Next Generation Planning: from Modeling to Web-based Tracking

PARADIGM ENVIRONMENTAL

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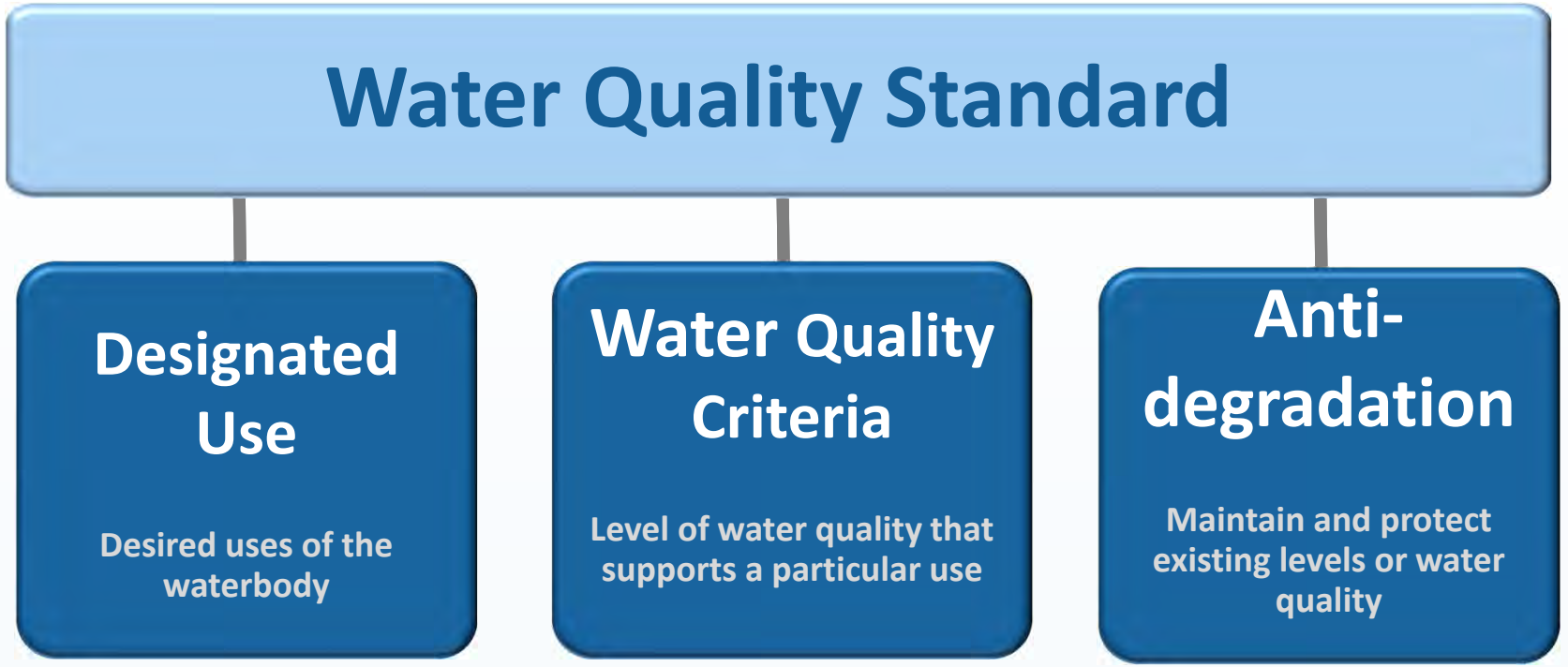
Overview

- Wading through Clean Water Act requirements
- Policy decisions informed through process-based modeling
- Implementation tracking and adaptive management
- Grand, overarching conclusions

Clean Water Act (fishable and swimmable)



Example:	Aquatic Life	Total copper < 18 ug/L (acute)	No degradation of “Outstanding National Resources Waters” allowed

So, where does this lead us?

Runoff is a primary source of pollutants

+ Not possible to instantly achieve water quality standards everywhere

+ Large array of options for where and how to control pollutants in runoff

+ Public needs clear path forward with costs and timeline

Need:
Tools to Analyze Costs and Benefits of an Array Stormwater Management Scenarios

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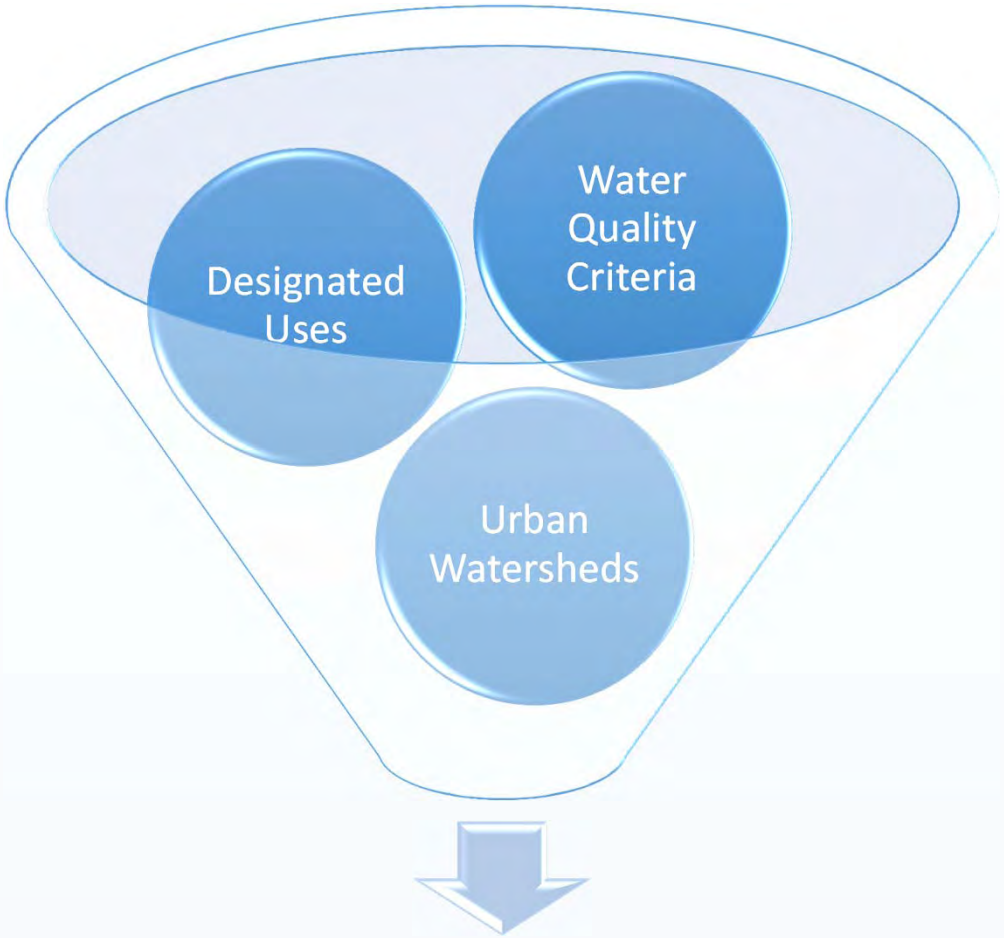
Watershed Management Programs (Los Angeles County)

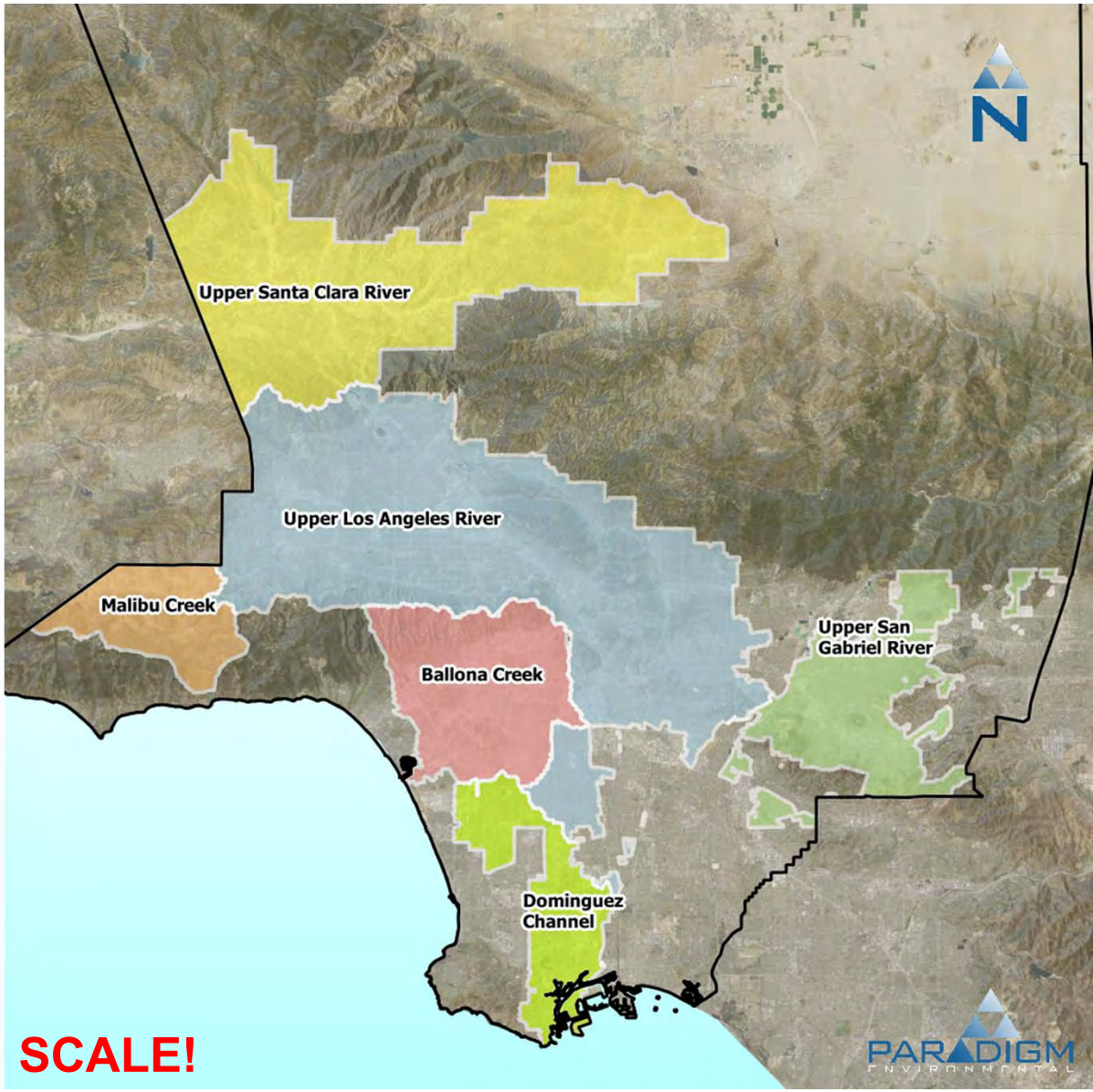


Watershed Management Programs

Recent Watershed Management Programs

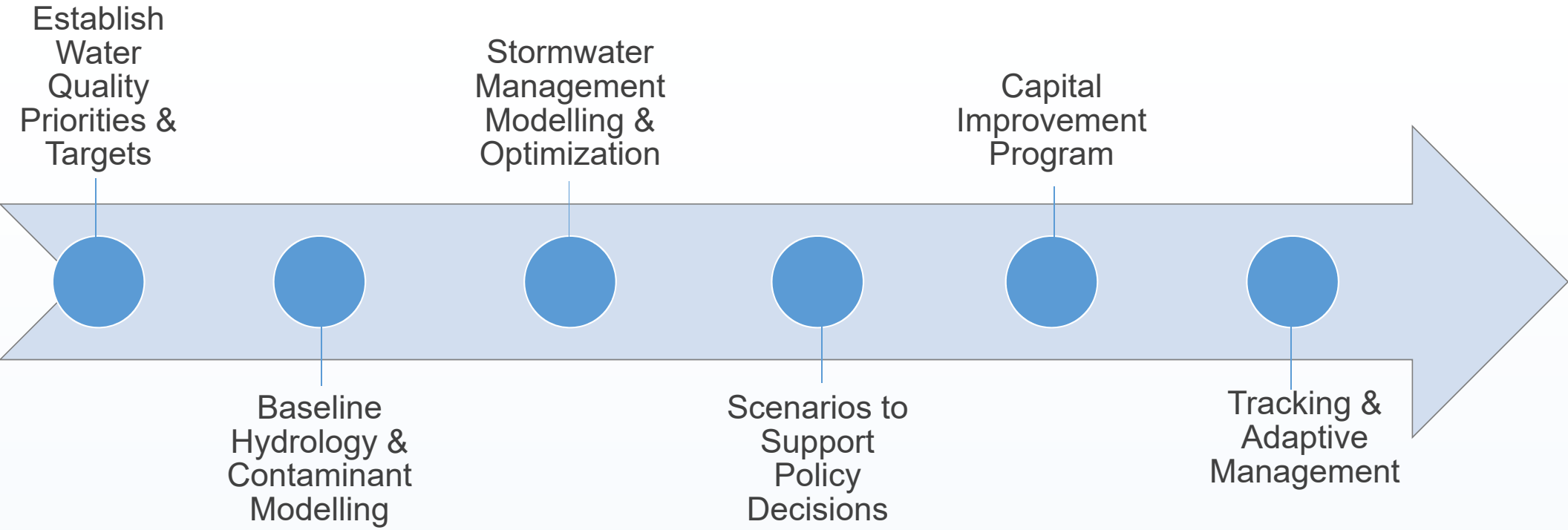
- Upper Los Angeles River
- Upper San Gabriel River
- Upper Santa Clara River
- Malibu Creek
- Ballona Creek
- Dominguez Channel

Plus: Snohomish County, Wash.



Next-Generation Programs

PARADIGM ENVIRONMENTAL



Next-Generation Stormwater Management Program

Watershed Management Modeling System

LSPC "Baseline Model"

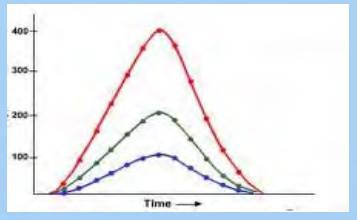
Data

- Real Rainfall
- Stream Gages
- Monitoring
- Land Use
- Elevation
- Slopes
- Evaporation
- Infiltration
- Reservoirs
- Spreading Grounds

Watershed processes

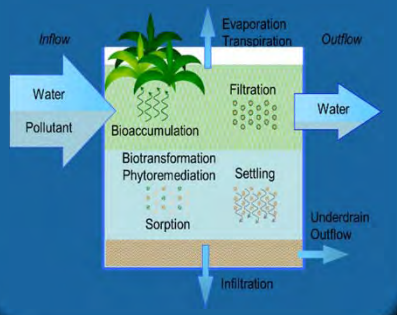
Baseline Conditions

Runoff
Nutrients
Metals
TSS
Bacteria

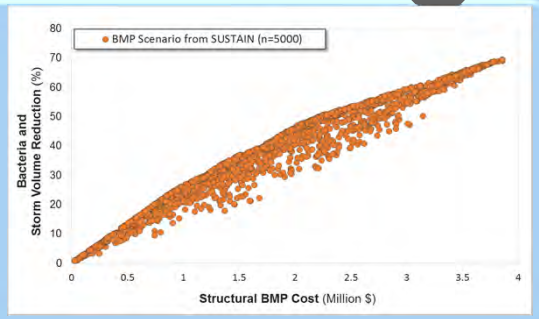


SUSTAIN

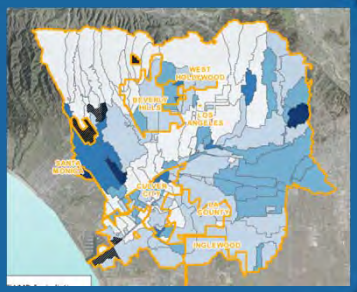
"Stormwater Management Model"



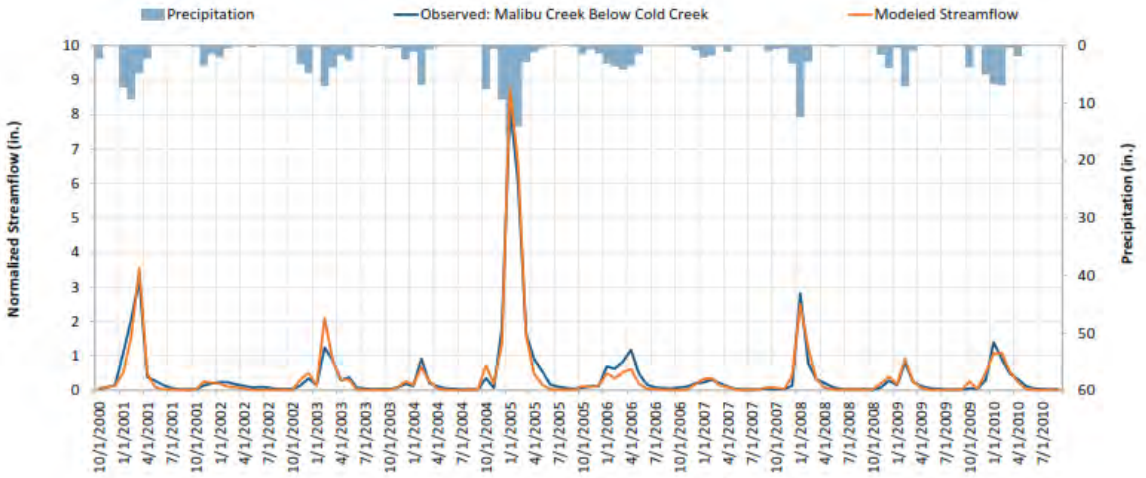
OPTIMIZATION ACROSS MILLIONS OF POTENTIAL STRATEGIES

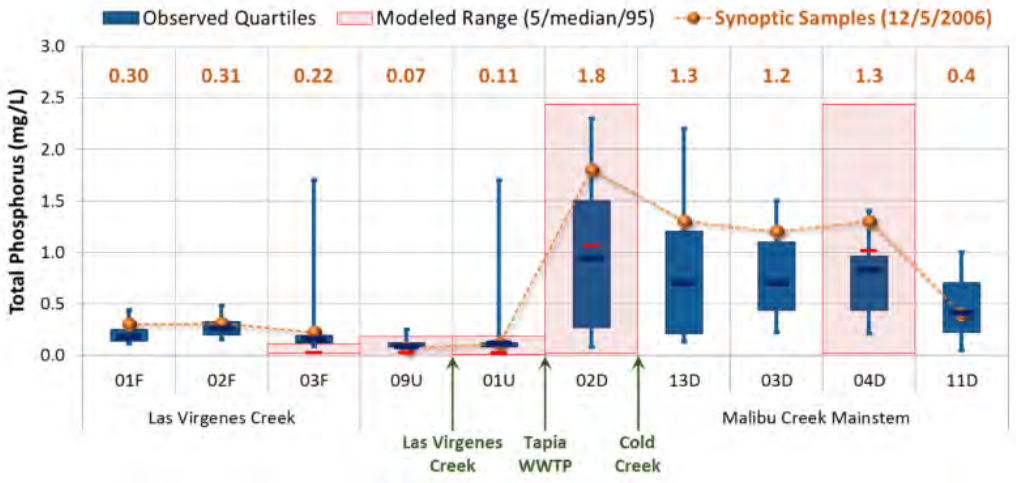


Stormwater Management Strategies

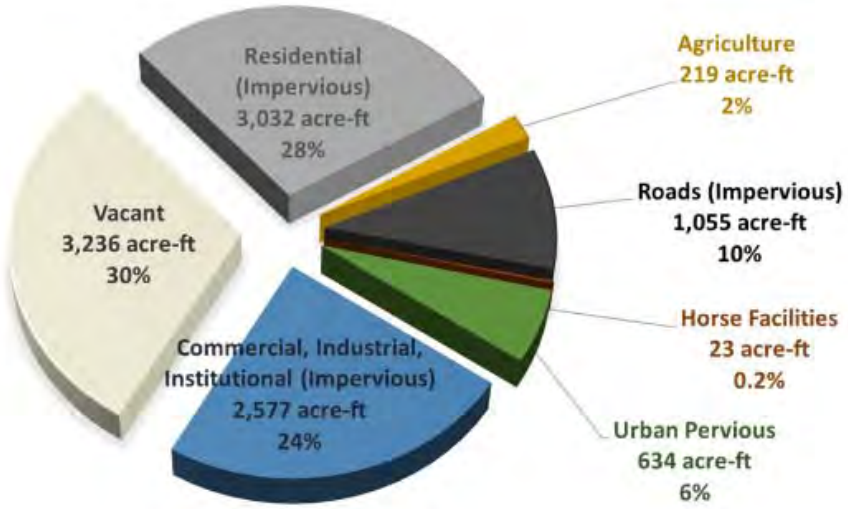


Baseline Hydrologic and Pollutant Modeling



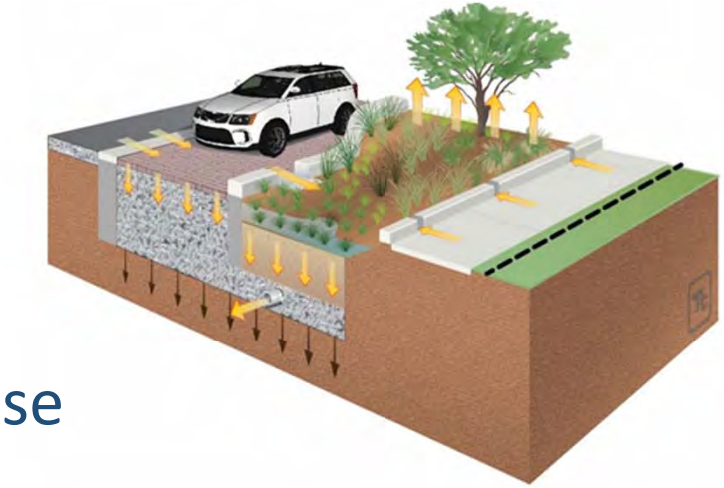


Malibu Creek Watershed Management Program



Stormwater Management Modeling and Optimization

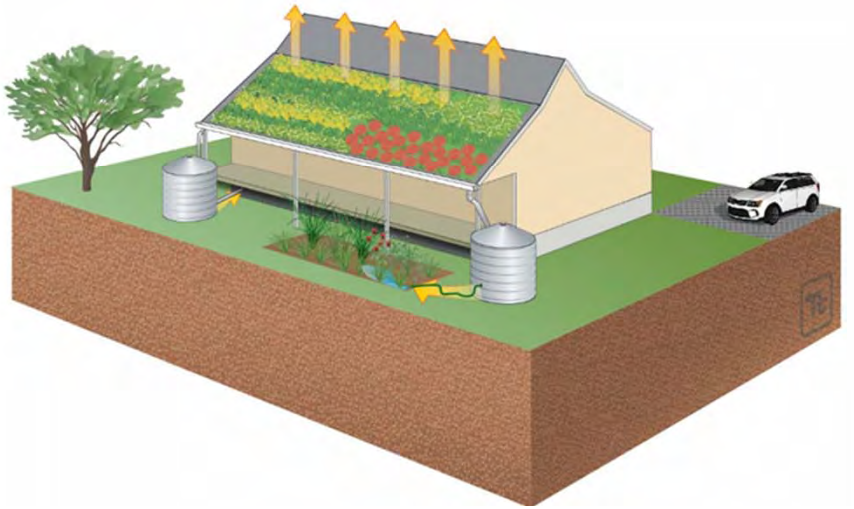
(1) Source Control
e.g., Enhanced sweeping

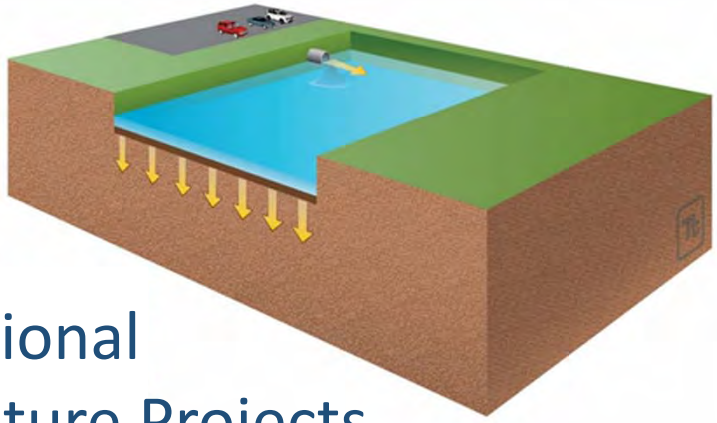


(2) Retention in Right of Way

(3) Parcel-scale Retention and Use

With: Opportunities and Cost Functions



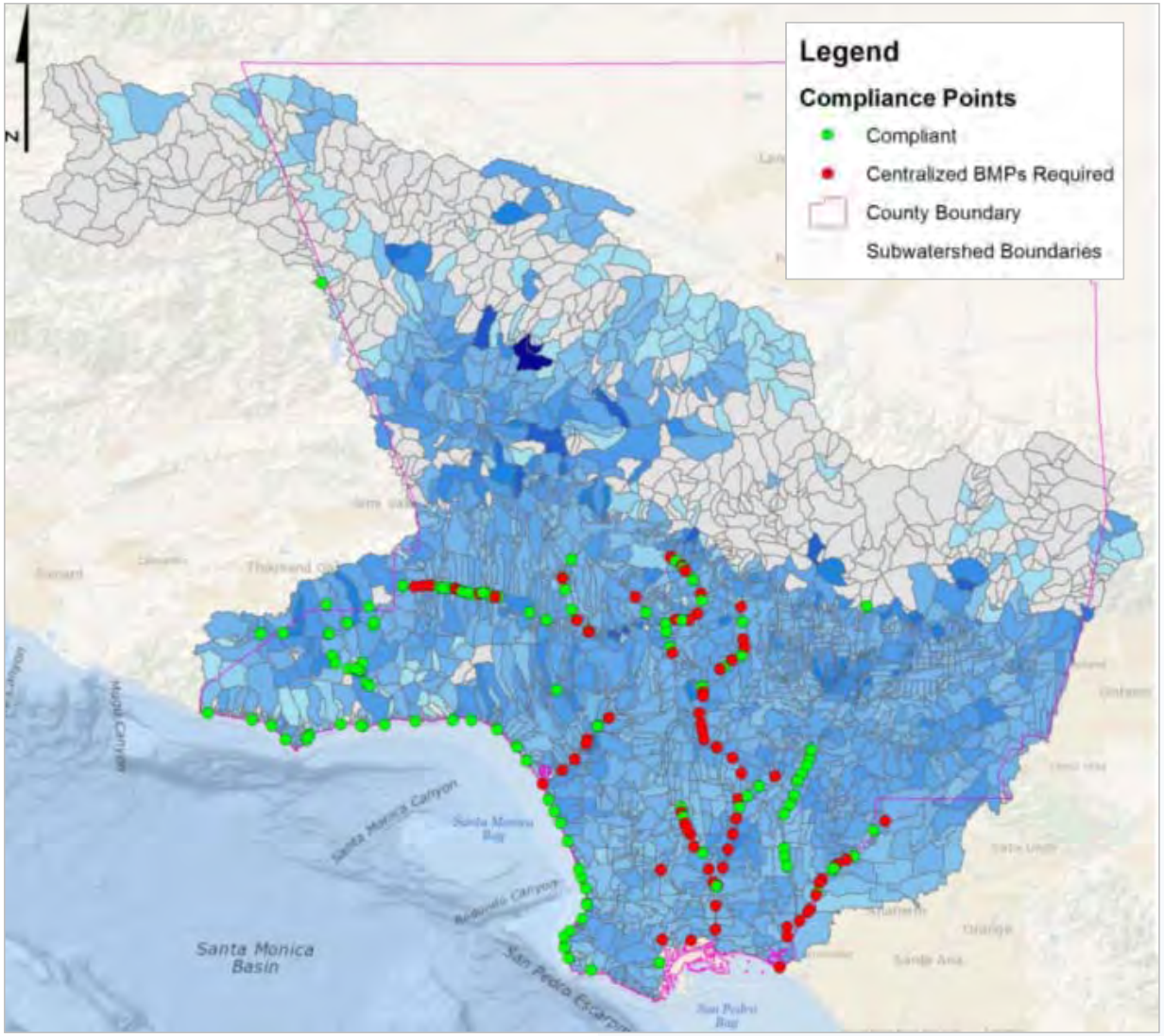


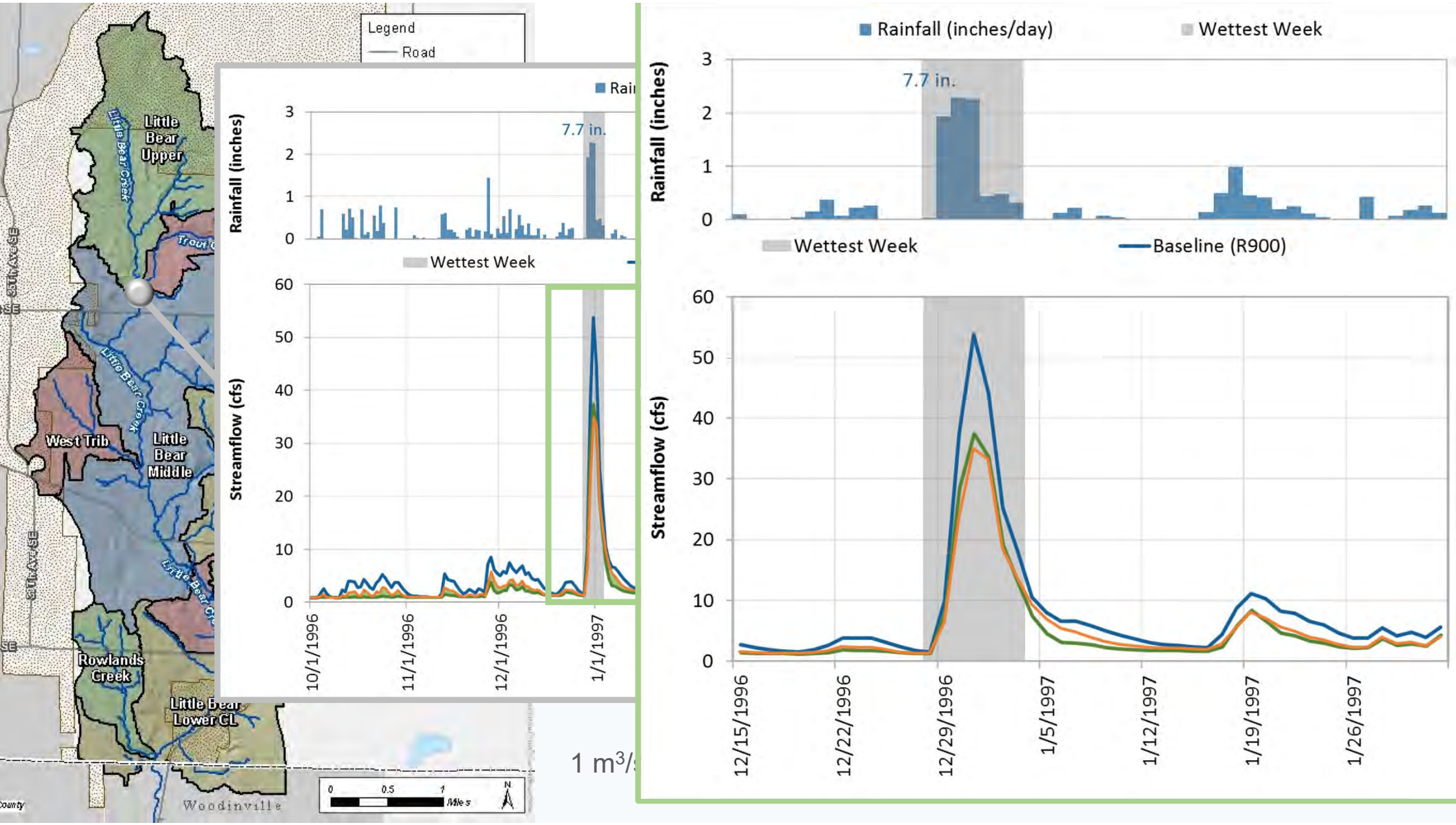
(4) Regional Capture Projects

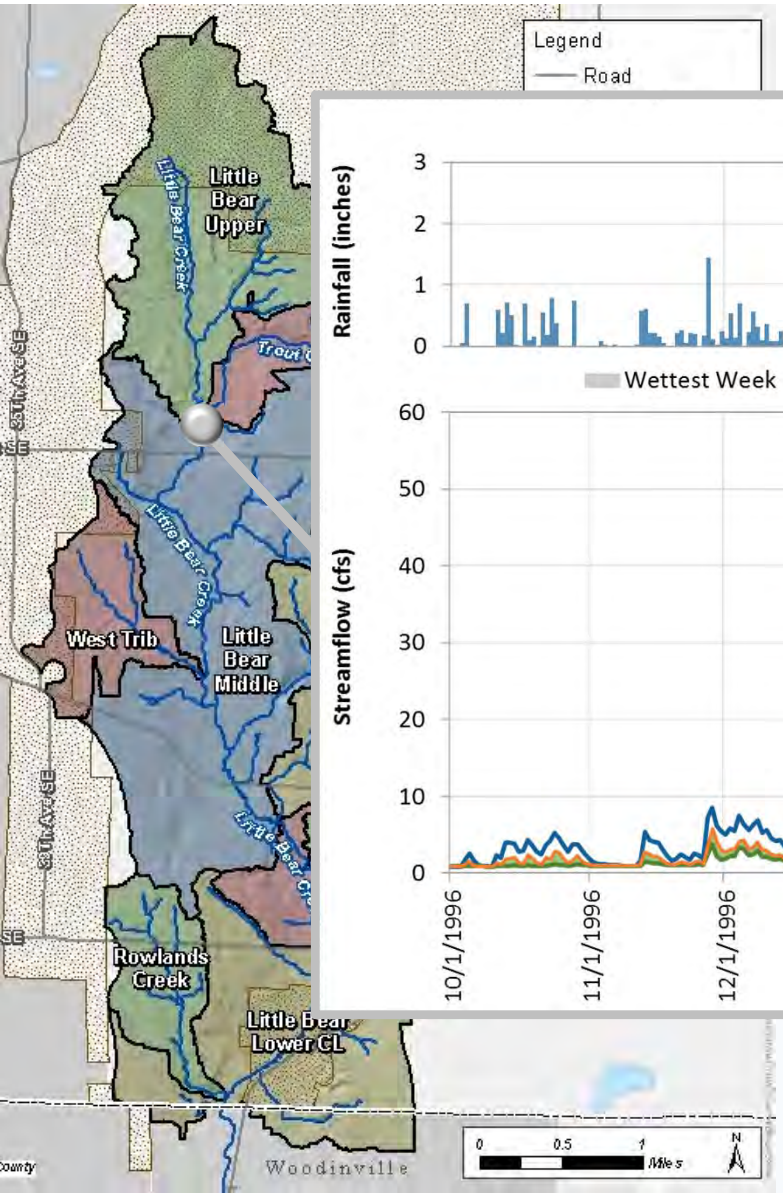
Example Modeling System Output

- Time series of flow and pollutants for each catchment
- Post-BMP water quality for each catchment
- Hydrograph attenuation and water quality downstream in rivers

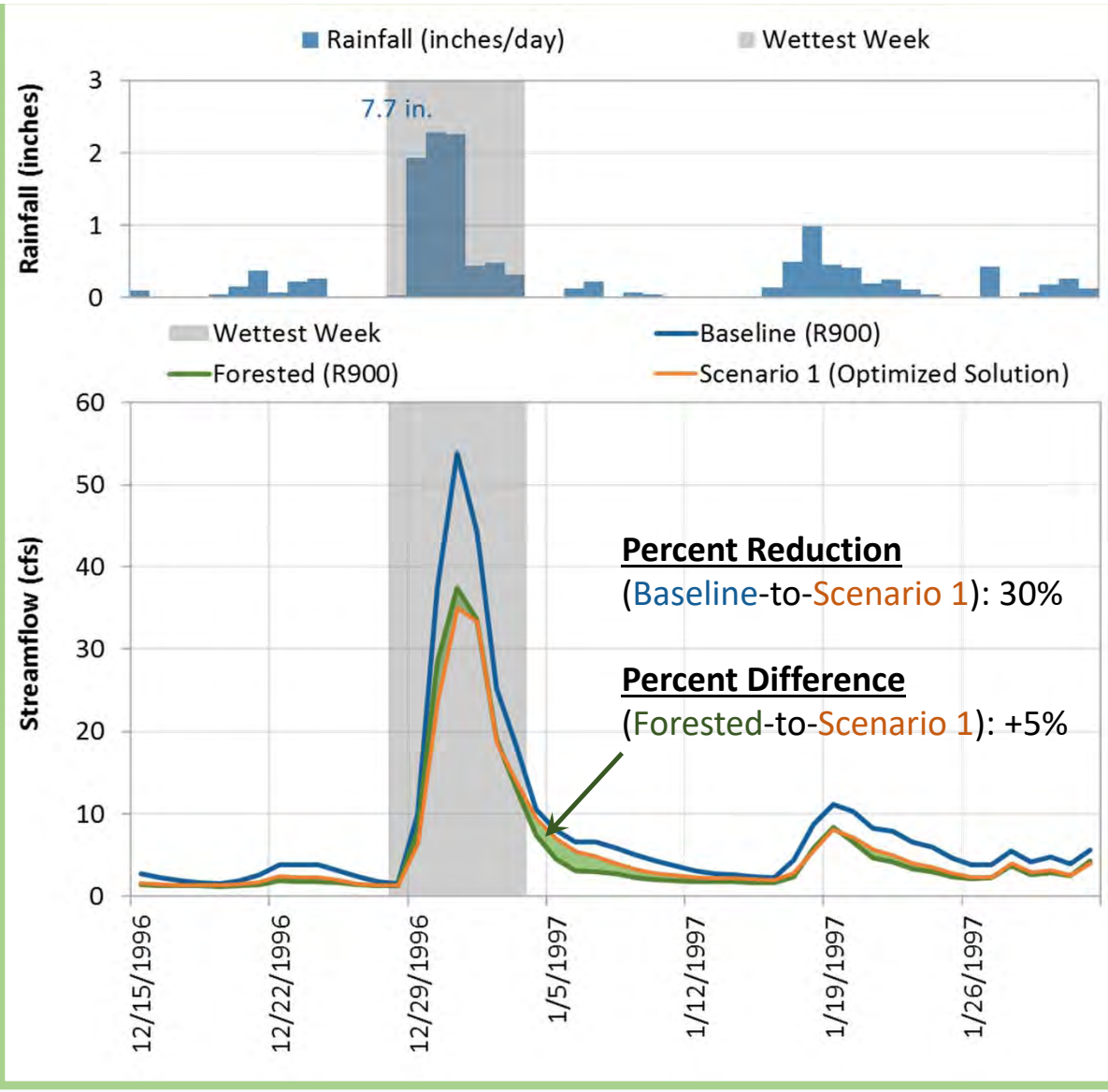
SCALE!




Legend
Road
Little Bear Upper
Little Bear Middle
West Trib
Rowlands Creek
Little Bear Lower CL
Little Bear Creek
Woodinville
0 0.5 1 Miles
N
Rainfall (inches)
7.7 in.
Wettest Week
Streamflow (cfs)
10/1/1996
11/1/1996
12/1/1996
1/1/1997
Rainfall (inches/day)
Baseline (R900)
12/15/1996
12/22/1996
12/29/1996
1/5/1997
1/12/1997
1/19/1997
1/26/1997



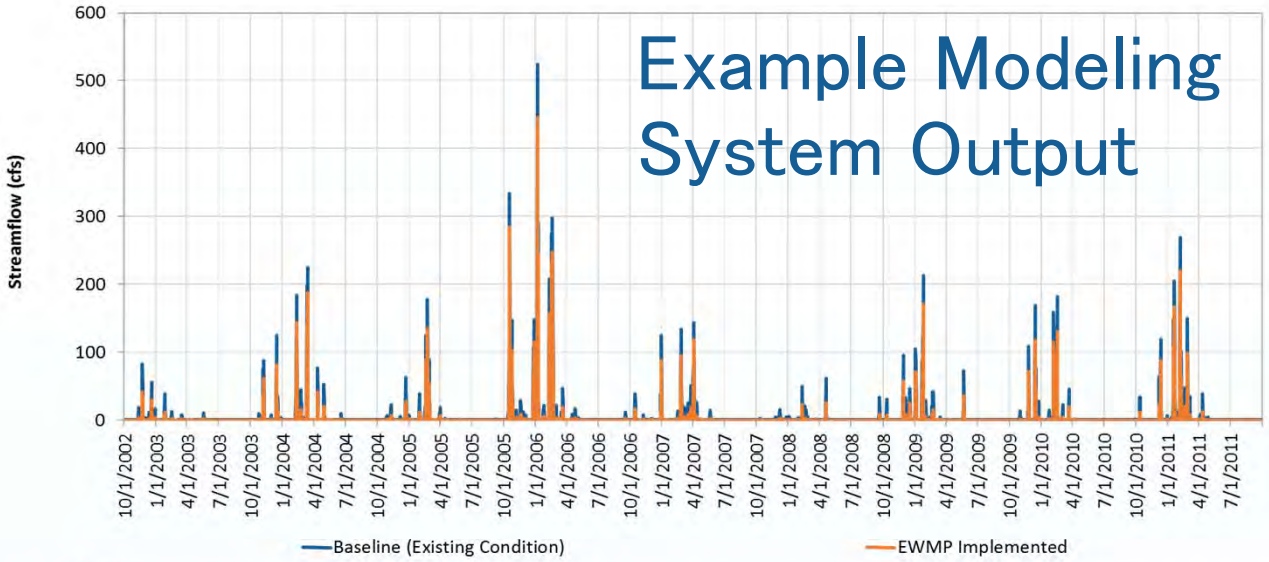
1 m^3/s



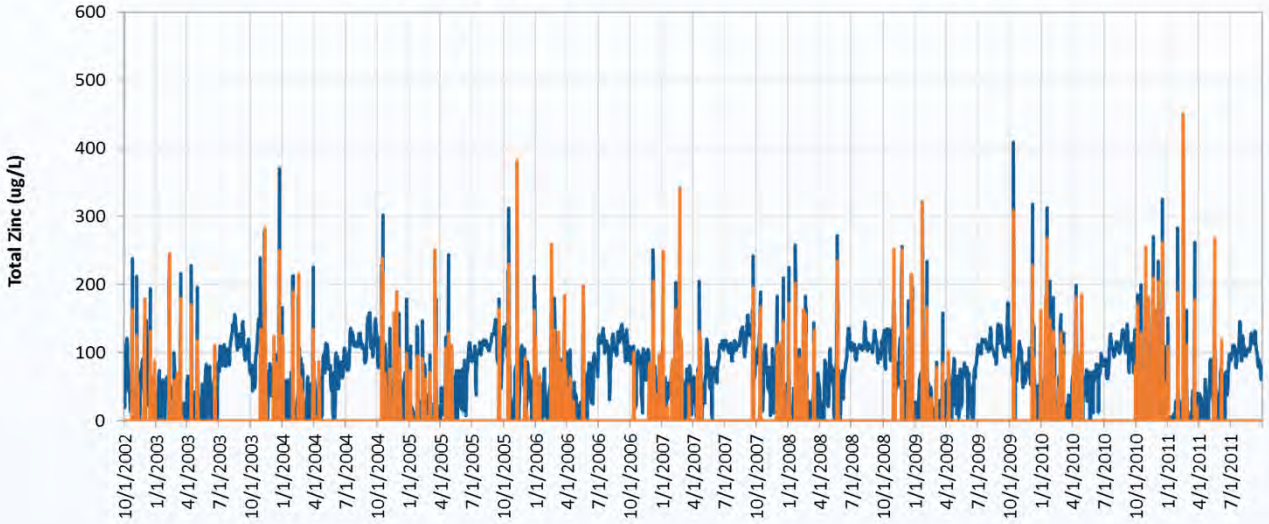
Percent Reduction
(Baseline-to-Scenario 1): 30%

Percent Difference
(Forested-to-Scenario 1): +5%

Example Modeling System Output



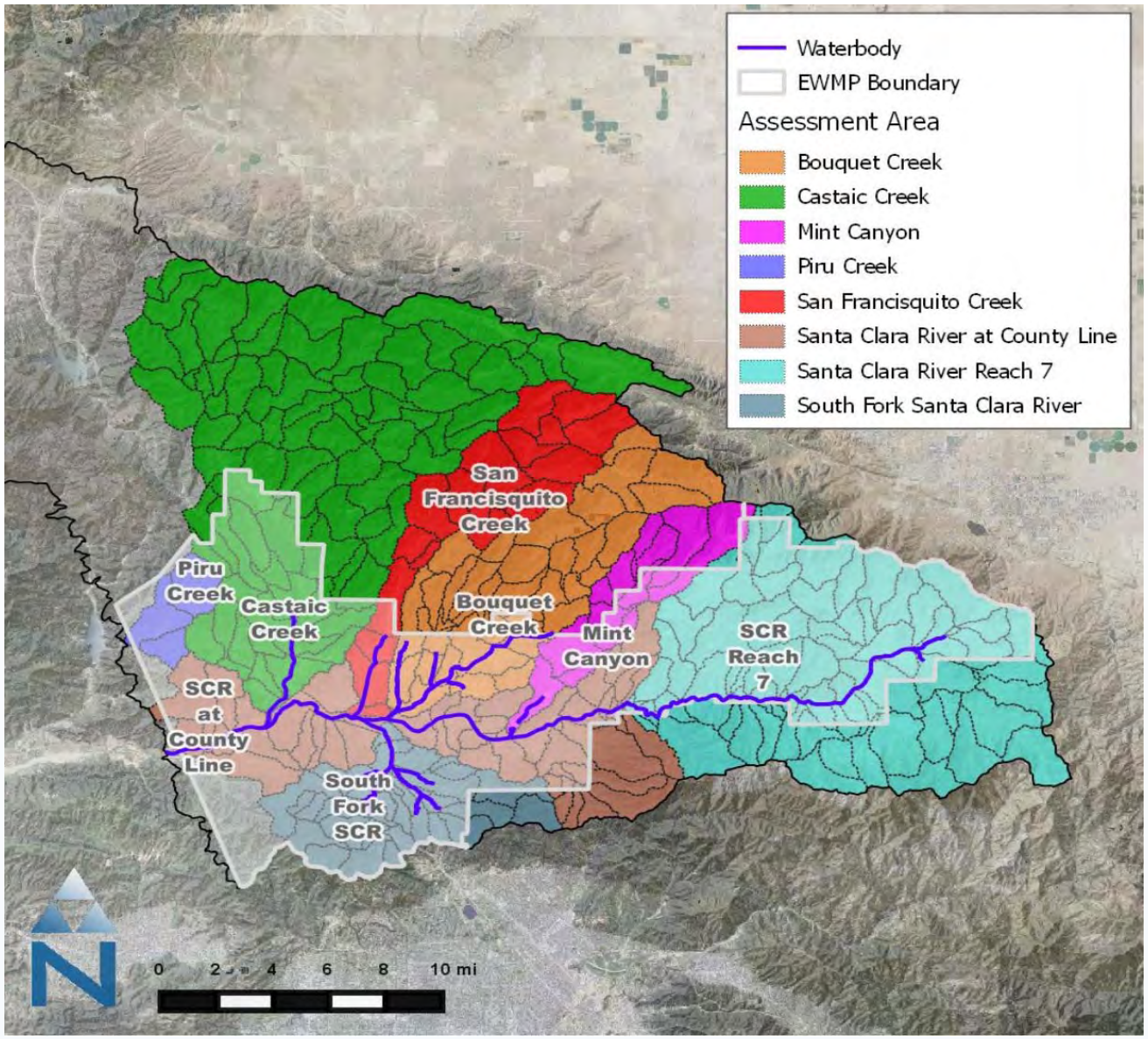
Streamflow Attenuation by Structural BMPs



Zinc Attenuation by Structural BMPs and Source Control

(time series is critical!)

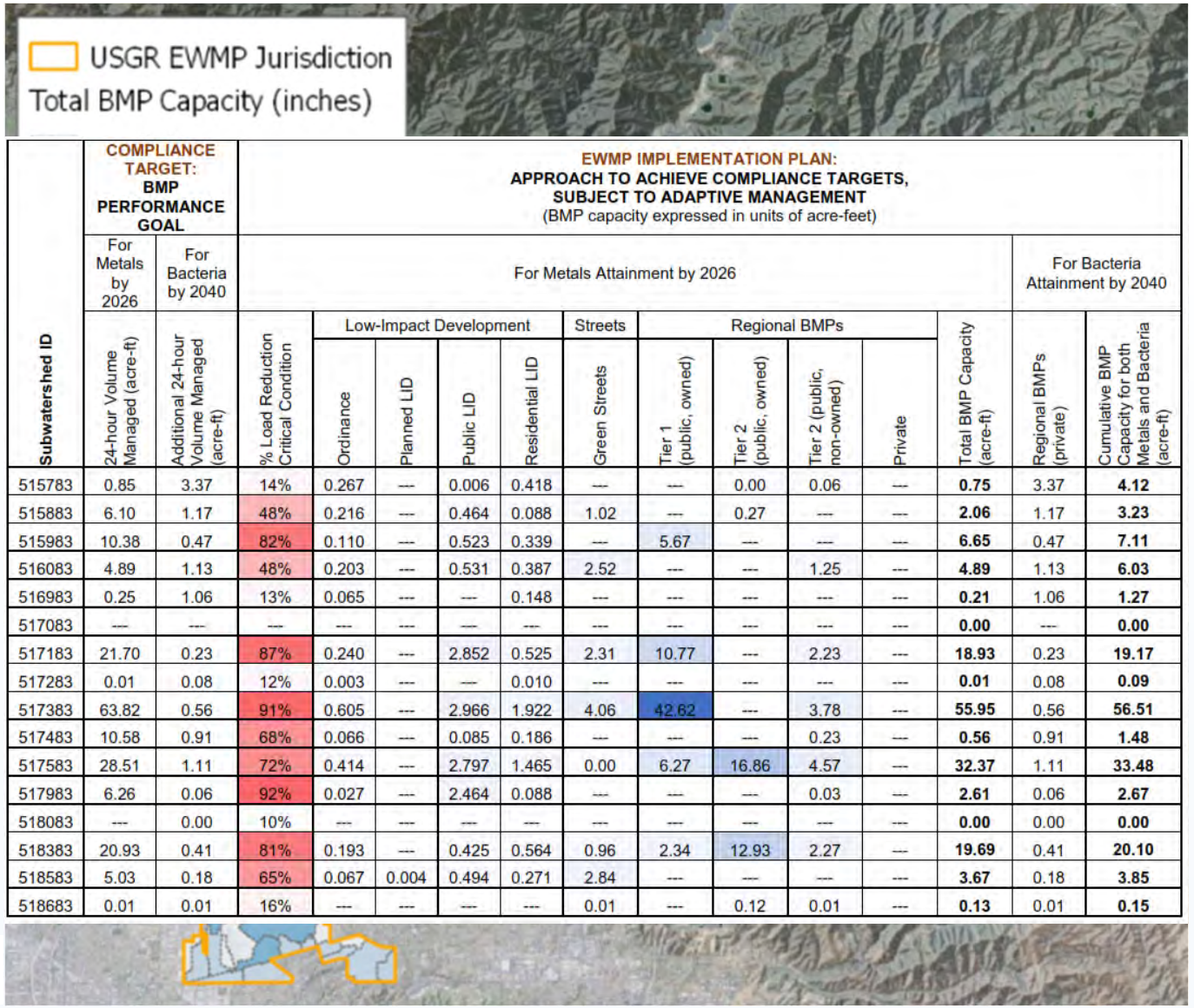
Implementation Strategy for each Major Waterbody



Upper Santa Clara River EWMP

Detailed Strategy for each Subwatershed

And costs!



Subwatershed ID	COMPLIANCE TARGET: BMP PERFORMANCE GOAL		EWMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT (BMP capacity expressed in units of acre-feet)													
	For Metals by 2026	For Bacteria by 2040	For Metals Attainment by 2026												For Bacteria Attainment by 2040	
				Low-Impact Development				Streets	Regional BMPs				Total BMP Capacity (acre-ft)			
	24-hour Volume Managed (acre-ft)	Additional 24-hour Volume Managed (acre-ft)	% Load Reduction Critical Condition	Ordinance	Planned LID	Public LID	Residential LID	Green Streets	Tier 1 (public, owned)	Tier 2 (public, owned)	Tier 2 (public, non-owned)	Private			Regional BMPs (private)	Cumulative BMP Capacity for both Metals and Bacteria (acre-ft)
515783	0.85	3.37	14%	0.267	---	0.006	0.418	---	---	0.00	0.06	---	**0.75**		3.37	**4.12**
515883	6.10	1.17	48%	0.216	---	0.464	0.088	1.02	---	0.27	---	---	**2.06**		1.17	**3.23**
515983	10.38	0.47	82%	0.110	---	0.523	0.339	---	5.67	---	---	---	**6.65**		0.47	**7.11**
516083	4.89	1.13	48%	0.203	---	0.531	0.387	2.52	---	---	1.25	---	**4.89**		1.13	**6.03**
516983	0.25	1.06	13%	0.065	---	---	0.148	---	---	---	---	---	**0.21**		1.06	**1.27**
517083	---	---	---	---	---	---	---	---	---	---	---	---	**0.00**		---	**0.00**
517183	21.70	0.23	87%	0.240	---	2.852	0.525	2.31	10.77	---	2.23	---	**18.93**		0.23	**19.17**
517283	0.01	0.08	12%	0.003	---	---	0.010	---	---	---	---	---	**0.01**		0.08	**0.09**
517383	63.82	0.56	91%	0.605	---	2.966	1.922	4.06	42.62	---	3.78	---	**55.95**		0.56	**56.51**
517483	10.58	0.91	68%	0.066	---	0.085	0.186	---	---	---	0.23	---	**0.56**		0.91	**1.48**
517583	28.51	1.11	72%	0.414	---	2.797	1.465	0.00	6.27	16.86	4.57	---	**32.37**		1.11	**33.48**
517983	6.26	0.06	92%	0.027	---	2.464	0.088	---	---	---	0.03	---	**2.61**		0.06	**2.67**
518083	---	0.00	10%	---	---	---	---	---	---	---	---	---	**0.00**		0.00	**0.00**
518383	20.93	0.41	81%	0.193	---	0.425	0.564	0.96	2.34	12.93	2.27	---	**19.69**		0.41	**20.10**
518583	5.03	0.18	65%	0.067	0.004	0.494	0.271	2.84	---	---	---	---	**3.67**		0.18	**3.85**
518683	0.01	0.01	16%	---	---	---	---	0.01	---	0.12	0.01	---	**0.13**		0.01	**0.15**

Scenario Evaluation:

Cost and benefits for Watershed Management Programs

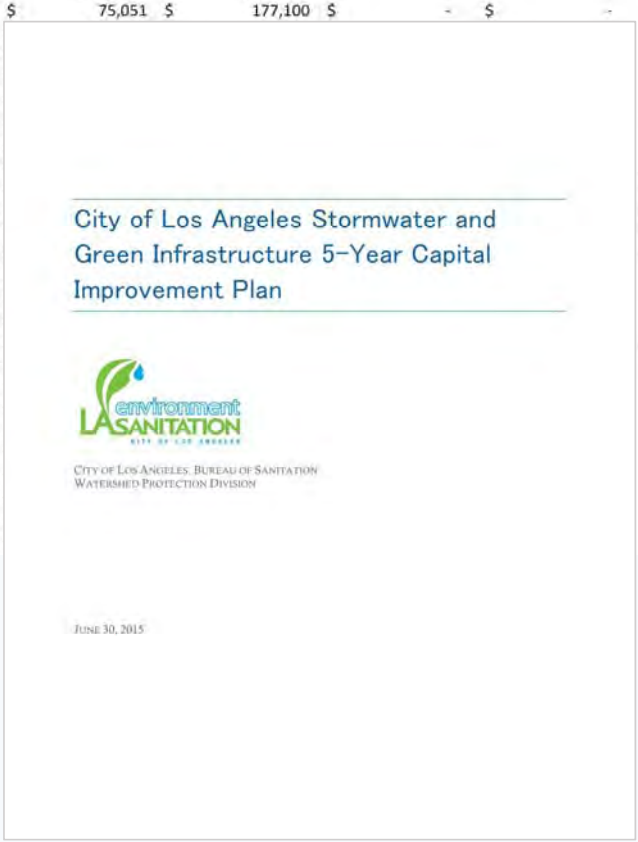
Water Quality Criteria Attained	Approach	Attainment Condition	Attainment Location	Source Control Approach
Acute	Emphasize green infrastructure	Median year	Only at major river outlets	Current level
Chronic	Emphasize capture by basins on public lands	Wet year	At outlets of rivers and tributaries	Reduce fertilizers
Primary Contact	Minimize cost	85th percentile 24-hour storm	At each 1 mile segment	Increase sweeping
Secondary Contact	Maximize benefit	1 inch rainfall event		

And Timeline!

Capital Improvement Program

City of Los Angeles Stormwater and Green Infrastructure 5-Year Capital Improvement Plan - Project Summary

No.	Project Name	Watershed	Cost Sharing Opportunity	Total Project Cost	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 20/21
LRS-1	LA River Segment B Urban Runoff Project No. 1	LAR	No	$ 7,809,000	$ 798,000	$ 2,086,770	$ 4,924,230	$ -	$ -
LRS-2	LA River Segment B Urban Runoff Project No. 2	LAR	No	$ 7,398,000	$ 756,000	$ 1,976,940	$ 4,665,060	$ -	$ -
LRS-3	LA River Segment B Urban Runoff Project No. 3	LAR	No	$ 5,343,000	$ 546,000	$ 1,427,790	$ 3,369,210	$ -	$ -
LRS-4	Arroyo Seco Urban Runoff Project No. 1	LAR	No	$ 280,850	$ 28,700	$ 75,051	$ 177,100	$ -	$ -
LRS-5	Arroyo Seco Urban Runoff Project No. 2	LAR	No	$ 2,457,506	$ 251,132				
LRS-6	Arroyo Seco Urban Runoff Project No. 3	LAR	No	$ 1,737,112	$ 177,515				
LRS-7	Arroyo Seco Urban Runoff Project No. 4	LAR	No	$ 4,795,000	$ 490,000				
LRS-8	Arroyo Seco Urban Runoff Project No. 5	LAR	No	$ 342,500	$ 35,000				
LRS-9	4th St & Santa Fe Priority Greenway + Sustainable Little Tokyo	LAR	No	$ 17,125,000	$ 1,750,000				
TSO-1	NOTF/LFTF-1 Phase I	BC	No	$ 16,968,820	$ 1,734,040				
TSO-2	Sepulveda Channel Diversion BMP Project	BC	No	$ 6,067,730	$ 620,060				
BC-1	Lafayette Park	BC	No	$ 27,256,150	$ 1,997,458				
BC-2	Queen Anne Recreation Center	BC	No	$ 37,059,870	$ 2,715,920				
BC-3	Rancho Park Golf Course	BC	No	$ 18,119,620	$ 1,327,890				
BC-4	Poinsettia Park	BC	No	$ 15,094,660	$ 1,106,207				
BC-5	Westwood Neighborhood Greenway Project	BC	No	$ 3,104,420	$ 317,240				
BC-6	Del Rey Lagoon Water Quality Improvement Project	BC	No	$ 1,441,832	$ 147,340				
BC-7	Vermont Square Park Stormwater Treatment and Infiltration Project	BC	No	$ 2,113,088	$ 215,936				
BC-8	National Boulevard Runoff Treatment Project	BC	No	$ 14,111,000	$ 1,034,120				
BC-9	Westlake EWMP Regional Project 1	BC	No	$ 4,914,204	$ 502,181				
BC-10	Palms EWMP Regional Project 1	BC	No	$ 12,026,075	$ 1,228,942				
BC-11	South Los Angeles EWMP Regional Project 1	BC	No	$ 3,229,412	$ 330,013				
BC-12	Wilshire EWMP Regional Project 1	BC	No	$ 2,722,501	$ 278,212				
BC-13	West Adams EWMP Regional Project 1	BC	No	$ 7,730,833	$ 790,012				
BC-14	West Los Angeles EWMP Regional Project 1	BC	No	$ 6,150,441	$ 628,512				
BC-15	Wilshire EWMP Regional Project 2	BC	No	$ 2,628,495	$ 268,605				
BC-16	South Los Angeles EWMP Regional Project 2	BC	No	$ 4,184,084	$ 427,571				
BC-17	West Adams EWMP Regional Project 2	BC	No	$ 2,053,915	$ 209,889				



Implementation Tracking

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Grand, Overarching Conclusions

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Conclusions

- It is time for municipalities to understand the implications and opportunities driven by Clean Water Act requirements
- Process-based models are valuable tool for analyzing the cost and benefit of policy decisions
- Programs not plans! Tracking and adaptive management are critical.

I APPRECIATE YOU

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BACKUP

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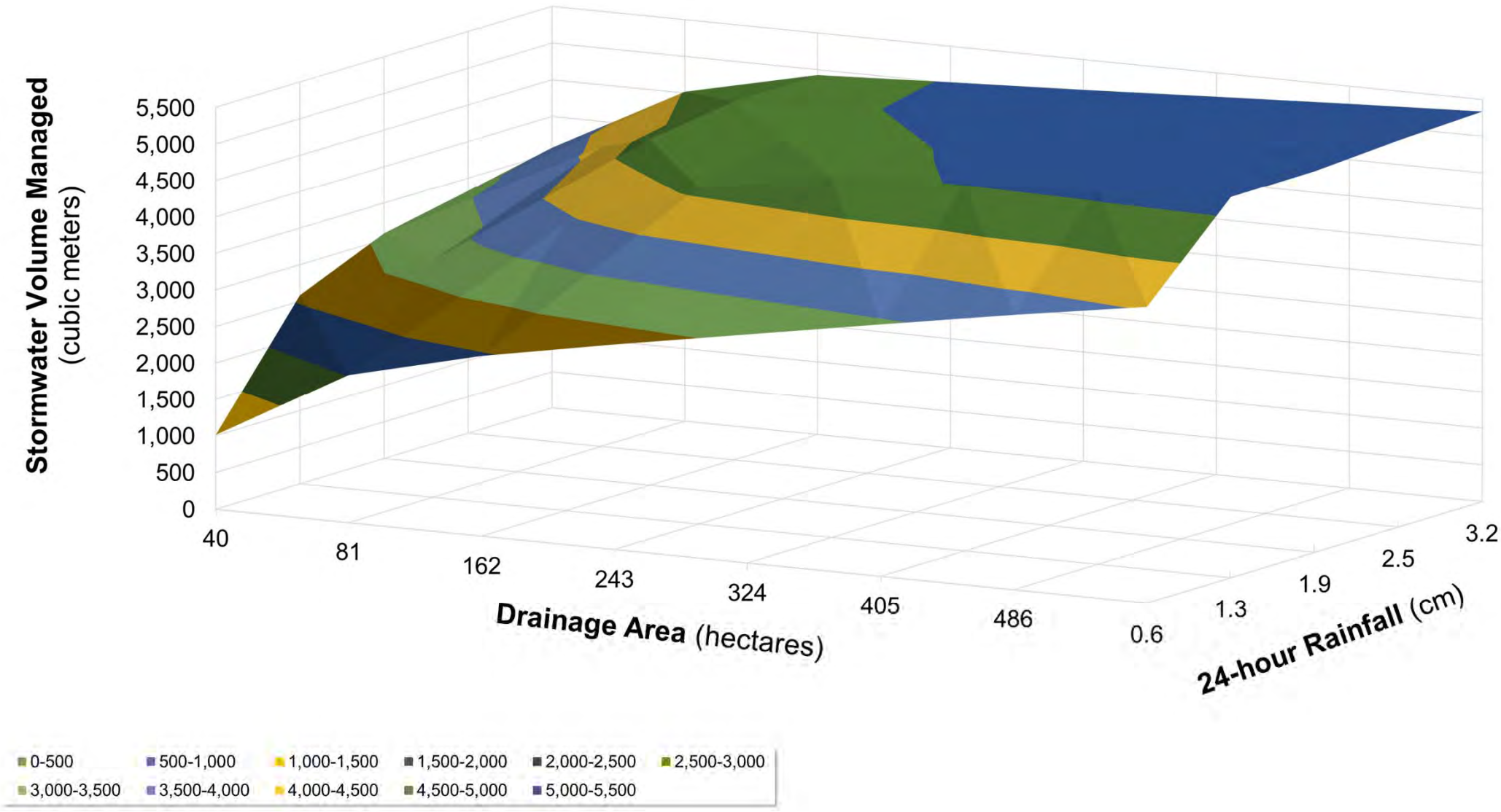
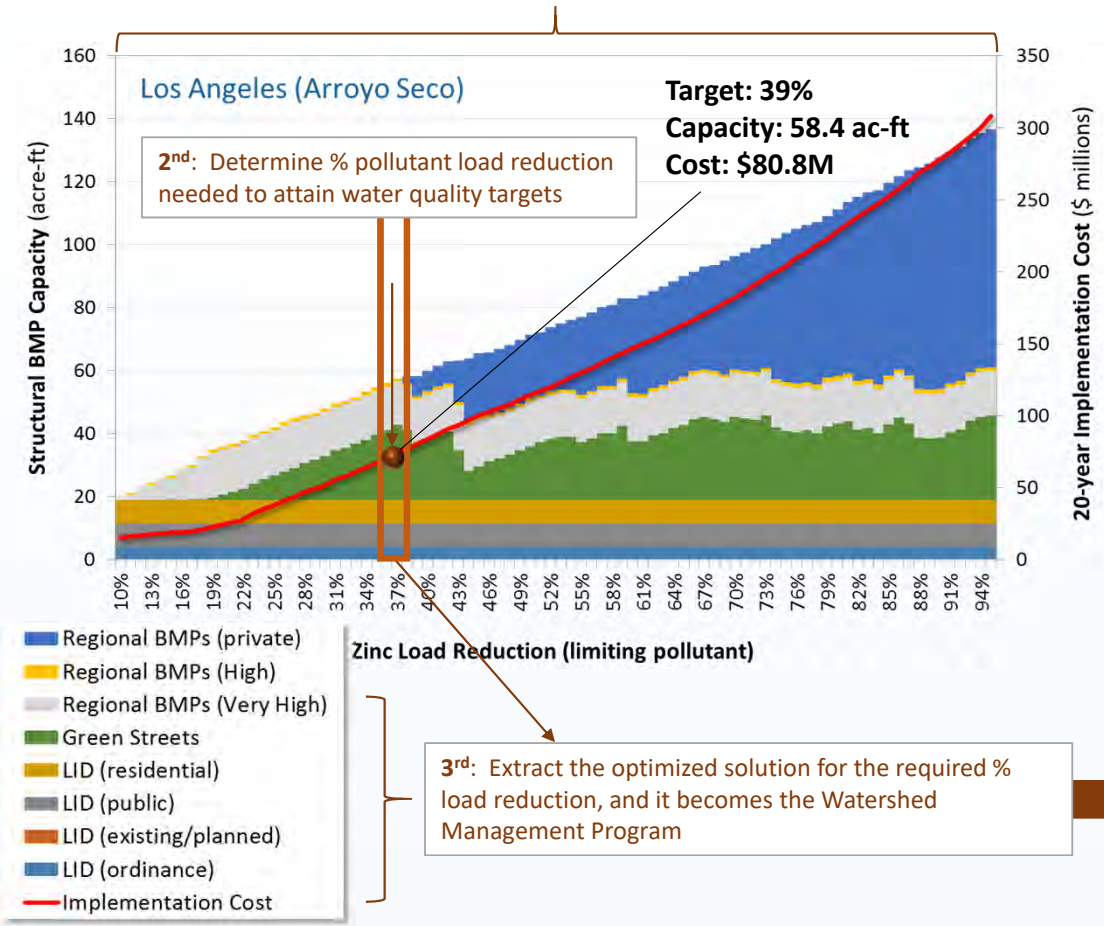

Stormwater Volume Managed
(cubic meters)
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
40
81
162
243
324
405
486
Drainage Area (hectares)
0.6
1.3
1.9
2.5
3.2
24-hour Rainfall (cm)
0-500
500-1,000
1,000-1,500
1,500-2,000
2,000-2,500
2,500-3,000
3,000-3,500
3,500-4,000
4,000-4,500
4,500-5,000
5,000-5,500

1st: Use cost-optimization to identify solutions to achieve a wide range of percent pollutant load reductions for each jurisdiction and each assessment area/watershed.



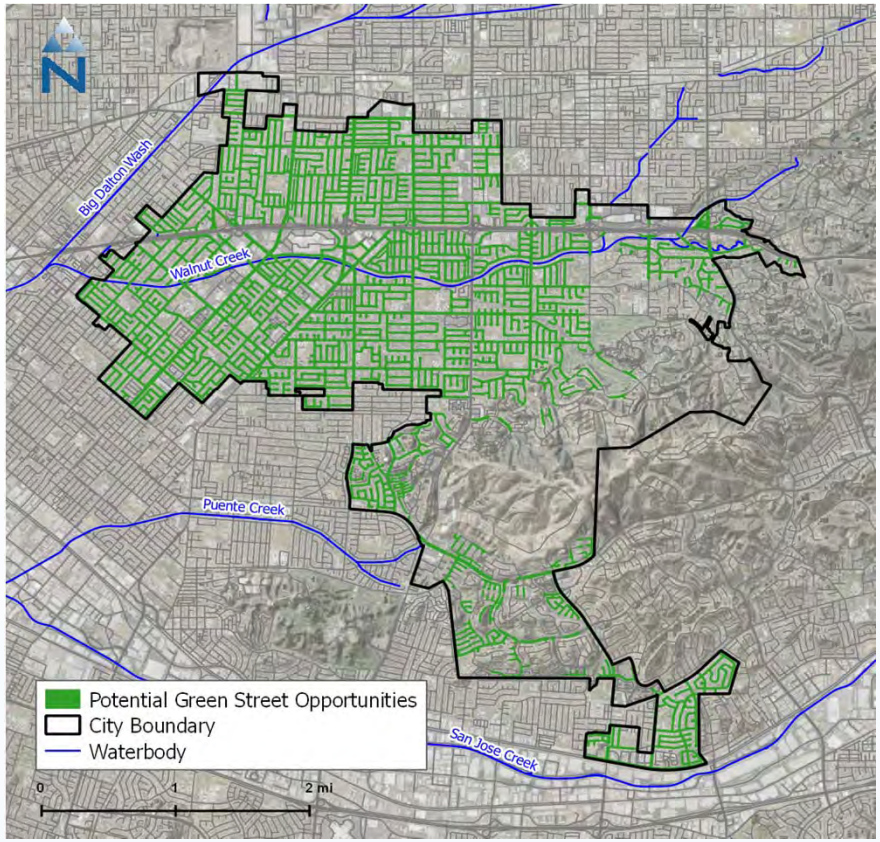
3rd: Extract the optimized solution for the required % load reduction, and it becomes the Watershed Management Program

Subwatershed ID	COMPLIANCE TARGETS: MEASURABLE AND ENFORCEABLE		EWMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT (BMP capacity expressed in units of acre-feet)								
			Low-Impact Development				Streets	Regional BMPs			
	% Load Reduction Critical Condition	24-hour Volume to be Managed (acre-ft)	Ordinance	Planned LID	Public LID	Residential LID	Green Streets, All Components	Regional BMPs (Very High)	Regional BMPs (High)	Private Regional BMPs	Total BMP Capacity (acre-ft)
640249	9%	1.66	1.03	---	1.36	1.80	0.00	0.00	0.00	0.00	**4.2**
640349	19%	0.94	0.18	---	0.90	0.01	0.36	0.00	0.00	0.00	**1.4**
640449	14%	0.15	0.15	---	0.38	0.03	0.00	0.00	0.00	0.00	**0.6**
640549	67%	26.30	1.14	0.04	0.14	3.14	9.63	13.75	0.00	0.00	**27.8**
640649	84%	13.22	0.31	---	0.54	0.33	3.98	0.00	0.00	6.44	**11.6**
640749	38%	2.70	0.50	0.00	2.07	0.48	2.98	0.00	0.00	0.00	**6.0**
640849	16%	1.94	0.48	---	0.81	1.22	0.35	0.00	1.00	0.00	**3.9**
640949	27%	0.80	0.08	---	0.36	0.02	0.22	0.00	0.00	0.00	**0.7**
641049	39%	1.81	0.12	---	0.07	0.20	0.06	0.00	0.00	0.00	**0.5**
641149	7%	0.09	0.05	---	0.18	0.09	0.35	0.00	0.00	0.00	**0.7**
641449	8%	0.00	0.00	---	---	0.00	0.00	0.00	0.00	0.00	**0.0**
641549	26%	0.52	0.09	---	0.41	0.30	0.05	0.20	0.00	0.00	**1.0**
641649	12%	0.00	0.00	---	---	0.01	0.00	0.00	0.00	0.00	**0.0**
642049	6%	0.00	0.00	---	---	---	0.00	0.00	0.00	0.00	**0.0**
Total	**39%**	**50.1**	**4.1**	**0.0**	**7.2**	**7.6**	**18.0**	**14.0**	**1.0**	**6.4**	**58.4**

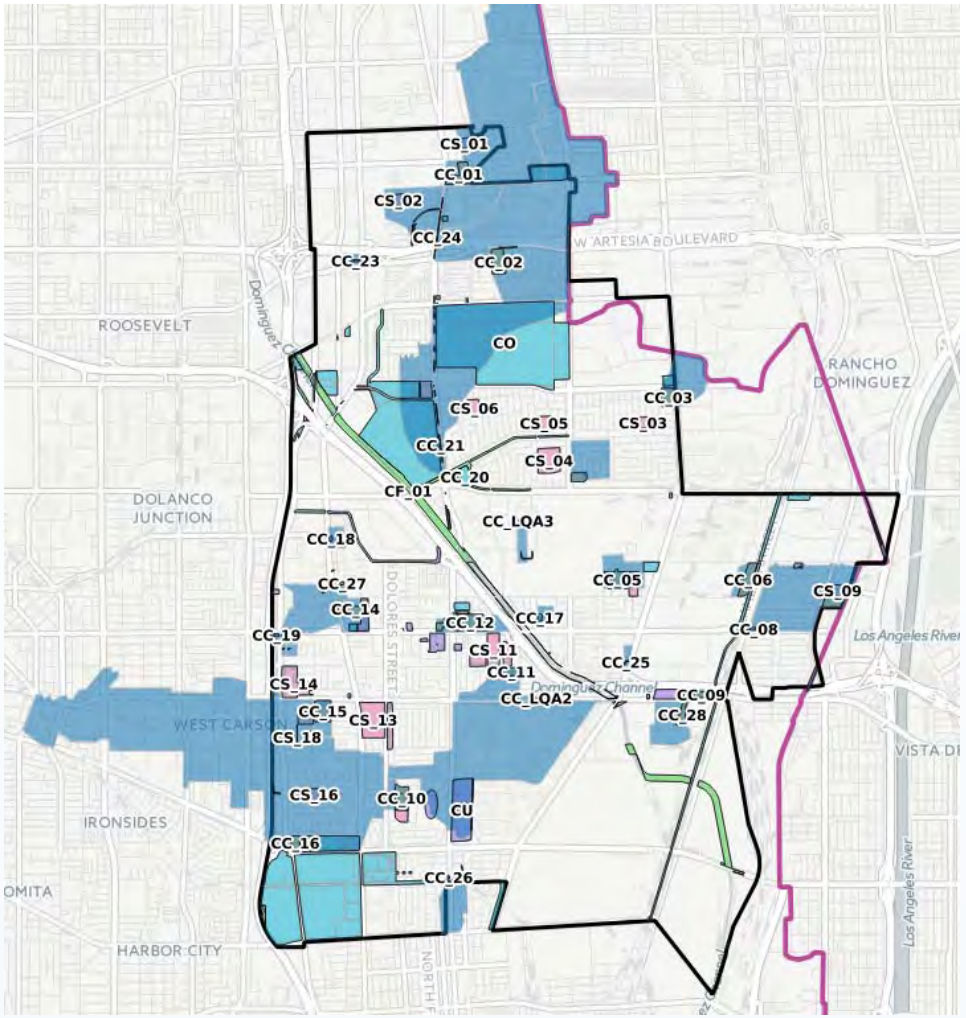
RED = Subwatersheds with highest required % load reductions
BLUE = Subwatersheds with highest BMP capacities within a BMP category

Opportunity Screening

Street Retention Opportunity Screening

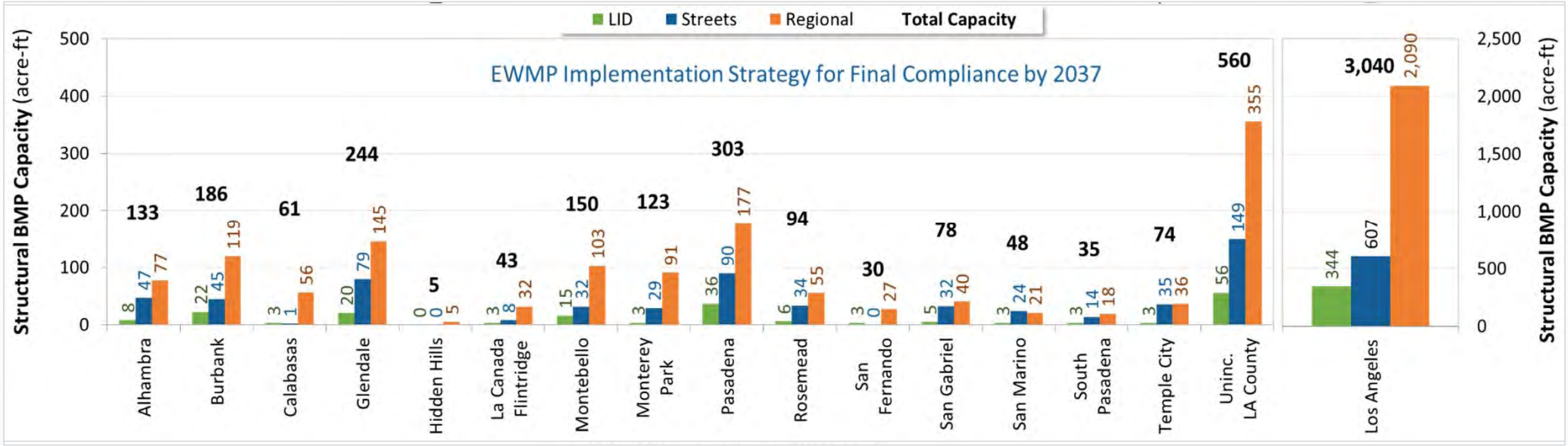


Infiltration Basin Opportunity Screening



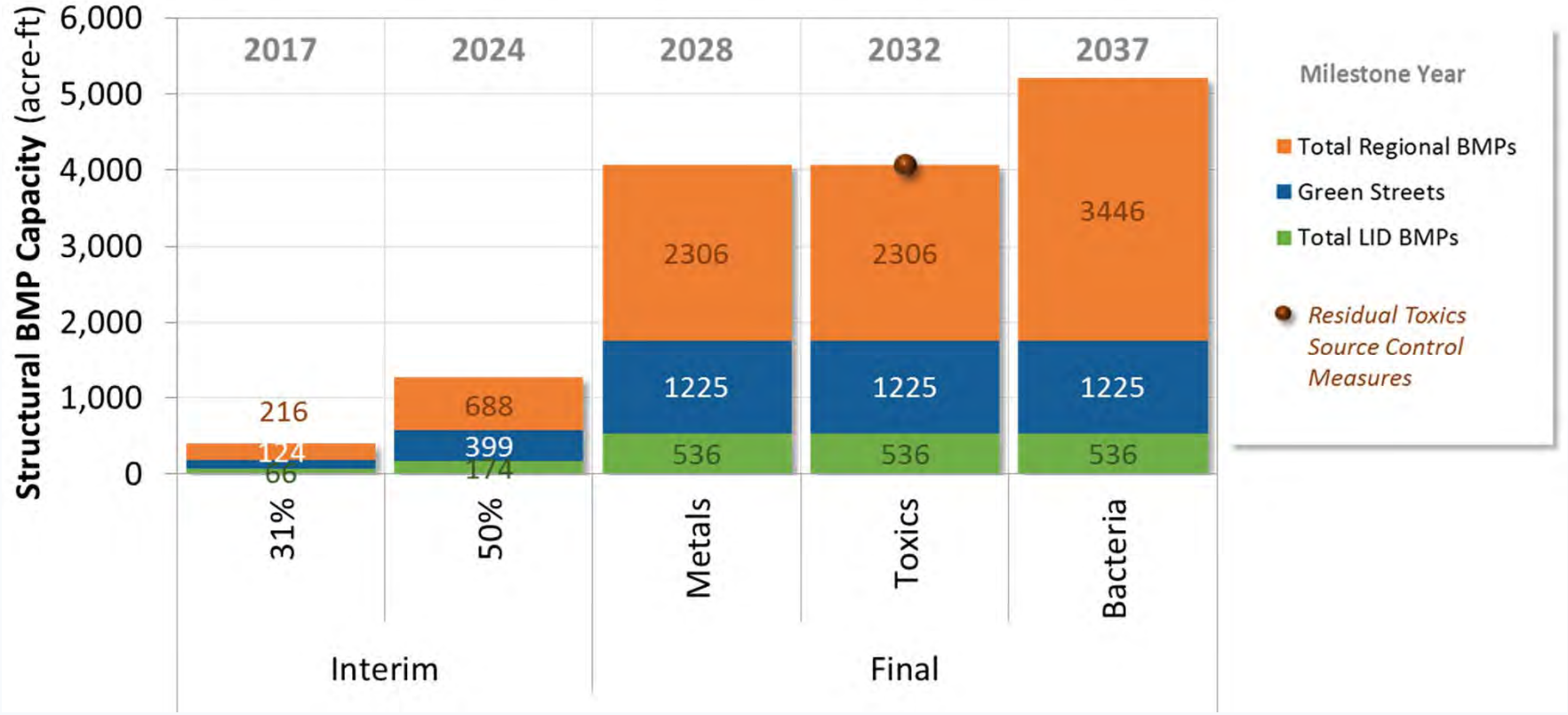
WMP Implementation Strategy

Upper Los Angeles River WMP

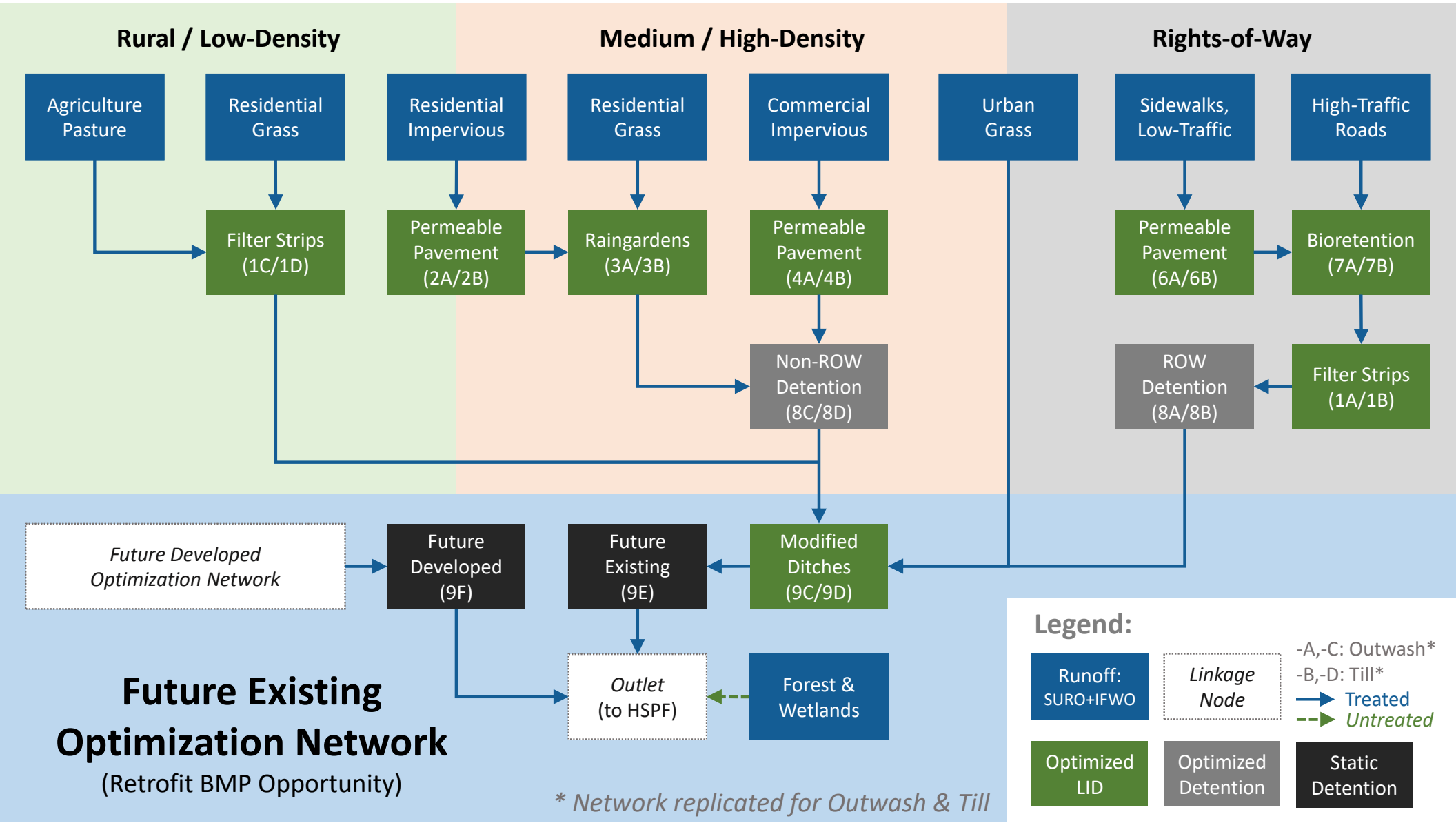


1 acre-ft = 1233 m^3

Scheduling



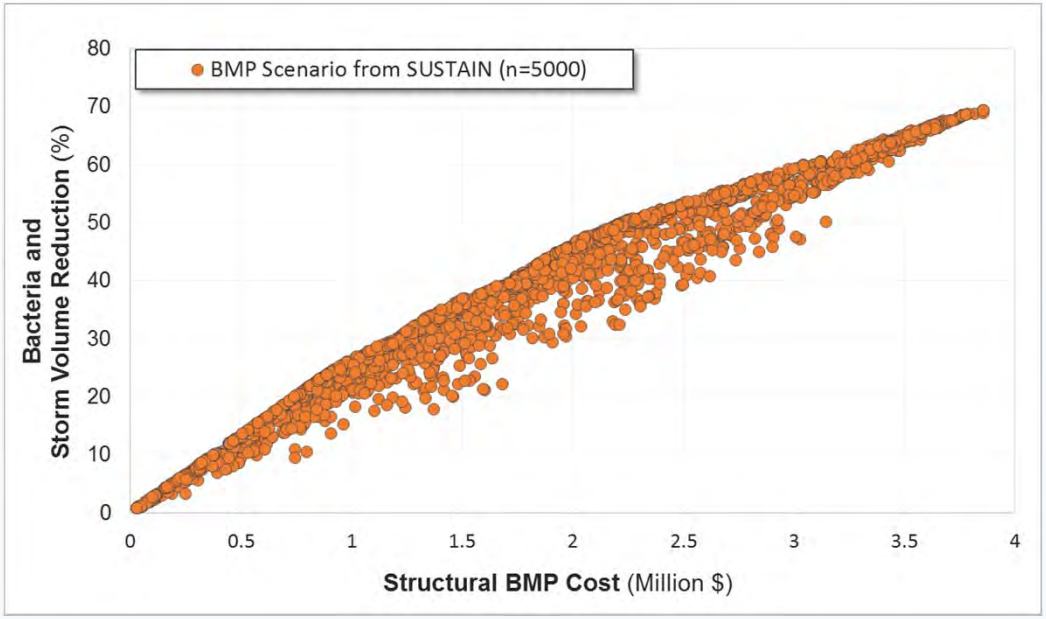
1 acre-ft = 1233 m^3


Rural / Low-Density
Medium / High-Density
Rights-of-Way
Agriculture Pasture
Residential Grass
Residential Impervious
Residential Grass
Commercial Impervious
Urban Grass
Sidewalks, Low-Traffic
High-Traffic Roads
Filter Strips (1C/1D)
Permeable Pavement (2A/2B)
Raingardens (3A/3B)
Permeable Pavement (4A/4B)
Permeable Pavement (6A/6B)
Bioretention (7A/7B)
Non-ROW Detention (8C/8D)
ROW Detention (8A/8B)
Filter Strips (1A/1B)
Future Developed Optimization Network
Future Developed (9F)
Future Existing (9E)
Modified Ditches (9C/9D)
Outlet (to HSPF)
Forest & Wetlands
Future Existing Optimization Network
(Retrofit BMP Opportunity)
* Network replicated for Outwash & Till
Legend:
Runoff: SURO+IFWO
Linkage Node
-A,-C: Outwash*
-B,-D: Till*
Treated
Untreated
Optimized LID
Optimized Detention
Static Detention

Unit Cost Functions

BMP Category	BMP Types	Formulas For Estimating Total Costs[1]	
		Capital Costs	Annual O&M
LID and Green Streets	Bioretention with Underdrain	*Cost = 17.688 (A) + 2.165 (Vt) + 2.64 (Vm) + 3.3 (Vu)*	*Cost = 2.54 (A)*
	Bioretention without Underdrain	*Cost = 9.438 (A) + 2.165 (Vt) + 2.64 (Vm)*	*Cost = 2.54 (A)*
	Residential LID	*Cost = 4.000 (A)*	--
	Permeable Pavement with Underdrain	*Cost = 33.594 (A) + 3.3 (Vu)*	*Cost = 1.74 (A)*
	Permeable Pavement without Underdrain	*Cost = 25.344 (A)*	*Cost = 1.74 (A)*
Regional BMPs	Pump	*Cost = 56,227*(Pump Capacity$_{cfs}$) + $1,207,736*[2]	
	Regional Project on Public Parcel	*Cost = 10.01 (A) + 2.296 (Vt) + 2.8 (Vm)*	*Cost = 1.918 (A)*
	Regional Project on Private Parcel	*Cost = 139.01 (A) + 2.296 (Vt) + 2.8 (Vm)*	*Cost = 1.918 (A)*

Catchment-scale Optimization



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