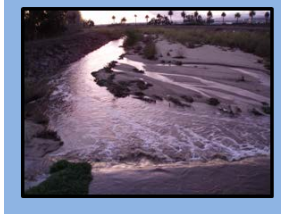
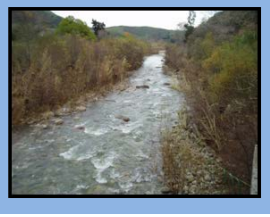
Ventura County Technical Guidance Manual for Stormwater Quality Control Measures

2011 Manual Update Workshop





Kelly Havens, Geosyntec Consultants

Ventura Countywide Stormwater Quality Management Program

Geosyntec consultants

LARRY WALKER ASSOCIATES

Training Schedule

1:00 – 2:00 PM	**Redevelopment Development Scenario**
2:00 – 2:10 PM	**Break**
2:10 – 2:55 PM	**Mixed Use & Residential Development Scenarios**
2:55 – 3:20 PM	**Q & A**
3:20 – 3:30 PM	**Summary and Closing**

Geosyntec consultants

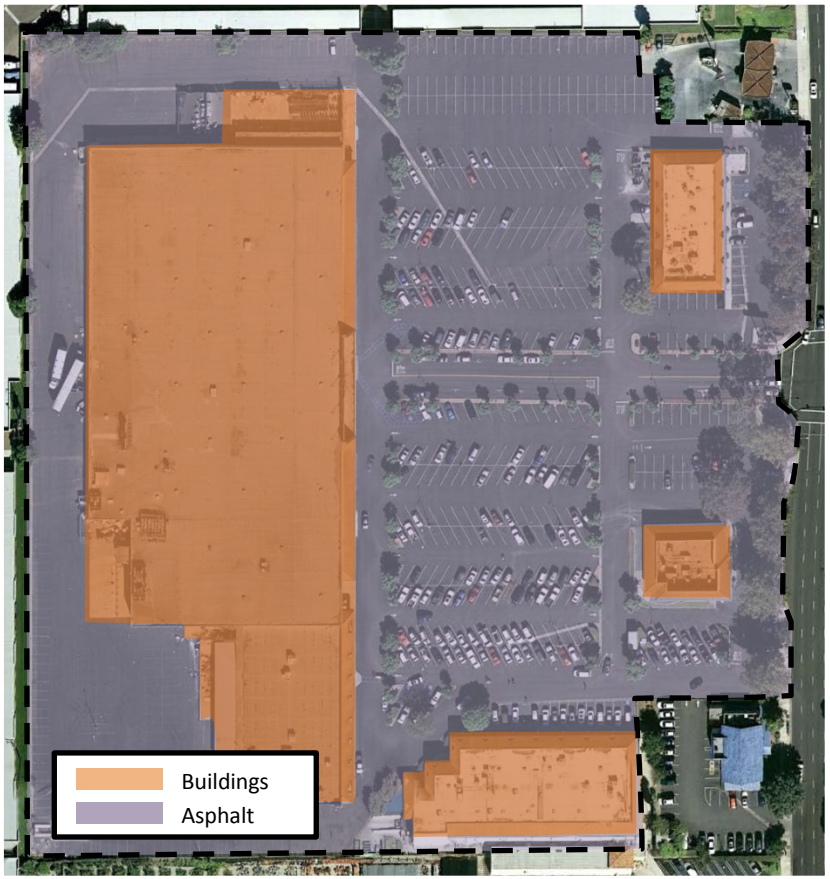
Afternoon Training: Case Studies

- Scenario 1: Commercial Development Achieving EIA
- Scenario 2: Commercial Development Implementing Alternative Compliance
- Scenario 3: Single-Family Residential Development
- Training Summary and Closing

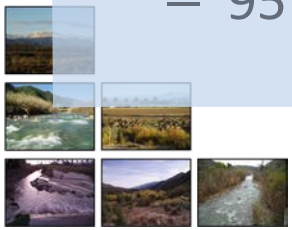
Geosyntec consultants

Scenario 1: Commercial

- Project Information:
  - Redevelopment of a former Kmart center in City of Ventura
  - Highly urbanized area along South Victoria Avenue
  - Site is covered by building roof and parking lot, with some vegetation (curbed off trees) within the main parking lot.
  - 12.2 Acres
  - 95% Impervious



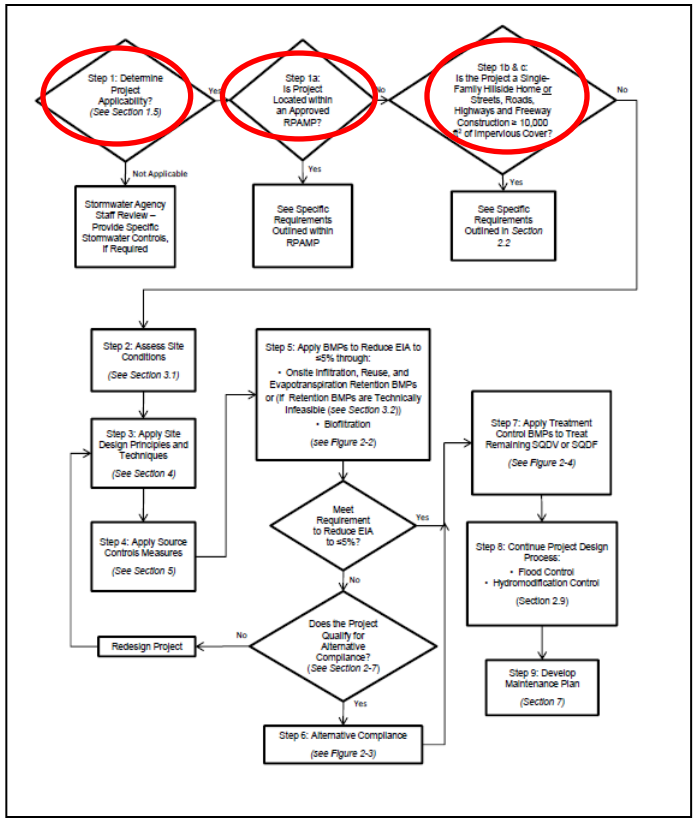
Kmart Site (*Image from Google Earth Pro™, June 2011*)



Geosyntec consultants

Step 1: Project Applicability

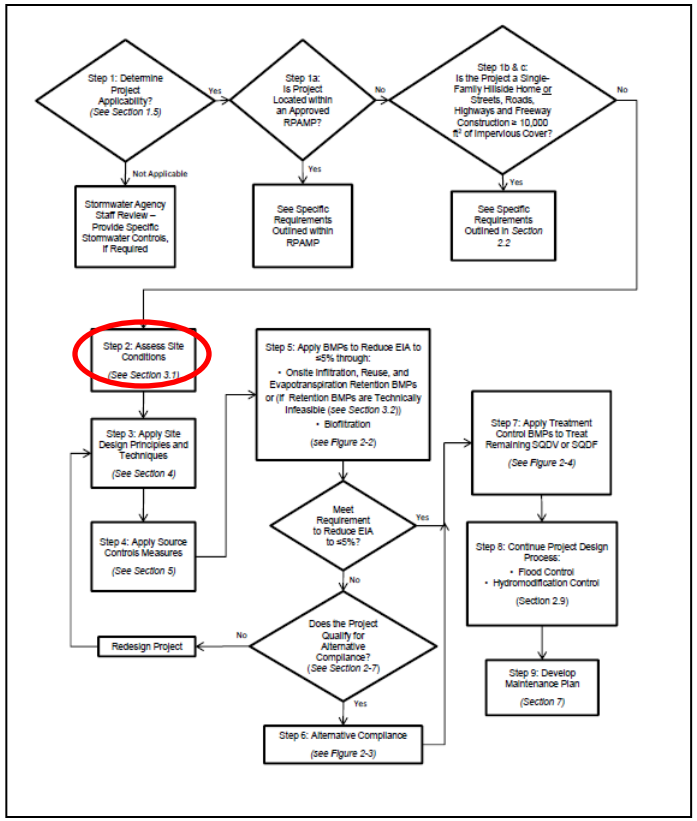
- Step 1: Project Applicability
  - Project is Subject to Requirements
  - Project not located within approved RPAMP
  - Project does not require specifications indicated for Step 1b & 1c

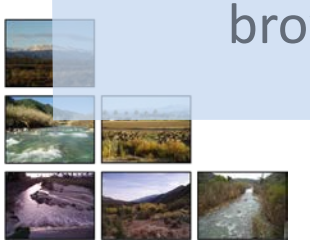


Geosyntec consultants

Step 2: Assess Site Conditions

- Collect Site Information (Section 3.1):
  - Topography
    - Slopes < 15%
  - No Geological/ Geotechnical Hazards
  - Ventura Soil Type 4
  - Seasonal High Groundwater is greater than 10 feet below ground surface (BGS)
  - No nearby groundwater wells
  - No pollutant plumes/ not a brownfield site

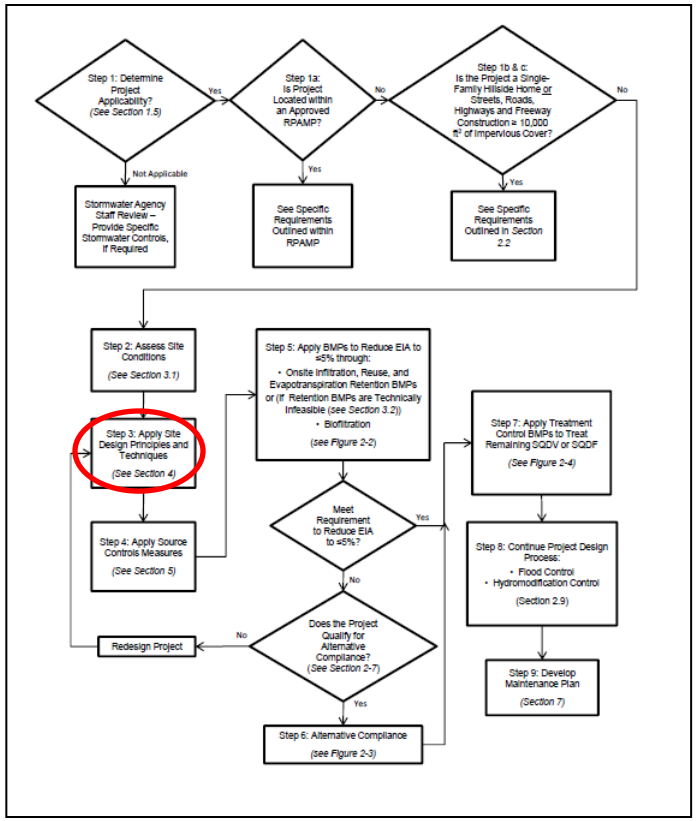


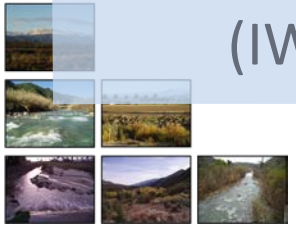


Geosyntec consultants

Step 3: Apply Site Design Principles and Techniques

- Site Design Principles (Section 4):
  - Site Planning
  - Conservation of Natural Areas
  - Minimizing Land Disturbance
  - Minimizing Impervious Cover
  - Applying LID at Various Scales
  - Implementing Integrated Water Resource Management Practices (IWRM)





Geosyntec consultants

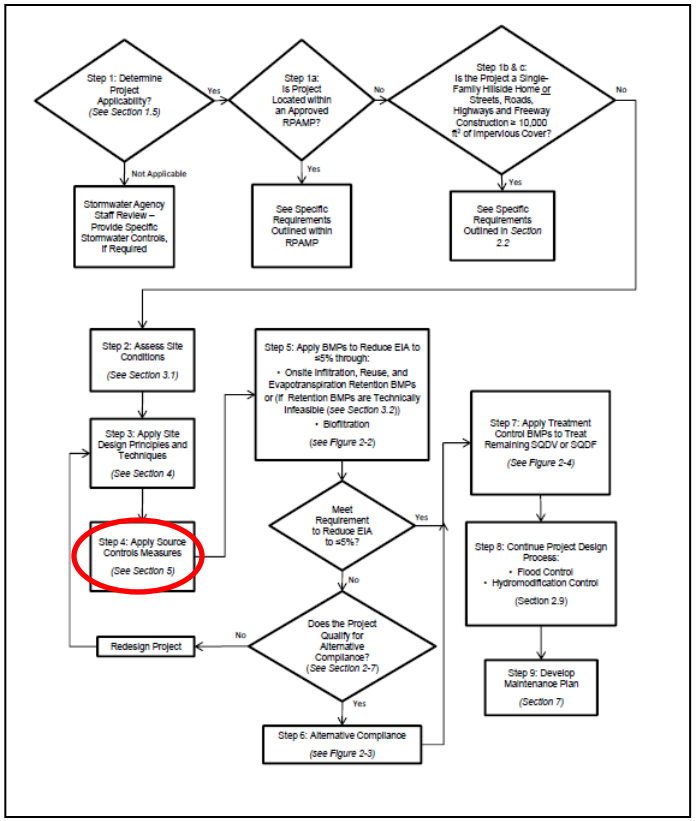
Step 3: Apply Site Design Principles and Techniques

Design Principle	Applicable	Not Applicable	Notes
Site Planning (4.2)		X	*Redevelopment Site*
Conservation of Natural Areas (4.3)		X	*Redevelopment Site*
Minimizing Land Disturbance (4.4)		X	*Redevelopment Site*
Minimizing Impervious Cover (4.5)	X		Pervious areas and BMPs provide minimization of impervious areas
Applying LID at Various Scales (4.6)		X	*Redevelopment Site*
Implementing IWRM (4.7)	X		Use of LID BMPs promotes IWRM

Geosyntec consultants

Step 4: Apply Source Controls

- Refer to Section 5 of TGM



Geosyntec consultants

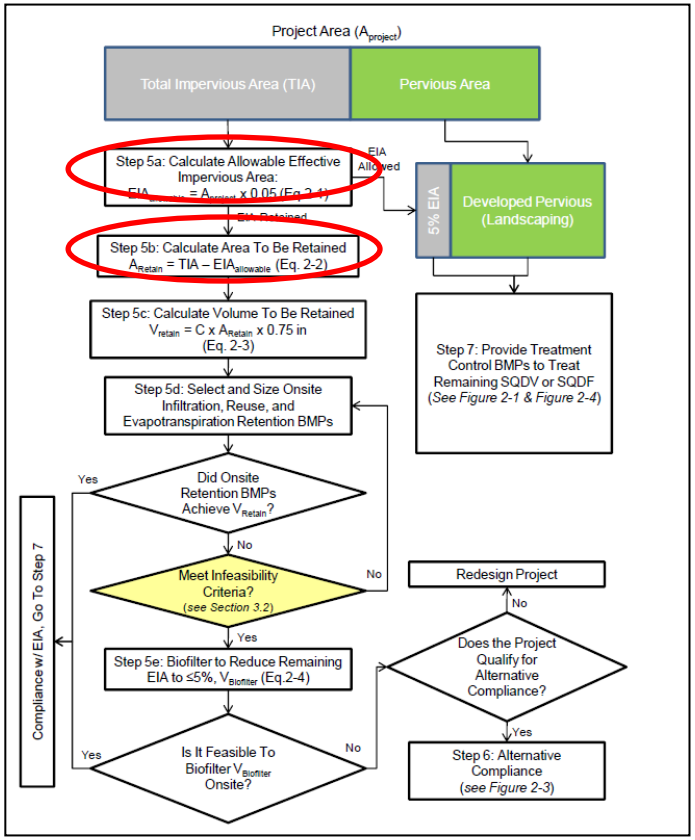
Step 4: Apply Source Controls

Source Control	Applicable	Not Applicable	Notes
S-1: Storm Drain Message/Signage	X		Storm drains expected on-site
S-2: Outdoor Material Storage Area Design		X	No outdoor material storage
S-3: Outdoor Trash Storage Area Design	X		Outdoor trash area on-site should be properly contained
S-4: Outdoor Loading/ Unloading Dock Area	X		Outdoor loading dock on-site
S-5: Outdoor Repair/ Maintenance Bay Design		X	No outdoor repair/ maintenance bay on-site
S-6: Outdoor Vehicle Washing Area Design		X	No outdoor vehicle washing allowed on-site
S-7: Fueling Area Design		X	No vehicle fueling area on-site
S-8: Proof of Control Measure Maintenance	X		Required for all sites

consultants

Step 5: Apply BMPs to Reduce EIA to ≤ 5%

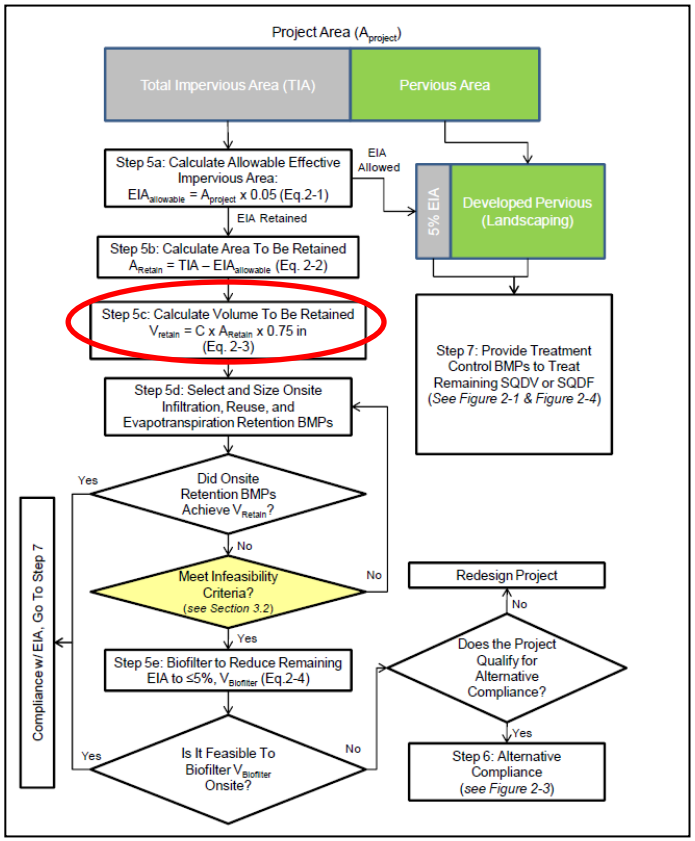
- Step 5a: Calculate Allowable Effective Impervious Area
  - $EIA_{allowable}$ = (12.2 ac)*(0.05) = 0.6 acres
- Step 5b: Calculate Area to be retained
  - A_{retain} = (12.2 ac* 0.95) – 0.6 ac = 11 acres



Geosyntec consultants

Step 5: Apply BMPs to Reduce EIA to ≤ 5%

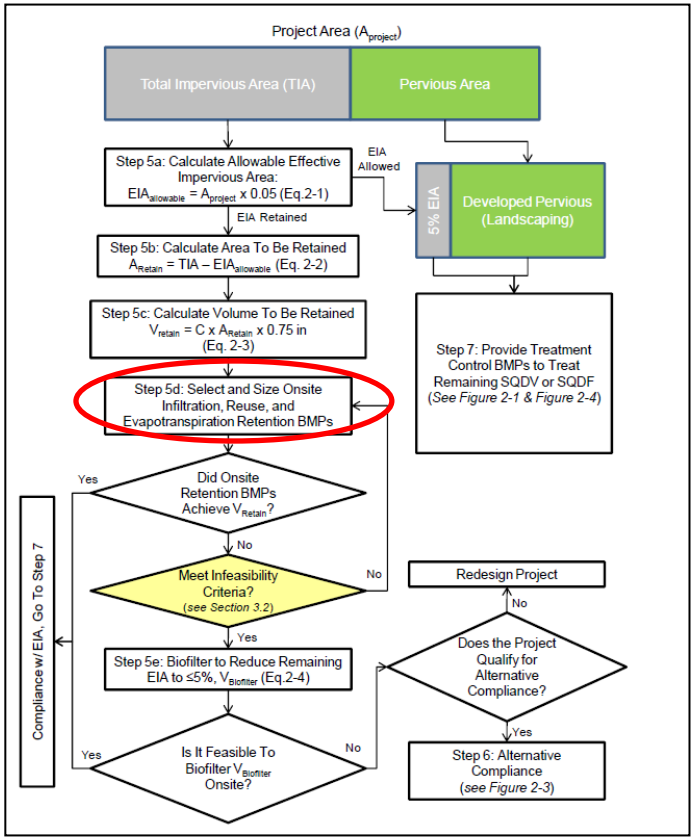
- Step 5c: Calculate Volume to be Retained
  - V_{retain} = 0.95*11 ac* (0.75 in/12 (in/ft))
    - **V_{retain}= 0.65 ac-ft**



Geosyntec consultants

Step 5: Apply BMPs to Reduce EIA to ≤ 5%

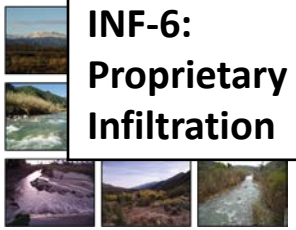
- Step 5d: Select and Size On-site Infiltration, Evapotranspiration, and Harvest and Reuse BMPs
  - Develop Stormwater Management Plan Options
  - Infiltration
  - Harvest and Reuse
  - Evapotranspiration



Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
Infiltration BMPs

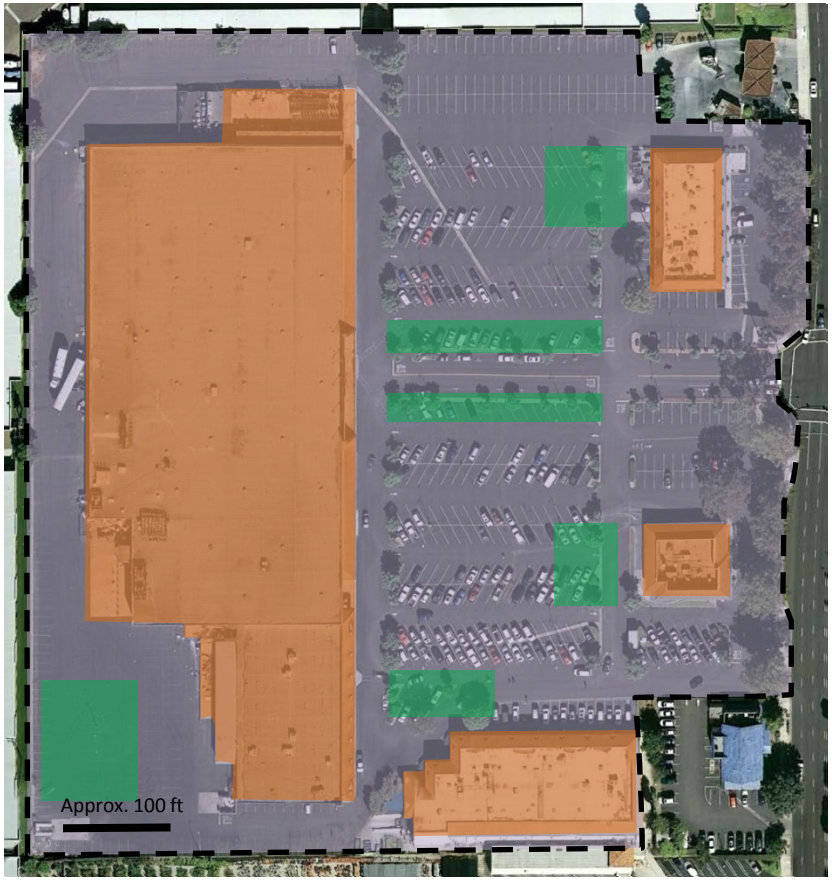
BMP	Recommended	Possible	Not Recommended	Notes
INF-1: Infiltration Basin			X	Infiltration basin generally not practical for parking lot site
INF-2: Infiltration Trench		X		Infiltration trench could be applied with biofiltration pretreatment
INF-3: Bioretention	X			Bioretention can be applied to parking lot land uses and can treat smaller or larger tributary areas
INF-4: Drywell		X		Drywells could be installed near roof drains with adequate pretreatment
INF-5: Permeable Pavement	X			Permeable pavement is a good option for parking stalls and other low traffic areas
INF-6: Proprietary Infiltration		X		Underground vaults could be installed below grade to capture and infiltrate runoff



Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
Infiltration BMP Options

- Infiltration Option 1: Distributed Bioretention
- Infiltration Option 2: Permeable Pavement

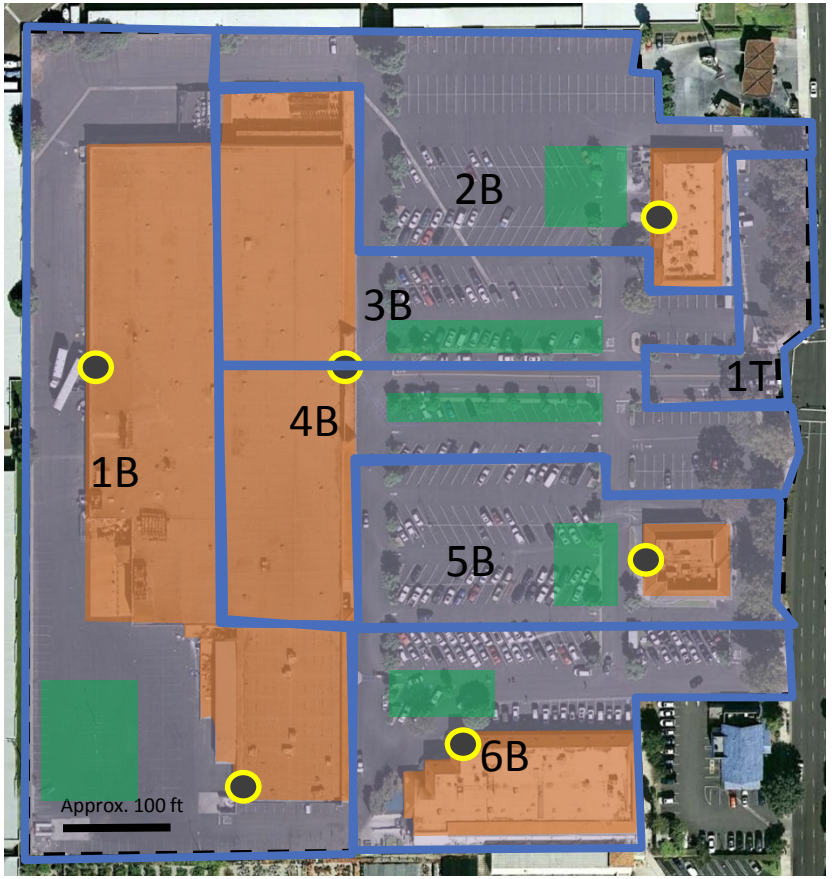


Buildings
Asphalt
Bioretention Areas

Geosyntec consultants

Step 5d: Infiltration Option 1

- Option 1: Distributed Bioretention
  - Determine BMP drainage areas
    - Sub-areas 1B – 6B: Treated by bioretention (INF-3)
    - Sub-area 1T: Grades up from street
      - Difficult to find space for bioretention
      - Treatment Control Measure will be used **(Step 7)**
      - This area will count as Project EIA

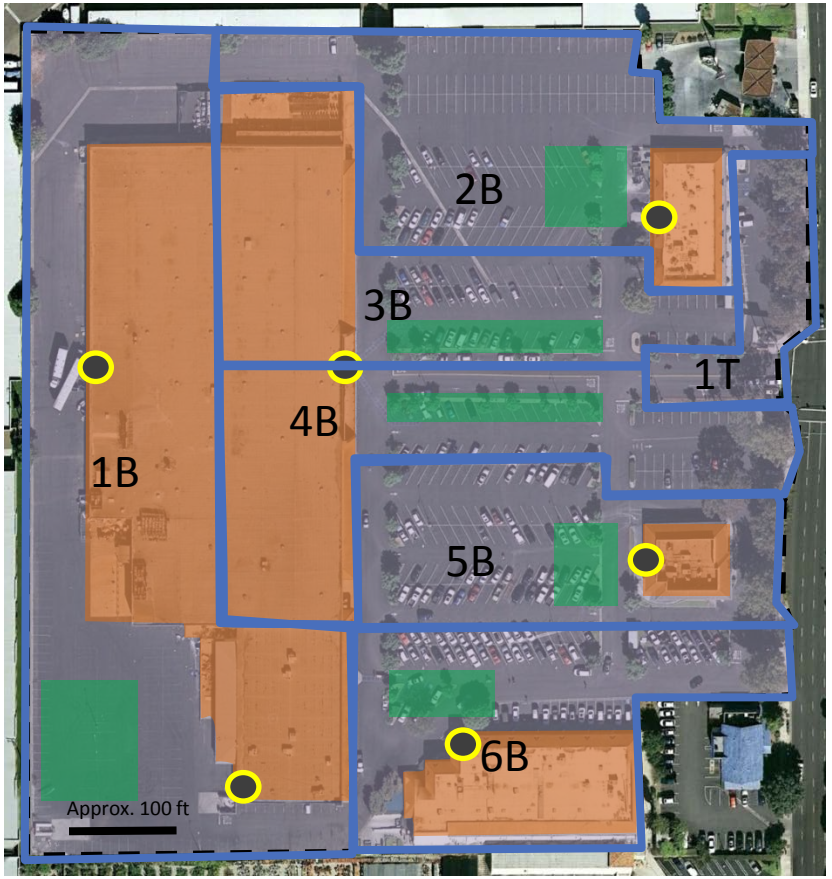


Buildings
Asphalt
Bioretention Areas
Roof Drain

Geosyntec consultants

Step 5d: Infiltration Option 1

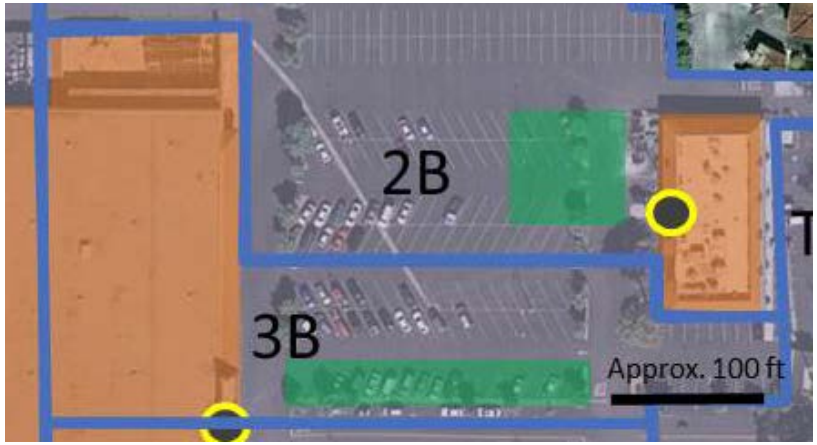
- Also consider drainage infrastructure and pretreatment needed
  - Conveyance system
  - Include pretreatment BMPs
    - Catch Basin Inserts Recommended (PT-2)
    - Could also use Hydrodynamic Separators (PT-1)
- Next Step: Size BMPs for tributary area



Geosyntec consultants

Step 5d: Infiltration Option 1

- Sizing Example: Sub-area 3B
  - Bioretention (INF-3)
- Drainage area:
  - ~1.3 Acre = 56,600 ft^2
  - 95% Impervious
    - LUs: Building roof, parking lot area, and some landscaping
- Use INF-3 sizing worksheet (Section E.3)



Buildings
Asphalt
Bioretention Areas
Roof Drain

Geosyntec consultants

Sizing Worksheet

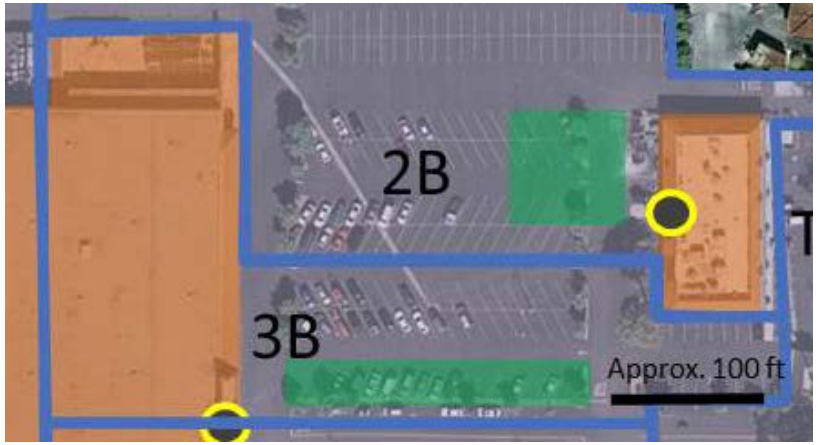
Step 1: Determine water quality design volume	
1-1. Enter Project area (acres), $A_{project}$	$A_{project}$ = acres
1-2. Enter the maximum allowable percent of the Project area that may be effective impervious area (%) (refer to permit), ranges from 5-30%, $\%_{allowable}$	$\%_{allowable}$ = %
1-3. Determine the maximum allowable effective impervious area (acres), $EIA_{allowable} = (A_{project})*(\%_{allowable})$	$EIA_{allowable}$= acres
1-4. Enter Project impervious fraction, *Imp* (e.g. 60% = 0.60)	Imp=
1-5. Determine the Project Total Impervious area (acres), $TIA=A_{project}*Imp$	TIA= acres
1-6. Determine the total area from which runoff must be retained (acres), $A_{retain}=TIA-EIA_{allowable}$	**Area = 56,600 ft²**
1-7. Determine pervious runoff coefficient using Table E-1, C_p	C_p = **0.05**
1-8. Calculate runoff coefficient, $C = 0.95*imp + C_p\ (1-imp)$	C = **0.91**
1-9. Enter design rainfall depth of the storm (in), P_i	P_i = **0.75 in**
1-10. Calculate rainfall depth (ft), $P = P_i/12$	P = **0.0625 ft**
1-11. Calculate water quality design volume (ft³), $SQDV=43560\times C*P*A_{retain}$	SQDV= **3,200 ft³**

Note that Area here is not 100% impervious; BMP must be sized for runoff from impervious and pervious areas on-site

Geosyntec consultants

Step 5d: Infiltration Option 1 Determining Infiltration Rate

- From Ventura County Soils Map: Site Soil Type SxC (Sorrento Silty Clay Loam)
- NRCS Web Soil Data:
  - Hydraulic Conductivity ranges from 1.4 – 4.0 in/hr
    - *http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*



Buildings
Asphalt
Bioretention Areas
Roof Drain

Geosyntec consultants

Step 5d: Infiltration Option 1 Determining Infiltration Rate

Table 6-9: Infiltration Facility Safety Factor Determination Worksheet

Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	3	0.75
		Predominant soil texture	0.25	0.91	0.23
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	2	0.5
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.75
B	Design	Tributary area size	0.25	1	0.25
		Level of pre-treatment/ expected sediment loads	0.25	3	0.75
		Redundancy	0.25	2	0.5
		Compaction during construction	0.25	2	0.5
		Design Safety Factor, $S_B = \Sigma p$			2
		Combined Safety Factor = S_A x S_B			3.5

Note: The minimum combined adjustment factor shall not be less than 2.0 and the maximum combined adjustment factor shall not exceed 9.

Geosyntec consultants

Step 5d: Infiltration Option 1 Determining Infiltration Rate

Step 2: Determine the design percolation rate	
2-1. Enter measured soil percolation rate (in/hr) (0.5 in/hr minimum), $P_{measured}$	$P_{measured}$ = **1.4 in/hr**
2-2. Determine percolation rate correction factor, S_A based on suitability assessment (see Section 6 INF-3)	S_A = **1.75**
2-3. Determine percolation rate correction factor, S_B based on design (see Section 6 INF-3)	S_B = **2**
2-4. Calculate combined safety factor, $S = S_A \times S_b$	S = **3.5**
2-5. Calculate the design percolation rate (in/hr), $P_{design} = P_{measured}/S$	P_{design} = **0.4 in/hr**

Next Step: Calculate required infiltrating area

Geosyntec consultants

Step 3: Calculate Bioretention Infiltrating surface area	
3-1. Enter water quality design volume (ft^3), *SQDV*	SQDV = **3,200 ft^3**
3-2. Enter design percolation rate (in/hr), P_{design}	P_{design} = **0.4 in/hr**
3.3 Enter the required drain time (48 hours), $t_{ponding}$	$t_{ponding}$ = **48 hours**
3-3. Calculate the maximum depth of surface ponding that can be infiltrated within the required drain time (ft): $d_{max} = (P_{design} \times t_{ponding})/12$	d_{max} = **1.6 ft**
3-4. Select surface ponding depth (ft), d_p, such that $d_p \leq d_{max}$	d_p = **1.5 ft**
3-5. Select thickness of amended media (ft,2 feet minimum, 3 preferred), l_{media}	l_{media} = **3 ft**
3-6. Enter porosity of amended media (roughly 25% or 0.25 ft/ft), n_{media}	n_{media}= **0.25**
3-7. Select thickness of optional gravel layer (ft), l_{gravel}	l_{gravel} = **N/A**
3-8. Enter porosity of gravel (roughly 30% or 0.3 ft/ft), n_{gravel}	n_{gravel}= **N/A**
3-9. Calculate the total effective storage depth of bioretention facility (ft): $d_{effective} \leq (d_p + n_{media}l_{media} + n_{gravel}l_{gravel})$	$d_{effective}$= **2.25 ft**

Geosyntec consultants

Step 5d: Infiltration Option 1 Calculating Infiltrating Area

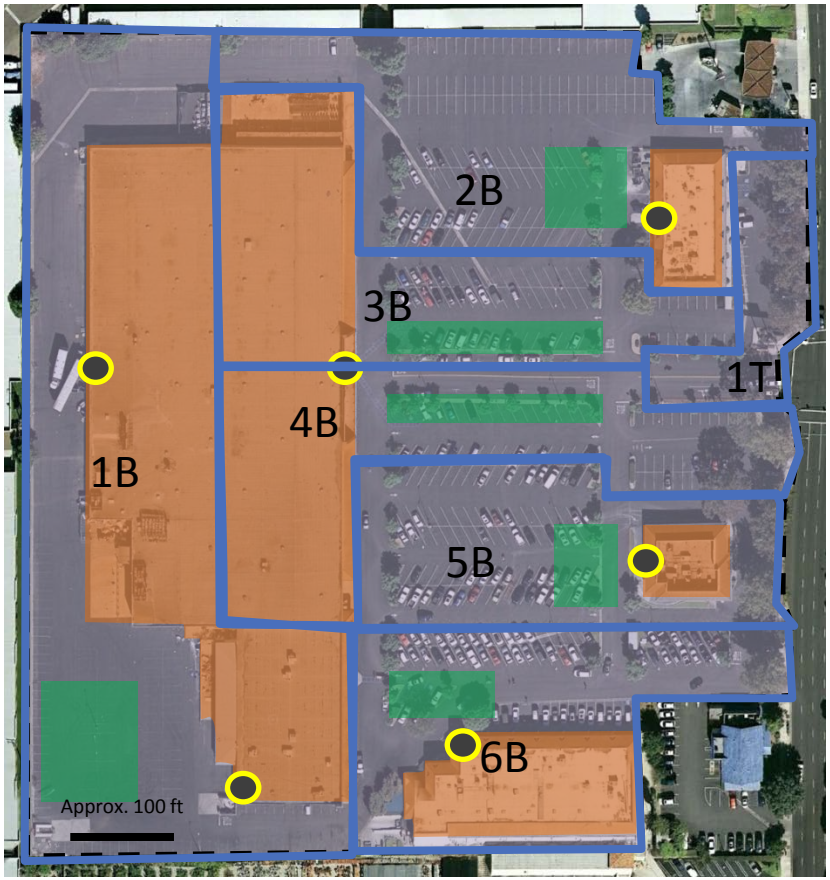
3-10. Check that the entire effective depth infiltrates in required drainage time, 96 hours: $t_{total} = (d_{effective}/P_{design}) \times 12$ If t_{total} > 96 hours, reduce surface ponding depth and/or amended media thickness and/or gravel thickness and return to 3-4. If $t_{total} \leq$ 96 hours, proceed to 3-11.	t_{total} = **54 hours**
3-11. Calculate the required infiltrating surface area (ft²): $A_{req} = SQDV/d_{effective}$	A_{req} = **1,420 ft²**

Buildings
Asphalt
Bioretention Areas
Roof Drain

Geosyntec consultants

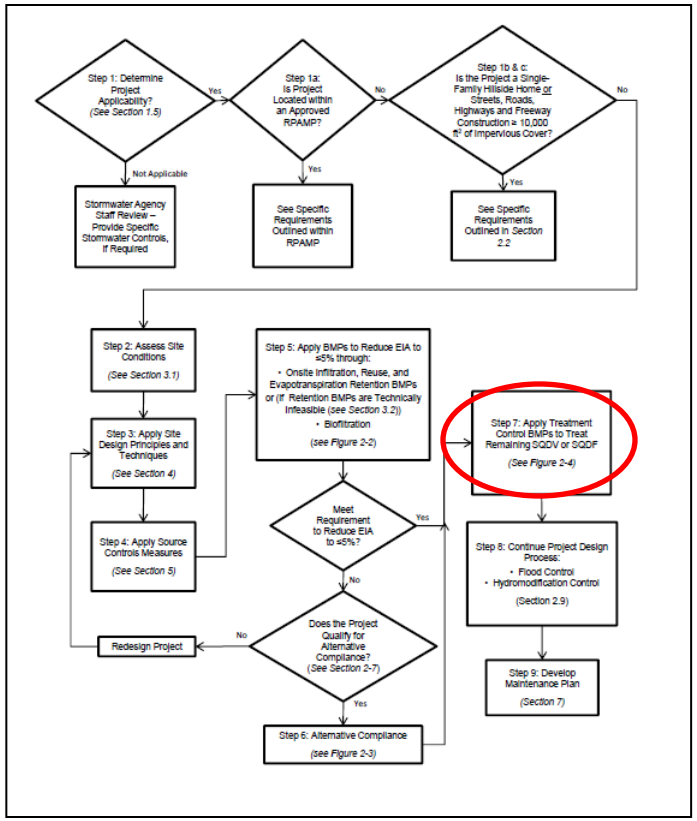
Step 5d: Infiltration Option 1

- Repeat sizing procedure for sub-areas 1B, 2B, 4B, 5B, and 6B
- Ensure that ($SQDV_{1B}$ + $SQDV_{2B}$+ $SQDV_{3B}$ + $SQDV_{4B}$ + $SQDV_{5B}$ + $SQDV_{6B}$) ≥ V_{retain}



Step 7: Apply Treatment Control BMPs to Treat Remaining SQDV

- Continue to **Step 7** to size treatment control measure for 1T – remaining tributary area runoff volume
  - Selection of appropriate TCM (Section 3.3 of TGM)
  - Determine Primary POCs
    - Sediment, Oil & Grease, and Trash
  - Discharge to an Impaired Waterbody?
    - EPA MyWATERS Mapper (303(d) listed receiving waters)
    - SCR Reach 1 Impaired for Toxicity



Geosyntec consultants

Step 7: Apply Treatment Control BMPs to Treat Remaining SQDV

- Select TCM that addresses pollutant causing impairment
  - Table 3-4 of TGM (a portion is shown ->)
  - Toxicity not listed
  - Surrogates: Metals, Pesticides
  - Cartridge Media Filter (TCM-5) acceptable for these POCs

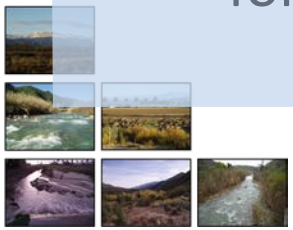
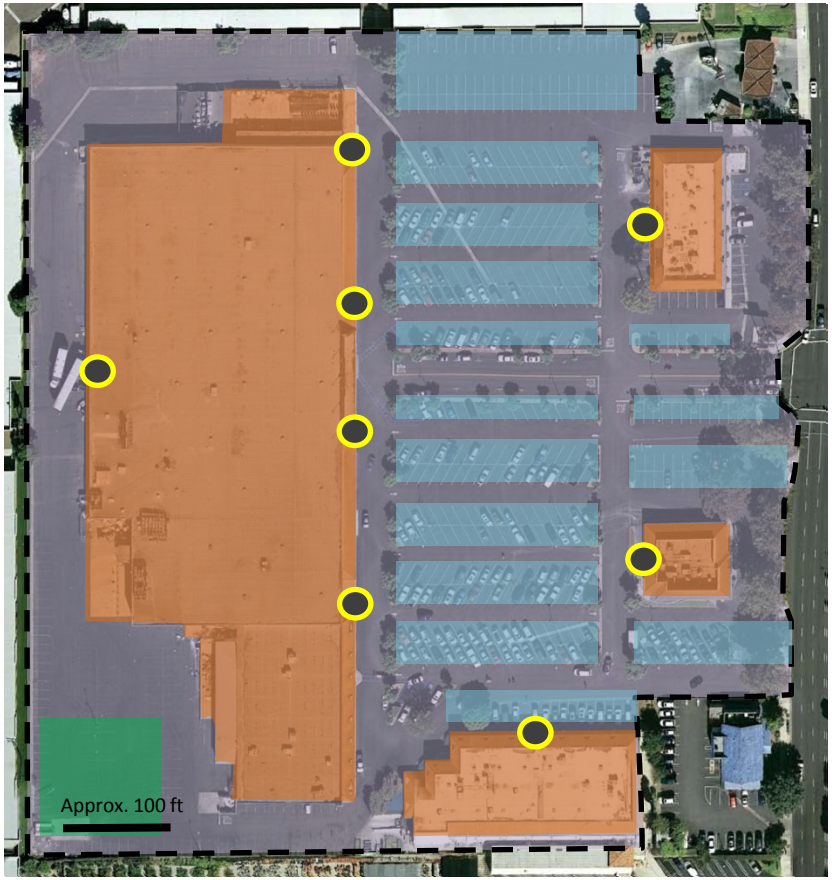


Table 3-4: Treatment Control Measures for Addressing Pollutants of Concern

Class of Pollutant	Recommended BMPs (in Order of Performance)
Sediment	1. Retention BMPs (Infiltration, Rainwater Harvesting, and Evapotranspiration BMPs) 2. Any of the following BMPs(equivalent performance): a. Biofiltration BMPs b. Wet Detention Basin c. Constructed Wetland d. Sand Filter/Cartridge Media Filter 3. Dry Extended Detention Basin
Metals / Metalloids	1. Retention BMPs (Infiltration, Rainwater Harvesting, and Evapotranspiration BMPs) 2. Any of the following BMPs (equivalent performance): a. Constructed Wetland b. Biofiltration BMPs c. Wet Detention Basin d. Sand Filter/Cartridge Media Filter 3. Dry Extended Detention Basin
Nutrients[1]	1. Retention BMPs (Infiltration, Rainwater Harvesting, and Evapotranspiration BMPs) 2. Any of the following BMPs (equivalent performance): a. Bioinfiltration b. Wet Detention Basin c. Constructed Wetland 3. Any of the following BMPs (equivalent performance): a. Biofiltration BMPs 4. Any of the following (equivalent performance): a. Sand Filter/Cartridge Media Filter b. Dry Extended Detention Basin
Pesticides[2]	1. Source controls, erosion controls 2. Retention BMPs (Infiltration, Rainwater Harvesting, and Evapotranspiration BMPs) 3. Any of the following BMPs (equivalent performance): a. Biofiltration BMPs b. Wet Detention Basin c. Constructed Wetland d. Sand Filter/Cartridge Media Filter 4. Dry Extended Detention Basin

Step 5d: Selecting and Sizing BMPs
Infiltration BMP Options

- Infiltration Option 1: Distributed Bioretention
- Infiltration Option 2: Permeable Pavement

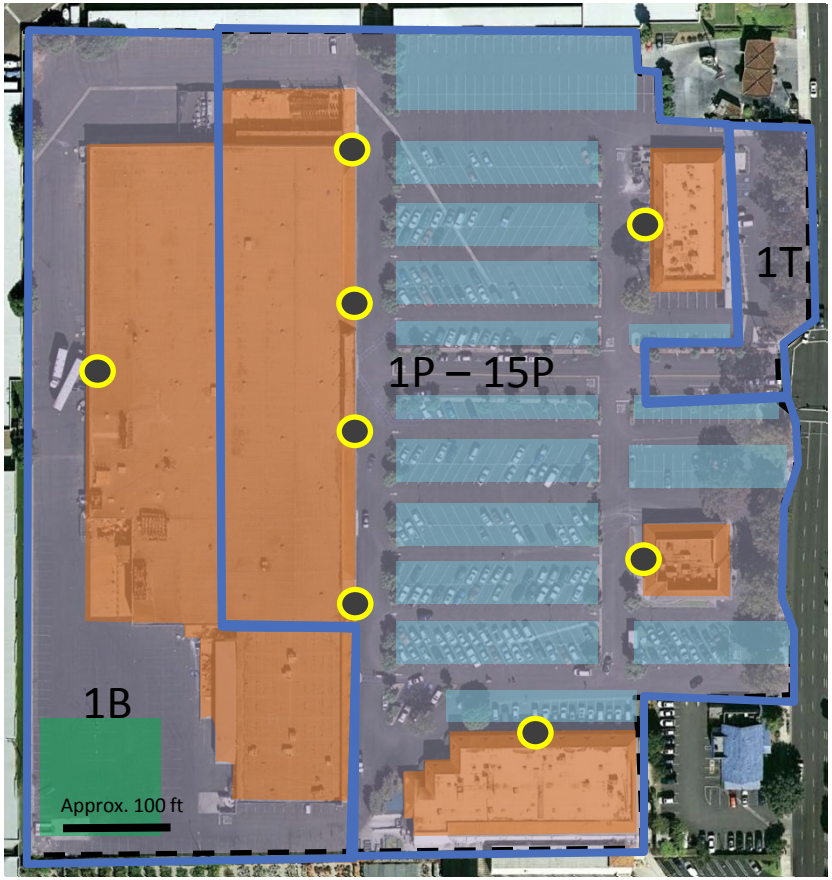


Buildings
Asphalt
Permeable Pavement
Roof Drain

Geosyntec consultants

Step 5d: Infiltration Option 2

- Parking stalls constructed with permeable pavement
  - Sub-areas 1P-15P (not individually delineated)
    - Lanes sheet flow into stalls or piped via catch basins
    - Roof runoff piped to porous pavement
  - Pretreatment should be implemented:
    - Roof runoff => ex: planter boxes (BIO-2)
    - Piped lane runoff => catch basin inserts (PT-2)

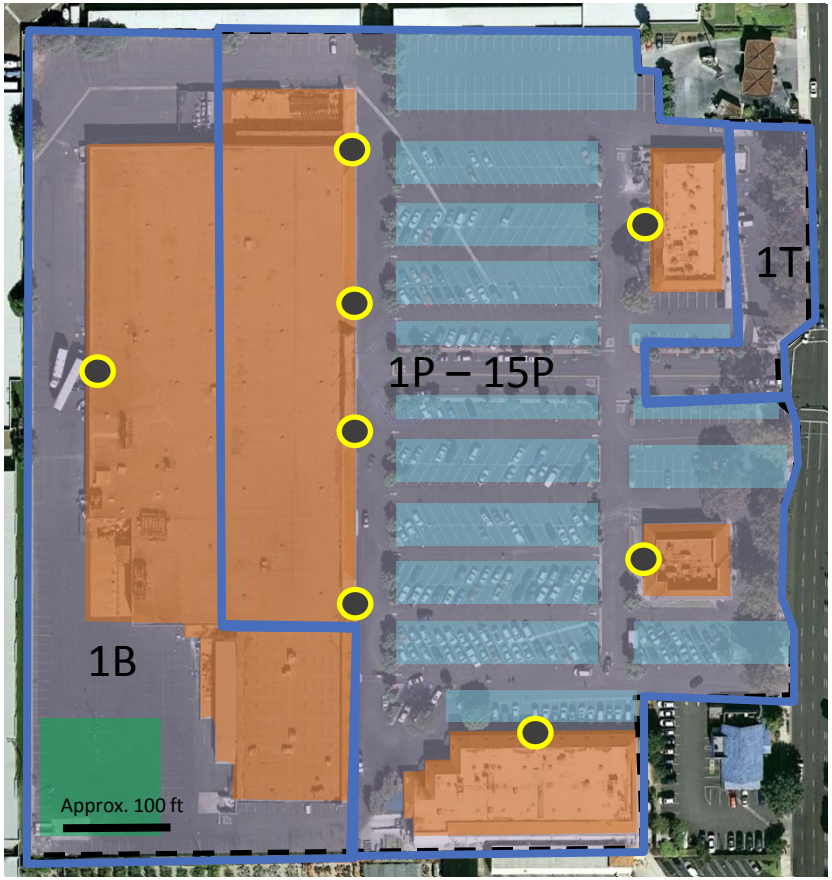


Buildings
Asphalt
Permeable Pavement
Roof Drain

Geosyntec consultants

Step 5d: Infiltration Option 2

- Loading dock area drains to bioretention
  - Permeable pavement not recommended for high traffic load area
  - Drainage sub-area 1B
- Entry road treated by cartridge media filter
  - Space constraints
  - Drainage sub-area 1T (Project EIA)

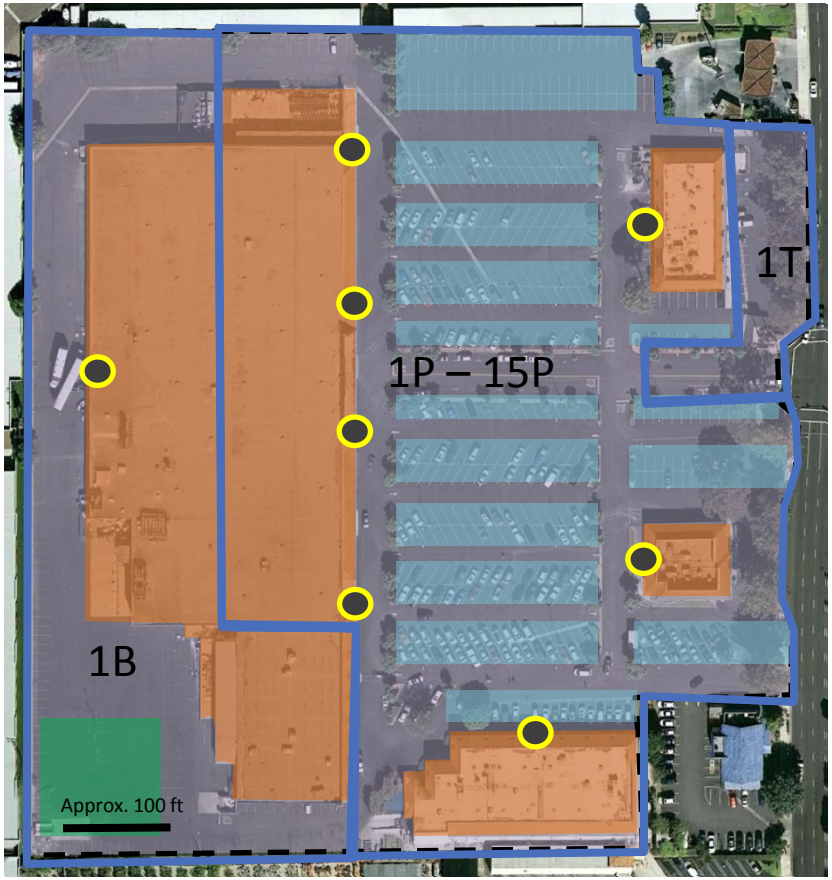


Buildings
Asphalt
Permeable Pavement
Roof Drain

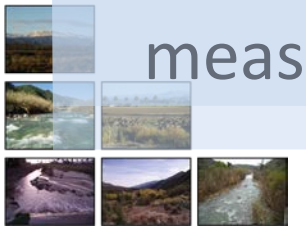
Geosyntec consultants

Step 5d: Infiltration Option 2

- Size permeable pavement for drainage areas P1- P15
- Size bioretention for area B1
- Ensure that:
  - $(SQDV_{1P} + \ldots + SQDV_{15P} + SQDV_{1B}) \geq V_{retain}$
- Continue to **Step 7** to size treatment control measure for 1T



Buildings
Asphalt
Permeable Pavement
Roof Drain



Geosyntec consultants

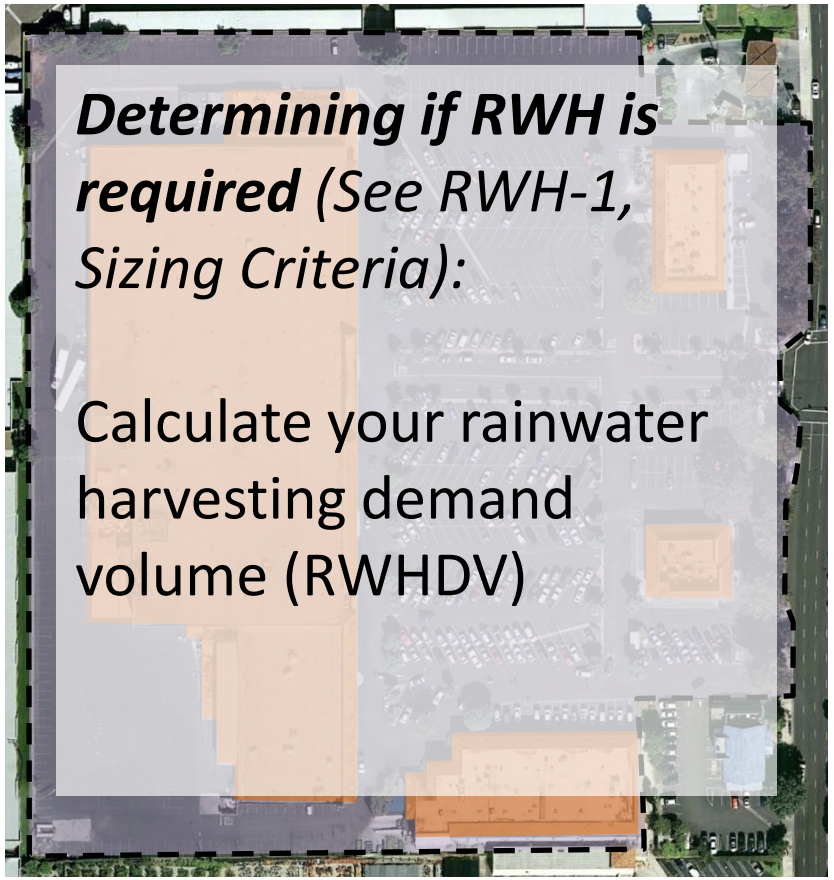
Step 5d: Selecting and Sizing BMPs
Rainwater Harvesting and Evapotranspiration BMPs

BMP	Recommended	Possible	Not Recommended	Notes
RWH-1: Rainwater Harvesting		**X**		Possible to capture runoff from roof and use for non-potable water demand ***IF*** there is enough demand
ET-1: Green Roof		**X**		Possible to install green roof above Kmart facility
ET-2: Hydrologic Source Controls		**X**		Possible to implement some hydrologic source controls

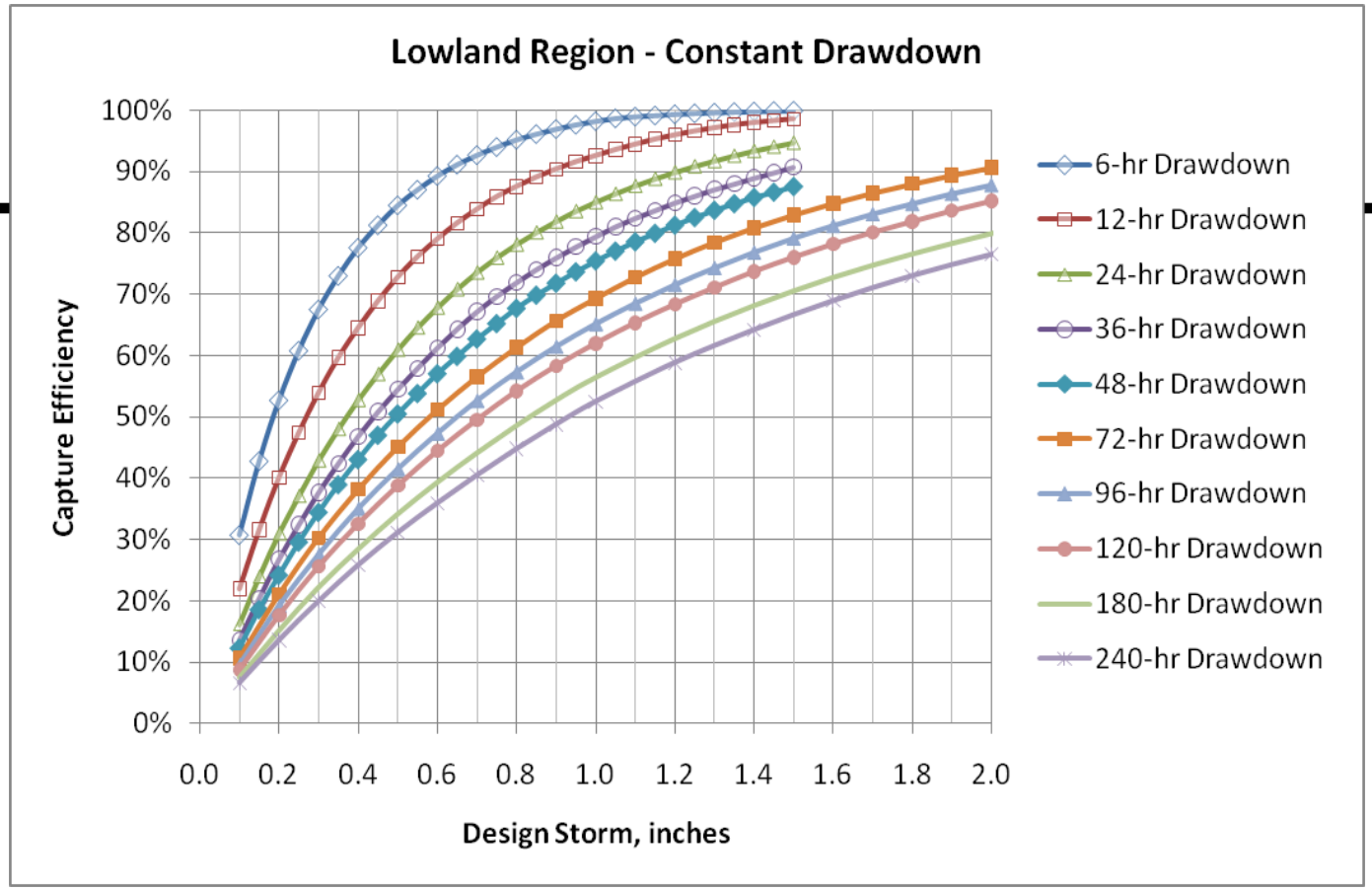
Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
Rainwater Harvesting and Evapotranspiration BMPs

- Rainwater Harvesting Option
- Evapotranspiration Option: Green Roof

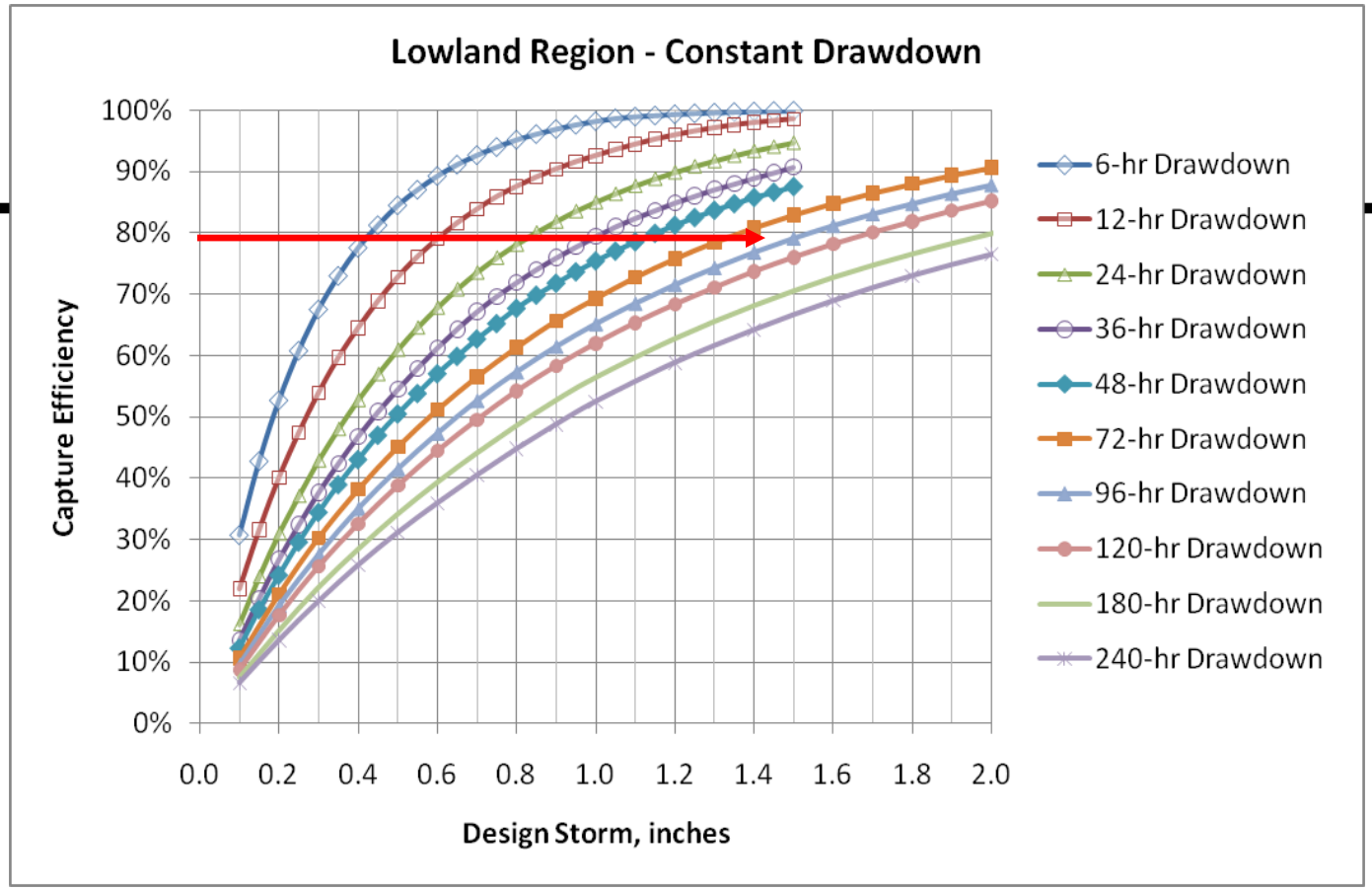


Geosyntec consultants



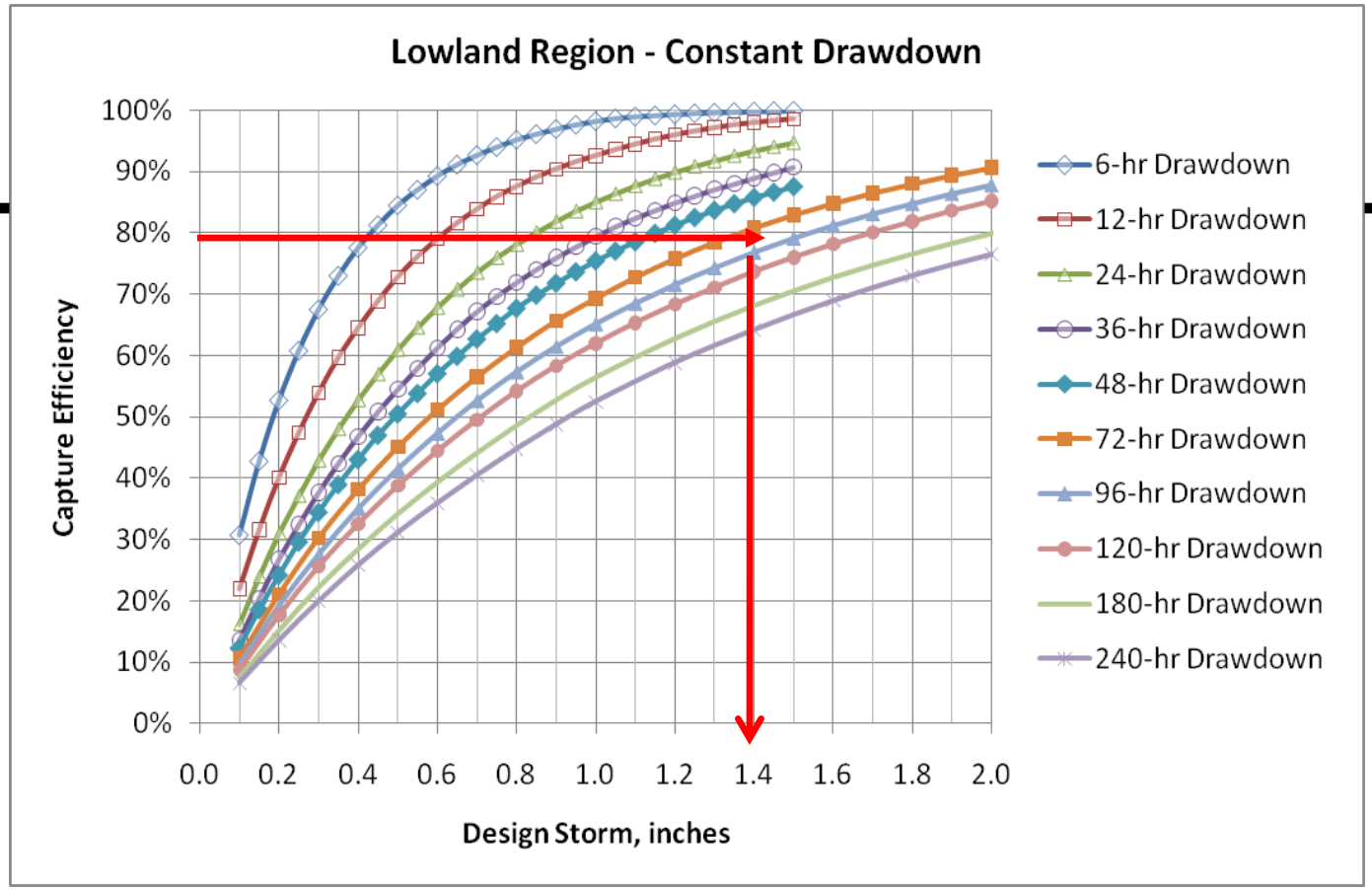
- RWHDV = $C*(d_{design}/12)*A_{retain}$
- Determine your d_{design}
- d_{design} used for feasibility purposes only

Geosyntec consultants



- d_{design} is the design storm (inches) which achieves 80% drawdown in 72 hours

Geosyntec consultants



- d_{design} = 1.4 inches

Geosyntec consultants

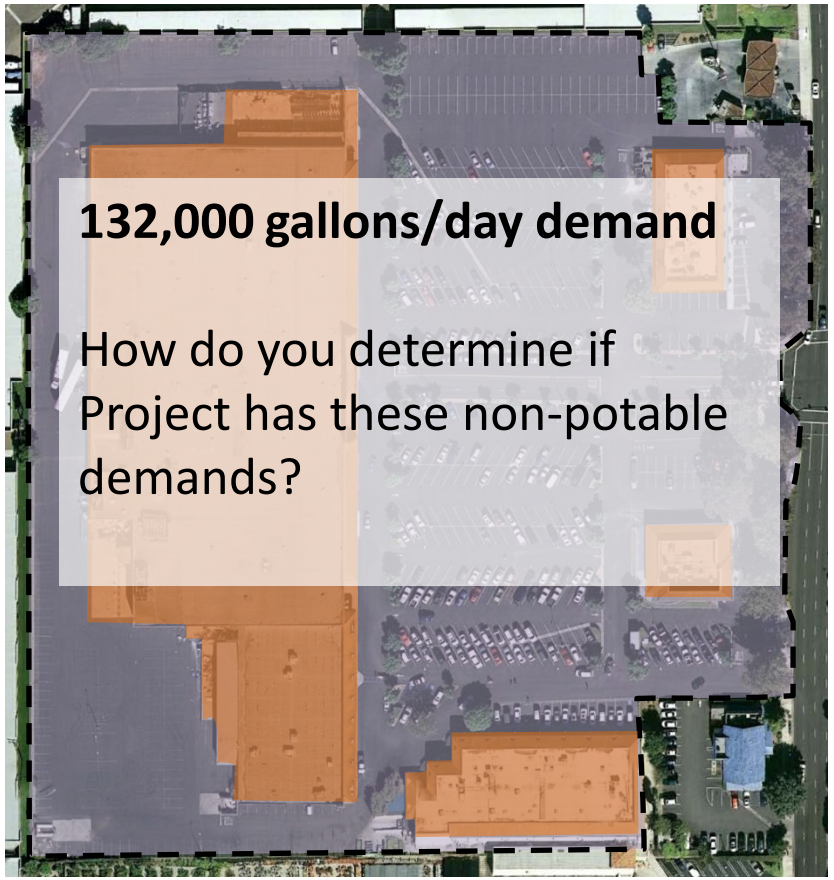
Step 5d: Selecting and Sizing BMPs
Rainwater Harvesting and Evapotranspiration BMPs

- RWHDV = 0.95*11 ac*[1.4 in/12 (in/ft)]
  - RWHDV = 1.2 ac-ft
- Demand = [RWHDV/(72 hours /24 (hours/day))] * (325,851 (gal/ac-ft))
  - Demand = 132,000 gal
- How do you determine your demand?

Geosyntec consultants

Step 5d: Rainwater Harvesting Option

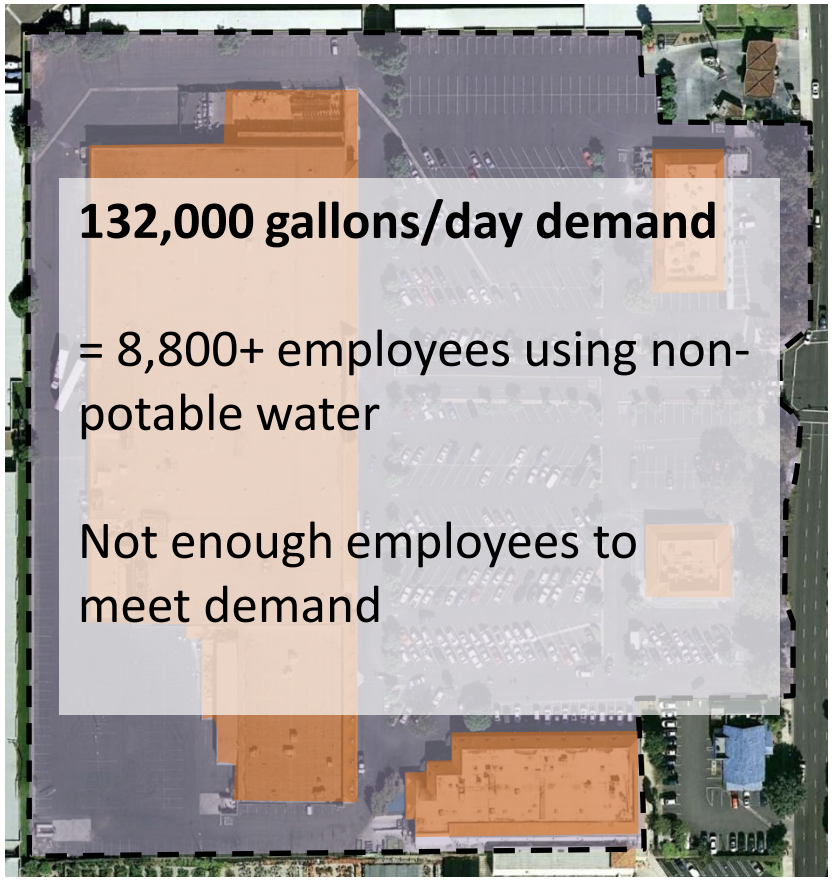
- *References:*
  - Outdoor Demand-
    - Water Efficient Landscape Ordinance AB1881 http://www.water.ca.gov/wateruseefficiency/landscapeordinance/
    - WUCOLS – Water Use Classification of Landscape Species, UC Davis
  - Indoor Demand –
    - *"Waste not, Want not…"* Report, Pacific Institute, 2003
  - Use site specific Information if available



Geosyntec consultants

Step 5d: Rainwater Harvesting Option

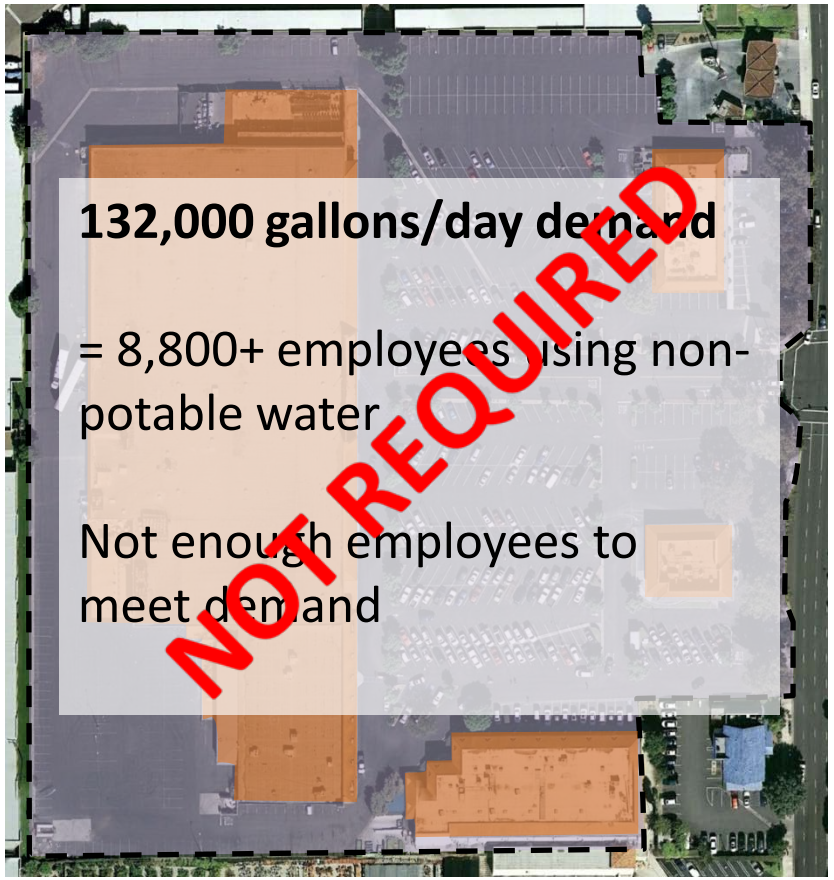
- Determining Demand
  - No outdoor demand on site
  - Indoor Demand
    - Using Pacific Institute information, average non-potable per capita use per day for commercial buildings (for employees) ~ 15 gallons
    - To meet demands, would need **8,800+ employees** using non-potable water



Geosyntec consultants

Step 5d: Rainwater Harvesting Option

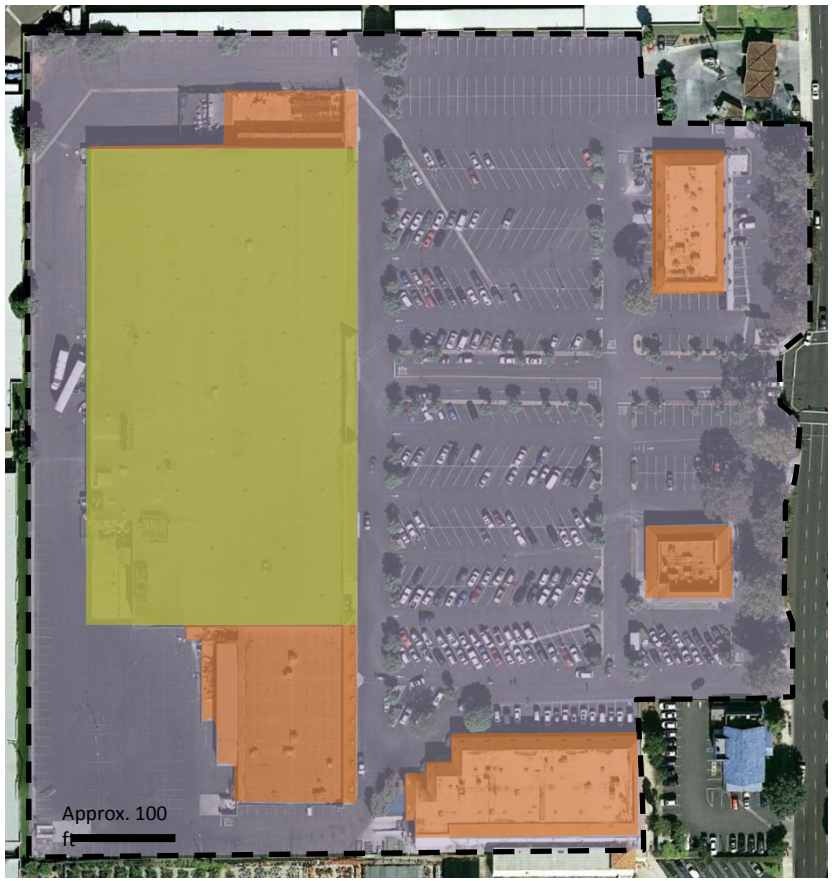
- Determining Demand
  - No outdoor demand on site
  - Indoor Demand
    - Using Pacific Institute information, average non-potable per capita use per day for commercial buildings (for employees) ~ 15 gallons
    - To meet demands, would need **8,800+ employees** using non-potable water



Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
Rainwater Harvesting and Evapotranspiration BMPs

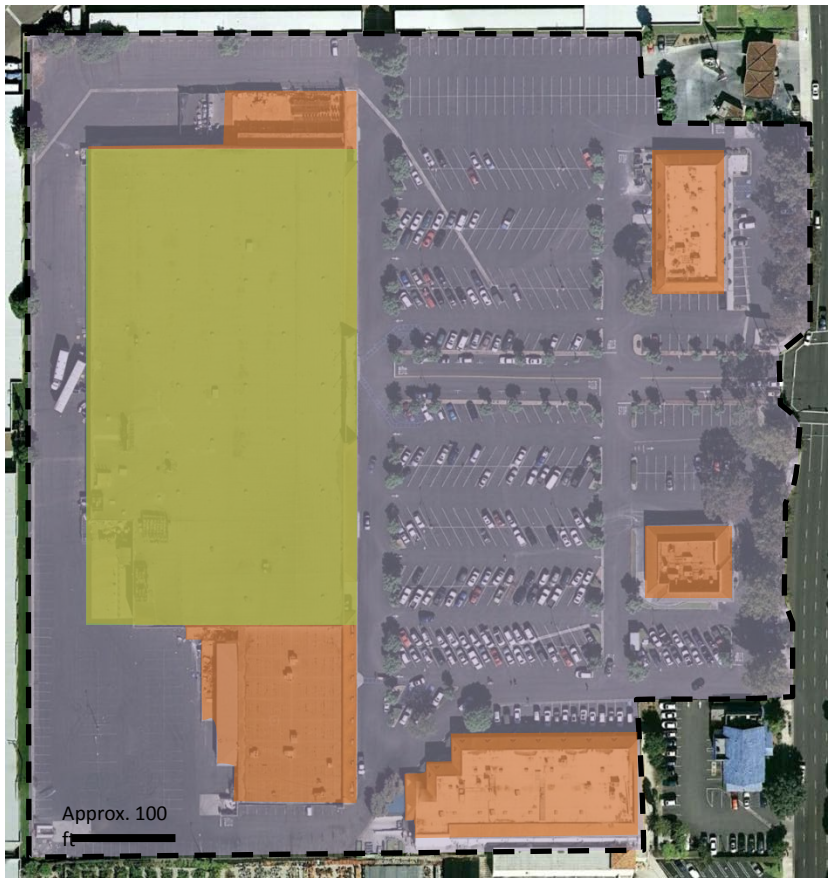
- Rainwater Harvesting Option
- Evapotranspiration Option: Green Roof

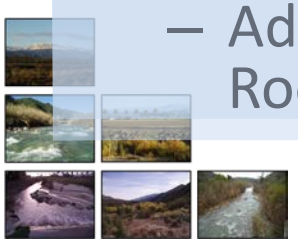


Geosyntec consultants

Step 5d: Evapotranspiration Option

- Area considered pervious where green roof (ET- 1) is located
- Adding a green roof changes:
  - A_{retain} calc (Step 5b)
  - V_{retain} calc (Step 5c)
  - EIA limit does not change = 0.6 Acres
  - Site: 12.2 Acres; 95% Impervious
  - Adding 2.5 Acre Green Roof (100% pervious)

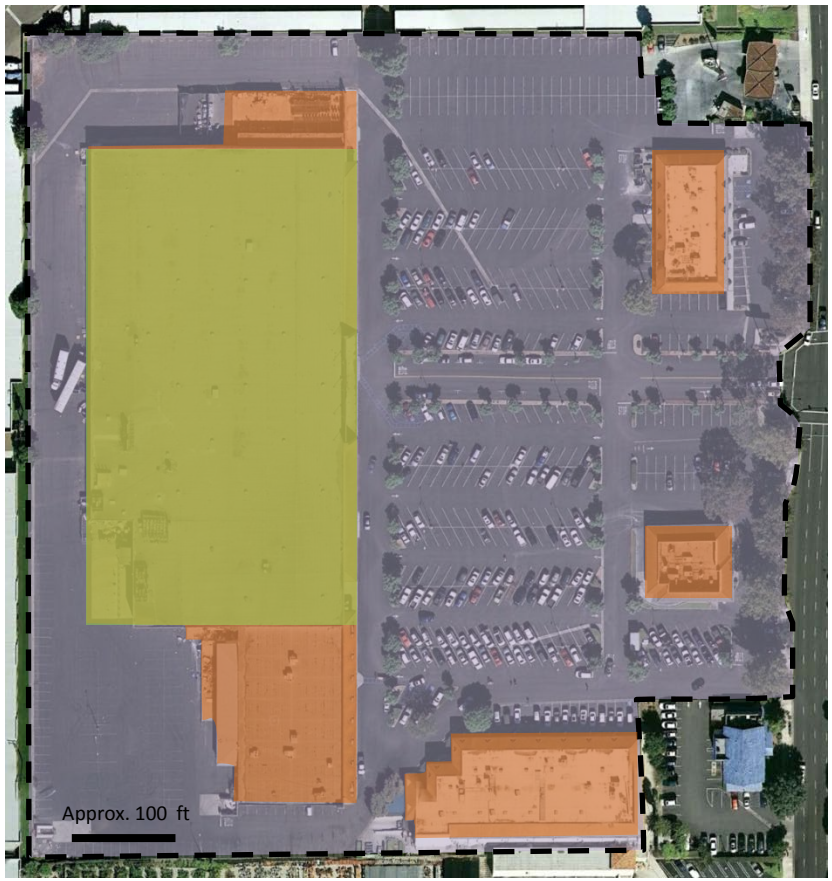




Geosyntec consultants

Step 5d: Evapotranspiration Option

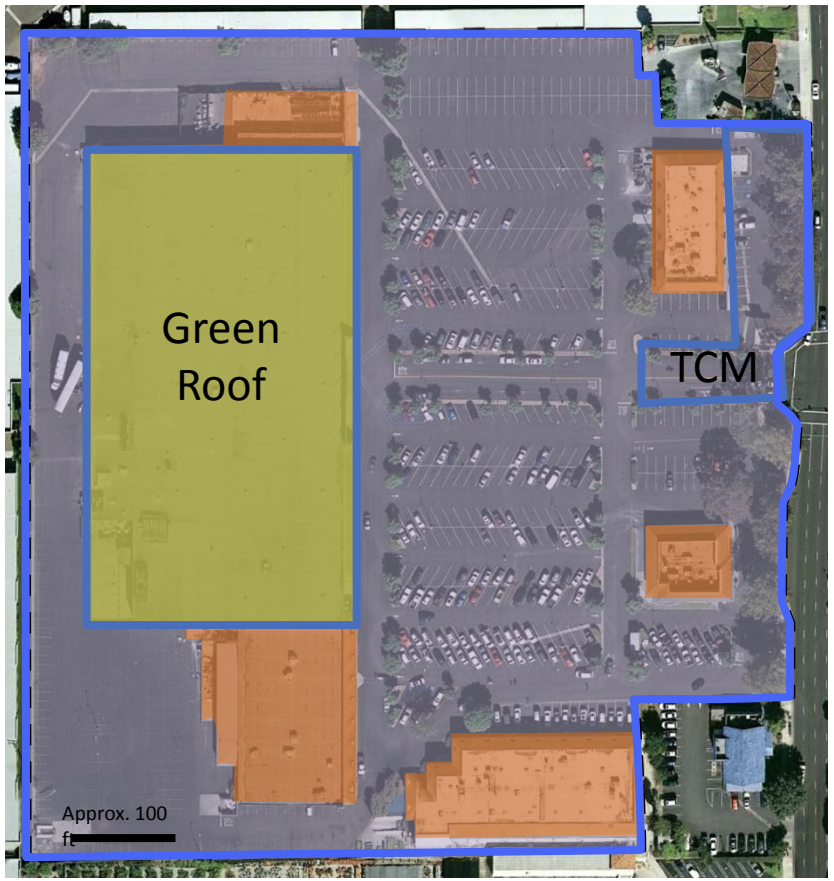
- New A_{retain}/V_{retain}:
  - New A_{retain} = (12.2 acres)*(0.95) – 2.5 acres – 0.6 acres
    - **A_{retain} = 8.5 Acres**
  - New V_{retain} = (0.95)*(8.5 acres)*(0.75 in/12 (in/ft)) =
    - **V_{retain} = 0.5 acre-feet**



Geosyntec consultants

Step 5d: Evapotranspiration Option

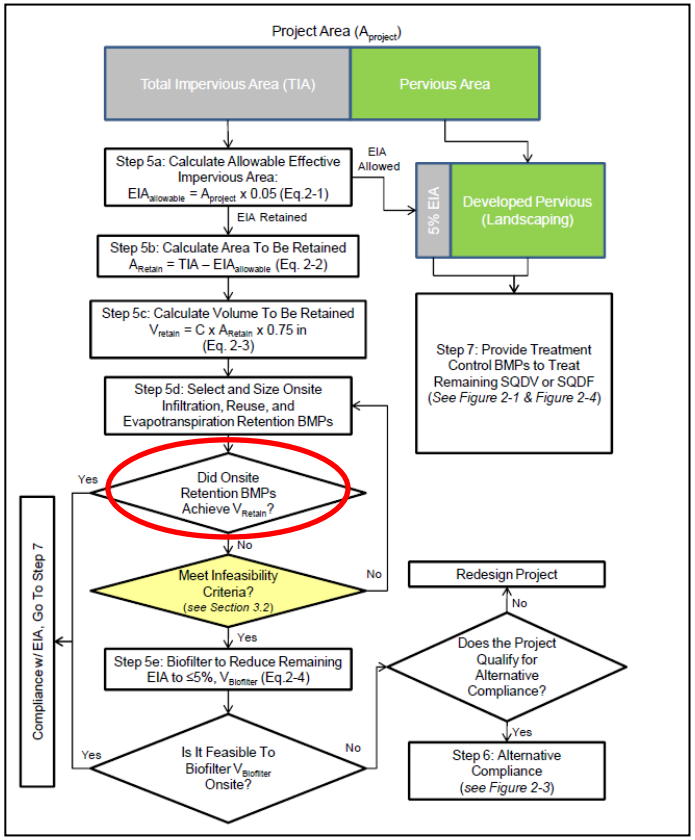
- Like Option 1, determine drainage areas for other proposed BMPs
  - TCM for driveway (Step 7 to determine TCM)
  - Infiltration BMPs should be used for rest of site
- Calculate SQDV for non-TCM BMPs
- $\sum SQDV_{sub\text{-}areas} \geq V_{retain}$

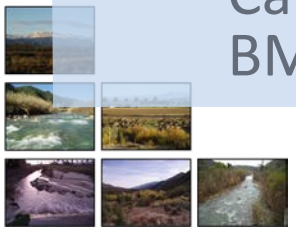


Geosyntec consultants

Step 5d: Selecting and Sizing BMPs

- Infiltration Option 1: Distributed Bioretention
  - Can meet EIA
- Infiltration Option 2: Permeable Pavement
  - Can meet EIA
- Rainwater Harvesting Option
  - Not enough demand
- Evapotranspiration Option: Green Roof
  - Can meet EIA with infiltration BMPs retaining rest of site

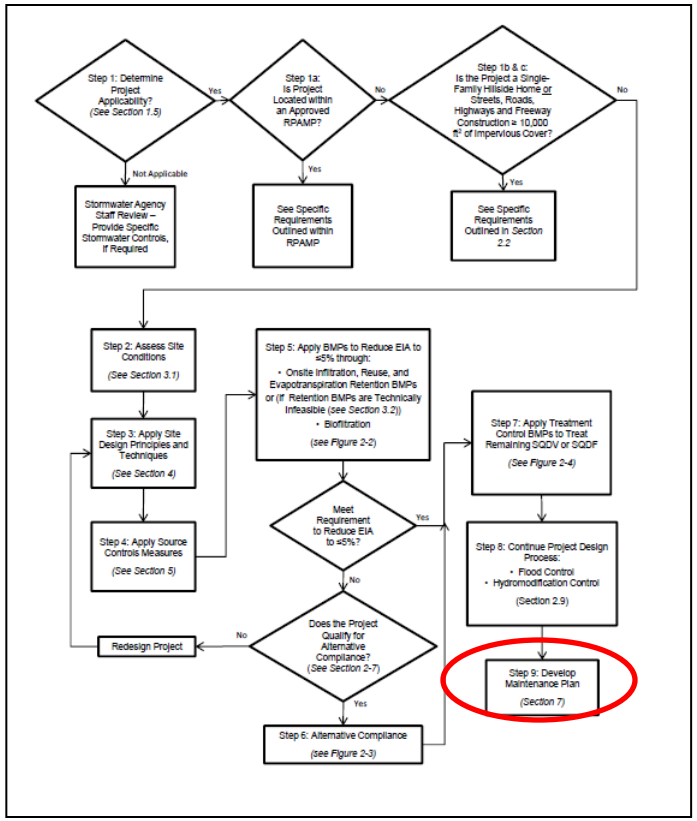




Geosyntec consultants

Step 9: Develop Maintenance Plan

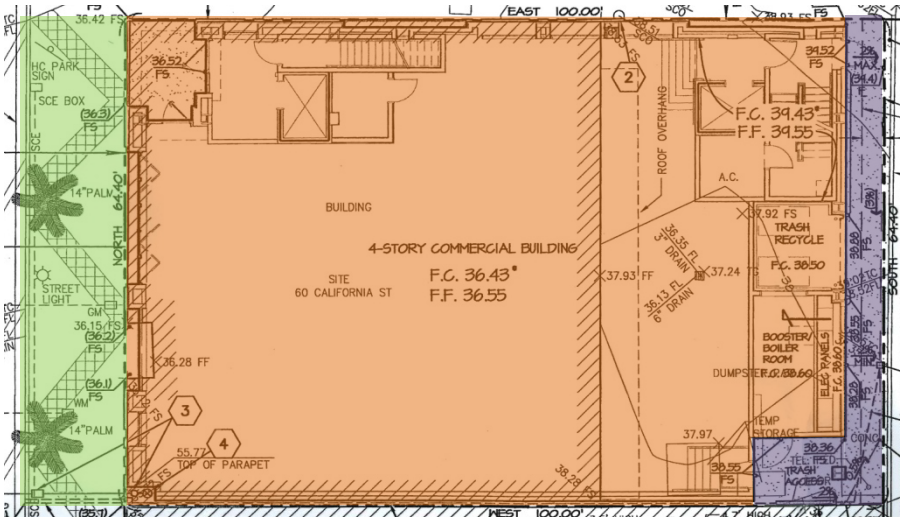
- Submit Maintenance Plan
  - Site Map
  - Baseline Descriptions of BMPs
  - Spill Plan
  - Facility Changes
  - Training
  - Basic Inspection and Maintenance Activities
  - Future Revisions of Pollution Mitigation Measures
  - Monitoring and Reporting Program



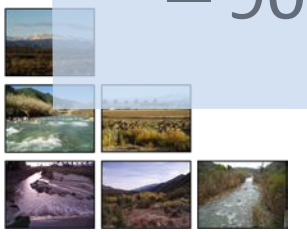
Geosyntec consultants

Scenario 2: Commercial/ Mixed Use

- Project Information:
  - Small lot line to lot line redevelopment
  - Commercial/ Mixed-Use
  - Commercial area along California Street
  - 7,320 ft^2 (<0.2 ac)
  - 90% Impervious



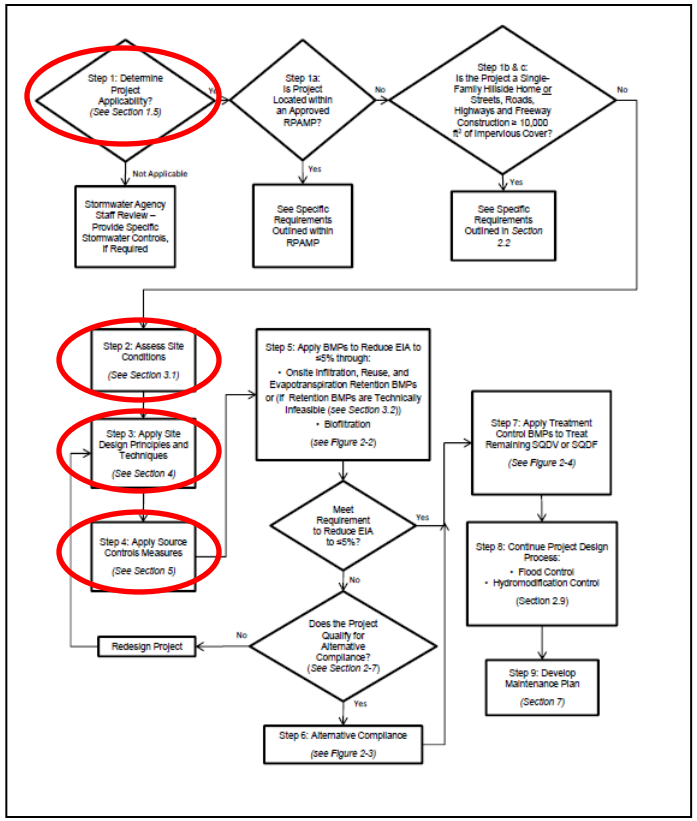
Landscaped Area
Building Area
Concrete Area



Geosyntec consultants

Flow Chart Steps 1-4

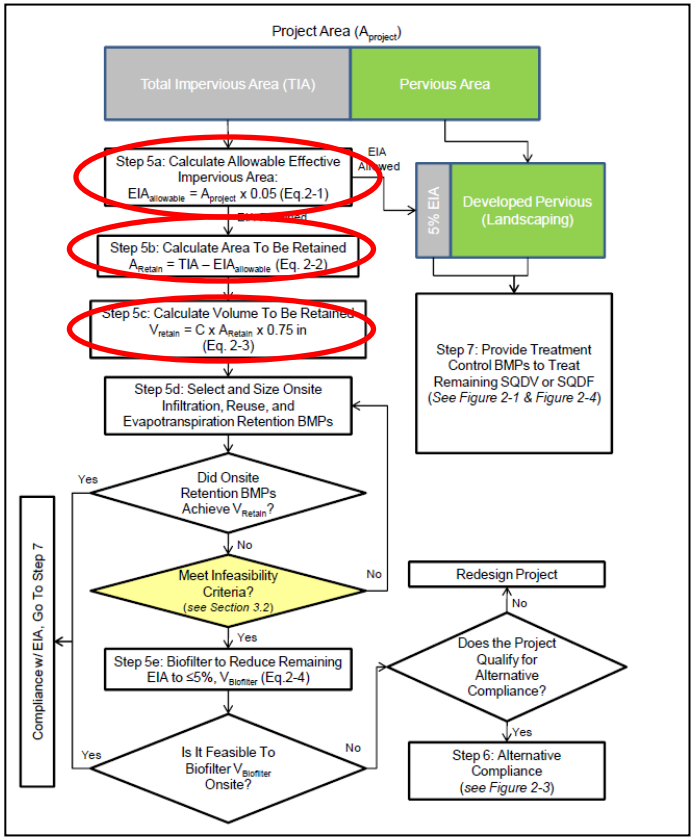
- Step 1: Project meets Applicability
- Step 2: Site Conditions
  - Soil Type 4
- Step 3: Apply Site Design Principles
- Step 4: Apply Source Control Measures

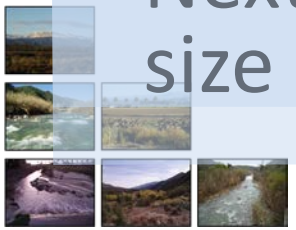


Geosyntec consultants

Flow Chart Step 5a – 5c

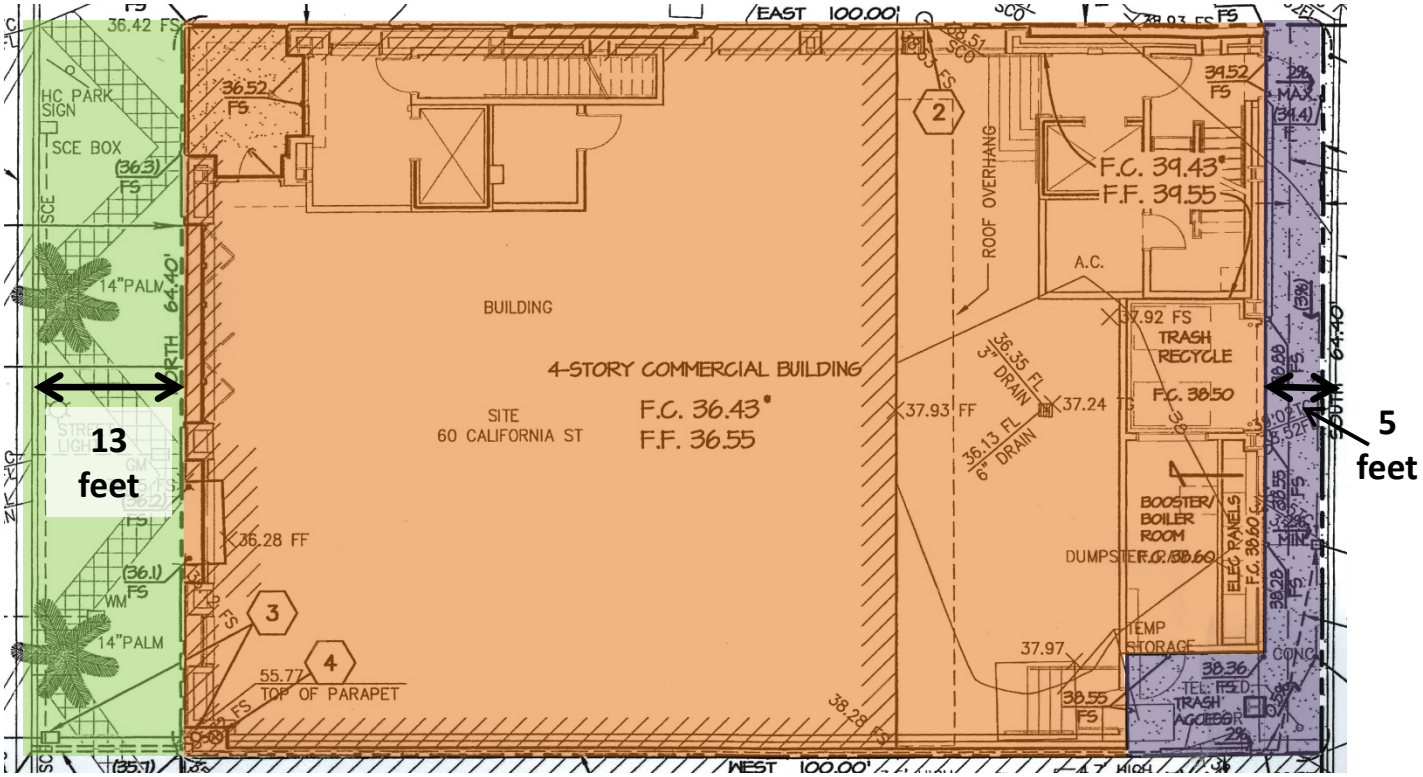
- Step 5a: Calculate EIA
  - EIA = 7,320 ft^2 *0.05 = 370 ft^2
- Step 5b: Calculate A_{retain}
  - A_{retain} = 6,560 ft^2 – 370 ft^2 = 6,190 ft^2
- Step 5c: Calculate V_{retain}
  - V_{retain} = 370 ft^3
- Next: Step 5d – Select and size BMPs





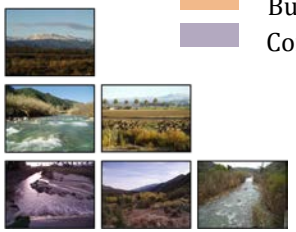
Geosyntec consultants

Step 5d: Select and Size BMPs



Landscaped Area
Building Area
Concrete Area

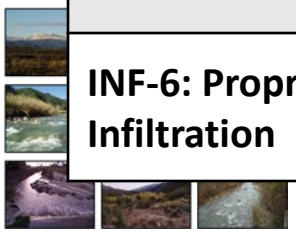
- Infiltration BMPs must be set back at least 8 feet from building foundations



Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
Infiltration BMPs

BMP	Possible	Not Possible/ Recommended	Notes
INF-1: Infiltration Basin		**X**	No space within site
INF-2: Infiltration Trench		**X**	Not enough space for trench/ safety concerns
INF-3: Bioretention		**X**	Available area is too small to implement bioretention (including side slopes)
INF-4: Drywell		**X**	Drywells may fit within site constraints, but would have to be located directly adjacent to street, which is not recommended.
INF-5: Permeable Pavement		**X**	No pavement location located greater than 8 feet from building foundation
INF-6: Proprietary Infiltration		**X**	No large area available for underground proprietary infiltration



consultants

Step 5d: Selecting and Sizing BMPs
RWH/ET BMPs

BMP	Recommended	Possible	Not Recommended	Notes
RWH-1: Rainwater Harvesting		**X**		Possible to capture runoff from roof and use for non-potable water demand ***IF*** there is enough demand
ET-1: Green Roof		**X**		Possible to install green roof on building but this option is not required
ET-2: Hydrologic Source Controls		**X**		Possible to implement some hydrologic source controls

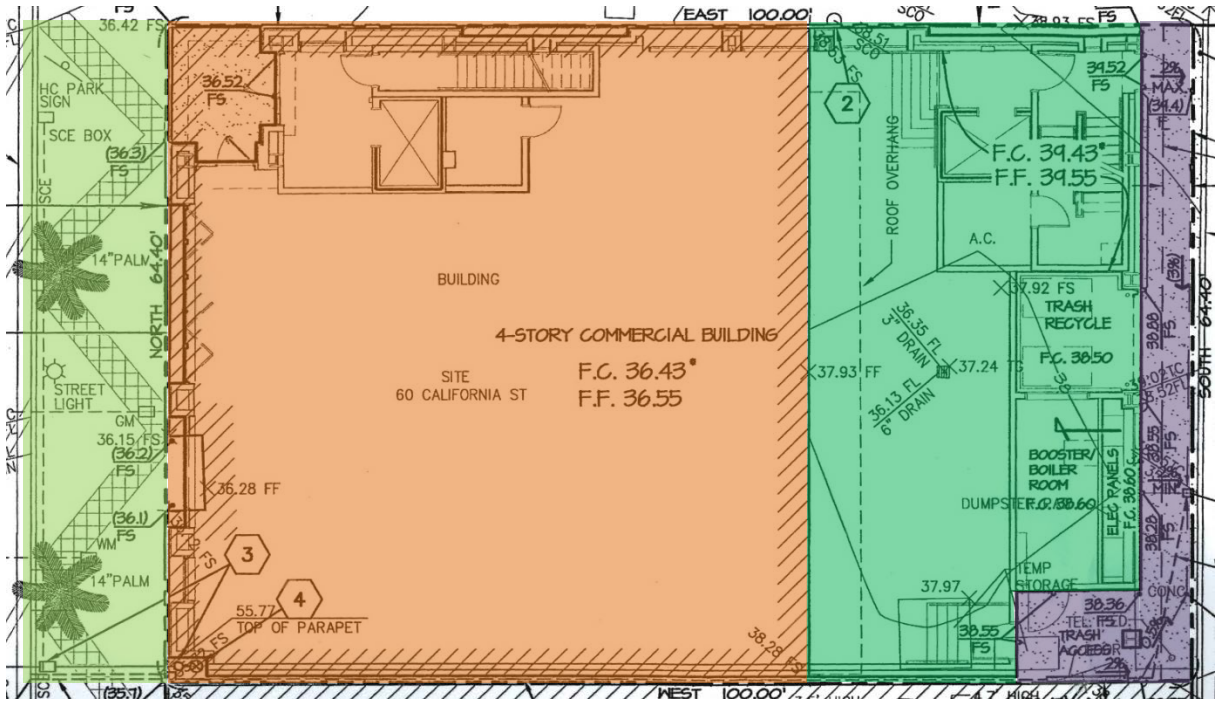
Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
Rainwater Harvesting Option

- Rainwater Harvesting Option
- d_{design} = 1.4 inches
- RWHDV = 690 ft^3
- Daily Demand = [690 ft^3/(72 hrs/24 (hrs/day))]*7.5 (gal/ft^3) = 1,700 gallons/day
- Pacific Institute = 15 gal/employee/day
  - ~110 employees needed to meet demand
- RWH is possible depending on occupancy and should be further investigated

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs Evapotranspiration Option



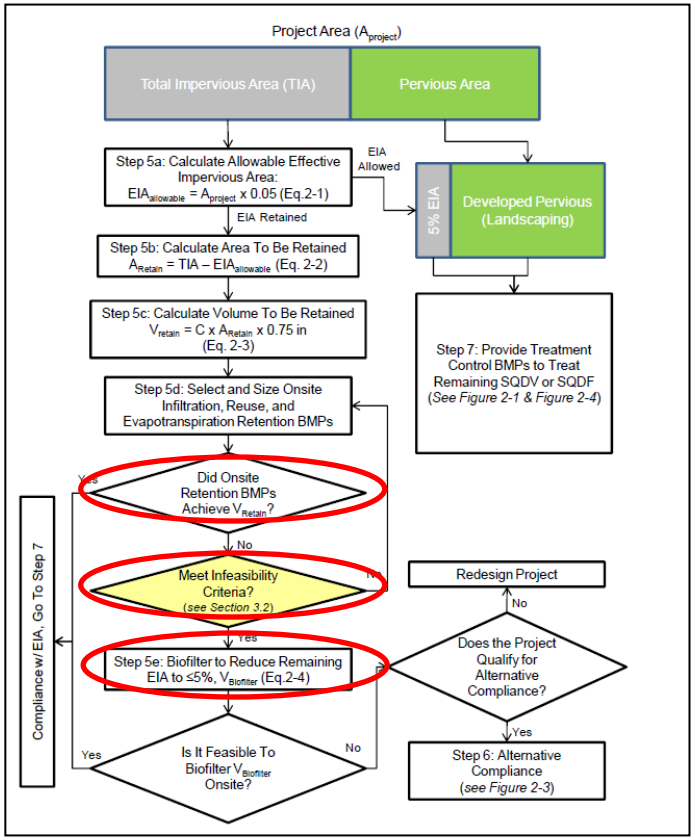
Landscaped Area
Building Area
Green Roof
Concrete Area

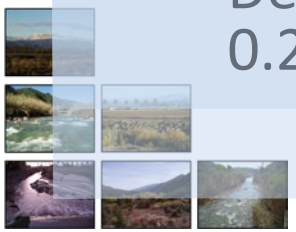
- Install Green Roof (ET-1) on lower portion of Roof
  - Aesthetic benefits
  - Counts as pervious area
- Implement Hydrologic Source Controls (ET-2) for impervious areas within landscaped area

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs Evapotranspiration Option

- Green Roof/ HSC Option
  - Green Roof = 2050 ft^2
  - New A_{retain} = (6560 ft^2 – 2050 ft^2) – 370 ft^2 = 4,140 ft^2
- Impervious area in landscaping treated by HSCs
  - 85 ft^2 treated by HSCs with 1:1 pervious to impervious ratio
  - d_{HSC} = 0.5 inches
    - See ET-2 section for determining d_{HSC}
  - Design storm = 0.75 in – 0.5 in = 0.25 inches





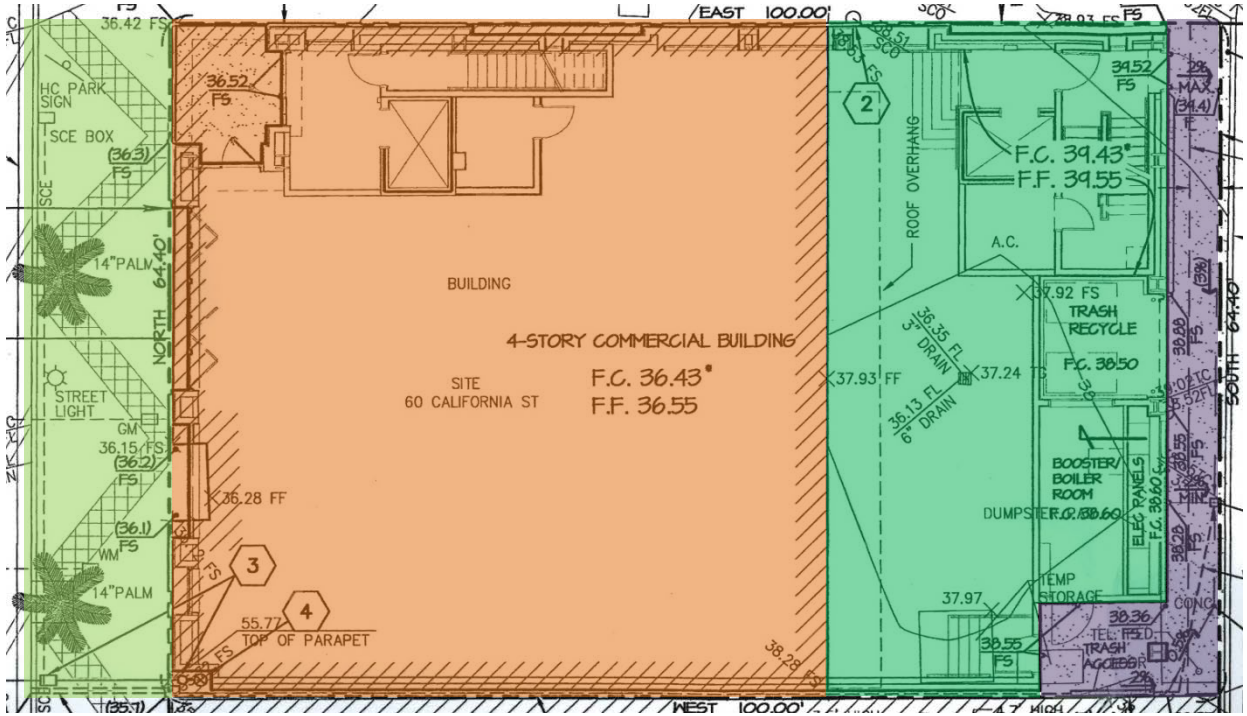
Geosyntec consultants

Step 5d: Selecting and Sizing BMPs Evapotranspiration Option

- New $V_{retain} = C*\{[(A_{retain} - A_{HSC})*0.75\ in)] + [A_{HSC}* 0.25\ in]\}$
  - $V_{retain} = 0.95*\{[(4{,}140\ ft^2 - 85\ ft^2)*(0.75\ in/12\ (in/ft))] + [85\ ft^2*(0.25\ in/12\ (in/ft))]\}$
  - $V_{retain} = 240\ ft^3$
- Infiltration BMPs not possible due to site constraints
  - Step 5e: Biofilter to reduce remaining EIA to ≤ 5%

Geosyntec consultants

Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5%



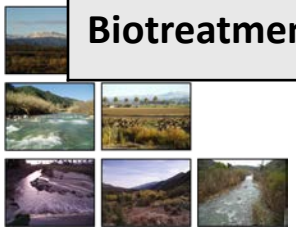
Landscaped Area
Building Area
Green Roof
Concrete Area

- Determine biofilter volume:
  - $V_{biofilter} = (V_{retain} - V_{achieved}) * 1.5$
  - $V_{biofilter} = (240\ ft^3) * 1.5 = 360\ ft^3$

Geosyntec consultants

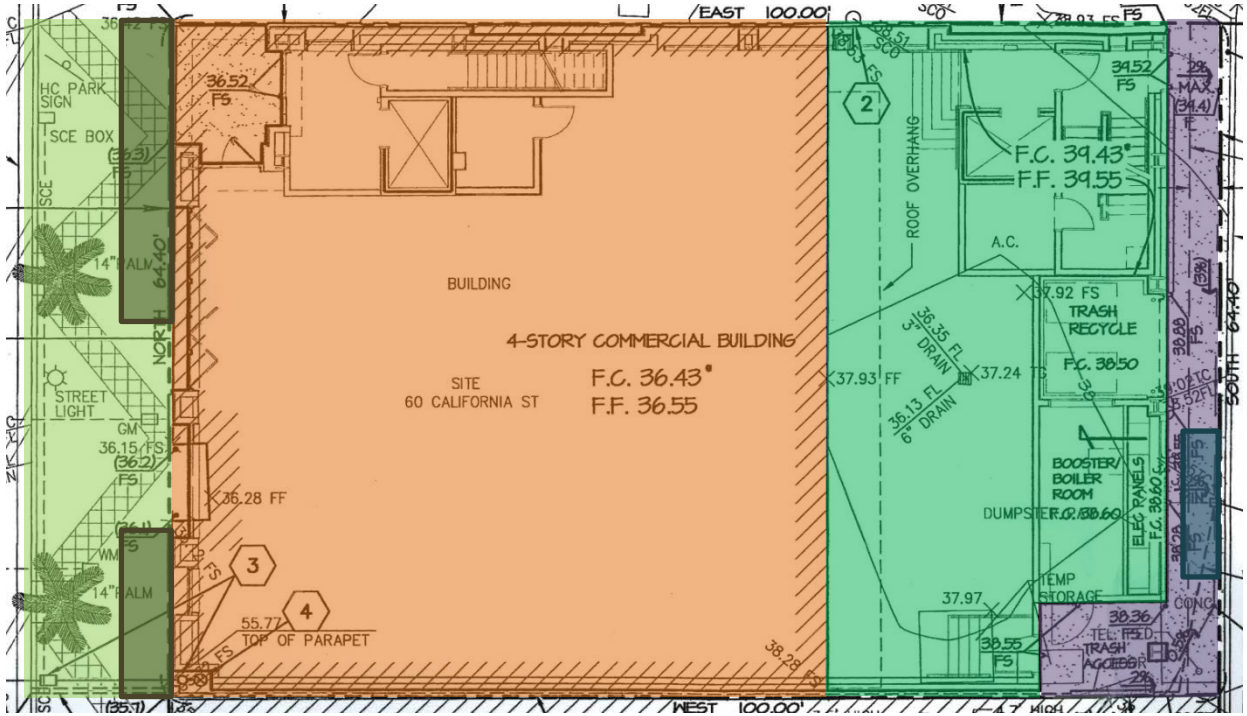
Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5%
Biofilter Selection

BMP	Recommended	Possible	Not Recommended	Notes
BIO-1: Bioretention with Underdrain		**X**		Possible to fit bioretention with underdrain within landscaped area
BIO-2: Planter Box	**X**			Planter boxes are recommended for this site and can be placed next to building
BIO-3: Vegetated Swale			**X**	No space within site
BIO-4: Vegetated Filter Strip			**X**	No space within site
BIO-5: Proprietary Biotreatment	**X**			Proprietary biotreatment is a good option with space constraints



Geosyntec consultants

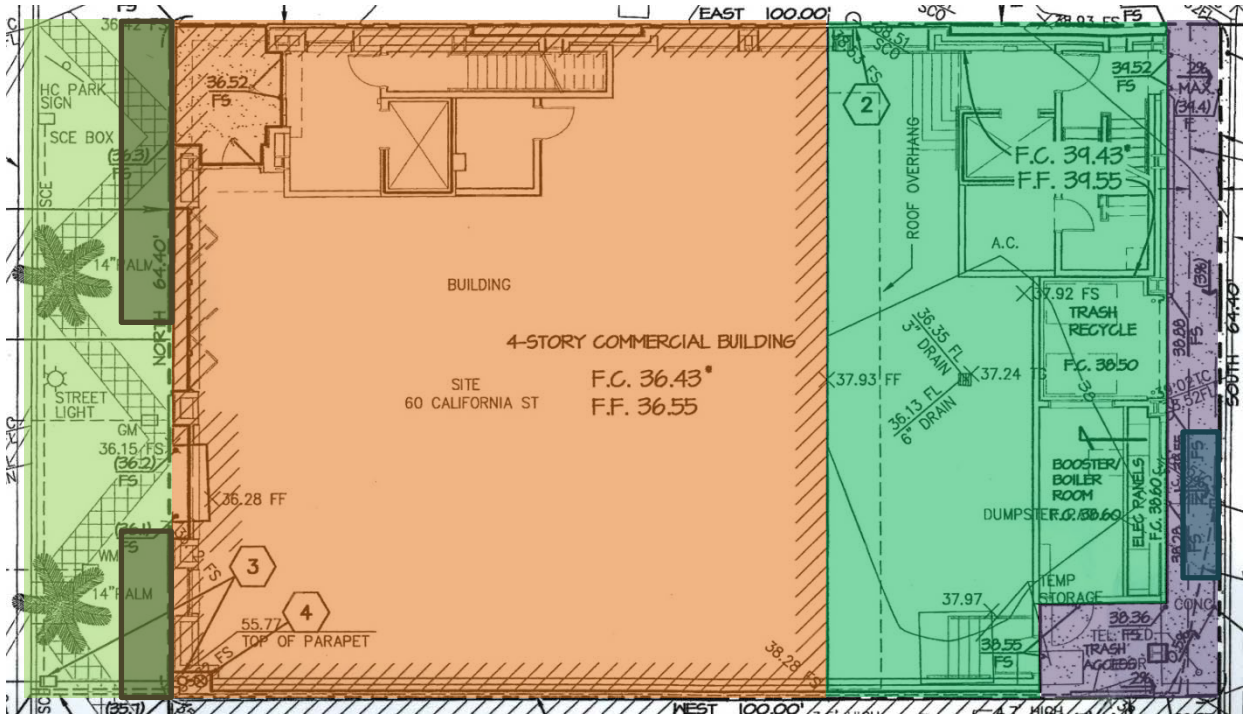
Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5%



- Biofilter Option:
  - Proprietary biotreatment to treat concrete alley SQDF
    - Sized per manufacturer flow rate
  - Planter boxes to treat roof area

Geosyntec consultants

Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5%



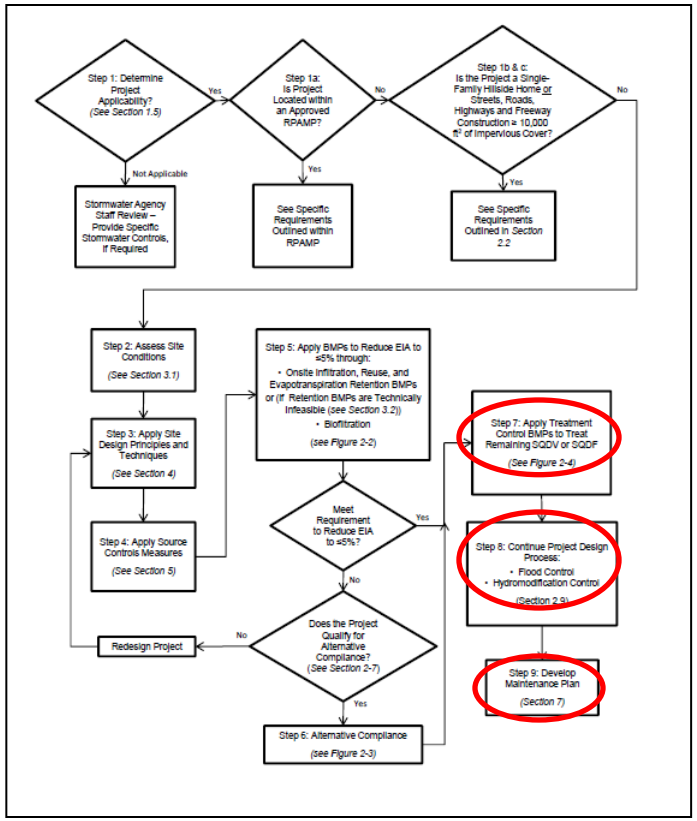
Landscaped Area
Building Area
Green Roof
Concrete Area
Proprietary Biotreatment
Planter Boxes

- Planter boxes treat roof SQDV (per sizing procedure for BIO-2 in TGM):
  - A_{req} = 220 ft²
    - PB_1 sized at 5 ft x 29 ft; PB_2 sized at 5 ft x 15 ft

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs Evapotranspiration Option

- Size planter boxes for roof area per sizing criteria in TGM
- For proprietary biotreatment, refer to manufacturer instructions
  - Feasible to biofilter $V_{biofilter}$ onsite
  - Proceed to Step 7, 8, 9



Geosyntec consultants

Alternative Compliance

- What if $V_{biofilter}$ cannot be treated on-site?
  - For example: area on-site cannot be used for proposed biofilters
  - Alternative Compliance (Step 6)
    - See Section 2.7
  - Redevelopment projects qualify
- Provide treatment control BMPs to treat remaining SQDV or SQDF
  - Waterbodies in watershed Impaired for Pathogens
  - Proprietary Biofiltration (BIO-5), Cartridge Media Filters (TCM-5) can be used

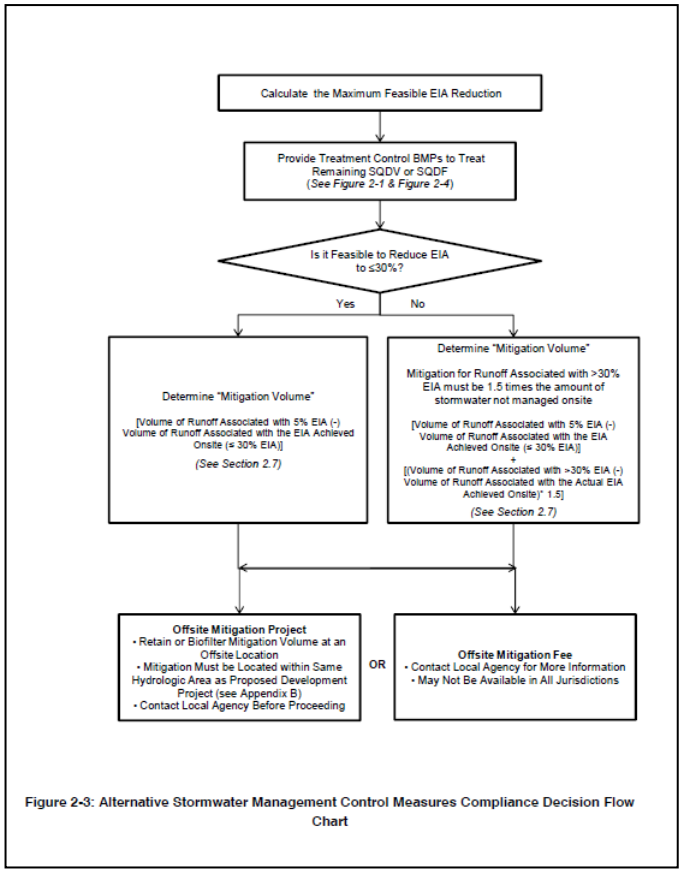
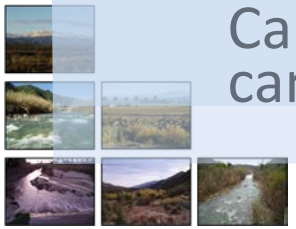
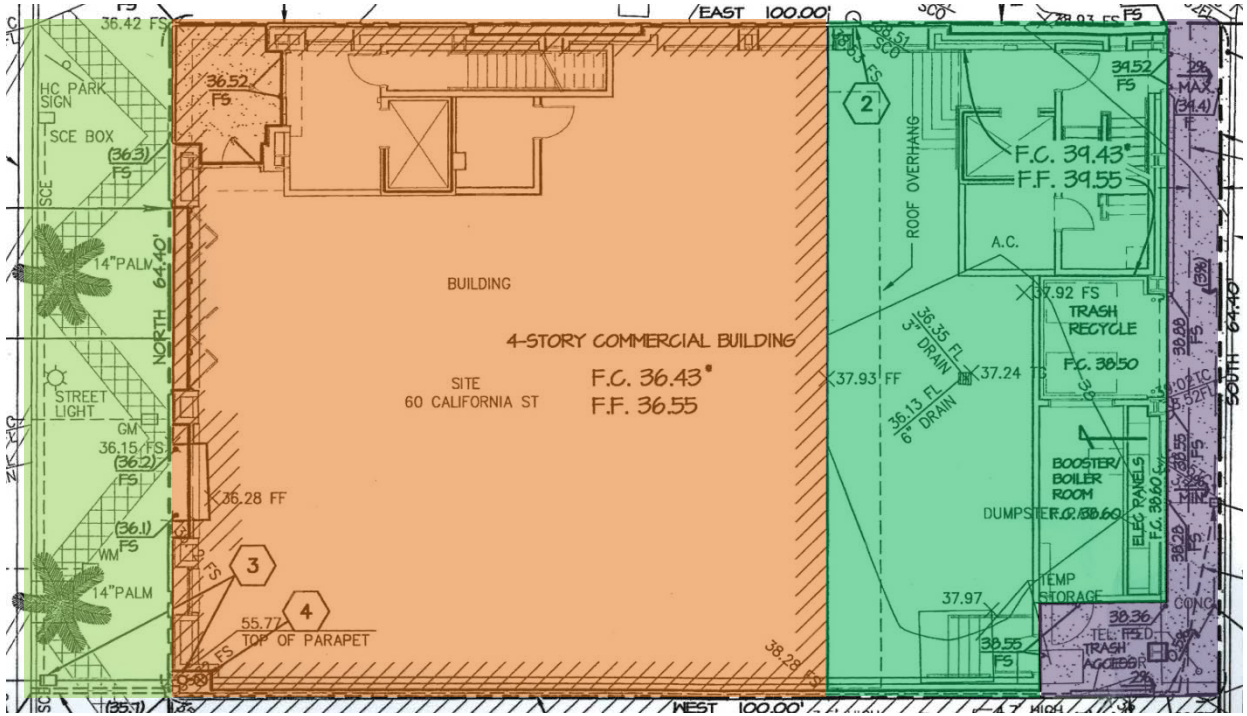


Figure 2-3: Alternative Stormwater Management Control Measures Compliance Decision Flow Chart



Geosyntec consultants

Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5%



- Roof/ Alley cannot be biofiltered
  - 4,410 ft^2 of EIA (limit: 370 ft^2)
  - First: apply TCM sized for remaining SQDV/SQDF (TCM-5 recommended given space constraints)

Geosyntec consultants

Step 6: Alternative Compliance

- Feasible to reduce EIA to ≤ 30%?
  - 4,410 ft^2 / 7,325 ft^2 = 62% EIA
    - Note that EIA = IMP
  - No
- Determine $A_{30\%EIA}$
  - $A_{30\%EIA} = (IMP - 30\%)*A_{project}$
    - $A_{30\%EIA} = (0.62 - 0.3)*7,325$
    - $A_{30\%EIA} = 2,340\ ft^2$
- Determine $V_{30\%EIA}$
  - $V_{30\%EIA} = 0.95*2,340*0.75/12$
    - $V_{30\%EIA} = 140\ ft^3$

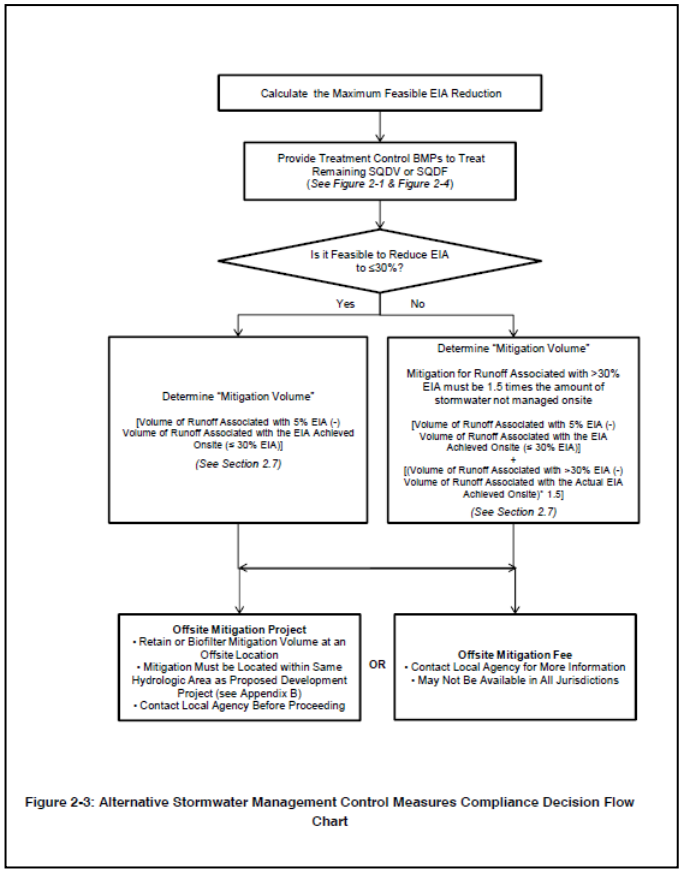
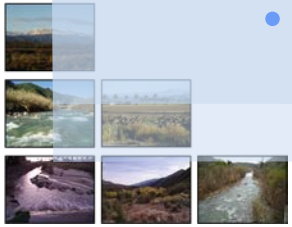


Figure 2-3: Alternative Stormwater Management Control Measures Compliance Decision Flow Chart



Geosyntec consultants

Step 6: Alternative Compliance

- Determine $V_{mitigation30\%}$
  - $V_{mitigation30\%} = V_{retain} - V_{30\%EIA}$
    - $V_{mitigation30\%} = 245 - 140$
    - $V_{mitigation30\%} = 105\ ft^3$
- Determine $V_{mitigation>30\%}$
  - $V_{mitigation>30\%} = (V_{30\%EIA} - V_{ActualEIA})*1.5$
    - $V_{mitigation>30\%} = (140 - 0)*1.5$
    - $V_{mitigation>30\%} = 210\ ft^3$
- Determine $V_{mitigationTotal}$
  - $V_{mitigationTotal} = (V_{mitigation>30\%} + V_{mitigation30\%})$
    - $V_{mititationTotal} = 105 + 210$
    - $V_{mitigationTotal} = 315\ ft^3$

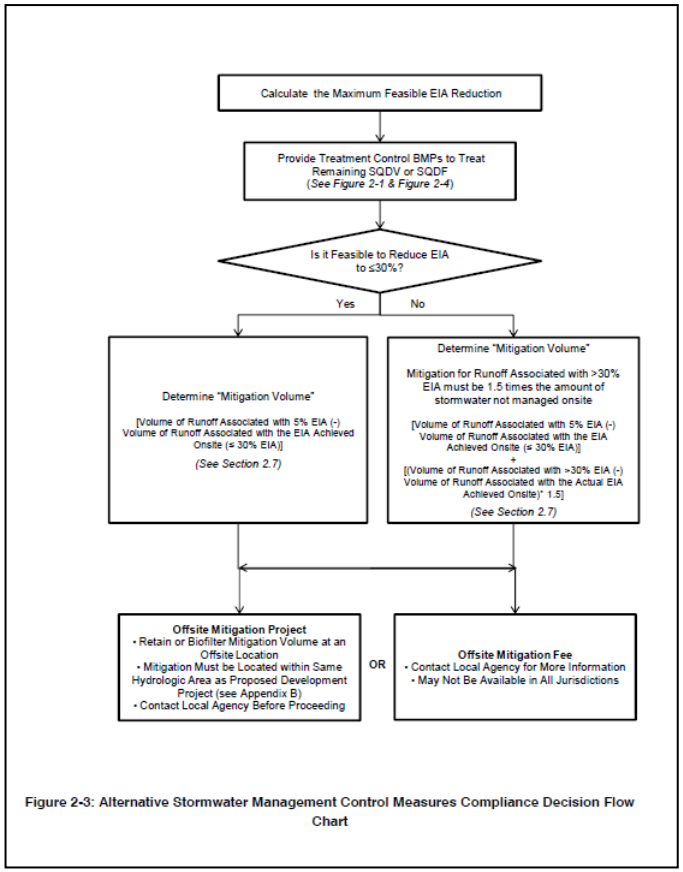
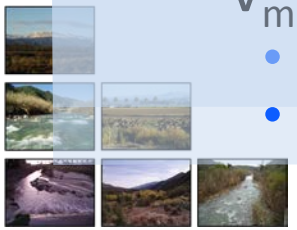


Figure 2-3: Alternative Stormwater Management Control Measures Compliance Decision Flow Chart



Geosyntec consultants

Alternative Compliance

- Retain or Biofilter Mitigation Volume at an Offsite Location
  - Must be located w/in same hydrologic area as proposed development

  OR
- Offsite Mitigation Fee

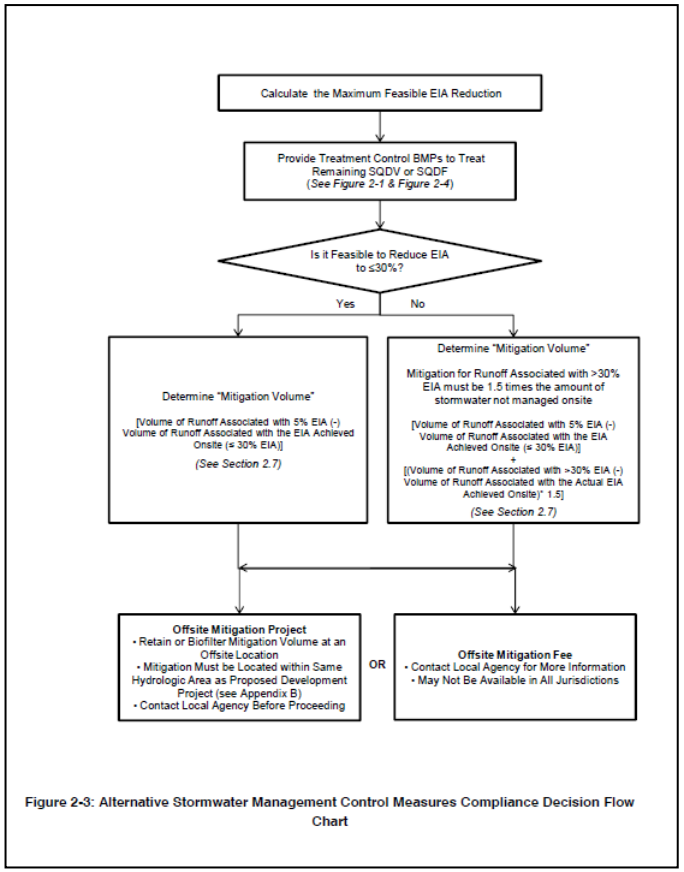
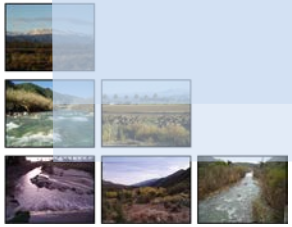
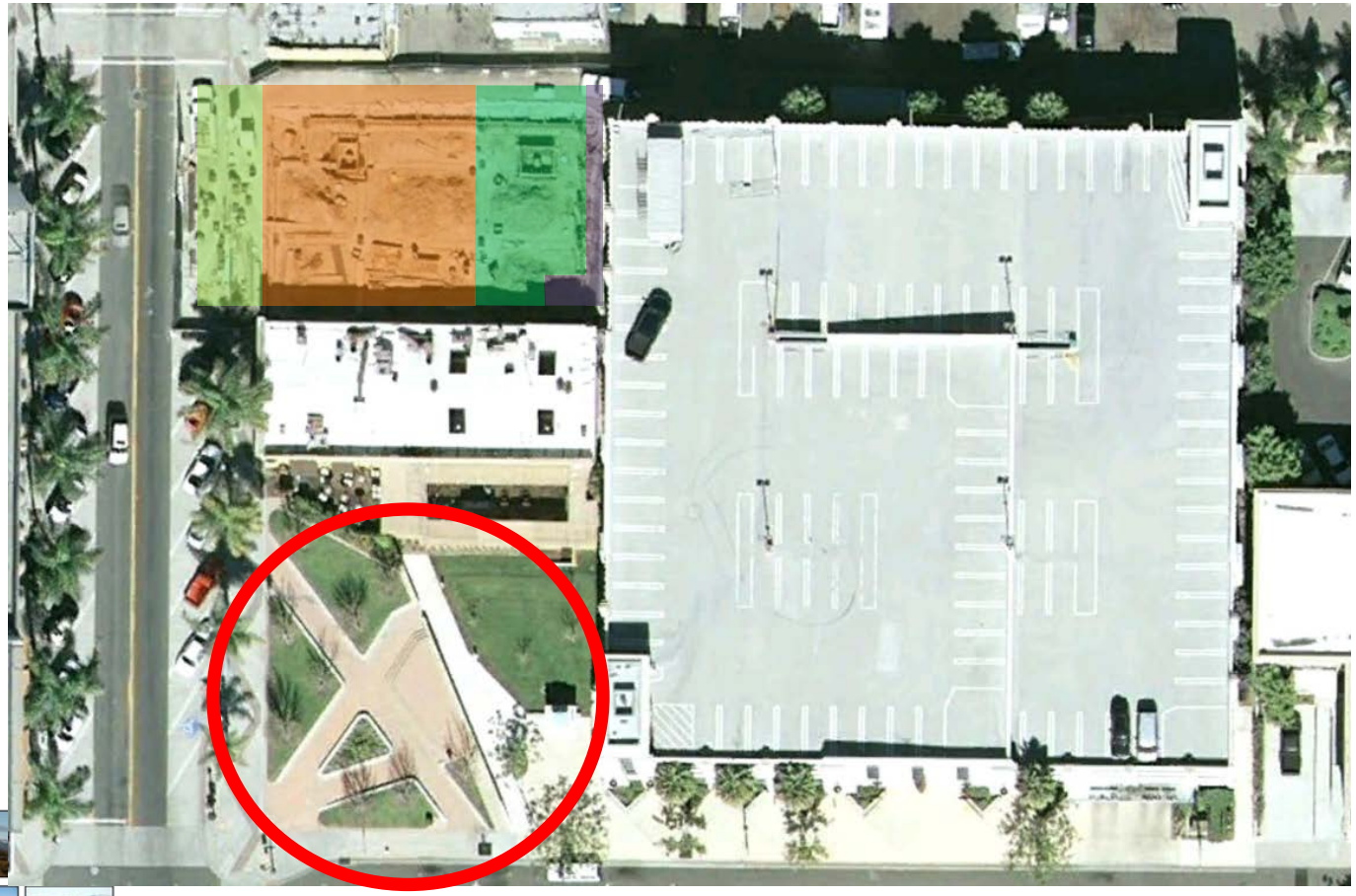


Figure 2-3: Alternative Stormwater Management Control Measures Compliance Decision Flow Chart



Geosyntec consultants

Step 6: Alternative Compliance

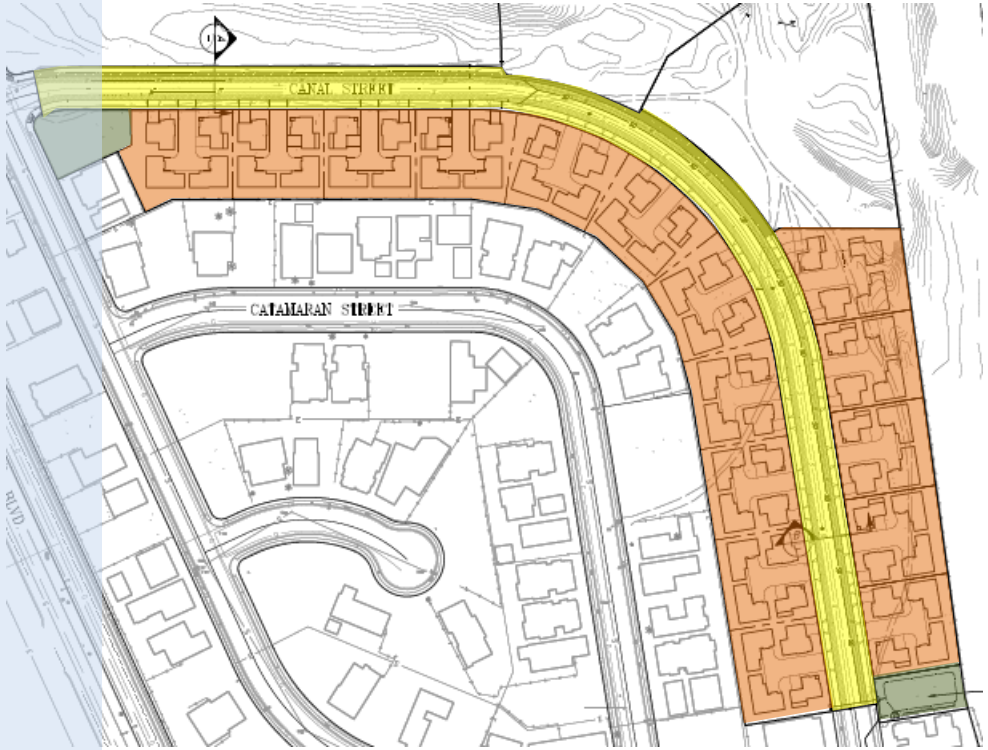


60 California Site (*Image from Google Earth Pro™, June 2011*)

Geosyntec consultants

Scenario 3: Residential

- Project Information:
  - Condominiums/ Single-Family housing
    - Some open space available in development area
  - Development area (shaded) = 8.5 Ac
  - 65% Impervious

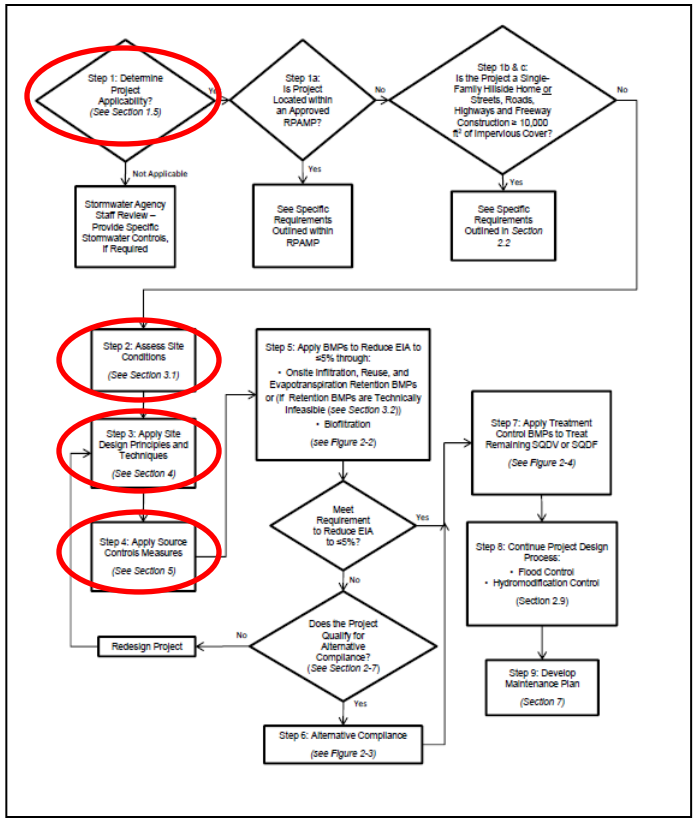


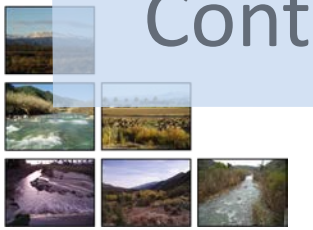
Open Area
Residential Area
Road Area

Geosyntec consultants

Flow Chart Steps 1-4

- Step 1: Project meets Applicability
- Step 2: Site Conditions
  - Soil Type 1
    - Infiltration BMPs not recommended
- Step 3: Apply Site Design Principles
- Step 4: Apply Source Control Measures

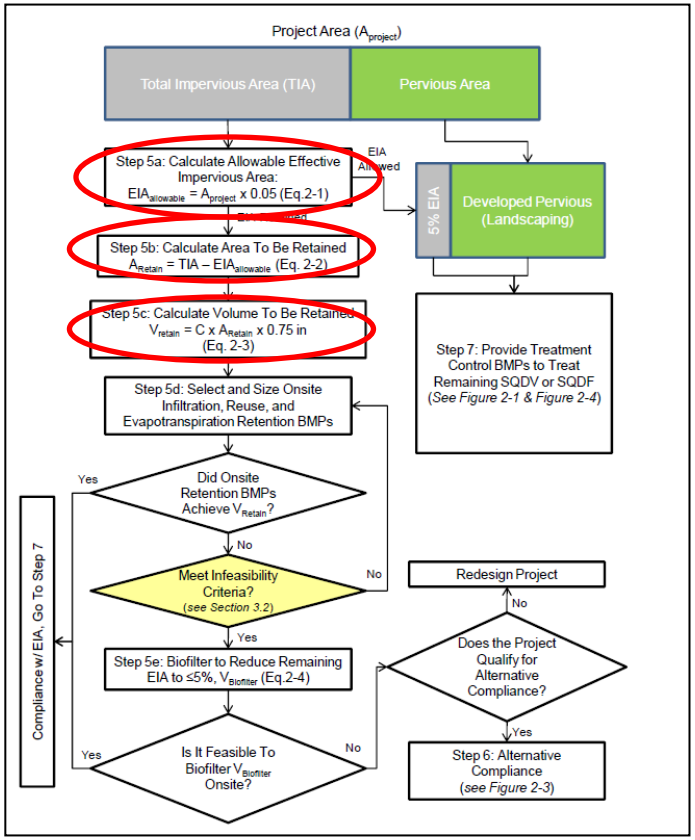


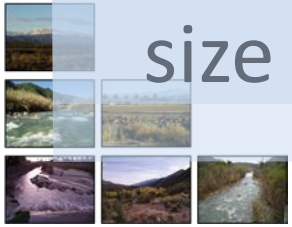


Geosyntec consultants

Flow Chart Step 5a – 5c

- Step 5a: Calculate EIA
  - EIA = 8.5 ac*0.05 = 0.4 ac
  - Step 5b: Calculate A_{retain}
  - A_{retain} = 5.5 ac – 0.4 ac = 5.1 ac
- Step 5c: Calculate V_{retain}
  - V_{retain} = 0.30 ac-ft
- Next: Step 5d – Select and size BMPs





Geosyntec consultants

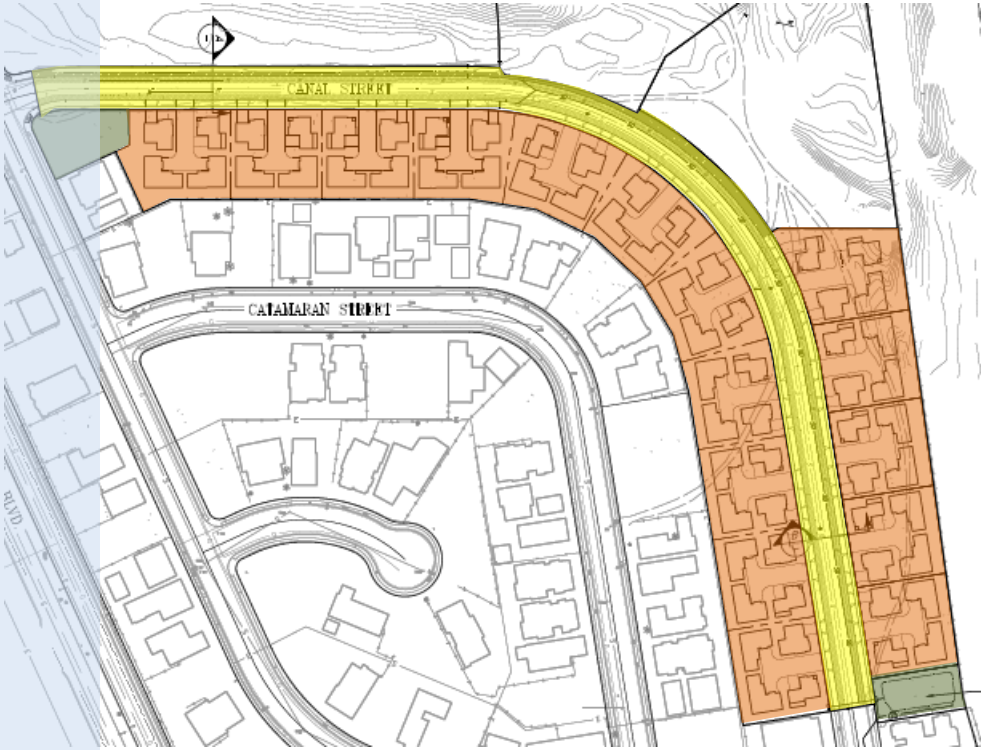
Step 5d: Selecting and Sizing BMPs
Infiltration, RWH, ET BMPs

BMP	Recommended	Possible	Not Possible/ Recommended	Notes
INF-1 through INF-6			**X**	Ventura Soil Type 1
RWH-1: Rainwater Harvesting		**X**		Possible to capture runoff from roofs and use for non-potable water demand ***IF*** there is enough demand
ET-1: Green Roof			**X**	Possible to install green roofs on single family homes but is often prohibitively expensive
ET-2: Hydrologic Source Controls		**X**		Possible to implement some hydrologic source controls throughout project area

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
RWH BMPs

- Rainwater Harvesting Option
- d_{design} = 1.4 inches
- RWHDV = 0.6 ac-ft
- Daily Demand = [0.6 ac-ft/(72/24)]* 325,851 (gal/ac-ft)
  - Needed demand= 61,300 gallons/day

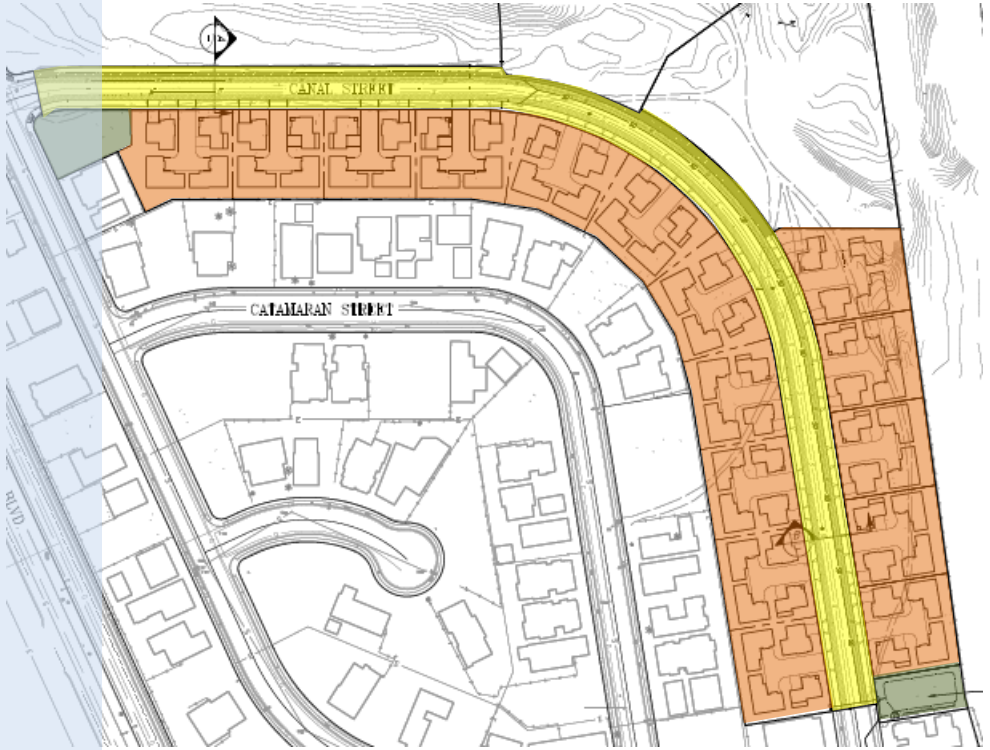


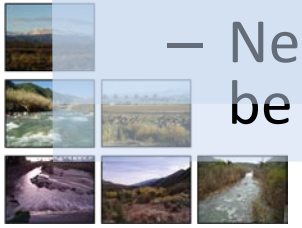
Open Area
Residential Area
Road Area

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
RWH BMPs

- Indoor Demand
  - 18.5 gal/resident/day (Pac. Inst.)
  - ~3,300 residents needed to meet demand (indoor)
  - 64 homes planned
- Outdoor demand
  - ~300 – 2,000[1] gal/irrigated acre per day (depending on plants used)
  - Need 30+ acres to be irrigated



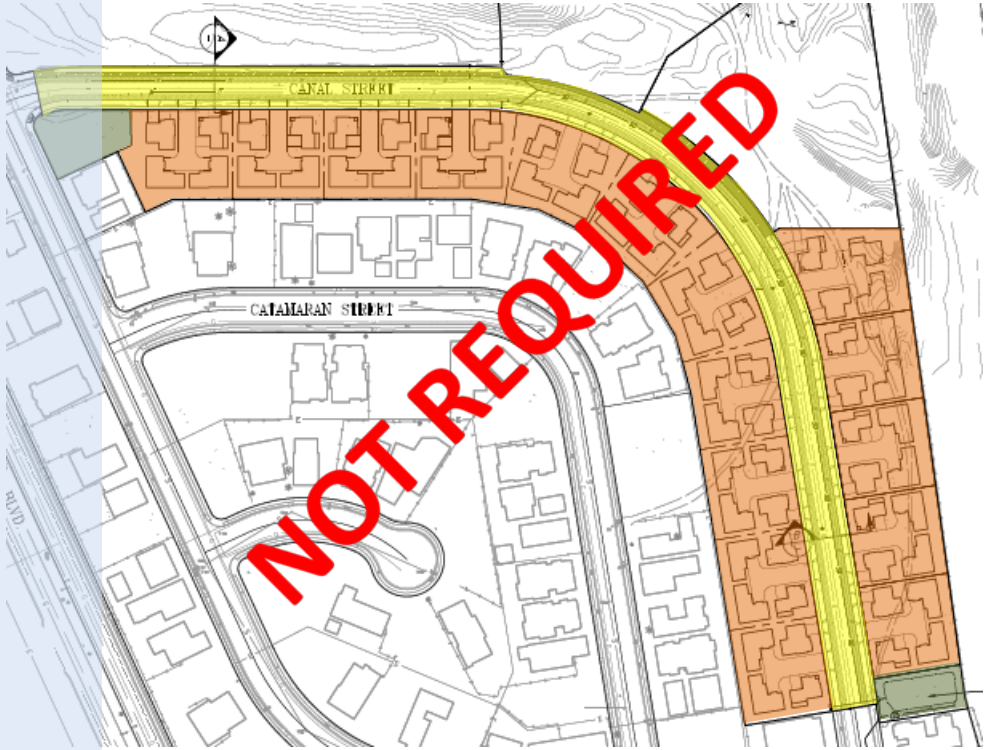


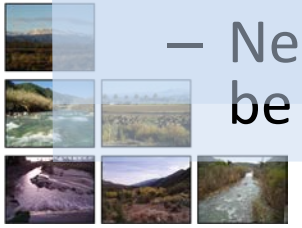
[1] *These demand numbers are meant for discussion purposes only and should not be used for irrigation demand calculations.*

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
RWH BMPs

- Indoor Demand
  - 18.5 gal/resident/day (Pac. Inst.)
  - ~3,300 residents needed to meet demand (indoor)
  - 64 homes planned
- Outdoor demand
  - ~300 – 2,000[1] gal/irrigated acre per day (depending on plants used)
  - Need 30+ acres to be irrigated



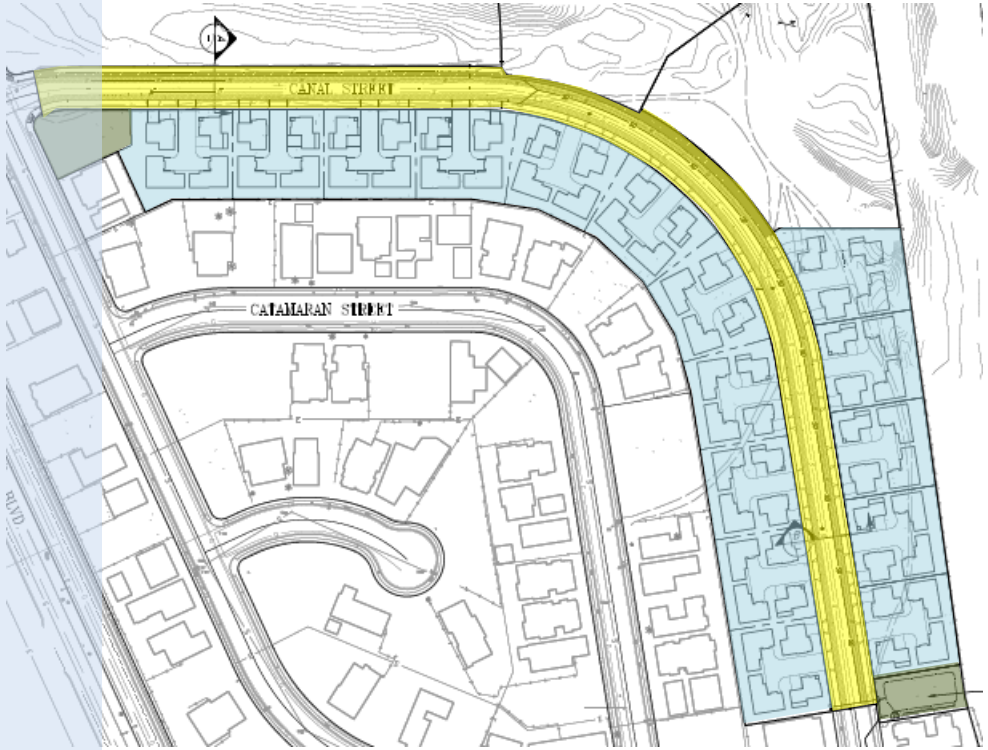


[1] *These demand numbers are meant for discussion purposes only and should not be used for irrigation demand calculations.*

Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
ET BMPs

- Hydrologic Source Controls
  - Can direct roof runoff to pervious areas on residential lots
  - Residential lots are 60% Impervious
    - Assume half of pervious area can receive roof runoff
  - Pervious to Impervious ratio = 20%/ 60% = 0.3
  - d_{HSC} = 0.15 inches

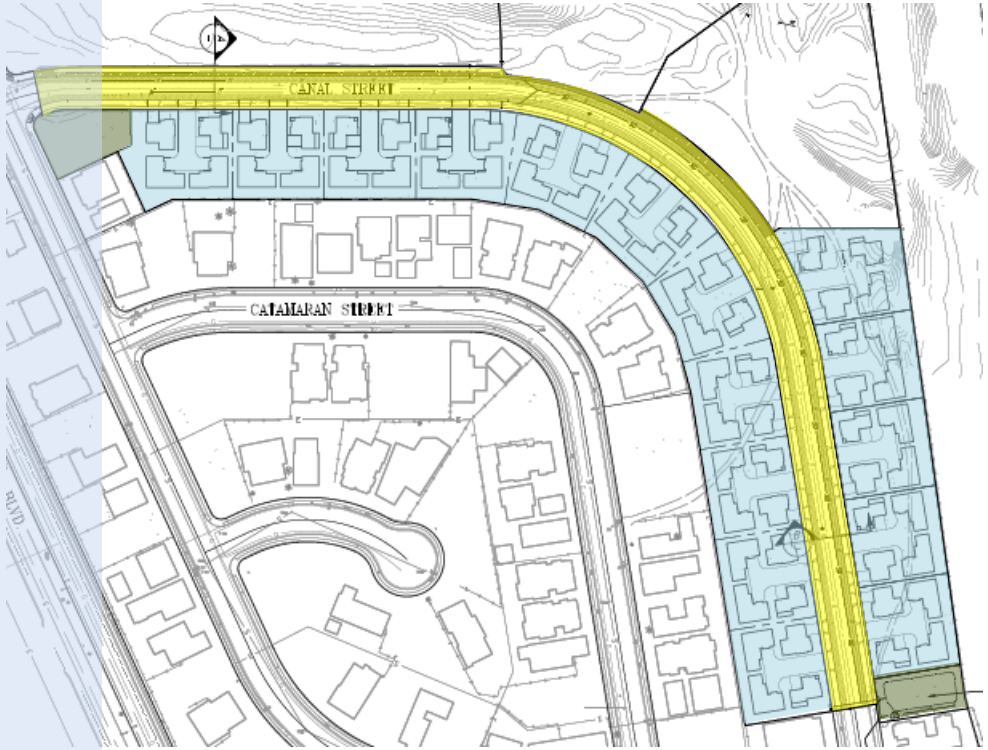


Open Area
Residential Area with Hydrologic Source Controls
Road Area

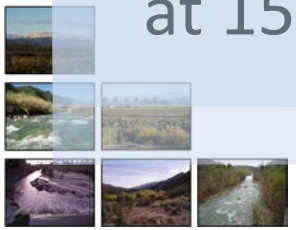
Geosyntec consultants

Step 5d: Selecting and Sizing BMPs
ET BMPs

- Calculate new V_{retain} accounting for hydrologic source controls
  - V_{retain} = 0.95 * {[(5.1 – 3.5) * (0.75/12)] + [3.5 * (0.6/12)]}
  - V_{retain} = 0.26 ac-ft
- Retention options exhausted
- Next step – Biofilter at 150%



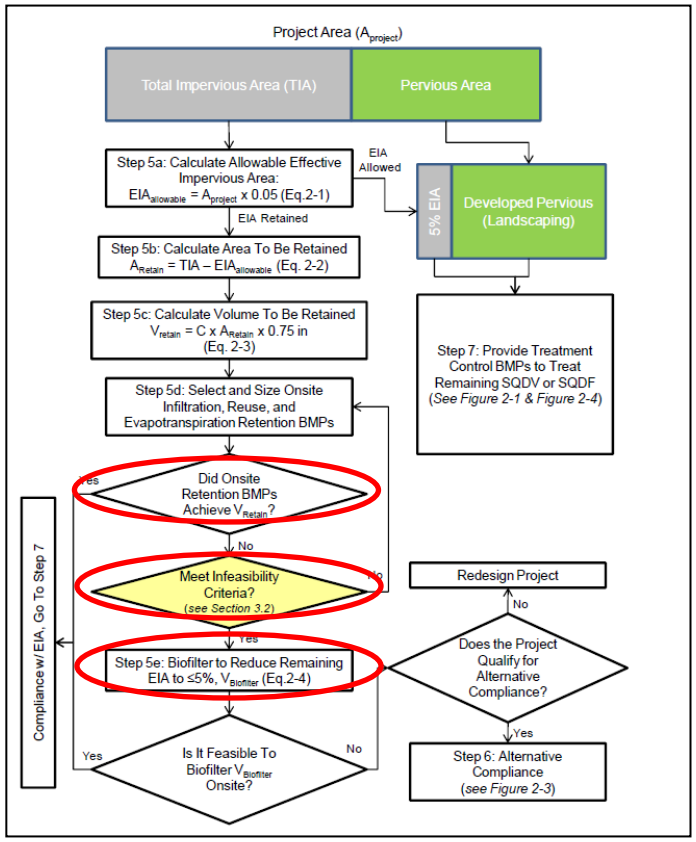
Open Area
Residential Area with Hydrologic Source Controls
Road Area



Geosyntec consultants

Flow Chart Step 5a – 5c

- Calculate $V_{biofilter}$
  - $V_{biofilter} = (V_{retain} - V_{achieved}) * 1.5$
  - $V_{biofilter} = 0.26 * 1.5 =$ 0.39 ac-ft
- Select biofiltration BMPs



Geosyntec consultants

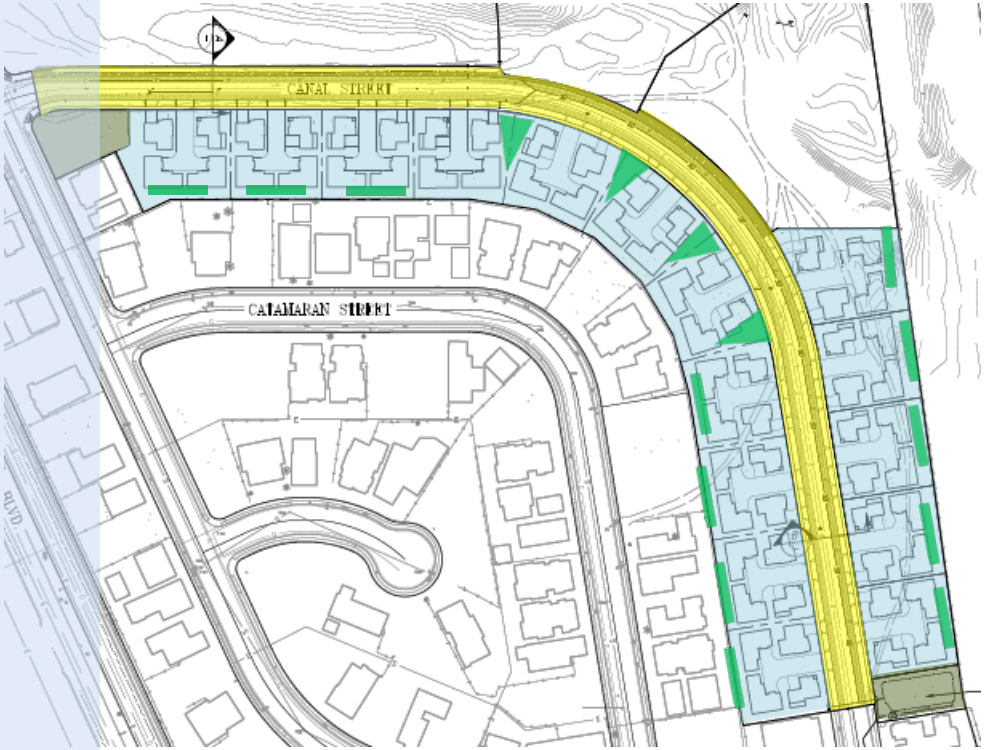
Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5% Biofilter Selection

BMP	Recommended	Possible	Not Recommended	Notes
BIO-1: Bioretention with Underdrain	**X**			Bioretention with underdrain is a good option for the site
BIO-2: Planter Box	**X**			Planter boxes can also be used next to buildings on-site
BIO-3: Vegetated Swale			**X**	Does not fit within site layout
BIO-4: Vegetated Filter Strip			**X**	Does not fit within site layout
BIO-5: Proprietary Biotreatment		**X**		Proprietary biotreatment can be used for this site

Geosyntec consultants

Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5% Biofilter Selection

- Distributed biofiltration BMPs or "onsite regional"?
  - Determine area needed for bioretention BMPs
  - A_{req} = 0.15 ac (includes 20% more area for side slopes, etc)
  - Open space areas ~0.4 acres

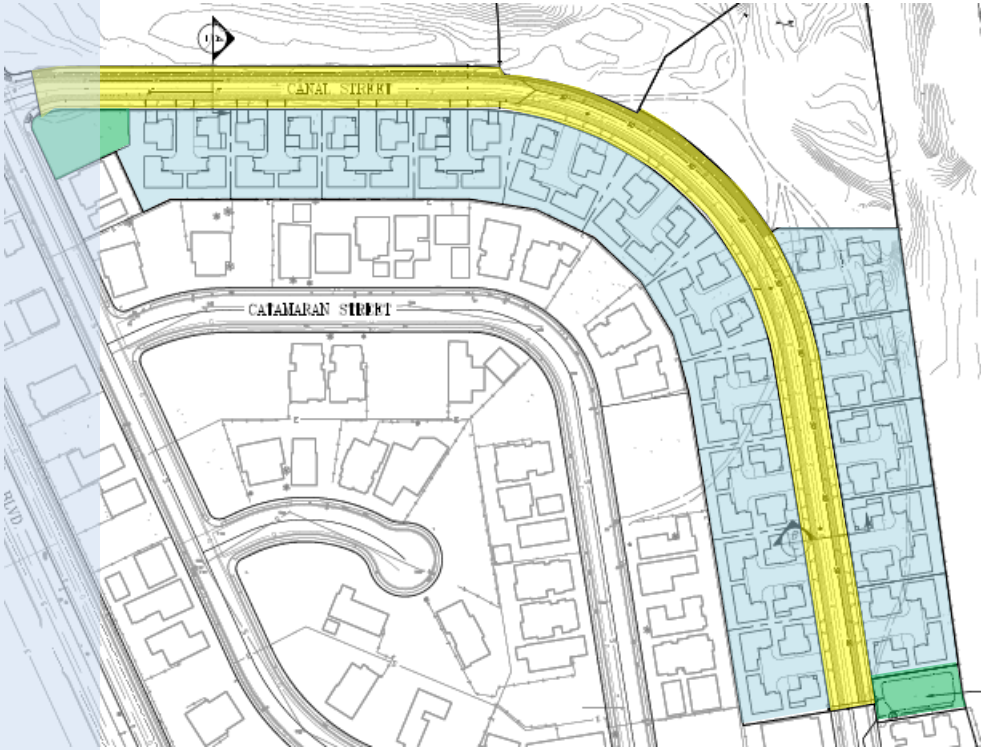


Open Area
Residential Area with Hydrologic Source Controls
Road Area
Bioretention BMPs

Geosyntec consultants

Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5% Biofilter Selection

- Distributed biofiltration BMPs or "onsite regional"?
  - Determine area needed for bioretention BMPs
  - A_{req} = 0.15 ac (includes 20% more area for side slopes, etc)
  - Open space areas ~0.4 acres

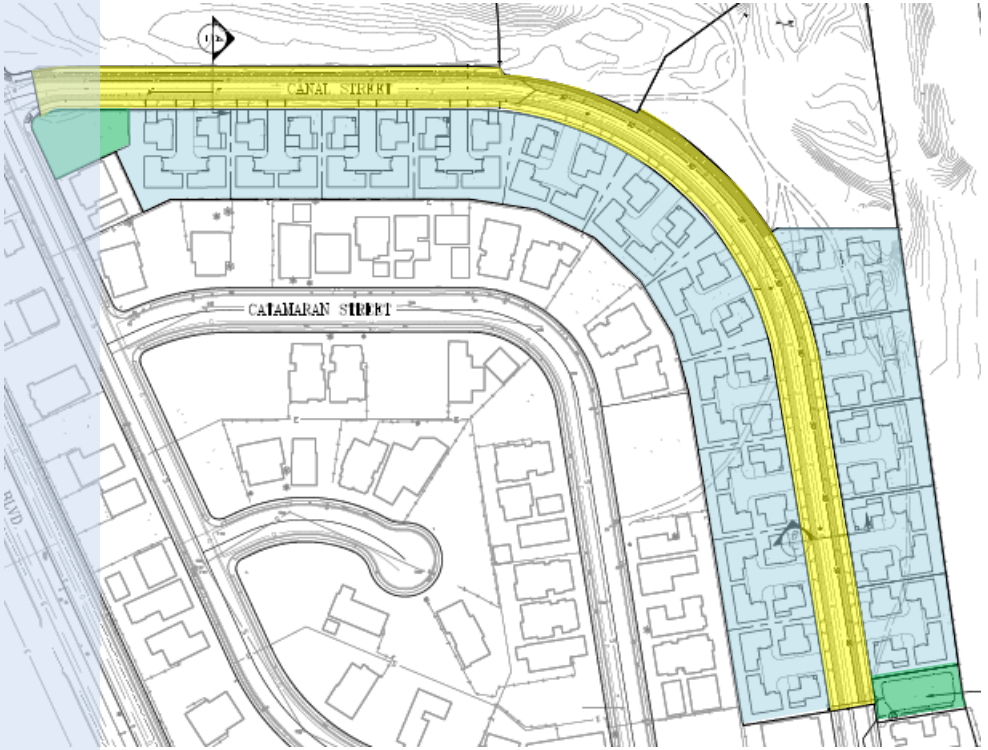


Open Area
Residential Area with Hydrologic Source Controls
Road Area
Bioretention BMPs

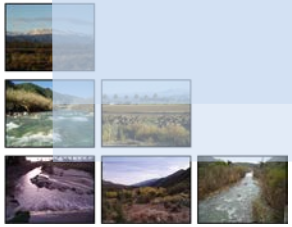
Geosyntec consultants

Step 5e: Biofilter to Reduce Remaining EIA to ≤ 5% Biofilter Selection

- Since enough area is available in open space areas, "onsite regional" biofilter BMPs are probably a better option
  - M & O
  - Cost
- $\sum V_{BMPs} \geq V_{biofilter}$



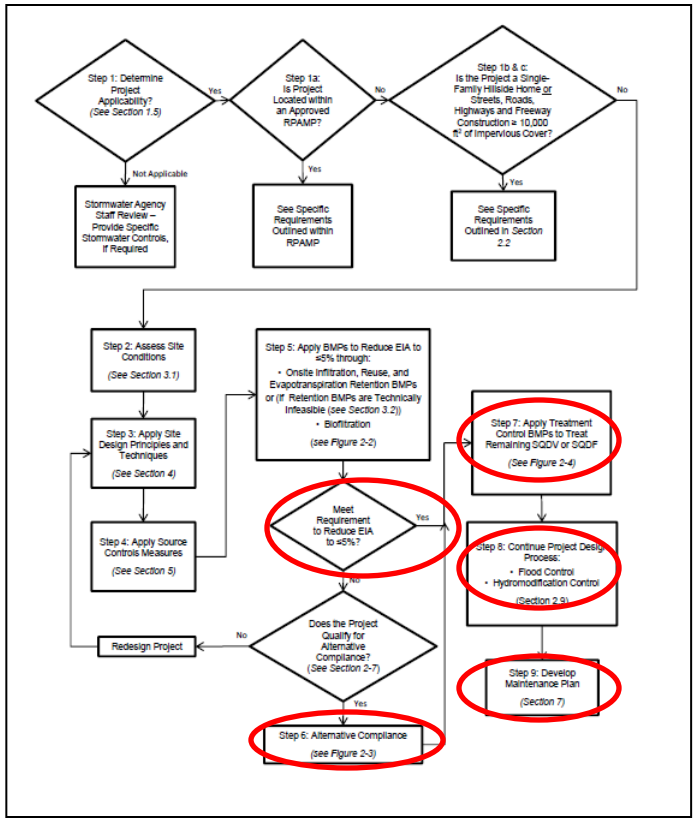
Open Area
Residential Area with Hydrologic Source Controls
Road Area
Bioretention BMPs

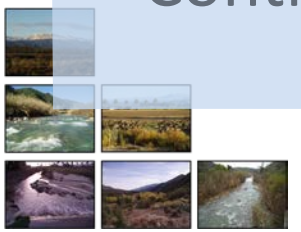


Geosyntec consultants

Flow Chart Steps 7-9

- Step 6: Alternative Compliance does not apply
- Step 7: If there is project EIA, apply TCMs
  - Recommend sizing complete project area for biofiltration so there is no EIA
  - Additional area (i.e., after A_{retain} has been biofiltered) does not need to be biofiltered at 1.5 times V_{retain}
- Continue to Steps 8 and 9





Questions?

Geosyntec consultants