APPENDIX A

Unit Designs and Costs

1.0 APPROACH – GREEN STREETS

The potential load reductions and design limitations associated with each of the infiltration, capture/reuse and filtration type MCMs considered for green streets in the MdR Watershed are summarized in Table 1. In general, infiltration or capture and infiltration/reuse MCMs were translated into 100% load reductions for the tributary design area, while filtration type MCMs were assumed to have a maximum load reduction potential of 63 percent. Downspout disconnects require MCMs to be implemented on private property. Although these systems have the potential to be highly effective and reducing the volume of runoff to the MdR harbor receiving water, implementation requires extensive outreach and coordination with private properties. Feasibility of implementation is therefore limited. This type of MCM was only incorporated into the life cycle cost (LCL) estimates for areas where groundwater levels prohibited infiltration (e.g., depth to groundwater of less than 15 feet). For residential land uses, the potential load reduction was capped at 20 percent, which translates to a maximal roof runoff capture of 60%, a very aggressive program. At commercial and industrial parks, where there are few other options, a public private partnership may be implemented to increase the roof runoff area captured and potentially treated. The unit designs and LCL assumptions for each type of MCM may be found at the end of this section.

Table 1. Minimum Control Measures for Green Streets

Structural Minimum Control Measure	Load Reduction	Notes
Filtration- Porous Pavement (Road Design only)	63%	Filtration requires 24-72 hours and filtered flows are directed to the MS4. Volume of stormwater capture is limited to the capacity of the porous pavement. Requires routine annual sweeping. Vacuum sweeper recommended. *MCM design assumes a road grade of 1% and one 6-inch underdrain per 8-foot wide section of pavement.*
Biofiltration- Sidewalks	63%	Biofiltration requires 24-72 hours and units have effectively zero storage capacity. Stormwater attenuation by a cistern required (100% treatment volume). Flow is routed from and back into the MS4. Requires routine maintenance (weeding) and replacement of plants, as well as routine inspection and maintenance of the cistern.
Capture and Use	100%	Flow is routed from the MS4 into a subsurface cistern. Approximately 1300 square feet of vegetated area is needed to utilize the runoff volume captured in a 1000-gallon cistern within 14 days of an event. This type of MCM has limited feasibility in MdR Watershed public right of way. If implemented as a downspout disconnect program on private property, a maximum load reduction of 20% is assumed to cut the runoff volume from a design area.
Infiltration-Sidewalks	100%	Flow directed from road via curb cuts. Requires routine maintenance (weeding) and replacement of plants. *MCM design assumes infiltration possible at 4 foot below grade.*
Infiltration-Porous Pavement	100%	Road level infiltration. Requires routine (at least monthly) sweeping. Vacuum sweeper recommended. *Road design assumes infiltration possible at 3-feet below grade. Sidewalk design (shallow infiltration design) assumes infiltration possible at 1.5-feet below grade. MCM design assumes a road grade of 1%.*
Infiltration-Infiltration Gallery	100%	Flow may be diverted from MS4, provided flow pre-treated by catch basin inserts. *Smallest MCM design assumes a minimum groundwater depth of 17 feet. This infiltration design was limited to the portion of subwatershed 4 with a depth to groundwater of ≥20 feet. MCM design assumes a road grade of 1%.*

*This is a minimum feasible load reduction and is generally not additive to other MCMs. Catch basin inserts are a fundamental aspect of treatment trains.

Next, the unit MCM costs were translated into values that could be scaled across the MdR Watershed. The two variables identified as strongly impacting feasibility of MCM implementation include depth to groundwater and land use. According to the Los Angeles County BM Design Manual the invert of an infiltration type MCM and the groundwater level must have a minimum separation of 10 feet, preferably more. Historical groundwater data was used to create three groundwater classes, including

- Groundwater greater than 20 feet (infiltration feasible),
- Groundwater between 10 and 20 feet (infiltration feasible if groundwater ≥15 feet), and
- Groundwater less than 10 feet (infiltration not feasible).

The MdR Watershed is predominately residential, small intermixed sections of commercial and industrial, or larger "parks" of concentrated commercial/industrial use. Three general land use classes were determined to adequately characterize the watershed, including single family residential (SFR), multi-family residential (MFR) and a general category called commercial (COMM) that was generally applied to industrial and public facilities (similar impervious land area). The watershed acreages by land use class, groundwater class and subwatershed is summarized in Table 2 and presented in Figure 1.

Table 2. Land Uses and Depth to Groundwater by BMP Design Zone

Land Use Class [#]	GW<10ft			10ft<GW<20ft			GW>20ft	Total Acres
	Water-shed 1	Water-shed 2	Water-shed 4	Water-shed 2	Water-shed 3	Water-shed 4	Water-shed 4	
MFR	171.2	23.5	23.4	146.3	28.4	100.6	26.8	520
SFM	36.0	26.6	55.2	57.3	30.2	66.5	100.0	371
COMM	161.6	9.8	69.9	61.2	11.8	128.5	74.6	517
Total Land Area	368.8	59.9	148.5	264.8	70.5	295.7	201.5	**1,409**

The COMM class includes Commercial, Industrial and Public Facilities land uses. All other land uses were distributed across these three classes.

Figure 1 Potential Regional BMP Locations within the MdR WMA Watershed

Six city blocks, representing the land use and groundwater classes, were selected as representative design areas for the MdR Watershed (Table 3). These design areas were used to evaluate the number of MCMs to treat the volume of runoff from each design area. The runoff volume for each design area was calculated using the 85th percentile 24-hour storm event (1.1. inches). The number of each type of MCM needed to treat the design runoff volume was determined, assuming infiltration type MCMs were treating for the 85th percentile storm and filtration type MCMs were treating for 1.5 times the 85th percentile storm. The cost of implementation was calculated and then translated into a land use-specific cost per acre treated value for each type of MCM.

Table 3. Representative Design Areas - MdR Watershed

Land Use Class	Area Name	Location	Depth to Groundwater (ft)	Block Area (ac)	Roof as % of Area	Notes
SFR	SFR-4-1	Walnut/Glyndon/ Victoria/Lucille Avenue	22	3.96	23%	Stormwater routed via alleys to larger roads with subsurface MS4. Utilities often in alleys.
	SFR-3	Olive/Harbor/ Clement/Clarke	12 to 13	1.77	27%	
MFR	MFR-4-1	Venice Blvd/Redwood/ Ashwood/Glenco	23 to 28	0.82	54%	Stormwater routed via alleys to larger roads with subsurface MS4. Utilities often in alleys.
	MFR-2	Pacific Ave/Speedway/ 24th Ave/24th Pl	18	0.84	63%	
COMM	COMM-4-1	Venice Blvd/Louella Ave/ Penmar/Glenco	20	1.23	75%	COMM-4-1 is a mixed land use, similar to SFR and MFR.
	COMM-4-2	Beach Ave/Del Rey Ave/ Glenco/Unnamed Alley	10 to 13	3.22	71%	

Cost was scaled across each subwatershed based on land use acreage and the feasible MCMs within each groundwater class (per Table 2, above). MCM implementation was scheduled for each subwatershed based on the 75% and 100% load reduction goals established for the Toxics TMDL.

GREEN STREET MCM DESIGNS - Design By Land Use & Depth to Groundwater

DESIGN AREAS 85th % Storm (ft) = 0.09

Land Use	Area ID	Depth to Groundwater (ft)	Perimeter Available for MCMs (ft)	Drainage Area (ac)	Runoff Coefficient	Design Runoff Volume (cft)
Multi-Family Residential	MFR-4-1	23 to 28	720	0.66	0.65	1,716
Multi-Family Residential	MFR-2	18	800	0.69	0.75	2,063
Multi-Family Residential	MFR-1	<10	300*	1.03	0.75	3,094
Single-Family Residential	SFR-4-1	22	1640	3.65	0.5	7,291
Single-Family Residential	SFR-3	12 to 13	1080	1.56	0.6	3,740
Commercial/Industrial	COMM-4-1	20	910	1.03	0.85	3,502
Commercial/Industrial	COMM-4-2	10 to 13	300**	2.86	0.85	9,701

**300ft length of road along Panay Way. No sidewalks.*

***In large commercial parks, limited ROW access. Short length of block ~150ft. Driveways ~20ft.*

Infiltration Design

Due to clay material present for the top ~10-13 feet of soil, infiltration type designs assume an additional 5-ft excavation volume. This made infiltration-type porous pavement and sidewalk swales infeasible.

A minimum depth to groundwater of 15 to 16 feet is required to maintain a 10 foot separation from the MCM invert to the groundwater table.

Design	Area	Volume Treated by 102-ft Section (cft)	No. 102-ft Sections	Vol Treated (cft)	Length MCM (ft)	Potential MCM Load Reduction	Space Constraint - Feasible Max Area Treated	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)
Infiltration Gallery	MFR-2	1,435	1.5	2,081	147.9	100%	Only if no sidewalk	$116,160	$446,997	$26,136	$1,452
	SFR-4-1	1,435	5.1	7,320	520.2	100%	N/A	$62,708	$337,090	$4,929	$821
	COMM-4-1	1,435	2.5	3,588	255.0	100%	Only if no parkway	$127,918	$612,191	$17,443	$3,876

Capture/Use Design

SFR-3 was considered a good representation of cost for 1-2 acre residential drainage areas where 50% of existing vegetation areas may be converted to swales.

COMM-4-1 was used to represent cost drainage areas where sidewalk would need to be converted into new vegetation areas.

Multi-family residential (MRF) land uses in subwatershed 1 and 2 generally lack sidewalks (with parkway); therefore, this type of MCM is not feasible in these areas.

Design	Area	Volume Treated by Unit Section (cft)	No. 100-ft Unit Sections	Vol Treated (cft)	Length MCM (ft)	Potential MCM Load Reduction	Space Constraint - Feasible Max Area Treated	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)
Sidewalk-Swale (Capture/Use)	SFR-3	230.0	10.8	2,484	1080	100%	66%	$65,586	$139,771	$17,361	$2,411
	COMM-4-1	230.0	9.1	2,093	910	100%	60%	$115,135	$249,654	$29,189	$4,054
	COMM-4-2	230.0	3.0	690	300	100%	7%	Limited Feasibility of Implementation			

Filtration Design

Design	Area	Volume Treated by Unit Section (cft)	No. 100-ft Unit Sections	Vol Treated (cft)	Length MCM (ft)	Potential MCM Load Reduction	Space Constraint - Feasible Max Area Treated	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)	Design Notes
Porous Pavement -Filtration (GW≥15 ft)	SFR-3	560.0	6.8	3,808	680	63%	N/A	$90,964	$263,548	$11,531	$1,281	
	MFR-2	560.0	3.7	2,072	370	63%	N/A	$132,132	$328,621	$26,136	$2,904	
	MFR-1	560.0	3.0	1,680	300	63%	34%	Limited Feasibility of Implementation				Effective area equiv to MFR-2
Sidewalk Filtration-MWS	COMM-4-1	1757.5	2	3,515	-	63%	Only if no parkway	$41,670	$118,796	$17,443	$1,454	

GREEN STREET MCM DESIGNS - Design By Land Use & Depth to Groundwater

DESIGN AREAS-ROOFING

Design Criteria = 1000 gallons captured per 1000 sq foot roof drainage area

Land Use	Area ID	Unit of Roof Area (sft)	# Roofs of Similar Size	Total Roof Area (sft)	No. 1000-gal Cisterns for 20% Runoff Reduction	Vegetated Area (sft)	Vegetation as % of Drainage Area	Design Notes
Multi-Family Residential	MFR-4-1	1,875	9	16,875	3.4	3,375	11.7%	38% participation
Multi-Family Residential	MFR-2	1,750	11	19,250	3.9	3,850	12.8%	35% participation
Multi-Family Residential	MFR-1	16,500	1	16,500	3.3	3,300	7.3%	100% participation - PPP or ordinance likely required to implement
Single-Family Residential	SFR-4-1	2,450	16	39,200	7.8	7,840	4.9%	50% participation
Single-Family Residential	SFR-3	1,500	14	21,000	4.2	4,200	6.2%	30% participation
Commercial/Industrial	COMM-4-1	4,000	10	40,000	8.0	8,000	17.8%	Not Feasible - lack of space for vegetation area
Commercial/Industrial	COMM-4-2	110,500	1	110,500	22.1	22,100	17.8%	Not Feasible - lack of space for vegetation area

Area	Design	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)
SFR-3	Existing Landscape	$31,389	$104,064	$11,531	$1,601
MFR-1	Impervious=>Pervious	$60,984	$323,622	$17,424	$1,936

UNIT OF INFILTRATION GALLERY *(1 row of chambers x 102-foot Length)*

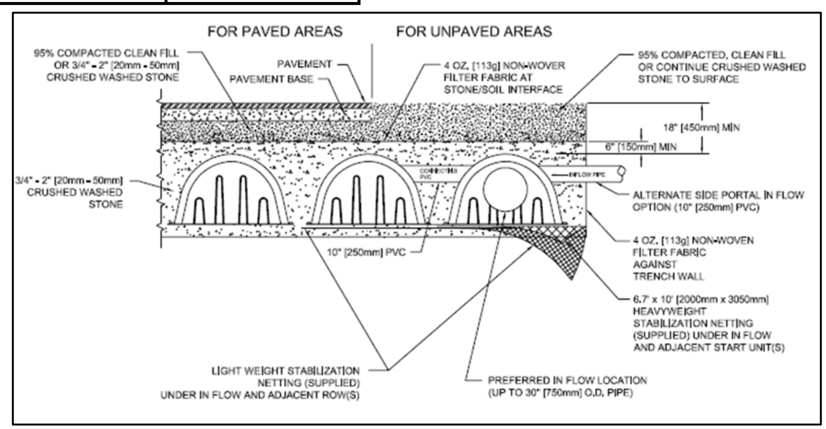
MAXIMUM METAL LOAD REDUCTION = 100%

STORMCHAMBER PARAMETERS	**Units**	**Amt**	**Notes**
Stormchamber - Depth (no stone or cover)	ft	2.8	
Stormchamber - Width	ft	5.0	
Stormchamber - Length	-	7'7" to 8'1"	
Volume of 1 Chamber	cft	75	
Cover	ft	1.5 to 2.5	MS4 connects to No.3 catch basin (V=3') via 6" pipe @ upstream end, 1% grade
Design Unit - Length	ft	102	1 row of 11 middle section chambers & 2 end chambers, footprint=719 sft
Stone Voids Ratio	-	0.35	
Design Storm - 85th Percentile	ft	0.09	(1.1 in)

DESIGN RESULTS *L=102-ft* *1% grade*

Configuration of Chamber	Capacity: 1 Chamber+ Gravel (cft)	Unit Design Capacity (cft)	Gravel Invert from Rd Surface (ft)	Min Depth to Groundwater (ft)	Excavation (cyd)	
12" Cover, with 6" Stone Above & 6" Below Chamber	110.4	1,435	4.8 to 5.8	15	134.4	Standard Design
12" Cover, with 6" Stone Above & 24" Below Chamber	134.5	1,605	6.3 to 7.3	17	181.1	
12" Cover, with 6" Stone Above & 36" Below Chamber	150.6	1,958	7.3 to 8.3	18	208.1	

**Depth of gravel gallery may be scaled based on groundwater*



Cost Estimate - Infiltration Gallery
SFR-4-1

Single-family residential

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			6" Stone Above+Below Chamber	
Construction BMP - Construction Fence	LF	$4.00	1,290.0	$5,160
Construction BMP - Gravel Bags	EA	$2.00	125.0	$250
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825
Sawcut Asphalt	LF	$8.00	624.0	$4,992
Remove Asphalt	SF	$5.00	4,360.0	$21,800
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export *(limited grading)*	CY	$45.00	1,602.2	$72,099
Filter Fabric	SF	$3.00	2,090.0	$6,270
3/4-inch Gravel	CY	$125.00	400.0	$50,000
Backfill	CY	$15.00	90.0	$1,350
Import and Place Amended Soils	CY	$150.00	812.2	$121,831
Inlet Structure - Curb Inlet	EA	$6,160.00	3.0	$18,480
Catch Basin Inlet BMP	EA	$2,500.00	3.0	$7,500
Clean Out	EA	$633.00	6.0	$3,798
6-Inch SDR-35 PVC	LF	$64.00	60.0	$3,840
Storm Chamber	EA	$1,000.00	80.0	$80,000
12 inches AC over 5 inches Class II Base	SF	$8.40	4,360.0	$36,624
Subgrade preparation	SF	$0.84	4,360.0	$3,662
Striping	LF	$0.80	624.0	$499
Shoring (subsurface structure)	SF	$14.34	4,360.0	$62,522
		Subtotal	-	$503,003
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$100,000
Construction Administration			10%	$50,000
Contingency			15%	$75,000
		CONSTRUCTION SUBTOTAL	-	**$1,231,005**
Engineering Design			40%	$199,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$229,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$114,500**
Quarterly Cleaning @ Catch Basin	yr	$3,000	20	$60,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

SFR-4-1	Project Area (acres)=		3.65
PLANNING/DESIGN		$/acre	**$62,708**
CONSTRUCTION		$/acre	**$337,090**
POST CONSTRUCTION STORMWATER MONITORING		$/acre	**$4,929**
POST CONSTRUCTION (O&M)		$/acre/yr	**$821**

Cost Estimate - Infiltration Gallery

MFR-2

Multi-family residential

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			6" Stone Above+Below Chamber	
Construction BMP - Construction Fence	LF	$4.00	310.0	$1,240
Construction BMP - Gravel Bags	EA	$2.00	30.0	$60
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825
Sawcut Asphalt	LF	$8.00	156.0	$1,248
Remove Asphalt	SF	$5.00	1,040.0	$5,200
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export *(limited grading)*	CY	$45.00	383.1	$17,238
Filter Fabric	SF	$3.00	500.0	$1,500
3/4-inch Gravel	CY	$125.00	100.0	$12,500
Backfill	CY	$15.00	20.0	$300
Import and Place Amended Soils	CY	$150.00	193.1	$28,960
Inlet Structure - Curb Inlet	EA	$6,160.00	1.0	$6,160
Catch Basin Inlet BMP	EA	$2,500.00	1.0	$2,500
Clean Out	EA	$633.00	2.0	$1,266
6-Inch SDR-35 PVC	LF	$64.00	20.0	$1,280
Storm Chamber	EA	$1,000.00	19.0	$19,000
12 inches AC over 5 inches Class II Base	SF	$8.40	1,040.0	$8,736
Subgrade preparation	SF	$0.84	1,040.0	$874
Striping	LF	$0.80	156.0	$125
Shoring (subsurface structure)	SF	$14.34	1,040.0	$14,914
Subtotal			-	$125,425
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$25,000
Construction Administration			10%	$13,000
Contingency			15%	$19,000
CONSTRUCTION SUBTOTAL			-	**$307,849**
Engineering Design			40%	$50,000
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$80,000**
PLANNING/DESIGN (assumes 2-year period)			per year	**$40,000**
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

MFR-2	Project Area (acres)=	0.69
PLANNING/DESIGN	$/acre	**$116,160**
CONSTRUCTION	$/acre	**$446,997**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$26,136**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,452**

Cost Estimate - Infiltration Gallery

COMM-4-1

Commercial/Industrial *(mixed neighborhood land use areas)*

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			6" Stone Above+Below Chamber	
Construction BMP - Construction Fence	LF	$4.00	530.0	$2,120
Construction BMP - Gravel Bags	EA	$2.00	50.0	$100
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825
Sawcut Asphalt	LF	$8.00	260.0	$2,080
Remove Asphalt	SF	$5.00	1,790.0	$8,950
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export *(limited grading)*	CY	$45.00	652.9	$29,379
Filter Fabric	SF	$3.00	860.0	$2,580
3/4-inch Gravel	CY	$125.00	170.0	$21,250
Backfill	CY	$15.00	40.0	$600
Import and Place Amended Soils	CY	$150.00	332.9	$49,931
4-inch Slotted PVC Pipe Under Drain	LF	$55.00	332.9	$18,308
Inlet Structure - Curb Inlet	EA	$6,160.00	4.0	$24,640
Catch Basin Inlet BMP	EA	$2,500.00	4.0	$10,000
Clean Out	EA	$633.00	8.0	$5,064
6-Inch SDR-35 PVC	LF	$64.00	80.0	$5,120
Storm Chamber	EA	$1,000.00	33.0	$33,000
12 inches AC over 5 inches Class II Base	SF	$8.40	1,790.0	$15,036
Subgrade preparation	SF	$0.84	1,790.0	$1,504
Striping	LF	$0.80	260.0	$208
Shoring (subsurface structure)	SF	$14.34	1,790.0	$25,669
Subtotal			-	$257,863
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$51,000
Construction Administration			10%	$26,000
Contingency			15%	$39,000
CONSTRUCTION SUBTOTAL			-	**$631,726**
Engineering Design			40%	$102,000
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$132,000**
PLANNING/DESIGN (assumes 2-year period)			per year	**$66,000**
Quarterly Cleaning @ Catch Basin	yr	$4,000	20	$80,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

COMM-4-1	Project Area (acres)=	1.03
PLANNING/DESIGN	$/acre	**$127,918**
CONSTRUCTION	$/acre	**$612,191**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,443**
POST CONSTRUCTION (O&M)	$/acre/yr	**$3,876**

UNIT OF SIDEWALK PLANTER - CAPTURE/USE

100 feet = three sidewalk planters

MAXIMUM METAL LOAD REDUCTION = 100%

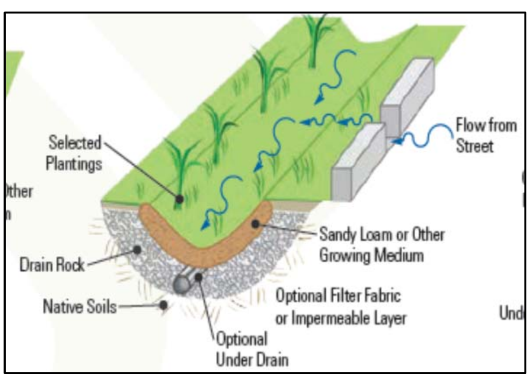
Design Sidwalk - Minor Road

Total parkway width = 10-12 ft

Sidewalk ~6-foot in COMM (0/100% parkway/walkway) and often lacking in commercial parks

SIDEWALK CAPTURE - PARAMETERS	Units	Capture/Use	Notes
Voids Ratio	-	0.35	
Planter Width	ft	4	
Total Section Length	ft	100	
No. Planters per 100-ft Sidewalk	-	3	
Planter Unit Length	*ft*	*20*	*3 ft curb cut, 17-ft swale (1% grade)*
Walking Path between Planters	ft	~13	
Total Depth	ft	2.5	
Planter Amended Soil Depth (LA BMP Manual)	*ft*	*2.0*	
Total Swale Headspace	*ft*	*0.5*	
Planter Ponding Depth	*ft*	*0.17 to 0.33*	*given 1% grade*
Gravel	*ft*	*0.5*	

DESIGN RESULT	Units	Capture/Use
Volume Treated-Unit Planter	cft	76.7
Volume Treated-100ft Section	cft	230.0



Cost Estimate - Sidewalk Capture/Use Planter
SFR-3

All Land Uses - Able to utilize 25% existing planters 648 ft of planter

			Planter Swale-Capture/Use	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	880.0	$3,520
Construction BMP - Gravel Bags	EA	$2.00	220.0	$440
Construction BMP - Erosion Control	EA	$2,000.00	1.0	$2,000
Demolish Sidewalk/Gutter	SF	$15.00	1,728.0	$25,920
Remove Asphalt	SF	$5.00	1,728.0	$8,640
Clear and Grubb *(salvage)*	SF	$1.50	864.0	$1,296
Tree Removal	EA	$500.00	6.0	$3,000
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export	CY	$45.00	224.0	$10,080
Excavation	CY	$5.00	64.0	$320
Backfill	CY	$15.00	64.0	$960
Filter Fabric	SF	$3.00	2,592.0	$7,776
Import and Place Amended Soils	CY	$150.00	128.0	$19,200
Construct Curb with Cuts for Runoff Flow	LF	$50.00	97.2	$4,860
Native/Drought Tolerant Landscaping	SF	$1.50	2,592.0	$3,888
Mulch	SF	$0.50	2,592.0	$1,296
New Subsurface Drip Irrigation	SF	$2.40	2,592.0	$6,221
Subtotal			-	$100,917
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$19,000
Construction Administration			10%	$10,000
Contingency			15%	$15,000
CONSTRUCTION SUBTOTAL			-	**$144,917**
Engineering Design			40%	$38,000
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$68,000**
PLANNING/DESIGN (assumes 2-year period)			per year	**$34,000**
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

	Project Area (acres)=		1.56
SFR-3	Project Area 100% Treated (acres)=		1.04
	PLANNING/DESIGN	$/acre	**$65,586**
	CONSTRUCTION	$/acre	**$139,771**
	POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,361**
	POST CONSTRUCTION (O&M)	$/acre/yr	**$2,411**

Cost Estimate - Sidewalk Capture/Use Planter

COMM-4-1

All Land Uses - Covert 100% of sidewalk to swale	546	ft of planter	Planter Swale-Capture/Use	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	740.0	$2,960
Construction BMP - Gravel Bags	EA	$2.00	185.0	$370
Construction BMP - Erosion Control	LS	$2,000.00	1.0	$2,000
Demolish Sidewalk/Gutter	SF	$15.00	2,184.0	$32,760
Remove Asphalt	SF	$5.00	2,184.0	$10,920
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export	CY	$45.00	242.7	$10,920
Filter Fabric	SF	$3.00	2,184.0	$6,552
Import and Place Amended Soils	CY	$150.00	161.8	$24,267
Construct Curb with Cuts for Runoff Flow	LF	$50.00	81.9	$4,095
Native/Drought Tolerant Landscaping	SF	$1.50	2,184.0	$3,276
Mulch	SF	$0.50	2,184.0	$1,092
New Subsurface Drip Irrigation	SF	$2.40	2,184.0	$5,242
		Subtotal	-	$105,953
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$21,000
Construction Administration			10%	$11,000
Contingency			15%	$16,000
		CONSTRUCTION SUBTOTAL	-	**$153,953**
Engineering Design			40%	$41,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$71,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$35,500**
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

		Project Area (acres)=	1.03
COMM-4-1		Project Area 100% Treated (acres)=	0.62
	PLANNING/DESIGN	$/acre	**$115,135**
	CONSTRUCTION	$/acre	**$249,654**
	POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$29,189**
	POST CONSTRUCTION (O&M)	$/acre/yr	**$4,054**

UNIT OF POROUS PAVEMENT

8-ft x 100 foot porous pavement section

MAXIMUM METAL LOAD REDUCTION = 63%

Design Road: Minor - 16 feet wide (8ft+8ft driving/parking lanes)

PP PARAMETERS	Units	Amt	Notes
Voids Ratio	-	0.35	
Length	ft	100.00	
Width	ft	8.00	
Depth	*ft*	*2.67*	
Capture Volume	cft	560	Based on rock reservior depth=2ft
Load Reduction	%	100%	

MATERIALS DESIGN		Amt
Road Slope	ft/ft	0.01
Excavation	cyd	93.8
Bedding Sand	cyd	4.9
Rock Reservior	cyd	74.1
Edger	ft	116.00
Filter Fabric	sft	832
6" Underdrain	ft	110

Pavement Layer Design

Pavement = 6"
Sand = 2"
Filter Fabric
Rock Reservior=2'
Underdrain-6"
Filter Fabric

Cost Estimate - Porous Pavement-Filtration
SFR-3

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
	680	ft of PP	Road Design (8ftx100ft)	
Construction BMP - Construction Fence	LF	$4.00	1,360	$5,440.00
Construction BMP - Gravel Bags	EA	$2.00	140	$280.00
Construction BMP - Concrete Wash Out	EA	$825.00	1	$825.00
Sawcut Asphalt	LF	$8.00	680	$5,440.00
Remove Asphalt	SF	$5.00	5,440	$27,200.00
Protect Utilities in place	LS	-	1,500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	638	$28,711.11
Filter Fabric	SF	$3.00	5,658	$16,972.80
3- to 6-inch Rock Reservoir	CY	$125.00	504	$62,962.96
1.5- to 2-inch Sand Course	CY	$125.00	34	$4,250.00
6-inch Sch. 40 PVC Under Drain	LF	$40.00	750	$30,000.00
Connection to Existing Catch Basin	EA	$1,200.00	2	$2,400.00
Concrete Edge Restraint (Containment Curb)	LF	$15.00	790	$11,850.00
Pervious Concrete Pavement - 6-inch	SF	$16.00	5,440	$87,040.00
Striping	LF	$0.80	680	$544.00
		Subtotal	-	$285,415.87
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$56,000.00
Construction Administration			10%	$28,000.00
Contingency			15%	$42,000.00
		CONSTRUCTION SUBTOTAL	-	**$411,416**
Engineering Design			40%	$112,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$142,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$71,000**
Vaccuming Sweeper (annual)	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

SFR-3	Project Area (acres)=	1.56
PLANNING/DESIGN	$/acre	**$90,964**
CONSTRUCTION	$/acre	**$263,548**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$11,531**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,281**

Cost Estimate - Porous Pavement-Filtration

Multifamily residential	300	ft of PP	Road Design (8ftx100ft)	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	600	$2,400.00
Construction BMP - Gravel Bags	EA	$2.00	60	$120.00
Construction BMP - Concrete Wash Out	EA	$825.00	1	$825.00
Sawcut Asphalt	LF	$8.00	300	$2,400.00
Remove Asphalt	SF	$5.00	2400	$12,000.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	281.5	$12,666.67
Filter Fabric	SF	$3.00	2496	$7,488.00
3- to 6-inch Rock Reservoir	CY	$125.00	222.2	$27,777.78
1.5- to 2-inch Sand Course	CY	$125.00	15	$1,875.00
6-inch Sch. 40 PVC Under Drain	LF	$40.00	330	$13,200.00
Connection to Existing Catch Basin	EA	$1,200.00	1	$1,200.00
Concrete Edge Restraint (Containment Curb)	LF	$15.00	350	$5,250.00
Pervious Concrete Pavement - 6-inch	SF	$16.00	2400	$38,400.00
Striping	LF	$0.80	300	$240.00
		Subtotal	-	$127,342.44
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$25,000.00
Construction Administration			10%	$13,000.00
Contingency			15%	$19,000.00
		CONSTRUCTION SUBTOTAL	-	**$184,342**
Engineering Design			40%	$50,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$80,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$40,000**
Vaccuming Sweeper (annual)	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

MFR-2		Project Area (acres)=	1.03
PLANNING/DESIGN		$/acre	**$77,440**
CONSTRUCTION		$/acre	**$178,443**
POST CONSTRUCTION STORMWATER MONITORING		$/acre	**$17,424**
POST CONSTRUCTION (O&M)		$/acre/yr	**$1,936**

Cost Estimate - Porous Pavement-Filtration

MFR-2

Multifamily residential	370	ft of PP	Road Design (8ftx100ft)	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	740	$2,960.00
Construction BMP - Gravel Bags	EA	$2.00	40	$80.00
Construction BMP - Concrete Wash Out	EA	$825.00	1	$825.00
Sawcut Asphalt	LF	$8.00	370	$2,960.00
Remove Asphalt	SF	$5.00	2960	$14,800.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	347.2	$15,622.22
Filter Fabric	SF	$3.00	3078.4	$9,235.20
3- to 6-inch Rock Reservoir	CY	$125.00	274.1	$34,259.26
1.5- to 2-inch Sand Course	CY	$125.00	19	$2,375.00
6-inch Sch. 40 PVC Under Drain	LF	$40.00	410	$16,400.00
Connection to Existing Catch Basin	EA	$1,200.00	1	$1,200.00
Concrete Edge Restraint (Containment Curb)	LF	$15.00	430	$6,450.00
Pervious Concrete Pavement - 6-inch	SF	$16.00	2960	$47,360.00
Striping	LF	$0.80	370	$296.00
		Subtotal	-	$156,322.68
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$31,000.00
Construction Administration			10%	$16,000.00
Contingency			15%	$23,000.00
		CONSTRUCTION SUBTOTAL	-	**$226,323**
Engineering Design			40%	$61,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$91,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$45,500**
Vaccuming Sweeper (annual)	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

MFR-2		Project Area (acres)=	0.69
PLANNING/DESIGN		$/acre	**$132,132**
CONSTRUCTION		$/acre	**$328,621**
POST CONSTRUCTION STORMWATER MONITORING		$/acre	**$26,136**
POST CONSTRUCTION (O&M)		$/acre/yr	**$2,904**

Sidewalk-Biofiltration (Modular Wetlands System or Equivalent)

MAXIMUM METAL LOAD REDUCTION = 63%

MWS PARAMETERS - MWS-L4-21	**Unit**	**Amt**
Unit Length	ft	21
Unit Width	ft	4
Unit Depth	ft	4
Peak Flow Rate (Manufacturer)	cfs	0.27
Excavation	cyd	27.1
Gravel Base	cyd	2.6
Backfill	cyd	4.1
Sidewalk Repair	sft	27

DESIGN PARAMETERS

Continuous simulation model (Day 4)	**Unit**	**Amt**
Design Storm	ft	0.09
Design Rainfall Intensity	in/hr	0.025
Time of Concentration	min	10
Design Peak Flow Rate for MWS	cfs	0.2

	SFR	MFR/COMM/IND	ROAD
	C=0.5	**C=0.7**	**C=0.9**
Tributary Drainage Area (ac)	0.90	0.65	0.5
Treated Flow (cft)	1749.5	1757.5	1750
Bypassed Flow (cft)	48	60	48
Flow Bypassed (%)	3%	3%	3%

Cost Estimate - Biofiltration by MWS or Equivalent

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			MWS	
Construction BMP - Construction Fence	LF	$4.00	100.0	$400.00
Construction BMP - Gravel Bags	EA	$2.00	40.0	$80.00
Demolish Sidewalk/Gutter	SF	$15.00	220	$3,300.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	54.2	$2,439.00
1/2-inch Gravel	CY	$125.00	5.2	$650.00
Backfill	CY	$15.00	8.2	$123.00
Type I Grate Inlet Catch Basin	EA	$6,200.00	2	$12,400.00
Cleanway Grate Inlet BMP	EA	$2,500.00	1	$2,500.00
4-inch PCC Sidewalk - Conventional	SF	$10.00	54	$540.00
6-Inch Curb & Gutter (also for Medians)	LF	$22.00	220	$4,840.00
21-ft Modular Wetland System, or Equivalent	EA	$25,000.00	2	$50,000.00
6-Inch SDR-35 PVC (MWS / Discharge Reservior)	LF	$64.00	40	$2,560.00
Native/Drought Tolerant Landscaping	SF	$1.50	168	$252.00
Controller Electrical Connection	LS	$800.00	2	$1,600.00
New Subsurface Drip Irrigation	SF	$2.40	168	$403.20
Subtotal			-	$83,587.20
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$17,000.00
Construction Administration			10%	$9,000.00
Contingency			15%	$13,000.00
CONSTRUCTION SUBTOTAL			-	**$122,587**
Engineering Design			40%	$34,000.00
CEQA + Permits			10%	$9,000.00
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$43,000**
PLANNING/DESIGN SUBTOTAL			per year	**$21,500**
Weeding + Re-planting, as needed	yr	$500	20	$10,000.00
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

COMM-4-1	Project Area (acres)=	1.03
PLANNING/DESIGN	$/acre	**$41,670**
CONSTRUCTION	$/acre	**$118,796**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,443**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,454**

UNIT OF DOWNSPOUT DISCONNECTION (CISTERNS)-CAPTURE/REUSE

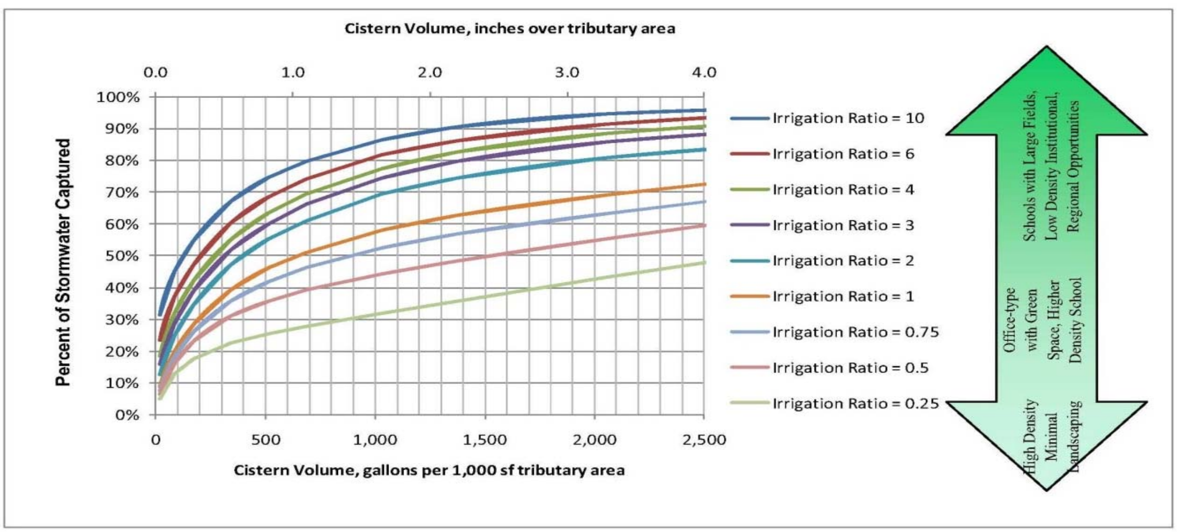
MAXIMUM METAL LOAD REDUCTION = 100%

CISTERN PARAMETERS	**Unit**	**Above Ground**	**Notes**
Tank Size	gal	1000	Supported by a concrete pad - 7.5ft x 7.5ft x 0.5ft
No.	-	1	
Total Tank Volume	gal	1000	
Capacity	%	90	Head space safety factor of 10%
Capture Volume / Capacity	cft	120.3	Exceeds capture need of the 85th% storm
Design Roof Area	sft	1000	
Max Roof Area Captured (85th % Design Storm)	sft	1,458	

GEOSYNTEC, 2009:
*Capture systems designed with landscape:drainage area ratios of 2 can achieve a 70% load reduction.

VEGETATION PARAMETERS*	**Unit**	**Amt**	**Notes**
Vegetated Area	sft	2000	Generally, loosen top 0.5-ft soil and ammend soil in place. For areas requiring new planter - 2-ft ammended soil.
Excavation Volume	cyd	148	COMM
Mulch	sft	2000	1" depth

This is generally considered to be a residential MCM - Significant space constraints make re-landscaping commercial/industrial land uses, especially large business parks, have limited feasibility.



Cost Estimate - Downspout Disconnection

SFR-3

DESCRIPTION	UNIT	UNIT COST	QUANTITY (1000 gal above-ground cistern, existing landscape)	TOTAL COST
Construction BMP - Construction Fence	LF	$4.00	1,000	$4,000.00
Construction BMP - Gravel Bags	EA	$2.00	100	$200.00
Loosen top 0.5" + Soil Ammendments	SF	$2.00	10,000	$20,000.00
Native/Drought Tolerant Landscaping	SF	$1.50	10,000	$15,000.00
1000-gallon fiberglass cistern	EA	$2,000.00	5	$10,000.00
7'X7'X0.5' Pad for Cistern	EA	$800.00	5	$4,000.00
System controller	EA	$400.00	5	$2,000.00
Irrigation Pump	EA	$600.00	5	$3,000.00
Shut Off Valve (install in irrigation system)	EA	$150.00	5	$750.00
First Flush Diversion w/ drain system	EA	$1,300.00	5	$6,500.00
Misc Rain Barrel Piping, fitting, etc.	LS	$1,000.00	5	$5,000.00
Cistern System Installation	LS	$2,000.00	5	$10,000.00
Controller Electrical Connection	LS	$1,600.00	5	$8,000.00
New Subsurface Drip Irrigation	SF	$2.40	10,000	$24,000.00
Subtotal			-	$112,450.00
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$22,000.00
Construction Administration			10%	$11,000.00
Contingency			15%	$17,000.00
CONSTRUCTION SUBTOTAL			-	**$162,450**
Engineering Design			40%	$44,000.00
CEQA + Permits			LS	$5,000
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$49,000**
PLANNING/DESIGN SUBTOTAL			per year	**$24,500**
Inspections / Repairs	yr	$2,500	20	$50,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

SFR-3	Project Area (acres)=	1.56
PLANNING/DESIGN	$/acre	**$31,389**
CONSTRUCTION	$/acre	**$104,064**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$11,531**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,601**

Cost Estimate - Downspout Disconnection

MFR-1

			1000 gal above-ground cistern, hardscape to landscape	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	800	$3,200.00
Construction BMP - Gravel Bags	EA	$2.00	80	$160.00
Demolish Sidewalk/Gutter/Pavement	SF	$15.00	8000	$120,000.00
Remove Asphalt	SF	$5.00	8000	$40,000.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	148	$6,660.00
Import and Place Amended Soils	CY	$150.00	148	$22,200.00
Native/Drought Tolerant Landscaping	SF	$1.50	8000	$12,000.00
Mulch	SF	$0.50	8000	$4,000.00
1000-gallon fiberglass cistern	EA	$2,000.00	4	$8,000.00
7'X7'X0.5' Pad for Cistern	EA	$800.00	4	$3,200.00
System controller	EA	$400.00	4	$1,600.00
Irrigation Pump	EA	$600.00	4	$2,400.00
Shut Off Valve (install in irrigation system)	EA	$150.00	4	$600.00
First Flush Diversion w/ drain system	EA	$1,300.00	4	$5,200.00
Misc Rain Barrel Piping, fitting, etc.	LS	$1,000.00	4	$4,000.00
Cistern System Installation	LS	$2,000.00	4	$8,000.00
Controller Electrical Connection	LS	$1,600.00	4	$6,400.00
New Subsurface Drip Irrigation	SF	$2.40	8000	$19,200.00
		Subtotal	-	$268,320.00
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$29,000.00
Construction Administration			10%	$15,000.00
Contingency			15%	$22,000.00
		CONSTRUCTION SUBTOTAL	-	**$334,320**
Engineering Design			40%	$58,000.00
CEQA + Permits			LS	$5,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$63,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$31,500**
Inspections / Repairs	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

MFR-1Create Landscape Project Area (acres)=		1.03
PLANNING/DESIGN	$/acre	**$60,984**
CONSTRUCTION	$/acre	**$323,622**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,424**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,936**

APPENDIX B

Project Designs and Cost Estimates

PROJECT DESIGN - COSTCO PARKING LOT

Area	Area (ac)	Runoff (cft)	Design Runoff (cft)
Total City	42	*115,600*	-
Costco	17.5	66,560	115,600
City (less Costco)	24.5	49,040	

Costco Property		
Lot Length (ft)	Average Lot Width (ft)	Area (ac)
930.0	820	17.5

Main Continuous Parking Lot: 930ft x 300ft			
Area (sft)	Area (ac)	Parking Aisles	Driving Lanes
279,000	*6.4*	14	15

Infiltration Gallery 25 x 30 chambers							
No Chambers	Chambers Long	~Length (ft)	Chambers Wide	~Width (ft)	Footprint (sft)	% Parking Lot	Sediment Traps
757.0	25.0	192	30.0	177.0	33,776	12.1%	4

Design Assumptions:	Units	Amt
Depth to Groundwater (ft)	ft	20 to 30
Impervious Clay Layer (ft)	ft	10 to 13

MS4 Diversion - Zanja to Costco	Units	Amt			
Depth to MS4	ft	4.0			
Diversion - Length of 36" pipe from Zanja to Infiltration Area	ft	400			
36" Diversion Bedslope	ft/ft	0.005			
36" Invert - End Diversion	ft	9.0	Gravel-CYD	Vol 36"-CYD	5"AC+5" base-CYD
Bedding Invert (6" gravel bedding)	ft	9.5	29.6	104.7	24.7
Excavation	cyd	503.7			
Reused Backfill	cyd	344.7			
		68.4%			

Infiltration Gallery	Units	Amt	Design Notes				
Infiltration Gallery MS4 Connection Invert	ft	9.0					
Cover (above chamber)	ft	7.0					
Backfill	*ft*	*6.5*					
Gravel	*ft*	*0.5*					
BMP Invert	ft	12.8					
Stormchamber	*ft*	*9.8*	At level to connect with MS4				
Amended Soils/Gravel	*ft*	*3.0*					
Capacity of one 102-ft row of 13 StormChambers: 6" above + 36" below	cft	1,958	Gravel Above Chambers-CYD	Ammended Soils/Gravel-CYD	Chambers-CYD	5"AC+5" base-CYD	Filter Fabric (sft)
No. Unit Sections required to Treat 100% Design Volume	-	59.0	625	5,153	2,083	521	33,776
Excavation	cyd	16,054.0					
Reused Backfill	cyd	7,671.4					
		47.8%					

Cost Estimate - Costco Parking Lot

			MS4 Diversion & Parking Lot Infiltration Gallery			
			Infiltration Gallery		Zanja Rd MS4 Diversion	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	1,600.0	$6,400	800	$3,200.00
Construction BMP - Gravel Bags	EA	$2.00	100.0	$200	100	$200.00
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825		
Construction BMP - Erosion Control	EA	$2,000.00	1.0	$2,000		
Demolish Sidewalk/Gutter or Parking Lot	SF	$15.00	35,375.9	$530,639	13600	$204,000.00
Remove Asphalt	SF	$5.00	35,375.9	$176,880	13600	$68,000
Protect Utilities in place	LS	-	5,000.0	$5,000	2500	$2,500
Excavation, Export	CY	$45.00	8,382.6	$377,215	159	$7,157
Excavation/Backfill	CY	$20.00	7,671.4	$153,428	345	$6,893
Filter Fabric	SF	$3.00	33,775.9	$101,328		
1/2-inch Gravel	CY	$125.00	625.5	$78,185	29.6	$3,704
Import and Place Amended Soils	CY	$150.00	5,152.5	$772,878		
Type I Grate Inlet Catch Basin	EA	$6,200.00	2.0	$12,400	1	$6,200
36-inch RCP	LF	$188.50			400	$75,400
18-inch RCP - transition from Catch Basin to Gallery	LF	$124.00	20.0	$2,480		
Cleanway Grate Inlet BMP	EA	$2,500.00	2.0	$5,000	1	$2,500
Clean Out	EA	$633.00	4.0	$2,532	4	$2,532
10-inch PVC (connecting rows of chambers)	LF	$80.64	180.0	$14,515		
Storm Chamber	EA	$1,000.00	757.0	$757,000		
StormChamber-Sediment Trap (recommend 1 @ inflow; 1 @ outflow chamber (L<120 ft)	EA	$550.00	4.0	$2,200		
5 inches AC over 5 inches Class II Base	SF	$8.40	33,775.9	$283,718	1000	$8,400
Striping	LF	$0.80	12,000.0	$9,600	400	$320
Diversion Structure - ZANJA	LS	$40,000.00			1	$40,000
Hydrodynamic Separator - (Bio Clean NSBB 6-12-84)	EA	$60,000.00			1.00	$60,000
Subtotal			-	$3,294,422.84	-	$491,006
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$657,000.00	20%	$98,000
Construction Administration			10%	$329,000.00	10%	$49,000.00
Contingency			15%	$493,000.00	25%	$122,000
CONSTRUCTION SUBTOTAL			-	**$4,773,423**	-	**$760,006**
Engineering Design			40%	$1,314,000.00	40%	$172,000
CEQA + Permits			LS	$30,000	LS	$30,000
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$1,344,000**	-	**$202,000**
PLANNING/DESIGN SUBTOTAL			per year	**$672,000**	per year	**$101,000**
Post-Construction Monitoring-3 storms	storm	$20,000	3	$60,000	3	$60,000
Quarterly Cleaning @ Catch Basins	yr	$1,000.00	20	$40,000	20	$20,000

REGIONAL PROJECTS - PARK CONCEPTUAL DESIGNS

Design Storm (ft) = 0.1

Park	Subwatershed	Park Drainage Area (ac)	Runoff C	Site Runoff Vol to be Maintained Onsite (cft)	Depth to Groundwater (ft)	Design Type	Design Notes
Venice of America Park	3	0.67	0.35	935	17	Infiltration Feasible	Assumes good soil - no need for over excavation
Canal Park	2	0.12	0.35	168	17	Infiltration Feasible	Assumes good soil - no need for over excavation
Triangle Park	4	0.09	0.35	120	11	Capture/Use Feasible	-
Via Dolce Park	2	0.21	0.35	290	12	Capture/Use Feasible	-

INFILTATION DESIGNS

MAXIMUM METAL LOAD REDUCTION = 100%

Infiltration Design	StormChamber Dimensions	Treat Capacity per Stormchamber (cft)	MCM Invert Depth from Surface (ft)
1 layer of Stormchambers w/ 6" Stone Above, 24" Below	5ftx8.2ftx2.8ft	134.5	6.3

Park	Potential Drainage Area Treated	Targeted Capture Area (ac)	Drainage Area Runoff C	Target Runoff Volume to Be Treated (cft)	Total Design Volume (cft)	Design Notes
Venice of America Park	S. Venice Blvd, Alhambra Court, Washington Way	3.9	0.55	8,480	9,415	Located at boundary of MdR Watershed subwatersheds 3 & 4
Canal Park	Multi-family residential NE of Dell Ave (Court D)	3.3	0.55	7,189	7,357	As-Builts indicate LID redevelopment in the vicinity.

Park	No. Chambers	Max Treatment Capacity (cft)	Design Footprint	Design Footprint (sft)	Chamber Layout	Excavation (Yd^3)
Venice of America Park	74	9,953	53ftx71ft	3,463	8 rows x ~9 long	805
Canal Park	58	7,801	47ftx64ft	2,739	7 rows x ~8 long	635

CAPTURE/REUSE DESIGNS

MAXIMUM METAL LOAD REDUCTION = 100%

Capture/Use Design	Landscape: Capture Area Ratio	Park	Cistern Capacity (gal)	Landscape Need (1000 ft2/1000 gal)(ac)	Tributary Drainage Area (ac) (C=0.55)
Subsurface Cistern & Irrigation w/ Park Space	~1 to 2	Via Dolce Park	3000.0	0.14	0.18
		Triangle Park	900	0.04	0.05

MATERIALS

Park	Tank Excavation Volume (cyd) (3 ft cover)	Tank Bedding-Gravel (cyd)	Backfill (cyd)
Via Dolce Park	46.9	4.3	27.8
Triangle Park	19.0	1.7	12.8

Landscape Area - Excavation Volume (cyd)	Amended Soil (cyd) - 2ft minimum depth
555.6	444.4
166.7	133.3

Cost Estimate - Infiltration Gallery @ Venice of America

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			Canal Park Infiltration Gallery - 24" Stone	
Construction BMP - Construction Fence	LF	$4.00	180.0	$720.00
Construction BMP - Gravel Bags	EA	$2.00	40.0	$80.00
Construction BMP - Erosion Control	EA	$2,000.00	1.0	$2,000.00
Protect Utilities in place	LS	-	500.0	$500.00
Excavation, Export	CY	$45.00	679.8	$30,591.91
Excavation	CY	$5.00	124.7	$623.43
Filter Fabric	SF	$3.00	776.2	$2,328.75
10-inch PVC (connecting rows of chambers)	LF	$80.64	48.0	$3,870.72
3/4-inch Gravel	CY	$125.00	474.3	$59,283.09
Backfill	CY	$15.00	124.7	$1,870.30
Type I Grate Inlet Catch Basin	EA	$6,200.00	1.0	$6,200.00
18-inch RCP to connect to Street Storm Drain	LF	$124.00	60.0	$7,440.00
Cleanway Grate Inlet BMP	EA	$2,500.00	1.0	$2,500.00
Clean Out	EA	$633.00	2.0	$1,266.00
Storm Chamber	EA	$1,000.00	74.0	$74,000.00
Native/Drought Tolerant Landscaping	SF	$1.50	3463.2	$5,194.85
New Subsurface Drip Irrigation	SF	$2.40	3463.2	$8,311.76
Shoring (subsurface structure)	SF	$40.25	3463.2	$139,395.22
Subtotal			-	$346,176.05
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$69,000.00
Construction Administration			10%	$35,000.00
Contingency			15%	$52,000.00
CONSTRUCTION SUBTOTAL			-	**$502,176.05**
Engineering Design			40%	$138,000.00
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$168,000**
PLANNING/DESIGN SUBTOTAL			per year	**$84,000**
Post-Construction Monitoring-3 storms	storm	$12,000	3	$36,000.00
Quarterly Cleaning @ Catch Basins	yr	$1,000.00	20	$20,000.00

Cost Estimate - Infiltration Gallery @ Canal Park

			Canal Park	
			Infiltration Gallery - 24" Stone	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	160.0	$640.00
Construction BMP - Gravel Bags	EA	$2.00	40.0	$80.00
Construction BMP - Erosion Control	LS	$2,000.00	1.0	$2,000.00
Protect Utilities in place	LS	-	500.0	$500.00
Excavation, Export	CY	$45.00	537.6	$24,193.11
Excavation	CY	$5.00	97.9	$489.29
Filter Fabric	SF	$3.00	652.0	$1,955.96
10-inch PVC (connecting rows of chambers)	LF	$80.64	42.0	$3,386.88
3/4-inch Gravel	CY	$125.00	376.5	$47,064.20
Backfill	CY	$15.00	97.9	$1,467.86
Type I Grate Inlet Catch Basin	EA	$6,200.00	1.0	$6,200.00
18-inch RCP to connect to Street Storm Drain	LF	$124.00	20.0	$2,480.00
Cleanway Grate Inlet BMP	EA	$2,500.00	1.0	$2,500.00
Clean Out	EA	$633.00	2.0	$1,266.00
Storm Chamber	EA	$1,000.00	58.0	$58,000.00
Native/Drought Tolerant Landscaping	SF	$1.50	2738.8	$4,108.26
New Subsurface Drip Irrigation	SF	$2.40	2738.8	$6,573.22
Shoring (subsurface structure)	SF	$40.25	2738.8	$110,238.42
		Subtotal	-	$273,143.20
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$55,000.00
Construction Administration			10%	$28,000.00
Contingency			15%	$41,000.00
		CONSTRUCTION SUBTOTAL	-	**$397,143.20**
Engineering Design			40%	$109,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$139,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$69,500**
Post-Construction Monitoring-3 storms	storm	$6,000	3	$18,000.00
Quarterly Cleaning @ Catch Basins	yr	$1,000.00	20	$20,000.00

Cost Estimate - Infiltration Park - Triangle Park

			Below-ground cistern / Relandscaped Park	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	350	$1,400.00
Construction BMP - Gravel Bags	EA	$2.00	40	$80.00
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000.00
Protect Utilities in place	LS	-	500	$500.00
Excavation, Export *(limited grading)*	CY	$45.00	172.8	$7,778.23
Excavation-Reuse Material	CY	$5.00	12.8	$64.05
1/2-inch Gravel - Cistern Bedding	CY	$125.00	1.7	$215.83
Import and Place Amended Soils - Landscape	CY	$150.00	133	$20,000.00
Type I Grate Inlet Catch Basin	EA	$6,200.00	1	$6,200.00
18-inch RCP	LF	$124.00	20	$2,480.00
Catch Basin Inlet BMP	EA	$2,700.00	1	$2,700.00
Clean Out	EA	$633.00	1	$633.00
Native/Drought Tolerant Landscaping	SF	$1.50	1800	$2,700.00
1000-gallon fiberglass cistern	EA	$2,000.00	0.9	$1,800.00
System controller	EA	$400.00	1	$400.00
Irrigation Pump	EA	$600.00	1	$600.00
Shut Off Valve (install in irrigation system)	EA	$150.00	1	$150.00
Controller Electrical Connection	LS	$1,600.00	1	$1,600.00
New Subsurface Drip Irrigation	SF	$2.40	1800	$4,320.00
		Subtotal	-	$55,621.10
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$11,000.00
Construction Administration			10%	$6,000.00
Contingency			15%	$8,000.00
		CONSTRUCTION SUBTOTAL	-	**$80,621**
Engineering Design			40%	$21,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$51,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$25,500**
Inspections / Repairs	yr	$2,000	20	$40,000.00
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

Cost Estimate - Infiltration Park - Via Dolce Park

DESCRIPTION	UNIT	UNIT COST	Below-ground cistern / Relandscaped Park QUANTITY	TOTAL COST
Construction BMP - Construction Fence	LF	$4.00	400	$1,600.00
Construction BMP - Gravel Bags	EA	$2.00	40	$80.00
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000.00
Protect Utilities in place	LS	-	500	$500.00
Excavation, Export *(limited grading)*	CY	$45.00	574.7	$25,860.29
Excavation-Reuse Material	CY	$5.00	27.8	$138.91
1/2-inch Gravel - Cistern Bedding	CY	$125.00	4.3	$532.96
Import and Place Amended Soils - Landscape	CY	$150.00	444	$66,666.67
Type I Grate Inlet Catch Basin	EA	$6,200.00	1	$6,200.00
18-inch RCP	LF	$124.00	20	$2,480.00
Catch Basin Inlet BMP	EA	$2,700.00	1	$2,700.00
Clean Out	EA	$633.00	3	$1,899.00
Native/Drought Tolerant Landscaping	SF	$1.50	6000	$9,000.00
1000-gallon fiberglass cistern	EA	$2,000.00	3	$6,000.00
System controller	EA	$400.00	3	$1,200.00
Irrigation Pump	EA	$600.00	3	$1,800.00
Shut Off Valve (install in irrigation system)	EA	$150.00	3	$450.00
Controller Electrical Connection	LS	$1,600.00	3	$4,800.00
New Subsurface Drip Irrigation	SF	$2.40	6000	$14,400.00
		Subtotal	-	$148,307.83
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$29,000.00
Construction Administration			10%	$15,000.00
Contingency			15%	$22,000.00
		CONSTRUCTION SUBTOTAL	-	**$214,308**
Engineering Design			40%	$58,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$88,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$44,000**
Inspections / Repairs	yr	$2,000	20	$40,000.00
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

Boone Olive - Existing Diversion to Sanitary Sewer

2015 existing BMP @ Boone Olive - Dry Weather BMP

Item	Units	Amount
Boone Olive Detention/Diversion to the Sanitary Sewer	gal	104,720.0
	cft	13,999.0
Area Treated	sft	152,716.7
	ac	3.5

Stormwater Diversion to Sanitary Sewer - Subwatershed 4

DESIGN PARAMETERS	Units	Amount
Design Area	ac	35.0
Design Storm	ft	0.09
Runoff c	-	0.65
Design Runoff Volume	cft	90,841

CISTERN DESIGN PARAMETERS	Unit	100%
Factor - Tank Capacity	-	1.1
Minim Cistern Capture Volume	cft	99,925
Discharge Rate to Sanitary Sewer (q=0.05 cfs)	cft/day	4,320
Days to Drain 100% Volume	days	23
Design Drawdown Period	days	14
Additional Tank Capacity Required	cft	39,445
Cistern Design Volume	cft	139,370
Cistern Design Volume	gallons	1,042,557

DESIGN RESULT	Unit	100%
Height	ft	10
Footprint	*sft*	*13,937*
Length	*ft*	*126.7*
Width	*ft*	*110*
Foundation	*sft*	*15,145*

REDEVELOPMENT PARAMETERS	Unit	100%
Area Needed to Redevelopment	*ac*	0.50
No. Multi-Family Residential Lots	-	4.0

Cost Estimate - Diversion to Sanitary Sewer-Subwatershed 4

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			Capture-Sanitary Sewer Subwatershed 4 (35ac)	
Construction BMP - Construction Fence	LF	$4.00	550	$2,200
Construction BMP - Gravel Bags	EA	$2.00	150	$300
Construction BMP - Concrete Wash Out	LS	$825.00	1	$825
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000
Protect Utilities in place	LS	-	10000	$10,000
Diversion Pump & Controls	SF	$40,000.00	1	$40,000
Concrete Tank large capacity	gal	$1.34	1,042,557	$1,397,027
Foundation for Large Tank	sft	$7.75	15145	$117,377
		Subtotal	-	$1,569,729
Land Purchase	ac	$20,000,000	0.5	$10,000,000
Demolition & Site Preparation 2-3 Story Condominimum	sft	$15	22,000.0	$330,000
		Redevelopment Subtotal	-	$10,330,000
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$313,000
Construction Administration			10%	$157,000
Contingency			15%	$235,000
		CONSTRUCTION SUBTOTAL	-	**$12,604,729**
Engineering Design			40%	$626,000
CEQA + Permits			LS	$50,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$676,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$338,000**
Post-Construction Monitoring-3 storms	storm	$20,000	3	$60,000
Parts	yr	$2,000.00	20	$40,000
Inspections	yr	$5,000.00	20	$100,000
SEWER DISCHARGE FEE - 100% Design *(empty ~7x/yr @ $5.00/HCF)*	yr	-	20	$975,655

Stormwater Diversion to Sanitary Sewer - Subwatershed 1

DESIGN PARAMETERS	Units	Amount
Design Storm	ft	0.09
Runoff c	-	0.65
Design Area-Subwatershed 1a	ac	22.0
Design Runoff Volume-Subwatershed1a	cft	57,100
Design Area-Subwatershed 1b	ac	48
Design Runoff Volume-Subwatershed1b	cft	124,582

CISTERN DESIGN PARAMETERS	Unit	Sub-1A	Sub-1B
Factor - Tank Capacity	-	1.1	1.1
Minim Cistern Capture Volume	cft	62,810	137,040
Discharge Rate to Sanitary Sewer (q=0.05 cfs)	cft/day	4,320	4,320
Days to Drain 100% Volume	days	15	32
Design Drawdown Period	days	14	14
Additional Tank Capacity Required	cft	2,330	76,560
Cistern Design Volume	cft	65,140	213,600
Cistern Design Volume	gallons	487,279	1,597,835

DESIGN RESULT	Unit	Sub-1A	Sub-1B
Height	ft	10	10
Footprint	*sft*	*6,514*	*21,360*
Length	*ft*	*76.6*	*194.2*
Width	*ft*	*85*	*110*
Foundation	*sft*	*7,347*	*22,906*

REDEVELOPMENT PARAMETERS	Unit	Sub-1A	Sub-1B
Area Needed to Redevelopment	*ac*	0.30	0.70

Cost Estimate - Diversion to Sanitary Sewer-Subwatershed 1

			Capture-Sanitary Sewer Subwatershed 1a (22ac)		Capture-Sanitary Sewer Subwatershed 1b (48ac)	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	400	$1,600	700	$2,800
Construction BMP - Gravel Bags	EA	$2.00	100	$200	200	$400
Construction BMP - Concrete Wash Out	LS	$825.00	1	$825	1	$825
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000	1	$2,000
Protect Utilities in place	LS	-	10000	$10,000	10000	$10,000
Pump & Controls for Sanitary Sewer	SF	$40,000.00	1	$40,000	1	$40,000
Concrete Tank large capacity	gal	$1.34	487,279	$652,954	1,597,835	$2,141,100
Foundation for Large Tank	sft	$7.75	7347	$56,940	22906	$177,520
		Subtotal	-	$764,520	-	$2,374,645
Land Purchase	ac	$20,000,000	0.3	$6,000,000	0.7	$14,000,000
Demolition & Site Preparation 2-3 Story Condominimum	sft	$15	13500	$202,500	30500	$457,500
		Redevelopment Subtotal	-	$6,202,500	-	$14,457,500
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$152,000	20%	$474,000
Construction Administration			10%	$76,000	10%	$237,000
Contingency			15%	$114,000	15%	$356,000
		CONSTRUCTION SUBTOTAL	-	**$7,309,020**	-	**$17,899,145**
Engineering Design			40%	$304,000	40%	$948,000
CEQA + Permits			LS	$50,000	LS	$50,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$354,000**	-	**$998,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$177,000**	per year	**$499,000**
Post-Construction Monitoring-3 storms	storm	$20,000	3	$60,000	3	$60,000
Parts	yr	$2,000.00	20	$40,000	20	$800,000
Inspections	yr	$5,000.00	20	$100,000	20	$2,000,000
SEWER DISCHARGE FEE - 100% Design *(empty ~7x/yr @ $5.00/HCF)*	yr	-	20	$456,010	20	$1,495,301

APPENDIX C

Reasonable Assurance Analysis Modeling Details

Marina del Rey
Enhanced Watershed Management Program

Appendix C

Reasonable Assurance Analysis
Modeling Details

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1. INTRODUCTION

Additional details on the modeling setup, including rainfall input, land use input, modeling output values, and continuous simulation model (CSM) development and parameters are provided in this appendix. As briefly detailed in the Section 5.1 of the Marina del Rey (MdR) Enhanced Watershed Management Program (EWMP), the Watershed Management Modeling System (WMMS) was selected as the tool to estimate storm water runoff volumes and pollutant loading from the MdR watershed. More details on the WMMS tool are available on the WMMS website at: http://dpw.lacounty.gov/wmd/wmms/res.aspx. The WMMS tool was calibrated using monitoring data collected from 2009-2014 and as detailed in the Section 5.1.2 of the EWMP. The output from the WMMS tool was utilized as the foundation for preparing CSMs for the four subwatershed areas within the MdR watershed. The CSM served as an interface with the WMMS data in which the user was provided the ability to adjust minimum control measures (MCMs) parameters, such as capture capacity, drainage area, etc. The CSM performed hourly time-step calculations and provided a summary of MCM volumes and associated load reductions. The CSMs are discussed in Section 5.1.5 of the EMWP, and additional details relating to MCM calculations are provided in this appendix.

2. RAINFALL INPUT DATA

2.1 Critical Rainfall year Determination

The WMMS tool used rainfall for the critical rainfall year to estimate the existing annual toxic pollutant loads and associated required load reductions. In accordance with the Toxic Pollutants in Marina del Rey Harbor TMDL (Toxics TMDL), the average rainfall year based on LAX rainfall data from 1948 to 2000 is considered the critical period. The LAX 1948-2000 data set was obtained and evaluated to determine the average rainfall year rainfall value, and this analysis is summarized in Table 1. This analysis considers the rainfall year to be from July 1 of the wet season year to June 30 of the following calendar year (e.g., the wet season period for 1948 is considered to be July 1, 1948 to June 30, 1949).

Table 1. Summary of Rainfall year Rainfall Data for LAX 1948-2000.

Wet Year	Rainfall (in)	Wet Year	Rainfall (in)	Wet Year	Rainfall (in)	Wet Year	Rainfall (in)
1948	7.97	1962	9.29	1975	4.37	1988	6.55
1949	9.15	1963	7.51	1976	12.47	1989	6.07
1950	6.64	1964	10.27	1977	28.55	1990	8.02
1951	19.12	1965	12.62	1978	13.88	1991	14.79
1952	8.55	1966	13.54	1979	21.02	1992	23.66
1953	12.19	1967	14.5	1980	8.36	1993	8.21
1954	9.87	1968	16.18	1981	13.18	1994	22.8
1955	13.51	1969	5.67	1982	25.61	1995	10.29
1956	8.93	1970	9.92	1983	10.65	1996	13.25
1957	18.91	1971	6.43	1984	9.6	1997	31.26
1958	5.6	1972	17.35	1985	18.69	1998	9.26
1959	9.16	1973	10.93	1986	6.01	1999	10.11
1960	4.48	1974	11.28	1987	8.91	2000	15.5
1961	18.22						

Average Wet Season Rainfall = 12.43 inches

The rainfall years with rainfall values closest to the average are summarized in Table 2. The closest rainfall years are 1953 and 1974.

Table 2. LAX Rainfall years Closest to Average Value (1948-2000 Data Set)

Rainfall year	Rainfall (in)
1981	13.18
1965	12.62
1976	12.47
1953	12.19
1974	11.28
1973	10.93

The available rainfall data for WMMS includes rainfall years from 1986 through 2013, and this period does not correspond to either of the two above-mentioned years that are closest to the average rainfall year value. The LAX data set includes daily rainfall totals, whereas the WMMS requires hourly rainfall amounts in order to accurately generate runoff volumes and associated pollutant loads (i.e., the LAX data cannot be used in the WMMS tool). As such, additional LAX rainfall data, matching the years for which WMMS data is available, were reviewed beyond the period stated in the Toxic TMDL of 1948-2000. This additional data includes rainfall years from 2001 through 2013, and is summarized in Table 3.

Table 3. Summary of Rainfall Year Rainfall Data for LAX 2001-2013.

Rainfall year	Rainfall (in)	Rainfall year	Rainfall (in)
2001	4.16	2008	8.14
2002	10.38	2009	12.42
2003	7.81	2010	17.85
2004	26.51	2011	7.61
2005	10.84	2012	6.85
2006	2.63	2013	4.45
2007	10.24		

2.2 WMMS Gauge Rainfall Year Values

Based on the comparison of the average value of 12.43 inches to the LAX rainfall year rainfall data from 2001-2013, the rainfall year of 2009 (with a rainfall of 12.42 inches) was selected. The WMMS tool utilizes the closest rain gauge to the area being modeled (Marina del Rey), WMMS Gauge 042214, which measured a total rainfall of 14.63 inches for the 2009 rainfall year. The data for WMMS Gauge 042214 are provided in Table 4. The hourly rainfall data along with the cumulative rainfall year rainfall are shown in Figure 1.

Table 4. 2009 Rainfall Year WMMS Gauge 042214 Rainfall

Date & Time	Rainfall (in)	Date & Time	Rainfall (in)	Date & Time	Rainfall (in)	Date & Time	Rainfall (in)
10/13/09 11:00	0.09	12/12/09 9:00	0.09	1/20/10 16:00	0.22	2/9/10 12:00	0.06
10/13/09 12:00	0.03	12/12/09 11:00	0.01	1/20/10 17:00	0.06	2/9/10 13:00	0.04
10/13/09 14:00	0.01	12/12/09 13:00	0.06	1/21/10 4:00	0.08	2/9/10 14:00	0.16
10/13/09 15:00	0.01	12/12/09 14:00	0.01	1/21/10 6:00	0.03	2/9/10 15:00	0.05
10/13/09 16:00	0.04	12/12/09 15:00	0.14	1/21/10 11:00	0.04	2/9/10 18:00	0.01
10/13/09 18:00	0.06	12/12/09 16:00	0.11	1/21/10 12:00	0.15	2/19/10 21:00	0.07
10/13/09 19:00	0.03	12/12/09 17:00	0.03	1/21/10 13:00	0.21	2/19/10 22:00	0.02
10/13/09 22:00	0.03	12/12/09 18:00	0.05	1/21/10 14:00	0.05	2/20/10 0:00	0.03
10/13/09 23:00	0.07	12/12/09 19:00	0.02	1/21/10 15:00	0.01	2/20/10 1:00	0.05
10/14/09 0:00	0.16	12/12/09 20:00	0.04	1/21/10 16:00	0.02	2/22/10 0:00	0.01
10/14/09 1:00	0.18	12/12/09 21:00	0.02	1/21/10 17:00	0.02	2/24/10 19:00	0.01
10/14/09 2:00	0.26	12/13/09 2:00	0.03	1/21/10 18:00	0.01	2/24/10 20:00	0.01
10/14/09 3:00	0.2	12/13/09 4:00	0.05	1/21/10 19:00	0.08	2/27/10 3:00	0.06
10/14/09 4:00	0.1	12/13/09 5:00	0.01	1/21/10 20:00	0.09	2/27/10 4:00	0.14
10/14/09 5:00	0.13	12/13/09 7:00	0.01	1/21/10 21:00	0.01	2/27/10 5:00	0.3
10/14/09 6:00	0.04	12/30/09 9:00	0.03	1/22/10 0:00	0.02	2/27/10 6:00	0.16
10/14/09 7:00	0.03	12/30/09 10:00	0.01	1/22/10 3:00	0.01	2/27/10 7:00	0.05
10/14/09 8:00	0.04	12/30/09 11:00	0.03	1/22/10 5:00	0.07	2/27/10 10:00	0.02
10/14/09 9:00	0.07	12/30/09 12:00	0.03	1/22/10 6:00	0.05	2/27/10 11:00	0.01
10/14/09 10:00	0.04	12/30/09 14:00	0.02	1/22/10 7:00	0.02	2/27/10 13:00	0.01
10/14/09 11:00	0.02	12/30/09 15:00	0.01	1/22/10 10:00	0.01	2/27/10 14:00	0.03
10/14/09 12:00	0.02	12/31/09 3:00	0.01	1/22/10 11:00	0.08	2/27/10 15:00	0.03
10/14/09 13:00	0.03	1/13/10 5:00	0.09	1/22/10 12:00	0.08	2/27/10 16:00	0.03
10/14/09 14:00	0.08	1/13/10 6:00	0.01	1/22/10 13:00	0.02	3/3/10 22:00	0.02
10/14/09 15:00	0.05	1/17/10 15:00	0.02	1/22/10 14:00	0.1	3/3/10 23:00	0.02
10/14/09 16:00	0.01	1/17/10 16:00	0.03	1/22/10 15:00	0.03	3/6/10 10:00	0.04
10/14/09 17:00	0.01	1/17/10 17:00	0.03	1/22/10 16:00	0.05	3/6/10 11:00	0.03
10/15/09 3:00	0.01	1/17/10 18:00	0.03	1/26/10 14:00	0.02	3/6/10 17:00	0.05
12/7/09 4:00	0.02	1/17/10 19:00	0.04	1/26/10 15:00	0.01	3/6/10 18:00	0.13
12/7/09 5:00	0.06	1/17/10 20:00	0.07	1/26/10 16:00	0.06	3/6/10 19:00	0.04
12/7/09 6:00	0.02	1/17/10 21:00	0.01	1/26/10 17:00	0.06	3/6/10 20:00	0.04
12/7/09 7:00	0.02	1/17/10 22:00	0.02	1/26/10 18:00	0.01	3/6/10 21:00	0.02
12/7/09 8:00	0.05	1/17/10 23:00	0.04	1/26/10 20:00	0.01	3/7/10 16:00	0.01
12/7/09 9:00	0.05	1/18/10 0:00	0.03	2/5/10 8:00	0.05	4/4/10 23:00	0.01
12/7/09 10:00	0.1	1/18/10 2:00	0.01	2/5/10 9:00	0.13	4/5/10 0:00	0.02
12/7/09 11:00	0.23	1/18/10 3:00	0.01	2/5/10 10:00	0.05	4/5/10 1:00	0.04
12/7/09 12:00	0.19	1/18/10 4:00	0.01	2/5/10 11:00	0.06	4/5/10 3:00	0.01
12/7/09 13:00	0.08	1/18/10 7:00	0.02	2/5/10 12:00	0.02	4/5/10 4:00	0.03
12/7/09 14:00	0.03	1/18/10 8:00	0.06	2/5/10 13:00	0.06	4/5/10 5:00	0.03
12/7/09 15:00	0.02	1/18/10 9:00	0.08	2/5/10 14:00	0.05	4/5/10 6:00	0.01
12/7/09 16:00	0.02	1/18/10 11:00	0.03	2/5/10 15:00	0.07	4/5/10 8:00	0.26
12/7/09 17:00	0.03	1/18/10 12:00	0.1	2/5/10 16:00	0.07	4/5/10 9:00	0.05
12/10/09 22:00	0.01	1/18/10 13:00	0.37	2/5/10 17:00	0.11	4/11/10 22:00	0.03
12/10/09 23:00	0.09	1/18/10 14:00	0.21	2/5/10 18:00	0.07	4/11/10 23:00	0.25
12/11/09 0:00	0.08	1/18/10 15:00	0.02	2/5/10 19:00	0.04	4/12/10 0:00	0.33
12/11/09 1:00	0.09	1/19/10 11:00	0.03	2/5/10 20:00	0.08	4/12/10 1:00	0.13
12/11/09 2:00	0.1	1/19/10 12:00	0.35	2/5/10 21:00	0.05	4/12/10 2:00	0.04
12/11/09 3:00	0.01	1/19/10 13:00	0.18	2/5/10 22:00	0.05	4/12/10 3:00	0.01
12/11/09 7:00	0.01	1/19/10 14:00	0.03	2/5/10 23:00	0.02	4/12/10 7:00	0.01
12/11/09 14:00	0.02	1/19/10 15:00	0.03	2/6/10 0:00	0.04	4/20/10 12:00	0.01
12/11/09 15:00	0.03	1/20/10 3:00	0.02	2/6/10 1:00	0.05	4/20/10 13:00	0.04
12/11/09 17:00	0.01	1/20/10 4:00	0.01	2/6/10 2:00	0.16	4/20/10 14:00	0.05
12/11/09 23:00	0.03	1/20/10 5:00	0.07	2/6/10 3:00	0.24	4/20/10 15:00	0.02
12/12/09 2:00	0.04	1/20/10 6:00	0.06	2/6/10 4:00	0.26	4/22/10 0:00	0.02
12/12/09 3:00	0.01	1/20/10 11:00	0.05	2/6/10 5:00	0.18	5/18/10 5:00	0.01
12/12/09 5:00	0.05	1/20/10 12:00	0.05	2/6/10 6:00	0.24	5/18/10 8:00	0.01
12/12/09 6:00	0.08	1/20/10 13:00	0.08	2/6/10 7:00	0.27	5/18/10 9:00	0.01
12/12/09 7:00	0.05	1/20/10 14:00	0.17	2/6/10 8:00	0.12	5/27/10 9:00	0.02
12/12/09 8:00	0.02	1/20/10 15:00	0.3			**Total**	**14.63**

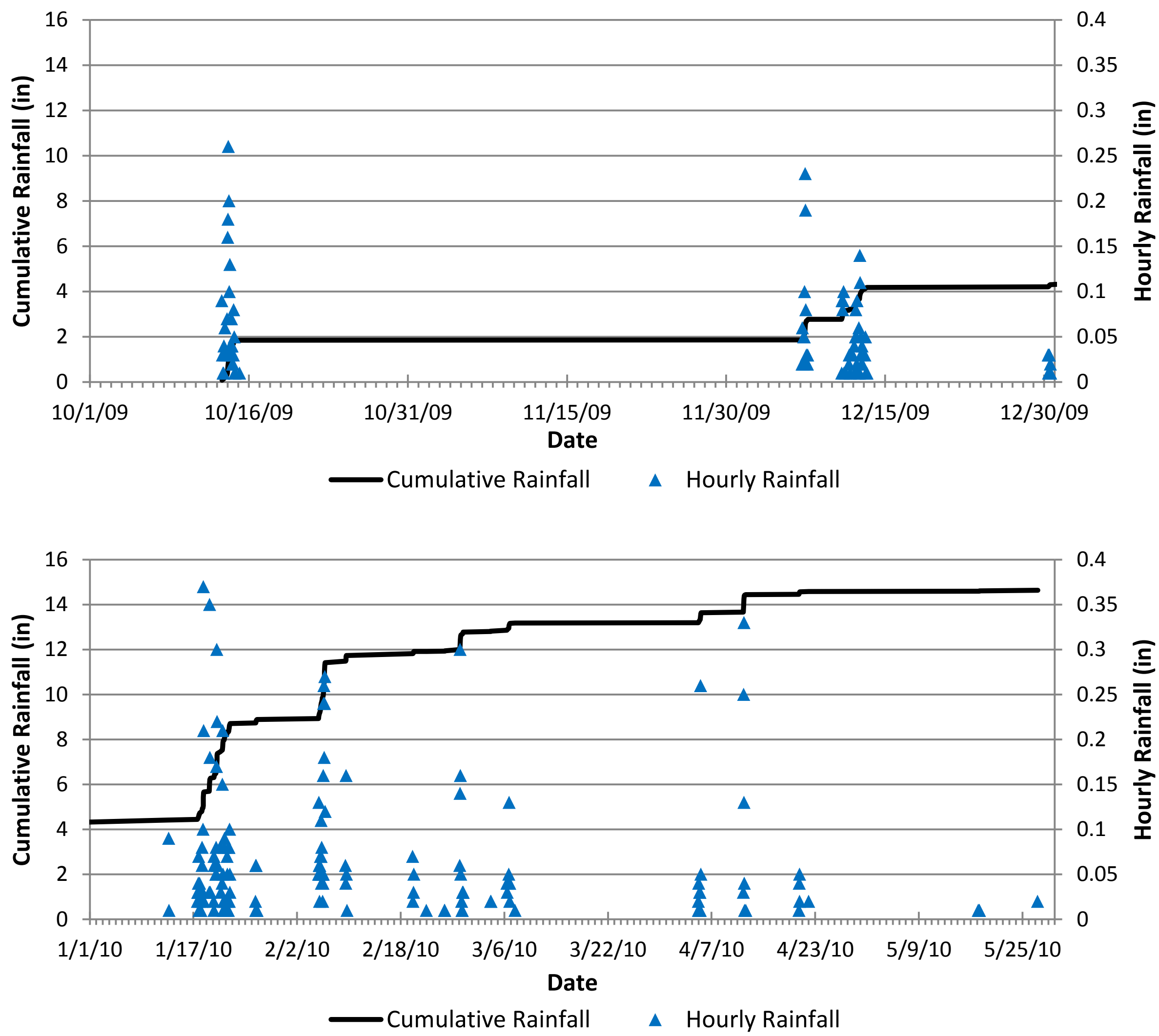

Figure 1. 2009 Rainfall Year WMMS Gauge 042214 Rainfall

2.3 WMMS Gauge 85th Percentile Event Values

Rainfall values for the 24-hour, 85th percentile storm event were used in the WMMS tool in order to estimate the associated volumes and pollutant loads for this storm event. The 85th percentile, 24-hour rain event was determined from the Los Angeles County 85th percentile precipitation isohyetal map to be 1.1 inches (LACDPW, 2004). Appendix A of the Los Angeles County Hydrology Manual (Hydrology Manual) (LACDPW, 2006) provides the temporal distribution of rainfall over a 24-hour period (Unit Hyetograph), and this distribution was used to calculate the incremental rainfall for the design storm. A watershed-specific hyetograph was created by applying 1.1 inches to the Unit Hyetograph, and the associated hourly and cumulative rainfall is shown on Figure 2.

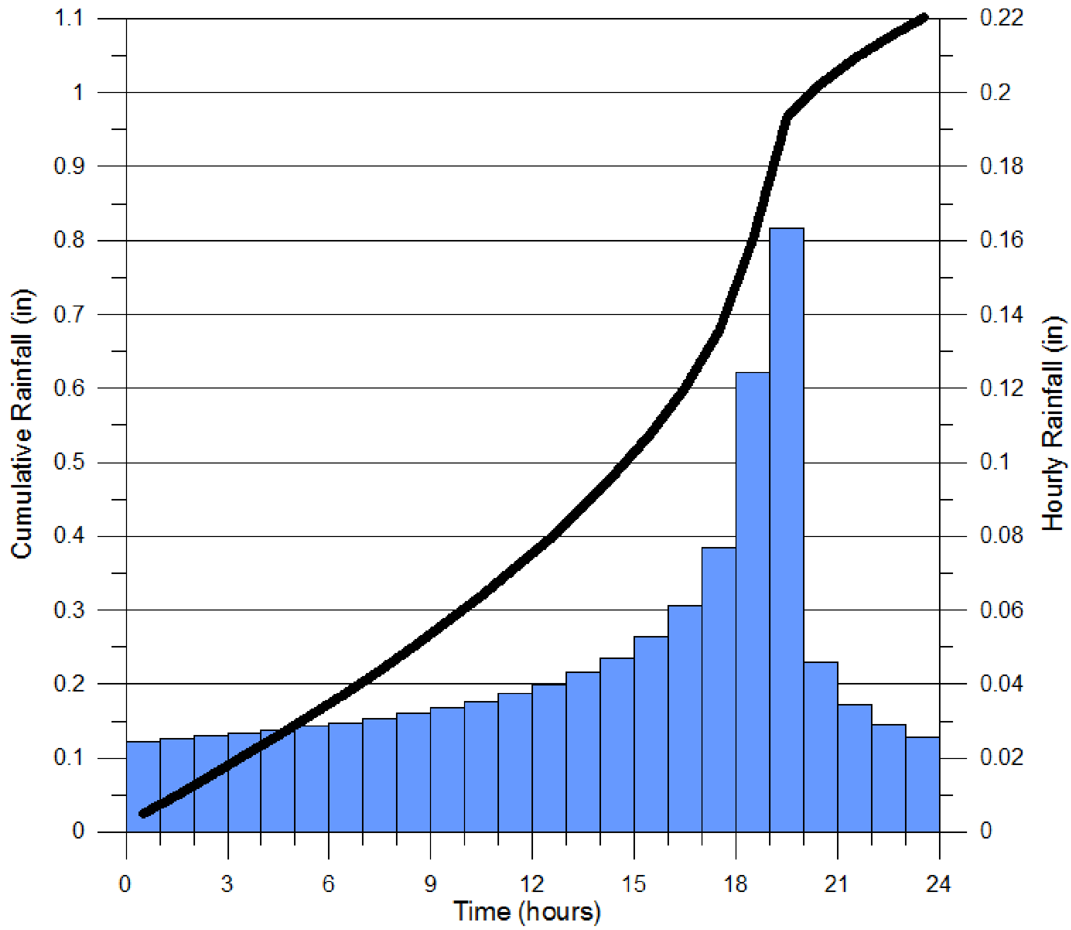

Figure 2. 85th Percentile Storm Event Rainfall

3. LAND USE INPUT DATA

The land use types and areas were determined for each MdR subwatershed based on the land use GIS layer obtained from the WMMS website. These data included both land use types and impervious cover percentages. For each area modeled and for the major land use types, composite land use areas (sum of land use areas for the specific land use types) and impervious percentage (area weighted average of impervious percentage for the specific land use types) were calculated. The land use data for each specific type were separated into impervious and pervious areas and used as input into the WMMS tool. This separating of each developed land use into two components was necessary, because WMMS considers land types as either completely impervious or pervious, and therefore the user needs to input the area, in acres, of impervious land use rather than the percentage of impervious cover. For example, if a subwatershed area contained 10 acres of single-family residential with 25 percent impervious cover, the user would need to convert that information to 2.5 acres single-family residential and 7.5 acres pervious area in order for WMMS to properly perform hydrologic and water quality calculations. Table 5 through Table 9 show the GIS land use data along with the converted values used for input into the WMMS tool.

Table 5. GIS and WMMS Input Land Use Data – Subwatershed 1A

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	0	32.9%	0.00	0.00	80%	0.00	0.00
2	LD_SF_Res_Moderate	0.43	6.0%	0.03	0.40	50%	0.20	0.20
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	17.34	63.3%	10.98	6.36	70%	4.45	1.91
5	Commercial	65.59	70.6%	46.28	19.31	85%	16.41	2.90
6	Institutional	0.73	71.3%	0.52	0.21	85%	0.18	0.03
7	Industrial	0.16	42.0%	0.07	0.09	85%	0.08	0.01
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	11.77	59.8%	7.03	4.74	20%	0.95	3.79
10	Urban_Grass_Irrigated	0		22.27	**Subtotal (ac)**		**22.27**	**8.84**
11	Urban_Grass_NonIrrigated	0		8.84				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	8.2		8.20				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	0		0.00				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**104.22**		**104.22**				

Table 6. GIS and WMMS Input Land Use Data – Subwatershed 1B

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	0	32.9%	0.00	0.00	80%	0.00	0.00
2	LD_SF_Res_Moderate	1.41	19.3%	0.27	1.14	50%	0.57	0.57
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	119.75	62.3%	74.59	45.16	70%	31.61	13.55
5	Commercial	94.28	63.8%	60.17	34.11	85%	29.00	5.12
6	Institutional	8.18	63.3%	5.18	3.00	85%	2.55	0.45
7	Industrial	0.02	0.0%	0.00	0.02	85%	0.02	0.00
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	26.23	53.6%	14.05	12.18	20%	2.44	9.74
10	Urban_Grass_Irrigated	0		66.18	**Subtotal (ac)**		**66.18**	**29.43**
11	Urban_Grass_NonIrrigated	0		29.43				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	0.15		0.15				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	14.52		14.52				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**264.54**		**264.54**				

Table 7. GIS and WMMS Input Land Use Data – Subwatershed 2

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	45.78	42.2%	19.34	26.44	80%	21.15	5.29
2	LD_SF_Res_Moderate	0	0.0%	0.00	0.00	50%	0.00	0.00
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	131.76	59.8%	78.74	53.02	70%	37.11	15.90
5	Commercial	23.17	92.6%	21.45	1.72	85%	1.46	0.26
6	Institutional	10.17	85.3%	8.68	1.49	85%	1.27	0.22
7	Industrial	0.22	0.0%	0.00	0.22	85%	0.19	0.03
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	83.25	67.9%	56.50	26.75	20%	5.35	21.40
10	Urban_Grass_Irrigated	0		66.53	**Subtotal (ac)**		**66.53**	**43.11**
11	Urban_Grass_NonIrrigated	0		43.11				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	33.33		33.33				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	0		0.00				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**327.68**		**327.68**				

Table 8. GIS and WMMS Input Land Use Data – Subwatershed 3

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	22.9	49.3%	11.30	11.63	80%	9.31	2.33
2	LD_SF_Res_Moderate	0	0.0%	0.00	0.00	50%	0.00	0.00
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	21.1	48.3%	10.19	10.91	70%	7.64	3.27
5	Commercial	2.9	95.0%	2.73	0.14	85%	0.12	0.02
6	Institutional	1.4	95.0%	1.29	0.07	85%	0.06	0.01
7	Industrial	0.2	95.0%	0.23	0.01	85%	0.01	0.00
8	Transportation	0	90.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	22.0	67.0%	14.72	7.24	20%	1.45	5.79
10	Urban_Grass_Irrigated	0		18.58	**Subtotal (ac)**		**18.58**	**11.43**
11	Urban_Grass_NonIrrigated	0		11.43				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	0		0.00				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	0		0.00				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**70.46**		**70.46**				

Table 9. GIS and WMMS Input Land Use Data – Subwatershed 4

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	166.32	33.9%	56.34	109.98	80%	87.99	22.00
2	LD_SF_Res_Moderate	0.85	7.9%	0.07	0.78	50%	0.39	0.39
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	96.28	44.7%	43.08	53.20	70%	37.24	15.96
5	Commercial	129.70	69.3%	89.82	39.88	85%	33.90	5.98
6	Institutional	63.60	64.4%	40.94	22.66	85%	19.26	3.40
7	Industrial	27.00	69.8%	18.84	8.16	85%	6.93	1.22
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	154.83	53.5%	82.89	71.94	20%	14.39	57.55
10	Urban_Grass_Irrigated	0		200.10	**Subtotal (ac)**		**200.10**	**106.50**
11	Urban_Grass_NonIrrigated	0		106.50				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	0.60		0.60				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	6.50		6.50				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**645.68**		**645.68**				

4. WMMS TOOL OUTPUT

The WMMS tool output data for the 85th percentile storm, 24-hour storm event are provided in Table 10 through Table 14 for each of the MdR subwatersheds for the key parameters related to the Toxics TMDL. For the simulation of the critical rainfall year the raw output from the WMMS tool includes 26 parameters and 8,760 time step lines. Therefore, output is only provided for the 85th percentile, 24-hour storm event.

Table 10. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 1A

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.015	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.015	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	0.015	0.000	0.000	0.000	0.000
10/25/2014 3:00	0.02	0.531	0.000	11.894	10.670	89.181
10/25/2014 4:00	0.03	0.833	23.032	9.679	8.684	72.579
10/25/2014 5:00	0.03	1.318	18.557	10.819	9.706	81.124
10/25/2014 6:00	0.03	1.635	26.477	10.664	9.567	79.961
10/25/2014 7:00	0.03	1.813	29.179	10.068	9.032	75.492
10/25/2014 8:00	0.03	1.911	11.825	9.573	8.588	71.782
10/25/2014 9:00	0.03	1.965	11.416	9.237	8.287	69.264
10/25/2014 10:00	0.04	1.994	11.142	9.027	8.099	67.690
10/25/2014 11:00	0.04	2.324	9.498	11.619	10.424	87.123
10/25/2014 12:00	0.04	2.510	13.448	12.183	10.930	91.350
10/25/2014 13:00	0.04	2.606	14.824	12.130	10.883	90.957
10/25/2014 14:00	0.05	2.655	15.135	11.976	10.744	89.796
10/25/2014 15:00	0.05	3.010	13.483	14.815	13.291	111.089
10/25/2014 16:00	0.06	3.192	18.034	15.224	13.658	114.157
10/25/2014 17:00	0.08	3.635	17.330	18.304	16.421	137.248
10/25/2014 18:00	0.12	4.553	20.804	25.320	22.715	189.855
10/25/2014 19:00	0.17	6.487	33.082	40.058	35.937	300.364
10/25/2014 20:00	0.04	9.330	67.713	57.260	51.370	429.350
10/25/2014 21:00	0.04	5.601	179.291	25.248	22.651	189.316
10/25/2014 22:00	0.02	4.070	45.432	14.221	12.758	106.634
10/25/2014 23:00	0.03	2.711	26.980	7.623	6.839	57.163
10/26/2014 0:00	0.00	2.389	11.242	7.531	6.756	56.470
10/26/2014 1:00	0.00	1.314	17.488	4.452	3.994	33.379
10/26/2014 2:00	0.00	0.795	9.399	3.190	2.862	23.917
10/26/2014 3:00	0.00	0.523	6.194	2.522	2.262	18.909
10/26/2014 4:00	0.00	0.361	4.667	2.087	1.872	15.648
10/26/2014 5:00	0.00	0.253	3.799	1.766	1.584	13.242
10/26/2014 6:00	0.00	0.196	2.918	1.553	1.393	11.642
10/26/2014 7:00	0.00	0.165	2.348	1.393	1.250	10.445
10/26/2014 8:00	0.00	0.141	2.093	1.242	1.114	9.309
10/26/2014 9:00	0.00	0.120	1.851	1.098	0.985	8.235
10/26/2014 10:00	0.00	0.104	1.624	0.963	0.864	7.224
10/26/2014 11:00	0.00	0.091	1.411	0.837	0.751	6.275
10/26/2014 12:00	0.00	0.080	1.213	0.719	0.645	5.395

Table 11. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 1B

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.043	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.044	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	0.046	0.000	0.000	0.000	0.000
10/25/2014 3:00	0.02	1.700	0.000	9.974	9.141	75.907
10/25/2014 4:00	0.03	2.388	23.805	7.242	6.637	55.118
10/25/2014 5:00	0.03	3.566	6.798	8.337	7.641	63.453
10/25/2014 6:00	0.03	4.185	10.500	7.811	7.158	59.444
10/25/2014 7:00	0.03	4.487	11.347	7.270	6.663	55.328
10/25/2014 8:00	0.03	4.639	11.226	6.956	6.375	52.942
10/25/2014 9:00	0.03	4.710	11.093	6.785	6.219	51.641
10/25/2014 10:00	0.04	4.745	10.990	6.699	6.139	50.980
10/25/2014 11:00	0.04	5.610	10.664	9.152	8.387	69.649
10/25/2014 12:00	0.04	6.018	15.613	9.290	8.514	70.703
10/25/2014 13:00	0.04	6.208	16.666	9.122	8.360	69.427
10/25/2014 14:00	0.05	6.294	16.871	8.983	8.233	68.369
10/25/2014 15:00	0.05	7.212	17.180	11.366	10.416	86.500
10/25/2014 16:00	0.06	7.629	23.301	11.476	10.518	87.343
10/25/2014 17:00	0.08	8.716	25.288	13.776	12.625	104.845
10/25/2014 18:00	0.12	11.041	35.512	18.968	17.383	144.355
10/25/2014 19:00	0.17	15.873	61.450	29.630	27.155	225.505
10/25/2014 20:00	0.04	22.825	98.777	42.078	38.563	320.241
10/25/2014 21:00	0.04	12.607	165.077	17.280	15.836	131.509
10/25/2014 22:00	0.02	8.947	65.141	9.806	8.987	74.633
10/25/2014 23:00	0.03	5.741	33.227	5.160	4.729	39.269
10/26/2014 0:00	0.00	5.257	10.261	5.758	5.277	43.820
10/26/2014 1:00	0.00	2.605	15.714	2.767	2.536	21.056
10/26/2014 2:00	0.00	1.447	7.121	1.547	1.418	11.775
10/26/2014 3:00	0.00	0.897	3.567	1.059	0.971	8.063
10/26/2014 4:00	0.00	0.599	2.268	0.791	0.725	6.019
10/26/2014 5:00	0.00	0.438	1.548	0.624	0.572	4.750
10/26/2014 6:00	0.00	0.330	1.183	0.498	0.457	3.792
10/26/2014 7:00	0.00	0.258	0.910	0.402	0.368	3.059
10/26/2014 8:00	0.00	0.212	0.700	0.329	0.301	2.501
10/26/2014 9:00	0.00	0.192	0.518	0.274	0.251	2.088
10/26/2014 10:00	0.00	0.176	0.428	0.227	0.208	1.728
10/26/2014 11:00	0.00	0.163	0.351	0.186	0.171	1.416
10/26/2014 12:00	0.00	0.152	0.285	0.151	0.139	1.151

Table 12. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 2

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.043	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.044	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	0.045	0.000	0.000	0.000	0.000
10/25/2014 3:00	0.02	4.660	10.048	13.373	12.848	125.400
10/25/2014 4:00	0.03	3.892	13.519	4.629	4.448	43.408
10/25/2014 5:00	0.03	5.406	12.655	6.178	5.935	57.930
10/25/2014 6:00	0.03	5.610	13.920	6.039	5.803	56.633
10/25/2014 7:00	0.03	5.638	13.905	6.004	5.768	56.298
10/25/2014 8:00	0.03	5.644	13.888	5.996	5.761	56.225
10/25/2014 9:00	0.03	5.647	13.880	5.993	5.758	56.194
10/25/2014 10:00	0.04	5.649	13.874	5.990	5.755	56.169
10/25/2014 11:00	0.04	7.289	17.731	8.138	7.819	76.309
10/25/2014 12:00	0.04	7.494	18.570	8.033	7.718	75.328
10/25/2014 13:00	0.04	7.521	18.531	8.001	7.687	75.024
10/25/2014 14:00	0.05	7.527	18.512	7.993	7.679	74.949
10/25/2014 15:00	0.05	9.181	22.396	10.123	9.726	94.921
10/25/2014 16:00	0.06	9.383	23.181	10.023	9.630	93.990
10/25/2014 17:00	0.08	11.079	27.049	12.110	11.635	113.556
10/25/2014 18:00	0.12	14.620	35.798	16.259	15.621	152.464
10/25/2014 19:00	0.17	21.687	53.564	24.561	23.597	230.309
10/25/2014 20:00	0.04	30.799	76.463	34.710	33.349	325.480
10/25/2014 21:00	0.04	10.083	43.590	9.976	9.585	93.547
10/25/2014 22:00	0.02	7.879	19.459	7.819	7.512	73.320
10/25/2014 23:00	0.03	4.353	12.094	3.943	3.788	36.973
10/26/2014 0:00	0.00	5.540	12.507	5.989	5.754	56.160
10/26/2014 1:00	0.00	0.930	15.290	2.003	1.925	18.787
10/26/2014 2:00	0.00	0.303	4.499	0.584	0.562	5.480
10/26/2014 3:00	0.00	0.172	1.068	0.143	0.138	1.342
10/26/2014 4:00	0.00	0.138	0.224	0.032	0.030	0.296
10/26/2014 5:00	0.00	0.126	0.046	0.007	0.006	0.062
10/26/2014 6:00	0.00	0.122	0.009	0.001	0.001	0.013
10/26/2014 7:00	0.00	0.119	0.002	0.000	0.000	0.003
10/26/2014 8:00	0.00	0.118	0.000	0.000	0.000	0.001
10/26/2014 9:00	0.00	0.116	0.000	0.000	0.000	0.000
10/26/2014 10:00	0.00	0.115	0.000	0.000	0.000	0.000
10/26/2014 11:00	0.00	0.114	0.000	0.000	0.000	0.000
10/26/2014 12:00	0.00	0.113	0.000	0.000	0.000	0.000

Table 13. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 3

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.012	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.012	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	1.236	14.119	6.027	5.870	23.845
10/25/2014 3:00	0.02	0.828	9.368	3.999	3.895	15.821
10/25/2014 4:00	0.03	1.236	14.120	6.028	5.870	23.845
10/25/2014 5:00	0.03	1.236	14.112	6.024	5.867	23.832
10/25/2014 6:00	0.03	1.237	14.104	6.021	5.864	23.819
10/25/2014 7:00	0.03	1.238	14.096	6.018	5.861	23.806
10/25/2014 8:00	0.03	1.239	14.088	6.014	5.858	23.793
10/25/2014 9:00	0.03	1.239	14.081	6.011	5.854	23.780
10/25/2014 10:00	0.04	1.648	18.825	8.036	7.827	31.791
10/25/2014 11:00	0.04	1.649	18.814	8.031	7.822	31.773
10/25/2014 12:00	0.04	1.650	18.803	8.027	7.818	31.755
10/25/2014 13:00	0.04	1.651	18.792	8.022	7.813	31.737
10/25/2014 14:00	0.05	2.060	23.533	10.046	9.784	39.742
10/25/2014 15:00	0.05	2.061	23.519	10.040	9.779	39.720
10/25/2014 16:00	0.06	2.470	28.256	12.062	11.748	47.719
10/25/2014 17:00	0.08	3.288	37.740	16.111	15.691	63.736
10/25/2014 18:00	0.12	4.922	56.716	24.212	23.581	95.783
10/25/2014 19:00	0.17	6.964	80.461	34.349	33.453	135.885
10/25/2014 20:00	0.04	1.664	18.643	7.959	7.751	31.484
10/25/2014 21:00	0.04	1.665	18.631	7.954	7.746	31.465
10/25/2014 22:00	0.02	0.850	9.127	3.896	3.795	15.414
10/25/2014 23:00	0.03	1.258	13.868	5.920	5.766	23.421
10/26/2014 0:00	0.00	0.035	0.000	0.000	0.000	0.000
10/26/2014 1:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 2:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 3:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 4:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 5:00	0.00	0.033	0.000	0.000	0.000	0.000
10/26/2014 6:00	0.00	0.033	0.000	0.000	0.000	0.000
10/26/2014 7:00	0.00	0.033	0.000	0.000	0.000	0.000
10/26/2014 8:00	0.00	0.032	0.000	0.000	0.000	0.000
10/26/2014 9:00	0.00	0.032	0.000	0.000	0.000	0.000
10/26/2014 10:00	0.00	0.032	0.000	0.000	0.000	0.000
10/26/2014 11:00	0.00	0.031	0.000	0.000	0.000	0.000
10/26/2014 12:00	0.00	0.031	0.000	0.000	0.000	0.000

Table 14. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 4

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.130	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.130	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	10.131	20.407	6.712	6.035	73.608
10/25/2014 3:00	0.02	6.796	13.519	4.446	3.998	48.765
10/25/2014 4:00	0.03	10.130	20.408	6.712	6.035	73.611
10/25/2014 5:00	0.03	10.138	20.393	6.707	6.030	73.557
10/25/2014 6:00	0.03	10.145	20.378	6.702	6.026	73.503
10/25/2014 7:00	0.03	10.152	20.363	6.697	6.022	73.451
10/25/2014 8:00	0.03	10.160	20.349	6.693	6.017	73.398
10/25/2014 9:00	0.03	10.167	20.334	6.688	6.013	73.346
10/25/2014 10:00	0.04	13.508	27.208	8.948	8.046	98.139
10/25/2014 11:00	0.04	13.518	27.187	8.942	8.040	98.065
10/25/2014 12:00	0.04	13.529	27.167	8.935	8.034	97.990
10/25/2014 13:00	0.04	13.539	27.146	8.928	8.028	97.917
10/25/2014 14:00	0.05	16.883	34.014	11.187	10.058	122.687
10/25/2014 15:00	0.05	16.896	33.989	11.178	10.051	122.597
10/25/2014 16:00	0.06	20.244	40.849	13.435	12.079	147.341
10/25/2014 17:00	0.08	26.930	54.590	17.954	16.143	196.905
10/25/2014 18:00	0.12	40.296	82.087	26.998	24.274	296.089
10/25/2014 19:00	0.17	56.979	116.508	38.318	34.453	420.245
10/25/2014 20:00	0.04	13.681	26.864	8.835	7.944	96.899
10/25/2014 21:00	0.04	13.692	26.843	8.828	7.938	96.822
10/25/2014 22:00	0.02	7.032	13.067	4.298	3.864	47.132
10/25/2014 23:00	0.03	10.371	19.933	6.556	5.895	71.900
10/26/2014 0:00	0.00	0.374	0.000	0.000	0.000	0.000
10/26/2014 1:00	0.00	0.372	0.000	0.000	0.000	0.000
10/26/2014 2:00	0.00	0.368	0.000	0.000	0.000	0.000
10/26/2014 3:00	0.00	0.365	0.000	0.000	0.000	0.000
10/26/2014 4:00	0.00	0.362	0.000	0.000	0.000	0.000
10/26/2014 5:00	0.00	0.358	0.000	0.000	0.000	0.000
10/26/2014 6:00	0.00	0.355	0.000	0.000	0.000	0.000
10/26/2014 7:00	0.00	0.352	0.000	0.000	0.000	0.000
10/26/2014 8:00	0.00	0.348	0.000	0.000	0.000	0.000
10/26/2014 9:00	0.00	0.345	0.000	0.000	0.000	0.000
10/26/2014 10:00	0.00	0.342	0.000	0.000	0.000	0.000
10/26/2014 11:00	0.00	0.339	0.000	0.000	0.000	0.000
10/26/2014 12:00	0.00	0.336	0.000	0.000	0.000	0.000

5. CONTINUOUS SIMULATION MODEL CALCULATIONS

The CSMs were prepared for the subwatersheds to (1) provide a means to sum the incremental volumes of runoff and associated pollutant loads from WMMS output data, (2) incorporate capture and treatment MCMs into the drainage areas, and (3) evaluate the load reductions achieved by those MCMs. The WMMS tool output data were used as the foundation for each CSM. The output data were converted into Microsoft Excel worksheets. Key parameters were organized into a user friendly format (arranged in adjacent columns) and included date and time, rainfall, flow, and concentrations of TSS, copper, and zinc. Calculations were programed into the CSM to determine the incremental (or time step) pollutant loading based on the WMMS output flows and applicable pollutant concentrations. The sum of these incremental time steps determined the total pollutant loading for the modeled period. Three different MCMs were incorporated into the CSM to simulate treatment, capture first followed by treatment, and capture for infiltration or reuse. In general, programing allowed the CSM user to provide the drainage size, runoff coefficient, and treatment rate or capture capacity. Based on the user provided values, the CSM performed calculations that simulated the runoff volume from drainage area to the MCM, the volume of either treatment (up to a maximum rate) or capture, and the drawdown (or recharge in capacity) for capture type MCMs. Based on the volumes simulated to be treated or capture, the pollutant concentrations, and the associated MCM effectiveness the CSM performed time step load reduction calculations. The summation of the time step load reductions provided the overall load reductions achieved with the selected MCMs for the period of the simulation. Additional details related to the MCM specific values used are provided in Table 15 through Table 20.

Table 15. Model Parameters: Curbside Filtration Device (e.g., Modular Wetland System® or Similar)

Model Parameter	Value Used	Notes
Description	n/a	These MCMs may be installed in areas just upstream of existing storm drain inlets. The MCMs were designed so that runoff from the curb and gutter would flow into the device, filtration would occur through a media (device dependent), and treated runoff would discharged into the existing storm drain system.
MCM Drainage Area	Various	Based on bottom-up approach of MCM selection. Filtration MCMs were only utilized in remaining subwatershed areas after maximizing the use of capture type MCMs. In general, these curbside device account for about 60% of the total area to be served by filtration MCMs.
Maximum Treatment Capacity	0.2 inches / hour rainfall	Each time step: For rainfall less than the 0.2 inches per hour value, calculations were performed to determine the runoff volume to the MCM (volume based on the MCM drainage area in relation to total modeled area multiplied by the modeled area total runoff). For rainfall greater than the 0.2 inches per hour, the same calculation was performed but now with a reduction factor equal to the value selected divided by the time step rainfall (e.g., with rainfall of 0.25 inches/hour calculation included 0.2/0.25 because only 80% of runoff from MCM drainage area would be treated).
MCM Pollutant Removal Effectiveness	63%	Based on International Stormwater BMP Data Base for TSS removal using media filter type measures (Geosyntec and WWE, 2008).
Load Reductions	Calculated	Load removal calculated based on time step flows and pollutant concentrations of runoff being treated by the MCM and the pollutant removal effectiveness.

Table 16. Model Parameters: Porous Concrete with Underdrain Filtration

Model Parameter	Value Used	Notes
Description	n/a	This MCM design included porous concrete installed over a gravel/rock reservoir with an underdrain system connected to the existing storm drain network (typically a catch basin box). These may be located in the roadside parking areas and would include removal of the adjacent curb and gutter and replacement with curb only so that the porous concrete could be extended to the curb. This design would allow runoff reaching the MCM from the up gradient curb and gutter to be conveyed into the system. The runoff would be temporarily stored in the underlying rock reservoir and slowly discharge through the underdrain into the nearby storm drain system. Filtration occurs both as the runoff penetrates the porous concrete and as the runoff travels through the rock reservoir towards the underdrain system.
MCM Drainage Area	Various	Based on bottom-up approach of MCM selection. Filtration MCMs utilized in remaining subwatershed area after maximizing the use of capture type MCMs. In general, porous concrete type MCMs account for about 40% of the total area to be served by filtration MCMs.
Runoff "C"	Calculated	The Runoff "C" was determined for the drainage to the MCM type based on both the drainage area impervious cover and the WMMS tool predicted runoff volume. First ***typical*** Runoff "C" values were calculated for each land use type in the overall modeled drainage area based on the impervious cover (Imp. % * 0.9 + 0.05). Next, the ***typical*** composite Runoff "C" for the modeled drainage area was determined using the area weighted average of ***typical*** Runoff "C" values. The ***typical*** composite Runoff "C" value was compared to the composite Runoff "C" determined from the WMMS output to develop an correction factor that was then applied to each of the ***typical*** Runoff "C" values previous calculated for each land use type to provide ***corrected typical*** Runoff "C" values. These adjusted Runoff "C" values were then used to estimate the Runoff "C" for the MCM drainage area based on an area weight average using the ***corrected typical*** land use Runoff "C" values..
Maximum Capture Capacity	1.1 inches of rainfall	Total MCM capacity calculated in cubic feet based on the provided rainfall capture capacity (1.1 inches), MCM drainage area, and MCM drainage area Runoff "C".
Recharge Capacity	12 hours	Conservative estimate based on the system at full capacity discharging through perforated or slotted underdrain piping. It is considered conservative because well maintained MCMs with this type of design (underdrain system) should be able to fully drain in 1 to 6 hours.
Temporary Storage	Calculated	Each time step: Similar to standard basin routing calculations the CSM performed a series of calculations to account for runoff entering the system, runoff being bypassed, treated runoff being discharged, and the net storage up to the MCM maximum capture capacity (when system at capacity runoff reaching the MCM would be bypassed and not treated).
MCM Pollutant Removal Effectiveness	63%	Based on International Stormwater BMP Data Base for TSS removal using media filter type measures (Geosyntec and WWE, 2008).
Load Reductions	Calculated	Load removal calculated based on time step flows and pollutant concentrations of runoff being treated by the MCM and the pollutant removal effectiveness.

Table 17. Model Parameters: Capture and Reuse MCM (Sidewalk Swale)

Model Parameter	Value Used	Notes
Description	n/a	This MCM design included capture of storm water runoff within depressed landscaped areas located within parkways (MCMs also known as rain gardens or bioretention basins). Due to the poor soil conditions across the watershed (clayey soils), the primary MCM water quality mechanism for these types of MCMs would be evapotranspiration. In order to maximize capture capacity, clayey soils would be removed and replaced with amended soils down to depth of about 2.5 feet. Design would only allow minimal ponding (approximately 2 inches) when the MCM is at full capacity (most storage would be within the voids of the amended soils).
MCM Drainage Area	Various	Based on bottom-up approach of MCM selection. Capture and reuse MCMs utilized to maximum extent feasible given the site constraints of limited parkway area. Typically located to capture runoff from between 10 to 25% of the up gradient drainage area.
Runoff "C"	Calculated	Same as described in Table 16.
Maximum Capture Capacity	1.1 inches of rainfall	Rainfall value is based on the 85th percentile, 24-hour storm event. Total MCM capacity calculated in cubic feet based on the provided rainfall capture capacity, MCM drainage area, and MCM drainage area Runoff "C".
Recharge Capacity	9 days	Reasonable recharge rate based on MCM design, evapotranspiration rate, and estimate recharge determined for water harvesting MCMs (see Table 19)
Temporary Storage	Calculated	Each time step: Calculations were similar to the standard basin routing calculations. The CSM performed a series of calculations to account for runoff entering the system, runoff being bypassed, and the net storage up to the MCM maximum capture capacity (when system at capacity runoff reaching the MCM would be bypassed and not captured).
MCM Pollutant Removal Effectiveness	100%	Capture type MCM. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	**Method 1:** Calculations at each time step were performed based on volume and concentration of the runoff captured in the MCM (flow into MCM). This method utilizes the CSM calculations to estimate load reductions that would have been achieved during the critical period modeled (rainfall year 2009). **Method 2:** This method conforms to the guidance document for conducting RAA (LARWQCB, 2014). The basis of design for these modeled MCMs is that they will capture and infiltrate or reuse runoff from the 85th percentile storm event. The guidance document considers the areas served by these types of MCMs to be in compliance. Therefore, annual load reductions achieved by these MCMs are equivalent to the required load reduction as estimated through modeling of critical year (required load reduction is equal to the modeled load minus waste load allocation). **Note:** The EWMP bottom up approach MCM load reduction tables present load reductions for capture and infiltration or reuse MCMs based on Method 2 calculations. For the single storm event (85th percentile), there are no differences between Method 1 and Method 2 calculations. For the annual load reductions calculates, the differences between the two methods are minimal (between 3 to 7.5 percent, depending on the amount of capture MCMs proposed).

Table 18. Model Parameters: Capture and Infiltration MCM (Infiltration Gallery)

Model Parameter	Value Used	Notes
Description	n/a	This infiltration gallery MCM design included capture of storm water runoff in storage chambers so that water would infiltrate into the substrata. Given design considerations listed in this table (see below), typical design would include installing inlets to convey storm water from the curb and gutter to underground storage chambers. A filtration device would be installed between inlet and the chambers to pretreat the water (remove trash and coarse grain materials).
MCM Drainage Area	Various	Based on bottom-up approach of MCM selection. In general, a layer of clayey materials exists down to depths of 9 to 12 feet below the surface. Additional design consideration is that groundwater occurs in the watershed at depths of less than 10 feet below the surface (near the harbor) and at greater depths away from the harbor (up to the 20 to 30 feet range). The bottoms of the capture chambers should be designed with a 10-foot separation from groundwater. (Note: if the bottoms of the chambers are located with the clayey layer, then the clayey materials would need to be removed and replaced would suitable materials.) In general, selection of these MCMs were limited to Subwatershed 3 and 4 where estimated groundwater depths were greater than 16 feet below ground surface, and in those areas used to capture runoff from the remaining drainage areas not served by sidewalk swale capture MCMs.
Runoff “C”	Calculated	Same as described in Table 16.
Maximum Capture Capacity	1.1 inches of rainfall	Total MCM capacity calculated in cubic feet based on the provided rainfall capture capacity, MCM drainage area, and MCM drainage area Runoff “C”.
Recharge Capacity	3 days	Conservative estimate based on the system at full capacity discharging through perforated or slotted underdrain piping. Well maintained MCM should be able to fully drain in 1 to 6 hours.
Temporary Storage	Calculated	Each time step: Similar to a standard basin routing calculations the CSM performed a series of calculation to account for runoff entering the system, runoff being bypassed, treated runoff being discharged, and the net storage up to the MCM maximum capture capacity (when system at capacity runoff reaching the MCM would be bypassed and not captured).
MCM Pollutant Removal Effectiveness	100%	Capture type MCM. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	Same as described in Table 17.

Table 19. Model Parameters: Capture and Reuse MCM (Downspout Disconnect/Cistern)

Model Parameter	Value Used	Notes
Description	n/a	This capture type MCM includes installing rainfall collection tanks (or cisterns) to collect runoff from roofs. The captured rainfall would then be used to irrigate nearby landscaping. Due to the clayey nature of the materials throughout the watershed, the soils within irrigated landscaped areas served by the cistern would be amended so that delivered water would penetrate the soils and the area would have better evapotranspiration rates. The landscaped area would also be slightly depressed, where feasible, to improve temporary storage and prevent rainfall landing directly on the landscaped areas from being surface runoff.
MCM Drainage Area	Various	Based on bottom-up approach of MCM selection. Within private and leased properties implementation of these MCMs would be voluntary; however, incentive programs and/or community outreach programs may be developed in the future to improve participation. Limited opportunities were incorporated into the models (45% of single-family residential) with a focus of locating these MCMs primarily in areas where groundwater depths were estimated to be less than 16 feet below ground surface (45% of single-family residential area for these areas of shallow groundwater depths).
Runoff "C"	Calculated	Same as described in Table 16.
Maximum Capture Capacity	1.6 inches of rainfall	Value is based on providing capture capacity of 1,000 gallons per 1,000 ft^2 of tributary rooftop area. Landscaped area that is part of the MCM is assumed to also capture this amount of runoff during the storm (no surface runoff).
Recharge Capacity	9 days	For the MCM drainage area capacity assumed 2 to 1 ratio of landscaped area to rooftop. A review of rainwater harvesting performance graphs indicated that with assumed capture capacity and landscaping ratio the MCM would capture approximately 70% of the annual rainfall (see Figure 3). Simulating the system with the stated assumptions for the critical period (2009 rainfall year) and varying the recharge duration resulted in the value of 9 days providing approximately 70% capture of annual runoff. This value seems reasonable when considering the typical rainfall distribution and average evapotranspiration rates for the region.
Temporary Storage	Calculated	Each time step: Calculations were similar to the standard basin routing calculations. The CSM performed a series of calculations to account for runoff entering the system, runoff being bypassed, and the net storage up to the MCM maximum capture capacity (when system at capacity runoff reaching the MCM would be bypassed and not captured).
MCM Pollutant Removal Effectiveness	100%	Capture type MCM. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	Same as described in Table 17.

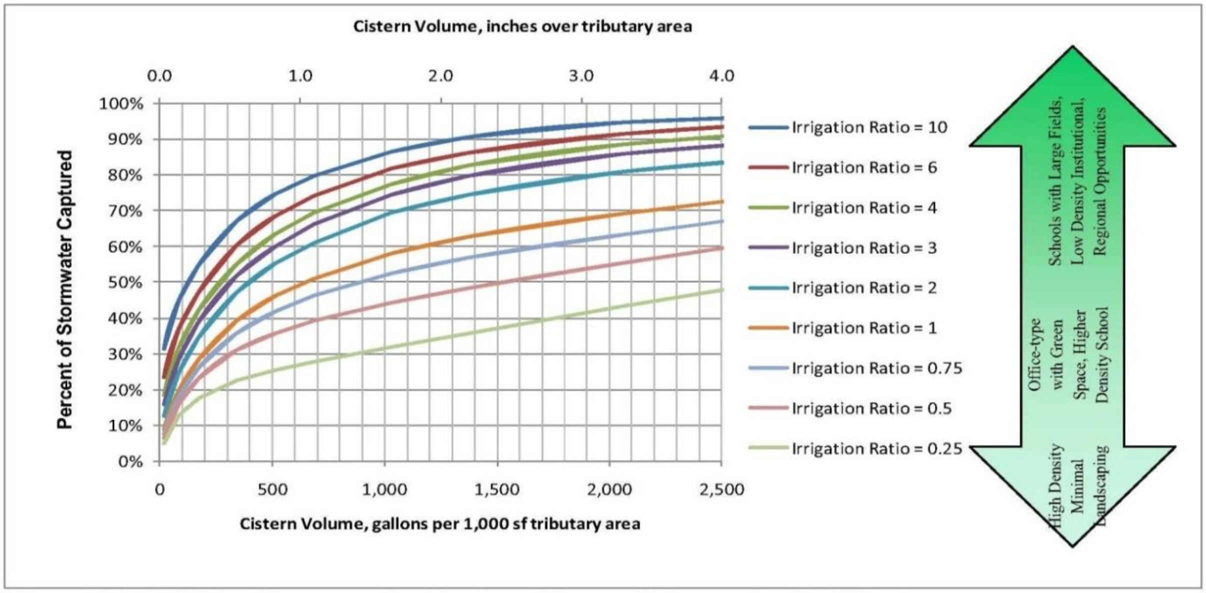

Figure 3. Rainwater Harvesting Systems Performance (Geosyntec, 2009)

Table 20. Model Parameters: Sanitary Sewer Diversion (Boone Olive Pump Station)

Model Parameter	Value Used	Notes
Description	n/a	The Boone Olive Pump / Low Diversion could be modified to function during wet weather. Current operating practice is not to divert flow to the sanitary sewer when measured rainfall exceeds 0.1 inches. This MCM includes modifying the operation of the system to continuously divert storm water during wet weather. The operation of the lift station pumps (that discharge to Basin E) would also be modified so that pumping of storm water to the harbor only occurs when the system nears capacity. This in turn would facilitate the capture and subsequent diversion of additional storm water runoff.
MCM Drainage Area	70.5	Pump station is located at the discharge point of Subwatershed 3.
Maximum Capture Capacity	13,000 gal (1,740 ft^3)	System has 14,000 gallon sump. Value selected assumed approximately 1,000 for water remaining in the sump below pump intake and allowed for freeboard within the system.
Recharge Capacity	0.216 ft^3 per second	Current rate at which water is diverted to the sanitary sewer system.
Temporary Storage	Calculated	Each time step: Similar to standard basin routing calculations, the CSM performed a series of calculation to account for runoff entering the system, runoff being bypassed, and the net storage up to the MCM maximum capture capacity (when system at capacity runoff reaching the MCM would be bypassed and not captured). The CSM estimated the pollutant concentrations of the storm water runoff reaching the system based on the runoff source (e.g., discharge from filtration MCM or untreated). The CSM also estimated the concentration of the water within holding tank, the concentrations and load runoff bypassing the MCM (being pumped to the harbor), and the concentrations of loads of diverted runoff .
MCM Pollutant Removal Effectiveness	100%	Capture type MCM. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	Load removal based on concentration of water in the holding tank at the time step when diverted (i.e., comingled concentrations).

6. REFERENCES

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