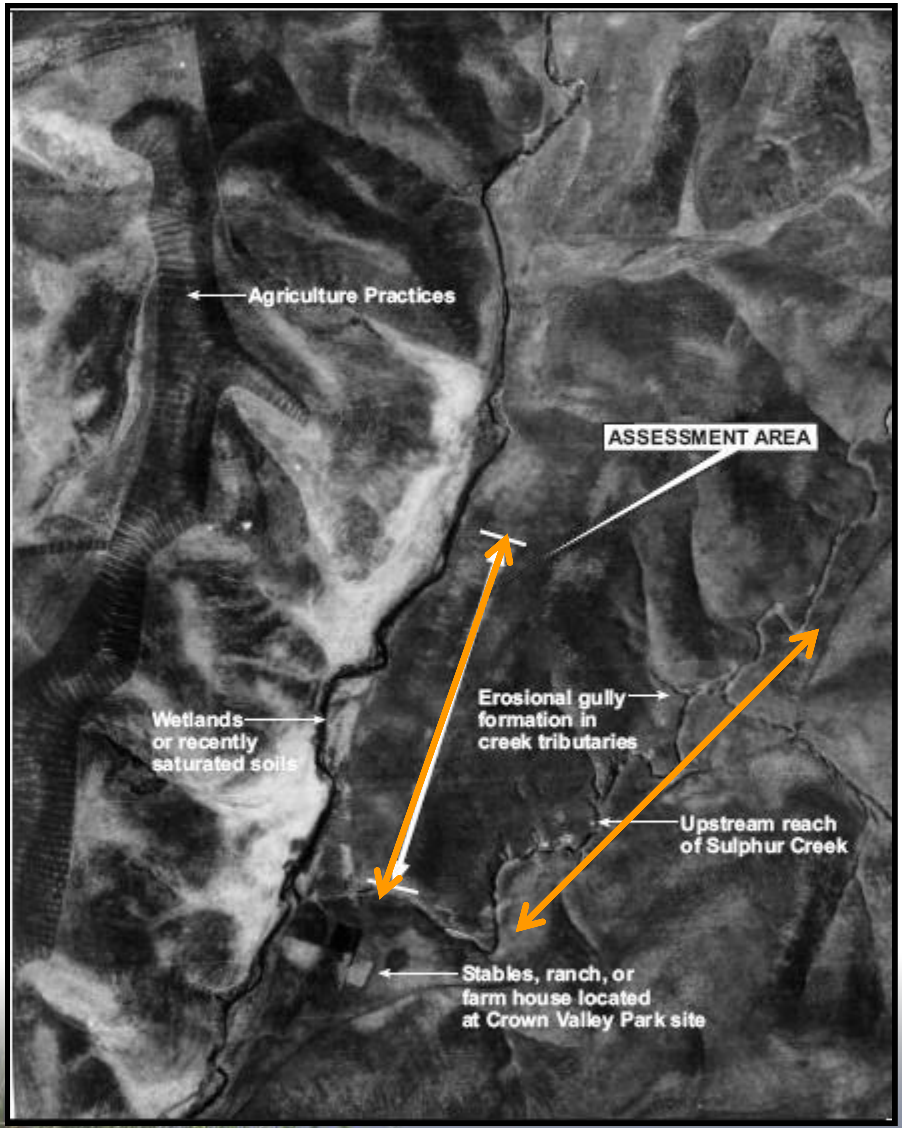
Use of Hydrogeomorphic Assessment Method (HGM) and the California Rapid Assessment Method (CRAM) in Guiding Adaptive Management Decisions: The Story of the City of Laguna Niguel and the Journey to Revitalizing a Southern California Urban Creek (Sulphur Creek)

Lindsay Teunis
ICF San Diego
lindsay.teunis@icf.com

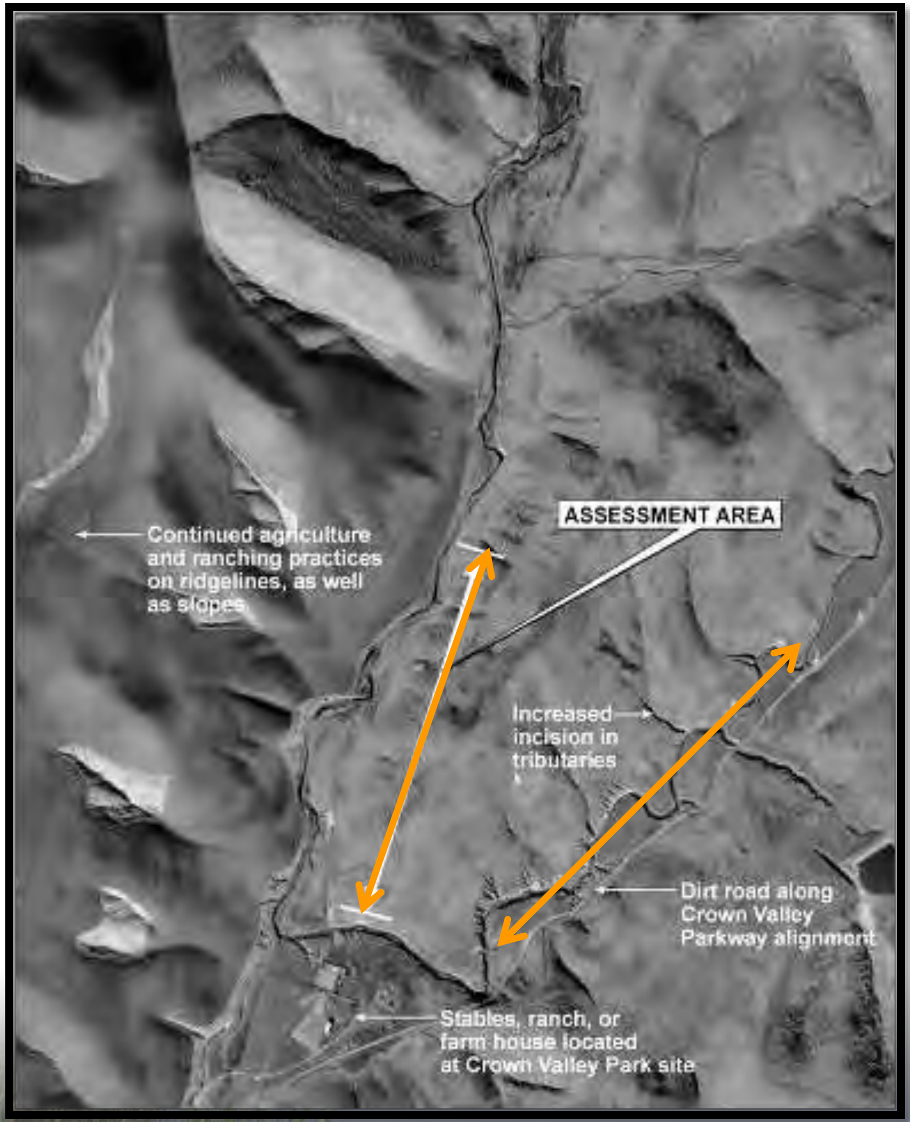
Aliso Creek Watershed and Sulphur Creek

- **Watershed covers 34.87 square mile**
- **Cities of Aliso Viejo, Dana Point, Laguna Hills, Laguna Niguel, Laguna Woods, Lake Forest and Mission Viejo.**

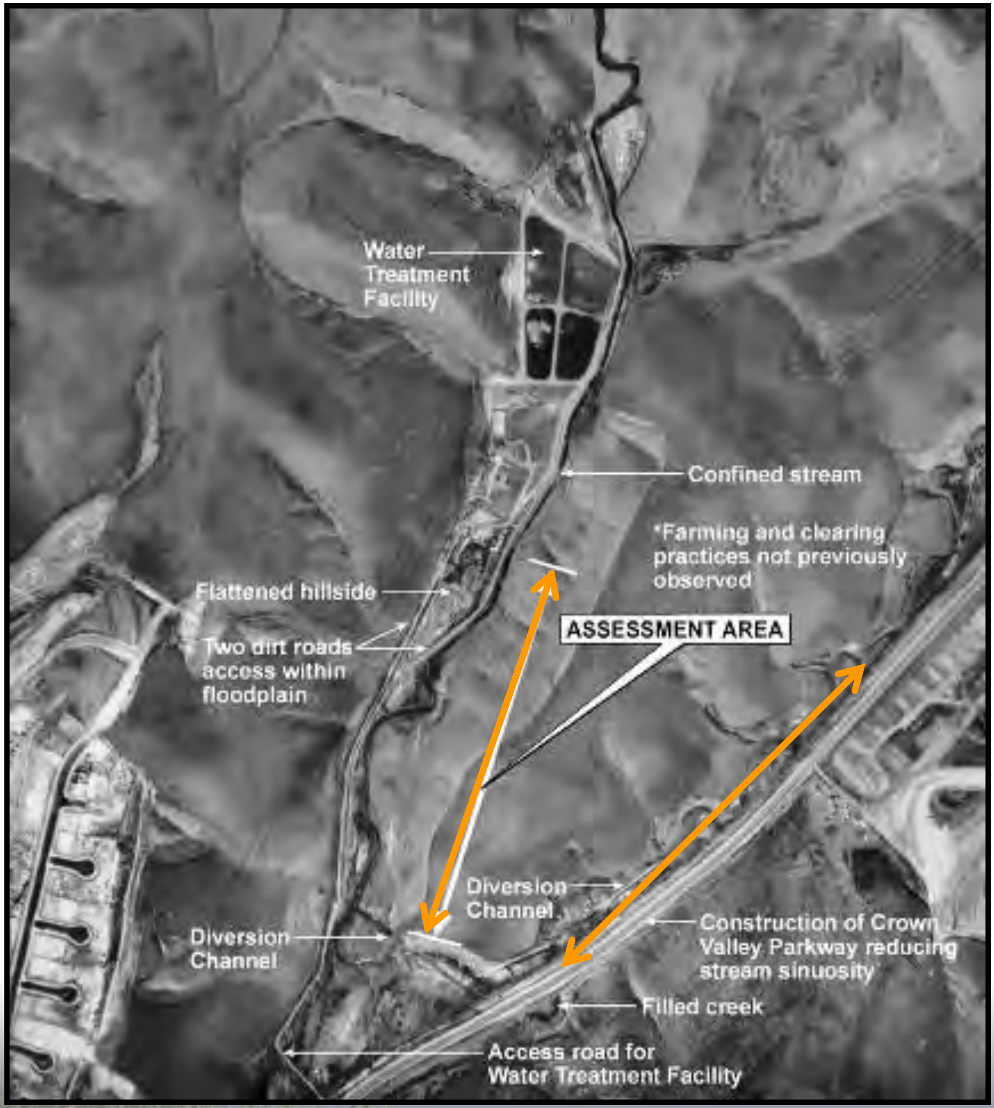
What is an "Urban Stream"?



1938


ASSESSMENT AREA
Continued agriculture and ranching practices on ridgelines, as well as slopes
Increased incision in tributaries
Dirt road along Crown Valley Parkway alignment
Stables, ranch, or farm house located at Crown Valley Park site

1952


Water
Treatment
Facility
Confined stream
*Farming and clearing
practices not previously
observed
Flattened hillside
ASSESSMENT AREA
Two dirt roads
access within
floodplain
Diversion
Channel
Diversion
Channel
Construction of Crown
Valley Parkway reducing
stream sinuosity
Filled creek
Access road for
Water Treatment Facility

1965

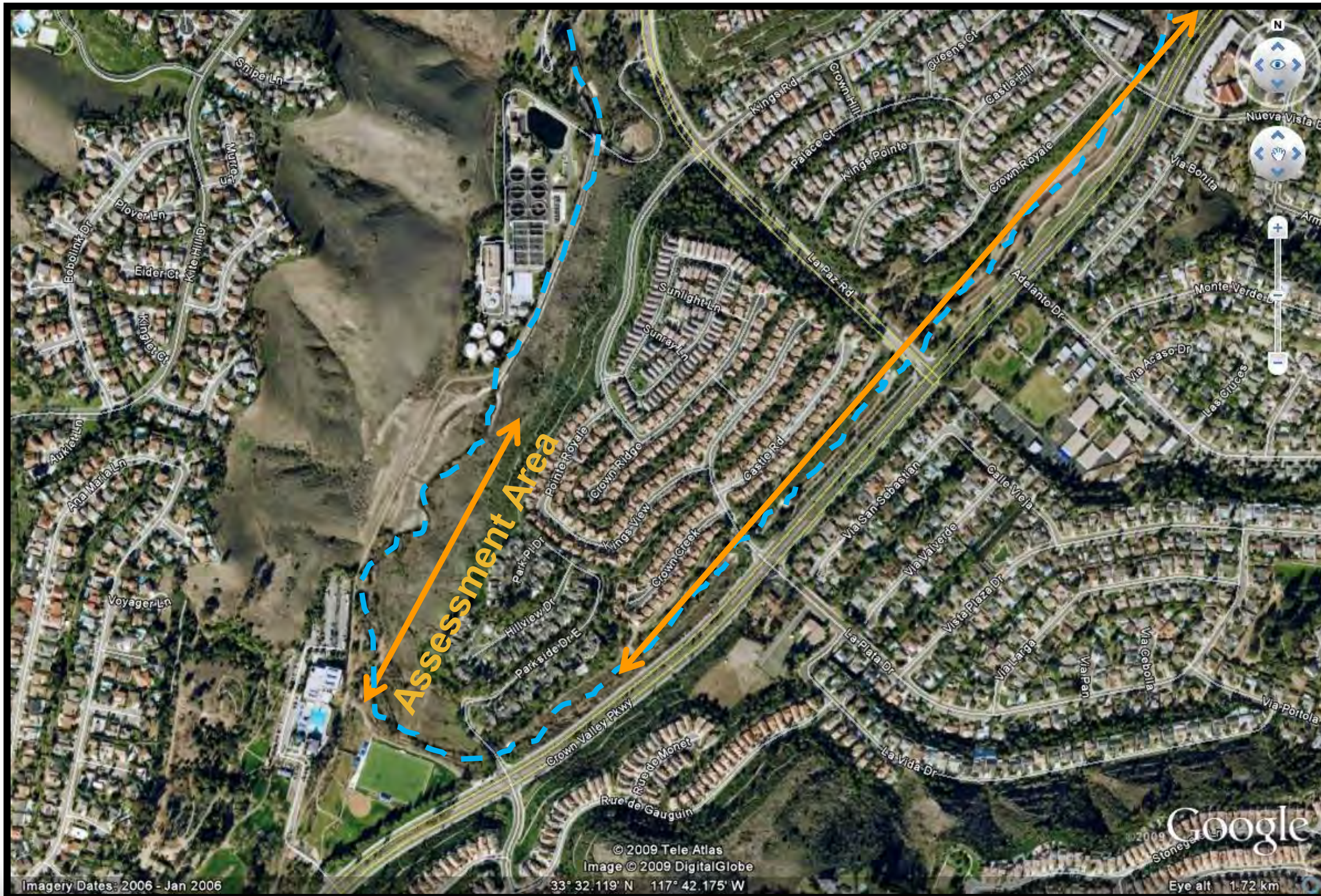

ASSESSMENT AREA
Straightened stream reach
Active Floodplain
Continued farming practices
Active Floodplain
Straightened stream reach

1971


Water Treatment Facility
Cement Diversion Channel
ASSESSMENT AREA
Disiling Basin
Abandonment of dirt road
New development
Park building
Straightened channel
Straightened and confined channel

1985

and NOW…

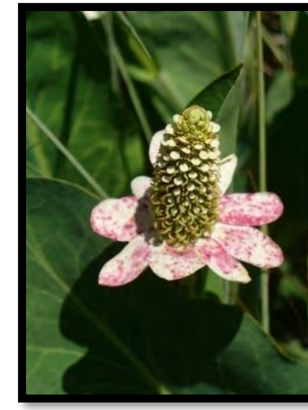

Assessment Area
Crown Valley Pkwy
La Paz Rd
Nueva Vista Dr
Google
© 2009 Tele Atlas
Image © 2009 DigitalGlobe
Imagery Dates: 2006 - Jan 2006
33° 32.119' N 117° 42.175' W
Eye alt 1.72 km

2006

Aliso Creek Watershed and Sulphur Creek

- July 1999, USACE Aliso Creek Watershed Management Feasibility Study.
- Study sponsored by the USACE, County of Orange, and municipalities and water districts
- Goal: (1) Re-establish stable, healthy, and sustainable watershed. (2) Identify feasible management options
- Study found that 12.2 of the total 14.2 Sulphur Creek miles (86 percent) are highly degraded
- 10.5 miles (74 percent) provide no measurable functional output
- None of the remaining stream reaches function at a high level.

Specific Goals for Restoration Identified



Enhancing **hydrologic processes** including:

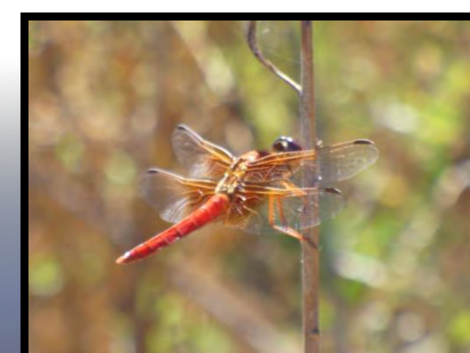
- Water storage, stream stability, and energy dissipation under existing constraints;

Restoring **biogeochemical functions** including:

- Nutrient cycling, nutrient availability, and sediment deposition; and

Restoring **biologic functions** including:

- Native wetland and riparian vegetation, plant and animal movement and dispersal, biomass production, and native plant and animal diversity.



Need to Evaluate Aspects of Project Throughout Lifecycle

Use Various Tools in the Restoration Planning Toolbox

EPA Three-tiered Monitoring Framework

Level 1 (Resource Inventories and Maps)

- National Wetland Inventory (NWI)
- Vegetation Mapping

Level 2 (Rapid Assessment of Overall Site Conditions)

- California Rapid Assessment Method (CRAM)
- Hydrogeomorphic Methodology (HGM)

Level 3 (Intensive Data Collection/Quantitative Assessment)

- Rare Plant Survey
- Wildlife Surveys (i.e., point counts, transects, grid)
- Index of Biotic Integrity (IBI) (algae, fish, invertebrate)
- Vegetation Monitoring (i.e., point/line intercept, quadrats)

Need to Evaluate Aspects of Project Throughout Lifecycle

Use Various Tools in the Restoration Planning Toolbox

EPA Three-tiered Monitoring Framework

Level 1 (Resource Inventories and Maps)

- National Wetland Inventory (NWI)
- Vegetation Mapping

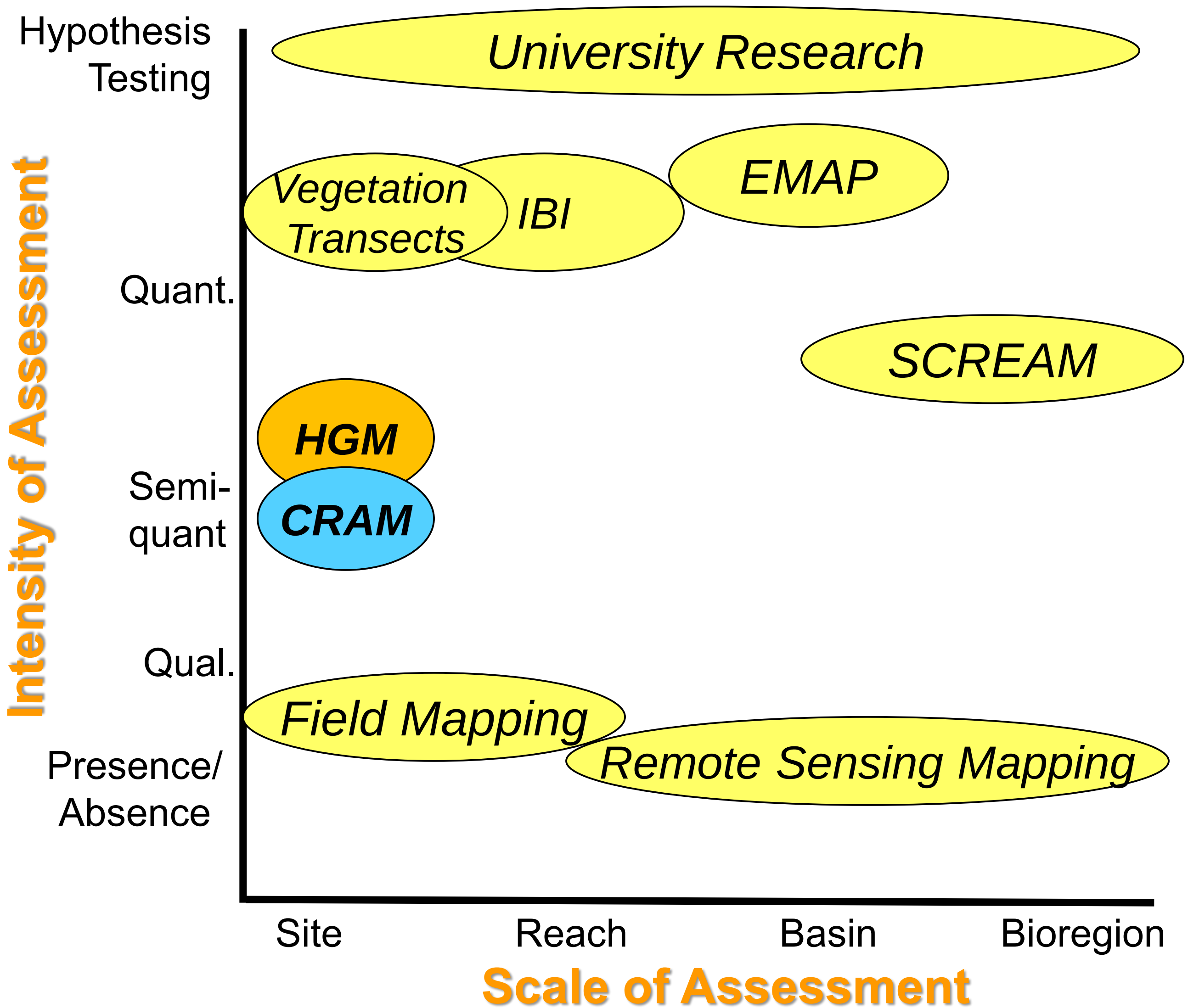
Level 2 (Rapid Assessment of Overall Site Conditions)

- California Rapid Assessment Method (CRAM)
- Hydrogeomorphic Methodology (HGM)

Focus on use of these tools in the Project Lifecycle

Level 3 (Intensive Data Collection/Quantitative Assessment)

- Rare Plant Survey
- Wildlife Surveys (i.e., point counts, transects, grid)
- Index of Biotic Integrity (IBI) (algae, fish, invertebrate)
- Vegetation Monitoring (i.e., point/line intercept, quadrats)


Hypothesis Testing
Quant.
Semi-quant
Qual.
Presence/ Absence
Intensity of Assessment
University Research
Vegetation Transects
IBI
EMAP
SCREAM
HGM
CRAM
Field Mapping
Remote Sensing Mapping
Site
Reach
Basin
Bioregion
Scale of Assessment

HGM Overview

- To assess the capacity of a stream reach to perform functions relative to similar streams in a region
- A method for assessing the functional capacity of an ecosystem
- Functional capacity is the degree or magnitude to which a ecosystem performs a function
- Ecosystem functions assessed through measures of commonly identified structural components
- HGM variables scored, used in simple algorithms to calculate riverine Functional Capacity Indices (FCIs), multiple by acreage to get Functional Capacity Units (FCU)
- Three HGM Indices Divided into 3 Distinct Functions

  1.) Hydrologic 2.) Biogeochemical 3.) Biologic

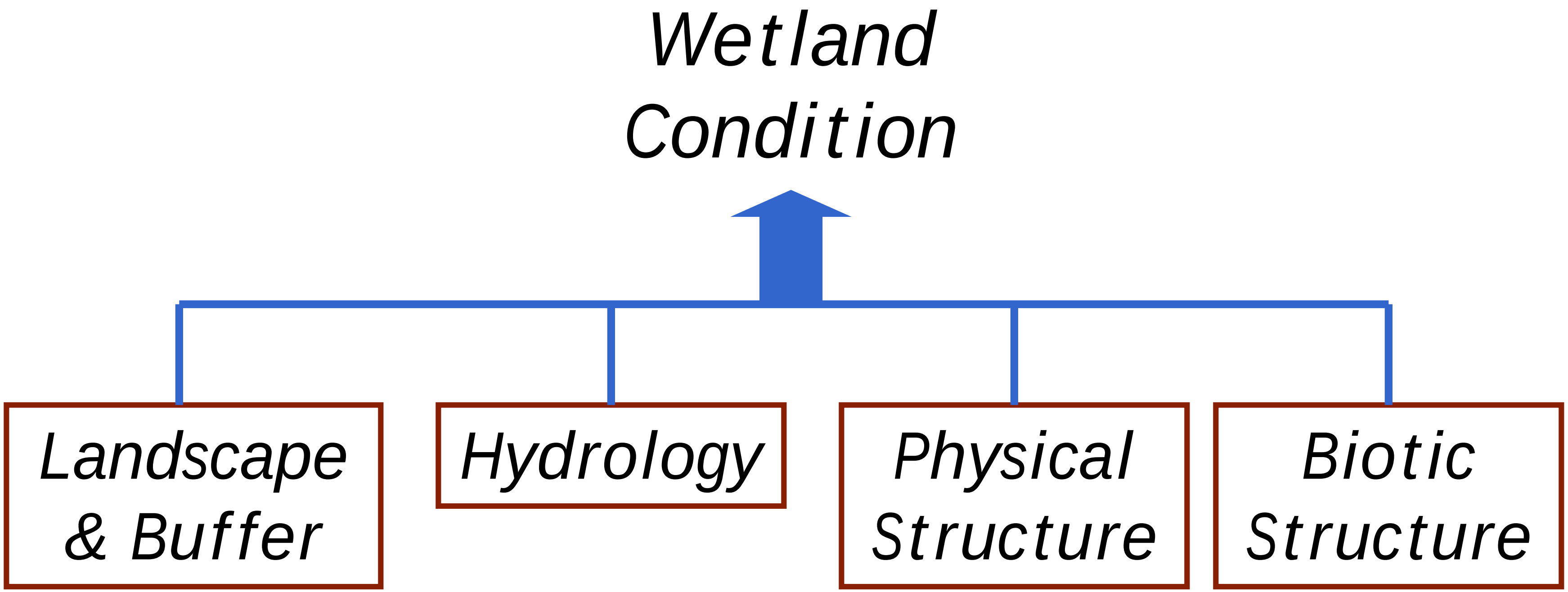
CRAM Overview

CRAM is a field-based “walk and talk” diagnostic tool that, when used as directed, provides rapid, repeatable, numeric assessment of the *overall condition* of a wetland based on visible indicators of its form, structure, and setting, relative to the least impacted reference condition.

What is *overall condition?*

Overall condition is the capacity or potential of a wetland to provide the functions and services expected for the same type of wetland in its natural setting, assessed relative to “best” reference condition.

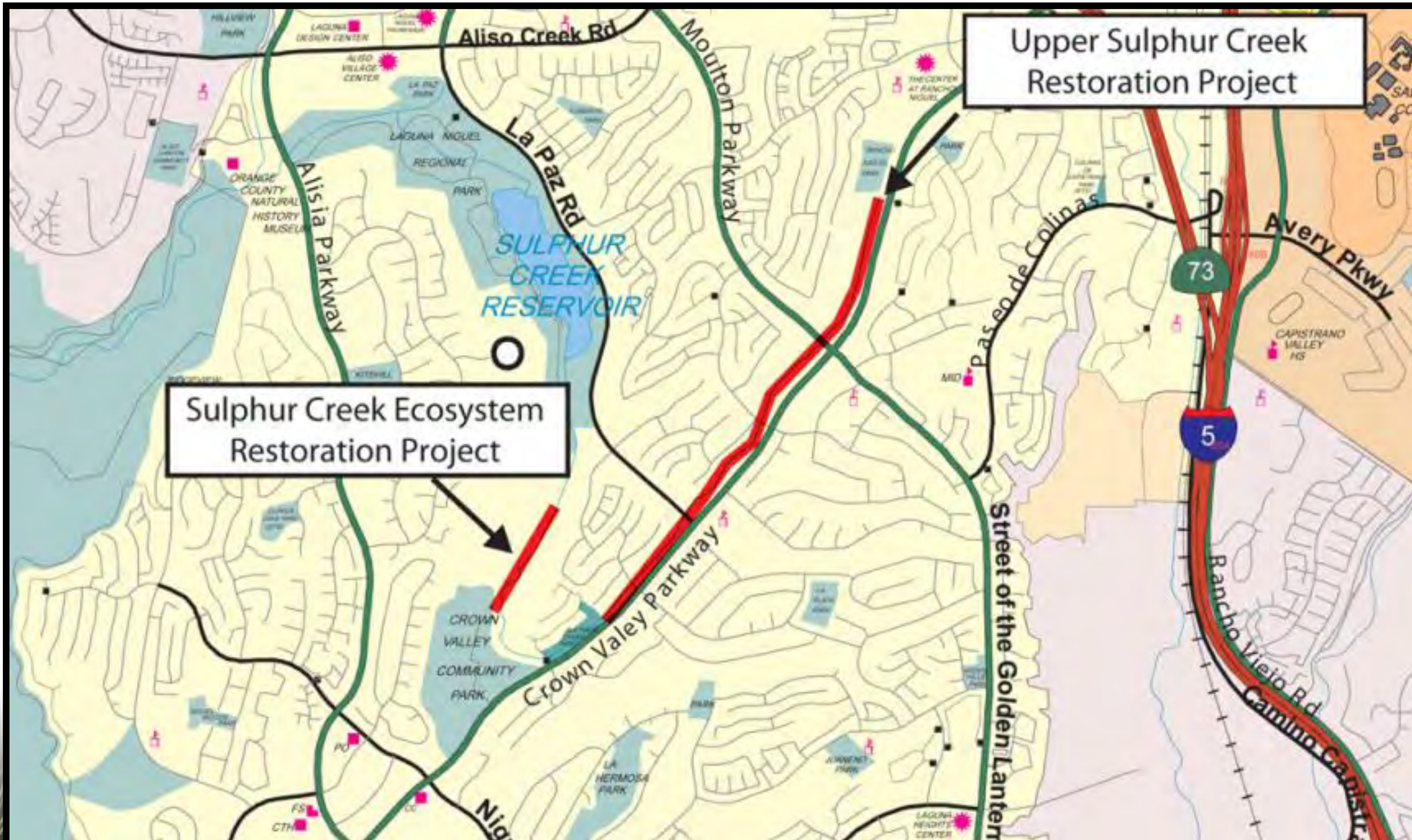
CRAM Design: Attributes



- CRAM recognizes 4 *attributes* of wetland condition
- Each attribute is represented by 2-3 *metrics*, some of which have *submetrics*

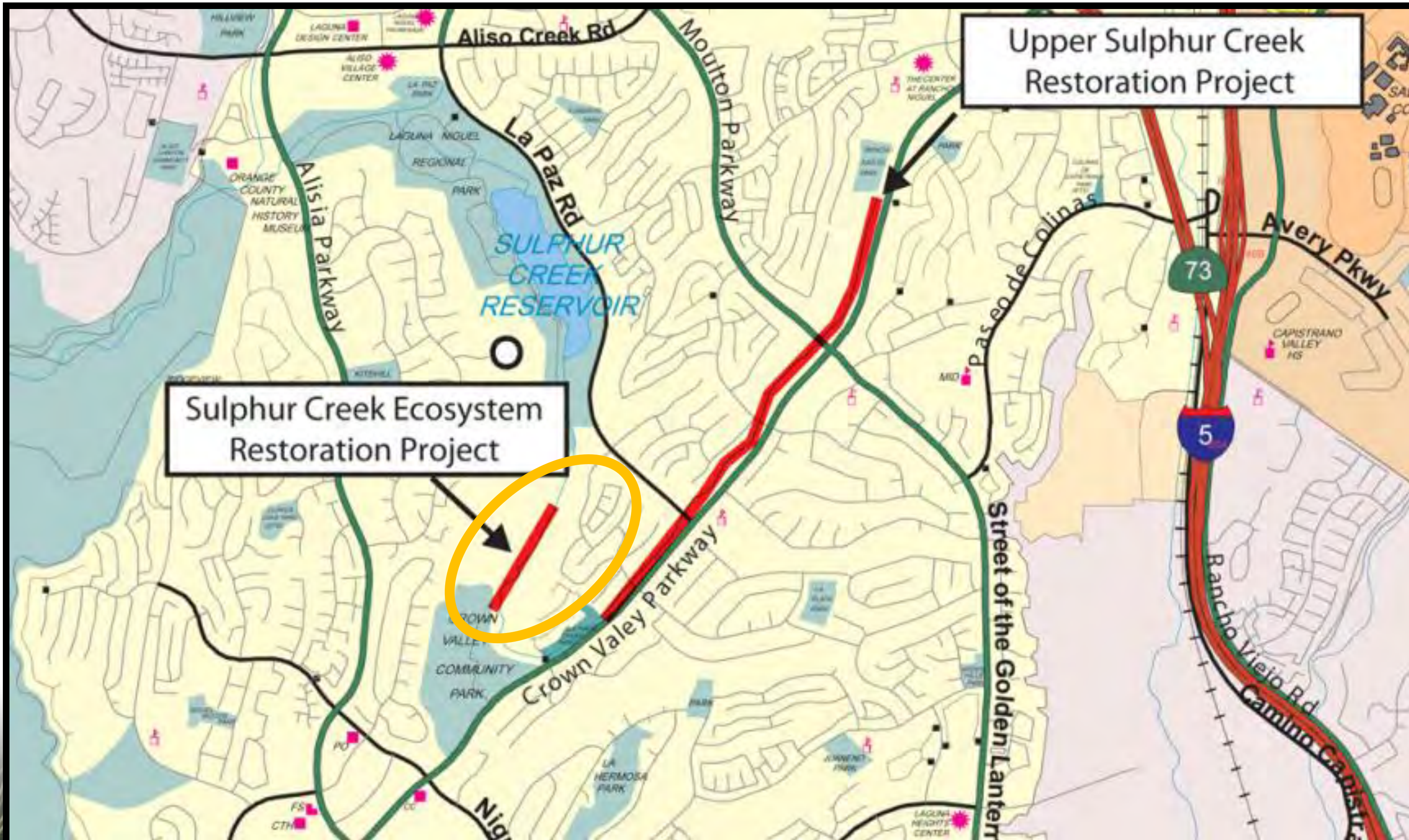
Attributes		Metrics and Submetrics
Buffer and Landscape Context		Aquatic Area Abundance Buffer Submetrics: • Percentage of Assessment Area with Buffer • Average Buffer Width • Buffer Condition
Hydrology		Water Source Hydroperiod Hydrologic Connectivity
Structure	Physical	Structural Patch Richness Topographic Complexity
	Biotic	Plant Community Composition Submetrics: • Number of Plant Layers • Number of Codominant Species • Percentage Invasion Horizontal Interspersion and Zonation Vertical Biotic Structure

Restoration was divided into two projects spanning over 2 miles of Sulphur Creek, an urbanized stream.



Sulphur Creek Ecosystem Restoration Project

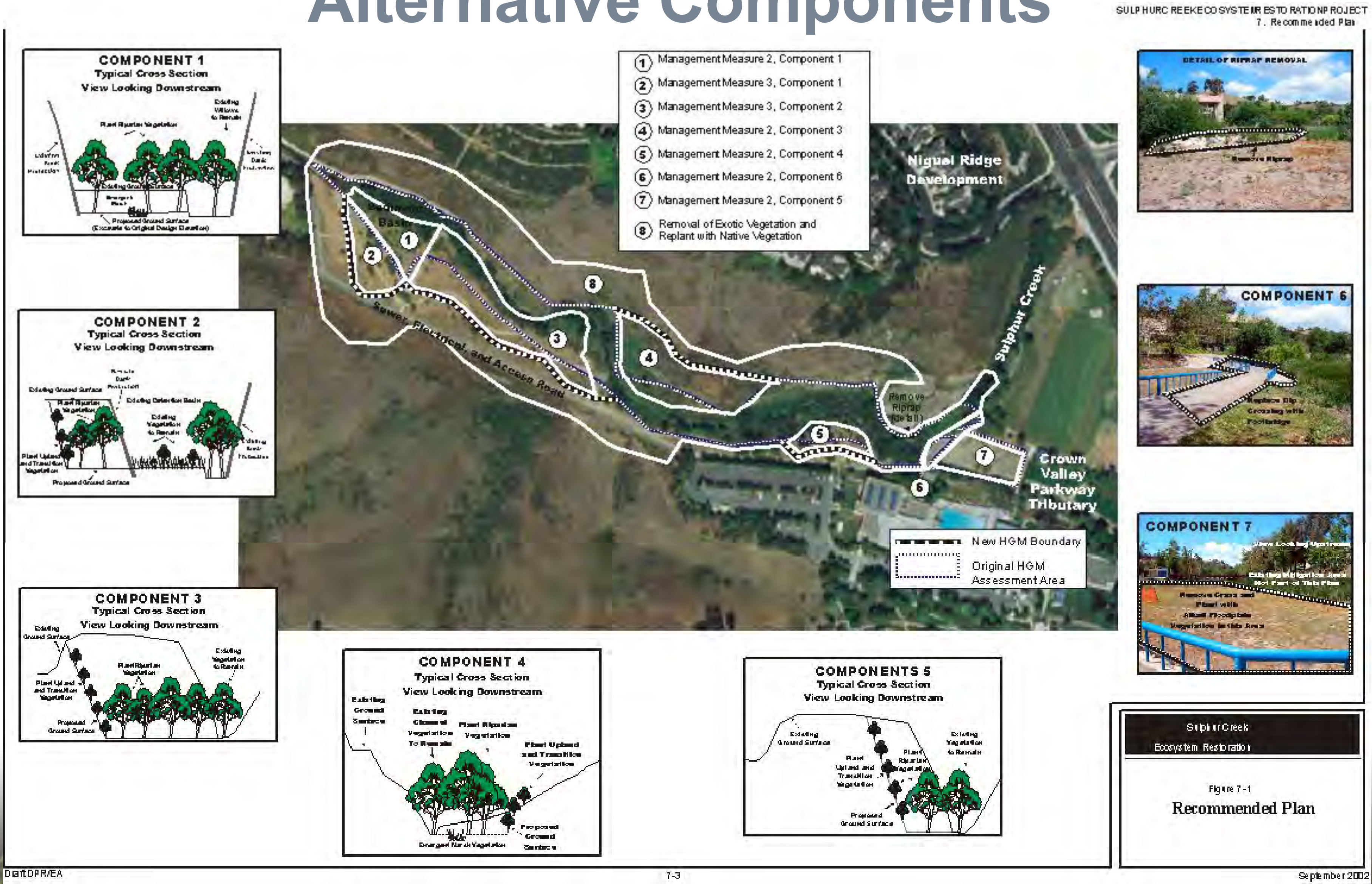
7.7 acres/ 2,000 linear feet



3 Alternatives Evaluated Using HGM

Component	Description	Total Area Acres	Riparian Area Acres
1 2 3	**Management Measure 1 (Exotic Vegetation Removal And Replacement)**		
Site wide	Remove exotic vegetation and replace with native vegetation	6.19	2.61
2 3	**Management Measure 2 (Inner Floodplain)**		
MM2-A	Excavate and replant the detention basin with native vegetation	0.39	0.39
MM2-B	Remove upstream bank protection for the detention basin and excavate and plant west overbank upstream of the basin	0.34	0.34
MM2-C	Excavate and plant the low area on the east overbank	1.48	1.48
MM2-D	Excavate and plant west overbank area	0.38	0.38
MM2-E	Remove exotic grasses in the area upstream of the footbridge and plant with native riparian vegetation	0.47	0.47
MM2-F	Remove the existing dip crossing at the confluence of Sulphur Creek and the Crown Valley Park tributary and replace with a bridge	0.16	0.16
3	**Management Measure 3 (Outer Floodplain)**		
MM3-A	Excavate the overbank area west of the detention basin and plant with native vegetation	0.38	0.38
MM3-B	Excavate the west overbank area upstream of the detention basin between the stream channel and access road and plant with native vegetation	1.48	1.48

Alternative Components



3 Alternatives Evaluated Using HGM

HGM FUNCTIONAL CAPACITY INDICES	Baseline	Future No Project	Future With Project		
			Alt 1	Alt 2	Alt 3
	2002	2014			
Hydrologic Functions (Average)	**0.40**	**0.24**	**0.20**	**0.65**	**0.71**
Maintenance of Characteristic Channel Dynamics	0.38	0.24	0.23	0.59	0.61
Dynamic Surface Water Storage and Energy Dissipation	0.35	0.24	0.24	0.78	0.79
Long-term Surface Water Storage	0.47	0.22	0.09	0.73	0.81
Dynamic Subsurface Water Storage	0.42	0.28	0.23	0.50	0.63
Biogeochemical Functions (Average)	**0.32**	**0.25**	**0.27**	**0.71**	**0.78**
Nutrient Cycling	0.24	0.24	0.32	0.69	0.81
Detention of Imported Elements and Compounds	0.32	0.24	0.26	0.74	0.82
Detention of Particulates	0.33	0.24	0.24	0.71	0.71
Organic Carbon Export	0.38	0.28	0.25	0.68	0.77
Habitat Functions (Average)	**0.53**	**0.49**	**0.49**	**0.89**	**0.90**
Maintain Characteristic Plant Community	0.43	0.43	0.55	0.90	0.90
Maintain Characteristic Detrital Biomass	0.40	0.40	0.40	0.75	0.75
Maintain Spatial Structure of Habitat	0.38	0.36	0.38	0.84	0.84
Maintain Habitat Interspersion and Connectivity	0.49	0.24	0.12	0.84	0.90
Maintain Characteristic Invertebrate Diversity	0.75	0.75	0.75	1.00	1.00
Maintain Characteristic Vertebrate Diversity	0.75	0.75	0.75	1.00	1.00

3 Alternatives Evaluated Using HGM

HGM FUNCTIONAL CAPACITY INDICES	Baseline	Future No Project	Future With Project		
			Alt 1	Alt 2	Alt 3
	2002	2014			
Hydrologic Functions (Average)	**0.40**	**0.24**	**0.20**	**0.65**	**0.71**
Maintenance of Characteristic Channel Dynamics	0.38	0.24	0.23	0.59	0.61
Dynamic Surface Water Storage and Energy Dissipation	0.35	0.24	0.24	0.78	0.79
Long-term Surface Water Storage	0.47	0.22	0.09	0.73	0.81
Dynamic Subsurface Water Storage	0.42	0.28	0.23	0.50	0.63
Biogeochemical Functions (Average)	**0.32**	**0.25**	**0.27**	**0.71**	**0.78**
Nutrient Cycling	0.24	0.24	0.32	0.69	0.81
Detention of Imported Elements and Compounds	0.32	0.24	0.26	0.74	0.82
Detention of Particulates	0.33	0.24	0.24	0.71	0.71
Organic Carbon Export	0.38	0.28	0.25	0.68	0.77
Habitat Functions (Average)	**0.53**	**0.49**	**0.49**	**0.89**	**0.90**
Maintain Characteristic Plant Community	0.43	0.43	0.55	0.90	0.90
Maintain Characteristic Detrital Biomass	0.40	0.40	0.40	0.75	0.75
Maintain Spatial Structure of Habitat	0.38	0.36	0.38	0.84	0.84
Maintain Habitat Interspersion and Connectivity	0.49	0.24	0.12	0.84	0.90
Maintain Characteristic Invertebrate Diversity	0.75	0.75	0.75	1.00	1.00
Maintain Characteristic Vertebrate Diversity	0.75	0.75	0.75	1.00	1.00

3 Alternatives Evaluated Using HGM

HGM FUNCTIONAL CAPACITY INDICES	Baseline	Future No Project	Future With Project		
			Alt 1	Alt 2	Alt 3
	2002	2014			
Hydrologic Functions (Average)	**0.40**	**0.24**	**0.20**	**0.65**	**0.71**
Maintenance of Characteristic Channel Dynamics	0.38	0.24	0.23	0.59	0.61
Dynamic Surface Water Storage and Energy Dissipation	0.35	0.24	0.24	0.78	0.79
Long-term Surface Water Storage	0.47	0.22	0.09	0.73	0.81
Dynamic Subsurface Water Storage	0.42	0.28	0.23	[illegible]	0.63
Biogeochemical Functions (Average)	**0.32**	**0.25**	**0.27**	**0.71**	**0.78**
Nutrient Cycling	0.24	0.24	0.32	0.69	0.81
Detention of Imported Elements and Compounds	0.32	0.24	0.26	0.74	0.82
Detention of Particulates	0.33	0.24	0.24	0.71	0.71
Organic Carbon Export	0.38	0.28	0.25	[illegible]	0.77
Habitat Functions (Average)	**0.53**	**0.49**	**0.49**	**0.89**	**0.90**
Maintain Characteristic Plant Community	0.43	0.43	0.55	0.90	0.90
Maintain Characteristic Detrital Biomass	0.40	0.40	0.40	0.75	0.75
Maintain Spatial Structure of Habitat	0.38	0.36	0.38	0.84	0.84
Maintain Habitat Interspersion and Connectivity	0.49	0.24	0.12	0.84	0.90
Maintain Characteristic Invertebrate Diversity	0.75	0.75	0.75	1.00	1.00
Maintain Characteristic Vertebrate Diversity	0.75	0.75	0.75	1.00	1.00

So How Did They Choose the Preferred Alternative???

- **USACE needs to determine "Best Buy"**
- **Looked at cost for each alternative**
- **Looked at Functional Capacity Units (FCU)**

FCU = Average FCI x Acreage

So How Did They Choose the Preferred Alternative???

Alternative #	Management Measures			Annualized Output (Total FCUs)	Annualized Cost	FCU Incremental Output	Incremental Cost	Incremental Cost Per FCU	Determination
No Action	0	0	0	4.08	NOT APPLICABLE				
1	1	0	0	4.57	$84,539	0.49	$84,539	$172,528	Eliminate
2	1	2	0	13.18	$129,806	9.10	$129,806	$14,264	Eliminate
3	1	2	3	18.29	$169,123	14.21	$169,123	$11,902	Best Buy

February 2006

July 2010

October 2017

September 2005

September 2005

July 2010

October 2017

September 2005

May 2008

July 2008

July 2010

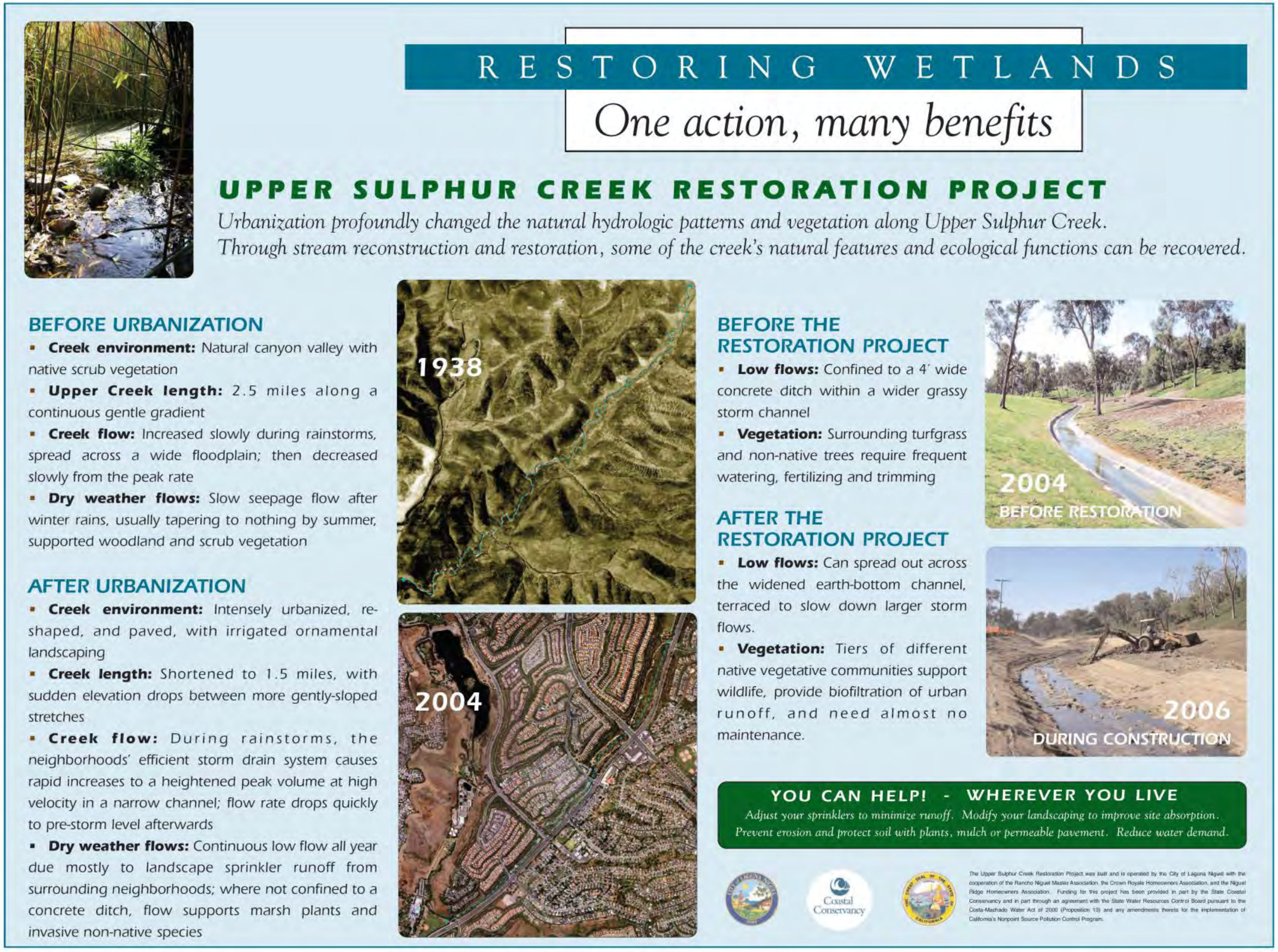
CRAM Scores

Attribute	Metric		Baseline 2008	Year 1 2009	Year 2 2010	Year 3 2011	Year 4 2012	Max Score
Buffer and Landscape Context	Aquatic Area Abundance		D	D**	D	D	D	D
	Buffer Submetrics:							
	• Percent of Assessment Area with Buffer		A	A**	A	A	A	A
	• Average Buffer Width		C	C**	C	C	C	C
	• Buffer Condition		C	C	C	C	C	B
	Attribute Score		38%	42%	42%	42%	42%	49%
Hydrology	Water Source		C	C**	C	C	C	C
	Channel Stability		B	B	B	B	*C*	A
	Hydrologic Connectivity		A	A**	A	A	A	A
	Attribute Score		75%	75%	75%	75%	*67%*	83%
Structure	Physical	Structural Patch Richness	D	**C**	C	C	C	B
		Topographic Complexity	C	**B**	*C*	C	C	B
	Attribute Score		50%	**62%**	50%	50%	50%	75%
	Biotic	Plant Community Submetrics:						
		• Number of Plant Layers Present	C	**A****	A	A	*B*	B
		• Number of Codominant Species	D	**B**	B	B	*C*	B
		• Percent Invasion	A	A**	A	A	A	A
		Horizontal Interspersion	C	**B**	B	B	*C*	B
		Vertical Biotic Structure	D	**B**	B	B	B	B
	Attribute Score		53%	**81%**	81%	81%	*67%*	78%
FINAL SCORE			51%	**68%**	65%	65%	*56%*	73%

HGM Scores

Functional Capacity Index	Pre-Con 2002	Baseline 2008	Year 1 2009	Year 2 2010	Year 3 2011	Year 4 2012	Max Score
Hydrologic Functions							
Maintenance of Characteristic Channel Dynamics	0.38	0.43	0.48	0.53	0.65	0.67	0.64
Dynamic Surface Water Storage and Energy Dissipation	0.35	0.39	0.48	0.60	0.68	0.75	0.88
Long-term Surface Water Storage	0.47	0.56	0.56	0.75	0.75	0.75	0.75
Dynamic Subsurface Water Storage	0.42	0.37	0.37	0.50	0.50	0.50	0.50
Biogeochemical Functions							
Nutrient Cycling/Transformation of Compounds	0.24	0.28	0.45	0.58	0.70	0.75	0.92
Detention of Imported Elements and Compounds	0.32	0.40	0.47	0.60	0.67	0.71	0.81
Detention of Particulates	0.33	0.37	0.44	0.55	0.66	0.71	0.79
Organic Carbon Export	0.38	0.39	0.45	0.52	0.60	0.65	0.72
Habitat Functions							
Maintain Characteristic Plant Community	0.43	0.42	0.62	0.75	0.82	0.85	0.95
Maintain Characteristic Detrital Biomass	0.40	0.42	0.42	0.39	0.63	0.83	0.88
Maintain Spatial Structure of Habitat	0.38	0.42	0.48	0.62	0.75	0.84	0.92
Maintain Habitat Interspersion and Connectivity	0.49	0.55	0.60	0.80	0.80	0.80	0.80
Maintain Characteristic Invertebrate Diversity	0.75	0.75	0.75	0.75	1.00	1.00	1.00
Maintain Characteristic Vertebrate Diversity	0.75	0.75	1.00	1.00	1.00	1.00	1.00

Thank you!!



RESTORING WETLANDS

One action, many benefits

UPPER SULPHUR CREEK RESTORATION PROJECT

Urbanization profoundly changed the natural hydrologic patterns and vegetation along Upper Sulphur Creek. Through stream reconstruction and restoration, some of the creek's natural features and ecological functions can be recovered.

BEFORE URBANIZATION

- **Creek environment:** Natural canyon valley with native scrub vegetation
- **Upper Creek length:** 2.5 miles along a continuous gentle gradient
- **Creek flow:** Increased slowly during rainstorms, spread across a wide floodplain; then decreased slowly from the peak rate
- **Dry weather flows:** Slow seepage flow after winter rains, usually tapering to nothing by summer, supported woodland and scrub vegetation

AFTER URBANIZATION

- **Creek environment:** Intensely urbanized, re-shaped, and paved, with irrigated ornamental landscaping
- **Creek length:** Shortened to 1.5 miles, with sudden elevation drops between more gently-sloped stretches
- **Creek flow:** During rainstorms, the neighborhoods' efficient storm drain system causes rapid increases to a heightened peak volume at high velocity in a narrow channel; flow rate drops quickly to pre-storm level afterwards
- **Dry weather flows:** Continuous low flow all year due mostly to landscape sprinkler runoff from surrounding neighborhoods; where not confined to a concrete ditch, flow supports marsh plants and invasive non-native species

1938

2004

BEFORE THE RESTORATION PROJECT

- **Low flows:** Confined to a 4′ wide concrete ditch within a wider grassy storm channel
- **Vegetation:** Surrounding turfgrass and non-native trees require frequent watering, fertilizing and trimming

AFTER THE RESTORATION PROJECT

- **Low flows:** Can spread out across the widened earth-bottom channel, terraced to slow down larger storm flows.
- **Vegetation:** Tiers of different native vegetative communities support wildlife, provide biofiltration of urban runoff, and need almost no maintenance.

2004 BEFORE RESTORATION

2006 DURING CONSTRUCTION

YOU CAN HELP! - WHEREVER YOU LIVE

Adjust your sprinklers to minimize runoff. Modify your landscaping to improve site absorption. Prevent erosion and protect soil with plants, mulch or permeable pavement. Reduce water demand.

Coastal Conservancy

The Upper Sulphur Creek Restoration Project was built and is operated by the City of Laguna Niguel with the cooperation of the Rancho Niguel Master Association, the Crown Royale Homeowners Association, and the Niguel Ridge Homeowners Association. Funding for this project has been provided in part by the State Coastal Conservancy and in part through an agreement with the State Water Resources Control Board pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program.