LEED™ Requirements: From A Hydrology & Drainage Design Perspective

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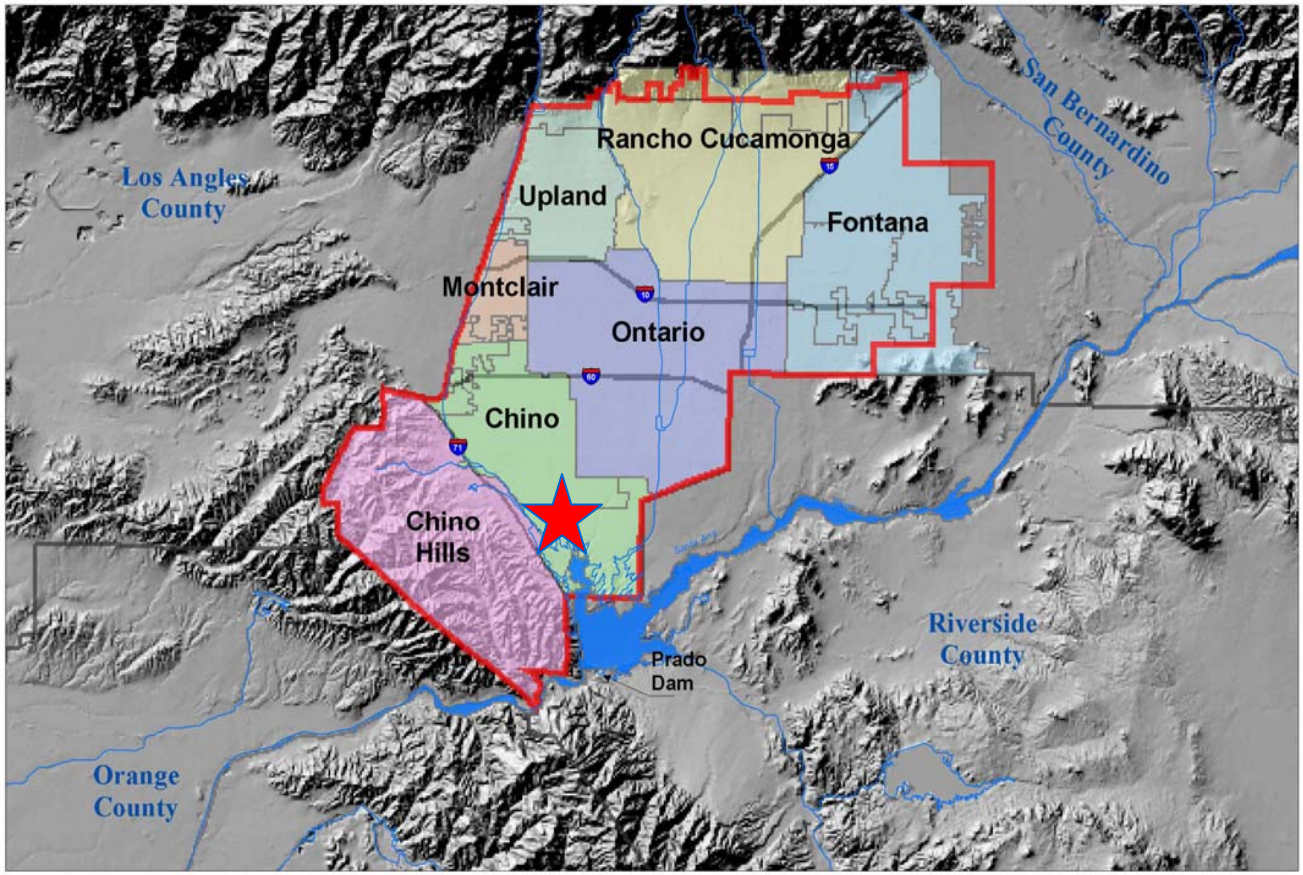
Inland Empire Utilities Agency-

"We Own and Operate Wastewater Treatment Plants"

IEUA

- 7 member Agencies
- 242 square miles
- Population 700,000 (Chino Basin expected to double to 1.4 million by 2020)
- Wastewater treatment services
- Recycled water program
- Provide wholesale water (30% imported water supplies)



IEUA Headquarters Project – Phase I

Project Information -

Total Site Acreage: 35 Acres

H.Q. Acreage - 14 Acres

Architecture –

Bldg. 1 - 33,000 S.F

Bldg. 2 - 33,000 S.F

Address

6075 Kimball Avenue

Chino, CA 91710

Stormwater Charrette held Oct 2001.

Design began March 2002.

Construction completed August 2003

Project Information

- **Project Name:** IEUA Headquarters Building

- **Type of Project:** Integrative BMP Project
  - Pervious Pavement
  - No Curb/Gutter
  - Swales
  - Detention Basin
  - Natural Drainage Systems
  - Roof Runoff Controls
  - Dry lake/pond via surface flow
  - Landscape Planning etc…

Stormwater Element Design Objectives

- Break even as it relates to costs
- Build a BMP parking lot for Phase I of the IEUA Headquarters Chino Park project – implement what others have not been able to do *(LACDPW)*
- Minimize stormwater runoff
- Increase on-site infiltration and reduce contaminants flowing to Chino Creek

- Meet U.S. Green Building Council 2.0 LEED™ manual's criteria for post project conditions:
  - SS.C06.1 (involves the rate or quantity of stormwater)
    - reduce the "C" value by 25%, capture 85% of the total runoff
  - SS.C06.2 (involves the treatment of stormwater)
    - remove 80% TSS and 40% TP of the post-project's annual nutrient loading

Challenging New Development Requirements

- 2001 Stormwater Charette involvement was key to City approval for modifications
- IEUA, a public entity, saved ratepayers $1,417,322 on stormwater project elements alone!
  - Alternative paving materials
  - No curb & gutter
  - Storm drain size reduction
  - Elimination of box culvert to Chino Creek

2.0 LEED™ Stormwater Requirements

- **Criteria SS.C06.1**
  - No increase in net imperviousness of the project site
- **Accomplishment**
  - The imperviousness percentage of the site was reduced from runoff coefficient C=0.75 to C=0.50
- **Criteria SS.C06.2**
  - Removal of approximately 80% of the average annual post-project Total Suspended Solids (TSS) and 40% of the average annual post project Total Phosphorous (TP)
- **Accomplishment**
  - Removed 89% of the average annual post-project TSS and 40% of the average annual phosphorous*

NOTE:

For purposes of this study, the "pre-project" condition refers to the site's condition prior to project construction (dairy). The "post-project" condition reflects project completion. (Theoretical value for phosphorous)

Runoff Coefficient "C" Calculation for Pre-Project Condition (Dairy)

Surface Type	Area (Sq. ft)	C	I	F_p	A_p	A_i	CN	K
Barren/Graded Soil	554,516.7	0.74	0.85	0.018	0.85	0.15	91	409,233.32
Dairy Wet Ponds	11,151.2	0.86	0.85	0.18	0.2	0.8	91	9,611.02
Buildings	36,118.1	0.9	0.85	0.18	0	1	91	32,506.29
Total Area (Sq. ft)	601,786				Total			451,350.627
					Weighted "C" Value			0.75

C = Runoff Coefficient - $C = 0.9 (A_i + (I - F_p)A_p I^{-1})$

I= Rainfall Intensity. Based on 85th percentile, where I = 0.87

F_p= Infiltration Rate for Pervious Area

A_p = Pervious Area

A_i = Impervious Area

Runoff Coefficient "C" Calculation for Post-Project Condition

Surface Type	Area (Sq. ft)	C	I	F_p	A_p	A_i	CN	K
AC Pavement	9,1251	0.81	0.85	0.59	0.15	0.85	69	73,546.12
Stabilized Decomposed Granite	24,335	0.81	0.85	0.59	0.15	0.85	69	19,621.17
Non-stabilized Decomposed Granite/Commercial Landscape	40,071	0.46	0.85	0.59	0.7	0.3	69	18,541.09
Landscaped Areas	266,263	0.28	0.85	0.59	1	0	69	73,300.64
Precast Pavers	33,060	0.78	0.85	0.59	0.2	0.8	69	25,623.44
Water Features	16,809	0.90	0.85	0.59	0	1	69	15,123.10
Buildings	68,040	0.90	0.85	0.59	0	1	69	61,236.00
Non-Porous Concrete	34,361	0.90	0.85	0.59	0	1	69	30,924.90
Porous Concrete	27,632	0.71	0.85	0.59	0.3	0.7	69	19,690.24
Total Area (Sq. ft)	601,786						Total	337,611.69
							Weighted "C" Value	0.56

Reduce On-site Runoff Coefficient

Infiltrate!

- Pervious pavement
- No curb & gutter
- Swales
- Detention basins
- Perforated pipe (!) for storm drains

- Conservation and creation of Natural Areas
- Natural Drainage System

Innovative Pervious Pavements v. Traditional Paving

Unit Pavers (Vehicular) = 11,890 Sq. ft

Pervious Concrete = 12,000 Sq. ft

Natural Gray Concrete (vehicular) = 34,976 Sq. ft

Precast Concrete Pavers (Pedestrian) = 11, 077 Sq. ft

Asphalt = 89,239 Sq. ft

No Curb/Gutter

- **Water sheet flows across the site allotting ample time for detention, infiltration, and retention**
- **Encourages drainage as a design element -** ***textures and colors were used to delineate walkways, landscaping, parking aisles, and driveways***
- **Utilizes natural drainage**
- **Reduces use of curbs saving $252,200**

Swales

- On and off site storm water is treated naturally via swales, wetlands, and native vegetation
- Provide opportunity for runoff to naturally infiltrate
- Easily integrated into site design
- Reduces stormwater velocities
- Swales enhance overall project aesthetics
- No ponding within 24 hours after ALL 2004/05 rainy season events *(calls from the Architect to make sure it worked!)*

Detention Basins

- Sized to detain a 25 year storm event on-site
- Sized to detain water quality volume
- Assisted in the prevention of downstream flooding (El Prado Rd)
- Decreased pollutant loading
- Assisted in ground water recharge
- Encouraged natural resources and ecosystems

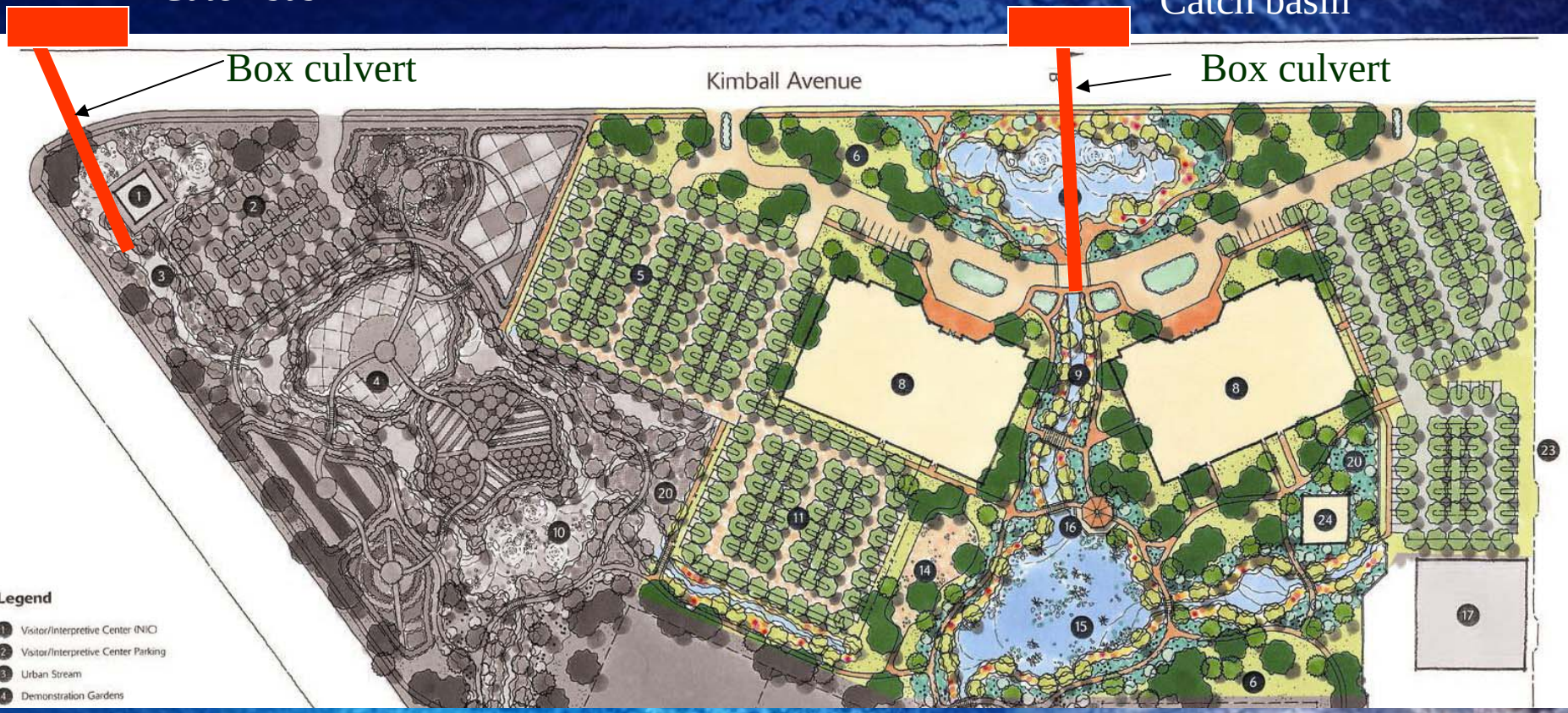
Restoring the Natural Drainage

Engineered drainage system mimics natural systems

- Assumed a watershed perspective
- City of Chino SW Master Plan's 10'X10' box culvert to convey off-site flows to Chino Creek was eliminated ($1.2 M savings !)
- Receives off-site storm flows previously directed from a 24" pipe into Chino Creek.

First seasonal storm event resulted in immediate improvements to water quality of Chino Creek.

Off-site Stormwater Capture



BMP Parking Lot Savings

SB Co most strict SW regs in So. Cal.

Design

- Traditional Box culvert ($1.2 M)
- Storm drains/ curb & gutter
- Agency Operational cost savings - Car washing allowed on site – currently saving over $18,000/ year . Potential of over $140,000/year)

Other

- Future savings to region Stormwater quality in Chino Creek/ SW runoff in City of Chino
- Developer savings – paved way with the City

Stormwater Infrastructure Construction Cost Comparison
(Headquarters vs. Conventional Design)

Item No. Description	Unit cost	Quantity	Headquarters	Conventional
1 Off-site Stormwater Management		1 L.S.	$ 621,879	$ 2,000,000
2 Hardscape 2.1 Pavers (Vehicular)	$ 6.65	11,890 S.F.	$ 79,069	$ N/A
2.2 Precast Concrete pavers (Pedestrian)	$ 5.50	11,077 S.F.	$ 60,924	$ N/A
2.3 Asphalt[2]	$ 2.30	89,329 S.F.	$ 205,457	$ 434,774
2.4 Pervious Concrete	$ 7.50	12,000 S.F.	$ 90,000	$ N/A
2.5 Decomposed Granite (Vehicular & Pedestrian)	$ 3.00	29,760 S.F.	$ 89,280	$ N/A
2.6 Natural Gray Concrete (Vehicular)	$ 7.50	34,976 S.F.	$ 262,320	
2.7 Natural Gray Concrete (Pedestrian)	$ 7.50	22,400 S.F.	$ N/A	$ 168,000
3 Base[3] 3.1 14” Class II (Vehicular Pavers)	$ 14.00	1,321 S.Y.	$ 18,496	$ N/A
3.2 4” Class II (Pedestrian Pavers)	$ 6.00	1,321 S.Y.	$ 7,385	$ N/A
3.3 6” &4” Class II (Vehicular Asphalt)	$ 8.00	9,925 S.Y.	$ 79,404	$ 168,028

Stormwater Infrastructure Construction Cost Comparison
(Headquarters vs. Conventional Design) Continued..

Item No. Description	Unit cost	Quantity	Headquarters	Conventional
3.4 10" ¾" Rock (Pervious Concrete)	$15.00	1,333 S.Y.	$ 20,000	$ N/A
3.5 4" Class II (Decomposed Granite)	$6.00	3,307 S.Y.	$ 19,840	$ N/A
3.6 4" Class II (Vehicular Concrete)	$6.00	34,976 S.Y.	$ 209,856	$ N/A
3.7 4" Class II (Pedestrian Concrete)	$6.00	22,400 S.Y.	$ N/A	$ 134,400
4 Storm Drain	$	1 L.S.	$ 42,289	$ 87,070
5 Boulders	$73.26	286 Each	$ 20,953	$ N/A
6 Curb & Gutter	$13.00	19,400 L.F.	$ N/A	$ 252,200
		TOTAL:	$ 1,827,150	$ 3,244,472
HEADQUARTERS SAVING: (Net Incremental Savings)				**$ 1,417,322**

Landscape Cost Comparison
(Headquarters vs. Conventional Designs)

Item No	Description	Unit Cost[1]	Quantity	Unit	Headquarters	Conventional
1	15 gallons trees	$ 95.00	434	Each	$ 41,230	$ 41,230
2	gal shrubs/trees	$ 15.00	9,990	Each	$ 149,850	N/A
3	5 gal shrubs/trees	$ 25.00	441	Each	$ 11,025	N/A
4	15 gal shrubs/trees	$ 60.00	196	Each	$ 11,760	N/A
5	24” Box Trees[2]	$ 225.00	500	Each	N/A	$ 112,500
6	36” Box Trees[2]	$ 615.00	40	Each	N/A	$ 24,600
7	48” Box Trees[2]	$ 1,500.00	10	Each	N/A	$ 15,000
8	Drip Irrigation	$ 1.00	274,000	S.F.	$ 274,000	N/A
9	Overhead Irrigation	$ 0.40	274,000	S.F.	N/A	$ 109,600
10	Maintenance 1 year	$ 0.24	274,000	S.F.	$ 65,760	$ 65,760
				TOTAL:	$ 553,625	$ 368,690

HEADQUARTERS SAVINGS (Net Incremental Costs): ($184,935)

Water Quality Empirical Data for Pollutant Removal (Assessment of BMP Effectiveness)

2004/05 Rainy Season Sampling

- TSS was reduced by 89% (exceeding 80% required by LEED™)
- Total Coliform was reduced by 95%
- Fecal Coliform was reduced by 84%
- 80% of the 30 constituents that were tested resulted in removals ranging from 74% up to 95%.
- Traditional method would have dumped into Chino Creek over the next 20 years:
  - Over 6 pounds of microbial bacteria, 1,600 pounds of oil & grease, 2,400 pounds of Nitrogen
  - A total of two million pounds of organic and inorganic constituents

IEUA Headquarters
Stormwater Quality Analysis

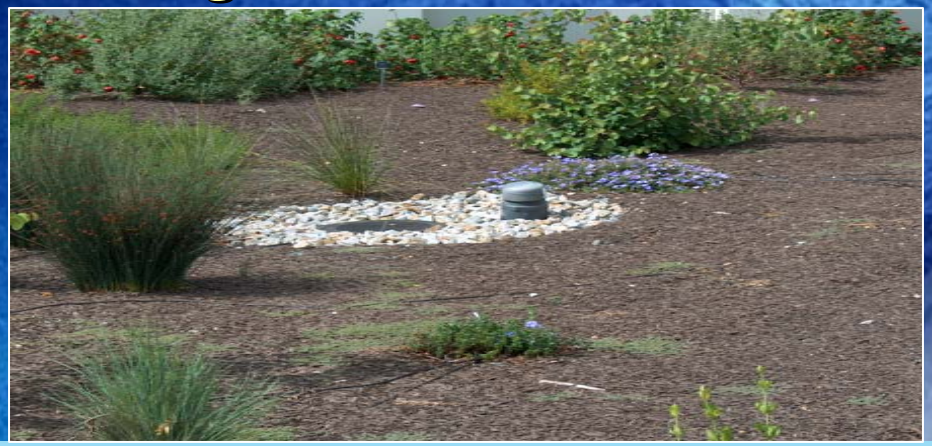
Parameter		Sample results		Unit	% Reduction
		Box Culvert	Pond		
Chloride	Cl	71	13	mg/L	82%
Nitrite	N02-N	0.65	0.12	mg/L	82%
Nitrate	N03-N	9.9	2.6	mg/L	74%
Sulfate	S04	136	28	mg/L	79%
Total Dissolved solids	TDS	684	166	mg/L	76%
Total Organic Carbon	TOC	52	19	mg/L	63%
Total Suspended Solids	**TSS**	**373**	**42**	**mg/L**	**89%**
Silver	AG	<0.01	<0.01	mg/L	--
Arsenic	As	<0.01	<0.01	mg/L	--
Boron	B	0.17	0.04	mg/L	76%
Barium	Ba	0.21	0.04	mg/L	81%
Beryllium	Be	<0.01	<0.01	mg/L	--
Calcium	Ca	102	20	mg/L	80%
Cadmium	Cd	<0.01	<0.01	mg/L	--
Cobalt	Co	<0.01	<0.01	mg/L	--

IEUA Headquarters
Stormwater Quality Analysis Continued…

Parameter		Sample results		Unit	% Reduction
		Box Culvert	Pond		
Chromium	Cr	0.03	<0.01	mg/L	--
Copper	Cu	0.03	<0.02	mg/L	--
Hardness, Total	$CaCO_3$	346	63	mg/L	82%
Potassium	K	30	7	mg/L	77%
Magnesium	Mg	22.2	3.5	mg/L	84%
Sodium	Na	67	14	mg/L	79%
Nickel	Ni	0.02	<0.01	mg/L	--
Lead	Pb	<0.02	<0.02	mg/L	--
Antimony	Sb	<0.02	<0.02	mg/L	--
Selenium	Se	<0.02	<0.02	mg/L	--
Thallium	Ti	<0.05	<0.05	mg/L	--
Zinc	ZN	<0.09	<0.02	mg/L	78%
Oil & Grease (Total)		12	8	--	33%
Fecal Coliform		**5000**	**800**	**fcu**	**84%**
Total Coliform		**160000**	**8000**	**fcu**	**95%**

Conclusion

Using drainage as a design element and incorporating environmentally sound landscaping and site design provides for a project that mimics the hydrology of a typical watershed (collects, conveys, and discharges runoff) as opposed to conventional storm drain and site designs known to cause water quality impacts.



IEUA has developed a stormwater program that is cost effective and truly personifies an exemplary approach to stormwater management by utilizing natural hydrologic techniques.