United States Environmental Protection Agency

Building Resilience to Drought in Ozone Park

Conceptual Design for Potable Water Offset Using Treated Urban Runoff

June 2015
EPA 832-R-15-010

Photo: Ozone Park, Santa Monica, CA

About the Green Infrastructure Technical Assistance Program

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, soil and plants absorb and filter the water. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems (storm sewers) and discharged into nearby water bodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, *green infrastructure* refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. Green infrastructure can be a cost-effective approach for improving water quality and helping communities stretch their infrastructure investments further by providing multiple environmental, economic, and community benefits. This multi-benefit approach creates sustainable and resilient water infrastructure that supports and revitalizes urban communities.

The U.S. Environmental Protection Agency (EPA) encourages communities to use green infrastructure to help manage stormwater runoff, reduce sewer overflows, and improve water quality. EPA recognizes the value of working collaboratively with communities to support broader adoption of green infrastructure approaches. Technical assistance is a key component to accelerating the implementation of green infrastructure across the nation and aligns with EPA's commitment to provide community focused outreach and support in the President's *Priority Agenda Enhancing the Climate Resilience of America's Natural Resources*. Creating more resilient systems will become increasingly important in the face of climate change. As more intense weather events or dwindling water supplies stress the performance of the nation's water infrastructure, green infrastructure offers an approach to increase resiliency and adaptability.

For more information, visit *http://www.epa.gov/greeninfrastructure*.

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Contents

Figures

Tables

1. Executive Summary

Regional droughts and increasingly stringent water quality requirements make stormwater management more important than ever for the City of Santa Monica, California. In response, the City is implementing best management practices (BMPs) on public parcels and rights-of-way to augment the local water supply and improve water quality before storm flows discharge into the ocean. Santa Monica identified Ozone Park as a potential location to implement water harvesting practices that will both reduce its dependence on imported water and increase the City's resiliency to future droughts.

The purpose of the project is threefold:

1) Reduce City reliance on imported water by harvesting, treating, and using urban runoff for non-potable uses.

2) Reduce urban runoff and improve water quality to meet the waste load allocations specified in local Total Maximum Daily Load (TMDL) requirements for metals, trash, and bacteria.

3) Demonstrate the feasibility of implementing a runoff-use system at Ozone Park and compare to other possible harvesting and use project locations.

Three scenarios were identified as feasible within the park footprint: a 10,000 gallon cistern, a 100,000 gallon cistern, and a 180,000 gallon cistern, each with an associated 0.5 acre-foot overflow infiltration gallery. The water use and potential water quality impacts modeled in this report are summarized below in Table 1-1. Annually, this project has the potential to harvest enough runoff to provide up to 100 percent of the 450,900 gallon irrigation demand at the Ozone Park site. This estimate is based on an annual rainfall of 12 inches.

Table 1-1. Scenario results summary at Ozone Park.

Model Scenario	Cistern Size, Gallons	Annual Cistern Usage, Gallons	Park Irrigation Offset	Infiltration Gallery Size, ac-ft	Annual Zinc Reduction, lbs	Annual Zinc Percent Reduction[1]	Annual Runoff Volume Reduction, ac-ft	Annual Runoff Volume Percent Reduction[1]
Scenario 1	10,000	286,968	64.0%	0.5	12.3	10.2%	7.4	4.1%
Scenario 2	100,000	386,324	86.1%	0.5	13.7	11.3%	7.6	4.3%
Scenario 3	180,000	448,504	100.0%	0.5	14.8	12.3%	7.9	4.4%

1. Percent reduction is the anticipated reduction from the current conditions.

2. Introduction

Santa Monica, California, is situated on the west side of Los Angeles County, about 16 miles west from downtown Los Angeles, where the Pacific Coast Highway and interstate Highway 10 meet. It is 8.3 square miles and bordered by the City of Los Angeles on three sides and the Pacific Ocean to the west. Its population is approximately 90,000 residents.

The City of Santa Monica depends on imported water from distant watersheds to supplement its local water supply. Currently, imported water accounts for 28 percent of the City's water supply, while the other 72 percent is provided by wells, along with treated stormwater and dry-weather runoff. This reliance leaves the City in a precarious position. In the future, imported water prices will undoubtedly rise, less imported water will be available as the City competes with other growing communities, and ecosystem requirements to protect endangered and threatened species and aquatic habitat will increase. In addition, supply disruptions due to natural disasters could further strain statewide water transportation systems. These factors contribute to an unreliable water supply and the need to improve the resiliency of Santa Monica's local water supply.

Where water supplies are limited, stormwater and dry-weather runoff harvesting provides a sustainable, alternative source of water for non-potable irrigation purposes, and can also significantly reduce demand on higher quality potable water sources. Stormwater and dry-weather runoff harvesting allows the conservation of potable water supplies by providing an alternative water source for irrigation of residential and commercial landscaping, agriculture, public parks, and golf courses. According to the City's Office of Sustainability and the Environment (2015), to meet the City's self-sufficiency goal to stop importing water by 2020 residents would need to reduce their water use to 123 gallons a day - a savings of 4,000 gallons, per person, per year.

2.1. Water Quality Issues/Vision

Santa Monica is a NPDES Phase I municipal separate storm sewer system (MS4) permittee and has a history of bacterial exceedances in stormwater and dry-weather runoff.

The City's Sustainable Water Master Plan was finalized in the summer of 2014 and has two major strategy portfolios: Supply Management and Demand Management. Supply management strategies include increasing groundwater pumping and maximizing local, non-traditional water supplies: gray water and stormwater (rain harvesting). This project is one critically important step to demonstrate the feasibility of harvesting local urban runoff (mainly stormwater) from the stormwater drainage network, treating and using the water to replace imported water, and helping the City to reach its 2020 goal of being self-reliant for water. Unlike traditional supply side projects, which build surface structures to divert surface waters from their natural flows, the City's strategy is to promote green infrastructure in its capital improvement water projects. Other community priorities that a green infrastructure approach would address include the City's Watershed Management Plan (2006), which promotes the use of green infrastructure to help meet water quality standards for its impaired water body, Santa Monica Bay.

The City also has an urban runoff pollution mitigation ordinance (SMMC 7.10) that promotes post-construction structural green infrastructure BMPs. While traditional watershed management often focuses on treating and releasing runoff to the receiving water body, the City's comprehensive watershed management strategy emphasizes stormwater harvesting, and indirect and direct onsite uses. This project is another example of a green infrastructure investment that, in keeping with the City's vision, harvests runoff for onsite beneficial uses and keeps water pollution sources out of receiving water bodies.

2.2. Project Overview and Goals and Scope

Ozone Park is a linear park located on the southern border of the City where Santa Monica meets Los Angeles. It has playgrounds on the eastern and western ends and a grassy lawn in between. Figure 2-1 shows the existing condition and location of the park.

This project aims to offset imported water demand by harvesting local stormwater and dry-weather runoff and applying it for park irrigation. Through this project, the City hopes to integrate the concept of green infrastructure water use systems for future landscaping, and to educate developers, engineers, and architects on green infrastructure design principles. The project identified three specific goals during the application process:

1) Reduce City reliance on imported water by harvesting, treating, and using urban runoff for non-potable uses.
2) Reduce urban runoff and improve water quality to meet the waste load allocations specified in local TMDLs.
3) Demonstrate the feasibility of implementing a runoff-use system at Ozone Park and compare to other possible project locations.

This project demonstrates an innovative water collection system that uses available dry- and wet-weather runoff to irrigate the turf within a park. This report includes recommended conceptual designs and planning level cost estimates. Also included are the anticipated permits required for project implementation. This project builds on the City's efforts to install similar green infrastructure on both private and public parcels, and to achieve its water self-sufficiency goal by 2020.

Figure 2-1. Location and existing condition of the Ozone Park site.

2.3. Project Benefits

Annually, this project has the potential to harvest enough runoff to provide up to 100 percent of the 450,900 gallon irrigation demand at the Ozone Park site. This estimate is based on an annual rainfall of 12 inches.

By removing polluted urban runoff from the storm drain system, this project will help improve water quality in Santa Monica Bay and help the City comply with requirements of its new green infrastructure-focused NDPES permit and meet TMDL requirements for marine debris, bacteria, and organic chemicals. Since the project prevents polluted water from entering the Bay, endangered and threatened species found in the Bay will also be better protected.

As the City begins to implement its 2020 water self-sufficiency plan, eliminating the need for imported water on this site will help the City reach this goal. This project will also help the City become more resilient to drought conditions and be better prepared for a time when water supplied from other sources is no longer reliable, as has been the case in past drought years.

Where runoff is harvested locally and used to replace imported water, energy is saved by not having to pump water into the local area. Based upon data from the Metropolitan Water District of Southern California, 11,111 kWh of energy is required per million gallons of water pumped or diverted into Southern California from other sources. Based upon the amount of water replaced from this project, the energy saved is estimated to be up to 3,189 kWh, 4,292 kWh, and 4,983 kWh on an annual basis for Scenarios 1, 2, and 3, respectively. Additionally, if the energy saved would have been produced by fossil fuels, there will be benefits associated with a reduction in greenhouse gas production (City of Santa Monica 2014).

3. Design Approach

The Ozone Park project is intended to harvest and use stormwater and dry-weather runoff for irrigation, and reduce downstream pollutant loading. Based on the park properties and project goals, below-ground cisterns and a subsurface infiltration gallery were proposed. These two strategies are described below.

3.1. Cisterns

A cistern is an above-ground or below-ground storage vessel with either a manually operated valve or a permanently open outlet (Figure 3-1). If the cistern has an operable valve, the valve can be closed to store stormwater and dry-weather runoff for irrigation or infiltration. This system requires continual monitoring by the grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern system openings must be covered to prevent mosquitoes from breeding. A cistern system with a permanently open outlet can also passively regulate the outflow of stormwater runoff. If the cistern

Figure 3-1. Cistern at Grand Canyon Visitor Center, Grand Canyon National Park, Arizona.

outlet is significantly smaller than the size of the inlet (e.g., ¼- to ½-inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. The cistern must be designed and maintained to minimize clogging by leaves and other debris.

3.1.1. Hydrology

Cisterns have been used for millennia to harvest and store water. Droughts in recent years have prompted a resurgence of rain harvesting technologies such as cisterns as a means of offsetting potable water use. Studies have shown that adequately designed and used systems reduce the demand for potable water and can provide important hydrologic benefits (Vialle et al. 2012; DeBusk et al. 2012). Hydrologic performance of rain harvesting practices varies with design and use; systems must be drained between rain events to reduce the frequency of overflow (Jones and Hunt 2010). When a passive drawdown system is included (e.g., an orifice that slowly bleeds water from the tank into an adjacent vegetation bed or infiltrating practice), significant runoff reduction can be achieved (DeBusk et al. 2012).

Cisterns are typically placed near a concentrated source of runoff (such as a roof downspout or existing drainage pipes) so that flows from existing downspouts or drainage networks can be easily diverted into the cistern. Pre-treated runoff (after large sediment and debris is removed) enters the cistern near the top and is stored for later use or infiltration. Collected water exits the cistern from near the bottom (4 to 6 inches above the bottom) or can be pumped. Water can be used to offset potable supply or piped to areas more conducive for infiltration. Cisterns can be used either as a reservoir for temporary storage or as a flow-through system for peak flow control. Cisterns are fitted with a valve that holds the stormwater for later use or slowly releases the stormwater from the cistern at a rate below the design storm rate. Regardless of the intent of the storage, an overflow must be provided for times when the capacity of the cistern is exceeded. The overflow system should route the runoff to a green infrastructure practice for treatment or safely pass the flow into the stormwater drainage system. The overflow should be conveyed away from structures.

3.1.2. Water Quality

Because most harvesting systems collect rooftop rainwater runoff, the water quality of runoff harvested in cisterns is largely determined by surrounding environmental conditions (e.g., overhanging vegetation, bird and wildlife activity, atmospheric deposition), roof material, and cistern material (Despins et al. 2009; Lee et al. 2012; Thomas and Greene 1993). Rooftop runoff tends to have relatively low levels of physical and chemical pollutants, but elevated microbial counts are typical (Gikas and Tsihrintzis 2012; Lee et al. 2012; Lye 2009; Thomas and Greene 1993). Physicochemical contaminants can be further reduced by implementing a first-flush diverter or similar pre-treatment device, depending upon runoff flow volume (see below for additional discussion); however, first-flush diverters and hydrodynamic pre-treatment devices generally have little impact on reducing microbial counts (Lee et al. 2012; Gikas and Tsihrintzis 2012).

Despite limited data describing reduction in stormwater contaminant concentrations in cisterns, urban runoff harvesting can greatly reduce pollutant loads to waterways if stored rainwater is infiltrated into surrounding soils using a low-flow drawdown configuration or when it is used for alternative purposes such as toilet flushing or vehicle washing. Urban runoff harvesting systems can also be equipped with filters and disinfection to further improve water quality.

3.1.3. Applications

A cistern typically holds several hundred to several thousand gallons of rainwater and can come in a variety of sizes and configurations. Figure 3-2 shows a typical above-ground plastic cistern and Figure 3-3 shows the same cistern with a wooden wrap. Cisterns can also be decorative, such as the one shown in Figure 3-4 at the Children's Museum in Santa Fe, New Mexico, or be placed below ground as shown in Figure 3-5. Cisterns can also be used in more innovative ways, such as part of the Oncenter War Memorial Arena Rainwater Reuse System Project in Syracuse, New York. The project captures rainwater and snow melt runoff from the War Memorial Arena roof, and uses the water for ice production and ice maintenance for sporting events and recreational activities at the arena (Onondaga County 2015).

Smaller cisterns (fewer than 100 gallons), or rain barrels, can be used on a residential scale (Figure 3-6). Collected water can be used to supplement municipal water for non-potable uses, primarily irrigation. Although useful for raising public awareness and for meeting basic irrigation needs, rain barrels do not typically provide substantial hydrologic benefits because they tend to be undersized relative to their contributing drainage area. Figure 3-7 shows rain barrels adequately sized for the contributing roof area.

Figure 3-2. Typical plastic cistern.


Figure 3-3. Wood wrapped cistern.


Source: Santa Fe, New Mexico Children's Museum

Figure 3-4. Decorative cistern.

Figure 3-5. Below-ground cistern.

Figure 3-6. Residential rain barrel.


Figure 3-7. Rain barrels adequately sized for contributing roof area.

3.2. Infiltration Galleries

An infiltration gallery is typically an excavated area containing voided space filled with plastic, concrete or metal structures with 95% void space, unlike rock or soil. It functions like a media filter but is implemented at a larger scale (Figure 3-8). Infiltration galleries can be designed as surface or subsurface units allowing for implementation adjacent to or below paved streets, parking lots, and buildings to provide initial stormwater detention or retention, and treatment of runoff. Such applications offer an ideal opportunity to minimize directly connected impervious areas in highly urbanized areas. In addition to stormwater management benefits, surface infiltration galleries provide green space and improve natural aesthetics in urban environments.


Figure 3-8. Subsurface infiltration gallery.

3.2.1. Hydrology

Subsurface infiltration galleries are underground storage areas that harvest and temporarily store stormwater runoff. The harvested runoff percolates through the bottom of the gallery and an approximately 1-foot amended, tilled native soil layer, which has an infiltration rate capable of draining the infiltration gallery within a specified design drawdown time (usually up to 72 hours). After the stormwater infiltrates through the amended surface, it percolates into the subsoil if site conditions allow for adequate infiltration and slope protection. If site conditions do not allow for adequate infiltration or slope protection, filtered water is directed toward a stormwater conveyance system or other stormwater runoff BMP via underdrain pipes. Infiltration galleries can be designed to help meet hydromodification criteria and also for conveyance of higher flows.

Infiltration galleries are designed to harvest a specified design volume and can be configured as online or offline systems. Online BMPs require an overflow system for managing extra volume created by larger storms. Offline BMPs do not require an overflow system but do require some freeboard (the distance from the overflow device and the point where stormwater would overflow the system) and a diversion structure.

If an underdrain is not needed because infiltration rates are adequate and slope is not a concern, the remaining stormwater passes through the soil media and infiltrates into the subsoil. Partial infiltration (approximately 20 to 50 percent, depending on soil conditions) can still occur when underdrains are present as long as an impermeable barrier is not between the soil media and subsoil. Partial infiltration occurs in such cases because some of the stormwater bypasses the underdrain and percolates into the subsoil (Hunt et al. 2006; Strecker et al. 2004).

3.2.2. Water Quality

Infiltration galleries are volume-based BMPs intended primarily for harvesting and infiltrating the design water quality treatment volume. These practices perform water quality functions through infiltration and runoff contact with soil media. Water quality improvement is accomplished through sedimentation, filtration, and adsorption associated with percolation of runoff through aggregate and underlying soil. Where site conditions allow, the volume-reduction and pollutant-removal capability of an infiltration gallery can be enhanced to achieve additional credit toward meeting any volume-reduction requirements by omitting underdrains and providing a gravel drainage layer beneath the soil media.

3.2.3. Applications

Infiltration galleries can be adapted and incorporated into many landscaped and paved settings. Common applications of surface infiltration galleries include parks, spreading grounds, groundwater recharge basins, and other open space areas. Common applications of subsurface infiltration galleries include parking lots, roadways, and park playing surfaces. Figure 3-9 shows an example of a surface infiltration gallery integrated into a park, and Figure 3-10 shows an example of a subsurface infiltration gallery using the StormTrap system.

Figure 3-9. Example of a surface infiltration gallery in a park.

Source: County of Los Angeles

Figure 3-10. Example of a subsurface infiltration gallery below a park.

4. Conceptual Design

Currently, approximately 300 acres drain through a 78-inch storm drain line that passes directly below the park and conveys upstream runoff out of the City and to the ocean. This conceptual design proposes alternative scenarios that harvest and utilize both the dry-weather and wet-weather flows found within the pipe network in an attempt to reduce the demand on potable water. These water sources will act as an offset to the irrigation potable demand of the park. The project proposes to install a pre-treatment device, storage tank, post-storage treatment train, and overflow infiltration gallery within the existing park footprint. The details of the proposed system, including the water quantity of the supply and demand, are outlined below.

The Santa Monica project partner American Rainwater Catchment Systems Association (ARCSA) provides technical guidance on finalizing rain harvesting systems including the pre-treatment, storage, final treatment, overflow and backup water supply components. Additional information on each of these components described in the subsequent sections can be found on the ARCSA website.[1]

4.1. Water Source & Demand Strategy

The schematic shown in Figure 4-1 summarizes the potential sources of water, potential diversion process, and potential end use elements. The primary sources of water are dry-weather and wet-weather runoff from upstream that is conveyed through the 78-inch storm drain pipe that travels underneath the park. The proposed layout of each element is found in Appendix A.

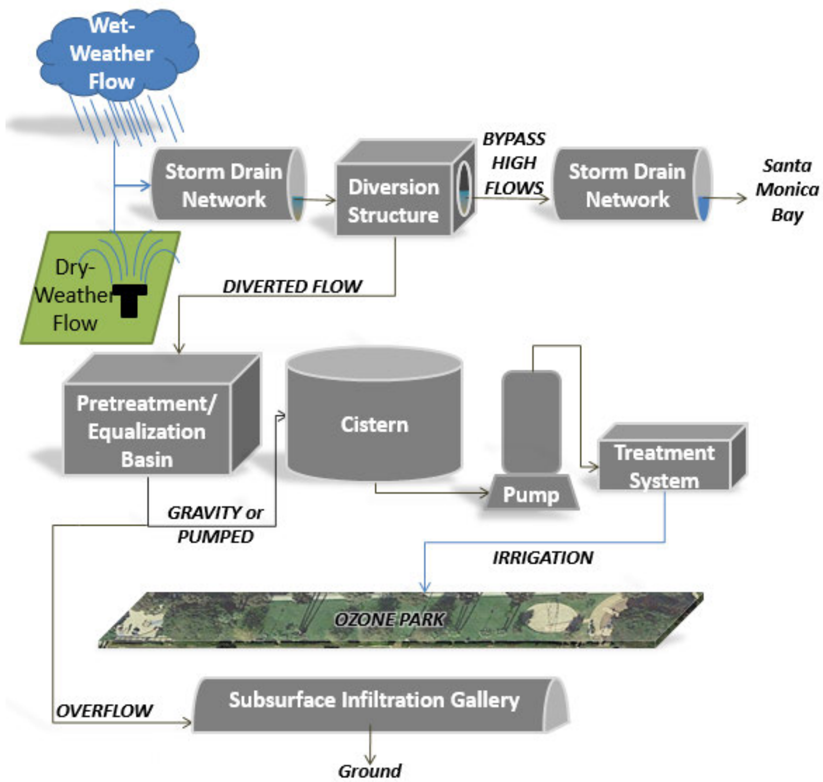

Figure 4-1. Flow diagram for water use strategy at Ozone Park.

4.1.1. Dry-weather Flow

Dry-weather flow results from excess irrigation, spills, construction sites, pool draining, car washing, and other outdoor water applications during dry periods of time, and then enters the storm drain network. This flow is typically observed on a daily basis and provides a baseline condition that can supply a

[1] http://www.arcsa.org

constant inflow of water into the proposed system. A 24-hour dry-weather distribution was desired to determine the typical daily total flow that is available for harvesting at this site. Continuous monitoring data was not available for the pipe beneath Ozone Park but a total of three dry-weather grab samples were taken at three different times over the course of several days. These samples allowed for scaling of typical dry-weather patterns that are observed within the Los Angeles County region. Continuous dry-weather monitoring for a watershed of nearly the same size and similar land use was performed in the City of Los Angeles and acts as the baseline dry-weather pattern (Tetra Tech 2015). The baseline was shifted and scaled to match the observed grab samples. The final 24-hour dry-weather distribution is shown below in Figure 4-2. The total daily dry-weather flow available was calculated to be 730 gallons per day.

The dry-weather pattern is likely to vary based on the seasons and the amount of rainfall received. For the purposes of this analysis, it was assumed that the daily dry-weather pattern observed would be consistent throughout the year due to limited monitoring data. Further dry-weather sampling can be performed during the full design process to determine the temporal distribution of the dry-weather flows through the multiple seasons of the year.

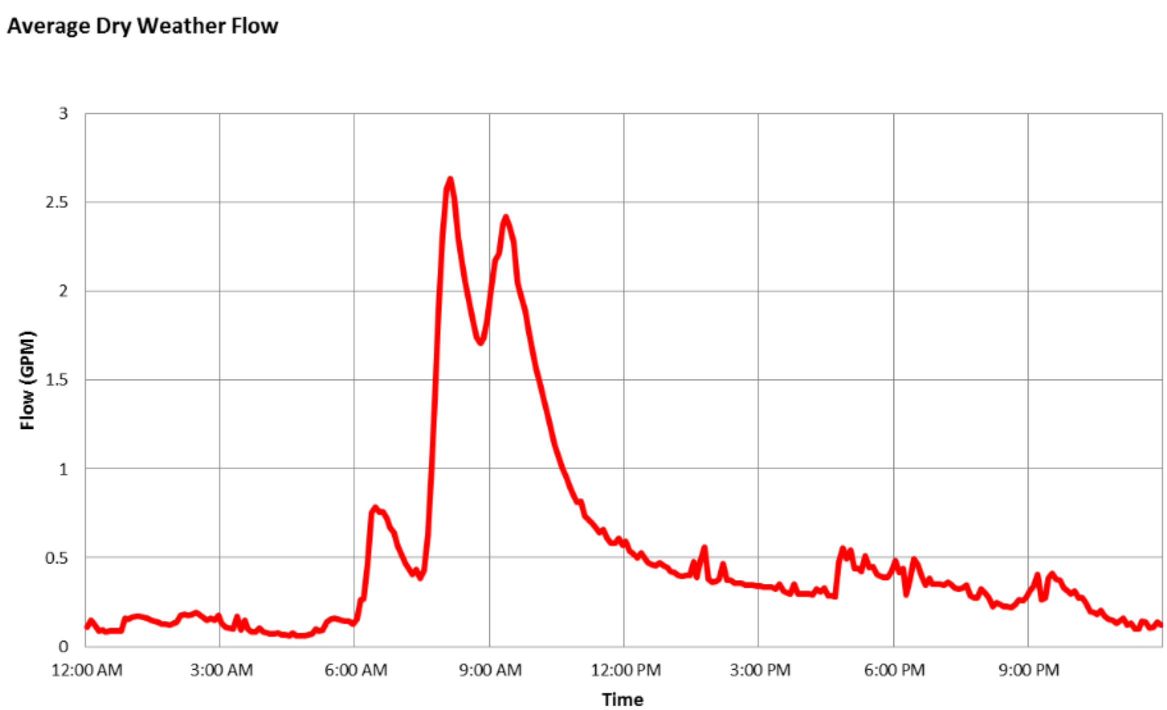

Figure 4-2. Typical dry-weather flow 24-hour distribution for Ozone Park.

4.1.2. Wet-weather Flow

The wet-weather flow varies significantly from storm to storm and from year to year. To analyze the proposed system and determine the potential inflow during wet weather, a continuous simulation period from October 1, 2001 to September 30, 2011 was used. The wet-weather information was obtained from the calibrated Los Angeles County Watershed Management Modeling System (WMMS) model (Tetra Tech 2010a; Tetra Tech 2010b). The runoff time series information from the WMMS model was multiplied by the associated land use and aggregated to determine the total anticipated flow rate within the pipe for every hour over the 10-year period. The runoff total for each month is displayed in Figure 4-3, while the average monthly runoff total is found in Table 4-1.

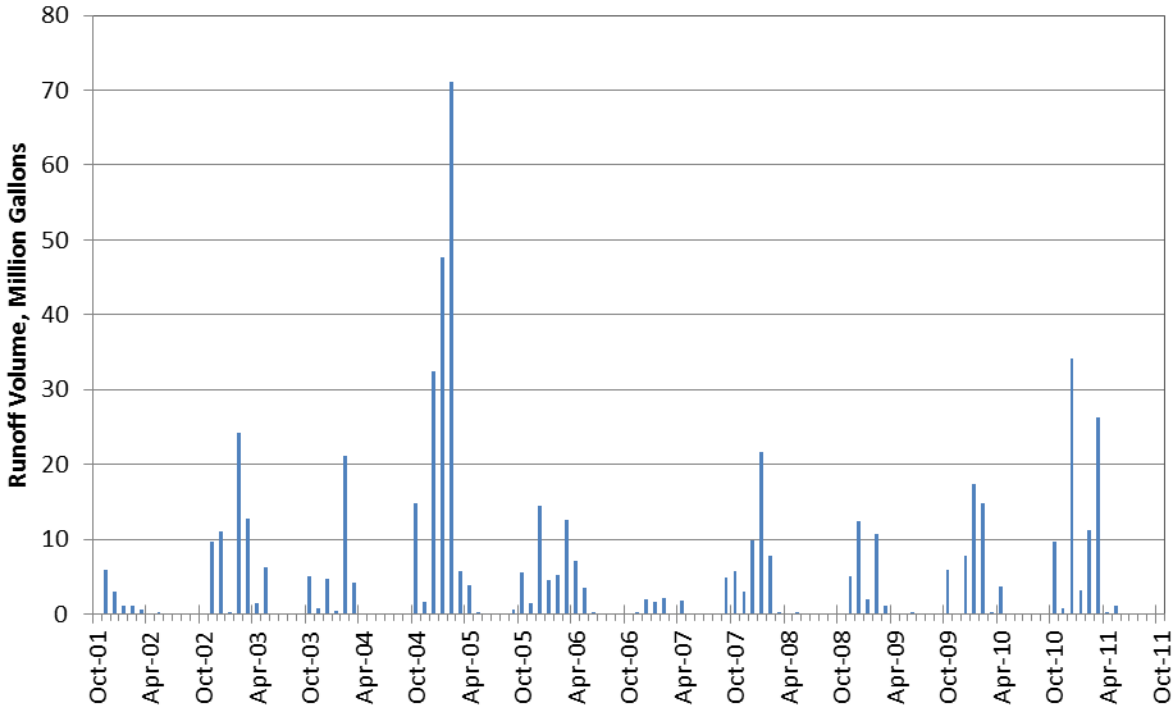

Figure 4-3. Continuous simulation runoff volume at Ozone Park from Oct 2001 to Sept 2011.

Table 4-1. Average monthly wet-weather volumes at Ozone Park.

Month	Average Monthly Runoff Volume, Million Gallons
January	9.94
February	16.97
March	6.33
April	1.80
May	1.08
June	0.03
July	0.00
August	0.00
September	0.56
October	4.65
November	2.87
December	13.17

4.1.3. Irrigation Demand

The current average daily irrigation demand for each month at Ozone Park was calculated using the water bill information from January 1, 2001 to December 31, 2013. The calculated daily and monthly demands by each month are shown in Table 4-2. Using these daily and monthly rates, the average annual irrigation demand was calculated to be 450,900 gallons.

Table 4-2. Average daily irrigation demands observed for each month at Ozone Park.

Month	Daily Irrigation Demand, Gallons	Monthly Irrigation Demand, Gallons
January	624	19,339
February	648	18,147
March	799	24,780
April	1,160	34,792
May	1,444	44,762
June	1,757	52,711
July	1,977	61,290
August	1,889	58,565
September	1,761	52,824
October	1,276	39,559
November	835	25,051
December	616	19,080

4.2. Diversion of Pipe Flows

To harvest the dry- and wet-weather flows within the storm drain, the runoff must be diverted out of the pipe, while still allowing for flood control during large storm events. Flows from the drainage pipe below the park would be routed through a pre-treatment system installed adjacent to the drainage pipe below the park. The flows would be routed through a primary treatment and effluent distribution system providing treatment, as well as a consistent irrigation source for the park.

4.2.1. Diversion Structure

A diversion structure is needed to divert stormwater from the existing 78-inch storm drain under the park to the cistern and pump station for irrigation. The diversion structure would be located at the existing maintenance hole found on the east end of the park. The invert elevation of the existing pipe is approximately 28.38 feet and is around 13 feet deep as measured from the surface per the City as-builts.

To divert the water from the drainage pipe, the existing maintenance hole would be upgraded with a passive low-flow diversion system consisting of a weir and a diversion pipe similar to the schematic shown in Figure 4-4. The floor of the junction box would be lowered in elevation to divert the water away from the main pipe and into the smaller diversion pipe. The existing pipe would remain at the current elevation for the incoming and outgoing pipe to ensure flood control. It is recommended to divert the flow from the side of the pipe, rather than the floor of the pipe, to ensure that sediment and trash build up will not block the diversion.

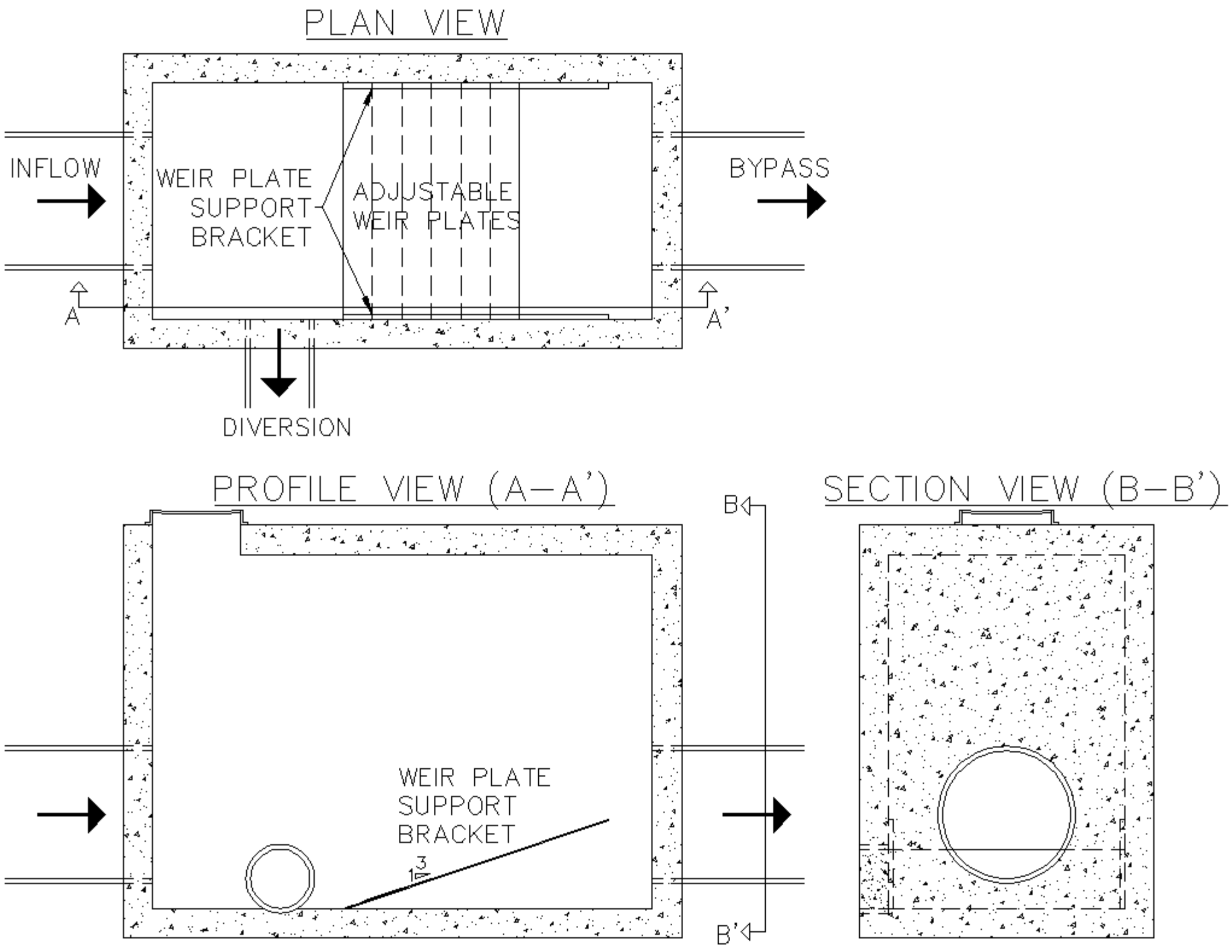

Figure 4-4. Typical diversion structure.

4.2.2. Pre-treatment/Equalization Basin

The influent runoff is anticipated to have variable pollutant concentrations and flow rates. Flow would pass from the diversion structure to a pre-treatment/equalization basin. This basin will act as a sedimentation chamber and remove many of the gross solids found within the runoff.

For smaller cistern installations, the transfer of the water from the pre-treatment/equalization basin to the cistern can be done through gravity or pumping. For larger cistern sizes, gravity flow is recommended from the diversion through the equalization basin and into the cistern. The costs of excavation versus the costs of pump operations need to be weighed to determine the most economical solution.

Multiple pre-treatment options exist including but not limited to vortex separators, sand filters, and baffle boxes.

4.3. Storage, Overflow, Treatment and Irrigation

The Rainwater Harvester (RH) model[2] simulates the performance of rainwater harvesting systems using historical precipitation data to evaluate a daily or hourly water balance. The model includes options for

[2] *http://www.bae.ncsu.edu/stormwater/downloads.htm*

daily or hourly rainfall input files, daily constant supplies, customized water demand inputs, and various hydrologic performance output metrics.

Several input scenarios were modeled to evaluate the performance of the Ozone Park runoff harvesting system for offsetting the turf grass irrigation demand. Scenario 1 investigates harvesting only the dry-weather flows and then adds the wet-weather flows for the minimum tank size of 10,000 gallons. Scenario 2 increases the cistern size to investigate intermediate options. Scenario 3 determines the minimum tank size needed to harvest wet-weather flows for 100 percent potable offset.

4.3.1. Subsurface Cistern

To provide different sizing options, three alternative scenarios were developed to evaluate the impact of different cistern sizes.

Scenario 1 –10,000 Gallon Cistern, Dry-weather flows only

Dry-weather flow acts as the primary water source for potable water offset. The dry-weather information calculated in Section 4.1.1 was used in the RH model to determine the maximum tank size required to meet the irrigation demand. It was determined that a cistern of 10,000 gallons will harvest all of the dry-weather flow and reduce the potable water demand by 60 percent. This tank size ensures that storage will be available for months where the dry-weather flow exceeds the irrigation demand (December, January, and February) and will carry it over to later months for use.

The wet-weather flows will also be partially diverted to the 10,000 gallon cistern when there is available capacity. The wet-weather flows will provide additional water supply when dry-weather flows do not fill the cistern. The model results show that when wet-weather is added to the 10,000 gallon cistern that total **potable water offset of 64 percent** could be achieved. See Figure 4-9 for a general site layout for Scenario 1.

Scenario 2 –100,000 Gallon Cistern

For Scenario 2, the cistern size was dramatically increased to determine if a point of diminishing returns was easily identified where potable offset versus tank size began to shrink significantly. The cistern size compared to the potable water offset displayed a linear relationship and the point of diminishing returns was identified as the 100 percent offset tank size. The point of diminishing returns is defined as the point at which the potable offset benefit decreases relative to the tank size. Because the diminishing point was not significant due to the linear nature, an intermediate tank size was selected for analysis. Interest was expressed in a 100,000 gallon tank and the model results show that a cistern of this capacity can provide a **potable water offset of 86 percent**. See Figure 4-10 for the site layout for the 100,000 gallon scenario.

Scenario 3 –180,000 Gallon Cistern

To meet the goal of maximum potable water offset, Scenario 3 was used to determine the minimum cistern size required to offset 100 percent of the potable water demand. This tank size will maintain enough water through the summer by capturing significant storm volumes during the wet winter months (Figure 4-3). **The minimum tank size to offset the potable water demand by 100 percent was identified as 180,000 gallons**. Figure 4-5 shows the multiple cistern size options that were compared in the model. The maximum potable water offset size was identified as the significant point of diminishing returns due to the linear nature of the relationship but sizing selection should be determined by the desired potable water offset. See Figure 4-11 for the site layout for the 180,000 gallon scenario.

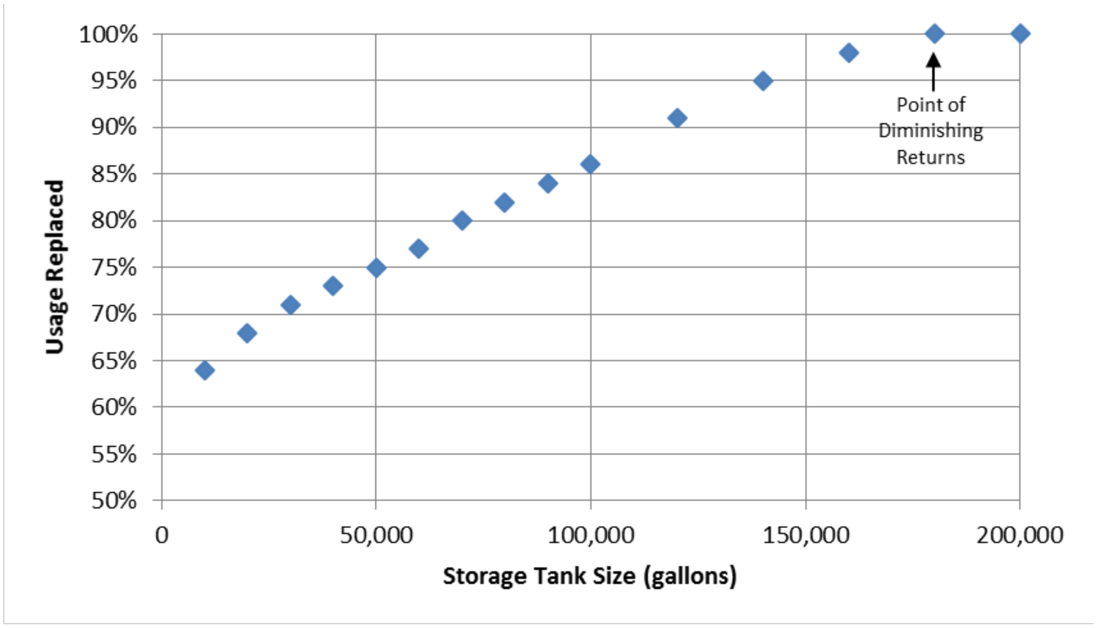

Figure 4-5. Wet-weather cistern sizing versus potable supply offset for Ozone Park.

The results of the three scenarios are summarized in Table 4-3. Model inputs and outputs are shown in Appendix B.

Table 4-3. Scenario cistern size results at Ozone Park.

Model Scenario	Cistern Size, Gallons	Annual Cistern Usage, Gallons	Irrigation Offset	Dry Frequency
Scenario 1 - Dry	10,000	267,115	60%	62%
Scenario 1 - Wet	10,000	286,968	64%	48%
Scenario 2	100,000	386,324	86%	20%
Scenario 3	180,000	448,504	100%	0%

4.3.2. Overflow Infiltration Gallery

During dry- and wet-weather events, if the cistern system is full, excess flows will be diverted to an underground infiltration gallery. The gallery will provide groundwater recharge[3] and additional water quality benefits to meet regional water quality standards. It is anticipated that during abnormally high dry-weather flows and small storms that the overflow will be utilized. Once the underground infiltration gallery is full during high-flow events, runoff will continue through the existing 78-inch pipe to provide flood management and will not overwhelm the diversion system.

To optimize the size of the infiltration gallery, different size basins for each of the cistern scenarios were modeled in the EPA System for Urban Stormwater Treatment and Analysis IntegratioN (SUSTAIN)

[3] Infiltrated water will enter the Coastal portion of the Santa Monica Basin. The groundwater is greater than 10 feet below the surface and sufficient filtration will occur to prevent the migration of pollutants (USEPA 2013). The basin is not actively used for drinking water but feasibility studies have been performed to identify potential locations for pumping. The infiltrated water will also act to supplement the water table in preventing seawater intrusion from occurring (MWD 2007; LADWP 2011).

model[4] using the 10-year, continuous simulation data to measure the overall impact on the water quality. For this particular region, zinc has been identified as a pollutant of concern and was used as the basis for removal comparison.

To limit the excavation depths to 20 feet, a total maximum depth of 4 feet was assumed possible for the infiltration gallery. Using this depth, the maximum footprint and volume were found to be 5,400 square feet and 21,600 cubic feet (0.5 acre feet) respectively. Due to the small park footprint and the large drainage area runoff volumes, pollutant removal is limited. It is recommended to make the infiltration gallery as large as feasibly possible to have the greatest water quality impact, as it may still be cost-effective even at the maximum footprint identified. Results are shown in Table 4-4.

The next analysis looks at the impact of the diversion structure on the overall water quality. The first analysis assumes that all of the runoff can be diverted to the BMP (an online system – all pipe flow will enter the BMP) when in reality, the system will be designed and implemented as an offline system with a design flow rate diverted towards the BMP. For Ozone Park, the peak flow rate from the online model was found to be 395.6 cfs and is likely not able to be harvested. As the diversion flow rate is decreased from the peak flow rate of the online system, the overall water-quality impact of the BMP is reduced, even when the infiltration gallery is the same size. This is due to the fact that access to the higher flow and more pollutant-laden storms is not possible thus decreasing the total load reduction and increasing bypass flows. Based on past project experience, a design diversion rate of 20 cfs was assumed feasible, and the results comparing the online versus offline zinc reductions for the maximum footprint available are shown in Table 4-5.

The next analysis performed allows for nearly unlimited infiltration gallery sizes to determine the point at which the cost begins to outweigh the benefit (the point of diminishing returns). These sizes far exceed the identified maximum available footprint and volume. However, the infiltration gallery volume can be increased through greater excavation or an increase in footprint size. The point of diminishing returns varies based on the diversion rate analysis that was performed prior to this analysis. As the diversion rate is decreased, the point of diminishing returns identifies smaller BMP volumes. Results are shown in Table 4-6 comparing the identified point of diminishing return for the online, full diversion system and the offline, 20 cfs design flow diversion system.

An additional analysis was performed to identify the size required to harvest and treat the 85th percentile, 24-hour design storm. Per the MS4 permit, the 85th percentile event is identified as the starting point for water quality BMP sizing. The design storm analysis distributes a hypothetical, typical storm over a 24-hour period, and the BMP is sized just large enough to ensure full harvesting with no overflow. The 10-year continuous time period is then modeled through the identified BMP size to measure the overall, long-term expected water quality impacts. Results are shown in Table 4-7. The required footprints are not possible at this location, and the required volume will be difficult to achieve even with significant excavation efforts due to the lack of available space. Creative measures to utilize greater depths or areas within the right-of-way can be further explored to discover feasible options if harvesting of the 85th percentile storm is desired.

Figure 4-6, Figure 4-7, and Figure 4-8 graphically display the total infiltration gallery BMP volume versus the percent load reduction results of the four wet-weather analyses for each of the three identified scenarios. Two curves relating the BMP volume to the average annual zinc reduction for each scenario are presented; one for the online, full diversion situation (orange line) and the other for the offline,

[4] *http://www2.epa.gov/water-research/system-urban-stormwater-treatment-and-analysis-integration-sustain*

design diversion situation (blue x). These cost-effectiveness curves can be used to approximate the anticipated water quality impact for any BMP volume ranging from 0 to 20 acre-feet. The assumed maximum BMP volume (0.5 acre-feet) is represented as a vertical line showing the maximum feasible BMP volume that can be constructed at the site. The cost-effectiveness curves also illustrate the optimal points (point of diminishing returns) found for both diversion situations. The final point shown on the curves is the BMP size required to harvest the 85th percentile storm. The optimal points and the 85th percentile volume far exceed the maximum feasible volumes for the site and are not likely to be achievable.

Table 4-4. Infiltration gallery results at Ozone Park (maximum available footprint & full diversion).

Model Scenario	Cistern Size, Gallons	Maximum BMP Volume, ac-ft	Maximum BMP Zinc Reduction		Maximum BMP Volume Reduction	
			Load, lbs	Percent	Volume, ac-ft	Percent
Scenario 1	10,000	0.5	35.2	29.2%	7.3	4.2%
Scenario 2	100,000	0.5	36.7	30.4%	7.6	4.3%
Scenario 3	180,000	0.5	38.0	31.5%	7.8	4.4%

Table 4-5. Infiltration gallery results at Ozone Park (maximum available footprint & 20 cfs diversion).

Model Scenario	Cistern Size, Gallons	Maximum BMP Volume, ac-ft	Maximum BMP Zinc Reduction		Maximum BMP Volume Reduction	
			Load, lbs	Percent	Volume, ac-ft	Percent
Scenario 1	10,000	0.5	12.3	10.2%	7.4	4.1%
Scenario 2	100,000	0.5	13.7	11.3%	7.6	4.3%
Scenario 3	180,000	0.5	14.8	12.3%	7.9	4.4%

Table 4-6. Infiltration gallery optimal size (point of diminishing returns) analysis at Ozone Park.

Model Scenario	Cistern Size, Gallons	Optimal BMP Volume, ac-ft	Optimal BMP Annual Zinc Reduction	Optimal BMP Volume, ac-ft	Optimal BMP Annual Zinc Reduction
		Full Diversion (395.6 cfs)		Design Diversion (20 cfs)	
Scenario 1	10,000	12.53	79%	9.02	34%
Scenario 2	100,000	12.53	79%	8.46	34%
Scenario 3	180,000	12.69	79%	8.26	34%

Table 4-7. Infiltration gallery size 85th percentile analysis results at Ozone Park.

Model Scenario	Cistern Size, Gallons	85th Percentile BMP Area, ac	85th Percentile BMP Volume, ac-ft
Scenario 1	10,000	2.72	10.9
Scenario 2	100,000	2.65	10.6
Scenario 3	180,000	2.64	10.6

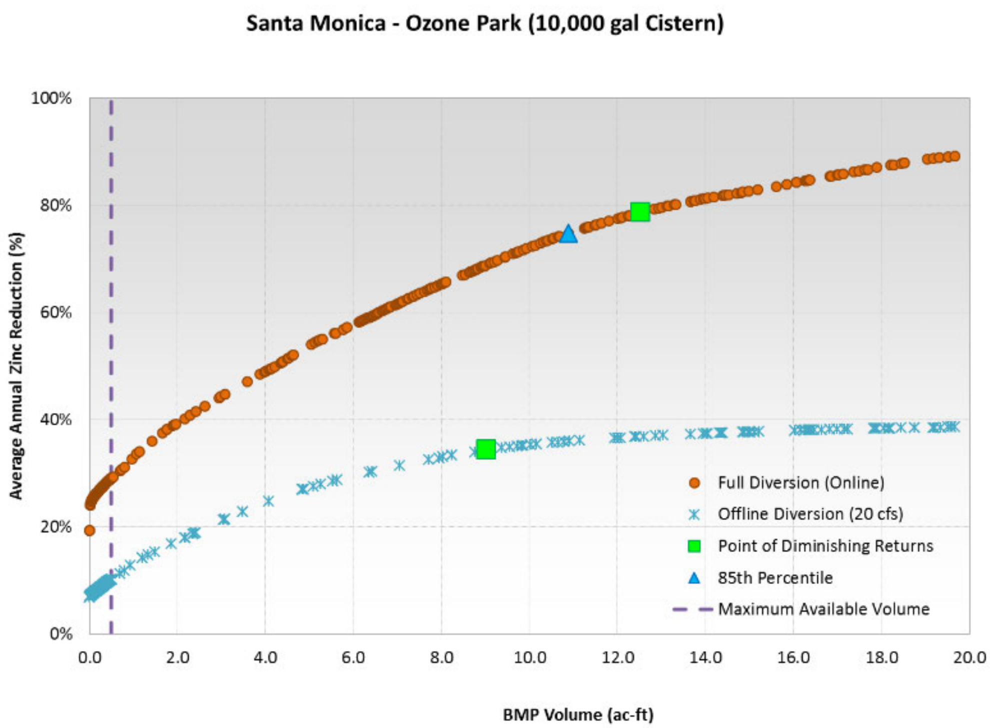

Figure 4-6. Infiltration gallery sizing optimization curve for Ozone Park (Scenario 1).

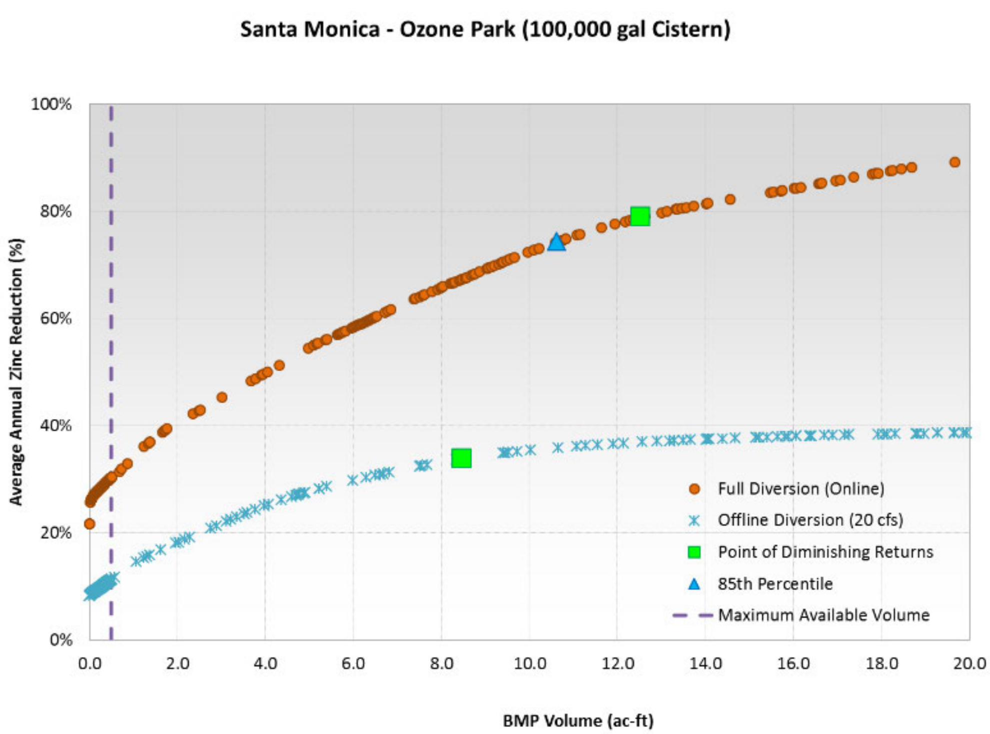

Figure 4-7. Infiltration gallery sizing optimization curve for Ozone Park (Scenario 2).

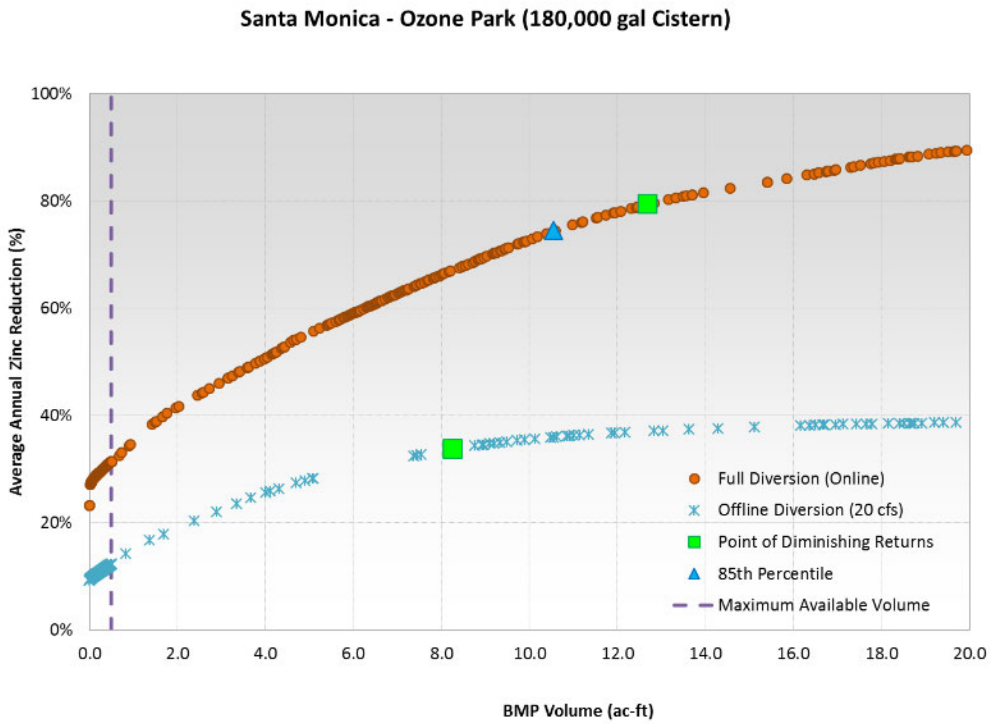

Figure 4-8. Infiltration gallery sizing optimization curve for Ozone Park (Scenario 3).

Figure 4-9. Scenario 1 (10,000 gallon) site layout at Ozone Park site.

Figure 4-10. Scenario 2 (100,000 gallon) site layout at Ozone Park site.

Figure 4-11. Scenario 3 (180,000 gallon) site layout at Ozone Park site.

4.3.3. Stormwater Pump Station

A pump station is required to lift the stormwater from the cistern to the treatment system and subsequent use. To size and recommend a pump, the flows were assumed to peak at 200 gallons per minute and a need for 200 feet of total dynamic head to provide 75 to 90 psi of working pressure. The pump will need to be approximately 40 horsepower.

A non-clogging submersible pump is recommended for this application. These pumps provide reliability while functioning under adverse/harsh conditions such as that expected to be encountered from non-potable water applications. They also are designed to pass solids such as dirt, grit, sand, trash, and debris that would be expected to pass through the diversion bar screens. Finally, they can easily be removed for maintenance purposes. These pumps can operate across a multitude of head and flow conditions to ensure operational efficiencies. These pumps can also be installed with variable-drives to allow for pumping under different flow conditions.

4.3.4. Water Treatment System

The Los Angeles County Department of Public Health (CDPH) prepared a guidance document titled the *Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-Potable Use* (2011). These guidelines are based on public health risks, with Tier I being low risk and Tier IV being higher risk. Based on the upstream land use and the scale of the collection system, Ozone Park falls under the Tier IV requirements and standards (runoff that includes agricultural, industrial, manufacturing, and transportation sources). The non-potable use guidelines applicable to the BMPs used in this project are as follows:

- Requirements
    - Install using manufacturer's instructions and local agency requirements.
    - Include an overflow and screened inlets to prevent vector intrusion.
    - Require prior plan review by the CDPH and local Building & Safety Department.
    - Spray irrigation allowed only when negligible human exposure (i.e., at night).
    - Offsite source waters generally result in the need for a storm drain diversion, stored water recirculation/disinfection, pump station, supplemental domestic water, and dedicated backflow preventer.
    - Implement stormwater monitoring plan
        - Sample three storms annually, analyze for metals, volatiles, and semi-volatiles.
        - Prepare and maintain onsite an annual water quality summary.
        - After nine sampling events, CDPH will assess and notify if sampling required.
        - If Tier IV water is present, test quarterly and compare to California Maximum Contaminant Levels (MCL) and California Toxics Rule (CTR).
            - If CTR human health standards are exceeded, cease distribution and notify enforcement agency.
            - If MCLs, but not CTR human health standards, are exceeded, then night time spray irrigation with Tier IV water allowed.
- Water Uses
    - Drip, subsurface, or spray irrigation, non-interactive outdoor water feature, street sweeping, dust control.
- Water Quality Standards
    - Not applicable for drip and subsurface irrigation.
    - All other water uses (standard applied at point of use).

        - Total coliforms: <10,000 MPN/100 mL.
        - Fecal coliforms: <400 MPN/100 mL.
        - Enterococcus: <104 MPN/100 mL.
- Treatment Process
    - Prescreening
    - Water uses other than drip and subsurface irrigation.
        - Screening/sedimentation device pre-treatment for offsite sources.
        - Disinfection by chlorination or equivalent.
        - Street sweeping applications require retention/sedimentation.

The CDPH guidelines identify the treatment process components as prescreening, sedimentation, and disinfection as the minimum allowable standard. Trash and other large solids are removed through a trash screen on the equalization basin. The screen also acts to ensure the pumps will not be fouled. The equalization basin also serves a pre-treatment function by removing gross solids and settling out some sediment and other sediment-bound pollutants.

Three potential disinfectants are available to treat the collected flow prior to spray irrigation in the park: chlorination, ultraviolet, and ozonation. All systems are required to treat at around 200 gallons per minute to meet the irrigation demands at Ozone Park. Chlorine is a common disinfectant and is available in a gaseous, solid (calcium hypochlorite), or liquid phase (sodium hypochlorite). Safety concerns favor the use of liquid sodium hypochlorite or solid calcium hypochlorite.

Ultraviolet (UV) disinfection can be used to meet the CDPH standards. UV uses irradiation that inactivates waterborne pathogens without the use of chemicals. The effectiveness of a UV disinfection system depends on the characteristics of the water (e.g., turbidity), the intensity of UV radiation, the amount of time the microorganisms are exposed to the radiation, and the reactor configuration.

Ozonation is another disinfection method used to meet the bacteriological standards. Ozone causes a chemical reaction which inactivates waterborne pathogens. Ozone is a highly unstable molecule and is required to be generated on-site, as it cannot be stored. The ozone generation systems require high voltage electricity to pass through an oxygen source.

4.3.5. Irrigation System

The park has an existing spray irrigation system that will be disconnected from the potable water line and re-connected to the cistern irrigation pumps. Water will be drawn from the cistern, pass through the treatment system, and then be immediately irrigated. To ensure a sufficient water supply, potable water will act as a supplement and will be connected post-final treatment through 3-way valves and a reduced pressure zone device. This ensures that potable water is not double treated. This meets the Los Angeles County Department of Public Health requirement to maintain a 2-inch air gap between a potable and non-potable source.

An alternative to the existing spray irrigation system is a subsurface drip line that would directly deposit water to the root systems of the plants. The subsurface irrigation system does not require the same level of water treatment as spray irrigation and can be used with minimal treatment. Installation of the subsurface irrigation system would require removal of the existing park surface and replacement. The existing spray system currently in place requires only minor surface impacts.

4.4. Cost Estimates

Planning level cost estimates for Scenarios 1, 2, and 3 are provided in Table 4-8, Table 4-9, and Table 4-10 respectively.

Table 4-8. 10,000 gallon cistern treatment cost (Scenario 1).

Item No.	Description	Quantity	Unit	Unit Cost	Total
	Planning/Design				
1	Planning (10% of subtotal)	1	LS	--	$126,000
2	Permits/Studies	1	LS	--	$15,000
3	Design (15% of construction total)	1	LS	--	$245,700
	Construction				
4	Temporary construction entrance	1	EA	$2,500	$2,500
5	Temporary construction fence	400	LF	$2.50	$1,000
6	Dewatering	1	LS	$368	$368
	Cistern & Irrigation				
7	Excavation	1,350	CY	$45	$60,750
8	Diversion structure	1	EA	$100,000	$100,000
9	Pre-treatment system	1	EA	$4,500	$4,500
10	Hydraulic restriction layer (30 mil liner)	1,000	SF	$0.50	$500
11	Cistern	10,000	Gal	$1.50	$15,000
12	Bedding	29	CY	$50	$1,450
13	Stormwater lift station/wet well (200 gpm)	1	EA	$200,000	$200,000
14	Water treatment system (UV)	1	EA	$300,000	$300,000
15	Landscaping	8,000	SF	$2	$16,000
16	Electrical/control integration	1	EA	$3,000	$3,000
	Infiltration Gallery				
17	Excavation	6,725	CY	$45	$302,625
18	Structure	161,568	Gal	$1.50	$242,352
19	Bedding	200	CY	$50	$10,000
	Subtotal				$1,260,045
20	Mobilization (10% of subtotal)				$126,000
21	Bonds and Insurance (5% of subtotal)				$63,000
22	Construction contingency (15% of subtotal)				$189,010
	Construction Total				$1,638,055
	Project Total				$2,024,755
	Total Estimate (Rounded)				$2,030,000

Table 4-9. 100,000 gallon cistern treatment cost (Scenario 2).

Item No.	Description	Quantity	Unit	Unit Cost	Total
	Planning/Design				
1	Planning (10% of subtotal)	1	LS	--	$161,000
2	Permits/Studies	1	LS	--	$15,000
3	Design (15% of construction total)	1	LS	--	$314,200
	Construction				
4	Temporary construction entrance	1	EA	$2,500	$2,500
5	Temporary construction fence	550	LF	$2.50	$1,375
6	Dewatering	1	LS	$368	$368
	Cistern & Irrigation				
7	Excavation	5,520	CY	$45	$248,400
8	Diversion structure	1	EA	$100,000	$100,000
9	Pre-treatment system	1	EA	$4,500	$4,500
10	Hydraulic restriction layer (30 mil liner)	5,350	SF	$0.50	$2,675
11	Cistern	100,000	Gal	$1.50	$150,000
12	Bedding	200	CY	$50	$10,000
13	Stormwater lift station/wet well (200 gpm)	1	EA	$200,000	$200,000
14	Water treatment system (UV)	1	EA	$300,000	$300,000
15	Landscaping	16,650	SF	$2	$33,300
16	Electrical/control integration	1	EA	$3,000	$3,000
	Infiltration Gallery				
17	Excavation	6,725	CY	$45	$302,625
18	Structure	161,568	Gal	$1.50	$242,352
19	Bedding	200	CY	$50	$10,000
	Subtotal				$1,611,095
20	Mobilization (10% of subtotal)				$161,1100
21	Bonds and Insurance (5% of subtotal)				$80,550
22	Construction contingency (15% of subtotal)				$241,660
	Construction Total				$2,094,415
	Project Total				$2,584,715
	Total Estimate (Rounded)				$2,590,000

Table 4-10. 180,000 gallon cistern treatment cost (Scenario 3).

Item No.	Description	Quantity	Unit	Unit Cost	Total
	Planning/Design				
1	Planning (10% of subtotal)	1	LS	--	$189,400
2	Permits/Studies	1	LS	--	$15,000
3	Design (15% of construction total)	1	LS	--	$369,400
	Construction				
4	Temporary construction entrance	1	EA	$2,500	$2,500
5	Temporary construction fence	700	LF	$2.50	$1,750
6	Dewatering	1	LS	$368	$368
	Cistern & Irrigation				
7	Excavation	8,650	CY	$45	$389,250
8	Diversion structure	1	EA	$100,000	$100,000
9	Pre-treatment system	1	EA	$4,500	$4,500
10	Hydraulic restriction layer (30 mil liner)	9,250	SF	$0.50	$4,625
11	Cistern	180,000	Gal	$1.50	$270,000
12	Bedding	341	CY	$50	$17,050
13	Stormwater lift station/wet well (200 gpm)	1	EA	$200,000	$200,000
14	Water treatment system (UV)	1	EA	$300,000	$300,000
15	Landscaping	23,110	SF	$2	$46,220
16	Electrical/control integration	1	EA	$3,000	$3,000
	Infiltration Gallery				
17	Excavation	6,725	CY	$45	$302,625
18	Structure	161,568	Gal	$1.50	$242,352
19	Bedding	200	CY	$50	$10,000
	Subtotal				$1,894,240
20	Mobilization (10% of subtotal)				$189,420
21	Bonds and Insurance (5% of subtotal)				$94,710
22	Construction contingency (15% of subtotal)				$284,140
	Construction Total				$2,462,510
	Project Total				$3,036,310
	Total Estimate (Rounded)				$3,040,000

The cistern and subsequent use for irrigation will reduce demand for potable. This resulting cost savings is calculated using the City of Santa Monica water rate of $3.57 per hundred cubic feet. The results are shown in Table 4-12.

Table 4-11. Potable water savings through rainwater harvesting at Ozone Park.

Model Scenario	Cistern Size, Gallons	Average Annual Irrigation Offset, HCF	Average Annual Cost Savings
Scenario 1	10,000	384	$1,375
Scenario 2	100,000	516	$1,850
Scenario 3	180,000	600	$2,150

To help compare the three scenarios, the cost efficiency for irrigation, infiltration, and zinc removal were calculated. The total cost was divided by the annual totals for irrigation from the system, the volume infiltrated, and the total zinc removal. The infiltration gallery remains constant through all three scenarios, and the primary cost difference is the cistern size and associated excavation. The values in Table 4-13 give a side-by-side comparison of the benefit received per each dollar spent.

Table 4-12. Cost efficiency at Ozone Park.

Model Scenario	Cistern Size, Gallons	Cost per Gallon of Irrigation	Cost per Gallon of Infiltration	Cost per Pound Zinc Removed
Scenario 1	10,000	$7.07	$0.85	$164,568
Scenario 2	100,000	$6.70	$1.04	$189,787
Scenario 3	180,000	$6.78	$1.19	$205,389

4.5. Operation and Maintenance

Routine operation and maintenance is critical for the long-term performance of any green infrastructure practice. Specific recommendations for scheduling inspection and maintenance for cisterns and subsurface infiltration galleries are presented in the following sections.

4.5.1. Subsurface Cistern

General maintenance activities for subsurface cisterns are similar to the routine periodic maintenance for on-site drinking water wells. The primary maintenance requirement is to inspect the tank and distribution system and test any backflow-prevention devices. Cisterns also require inspections for clogging and structural soundness twice a year, including inspection of all debris and vector control screens. If a pre-treatment device is used, it should be dewatered and cleaned between each significant storm event. Self-cleaning filters and screens can help prevent debris from entering the cistern and reduce maintenance. Accumulated sediment in the tank must be removed at least once a year.

Table 4-13. Inspection and maintenance tasks for cisterns.

Task	Frequency	Maintenance Notes
Dry season inspection	One time per year	Inspect once during the dry season to ensure volume capacity. Clean if required.
Wet season inspection	Monthly during wet season	Monthly during the wet season to ensure volume capacity
Trash well cleaning	Dry season – 1 time Wet season – 3 times	Dry season cleaning to happen just before the start of the wet season
Pump well cleaning	Dry season – 1 time Wet season – 3 times	Dry season cleaning to happen just before the start of the wet season.
Pump maintenance	As needed	
Valve maintenance	As needed	
Control panel maintenance	As needed	

4.5.2. Subsurface Infiltration Gallery

General maintenance activities for subsurface infiltration galleries are similar to the routine maintenance for cisterns. The primary maintenance requirement is to inspect the facility for clogging and structural soundness. Accumulated sediment removal might be required on an annual basis to ensure proper infiltration function.

Table 4-14. Inspection and maintenance tasks for subsurface infiltration galleries.

Task	Frequency	Maintenance Notes
Dry season inspection	One time per year	Inspect once during the dry season to ensure volume capacity. Clean if required.
Wet season inspection	Monthly during wet season	Monthly during the wet season to ensure volume capacity.
Vault cleaning	Dry season – 1 time Wet season – 3 times	Dry season cleaning to happen just before the start of the wet season.
Valve maintenance	As needed	

5. Policy Approach/Permits

Consultation with regulatory agencies and acquisition of permits is required before the project components can be constructed. The following summarizes the local regulatory permits and approvals relevant to the Ozone Park project.

California Environmental Quality Act (CEQA)

A Mitigated Negative Declaration may be required due to the potential for impacts that will occur during construction and operation.

State Water Resources Control Board – Construction General Permit

The State Water Resources Control Board adopted the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). The goal of the CGP is to prevent polluted discharges from entering the storm drain system and receiving waters during construction activities. The CGP requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP) which specifies BMPs that will prevent construction pollutants from contacting stormwater and with the intent of keeping products of erosion from moving offsite into receiving waters, eliminating or reducing non-stormwater discharges to storm sewer systems, and performing inspections of all BMPs.

Regional Water Quality Control Board, Los Angeles Region

The Regional Water Quality Control Board issues discharge permits to surface waters in compliance with the Clean Water Act and NPDES program.

In October 2012, the Los Angeles Regional Water Quality Control Board adopted the Los Angeles County Municipal Separate Storm Sewer System (MS4) Permit. The MS4 Permit includes extensive planning and construction requirements to manage the post-construction site runoff. The final plans require assurances that the appropriate BMPs are incorporated to address stormwater pollution prevention goals. For Ozone Park, the project retrofit itself includes implementation of stormwater BMPs.

South Coast Air Quality Management District

Construction activities in the South Coast Air Basin are subject to the South Coast Air Quality Management District's Rule 403, which requires applicable operations to prevent, reduce, or mitigate fugitive dust emissions. All construction must incorporate best available control measures included in Table 1 of Rule 403. During the active construction phase, the contractor would be required to implement dust control measures to ensure compliance with Rule 403.

County of Los Angeles

Structures that have the potential to alter storm drain conveyance capacities or change the timing of accumulated flows are required to be reviewed and approved by the Los Angeles County Flood Control District (LACFCD) Design Division. An Encroachment Permit to disturb the storm drain is also required by the Los Angeles County Department of Public Works Construction Division. It is anticipated that this project would require the LACFCD review and the Encroachment Permit.

City of Santa Monica (building permit, tree removal/relocation, grading, storm drain)

Various City of Santa Monica departments are likely to require some or all of the following permits: building permit, tree removal/relocation, grading, and storm drain permit. Collaboration with other City departments should be conducted before construction begins.

6. Conclusion

With Southern California facing water supply challenges, innovative solutions are necessary to reduce and replace potable water demand. Rain harvesting and use is one approach to help the City of Santa Monica achieve its water independence goals and build resiliency to drought. The proposed Ozone Park stormwater and dry-weather runoff harvesting project would provide sufficient on-site irrigation supply and help contribute to the City's regional requirement to improve outfall water quality. The project builds on the City's efforts to install similar green infrastructure on both private and public parcels, and to achieve its water self-sufficiency goal by 2020.

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Appendix A: Site Plan and Details

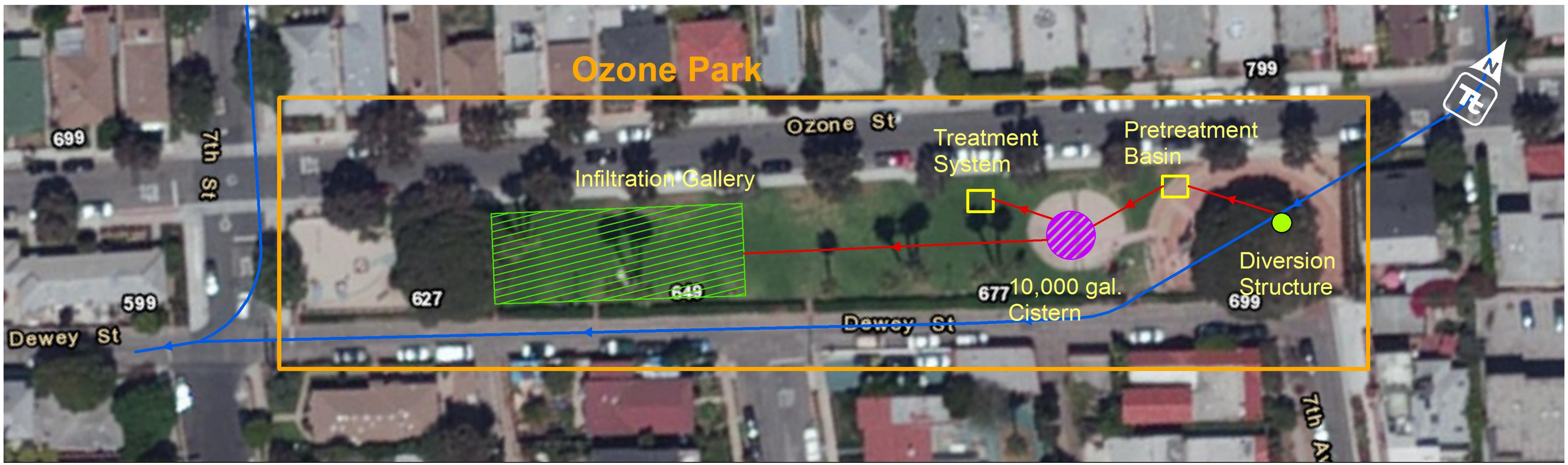
Ozone Park Conceptual Design Plan
CONCEPTUAL PLAN–EXHIBIT A.1
SITE: Ozone Park

Site Location				Watershed Characteristics	
AIN	4287033900	Latitude	34° 0'5.71"N	Drainage Area, acres	307
Major Watershed	Santa Monica Bay Watershed	Longitude	118°28'19.48"W	LA County Soil Class	013
Street Address	Ozone St. & 7th St. CA, 90405	Landowner	Santa Monica	Total Impervious, %	65

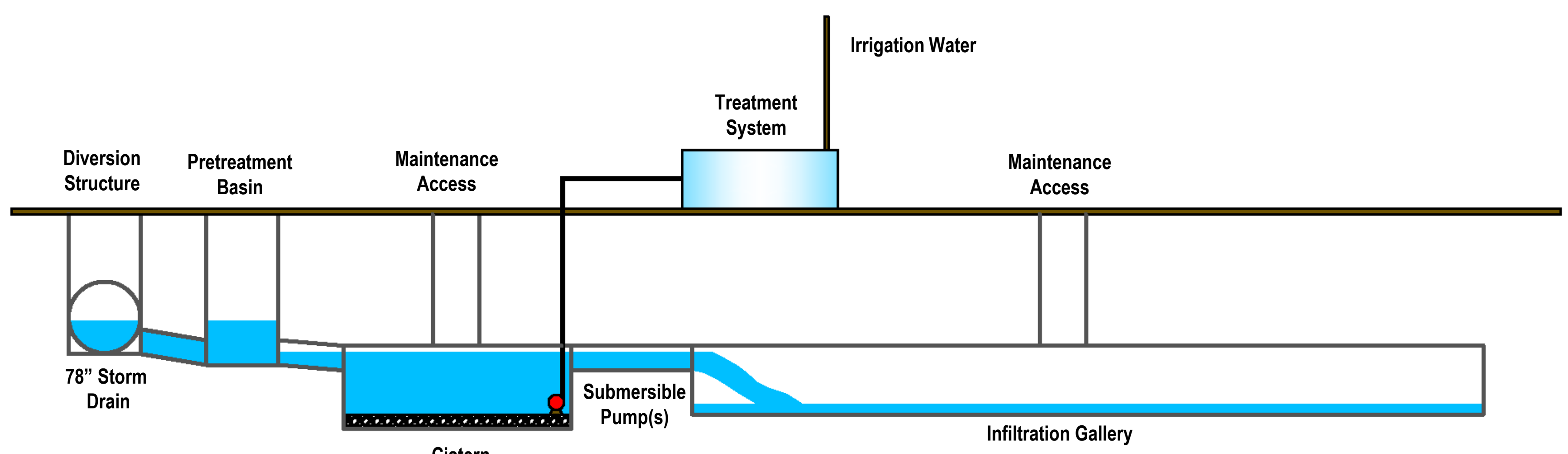
Existing Site Description: Ozone Park is a linear park with a total area of 0.7 acres located on the southern border of the City of Santa Monica where Santa Monica meets Los Angeles. The park has playgrounds on the eastern and western ends and a grassy lawn in between. It currently has a sprinkler irrigation system that sprays water through the park.

Retrofit Characteristics			
Cistern Size, gal.	10,000	Estimated Cost	$2,030,000
Infiltration Gallery footprint, ft^2	5,400	Potable Offset, %	60
Ponding Depth, ft	4	Zinc Reduction, %	10
Diversion Rate, cfs	20		

Proposed Retrofit Description: The proposed retrofit would involve installation of an underground diversion structure, pre-treatment basin, cistern, post-treatment system and overflow infiltration gallery within the existing park footprint. This conceptual design proposes a 10,000-gallon cistern to harvest all of the dry-weather flow and use it through park irrigation. The design would reduce the potable water demand by 60 percent.



Current Park View



Cross Section

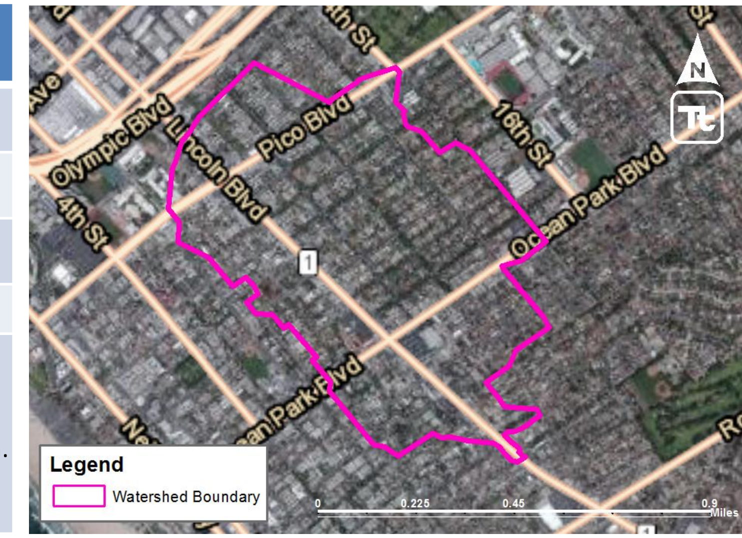
Ozone Park Conceptual Design Plan
CONCEPTUAL PLAN–EXHIBIT A.2
SITE: Ozone Park

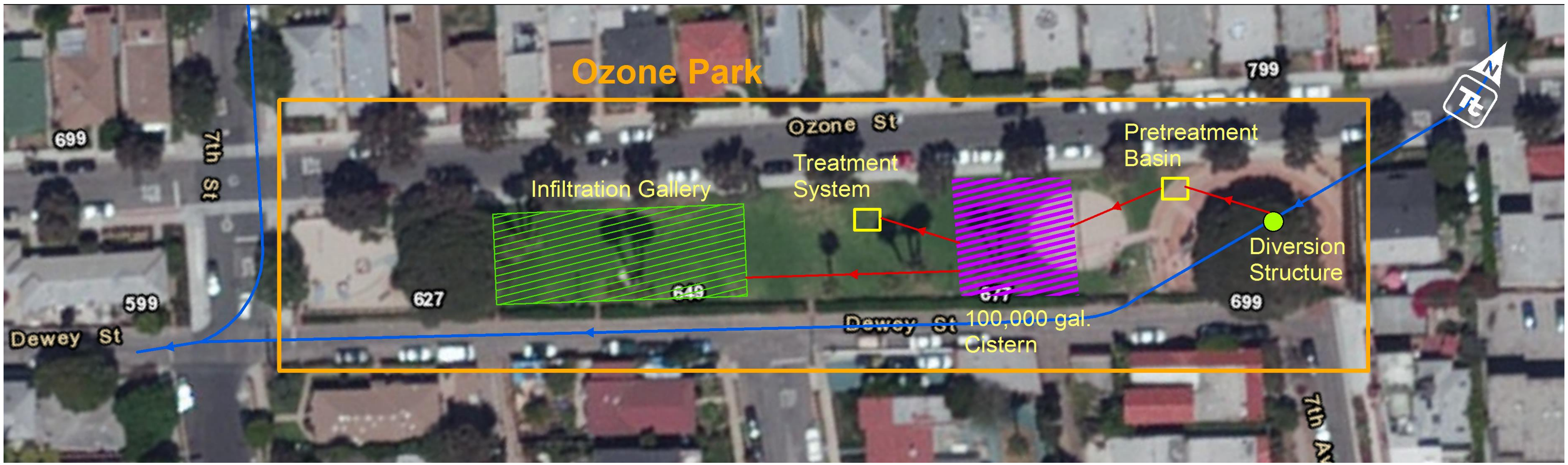
Site Location				Watershed Characteristics	
AIN	4287033900	Latitude	34° 0'5.71"N	Drainage Area, acres	307
Major Watershed	Santa Monica Bay Watershed	Longitude	118°28'19.48"W	LA County Soil Class	013
Street Address	Ozone St. & 7th St. CA, 90405	Landowner	Santa Monica	Total Impervious, %	65

Existing Site Description: Ozone Park is a linear park with a total area of 0.7 acres located on the southern border of the City of Santa Monica where Santa Monica meets Los Angeles. The park has playgrounds on the eastern and western ends and a grassy lawn in between. It currently has a sprinkler irrigation system that sprays water through the park.

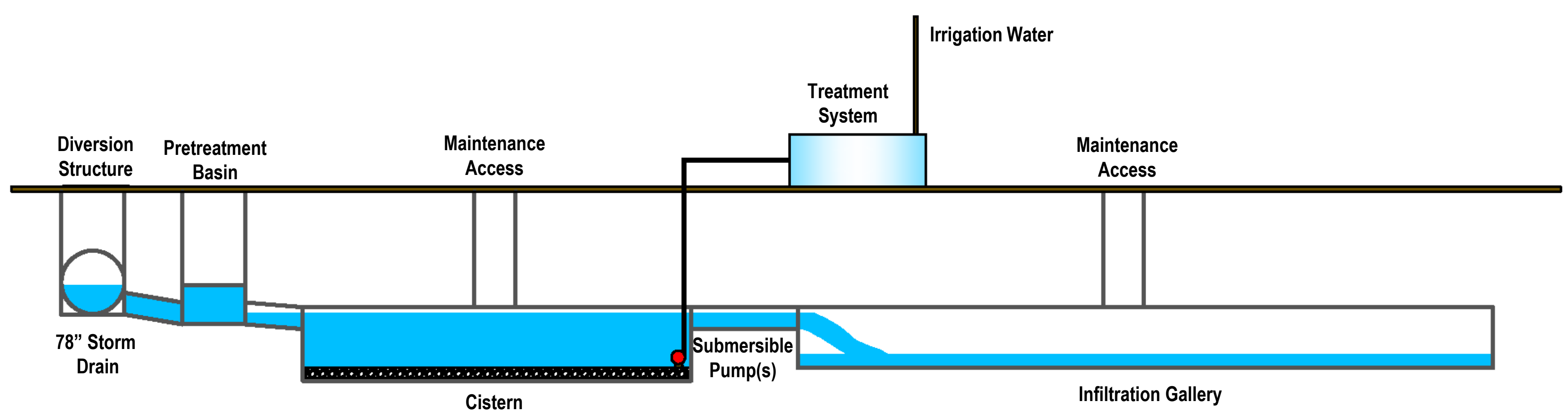
Retrofit Characteristics			
Cistern Size, gal.	100,000	Estimated Cost	$2,590,000
Infiltration Gallery footprint, ft^2	5,400	Potable Offset, %	86
Ponding Depth, ft	4	Zinc Reduction, %	11
Diversion Rate, cfs	20		

Proposed Retrofit Description: The proposed retrofit would involve installation of an underground diversion structure, pre-treatment basin, cistern, post-treatment system and overflow infiltration gallery within the existing park footprint. This conceptual design proposes a 100,000-gallon cistern to harvest dry and wet-weather flow and use it through park irrigation. The design would provide a potable water offset of 86 percent.





Current Park View



Cross Section

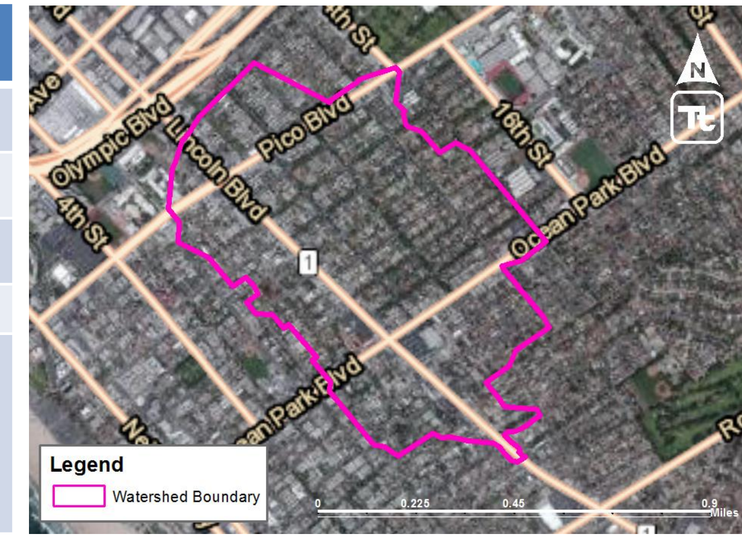
Ozone Park Conceptual Design Plan
CONCEPTUAL PLAN–EXHIBIT A.3
SITE: Ozone Park

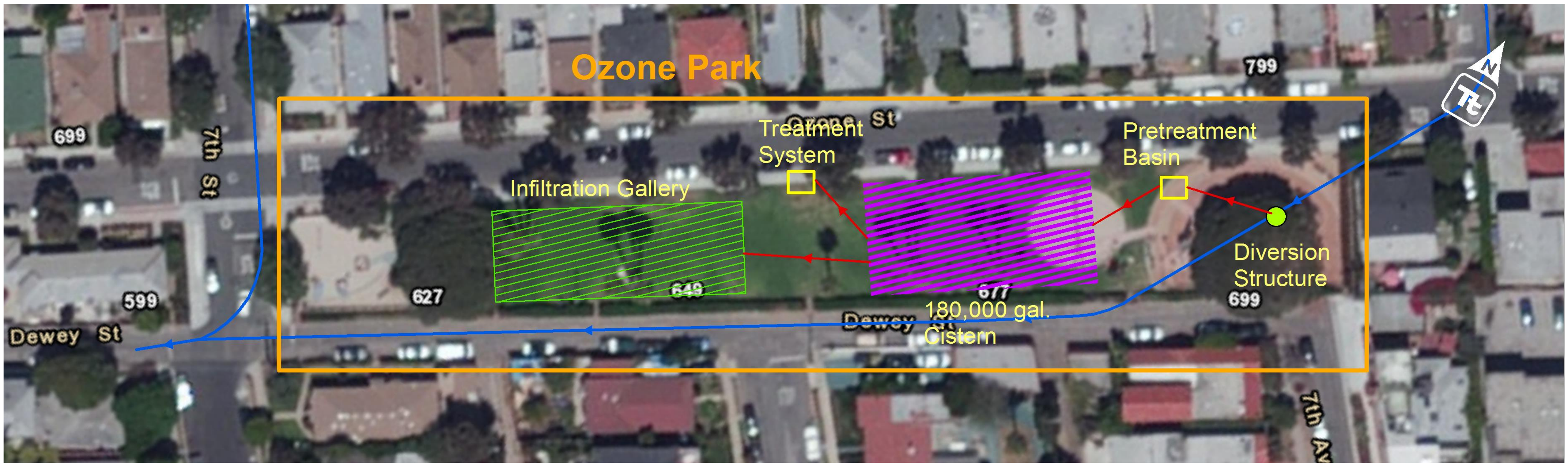
Site Location				Watershed Characteristics	
AIN	4287033900	Latitude	34° 0'5.71"N	Drainage Area, acres	307
Major Watershed	Santa Monica Bay Watershed	Longitude	118°28'19.48"W	LA County Soil Class	013
Street Address	Ozone St. & 7th St. CA, 90405	Landowner	Santa Monica	Total Impervious, %	65

Existing Site Description: Ozone Park is a linear park with a total area of 0.7 acres located on the southern border of the City of Santa Monica where Santa Monica meets Los Angeles. The park has playgrounds on the eastern and western ends and a grassy lawn in between. It currently has a sprinkler irrigation system that sprays water through the park.

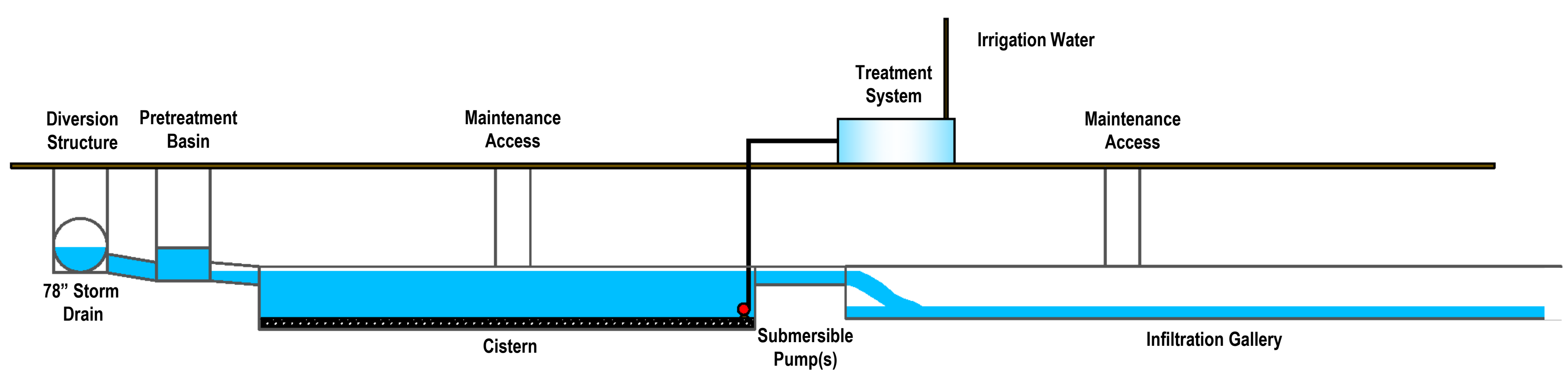
Retrofit Characteristics			
Cistern Size, gal.	180,000	Estimated Cost	$3,040,000
Infiltration Gallery footprint, ft^2	5,400	Potable Offset, %	100
Ponding Depth, ft	4	Zinc Reduction, %	12
Diversion Rate, cfs	20		

Proposed Retrofit Description: The proposed retrofit would involve installation of an underground diversion structure, pre-treatment basin, cistern, post-treatment system and overflow infiltration gallery within the existing park footprint. This conceptual design proposes a 180,000-gallon cistern to harvest all of the dry and wet-weather flow and use it through park irrigation. The design would offset 100 percent of the potable water demand.



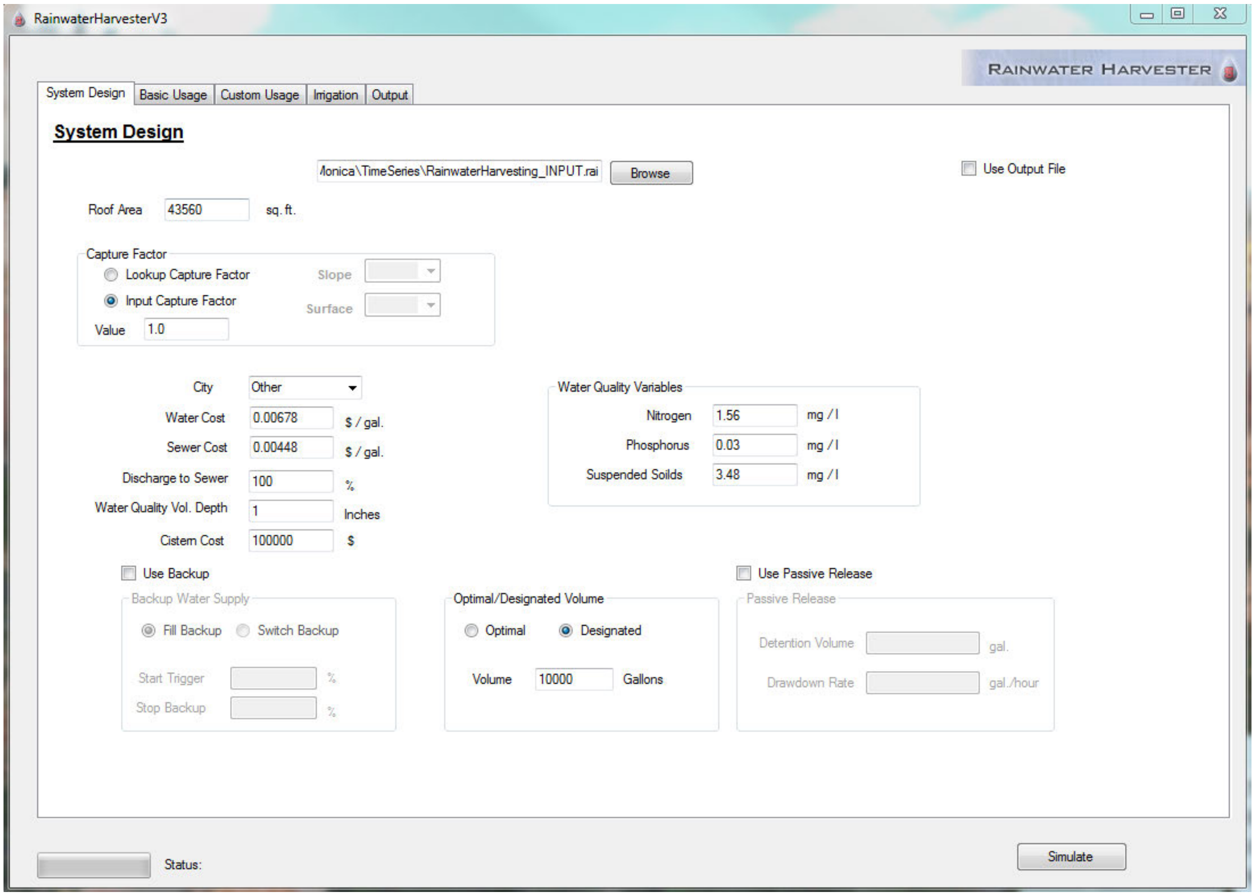


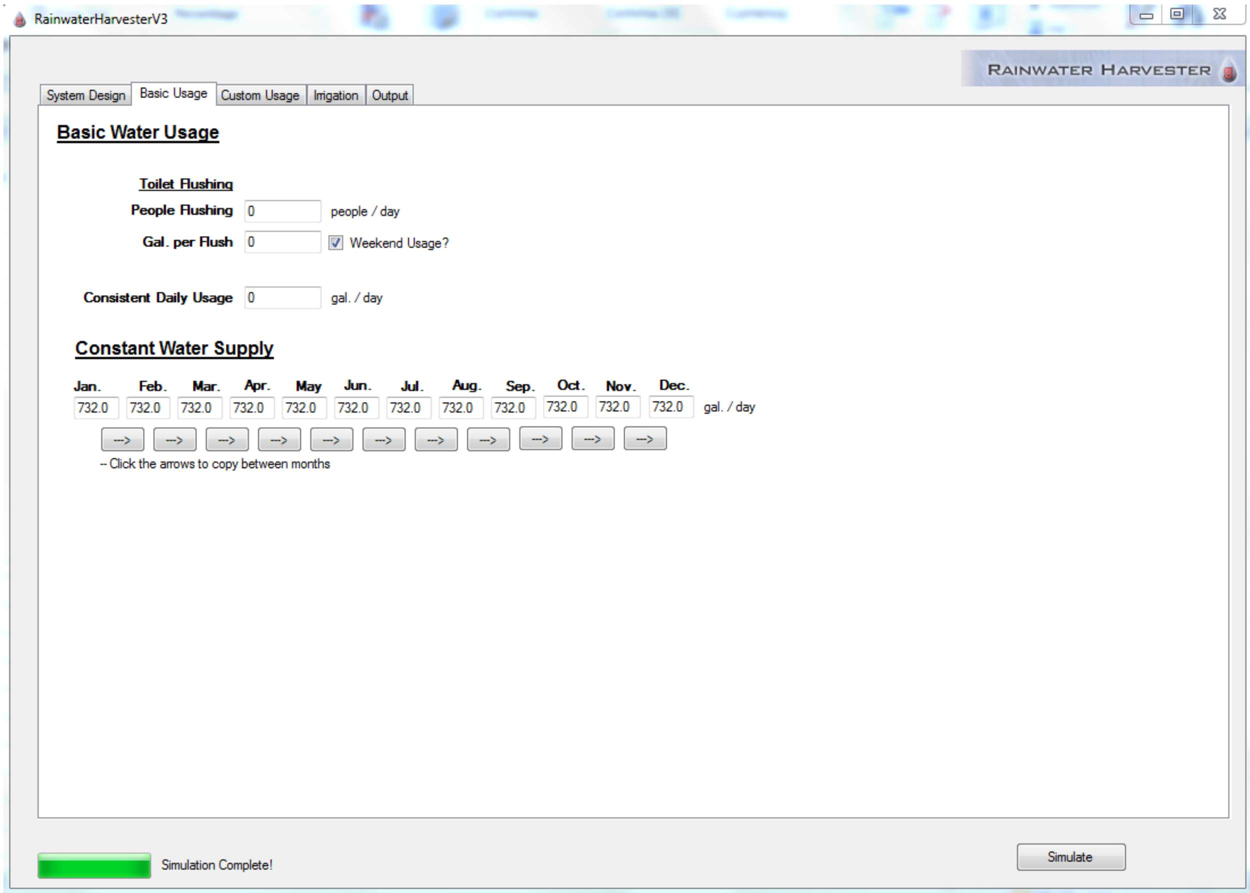
Current Park View

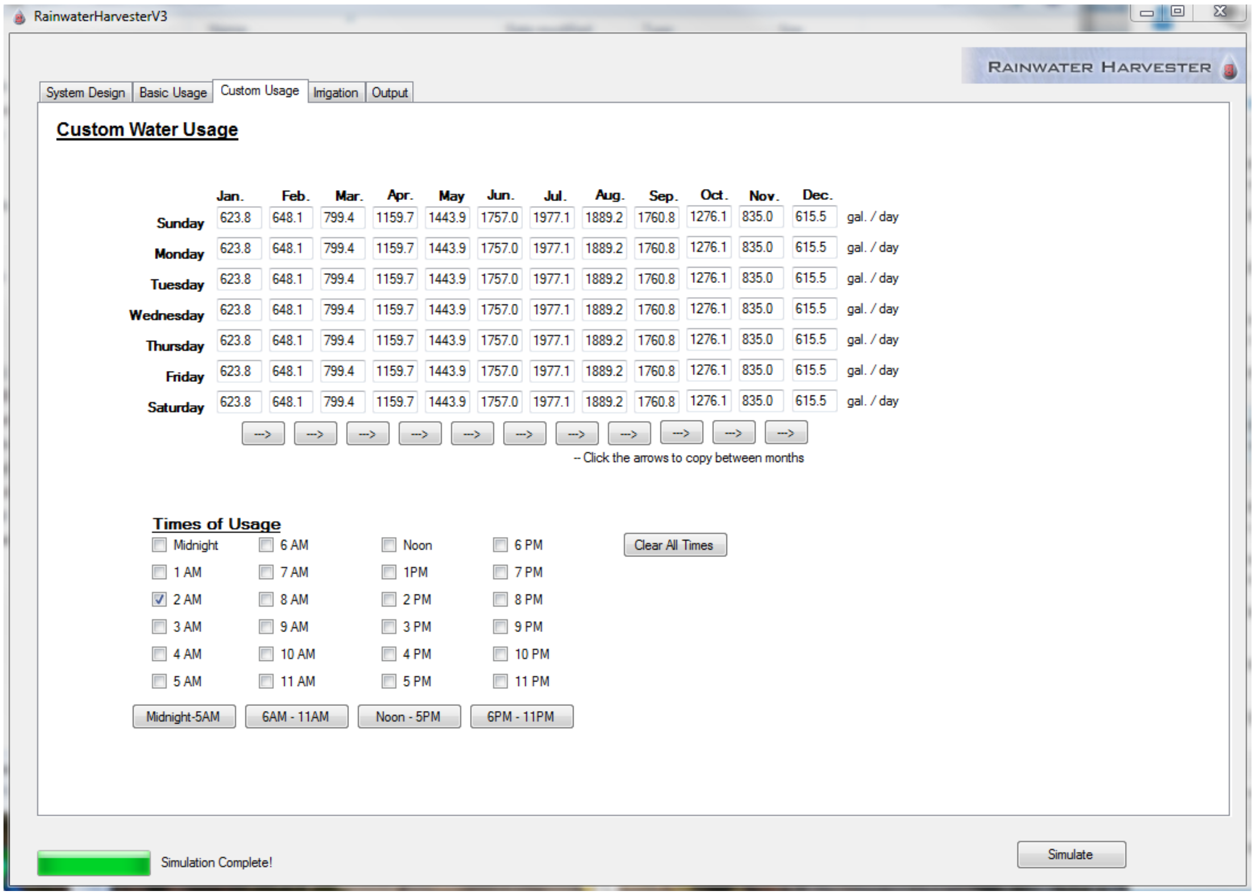


Cross Section

Appendix B: Rainwater Harvesting Model Data




RainwaterHarvesterV3
Rainwater Harvester
System Design
Basic Usage
Custom Usage
Irrigation
Output
Basic Water Usage
Toilet Flushing
People Flushing 0 people / day
Gal. per Flush 0 Weekend Usage?
Consistent Daily Usage 0 gal. / day
Constant Water Supply
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
732.0 732.0 732.0 732.0 732.0 732.0 732.0 732.0 732.0 732.0 732.0 732.0 gal. / day
-- Click the arrows to copy between months
Simulation Complete!
Simulate


RainwaterHarvesterV3
RAINWATER HARVESTER
System Design
Basic Usage
Custom Usage
Irrigation
Output
Custom Water Usage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Sunday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
Monday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
Tuesday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
Wednesday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
Thursday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
Friday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
Saturday 623.8 648.1 799.4 1159.7 1443.9 1757.0 1977.1 1889.2 1760.8 1276.1 835.0 615.5 gal. / day
-- Click the arrows to copy between months
Times of Usage
Midnight
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
Noon
1PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
10 PM
11 PM
Clear All Times
Midnight-5AM
6AM - 11AM
Noon - 5PM
6PM - 11PM
Simulation Complete!
Simulate