PCR Project Example

April 27, 2023

Whitson
ENGINEERS

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Senior Engineer

Whitson Engineers

Tricia Wotan

Environmental Regulations Manager, City of Monterey

Approach

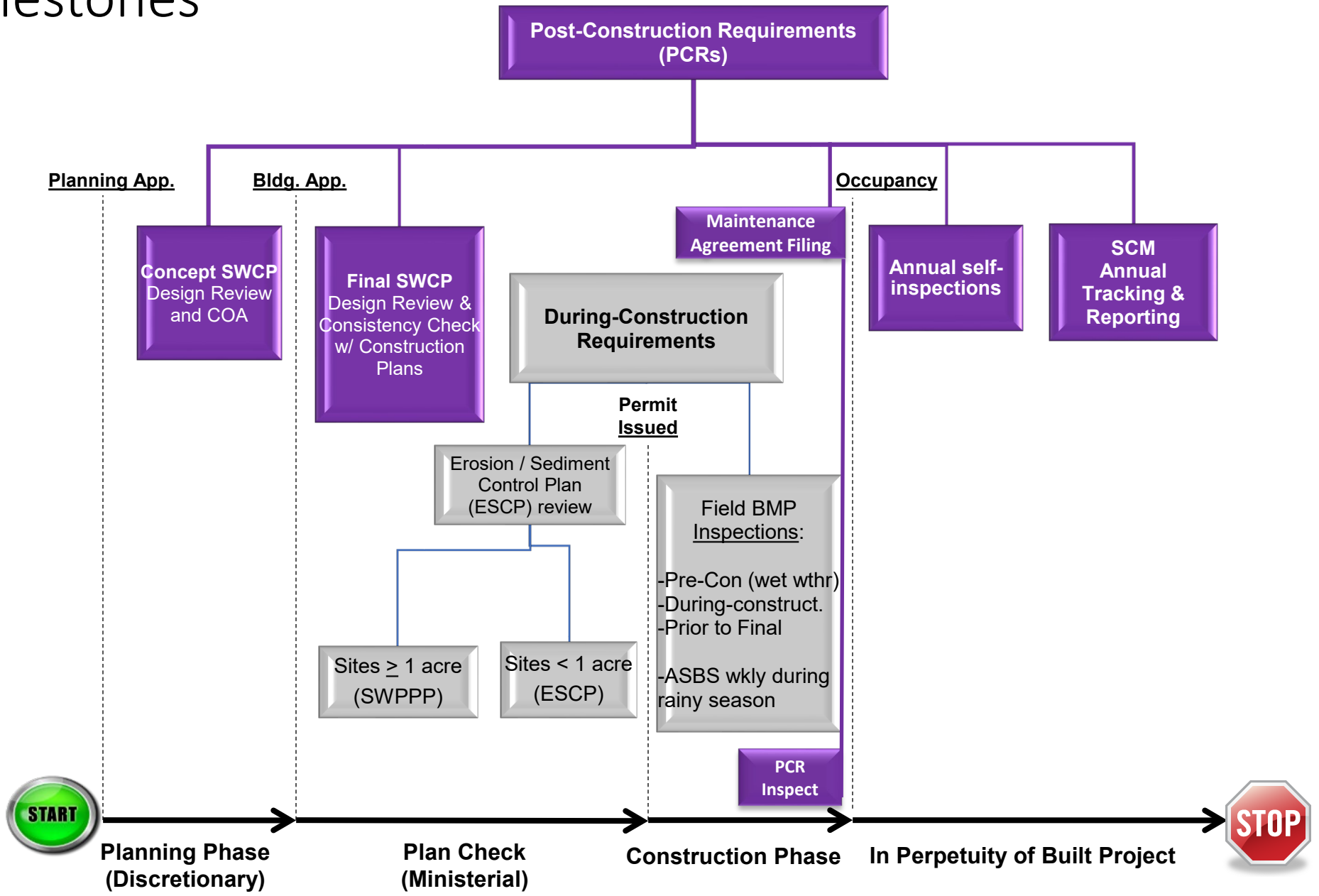
- Describe PCR goals and needs from “both sides of the counter”

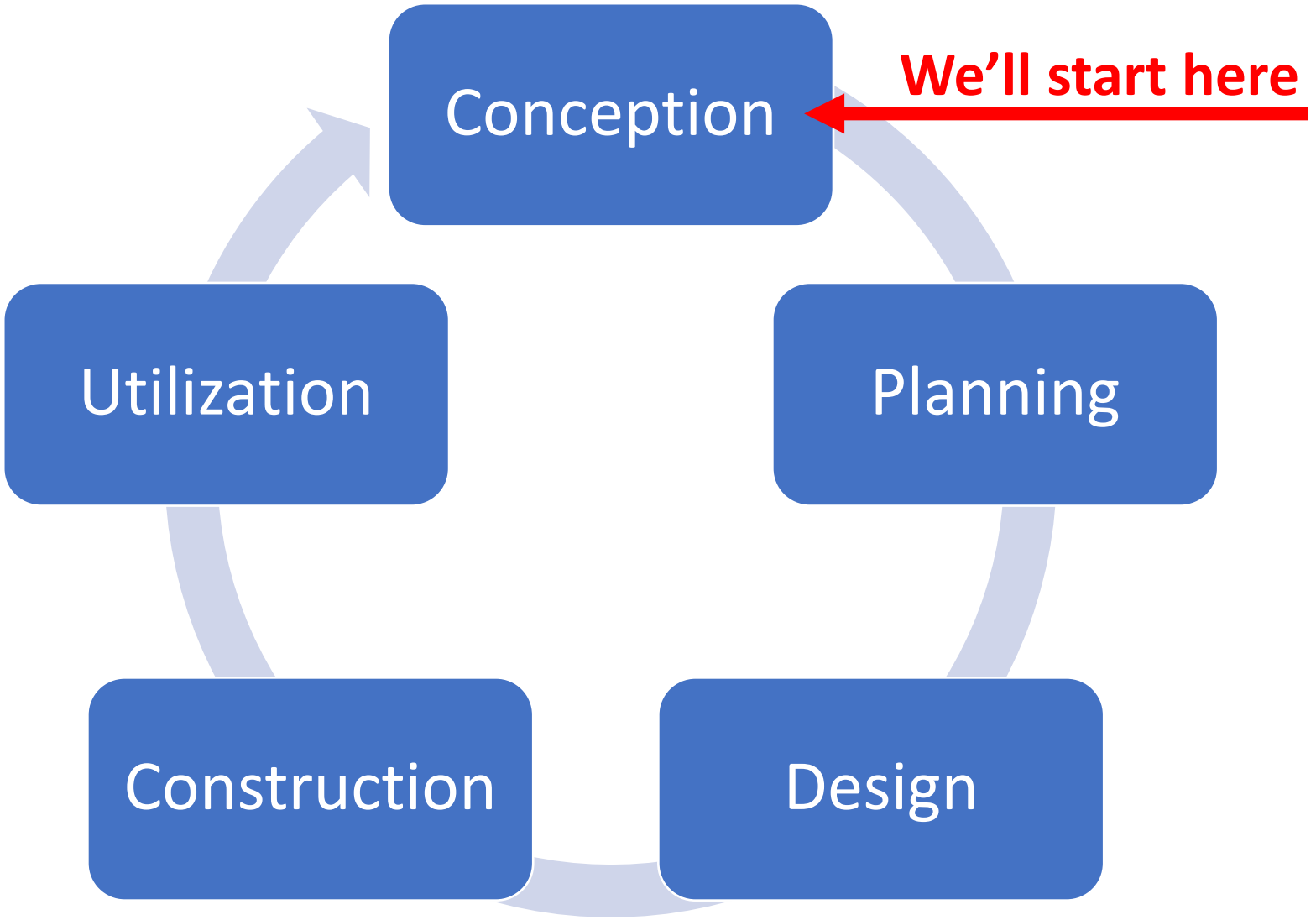
  → Context of project development workflow

- Utilize ‘real life’ project insights
- Share various project design and construction guidance, observations, and tips
- Highlight lessons learned
- Audience questions

This discussion is an illustration of how a theoretical project works its way through implementation of the PCRs, and illustrates the approaches, changes, problems, and solutions that are seen on real projects. Therefore this discussion should be taken as illustrative, and may not be exactly applicable to other projects, times, or places.

PCR Milestones

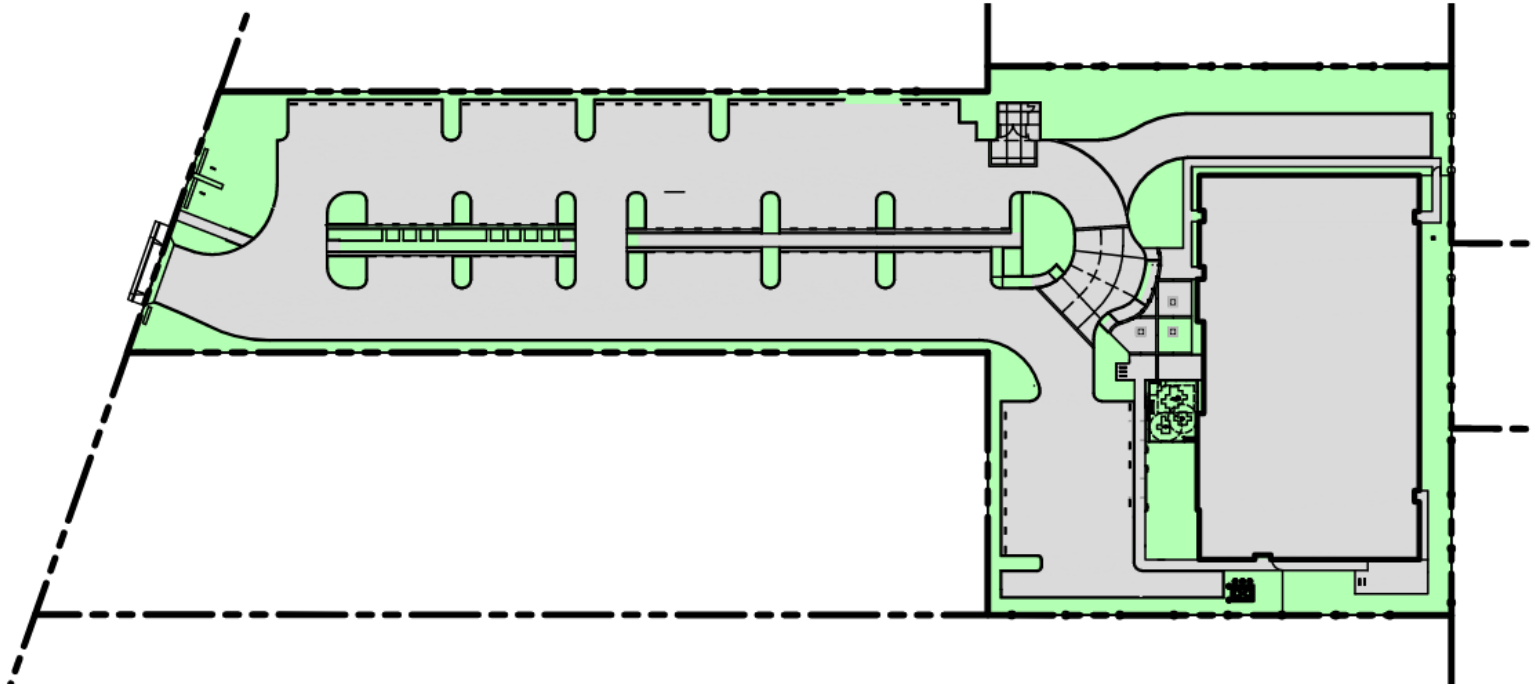



Conception
We'll start here
Planning
Design
Construction
Utilization

Project Conception

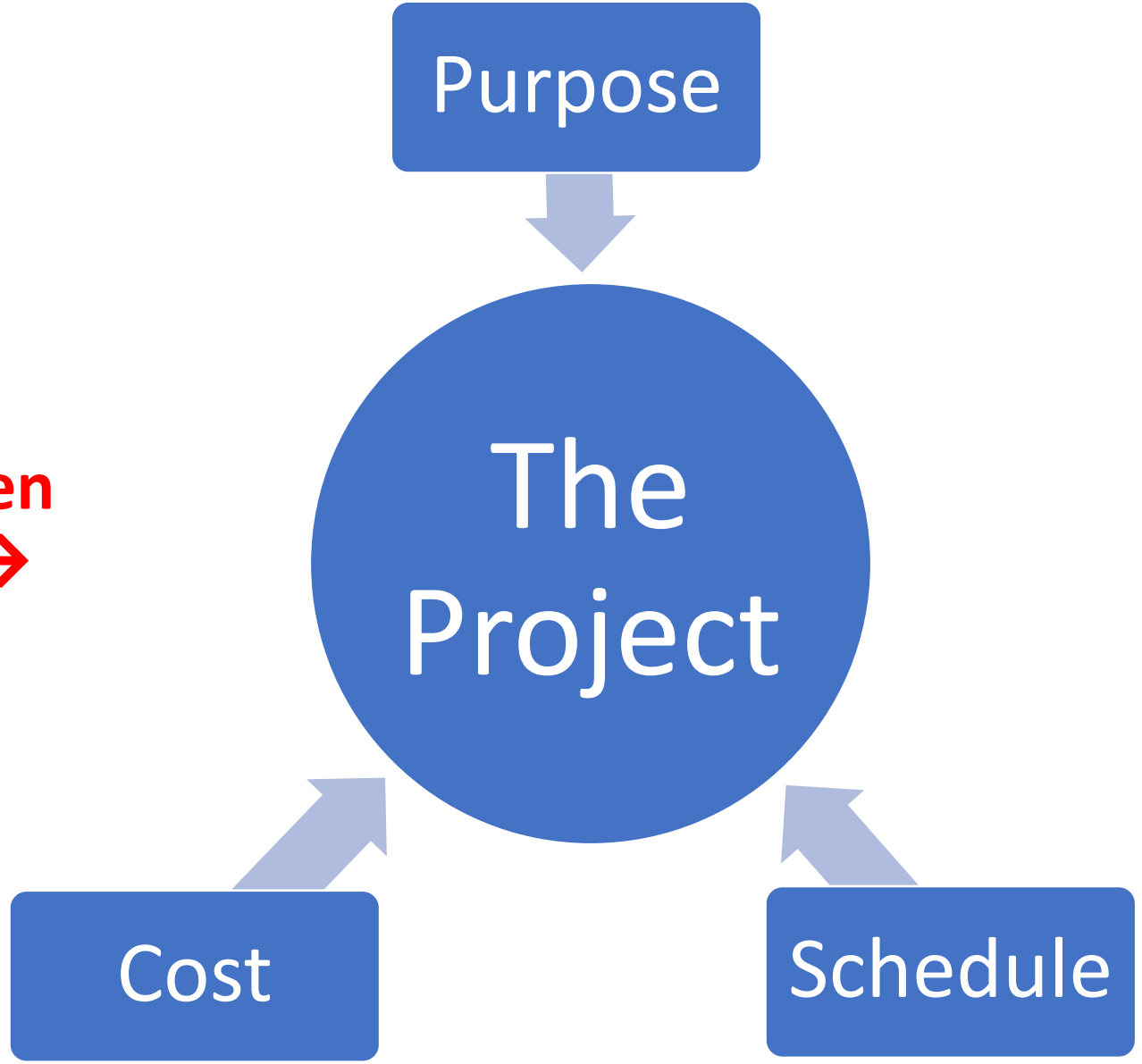
- ✓ *Existing developed 2.4-acre site*
- ✓ *Remodel existing or construct new buildings.*
- ✓ *Need 18,000 sf bldg.*
- ✓ *Keep a portion of the existing parking lot*

Proposed Site Plan



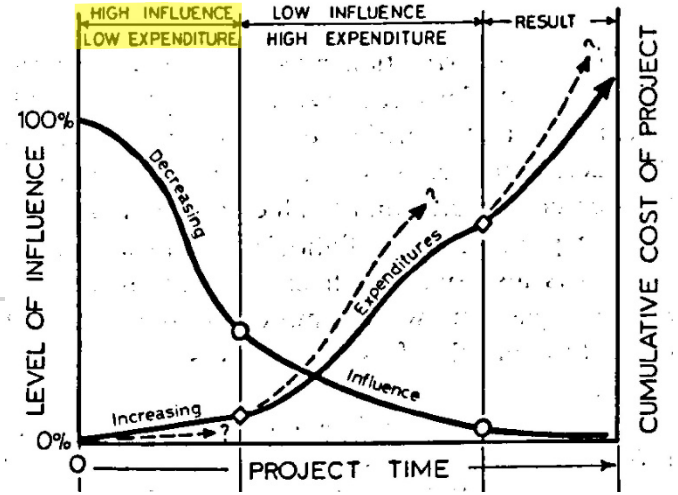
Project Conception

What we all think when we start the process →



What we end up thinking through

Reflections – Project Conception



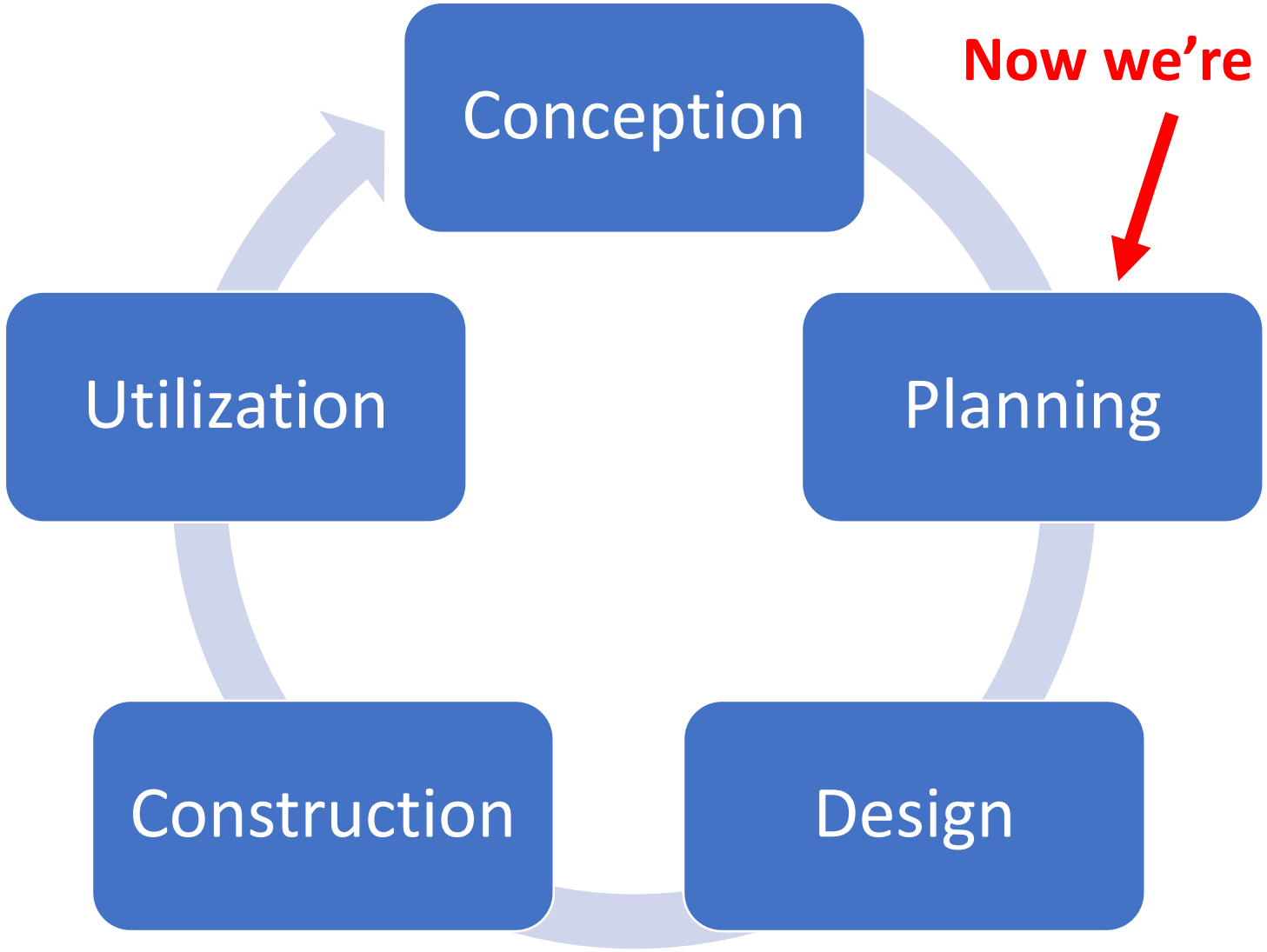
Tricia's

- Know basic metrics of proposed development – location, size, development type
- Gather as much regulatory information at the front end
- Seek early guidance to streamline review process

Nathaniel's

- Outreach / training for architects and planners is helpful
- Pre-application meetings are helpful
- Building size and site layout are frequently essentially set at this stage

Outline


Conception
Now we're here
Planning
Design
Construction
Utilization

Project Planning: the “big questions”

1. Permitting
   - Site layout (setbacks, density, parking, easements, slope restrictions, fire)
   - Subject to PCRs (and which ones)?
   - Local agency requirements (e.g. flood control ordinance)
   - Other (SWPPP, 401 Cert, etc)
2. Existing Conditions
   - Topography, drainage patterns
   - Buildings and retaining walls
   - Utilities, easements, setbacks
   - Soil infiltration
   - Soil contamination
   - Storm Drain Infrastructure
   - Groundwater
3. Proposed Site Plan
   - Site Plan
   - Grading and drainage
   - Off-site improvements
   - Roof drainage direction
4. Preliminary Design
   - Permit Requirements
   - PCR 1 Site Design Measures
   - Preliminary SCM Design for PCRs 2, 3 & 4
   - Flood control and conveyance

Project Planning: the “big questions”

SWCP Template

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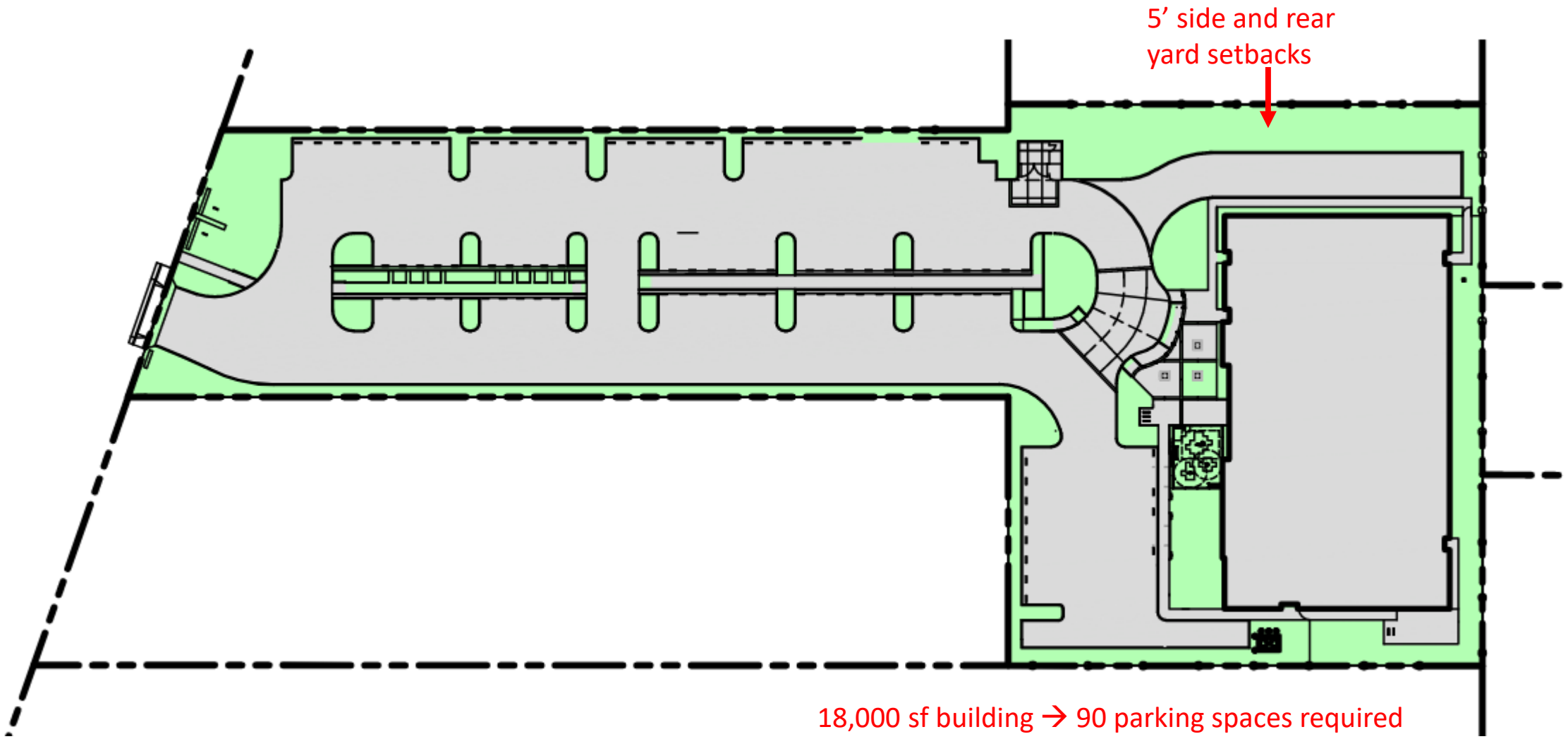
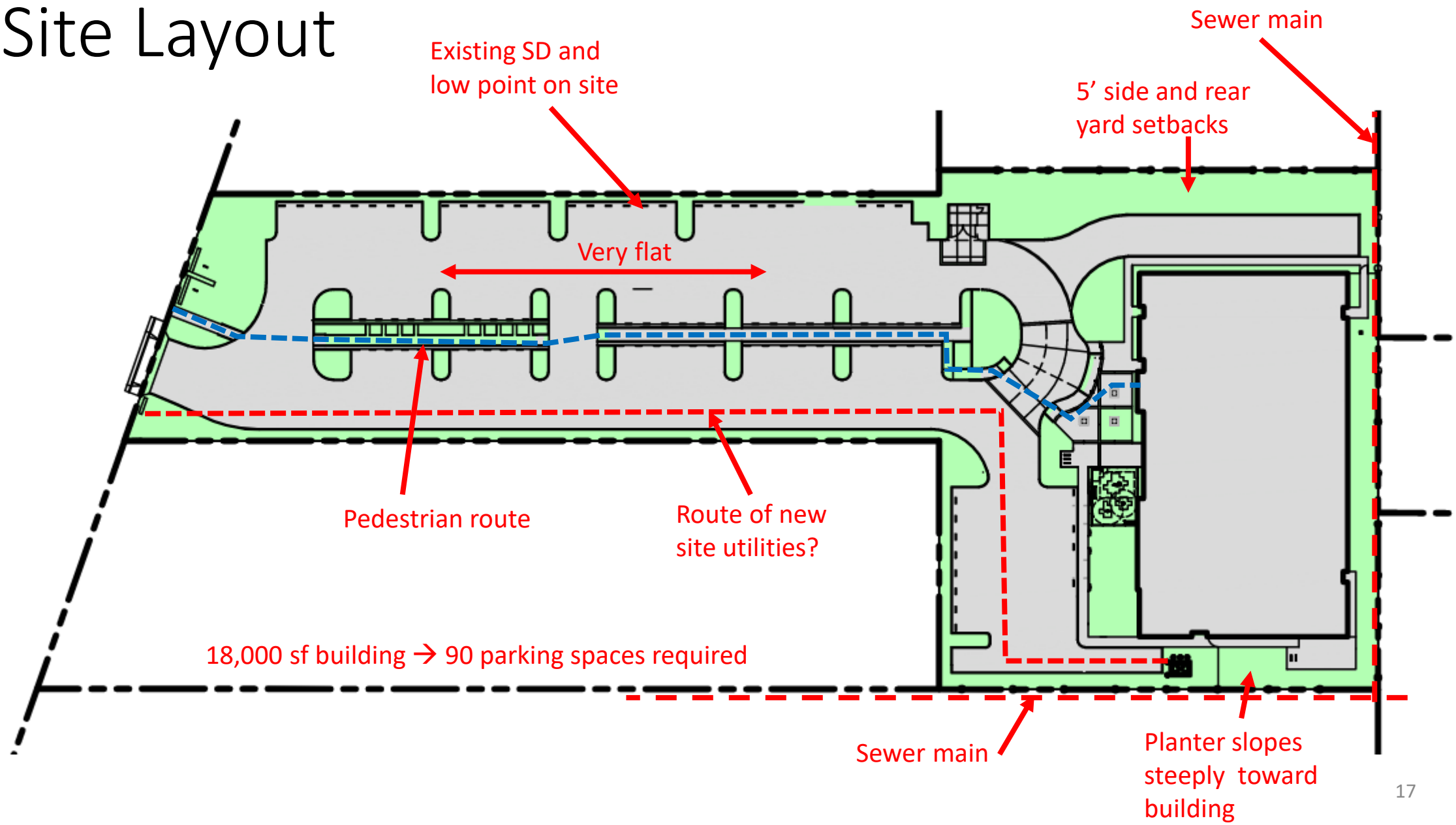
Site Layout


5’ side and rear
yard setbacks
18,000 sf building → 90 parking spaces required

Site Layout


Existing SD and
low point on site
Sewer main
5’ side and rear
yard setbacks
Very flat
Pedestrian route
Route of new
site utilities?
18,000 sf building → 90 parking spaces required
Sewer main
Planter slopes
steeply toward
building

Watershed Management Zone Map

Watershed Management Zone (WMZ) = 1

Site is not underlain by a groundwater basin

Source: Monterey County GIS, Accessed 8/25/20

WMZ 1 & > 22,500 sf → PCR's 1, 2, 3 & 4 apply.

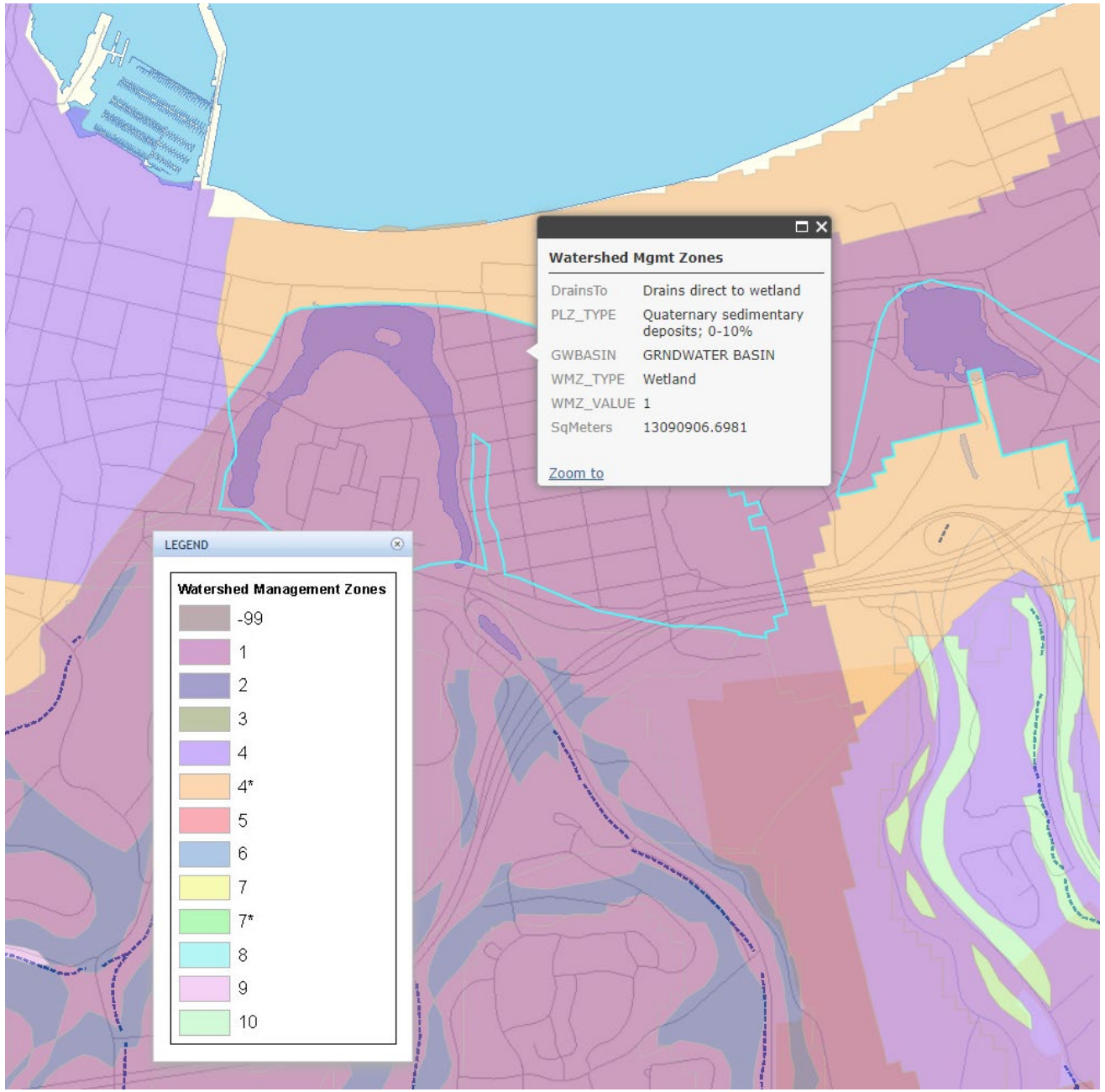
Additional Local Agency Requirements:
None.

Other Permit Requirements:
SWPPP

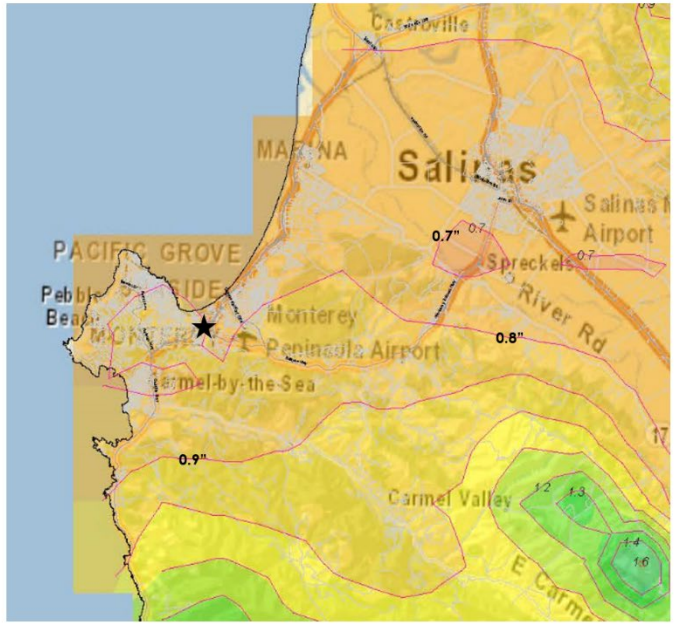
Example of a Local Agency requirement from another jurisdiction/project: "The applicant shall submit a Stormwater Control Report and Plan, prepared by a registered professional engineer addressing the Post-Construction Stormwater Management Requirements (PCRs) for Development Projects in the Central Coast Region. The plan shall include detention facilities designed to limit post-development runoff rates to pre-development rates for the 2, 5, 10, 25, 50, and 100-year 24-hour design storms."

Watershed Management Zones (WMZs)

City of Monterey GIS Portal



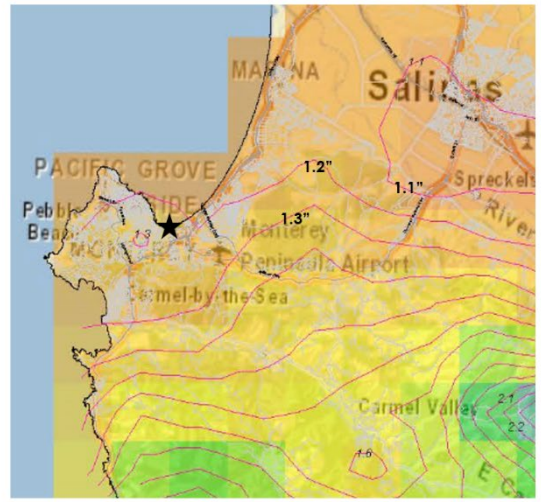
85th Percentile Precipitation Map



24-Hour Precipitation Depth at Project Site: 0.8"

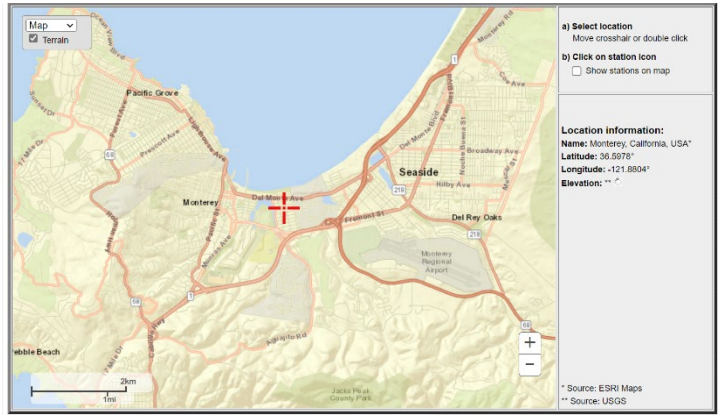
Source: "Central Coast Region 85th Percentile 24-Hour Rainfall Depth", SWRCB

95th Percentile Precipitation Map



24-Hour Precipitation Depth at Project Site: 1.3"

Source: "Central Coast Region 95th Percentile 24-Hour Rainfall Depth", SWRCB



POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

PF tabular | PF graphical | Supplementary information | Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)								
	1	2	5	10	25	50	100	200	500	1000
5-min	0.149 (0.130-0.171)	0.184 (0.160-0.212)	0.234 (0.204-0.271)	0.279 (0.241-0.326)	0.346 (0.297-0.420)	0.402 (0.336-0.508)	0.464 (0.369-0.593)	0.533 (0.407-0.703)	0.635 (0.464-0.878)	0.722 (0.507-1.04)
10-min	0.213 (0.186-0.246)	0.263 (0.230-0.304)	0.336 (0.292-0.389)	0.400 (0.345-0.468)	0.495 (0.412-0.602)	0.576 (0.468-0.717)	0.665 (0.525-0.859)	0.763 (0.584-1.01)	0.910 (0.665-1.26)	1.03 (0.727-1.49)
15-min	0.257 (0.225-0.297)	0.318 (0.278-0.368)	0.406 (0.354-0.471)	0.483 (0.417-0.566)	0.599 (0.498-0.728)	0.697 (0.565-0.867)	0.804 (0.635-1.03)	0.923 (0.706-1.22)	1.10 (0.804-1.52)	1.25 (0.879-1.80)
30-min	0.375 (0.329-0.433)	0.464 (0.406-0.536)	0.592 (0.516-0.686)	0.705 (0.608-0.825)	0.874 (0.726-1.06)	1.02 (0.824-1.26)	1.17 (0.925-1.50)	1.35 (1.03-1.78)	1.61 (1.17-2.22)	1.83 (1.20-2.62)
60-min	0.453 (0.396-0.523)	0.560 (0.489-0.647)	0.714 (0.622-0.828)	0.850 (0.734-0.995)	1.05 (0.876-1.28)	1.23 (0.994-1.53)	1.41 (1.12-1.81)	1.62 (1.24-2.14)	1.94 (1.41-2.68)	2.20 (1.55-3.16)
2-hr	0.607 (0.531-0.700)	0.748 (0.653-0.864)	0.946 (0.825-1.10)	1.12 (0.966-1.31)	1.37 (1.14-1.67)	1.58 (1.28-1.97)	1.80 (1.42-2.31)	2.05 (1.57-2.71)	2.41 (1.76-3.33)	2.70 (1.90-3.88)
3-hr	0.732 (0.641-0.845)	0.904 (0.790-1.05)	1.14 (0.996-1.33)	1.35 (1.17-1.58)	1.65 (1.37-2.00)	1.89 (1.54-2.36)	2.15 (1.70-2.76)	2.44 (1.87-3.22)	2.85 (2.08-3.94)	3.18 (2.24-4.57)
6-hr	0.921 (0.806-1.06)	1.15 (1.00-1.32)	1.46 (1.27-1.69)	1.72 (1.48-2.01)	2.10 (1.74-2.55)	2.40 (1.95-2.99)	2.73 (2.15-3.49)	3.08 (2.35-4.06)	3.57 (2.61-4.94)	3.98 (2.80-5.72)
12-hr	1.06 (0.927-1.22)	1.34 (1.17-1.55)	1.73 (1.51-2.00)	2.06 (1.78-2.41)	2.53 (2.11-3.08)	2.92 (2.37-3.63)	3.33 (2.63-4.25)	3.76 (2.88-4.97)	4.39 (3.20-6.07)	4.90 (3.44-7.04)
24-hr	1.40 (1.28-1.56)	1.81 (1.65-2.02)	2.37 (2.16-2.66)	2.85 (2.57-3.21)	3.53 (3.10-4.09)	4.08 (3.52-4.81)	4.66 (3.94-5.61)	5.28 (4.37-6.52)	6.17 (4.93-7.89)	6.90 (5.35-9.08)
2-day	1.73 (1.58-1.93)	2.26 (2.07-2.53)	2.98 (2.71-3.34)	3.58 (3.24-4.04)	4.41 (3.88-5.12)	5.07 (4.38-5.98)	5.76 (4.87-6.94)	6.48 (5.36-7.98)	7.48 (5.97-9.56)	8.28 (6.42-10.9)
3-day	1.98 (1.81-2.21)	2.60 (2.38-2.91)	3.44 (3.13-3.85)	4.12 (3.72-4.65)	5.06 (4.45-5.87)	5.79 (5.00-6.84)	6.54 (5.54-7.88)	7.32 (6.05-9.03)	8.39 (6.69-10.7)	9.22 (7.15-12.1)
4-day	2.15 (1.97-2.41)	2.85 (2.60-3.19)	3.77 (3.43-4.22)	4.51 (4.08-5.09)	5.53 (4.86-6.42)	6.32 (5.46-7.46)	7.12 (6.03-8.58)	7.94 (6.57-9.80)	9.07 (7.24-11.6)	9.94 (7.71-13.1)
7-day	2.65 (2.42-2.97)	3.53 (3.22-3.94)	4.67 (4.25-5.23)	5.59 (5.06-6.31)	6.84 (6.02-7.94)	7.80 (6.74-9.21)	8.76 (7.42-10.6)	9.76 (8.07-12.0)	11.1 (8.85-14.2)	12.1 (9.40-16.0)

Source: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

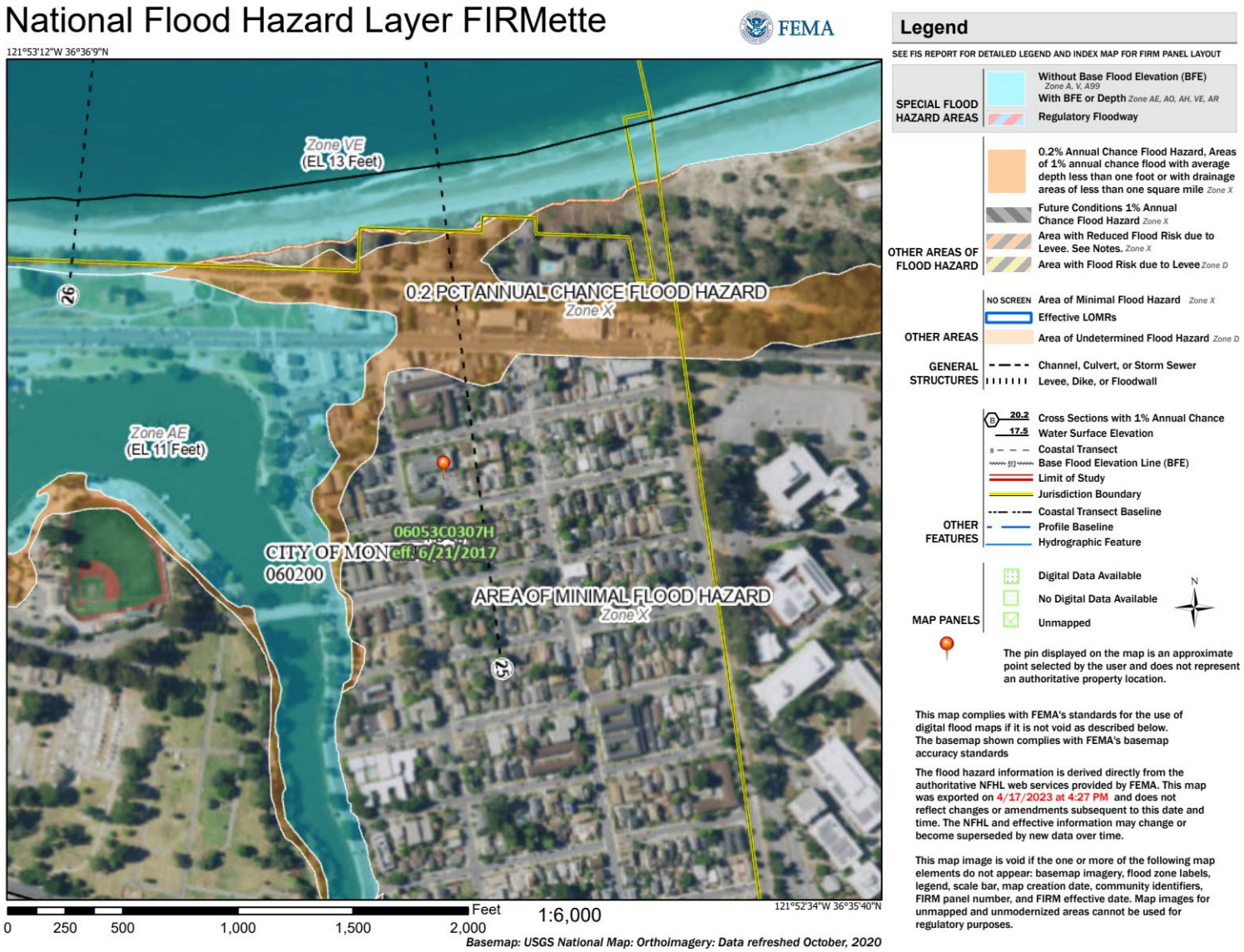
Floodplain

"The project is located within FEMA Zone X, Area of Minimal Flood Hazard and Future Conditions 1% Annual Chance of Flood Hazard. See Attachment D for FEMA FIRMette."

Another project example:

"The project site is located in FEMA Zone AO (1 foot depth). See Attachment D for FEMA FIRMette.

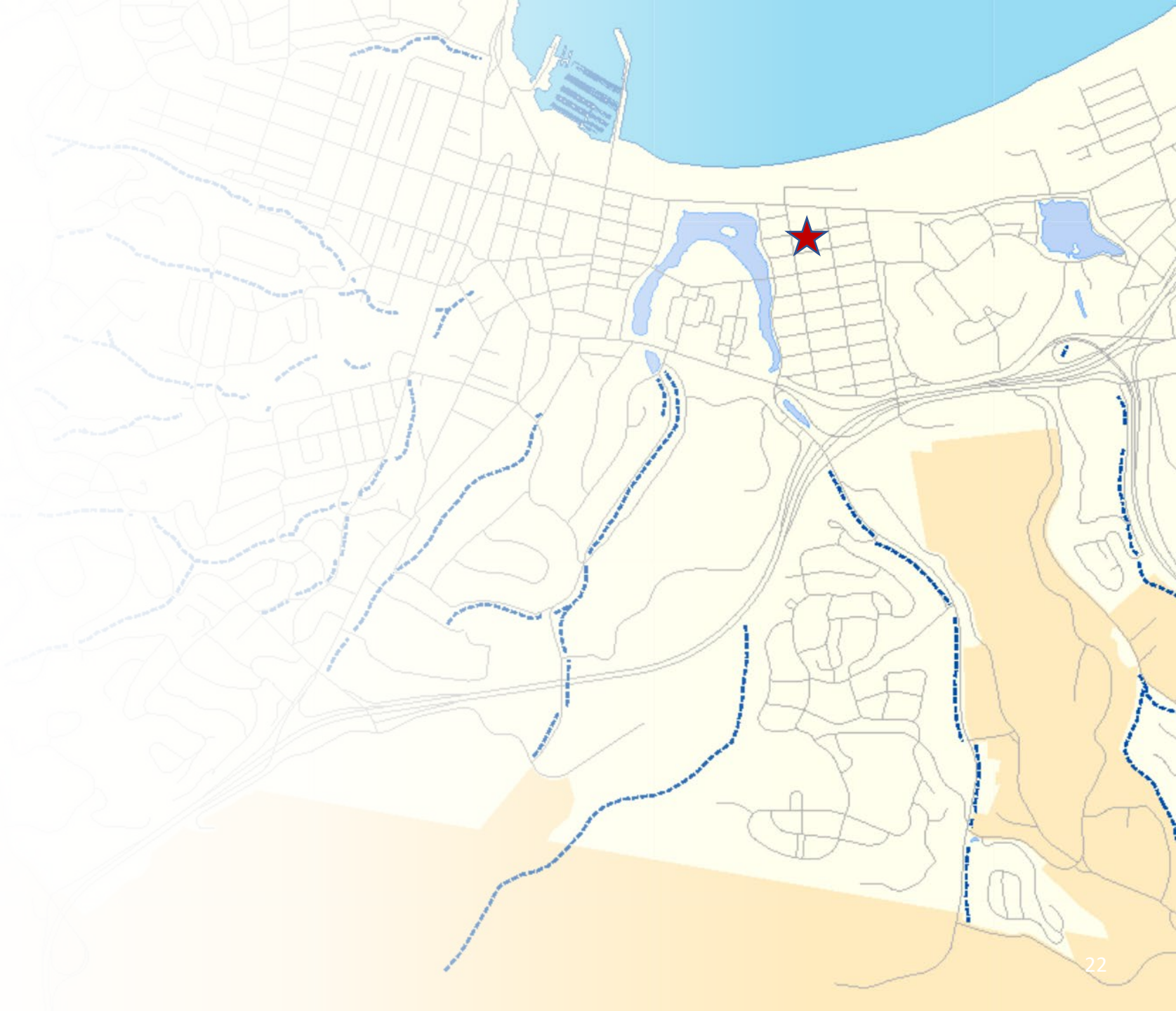
The County floodplain ordinance for development in Zone AO (1 foot depth) requires the building finished floors be at least 2 feet above the highest existing grade at each building (i.e., 1 foot above the Zone AO ponding depth). The finished floor elevation required to meet this requirement is 33.6 feet."



Source: https://www.fema.gov/flood-maps/national-flood-hazard-layer

Drainage

"No natural drainage courses, riparian or wetland areas exist within the site."

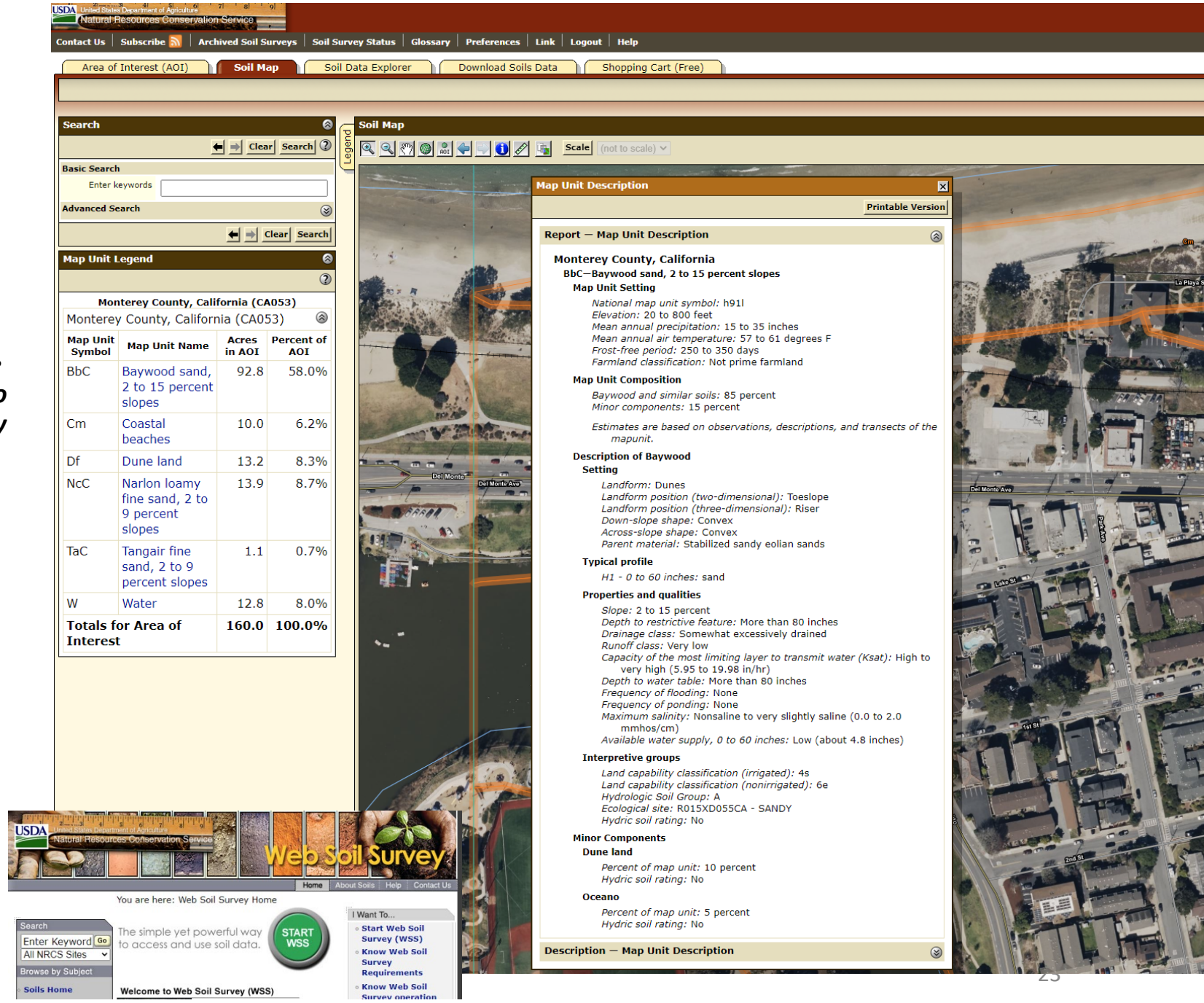


Soils, Infiltration, Groundwater

"Native soils at the Project Site are mapped as Baywood Sand, which is estimated to have a 6 to 20 inch per hour permeability. (See Attachment C.) The project's geotechnical borings show bedrock at 17' to 20' depth. Local groundwater levels are controlled by bedrock and the level of El Estero Lake and seasonal high groundwater is expected at 10' to 15' depth.

Due to the relatively shallow groundwater, "deep" infiltration facilities (underground infiltration chambers or seepage pits) are not feasible.

A factored infiltration rate of 0.75 in/hr and an infiltration rate "safety factor" of 1 is used for the proposed bioretention ponds and permeable pavements as recommended in the Monterey Regional Storm Water Management Program (MRSWMP) Stormwater Technical Guide for Low Impact Development."



Percolation Test Hole (3 inch diameter)	Depth (ft)	Soil Description	Percolation Rate (inches/hour)
1	9.9	Poorly Graded Sand	84
2	5..1	Poorly Graded Sand	132
3	10.3	Poorly Graded Sand	180
4	5.0	Poorly Graded Sand	216

Inversed Auger-Hole (Porchet) Method for Determining Field Saturated Hydraulic Conductivity (Kfs)

Test Location 1

Calc Method 1

$$I_t = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})}$$

Source: Orange County TGD (referenced in MRSWMP Technical Guidance)

Calc Method 2

$$K = 1.15\ r\ \frac{\log(h_0 + \tfrac{1}{2}r) - \log(h_t + \tfrac{1}{2}r)}{t - t_0}$$

Source: Chapter 12 in: H.P.Ritzema (Ed.), Drainage Principles and Applications

bore hole diameter	6	inches
casing diameter	3	inches
Annuar space rock porosity	0.4	--
bore hole void ratio	0.55	--
bore hole depth	9.94	feet
Reading distance above grade (riser height)	0.0	feet

Time	dt	Reading	H	dH	H_{avg}	Kfs Method 1	Kfs Method 2
(min)	(min)	(in)	(in)	inches	inches	in/hr	in/hr
0		19.8	99.5				
5	5	38.52	80.8	18.7	90.1	2.0	2.0
13	8	58.2	61.1	19.7	70.9	1.7	1.7
18	5	70.08	49.2	11.9	55.1	2.1	2.1
23	5	80.4	38.9	10.3	44.0	2.2	2.3
33	10	99.84	19.4	19.4	29.2	3.1	3.2
43	10	114.84	4.4	15.0	11.9	5.5	6.2
53	10	119.3		4.4	4.4	3.7	6.8
53		18	101.3				
63	10	34.2	85.1	16.2	93.2	0.8	0.8
73	10	48.95	70.3	14.8	77.7	0.9	0.9
83	10	60.12	59.2	11.2	64.7	0.8	0.8
93	10	70.44	48.8	10.3	54.0	0.9	0.9
103	10	79.44	39.8	9.0	44.3	1.0	1.0
113	10	88.56	30.7	9.1	35.3	1.2	1.2
123	10	97.44	21.8	8.9	26.3	1.6	1.6

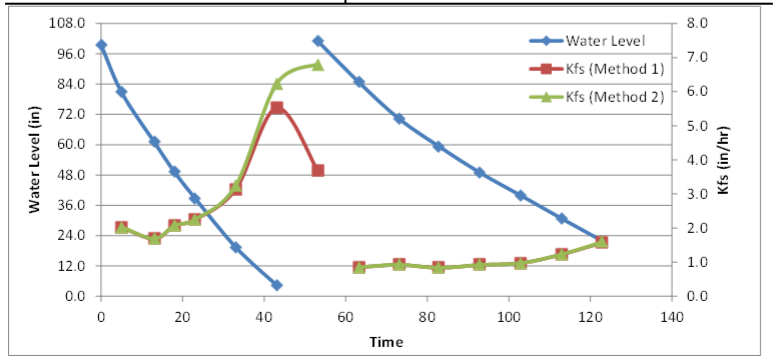


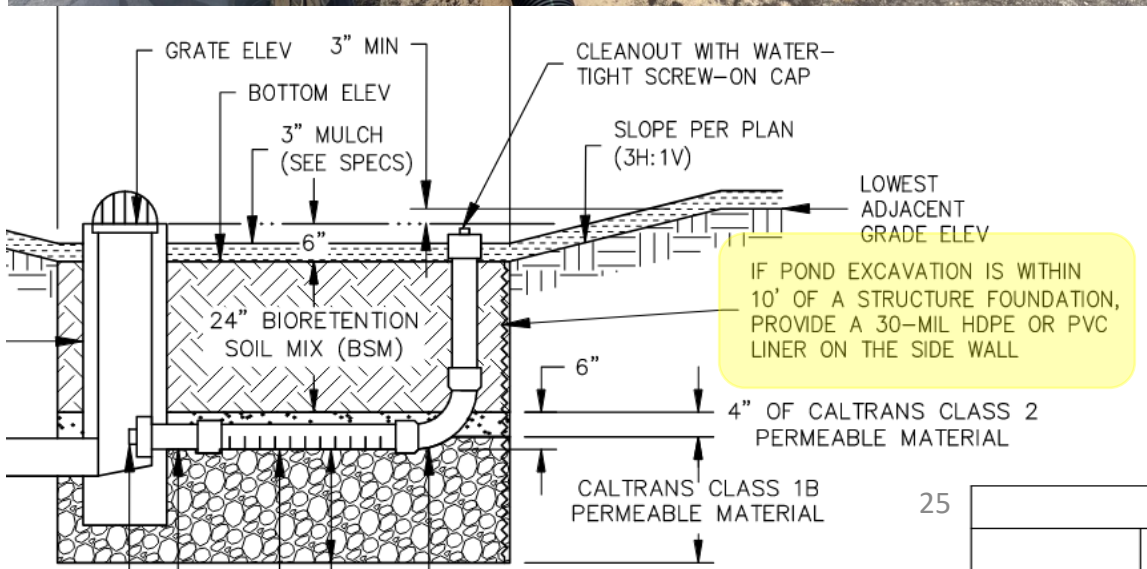
Table 2. Percolation Test Results

Location	Depth of Boring (ft)	Kfs, Calculated Field Saturated Hydraulic Conductivity (in/hr, minimum)
I-1	9.9	1.0
I-2	5.1	4.7
I-3	10.3	1.6
I-4	5.0	8.3

Setbacks to Structures and Slopes

"We consulted with the project Geotechnical Engineer regarding setbacks between proposed infiltration-based SCMs and buildings, and mitigation strategies for SCMs located closer than the preferred setback. One infiltration-based SCM is proposed to be constructed less than 10' away from a structure foundation. The side walls of that SCM will be lined with an impermeable liner."

20 feet is recommended, 10 feet is frequently acceptable, and less than 10 feet is generally either not acceptable or is acceptable with mitigation. Discuss with the project's geotechnical engineer.

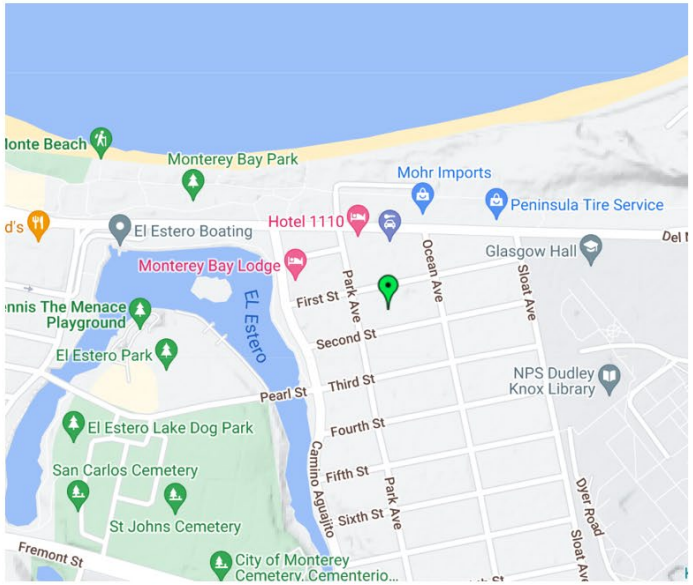


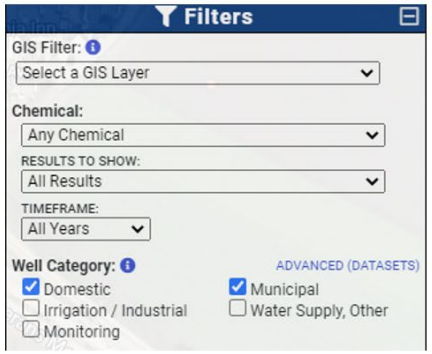
Water Wells

"No water wells exist on the site or within 200 feet of the proposed SCMs."

Generally, provide 200' setback to public domestic water wells and 100' setback to other domestic water wells. Applies to infiltration-based SCMs.

Map of Nearby Domestic Water Wells





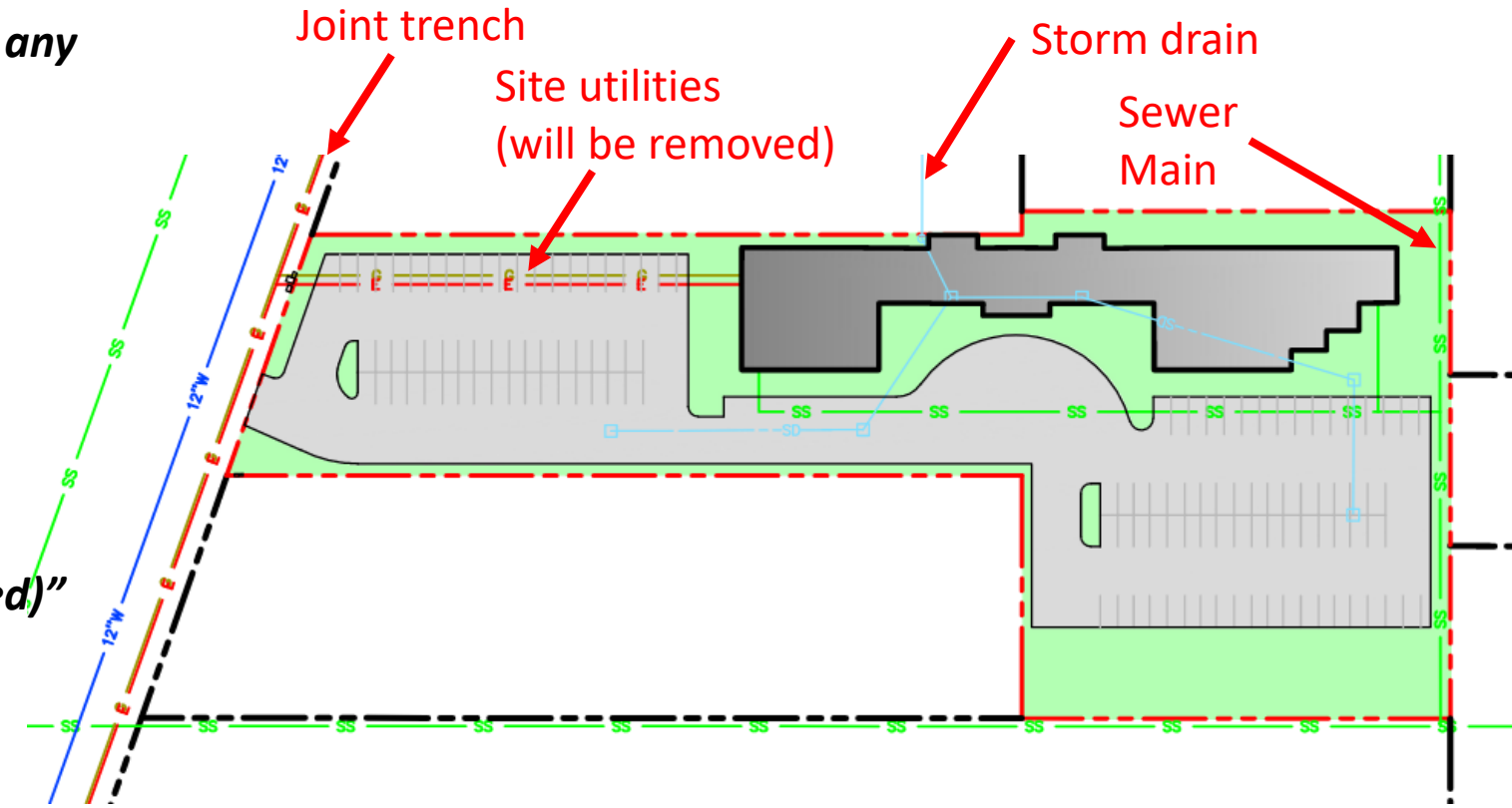
Source:
https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/default.asp
Accessed: 8/14/20

Utilities and Easements

"There are various existing utility easements on the site. SCMs are not proposed within any utility easement.

Setbacks between utilities and retention-based SCMs are provided as follows:

- ***Public water mains: 10' minimum***
- ***PG&E utility poles: 15' minimum***
- ***PG&E underground electric lines: 3' (minimum) / 4' (preferred)***
- ***Other underground utilities: 4' (preferred)"***



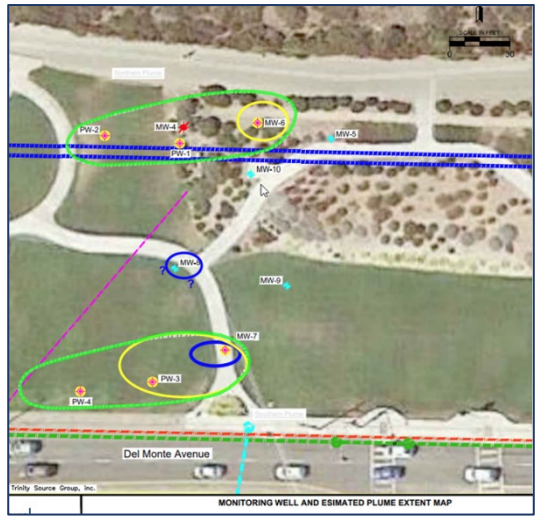
Utilities can be a significant limitation to site development as well as SCM placement.

Note that setback requirements vary by utility and jurisdiction.

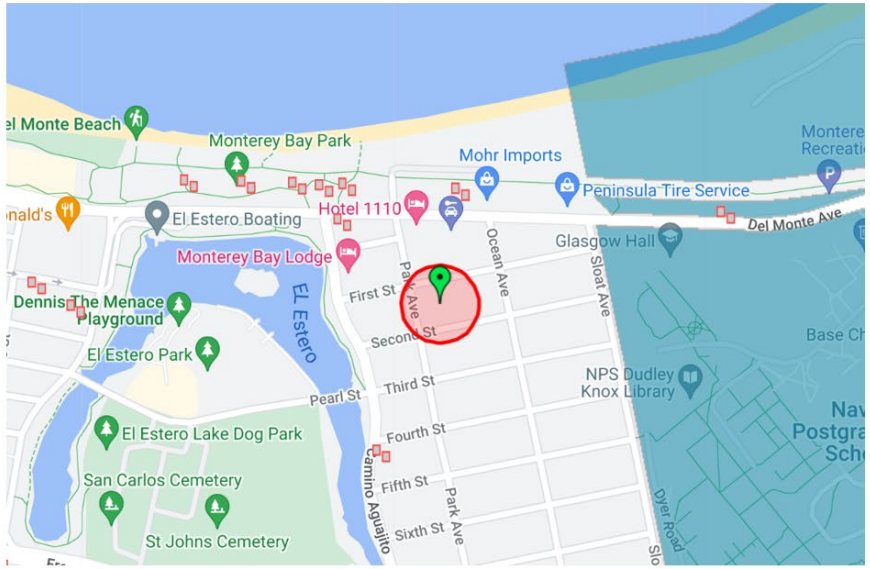
Underground Hazardous Materials

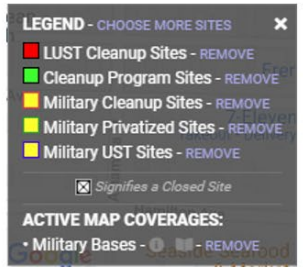
"There are no identified underground hazardous materials storage tanks, hazardous waste sites, or cleanup sites mapped near the site. (See Attachment D.)"

The Local Agency may prohibit infiltration over/near contaminated soils. This can present a problem for compliance with PCR 3.



Map of Nearby USTs, Hazardous Waste Sites, and Cleanup Sites





There are no identified USTs, hazardous waste, or cleanup sites within 200' of the proposed stormwater control measures (SCMs).

Source: https://geotracker.waterboards.ca.gov/

Accessed: 8/10/2020

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MRSWMP Template

Tables

Preliminary Design – PCR 1

MRSWMP Template

III. Performance Requirement No. 1 (Tier 1), Site Design and Runoff Reduction Strategies

[Explain how each measure is applicable or not applicable to the regulated project.]

III.A. Design Strategies to Optimize Site Layout for Water Quality
[describe how each of the following was achieved]

III.A.1. Limitation of development envelope.
[such as concentrated improvements on least sensitive portion of site, open space area(s) to be retained in natural/vegetated undisturbed state, etc.]

III.A.2. Preservation of natural drainage features.
[such as protecting natural drainage pathways, minimizing grading footprint to preserve topography of natural drainage areas, etc.]

III.A.3. Setbacks from creeks, wetlands, and riparian habitats.
[such as site development away from creeks, retain existing riparian area, limit disturbance within __ feet of natural drainage feature, etc.]

III.A.4. Minimization of imperviousness.
[such as retain natural areas on-site, heighten building to reduce building footprint, select pervious material for walkways, patios, etc.]

My SWCP

III. Site Design and Runoff Reduction Strategies (Tier 1)

III.A. Design Strategies to Optimize Site Layout for Water Quality

III.A.1. Limitation of development envelope.
Not applicable: no sensitive areas exist on site.

III.A.2. Preservation of natural drainage features.
No natural drainage features are present within the project area.

III.A.3. Setbacks from creeks, wetlands, and riparian habitats.
No creeks, wetlands, or riparian habitats are present within the project area.

III.A.4. Minimization of imperviousness.
Impervious areas are minimized and are 'disconnected' where feasible.

Preliminary Design – PCR 1

MRSWMP Template

III.B. Minimum Required Tier 1 Measures:

[All regulated projects are required to minimize stormwater runoff by implementing one (1) or more of the following Site Design Measures. Explain how each measure is applicable or not applicable to the regulated project.]

III.B.1. Direct roof runoff into cisterns or rain barrels for reuse.

III.B.2. Direct roof runoff onto vegetated areas safely away from building foundations and footings, consistent with the California Building Code.

III.B.3. Direct runoff from sidewalks, walkways and/or patios onto vegetated areas safely away from building foundations and footings, consistent with the California Building Code.

III.B.4. Direct runoff from driveways and/or uncovered parking lots onto vegetated areas safely away from building foundations and footings, consistent with the California Building Code.

III.B.5. Construct bike lanes, driveways, uncovered parking lots, sidewalks, walkways and patios with permeable surfaces.

My SWCP (I modified formatting a bit)

Table 2. Summary of Tier 1 Measures

Implemented	Measure
No	Direct roof runoff into cisterns or rain barrels for reuse. Notes: Cisterns and rain barrels are not proposed.
Yes	Direct roof runoff onto vegetated areas safely away from building foundations and footings, consistent with the California Building Code. Notes: Roof downspouts drain to adjacent landscape areas where feasible, as shown on the Construction Drawings.
Yes	Direct runoff from sidewalks, walkways and/or patios onto vegetated areas safely away from building foundations and footings, consistent with the California Building Code. Notes: Sidewalks, walkways and patios will be sloped to drain to adjacent planter areas where feasible, as shown on the Construction Drawings
Yes	Direct runoff from driveways and/or uncovered parking lots onto vegetated areas safely away from building foundations and footings, consistent with the California Building Code. Notes: Impervious driveways and/or parking lots drain to adjacent landscape areas where feasible, as shown on the Construction Drawings.
Yes	Construct bike lanes, driveways, uncovered parking lots, sidewalks, walkways and patios with permeable surfaces. Notes: Decorative permeable pavers are proposed to be used for pedestrian paving, as shown on the Construction Drawings.

Other Measures Considered But Rejected

Preliminary Design – PCR 1

III.B. Minimum Required Tier 1 Measures:

[All regulated projects are required to minimize stormwater runoff by implementing one (1) or more of the following Site Design Measures. Explain how each measure is applicable or not applicable to the regulated project.]

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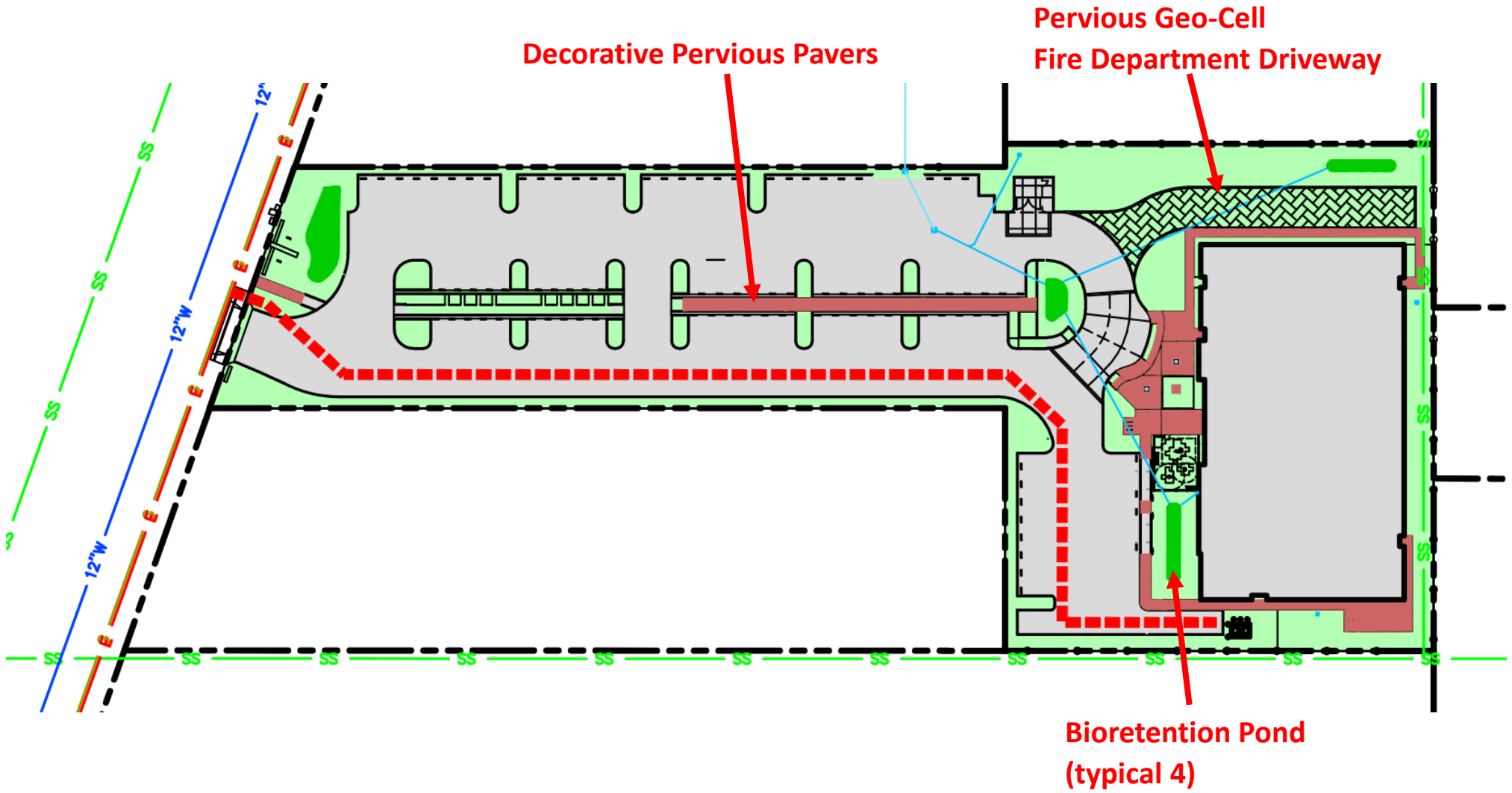
Table of Contents

MRSWMP Template

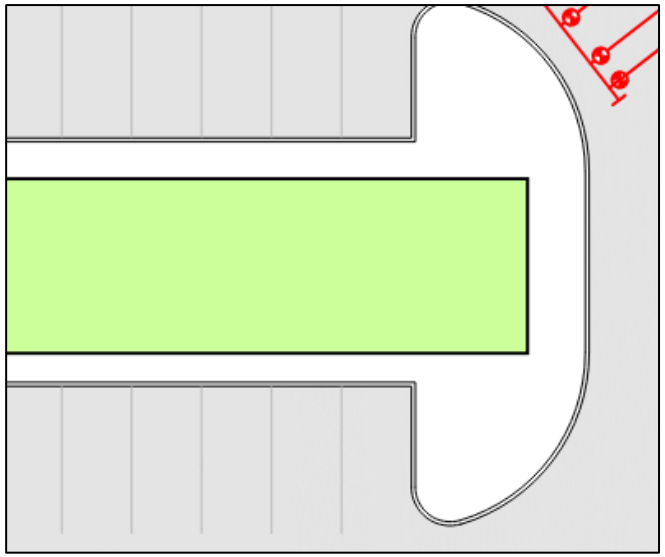
Tables

SCM Design

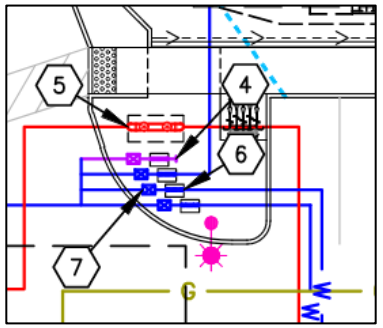
- Coordinate with Architect, Landscape, Geotech
- SCM sizing calculations
  - *PCR 1 – Not numerically sized*
  - PCR 2 – Typically an area ratio
  - PCR 3 – Central Coast SCM Calculator (simple Excel spreadsheet)
  - PCR 4 – Computer program (e.g. HEC-HMS or HydroCAD) *(maybe defer to later)*
- Flood control and conveyance
  - Local agency requirements
  - Check emergency overflow paths
  - Check for sometimes-problematic situations (e.g. concentrated flow on slopes)
- Construction Considerations
- O&M Considerations


Decorative Pervious Pavers
Pervious Geo-Cell
Fire Department Driveway
Bioretention Pond
(typical 4)
12"W
12"W
SS
E

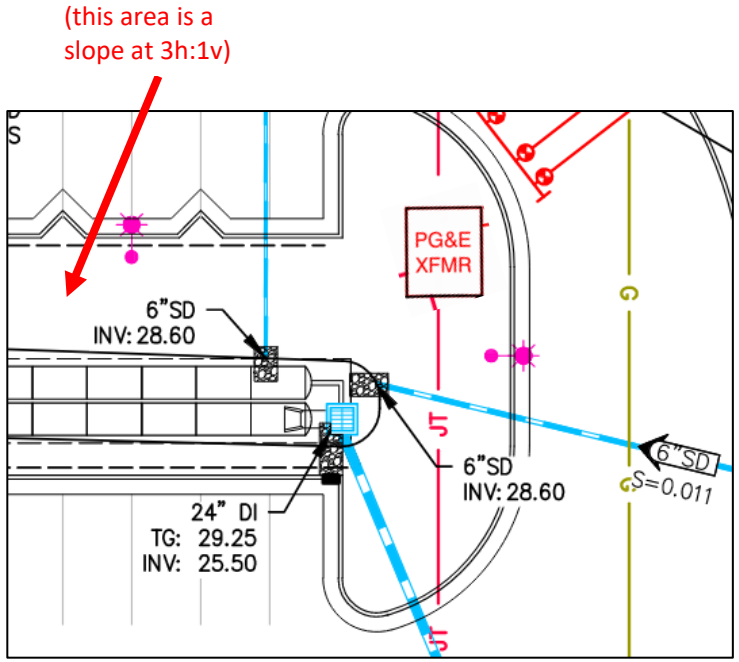

A
21 Jun 2021, 11:58:16
B



My initial concept drawing (6% AR)

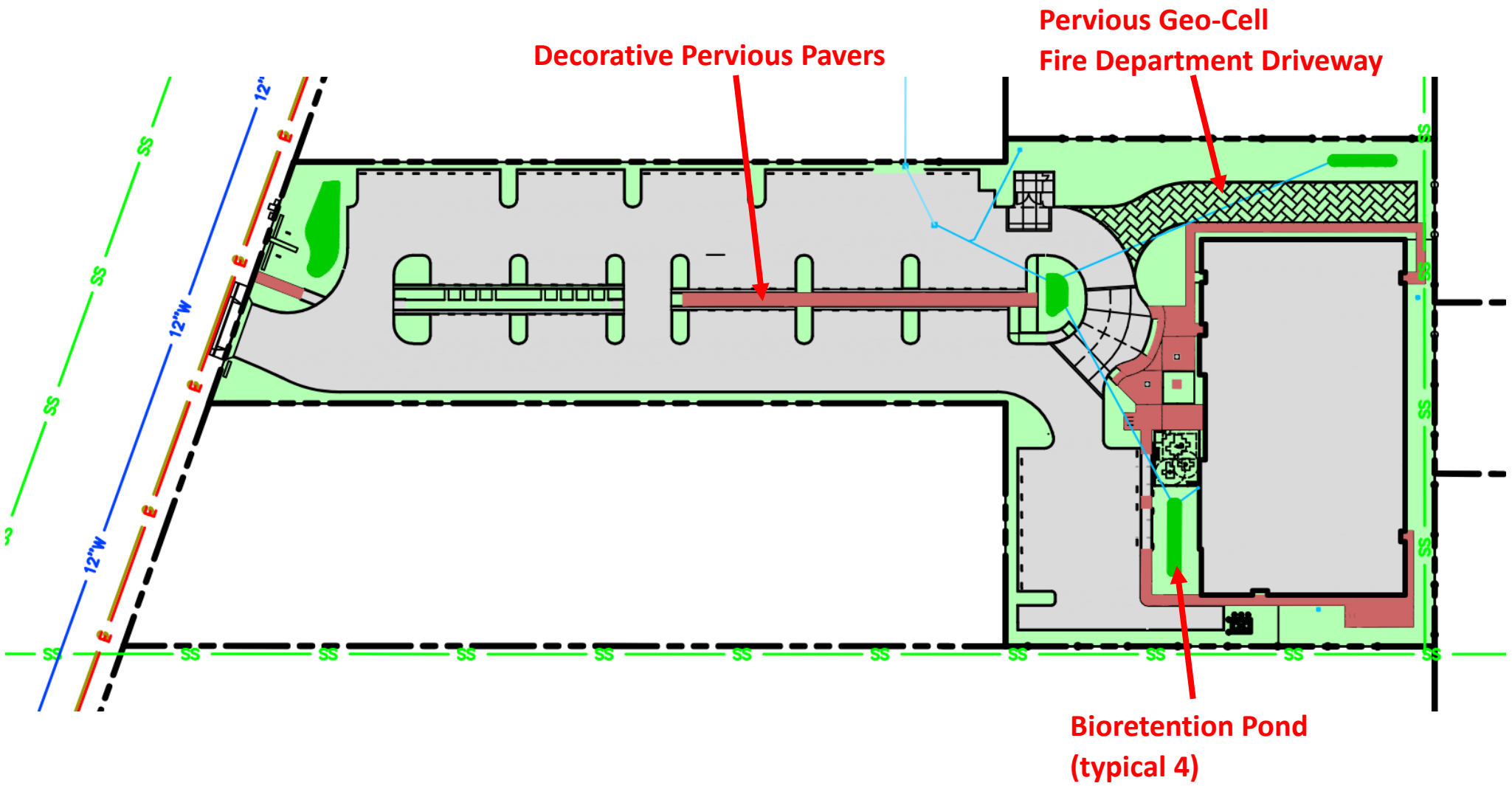


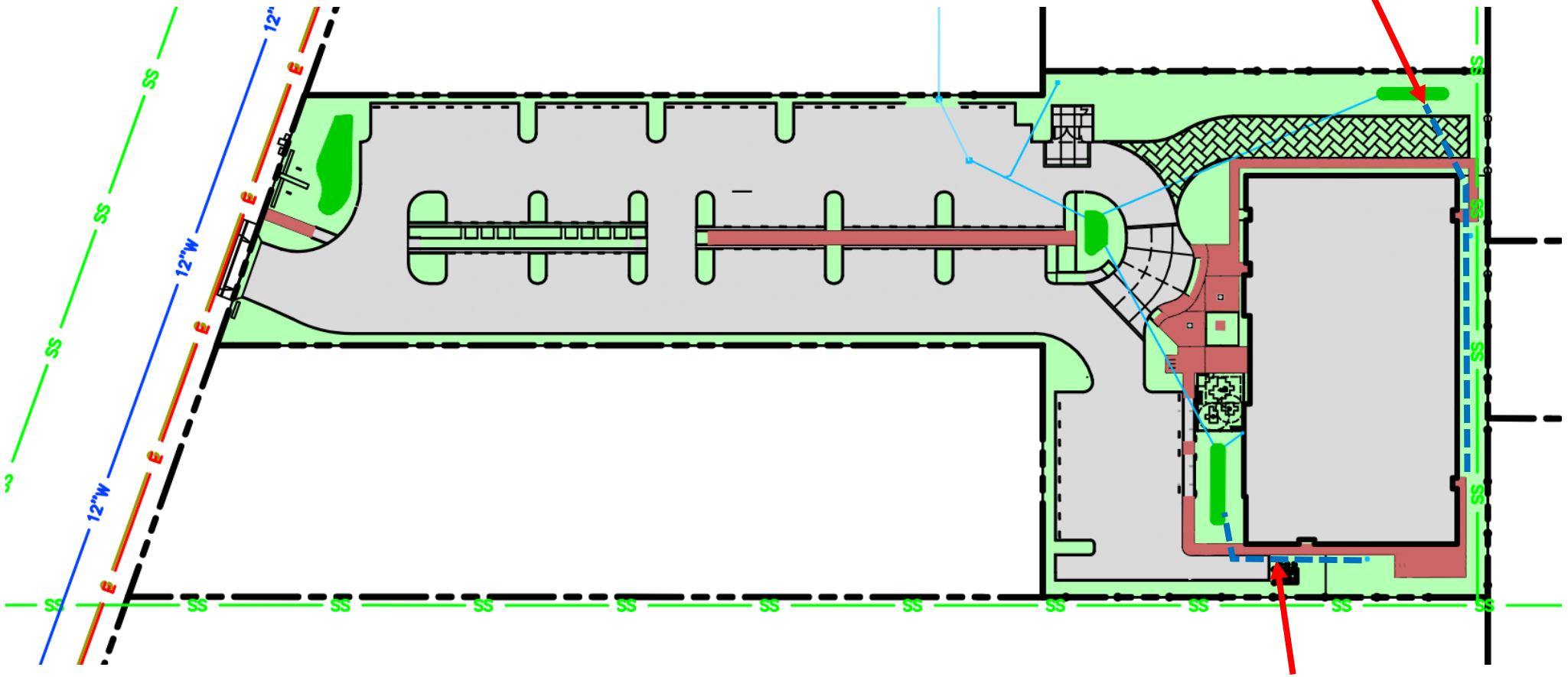
No help from this other planter, it's already taken.



What we ended up with (4% AR)


DANGER
POWER LINES ABOVE
GRAINGER
9302


Decorative Pervious Pavers
Pervious Geo-Cell
Fire Department Driveway
Bioretention Pond
(typical 4)


Storm drain from downspouts to bioretention area
Storm drain from downspouts to bioretention area
12"W
12"W
12"
SS
E

A 6”-deep bioretention planter

A 2’-deep bioretention planter
(still only ponds 6” deep)

A 6”-deep bioretention planter

A 2’ to 3’-deep bioretention planter
(elevation varies around perimeter)

PCR 3
Calcs, SWCP Tables

Central Coast Region
Stormwater Control Measure
Sizing Calculator

1. Project Information

Project name:	Carr Lake Restoration and Park
Project location:	PRELIMINARY 8/14/20
Tier 2/Tier 3:	Tier 3 - Retention
Design rainfall depth (in):	1.1
Total project area (ft2):	
Total DMA area (ft2):	0
Total new impervious area (ft2):	
Total replaced impervious within a USA (ft2):	
Total replaced impervious not in a USA (ft2):	
Total pervious/landscape area (ft2):	
Total SCM area (ft2):	

2. DMA Characterization

Name	DMA Type	Area (ft2)	Surface Type	New, Replaced?	Connection
DMA 1 NIA	Drains to SCM	38000	Concrete or asphalt	New	SCM A
DMA 1 RIA	Drains to SCM	0	Concrete or asphalt	Replaced	SCM A
DMA 1 NPA	Drains to SCM	0	Landscape	New	SCM A
DMA 1 RPA	Drains to SCM	52000	Landscape	Replaced	SCM A
DMA 2 NIA	Drains to SCM	47000	Concrete or asphalt	New	SCM B
DMA 2 RIA	Drains to SCM	12000	Concrete or asphalt	Replaced	SCM B
DMA 2 NPA	Drains to SCM	3000	Landscape	New	SCM B
DMA 2 RPA	Drains to SCM	88000	Landscape	Replaced	SCM B

DMA Summary Area

Total assigned DMA area (ft2):	240000	
New impervious area (ft2):	85000	*Check DMA table areas against plan sheet areas*
Replaced impervious within a USA (ft2):	0	
Replaced impervious not in a USA (ft2):	12000	*Check DMA table areas against plan sheet areas*
Total pervious/landscape area (ft2):	143000	*Check DMA table areas against plan sheet areas*

3. SCM Characterization

Name	SCM Type	Safety Factor	SCM Soil Type	Infilt. Rate (in/hr)	Area (ft2)
SCM A	Bioretention	1	HSG A/B	0.75	2000
SCM B	Bioretention	1	HSG A/B	0.75	3000

4. Run SBUH Model

5. SCM Minimum Sizing Requirements

SCM Name	Min. Required Storage Vol. (ft3)	Depth Below Underdrain (ft)	Drain Time (hours)	Orifice Diameter (in)
SCM A	1140	1.43	6.0	
SCM B	1528	1.27	4.6	

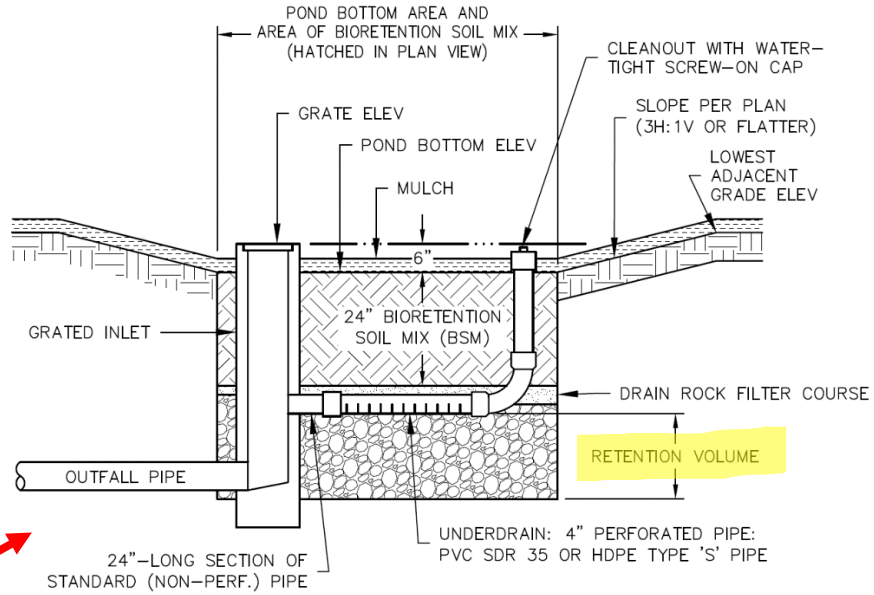


Table 7. Retention Volume Summary

SCM No.	Type	Infiltration Area (s.f.)	Required Retention Volume (c.f.)	Retention Volume Provided (c.f.)
1	Bioretention Pond w/ 24" Drain Rock	2,050	4,170	4,483
2	Bioretention Pond w/ 24" Drain Rock	410	738	896

PCR 4 Design (Volumetric)

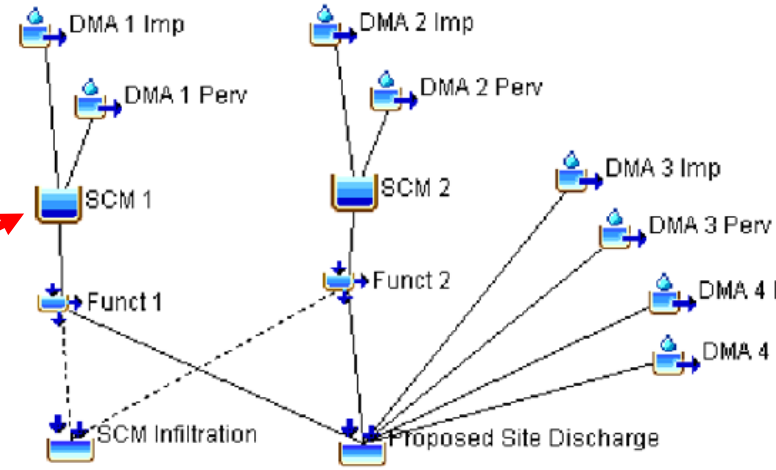
Drainage Management Areas (sq. ft.)

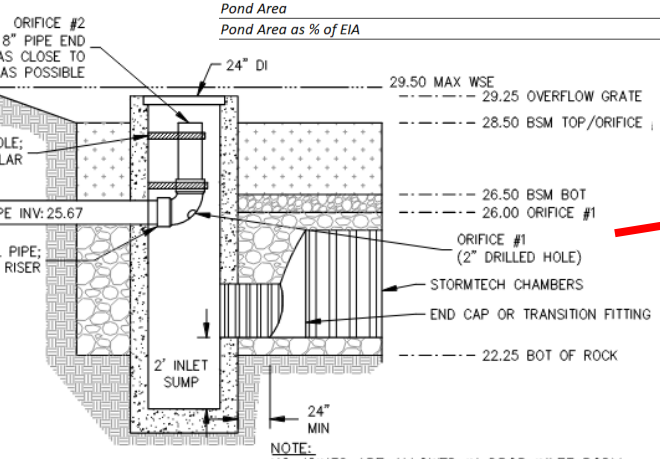
DMA:	DMA 1 SCM 1	DMA 2 SCM 2	DMA 3 Drains Off-site	DMA 4 Drains Off-site	DMA 5 Offsite, Exempt	DMA 6 Offsite, Exempt	DMA 7 Offsite, Exempt	DMA 8 Offsite, Exempt	Total
Project Area	**88,900**	**38,800**	**20,500**	**400**	**900**	**1,400**	**1,100**	**112,800**	**264,800**
New Impervious Area	71,400	12,800	400	300	300	1,000	300	-	**86,500**
Replaced Impervious Area	-	-	-	-	600	400	800	-	**1,800**
New Pervious Area	-	-	-	-	-	-	-	-	-
Replaced Pervious Area	14,200	24,500	-	100	-	-	-	-	**38,800**
SCM Area (New Pervious Area)	-	-	-	-	-	-	-	-	-
SCM Area (Replaced Pervious Area)	3,300	700	-	-	-	-	-	-	**4,000**
STA/SRA Area (Replaced Pervious Area)	-	800	20,100	-	-	-	-	112,800	**133,700**
Existing Areas to Remain (Runs On To Project Area)	**-**	**-**	**-**	**-**	**1,700**	**16,000**	**-**	**-**	**17,700**
Impervious Area to Remain	-	-	-	-	1,500	14,000	-	-	**15,500**
Pervious Area to Remain	-	-	-	-	200	2,000	-	-	**2,200**
Totals - Pre-Project	**88,900**	**38,800**	**20,500**	**400**	**2,600**	**17,400**	**1,100**	**112,800**	**282,500**
Total Impervious Area	-	-	-	-	2,100	14,400	800	-	17,300
Total Pervious Area	88,900	38,800	20,500	400	500	3,000	300	112,800	265,200
Totals - Post-Project	**88,900**	**38,800**	**20,500**	**400**	**2,600**	**17,400**	**1,100**	**112,800**	**282,500**
Total Impervious	71,400	12,800	400	300	2,400	15,400	1,100	-	103,800
Total SCM Area	3,300	700	-	-	-	-	-	-	4,000
Total STA/SRA Area	-	800	20,100	-	-	-	-	112,800	133,700
Total Pervious Area (excepting SCMs, STAs & SRAs)	14,200	24,500	-	100	200	2,000	-	-	41,000
Equivalent Impervious Area (EIA)	*76,120*	*15,950*							
Pond Area	*3300*	*700*							*4,000*
Pond Area as % of EIA	*4.3%*	*4.4%*							

Table 8. Routing Method Criteria

Hydrograph Analysis Method	NRCS TR-55 (using the HEC-HMS computer program)
Pond Routing Method	Storage-Discharge
Rainfall Distribution	NRCS Type 1
Time of Concentration	15 minute (which is equal to a 10 minute Lag Time)
Time Increment	1 minute

HEC-HMS Model





Elev. (ft)	Void Ratio (below)	Storage (below) (cf)	Cum. Storage Vol. (cf)	Cum. Storage Vol. (AF)	Exfiltr. into Soil (cfs)	Orifice Flow (cfs)	Over-flow (cfs)	Discharge to SD (cfs)	Total Q Out (cfs)	Description/Notes
57.60	**1.00**	112	1,075	0.0247	0.000	0.003	1.3	1.303	1.303	Design Max WSE
57.35	**1.00**	224	963	0.0221	0.000	0.003	0	0.003	0.003	Overflow Grate
56.85	**0.26**	233	739	0.0170	0.000	0.003	0	0.003	0.003	Top of BSM / Pond Bottom
54.85	**0.35**	78	506	0.0116	0.000	0.001	0	0.001	0.001	Top of Rock / Bottom of BSM
54.35	**0.35**	428	428	0.0098	0.000	0	0	0.000	0.000	Subdrain Invert
51.62	--	--	0	0.0000	0.000	0	0	0.000	0.000	Bottom of Rock

Pond/BSM/Rock Area:	448	sf	
Soil Hydraulic Conductivity (K):	0.003	in/hr	Source: Site-Specific Perc. Testing
Subdrain Orifice Diameter (D):	0.25	in	Source: MRSWMP SCM Calculator
Exfiltration (into soil):	0.000	cfs	= BSM Area x K
Flow through BSM w/o orifice:	0.052	cfs	= BSM Area x 5 in/hr
Flow through BSM w/ Orifice:	varies	cfs	= 3.78 D^2 Ho^0.5, where D and Ho are in feet, and Co=0.6
Overflow:	1.3	cfs	24"-Dia Beehive Grate at 3" Depth, Neenah R-4353

My “rules of thumb” for sizing bioretention for PCR 4

Redevelopment:

- PCR 2: Get 6% A.R. if you can (4% min)
- PCR 3: Run it through the Calculator. Rock depth shouldn’t be too bad due to the 50% RIA credit.
- PCR 4: likely met already, even at 4% A.R. Run it through the computer to confirm.

New Development:

- PCR 2: Get 6% A.R. if you can (“Goldilocks”). If you need to shrink down to ~4%, you’ll probably need to incorporate UG chambers.
- PCR 3: Run it through the Calculator. If over 3’ of rock, chambers start to make sense.
- PCR 4: Add 50% to the PCR 3 volume to get the total pond volume, as a starting point.
- If 100-year detention is required, you’re probably looking at even more volume, and an outfall control structure (weir plate or riser w/ orifices)
- Very roughly, for the design flood analysis the pond volume is typically between 25% and 50% of the 24-hour design storm depth x tributary equivalent impervious area.

Project: 4409 Susan Street 3 Bldgs Simulation Run: 10-Yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: DATA CHANGED, RECOMPUTE

Basin Model: Site
Meteorologic Model: 10-Yr
Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) ACRE-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DMA 1 Imp	0.002679	3.94046	01Jan2000, 10:03	3.98850
DMA 1 Perv	0.000509	0.12524	01Jan2000, 10:05	0.91149
SCM 1	0.003188	2.44160	01Jan2000, 10:12	2.87979
Funct 1	0.003188	2.40860	01Jan2000, 10:12	2.56719
DMA 2 Perv	0.000908	0.22341	01Jan2000, 10:05	0.91149
DMA 2 Imp	0.000484	0.71190	01Jan2000, 10:03	3.98850
SCM 2	0.001392	0.68931	01Jan2000, 10:10	1.68854
Funct 2	0.001392	0.68331	01Jan2000, 10:10	1.55953
DMA 3 Perv	0.000721	0.17740	01Jan2000, 10:05	0.91149
DMA 3 Imp	0.000014	0.02059	01Jan2000, 10:03	3.98850
DMA 4 Imp	0.000011	0.01618	01Jan2000, 10:03	3.98850
DMA 4 Perv	0.000004	0.00098	01Jan2000, 10:05	0.91149
Existing Site DMAs 1 - 4	0.005330	3.30371	01Jan2000, 10:04	1.65805
Existing Site Discharge	0.005330	3.30371	01Jan2000, 10:04	1.65805
Proposed Site Discharge	0.005330	3.24203	01Jan2000, 10:11	2.08548
SCM Infiltration	0.000000	0.03900	01Jan2000, 08:09	n/a

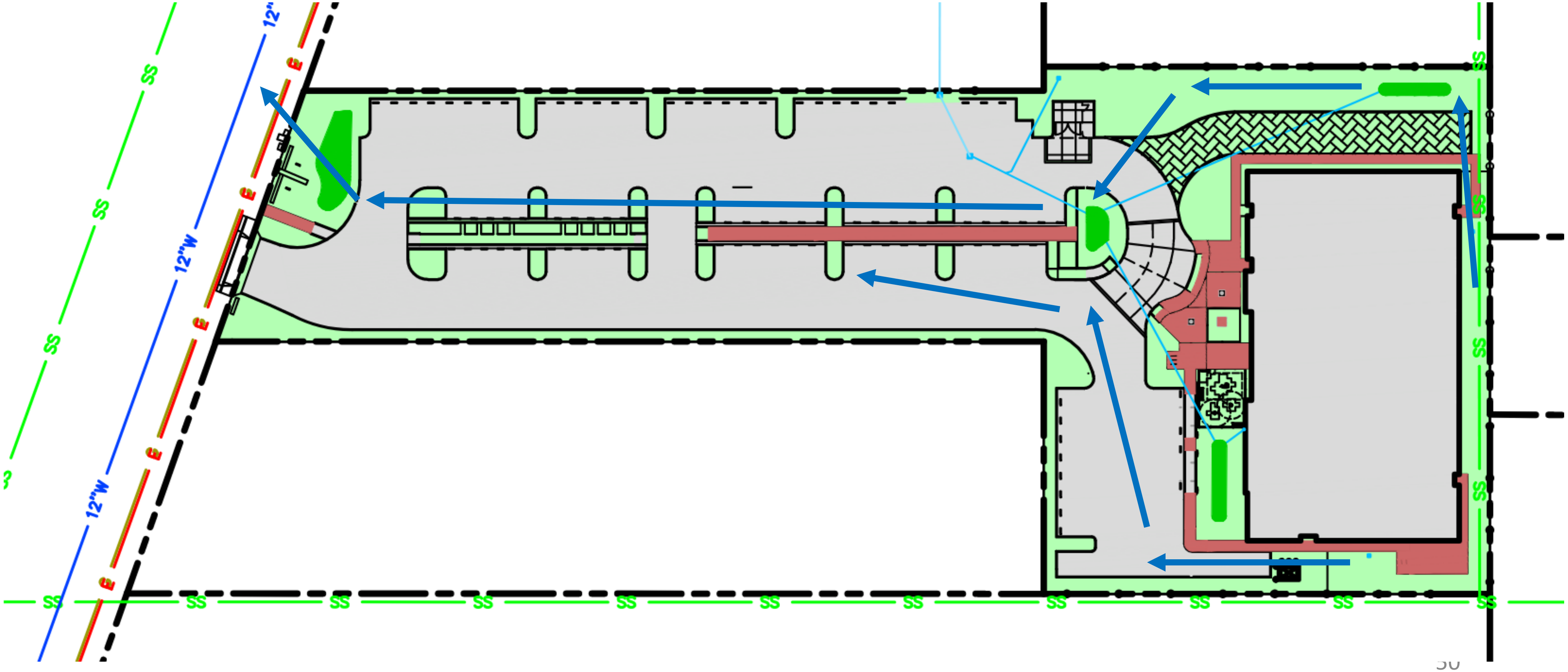
Table 9. Peak Discharge Comparison

Storm Event	24-Hour Precipitation (inches)	Pre-Project Peak Discharge (cfs)	Post-Project Peak Discharge (cfs)
2-Year	2.61	1.17	1.13
5-Year	3.37	2.27	2.23
10-Year	4.00	3.30	3.24
25-Year	4.88	4.86	4.63
50-Year	5.58	6.17	5.72
100-Year	6.30	7.57	6.76

(This example table includes 2- through 100-year storms to meet Local Agency requirements).

“Pre-mortem”:

- What happens when X is overwhelmed by a very large storm?
- What happens when there are back-to-back large storms?
- What happens when X becomes clogged/plugged?
- What happens when X is not maintained?
- What happens if X is not built exactly precisely per plan?
- What if I’m not thinking of X correctly?



Detailed Design

CD's should address:

- Plan View and Grading
- Details*
- Material Specs*
- Construction Inspections
- Temporary protection during construction

Table in the SWCP ties to Plans, Specs

Table 11: Construction Plan Checklist

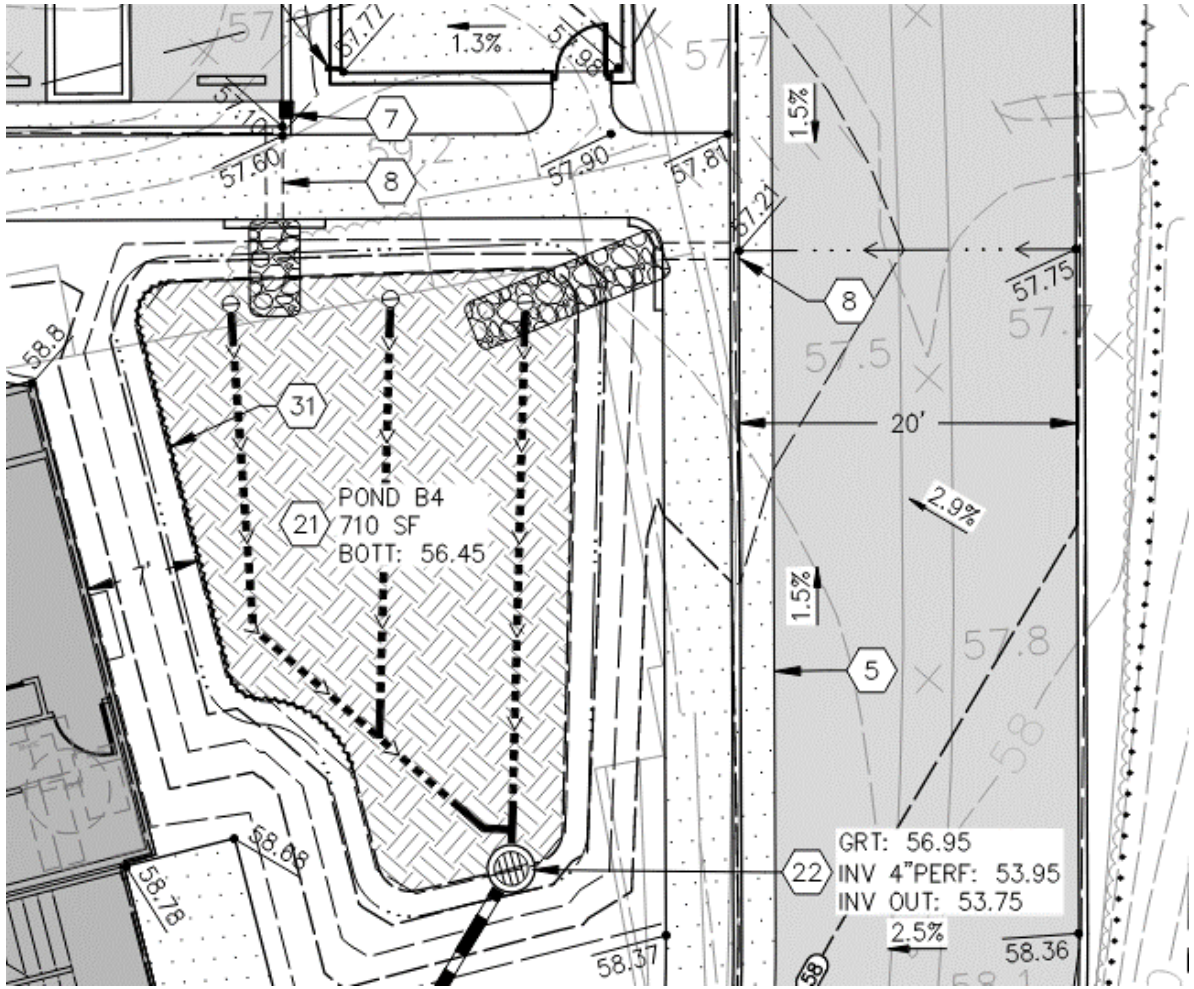
SCM #	SCM Description	Detail Plan Sheet #'s	Plan View Sheet #'s
1	Bioretention pond	C0.6, C0.8,	C1.4, C1.5
2	Bioretention pond	C0.6, C0.8,	C1.6

- **Design Phase Deliverables:**
  - **CD's**
    - **Drawings**
    - **Specifications***
  - **SWCP***
  - **O&M Plan***
  - **Maintenance Agreement***

* Templates are available

Bioretention Pond in plan view

- Elevations, slopes
- Setbacks
- Overflow structure
- Perforated pipe, cleanouts
- BSM (use a hatch to define limits)
- Curb cuts / under-sidewalk drains
- Rock slope protection (RSP)
- Liner (if used)
- Underground chambers (if used)



Details & Specs: Bioretention Pond

Bioretention Pond

Example local agency inspection requirements

CONSTRUCTION INSPECTIONS

1. COPIES OF ALL SWPPP INSPECTION REPORTS SHALL BE PROVIDED TO THE CITY VIA EMAIL AT stormwater@ci.salinas.ca.us
2. PRIOR TO COMMENCEMENT OF ANY LAND DISTURBANCE, THE CONTRACTOR SHALL SCHEDULE AN INSPECTION WITH THE CITY OF SALINAS TO ENSURE ALL NECESSARY SEDIMENT CONTROLS ARE IN PLACE AND IN COMPLIANCE WITH CALTRANS OR CASQA BMP FACT SHEETS.
3. DURING CONSTRUCTION, INSPECTIONS BY THE CITY OF SALINAS WILL BE CONDUCTED TO INSPECT DRAINAGE DEVICE INSTALLATION, REVIEW THE MAINTENANCE AND EFFECTIVENESS OF BMPs, AS WELL AS TO VERIFY THAT POLLUTANTS OF CONCERN ARE NOT DISCHARGED FROM THE SITE.
4. CONTRACTOR SHALL SCHEDULE INSPECTIONS WITH THE CITY OF SALINAS AT ALL STAGES OF CONSTRUCTION OF PERMANENT STORMWATER CONTROL MEASURE (SCM). THESE INCLUDE BIORETENTION PONDS, BIORETENTION PLANTERS, AND PERMEABLE PAVEMENTS.
5. BETWEEN OCT 31 AND APRIL 30, THE CONSTRUCTION CONTRACTOR SHALL SUBMIT TO THE CITY MONTHLY CERTIFICATIONS THAT ALL EROSION AND SEDIMENT CONTROL MEASURES IDENTIFIED ON THE APPROVED EROSION AND SEDIMENT CONTROL PLAN ARE IN PLACE. IF MEASURES ARE NOT IN PLACE, THE CONTRACTOR OR OWNER'S REPRESENTATIVE SHALL PROVIDE THE CITY WITH A WRITTEN EXPLANATION OF WHY THE MEASURE IS NOT PLACE AND WHAT WILL BE DONE TO REMEDY THIS SITUATION.
6. PRIOR TO FINAL INSPECTION, THE CONTRACTOR SHALL SCHEDULE AN INSPECTION WITH THE CITY OF SALINAS TO ENSURE THAT ALL DISTURBED AREAS HAVE BEEN STABILIZED AND THAT ALL TEMPORARY BMPs THAT ARE NO LONGER NEEDED HAVE BEEN REMOVED.

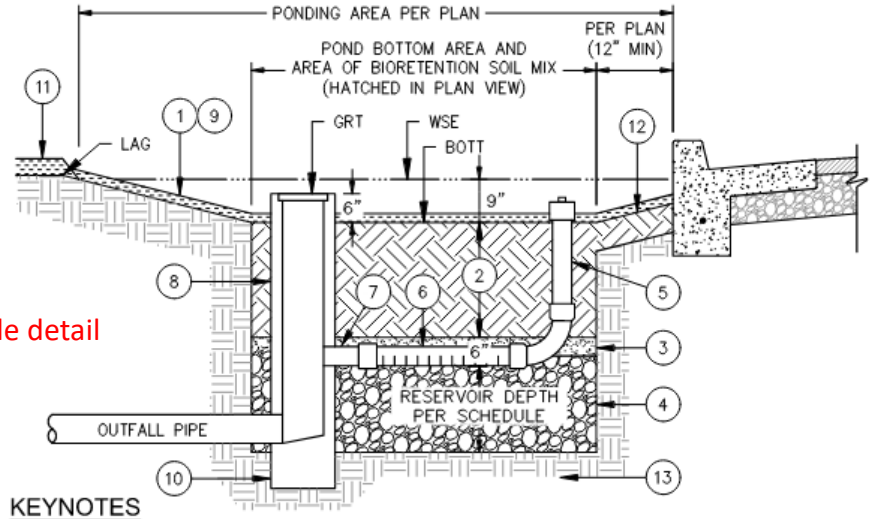
Example Stage-Storage-Discharge Table

SCM A4 - Bioretention Pond

Elev. (ft)	Void Ratio (below)	Storage (below) (cf)	Cum. Storage Vol. (cf)	Cum. Storage Vol. (AF)	Exfiltr. into Soil (cfs)	Orifice Flow (cfs)	Over-flow (cfs)	Discharge to SD (cfs)	Total Q Out (cfs)	Description/Notes
58.25	1.00	117	1,159	0.0266	0.000	0.003	1.3	1.303	1.303	Design Max WSE
58.00	1.00	234	1,042	0.0239	0.000	0.003	0	0.003	0.003	Overflow Grate
57.50	0.26	243	808	0.0186	0.000	0.003	0	0.003	0.003	Top of BSM / Pond Bottom
55.50	0.35	82	565	0.0130	0.000	0.001	0	0.001	0.001	Top of Rock / Bottom of BSM
55.00	0.35	483	483	0.0111	0.000	0	0	0.000	0.000	Subdrain Invert
52.05	--	--	0	0.0000	0.000	0	0	0.000	0.000	Bottom of Rock

Pond/BSM/Rock Area:	468	sf	
Soil Hydraulic Conductivity (K):	0.003	in/hr	Source: Site-Specific Perc. Testing
Subdrain Orifice Diameter (D):	0.25	in	Source: MRSWMP SCM Calculator
Exfiltration (into soil):	0.000	cfs	= BSM Area x K
Flow through BSM (no orifice):	0.054	cfs	= BSM Area x 5 in/hr
Flow through BSM w/ Orifice:	varies	cfs	= 3.78 D^2 Ho^0.5, where D and Ho are in feet, and Co=0.6
Overflow:	1.3	cfs	24"-Dia Beehive Grate at 3" Depth, Neenah R-4353

Example detail



KEYNOTES

1. 1" AGED COMPOST MULCH (USE WITHIN THE ENTIRE PONDING LIMITS): SEE SPECIFICATIONS.
2. 24" BIORETENTION SOIL MIX (BSM): SEE SPECIFICATIONS.
3. 6" GRAVEL FILTER COURSE: WASHED CALTRANS CLASS 2 PERMEABLE MATERIAL
4. ROCK RESERVOIR COURSE (THICKNESS VARIES): WASHED CALTRANS CLASS 1A PERMEABLE MATERIAL
5. UNDERDRAIN CLEANOUT: 90° SWEEP, 4" SOLID (NON-PERFORATED) CLEANOUT RISER AND WATER-TIGHT SCREW-ON CAP SET 3" ABOVE POND BOTTOM ELEVATION.
6. UNDERDRAIN: 4"-DIA. PERFORATED PVC SDR 35 OR HDPE TYPE 'S' PIPE
7. CONNECT UNDERDRAIN TO STRUCTURE WITH 24"-LONG SECTION OF STANDARD (NON-PERFORATED) PIPE.
8. OVERFLOW INLET: 24"x24" FLAT GRATE INLET: SEE DRAIN INLET SCHEDULE. NO JOINTS ARE ALLOWED IN INLET BODY FOR DRAIN INLETS WITHIN BIORETENTION PONDS. (A JOINT IS ALLOWED BETWEEN THE BASE AND THE BODY SECTION ONLY.)
9. POND SIDE SLOPES SHALL BE 3H:1V OR FLATTER.
10. CAST IN PLACE DRAIN INLET BASE SHALL BE EXCAVATED MIN. 8" INTO UNDISTURBED SOIL. FOR PRECAST BASE, PROVIDE MIN. 8" FOUNDATION OF CALTRANS CLASS 1A PERMEABLE MATERIAL.
11. GENERAL MULCH (OUTSIDE PONDING LIMITS): S.L.D.
12. USE BSM TO BACKFILL BETWEEN CONCRETE FLATWODK AND POND, WHERE BACKFILL IS REQUIRED.
13. PROTECT THE POND EXCAVATION SUBGRADE FROM CONSTRUCTION SEDIMENT AND COMPACTION. DO NOT OVER-EXCAVATE AND RECOMPACT POND SUBGRADE. DO NOT PLACE ENGINEERED FILL SOIL WITHIN THE POND EXCAVATION. SEE SPECIFICATIONS.

GRADE CALLOUTS (SEE PLAN)

LAG – LOWEST ADJACENT GRADE

WSE – DESIGN MAXIMUM WATER SURFACE ELEVATION

GRT – OVERFLOW GRATE ELEVATION

BOTT – POND BOTTOM ELEVATION

GENERAL NOTES

1. SEE LANDSCAPE PLANS FOR PLANTING AND IRRIGATION.
2. NO WEED FABRIC, CHEMICAL FERTILIZERS OR HERBICIDES WITHIN THE PONDING AREA.
3. LOWEST ADJACENT GRADE MUST BE ABOVE THE DESIGN MAXIMUM WATER SURFACE ELEVATION.

1 - BIORETENTION POND
NOT TO SCALE

Example “Sheet specs”

BIORETENTION POND SPECIFICATIONS

GENERAL

1. SEE LANDSCAPE DRAWINGS FOR MULCHING, PLANTING AND IRRIGATION REQUIREMENTS.

CONSTRUCTION OBSERVATIONS

THE ENGINEER OF RECORD (WHITSON ENGINEERS) WILL PROVIDE PROVIDE THE FOLLOWING CONSTRUCTION OBSERVATIONS. THE CONSTRUCTION CONTRACTOR SHALL PROVIDE AT LEAST 72 HOURS NOTICE FOR REQUESTED OBSERVATIONS.

1. POND EXCAVATION – THE CIVIL ENGINEER WILL MEASURE EXCAVATION AREA AND ELEVATION, AND OBSERVE SUBGRADE CONDITION. THE SOILS ENGINEER WILL VALIDATE SUITABILITY OF SOIL FOR PERCOLATION AS IDENTIFIED IN THE SOILS REPORT.
2. STRUCTURES – MEASURE STRUCTURE ELEVATIONS AND OBSERVE ALL STRUCTURES, AND PIPES AND APPURTENANCES
3. ROCK RESERVOIR, SUBDRAINAGE SYSTEM AND CHAMBERS – MEASURE COMPLETED ROCK RESERVOIR ELEVATION AND OBSERVE SUBDRAIN AND CHAMBER SYSTEM.
4. BIORETENTION SOIL / FINISHED GRADE – MEASURE POND AREA AND GRADING, AND OBSERVE BSM CONDITION.

CONSTRUCTION SCHEDULING AND POLLUTION PROTECTION:

1. AS FIRST ORDER OF WORK, THE CONSTRUCTION CONTRACTOR MUST PROVIDE THE ENGINEER WITH A CONSTRUCTION SCHEDULE OUTLINING THE PROPOSED CONSTRUCTION SEQUENCE AND DEMONSTRATING COMPLIANCE WITH THESE SPECIFICATIONS. PROPER SCHEDULING IS THE PRIMARY METHOD USED TO PROTECT THE BIORETENTION POND FROM DAMAGE AND CONTAMINATION DURING CONSTRUCTION.
2. THE SCHEDULE SHALL SHOW A MAXIMUM OF 40 WORKING DAYS BETWEEN COMPLETION OF POND EXCAVATION, AND COMPLETION OF BIORETENTION SOIL AND MULCH INSTALLATION.
3. THE CONSTRUCTION CONTRACTOR MUST REQUEST AND OBTAIN THE ENGINEER'S APPROVAL PRIOR TO COMMENCING POND EXCAVATION.
4. POND EXCAVATION SHALL COMMENCE AFTER APRIL 15 AND THE POND SHALL BE COMPLETED (INCLUDING INSTALLATION OF MULCH, COBBLE, PLANTING AND IRRIGATION, AS APPLICABLE) PRIOR TO OCTOBER 15 OF THE SAME YEAR.
5. THE CONSTRUCTION CONTRACTOR SHALL DEPLOY TEMPORARY BMP's TO PREVENT LOOSE SOIL, SUCH AS FROM ADJACENT GRADING, STOCKPILES, OR TRENCH SPOILS, FROM ENTERING THE POND DURING CONSTRUCTION. DURING ACTIVE POND CONSTRUCTION THERE SHOULD BE A CLEAR AND LEVEL AREA AROUND THE POND, FREE OF SPOILS AND STOCKPILED SOIL. AFTER THE POND HAS BEEN BACKFILLED WITH BSM, TEMPORARY SILT FENCE OR TEMPORARY GEOTEXTILE COVER SHOULD BE PROVIDED TO AVOID CONTAMINATING THE BSM WITH SITE SOIL DURING CONSTRUCTION OF ADJACENT IMPROVEMENTS.
6. THE CONSTRUCTION CONTRACTOR IS RESPONSIBLE FOR POND MAINTENANCE DURING CONSTRUCTION UNTIL CONTRACT ACCEPTANCE. THIS INCLUDES REMOVAL OF SEDIMENT, TRASH AND DEBRIS WHICH ARE DEPOSITED IN THE PONDS DURING CONSTRUCTION.
7. IMMEDIATELY PRIOR TO CONTRACT ACCEPTANCE, THE CONSTRUCTION CONTRACTOR MUST REMOVE ALL TRASH, DEBRIS AND ACCUMULATED SEDIMENT FROM WITHIN THE POND, TO THE SATISFACTION OF THE ENGINEER. IF A SIGNIFICANT AMOUNT OF SEDIMENT ENTERED THE POND DURING CONSTRUCTION, THE ENGINEER MAY REQUIRE REMOVAL AND REPLACEMENT OF THE AFFECTED AREA OF MULCH, AND MAY ALSO REQUIRE REMOVAL AND REPLACEMENT OF ANY CONTAMINATED BSM.
8. THE PROJECT STORM WATER CONTROL PLAN (SWCP) AND OPERATION & MAINTENANCE PLAN (OMP) OUTLINE THE OPERATION AND MAINTENANCE REQUIREMENTS AFTER CONTRACT ACCEPTANCE.

BIORETENTION SOIL MIX

BIORETENTION SOIL MIX (BSM) MUST CONFORM TO APPENDIX D, "REGIONAL BIORETENTION SOIL GUIDANCE MODEL SPECIFICATION", OF THE CITY OF SALINAS STORMWATER DEVELOPMENT STANDARDS. THIS MODEL SPECIFICATION IS AVAILABLE ON THE CITY'S WEBSITE, AS WELL AS FROM WHITSON ENGINEERS, UPON REQUEST.

BSM SHALL:

1. ACHIEVE A LONG-TERM, IN-PLACE INFILTRATION RATE OF AT LEAST 5 INCHES PER HOUR.
2. SUPPORT VIGOROUS PLANT GROWTH

THE BSM MUST BE WELL MIXED AND CONTAIN THE FOLLOWING, MEASURED ON A VOLUME BASIS:

1. 60-70% CLEAN, WASHED, FINE SAND, COMPLYING WITH SECTION 1.2 OF THE MODEL SPECIFICATION
2. 30-40% WELL DECOMPOSED, STABLE, CERTIFIED WEED FREE ORGANIC COMPOST, COMPLYING WITH SECTION 1.3 OF THE MODEL SPECIFICATION

MULCH

THE MULCH PLACED ON THE SURFACE OF THE BIORETENTION FACILITY MUST BE NON-FLOATING "COMPOST MULCH". MULCH MUST BE PATHOGEN FREE, WEED FREE, AND FREE OF INORGANIC IMPURITIES, AND HAVE A DARK BROWN COLOR AND SEMI-FINE TEXTURE.

SUBMITTALS

SUBMIT TO THE ENGINEER AND TO THE COUNTY OF MONTEREY FOR APPROVAL:

A. A 1-GALLON (MIN) SAMPLE OF MIXED BIORETENTION SOIL.
B. CERTIFICATION FROM THE BSM SUPPLIER OR AN ACCREDITED LABORATORY THAT THE BSM MEETS THE MODEL SPECIFICATION.
C. GRAIN SIZE ANALYSIS RESULTS OF THE FINE SAND COMPONENT PERFORMED IN ACCORDANCE WITH ASTM D 422, STANDARD TEST METHOD FOR PARTICLE SIZE ANALYSIS OF SOILS. SAND SHALL BE FREE OF WOOD, WASTE, COATING (SUCH AS CLAY), STONE DUST, CARBONATE, ETC., OR ANY OTHER DELETERIOUS MATERIAL. (ALL SANDS COMPLYING WITH ASTM C33 FOR FINE AGGREGATE COMPLY WITH THE MODEL SPECIFICATION.)
D. QUALITY ANALYSIS RESULTS FOR COMPOST PERFORMED IN ACCORDANCE WITH SEAL OF TESTING ASSURANCE (STA) STANDARDS, AS SPECIFIED IN MODEL SPECIFICATION SECTION 1.3.
E. ORGANIC CONTENT TEST RESULTS OF THE MIXED BIORETENTION SOIL. ORGANIC CONTENT TEST SHALL BE PERFORMED IN ACCORDANCE WITH BY TESTING METHODS FOR THE EXAMINATION OF COMPOST AND COMPOSTING (TMECC) 05.07A, "LOSS-ON-IGNITION ORGANIC MATTER METHOD".
F. GRAIN SIZE ANALYSIS RESULTS OF COMPOST COMPONENT PERFORMED IN ACCORDANCE WITH ASTM D 422, STANDARD TEST METHOD FOR PARTICLE SIZE ANALYSIS OF SOILS.
G. A DESCRIPTION OF THE EQUIPMENT AND METHODS USED TO MIX THE SAND AND COMPOST TO PRODUCE THE BSM, AND WHETHER THE BSM WILL BE DELIVERED PRE-MIXED OR MIXED ON SITE.
H. A DESCRIPTION OF THE EQUIPMENT AND METHODS USED TO PLACE AND COMPACT THE BSM.
I. THE TESTING LABORATORY(IES) NAME AND 1) CONTACT PERSON(S), 2) ADDRESS(ES), 3) PHONE CONTACT(S), 4) E-MAIL ADDRESS(ES), 5) QUALIFICATIONS OF LABORATORY(IES), AND 6) CERTIFICATIONS FOR PERSONNEL PERFORMING THE TESTING, INCLUDING DATE OF CURRENT CERTIFICATION BY STA, ASTM, OR APPROVED EQUAL.

BSM INSTALLATION

OBTAIN THE ENGINEER'S WRITTEN APPROVAL OF THE INSTALLED DRAINAGE LAYER, OR SUBGRADE IF THERE IS NO DRAINAGE LAYER, PRIOR TO INSTALLING BSM.

PLACE BIORETENTION SOIL IN 12" (MAXIMUM) LIFTS WITH MACHINERY OPERATED ADJACENT TO, AND NOT IN, THE BIORETENTION FACILITY. IF WORKING WITHIN THE FACILITY, AVOID OVER COMPACTION OF THE SOIL, USING LIGHT WEIGHT, LOW GROUND-CONTACT PRESSURE EQUIPMENT.

ALLOW BIORETENTION SOIL LIFTS TO SETTLE NATURALLY, AND ACHIEVE 83%-87% RELATIVE COMPACTION. BIORETENTION SOILS MAY ALTERNATIVELY BE COMPACTED BY LIGHTLY WATERING UNTIL SOILS ARE JUST SATURATED. ALLOW FOR EXTRA TIME TO LET SOILS DRY BETWEEN EACH LIFT. NOTE THAT BIORETENTION SOIL CANNOT BE WORKED WHEN SATURATED. THE CONTRACTOR'S PROPOSED METHOD TO ACHIEVE COMPACTION MUST BE APPROVED BY BEFORE THE BIORETENTION SOIL IS INSTALLED.

AFTER ALL LIFTS ARE PLACED, WAIT AT LEAST 7 DAYS TO CHECK FOR SETTLEMENT, AND ADD ADDITIONAL BSM AS NEEDED.

OBTAIN THE ENGINEER'S WRITTEN APPROVAL OF THE COMPLETED BSM PRIOR TO INSTALLING IRRIGATION, PLANTING AND MULCH.

Example Specification
(based on BASMA template)

DIVISION 33 UTILITIES

SECTION 32 91 16

BIORETENTION SOIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to the work of this Section.

1.2 DESCRIPTION OF WORK

A. Extent: Furnish all labor, material, equipment, tools, and incidentals necessary for supply, preparation and installation of Bioretention Soil in storm water treatment measures as shown on the Drawings and as specified in this Section.

B. Related work includes but is not limited to:

1. Earthwork and Grading
2. Soil Preparation

1.3 STANDARDS

A. Applicable ASTM International Standards (latest revisions) as they apply to this work and related test methods, including:

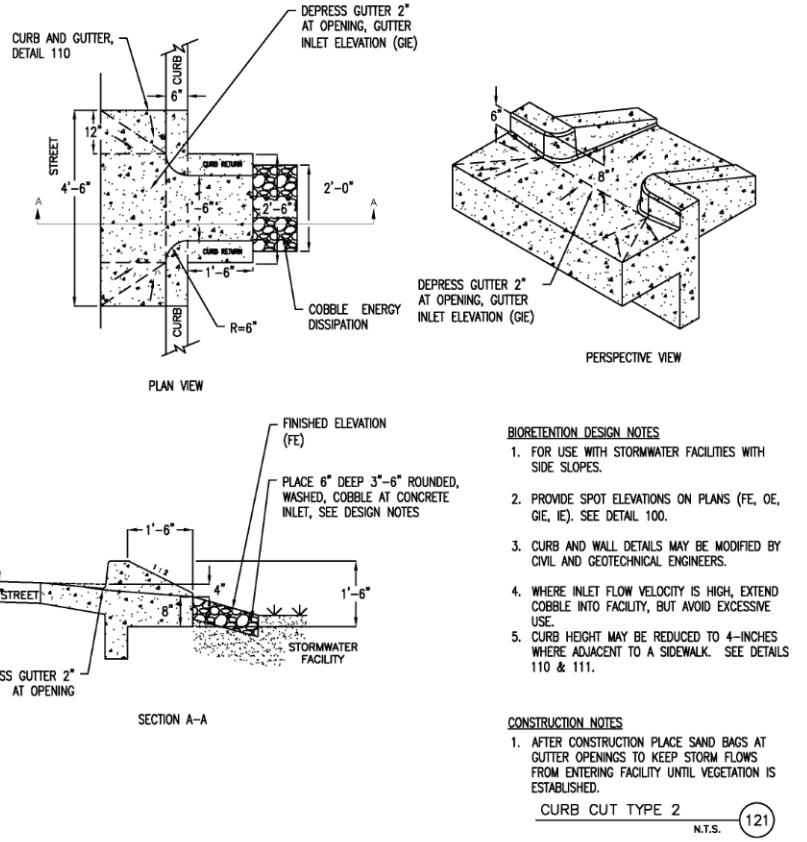
1. C33 / C33M Specification for Concrete Aggregates
2. D422 Standard Test Method for Particle Size Analysis of Soils

1.4 SUBMITTALS

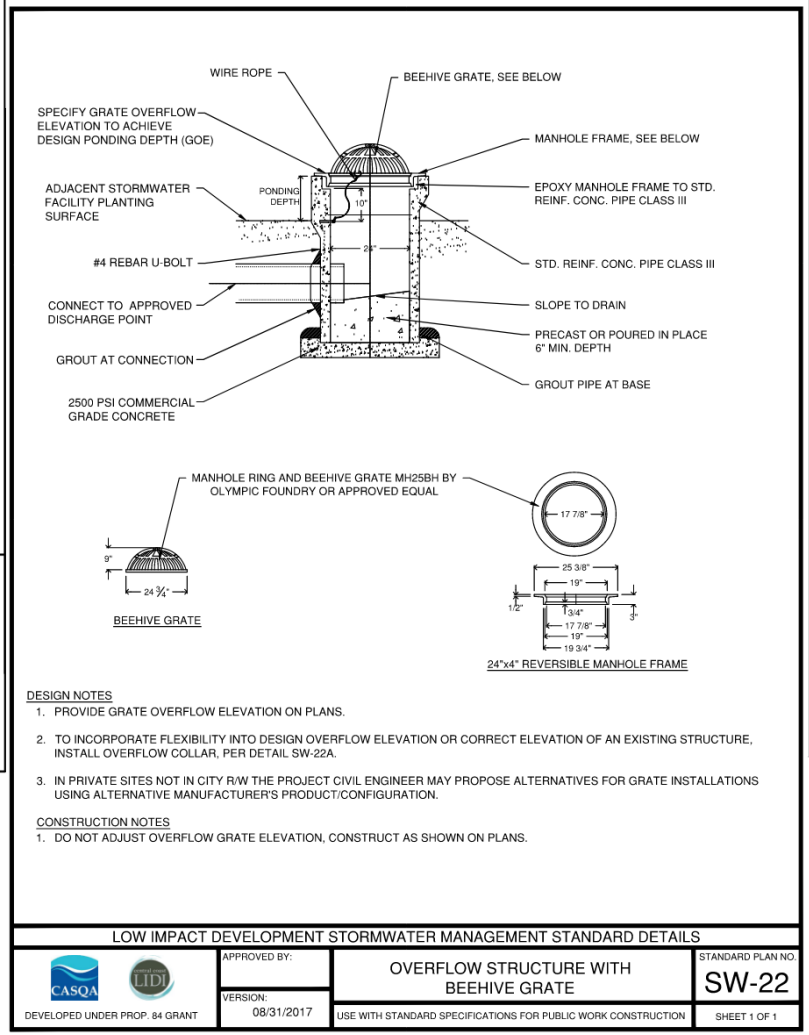
A. Samples: Provide one quart samples each of compost, mulch, and mixed Bioretention Soil to the ARCHITECT for review.

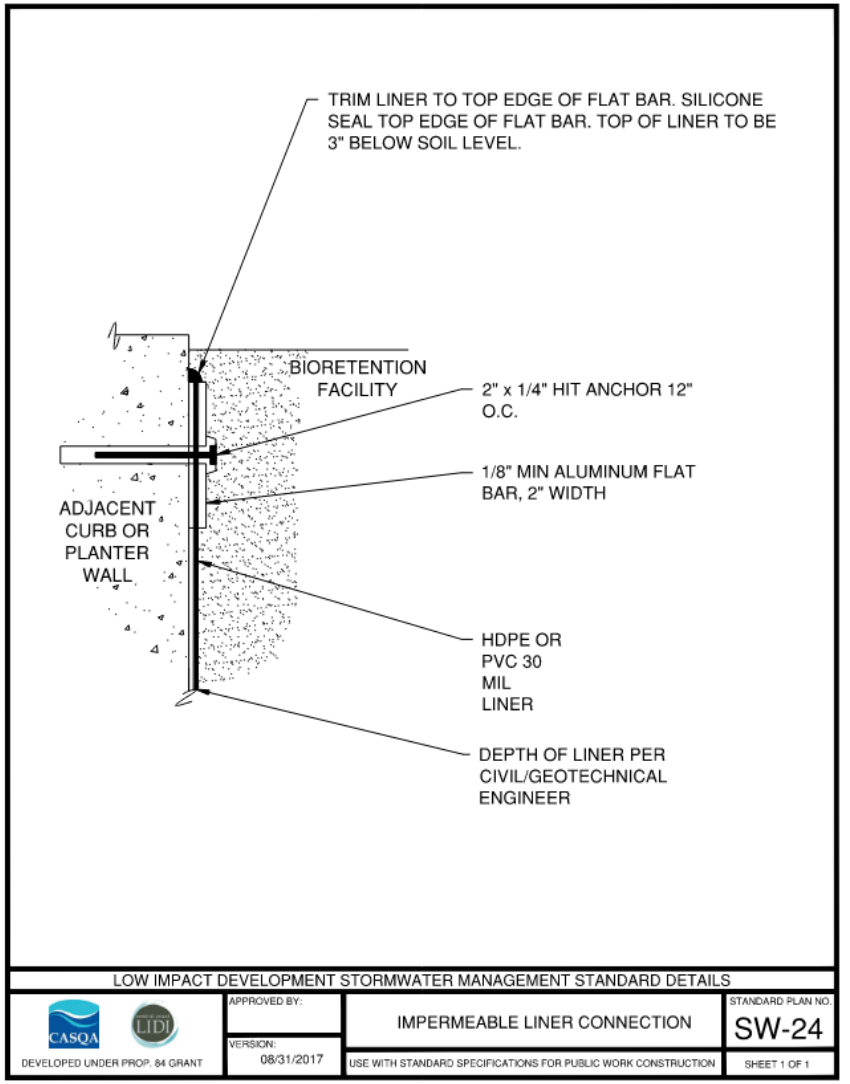
B. Certification, signed and dated, from the soil supplier that the Bioretention Soil meets the requirements of this specification.

1. Certification shall include, as included at the end of this Specification:
   a. Supplier Analysis of Bioretention Soil Mix
   b. Lab Analysis OR supplier/quarry sieve analysis of Sand Component of Bioretention Soil Mix
   c. Lab Analysis of Compost Component of Bioretention Soil Mix
   d. Supplier Analysis of Compost Component of Bioretention Soil Mix
2. Compost Testing: Laboratory (Lab) analysis for Compost Component noted above shall be performed by either:
3. Pre-approved Lab - Control Laboratories Inc., 42 Hangar Way, Watsonville, CA 95076, (831)724-5422
4. A Lab that is enrolled in the US Composting Council Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Evaluation of Composting and Compost (TMECC). Lab qualifications shall include:
   a. Address, phone number, email address.
   b. Qualifications of Lab personnel
   c. Date of current certification by STA, ASTM, or approved equal.



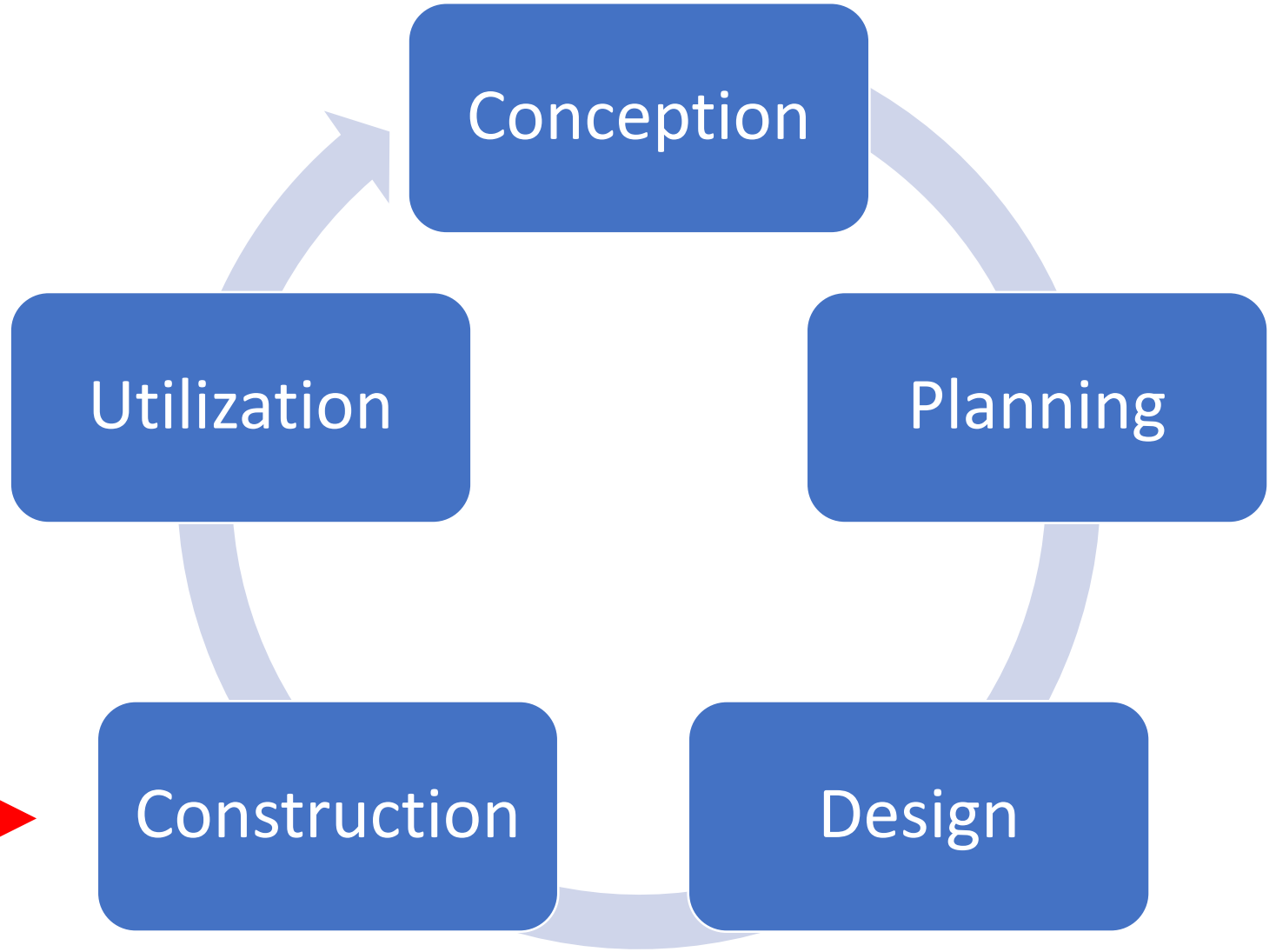
Available from MRSWMP and LIDI





More Supporting Details

Outline

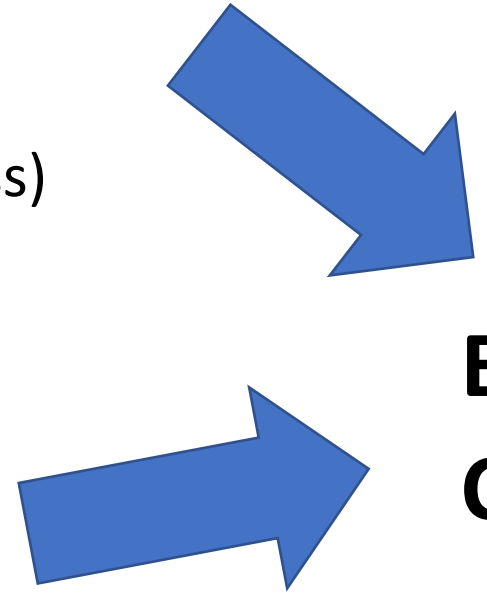


We are now here

Construction

- Schedule
- Submittals
- Agency Inspections
- Engineer’s Observations
- Temporary Controls

- Submittals
  - Schedule
  - Manholes, catch basins, pipes, connections
  - Bioretention Pond (use one of the two approved spec templates)
  - Drain Rock
  - Permeable Pavers
  - Permeable Geo-Cell (Fire Department Access)
- Construction Inspections/Observations:
  - Completed excavation
  - Completed rock, structures, perf. pipe
  - Completed BSM and grading (side slopes)
  - Final (landscaping, mulch, rock)
  - *Possibly geotechnical observations*
  - *Possibly as-built survey*
  - *Possibly infiltration testing*



Engineer's Certification

Pond Excavation
Drain Rock
Pipes
Structures

Perforated pipe is missing

Riser with orifices at correct elevations

Sealant between precast sections

BSM,
Final Grading
& Landscaping

Pervious FD Access and Pavers

CITY OF SALINAS
DEVELOPMENT ENGINEERING, *A division of the Public Works Department*
65 West Alisal Street | Salinas, CA 93901 | 831-758-7251 | *www.ci.salinas.ca.us*

CERTIFICATION FOR STORMWATER QUALITY DRAINAGE IMPROVEMENTS

PROJECT NAME: _____

PROJECT ADDRESS: _____

PERMIT NUMBER(S)# _____

I, the undersigned certify that I am a California Registered Civil Engineer. I, or my authorized
have inspected the Stormwater Quality Drainage Improvements (i.e. LID treatment systems,
basins, storm drain conveyance systems, overflow conveyance, drainage inlets, junctions, s
channels, etc.) required for the approval of the above referenced Project. To the best of my know
information and belief, the Stormwater Quality Drainage Improvements have been construc
substantial conformance with the approved Grading and/or Improvement Plans.

DATED: _____

_____
SIGNATURE OF CIVIL ENGINEER

CIVIL ENGINEER STAMP

_____
TYPED NAME OF CIVIL ENGINEERING/REG NO

_____
FIRM OR COMPANY NAME

_____
ADDRESS OF FIRM OR COMPANY

Submit completed form to City of Salinas (Attn: Public Works, Development Engineering Division) prio
final clearance request.

CITY OF SALINAS
DEVELOPMENT ENGINEERING, *A division of the Public Works D*
65 West Alisal Street | Salinas, CA 93901 | 831-758-7251 | *www.ci.sa*

CERTIFICATIONS FOR NOTICE OF TERMINATION

PROJECT NAME: _____

PROJECT ADDRESS: _____

PERMIT NUMBER(S)# _____

FINAL STABILIZATION CERTIFICATION – COMPLETED BY QSP
I hereby certify that all disturbed areas have achieved final stabilization as defined in the c
version of the general permit, and that all temporary, structural erosion and sediment contr
measures have been removed. Furthermore, I understand that certifying false, incorrect or i
information is a violation of the referenced permit and the laws of the State of California a
subject me to criminal, civil and/or administrative proceedings.

_____ _____
QSP SIGNATURE DATE

_____ _____
PRINTED NAME QSP NUMBER

_____
TITLE/POSITION

_____
FIRM/COMPANY NAME

Submit completed form to City of Salinas (Attn: Public Works, Development Engineering Division)
final clearance request.

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STORMWATER CERTIFICATE OF COMPLETION
FOR NOTICE OF TERMINATION

PROJECT NAME: _____

PROJECT ADDRESS: _____

PERMIT NUMBER(S)#: _____

The following documentation has been received and reviewed for conformance with the City of Salinas's NPDES Permit No. CA0049981, Order No. R3-2012-0005, and Stormwater Development Standards, dated December 2013.

Document	File/Recording No.	Date Approved/Recorded
Improvement Plans/Grading Plans		
Final Stormwater Control Plan		
Maintenance Declaration		
Final Inspection		
QSP Certification for Notice of Termination		
Certification for Stormwater Quality Drainage Improvements		

The City of Salinas through acceptance of the project documentation assumes no responsibility for the accuracy and adequacy of the design. Review and acceptance of the project documentation by the City of Salinas does not relieve the owner/operator, engineer and/or the QSP of the responsibility or liability for errors or omissions in the plans or reports.

Signature: _____

Name: _____

Title/Position: _____

Date: _____

Certification

We’re done!

(just kidding)

Maintenance Agreement with O&M Plan

Maintenance Agreement*

A. Legal Description of parcel
B. Site Map showing SCM Locations
C. O&M Plan (Contents per PCRs Part. E)
   1. SCM Site Map (can reuse Exhibit B)
   2. SCM O&M Procedures (Fact Sheets**)
   3. SCM Annual Maintenance Costs

Maintenance Agreement Exhibits A, B and C

Included in Exhibit C – Stand-alone document for owner use

All part of the Maintenance Agreement

Owner may also need to provide a Certificate of Insurance to the Local Agency (varies by agency)

* Varies by agency. Check for local agency needs and templates.
** Templates coming soon, https://montereysea.org/

Agency Template

UALITY MANAGEMENT PLAN AND STORMWATER BMP
NTENANCE AND RIGHT OF ENTRY AGREEMENT

UALITY MANAGEMENT PLAN AND STORMWATER BMP MAINTENANCE AND
NTRY AGREEMENT ("Agreement") is made and entered into in the City of Monterey, , this _____ day of _____, 20___ by and between [Official Owner Name], nafter referred to as "Owner" and the City of Monterey ("City"), a municipal corporation. This Agreement applies to property located at STREET ADDRESS, Monterey (APN ###-###-###) in the County of Monterey, State of California. The Agreement is subject to the following recitals:

RECITALS

WHEREAS, the Owner owns real property ("Property") in the City of Monterey, County of Monterey, State of California, more specifically described in Exhibit 'A [Legal Description]' which exhibit is attached hereto and incorporated herein by this reference;

WHEREAS, The [City Council, Planning Commission, Architectural Review Committee, or Historic Preservation Committee] of the City of Monterey approved granting of [Type of Discretionary Permit] Permit No. ##-#### [Permit Title] at [Address] for the subject property;

WHEREAS, at the time of initial approval of said [Type of Discretionary Permit] Permit No. ##-#### the City required the project to employ Post-Construction Best Management Practices, hereinafter referred to as "BMPs," in accordance with Municipal Code Chapter 31.5 Article 2 and associated regulations in the City approved National Pollutant Discharge Elimination System (NPDES) Storm Water permit to minimize pollutants in urban runoff from new- and re-development projects;

WHEREAS, the Owner has chosen to install and/or implement BMPs as shown on Exhibit B, a Project Site Plan showing the permanent BMPs and their locations, and as detailed on the MM/DD/YYYY Civil Engineering Plan Sheet C# TITLE and associated Details, on file with the City for Building Permit No. B##-#### hereinafter referred to as "Plans", to minimize pollutants in urban runoff and to minimize other adverse impacts of urban runoff;

WHEREAS, the Plans have been certified by the Owner and reviewed and approved by the City;

WHEREAS, the BMPs, with installation and implementation on private property and draining only private property, are part of a private facility with all maintenance or replacement, therefore, the sole responsibility of the Owner in accordance with the terms of this Agreement;

WHEREAS, the Owner is aware that periodic and continuous maintenance are required as set forth in Exhibit C Operations and Maintenance (O&M) Plan; maintenance is required to assure peak performance of all BMPs in the Plans and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs;

NOW, THEREFORE, in consideration of the foregoing premises, the mutual stipulations and agreements contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. **Responsibility for Operation and Maintenance of BMPs:** Owner shall diligently maintain all BMPs in a manner consistent with Exhibit 'C' Operations and Maintenance (O&M) Plan, and that maintains the original low impact development runoff reduction, treatment, retention, and/or flow management requirements at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of

Rev 05/10/2017 PAGE 1

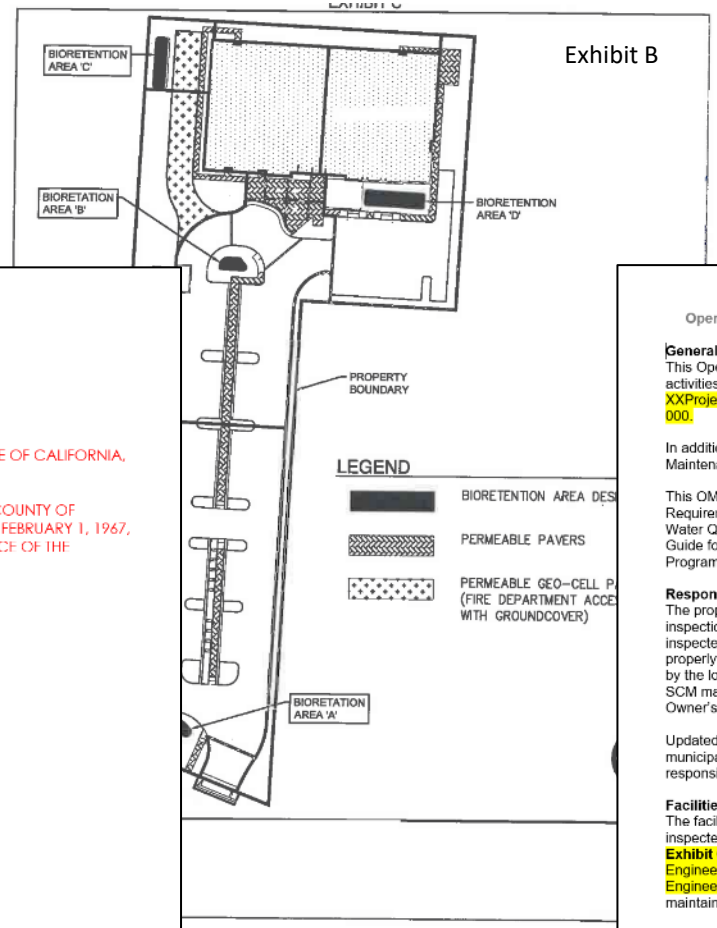


Exhibit B

EXHIBIT A

LEGAL DESCRIPTION

olion from the Title Report or Deed.]

ITY OF SEASIDE, COUNTY OF MONTEREY, STATE OF CALIFORNIA,
S:

EL MONTE HEIGHTS, IN THE CITY OF SEASIDE, COUNTY OF
ALIFORNIA, ACCORDING TO MAP RECORDED FEBRUARY 1, 1967,
, "CITIES AND TOWNS" AT PAGE 16, IN THE OFFICE OF THE
UNTY.

END OF DESCRIPTION

This is the legal description of the parcel that the SCMs are located on.

Copy from the Title Report.

Exhibit C

Operation and Maintenance Plan (OMP) for Stormwater Control Measures (SCMs) at XXProjectXX

General
This Operation and Maintenance Plan (**OMP**) outlines the minimum operation and maintenance activities required for the stormwater control measures (**SCMs**) constructed as part of the XXProjectXX (**Project**), located at XXAddressXX, Assessor's Parcel Numbers (APNs) 000-000-000.

In addition to being kept on-site as part of the Project Manual, this OMP is an attachment to a Maintenance Agreement which will be recorded at the County Recorder's office.

This OMP was prepared pursuant to the "Post Construction Stormwater Management Requirements for Development Projects in the Central Coast Region", Central Coast Regional Water Quality Control Board Resolution No. R3-2013-0032 and the "Stormwater Technical Guide for Low Impact Development, 3rd Edition" by Monterey Regional Stormwater Management Program dated May 1, 2020.

Responsibilities
The property owner, XXOwner NameXX (**Owner**), is responsible for facility operation, inspection, and maintenance. SCMs installed as part of the Project must be operated, inspected, and maintained for the life of the Project. Any change or alteration, or the failure to properly operate and maintain any feature described herein, could result in fines or other actions by the local municipality (City/County of XX), or by a state or federal authority. Furthermore, if SCM maintenance is not adequate, the municipality may conduct inspections and repairs, at the Owner's expense. For more information please refer to the Maintenance Agreement.

Updated information, including contact information (**Attachment 1**), must be provided to the municipality if and when the property is sold, or whenever there is a change to one of the listed responsible parties.

Facilities to be Maintained
The facilities which are constructed as part of the Project, and which must be operated, inspected, and maintained, are listed in **Table 1**, below. SCM locations are shown graphically in **Exhibit C**. For more detailed construction information see the Construction Plans (XX Engineers, 20XX). For facility sizing information see the Storm Water Control Plan (XX Engineers, 20XX). Copies of the Construction Plans and Storm Water Control Plan should be maintained with this OMP by the Owner.

Table 1. Facilities to be Maintained

- EXAMPLE: Sixteen (16) 3-inch deep graded depressions (Self Retaining Landscape Areas 1 – 16)
- EXAMPLE: 5,250 s.f. of permeable pavement
- EXAMPLE: Two bioretention ponds (SCMs 1 and 4)
- EXAMPLE: Two high-flow tree box biofilters (SCMs 2A and 3)
- EXAMPLE: One StormTech chamber system (SCM 2B)

These facilities must be inspected and maintained in accordance with the Fact Sheets provided in **Attachment 4**.

XXProjectXX XXDateXX
Project # XXXX Page 1 of 2

Attachment 4

Stormwater Facility Operation and Maintenance Fact Sheet

► GENERAL SITE AND STORM DRAINAGE FACILITY MAINTENANCE

General Site:

1. Collect trash and sweep pa
   debris, and trash.
2. Require contractors to collect
3. Provide cigarette butt recepto
4. Communicate trash best ma
   Include trash control requirem

Landscaping:

1. Remove debris and trash regu
2. Prune or cut back plants for
   inlets and through curb cuts.
3. Control weeds by manual m
   vinegar, vinegar-based pro
   herbicides such as Safer's Shar
4. Fertilizer and pesticide use
   professionals.
5. Examine the vegetation to e
   soils from erosion. Remove and
6. Replenish mulch as necessary
   a mulch layer thickness of 3".
7. Confirm that irrigation system
   on/off function and adjust as
   For point source drip irrigatio
   and check that emitters are n

Storm Drain Inlets and Pipes

1. Maintain and periodically repa
   markings.
2. Clean storm drain inlets and c
   remove sediments, trash and

O&M Fact Sheet – General

Stormwater Facility Operation and Maintenance Fact Sheet

► BIORETENTION PLANTERS

Bioretention planters are intended to:

1. Reduce pollutant loads by filtering stormwat
   formulated soil and then infiltrating stormwat
2. Pond water before overflowing to a drain inl
3. Infiltrate completely following each rain ever

Bioretention <u>are not</u> intended to:

1. Have standing water for periods longer than
2. Serve as wetland or riparian habitat
3. Be accessed by anyone other than authorize

The recommended routine maintenance activities f

On an as-needed basis:

1. Remove any soil build-up, fallen leaves, debris, a
2. Irrigate plants as needed during prolonged dry
   selected to be drought-tolerant and not require
   three years).
3. Prune or cut back plants for health and to en
   inlets and across the surface of the facility. Rem
   replanting, maintain the design surface elevati
   soil
4. Control weeds by manual methods or by add
   corn gluten, white vinegar, vinegar-based p
   selective natural herbicides such as Safer's Sharp
5. Examine the vegetation to ensure that it is hea
   filtering and to protect soils from erosion. Re
   diseased vegetation.
6. Fertilizers and pesticide use should be limited
   professionals. Synthetic pesticides shall not be us
7. Replenish mulch as necessary. Use "aged mul
   reduce the ability of weeds to establish, keep s

Stormwater Facility Operation and Maintenance Fact Sheet

► TREE BOX FILTER

High flow rate tree box type biofilters ("tree

1. Reduce pollutant loads by filterin
   engineered soil media.
2. Pond water to a specified depth bef
3. Drain completely following each rain

Tree box filters <u>are not</u> intended to:

1. Infiltrate significant amounts of water
2. Have standing water after a storm
3. Serve as wetland or riparian habitat
4. Be accessed by anyone other than c

The recommended routine maintenance ac

On an as-needed basis:

1. Remove accumulated sediment, fallen l
2. Prune or cut back plants for health an
   inlets and across the surface of the facili
   replanting, maintain the design surface
   soil.
3. Control weeds by manual methods.
4. Examine the vegetation to ensure that
   and diseased vegetation.
5. Fertilizers and pesticide use should be
   professionals. Synthetic pesticides shall n
6. Remove graffiti and replace signs and m
7. Confirm that irrigation is adequate and r

Annually, prior to the beginning of the rainy

1. Remove trash, debris, weeds, and accur

Stormwater Facility Operation and Maintenance Fact Sheet

► PERMEABLE GEO-CELL PAVING

Permeable geo-cell paving is intended to:

1. Provide an all-weather driving surface for vehicular traffic.
2. Infiltrate all precipitation during smaller storms.
3. Surface drain during higher-intensity storms.
4. Reduce pollutant loads by infiltrating stormwater and by filtering stormwater runoff though the aggregate base course.
5. Drain completely following each rain event.

Permeable geo-cell paving <u>is not</u> intended to:

1. Have standing water on its surface.
2. Become soft or unstable, even after prolonged precipitation.

The recommended routine maintenance activities for permeable geo-cell paving are:

On an ongoing and as-needed basis:

1. Keep surrounding landscaped areas well maintained and covered with landscaping and/or mulch so that soils are prevented from being washed onto the pervious pavement.
2. Remove soil build-up, fallen leaves, debris, and trash.
3. Ensure pervious pavement system is draining and that there is no standing water.
4. Control weeds by manual methods. If problem areas occur, corn gluten, white vinegar, vinegar-based products such as Burnout, or non-selective natural herbicides such as Safer's Sharpshooter may be used.
5. Pesticide use should be limited and conducted by appropriate professionals. Synthetic pesticides shall not be used.

New!

MRSWMP Templates

Reflections – Construction

Tricia's

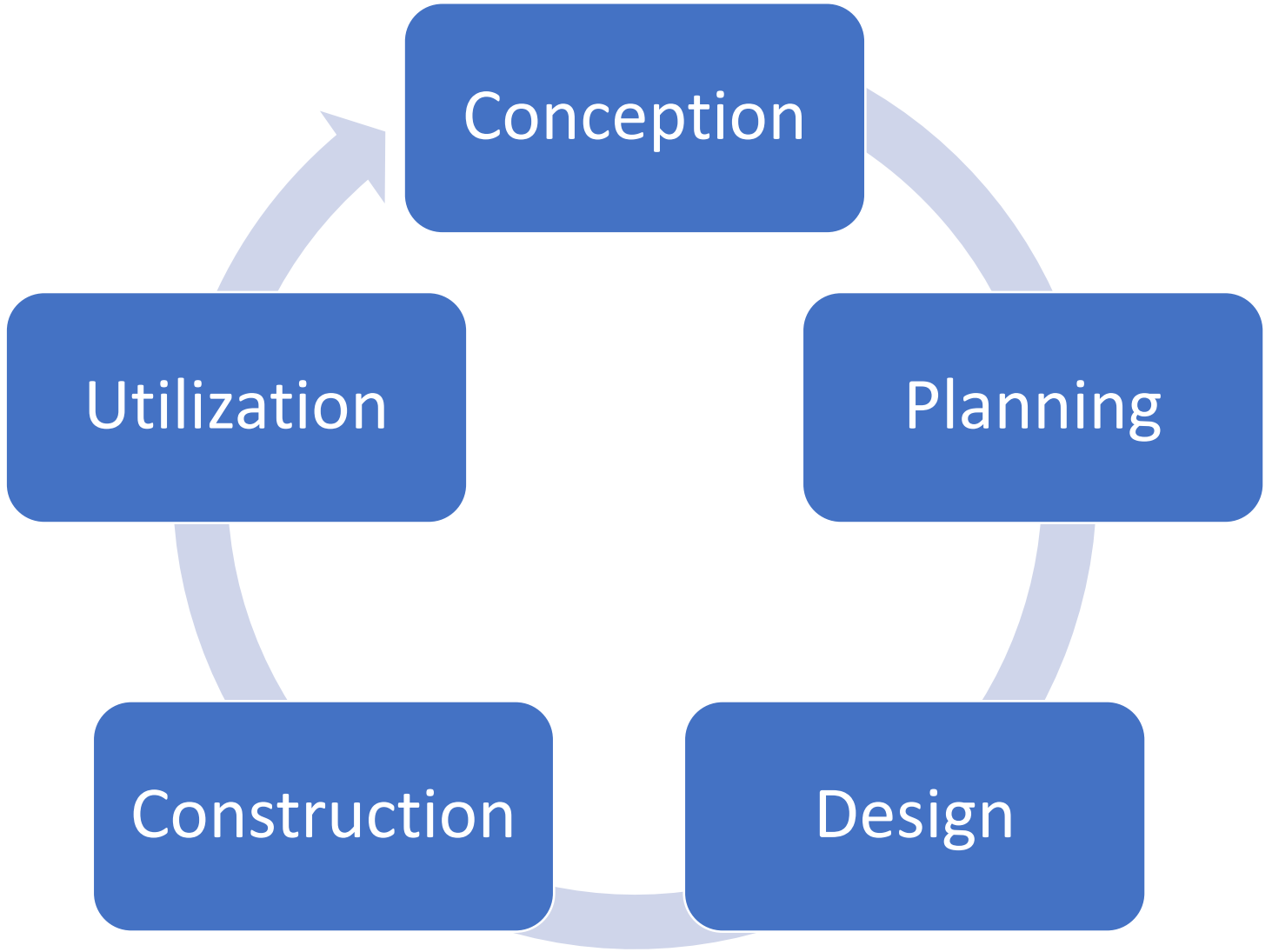
- Communicate schedule to agency inspector (PCR feature constr.)
- Inspect over course of PCR constr.
- Design Engineer on-site for insp.
- Design Engineer - PCR Certificate
- In advance of Cert. of Occupancy Coordinate Maintenance Agreement execution & recordation with agency
- Exhibits critical Maintenance Agrmnt. Accurate to what's constructed; long-term O&M guidance to owners

Nathaniel's

- Scheduling is the most important BMP
- Water is irresponsible (it goes where it wants, not where it's told)
- Don't leave rock reservoir exposed
- You (Engineer) will have to certify that the completed work is per Plans, Specs and SWCP

Outline

We are now here



Utilization Phase

Permit-Required Maintenance, Monitoring and Reporting

- In accordance w/ the Agreement and O&M Plan
- Regular Maintenance by Owner or landscape maintenance company
- Specialty work (typically needs to be contracted, which adds cost)
  - Underground chambers, filters
  - Tree box biofilters
  - Pervious pavements
- Annual SCM Inspection and certification (by PE?)

City of Seaside

Stormwater Management Facilities

Annual Maintenance Certificate

For Calendar Year _____

I, _____ certify that the stormwater management facilities at
Print Name

_____ (Address),

_____ (APN),

including the stormwater site design measures, treatment measures and source control measures have been properly operated and maintained during the preceding year, and have been recently inspected during a period beginning on September 1 and ending no later than September 30 and repaired as necessary to ensure continued proper operation.

(Attach copies of any maintenance records and/or receipts, if applicable)

_____ _____
Signature Date

_____
Title

This Certificate shall be submitted to the City of Seaside no later than October 1 annually.

Pursuant to City of Seaside Municipal Code Title 8.46 Urban Stormwater Quality Management and Discharge Control, the City Engineer or designee maintains the authority, whenever reasonably necessary, to make an inspection, make copies of related records, take water samples and perform any testing necessary to enforce any provision of the Storm Water Management Ordinance.

City of Seaside 440 Harcourt Avenue, Seaside, CA 93955 Tel: (831) 899-6825

Reflections – Utilization Phase

Tricia's

- First few years – owner learning curve
- May require some guidance
- Records important

→ Informs future redevelopment: understanding of existing site features (above & below ground)

Nathaniel's

- Take time to write down Lessons learned
- Check in w/ Owners, especially the first year after construction
- "Complete the circle"

Reference Materials

Monterey Regional Stormwater Management Program (MRSWMP)

https://montereysea.org/

- Technical Guide
- SWCP Templates
- O&M Plan Templates
- Bioretention Construction Checklist
- Technical Criteria for Non-LID (cartridge filter and tree box biofilter)
- SCM Sizing Calculator (Excel file for volumetric sizing for PCR 3)
- Infiltration Testing Guidance
- Past PCR Presentations

Central Coast RWQCB PCRs Website

https://www.waterboards.ca.gov/centralcoast/water_issues/programs/stormwater/docs/lid/lid_hydromod_charette_index.html

- The text of the PCRs (*Attachment 1*)
- WMZ and MS4 Maps
- 85th and 95th Percentile Precipitation Maps
- Self-Retaining Area Guidance
- Other presentations and guides

https://montereysea.org/lid-design-and-construction/

Design

LID facilities may look like conventional landscapes, but they are specially designed to slow, treat, and infiltrate stormwater runoff. Bioretention designs are particularly common due to their ability to provide multiple benefits and support regulatory compliance. Therefore, LIDI has focused on bioretention design and has developed details and specifications; guidance on bioretention soil media; and plant selection and landscape installation.

Using good design details and specifications is a crucial first step toward a successful project. LIDI has focused on bioretention design as this type of LID facility is one of the most commonly used. LIDI worked with state and national LID experts to improve bioretention details and specifications based on years of implementation and lessons learned. This website provides designers with a full set of AutoCAD standard details for bioretention facilities and the associated infrastructure elements such as curb cuts, overflow inlets, and check dams; as well as guidance on bioretention soil media and plants. Use of correct materials such as bioretention soil media and plants is also very important to achieve a successful LID project. Material specifications, guidance for installation and a list of regional vendors are available.

View and download the LID parking lot guidance PDF here.

Details and Specifications

Soils

Landscape

Construction

Although projects with LID features may look like conventional development projects, there are key differences construction contractors need to understand to build successful LID projects.

LIDI has developed construction training videos, technical assistance documents, and local material vendor lists to support LID construction. The videos provided below provide insight related to construction of LID facilities.

- LID for Contractors and Developers – Technical Assistance Memo

- Best Practices for Bioretention and Overflow Structures

Details and Specifications

Bioretention Engineering Standards

Bioretention, or the use of plants and soil to infiltrate, slow and clean stormwater, is one of the most commonly used structural LID stormwater control measures. LIDI worked with bioretention experts to create a set of standard details and technical specifications that incorporate the most current knowledge of bioretention design and are consistent with the Central Coast Water Board's newly adopted Post-Construction Stormwater Control Requirements.

- Bioretention Standard Details and Technical Specifications Memo
- Bioretention Standard Details PDF
- Bioretention Standard Details (AutoCAD DWG in zip folder)
- Bioretention Technical Specifications PDF

NEW!

- Bioretention/Dry Well Standard Details PDF
- Bioretention/Dry Well Standard Details (AutoCAD DWG in zipped folder)
- Bioretention/Dry Well Design Memo PDF

https://montereysea.org/design-and-specifications/

Soils

Site Soil Infiltration Testing

Understanding the suitability of a project site for infiltration-based LID structures is critical for facility success and aids in maximizing functionality during design. A guidance document was prepared for LIDI by Earth Systems Pacific to provide a simple and cost-effective field investigation methodology to support location and sizing of small-scale infiltration facilities. Click here to download.

Bioretention Facility Soil

Bioretention Soil Media (BSM) is a critical element of the bioretention system. The BSM has a ratio of inorganic and organic materials to allow the appropriate infiltration rates for stormwater; facilitate pollutant removal through chemical, biological and physical processes; and provide a sufficient growing medium for plants. Research is still being conducted to determine the ideal specification for BSM.

Currently, the Central Coast Water Quality Control Board allows use of two BSM specifications:

1. The Bay Area Stormwater Management Agencies (BASMA) developed a technical report that includes a BSM specification.
   BASMA Technical Report and BSM Specification

2. A BSM specification was developed for the San Diego Region that includes a slightly lower compost percentage.
   San Diego Region BSM Specification with accompanying Memorandum

https://montereysea.org/soils/

Landscape

The selection of appropriate plants for bioretention and other vegetated stormwater facilities is crucial to a successful design. California plant palettes need to be drought-tolerant, appropriate for the regional climate, aesthetically-pleasing, and support stormwater function. LIDI has created several bioretention plant design resource documents for California. While primarily focused on the Central Coast region, the plant design approaches and many of the actual plant types are appropriate throughout California.

- Bioretention Plant List
- LID Plant Guidance for Bioretention
- Bioretention Plant Palette Guidebook

https://montereysea.org/landscape/

Other sources of good SCM details

- Central Coast LIDI (PDF and DWG)
  https://www.centralcoastlidi.org/bioretention-details-and-specs.php
- City of Salinas (PDF and DWG)
  https://www.cityofsalinas.org/our-city-services/public-works/stormwater-program
- Santa Clara Valley Urban Runoff Pollution Prevention Program
  https://scvurppp.org/wp-content/uploads/2019/09/SCVURPPP-GSI-Handbook-Part-2_Sept-2019_9-24-19.pdf

Computer Programs

- Army Corps of Engineers' HEC-HMS (free)
  - https://www.hec.usace.army.mil/software/hec-hms/downloads.aspx
- EPA's Storm Water Management Model (SWMM) (free)
  - https://www.epa.gov/water-research/storm-water-management-model-swmm
- HydroCAD
  - https://hydrocad.net/

References

- HEC-22 Urban Drainage Design Manual (free)
  - https://www.fhwa.dot.gov/engineering/hydraulics/pubs/10009/10009.pdf
- National Engineering Handbook, Part 630 – Hydrology (free)
  - https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21422

Q&A