Capturing Storm Water in Semi-arid Climate

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Effect of Urbanization

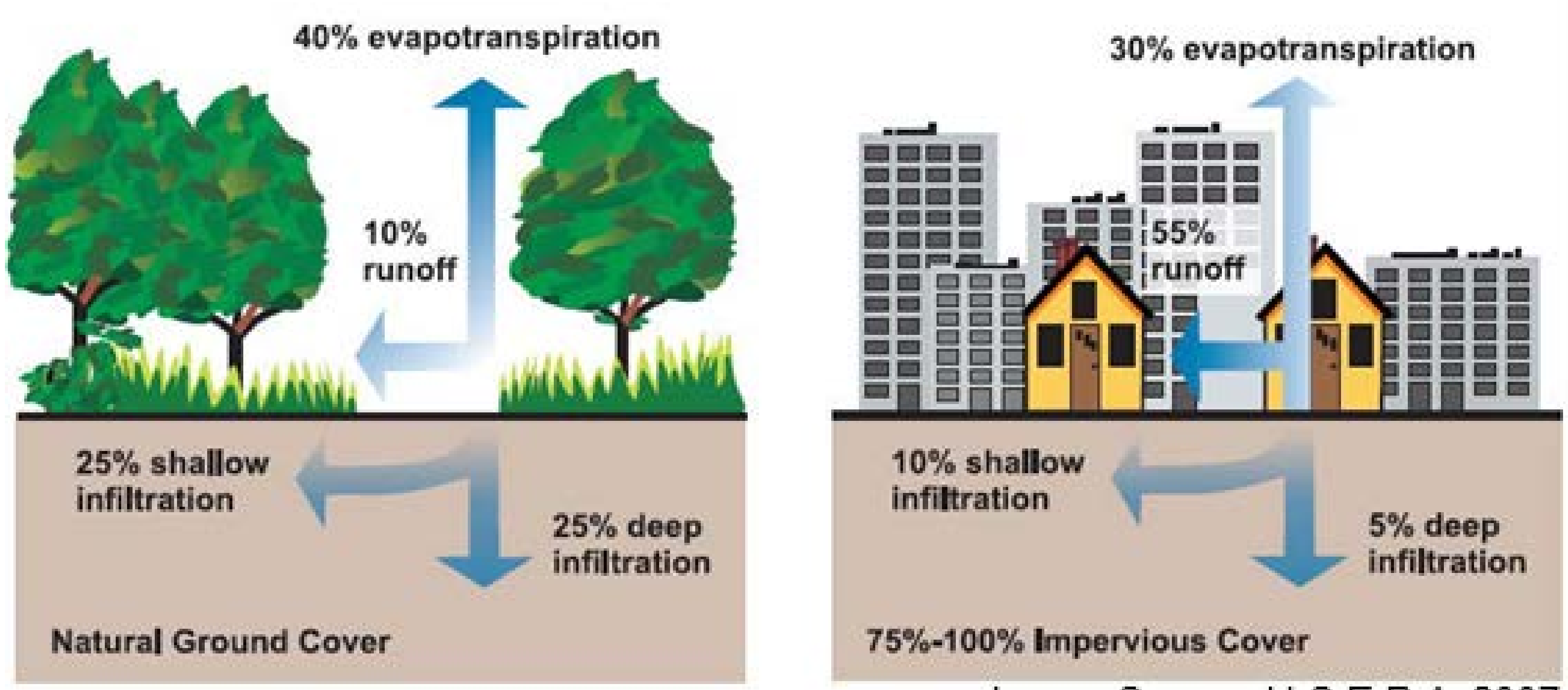


Image Source: U.S E.P.A, 2007

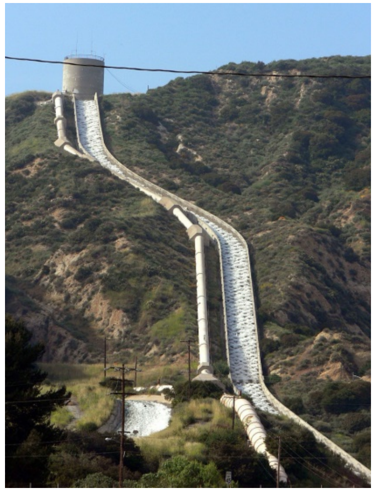
- Infiltration is reduced resulting in increasing quantities of runoff.
- This storm water runoff has been regarded as nuisance.
- Conventional storm water drainage systems have been developed to drain away the runoff from the developments as quickly as possible following a rainfall.

Water Balance in Southern California

In 2000

Demand	Amount (x1000 acre-feet)
Storm water runoff to the ocean	2,498
Evapotranspiration	7,441
Consumptive use	1,819
Total Demand	**11,758**

Supply	Amount (x1000 acre-feet)
Precipitation	7,500
Ground water extraction	1,245
Imported water	2,991
Total Supply	**11,752**



With continued population increase in the area, the demand is likely to grow and deficit in natural water resources will potentially increase in future.

Stormwater runoff- A LOST RESOURCE

Storm water Management

- The Low impact development (LID) approach is an alternative to conventional storm water management tools that are purely structural and mitigation based.

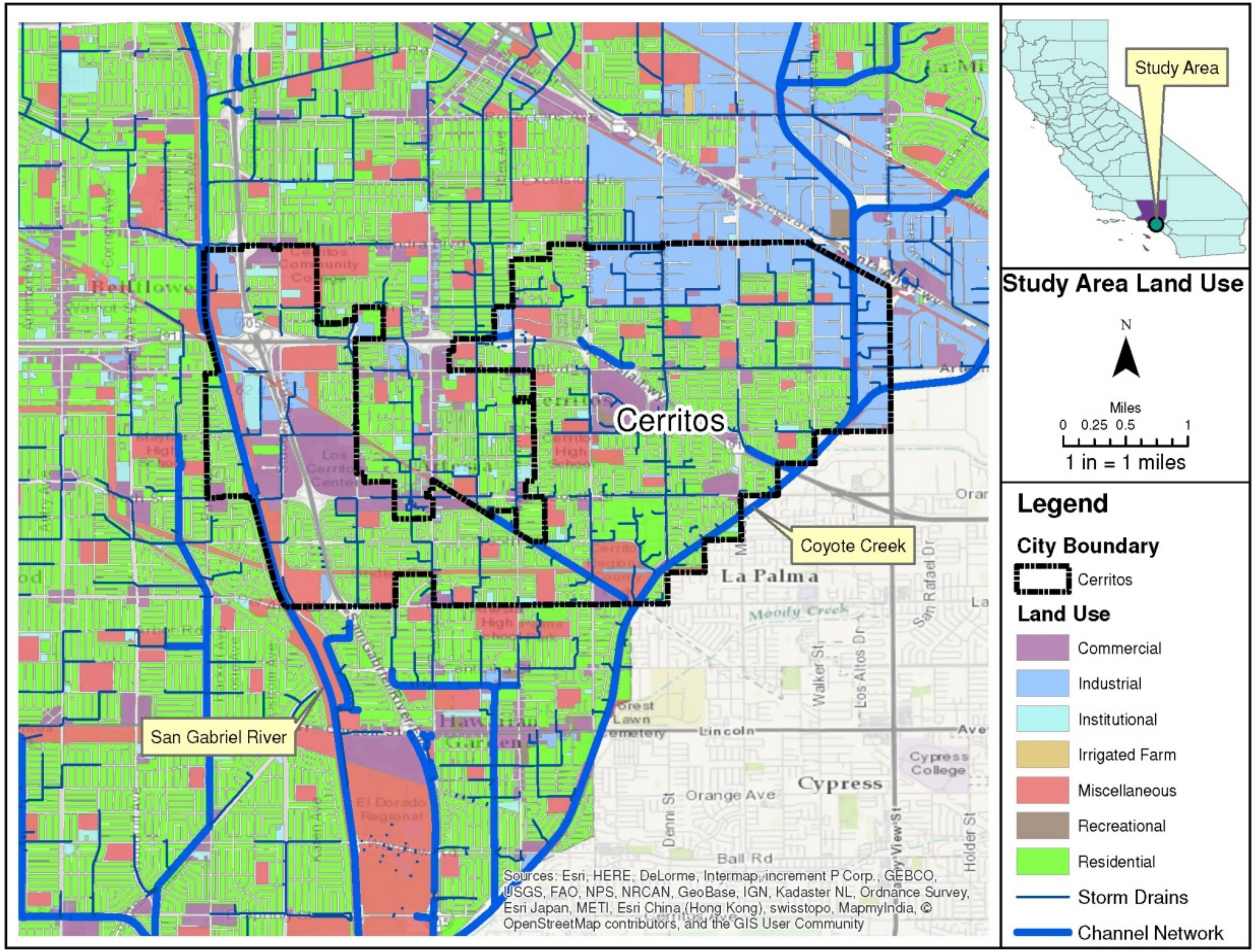
- The LID approach, started in 1990 in Maryland, allows storm water runoff to infiltrate, store at or close to its source and are primarily used to reduce concentration of pollutants' in receiving water bodies.

- LIDs can also be used to "harvest" rain for use. Depending on the source or application, captured storm water can be used without any treatment or may be blended to augment local supplies.

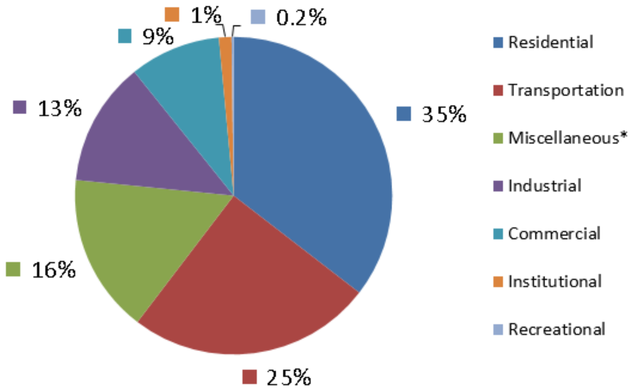
Research Objective

How much water can be saved in an urban residential area of Southern California using LIDs?

Study Area: City of Cerritos



The city of Cerritos is 8.7 square miles and
Is situated in the San Gabriel River watershed
about 7 miles upstream of the confluence of
the Pacific Ocean.



Where does Cerritos meets its water need?

- The city receives its water from the State Water Project, the Colorado River, and the local groundwater basin.

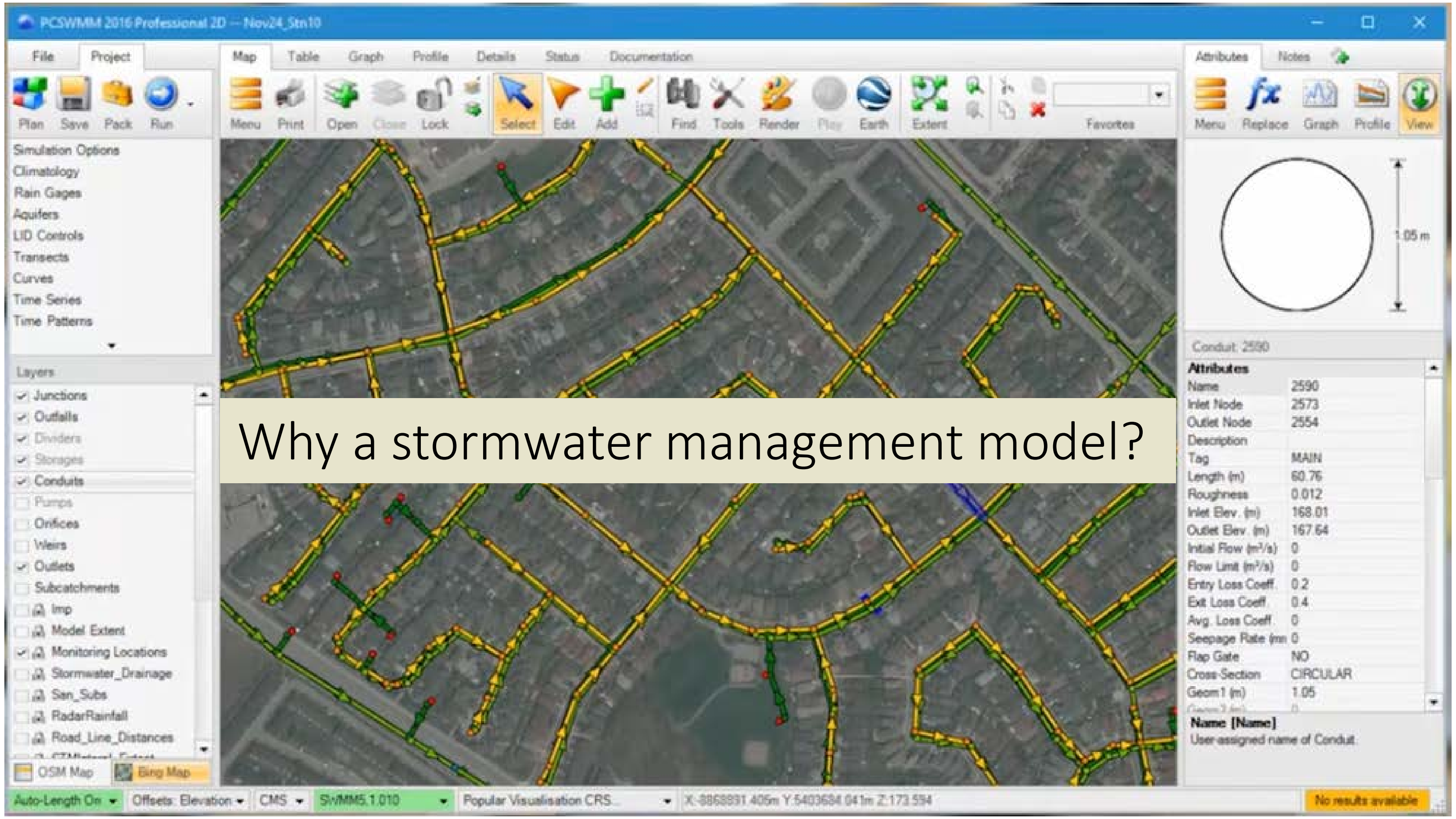
- The city also purchases reclaimed water every year from the neighboring water reclamation plant.

- The reclaimed water is generated from the wastewater from industries, businesses, and homes and used for irrigation of the city’s 200 acres parks.

During the 2014-2015 extreme drought year, the city reduced its water consumption by 18.9% compared to water usage in 2013-2014 by educating its residents and businesses about water conservation.

The city did not achieve its 28% state mandated reduction goal primarily because of the water used for irrigation of the residential lots.

Methodology



Why a stormwater management model?

PC Storm Water Management Model (PCSWMM) by developed by ChiWater

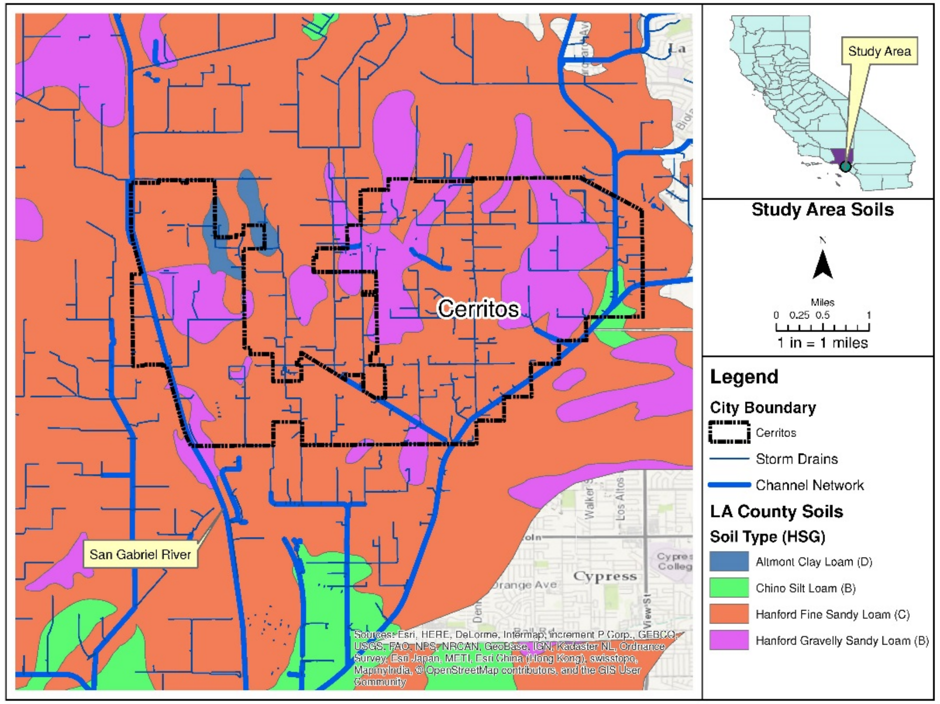
This dynamic water quality and quantity model is selected because of its powerful GIS interface and its full support of Environmental Protection Agency's (EPA) Storm water Management Model (SWMM5) hydrology and hydraulic engines.

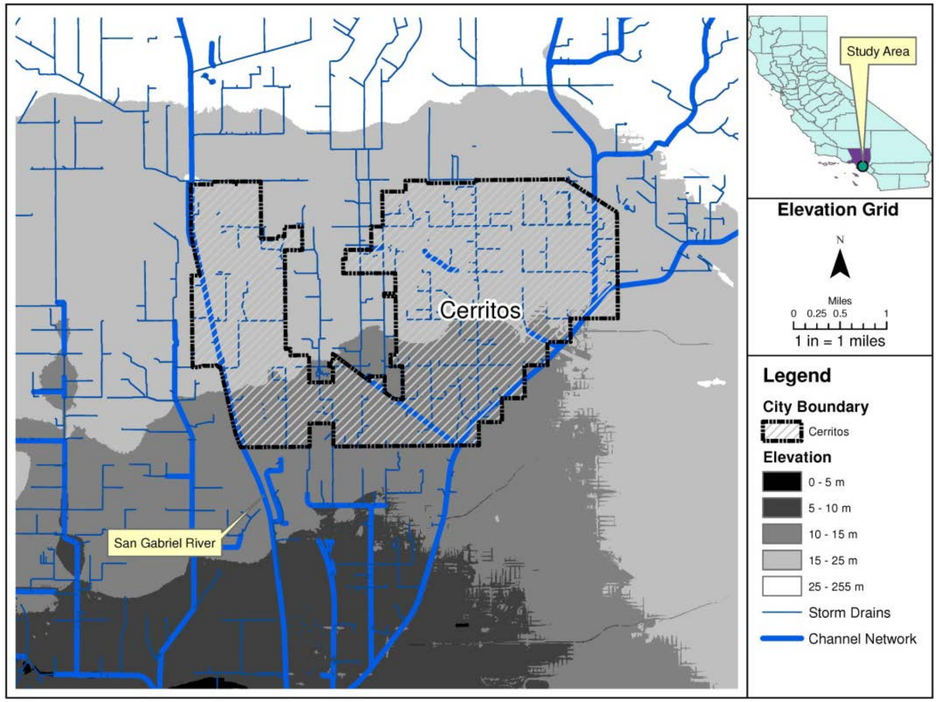
Data Requirements

The data required for the model is GIS map of the city, land use and land cover data, demographic information, design rainfall and continuous rainfall data.

Input Data	**Source**
Land use	Los Angeles County Tax Assessor's Parcel map
Topography	USGS National Elevation Data 10 m grid
Soil type	Los Angeles County Department of Public Works, 2006 Los Angeles County GIS Data Portal, 2004
Weather	Los Angeles County Department of Public Works, 2006 NOAA, National Climatic Data Center, 2017
Storm sewer system	Los Angeles County GIS Data Portal

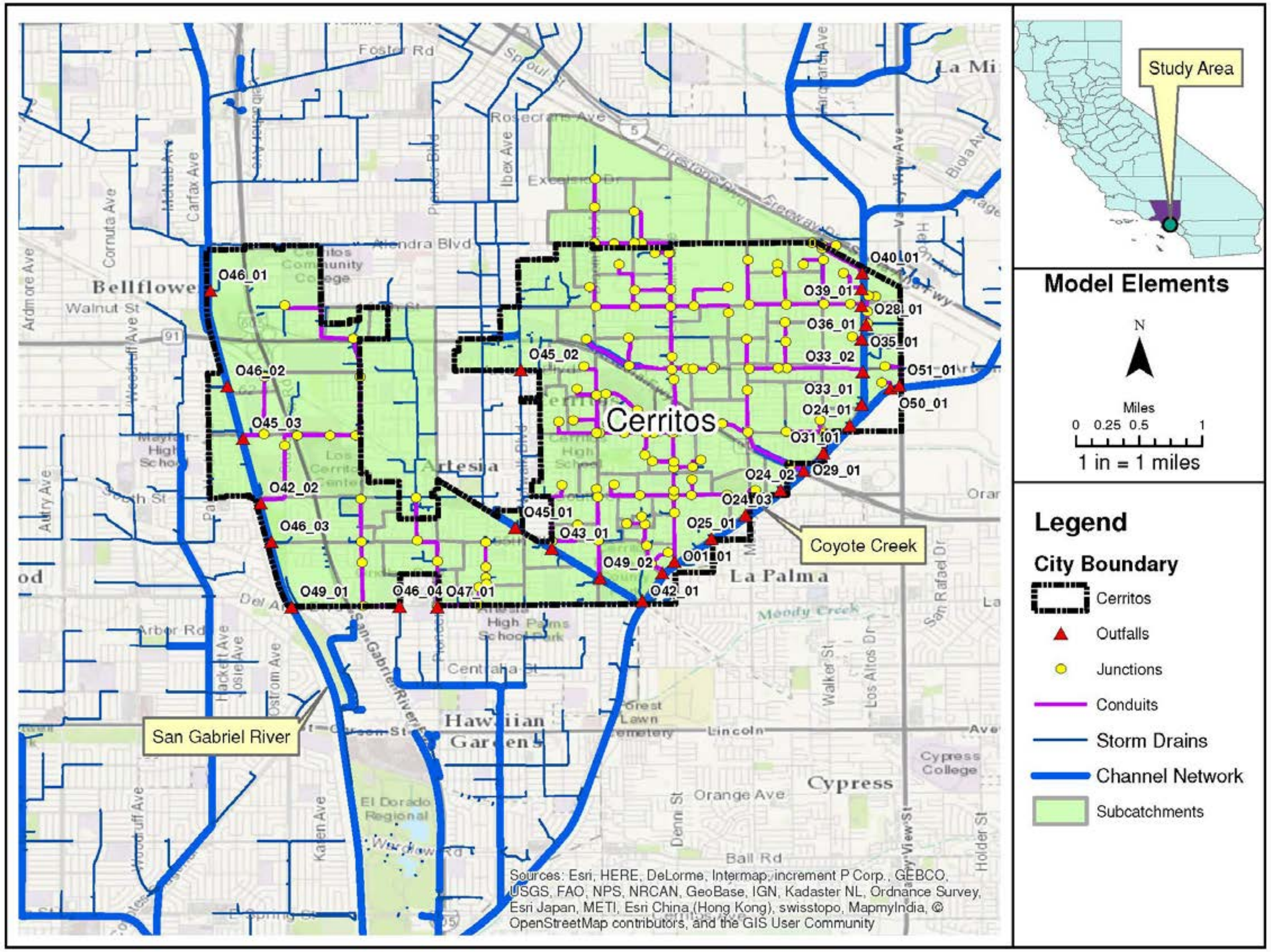
Study Area: Geography and Hydrology





- The topography of the area is generally flat (mean elevation of about 17 m) with gentle slopes towards the southwest.
- The dominant soil type in the city is silty loam soil with some gravel (type C soil).
- Mean annual rainfall in the city is 30.5 cm/year (12 inch/year), which is less the average annual rainfall of the Los Angeles County.

Base model



Scenario 1

1 rain barrel per residential lot (55 gallons of storage)

Scenario 2

5 rain barrel per residential lot (5x55 gallons of storage)

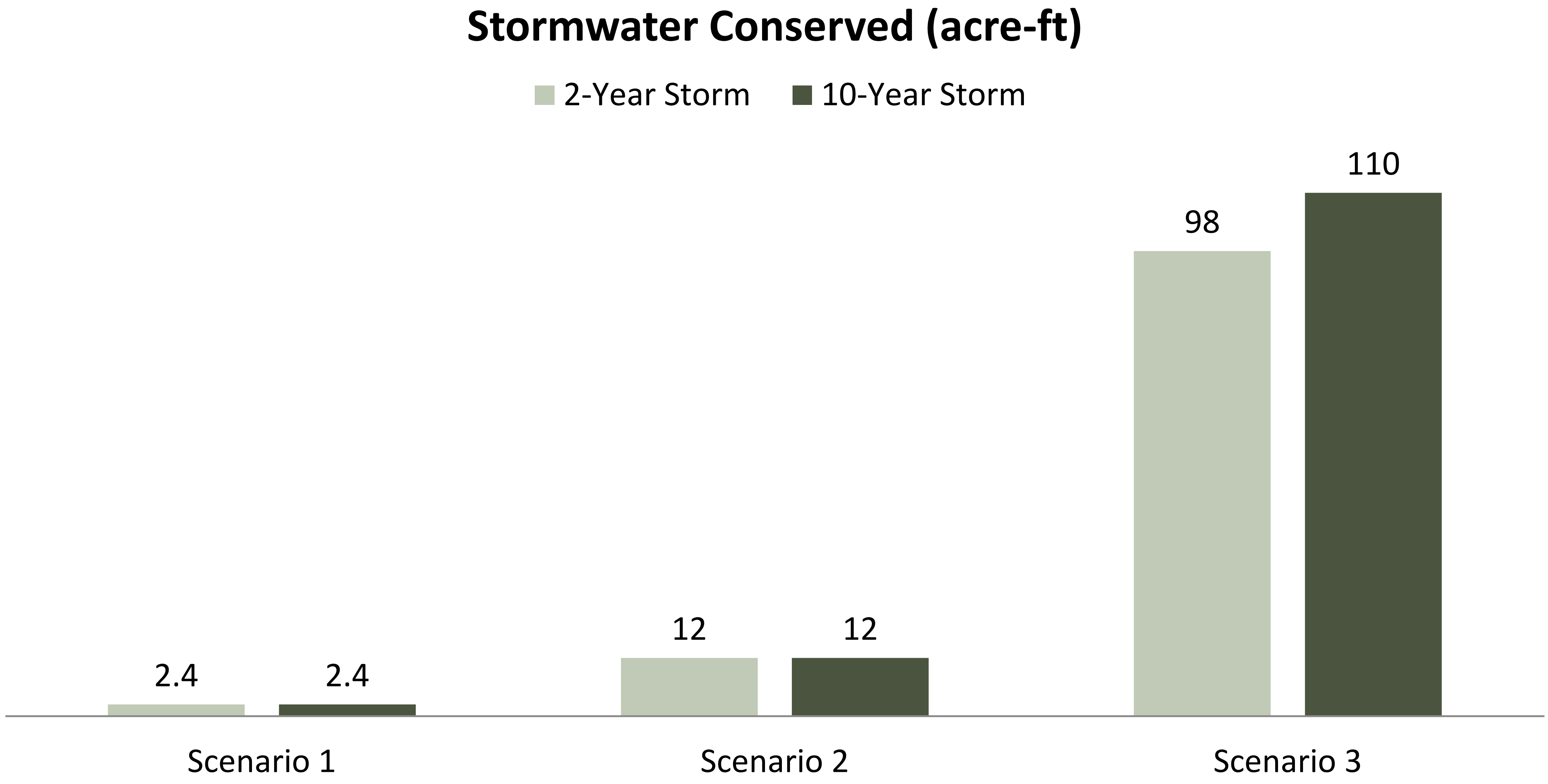
Scenario 3

Storage for 0.75 inches of impervious residential runoff (1250 gallons of storage)

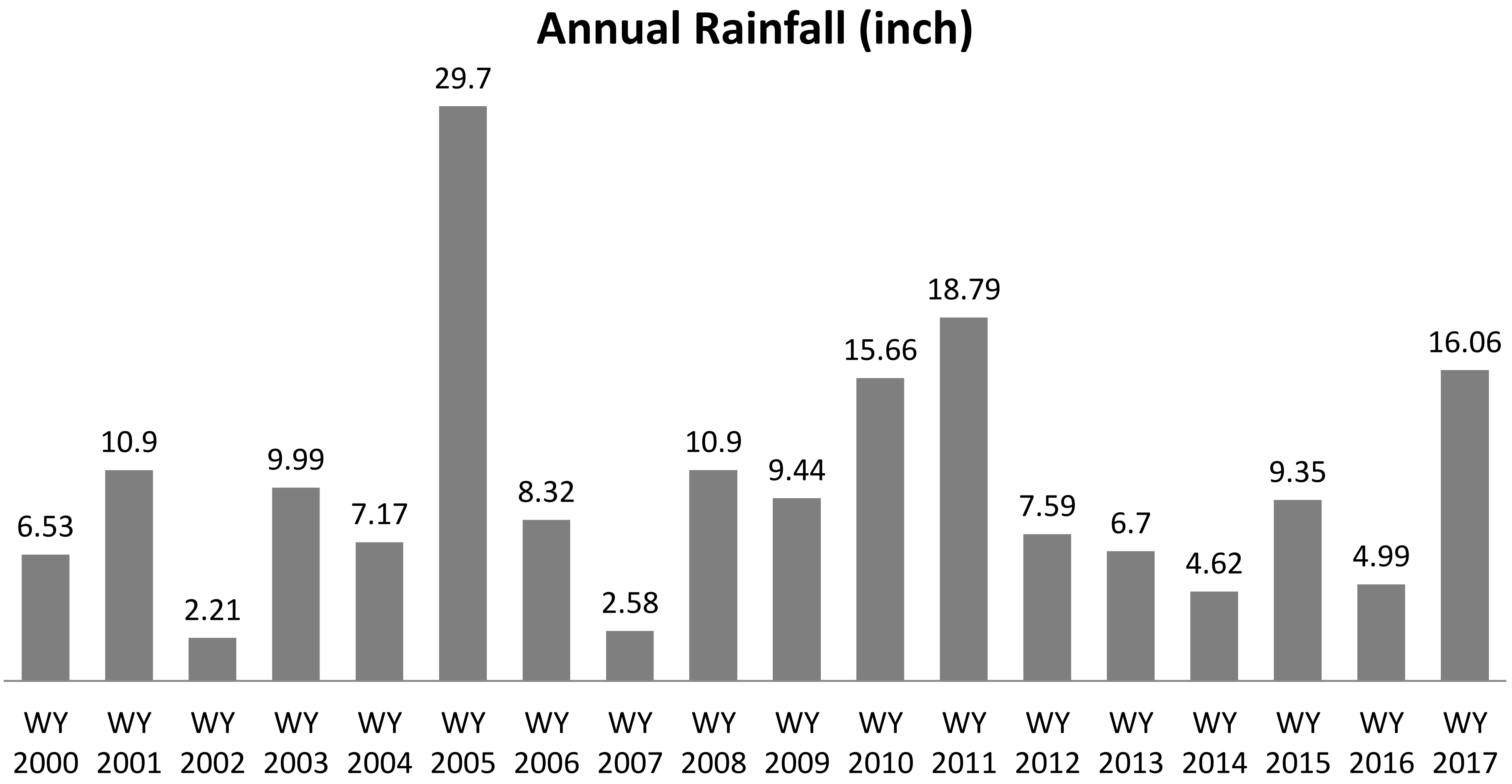
Results: Design Storm

	Base model	Scenario 1		Scenario 2		Scenario 3	
Storm type	Runoff Volume [acre-ft]	Runoff Volume [acre-ft]	Stormwater Conserved [acre-ft]	Runoff Volume [acre-ft]	Stormwater Conserved [acre-ft]	Runoff Volume [acre-ft]	Stormwater Conserved [acre-ft]
2-year storm	967	964	2	955	12	870	98
10-year storm	1,843	1,841	2	1,831	12	1,734	110

Results: Design Storm



Results: Historic Rainfall



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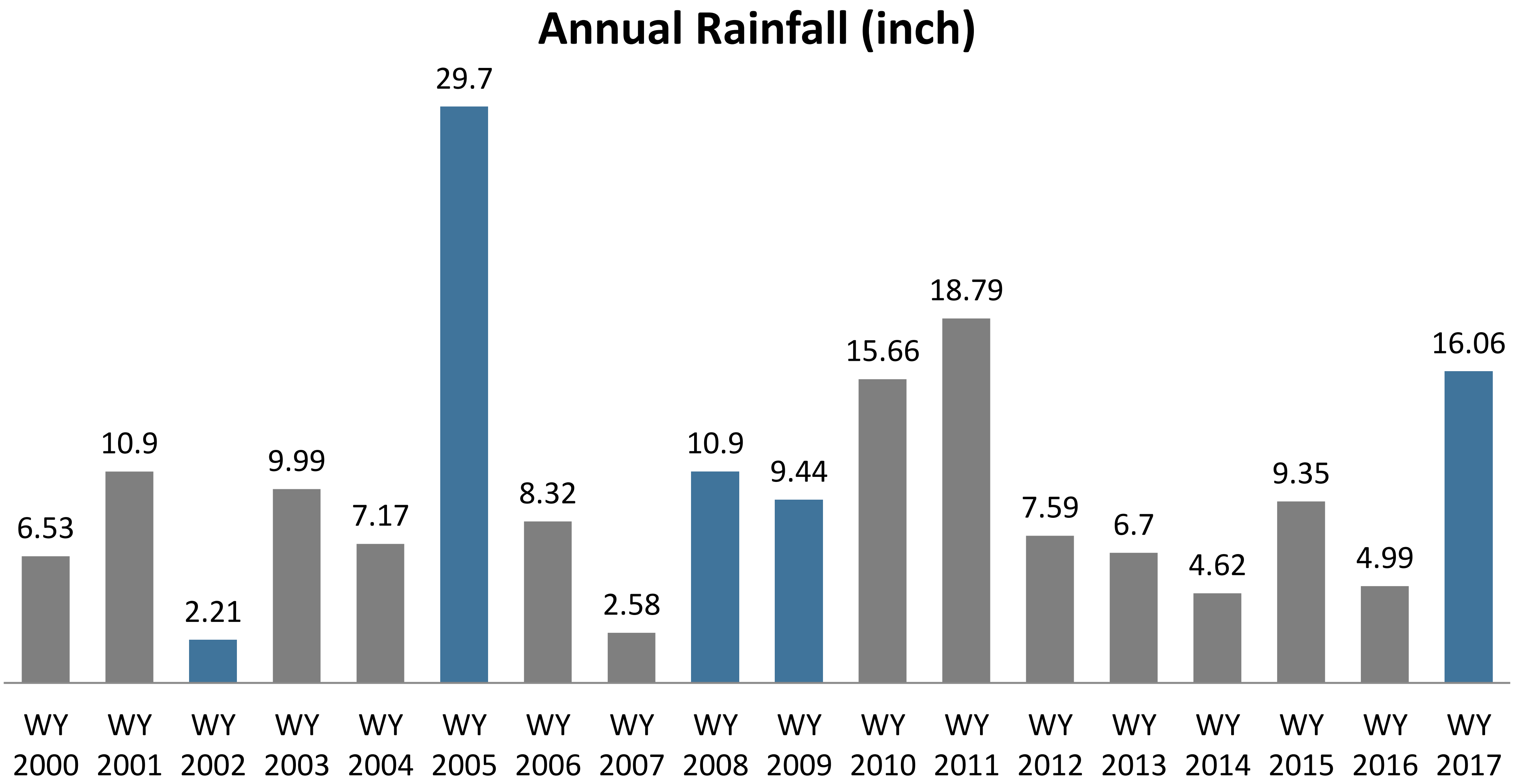

Results: Historic Rainfall

LID Scenario	WY 2002 (Dry)[2] Volume Conserved [acre-ft]	WY 2005 (Wet)[2] Volume Conserved [acre-ft]	WY 2008 (Mid)[3] Volume Conserved [acre-ft]	WY 2009 (Mid)[3] Volume Conserved [acre-ft]	WY 2017[1] Volume Conserved [acre-ft]
Scenario 1	31	42	28	30	28
Scenario 2	80	166	112	116	120
Scenario 3	108	917	454	451	531

[1]WY 2017 is partial and is based on rainfall from 10/01/2016 to 2/08/2017

[2]The Dry (WY2002) and Wet (WY2005) are based on the driest and wettest year from 2000 to 2017 as measured by total annual rainfall

[3] The middle runs (WY2008 and WY2009) are based on years that had approximately the mean annual rainfall for the region compared to other years between 2000 and 2017.

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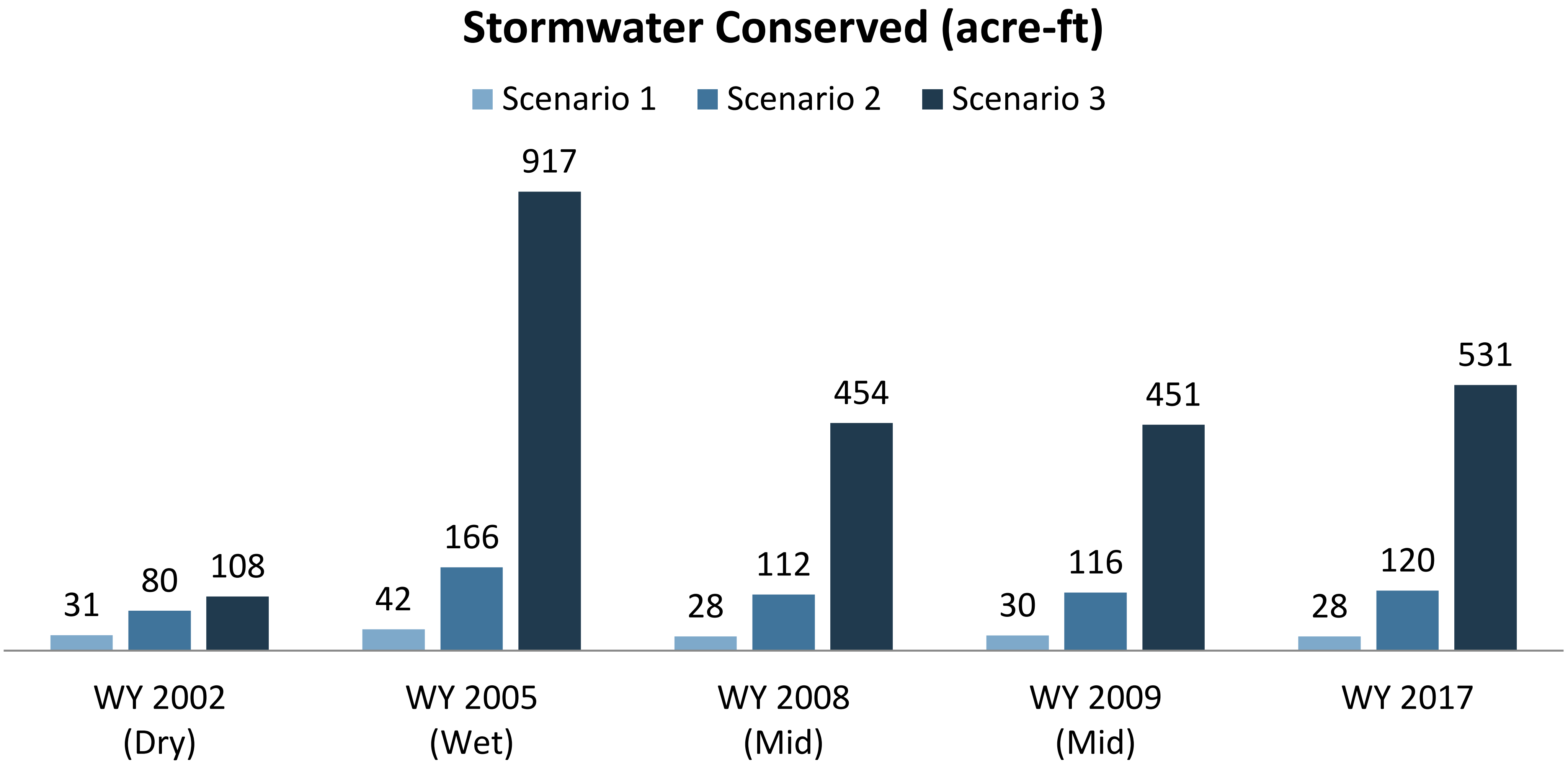

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Scenario 1	29%	3%	5%	6%	4%
Scenario 2	74%	11%	21%	25%	15%
Scenario 3	100%	62%	84%	96%	72%

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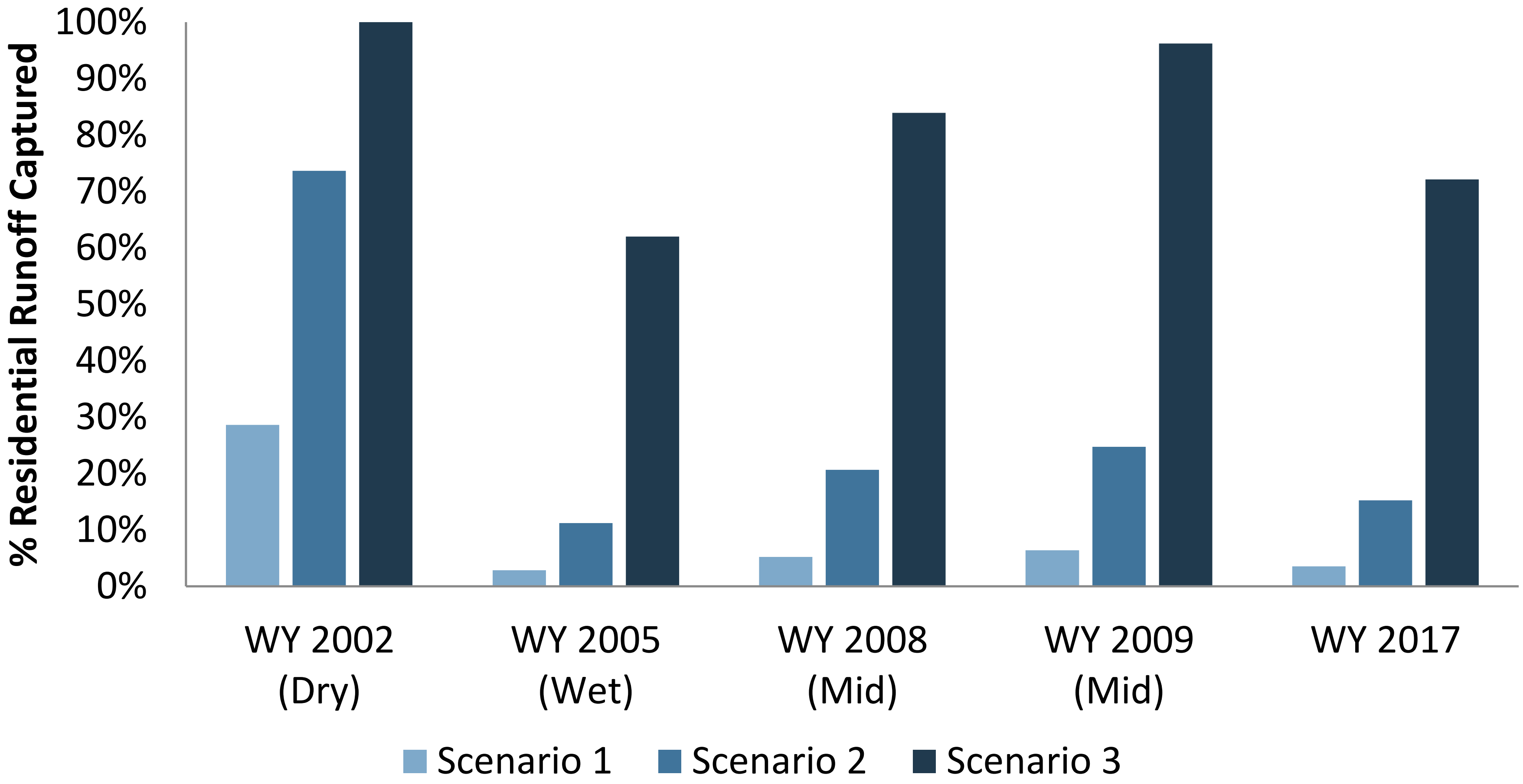

Conclusions

- Scenario 3 has the most conservation. This Scenario models 1,250 gallons of storage per residential parcel. The storage could be a tank or integrated into the landscaping.

- In an average year, the city can save 450 acre-ft (146 million gallons) of water which is about 18% of the city's recycled water use (815 million gallons). That could water about 2,000 yards for the whole year. (https://www3.epa.gov/watersense/pubs/outdoor.html)

- Significant increase in LID volume produces much smaller increase in volume captured.

- The percent of runoff captured is much less sensitive to total annual rainfall than total volume conservation.

- Scenario 3 is the more resilient in terms of adaptability to weather variability and uncertainty. It is more sensitive to total runoff volume compared to the other scenarios.

Acknowledgements

SANITATION DISTRICTS OF LOS ANGELES COUNTY

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water for people

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CALIFORNIA STATE UNIVERSITY LONG BEACH 1949

Questions