



# Stormwater as a Local Resource

## *LADWP's Stormwater Capture Master Plan*

Mark Hanna, PhD, PE

May 6, 2016

- Water imports under pressure and water scarcity becoming the new normal
- Local resource development, like stormwater capture, can help offset imports
- The many municipal needs greatly outweigh funding
- Local investment in water supply can leverage other initiatives such as water quality improvements, flood management, open space development, etc.
- Need to develop technically sound defensible plans to direct our limited resources

# LA's Water Supply

## Water Sources and Reliability Challenges



Delta

Sierra Mountains

State Water Project

Local Groundwater, Conservation,  
Recycled Water, Stormwater Capture



Los Angeles Aqueduct

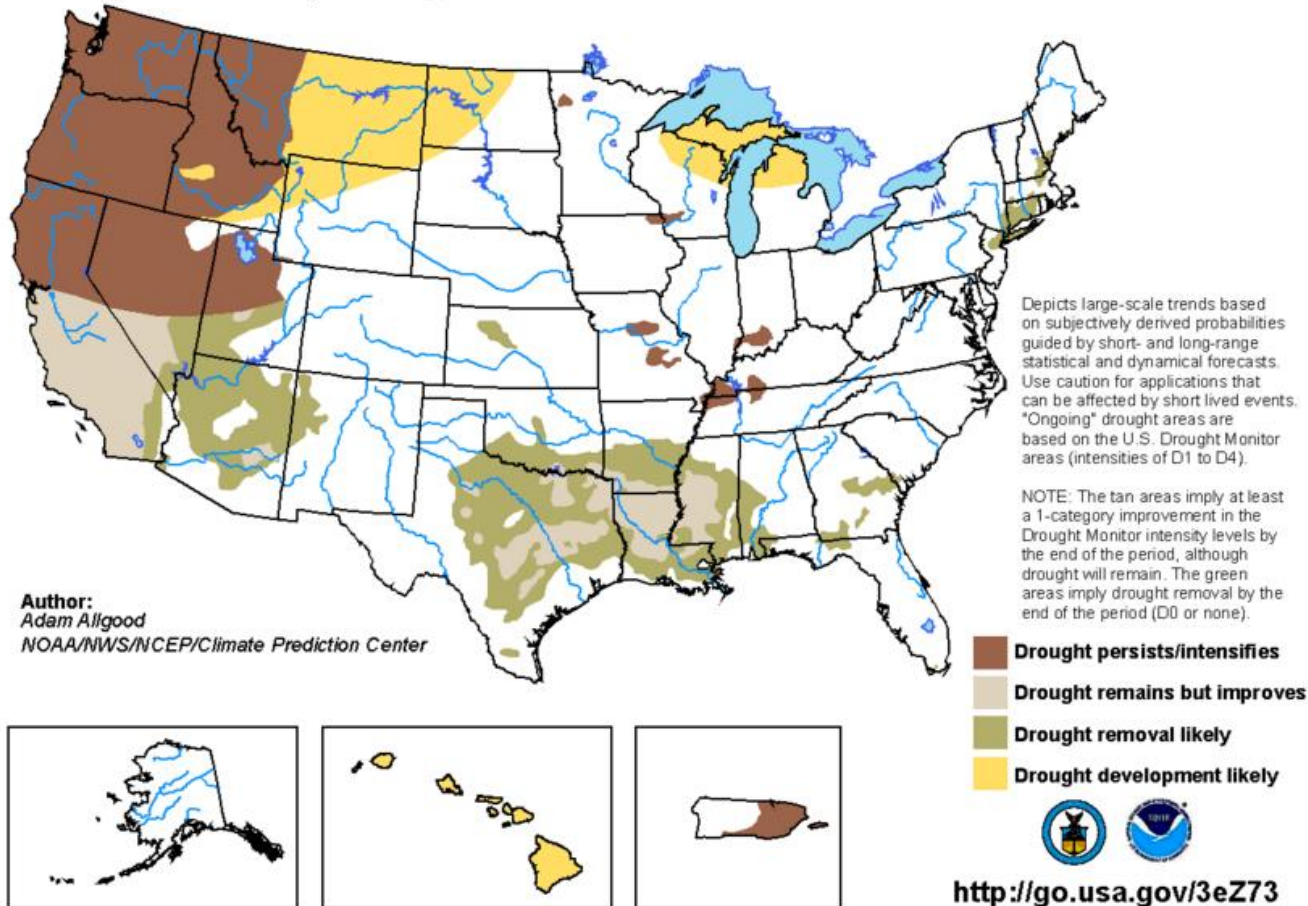


Colorado River Aqueduct

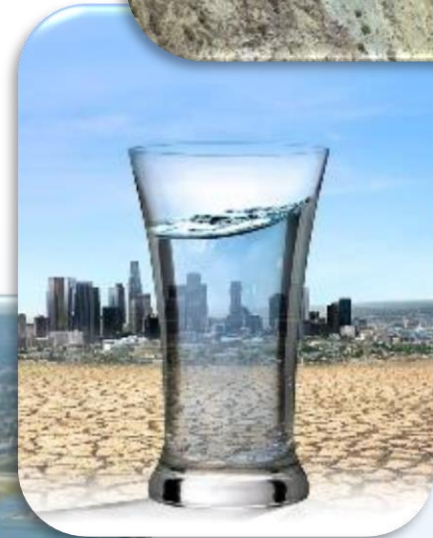


## U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

Valid for October 15 - January 31, 2016  
Released October 15, 2015

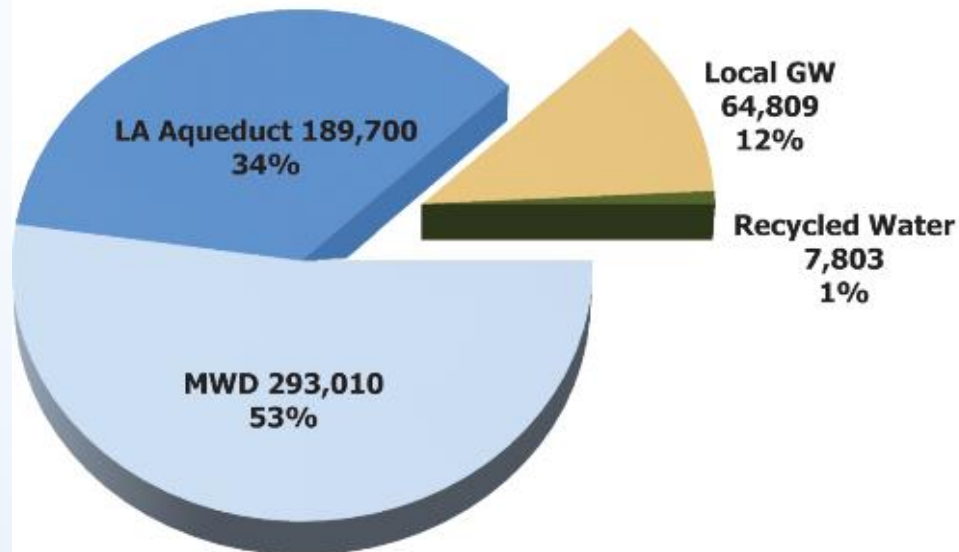


- Increase Water Conservation
- Increase Recycled Water Usage
- Clean-up the Local Groundwater Basins
- Increase Stormwater Capture



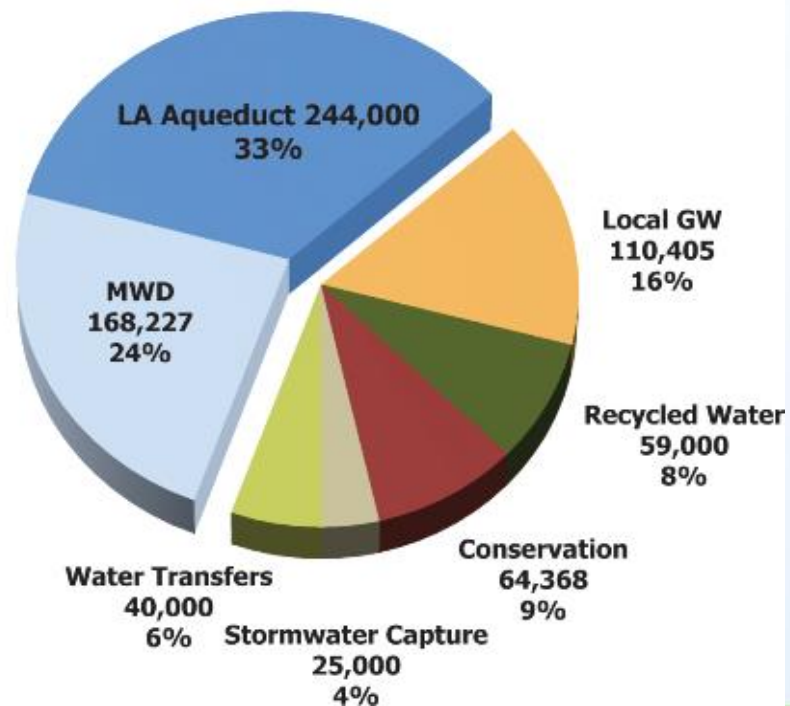
## Today

FYE 2010 - 2014 Average  
Total: 553,876 AFY

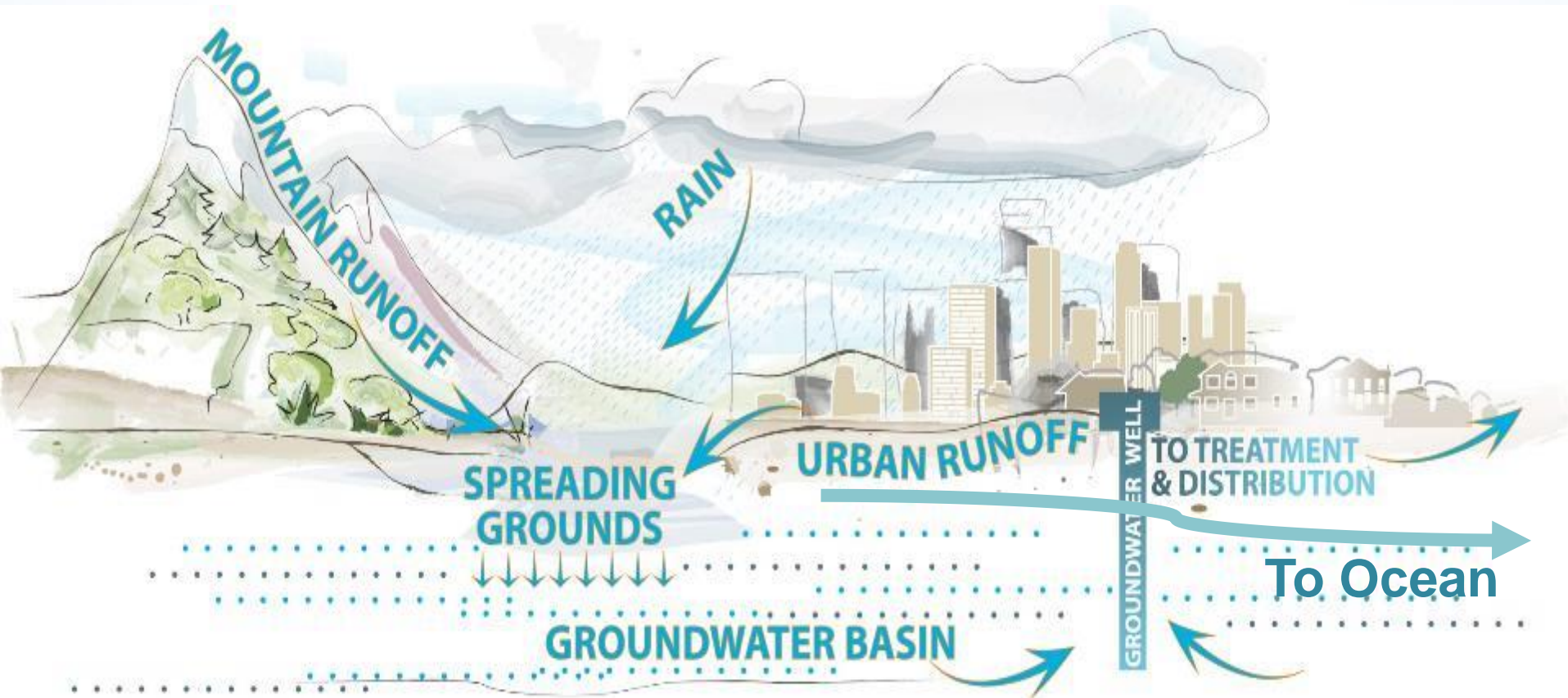


## Future

Fiscal Year 2034 - 35  
Total: 711,000 AFY





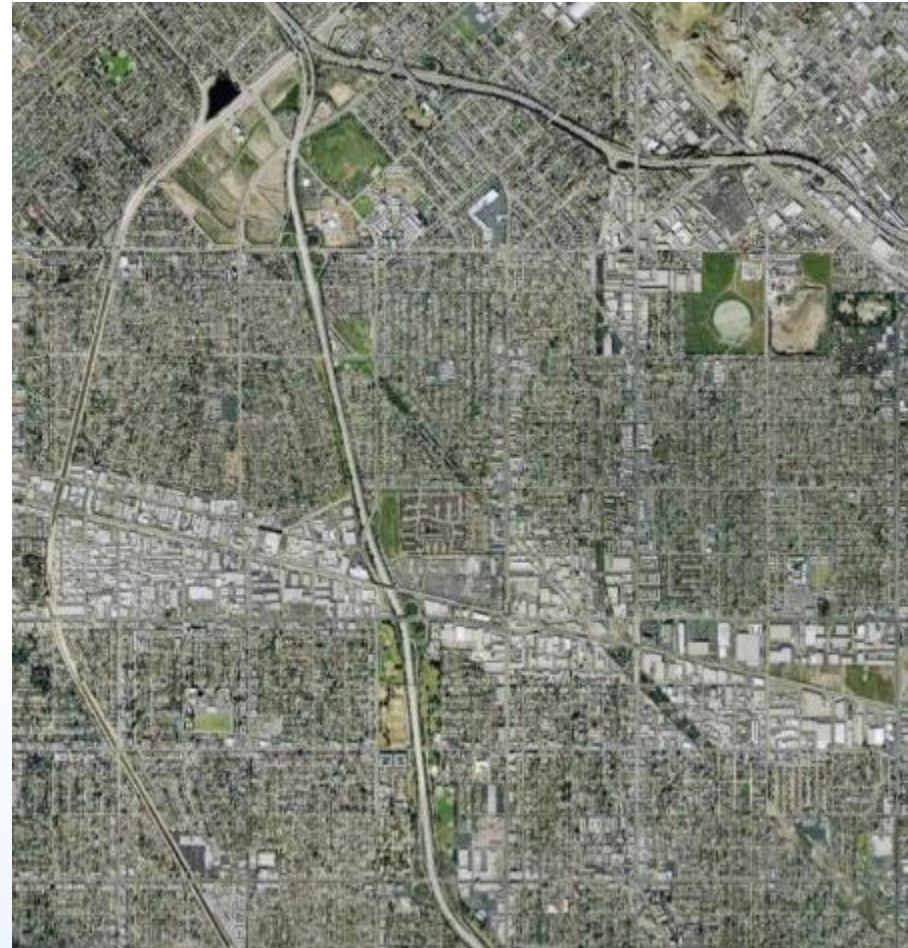




## Why we need to take action



**Eastern San Fernando Valley  
1949**



**Eastern San Fernando Valley  
2008**





WATER & DROUGHT

OCTOBER 25, 2015

# South state storms show no easy remedies for California drought



## HIGHLIGHTS

Mudslides, floods but little drought relief

El Niño stays south, where water storage is lacking

Snow in Sierra Nevada needed for long-term recovery

## Wet Weather



Flow Volume (acre feet per year)			
Reach ID	Average Annual	Wettest Year (2005)	Driest Year (2007)
Reach 6	44,061	117,115	9,202
Reach 5	66,444	178,209	14,942
Reach 4	147,636	517,631	26,181
Reach 3	202,955	709,974	34,758
Reach 2	274,217	939,492	48,095
Reach 1	278,814	951,673	48,887
<p>1. flows do not include point source discharges or dry weather runoff</p> <p>2. water year runs from Oct 1 - Sep 30</p>			



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# Alluvial Groundwater Basins and Subbasins within the South Coast Hydrologic Region





A map of Southern California showing county boundaries and various numbered locations. A red arrow points to the Orange County area, specifically near the Long Beach and Anaheim region. The map includes labels for counties such as Kern, Ventura, Los Angeles, San Bernardino, Orange, Riverside, and San Diego. Numbered locations are scattered across the map, with a concentration in the Los Angeles and Orange County areas. A red arrow points to the Orange County area, specifically near the Long Beach and Anaheim region.

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The map displays the distribution of 100 bird species across Southern California. The species are numbered 1 through 100, with a red arrow highlighting the coastal plain of Los Angeles as the area of highest species richness. The map includes county boundaries and major cities. The distribution is as follows:

- Ventura County:** 4-3, 4-2, 4-1, 4-4, 4-17, 4-18, 4-3.01, 4-3.02, 4-4.01, 4-4.02, 4-4.03, 4-4.04, 4-4.05, 4-4.06.
- Los Angeles County:** 4-5, 4-8, 4-7, 4-15, 4-9, 4-12, 4-23, 4-13, 4-11, 4-16, 4-19, 4-20, 4-11.01, 4-11.02, 4-11.03, 4-11.04.
- San Bernardino County:** 8-2.01, 8-2.02, 8-2.03, 8-2.04, 8-2.05, 8-2.06, 8-2.07, 8-2.08, 8-2.09, 8-8, 8-9, 8-7.
- Orange County:** 8-1, 9-1, 9-2, 9-3, 9-4.
- Riverside County:** 8-5, 8-6, 9-5, 9-6, 9-7, 9-8, 9-25.
- San Diego County:** 9-9, 9-10, 9-22, 9-24, 9-32.

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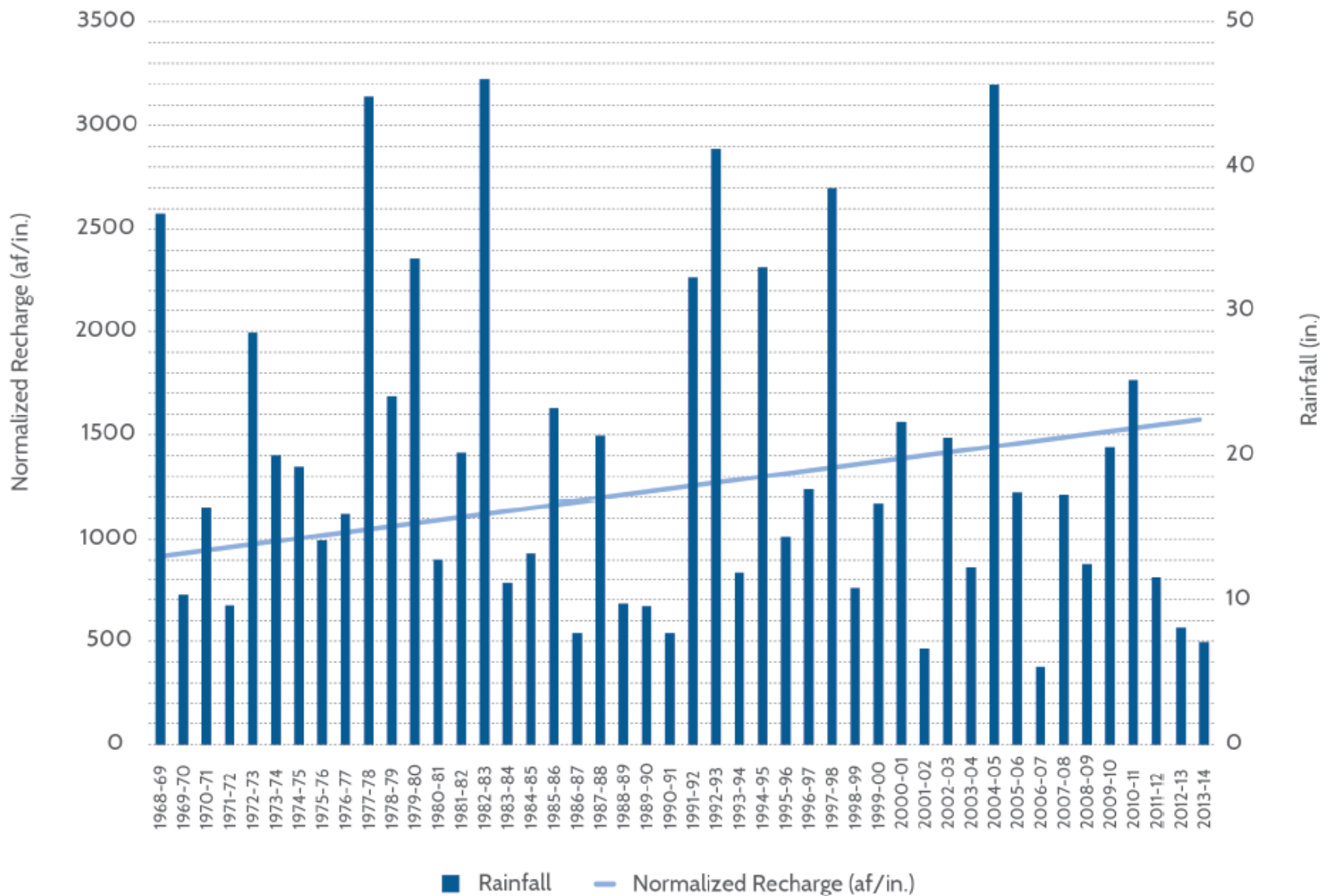
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A map of Southern California showing county boundaries and various numbered locations. A red arrow points to the number 4-12 near Glendale. The map includes labels for counties: KERN, VENTURA, LOS ANGELES, SAN BERNARDINO, ORANGE, RIVERSIDE, and SAN DIEGO. Numbered locations include: 4-3 Ventura River Valley, 4-2, 4-1, 4-4, 4-17, 4-18, 4-10, 4-11, 4-12, 4-13, 4-14, 4-15, 4-16, 4-19, 4-20, 4-22, 4-23, 4-25, 4-26, 4-27, 4-28, 4-29, 4-30, 4-31, 4-32, 4-33, 4-34, 4-35, 4-36, 4-37, 4-38, 4-39, 4-40, 4-41, 4-42, 4-43, 4-44, 4-45, 4-46, 4-47, 4-48, 4-49, 4-50, 4-51, 4-52, 4-53, 4-54, 4-55, 4-56, 4-57, 4-58, 4-59, 4-60, 4-61, 4-62, 4-63, 4-64, 4-65, 4-66, 4-67, 4-68, 4-69, 4-70, 4-71, 4-72, 4-73, 4-74, 4-75, 4-76, 4-77, 4-78, 4-79, 4-80, 4-81, 4-82, 4-83, 4-84, 4-85, 4-86, 4-87, 4-88, 4-89, 4-90, 4-91, 4-92, 4-93, 4-94, 4-95, 4-96, 4-97, 4-98, 4-99, 4-100, 4-101, 4-102, 4-103, 4-104, 4-105, 4-106, 4-107, 4-108, 4-109, 4-110, 4-111, 4-112, 4-113, 4-114, 4-115, 4-116, 4-117, 4-118, 4-119, 4-120, 4-121, 4-122, 4-123, 4-124, 4-125, 4-126, 4-127, 4-128, 4-129, 4-130, 4-131, 4-132, 4-133, 4-134, 4-135, 4-136, 4-137, 4-138, 4-139, 4-140, 4-141, 4-142, 4-143, 4-144, 4-145, 4-146, 4-147, 4-148, 4-149, 4-150, 4-151, 4-152, 4-153, 4-154, 4-155, 4-156, 4-157, 4-158, 4-159, 4-160, 4-161, 4-162, 4-163, 4-164, 4-165, 4-166, 4-167, 4-168, 4-169, 4-170, 4-171, 4-172, 4-173, 4-174, 4-175, 4-176, 4-177, 4-178, 4-179, 4-180, 4-181, 4-182, 4-183, 4-184, 4-185, 4-186, 4-187, 4-188, 4-189, 4-190, 4-191, 4-192, 4-193, 4-194, 4-195, 4-196, 4-197, 4-198, 4-199, 4-200, 4-201, 4-202, 4-203, 4-204, 4-205, 4-206, 4-207, 4-208, 4-209, 4-210, 4-211, 4-212, 4-213, 4-214, 4-215, 4-216, 4-217, 4-218, 4-219, 4-220, 4-221, 4-222, 4-223, 4-224, 4-225, 4-226, 4-227, 4-228, 4-229, 4-230, 4-231, 4-232, 4-233, 4-234, 4-235, 4-236, 4-237, 4-238, 4-239, 4-240, 4-241, 4-242, 4-243, 4-244, 4-245, 4-246, 4-247, 4-248, 4-249, 4-250, 4-251, 4-252, 4-253, 4-254, 4-255, 4-256, 4-257, 4-258, 4-259, 4-260, 4-261, 4-262, 4-263, 4-264, 4-265, 4-266, 4-267, 4-268, 4-269, 4-270, 4-271, 4-272, 4-273, 4-274, 4-275, 4-276, 4-277, 4-278, 4-279, 4-280, 4-281, 4-282, 4-283, 4-284, 4-285, 4-286, 4-287, 4-288, 4-289, 4-290, 4-291, 4-292, 4-293, 4-294, 4-295, 4-296, 4-297, 4-298, 4-299, 4-300, 4-301, 4-302, 4-303, 4-304, 4-305, 4-306, 4-307, 4-308, 4-309, 4-310, 4-311, 4-312, 4-313, 4-314, 4-315, 4-316, 4-317, 4-318, 4-319, 4-320, 4-321, 4-322, 4-323, 4-324, 4-325, 4-326, 4-327, 4-328, 4-329, 4-330, 4-331, 4-332, 4-333, 4-334, 4-335, 4-336, 4-337, 4-338, 4-339, 4-340, 4-341, 4-342, 4-343, 4-344, 4-345, 4-346, 4-347, 4-348, 4-349, 4-350, 4-351, 4-352, 4-353, 4-354, 4-355, 4-356, 4-357, 4-358, 4-359, 4-360, 4-361, 4-362, 4-363, 4-364, 4-365, 4-366, 4-367, 4-368, 4-369, 4-370, 4-371, 4-372, 4-373, 4-374, 4-375, 4-376, 4-377, 4-378, 4-379, 4-380, 4-381, 4-382, 4-383, 4-384, 4-385, 4-386, 4-387, 4-388, 4-389, 4-390, 4-391, 4-392, 4-393, 4-394, 4-395, 4-396, 4-397, 4-398, 4-399, 4-400, 4-401, 4-402, 4-403, 4-404, 4-405, 4-406, 4-407, 4-408, 4-409, 4-410, 4-411, 4-412, 4-413, 4-414, 4-415, 4-416, 4-417, 4-418, 4-419, 4-420, 4-421, 4-422, 4-423, 4-424, 4-425, 4-426, 4-427, 4-428, 4-429, 4-430, 4-431, 4-432, 4-433, 4-434, 4-435, 4-436, 4-437, 4-438, 4-439, 4-440, 4-441, 4-442, 4-443, 4-444, 4-445, 4-446, 4-447, 4-448, 4-449, 4-450, 4-451, 4-452, 4-453, 4-454, 4-455, 4-456, 4-457, 4-458, 4-459, 4-460, 4-461, 4-462, 4-463, 4-464, 4-465, 4-466, 4-467, 4-468, 4-469, 4-470, 4-471, 4-472, 4-473, 4-474, 4-475, 4-476, 4-477, 4-478, 4-479, 4-480, 4-481, 4-482, 4-483, 4-484, 4-485, 4-486, 4-487, 4-488, 4-489, 4-490, 4-491, 4-492, 4-493, 4-494, 4-495, 4-496, 4-497, 4-498, 4-499, 4-500, 4-501, 4-502, 4-503, 4-504, 4-505, 4-506, 4-507, 4-508, 4-509, 4-510, 4-511, 4-512, 4-513, 4-514, 4-515, 4-516, 4-517, 4-518, 4-519, 4-520, 4-521, 4-522, 4-523, 4-524, 4-525, 4-526, 4-527, 4-528, 4-529, 4-530, 4-531, 4-532, 4-533, 4-534, 4-535, 4-536, 4-537, 4-538, 4-539, 4-540, 4-541, 4-542, 4-543, 4-544, 4-545, 4-546, 4-547, 4-548, 4-549, 4-550, 4-551, 4-552, 4-553, 4-554, 4-555, 4-556, 4-557, 4-558, 4-559, 4-560, 4-561, 4-562, 4-563, 4-564, 4-565, 4-566, 4-567, 4-568, 4-569, 4-570, 4-571, 4-572, 4-573, 4-574, 4-575, 4-576, 4-577, 4-578, 4-579, 4-580, 4-581, 4-582, 4-583, 4-584, 4-585, 4-586, 4-587, 4-588, 4-589, 4-590, 4-

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# Increased Recharge Efficiencies



**Dam Improvements**



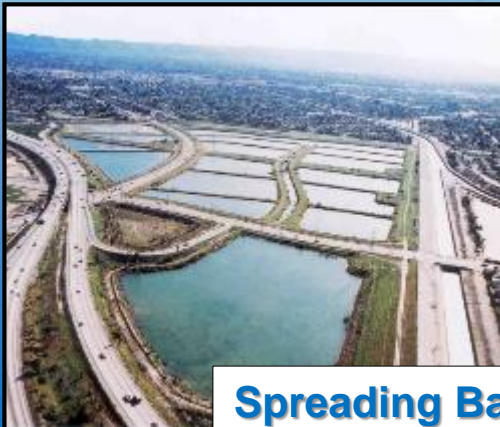
**Sub-Regional**



Centralized

**CAPTURE**

Distributed



**Spreading Basins**

**Parkway Basins**



**Rain Barrels**







## What is the Master Plan?

- Technically sound and defensible plan to guide LADWP's stormwater investments over the next 20 years

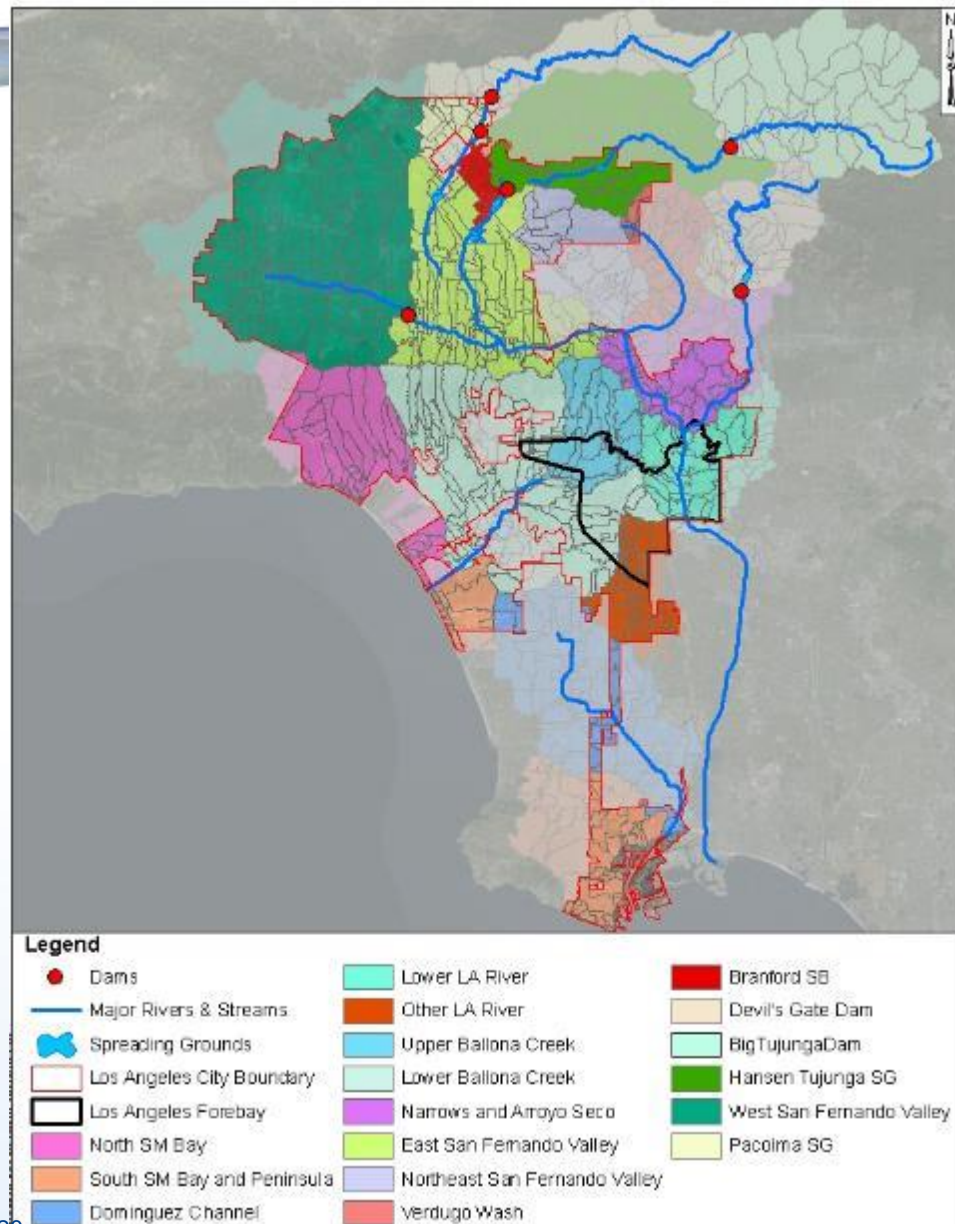
## Goals of the Master Plan

- Quantify stormwater capture potential through a flexible scenario-based program
- Identify new projects, programs, and policies
- Prioritize based on water supply criteria
- Develop cost/benefits for proposed projects/programs/policies

# Subwatersheds

Study area divided into 1001 subbasins grouped into 17 subwatersheds by:

- Major watersheds
- Centralized facilities
- River networks
- Aquifer boundaries



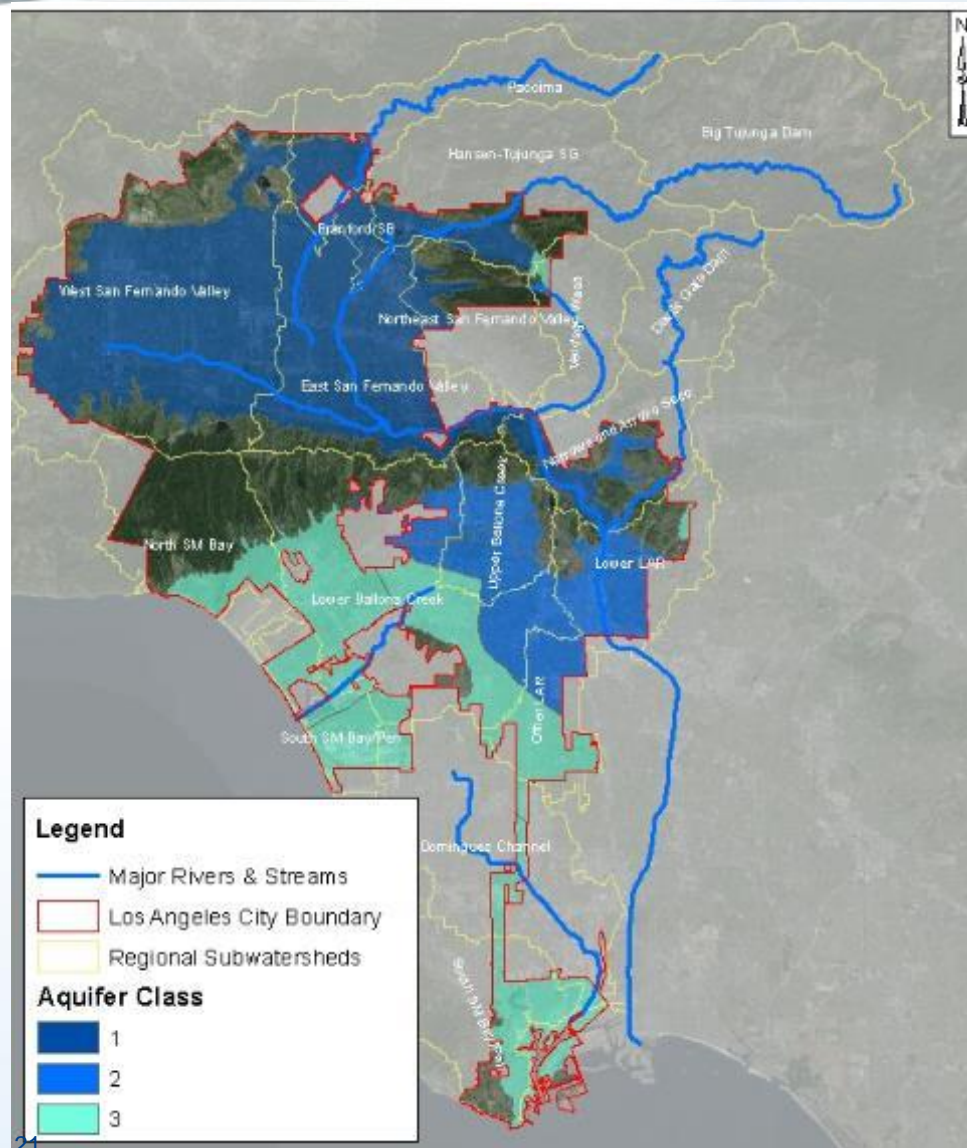


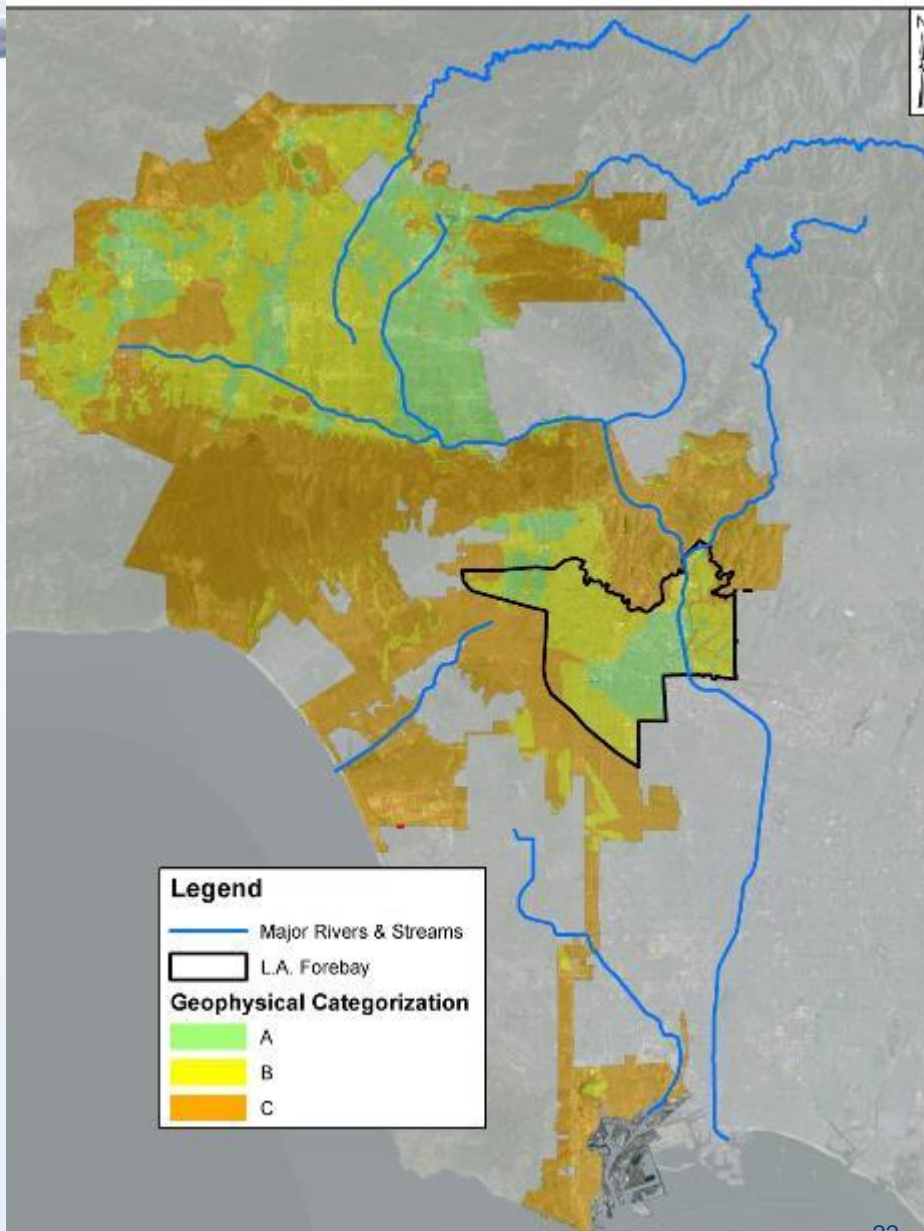
## Groundwater Basins

- San Fernando Basin
- Hollywood Basin
- Santa Monica Basin
- Central Basin
- West Coast Basin

## Aquifer Classes

- Class 1: City controlled
- Class 2: Regionally controlled
- Class 3: Perched





## CATEGORY A

- Least hydrogeologically constrained
- Highest priority aquifers
- Conducive to infiltration BMPs

## CATEGORY B

- Somewhat hydrogeologically constrained
- Mid level priority aquifers
- Conducive to infiltration BMPs

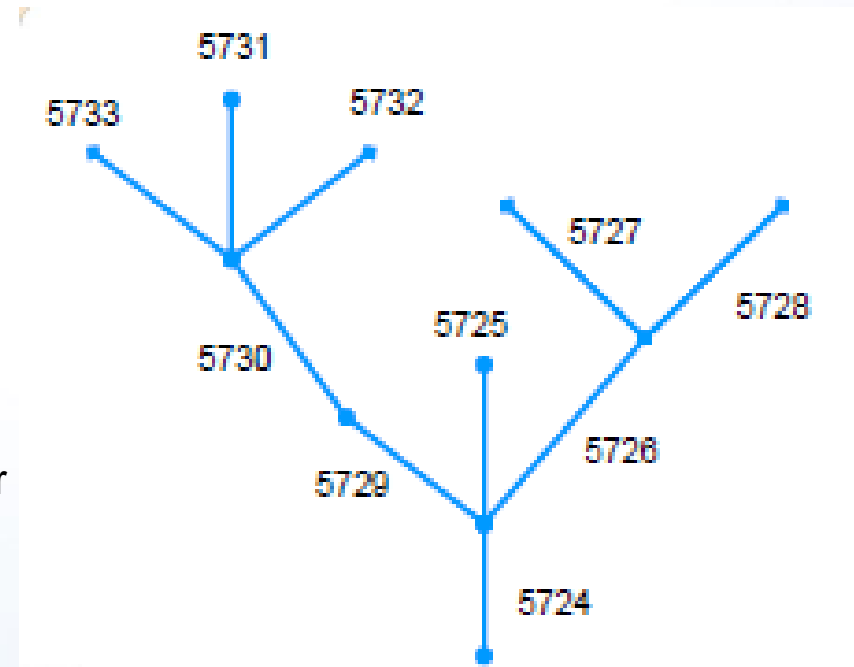
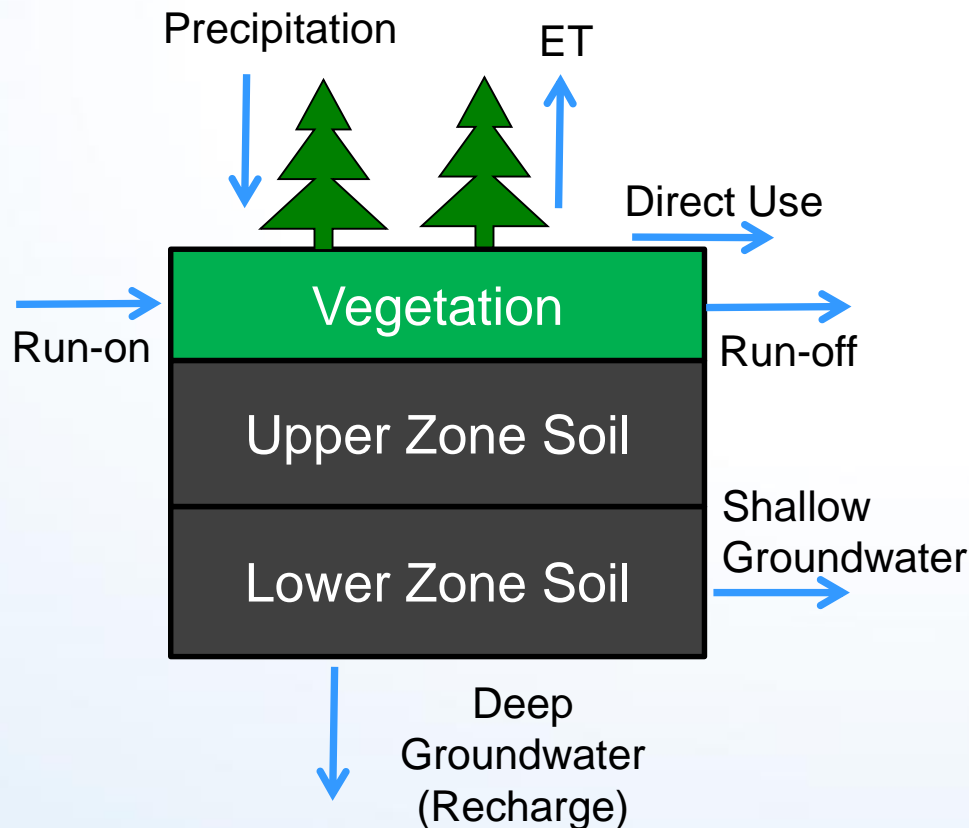
## CATEGORY C

- Most hydrogeologically constrained
- Lower priority aquifers
- More advantageous for direct use BMPs



# Modeling Process

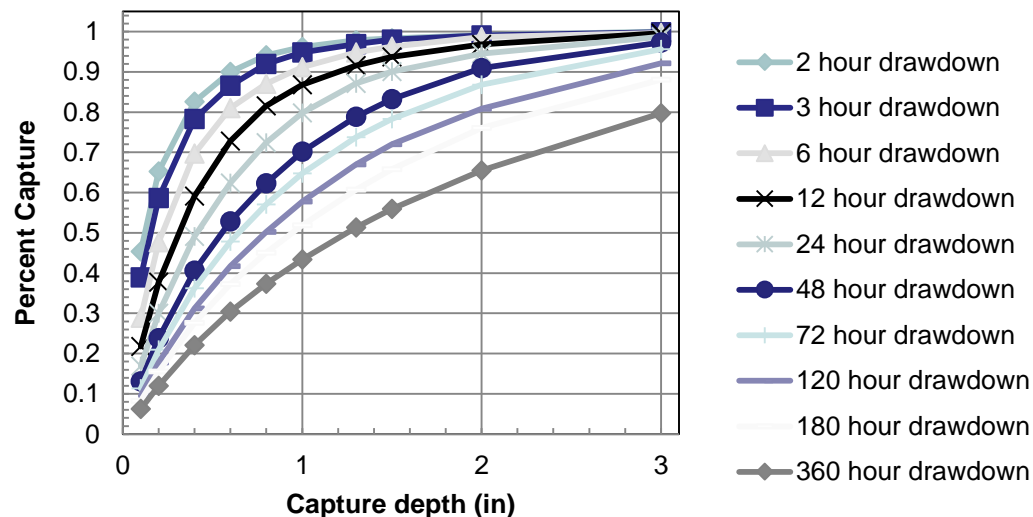
## Step 1: Hydrology modeling of existing condition. (LSPC/GWAM)



# Modeling Process

## Step 2: Modeling of unit BMPs to develop nomographs. (LSPC)

**Example: Burbank Rain Gauge**



Precip / ET (71 gages)



Runoff

1 acre-impervious area

Generic BMP  
(10 capture depths,  
10 drawdown times)

Overflow

Capture (recharge / direct use)



# Modeling Process

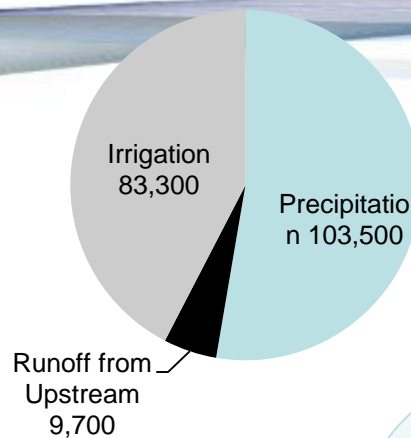
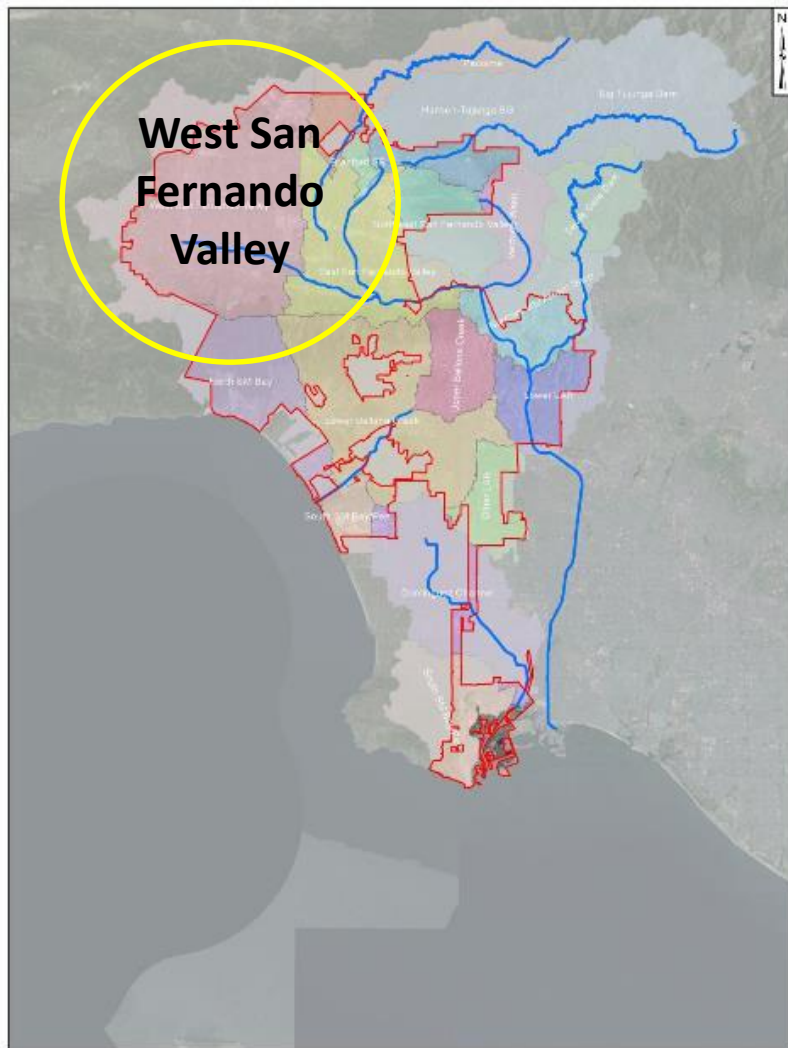
Step 3: Project and program development, application throughout City, and quantification of capture

## Centralized Facilities

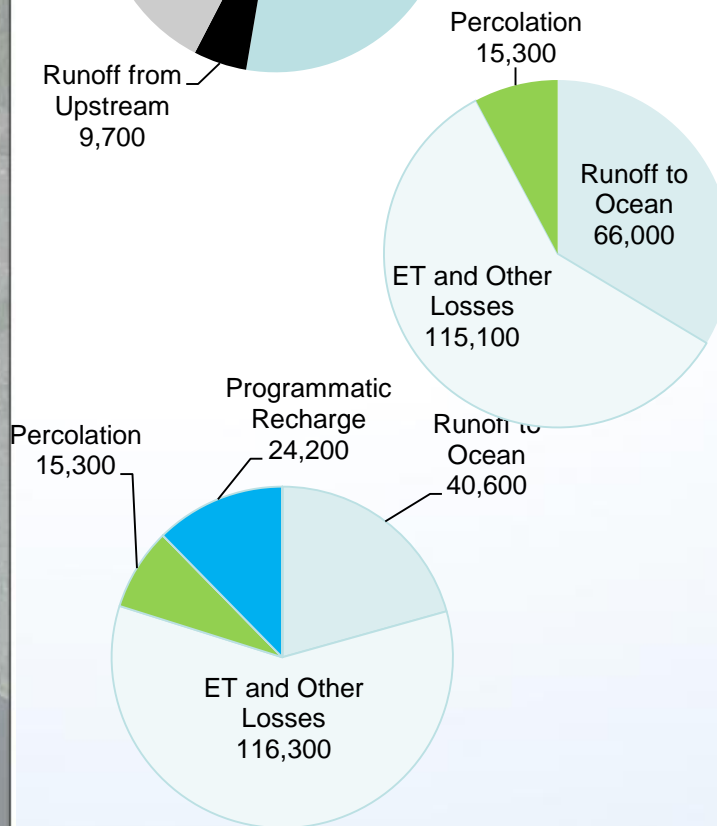


## Distributed Programs

Program	Examples
On-site Infiltration	Residential Rain Garden Program
Green Streets	Commercial Green Street Program
Subregional Infiltration	Neighborhood Recharge Facility Program
On-site Direct Use	Residential or Commercial Cistern Program
Subregional Direct Use	Distributed Reservoir Program
Impervious Replacement	Impervious Surface Replacement Program



**Inputs  
(af/yr)**

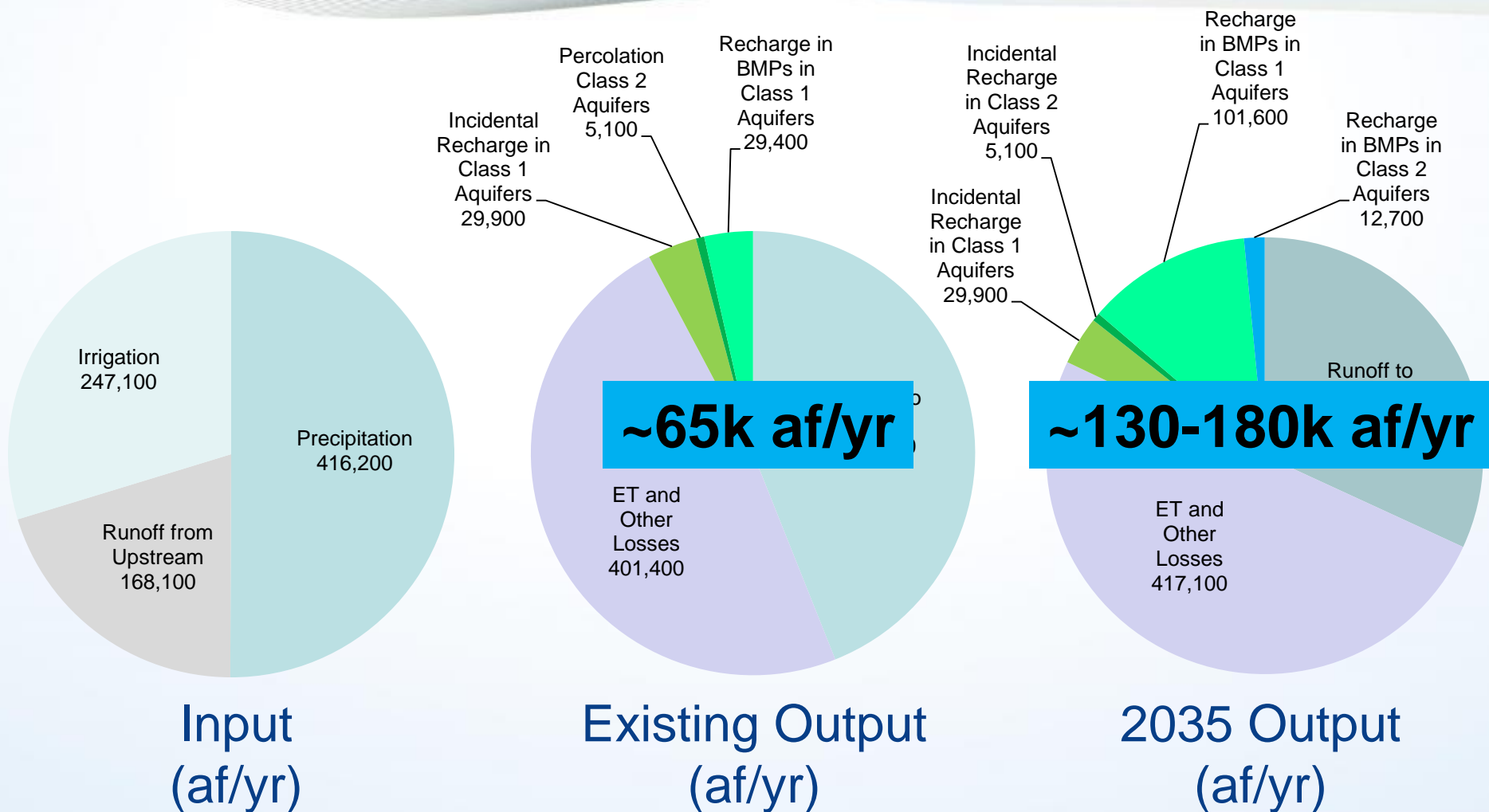


**2015  
Output  
(af/yr)**

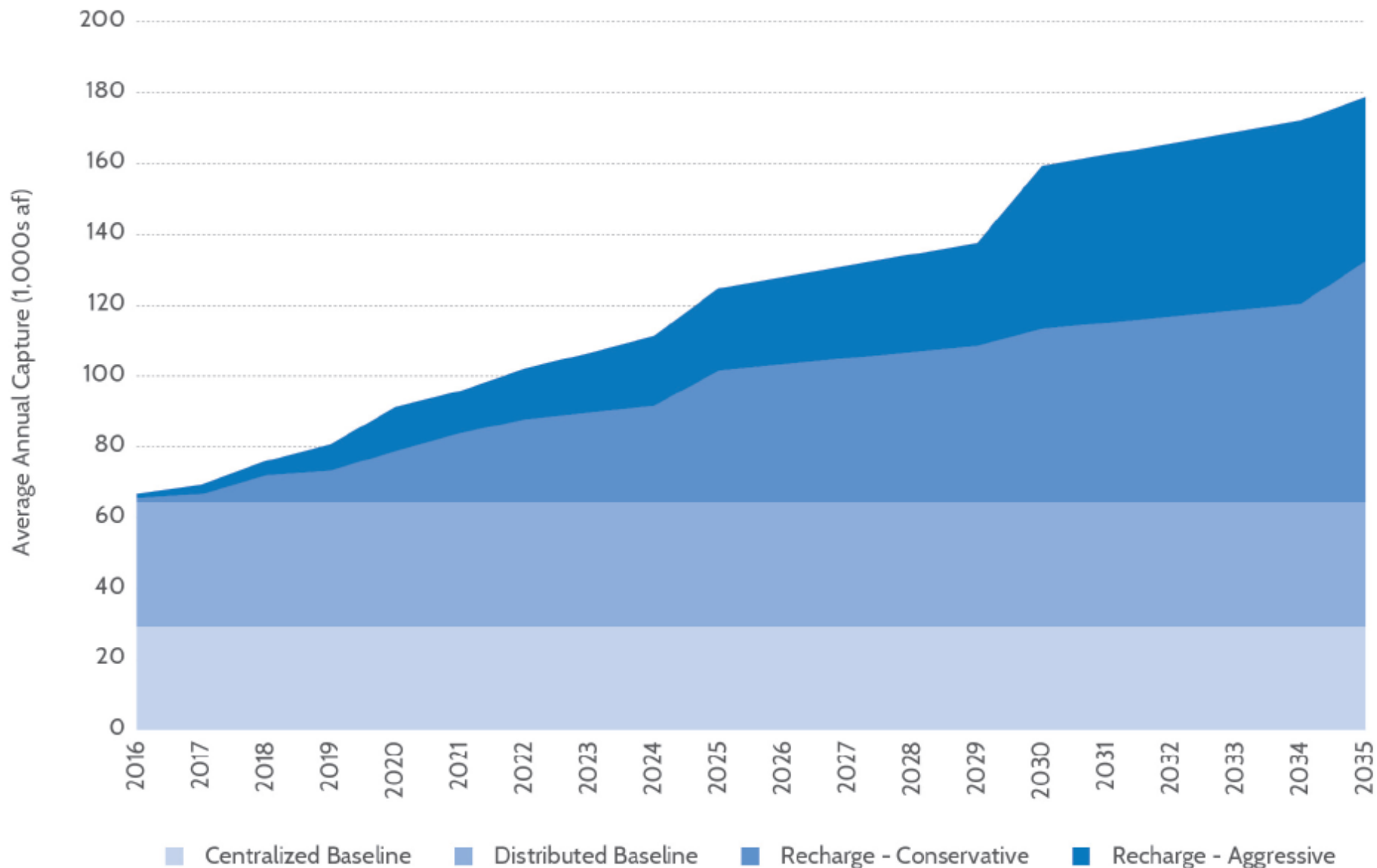
**2035  
Output  
(af/yr)**



# Results (City Wide)

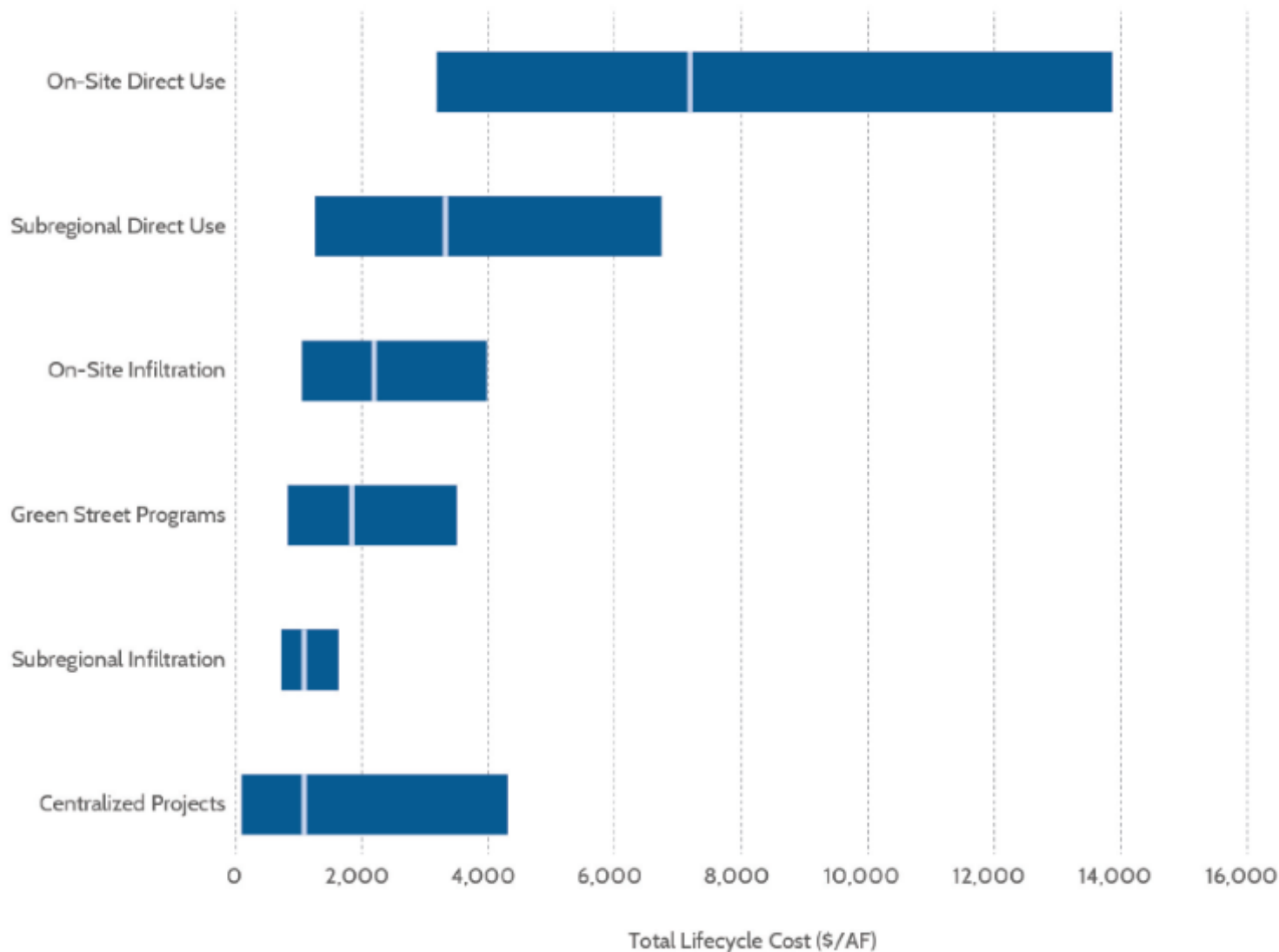


# Water Supply Benefits Over Time



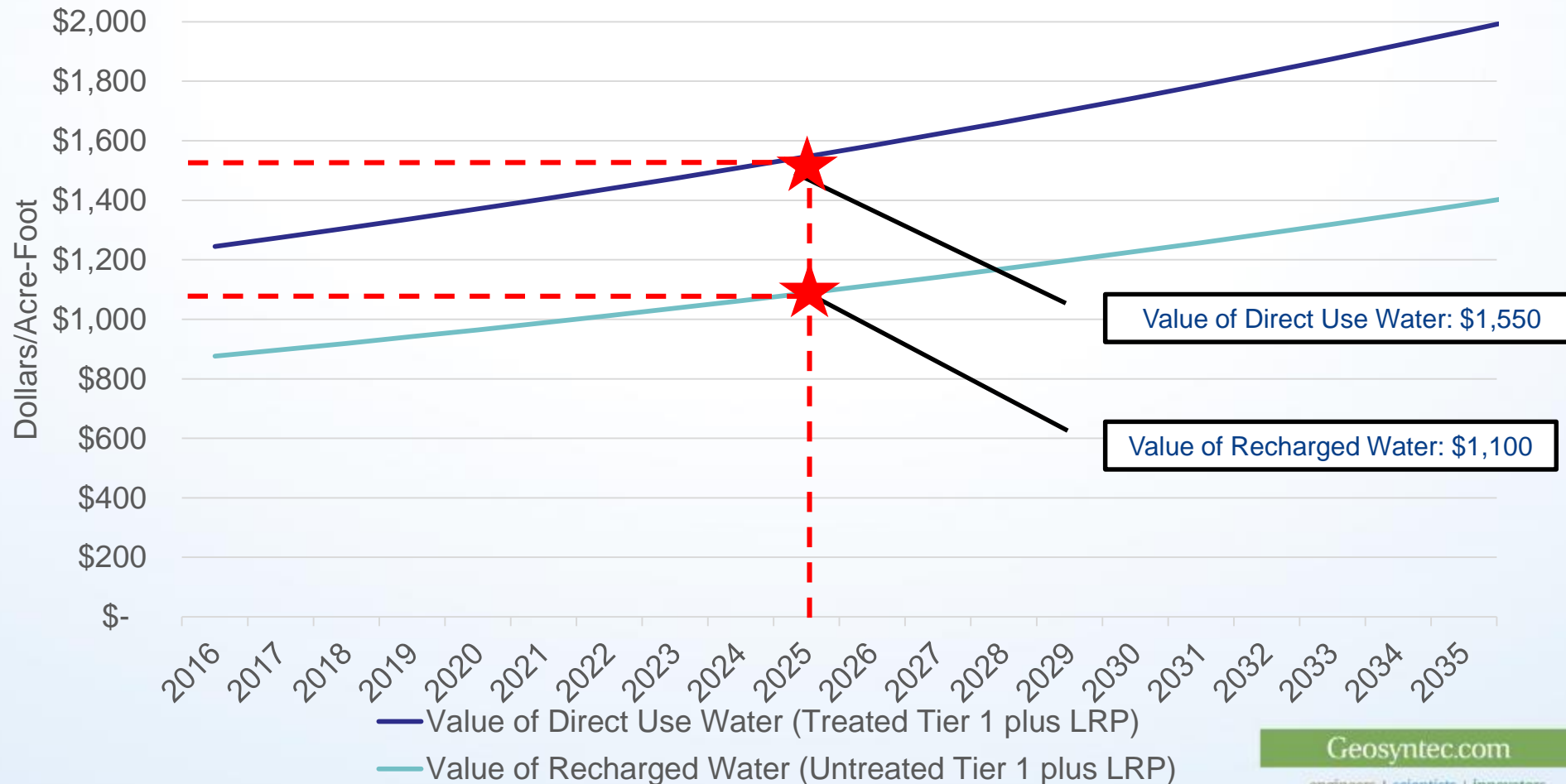


# Program Cost Effectiveness



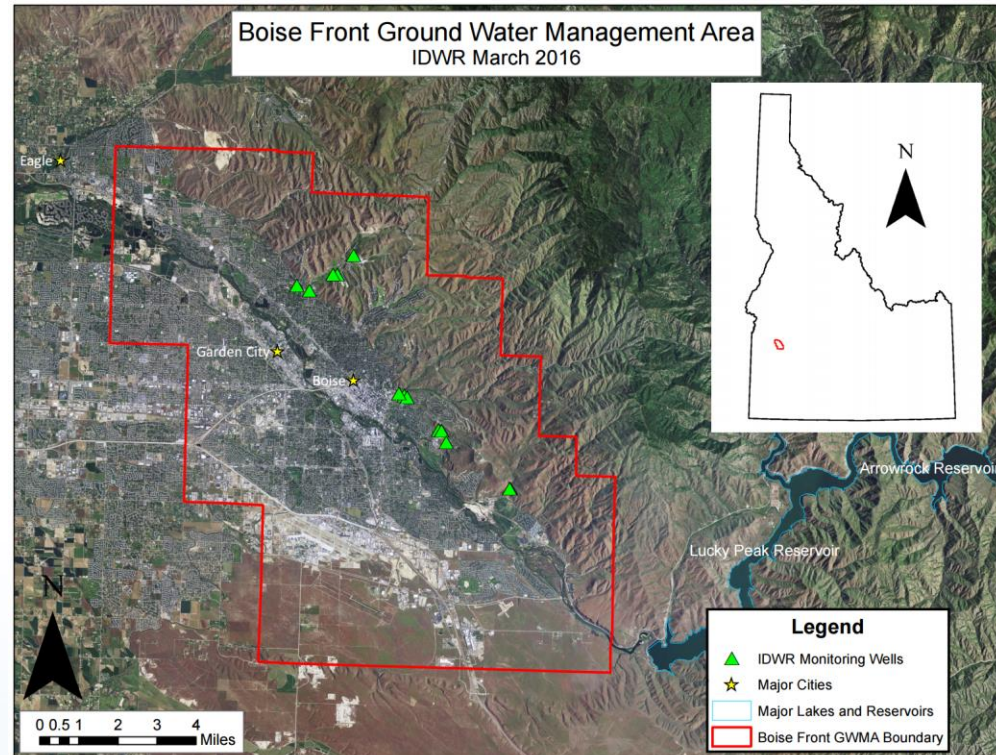
# Implementation Strategies – Value of Captured Water to LADWP

Projected Cost of MWD Water



# Summary of Benefits

- Water supply through groundwater augmentation
- Water conservation through direct use programs
- Improved flood risk management
- Enhanced water quality
- Peak flow reductions
- Open space creation/preservation

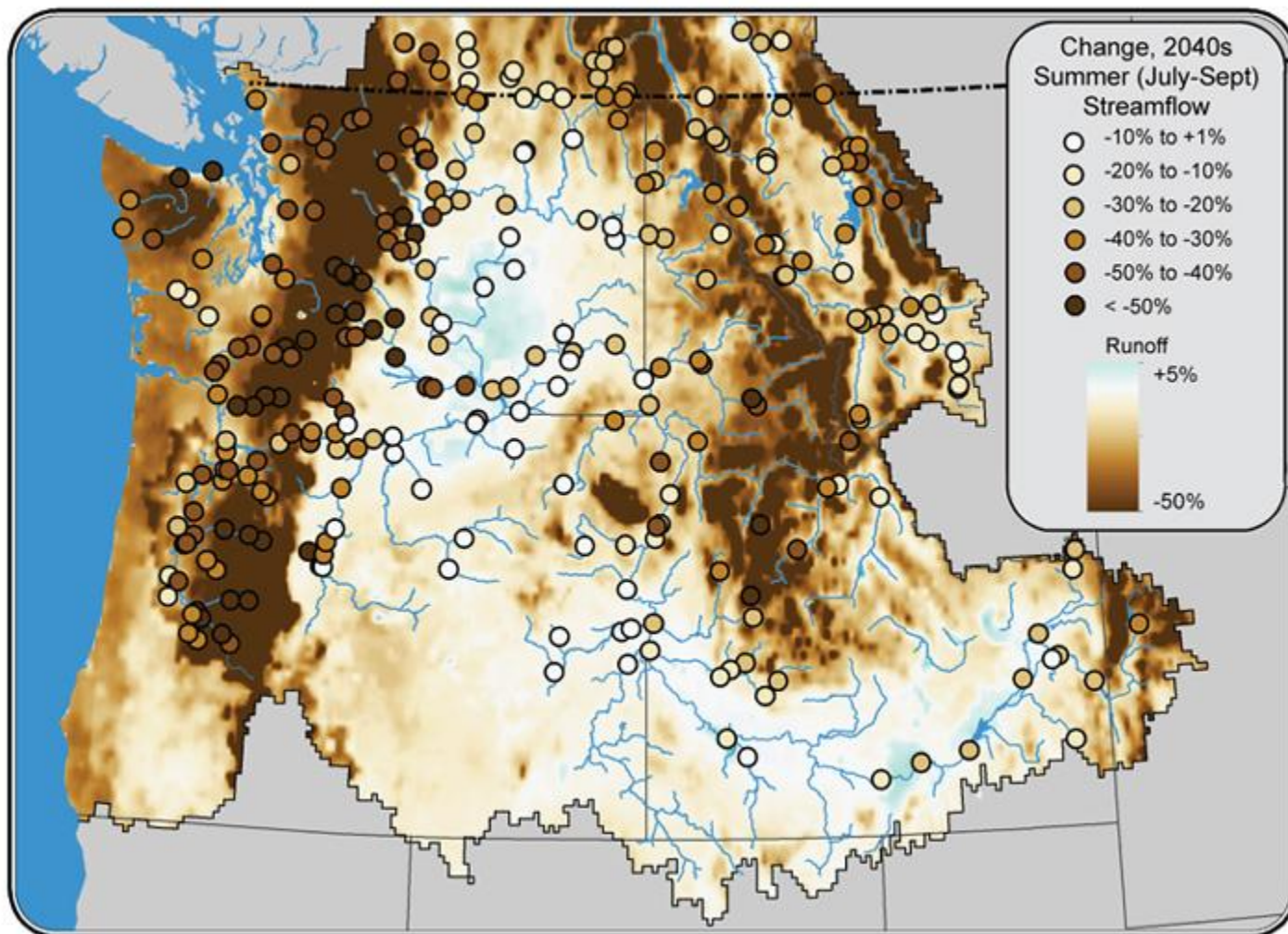




- Purveyor-led projects and programs
  - Centralized and subregional facilities specifically for water supply
- Purveyor-coordinated (with other agencies)
  - Multi-benefit approaches to stormwater management
- Property owner implementation
  - Require LID (and incentivize voluntary actions)

# Implications for the PNW

## Reduced Summer Flows



- Stormwater capture master planning for water supply can help guide other policies and investments being made.
- The development of technically sound and defensible plans requires surface water and groundwater modeling, and a comprehensive understanding of future conditions
- In Los Angeles, the current value of water delivered to the City is ~\$800 per acre-foot with a premium of ~\$300 for locally controlled water



- [https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-water-sourcesofsupply/a-w-sos-stormwatercapture?\\_adf.ctrl-state=7kadrrnkq\\_29&\\_afLoop=119111353319321](https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-water-sourcesofsupply/a-w-sos-stormwatercapture?_adf.ctrl-state=7kadrrnkq_29&_afLoop=119111353319321)

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[Start new service](#) →

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[New construction](#) →  
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## Stormwater Capture

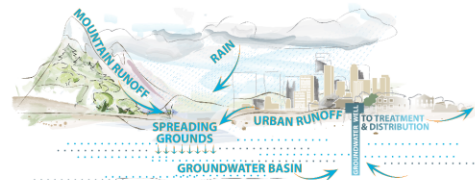
### Background

LADWP is working to reduce our reliance on higher cost imported water. To do so, the LADWP is pursuing a multi-pronged initiative that includes stormwater capture, water conservation, recycled water, and groundwater reclamation.

Stormwater capture is an important element of the LADWP's overall plan to increase our local water supply. The principle involves capturing precious rainfall and runoff from open space and urban lands for either direct use or allowing the water to infiltrate into groundwater basins for future use.

Each year, on average, more than 27,000 acre-feet (more than 8.8 billion gallons) of stormwater is captured each year at centralized spreading grounds where it recharges the San Fernando Groundwater Basin. Stormwater runoff that cannot be contained at these facilities is discharged to the Pacific Ocean via streams, rivers, and storm drains. LADWP plans to continue implementing stormwater capture projects that decrease the amount of runoff lost to the Pacific Ocean. Projects include large scale spreading grounds enhancements and smaller scale green streets, rain gardens, and rain barrels.

To learn more about how stormwater capture fits into the LADWP's efforts to secure a sustainable water supply for Los Angeles, please view the [2010 Urban Water Management Plan](#).



### Contact Us

For more information on the Stormwater Capture Program, please fill out our [Contact Us Form](#) →.

### Stormwater Capture Master Plan

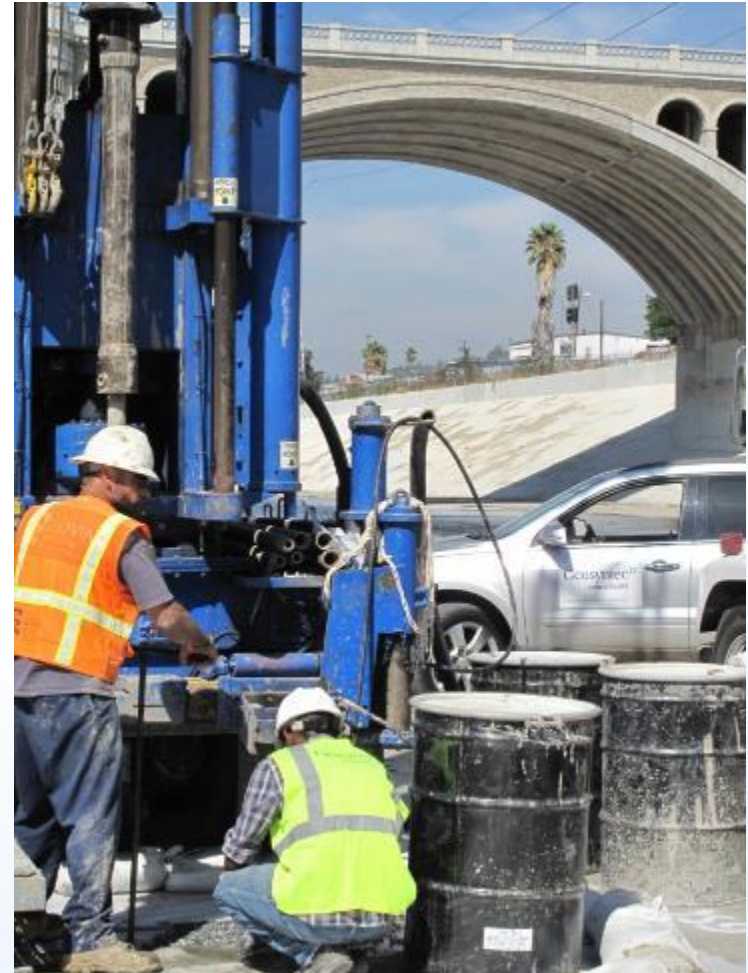
LADWP has completed its Stormwater Capture Master Plan.

[Learn more about the Stormwater Capture Master Plan](#) →

### Final Documents

- [Stormwater Capture Master Plan Final Report](#)
- [Stormwater Capture Master Plan Appendices](#)
- [Stormwater Capture Master Plan Fact Sheet](#)

**Mark Hanna, PhD, PE**  
**Geosyntec Consultants**  
**[mhanna@geosyntec.com](mailto:mhanna@geosyntec.com)**





- Yakima Basin, WA
  - In the basin, drought conditions lead to curtailed water deliveries to preserve environmental flows. Multiple stakeholders have collaborated to:
    - Evaluate recharge to surficial alluvial aquifers with excess streamflows
    - Evaluate aquifer storage and recovery (ASR) into deeper basalt aquifers
- Nisqually Watershed, WA
  - The community has been evaluating surface and subsurface storage options to retain excess streamflow
- Snohomish County, WA
  - The County has evaluated infiltration of stormwater flows for aquifer storage, including:
    - Investigation of land use effects on aquifer storage and baseflow to streams
    - Delineation of critical aquifer recharge areas
- City of Salem, OR
  - The City developed a municipal aquifer storage and recovery (ASR) well field
  - The ASR wellfield provides 10 million gallons per day capacity in a basalt aquifer.
- City of Issaquah, WA
  - The City has evaluated water quantity and quality impacts from the development of aquifer storage projects.
  - Investigated infiltrating stormwater flows.