REVISED
PRELIMINARY
DRAINAGE REPORT

FOR

915 E. ANAPAMU STREET

CLIENT: Mr. Charles Crail
1187 Coast Village Road
Suite I-528
Santa Barbara, CA 93101

PREPARED BY: Dale W. Weber, P.E.
MAC Design Associates
1933 Cliff Drive, Suite 6
Santa Barbara, CA 93110

DATE: July 29, 2009

W.O. 0357

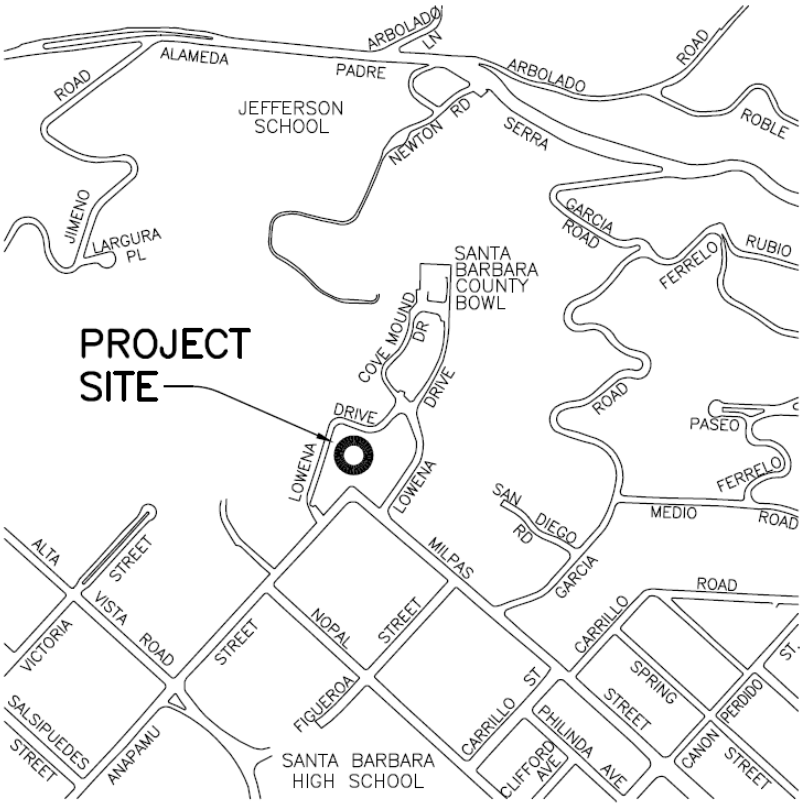
MAC DESIGN ASSOCIATES

Exhibit L

PURPOSE OF REPORT

The purpose of this report is to summarize the pre and post project runoff from the 915 E. Anapamu Street project site.

LOCATION OF SITE



VICINITY MAP

NO SCALE

METHODOLOGY

The property is approximately 0.92 acres in size, and is currently developed as a single family dwelling. Currently, there is approximately 1,700 SF of impervious area on the property. The property is bisected by a small drainage course with a tributary watershed of approximately 15 acres, which drains to an existing 24" diameter City storm drain. This small drainage course hydraulically separates the project into an eastern project site and a western project site. During a 100-year storm event this watershed will produce flows of approximately 43 cfs with flow depths between 1.4 feet and 1.7 feet through the drainage course. This small watershed typically flows a few inches deep a few days each year for a very short time. These intermittent flows are considered inadequate to cause significant erosion through this drainage course. Site inspection indicates that no significant erosion is occurring in the drainage course through the project site.

The project proposes to demolish the existing house and redevelop the property with 13 residential rental units. For post-development runoff calculations, this report will conservatively assume the proposed project will result in approximately 19,500 SF of impervious area.

Water quality measures include bioswales, rain gardens, permeable pavers, and the subsurface Stormtech chamber system. The primary source of water quality impacts for a multi-unit residential project is typically considered to be from vehicles. This project proposes 28 parking stalls, with 24 of those parking stalls being located within parking garages and not being subject to rainfall. The remaining 4 exterior parking stalls will be subject to rainfall, however it is proposed to use a permeable pavement material for these stalls. Roof water will be drained through bio-swales and rain gardens before discharging to the Stormtech system and on-site drainage course.

A preliminary drainage plan has been prepared, and is attached. Runoff from the eastern project site impervious areas will be routed to rain gardens and a subsurface Stormtech chamber system. The Stormtech system will provide for both filtration and retention of runoff. Post-development runoff rates will not exceed calculated pre-development rates for the BMP storm event through the 100-year storm event. The BMP storm event was assumed to be a 1 inch – 24 hour storm. The BMP storm event will be treated through the permeable pavers and rain gardens before entering the Stormtech system. A minimum of 6” of gravel will be placed below the Stormtech chamber and will provide additional treatment for the BMP storm event. The lag time for the BMP storm outflow hydrograph from the Stormtech system is approximately 86 minutes, as shown in the calculations provided below. Outflow from the Stormtech system will be routed to the on-site drainage course in a non-erosive manner.

Runoff from the western project site impervious areas will be routed to bio-swales and then to the on-site drainage course. Increased runoff from the western project site will be accounted and mitigated for by providing additional retention in the Stormtech system on the eastern project site.

The anticipated storm water runoff was calculated using HydroCad software, with the Santa Barbara Urban Hydrograph (SBUH) method. All input parameters are in accordance the Santa Barbara County Flood Control District (SBCFD) standards.

The time of concentration was established using Santa Barbara County nomograph. Due to the small size of the site, the pre-project time of concentration was at the minimum of 12 minutes. Therefore, the post-project time of concentration was also at the minimum of 12 minutes. Hydrologic Soil Group for the project site is Group D (highest runoff potential) per the Natural Resources Conservation Service (NRCS) Web Soil Survey, as attached.

CONCLUSIONS

The project has been designed with the following Low Impact Design measures:

- Bio-Swales
- Rain Gardens
- Permeable Pavements
- Garaged parking
- Stormtech subsurface system

Through the use of these LID measures, no water quality or flood control impacts are anticipated from this project. Runoff calculations are included below, and indicate that no increase in runoff will occur due to the project.

OVERALL CHANGE IN RUNOFF – ALL STORM EVENTS

Storm Event	**Overall Project increase (cfs)**	**Reduction from Stormtech (cfs)**	**Overall change in runoff (cfs)**
BMP	+0.17	-0.13	+0.04
2year	+0.30	-0.25	+0.05
5year	+0.31	-0.41	-0.10
10year	+0.31	-0.51	-0.20
25year	+0.31	-0.57	-0.26
50year	+0.29	-0.52	-0.23
100year	+0.29	-0.54	-0.25

CALCULATIONS

PRE PROJECT 25-YEAR STORM EVENT

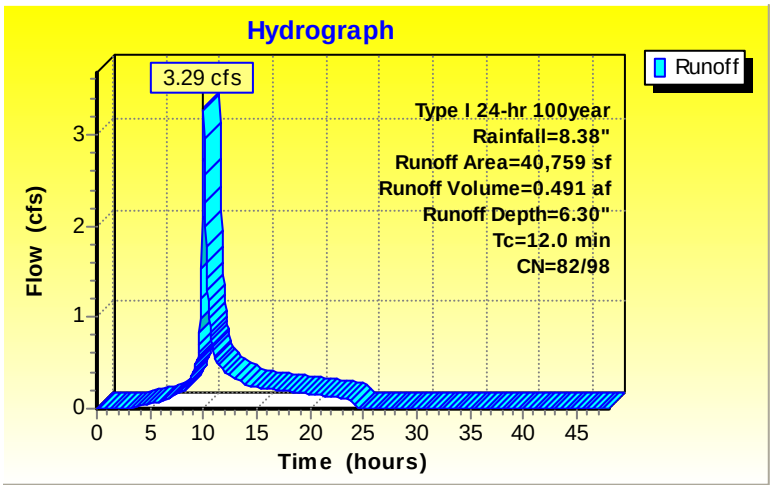
Summary for Subcatchment 1S: Existing Condition

Runoff = 3.29 cfs @ 9.99 hrs, Volume= 0.491 af, Depth= 6.30"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type I 24-hr 100year Rainfall=8.38"

Area (sf)	CN	Description
39,059	82	Woods/grass comb., Fair, HSG D
1,700	98	Paved parking & roofs
40,759	83	Weighted Average
39,059	82	Pervious Area
1,700	98	Impervious Area

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



PRE-PROJECT RUNOFF – ALL EVENTS

Events for Subcatchment 1S: Existing Conditio

Event	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2year	0.78	0.125	1.60
5year	1.44	0.218	2.80
10year	1.89	0.284	3.65
25year	2.46	0.368	4.72
50year	2.89	0.431	5.52
100year	**3.29**	**0.491**	**6.30**
BMP	0.01	0.001	0.01

POST PROJECT 25-YEAR STORM EVENT – W/O STORMTECH SYSTEM

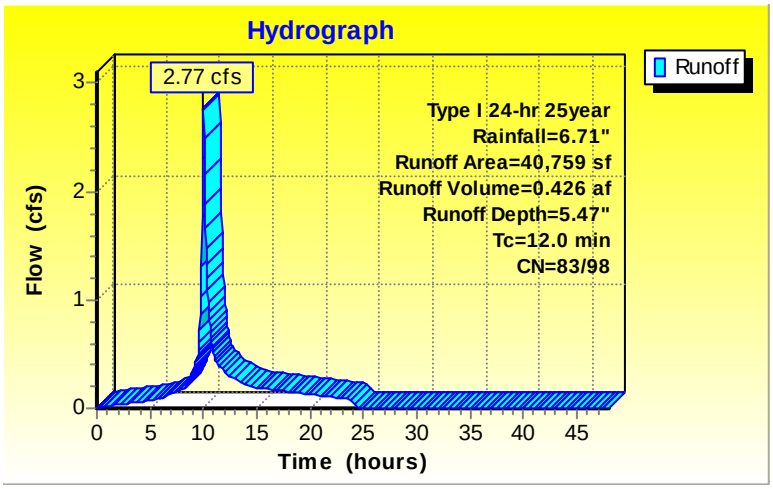
Summary for Subcatchment 5S: Proposed Condition

Runoff = 2.77 cfs @ 9.98 hrs, Volume= 0.426 af, Depth= 5.47"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type I 24-hr 25year Rainfall=6.71"

	Area (sf)	CN	Description
	20,486	82	Woods/grass comb., Fair, HSG D
	16,868	98	Paved parking & roofs
*	796	85	Rain Gardens
*	2,609	92	Courtyard
	40,759	89	Weighted Average
	23,891	83	Pervious Area
	16,868	98	Impervious Area

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



POST-PROJECT RUNOFF – ALL EVENTS

Events for Subcatchment 5S: Proposed Condit

Event	Runoff (cfs)	Volume (acre-feet)	Depth (inches)
2year	1.08	0.169	2.17
5year	1.75	0.270	3.47
10year	2.20	0.339	4.35
25year	2.77	0.426	5.47
50year	3.18	0.490	6.29
100year	**3.58**	**0.552**	**7.09**
BMP	0.18	0.032	0.40

STORMTECH SYSTEM

POST PROJECT INFLOW – STORMTECH SYSTEM – BMP STORM EVENT

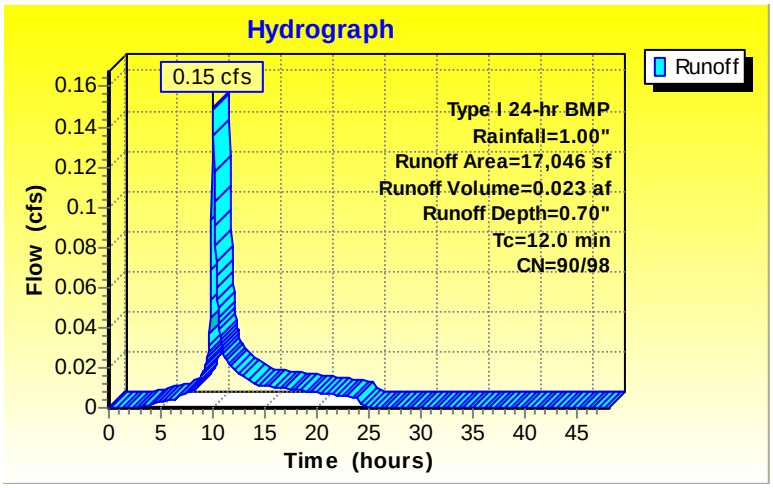
Summary for Subcatchment 7S: East Side to Stormtech

Runoff = 0.15 cfs @ 9.99 hrs, Volume= 0.023 af, Depth= 0.70"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type I 24-hr BMP Rainfall=1.00"

	Area (sf)	CN	Description
	13,641	98	Paved parking & roofs
*	796	85	Rain Gardens
*	2,609	92	Courtyard
	17,046	96	Weighted Average
	3,405	90	Pervious Area
	13,641	98	Impervious Area

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



POST PROJECT INFLOW/OUTFLOW – STORMTECH SYSTEM – BMP STORM EVENT

Summary for Pond 8P: Stormtech

Inflow Area =	0.391 ac,	80.02% Impervious,	Inflow Depth =	0.70"	for BMP event
Inflow =	0.15 cfs @	9.99 hrs,	Volume=	0.023 af	
Outflow =	0.02 cfs @	11.41 hrs,	Volume=	0.013 af,	Atten= 85%, Lag= 85.7 min
Primary =	0.02 cfs @	11.41 hrs,	Volume=	0.013 af	

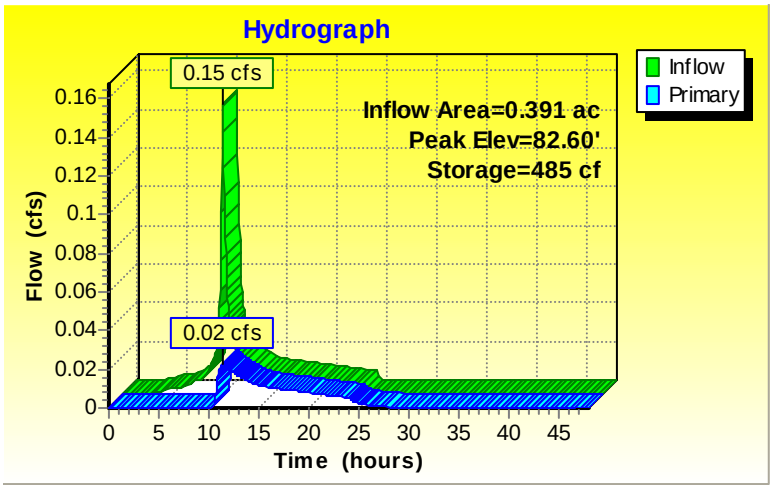
Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 82.60' @ 11.41 hrs Surf.Area= 686 sf Storage= 485 cf

Plug-Flow detention time= 401.7 min calculated for 0.013 af (57% of inflow)
Center-of-Mass det. time= 217.5 min (980.0 - 762.6)

Volume	Invert	Avail.Storage	Storage Description
#1	81.50'	868 cf	**22.50'W x 30.50'L x 4.50'H Prismatoid**
			3,088 cf Overall - 919 cf Embedded = 2,169 cf x 40.0% Voids
#2	82.00'	919 cf	**44.6"W x 30.0"H x 7.12'L StormTech SC-740** x 20 Inside #1
		1,787 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	82.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	85.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	86.00'	**2.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.02 cfs @ 11.41 hrs HW=82.60' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.02 cfs @ 1.05 fps)
- **2=Orifice/Grate** (Controls 0.00 cfs)
- **3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)



POST PROJECT INFLOW – STORMTECH SYSTEM – 25YEAR EVENT

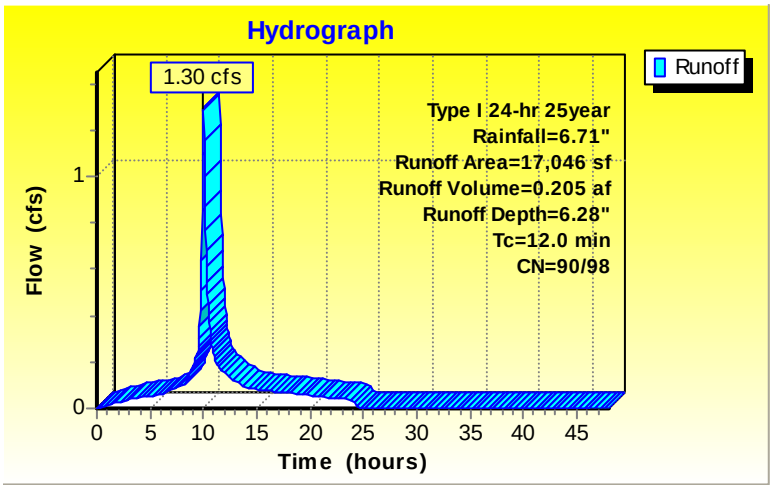
Summary for Subcatchment 7S: East Side to Stormtech

Runoff = 1.30 cfs @ 9.98 hrs, Volume= 0.205 af, Depth= 6.28"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type I 24-hr 25year Rainfall=6.71"

	Area (sf)	CN	Description
	13,641	98	Paved parking & roofs
*	796	85	Rain Gardens
*	2,609	92	Courtyard
	17,046	96	Weighted Average
	3,405	90	Pervious Area
	13,641	98	Impervious Area

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



POST PROJECT INFLOW/OUTFLOW – STORMTECH SYSTEM – 25YEAR EVENT

Summary for Pond 8P: Stormtech

Inflow Area =	0.391 ac,	80.02% Impervious,	Inflow Depth =	6.28"	for 25year event
Inflow =	1.30 cfs @	9.98 hrs,	Volume=	0.205 af	
Outflow =	0.73 cfs @	10.22 hrs,	Volume=	0.195 af,	Atten= 43%, Lag= 14.6 min
Primary =	0.73 cfs @	10.22 hrs,	Volume=	0.195 af	

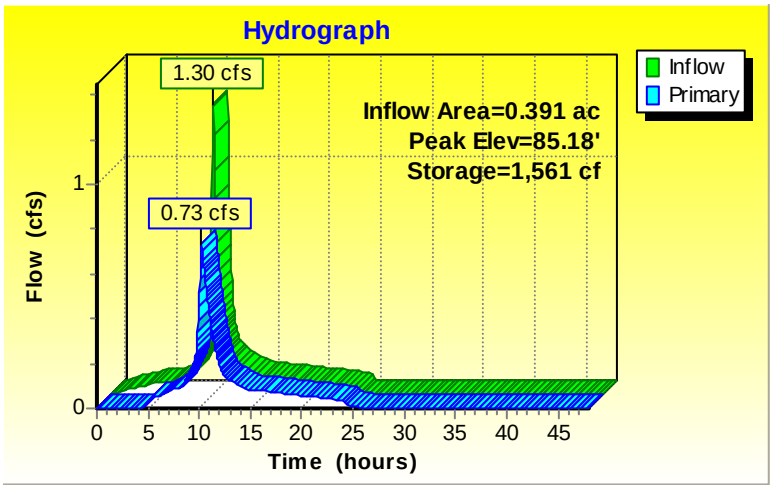
Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 85.18' @ 10.22 hrs Surf.Area= 686 sf Storage= 1,561 cf

Plug-Flow detention time= 84.7 min calculated for 0.195 af (95% of inflow)
Center-of-Mass det. time= 50.9 min (755.8 - 704.9)

Volume	Invert	Avail.Storage	Storage Description
#1	81.50'	868 cf	**22.50'W x 30.50'L x 4.50'H Prismatoid**
			3,088 cf Overall - 919 cf Embedded = 2,169 cf x 40.0% Voids
#2	82.00'	919 cf	**44.6"W x 30.0"H x 7.12'L StormTech SC-740** x 20 Inside #1
		1,787 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	82.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	85.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	86.00'	**2.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.73 cfs @ 10.22 hrs HW=85.17' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.66 cfs @ 7.62 fps)
- **2=Orifice/Grate** (Orifice Controls 0.06 cfs @ 1.40 fps)
- **3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)



POST PROJECT INFLOW/OUTFLOW FROM STORMTECH SYSTEM – ALL STORM EVENTS

Events for Pond 8P: Stormtech

Event	Inflow (cfs)	Primary (cfs)	Elevation (feet)	Storage (cubic-feet)
2year	0.59	0.34	83.34	890
5year	0.88	0.47	83.90	1,160
10year	1.06	0.55	84.41	1,349
25year	1.30	0.73	85.18	1,561
50year	1.47	0.95	85.49	1,648
100year	**1.63**	**1.09**	**85.83**	**1,741**
BMP	0.15	0.02	82.60	485

OVERALL CHANGE IN RUNOFF – ALL STORM EVENTS

Storm Event	Overall Project increase (cfs)	Reduction from Stormtech (cfs)	Overall change in runoff (cfs)
BMP	+0.17	-0.13	+0.04
2year	+0.30	-0.25	+0.05
5year	+0.31	-0.41	-0.10
10year	+0.31	-0.51	-0.20
25year	+0.31	-0.57	-0.26
50year	+0.29	-0.52	-0.23
100year	+0.29	-0.54	-0.25

WATERSHED TRIBUTARY TO DRAINAGE COURSE – 100 YEAR STORM EVENT

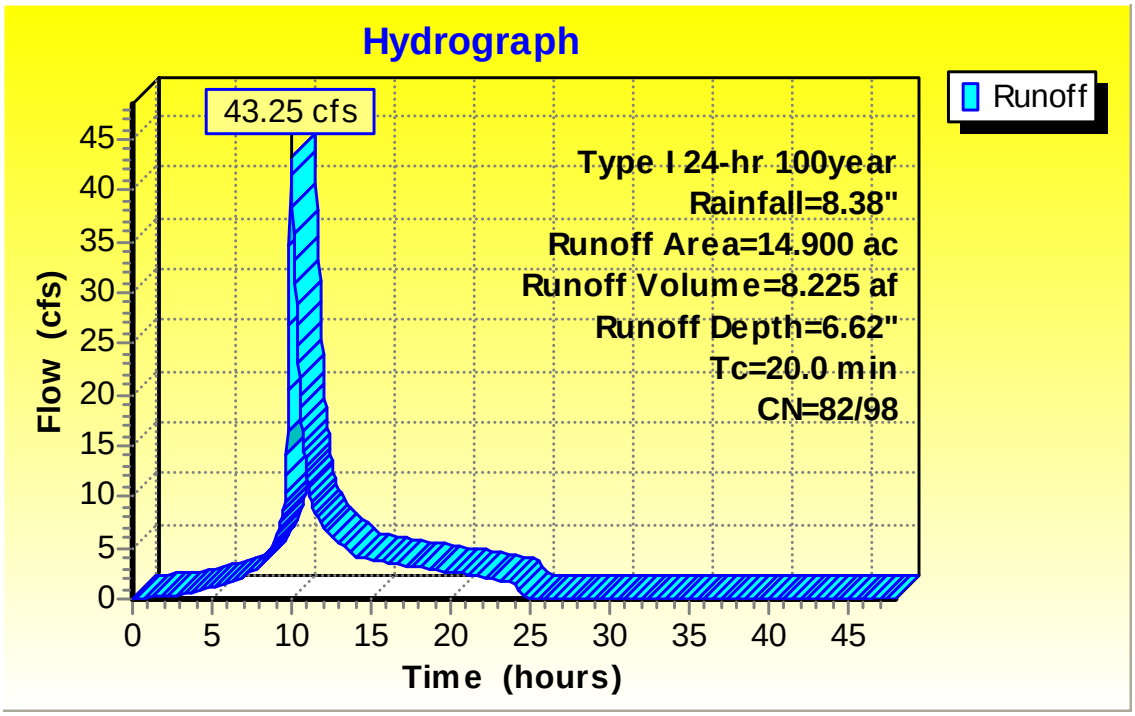
Summary for Subcatchment 9S: Watershed

Runoff = 43.25 cfs @ 10.00 hrs, Volume= 8.225 af, Depth= 6.62"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type I 24-hr 100year Rainfall=8.38"

Area (ac)	CN	Description
3.130	98	Paved parking & roofs
11.770	82	Woods/grass comb., Fair, HSG D
14.900	85	Weighted Average
11.770	82	Pervious Area
3.130	98	Impervious Area

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



DRAINAGE COURSE CROSS SECTIONS – 100YEAR WATER SURFACE CALCULATIONS

Irregular Section (Crail.fm8) Report

Label	Solve For	Friction Method	Roughness Coefficient
Irregular Section - 2	Normal Depth	Manning Formula	0.045
Irregular Section - 3	Normal Depth	Manning Formula	0.045
Irregular Section - 4	Normal Depth	Manning Formula	0.045
Irregular Section - 5	Normal Depth	Manning Formula	0.045
Irregular Section - 6	Normal Depth	Manning Formula	0.045
Irregular Section - 7	Normal Depth	Manning Formula	0.045

Channel Slope (ft/ft)	Water Surface Elevation (ft)	Elevation Range	Discharge (ft^3/s)
0.04970	75.77	74.12 to 76.00 ft	43.25
0.05100	77.29	75.68 to 78.00 ft	43.25
0.02030	78.39	76.66 to 80.00 ft	43.25
0.07460	78.59	77.18 to 80.00 ft	43.25
0.06450	79.81	78.37 to 82.00 ft	43.25
0.09270	81.69	79.99 to 84.00 ft	43.25

Flow Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)	Normal Depth (ft)
7.00	9.11	8.47	1.65
7.00	9.29	8.71	1.61
10.24	12.05	11.48	1.73
6.10	8.76	8.19	1.41
6.62	9.62	9.18	1.44
5.25	7.08	6.19	1.70

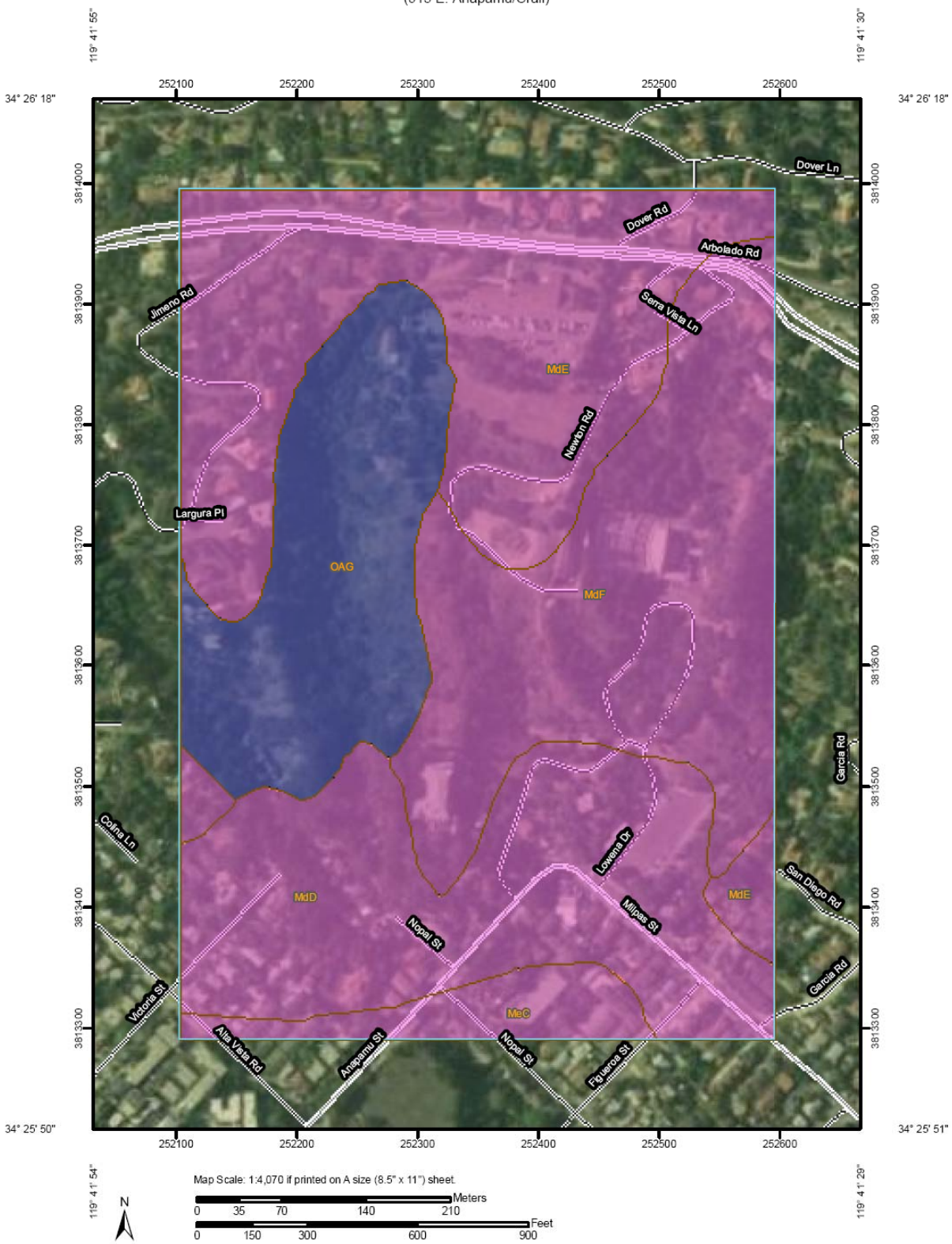
Irregular Section (Crail.fm8) Report

Critical Depth (ft)	Critical Slope (ft/ft)	Velocity (ft/s)	Velocity Head (ft)
1.78	0.03384	6.18	0.59
1.74	0.03369	6.18	0.59
1.57	0.03378	4.22	0.28
1.65	0.03386	7.09	0.78
1.63	0.03364	6.54	0.66
2.04	0.03507	8.24	1.05

Specific Energy (ft)	Froude Number	Flow Type	Notes
2.25	1.20	Supercritical	
2.20	1.21	Supercritical	
2.01	0.79	Subcritical	
2.19	1.45	Supercritical	
2.11	1.36	Supercritical	
2.75	1.58	Supercritical	

Messages

Hydrologic Soil Group—Santa Barbara County, California, South Coastal Part
(915 E. Anapamu/Crail)



USDA Natural Resources Conservation Service

Web Soil Survey 2.1
National Cooperative Soil Survey

2/24/2009
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MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:4,070 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Santa Barbara County, California, South Coastal Part
Survey Area Data: Version 5, Jan 3, 2008

Date(s) aerial images were photographed: 6/7/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Santa Barbara County, California, South Coastal Part				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
MdD	MILPITAS STONY FINE SANDY LOAM, 9 TO 15 PERCENT SLOPES	D	20.2	23.5%
MdE	MILPITAS STONY FINE SANDY LOAM, 15 TO 30 PERCENT SLOPES	D	25.1	29.3%
MdF	MILPITAS STONY FINE SANDY LOAM, 30 TO 50 PERCENT SLOPES	D	22.4	26.1%
MeC	MILPITAS-POSITAS FINE SANDY LOAMS, 2 TO 9 PERCENT SLOPES	D	3.5	4.1%
OAG	ORTHENTS, 50 TO 75 PERCENT SLOPES	B	14.6	17.0%
Totals for Area of Interest			**85.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower