Elmer Avenue: Post-Project

PHOTO: COUNCIL FOR WATERSHED HEALTH

Sustainable Infrastructure: The Elmer Avenue Neighborhood Retrofit

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Abstract

Southern California faces significant pollution along its beaches and reduced reliability of imported water from distant lands. Sustainable solutions are needed that integrate natural processes into the built environment to solve these problems. The Elmer Avenue Neighborhood Retrofit Project demonstrates a transformation of conventional paved landscapes from liabilities to assets that provide multiple benefits such as improved water quality, increased water supply, and new green space. This effort worked with residents and numerous stakeholders to install best management practices on public and private property that reduce flooding, increase groundwater recharge, prevent pollutants from reaching waterways, and reduce carbon emissions. An extensive monitoring program is under way at Elmer Avenue, and findings to date show that residents along the street are able to maintain the improvements, and more than 10 acre-feet of runoff for groundwater recharge was captured in the first year (rain year 2010–2011). As monitoring continues and the additional projects are built to work with the existing improvements, valuable information and lessons learned will assist designing, installing, and maintaining future green and sustainable infrastructure projects.

Introduction

Coastal resources are only as healthy as the water flowing into them. The health of watersheds and the quality of ecosystems are linked to the sustainability of the surrounding community. Urban development patterns have resulted in less infiltration and more polluted runoff entering rivers and the ocean. By restoring the natural hydrologic connections and ensuring more precipitation percolates into the ground, the Los Angeles region can greatly increase locally available water supplies (Los Angeles & San Gabriel Rivers Watershed Council 2010). Sustainable solutions to the problems of pollution and unsustainable water supplies can be implemented in new and existing public and private developments throughout the watersheds of Southern California as shown by the Elmer Avenue Neighborhood Retrofit Project.

Figure 1. Stormwater Infiltration

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In 2000, the Los Angeles Basin Water Augmentation Study was initiated by the Council for Watershed Health (formerly the Los Angeles & San Gabriel Rivers Watershed Council 2002), as a long-term study to investigate the efficacy of using stormwater for groundwater recharge in the Los Angeles Basin. The study monitored six best management practice (BMP) installations on various land-use types across the region and determined that stormwater could be safely infiltrated to augment groundwater supplies under most conditions (Figure 1). Using the Los Angeles Basin Groundwater Augmentation Model (U.S. Department of the Interior: Bureau of Reclamation [USBR] 2007), the study found that in an average precipitation year, 384,000 acre-feet of stormwater could be available for recharge if the first 0.75 inch of each rain event is captured throughout the region. The opportunities for additional surface water storage are limited in the developed Los Angeles basin, but the groundwater aquifers have unused capacity of more than 1 million acre-feet (Metropolitan Water District of Southern California [MWD] 2007).

Based on the study findings, the Council for Watershed Health and its partners embarked on a demonstration project in a residential setting (Los Angeles & San Gabriel Rivers Watershed Council 2010). The Elmer Avenue Neighborhood Retrofit Project demonstrates an integrated, comprehensive approach to water resource management through the retrofit of a residential street in the northeast San Fernando Valley. A number of different BMPs and green infrastructure approaches are employed to promote water conservation, reduce and treat pollution, and encourage urban greening. The project is located in a flood-prone and open space–deficient portion of Sun Valley in the City of Los Angeles (Figure 2). The project includes enhancements in the public right-of-way and on thirteen private residential properties along a single block that work in concert to demonstrate low-impact design principles and sustainable stormwater management (See GWAM insert, page 94).

Infrastructure Retrofit

Sustainable stormwater management and green infrastructure use natural processes to capture and treat water and manage runoff at either the parcel or neighborhood scale. Elmer Avenue, located in the Sun Valley subwatershed of the Los Angeles River, has forty acres of residential land that drained to the roadway. This caused flooding problems, deteriorating street surfaces, and increased pollution along the block and downstream. Elmer Avenue did not have a traditional storm drain system to route flows off the street's surface. The flooding hazard suggested the need to install a traditional drainage system, presenting an opportunity to use a sustainable approach instead to reduce runoff and conserve water.

The Elmer Avenue Neighborhood Retrofit Project is designed to reduce, capture, treat, and infiltrate runoff from forty acres using an infiltration gallery under the street (Figure 3), bioswales along the public right-of-way, permeable surfaces for walkways and driveways, rain gardens and rain barrels to utilize and capture water from downspouts, as well as drought-tolerant landscaping and drip irrigation to lower water usage and utility bills. Infiltration is an effective stormwater management strategy along Elmer Avenue and in the Sun Valley area because the soil is highly permeable (Los Angeles County Department of Public Works [LADPW] 2004).

The project relies on an extensive partnership among nonprofits, municipalities, state and federal agencies, and local residents. Residents care for and maintain the new private property and public right-of-way features that reduce runoff and conserve water. The Council provided the residents of each home with a manual explaining how to maintain the vegetation and other features installed on their property; landscaping experts then trained all residents on three separate occasions. New sidewalks, solar street lights, street trees, and green space with native plants provide a park-like setting that attracts people from surrounding blocks, as well as birds, butterflies, and other wildlife (Figure 4). A comprehensive monitoring program is under way to answer questions about the quantity of water infiltrated,

Figure 2. Residence and Right-of-Way: Pre-Project

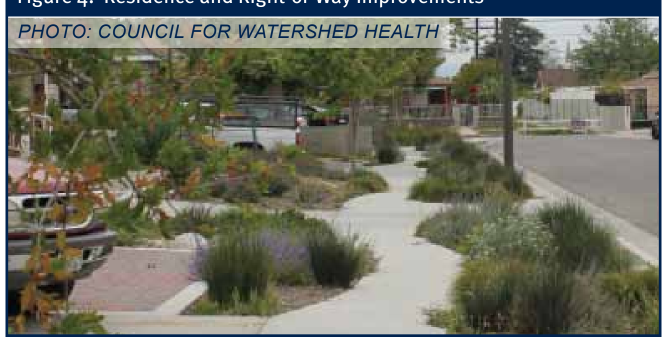
PHOTO: COUNCIL FOR WATERSHED HEALTH

Figure 3. Infiltration Gallery

PHOTO: COUNCIL FOR WATERSHED HEALTH

Figure 4. Residence and Right-of-Way Improvements

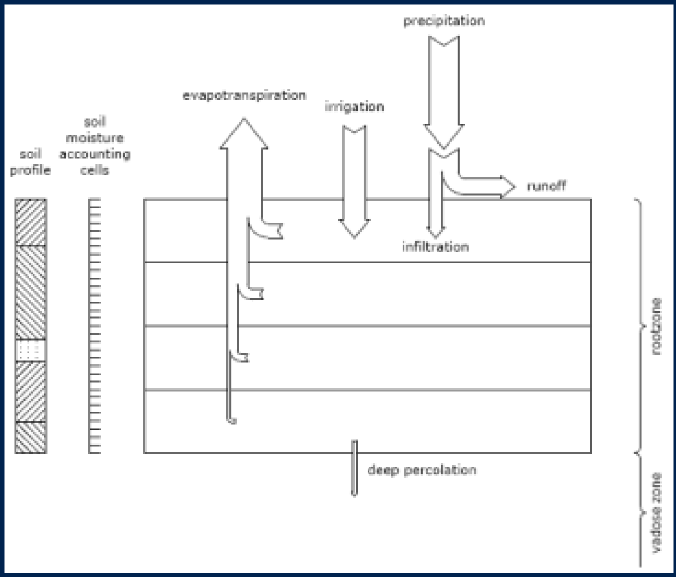
PHOTO: COUNCIL FOR WATERSHED HEALTH



Ground Water Augmentation Model

GWAM was developed by the U.S. Department of Interior: Bureau of Reclamation and the Council for Watershed Health for use in the Los Angeles Basin Water Augmentation Study. The model estimates the amount of groundwater recharge and stormwater runoff generated within the urbanized portion of the Greater Los Angeles Region.

GWAM can also explore the potential for greater groundwater recharge if various capture strategies are implemented (Bureau of Reclamation 2007). Using runoff diversion-to-infiltration scenarios, the model shows the potential increase in groundwater recharge given changes to the urban landscape. The model can be used to evaluate multi-benefit approaches to solving supply and runoff problems by predicting the results of methods to capture stormwater via low impact design or other best management practices (BMPs).



Two mass balance principles are integral to the estimates made by this model. These principals are described in a simplified manner below, but the detailed GWAM user's manual is available for download at WatershedHealth.org.

First Principle:

The amount of infiltration generated when it rains as described with this generalized equation:

Infiltration = Precipitation – Bare Surface & Canopy Evaporation – Runoff

Infiltration	Volume of water (acre-feet) entering into the root zone
Precipitation	Hourly precipitation data (inches) from a 50-year record
Bare Surface & Canopy Evaporation	Volume of water intercepted and/or evaporated before it infiltrates or becomes runoff
Runoff	Runoff predicted by the model using the Soil Conservation Survey curve number procedure (USDA 1986)

Second Principle:

For deep percolation as described by the following generalized equation:

Deep Percolation = Previous Soil Moisture + Infiltration + Irrigation – Evapotranspiration

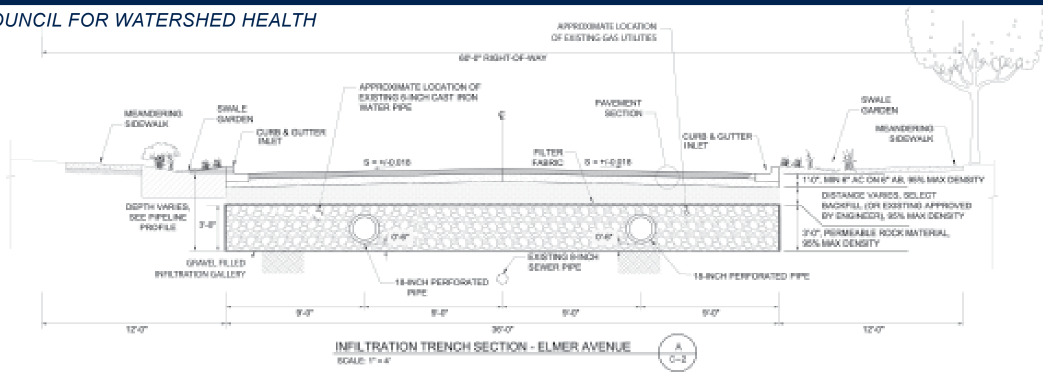
Deep Percolation	Volume of water predicted to infiltrate past the root zone and into the vadose zone
Previous Soil Moisture	Soil moisture from each previous daily time step in the model
Infiltration	As described above
Irrigation	Applied water to fulfill deficits in soil moisture
Evapotranspiration	Calculated within the model from California Irrigation Management System data and processed using accepted methods

The dynamics of runoff and infiltration in the model can be altered with user-selected diversions of runoff to infiltration. This allows the model to consider efforts to diminish runoff volume by retaining water as a potential recharge source. The diversions are set prior to the model run as a fraction of runoff (a percentage) or an absolute amount of runoff (a depth of water).

If no diversion is set, the model factors the saturated hydrologic conductivity of the soils as a limiting factor on infiltration. In impervious diversion scenarios, the diverted volume is routed past the root zone directly to the vadose zone, and therefore, the soil's capacity is not a factor. In pervious diversions, saturated hydrologic conductivity can be activated as a limiting factor, or left disabled, to imply that the unnamed BMP is capable of surface storage capacity, thus allowing as much time as is needed to completely drain the diverted volume into the root zone.

Figure 5. Cross-Section Schematic of Project

IMAGE: COUNCIL FOR WATERSHED HEALTH



pollutant load reductions, perceptions among homeowners, changes in the surrounding neighborhoods' landscapes, life-cycle costs, and changes in biological diversity.

Managing the Run-On to Elmer Avenue

The stormwater flowing to Elmer Avenue (run-on) from the 40-acre neighborhood to the north now enters catch basins that convey water into two infiltration galleries underneath the street. The bottomless catch basins allow particulates to settle out of the water before it enters the infiltration galleries. The two basins work in series, with water filling one before entering the next, which must also then fill before flow is conveyed to the gallery. The catch basins have no concrete bottoms, so some infiltration occurs there as well. The infiltration galleries below the street each consist of two 18-inch-diameter perforated pipes in a gravel bed five feet deep (Figure 5). Each gallery runs the 36-foot width of the street; the north gallery is 250 feet long, and the south gallery is 100 feet long.

The infiltration galleries are capable of infiltrating flow running on to Elmer Ave from "upstream" neighborhoods generated during a 2-year 24-hour storm (2.6 inches). The peak flow and volume of the 2-year storm are estimated to be about 10 cubic feet per second and 5 acre-feet, respectively. Based on historical rainfall data, the galleries are expected to infiltrate about 16 acre-feet of runoff annually.

Managing Runoff at Its Source

Runoff originating from the twenty-four homes on this block is managed with a variety of low-maintenance BMPs that apply low impact development (LID) and sustainable landscaping concepts. BMPs were installed on private property and on the public right-of-way, including the following:

- Vegetated bioswales running the length of Elmer Avenue on both sides of the street
- Permeable pavers
- Dry swales
- Rain barrels
- Native and drought-tolerant landscaping to replace existing lawns
- Gutters to direct rooftop runoff toward the rain barrels or swales
- Driveway drains to direct runoff to bioswales
- Street tree landscaping

Thirteen homeowners chose to have some or all of the LID improvements installed on their property. Each participating home received site-specific designs to meet individual needs such as additional parking with permeable pavers or drought-tolerant turf alternatives. The design for private property used a similar plant palette as the public right-of-way to provide a continuous landscape design. Installation of the private and public property designs was sequenced so grading and plantings occurred in similar timeframes and did not conflict with each other. The bioswales have curb inlets and driveway drains to direct flows into the system. The swales include plants and native soils to mimic natural treatment and infiltration processes (Figure 6).

Community and Project Integration

The project is unique in the region because it addresses stormwater runoff at its source with seamless integration of private property and public right-of-way improvements. This integration is primarily the result of engaging the homeowners as critical partners throughout the project. During final site selection, most homeowners indicated they were willing to have improvements installed along their street. Residents participated in developing

Figure 6. Residence and Right-of-Way Improvements: One Year Post-Project

PHOTO: COUNCIL FOR WATERSHED HEALTH

Figure 7. Residence Improvements

PHOTO: COUNCIL FOR WATERSHED HEALTH

the conceptual and final designs through six community meetings and numerous door-to-door interactions. The final plant palette of native- and climate-appropriate vegetation includes the neighborhood's stated preferences for evergreens, blooming color, and variety, as well as reduced water and maintenance needs. The engagement continued throughout construction, when homeowners were provided a single point of contact to report problems and ask questions. This easy and familiar access point allowed the community to be more comfortable participating in the complex web of partners and project efforts.

Community involvement continues today with residents helping to monitor the landscapes. Maintenance and training days for all residents are held quarterly on Saturdays to cover the items in the maintenance manual. The manual provided to each house has a calendar of activities to be performed, from cleaning the inlets to trimming native plants, and includes contact numbers for additional resources (Figure 7).

Monitoring the Progress

The monitoring effort uses multiple indicators to answer five key management questions:

1. What effect do the BMPs have on water quality?
2. What effect do the BMPs have on water supply?
3. What are the operations & maintenance (O&M) needs of the BMPs?
4. How has the project affected the residents' relationship to watershed health?
5. What are the project's additional benefits?

The Council for Watershed Health is implementing the monitoring program with support from the City of Los Angeles, the study

Table 1. Elmer Avenue Project: Monitoring Program Summary

Question		Approach	Indicators	Frequency
Q1:	What effect do the BMPs have on water quality (WQ)?	Flow weighted sampling at inlets to galleries, lysimeter, swale monitoring; before and after soil and plant monitoring	**WQ:** Pollutants of concern, concentration and flow (loadings)	**WQ:** 7 storms for 1st year; 3 storms annually for following 4 years
			Soil: Pollutants of concern, loads and concentrations, bacteria functional genes	**Soil:** Before; 2 per year for 5 years
			Plants: Nutrients, organics, bacteria, metals	**Plants:** Before; 2 per year for 5 years
Q2:	What effect do the BMPs have on water supply?	Water balance approach including monitoring the infiltration system, swales, permeable pavers, and rain barrels	Flow into infiltration system, rain gauge, swale storage via pressure transducers, permeable pavers storage via pressure transducers, sub-meters of water use in swales and residential lot, residential water bills, evapotranspiration	Annually for 5 years
Q3:	What are the O&M needs of the BMPs?	Monitoring of BMPs using photos, observation, and residential surveys	Sediment and trash accumulation, number of cleanouts, BMPs' O&M needs	Monthly BMP evaluation; annual residential survey
Q4:	What is the effect of the project on the residents' relationship to the watershed?	Residential and neighborhood surveys	Residents' responses to BMP maintenance requirements, adoption of new BMPs	**Pre-construction survey:** 2006
				Post-construction survey: September 2011; annually for following 5 years
Q5:	What are the project's additional benefits?	Biological surveys, changes to impervious surface, greenhouse gas emission reductions	**Avifauna and insects:** Abundance and diversity of bird and insect species	**Avifauna and insect survey:** Annually in winter and spring
			Surfaces and carbon emission reductions: Square footage of pervious surface, vegetation and tree canopy, carbon dioxide equivalents	**Surfaces and carbon emission reductions survey:** Annually

partners, and students from local universities. Table 1 expresses the range of monitoring approaches employed. The monitoring effort was phased in over the first year (2010–2011).

Preliminary Data and Analysis

What effect do the BMPs have on water quality?

Water quality monitoring to assess the performance of the infiltration gallery and pre-treatment commenced in 2010. Each gallery has pre-treatment catch basins for settling out debris and sediment before allowing water to infiltrate for groundwater recharge. At present, two automated samplers and two automated flow sensors monitor water quality at two points: (1) along the street before the water enters the catch basin and (2) at the entrance to the infiltration gallery following catch basin pre-treatment. During the 2010–2011 storm season, time-weighted and flow-weighted composite samples were collected with accompanying flow measurements to determine event mean concentrations and pollutant loadings before the catch basins and as flow enters the infiltration gallery. Future monitoring will determine the effect of the bioswales on water quality (Figure 8). Total suspended solids (TSS), total and dissolved metals, nutrients, volatile organic compounds (VOCs), and conventional constituents, such as pH and electrical conductivity, are examples of the range of constituents that are monitored.

The preliminary findings indicate that settling of sediments in the catch basin is reducing the concentration of metals and TSS in the flow entering the infiltration gallery (Figure 9). No VOCs were identified in the samples from either the inlets or the infiltration gallery. It should be noted that these data are preliminary, and the number of data points is too small to determine statistical significance.

What effect do the BMPs have on water supply?

The quantity of water entering the two large infiltration galleries is monitored using area-velocity flow sensors (Hach-Sigma, CO) in the inlet pipes after the catch-basins. Between April 1, 2010 and December 18, 2011 (latest data available), 23 acre-feet of stormwater were recorded entering the galleries to be percolated to groundwater.

What are the O&M needs of the BMPs?

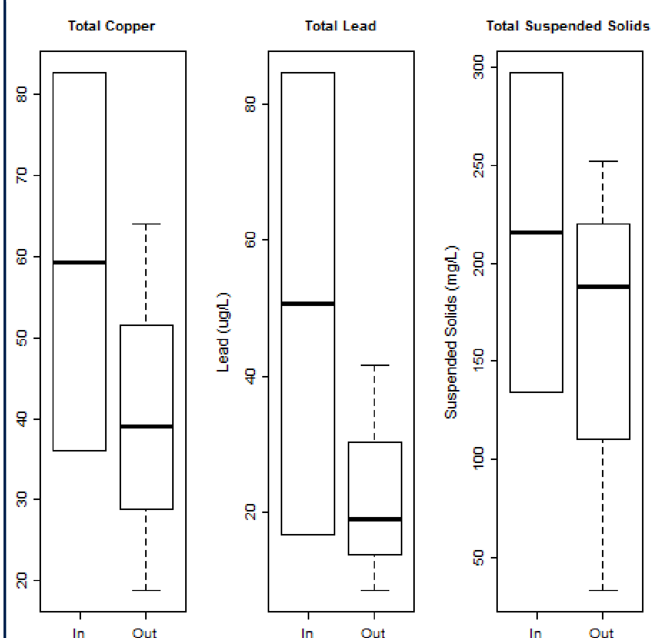
Monthly observational monitoring assesses the performance and maintenance requirements of the public right-of-way and private property improvements. Since surveys began in October 2010, the following have been observed:

Figure 8. Bioswale

PHOTO: COUNCIL FOR WATERSHED HEALTH

Figure 9. Concentrations of Stormwater Copper, Lead, and Total Suspended Solids at the Street Inlet vs. Catch Basin Outlet

IMAGE: COUNCIL FOR WATERSHED HEALTH



- Qualitative assessment suggests plant survival rate is high.

- Weed cover remains particularly low, which may be attributed to proactive residents who routinely weed the bioswales in front of their homes.

- Trash carried by the stormwater and the wind is caught in the bioswales and then removed by the residents.

- As was expected, mulch levels in the bioswales are decreasing since installation. Continued monitoring will determine the need and frequency to reapply mulch.

- Unexpected amounts of sediment are accumulating on the east side of Elmer Avenue causing some inlets and swales to require additional maintenance. The effect of the increased sediment is primarily an aesthetic concern, but will be assessed over time.

- The irrigation system is in good condition and appears to be supplying the plants with the required amount of water. Drip irrigation of the bioswales is scheduled to continue through July 2012.

- The rain barrels are in good condition; barrels are receiving water from the storms and are being used by the residents.

Visual surveys of Elmer Avenue's bioswales are conducted quarterly to assess the plants' health and growth. Photos are taken on a quarterly basis of each bioswale in a consistent manner to observe changes over time (Figure 10).

How has the project affected the residents' relationship to watershed health?

In January 2011, mail-in and door-to-door surveys were conducted of all residents on Elmer Avenue and Bakman Avenue (one block east). This survey was a repeat of a "before" survey conducted in October 2006. Bakman Avenue residents represent the views of residents on a street without stormwater improvements and serve as the control. On Elmer Avenue, 13 out of 24 households responded, while 9 out of 24 houses on Bakman Avenue responded. Where applicable, survey results were compared to the prior 2006 survey. The surveys (available at was.watershedhealth.org) found the following:

- 92% of respondents along Elmer Avenue felt that the hands-on training, maintenance manual, and project contacts were somewhat or very effective.

Figure 10. Bioswale Progress: June 2010 vs. July 2011

PHOTOS: COUNCIL FOR WATERSHED HEALTH

- 92% of Elmer Avenue respondents were satisfied with the walkability on their block in 2011, versus less than 2% in 2006. Bakman Avenue respondents, however, were split—50% were satisfied, and 50% were not.

- A majority of Elmer Avenue residents found maintenance of the elements installed in the public right-of-way to be easy or very easy, with most residents spending less than two times per month weeding the bioswales.

The results from the mail-in and door-to-door surveys along Elmer Avenue and Bakman Avenue suggest a positive impact from direct community outreach and education performed along Elmer Avenue but not along Bakman Avenue. Some highlights of the survey results:

- 100% of the 2011 survey respondents from Elmer Avenue agreed that rain falling on local homes can be captured and used to supply their community with water, versus 60% in 2006. In 2011, 80% of the residents on Bakman Avenue agreed (Figure 11).

- Only 22% of respondents from Bakman Avenue are familiar with the term "infiltration" while 69% respondents from Elmer Avenue are familiar with the term.

- 85% of Elmer Avenue respondents and 50% of Bakman Avenue respondents are familiar with the term "runoff."

- 60% of Elmer Avenue respondents are familiar with the term "watershed" while only 30% of Bakman Avenue respondents are familiar with the term.

An additional mail-in survey was sent to approximately 500 homes in the census block that surrounds the Elmer Avenue Neighborhood Retrofit Project. This additional survey sought to determine the awareness and influence, if any, of the project on the surrounding area. One of Elmer Avenue's potential impacts is educating and influencing surrounding neighborhoods on issues pertaining to water. Below are some preliminary findings from an 11% response rate (Bartrosouf 2011):

- 28% of respondents are familiar with the project.

- Of those who are familiar with the project, 88% feel influenced by its presence (Figure 12).

- 67% would consider purchasing a rain barrel if their neighbors had one.

- 80% of respondents feel that individuals can help reduce the amount of polluted water that flows to the ocean while adding to local potable water supplies.

What are the project's additional benefits?

Additional monitoring of the abundance and diversity of bird and insect species, and an evaluation of the reductions in carbon emissions from the site are ongoing. Rough calculations suggest that 10 acre-feet of recharged groundwater offsets the 4.3 tons of carbon emissions produced by the importation of a similar volume of water (Los Angeles Department of Water and Power [LADWP] 2011).

Conclusions and Lessons Learned

Monitoring results suggest that many of the goals of the Elmer Avenue Neighborhood Retrofit project are being met. Continued monitoring of the project, and additional monitoring at the upcoming Elmer Paseo project (details below), will provide further knowledge about the value of sustainable infrastructural retrofits in Southern California. Numerous agencies, homeowners, residents, and municipalities throughout the region regularly tour Elmer Avenue as an example of sustainable infrastructure (Figure 13).

Extensive outreach and community involvement are clearly critical components of the project's success. A survey of residents in the surrounding census block showed that those passing by have noticed the project, but additional educational signage or tours would better explain the various elements installed along the street.

Figure 11. Thriving Plants (foreground) and Rain Barrel (background)

PHOTO: COUNCIL FOR WATERSHED HEALTH

Figure 12. Thriving Residence Improvements

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Figure 13. Elmer Avenue: Post-Project

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Only thirteen of the twenty-four homes selected private property improvements when asked. However, once the improvements were installed, other homeowners expressed regret at passing up the opportunity. Similar future projects should budget explicitly for the late adopters, and/or consider an early physical demonstration of the amenities being offered.

The ageing infrastructure throughout Southern California represents an opportunity to apply the approaches and lessons learned along Elmer Avenue as streets are upgraded. Constructing a system of sustainable infrastructure will provide multiple benefits while replacing an historic single-purpose system that has reached its end-of-life.

Figure 14. Residence and Right-of-Way: Post-Project

PHOTO: COUNCIL FOR WATERSHED HEALTH

Future Work

The work within the Elmer Avenue Neighborhood Retrofit now continues with the Elmer Paseo project, a 270-foot-long paved pedestrian walkway at the southern end of Elmer Avenue. The Paseo is the outlet for the full 40-acre Elmer Avenue watershed and an additional 20 acres of adjoining neighborhoods. The project, currently in its design phase (February 2012) will remove the asphalt surface of the Paseo and replace it with bioswales, a permeable walkway, and other community amenities, including plants, benches, and educational signage explaining how the elements along Elmer Avenue work. A subsurface BMP for additional infiltration is being considered.

Monitoring along Elmer Avenue and the Paseo will provide valuable information on the performance of the various BMPs, the influence of these types of demonstration projects on the community, and additional information on what works and what is needed to convert the urban landscape into a healthy watershed (Figure 14).

Water Augmentation Study Partners and Elmer Project Funders

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