive amount and financial instrument. The analysis on the financial incentive allowed us to calculate the amount of budget required for the program, and we further explored the feasibility of financial instruments conditioned by the budget required. The diagram below shows each step of our two-fold analysis.

The first step addresses the first part of our policy question, which is to find the right incentive amount that will encourage the desired quantity of participants in the program. This incentive amount is how much participants will receive once they install the rainwater cistern on their properties. We first conducted data analysis to evaluate the current rainwater harvesting program in the City of Los Angeles. Based on the findings, we chose policy alternatives regarding the financial incentive amount. Next, we evaluated each different financial incentive amount with criteria in order to choose the best option.

The second step addresses the second part of the policy question, which aims to find the right financial instrument that will deliver the incentive amount found in the first step. Financial instruments are the means that agencies will utilize to give the incentive amount to customers participating in the program. In order to do this, we will evaluate different policy options of financial instruments using several criteria. Once evaluated, we proceeded to choose the best financial instrument, which in combination with our result from the first step, will be our final recommendation and answer our policy question.

## Flow of Analysis

### Diagram of Analysis Procedure

#### STEP 1

Conduct data analysis on the current rebate program



Decide policy options for financial incentive amount



Evaluate policy options for incentive amount with criteria



Choose the best financial incentive amount

#### STEP 2



Decide policy options for financial instrument



Evaluate policy options for financial instrument with criteria



Choose the best financial instrument



## **Financial Impact on Household**

We first conducted data analysis to evaluate the current rainwater harvesting program in the City of Los Angeles. The primary purpose of this chapter is to conduct the program evaluation from a residential point of view since residents' participation is essential for the success of the program. We used a household payback period based on the net present value (NPV) method as a measurement of residents' willingness to participate in the program. Then, we proposed a set of policy options with different financial incentive amounts. We analyzed the relationship between the different financial incentive amounts and the household payback period.

### **Calculation of Household Payback Period**

We introduced a household payback period to analyze the financial impact on residents. The payback period is the length of time required to recoup the costs of investment. We used NPV to calculate financial benefits and costs that a single-family homeowner would incur from participating in the cistern installation program.

The payback period is the point in time when the value of the financial benefit turns from negative to positive. The payback period is "the expected number of years required to recover the original investment."<sup>23</sup> The project with a shorter payback period is favorable in that investors can recover the capital money in a shorter period of time. Although the payback period does not necessarily indicate profitability because it ignores any profits after this period, it does enable us to assess and compare the financial impact of the different incentive amounts.

In our NPV calculation, we considered three factors that define benefits and costs:

- i) Financial incentive: the amount of rebate that each participant receives from agencies.

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<sup>23</sup> Ong, Tse San, and Chun Hau Thum. "Net Present Value and Payback Period for Building Integrated Photovoltaic Projects in Malaysia." February 2013. Accessed March 16, 2017. <http://www.hrmars.com/admin/pics/1576.pdf>.

In the data analysis, we assumed that each household can receive the financial incentive when installing a cistern (year 1).

ii) Avoided water cost: the monetary value of saved water due to the water collected from the cistern. We calculated the annual saved water cost by multiplying LADWP's water price by the amount of saved water. We assumed the water price provided by LADWP will increase at a certain rate each year.

iii) Cistern cost: an upfront cost for installing a cistern. This cost includes the cost of the cistern itself, installation and labor. There are many types of cisterns available in the market, as well as different installation options depending on specific needs. As a result, the prices can vary. For example, a resident can add options such as pumps, and change designs of cisterns upon request. Here, we assumed that each household installs the least expensive cistern without extra features. Furthermore, we assumed that there are no maintenance costs incurred after installation because the residents can maintain the cistern themselves in most cases.

The following equation expresses a household's NPV in  $t$  years. Each term represents financial incentive ( $F_1$ ), avoided water cost ( $\text{Roof size} \times \text{Rainfall} \times \sum P_{DWP_i} / (1+r)^{i-1}$ ), and cistern cost ( $C_1$ ), in sequence.  $P_{DWP_i}$  refers to LADWP water price during year  $i$ , and  $r$  is the discount rate.

$$NPV_t = F_1 + \text{Roof size} \times \text{Rainfall} \times \sum_{i=1}^t \frac{P_{DWP_i}}{(1+r)^{i-1}} - C_1$$

Table 1 shows the assumptions and values used for the NPV calculation. First, we

investigated the roof size of single-family houses in the City of Los Angeles. Using data from the Los Angeles County Office of the Assessor, we computed 1,488 square feet as the average roof size. The details are as explained in the Appendix. We estimated the annual rainfall as 15 inches,<sup>24</sup> and also assumed that the entire amount of rainfall on the resident's roof could be captured and used entirely for irrigation with zero waste in order to simplify our calculation. Regarding the cost of the cistern, we estimated it to be \$2,060 per unit based on the cost estimates of cisterns from our client's pilot project.<sup>25</sup> We also assumed that LADWP's water price will continuously increase by 4% on a yearly base.<sup>26</sup>

	Variable	Value	Unit
Discount Rate	r	3	%
Average Roof Size	Roofsize	1,488	SqFt
Annual Rainfall	Rainfall	15	Inch
Upfront Cost (Cost of Cistern)	C <sub>1</sub>	2,060	\$
Annual Water Price Increase Rate (LADWP)	N/A	4	%
LADWP's Water Price	P <sub>DWP1</sub>	5.45	\$/HCF

Table 1: Assumptions used for the data analysis

## Assessment of the Results

In this section, we assessed the results of the household payback periods by analyzing the

<sup>24</sup> "Los Angeles, California Average Rainfall." Accessed March 16, 2017. <https://rainfall.weatherdb.com/l/40/Los-Angeles-California>.

<sup>25</sup> Berger, Daniel. E-mail interview by author. November 22, 2016.

<sup>26</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, "Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles" (2016)

relationship to the financial incentive amount, and the appropriateness of our model.

Figure 2 shows the output of our analysis: the relationship between the financial incentive amounts and the household payback period in the rainwater harvesting program. The results suggested a nonlinear relationship. Our analysis revealed that it takes 15.17 years for a single-family homeowner in the City of Los Angeles to collect the upfront cost of installing a cistern with no financial incentive. Under the current financial incentive amount by both LADWP and MWD of \$300 for a cistern between 250 to 500 gallons, the household payback period is 13.44 years.

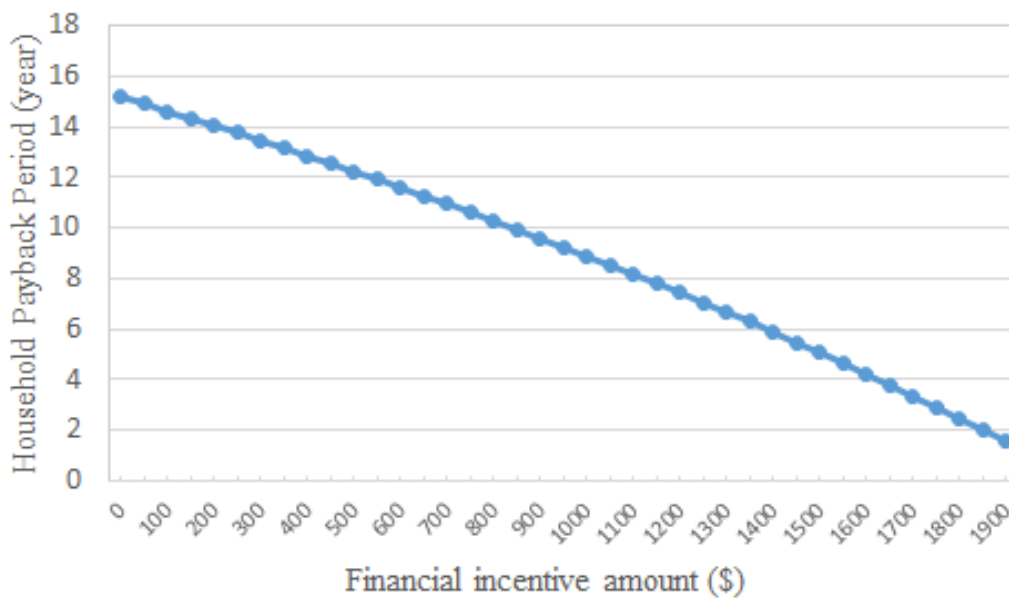


Figure 2. Household payback period (years) vs. financial incentive amount (in dollars)

Next, we corroborated the rationale of these outputs by referring to an academic report. A report from the Water Science and Technology Board states that household payback periods of

cistern water conservation projects range from 14 years to more than 50 years without any financial support.<sup>27</sup> The period varies significantly because it depends on weather conditions and cistern installation costs.<sup>28</sup> Compared to our result, 15.17 years appears to be in the shorter side of the range that is suggested in the report. It is true that the payback period should be longer considering the fact that the average annual precipitation in the City of Los Angeles region is almost half of the average in the entire U.S.<sup>29</sup> However, we analyzed that this relatively shorter payback period is attributed to the cistern installation cost rather than weather conditions. As we assumed in the previous section, we used a low-end type of cistern system in our calculation. Any optional component costs, such as pumps or gutters, are not taken into consideration. Second, the report was written in 2001, over 15 years ago. Due to technology advancements and the increasing use of cisterns, the average market price of cisterns should be lower compared to that in 2001. As such, it is fair to say that our analysis model reasonably captures the household payback period.

### **Selection of Policy Options for Financial Incentive Amounts**

As a result of our analysis above, we have the following policy options for incentive amounts. We also show the percentage of the cost of a cistern that the incentive amount covers in parenthesis:

Policy Option 1: \$300 (14.7% of total low-end cistern cost)

First of all, we use the status quo (financial incentive amount: \$300) as one of the policy

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<sup>27</sup> Water Science and Technology Board; National Academies of Sciences, Engineering, and Medicine, "Using Graywater and Stormwater to Enhance Local Water Supplies, An Assessment of Risks, Costs, and Benefits" (2001): p6.

<sup>28</sup> Ibid.

<sup>29</sup> "Average Annual Precipitation by State." Accessed March 16, 2017.  
<https://www.currentresults.com/Weather/US/average-annual-state-precipitation.php>.

options. This is because the current financial incentive amount is a good benchmark and the status quo should be compared to other policy options. The associated household payback period is 13.44 years.

Policy Option 2: \$843 (40.9% of total low-end cistern cost)

Next, we investigated the possibility to reduce the household payback period, since 13.44 years may be longer than other water or energy-related programs mentioned in literature. For example, most residents generally “would require payback periods around 10 years or below before considering an investment.”<sup>30</sup> A different study shows that the typical payback period is seven to ten years in the case of energy efficiency and renewable energy projects.<sup>31</sup> As such, we chose a 10-year payback period as the second policy option. In order to achieve a 10-year payback period, the incentive amount would need to be set at \$843.

Policy Option 3: \$1,126 (54.7% of total low-end cistern cost)

It is also beneficial for us to look into successful projects and analyze their payback periods. We considered two water and energy-related projects that have been successfully implemented in the City of Los Angeles. The first case is the Turf Replacement Program, which the city launched in 2009. As of September 2016, 23,730 of LADWP’s residential customers have participated in this program.<sup>32</sup> Under the current rebate level of \$1.75/SqFt offered by LADWP,<sup>33</sup> 8.3 years is needed for residents to recoup the turf replacement costs.<sup>34</sup> Since this is

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<sup>30</sup> Gerard Reid and Gerard Wynn, “The Future Solar Power in the United Kingdom” (2015) p.8

<sup>31</sup> Prashant Vaze, Stephen Tindale, “Repowering Communities: Small-Scale Solutions for Large-Scale Energy Problems” (2011) P.85

<sup>32</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, “Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles” (2016), P.1

<sup>33</sup> “Turf Replacement.” Accessed March 16, 2017. [https://www.ladwp.com/ Path: LADWP>About Us>Water>Water Conservation>Turf Replacement](https://www.ladwp.com/Path: LADWP>About Us>Water>Water Conservation>Turf Replacement)

<sup>34</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, “Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles” (2016), under the condition of medium

one of the leading projects that contributes to local water supply, it can be a benchmark for the cistern installation project. Therefore, we set our third policy option as a financial incentive amount of \$1,126, which has a household payback period of 8.00 years.

Policy Option 4: \$1,511 (73.3% of total low-end cistern cost)

Another case we reviewed was the solar panel installation project in the City of Los Angeles. Under the solar panel incentive program, residents in Los Angeles only need approximately five years to break even on their investment.<sup>35</sup> Since this shorter payback period strongly incentivizes more residents to participate in the program, we chose a five-year payback period as our fourth option, which gave us an incentive amount of \$1,511.

	Option 1	Option 2	Option 3	Option 4
Financial incentive amount (% of the cost of cistern)	\$300 (14.7%)	\$843 (40.9%)	\$1,126 (54.7%)	\$1,511 (73.3%)
Household payback period (in years)	13.44	10.00	8.00	5.00

Table 2. Four policy options within Step 1

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climate zone and medium cost turf (\$5.50/SqFt).

<sup>35</sup> Matasci, Sara. "What Does Solar Actually Cost in the U.S.?" March 13, 2017. Accessed March 17, 2017. <http://news.energysage.com/how-much-does-the-average-solar-panel-installation-cost-in-the-u-s/>.

## **SECTION III: CRITERIA ANALYSIS ON FINANCIAL INCENTIVE AMOUNT**

### **1. Household Payback Period**

The household payback period is the length of time it would take the household to recover the cost of purchasing and installing the cistern. Therefore, a shorter payback period is desirable. It is an important indicator to quantify the residential benefit and cost in participating in the program. Table 3 summarizes the household payback period for each policy option. As we analyzed in the previous section regarding the financial impact on households, the relationship between the financial incentive amount (\$) and the household payback period (years) is not linear. As the financial incentive amount rises, the payback period decreases. Option 4 has the shortest payback period, which is preferred, followed by Option 3, Option 2, and finally Option 1.

	Option 1	Option 2	Option 3	Option 4
Financial incentive amount (Percentage of the cost of cistern)	\$300 (14.7%)	\$843 (40.9%)	\$1,126 (54.7%)	\$1,511 (73.3%)
Household payback period (year)	13.44	10.00	8.00	5.00

Table 3. Household payback periods (same as Table 2)

### **Marginal Analysis**

Since the household payback period is not linear to the financial incentive amount, we analyze the marginal effects among the four policy options. The marginal household payback period is defined as the reduction in the payback period that results from an additional amount of rebate. It is calculated by dividing the difference in the household payback period by the



difference of incentive level between two options. We compared the different effects on household payback periods as a result of the incentive level between Option 1 and Option 2, Option 2 and Option 3, and Option 3 and Option 4. Table 4 shows the results of the marginal household payback period between policy options. For example, when we compare Option 1 and Option 2, the marginal payback period is calculated to be 0.634. This output suggests that the highest incentive amount option is more cost-efficient in reducing one year of household payback period. Although one unit of money has the same value, the agencies can reduce the household payback period more significantly at higher incentive amounts.

	$\Delta\text{Op.1-Op.2}$	$\Delta\text{Op.2-Op.3}$	$\Delta\text{Op.3-Op.4}$
Change in financial incentive amount (\$)	543	283	385
Change in household payback period (year)	3.44	2.00	3.00
Marginal household payback period (year/\$100)	0.634	0.707	0.779

Table 4. Marginal household payback periods

## 2. Participation

Residential participation is necessary to accomplish water conservation on a local level. Participation affects the total amount of water collected with the cisterns, also known as the total amount of water saved by households. This also indicates the total amount of water that LADWP can avoid purchasing from MWD. Since financial incentive amounts affect participation, we assumed that participation differs among policy options. In our calculations, we applied the elasticity of participation from the Turf Replacement Program into our analysis model. The results show that a higher incentive amount leads to a higher participation rate.

In order to analyze participation rates in the rainwater harvesting program, we first assumed that there is a positive correlation between financial incentive amounts and the annual

participation rate. We took into account the current status of the rainwater harvesting program. LADWP received approximately 209 rebate requests for the cistern installation program since the program started in August 2016.<sup>36</sup> We used the expected annual participation number (502) and rate (0.078%) under the current financial incentive amount of \$300. In the next step, we calculated changes of the participation rate according to the shift in the financial incentive amount. Higher financial incentive amounts positively affect the household's decision-making and incentivizes more residents to join the program.

To estimate the participation rate at various incentive amounts, we incorporated the elasticity between the participation and incentive amount into a calculation formula. The elasticity ( $E_r$ ) is defined as the ratio between the percentage change in the annual participation rate ( $r$ ) and the percentage change in the financial incentive amount ( $L$ ). The City of Los Angeles introduced the Turf Replacement Program in 2009 in order to achieve the same objective of water savings and local water reliance. This program is considerably similar to our cistern incentive program in that its target population is the same (single-family homes in the City of Los Angeles) and both projects are water conservation-related projects at the residential level. Thus, we applied the elasticity in the Turf Replacement Program in the City of Los Angeles to the cistern incentive program since we can expect that the residents in single-family homes will respond to the increase in the financial incentive amounts in our cistern incentive program.

Table 5 shows the shifts in the number of rebate receivers and the total rebate levels over two fiscal years,<sup>37</sup> assuming that the rebate level from the different agencies involved increased

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<sup>36</sup> Rodriguez, Martha. E-mail interview by author. December 22, 2016

<sup>37</sup> Galperin, Ron. "Audit of DWP Customer-Based Water Conservation Programs." November 20, 2015. Accessed March 16, 2017. <https://assets.documentcloud.org/documents/2519638/lacityp-031982.pdf>.

simultaneously<sup>38</sup>. Since the  $E_r$  is defined as  $(dr/r)/(dL/L)$ ,  $E_r$  at the point of ( $L=\$2.00$ ,  $r=0.38\%$ ) can be calculated as 3.76.

	Number of rebate receivers	Annual participation rate (%)	Rebate amount (\$/SqFt)
July 2013 - June 2014	1,236	0.38	2.00
July 2014 - June 2015	5,320	1.63	3.75

Table 5. Modified data in Turf Replacement Program in the City of Los Angeles

$$E_r = \frac{dr/r}{dL/L} = \frac{(1.63 - 0.38)/0.38}{(3.75 - 2.00)/2.00} = 3.76$$

Next, we applied the elasticity ( $E_r = 3.76$ ) to our cistern incentive program in order to calculate the annual participation rate. The following expression shows the relationship between the financial incentive amount ( $L$ ) and annual participation rate ( $r$ ). Figure 3 also illustrates the linear relationship between the financial incentive amount ( $L$ ) and annual participation rate ( $r$ ).

$$E_r = 3.76 = \frac{(r - 0.00117)/0.00117}{(L - 300)/300}$$

<sup>38</sup> In the Turf Replacement Program, LADWP and MWD gave different amounts of rebates to a participant. We assumed that LADWP and MWD raised each rebate amount simultaneously at the end of June 2014 to simplify our calculation.

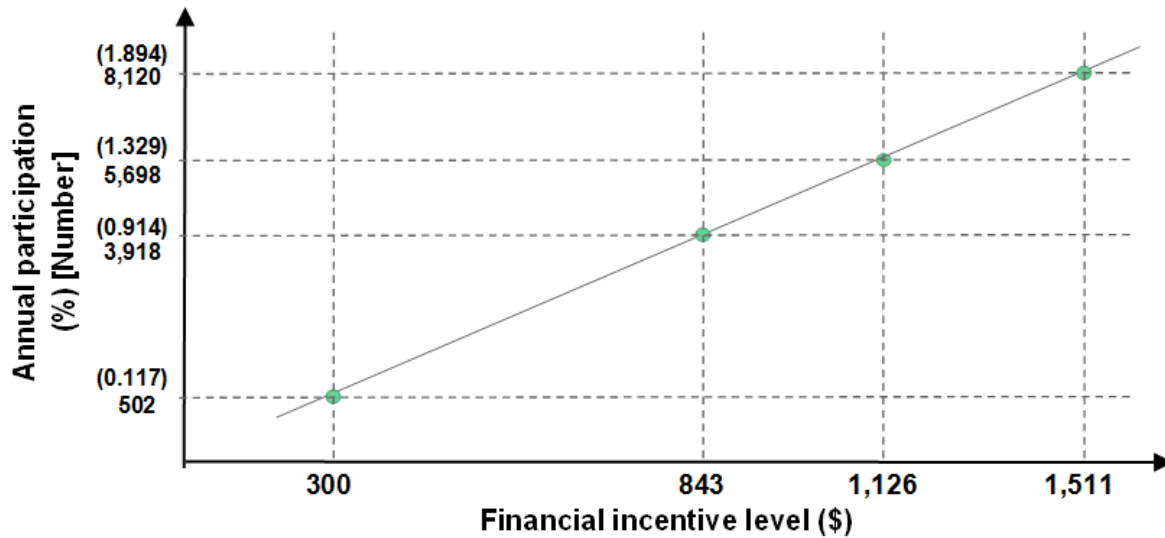


Figure 3. Relationship between the financial incentive amount and annual participation rate

Table 6 shows the annual participation rate and number of annual participants for our four policy options. It shows that the annual participation rate increases according to the rise in the financial incentive amount in a linear fashion. In options 3 and 4, the expected number of annual participants is more than 10 times greater than under policy Option 1 (status quo).

	Option 1	Option 2	Option 3	Option 4
Financial incentive amount (Percentage of the cost of cistern)	\$300 (14.7%)	\$843 (40.9%)	\$1,126 (54.7%)	\$1,511 (73.3%)
Annual participation rate (%)	0.117	0.914	1.329	1.894
Number of participants	502	3,918	5,698	8,120

Table 6. Annual participation rates and number of participants for policy options

### 3. Revenue Requirement

Revenue requirement indicates the budget amount that involved agencies need for the incentives. We determined the amount of the annual revenue requirement for each policy option by multiplying the financial incentive amount by the associated annual participation number.

From the agencies' perspective, it is important to consider the size of the budget required when the financial incentive amount changes. The required amount of budget for the cistern incentive program is the same as the revenue requirement.

Table 7 shows the required amount of budget for each policy option. The required amount of budget increases exponentially because the increase of the financial incentive amount incentivizes more participants to join in the program. Under the current incentive amount (\$300), agencies spend only \$0.15 million; however, Option 4 requires \$12.27 million, which is approximately 80 times higher. Compared to the status quo, Option 2 has a budget that is approximately 22 times bigger, and the budget required for Option 3 is 43 times greater than the status quo. Agencies would prefer a smaller required budget due to potential political constraints in associated with increased spending.

	Option 1	Option 2	Option 3	Option 4
Financial incentive amount (Percentage of the cost of cistern)	\$300 (14.7%)	\$843 (40.9%)	\$1,126 (54.7%)	\$1,511 (73.3%)
Required amount of budget (Millions of dollars/year)	0.15	3.30	6.42	12.27

Table 7. Required amounts of budget of policy options

### Marginal Analysis

The marginal required budget is defined as the increase in the required amount of budget resulting from an additional amount of rebate. Table 8 shows the results of the marginal required budget between policy options. For example, when we compare Option 1 and Option 2, the marginal required budget is 0.58. This output indicates that the policy option of higher financial incentive amount contributes to an increase in the required budget. In other words, higher incentive amounts lead to a larger marginal required budget.

	$\Delta\text{Op.1-Op.2}$	$\Delta\text{Op.2-Op.3}$	$\Delta\text{Op.3-Op.4}$
Change in financial incentive amount (\$)	543	283	385
Change in required budget (\$ million)	3.15	3.12	5.85
Marginal required budget (\$ million/\$100)	0.58	1.10	1.52

Table 8. Marginal required budget for policy options

#### 4. Ratepayer Payback Period

Ratepayers refer to the general LADWP customer base that may benefit from reduced costs of the utility.<sup>39</sup> The analysis for ratepayer payback period aims to investigate the financial impacts on the whole ratepayers, measuring the length of time for recouping ratepayers' investment in a cistern incentive program. In addition, by reducing the amount of imported water purchased and utilizing collected rainwater as a potential future local water source, LADWP will be able to save money. The saved costs for LADWP could be passed down to ratepayers through lower water utility rates.<sup>40</sup> Thus, a shorter payback period indicates a shorter amount of time for LADWP and ratepayers to recoup the investment on the cistern capture program. Thus, it is important to consider the potential impact on ratepayers and analyze their costs and benefits. In this section, we calculated the ratepayer payback period with NPV method.

In our model, we calculated the ratepayer payback period with NPV method. There we took into account two factors: saved costs and financial incentive.

Saved cost is the total monetary value of saved water that LADWP would have purchased from MWD. It is calculated by using three variables: MWD's water price, amount of water saved in each household, and the accumulated number of participants. We used the same annual

<sup>39</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, "Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles" (2016)

<sup>40</sup> Ibid.

participation rate calculated earlier in this section. The financial incentive is the amount of money agencies offer to participants when the participants join the cistern incentive program. We assumed that a certain number of participants will join the program every year and only new participants can receive the financial incentive. Thus, agencies have to pay the financial incentive only when new residents participate in the program.

The following equation expresses a ratepayer's NPV in  $t$  years. Each term represents saved costs and financial incentive. Each term represents saved costs ( $\text{Roof size} \times \text{Rainfall} \times \sum P_{MWDi} \times HH_t / (1+r)^{i-1}$ ) and financial incentive ( $\sum F \times \Delta HH / (1+r)^{i-1}$ ), in sequence.  $P_{MWDi}$  refers to the water price during year  $i$  provided by MWD,  $HH$  is the number of owner-occupied houses,  $F$  is the financial incentive provided to one household, and  $r$  is the discount rate.

$$NPV_t = \text{Roof size} \times \text{Rainfall} \times \sum_{i=1}^t \frac{P_{MWDi} \times HH_t}{(1+r)^{i-1}} - \sum_{i=1}^t \frac{F \times \Delta HH}{(1+r)^{i-1}}$$

Table 9 shows the assumptions and values used for the calculation of the ratepayer payback period. The first assumption is the potential number of targeted people in the City of Los Angeles. We estimated that there are 428,830 potential single-family houses that would qualify to participate in the cistern incentive program. This number is the estimated total number of owner-occupied single-family houses.<sup>41</sup> We excluded renters who live in single-family houses because renters would require the property owner's permission to install cisterns. In addition, owners would be less likely to be motivated to participate in the program because they would not directly receive a benefit. The second assumption is that MWD's water price will continuously

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<sup>41</sup> We estimated that there are 576,385 single-family houses (including renters) in the City of Los Angeles according to the Los Angeles County Tax Assessor. According to the American Fact Finder offered by United States Census Bureau (2011-2015), 74.4% of residents who live in single-family houses in the City of Los Angeles are house owners.

increase by 6% on a yearly basis.<sup>42</sup>

	Variable	Value	Unit
Discount Rate	r	3	%
Average Roof Size	Roofsize	1,488	SqFt
Number of owner-occupied houses	HH	428,830	HHs
Annual Rainfall	Rainfall	15	Inch
Upfront Cost (Cost of Cistern)	C <sub>1</sub>	2,060	\$
Annual Water Price Increase Rate (MWD)	N/A	46	%
MWD's Water Price	P <sub>MWD</sub>	900	\$/AF

Table 9. Data summary in the ratepayer payback period analysis

Table 10 below shows the ratepayer payback periods for each policy option. The result suggests that the relationship between the financial incentive amounts (\$) and the ratepayer payback period (year) is nonlinear. LADWP would prefer a shorter amount of payback period because LADWP can recoup their investment in a shorter period. Therefore, the preferred option is Option 1 followed by Option 2, then Option 3 and finally Option 4.

	Option 1	Option 2	Option 3	Option 4
Financial incentive amount (Percentage of the cost of cistern)	\$300 (14.7%)	\$843 (40.9%)	\$1,126 (54.7%)	\$1,511 (73.3%)
Ratepayer payback period (Years)	9.06	17.14	19.84	22.76

Table 10. Ratepayer payback periods

## Marginal Analysis

<sup>42</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, "Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles" (2016)



The marginal payback period is defined as the increase in the payback period resulting from an additional amount of rebate. It is calculated by dividing the difference of the ratepayer payback period by the difference of incentive amount between two options. Table 11 shows the results of the marginal ratepayer payback period between policy options. For example, when we compare Option 1 and Option 2, the marginal payback period is 1.49. This output indicates that the policy option of the lower financial incentive amount is more influential in increasing the ratepayer payback period. In other words, the higher the incentive amount the lower the marginal payback periods.

	$\Delta\text{Op.1-Op.2}$	$\Delta\text{Op.2-Op.3}$	$\Delta\text{Op.3-Op.4}$
Change in financial incentive amount (\$)	543	283	385
Change in ratepayer payback period (year)	8.08	2.70	2.92
Marginal ratepayer payback period (years/\$100)	1.49	0.95	0.76

Table 11. Marginal Ratepayer Payback Periods

## Policy Recommendation for Financial Incentive Amounts

In this section, we chose the best policy option regarding the financial incentive amount. We used four criteria to determine the best option: household payback period, participation, revenue requirement, and ratepayer payback period. Since the city's ultimate goal is to reduce water reliance and enhance local water supply, household payback period (criterion 1) and participation (criterion 2) are the two most important criteria. Table 12 shows the summary of outputs for each criterion.

Criteria		Option 1	Option 2	Option 3	Option 4
Financial incentive amount (Percentage of the cost of cistern)		\$300 (14.7%)	\$843 (40.9%)	\$1,126 (54.7%)	\$1,511 (73.3%)
Criterion 1	Household payback period (Years)	13.44	10.00	8.00	5.00
Criterion 2	Number of participants	502	3,918	5,698	8,120
Criterion 3	Required amount of budget (\$ million/year)	0.15	3.30	6.42	12.27
Criterion 4	Ratepayer payback period (Years)	9.06	17.14	19.84	22.76

Table 12. Summary of each criterion in each policy option

We first examined the status quo (Option 1) and compared it to the next level of incentive amount (Option 2). Option 2 outweighs Option 1 for its shorter household payback period and a larger participation number. Additionally, the household payback period in Option 2 is shorter than 13 years, which is the average number of years single-family homeowners are expected to remain in their home.<sup>43</sup> Although the ratepayer payback period increases to 17.14 years in Option 2, it is relatively close to the ratepayer payback period of 14 years from the Turf Replacement Program.<sup>44</sup>

Next, we compared Option 2 with Option 3. Option 3 is more demanding due to the larger budget size required. Since the marginal required budget increases as the financial incentive amount goes up, the agencies would pay additional money in an absolute and a relative amount. However, “the City of Los Angeles spent more than \$42 million on the Turf

<sup>43</sup> National Association of Home Builders. "Latest Calculations Show Average Buyer Expected to Stay in a Home 13 Years." Accessed March 17, 2017. <http://nahbclassic.org/generic.aspx?genericContentID=194717>.

<sup>44</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, “Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles” (2016), P.32

Replacement Program”<sup>45</sup> from 2009 until 2015. This means that the city spent on average more than \$7 million per year. Additionally, in 2014, the agencies increased its rebate level from \$1.00/SqFt to \$1.75/ SqFt.<sup>46</sup> If we assumed that annual participation number had been the same over the seven years and the higher rebate level (\$1.75/SqFt) was applied during 2014 and 2015, the average required size of the budget was more than \$8.65 million per year during 2014 and 2015.<sup>47</sup> Therefore, the budget size in Option 3 (\$6.42 million per year) is attainable. Also, the marginal effects of the financial incentive amount on the shift of the household payback period increases. Compared to the marginal payback period between options 1 and 2 (0.634 years/\$100), switching from Option 2 to Option 3 (0.707 years/\$100) has approximately 1.12 times larger positive effect on reducing the household payback period. As such, it is fair to say that Option 3 is also acceptable and feasible.

Lastly, we compared Option 3 with Option 4. Option 4 is more attractive than Option 3 due to its shorter household payback period and higher number of participation. However, Option 4 has a higher required budget and a longer agencies’ payback period. The required budget is \$12.27 million, which is approximately 1.9 times higher than Option 3. This amount exceeds \$8.65 million, which is the estimated average annual budget of the Turf Replacement Program during 2014 and 2015. Additionally, the ratepayer payback period is 22.76 years, which is slightly longer than the typical manufacturer warranty for a polyethylene cistern, which is 20 years.<sup>48</sup> The agencies might not be able to recoup its investment, because some cisterns installed


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<sup>45</sup> UCLA Luskin School of Public Affairs, Luskin Center for Innovation, “Turf Replacement Program Impacts on Households and Ratepayers: An Analysis for the City of Los Angeles” (2016), P.1

<sup>46</sup> Ibid.

<sup>47</sup> For this calculation, we assumed that the agencies’ rebate level was \$1.00/ SqFt for five years (between 2009 and 2013) and \$1.00/SqFt for two years (between 2014 and 2015).

<sup>48</sup> Berger, Daniel. E-mail interview by author. November 22, 2016.



in earlier years may not work after this time. We estimated that the drawbacks outweigh the benefits for Option 4. Thus, Option 3 outweighed Option 4.

In conclusion, our recommendation for the best financial incentive amount is \$1,126 (54.7% of the cost of a cistern). At this level, the owner-occupied single-family houses can have 8.00-years payback period, and we expect 5,698 residents to participate in the program on a yearly basis. Under this incentive amount, the ratepayer payback period is 19.84 years, and the estimated required budget size is \$6.42 million annually.

## **SECTION IV: POLICY OPTIONS AND CRITERIA ANALYSIS FOR FINANCIAL INSTRUMENTS**

After finding an appropriate incentive level, the next step is to select the best financial instrument that would increase cistern use. We determined three policy options for a financial instrument to channel incentives towards the participants. First, property tax credit option is a financial instrument used on an existing solar panel incentive program. Second, a rebate option, which is the status quo; however, we would like to examine the effect of an alternative rebate amount on this financial instrument. Lastly, our client recommended avoided stormwater fees as an option for our analysis.

### **Policy Options for Financial Instrument**

#### **1: Property Tax Credit**

When conducting literature review on environmental projects that have incentive programs, we found a Solar Investment Tax Credit (SITC) from the federal government that incentivizes installation of solar panels on private houses. This tax credit “is a dollar-for-dollar reduction in the income taxes that a person or company claiming the credit would otherwise pay the federal government.”<sup>49</sup> We took this program as a model to incentivize residents to install cisterns. However, since only the federal government can provide income tax credits, we found it more feasible to give property tax credits approved by Los Angeles County.

#### **2: Rebate**

Rebate is the current incentive method used by LADWP and MWD. This rebate continues to be a feasible option and we evaluated it along with the other policy options. The

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<sup>49</sup> "Solar Investment Tax Credit (ITC)." Accessed March 15, 2017. <http://www.seia.org/policy/finance-tax/solar-investment-tax-credit>.

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rebates would be used to encourage the installation of cisterns by offsetting part of the cost.

### **3: Avoided Stormwater Fee**

The City of Los Angeles charges a Stormwater Fee, also called Stormwater Pollution Abatement Charge, to pay for flood control projects and stormwater pollution abatement programs. This fee is charged yearly on the property tax bill by the County and distributed to the City of Los Angeles.<sup>50</sup> This policy option would work in the following manner: the City of Los Angeles would exempt this fee to those households that install rainwater cisterns. Encouraging rainwater capture on the household level reduces stormwater runoff that pollutes the city's waterways.

## **Criteria Analysis**

To determine the best option for a financial instrument we used equity and political feasibility as evaluative criteria.

### **Equity**

Equity is defined as the “fair distribution of resources and burdens.”<sup>51</sup> Eligibility and progressive distribution of financial benefits are two measures in which we measured equity.

In the first measure, eligibility, we determined if all residents in the city will be able to benefit from participating in the incentive program. A higher number of eligible participants indicates a higher eligibility level of the policy option. The second measure, distribution of financial benefit, refers to the monetary value of the incentive. A progressive distribution of this financial benefit allows a lower income population to obtain a higher level of financial support. A fixed amount of

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<sup>50</sup> City of Los Angeles. “Water Quality Compliance Master Plan for Urban Runoff” Pg. 10-9 May 2009. Accessed March 16, 2017. [http://www.lastormwater.org/wp-content/files\\_mf/wqcmpur.pdf](http://www.lastormwater.org/wp-content/files_mf/wqcmpur.pdf).

<sup>51</sup> Österle, August. "Evaluating equity in social policy: A framework for comparative analysis." *Evaluation* 8.1 (2002): 46-59.

incentive offered to all socioeconomic groups creates a more progressive distribution effect.

All participants will have the eligibility to financially benefit from either avoiding paying for the stormwater fee or receiving a rebate. However, certain homeowners, such as veterans and permanently disabled individuals, may not be eligible for the property tax credit as a result of their exemptions.<sup>52</sup> Therefore, the property tax credit option receives a score of 1 and the other two options receive scores of 2. A lower score indicates a low equity level for the policy option.

We also measured equity by the progressiveness of the net financial burden on the household. Progressiveness applies when the ratio of the amount of net financial burden on the participant's income increases as income level rises. The net financial burden equals to the difference between the total cistern cost and the financial incentive received. For example, a progressive system is one in which higher income households pay a greater net financial burden in proportion to their income compared to lower income households. On the contrary, it is regressive when a system imposes higher income households with less net financial burden than lower income households.

In the property tax credit and rebate options, a fixed amount tax credit (where everyone receives the same amount of credit or a rebate level) demonstrates a progressive distribution of resources since the amount will represent a higher proportion of the income as income level decreases. We gave these two options scores of 2. The avoided fee option is less equitable with a score of 1. This option takes into account the size of the parcel land where the house is located, and we assumed that a larger parcel size likely indicates a larger house associated with a larger household income level. Therefore, the avoided fee option offers a greater amount of financial

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<sup>52</sup> "Los Angeles County Assessor's Office - Exemptions, Exclusions and Tax Relief." Accessed March 17, 2017. <http://assessor.co.la.ca.us/extranet/guides/exemptions.aspx>.

benefit to the higher income groups relative to those individuals in the lower income group.

The total score shown in Table 13 is calculated by adding up the scores from the two measures of equity, eligibility and progressiveness. The rebate option has a higher total score (4) than the other two options.

Policy Option	Equity		Total Score
	Eligibility	Progressiveness	
Property Tax Credit	1	2	3
Rebate	2	2	4
Avoided Stormwater Fee	2	1	3

Table 13. Summary of Scores in Equity Criterion

## Political Feasibility

We used three different measures to evaluate the political feasibility of our options: political acceptability, consistency with the agencies' mission, and institutional complexity.

### Political acceptability

The political acceptability takes into account financial burden and compares the financial impact of the estimated cistern project cost on the involved agencies. It is the percentage of the estimated cistern project cost over the total budget of each involved agencies. For our property tax credit option, we calculated the proportion of the estimated budget needed over the city's revenue from property taxes. For rebates, we calculated the proportion of our estimated budget needed over LADWP and MWD's combined total budget of their stormwater capture program. For avoided stormwater fees, we calculated the proportion of our estimated budget needed over the city's annual revenue from stormwater fees. By comparing the values of these proportions,



the policy option with the smallest value yields the lowest financial impact for the involved agencies.

The political acceptability criterion examines the financial impact of program implementation for each involved agencies. The measure is the ratio of our estimated project budget to the involved agencies' budget for the cistern incentive program. We estimated the project budget by multiplying the chosen incentive amount (\$1,126) by the number of participants (5,698). The total estimated project budget is **\$6,415,948**.

We assigned each option a score depending on if they have a low, medium, or high ratio. The option with the lowest ratio indicates the smallest impact on the agencies' budgets, which obtains the highest score of 3. The option with the second lowest ratio receives a score of 2. The option with the highest ratio indicates the highest financial impact on the agencies' budget, which receives a score of 1. We calculated this ratio by dividing the estimated project budget by the following denominators:

- Property Tax Credit: The denominator is the revenue from the property tax, which by the time of this report was of \$1,786,069,000.<sup>53</sup>
- Rebates: The denominator is LADWP's budget for the stormwater capture program, which is about \$76.4 million.<sup>54</sup>
- Stormwater Fee Exemption: The denominator for this option is the Annual City Stormwater Pollution Abatement Charge, which is currently \$28 million.<sup>55</sup>

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<sup>53</sup> "City of Los Angeles 2016-17 Budget Summary." Office of the Mayor. Accessed March 16, 2017. [http://cao.lacity.org/budget16-17/2016-17Budget\\_Summary.pdf](http://cao.lacity.org/budget16-17/2016-17Budget_Summary.pdf).

<sup>54</sup> This amount is the sum of the combined budgets of LADWP and MWD allocated for stormwater capture programs. LADWP has \$26.4millions and MWD has \$50millions.

<sup>55</sup> "Funding. City of Los Angeles Stormwater Program." City of Los Angeles Stormwater Program. Accessed February 17, 2017. <http://www.lastormwater.org/about-us/funding/>

The financial feasibility criterion predicts the financial impact of policy options on agencies' budget. This is determined by the aforementioned ratio. The property tax credit option has a ratio of 0.0036 (\$6,415,948/\$1,786,069,000), which is the lowest ratio compared to the other options. This option, therefore, receives the highest score of 3. The rebate option yields a ratio of 0.084 (\$6,415,948/\$76,400,000), which is the second lowest ratio compared to the others. This option receives a score of 2. The avoided stormwater fee option is 0.22 (\$6,415,948/\$28,000,000), which has the highest ratio and is therefore the least desirable among the three options. Hence, it receives the lowest score of 1. Based on the calculations above, the option with the highest political acceptability is the property tax credit option.

#### Consistency with agencies' mission

Our second measure is comparing the consistency between the cistern project and the involved agencies' mission. The more consistent our project goal to the mission is, the higher the score the option receives.

Under policy Option 1, the Los Angeles County Assessor distributes the revenue from property taxes to the city, and the city appropriates the budget plan. Because the city has many other budget obligations, the appropriation for water and electricity is \$41,800,000, which is 0.48% of the total revenue generated from property taxes.<sup>56</sup> However, rainwater-related projects are not considered or accounted for in this water and electricity budget. Hence, there is very little consistency between the rainwater harvesting project and the city's mission.

Under policy Option 2, MWD and LADWP have the highest consistency between the rainwater harvesting project and the agencies' mission, in comparison to agencies involved in the

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<sup>56</sup> "City of Los Angeles 2016-17 Budget Summary." Office of the Mayor. Accessed March 16, 2017. [http://cao.lacity.org/budget16-17/2016-17Budget\\_Summary.pdf](http://cao.lacity.org/budget16-17/2016-17Budget_Summary.pdf).

other two policy options. First, MWD has a mission to provide adequate and reliable supplies of high-quality water to “meet present and future needs in an environmentally and economically responsible way.”<sup>57</sup> Second, MWD assists its member agencies in water conservation planning.<sup>58</sup> Last, LADWP has a mission to “provide customers with safe, reliable, high quality and reasonably priced water services in a transparent and environmentally responsible manner.”<sup>59</sup>

Under policy Option 3, the Stormwater Fees policy option has a high consistency with the agencies’ mission. There are three major uses of the funding collected by the Stormwater Pollution Abatement Charge. First, the funding is used for the treatment and abatement of stormwater in accordance to requirements imposed by the EPA.<sup>60</sup> Second, the funding is for construction of flood control and pollution abatement projects.<sup>61</sup> Last, the funding is also used for the cost of stormwater-related activities in various city departments, offices, and bureaus.<sup>62</sup> Among these three designations, all three uses are consistent with the rainwater harvesting project.

### *Institutional complexity*

This measure takes into account the process necessary to implement the different policy options. Institutional complexity entails bureaucratic coordination and ordinance requirements. The higher the level of institutional complexity, the lower the score the policy option will

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<sup>57</sup> "The Metropolitan Water District of Southern California. Overview and Mission." Accessed February 17, 2017. <http://www.mwdh2o.com/WhoWeAre/Mission/Pages/default.aspx>

<sup>58</sup> Ibid.

<sup>59</sup> "LADWP Strategic Plan Draft Framework." March 2009. Accessed March 16, 2017. <http://www.ladwpneighborhoodnews.com/external/content/document/1643/280504/1/LADWP%20Strategic%20Planning.pdf>.

<sup>60</sup> "Funding Options for the Implementation Strategy for the Enhanced Watershed Management Plans." Office of the City Administrative Officer. 5 January 2017. Accessed March 16, 2017. [http://clkrep.lacity.org/online/docs/2015/15-0605\\_rpt\\_CAO\\_01-05-2017.pdf](http://clkrep.lacity.org/online/docs/2015/15-0605_rpt_CAO_01-05-2017.pdf)

<sup>61</sup> Ibid.

<sup>62</sup> Ibid.

receive.

Making changes to property taxes requires a high level of institutional complexity. Intragovernmental and intergovernmental coordination is required in this political process and poses several challenges to the process. First, city agencies and the county clerk submit information to the Assessor. Particularly, the City of Los Angeles provides copies of all building permits issued, and the Los Angeles County Clerk provides copies of all deeds and other recorded documents.<sup>63</sup> Second, three separate Los Angeles County offices, the Assessor, the Auditor-Controller, and the Treasurer and Tax Collector offices are all involved in the property tax assessment process.<sup>64</sup> The Los Angeles County Assessor creates the “Assessment Roll” with appraised values of all properties under applicable state laws.<sup>65</sup> The Los Angeles County Auditor-Controller then creates an “Extended Assessment Roll” with applied tax rates.<sup>66</sup> As a last step, the Los Angeles County Treasurer and Tax Collector mails the property tax bills and collects taxes.<sup>67</sup>

To implement the property tax credit, city agencies and the county clerk will submit changes on the property tax payment value for single-family houses in the City of Los Angeles. The Assessor then approves the changes, which are further reviewed by the Auditor-Controller. Lastly, the Treasurer and Tax Collector office will change the value on property tax bills and collect the amount accordingly.

Stormwater Fees, also known as the Stormwater Pollution Abatement Charge, is

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<sup>63</sup> "How the Property Tax System Works." Los Angeles County Assessor's Office. Accessed February 17, 2017. <http://lacountypropertytax.com/portal/contactus/taxsystem.aspx>

<sup>64</sup> "An Overview of the Property Tax and Assessment Process." Los Angeles County Tax Assessor Office. Accessed February 17, 2017. <http://lacountypropertytax.com/portal/contactus/overview.aspx>.

<sup>65</sup> Ibid.

<sup>66</sup> Ibid.

<sup>67</sup> Ibid.

collected by the Los Angeles County Assessor and appears on a property's annual tax bill. In comparison to the property tax, making changes to the Stormwater Pollution Abatement Charge requires relatively less institutional coordination. The Board of Public Works of the City of Los Angeles has "the power to establish rules and regulations for the filing, review, and determination of adjustments and exemptions."<sup>68</sup> "Where a determination, adjustment, or exemption has become final as provided in this section, future tax bills shall reflect the adjustment unless otherwise determined by the Board."<sup>69</sup>


Compared to property tax credits and stormwater fees exemptions, changes to the rebate amount require the least amount of institutional complexity. Because MWD and LADWP are the only decision-makers, no intergovernmental coordination is involved. The Board of Public Works shall determine the change based on funding availability.

		Score		Score		Score	Total Score
Property Tax Credits	Low Political Acceptability	3	Low Consistency with Agencies' Mission	1	High Institutional Complexity	1	<b>5</b>
Rebates	Medium Political Acceptability	2	High Consistency with Agencies' Mission	3	Low Institutional Complexity	3	<b>8</b>
Avoided Stormwater Fee	High Political Acceptability	1	Medium Consistency with Agencies' Mission	3	High Institutional Complexity	1	<b>5</b>

Table 14. Summary of Score in Political Feasibility Criterion

<sup>68</sup> "Official City of Los Angeles Municipal Code (TM)." Accessed March 17, 2017. <https://law.resource.org/pub/us/code/city/ca/LosAngeles/Municipal/chapter06.pdf>

<sup>69</sup> Ibid.



A summary of the total scores given to each of the evaluative criteria can be seen on Table 14. The total score for political feasibility is calculated by aggregating the data from three measures in political acceptability, consistency with agencies' mission, and institutional complexity. The rebate option receives the highest total score of 8. The property tax credit option receives a total score of 5, and the avoided stormwater fee option receives a total score of 5.

### **Policy Recommendation for Financial Instruments**

In summary, we used equity and political feasibility as the evaluative criteria to select the best method to distribute our recommended incentive of \$1,126 to encourage households in purchasing a cistern. Because the rebate policy option receives the highest score in equity and political feasibility criteria, we recommend our client to endorse and advocate for this policy option. Therefore, LADWP and MWD, the agencies that currently provide a rebate, will need to increase the amount from \$300 to \$1,126 to successfully increase the amount of water cisterns installed in Los Angeles households.

## **SECTION V: CONCLUSION**

### **Policy Recommendation**

Overall, our rainwater harvesting project aims to increase the participation of cistern installation among owner-occupied single-households in the City of Los Angeles. To achieve an increase in participation, the study examines the best financial incentive amount and financial instrument to encourage cistern installation.

In the first step of the policy analysis, a financial incentive amount of \$1,126 (54.7% of the cost of a cistern system) is recommended by evaluating the impact of various financial incentive amounts on household payback period, participation, revenue requirement, and ratepayer payback period. In the second step of the policy analysis, a rebate is chosen as the best approach for the financial instrument of the program by evaluating equity and political feasibility criteria. Hence, we recommend using a rebate of \$1,126 as an incentive to encourage the adoption of cisterns provided through a rebate mechanism.

### **Estimated Impacts by Our Recommended Policy**

In order to increase the rebate amount and meet the associated revenue requirement, these agencies will most likely increase the water price to ratepayers. We estimated that LADWP would need to increase its water price by 0.03 (\$/HCF) for its residential customers,<sup>70,71</sup> and this amount is equal to a 0.55% increase of the current water rate.<sup>72</sup> This means that LADWP's ratepayers will have their utilities increased by 0.55%. This percentage is less than the 5-year

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<sup>70</sup> KPCC, 89.3. "Los Angeles Department Of Water And Power December water use." Accessed March 16, 2017. <http://projects.scpr.org/applications/monthly-water-use/los-angeles-department-of-water-and-power/>.

<sup>71</sup> We calculated 0.03 (\$/HCF) by dividing the required budget size (\$6,415,948) by the total amount of water consumption during 2016 (154,953 million gallons).

<sup>72</sup> We assume that the LADWP's current water price is 5.45 (\$/HCF), same as the value on Table 1.

average annual water rate change, which is 4.8%.<sup>73</sup>

This water price increase has impacts on all the ratepayers in the City of Los Angeles. Even though households who participate in the rebate program and install cisterns will benefit from saved water costs, we understand that non-participating households will not benefit and have a financial burden, in the short term. However, in the long term we expect a ratepayer payback period of 19.84 years. At this point in time fees should decrease and all households, including those without a cistern, will benefit from the cistern incentive program.

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<sup>73</sup> LADWP Website. “2016 - 2020 Rate Changes” Accessed May 9, 2017.  
[http://www.myladwp.com/2016\\_2020\\_rate\\_request](http://www.myladwp.com/2016_2020_rate_request)



## APPENDIX

### Roof size analysis

**Total number of HHs: 576,385**

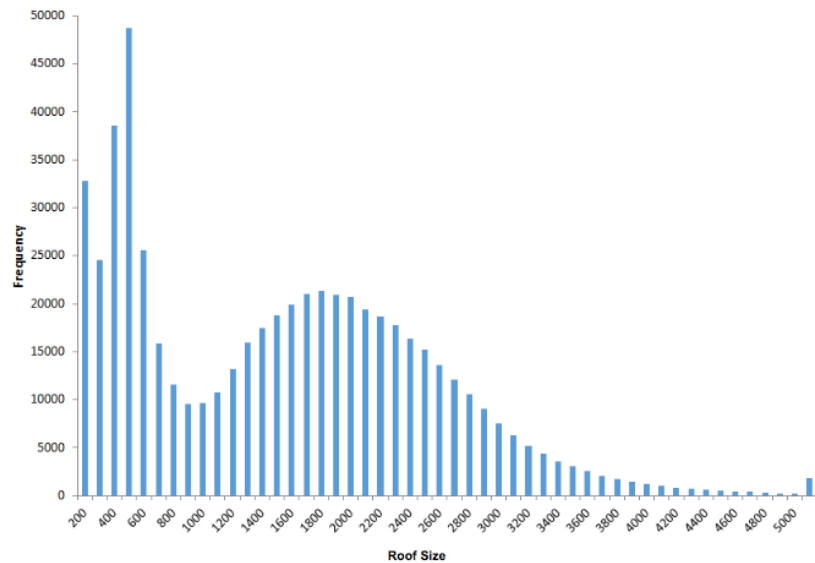
Roof size (sqft)

Minimum: 101

Maximum: 9,956

**Average: 1,488**

Median: 1,513



This roof size analysis was conducted by combining two datasets. First, we used the Countywide Building Outline dataset from the Los Angeles County GIS data portal, in order to get the roof size information of all properties in the County of Los Angeles. We used the outline of the City of Los Angeles to filter out information from other cities. Second, we used the dataset from the Los Angeles County Tax Assessor to obtain the property type codes in order to select single-family homes only. As a result we created a histogram to show the distribution of roof sizes of single-family homes in the City of Los Angeles. We also filtered out roof sizes equal or smaller than 100 square feet, as well as those properties with a roof size greater than 10,000 square feet. From there we obtained the average roof size (1,488 SqFt) that we used for the estimation of water collected by cisterns. Additionally, we obtained the number of single-family houses to estimate participation rate.