PRELIMINARY DRAINAGE REPORT
Cancer Center of Santa Barbara

540 West Pueblo Street
Santa Barbara, California

April 6, 2009

CLIENT: Cancer Center of Santa Barbara

PREPARED BY:

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WORK ORDER NO.: 15708.09

PROJECT MANAGER: Jason J. Gotsis, P.E.

EXHIBIT Q

PURPOSE OF REPORT

The purpose of this report is to outline the pre-project drainage conditions of the site and present a description of the post-project drainage conditions and drainage improvement recommendations. Significant drainage facilities, as applicable, are described and analyzed. Storm water volume reduction and treatment is addressed by providing analysis and details of several Best Management Practices (BMPs) that are described in the City of Santa Barbara Storm Water BMP Guidance Manual, dated June 2008 (Final).

LOCATION

The address for the project is 540 West Pueblo Street. In addition to the parcel on record for this address, the site is also made up of the parcels at 520, 524 and 526 West Pueblos Street; 519, 521, 525, 529, and 601 West Junipero Street; and 2317 Oak Park Lane. See Figure A.

Figure A. Vicinity Map

BACKGROUND

The Cancer Center currently operates from existing structures on the project site, along with space on the first floor of Cottage Hospital. The project owners propose to redevelop the subject property for its current use and add residential units for workforce housing. Presently the property is fully developed. The property is comprised of the following ten parcels:

APN	Street Address
025-090-005	601 W. Junipero Street
025-090-008	519 W. Junipero Street
025-090-022	520 W. Pueblo Street
025-090-023	524 W. Pueblo Street
025-090-024	526 W. Pueblo Street
025-090-031	529 W. Junipero Street
025-090-039	521 W. Junipero Street
025-090-040	525 W. Junipero Street
025-090-046	540 W. Junipero Street
025-090-047	2317 Oak Park Lane

It is anticipated that these parcels will be merged to become one. See the attached Drainage Maps for parcel layout.

The major features of the proposed project include:

- Removal of the existing pavement
- Removal of the main structure at 540 W. Pueblo Street
- Removal of the existing structures at 524 and 526 W. Pueblo Street; and 521 W. Junipero Street
- Partial removal of the rear part of the structure at 519 W. Junipero Street
- Relocation of the structure at 520 W. Pueblo Street to the front of 521 W. Junipero Street
- New structural additions to the rear of the remaining and relocated structures at 519 and 521 W. Junipero Street, respectively
- Improvements to the existing structures at 525 and 601 West Junipero Street
- Construction of a new Cancer Center facility for treatment and office use.
- Construction of a new parking structure.
- Construction of storm water runoff BMP's (infiltration basin, drywells, vegetated swale filter, and permeable pavement) for volume reduction and treatment
- Other improvements to the project site include utility services, surface parking areas, and landscaping areas.

The property is zoned C-O (Commercial Office). The project site is bound to the west by Mission Creek and the Oaks Parent Child Workshop (pre-school), to the north by West Junipero Street, to the east by medical buildings, and to the south by West Pueblo Street. According to survey records the westerly property line for the 540 West Pueblo Street parcel is located along the approximate center line of Mission Creek. For analysis purposes the drainage area near this property line will extend up to the surveyed top of creek bank. The site is to be served by a privately maintained storm drain system.

The site is subject to flooding from Mission Creek. 100 Year Storm event Base Flood Elevations (BFE's) shown are based on the Conditional Letter of Map Revision (CLOMR) approved by FEMA on December 19, 2008 (Case No. 08-09-0424R). This study analyzes the overflow from Mission Creek and the drainage culvert that was constructed in Junipero Street and Oak Park Lane as part of the Cottage Hospital Improvements. Upon completion of the Cottage Hospital Project, the hospital will apply to FEMA for a permanent flood map change consistent with the CLOMR. The BFE's shown on project plans and exhibits are based upon the CLOMR.

METHOD OF ANALYSIS

The analysis was based on research that included field investigations, review of field and aerial topography, and hydrologic analysis. Detailed drainage maps were prepared based on aerial photography taken on January 28, 2004 at a 1' contour interval; field surveys made in February and March of 2004, and September of 2006; and project preliminary improvement plans for the site in the post-project condition. Watershed boundaries are defined based on proposed drainage system layouts. Soil type is Hydrologic Group B, and is referenced from Table 9 and Santa Barbara Quadrangle Sheet No. 8 in the Soil Survey of Santa Barbara County, California South Coastal Part (see attachments.)

The storm water quantity and quality design applies the formulas and approaches provided in the City of Santa Barbara BMP Guidance Manual. It is our understanding that application of these principles will indicate compliance with the City Storm Water Management Plan.

The design process begins with the assessment of the potential pollutants of concern both for the type of project as well as those pollutants associated with the water body into which the project is discharging (Mission Creek). Table 2-2[1] indicates the following pollutants of concern for multi- and single-family residences:

[1] City of Santa Barbara Storm Water BMP Guidance Manual; June 2008 (Final).

- Trash
- Nutrients
- Bacteria
- Sediment
- Hydrocarbons
- Pesticides and Herbicides

Soils infiltration testing was performed and assessment reports[2,3] were prepared by Earth Systems Pacific, the project's Geotechnical Engineer.

As recommended in the BMP Guidance Manual, the HydroCAD Stormwater Modeling Software, which utilizes the SBUH Runoff Method, was used to calculate runoff quantities for the pre-project and post-project runoff analysis. Since the project site's runoff areas are relatively small, a 12 minute minimum time of concentration is used. See the attached HydroCAD output.

The City water quality requirements include:

- Retaining the increase in volume due to development for up to the 25-year storm or the volume from a 1-inch storm (whichever is larger), where possible.
- Reducing the post-project peak flow rate to less than the pre-project condition for up to the 25-year storm event.
- Providing storm water filtering for storm water runoff.

Volume reduction was addressed using the following BMPs:

- Infiltration basin
- Dry wells
- Permeable pavers

Additionally low impact development (LID) principles and storm water filtering BMPs were applied to lengthen the flow paths, slow the runoff from the site, and provide a significant amount of hydraulically unconnected impervious surfaces. The specific BMPs used in the design were:

- Vegetated swale filter

[2] Report of Percolation Testing, December 17, 2008, prepared by Earth Systems Pacific.
[3] Soil Assessment, January 29, 2009, prepared by Earth Systems Pacific.

- Smaller landscaped swales

Tributary areas cannot be determined for each proposed area drain and storm drain pipe until construction documents are being drafted. At that time, the drainage system will be designed based on the 25-year storm event flow to the respective gravity storm drain line and pressure pipe (from underground parking area).

RESULTS

Pre-Project Condition

See Watershed Areas and Collection Points on Preliminary Drainage Map, Pre-Project Condition, Sheet 1 of 2 (attached) and Tables 1 and 2, below.

Most of the existing site coverage consists of one large commercial building, several residential-style buildings converted to commercial use, and asphalt pavement. The site generally slopes from the northwest towards the southeast. There is an off-site parcel, APN 025-090-009, on Junipero Street at the north side of the project site (within Area E2) that contributes runoff to the project site (Area E2.) Since no improvements are being made to this area, and it is not owned by the project's owner, the runoff from this area will be collected in the post-project condition in an on-site area drain and conveyed via pipe directly to the back of the existing curb inlet in West Pueblo Street. Drainage of the majority of the site (Areas E2 and E6) sheet flows towards the gutter in West Pueblo Street and into an existing curb inlet (Collection Point B.) A portion of the site flows to an onsite drain inlet at the end of the main facility's driveway (Area E6.) This drain inlet is connected by an 8" vitrified clay pipe to the back of the same existing curb inlet in West Pueblo Street. Drainage of a portion on the northwest side of the site (Area E1) sheet flows towards the gutter along West Junipero Street and into an existing curb inlet (Collection Point A.) Both curb inlets drain directly into Mission Creek. There are three existing 8" cast iron pipes on-site that drain directly into Mission Creek. They pick up the atrium area (Area E3) within the existing Cancer Center building, and patio areas on the west and south sides of this building (Areas E4 and E5, respectively).

Since the entire site is within the 100-year floodplain boundary adjacent to Mission Creek, the potential for on-site flooding caused from overflow of the Mission Creek during extreme storm events has a one percent chance of occurrence in any one year. Flood proofing measures will be incorporated into the design of the proposed and existing structures by the Architect. See the attached Drainage Maps.

Post-Project Condition

See Watershed Areas and Collection Points on Preliminary Drainage Map, Post-Project Condition, Sheet 2 of 2 (attached) and Tables 1 and 2, below.

The preliminary plans show the layout of structures, parking areas, landscaping with grades, finished floor elevations, and most of the major utilities. There is approximately 5000 sf footprint for future building expansion proposed. This area is calculated as impervious surface to show that the vegetated filter swale and infiltration basin for the currently proposed project will be able to meet the City's water quality and quantity conditions for future building expansion of this size. See attached Preliminary Grading and Drainage Plan.

In the post-project condition stormwater runoff will be collected by roof and area drains and a network of storm drainage pipes. Prior to entering the pipe network, much of the runoff will flow over landscape and pervious paved surface. The majority of the site paved surface is to be made up of pre-cast permeable pavers to maximize the pervious areas. A runoff coefficient (CN) value of 85 was selected for permeable pavement. During the final design phase of the project, the project Mechanical-Plumbing Engineer will size horizontal and vertical roof drains and design the system that pumps the stormwater runoff that is collected at the lower level of the parking structure.

The post-project design decreases creek bank erosion by eliminating the three existing 8" cast iron pipes that currently extend out of the existing creek bank and discharge directly into mission creek. The tributary areas that currently flow to these pipes will be re-directed to the proposed infiltration basin along W. Pueblo Street.

The post-project improvements will not increase the peak storm water runoff or the peak storm water volume from the site. Therefore, storm water runoff detention will not be required. Peak runoff rates are quantified in Tables 1 and 2.

TABLE 1. SUMMARY OF PEAK RUNOFF FLOW TO DISCHARGE POINTS

Collection Point	Discharge Point	Pre-Project Q_{25} (cfs)	Post-Project Q_{25} (cfs)	Change in Q_{25} (cfs)
A	W. Junipero Street	0.83	0.90	0.07
B	W. Pueblo Street	6.78	7.03	0.25
C	Mission Creek	0.34	0	-0.34
D	Mission Creek	0.53	0	-0.53
E	Mission Creek	0.37	0	-0.37
	Totals	**8.85**	**7.93**	**0.92 decrease**

TABLE 2. SUMMARY OF PEAK RUNOFF VOLUME

Watershed	Area (ac)	V_{25} (ac-ft)
Pre-Project	3.38	1.49
Post-Project	3.38	1.33
		0.16 decrease

Project Volume Reduction

The larger volume of either the difference between the pre- and post-conditions for the 25-year design storm or the one-inch storm is required to set the $V_{reduction}$. The change in the 25-year volume for the project was calculated to be a decrease of 0.16 acre-feet. The one-inch volume was calculated by Option 1 as shown in the BMP Guidance Manual on page C-3. This resulted in a runoff volume of 0.099 acre-feet. Since the runoff volume of the one-inch storm is greater, the $V_{reduction}$ requirement was taken to be 0.099 ac-ft or 4,312 cubic feet for the project.

Various means of storm water volume reduction has been proposed and are outlined in Table 3. Worksheets are provided for volume reduction via infiltration basin and dry well BMP's. Permeable pavers are proposed for the driveways and exterior parking areas on the site.

TABLE 3. STORM WATER VOLUME REDUCTION RESULTS

$V_{reduction}$ Required for Entire Site	**4,312**	**ft^3**
$V_{reduction}$ Provided:		
$V_{reduction}$ From Area P1 Infiltration Basin	3,790	ft^3
$V_{reduction}$ From Area P1 Permeable Pavement (Areas PP1 thru PP3)	480	ft^3
$V_{reduction}$ From Area P2 Dry Well	44	ft^3
$V_{reduction}$ From Area P4 Dry Well	174	ft^3
$V_{reduction}$ From Area P5 Dry Well	174	ft^3
$V_{reduction}$ From Area P6 Dry Well	87	ft^3
$V_{reduction}$ From Area P3 Permeable Pavement (Area PP4)	44	ft^3
$V_{reduction}$ Total Provided for Entire Site	**4,793**	**ft^3**
Percent of Volume Goal Achieved =	111%	

As can be seen, 111 percent of the estimated $V_{reduction}$ can be met with infiltrative devices. The project has provided hydraulically unconnected surfaces over the developed portion of this project. Please note that during final design some minor alterations in infiltrative devices may be applied which may reduce the application of one method and increase the use of another. Under all situations, 100 percent of the $V_{reduction}$ will be met.

Project Storm Water Treatment

Filtering of storm water is proposed using vegetated swales and permeable pavement. A vegetated swale filter is proposed for treating runoff from the main Cancer Center facility roof and parking structure surface prior to conveying it to the infiltration basin. Smaller landscaped swales are proposed to capture and treat runoff from the roof surfaces of the mostly residential structures along W. Junipero Street. Runoff from these areas are conveyed to drywell infiltration BMP's. Storm water runoff from all of the impervious site areas is treated. Vegetated swales are effective in removing all of the anticipated pollutants except bacteria. Permeable pavers are effective in removing all of the anticipated pollutants except trash.

In some areas only receiving runoff from roofs and garden areas, local drainage inlets will be located to allow roof runoff to pass across vegetated areas prior to pick up. In some instances, there are multiple methods of storm water filtering applied prior to discharge from the site. For example, a roof garden is proposed over the portion of the main facility which is also treated by the vegetated swale filter. See the attached calculations and Storm Water Quality Exhibit for BMP locations and coverage.

CONCLUSION

The project as proposed will reduce the peak runoff from a 25-Year storm event to less than the pre-project condition (See Table 4.)

TABLE 4. SUMMARY OF PERVIOUS VS. IMPERVIOUS AREA

Watershed	Pervious (ac)	Impervious (ac)	Total (ac)
Pre-Project	1.16 (34.2%)	2.22 (65.8%)	3.38
Post-Project	1.73 (51.3%)	1.65 (48.7%)	3.38

Storm water quality concerns for the entire project site are addressed through volume reduction and flow-based treatment of main facility roof and parking structure via vegetated swale filter.

Post-project design improvements will include sizing the storm drain system to accommodate the 25-Year flow rate.

CALCULATIONS AND ATTACHMENTS

- **SOIL SURVEY**
- **HYDROCAD PRINTOUTS**
  - Pre-Project Condition (25 Year Storm)
  - Post-Project Condition
    - 25 Year Storm
    - 1 Inch Storm for On-Site Only
    - 1 Inch Storm for Permeable Pavement Areas
- **CALCULATIONS**
  - Infiltration Basin
  - Dry Wells
  - Permeable Pavers
  - Vegetated Swale Filter
- **GEOTECHNICAL REPORTS (EARTH SYSTEMS PACIFIC)**
  - Report of Percolation Testing, December 17, 2008
  - Soil Assessment, January 29, 2009
- **MAPS AND EXHIBITS**
  - Preliminary Drainage Map- Pre-Project Condition
  - Preliminary Drainage Map- Post Project Condition
  - Water Quality Exhibit
  - Preliminary Grading & Drainage Plan

SOIL SURVEY

(from Sheet No. 8 Santa Barbara County, CA
South Coastal Part- Santa Barbara Quadrangle)

FROM SHEET NO. 8
SANTA BARBARA COUNTY, CA
SOUTH COASTAL PART
(SANTA BARBARA QUADRANGLE)

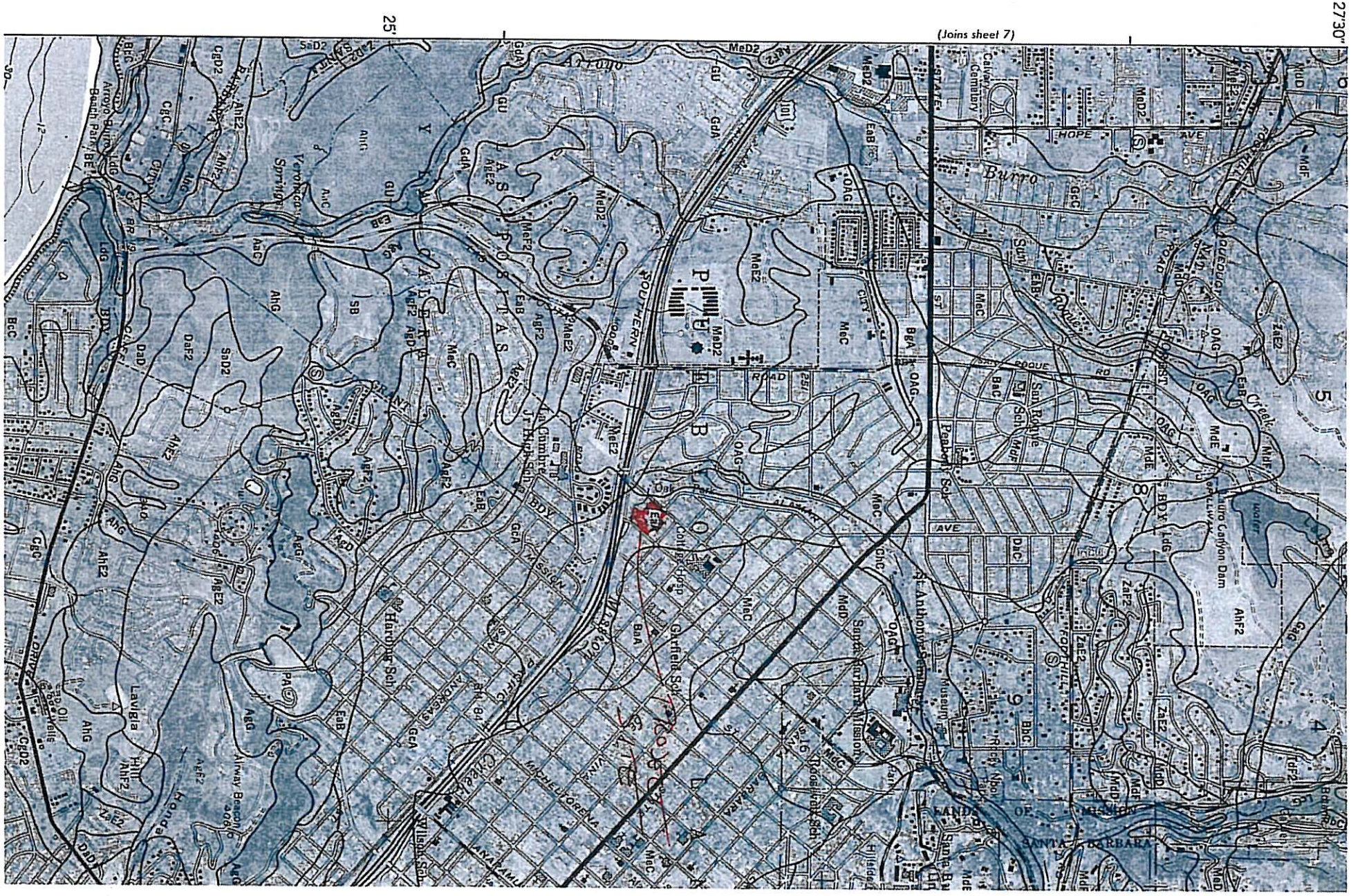
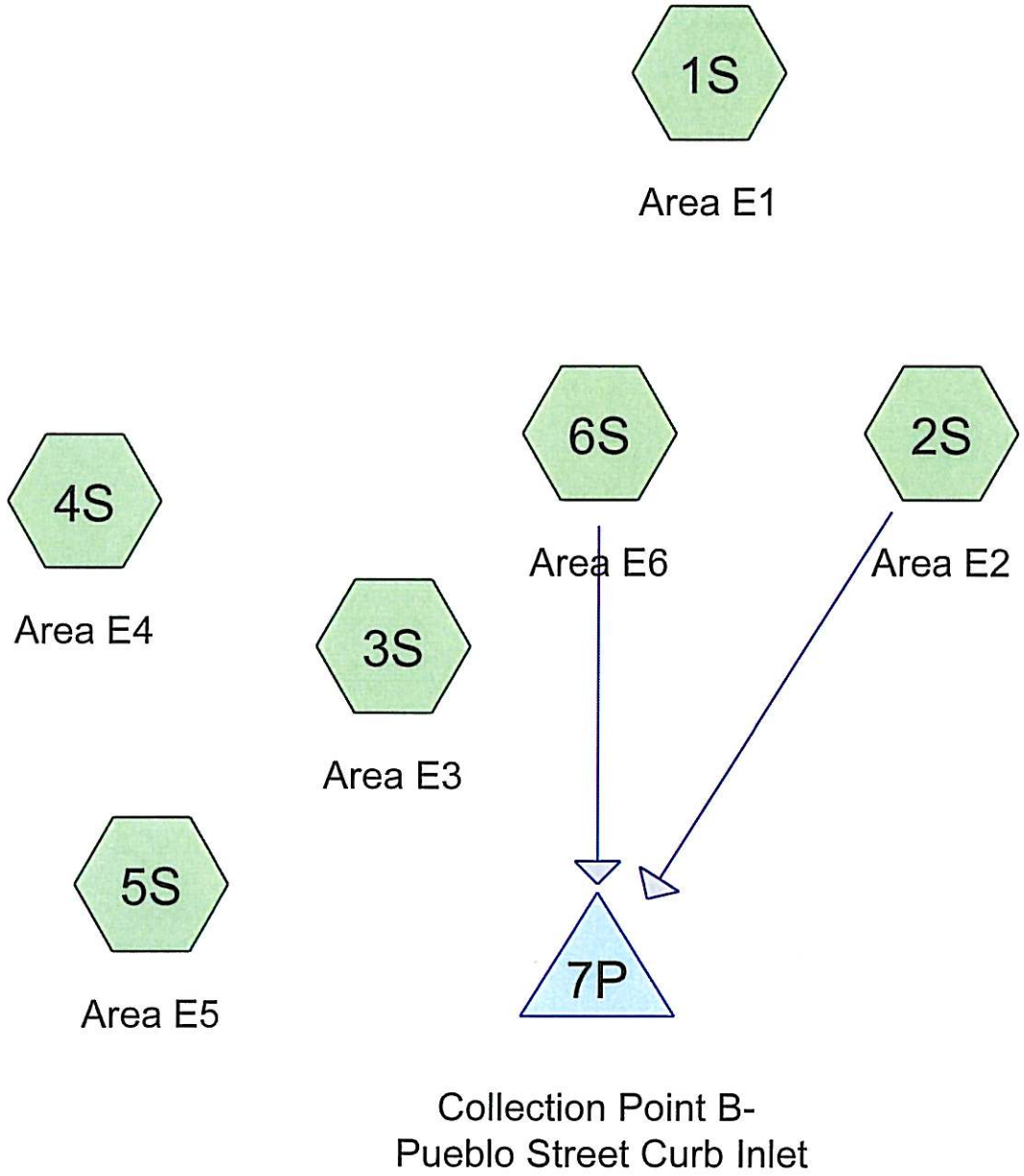
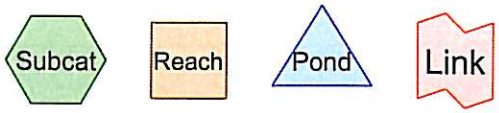


TABLE 9.—*Soil and water features*—Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			*In*	
Diablo: DaC, DaD, DaE2, DaF2	D	None			>6.0			40–60	Rippable.
Dune land: DU									
Elder: EaA, EaB	B	Rare			>6.0			>60	
[1] Eb:									
Elder part	B	Rare			>6.0			>60	
Soboba part	A	Common	Very brief	Nov-Mar	>6.0			>60	
Escarpment: ES									
Gaviota: GaE, GaG	D	None			>6.0			10–20	Hard.
[1] GbG:									
Gaviota part	D	None			>6.0			10–20	Hard.
Rock outcrop part									
Goleta: GcA, GcC, GdA	B	Rare			>6.0			>60	
Gullied land: GU									
Linne: LaE, LaF2, LaG	C	None			>6.0			26–50	Rippable.
Lodo:									
[1] LbG:									
Lodo part	D	None			>6.0			6–20	Rippable.
Rock outcrop part									
[1] LcG:									
Lodo part	D	None			>6.0			6–20	Rippable.
Sespe part	C	None			>6.0			24–40	Rippable.
Lopez:									
[1] LdG, [1] LdH:									
Lopez part	D	None			>6.0			6–20	Hard.
Rock outcrop part									
[1] LeE2, [1] LeF2:									
Lopez part	D	None			>6.0			6–20	Hard.
Santa Lucia part	C	None			>6.0			20–40	Hard.
Los Osos: LgE2, LgF2	C	None			>6.0			25–40	Hard.
[1] LhG:									
Los Osos part	C	None			>6.0			20–35	Hard.
Maymen part	D	None			>6.0			8–18	Hard.
Maymen: MaE, MaG	D	None			>6.0			10–20	Hard.
[1] MbH:									
Maymen part	D	None			>6.0			10–20	Hard.

HYDROCAD PRINTOUT
(Pre-Project Condition- 25 Year Storm)





Drainage Diagram for 15708-Pre-Project
Prepared by Penfield & Smith, Printed 4/6/2009
HydroCAD® 8.50 s/n 004468 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.820	61	>75% Grass cover, Good, HSG B (1S,2S,4S)
0.007	69	50-75% Grass cover, Fair, HSG B (5S)
0.333	79	<50% Grass cover, Poor, HSG B (2S,3S,6S)
2.220	98	Paved parking & roofs (1S,2S,3S,4S,5S,6S)
3.380		**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Goup	Subcatchment Numbers
0.000	HSG A	
1.160	HSG B	1S, 2S, 3S, 4S, 5S, 6S
0.000	HSG C	
0.000	HSG D	
2.220	Other	1S, 2S, 3S, 4S, 5S, 6S
3.380		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.10 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Area E1 Runoff Area=14,811 sf 61.76% Impervious Runoff Depth=4.95"
Flow Length=198' Slope=0.0109 '/' Tc=12.0 min CN=61/98 Runoff=0.83 cfs 0.140 af

Subcatchment 2S: Area E2 Runoff Area=77,929 sf 59.08% Impervious Runoff Depth=4.92"
Flow Length=668' Tc=12.0 min CN=63/98 Runoff=4.34 cfs 0.734 af

Subcatchment 3S: Area E3 Runoff Area=7,753 sf 74.72% Impervious Runoff Depth=5.93"
Flow Length=74' Slope=0.0100 '/' Tc=12.0 min CN=79/98 Runoff=0.53 cfs 0.088 af

Subcatchment 4S: Area E4 Runoff Area=6,665 sf 61.44% Impervious Runoff Depth=4.94"
Flow Length=80' Tc=12.0 min CN=61/98 Runoff=0.37 cfs 0.063 af

Subcatchment 5S: Area E5 Runoff Area=4,792 sf 93.64% Impervious Runoff Depth=6.27"
Flow Length=157' Tc=12.0 min CN=69/98 Runoff=0.34 cfs 0.057 af

Subcatchment 6S: Area E6 Runoff Area=35,284 sf 76.91% Impervious Runoff Depth=5.97"
Flow Length=405' Tc=12.0 min CN=79/98 Runoff=2.44 cfs 0.403 af

Pond 7P: Collection Point B- Pueblo Street Curb Inlet Inflow=6.78 cfs 1.137 af
Primary=6.78 cfs 1.137 af

Total Runoff Area = 3.380 ac Runoff Volume = 1.486 af Average Runoff Depth = 5.27"
34.32% Pervious = 1.160 ac 65.68% Impervious = 2.220 ac

Summary for Subcatchment 1S: Area E1

Area that drains to W. Junipero Street curb inlet.

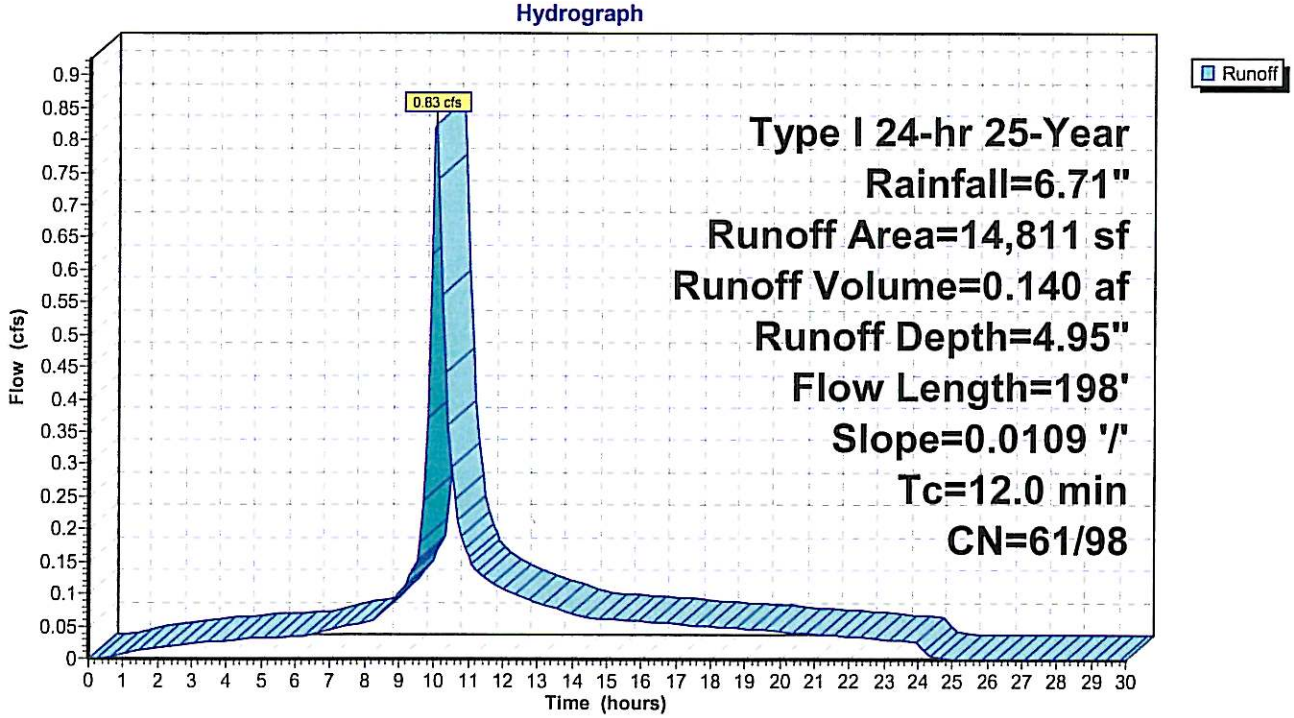
Runoff = 0.83 cfs @ 10.02 hrs, Volume= 0.140 af, Depth= 4.95"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
9,148	98	Paved parking & roofs
5,663	61	>75% Grass cover, Good, HSG B
14,811	84	Weighted Average
5,663	61	Pervious Area
9,148	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	67	0.0109	0.94		**Sheet Flow, down driveway at 519 W. Junipero** Smooth surfaces n= 0.011 P2= 2.83"
1.0	131	0.0109	2.12		**Shallow Concentrated Flow, Gutter flow to existing CB** Paved Kv= 20.3 fps
2.2	198	Total, Increased to minimum Tc = 12.0 min			

Subcatchment 1S: Area E1



Summary for Subcatchment 2S: Area E2

Area that drains to W. Pueblo curb inlet

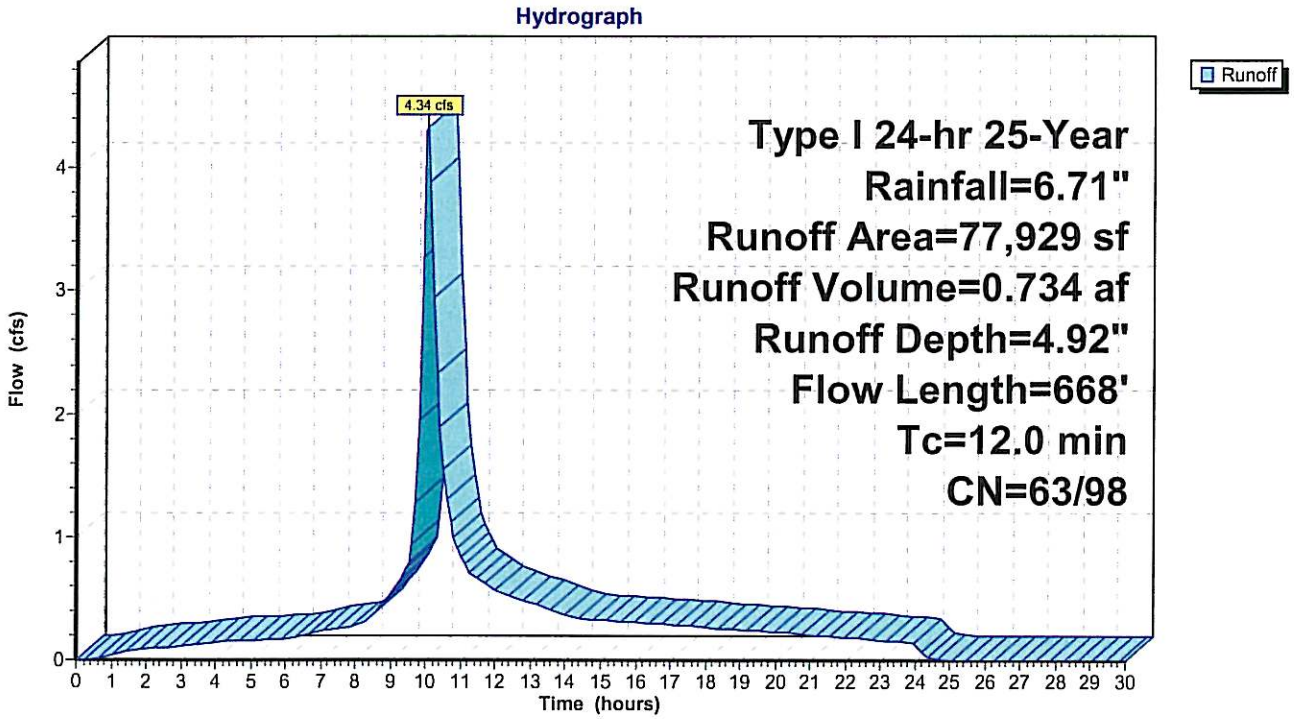
Runoff = 4.34 cfs @ 10.02 hrs, Volume= 0.734 af, Depth= 4.92"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
46,043	98	Paved parking & roofs
27,486	61	>75% Grass cover, Good, HSG B
4,400	79	<50% Grass cover, Poor, HSG B
77,929	84	Weighted Average
31,886	63	Pervious Area
46,043	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	153	0.0240	1.51		**Sheet Flow, across paved area of off-site parcel** Smooth surfaces n= 0.011 P2= 2.83"
3.0	258	0.0080	1.44		**Shallow Concentrated Flow, across portion of 2317 Oak Park L** Unpaved Kv= 16.1 fps
0.7	68	0.0434	1.63		**Sheet Flow, down 520 W. Pueblo driveway** Smooth surfaces n= 0.011 P2= 2.83"
2.1	189	0.0054	1.49		**Shallow Concentrated Flow, down W. Pueblo gutter** Paved Kv= 20.3 fps
7.5	668	Total, Increased to minimum Tc = 12.0 min			

Subcatchment 2S: Area E2



Summary for Subcatchment 3S: Area E3

Flow to courtyard CB and out to creek

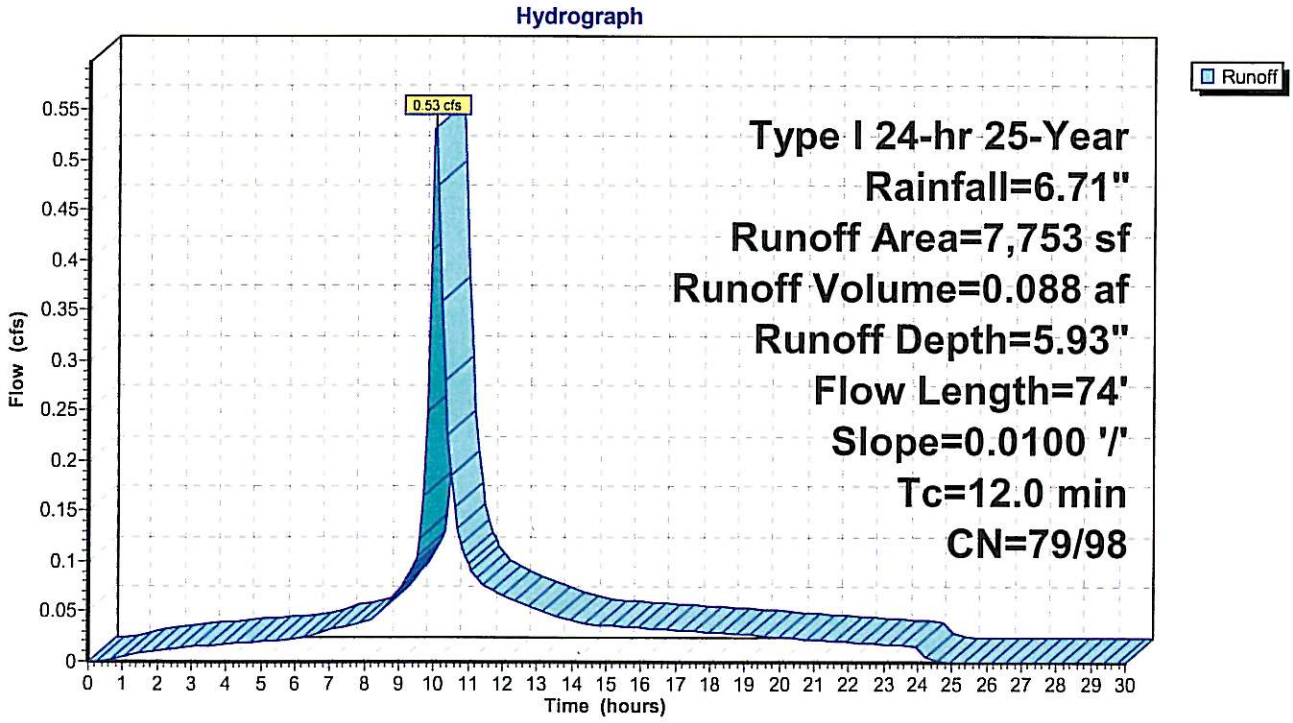
Runoff = 0.53 cfs @ 10.02 hrs, Volume= 0.088 af, Depth= 5.93"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
5,793	98	Paved parking & roofs
1,960	79	<50% Grass cover, Poor, HSG B
7,753	93	Weighted Average
1,960	79	Pervious Area
5,793	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	37	0.0100	0.80		**Sheet Flow, across roof** Smooth surfaces n= 0.011 P2= 2.83"
6.2	37	0.0100	0.10		**Sheet Flow, across courtyard** Grass: Short n= 0.150 P2= 2.83"
7.0	74	Total, Increased to minimum Tc = 12.0 min			

Subcatchment 3S: Area E3



Summary for Subcatchment 4S: Area E4

Flow to CB and out to creek.

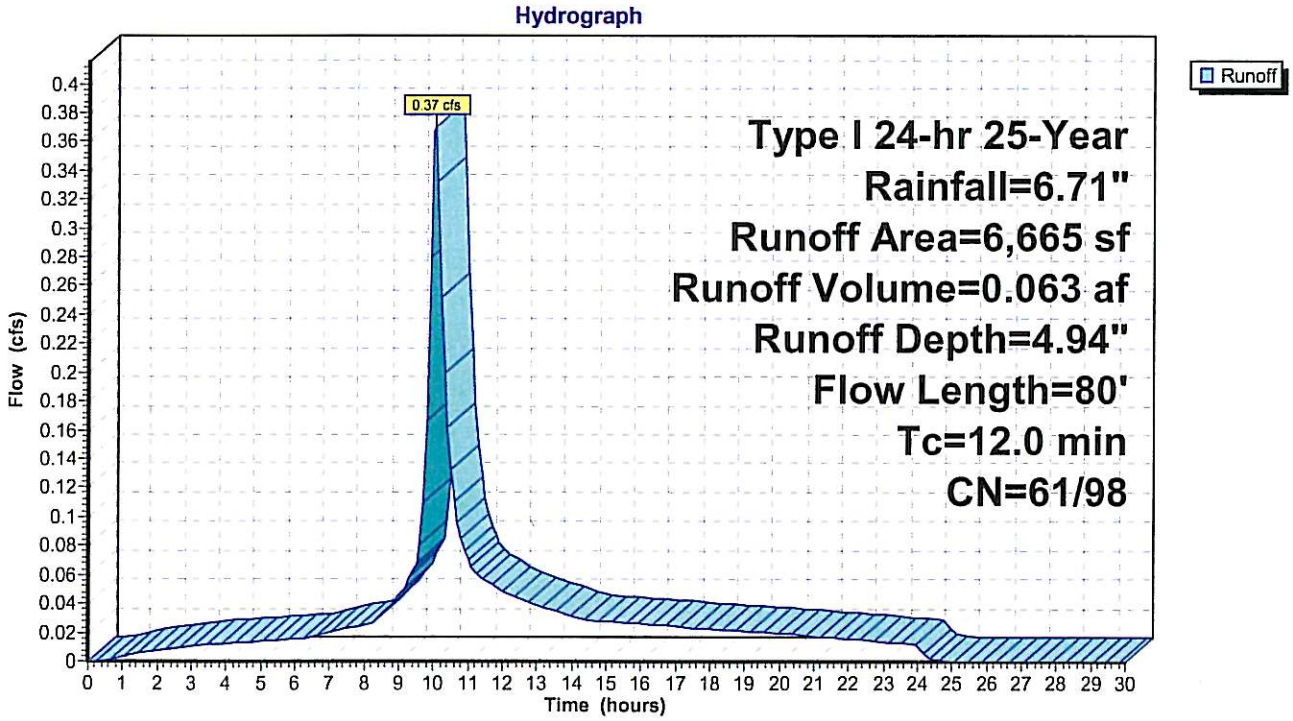
Runoff = 0.37 cfs @ 10.02 hrs, Volume= 0.063 af, Depth= 4.94"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
4,095	98	Paved parking & roofs
2,570	61	>75% Grass cover, Good, HSG B
6,665	84	Weighted Average
2,570	61	Pervious Area
4,095	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	25	0.0100	0.74		**Sheet Flow, across roof** Smooth surfaces n= 0.011 P2= 2.83"
8.9	55	0.0090	0.10		**Sheet Flow, from downspout to CB** Grass: Short n= 0.150 P2= 2.83"
9.5	80	Total, Increased to minimum Tc = 12.0 min			

Subcatchment 4S: Area E4



Summary for Subcatchment 5S: Area E5

Flow from CB to creek.

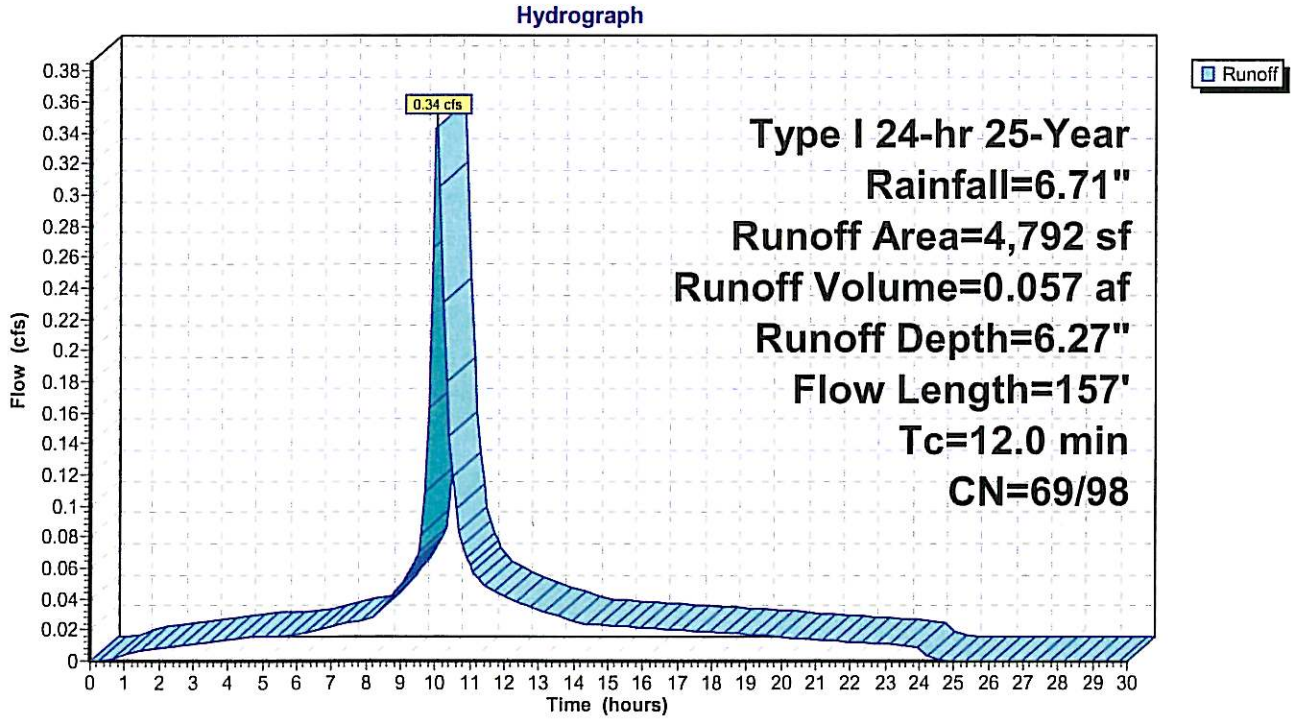
Runoff = 0.34 cfs @ 10.02 hrs, Volume= 0.057 af, Depth= 6.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
4,487	98	Paved parking & roofs
305	69	50-75% Grass cover, Fair, HSG B
4,792	96	Weighted Average
305	69	Pervious Area
4,487	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	28	0.0100	0.76		**Sheet Flow, across roof** Smooth surfaces n= 0.011 P2= 2.83"
2.1	129	0.0040	1.02		**Shallow Concentrated Flow, across rock swale to CB** Unpaved Kv= 16.1 fps
2.7	157	Total, Increased to minimum Tc = 12.0 min			

Subcatchment 5S: Area E5



Summary for Subcatchment 6S: Area E6

Area that flows to catch basin at the bottom of 540 W. Pueblo Street driveway. Then flows through existing clay pipe to curb inlet box on West Pueblo Street.

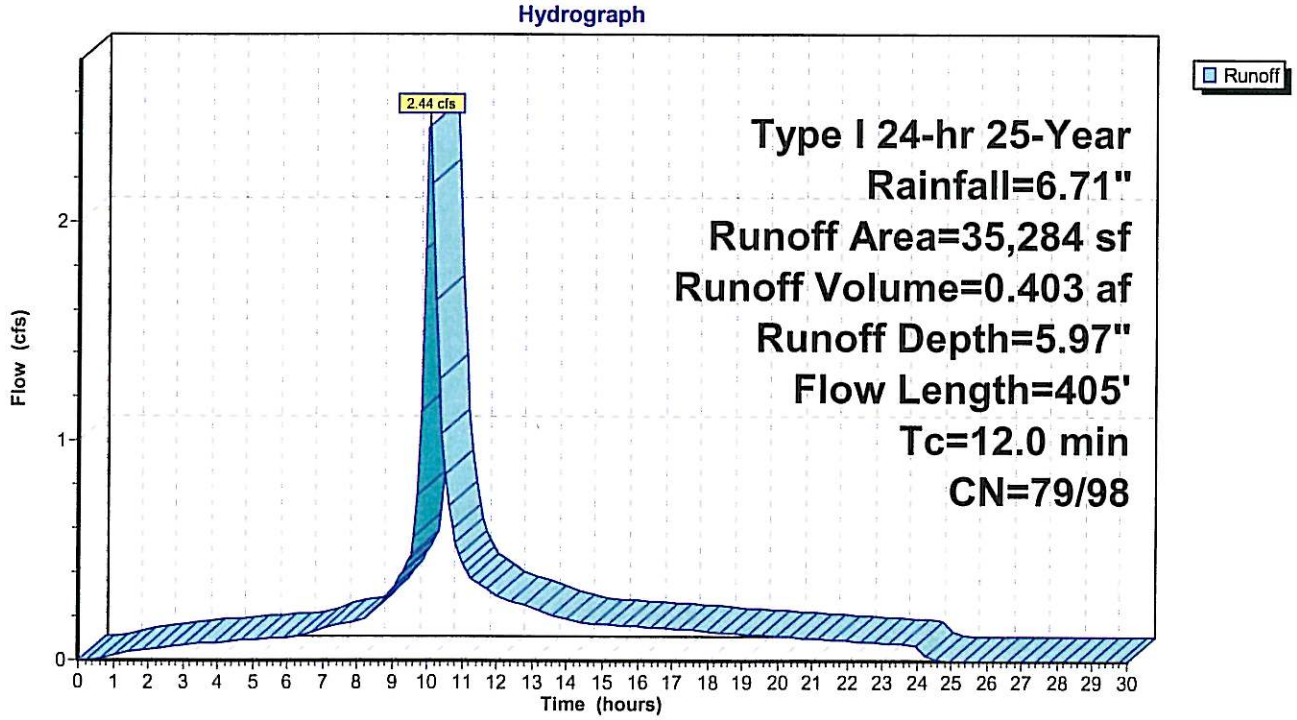
Runoff = 2.44 cfs @ 10.02 hrs, Volume= 0.403 af, Depth= 5.97"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
27,138	98	Paved parking & roofs
8,146	79	<50% Grass cover, Poor, HSG B
35,284	94	Weighted Average
8,146	79	Pervious Area
27,138	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	39	0.3000	3.17		**Sheet Flow, across 601 W. Junipero roof** Smooth surfaces n= 0.011 P2= 2.83"
1.9	204	0.0300	1.75		**Sheet Flow, across 529 W. Junipero d/w and 540 W. Pueblo pa** Smooth surfaces n= 0.011 P2= 2.83"
0.9	162	0.0226	3.05		**Shallow Concentrated Flow, down 540 W. Pueblo driveway** Paved Kv= 20.3 fps
3.0	405	Total, Increased to minimum Tc = 12.0 min			

Subcatchment 6S: Area E6



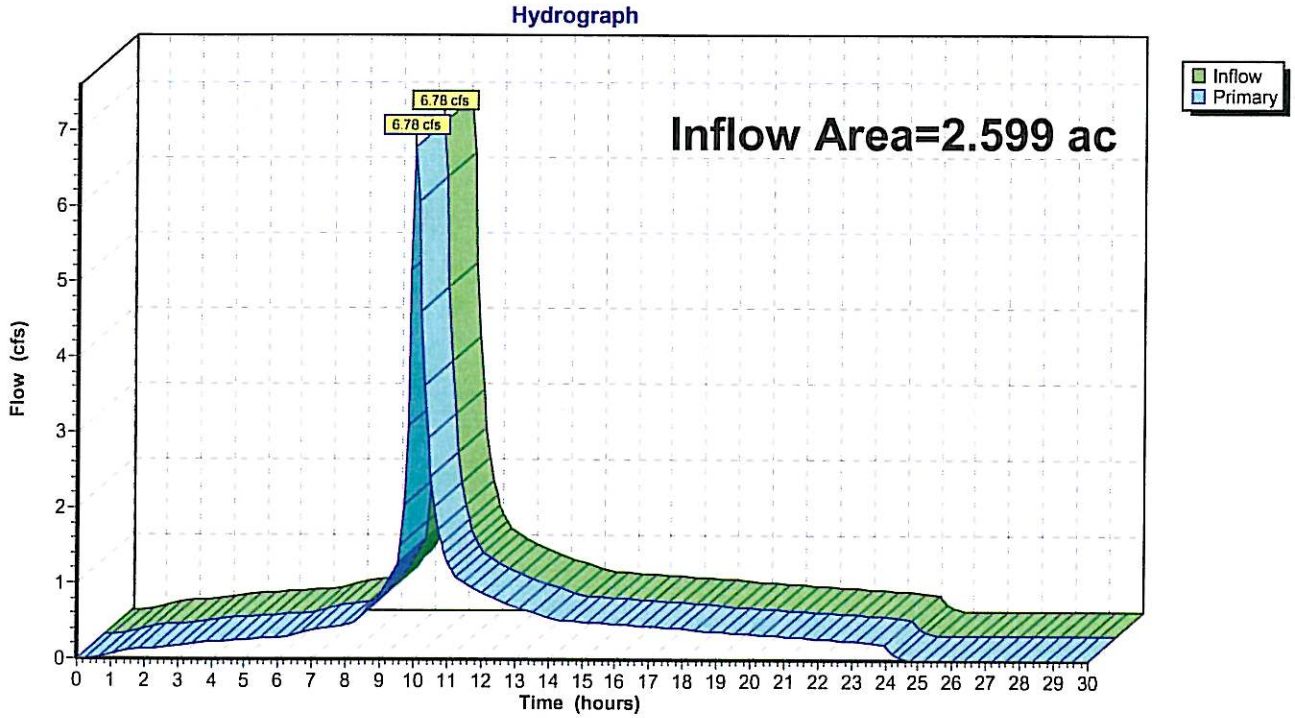
Summary for Pond 7P: Collection Point B- Pueblo Street Curb Inlet

[40] Hint: Not Described (Outflow=Inflow)

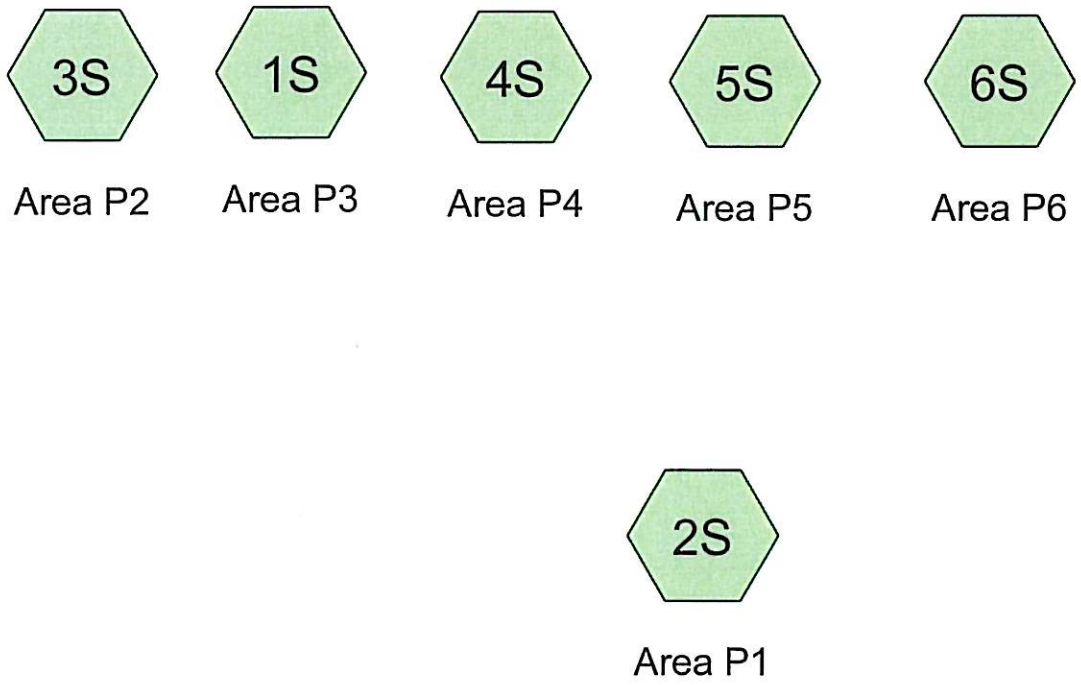
Inflow Area =	2.599 ac, 64.64% Impervious, Inflow Depth = 5.25" for 25-Year event			
Inflow =	6.78 cfs @ 10.02 hrs, Volume=	1.137 af		
Primary =	6.78 cfs @ 10.02 hrs, Volume=	1.137 af, Atten= 0%, Lag= 0.0 min		

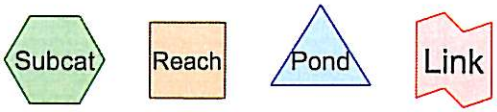
Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.10 hrs

Pond 7P: Collection Point B- Pueblo Street Curb Inlet



HYDROCAD PRINTOUT
(Post-Project Condition- 25 Year Storm)





Drainage Diagram for 15708-Post-Project
Prepared by Penfield & Smith, Printed 4/6/2009
HydroCAD® 8.50 s/n 004468 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.292	61	>75% Grass cover, Good, HSG B (2S,3S,4S,5S,6S)
0.399	85	Permeable Pavement (2S)
0.045	85	Permeable Pavment (1S)
0.164	98	Off-site Junipero (2S)
1.487	98	Paved parking & roofs (2S,3S,4S,5S,6S)
3.386		**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Goup	Subcatchment Numbers
0.000	HSG A	
1.292	HSG B	2S, 3S, 4S, 5S, 6S
0.000	HSG C	
0.000	HSG D	
2.094	Other	1S, 2S, 3S, 4S, 5S, 6S
3.386		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.10 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Area P3 Runoff Area=1,946 sf 0.00% Impervious Runoff Depth=4.98"
Tc=12.0 min CN=85/0 Runoff=0.12 cfs 0.019 af

Subcatchment 2S: Area P1 Runoff Area=128,837 sf 50.07% Impervious Runoff Depth=4.78"
Tc=12.0 min CN=67/98 Runoff=7.03 cfs 1.177 af

Subcatchment 3S: Area P2 Runoff Area=2,056 sf 40.76% Impervious Runoff Depth=4.12"
Tc=12.0 min CN=61/98 Runoff=0.09 cfs 0.016 af

Subcatchment 4S: Area P4 Runoff Area=6,130 sf 40.65% Impervious Runoff Depth=4.11"
Tc=12.0 min CN=61/98 Runoff=0.28 cfs 0.048 af

Subcatchment 5S: Area P5 Runoff Area=5,354 sf 51.94% Impervious Runoff Depth=4.56"
Tc=12.0 min CN=61/98 Runoff=0.27 cfs 0.047 af

Subcatchment 6S: Area P6 Runoff Area=3,159 sf 39.92% Impervious Runoff Depth=4.08"
Tc=12.0 min CN=61/98 Runoff=0.14 cfs 0.025 af

Total Runoff Area = 3.386 ac Runoff Volume = 1.332 af Average Runoff Depth = 4.72"
51.26% Pervious = 1.735 ac 48.74% Impervious = 1.650 ac

Summary for Subcatchment 1S: Area P3

Area that drains to W. Junipero Street curb inlet.

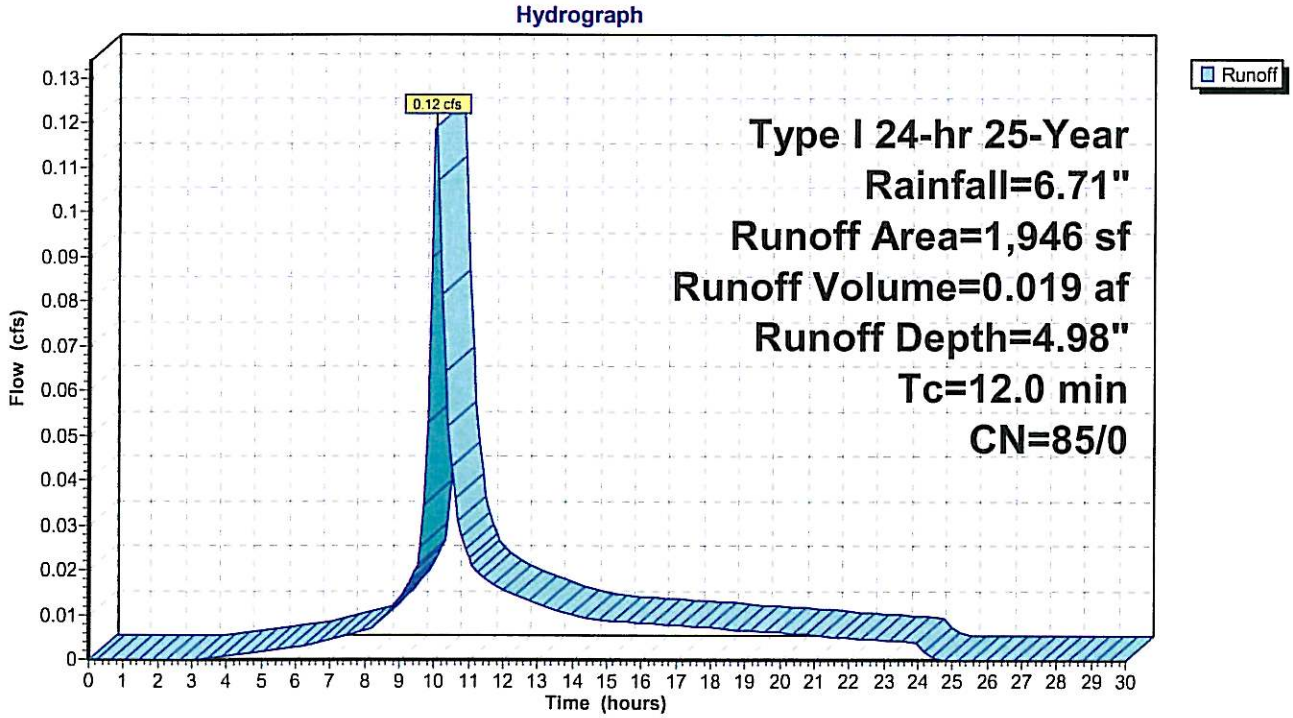
Runoff = 0.12 cfs @ 10.02 hrs, Volume= 0.019 af, Depth= 4.98"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

	Area (sf)	CN	Description
*	1,946	85	Permeable Pavment
	1,946	85	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 1S: Area P3



Summary for Subcatchment 2S: Area P1

Area that drains to W. Pueblo curb inlet

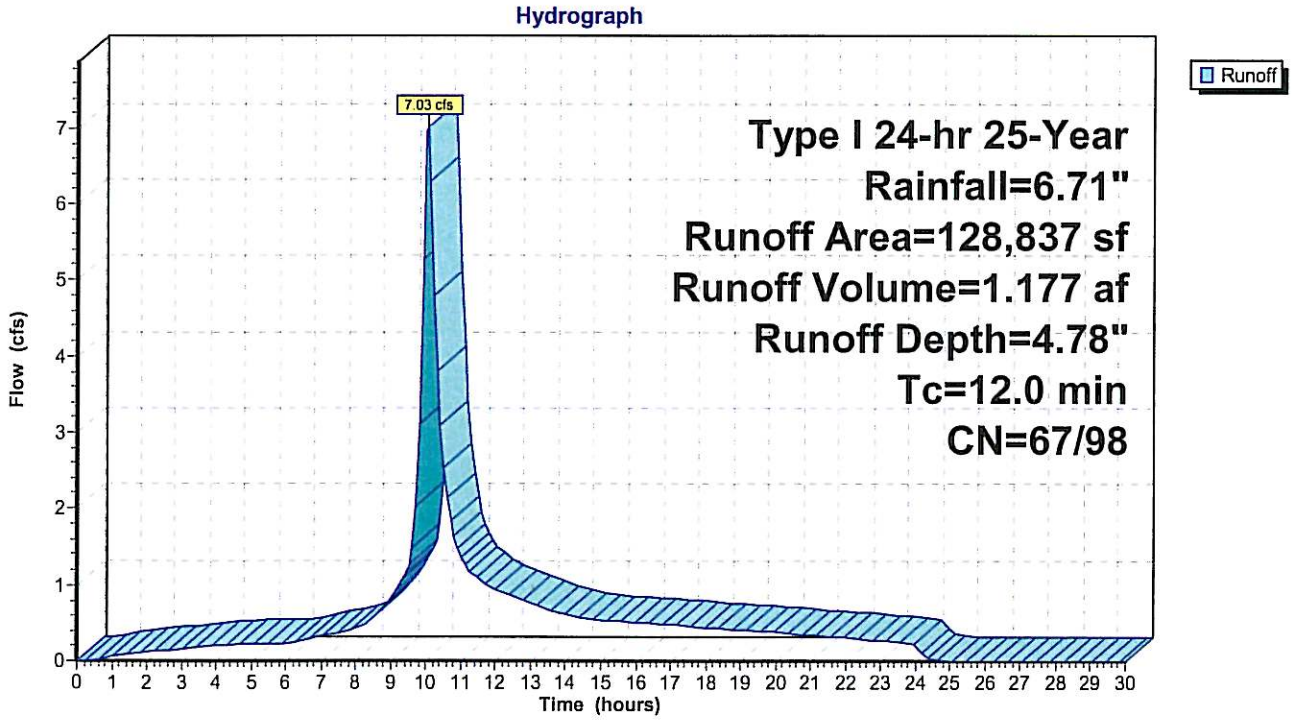
Runoff = 7.03 cfs @ 10.02 hrs, Volume= 1.177 af, Depth= 4.78"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

	Area (sf)	CN	Description
	57,389	98	Paved parking & roofs
	46,953	61	>75% Grass cover, Good, HSG B
*	17,370	85	Permeable Pavement
*	7,125	98	Off-site Junipero
	128,837	83	Weighted Average
	64,323	67	Pervious Area
	64,514	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 2S: Area P1



Summary for Subcatchment 3S: Area P2

Area that drains to W. Junipero Street curb inlet.

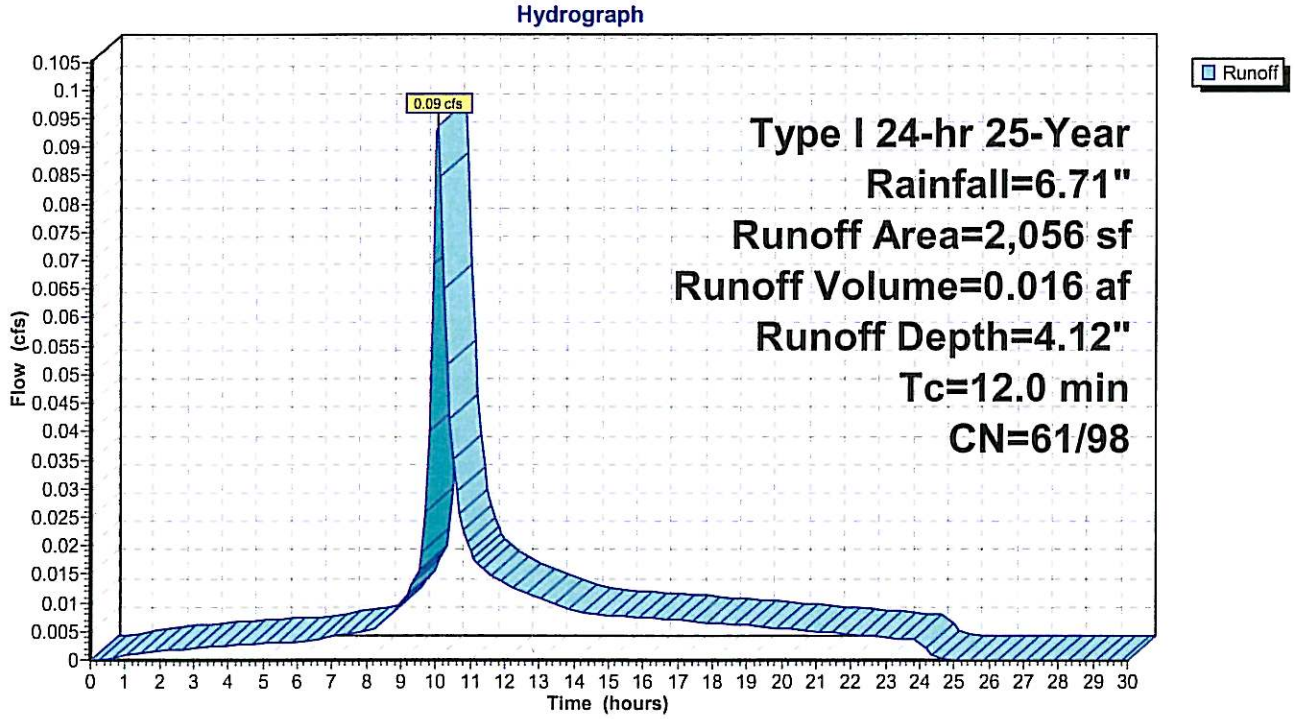
Runoff = 0.09 cfs @ 10.02 hrs, Volume= 0.016 af, Depth= 4.12"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
838	98	Paved parking & roofs
1,218	61	>75% Grass cover, Good, HSG B
2,056	76	Weighted Average
1,218	61	Pervious Area
838	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 3S: Area P2



Summary for Subcatchment 4S: Area P4

Area that drains to W. Junipero Street curb inlet.

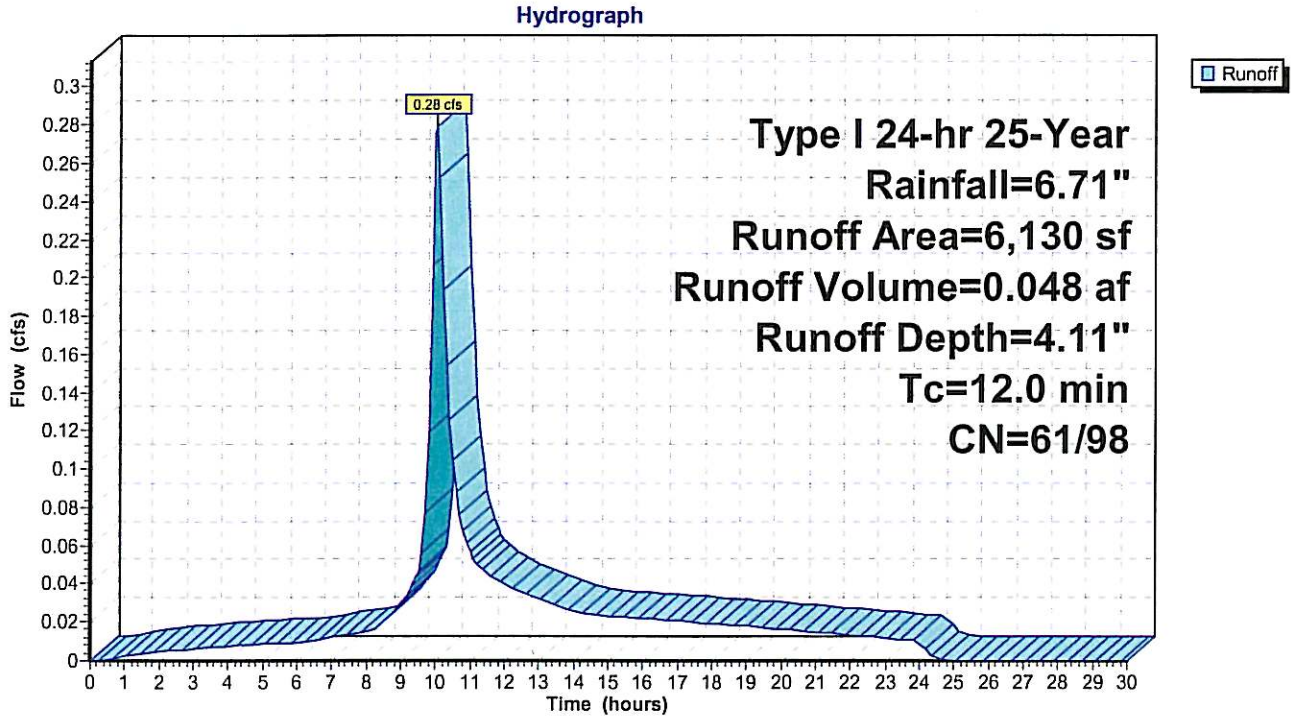
Runoff = 0.28 cfs @ 10.02 hrs, Volume= 0.048 af, Depth= 4.11"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
2,492	98	Paved parking & roofs
3,638	61	>75% Grass cover, Good, HSG B
6,130	76	Weighted Average
3,638	61	Pervious Area
2,492	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 4S: Area P4



Summary for Subcatchment 5S: Area P5

Area that drains to W. Junipero Street curb inlet.

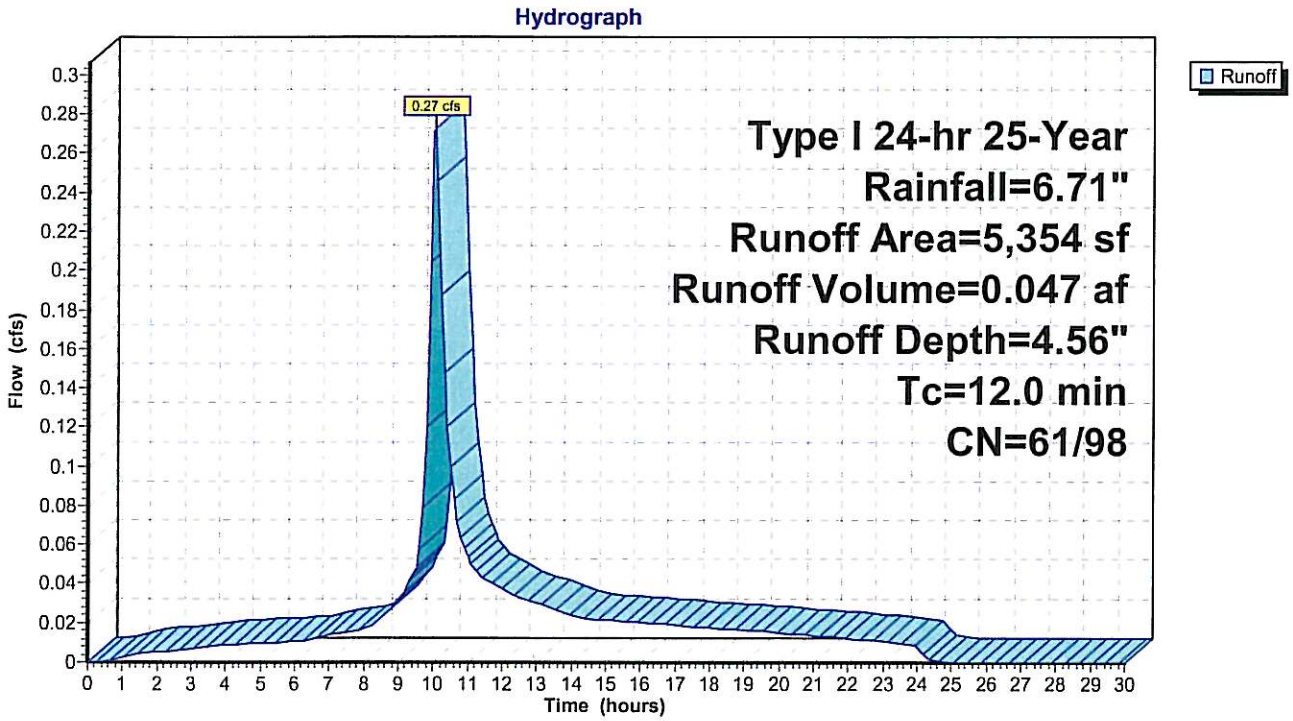
Runoff = 0.27 cfs @ 10.02 hrs, Volume= 0.047 af, Depth= 4.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

Area (sf)	CN	Description
2,781	98	Paved parking & roofs
2,573	61	>75% Grass cover, Good, HSG B
5,354	80	Weighted Average
2,573	61	Pervious Area
2,781	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 5S: Area P5



Summary for Subcatchment 6S: Area P6

Area that drains to W. Junipero Street curb inlet.

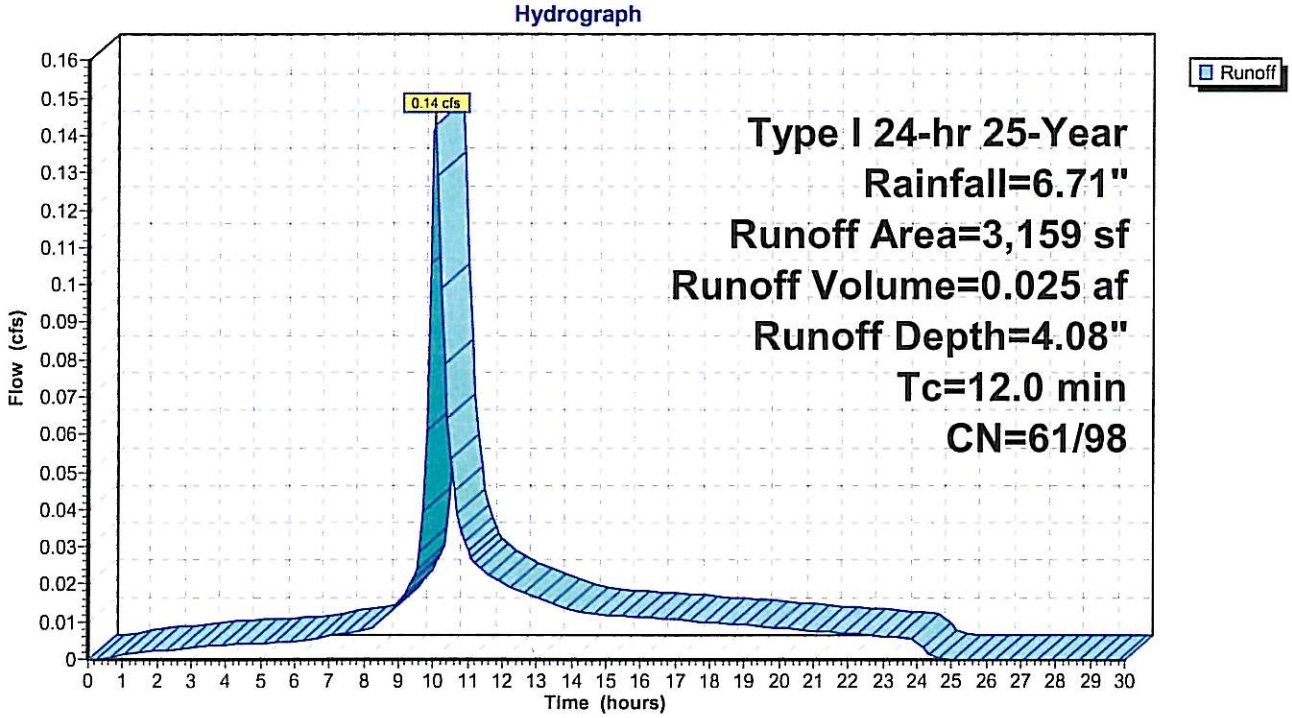
Runoff = 0.14 cfs @ 10.02 hrs, Volume= 0.025 af, Depth= 4.08"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr 25-Year Rainfall=6.71"

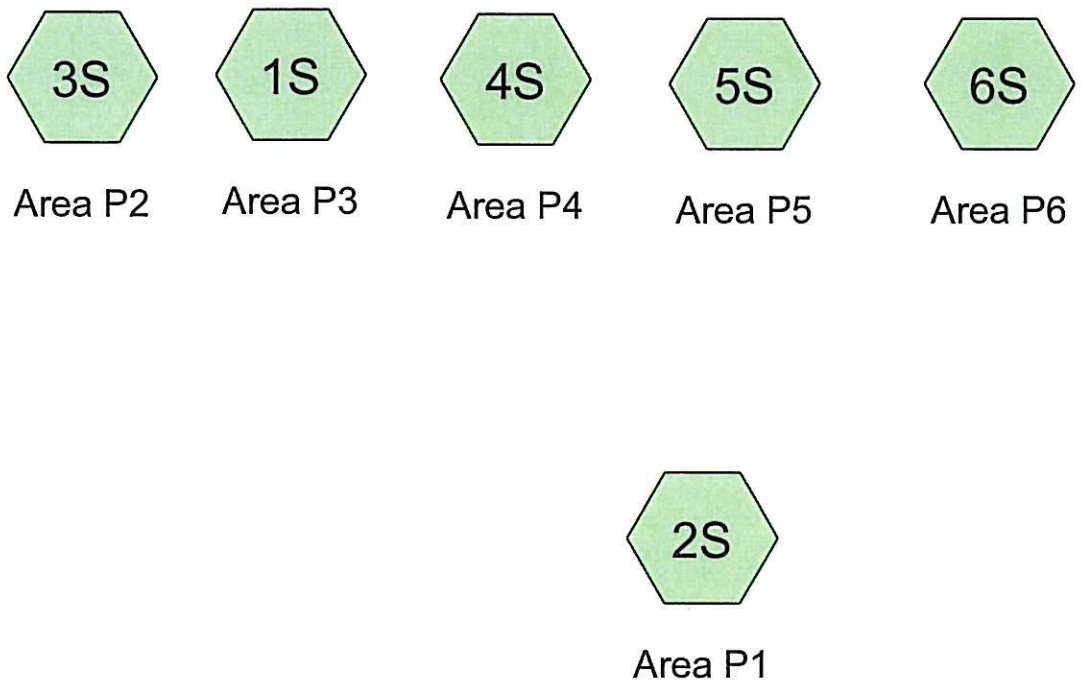
Area (sf)	CN	Description
1,261	98	Paved parking & roofs
1,898	61	>75% Grass cover, Good, HSG B
3,159	76	Weighted Average
1,898	61	Pervious Area
1,261	98	Impervious Area

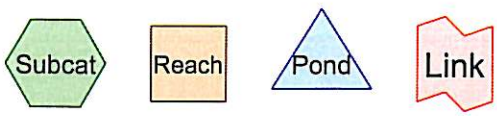
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 6S: Area P6



HYDROCAD PRINTOUT
(Post-Project Condition-
One Inch Storm for On-Site Only)





Drainage Diagram for 15708-Post-Project-OnSite-Volume
Prepared by Penfield & Smith, Printed 4/6/2009
HydroCAD® 8.50 s/n 004468 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.292	61	>75% Grass cover, Good, HSG B (2S,3S,4S,5S,6S)
0.399	85	Permeable Pavement (2S)
0.045	85	Permeable Pavment (1S)
1.487	98	Paved parking & roofs (2S,3S,4S,5S,6S)
3.222		**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Goup	Subcatchment Numbers
0.000	HSG A	
1.292	HSG B	2S, 3S, 4S, 5S, 6S
0.000	HSG C	
0.000	HSG D	
1.930	Other	1S, 2S, 3S, 4S, 5S, 6S
3.222		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.10 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1S: Area P3 Runoff Area=1,946 sf 0.00% Impervious Runoff Depth=0.17"
Tc=12.0 min CN=85/0 Runoff=0.00 cfs 0.001 af

Subcatchment 2S: Area P1 Runoff Area=121,712 sf 47.15% Impervious Runoff Depth=0.37"
Tc=12.0 min CN=67/98 Runoff=0.56 cfs 0.087 af

Subcatchment 3S: Area P2 Runoff Area=2,056 sf 40.76% Impervious Runoff Depth=0.32"
Tc=12.0 min CN=61/98 Runoff=0.01 cfs 0.001 af

Subcatchment 4S: Area P4 Runoff Area=6,130 sf 40.65% Impervious Runoff Depth=0.32"
Tc=12.0 min CN=61/98 Runoff=0.02 cfs 0.004 af

Subcatchment 5S: Area P5 Runoff Area=5,354 sf 51.94% Impervious Runoff Depth=0.41"
Tc=12.0 min CN=61/98 Runoff=0.03 cfs 0.004 af

Subcatchment 6S: Area P6 Runoff Area=3,159 sf 39.92% Impervious Runoff Depth=0.32"
Tc=12.0 min CN=61/98 Runoff=0.01 cfs 0.002 af

Total Runoff Area = 3.222 ac Runoff Volume = 0.099 af Average Runoff Depth = 0.37"
53.86% Pervious = 1.735 ac 46.14% Impervious = 1.487 ac

Summary for Subcatchment 1S: Area P3

Area that drains to W. Junipero Street curb inlet.

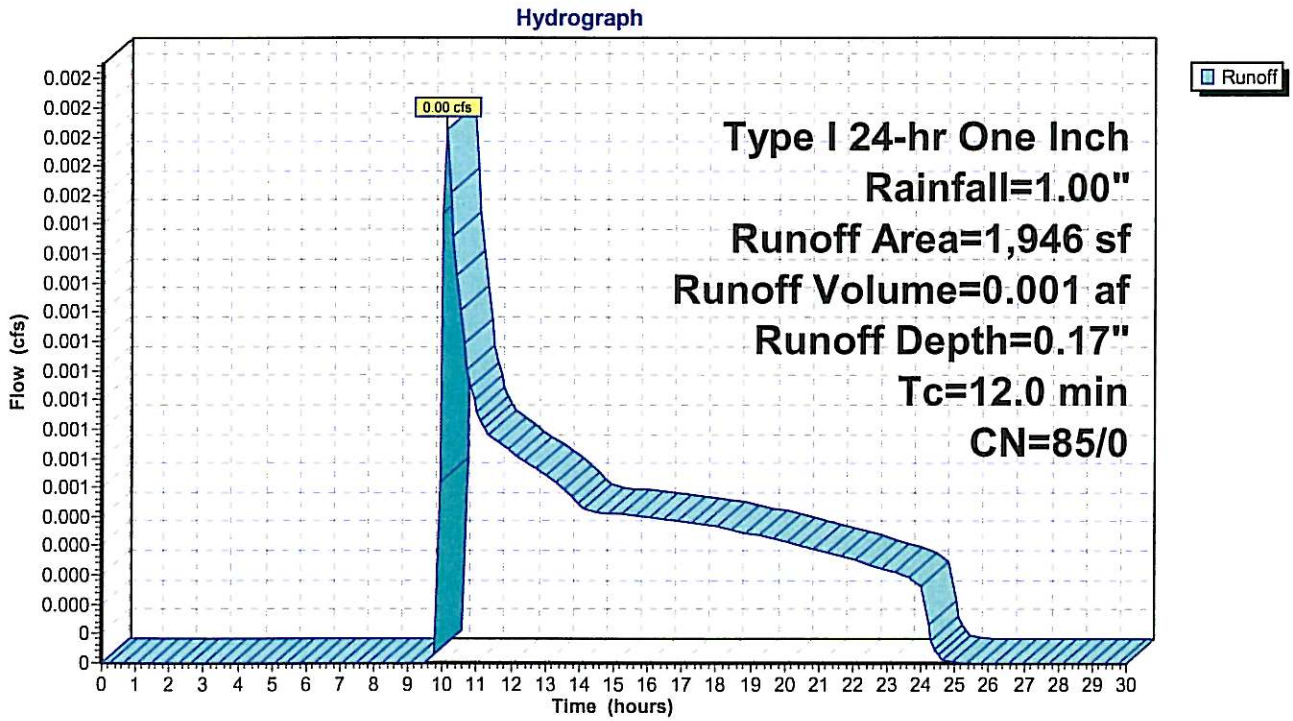
Runoff = 0.00 cfs @ 10.11 hrs, Volume= 0.001 af, Depth= 0.17"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

	Area (sf)	CN	Description
*	1,946	85	Permeable Pavment
	1,946	85	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 1S: Area P3



Summary for Subcatchment 2S: Area P1

Area that drains to W. Pueblo curb inlet

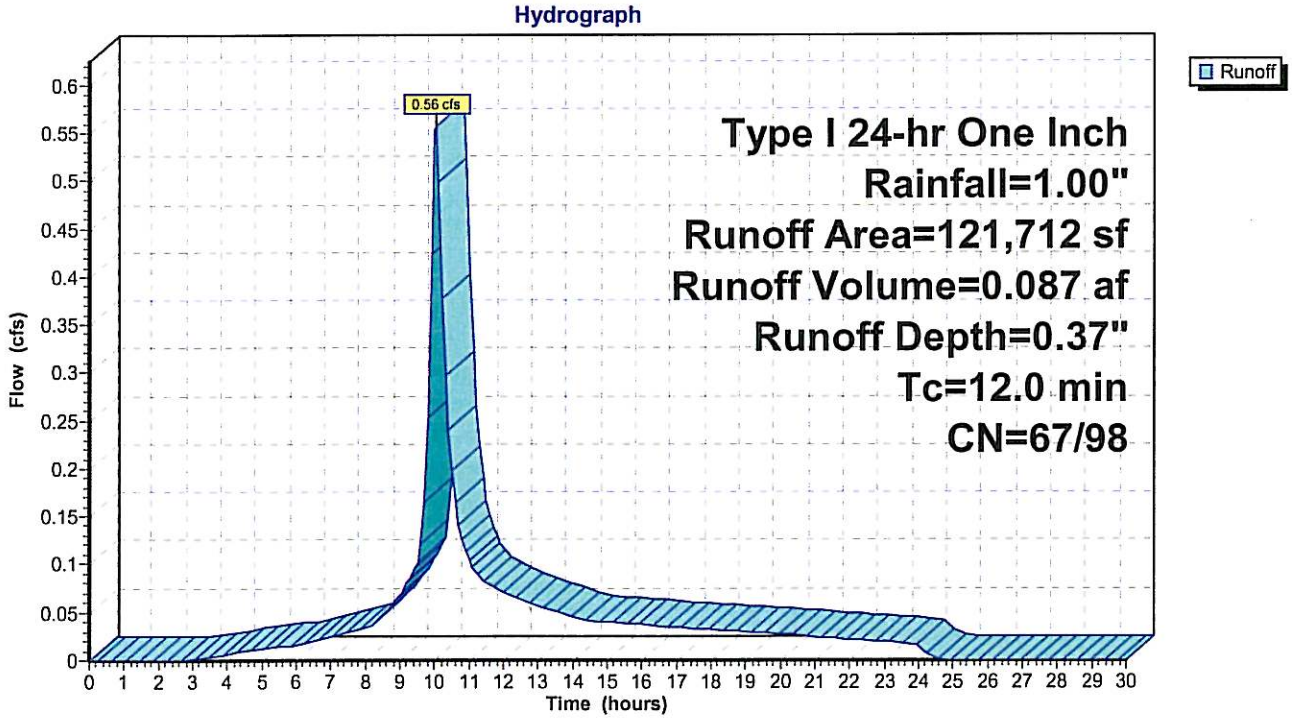
Runoff = 0.56 cfs @ 10.02 hrs, Volume= 0.087 af, Depth= 0.37"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

	Area (sf)	CN	Description
	57,389	98	Paved parking & roofs
	46,953	61	>75% Grass cover, Good, HSG B
*	17,370	85	Permeable Pavement
	121,712	82	Weighted Average
	64,323	67	Pervious Area
	57,389	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 2S: Area P1



Summary for Subcatchment 3S: Area P2

Area that drains to W. Junipero Street curb inlet.

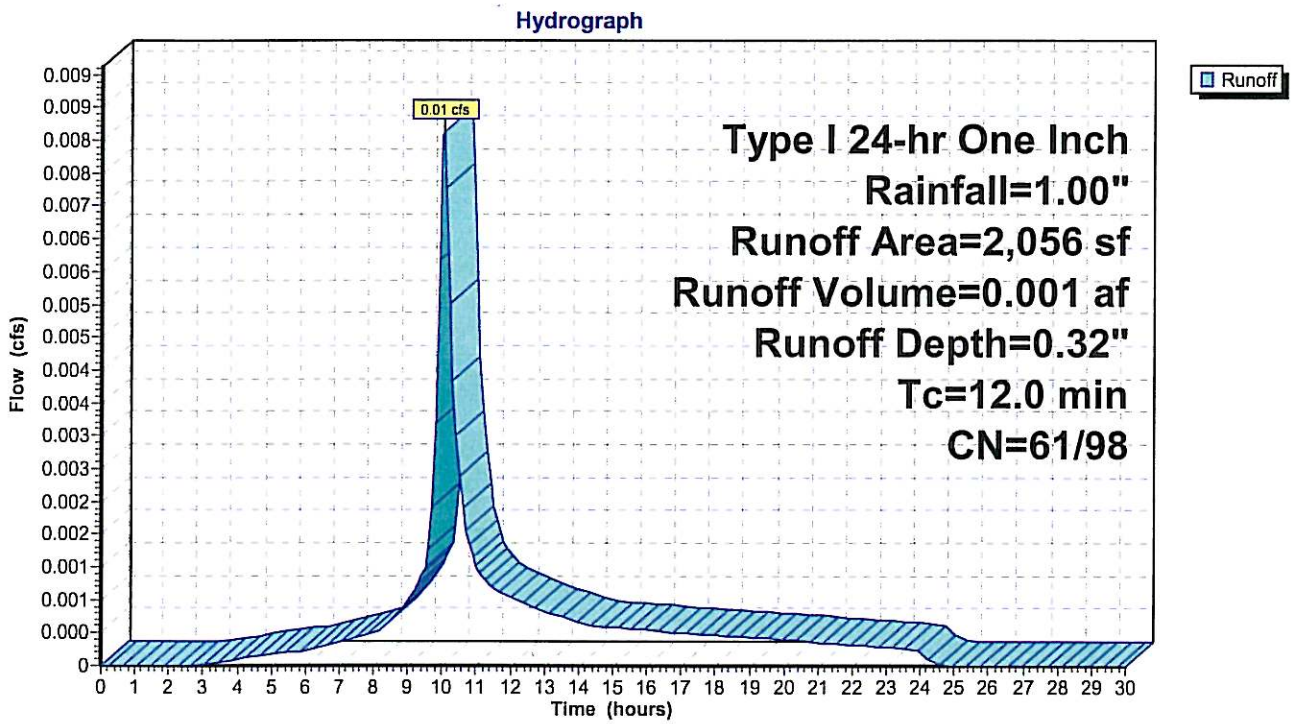
Runoff = 0.01 cfs @ 10.02 hrs, Volume= 0.001 af, Depth= 0.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

Area (sf)	CN	Description
838	98	Paved parking & roofs
1,218	61	>75% Grass cover, Good, HSG B
2,056	76	Weighted Average
1,218	61	Pervious Area
838	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 3S: Area P2



Summary for Subcatchment 4S: Area P4

Area that drains to W. Junipero Street curb inlet.

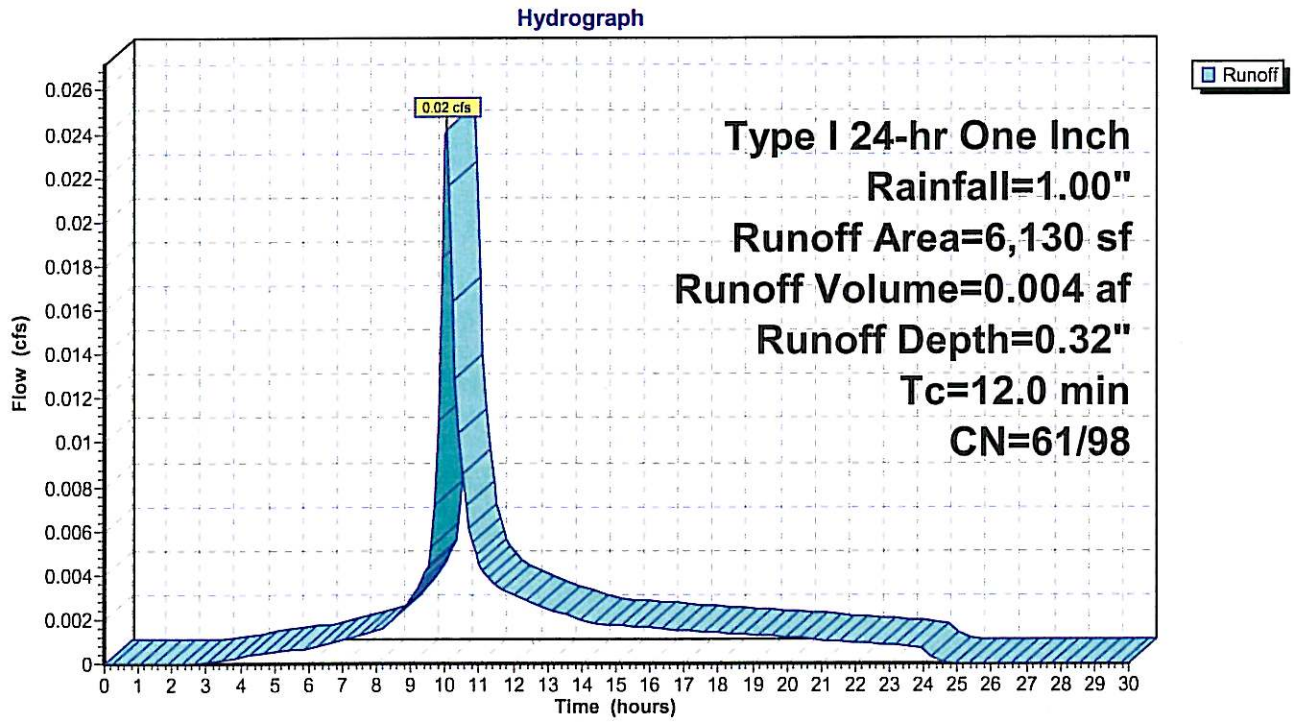
Runoff = 0.02 cfs @ 10.02 hrs, Volume= 0.004 af, Depth= 0.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

Area (sf)	CN	Description
2,492	98	Paved parking & roofs
3,638	61	>75% Grass cover, Good, HSG B
6,130	76	Weighted Average
3,638	61	Pervious Area
2,492	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 4S: Area P4



Summary for Subcatchment 5S: Area P5

Area that drains to W. Junipero Street curb inlet.

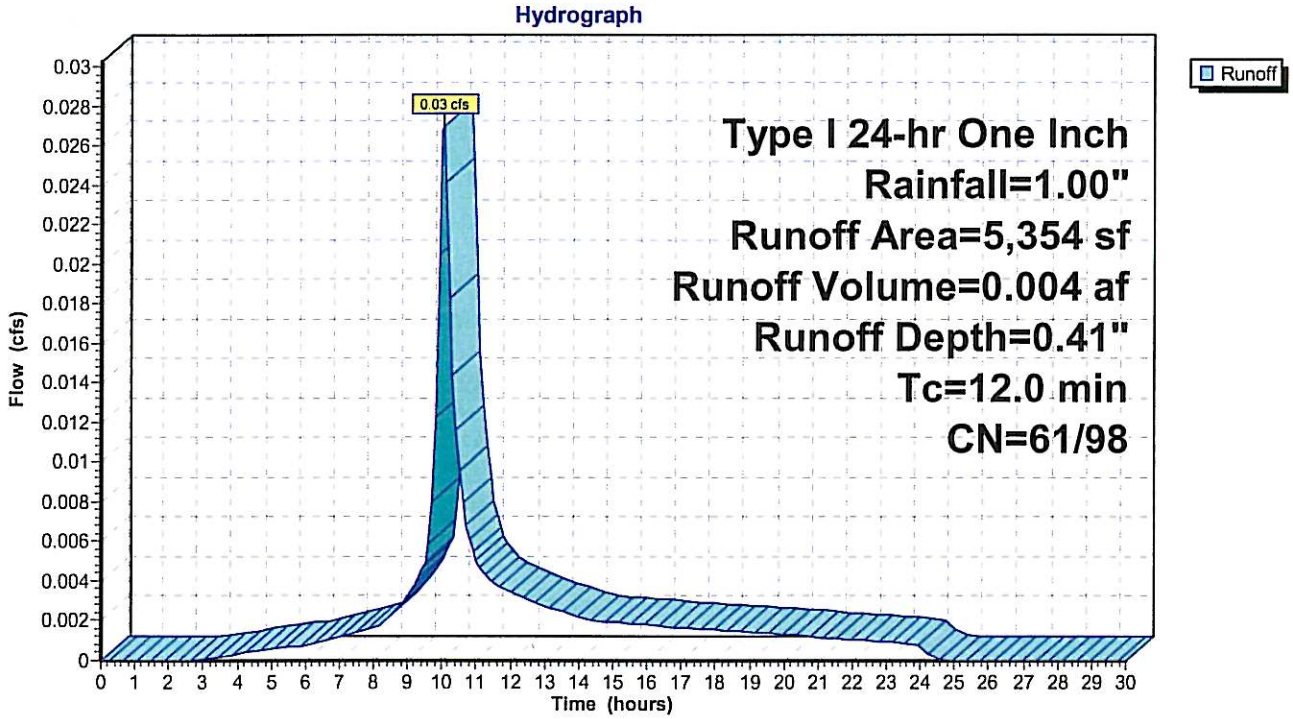
Runoff = 0.03 cfs @ 10.02 hrs, Volume= 0.004 af, Depth= 0.41"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

Area (sf)	CN	Description
2,781	98	Paved parking & roofs
2,573	61	>75% Grass cover, Good, HSG B
5,354	80	Weighted Average
2,573	61	Pervious Area
2,781	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 5S: Area P5



Summary for Subcatchment 6S: Area P6

Area that drains to W. Junipero Street curb inlet.

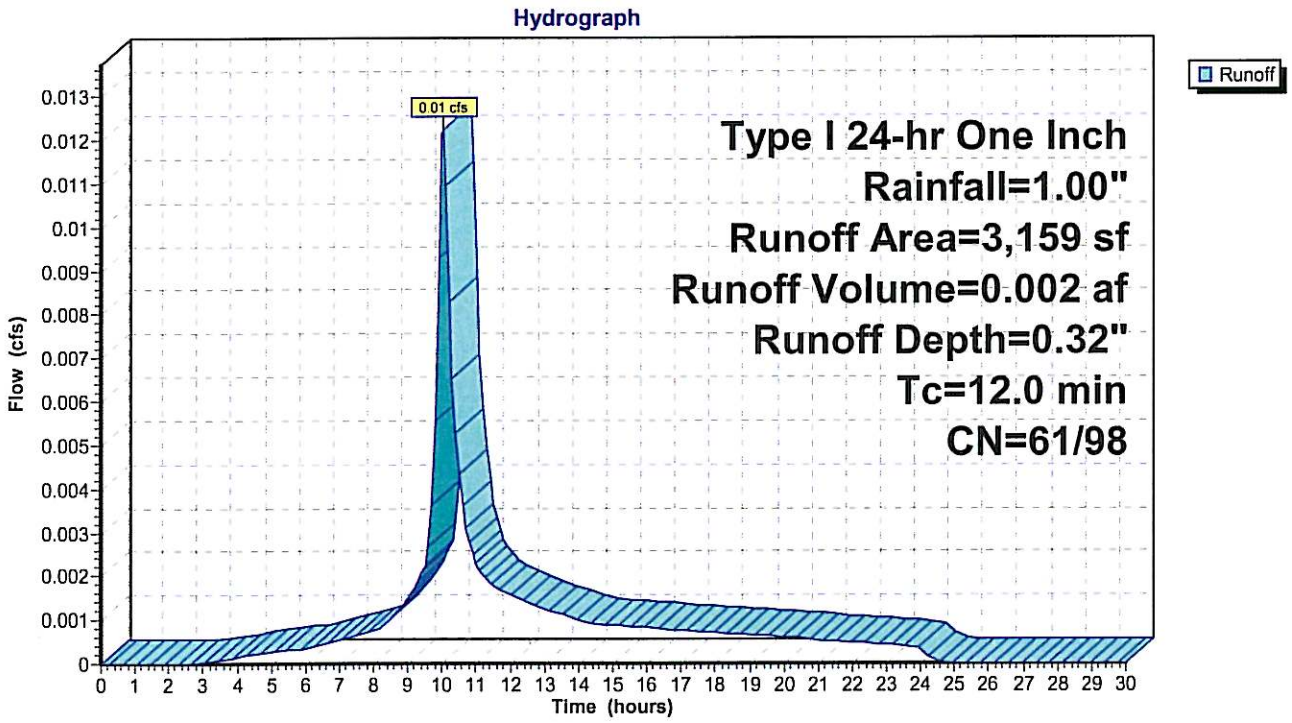
Runoff = 0.01 cfs @ 10.02 hrs, Volume= 0.002 af, Depth= 0.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

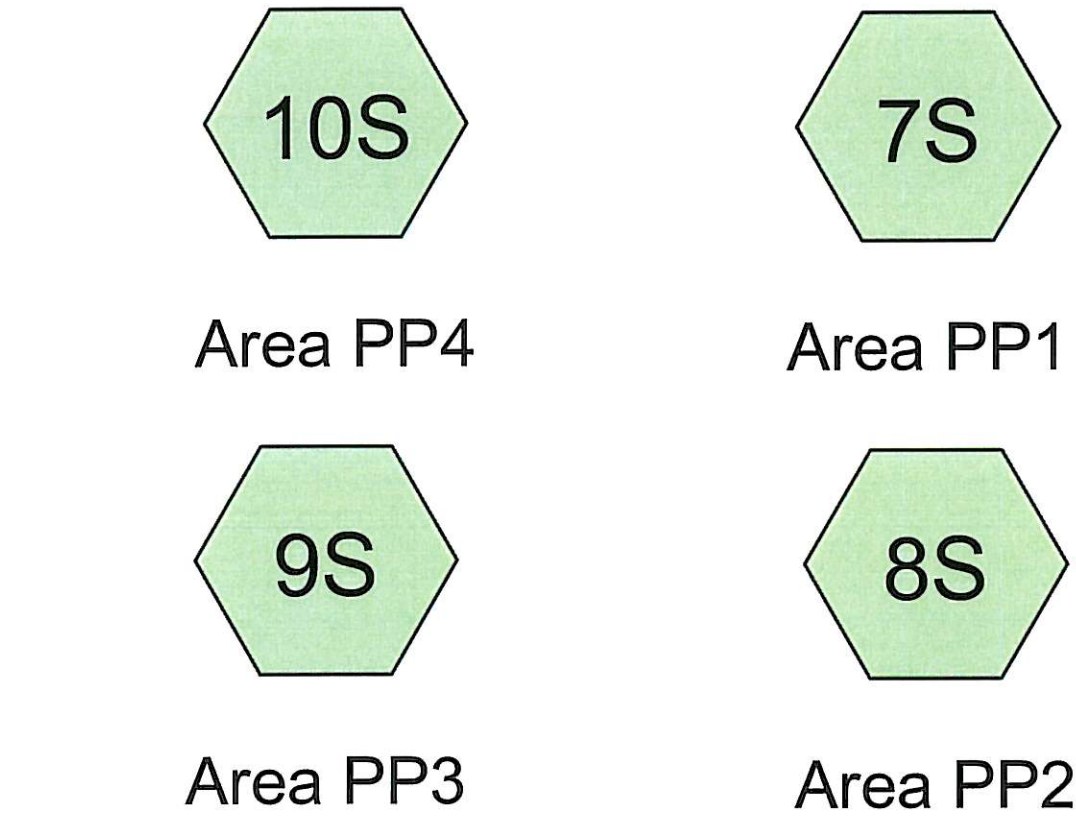
Area (sf)	CN	Description
1,261	98	Paved parking & roofs
1,898	61	>75% Grass cover, Good, HSG B
3,159	76	Weighted Average
1,898	61	Pervious Area
1,261	98	Impervious Area

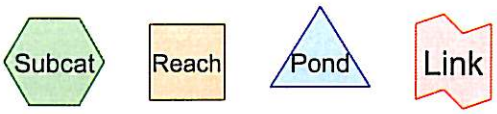
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 6S: Area P6



HYDROCAD PRINTOUT
(Post-Project Condition-
One Inch Storm for Permeable Pavement)





Drainage Diagram for 15708-Post-Project-V-1in Treated by Perm Pvmt
Prepared by Penfield & Smith, Printed 4/6/2009
HydroCAD® 8.50 s/n 004468 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.361	85	Permeable Pavement (7S,8S,9S)
0.123	98	Paved parking & roofs (7S,9S,10S)
0.484		**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Goup	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.484	Other	7S, 8S, 9S, 10S
0.484		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.10 hrs, 301 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 7S: Area PP1 Runoff Area=8,040 sf 21.77% Impervious Runoff Depth=0.31"
Tc=12.0 min CN=85/98 Runoff=0.02 cfs 0.005 af

Subcatchment 8S: Area PP2 Runoff Area=3,290 sf 0.00% Impervious Runoff Depth=0.17"
Tc=12.0 min CN=85/0 Runoff=0.00 cfs 0.001 af

Subcatchment 9S: Area PP3 Runoff Area=7,800 sf 21.15% Impervious Runoff Depth=0.30"
Tc=12.0 min CN=85/98 Runoff=0.02 cfs 0.005 af

Subcatchment 10S: Area PP4 Runoff Area=1,946 sf 100.00% Impervious Runoff Depth=0.79"
Tc=12.0 min CN=0/98 Runoff=0.02 cfs 0.003 af

Total Runoff Area = 0.484 ac Runoff Volume = 0.013 af Average Runoff Depth = 0.33"
74.63% Pervious = 0.361 ac 25.37% Impervious = 0.123 ac

Summary for Subcatchment 7S: Area PP1

Area adjacent to main entrance that is treated by permeable pavement.

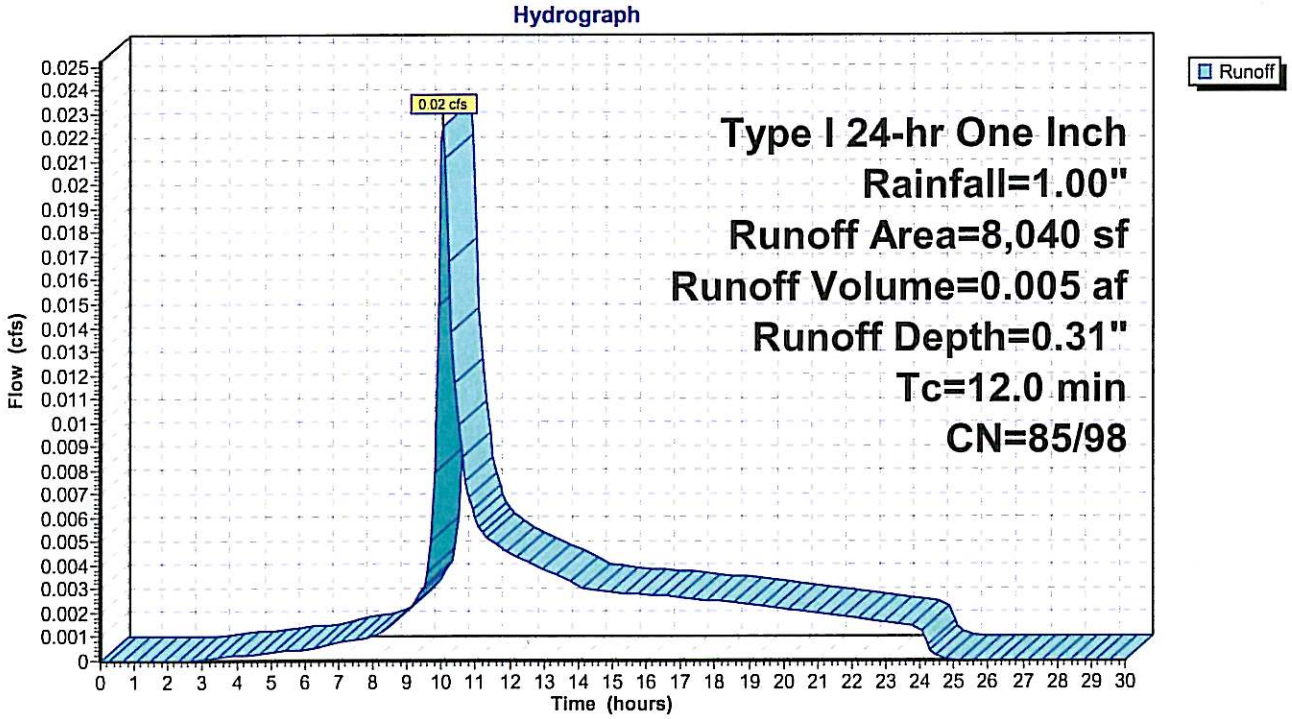
Runoff = 0.02 cfs @ 10.04 hrs, Volume= 0.005 af, Depth= 0.31"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

	Area (sf)	CN	Description
	1,750	98	Paved parking & roofs
*	6,290	85	Permeable Pavement
	8,040	88	Weighted Average
	6,290	85	Pervious Area
	1,750	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 7S: Area PP1



Summary for Subcatchment 8S: Area PP2

Area of dirveway that slopes from highpoint near main entry down to Pueblo Street.

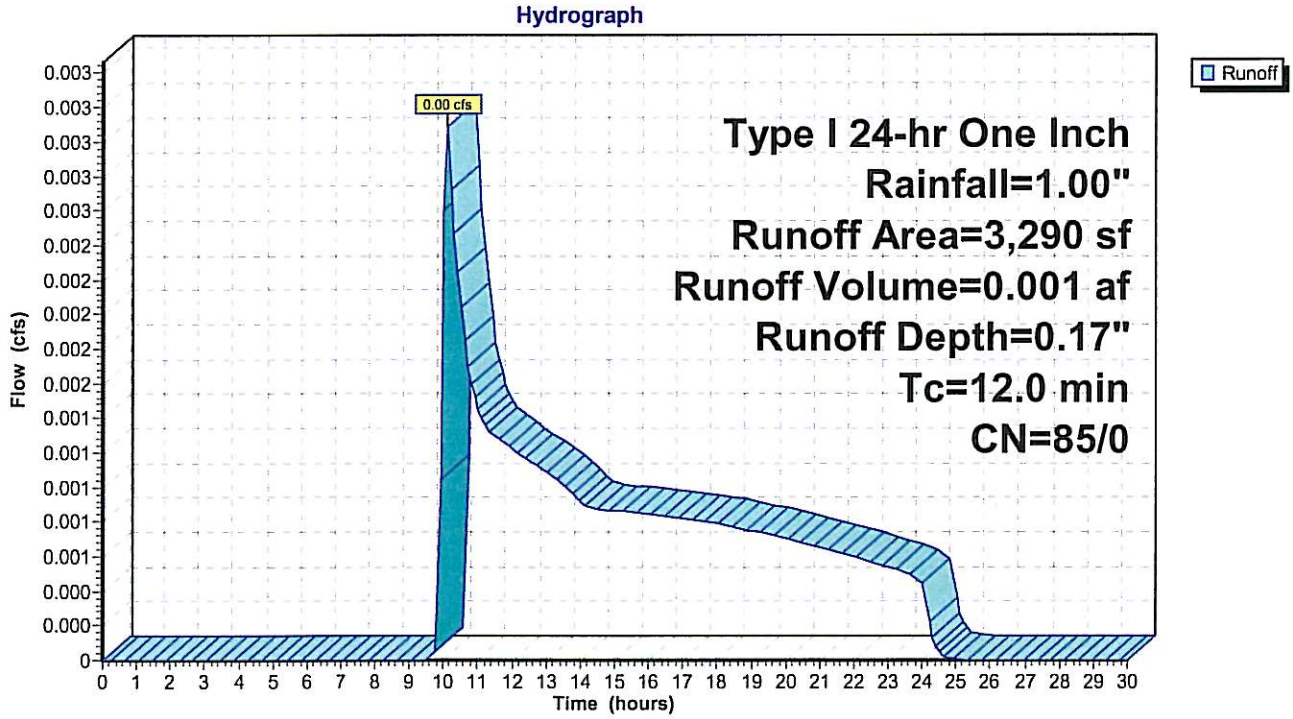
Runoff = 0.00 cfs @ 10.11 hrs, Volume= 0.001 af, Depth= 0.17"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

	Area (sf)	CN	Description
*	3,290	85	Permeable Pavement
	3,290	85	Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 8S: Area PP2



Summary for Subcatchment 9S: Area PP3

West parking lot area treated by permeable pavement.

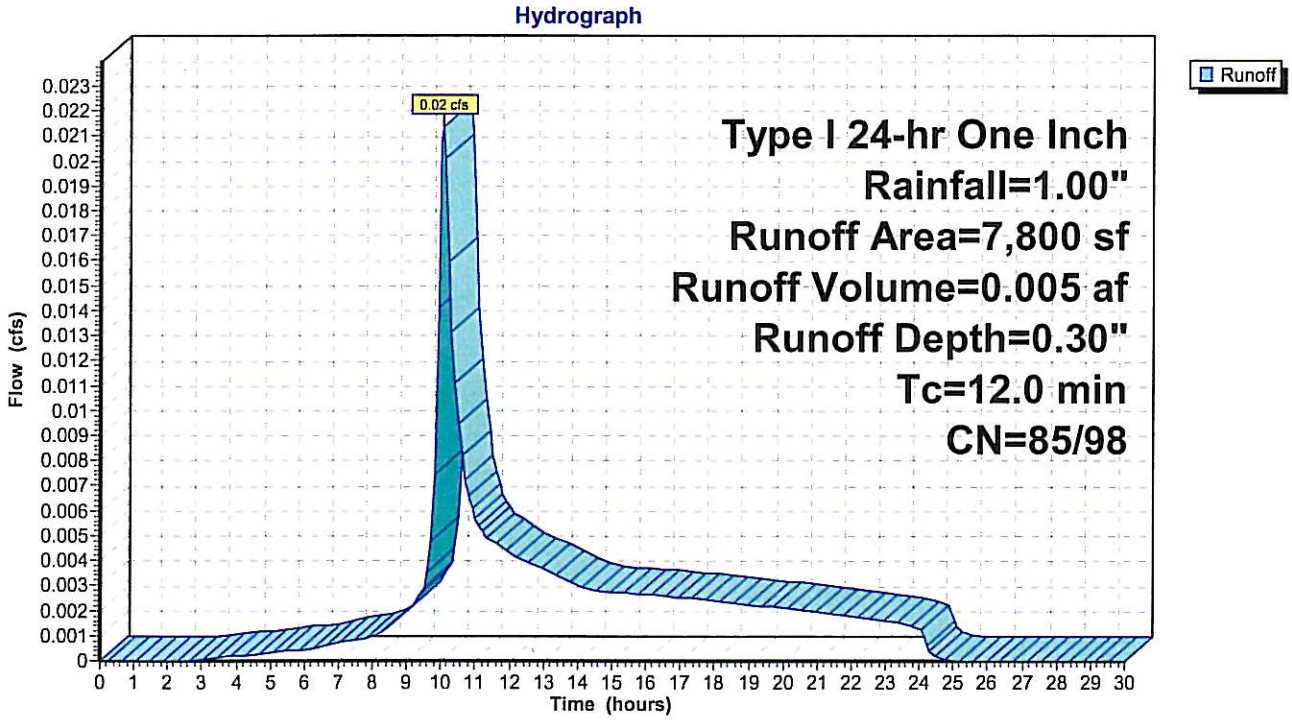
Runoff = 0.02 cfs @ 10.04 hrs, Volume= 0.005 af, Depth= 0.30"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

	Area (sf)	CN	Description
	1,650	98	Paved parking & roofs
*	6,150	85	Permeable Pavement
	7,800	88	Weighted Average
	6,150	85	Pervious Area
	1,650	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry, Minimum Tc**

Subcatchment 9S: Area PP3



Summary for Subcatchment 10S: Area PP4

Area of driveway that slopes from highpoint near garage entry on west side down to Junipero Street.

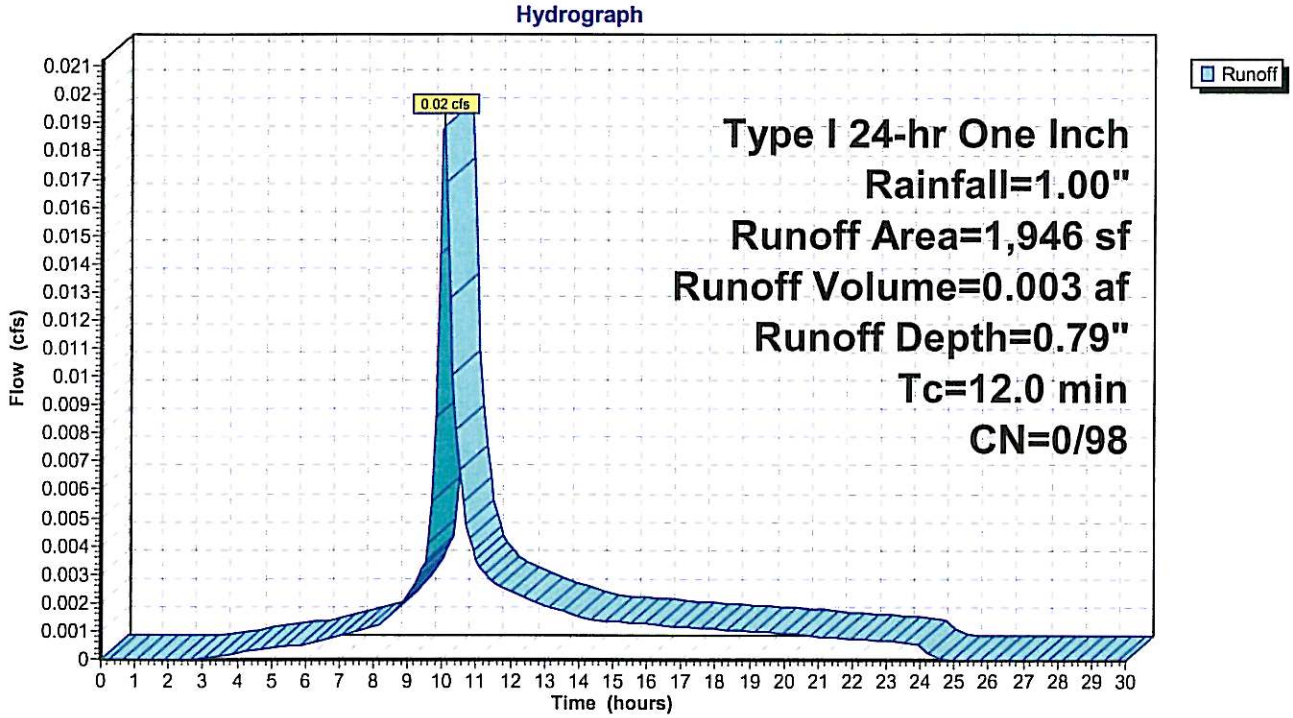
Runoff = 0.02 cfs @ 10.02 hrs, Volume= 0.003 af, Depth= 0.79"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-30.00 hrs, dt= 0.10 hrs
Type I 24-hr One Inch Rainfall=1.00"

Area (sf)	CN	Description
1,946	98	Paved parking & roofs
1,946	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0					**Direct Entry,**

Subcatchment 10S: Area PP4



CALCULATIONS

(Worksheets from City of Santa Barbara Storm Water BMP Guidance Manual, June 2008 (Final))

- Infiltration Basin
- Dry Wells
- Permeable Pavers
- Vegetated Swale Filter

Infiltration Basin

Location: Along W. Pueblo Street side of site (Area P1)

Infiltration BMP Worksheet

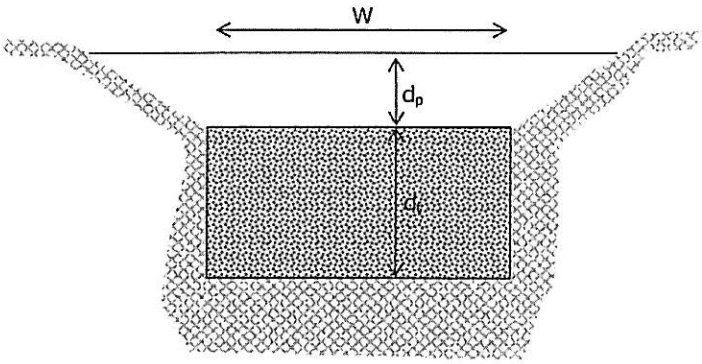


Figure D-5: Infiltration BMP cross-section

Refer to Figures D-5, 6-12, 6-13 and 6-14 for a diagrammatic description of the geometric variables.

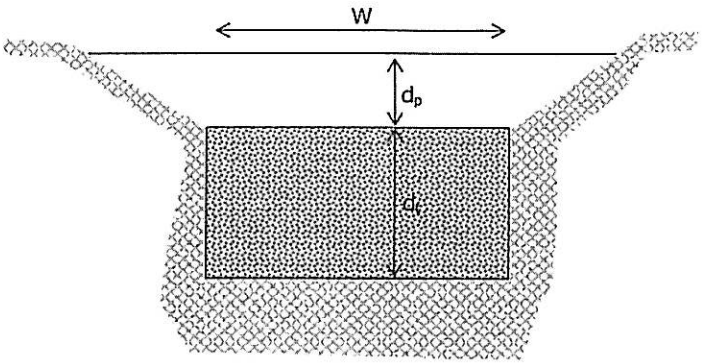
Step 1: Determine design volume reduction, $V_{reduction}$		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = _____ ft^3	-7100 ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = _____ ft^3	3790 ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = _____ ft^3	3790 ft^3
Step 2: Determine storm water quality design volume, V_{wq}		
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = _____ ft^3	3790 ft^3
Step 3: Determine design volume, V_{design} (for sizing)		
3-1. V_{design} = the larger of $V_{reduction}$ and V_{wq}	V_{design} = _____ ft^3	3790 ft^3

Step 4: Calculate design infiltration rate			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ = _____	in/hr	6 in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t = _____	ft	0.3
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p = _____		0.8
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D = _____	ft	29.6 ft
4-5. Enter the estimated width of the facility	W = _____	ft	15 ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g = _____		1
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} = _____	in/hr	1.44 in/hr
Step 5: Determine facility size			
5-1. Enter drawdown time(72 hrs max.), t_d	t_d = _____	hrs	72 hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t_d, $d_{max}=k_{design}t_d/12$	d_{max}= _____	ft	8.64 ft
5-3. Enter trench fill aggregate porosity, n_t	n_t= _____		
5-4. Enter depth of trench fill, d_t	d_t = _____	in	
5-5. Enter max ponding depth, or max. $d_p=d_{max}-n_td_t$	d_p= _____	ft	1 ft
Step 6: Determine infiltrating surface area (filter bottom area)			
6-1. Enter the time to fill infiltration basin or trench with water (Use 2 hours for most designs), T	T = _____	hrs	2 hrs
6-2. Calculate infiltrating surface area for infiltration basin: $A_b=V_{design}/((Tk_{design}/12)+d_p)$	A_b = _____	ft^2	3056 ft^2
6-3. Calculate infiltrating surface area for infiltration trenches: $A_t=V_{design}/((Tk_{design}/12)+n_td_t+dp)$	A_t = _____	ft^2	
6-4. Calculate infiltrating surface area for dry wells: $A_{dw}=V_{design}/(Tk_{design}/12)+n_td_t))$	A_{dw} = _____	ft^3	
Step 7: Provide conveyance capacity for filter clogging			
7-1.The infiltration facility should be placed off-line, but an emergency overflow must still be provided in the event the filter becomes clogged.			

Dry Well

Location: 601 W. Junipero Street (Area P2)

Infiltration BMP Worksheet



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Step 1: Determine design volume reduction, $V_{reduction}$		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = _____ ft^3	See Note Below
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = _____ ft^3	44 ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = _____ ft^3	44 ft^3
Step 2: Determine storm water quality design volume, V_{wq}		
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = _____ ft^3	44 ft^3
Step 3: Determine design volume, V_{design} (for sizing)		
3-1. V_{design} = the larger of $V_{reduction}$ and V_{wq}	V_{design} = _____ ft^3	44 ft^3

Note: V_{25} not applicable since decrease in volume is calculated for entire site.

Step 4: Calculate design infiltration rate			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ = _____	in/hr	6 in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t = _____	ft	0.3
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p = _____		0.8
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D = _____	ft	26.6 ft
4-5. Enter the estimated width of the facility	W = _____	ft	5 ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g = _____		1
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} = _____	in/hr	1.44 in/hr
Step 5: Determine facility size			
5-1. Enter drawdown time(72 hrs max.), t_d	t_d = _____	hrs	72 hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t_d. $d_{max}=k_{design}t_d/12$	d_{max}= _____	ft	8.64 ft
5-3. Enter trench fill aggregate porosity, n_t	n_t= _____		0.35
5-4. Enter depth of trench fill, d_t	d_t = _____	in	48 in
5-5. Enter max ponding depth, or max. $d_p=d_{max}-n_td_t$	d_p= _____	ft	
Step 6: Determine infiltrating surface area (filter bottom area)			
6-1. Enter the time to fill infiltration basin or trench with water (Use 2 hours for most designs), T	T = _____	hrs	2 hrs
6-2. Calculate infiltrating surface area for infiltration basin: $A_b=V_{design}/((Tk_{design}/12)+d_p)$	A_b = _____	ft^2	
6-3. Calculate infiltrating surface area for infiltration trenches: $A_t=V_{design}/((Tk_{design}/12)+n_td_t+dp)$	A_t = _____	ft^2	
6-4. Calculate infiltrating surface area for dry wells: $A_{dw}=V_{design}/(Tk_{design}/12)+n_td_t))$	A_{dw} = _____	ft^3	27 ft^2
Step 7: Provide conveyance capacity for filter clogging			
7-1.The infiltration facility should be placed off-line, but an emergency overflow must still be provided in the event the filter becomes clogged.			

Dry Well

Location: Area P4

Infiltration BMP Worksheet

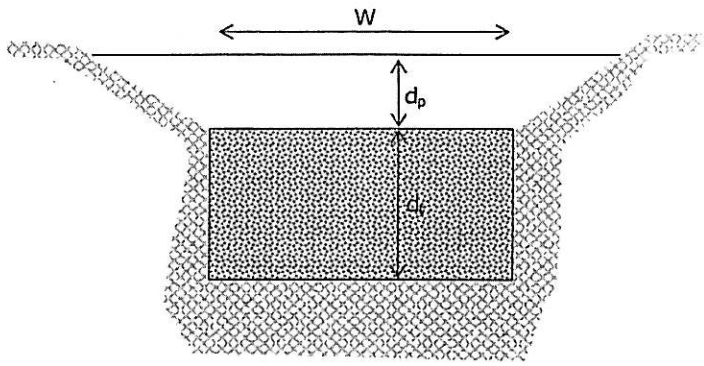


Figure D-5: Infiltration BMP cross-section

Refer to Figures D-5, 6-12, 6-13 and 6-14 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = _____ ft^3	See Note Below
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = _____ ft^3	0 ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = _____ ft^3	174 ft^3
Step 2: Determine storm water quality design volume, V_{wq}		
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = _____ ft^3	174 ft^3
Step 3: Determine design volume, V_{design} (for sizing)		
3-1. V_{design} = the larger of $V_{reduction}$ and V_{wq}	V_{design} = _____ ft^3	174 ft^3

Note: V_{25} not applicable since decrease in volume is calculated for entire site.

Step 4: Calculate design infiltration rate			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ = _____	in/hr	6 in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t = _____	ft	0.3
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p = _____		0.8
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D = _____	ft	26.6 ft
4-5. Enter the estimated width of the facility	W = _____	ft	10 ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g = _____		1
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} = _____	in/hr	1.44 in/hr
Step 5: Determine facility size			
5-1. Enter drawdown time(72 hrs max.), t_d	t_d = _____	hrs	72 hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t_d. $d_{max}=k_{design}t_d/12$	d_{max}= _____	ft	8.64 ft
5-3. Enter trench fill aggregate porosity, n_t	n_t= _____		0.35
5-4. Enter depth of trench fill, d_t	d_t = _____	in	48 in
5-5. Enter max ponding depth, or max. $d_p=d_{max}-n_td_t$	d_p= _____	ft	
Step 6: Determine infiltrating surface area (filter bottom area)			
6-1. Enter the time to fill infiltration basin or trench with water (Use 2 hours for most designs), T	T = _____	hrs	2 hrs
6-2. Calculate infiltrating surface area for infiltration basin: $A_b=V_{design}/((Tk_{design}/12)+d_p)$	A_b = _____	ft^2	
6-3. Calculate infiltrating surface area for infiltration trenches: $A_t=V_{design}/((Tk_{design}/12)+n_td_t+dp)$	A_t = _____	ft^2	
6-4. Calculate infiltrating surface area for dry wells: $A_{dw}=V_{design}/(Tk_{design}/12)+n_td_t))$	A_{dw} = _____	ft^3	106 ft^2
Step 7: Provide conveyance capacity for filter clogging			
7-1.The infiltration facility should be placed off-line, but an emergency overflow must still be provided in the event the filter becomes clogged.			

Dry Well

Location: Area P5

Infiltration BMP Worksheet

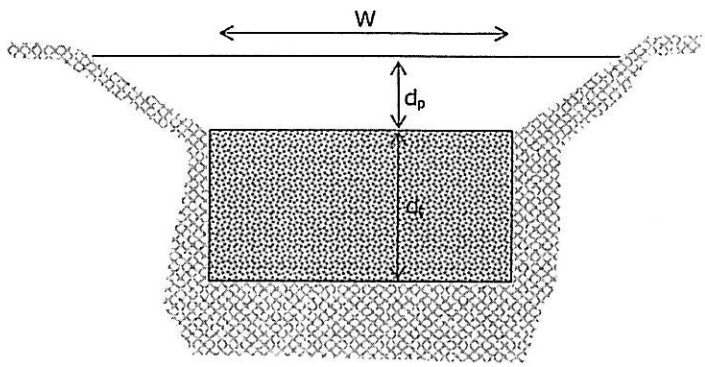


Figure D-5: Infiltration BMP cross-section

Refer to Figures D-5, 6-12, 6-13 and 6-14 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = _____ ft^3	See Note Below
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = _____ ft^3	0 ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = _____ ft^3	174 ft^3
Step 2: Determine storm water quality design volume, V_{wq}		
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = _____ ft^3	174 ft^3
Step 3: Determine design volume, V_{design} (for sizing)		
3-1. V_{design} = the larger of $V_{reduction}$ and V_{wq}	V_{design} = _____ ft^3	174 ft^3

Note: V_{25} not applicable since decrease in volume is calculated for entire site.

Step 4: Calculate design infiltration rate			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ = _____	in/hr	6 in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t = _____	ft	0.3
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p = _____		0.8
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D = _____	ft	26.6 ft
4-5. Enter the estimated width of the facility	W = _____	ft	9 ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g = _____		1
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} = _____	in/hr	1.44 in/hr
Step 5: Determine facility size			
5-1. Enter drawdown time(72 hrs max.), t_d	t_d = _____	hrs	72 hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t_d, $d_{max}=k_{design}t_d/12$	d_{max}= _____	ft	8.64 ft
5-3. Enter trench fill aggregate porosity, n_t	n_t= _____		0.35
5-4. Enter depth of trench fill, d_t	d_t = _____	in	48 in
5-5. Enter max ponding depth, or max. $d_p=d_{max}-n_td_t$	d_p= _____	ft	
Step 6: Determine infiltrating surface area (filter bottom area)			
6-1. Enter the time to fill infiltration basin or trench with water (Use 2 hours for most designs), T	T = _____	hrs	2 hrs
6-2. Calculate infiltrating surface area for infiltration basin: $A_b=V_{design}/((Tk_{design}/12)+d_p)$	A_b = _____	ft^2	
6-3. Calculate infiltrating surface area for infiltration trenches: $A_t=V_{design}/((Tk_{design}/12)+n_td_t+dp)$	A_t = _____	ft^2	
6-4. Calculate infiltrating surface area for dry wells: $A_{dw}=V_{design}/(Tk_{design}/12)+n_td_t))$	A_{dw} = _____	ft^3	106 ft^2
Step 7: Provide conveyance capacity for filter clogging			
7-1.The infiltration facility should be placed off-line, but an emergency overflow must still be provided in the event the filter becomes clogged.			

Dry Well

Location: Area P6

Infiltration BMP Worksheet

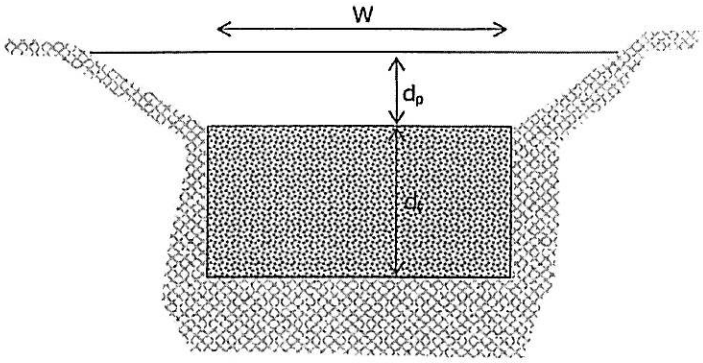


Figure D-5: Infiltration BMP cross-section

Refer to Figures D-5, 6-12, 6-13 and 6-14 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = _____ ft^3	See Note Below
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = _____ ft^3	0 ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = _____ ft^3	87 ft^3
Step 2: Determine storm water quality design volume, V_{wq}		
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = _____ ft^3	87 ft^3
Step 3: Determine design volume, V_{design} (for sizing)		
3-1. V_{design} = the larger of $V_{reduction}$ and V_{wq}	V_{design} = _____ ft^3	87 ft^3

Note: V_{25} not applicable since decrease in volume is calculated for entire site.

Step 4: Calculate design infiltration rate			
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ = _____	in/hr	6 in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t = _____	ft	0.3
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p = _____		0.8
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D = _____	ft	26.6 ft
4-5. Enter the estimated width of the facility	W = _____	ft	7 ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g = _____		1
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} = _____	in/hr	1.44 in/hr
Step 5: Determine facility size			
5-1. Enter drawdown time(72 hrs max.), t_d	t_d = _____	hrs	72 hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t_d, $d_{max}=k_{design}t_d/12$	d_{max}= _____	ft	8.64 ft
5-3. Enter trench fill aggregate porosity, n_t	n_t= _____		0.35
5-4. Enter depth of trench fill, d_t	d_t = _____	in	48 in
5-5. Enter max ponding depth, or max. $d_p=d_{max}-n_td_t$	d_p= _____	ft	
Step 6: Determine infiltrating surface area (filter bottom area)			
6-1. Enter the time to fill infiltration basin or trench with water (Use 2 hours for most designs), T	T = _____	hrs	2 hrs
6-2. Calculate infiltrating surface area for infiltration basin: $A_b=V_{design}/((Tk_{design}/12)+d_p)$	A_b = _____	ft^2	
6-3. Calculate infiltrating surface area for infiltration trenches: $A_t=V_{design}/((Tk_{design}/12)+n_td_t+dp)$	A_t = _____	ft^2	
6-4. Calculate infiltrating surface area for dry wells: $A_{dw}=V_{design}/(Tk_{design}/12)+n_td_t))$	A_{dw} = _____	ft^3	53 ft^2
Step 7: Provide conveyance capacity for filter clogging			
7-1.The infiltration facility should be placed off-line, but an emergency overflow must still be provided in the event the filter becomes clogged.			

PERMEABLE PAVERS

Location: Driveway loop in front of main entrance (Area PP1)

Permeable Pavement Worksheet

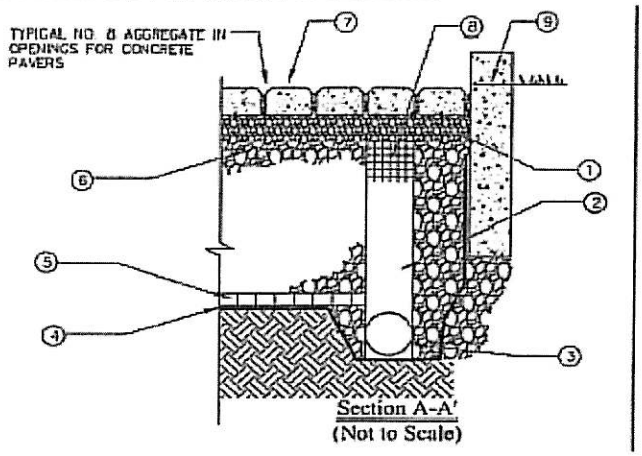


Figure D-6: Permeable Pavement cross-section

Refer to Figures D-6 and Figure 6-16 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = 32,000 ft³		
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = 25,700 ft³		
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = 32,000 ft³	218	cf
Step 2: Determine stormwater quality design volume, V_{wq}			
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = 25,700 ft³	218	cf
Step 3: Determine design volume, V_{design} (for sizing)			
3-1. If no infiltration (i.e., impermeable liner w/ underdrains), $V_{design} = V_{wq}$	V_{design} = 25,700 ft³	218	cf
3-2. If partial infiltration (i.e., permeable liner w/underdrains), $V_{design} = V_{wq}+0.2V_{wq}$	V_{design} = 30,840 ft³	262	cf
3-3. If full infiltration (i.e., permeable liner w/ no underdrains), $V_{design} = V_{reduction}$	V_{design} = 32,000 ft³	218	cf

Step 4: Calculate design infiltration rate (assume full infiltration, $V_{design} = V_{reduction}$)					
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ =	3	in/hr	6	in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t =	0.3	ft	0.3	
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p =	0.8		0.8	
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D =	10	ft	28.6	ft
4-5. Enter the estimated width of the facility	W =	60	ft	20	ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g =	0.72		1	
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} =	0.52	in/hr	1.44	in/hr
Step 5: Determine maximum depth that can be infiltrated					
5-1. Enter drawdown time (72 hrs max.), t	t =	72	hrs	72	hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t, $d_{max}=k_{design}t/12$	d_{max}=	3.10	ft	8.64	ft
Step 6: Determine infiltrating surface area (gravel drainage area)					
6-1. Enter gravel drainage layer porosity, n	n=	0.32		0.32	
6-2. Enter depth of gravel drainage layer, l	l =	48.00	in	12	inches
6-3. Enter the time to fill the gravel drainage layer with water (Use 2 hours for most designs), T	T =	2	hrs	2	
6-4. Calculate infiltrating surface area for dry wells: $A=V_{design}/(Tk_{design}/12)+n*l)$	A =	2,072	ft^3	64	sf required
Step 7: Provide conveyance capacity for filter clogging				6290	sf supplied
7-1.The permeable pavement must have an emergency overflow for storm events greater than the design and in the event the permeable pavement becomes clogged.					

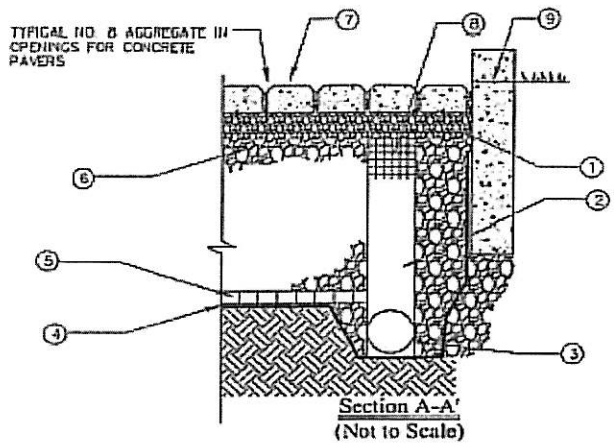
Permeable Pavement Design Example

Step 1: Determine Stormwater Quality Design Volume Reduction, $V_{reduction}$

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} =	20	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ =	25,700	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ =	25,700	ft^3

Location:	Driveway from W. Pueblo Street up to main entrance (Area PP2)		

Permeable Pavement Worksheet



Section A-A'
(Not to Scale)

Figure D-6: Permeable Pavement cross-section

Refer to Figures D-6 and Figure 6-16 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$				
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = 32,000	ft^3		
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = 25,700	ft^3		
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = 32,000	ft^3	44.00	cf
Step 2: Determine stormwater quality design volume, V_{wq}				
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = 25,700	ft^3	44	cf
Step 3: Determine design volume, V_{design} (for sizing)				
3-1. If no infiltration (i.e., impermeable liner w/ underdrains), $V_{design} = V_{wq}$	V_{design} = 25,700	ft^3	44	cf
3-2. If partial infiltration (i.e., permeable liner w/underdrains), $V_{design} = V_{wq}+0.2V_{wq}$	V_{design} = 30,840	ft^3	53	cf
3-3. If full infiltration (i.e., permeable liner w/ no underdrains), $V_{design} = V_{reduction}$	V_{design} = 32,000	ft^3	44	cf

Step 4: Calculate design infiltration rate (assume full infiltration, $V_{design} = V_{reduction}$)					
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ =	3	in/hr	6	in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t =	0.3	ft	0.3	
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p =	0.8		0.8	
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D =	10	ft	28.6	ft
4-5. Enter the estimated width of the facility	W =	60	ft	20	ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g =	0.72		1	
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} =	0.52	in/hr	1.44	in/hr
Step 5: Determine maximum depth that can be infiltrated					
5-1. Enter drawdown time (72 hrs max.), t	t =	72	hrs	72	hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t, $d_{max}=k_{design}t/12$	d_{max}=	3.10	ft	8.64	ft
Step 6: Determine infiltrating surface area (gravel drainage area)					
6-1. Enter gravel drainage layer porosity, n	n=	0.32		0.32	
6-2. Enter depth of gravel drainage layer, l	l =	48.00	in	12	inches
6-3. Enter the time to fill the gravel drainage layer with water (Use 2 hours for most designs), T	T =	2	hrs	2	
6-4. Calculate infiltrating surface area for dry wells: $A=V_{design}/(Tk_{design}/12)+n*l))$	A =	2,072	ft^3	13	sf required
Step 7: Provide conveyance capacity for filter clogging				3290	sf supplied
7-1.The permeable pavement must have an emergency overflow for storm events greater than the design and in the event the permeable pavement becomes clogged.					

Permeable Pavement Design Example

Step 1: Determine Stormwater Quality Design Volume Reduction, $V_{reduction}$

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} =	20	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ =	25,700	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ =	25,700	ft^3

Location:	Parking and paved area west of garage structure (Area PP3)		

Permeable Pavement Worksheet

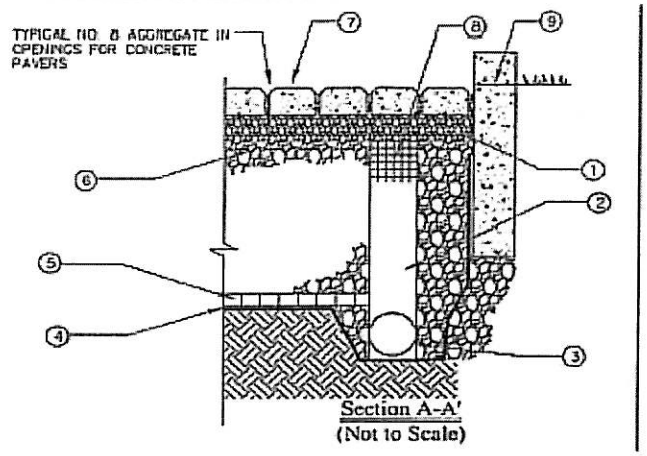


Figure D-6: Permeable Pavement cross-section

Refer to Figures D-6 and Figure 6-16 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$				
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = 32,000	ft^3		
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = 25,700	ft^3		
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = 32,000	ft^3	218	cf
Step 2: Determine stormwater quality design volume, V_{wq}				
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = 25,700	ft^3	218	cf
Step 3: Determine design volume, V_{design} (for sizing)				
3-1. If no infiltration (i.e., impermeable liner w/ underdrains), $V_{design} = V_{wq}$	V_{design} = 25,700	ft^3	218	cf
3-2. If partial infiltration (i.e., permeable liner w/underdrains), $V_{design} = V_{wq}+0.2V_{wq}$	V_{design} = 30,840	ft^3	262	cf
3-3. If full infiltration (i.e., permeable liner w/ no underdrains), $V_{design} = V_{reduction}$	V_{design} = 32,000	ft^3	218	cf

Step 4: Calculate design infiltration rate (assume full infiltration, $V_{design} = V_{reduction}$)					
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ =	3	in/hr	6	in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t =	0.3	ft	0.3	
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p =	0.8		0.8	
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D =	10	ft	28.6	ft
4-5. Enter the estimated width of the facility	W =	60	ft	20	ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g =	0.72		1	
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} =	0.52	in/hr	1.44	in/hr
Step 5: Determine maximum depth that can be infiltrated					
5-1. Enter drawdown time (72 hrs max.), t	t =	72	hrs	72	hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t, $d_{max}=k_{design}t/12$	d_{max}=	3.10	ft	8.64	ft
Step 6: Determine infiltrating surface area (gravel drainage area)					
6-1. Enter gravel drainage layer porosity, n	n=	0.32		0.32	
6-2. Enter depth of gravel drainage layer, I	I =	48.00	in	12	inches
6-3. Enter the time to fill the gravel drainage layer with water (Use 2 hours for most designs), T	T =	2	hrs	2	
6-4. Calculate infiltrating surface area for dry wells: $A=V_{design}/(Tk_{design}/12)+n*I))$	A =	2,072	ft^3	64	sf required
Step 7: Provide conveyance capacity for filter clogging				6150	sf supplied
7-1.The permeable pavement must have an emergency overflow for storm events greater than the design and in the event the permeable pavement becomes clogged.					

Permeable Pavement Design Example

Step 1: Determine Stormwater Quality Design Volume Reduction, $V_{reduction}$

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} =	20	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ =	25,700	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ =	25,700	ft^3

Location: Driveway from W. Junipero Street (Area PP4)

Permeable Pavement Worksheet

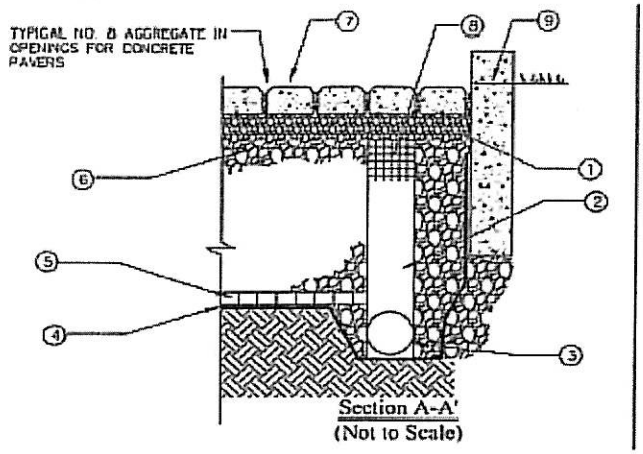


Figure D-6: Permeable Pavement cross-section

Refer to Figures D-6 and Figure 6-16 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$				
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = 32,000	ft^3		
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = 25,700	ft^3		
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = 32,000	ft^3	44.00	cf
Step 2: Determine stormwater quality design volume, V_{wq}				
2-1. Determine the water quality design volume, V_{wq}, using SBUH method, Appendix C (Note: V_{wq} is always equal to $V_{one\text{-}inch}$)	V_{wq} = 25,700	ft^3	44	cf
Step 3: Determine design volume, V_{design} (for sizing)				
3-1. If no infiltration (i.e., impermeable liner w/ underdrains), $V_{design} = V_{wq}$	V_{design} = 25,700	ft^3	44	cf
3-2. If partial infiltration (i.e., permeable liner w/underdrains), $V_{design} = V_{wq}+0.2V_{wq}$	V_{design} = 30,840	ft^3	53	cf
3-3. If full infiltration (i.e., permeable liner w/ no underdrains), $V_{design} = V_{reduction}$	V_{design} = 32,000	ft^3	44	cf

Step 4: Calculate design infiltration rate (assume full infiltration, $V_{design} = V_{reduction}$)					
4-1. Enter soil infiltration rate (0.5 in/hr min.), $k_{measured}$	$k_{measured}$ =	3	in/hr	6	in/hr
4-2. Enter correction factor for testing (0.3 small scale, 0.5 large scale), F_t	F_t =	0.3	ft	0.3	
4-3. Enter correction factor for plugging, (0.7 loams-sandy loams, 0.8 fine-loamy sands, 0.9 medium sands, 1.0 coarse sands-cobbles, F_p	F_p =	0.8		0.8	
4-4. Enter the depth from the bottom of the facility to the maximum wet-season water table or nearest impervious layer, whichever is less. D	D =	10	ft	28.6	ft
4-5. Enter the estimated width of the facility	W =	60	ft	20	ft
4-6. Calculate the correction factor of geometry (0.25 min, 1.0 max), Fg = 4•D/W +0.05	F_g =	0.72		1	
4-7. Calculate the design infiltration rate, $k_{design}=k_{measured}F_tF_pF_g$	k_{design} =	0.52	in/hr	1.44	in/hr
Step 5: Determine maximum depth that can be infiltrated					
5-1. Enter drawdown time (72 hrs max.), t	t =	72	hrs	72	hrs
5-2. Calculate max.depth of runoff that can be infiltrated within the t, $d_{max}=k_{design}t/12$	d_{max}=	3.10	ft	8.64	ft
Step 6: Determine infiltrating surface area (gravel drainage area)					
6-1. Enter gravel drainage layer porosity, n	n=	0.32		0.32	
6-2. Enter depth of gravel drainage layer, I	I =	48.00	in	12	inches
6-3. Enter the time to fill the gravel drainage layer with water (Use 2 hours for most designs), T	T =	2	hrs	2	
6-4. Calculate infiltrating surface area for dry wells: $A=V_{design}/(Tk_{design}/12)+n*I))$	A =	2,072	ft^3	13	sf required
Step 7: Provide conveyance capacity for filter clogging				1946	sf supplied
7-1.The permeable pavement must have an emergency overflow for storm events greater than the design and in the event the permeable pavement becomes clogged.					

Permeable Pavement Design Example

Step 1: Determine Stormwater Quality Design Volume Reduction, $V_{reduction}$

Step 1: Determine design volume reduction, $V_{reduction}$			
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} =	20	ft^3
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ =	25,700	ft^3
1-3. Determine design volume reduction which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ =	25,700	ft^3

Vegetated Swale Filter

Location: Main Structure and Garage Structure treatment

Vegetated Swale Filter Worksheet

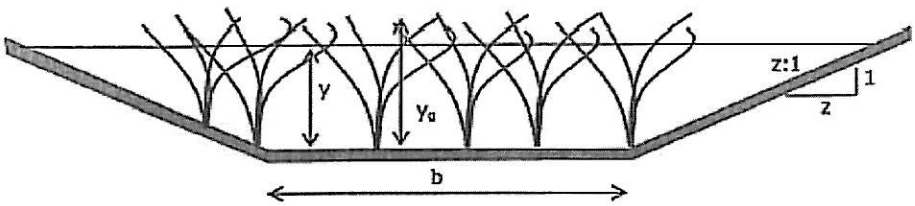


Figure D-2: Vegetated swale filter cross-section

Refer to Figure D-2, Figure 6-5, and Figure D-2 for a diagrammatic description of the geometric variables.

Step 1: Determine design volume reduction, $V_{reduction}$ (if applicable)		
1-1. Enter the volume difference between the pre- and post-development conditions for the 25-yr, 24-hr design storm, V_{25}, calculated using SBUH method, Appendix C	V_{25} = _____ ft^3	
1-2. Enter the volume generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$, calculated using SBUH method, Appendix C	$V_{one\text{-}inch}$ = _____ ft^3	
1-3. Determine the design volume reduction, $V_{reduction}$, which is the larger of V_{25} and $V_{one\text{-}inch}$ and is the volume to be retained on-site	$V_{reduction}$ = _____ ft^3	
Note: Volume reduction credit is only provided for vegetated swale filters that include a gravel drainage layer to encourage infiltration.		
Step 2: Determine stormwater quality design flow rate, Q_{wq}		
2-1. Enter drainage area, A	A = _____ acres	1.99 ac
2-2. Enter impervious fraction, Imp	Imp = _____	0.59
2-3. Calculate runoff coefficient, C = (0.9·Imp + 0.05)	C = _____	0.58
2-4. Calculate the water quality design flow rate, Q_{wq}, based on a constant rainfall intensity of 0.25 in/hr, Appendix C	Q_{wq} = _____ cfs	0.29 cfs
Step 3: Determine design volume for sizing gravel drainage layer, if applicable		
3-1. $V_{design} = V_{reduction}$	V_{design} = _____ ft^3	
3-2. Please follow Steps 3 through 5 of the Permeable Pavement Worksheet, Appendix D to calculate the size of the gravel drainage layer		

Step 4: Calculate flow depth, d, and swale bottom width, b		
4-1. Enter Manning's roughness coefficient for shallow flow conditions (0.2 typical), n	n = _____	0.2 n
4-2. Enter expected vegetation height, y_v	y_v = _____ in	4 in
4-3. Calculate design flow depth (0.33 ft max), $d = y_v/18$	d = _____ ft	0.22 ft
4-4. Enter longitudinal slope (along direction of flow), s	s = _____ ft/ft	0.0117 ft/ft
4-5. Enter side slope length per unit height (e.g. 3 if side slope are 3H :1V), Z	Z = _____	
4-6. Calculate bottom width of swale assuming a trapezoidal channel shape, $b = Q_{wq}n_{wq}/1.49y^{1.67}s^{0.5}$	b = _____ ft	
4-7. Calculate $AR^{2/3}$, using $Q_{wq}n/1.49s^{0.5}$ (Equation 6-5)	$AR^{2/3}$ = _____	
4-8. Calculate the wetted area, A	A = _____ ft^2	
4-9. Calculate the wetted perimeter, P	P = _____ ft	
4-10. Calculate the hydraulic radius, R	R = _____ ft	
4-11. Re-calculate $AR^{2/3}$, using the A and R calculated in steps 4-8 and 4-10. Change b until the $AR^{2/3}$ calculated in this step is equal to $AR^{2/3}$ calculated in 4-7.	$AR^{2/3}$ = _____	
4-12. If b is between 2 and 10 feet, go to Step 5		
4-13. If b < 2 ft, set b = 2 ft and go to Step 4-4 and decrease swale slope (0.015 ft/ft max.). If slope cannot be changed due to site constraints, go to Step 4-14.		
4-14. If b < 2 ft and slope is maximized, set b= 2 ft and go to Step 4-2 and decrease vegetation height		
4-15. If b is greater than 10 ft, one of the following design adjustments must be made: 1) increase the longitudinal slope to a maximum of 0.06 ft/ft, and repeat steps 4-7 to 4-11 above. 2) include a flow splitter longitudinally along the swale bottom (Figure 6-6 and Appendix F) at least three-quarters of the swale length (beginning at the inlet)		
Step 5: Determine design flow velocity		
5-1. Calculate design flow velocity, $v_{wq} = Q_{wq}/A$	v_{wq} = _____ ft/s	0.25 ft/s
5-2. If the design flow velocity is higher than 1ft/s go to Step 4-4 and decrease the slope, if possible		see calcs below
Step 6: Calculate swale length		
6-1. Enter target residence time (10 minutes minimum), t_{HR}	t_{HR} = _____ min	10.0 min
6-1. Calculate swale length, $L = v_{wq} \cdot 60 \cdot t_{HR}$	L = _____ ft	150 $=L_{required}$
6-2. If L is too long for the site, proceed to step 5 to adjust the swale layout		280 $=L_{provided}$

Step 7: Adjust swale layout to fit within site constraints		
7-1. Choose a reduced swale length, L_f	L_f = _____	ft
7-2. Recalculate flow velocity, $v_{wq} = L_f / (t_{hft} \cdot 60)$	v_{wq} = _____	ft/s
7-3. Recalculate cross-sectional area, $A_{wq} = Q_{wq} / v_{wq}$	A_{wq} = _____	ft^2
7-4. Calculate an increased bottom width, $b_f = (A_{wq} - Zy^2) / y$	b_f = _____	ft
7-5. Recalculate longitudinal slope assuming a rectangular channel shape, $s_f = [Q_{wq} n_{wqft} / 1.49\ A_{wq}\ y^{0.67}]^2$	s_f = _____	ft/ft
7-6. If s_f is between 1.5% and 6%, the swale design is acceptable for water quality, proceed to Step 6 7-7. If s_f is between 1% and 1.5%, the swale design is acceptable for water quality with underdrains (see design requirements). Proceed to Step 6. 7-8. If s_f is <1%, the swale design is unacceptable. Consider subdividing drainage area and repeat all above steps, or choose a different BMP for the site.		
Step 8: Provide conveyance capacity for flows higher than Q_{wq}		
8-1. If the swale already includes a high-flow bypass to convey flows higher than the water quality design flow rate, skip this step and verify that all parameters meet design requirements to complete sizing.		
8-2. If swale does not include a high-flow bypass, check the swale size for the peak discharge rate that will be conveyed in the swale. If online, the peak discharge rate is the 100-yr, 24-hr design storm calculated using the SBUH method (See Appendix C). Calculate the peak discharge velocity, $v_{peak} = Q_{peak}/A_{swale}$, where Q_{peak} = the peak discharge rate (cfs) and A_{swale} = the cross-sectional area of the swale including freeboard (ft^2)	V_{peak} = _____	ft/s
8-3. If V_{peak} > 3.0 feet per second, return to Step 2 and increase the bottom width or flatten the longitudinal slope as necessary to reduce the peak discharge flow velocity to 3.0 feet per second or less. If the longitudinal slope is flattened, the swale bottom width must be recalculated (Step 2) and must meet all design criteria.		

6.53 cfs

2.74 ft/s
see Trapezoidal Channel Calculations

Swale OK

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

February 10, 2009

==========

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	0.29
Channel Bottom Slope (ft/ft)	0.0117
Manning's Roughness Coefficient (n-value)	0.2
Channel Left Side Slope (horizontal/vertical)	5.0
Channel Right Side Slope (horizontal/vertical)	5.0
Channel Bottom Width (ft)	5.0

==========

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.2
Flow Velocity (fps)	0.25
Froude Number	0.105
Velocity Head (ft)	0.0
Energy Head (ft)	0.2
Cross-Sectional Area of Flow (sq ft)	1.18
Top Width of Flow (ft)	6.97

==========

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Phone:(281)440-3787, Fax:(281)440-4742, Email:software@dodson-hydro.com
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Peak 100-year Flow Calc

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION

February 10, 2009

==========

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	6.53
Channel Bottom Slope (ft/ft)	0.0117
Manning's Roughness Coefficient (n-value)	0.025
Channel Left Side Slope (horizontal/vertical)	5.0
Channel Right Side Slope (horizontal/vertical)	5.0
Channel Bottom Width (ft)	5.0

==========

COMPUTATION RESULTS

DESCRIPTION	VALUE
Normal Depth (ft)	0.35
Flow Velocity (fps)	2.74
Froude Number	0.912
Velocity Head (ft)	0.12
Energy Head (ft)	0.47
Cross-Sectional Area of Flow (sq ft)	2.39
Top Width of Flow (ft)	8.53

==========

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GEOTECHNICAL REPORTS

- Report of Percolation Testing, December 17, 2008
- Soil Assessment, January 29, 2009

REC'D 12/23/08

Earth Systems Pacific

2049 Preisker Lane, Suite E
Santa Maria, CA 93454

(805) 928-2991
FAX (805) 928-9253

December 17, 2008

FILE NO.: SL-14435-SC

Mr. Brad Hess
Cancer Center of Santa Barbara
300 West Pueblo Street
Santa Barbara, CA 93105

PROJECT: CANCER CENTER OF SANTA BARBARA DRAINAGE BASINS
540 WEST PUEBLO STREET, SANTA BARBARA, CALIFORNIA

SUBJECT: Report of Percolation Testing

REF: 1) Proposal for Three Percolation Tests, Cancer Center of Santa Barbara Drainage Basins, 540 West Pueblo Street, Santa Barbara, California, by Earth Systems Pacific, dated November 14, 2008, Doc. No. 0811-025.PRP.

2) Soils Engineering and Engineering Geology Report, Cancer Center of Santa Barbara, 540 West Pueblo Street, Santa Barbara, California, by Earth Systems Pacific, dated August 2, 2007, Doc. No. 0708-013.SER

Dear Mr. Hess:

Per your authorization of the above-referenced proposal, our firm performed percolation tests within three of the drainage basins planned at the Cancer Center of Santa Barbara located at 540 West Pueblo Street in the City of Santa Barbara, California.

Percolation Test Procedure and Measured Infiltration Rates

On December 4, 2008, three percolation test borings were drilled in the area of three of the planned drainage basins. The approximate locations of the borings are shown on the attached Percolation Test Location Map and are designated as A through I. The borings were drilled to approximate depths of 4, 8, and 12 feet below the existing ground surface in each basin with a Mobile drill rig, Model B-24, equipped with a 6-inch diameter solid stem auger. A 4-inch diameter perforated pipe was installed in each of the borings. The bottom 2 inches of the borings and the annular spaces around the outside of the pipes were filled with gravel to reduce caving of the area to be tested.

The borings were initially completely filled with clean water and allowed to presoak overnight or allowed to completely drain prior to implementing the percolation test. Subsequently, they were filled with clean water to an approximate height of 10 inches and

the rate of infiltration monitored every 10 minutes over a period of 4 hours. As the percolation tests proceeded, clean water was added to an approximate height of 10 inches after the water completely infiltrated into the soil. Adjusted infiltration rates for the last hour of the percolation tests are presented in the following table.

Location (see Percolation Test Location Map)	Boring/Percolation Test Depth (feet)	Infiltration Rate (minutes/inch)	Infiltration Rate (inches/hour)
A	12	10	6
B	8	10	6
C	4	10	6
D	12	10	6
E	8	10	6
F	4	10	6
G	12	10	6
H	8	15	4
I	4	10	6

Observation of Infiltration Rates

Infiltration rates were fairly consistent in the three areas tested. We did observe that infiltration varied from generally faster to slower rates as the percolation test proceeded over time. It is likely that infiltration rates would be further reduced if the percolation tests were carried out over a longer timeframe. This is also indicative of how actual drainage basins perform; therefore, large factors of safety, experience, sound judgment should be used in determining the appropriate infiltration rate(s) that will be used in the drainage basin design.

General Soil Profile

The soil profile encountered in all of the percolation test borings generally consisted of silty sand in a moist condition with a loose to medium dense consistency. Cobbles were encountered below a depth of 8 feet; practical drilling refusal on the cobbles terminated all the borings at an approximate depth of 12 feet. Groundwater was not observed within the depths explored. Please refer to the attached boring logs for a more complete description of the subsurface conditions

Groundwater

The City of Santa Barbara Water Resource Division, Public Works Department provides well locations and historical groundwater levels recorded for 1999 through 2005 on its

website. Well 4N/27W-17J1 is located very near to the site, across West Junipero Street to the northwest in Oak Park. The year of 1999 contained the highest reported groundwater levels, ranging from 30.60 feet below the ground surface (bgs) in April and 34.87 feet bgs in September. The website indicates that the groundwater data relates to deep producing zones and may not be necessarily indicative of shallow groundwater levels.

Closure

Our intent was to perform the percolation testing in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the locality of this project under similar conditions at this time. No representation, warranty, or guarantee is either expressed or implied. Evaluation of percolation potential, determination of disposal criteria, design of the drainage basins, application of appropriate safety factors, maintenance requirements, etc. is the responsibility of the architect/engineer.

If there are any questions concerning this report, please do not hesitate to contact me.

Sincerely,

Earth Systems Pacific

Doug Dunham

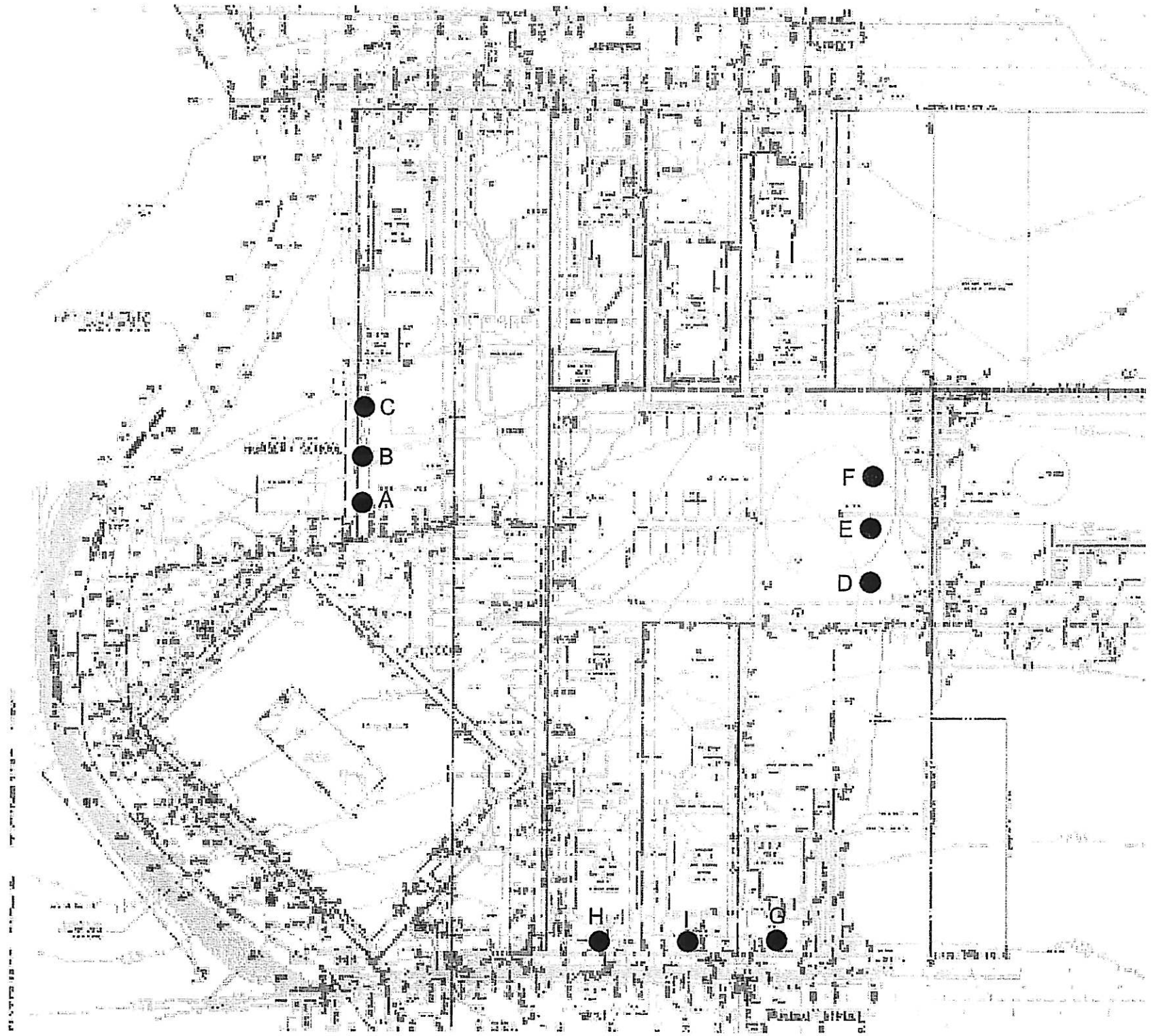
Doug Dunham, G.E.

REGISTERED PROFESSIONAL ENGINEER DOUGLAS A. DUNHAM No. 2586 Exp. 12-31-09 GEOTECHNICAL STATE OF CALIFORNIA

Attachments: Percolation Test Location Map and Boring Logs

Copies to: (2) Mr. Jason Gotsis, Penfield & Smith, 111 East Victoria Street, Santa Barbara, California 93101

Doc. No. 0812-044.RPT/ln



LEGEND

● Percolation Test Location (Approx.)

NOT TO SCALE

PERCOLATION TEST LOCATION MAP

CANCER CENTER OF SANTA BARBARA DRAINAGE BASINS

540 West Pueblo Street
Santa Barbara, California

Earth Systems Pacific

2049 North Preisker Lane, Suite E
Santa Maria, California 93454

(805) 928-2991 • FAX (805) 928-9253
E-mail: esc@earthsys.com

December 17, 2008 SMK SL-14435-SC

CANCER CENTER OF SB DRAINAGE BASINS PTLM-121708.dwg

Earth Systems Pacific

Percolation Test No. A

LOGGED BY: R. Wagner
DRILL RIG: Mobile Drill, Model B-24
AUGER TYPE: 6-inch Solid Stem

JOB NO.: SL-14435-SC
DATE: 12/04/08

Santa Barbara Cancer Center Drainage Basins
540 West Pueblo Street
Santa Barbara, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SM		SILTY SAND: brown, medium dense, moist					
5			tree roots					
11			some cobbles					
12			End of Boring @ 12.0' due to refusal No subsurface water encountered.					

LEGEND: ■ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Percolation Test No. D

LOGGED BY: R. Wagner
DRILL RIG: Mobile Drill, Model B-24
AUGER TYPE: 6-inch Solid Stem

JOB NO.: SL-14435-SC
DATE: 12/04/08

Santa Barbara Cancer Center Drainage Basins
540 West Pueblo Street
Santa Barbara, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SM		SILTY SAND: brown, loose, moist					
3			trace gravel, medium dense					
8			some cobbles					
12			End of Boring @ 12.0' due to refusal No subsurface water encountered.					

LEGEND: Ring Sample ◯ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

Percolation Test No. G

LOGGED BY: R. Wagner
DRILL RIG: Mobile Drill, Model B-24
AUGER TYPE: 6-inch Solid Stem

JOB NO.: SL-14435-SC
DATE: 12/04/08

Santa Barbara Cancer Center Drainage Basins
540 West Pueblo Street
Santa Barbara, California

DEPTH (feet)	USCS CLASS	SYMBOL	SOIL DESCRIPTION	SAMPLE DATA: INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
0	SM		SILTY SAND: dark brown, medium dense, moist					
10			some cobbles					
12			End of Boring @ 12.0' due to refusal No subsurface water encountered.					

LEGEND: Ring Sample ◯ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Earth Systems Pacific

2049 Preisker Lane, Suite E
Santa Maria, CA 93454

(805) 928-2991
FAX (805) 928-9253

January 29, 2009

FILE NO.: SL-14435-SC

Mr. Brad Hess
Cancer Center of Santa Barbara
300 West Pueblo Street
Santa Barbara, CA 93105

PROJECT: CANCER CENTER OF SANTA BARBARA DRAINAGE BASINS
540 WEST PUEBLO STREET, SANTA BARBARA, CALIFORNIA

SUBJECT: Soil Assessment

REF: 1) Report of Percolation Testing, Cancer Center of Santa Barbara Drainage Basins, 540 West Pueblo Street, Santa Barbara, California, by Earth Systems Pacific, dated December 17, 2008, Doc. No. 0812-044.RPT.

2) Soils Engineering and Engineering Geology Report, Cancer Center of Santa Barbara, 540 West Pueblo Street, Santa Barbara, California, by Earth Systems Pacific, dated August 2, 2007, Doc. No. 0708-013.SER

Dear Mr. Hess:

This letter presents our soil assessment for the drainage basins planned at the Cancer Center of Santa Barbara (referred to herein as "the site") located at 540 West Pueblo Street in the City of Santa Barbara, California.

Site Assessment

In our opinion, the site appears to be suitable for the planned drainage basins. Under the purview of Reference 1, the infiltration rates were determined at three of the drainage basin locations. The tests were performed at approximate depths of 4, 8, and 12 feet below the existing ground surface at each location for use by the engineer (Penfield & Smith) in the design of the drainage basins. The soil profile encountered in all of the percolation test borings generally consisted of silty sand in a moist condition with a loose

to medium dense consistency. Cobbles were also encountered below a depth of 8 feet.

The measured infiltration rates were between 4 to 6 inches/hour at all locations and these values are faster than the desired 0.5 to 2.4 inches/hour listed in Section 3.4 of the City of Santa Barbara BMP Storm Water Guidance Manual. It has been our experience from observation of actual drainage basin performance in soils that are similar to the site soils that the initial measured infiltration rates are generally reduced after the drainage basin has been in service over period of time. Portions of the silts tend to flocculate out of the silty sand matrix and concentrate in a shallow layer that will effectively reduce the initially measured infiltration rates.

We understand from the engineer that the measured infiltration rates have been multiplied by the coefficients recommended in the City of Santa Barbara BMP Storm Water Guidance Manual to develop a design infiltration rate of 1.44 inches/hour. It is our opinion that this design infiltration rate appears reasonable for the type of soils encountered at the site provided that the drainage basins are properly maintained.

Groundwater

Groundwater was not observed within the depths explored in References 1 and 2 as our deepest boring met refusal on cobbles at an approximate depth of 23 feet below the existing ground surface. However, the City of Santa Barbara Water Resource Division, Public Works Department provides well locations and historical groundwater levels recorded for 1999 through 2005 on its website. Well 4N/27W-17J1 is located very near to the site, across West Junipero Street to the northwest in Oak Park. The year of 1999 contained the highest reported groundwater levels, ranging from 30.60 feet below the ground surface (bgs) in April and 34.87 feet bgs in September.

Subsurface Flow

Based on the site soil conditions, we expect subsurface water to predominately flow in a vertical direction. As the soil matrix does contain a silt component, we estimate that lateral movement of the subsurface water should not exceed a distance of 5 feet beyond the perimeter of the drainage basins.

Adverse Geologic Conditions

There does not appear to be any adverse geologic conditions that would inhibit the subsurface movement of the water. Also, there are no natural or man-made slopes within the influence of the drainage basins whose stability would be affected by the introduction of subsurface water.

Impacts to Structure Foundations

We understand that the drainage basins will be at least 10 feet from any structure foundation system; therefore, there should not be any adverse impacts from the drainage basins on the structure foundations.

If there are any questions concerning this letter, please do not hesitate to contact me.

Sincerely,

Earth Systems Pacific

Doug Dunham

Doug Dunham, G.E.

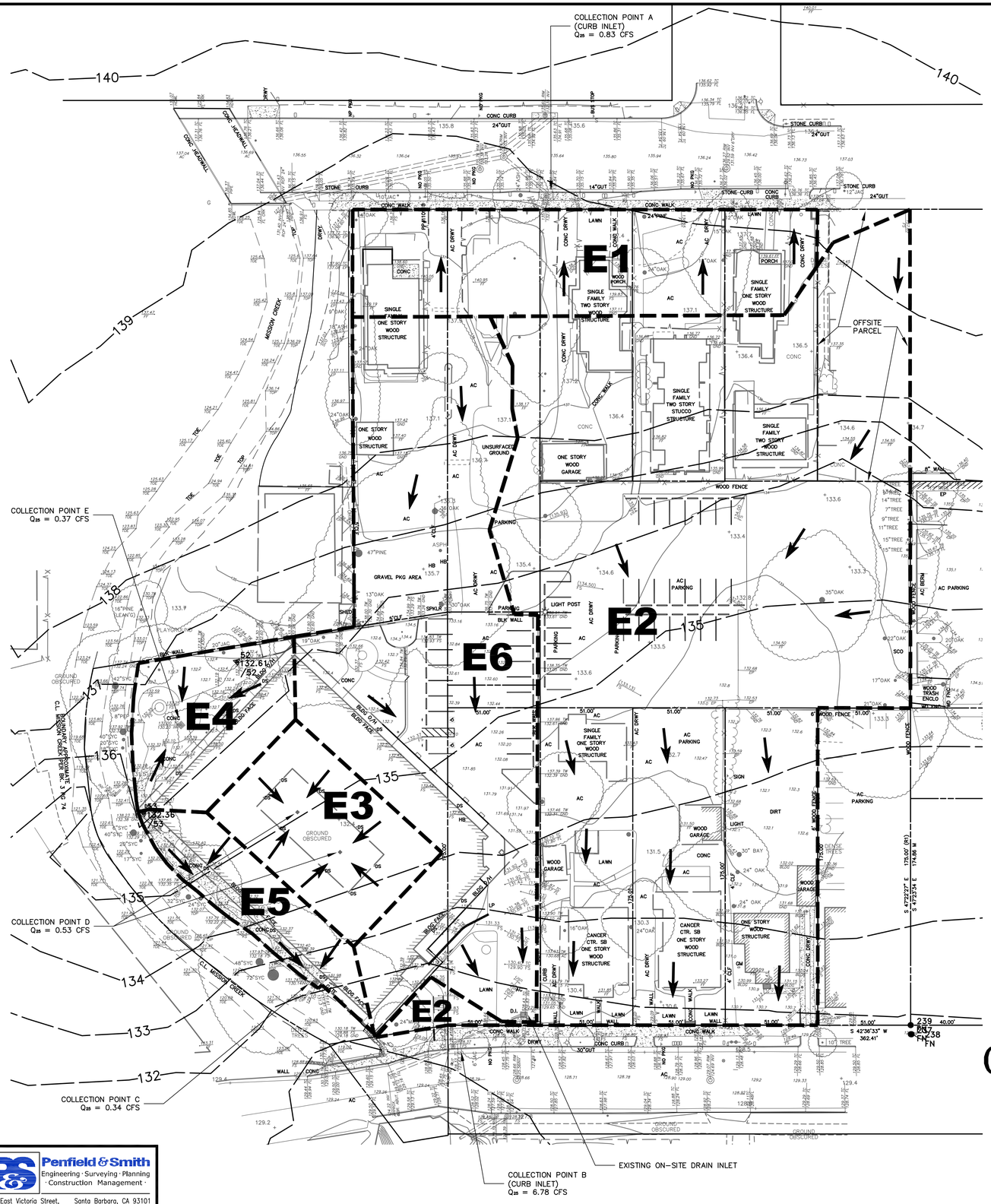
REGISTERED PROFESSIONAL ENGINEER
DOUGLAS A. DUNHAM
No. 2586
Exp. 12-31-09
GEOTECHNICAL
STATE OF CALIFORNIA

Copies to: (2) Mr. Jason Gotsis, Penfield & Smith, 111 East Victoria Street, Santa Barbara, California 93101

Doc. No. 0901-071.RPT/ln

MAPS AND EXHIBITS

- Preliminary Drainage Map- Pre-Project Condition
- Preliminary Drainage Map- Post Project Condition
- Water Quality Exhibit
- Preliminary Grading Plan & Drainage Plan



SURVEY NOTES

BASIS OF BEARINGS:
THE BASIS OF BEARINGS FOR THIS SURVEY IS THE CALCULATED BEARING BETWEEN CONTROL POINT 25 AND CONTROL POINT 26, N21°05'56"W BETWEEN PLANE COORDINATES AS SHOWN ON RECORD OF SURVEY NO. 00081.

HORIZONTAL CONTROL NETWORK, POINTS 25 AND 26 WERE ESTABLISHED BY THE CITY OF SANTA BARBARA AS THE BASIS OF HORIZONTAL CONTROL FOR THE SANTA BARBARA COTTAGE HOSPITAL PROJECT.

ELEVATIONS:
ELEVATIONS SHOWN HEREON ARE BASED ON THE CITY OF SANTA BARBARA HORIZONTAL CONTROL POINT 25 AND ARE ACCORDING TO THE CITY OF SANTA BARBARA HORIZONTAL CONTROL NETWORK.

POINT NO.	NORTHING	EASTING
25	1983870.2560	6045
26	1984044.1540	6046

VERTICAL DATUM – BENCHMARK:
THE ELEVATIONS SHOWN HEREON ARE BASED ON THE CITY OF SANTA BARBARA HORIZONTAL CONTROL PT. 25, BEING A 2 1/2" B.C. IN THE CONCRETE SIDEWALK ON PADRE STREET 19.7FT. S.L.Y. OF A CB, CAS TILL ELEVATION OF 119.76, U.S. SURVEY FEET.

FLOODPLAIN NOTE

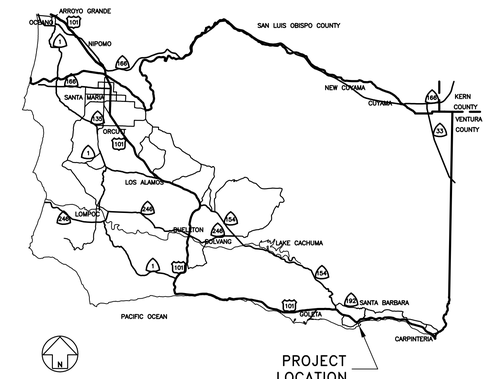
100 YEAR FLOOD ELEVATIONS SHOWN ARE BASED ONEAR FLOOD ELEVATIONS SHOWN ARE BASED ON
LETTER OF MAP REVISION (CLOMR) APPROVED BY FEMA FOR THE CITY OF SANTA BARBARA
2008 (CASE NO. 08-09-0424R). THIS STUDY ANALYZED THE CHANGES TO THE FLOODPLAIN
ALONG MISSION CREEK DUE TO THE PARKING LOT LANE AT THE INTERSECTION OF
JUNIPERO STREET AND OAK PARK LANE AS PART OF THE COTTAGE HOSPITAL
HOSPITAL IMPROVEMENTS. UPON COMPLETION OF THE COTTAGE HOSPITAL
PROJECT, THE HOSPITAL WILL APPLY TO FEMA FOR A LETTER OF MAP
MAP CHANGE CONSISTENT WITH THE CLOMR.

WATERSHED AREAS

AREA	SIZE (AC.)
E1	0.34
E2	1.79
E3	0.18
E4	0.15
E5	0.11
E6	0.81
TOTAL	**3.38**

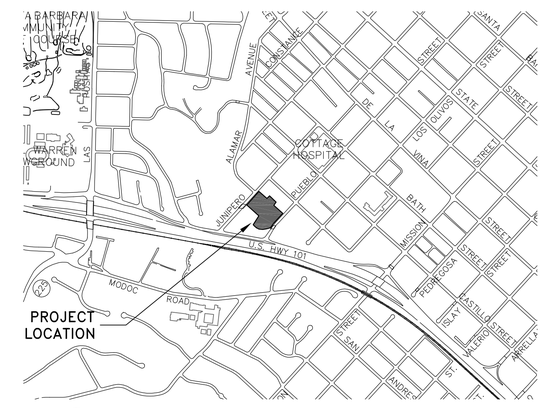
LEGEND

- PROPERTY BOUNDARY
- EXISTING CONTOUR
- WATERSHED BOUNDARY
- 138 — 100 YEAR FLOOD ELEVATION
- DRAINAGE PATTERN FLOW ARROW



LOCATION MAP

NOT TO SCALE



VICINITY MAP

SCALE: 1"=1000'

SHEET INDEX

1 DRAINAGE MAP– PRE–PROJECT CONDITION
2 DRAINAGE MAP– POST–PROJECT CONDITION

SCALE: 1"=30'
0 30 60 90

CANCER CENTER OF SANTA BARBARA
PRELIMINARY DRAINAGE MAP
PRE–PROJECT CONDITION

CITY OF SANTA BARBARA, CALIFORNIA
APRIL 6, 2009

Penfield & Smith
Engineering · Surveying · Planning
· Construction Management ·
111 East Victoria Street, Santa Barbara, CA 93101
Phone: (805) 963-9532 Fax: (805) 966-9801

36-EXB SAVE DATE: 4/6/2009 3:25:59 PM PLOT BY: Jason Gotsis PLOT DATE: 4/6/2009 3:31:52 PM PLOT SCALE: 1:1
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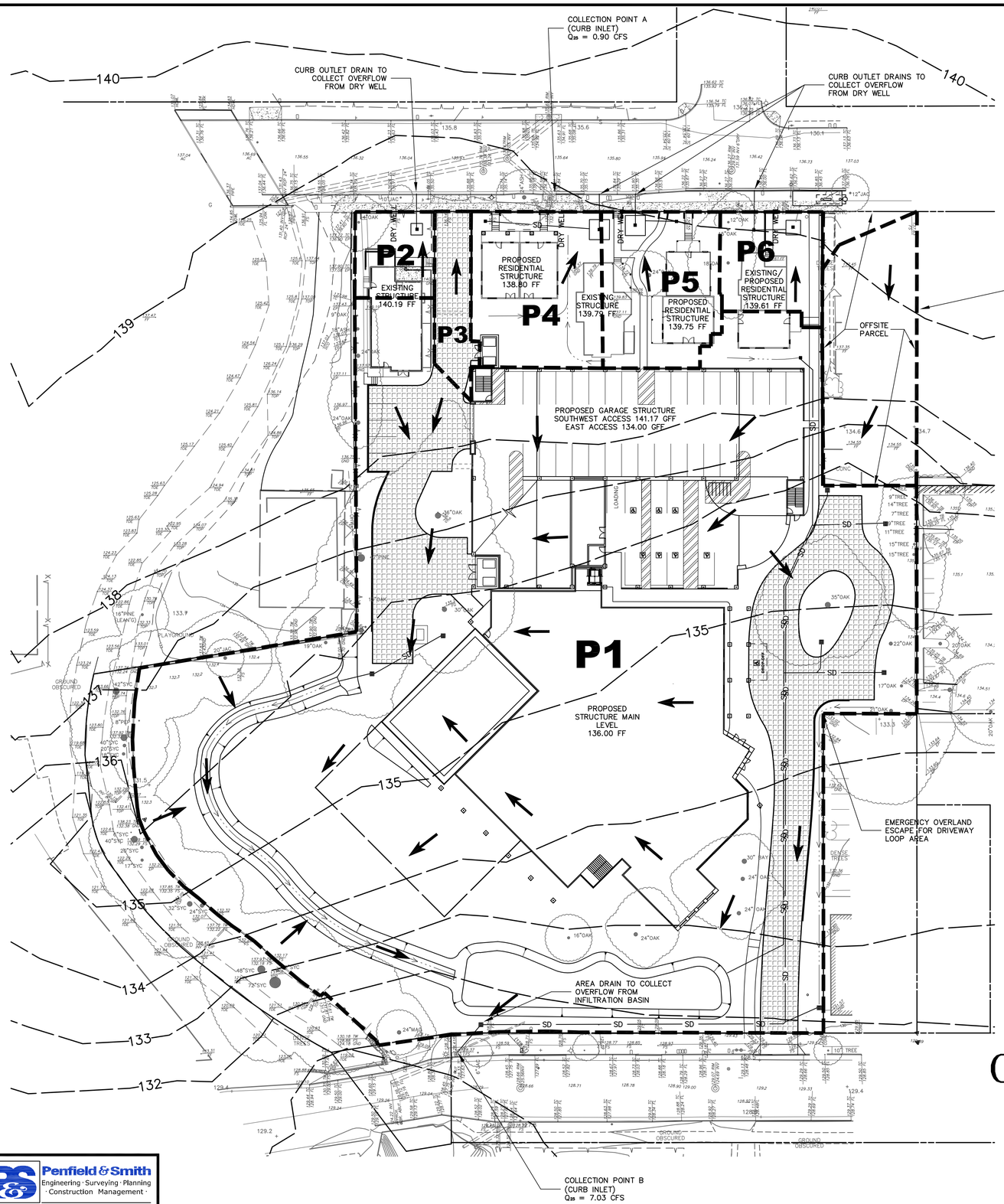

AREA FOR OFFSITE PARCEL INLCLUDE WITH AREA P1 FOR 25-YEAR POST-PROJECT ANALYSIS AND EXCLUDED FROM ONE-INCH STORM POST-PROJECT ANALYSIS

WATERSHED AREAS

AREA	SIZE (AC.)
P1	2.79
P2	0.05
P3	0.05
P4	0.14
P5	0.12
P6	0.07
OFFSITE	0.16
TOTAL	**3.38**

LEGEND

- PROPERTY BOUNDARY
- EXISTING CONTOUR
- WATERSHED BOUNDARY
- 138 — 100 YEAR FLOOD ELEVATION
- PROPOSED SWALE
- SD — PROPOSED STORM DRAIN
- DRAINAGE PATTERN FLOW ARROW
- PERMEABLE PAVING

SCALE: 1"=30'

0 30 60 90

CANCER CENTER OF SANTA BARBARA
PRELIMINARY DRAINAGE MAP
POST-PROJECT CONDITION

CITY OF SANTA BARBARA, CALIFORNIA
APRIL 6, 2009

Penfield & Smith
Engineering · Surveying · Planning · Construction Management ·
111 East Victoria Street, Santa Barbara, CA 93101
Phone: (805) 963-9532 Fax: (805) 966-9801

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LEGEND

- PERVIOUS PAVEMENT AND TRIBUTARY AREA (TYPICAL) (PP#)
- VEGETATED SWALE FILTER
- INFILTRATION BMP
- LANDSCAPED SWALE
- LANDSCAPED AREA
- IMPERVIOUS AREA
- OFFSITE PARCEL
- ROOF GARDEN

N

SCALE: 1"=30'

0 30 60 90

CANCER CENTER OF SANTA BARBARA
WATER QUALITY EXHIBIT
POST-PROJECT CONDITION

CITY OF SANTA BARBARA, CALIFORNIA
APRIL 6, 2009

Penfield & Smith
Engineering · Surveying · Planning
· Construction Management ·
111 East Victoria Street, Santa Barbara, CA 93101
Phone: (805) 963-9532 Fax: (805) 966-9801

SHEET 1 OF 1

36-EXB SAVE DATE: 4/6/2009 3:33:00 PM PLOT BY:Jason Gotsis PLOT DATE:4/6/2009 3:33:48 PM PLOT SCALE:1:1

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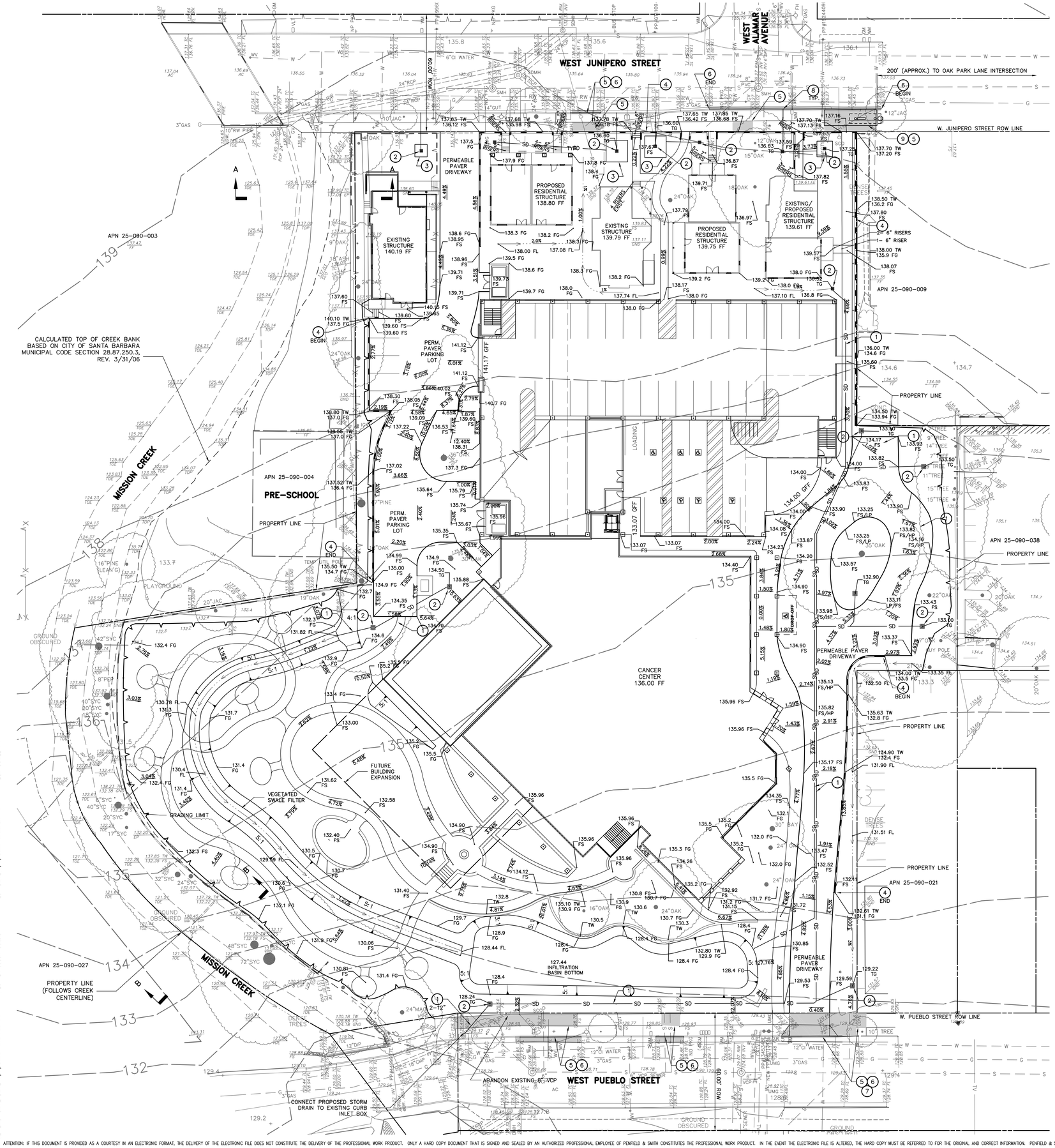


GENERAL NOTES

1. COORDINATE WITH ARBORIST AND LANDSCAPE ARCHITECT WITH RESPECT TO PLACING ROOT BARRIERS ALONG EDGES OF PROPOSED SIDEWALKS AND UNDERGROUND UTILITIES.
2. SEE LANDSCAPE ARCHITECT'S PLANS FOR PLANTING AND HARDSCAPE IMPROVEMENTS.
3. SEE ARCHITECT'S PLANS FOR FLOOD PROOFING MEASURES.
4. SITE PLAN BASED ON CAD FILE RECEIVED FROM ARCHITECT ON NOVEMBER 6, 2008.

CONSTRUCTION NOTES

1. CONSTRUCT PVC STORM DRAIN.
2. CONSTRUCT AREA DRAIN.
3. CONSTRUCT DRY WELL.
4. CONSTRUCT RETAINING WALL.
5. PORTIONS OF EXISTING SIDEWALK IN PUBLIC RIGHT-OF-WAY THAT ARE DAMAGED OR DISPLACED SHALL BE SAWCUT AT THE NEAREST CONSTRUCTION JOINT, REMOVED, AND REPLACED PER CITY OF SANTA BARBARA STANDARD DETAILS 1-006.0 AND 1-006.1, TYPE "A" (WIDTH TO MATCH EXISTING.)
6. SAWCUT AND REMOVE EXISTING CURB AND GUTTER ALONG PROJECT FRONTAGE. SAWCUT LINE SHALL BE 1' FROM LIP OF EXISTING GUTTER. REPLACE WITH CURB AND VARIABLE GUTTER PER CITY OF SANTA BARBARA STANDARD DETAIL 1-002.1. GUTTER WIDTH TO MATCH EXISTING.
7. CONSTRUCT COMMERCIAL DRIVEWAY PER CITY OF SANTA BARBARA STANDARD DETAIL 1-003.1.
8. CONSTRUCT CURB OUTLET DRAIN- TYPE B PER CITY OF SANTA BARBARA STANDARD DETAIL 2-006.1-06. USE TWO (2) 3" DIAMETER PIPES AT 1% SLOPE.
9. CONSTRUCT BUS SHELTER WITH 27' X 8' LOADING AREA PER MTD STANDARDS.

EARTHWORK QUANTITIES

	CANCER CENTER	PARKING STRUCTURE	REMAINING SITE	TOTAL
EXCAVATION	0 C.Y.	1,100 C.Y.	1,600 C.Y.	**2,700 C.Y.**
FILL	2,200 C.Y.	900 C.Y.	2,400 C.Y.	**5,500 C.Y.**

THE ABOVE QUANTITIES ARE APPROXIMATE IN PLACE VOLUMES CALCULATED FROM THE EXISTING GROUND TO THE PROPOSED FINISH GRADE OR SUBGRADE. EXISTING GROUND IS DEFINED BY THE CONTOURS ON THE PLAN. PROPOSED FINISH GRADE IS DEFINED AS THE DESIGN SURFACE ELEVATION OF EARTH TO BE CONSTRUCTED. PROPOSED SUBGRADE ELEVATION IS DEFINED AS THE DESIGN SURFACE ELEVATION OF EARTH TO BE CONSTRUCTED BENEATH PAVEMENTS OR STRUCTURES.

THE EARTHWORK QUANTITIES ABOVE ARE FOR BUILDING PERMIT PURPOSES ONLY. THEY HAVE NOT BEEN FACTORED TO ACCOUNT FOR CHANGES IN VOLUME DUE TO CLEARING AND GRUBBING, SHRINKAGE, OVER-EXCAVATION, AND RECOMPACTION.

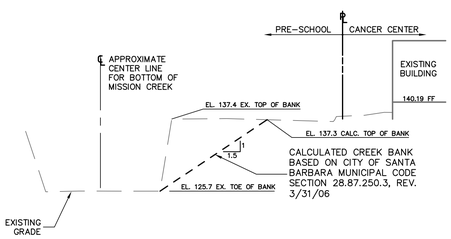
THE CONTRACTOR SHALL PERFORM AN EARTHWORK ESTIMATE FOR THE PURPOSE OF PREPARING A LUMP SUM BID PRICE FOR EARTHWORK. THE BID PRICE SHALL INCLUDE COSTS FOR ANY NECESSARY IMPORT AND PLACEMENT OF EARTH MATERIALS OR THE EXPORT AND PROPER DISPOSAL OF EXCESS EARTH MATERIALS.

LEGEND

- PROPOSED AREA DRAIN
- 2.9% — PROPOSED SWALE
- SD — PROPOSED STORM DRAIN
- 134.80 FS — PROPOSED SPOT ELEVATION
- 132.10 134.56 FF — EXISTING SPOT ELEVATIONS
- 2.0% — PROPOSED GRADE (DOWN HILL DIRECTION)
- PROPOSED PARKING OVERHANG LIMIT
- EXISTING TREE DRIPLINE
- PROPOSED GRADE BREAK
- PROPOSED RETAINING WALLS
- LIMIT OF GRADING
- CONCRETE TO BE REMOVED
- 138 — BASE FLOOD ELEVATION FROM CONDITIONAL LETTER OF MAP REVISION (CLOMR) APPROVED BY FEMA DECEMBER 19, 2008 (CASE NO. 08-09-0424R)

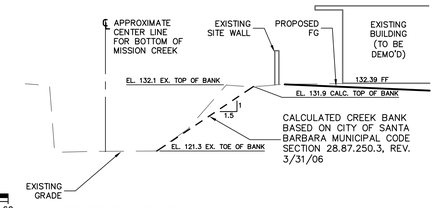
ABBREVIATIONS

AC	ASPHALT CONCRETE	GUT	GUTTER
CB	CATCH BASIN	INV	INVERT
CI	CAST IRON	PB	PULL BOX
CIP	CAST IRON PIPE	PP	POWER POLE
CMP	CORREGATED METAL PIPE	RW	RECLAIMED WATER
DI	DRAIN INLET	S	SEWER
DS	DOWN SPOUT	SCE	SOUTHERN CALIFORNIA EDISON
EP	EDGE OF PAVEMENT	SCO	SEWER CLEAN OUT
FF	FINISH FLOOR	SD	STORM DRAIN
FG	FINISH GRADE	TC	TOP OF CURB
FL	FLOW LINE	TG	TOP OF GRATE
FS	FINISH SURFACE	TW	TOP OF WALL
G	GAS	VC	VERTICAL CURVE
GFF	GARAGE FINISH FLOOR	VCP	VITRIFIED CLAY PIPE
GM	GAS METER	W	WATER
GND	GROUND	WM	WATER METER



SECTION A-A

SCALE: 1"=10'



SECTION B-B

SCALE: 1"=10'

PROPOSED DEVELOPMENT PLAN FOR :

CANCER CENTER Santa Barbara

540 West Pueblo
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CA 93105
(805) 563-5800

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JOB NUMBER: 05-032

CONTENTS:
PRELIMINARY GRADING & DRAINAGE PLAN

DRAWN BY: JJG

CHECKED BY:

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ISSUE DATE: April 2009

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SHEET 2 OF 4

PLOT SCALE:1:1
PLOT DATE:4/6/2009 3:38:26 PM
PLOT BY:Jason Gotsis
42-ENG SAVE DATE: 4/6/2009 10:51:53 AM
DRAWING:r:\acad\work\15708\civil\15708gp.dwg

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