TECHNICAL MEMORANDUM:

SWMM Modeling for Hydromodification Compliance of:

Pico Place

Prepared For:

DMS Consultants, Inc.

Prepared by:

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November 3, 2022

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R·E·C

TECHNICAL MEMORANDUM

TO: DMS Consultants, Inc.

FROM: Luis Parra, PhD, PE, CPSWQ, ToR, D.WRE, CFM.
David Edwards, MS, PE, CFM.

DATE: November 3, 2022

RE: Summary of SWMM Modeling for Hydromodification Compliance for Pico Place, San Marcos, CA.

INTRODUCTION

This memorandum summarizes the approach used to model the proposed residential development project site in the City of San Marcos using the Environmental Protection Agency (EPA) Storm Water Management Model 5.0 (SWMM). SWMM models were prepared for the pre and post-developed conditions at the site in order to determine if the proposed LID facilities have sufficient volume to meet Order R9-2013-001 requirements of the California Regional Water Quality Control Board San Diego Region (SDRWQCB), as explained in the Final Hydromodification Management Plan (HMP), dated March 2011, prepared for the County of San Diego by Brown and Caldwell.

SWMM MODEL DEVELOPMENT

The Pico Place project comprises of a multi0family development inclusive of a private drive accessway and vegetated landscaped areas. Two (2) SWMM models were prepared for this study: the first for the pre-development and the second for the post-developed conditions. The project site drains to one (1) overall Point of Compliance (POC-1), located at the existing storm drain system to the eastern boundary of the project site within the adjacent Pico Avenue.

Per Section G.1.2 in Appendix G of the 2016 City of San Marcos' BMP Design Manual, the EPA SWMM model was used to perform the continuous hydrologic simulation. For both SWMM models, flow duration curves were prepared to determine if the proposed HMP facility is sufficient to meet the current HMP requirements.

The inputs required to develop SWMM models include rainfall, watershed characteristics, and BMP configurations. The Poway gauge from the Project Clean Water website was used for this study, since it is the most representative of the project site precipitation due to elevation and proximity to the project site. Please see gauge location and project location map on Attachment 5.

The Escondido gage is not recommended for continuous simulation because (a) 22% of the intensities higher than 0.4 in/hr have data problems, and (b) the highest intensities measured in this station do not belong to the location of the gage (were copied from Wolford, at an elevation 850 ft higher than Escondido). Similarly, Wohlford data was not used mainly because the difference in elevation. At this point, we decided that the closest gage, with no significant data problems at similar elevation than the project elevation, was the most appropriate, therefore we used Poway precipitation.

Per the California Irrigation Management Information System "Reference Evaporation Zones" (CIMIS ETo Zone Map), the project site is located within the Zone 6 Evapotranspiration Area. Thus evapotranspiration values for the site were modeled using Zone 9 average monthly values from Table G.1-1 from the City of San Marcos' 2016 BMP Design Manual. The site was modeled with type C hydrologic soil per the site-specific geotechnical report undertaken for the project site (please refer to Attachment 8 of this memo).

Soils have been assumed to be compacted in the existing condition to represent the current developed condition of the site. In the post developed conditions, the soils have been modeled as fully compacted. Other SWMM inputs for the subareas are discussed in the appendices to this document, where the selection of the parameters is explained in detail.

HMP MODELING

PRE DEVELOPED CONDITIONS

The current property consists on a developed residential site that drains via overland flow to a receiving storm drain system (POC-1) located within Pico Avenue to the east of the project site. Table 1 below illustrates the pre-developed area to be developed and impervious percentage accordingly.

TABLE 1 – SUMMARY OF PRE-DEVELOPED CONDITIONS

POC	DMA	Tributary Area, A (Ac)	Impervious Percentage, Ip(1)
POC-1	DMA-1C	0.675	0%
TOTAL	**--**	**0.675**	0%

Notes: (1) – Per the 2013 RWQCB permit, existing condition impervious surfaces are not to be accounted for in existing conditions analysis.

DEVELOPED CONDITIONS

Runoff from the developed project site is drained to one (1) onsite receiving LID Infiltration BMP. Once flows are routed via the proposed LID BMPs, developed onsite flows are then conveyed to the aforementioned POC. Table 2 below summarizes the DMAs for the developed site.

TABLE 2 – SUMMARY OF DEVELOPED CONDITIONS

POC	DMA	Tributary Area, A (Ac)	Impervious Percentage, Ip
POC-1	DMA-1C	0.675	74.79%
TOTAL	--	**0.675**	--

Developed flows from the project site are conveyed to one (1) onsite detention facility prior to discharging to the existing storm drain system. The vault system is approximately 9-feet deep with a width of 8-feet and length of 45-feet. Due to the limited grade on the project site and utility constraints, the vault is to be located several feet below the existing storm drain invert in Pico Avenue such that the vault can only be drained via the use of pumps. Due to HMP criteria, two (2) separate pumps will be employed on the project site, a low flow pump outlet will be located at 3.2 feet from the bottom of the basin invert while the peak Q100 flow pump will be located at 7.25 feet from the basin invert. A secondary pump will be provided on site should the primary pump fail and in an extreme event, flows will outlet via the surface private drive to Pico Avenue without risk of flooding the residential structures and also providing single vehicular lane access.

Due to the high rate of measured infiltration onsite experienced during the geotechnical investigation, the base of the vault will be unlined such that flows can infiltrate into the underlying base. The filtration basin has been modeled directly as basins within SWMM can have infiltration associated with the base footprint accordingly.

Water Quality BMP Sizing &Drawdown Calculations

It is assumed all storm water quality requirements for the project will be met by the LID BMPs detailed in the SWQMP and other BMPs included within the site design. However, detailed water quality requirements are not discussed within this technical memo. For further information in regards to storm water quality requirements for the project (including sizing and drawdown) please refer to the site-specific Storm Water Quality Management Plan (SWQMP).

BMP MODELING FOR HMP PURPOSES

Modeling of HMP BMPs

One (1) LID BMP basin is proposed for hydromodification conformance for the project site. Tables 4 and 5 illustrates the dimensions required for HMP compliance according to the SWMM model that was undertaken for the project. It should be noted that pumps are the only possible outlet structure such that an elevation and flow will be identified for the system.

TABLE 4 – SUMMARY OF BIOFILTRATION / PARTIAL INFILTRATION BMP

BMP	DIMENSIONS				
	Tributary Area (ft^2)	Vault Width (ft)	Vault Length (ft)	Vault Depth (ft)	Total Vault Volume (ft^3)
Vault	30,596	8	45	9	3,240

TABLE 5 – SUMMARY OF OUTLET PUMP DETAILS

BMP	Low Flow Pump		Peak Flow Pump	
	Flow Rate (cfs)	Elevation(1) (ft)	Flow Rate (cfs)	Elevation(1) (ft)
Vault	0.02	3.2	1.9	7.25

Notes:
(1): Basin ground surface elevation assumed to be 0.00 ft elevation..

FLOW DURATION CURVE COMPARISON

The Flow Duration Curve (FDC) for the site was compared at the POCs by exporting the hourly runoff time series results from SWMM to a spreadsheet.

Q_2 and Q_{10} were determined with a partial duration statistical analysis of the runoff time series in an Excel spreadsheet using the Cunnane plotting position method (which is the preferred plotting methodology in the HMP Permit). As the SWMM Model includes a statistical analysis based on the Weibull Plotting Position Method, the Weibull Method was also used within the spreadsheet to ensure that the results were similar to those obtained by the SWMM Model.

The range between 10% of Q_2 and Q_{10} was divided into 100 equal time intervals; the number of hours that each flow rate was exceeded was counted from the hourly series. Additionally, the intermediate peaks with a return period "i" were obtained (Q_i with i=3 to 9). For the purpose of the plot, the values were presented as percentage of time exceeded for each flow rate. FDC comparison at the POC is illustrated in Figure 1 in both normal and logarithmic scale.

As can be seen in Figure 1, the FDC for the proposed condition with the HMP BMPs is within 110% of the curve for the existing condition in both peak flows and durations. The additional runoff volume generated from developing the site will be released to the existing point of discharge at a flow rate below the 10% Q_2 lower threshold for the POC. Additionally, the project will also not increase peak flow rates between the Q_2 and the Q_{10}, as shown in the peak flow table in Attachment 1.

Discussion of the Manning's coefficient (Pervious Areas) for Pre and Post-Development Conditions

Typically, the Manning's coefficient is selected as n = 0.10 for pervious areas and n = 0.012 for impervious areas. However, due to the impact that n has in the continuous simulation a more accurate value of the Manning's coefficient has been chosen for pervious areas. Taken into consideration the study prepared by TRWE (Reference [6]) a value of n = 0.05 has been selected (see Table 1 of Reference [6] included in Attachment 7). An average n value between average grass plus pasture (0.04) and dense grass (0.06) has been selected per the reference cited, for light rain (<0.8 in/hr) as more than 99% of the rainfall has been measured with this intensity.

SUMMARY

This study has demonstrated that the proposed HMP BMP provided for the Pico Place site is sufficient to meet the current HMP criteria if the cross-section areas and volumes recommended within this technical memorandum, and the respective orifice and outlet structure are incorporated as specified within the proposed project site.

KEY ASSUMPTIONS

1. Type C Soil is representative of the existing condition site. This is based on the site-specific geotechnical investigation undertaken for the project site.

ATTACHMENTS

1. Q_2 to Q_{10} Comparison Tables
2. FDC Plots (log and natural "x" scale) and Flow Duration Table.
3. List of the "n" largest Peaks: Pre-Development and Post-Development Conditions
4. Elevations vs. Discharge Curves to be used in SWMM
5. Pre & Post Development Maps, Project plan and section sketches
6. SWMM Input Data in Input Format (Existing and Proposed Models)
7. SWMM Screens and Explanation of Significant Variables
8. Geotechnical Documentation
9. Summary files from the SWMM Model

REFERENCES

[1] – *"Review and Analysis of San Diego County Hydromodification Management Plan (HMP): Assumptions, Criteria, Methods, & Modeling Tools – Prepared for the Cities of San Marcos, Oceanside & Vista",* May 2012, TRW Engineering.

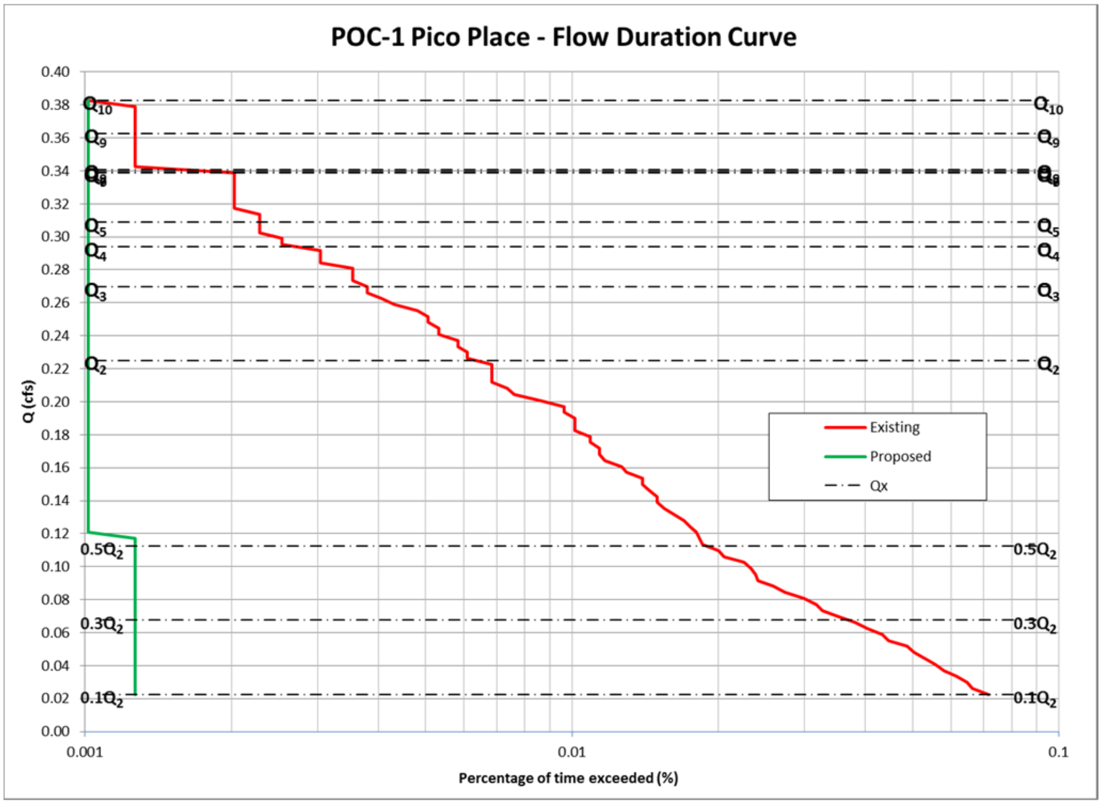
[2] – *"Final Hydromodification Management Plan (HMP) prepared for the County of San Diego",* March 2011, Brown and Caldwell.

[3] - Order R9-2013-001, California Regional Water Quality Control Board San Diego Region (SDRWQCB).

[4] – "*Handbook of Hydrology*", David R. Maidment, Editor in Chief. 1992, McGraw Hill.

[5] – "*City of San Marcos BMP Design Manual*", February 2016.

[6] – *"Improving Accuracy in Continuous Hydrologic Modeling: Guidance for Selecting Pervious Overland Flow Manning's n Values in the San Diego Region"*, TRWE, 2016.



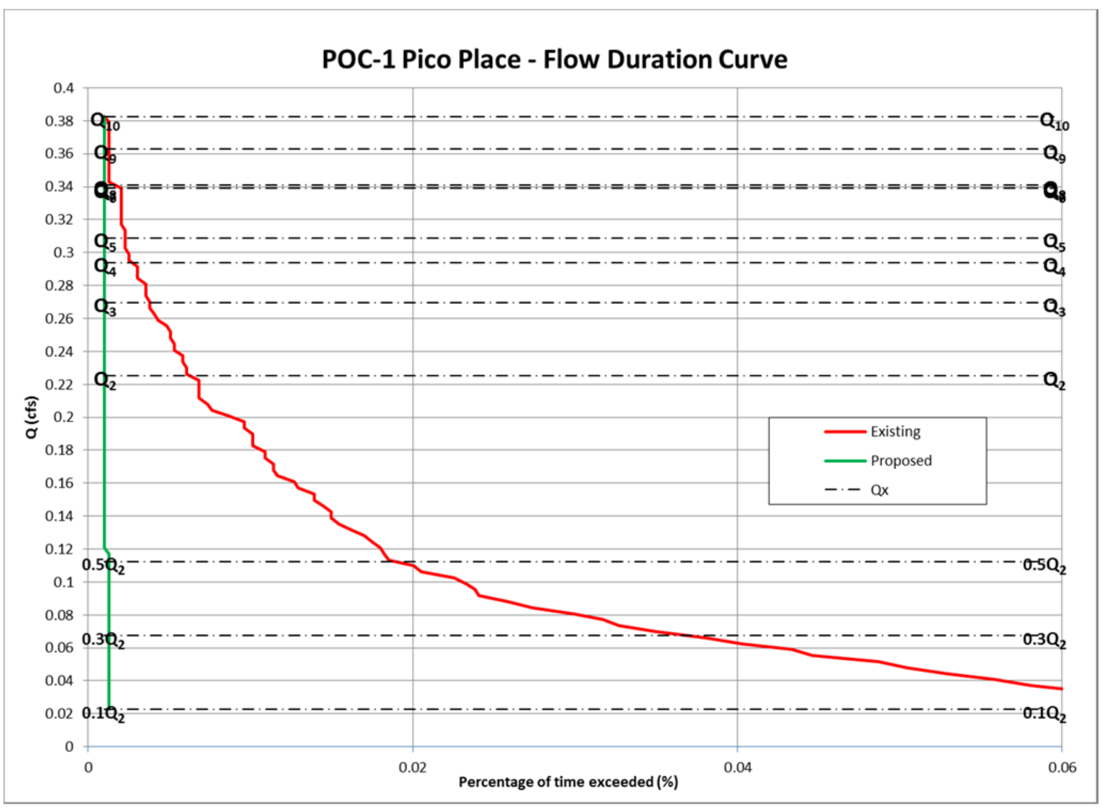


Figure 1a and 1b. Flow Duration Curve Comparison (logarithmic and normal “x” scale)

ATTACHMENT 1.

Q_2 to Q_{10} Comparison Table – POC 1

Return Period	Existing Condition (cfs)	Mitigated Condition (cfs)	Reduction, Exist - Mitigated (cfs)
2-year	0.225	0.020	0.205
3-year	0.270	0.020	0.250
4-year	0.294	0.020	0.274
5-year	0.309	0.020	0.289
6-year	0.339	0.020	0.319
7-year	0.339	0.020	0.319
8-year	0.341	0.020	0.321
9-year	0.363	0.072	0.291
10-year	0.383	0.137	0.246

ATTACHMENT 2

FLOW DURATION CURVE ANALYSIS

1) Flow duration curve shall not exceed the existing conditions by more than 10%, neither in peak flow nor duration.

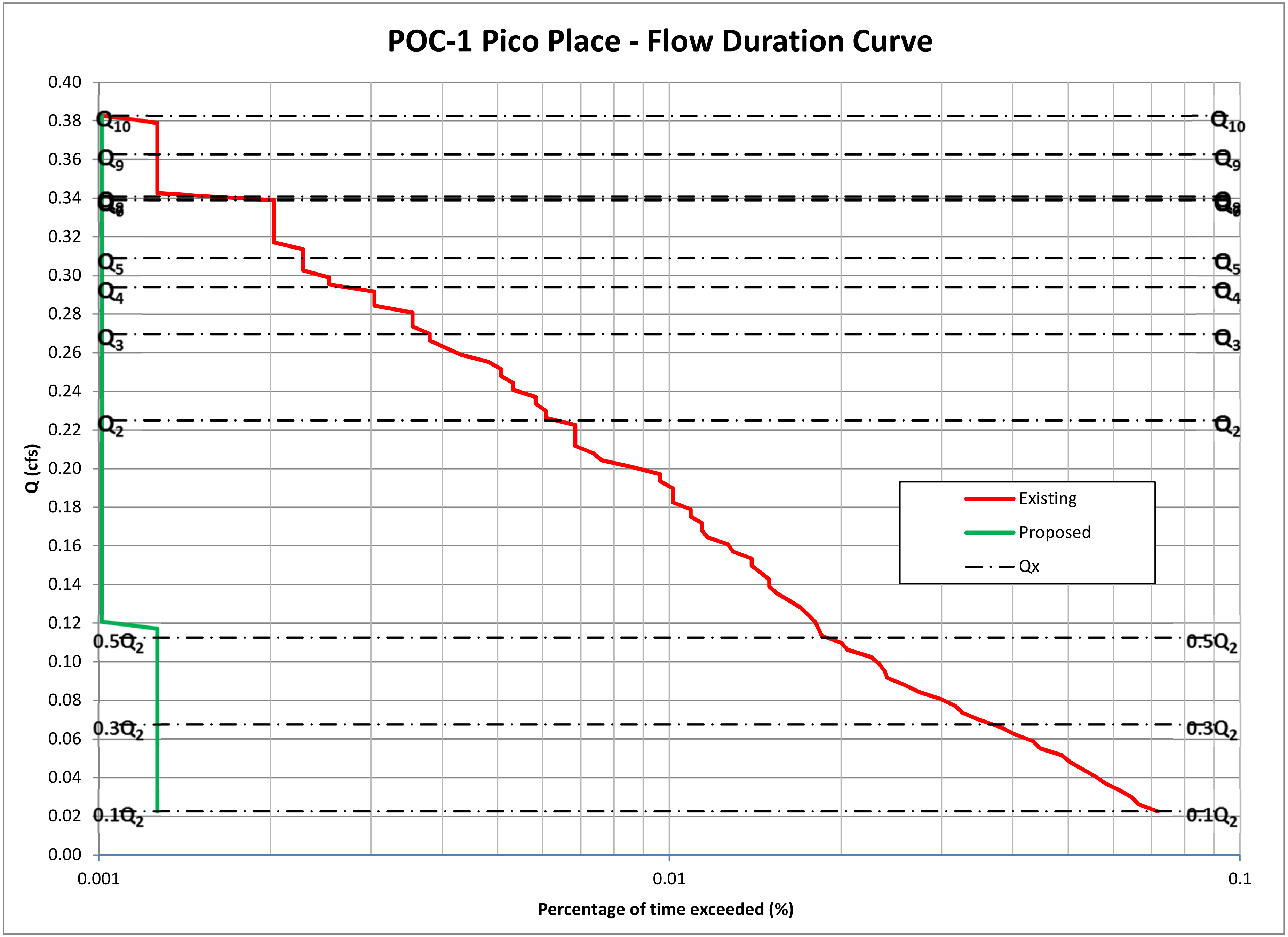
The figures on the following pages illustrate that the flow duration curve in post-development conditions after the proposed BMP is below the existing flow duration curve. The flow duration curve table following the curve shows that if the interval $0.10Q_2 - Q_{10}$ is divided in 100 sub-intervals, then a) the post development divided by pre-development durations are never larger than 110% (the permit allows up to 110%); and b) there are no more than 10 intervals in the range 101%-110% which would imply an excess over 10% of the length of the curve (the permit allows less than 10% of excesses measured as 101-110%).

Consequently, the design passes the hydromodification test.

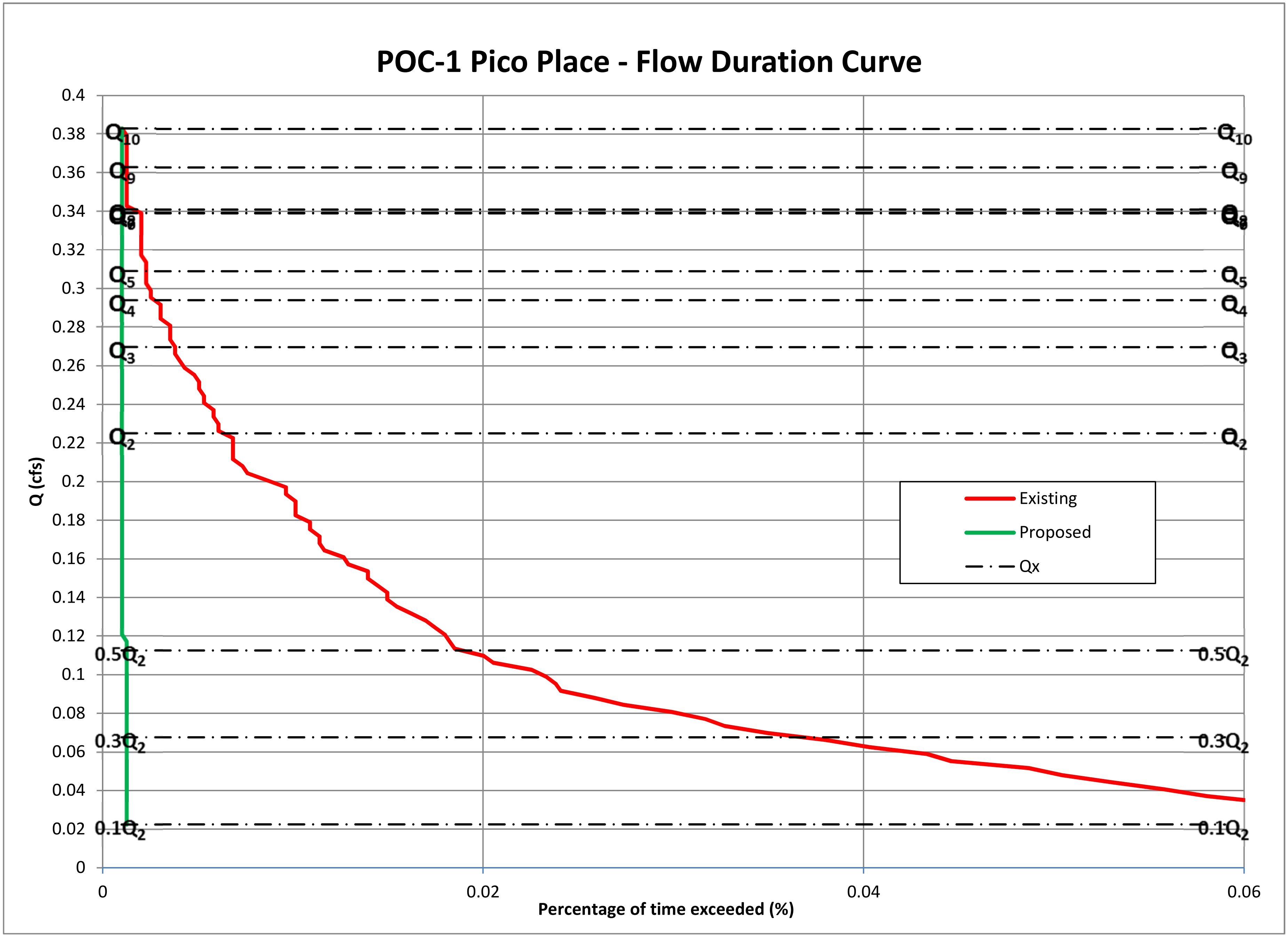
It is important to note that the flow duration curve can be expressed in the "x" axis as percentage of time, hours per year, total number of hours, or any other similar time variable. As those variables only differ by a multiplying constant, their plot in logarithmic scale is going to look exactly the same, and compliance can be observed regardless of the variable selected. However, in order to satisfy the City of San Marcos HMP example, % of time exceeded is the variable of choice in the flow duration curve. The selection of a logarithmic scale in lieu of the normal scale is preferred, as differences between the pre-development and post-development curves can be seen more clearly in the entire range of analysis. Both graphics are presented just to prove the difference.

In terms of the "y" axis, the peak flow value is the variable of choice. As an additional analysis performed by REC, not only the range of analysis is clearly depicted (10% of Q_2 to Q_{10}) but also all intermediate flows are shown (Q_2, Q_3, Q_4, Q_5, Q_6, Q_7, Q_8 and Q_9) in order to demonstrate compliance at any range $Q_x - Q_{x+1}$. It must be pointed out that one of the limitations of both the SWMM and SDHM models is that the intermediate analysis is not performed (to obtain Q_i from i = 2 to 10). REC performed the analysis using the Cunnane Plotting position Method (the preferred method in the HMP permit) from the "n" largest independent peak flows obtained from the continuous time series.

The largest "n" peak flows are attached in this appendix, as well as the values of Q_i with a return period "i", from i=2 to 10. The Q_i values are also added into the flow-duration plot.



POC-1 Pico Place - Flow Duration Curve
Q (cfs)
Percentage of time exceeded (%)
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.001
0.01
0.1
Q10
Q9
Q8
Q5
Q4
Q3
Q2
0.5Q2
0.3Q2
0.1Q2
Existing
Proposed
Qx



POC-1 Pico Place - Flow Duration Curve
Q (cfs)
Percentage of time exceeded (%)
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.02
0.04
0.06
Q10
Q9
Q8
Q5
Q4
Q3
Q2
0.5Q2
0.3Q2
0.1Q2
Existing
Proposed
Qx

Flow Duration Curve Data for Pico Place POC 1 - San Marcos, CA

Q2 =	0.225	cfs	Fraction	10 %
Q10 =	0.38	cfs		
Step =	0.0036	cfs		
Count =	394487	hours		
	45.00	years		

	Existing Condition			Detention Optimized			Pass or
Interval	Q (cfs)	Hours > Q	% time	Hours>Q	% time	Post/Pre	Fail?
1	0.023	283	7.17E-02	5	1.27E-03	2%	Pass
2	0.026	262	6.64E-02	5	1.27E-03	2%	Pass
3	0.030	255	6.46E-02	5	1.27E-03	2%	Pass
4	0.033	243	6.16E-02	5	1.27E-03	2%	Pass
5	0.037	229	5.81E-02	5	1.27E-03	2%	Pass
6	0.041	220	5.58E-02	5	1.27E-03	2%	Pass
7	0.044	209	5.30E-02	5	1.27E-03	2%	Pass
8	0.048	199	5.04E-02	5	1.27E-03	3%	Pass
9	0.052	192	4.87E-02	5	1.27E-03	3%	Pass
10	0.055	176	4.46E-02	5	1.27E-03	3%	Pass
11	0.059	171	4.33E-02	5	1.27E-03	3%	Pass
12	0.063	159	4.03E-02	5	1.27E-03	3%	Pass
13	0.066	150	3.80E-02	5	1.27E-03	3%	Pass
14	0.070	138	3.50E-02	5	1.27E-03	4%	Pass
15	0.073	129	3.27E-02	5	1.27E-03	4%	Pass
16	0.077	125	3.17E-02	5	1.27E-03	4%	Pass
17	0.081	118	2.99E-02	5	1.27E-03	4%	Pass
18	0.084	108	2.74E-02	5	1.27E-03	5%	Pass
19	0.088	102	2.59E-02	5	1.27E-03	5%	Pass
20	0.092	95	2.41E-02	5	1.27E-03	5%	Pass
21	0.095	94	2.38E-02	5	1.27E-03	5%	Pass
22	0.099	92	2.33E-02	5	1.27E-03	5%	Pass
23	0.103	89	2.26E-02	5	1.27E-03	6%	Pass
24	0.106	81	2.05E-02	5	1.27E-03	6%	Pass
25	0.110	79	2.00E-02	5	1.27E-03	6%	Pass
26	0.113	73	1.85E-02	5	1.27E-03	7%	Pass
27	0.117	72	1.83E-02	5	1.27E-03	7%	Pass
28	0.121	71	1.80E-02	4	1.01E-03	6%	Pass
29	0.124	69	1.75E-02	4	1.01E-03	6%	Pass
30	0.128	67	1.70E-02	4	1.01E-03	6%	Pass
31	0.132	64	1.62E-02	4	1.01E-03	6%	Pass
32	0.135	61	1.55E-02	4	1.01E-03	7%	Pass
33	0.139	59	1.50E-02	4	1.01E-03	7%	Pass
34	0.143	59	1.50E-02	4	1.01E-03	7%	Pass
35	0.146	57	1.44E-02	4	1.01E-03	7%	Pass
36	0.150	55	1.39E-02	4	1.01E-03	7%	Pass

Interval	Existing Condition			Detention Optimized			Pass or Fail?
	Q (cfs)	Hours > Q	% time	Hours>Q	% time	Post/Pre	
37	0.153	55	1.39E-02	4	1.01E-03	7%	Pass
38	0.157	51	1.29E-02	4	1.01E-03	8%	Pass
39	0.161	50	1.27E-02	4	1.01E-03	8%	Pass
40	0.164	46	1.17E-02	4	1.01E-03	9%	Pass
41	0.168	45	1.14E-02	4	1.01E-03	9%	Pass
42	0.172	45	1.14E-02	4	1.01E-03	9%	Pass
43	0.175	43	1.09E-02	4	1.01E-03	9%	Pass
44	0.179	43	1.09E-02	4	1.01E-03	9%	Pass
45	0.183	40	1.01E-02	4	1.01E-03	10%	Pass
46	0.186	40	1.01E-02	4	1.01E-03	10%	Pass
47	0.190	40	1.01E-02	4	1.01E-03	10%	Pass
48	0.193	38	9.63E-03	4	1.01E-03	11%	Pass
49	0.197	38	9.63E-03	4	1.01E-03	11%	Pass
50	0.201	34	8.62E-03	4	1.01E-03	12%	Pass
51	0.204	30	7.60E-03	4	1.01E-03	13%	Pass
52	0.208	29	7.35E-03	4	1.01E-03	14%	Pass
53	0.212	27	6.84E-03	4	1.01E-03	15%	Pass
54	0.215	27	6.84E-03	4	1.01E-03	15%	Pass
55	0.219	27	6.84E-03	4	1.01E-03	15%	Pass
56	0.223	27	6.84E-03	4	1.01E-03	15%	Pass
57	0.226	24	6.08E-03	4	1.01E-03	17%	Pass
58	0.230	24	6.08E-03	4	1.01E-03	17%	Pass
59	0.233	23	5.83E-03	4	1.01E-03	17%	Pass
60	0.237	23	5.83E-03	4	1.01E-03	17%	Pass
61	0.241	21	5.32E-03	4	1.01E-03	19%	Pass
62	0.244	21	5.32E-03	4	1.01E-03	19%	Pass
63	0.248	20	5.07E-03	4	1.01E-03	20%	Pass
64	0.252	20	5.07E-03	4	1.01E-03	20%	Pass
65	0.255	19	4.82E-03	4	1.01E-03	21%	Pass
66	0.259	17	4.31E-03	4	1.01E-03	24%	Pass
67	0.263	16	4.06E-03	4	1.01E-03	25%	Pass
68	0.266	15	3.80E-03	4	1.01E-03	27%	Pass
69	0.270	15	3.80E-03	4	1.01E-03	27%	Pass
70	0.274	14	3.55E-03	4	1.01E-03	29%	Pass
71	0.277	14	3.55E-03	4	1.01E-03	29%	Pass
72	0.281	14	3.55E-03	4	1.01E-03	29%	Pass
73	0.284	12	3.04E-03	4	1.01E-03	33%	Pass
74	0.288	12	3.04E-03	4	1.01E-03	33%	Pass
75	0.292	12	3.04E-03	4	1.01E-03	33%	Pass
76	0.295	10	2.53E-03	4	1.01E-03	40%	Pass
77	0.299	10	2.53E-03	4	1.01E-03	40%	Pass
78	0.303	9	2.28E-03	4	1.01E-03	44%	Pass
79	0.306	9	2.28E-03	4	1.01E-03	44%	Pass
80	0.310	9	2.28E-03	4	1.01E-03	44%	Pass
81	0.314	9	2.28E-03	4	1.01E-03	44%	Pass

Interval	Existing Condition			Detention Optimized			Pass or Fail?
	Q (cfs)	Hours > Q	% time	Hours>Q	% time	Post/Pre	
82	0.317	8	2.03E-03	4	1.01E-03	50%	Pass
83	0.321	8	2.03E-03	4	1.01E-03	50%	Pass
84	0.324	8	2.03E-03	4	1.01E-03	50%	Pass
85	0.328	8	2.03E-03	4	1.01E-03	50%	Pass
86	0.332	8	2.03E-03	4	1.01E-03	50%	Pass
87	0.335	8	2.03E-03	4	1.01E-03	50%	Pass
88	0.339	8	2.03E-03	4	1.01E-03	50%	Pass
89	0.343	5	1.27E-03	4	1.01E-03	80%	Pass
90	0.346	5	1.27E-03	4	1.01E-03	80%	Pass
91	0.350	5	1.27E-03	4	1.01E-03	80%	Pass
92	0.354	5	1.27E-03	4	1.01E-03	80%	Pass
93	0.357	5	1.27E-03	4	1.01E-03	80%	Pass
94	0.361	5	1.27E-03	4	1.01E-03	80%	Pass
95	0.364	5	1.27E-03	4	1.01E-03	80%	Pass
96	0.368	5	1.27E-03	4	1.01E-03	80%	Pass
97	0.372	5	1.27E-03	4	1.01E-03	80%	Pass
98	0.375	5	1.27E-03	4	1.01E-03	80%	Pass
99	0.379	5	1.27E-03	4	1.01E-03	80%	Pass
100	0.383	4	1.01E-03	4	1.01E-03	100%	Pass

Peak Flows calculated with Cunnane Plotting Position

Return Period (years)	Pre-dev. Q (cfs)	Post-Dev. Q (cfs)	Reduction (cfs)
10	0.383	0.137	0.246
9	0.363	0.072	0.291
8	0.341	0.020	0.321
7	0.339	0.020	0.319
6	0.339	0.020	0.319
5	0.309	0.020	0.289
4	0.294	0.020	0.274
3	0.270	0.020	0.250
2	0.225	0.020	0.205

ATTACHMENT 3

List of the “n” Largest Peaks: Pre & Post-Developed Conditions

Basic Probabilistic Equation:

R = 1/P R: Return period (years).

P: Probability of a flow to be equaled or exceeded any given year (dimensionless).

Cunnane Equation:

$$P = \frac{i-0.4}{n+0.2}$$

Weibull Equation:

$$P = \frac{i}{n+1}$$

i: Position of the peak whose probability is desired (sorted from large to small)

n: number of years analyzed.

Explanation of Variables for the Tables in this Attachment

Peak: Refers to the peak flow at the date given, taken from the continuous simulation hourly results of the n year analyzed.

Posit: If all peaks are sorted from large to small, the position of the peak in a sorting analysis is included under the variable Posit.

Date: Date of the occurrence of the peak at the outlet from the continuous simulation

Note: all peaks are not annual maxima; instead they are defined as event maxima, with a threshold to separate peaks of at least 12 hours. In other words, any peak P in a time series is defined as a value where dP/dt = 0, and the peak is the largest value in 25 hours (12 hours before, the hour of occurrence and 12 hours after the occurrence, so it is in essence a daily peak).

List of Peak events and Determination of P2 and P10 (Pre-Development)
Pico Place POC 1 - San Marcos

T (Year)	Cunnane (cfs)	Weibull (cfs)	Peaks (cfs)	Date	Posit	Period of Return (Years) Weibull	Period of Return (Years) Cunnane
10	**0.38**	**0.39**					
9	**0.36**	**0.38**	0.155	12/6/1966	45	1.02	1.01
8	**0.34**	**0.35**	0.157	2/15/1992	44	1.05	1.04
7	**0.34**	**0.34**	0.157	2/8/1993	43	1.07	1.06
6	**0.34**	**0.34**	0.158	4/14/2003	42	1.10	1.09
5	**0.31**	**0.31**	0.163	4/1/1982	41	1.12	1.11
4	**0.29**	**0.29**	0.163	1/9/1998	40	1.15	1.14
3	**0.27**	**0.27**	0.174	12/5/1966	39	1.18	1.17
2	**0.23**	**0.23**	0.179	11/29/1982	38	1.21	1.20
			0.182	2/21/2005	37	1.24	1.23
			0.191	2/21/2000	36	1.28	1.27
			0.198	3/8/1974	35	1.31	1.31
			0.198	1/18/1993	34	1.35	1.35
			0.199	2/17/1998	33	1.39	1.39
			0.2	1/4/1995	32	1.44	1.43
			0.201	2/6/1976	31	1.48	1.48
			0.201	9/10/1976	30	1.53	1.53
			0.201	2/16/1980	29	1.59	1.58
			0.204	4/21/1988	28	1.64	1.64
			0.205	11/16/1972	27	1.70	1.70
			0.209	11/23/1965	26	1.77	1.77
			0.224	2/27/2001	25	1.84	1.84
			0.224	2/12/2003	24	1.92	1.92
			0.225	3/17/1963	23	2.00	2.00
			0.24	1/29/1980	22	2.09	2.09
			0.24	4/18/1995	21	2.19	2.19
			0.246	1/6/1979	20	2.30	2.31
			0.253	3/1/1983	19	2.42	2.43
			0.257	1/9/2005	18	2.56	2.57
			0.26	2/8/1983	17	2.71	2.72
			0.266	11/30/1982	16	2.88	2.90
			0.273	1/7/1974	15	3.07	3.10
			0.282	2/28/1970	14	3.29	3.32
			0.284	11/12/1976	13	3.54	3.59
			0.294	12/18/1978	12	3.83	3.90
			0.294	12/29/1978	11	4.18	4.26
			0.302	2/14/1998	10	4.60	4.71
			0.315	11/5/1987	9	5.11	5.26
			0.339	2/3/1998	8	5.75	5.95
			0.339	2/8/1998	7	6.57	6.85
			0.341	12/29/2004	6	7.67	8.07
			0.382	3/17/1982	5	9.20	9.83
			0.392	1/10/1978	4	11.50	12.56
			0.413	1/25/1995	3	15.33	17.38
			0.423	3/24/1983	2	23.00	28.25
			0.472	2/21/1980	1	46.00	75.33

Note:
Cunnane is the preferred method by the HMP permit.

List of Peak events and Determination of P2 and P10 (Post-Development)
Cranston POC 1 - Escondido

T (Year)	Cunnane (cfs)	Weibull (cfs)	Peaks (cfs)	Date	Posit	Period of Return (Years) Weibull	Period of Return (Years) Cunnane
10	**0.14**	**0.22**					
9	**0.07**	**0.11**	0.02	2/9/1963	45	1.02	1.01
8	**0.02**	**0.04**	0.02	2/9/1963	44	1.05	1.04
7	**0.02**	**0.02**	0.02	2/9/1963	43	1.07	1.06
6	**0.02**	**0.02**	0.02	2/9/1963	42	1.10	1.09
5	**0.02**	**0.02**	0.02	2/10/1963	41	1.12	1.11
4	**0.02**	**0.02**	0.02	2/10/1963	40	1.15	1.14
3	**0.02**	**0.02**	0.02	2/10/1963	39	1.18	1.17
2	**0.02**	**0.02**	0.02	2/10/1963	38	1.21	1.20
			0.02	2/10/1963	37	1.24	1.23
			0.02	2/10/1963	36	1.28	1.27
			0.02	2/10/1963	35	1.31	1.31
			0.02	2/10/1963	34	1.35	1.35
			0.02	2/11/1963	33	1.39	1.39
			0.02	2/11/1963	32	1.44	1.43
			0.02	2/11/1963	31	1.48	1.48
			0.02	2/11/1963	30	1.53	1.53
			0.02	2/11/1963	29	1.59	1.58
			0.02	2/11/1963	28	1.64	1.64
			0.02	3/17/1963	27	1.70	1.70
			0.02	3/17/1963	26	1.77	1.77
			0.02	3/17/1963	25	1.84	1.84
			0.02	3/17/1963	24	1.92	1.92
			0.02	3/17/1963	23	2.00	2.00
			0.02	11/21/1963	22	2.09	2.09
			0.02	11/21/1963	21	2.19	2.19
			0.02	11/16/1965	20	2.30	2.31
			0.02	11/16/1965	19	2.42	2.43
			0.02	11/16/1965	18	2.56	2.57
			0.02	11/16/1965	17	2.71	2.72
			0.02	11/17/1965	16	2.88	2.90
			0.02	11/17/1965	15	3.07	3.10
			0.02	11/23/1965	14	3.29	3.32
			0.02	12/9/1965	13	3.54	3.59
			0.02	12/9/1965	12	3.83	3.90
			0.02	12/9/1965	11	4.18	4.26
			0.02	12/9/1965	10	4.60	4.71
			0.02	12/9/1965	9	5.11	5.26
			0.02	12/9/1965	8	5.75	5.95
			0.02	12/9/1965	7	6.57	6.85
			0.02	12/9/1965	6	7.67	8.07
			0.118	1/6/1979	5	9.20	9.83
			0.415	12/5/1966	4	11.50	12.56
			1.164	12/18/1978	3	15.33	17.38
			1.185	1/15/1978	2	23.00	28.25
			1.92	11/23/1965	1	46.00	75.33

Note:
Cunnane is the preferred method by the HMP permit.

ATTACHMENT 4

AREA VS ELEVATION

The storage provided by the detention vault is entered into the Storage Module within SWMM – please refer to Attachment 7 for further information. It should be noted that all facilities are walled; as such the stage-area relationship is a constant. A stage-storage calculation is provided on the following page for verification.

DISCHARGE VS ELEVATION

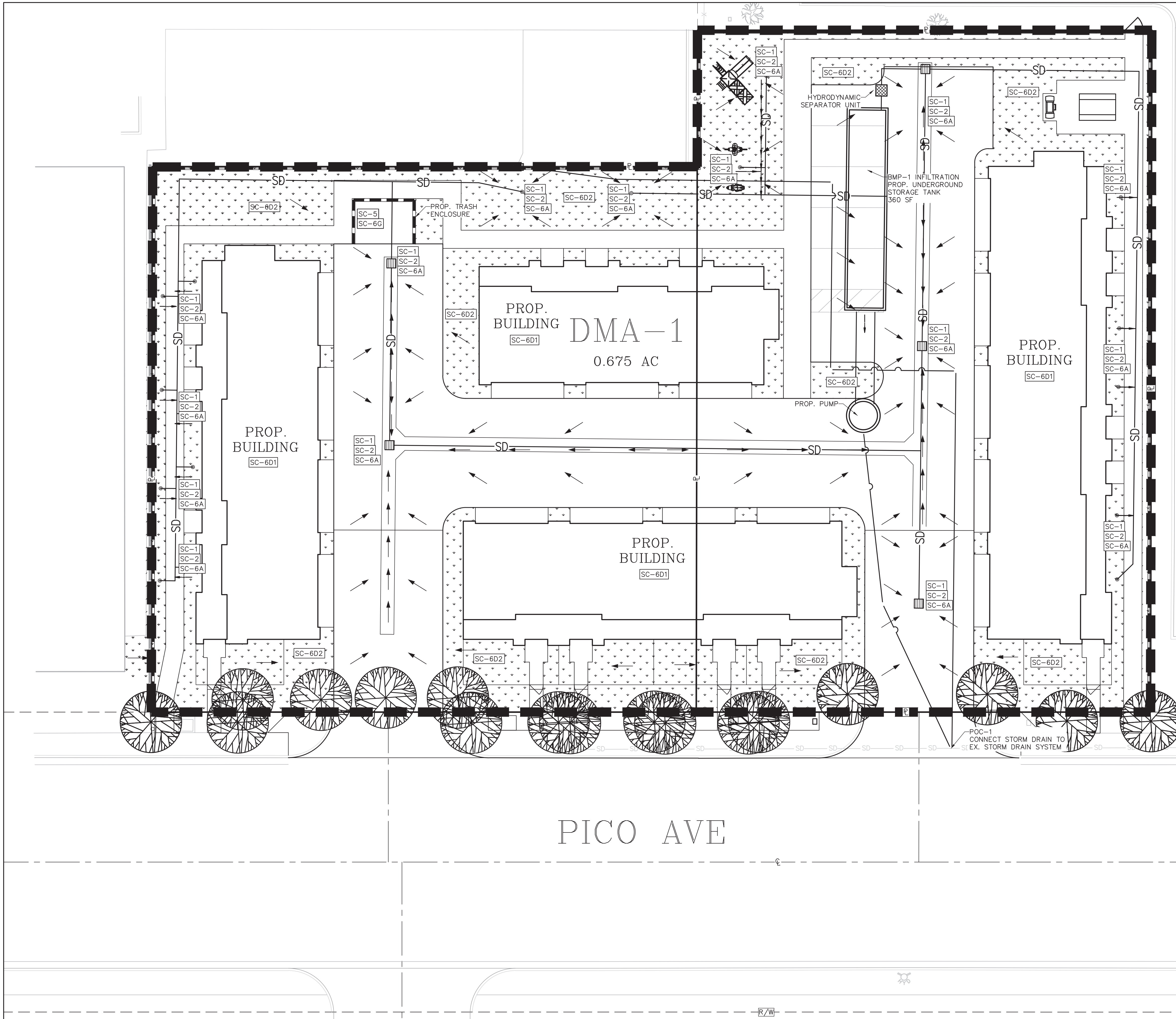
Due to elevation constraints on the project site, the outlets from the vault are pumps – as such a constant flow out from the vault is experienced when the volume within the basin exceeds the invert elevation of the pump outlet invert.

Stage-Storage-Discharge Summary Table

Depth (ft)	Area (ft2)	Volume (ft3)	Ac-Ft	Q-out (cfs)
0	360	0	0	0
1	360	360	0.008264	0
2	360	720	0.016529	0
3	360	1080	0.024793	0
3.2	360	1152	0.026446	0.02
4	360	1440	0.033058	0.02
5	360	1800	0.041322	0.02
6	360	2160	0.049587	0.02
7	360	2520	0.057851	0.02
7.25	360	2610	0.059917	1.902
8	360	2880	0.066116	1.902
9	360	3240	0.07438	1.902

ATTACHMENT 5

Pre & Post-Developed Maps, Project Plan and Detention Section Sketches



LEGEND

DESCRIPTION	SYMBOL
PROPERTY LINE	
RIGHT-OF-WAY LINE	
DMA BOUNDARY	
SURFACE FLOW	
PROP. STORM DRAIN PIPE	
EX. STORM DRAIN PIPE	SD
PERVIOUS AREA	
IMPERVIOUS AREA	
PROP. CATCH BASIN	
PROP. AREA DRAIN	

DMA TYPE: DRAINS TO BMP
HYDROLOGIC SOIL GROUP: C
DEPTH TO GROUNDWATER: > 20 FT
NATURAL HYDROLOGIC FEATURES: NONE
CRITICAL COARSE SEDIMENT YIELD AREAS: NONE
IMPERVIOUS DMA AREA: 21,975 SF
PERVIOUS DMA AREA: 7,407 SF

SOURCE CONTROL BMPS

SC-1	PREVENTION OF ILLICIT DISCHARGES INTO THE MS4
SC-2	STORM DRAIN STENCILING OR SIGNAGE
SC-5	PROTECT TRASH STORAGE AREAS FROM RAINFALL, RUN-ON, RUNOFF, AND WIND DISPERSAL
SC-6A	ON-SITE STORM DRAIN INLETS
SC-6D1	NEED FOR FUTURE INDOOR & STRUCTURAL PEST CONTROL
SC-6D2	LANDSCAPE/OUTDOOR PESTICIDE USE
SC-6G	REFUSE AREAS

10 5 0 10 20 30
SCALE: 1" = 10'

REVISIONS

NO.	DESCRIPTION	DATE	APP'D

REC Consultants, Inc.
Civil Engineering•Environmental
Land Surveying
2970 Fifth Avenue, Unit 340
San Diego, CA 92103
(619)232-9200 (619)232-9210 Fax

DATE: 10/10/2022
SCALE: 1" = 10'
DRAWN: E.R.F.
CHECKED: D.E.

SHEET TITLE
DMA/BMP PLAN - PROPOSED

PROJECT
PICO PLACE
236-244 SAN MARCOS PICO AVENUE
SAN MARCOS, CA 92069

SHEET 1
OF 1 SHEETS

ATTACHMENT 6

SWMM Input Data in Input Format (Existing & Proposed Models)

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           10/05/1962
START_TIME           00:00:00
REPORT_START_DATE    10/05/1962
REPORT_START_TIME    00:00:00
END_DATE             10/05/2007
END_TIME             23:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      0.07   0.1    0.13   0.17   0.19   0.22   0.24   0.22   0.19   0.13   0.09   0.06
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
Poway            INTENSITY 1:00   1.0    TIMESERIES Poway

[SUBCATCHMENTS]
;;                                                Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
DMA-1-C          Poway            POC-1            0.675    0        114      1        0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-1-C          0.012      0.05       0.05       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
DMA-1-C          6          0.075      0.32

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-1            0          FREE                        NO

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
Poway            FILE "PowayRain.prn"

[REPORT]
INPUT      NO
```

```
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2332.031 5700.000 3253.906 12300.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            -1889.283          9043.612

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-1-C          -2819.679          11253.304

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
Poway            3324.814           11388.987
```

POST_DEV

```
[TITLE]

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         KINWAVE
START_DATE           10/05/1962
START_TIME           00:00:00
REPORT_START_DATE    10/05/1962
REPORT_START_TIME    00:00:00
END_DATE             10/05/2007
END_TIME             23:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          01:00:00
WET_STEP             00:15:00
DRY_STEP             04:00:00
ROUTING_STEP         0:01:00
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
MONTHLY      0.07   0.1    0.13   0.17   0.19   0.22   0.24   0.22   0.19   0.13   0.09   0.06
DRY_ONLY     NO

[RAINGAGES]
;;                Rain      Time   Snow   Data
;;Name            Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
Poway             INTENSITY 1:00   1.0    TIMESERIES Poway

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name            Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
DMA-1-C           Poway            1                0.675    74.79    114      1        0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
DMA-1-C           0.012      0.05       0.05       0.1        25         OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
DMA-1-C           6          0.075      0.32

[OUTFALLS]
;;                Invert     Outfall    Stage/Table      Tide
;;Name            Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
POC-1             0          FREE                        NO

[STORAGE]
;;                Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name            Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration
Parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------
------
1                 0        9        0        TABULAR    Vault                      360      0        6        1.5
0.32
```

POST_DEV

```
[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet          Qcoeff/                     Flap
;;Name           Node             Node             Height     Type            QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- --------------- ---------------- ---------- ----
1                1                POC-1            0          TABULAR/DEPTH   Out                         NO

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
Out              Rating     0          0
Out                         0.49       0
Out                         0.5        0
Out                         1          0
Out                         2          0
Out                         3          0
Out                         3.19       0.0001
Out                         3.2        0.02
Out                         4          0.02
Out                         5          0.02
Out                         6          0.02
Out                         7          0.02
Out                         7.24       0.02
Out                         7.25       1.920
Out                         8          1.922
Out                         9          1.923

Vault            Storage    0          360
Vault                       9          360

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
Poway            FILE "PowayRain.prn"

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2332.031 5700.000 3253.906 12300.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
POC-1            -1889.283          9043.612
1                -2383.226          10232.685

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[Polygons]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------
DMA-1-C          -2819.679          11253.304

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
Poway            22.077             10601.554
```

ATTACHMENT 7

EPA SWMM FIGURES AND EXPLANATIONS

Per the attached, the reader can see the screens associated with the EPA-SWMM Model in both pre-development and post-development conditions. Each portion, i.e., sub-catchments, outfalls, storage units, weir as a discharge, and outfalls (point of compliance), are also shown.

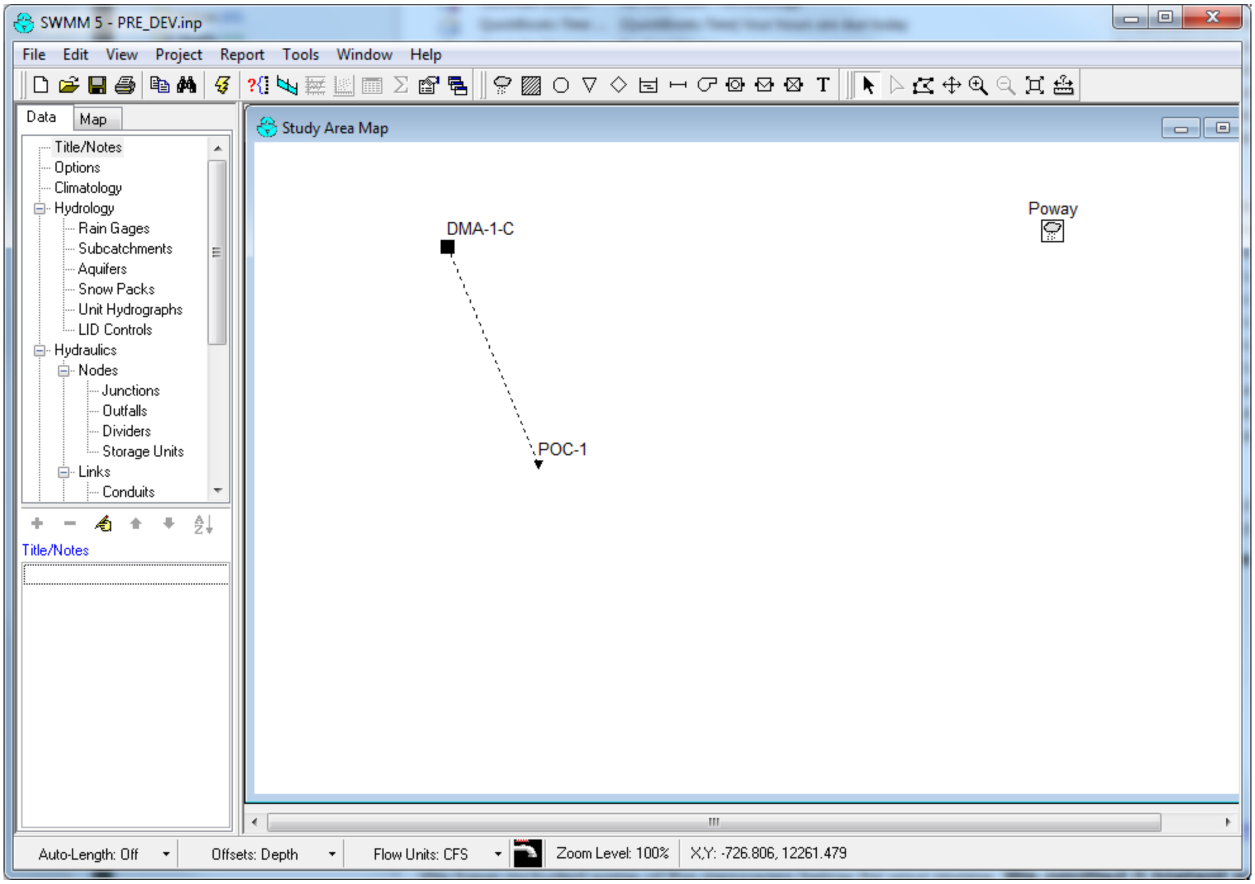
Variables for modeling are associated with typical recommended values by the EPA-SWMM model, typical values found in technical literature (such as Maidment's Handbook of Hydrology). Recommended values for the SWMM model have been attained from Appendix G of the 2016 City of San Marcos BMP Design Manual.

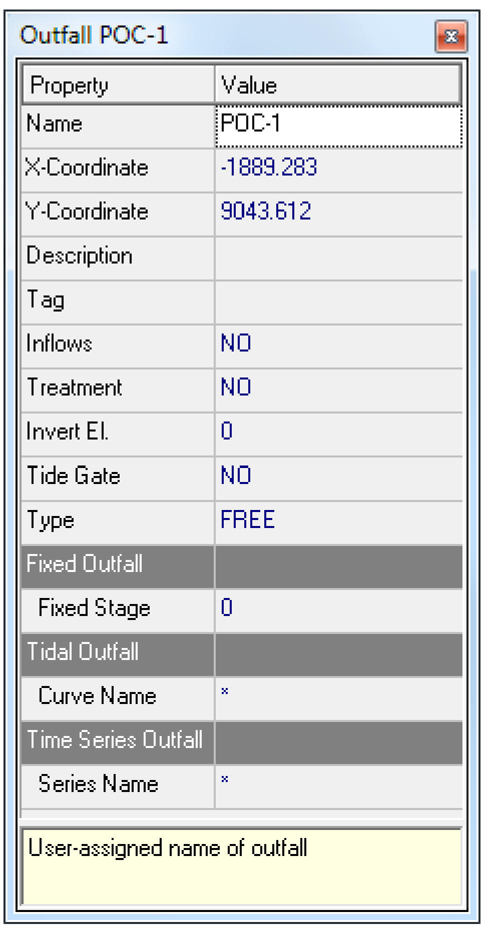
Soil characteristics of the existing soils were determined from the NRCS Web Soil Survey and site specific geotechnical report (located in Attachment 8 of this report).

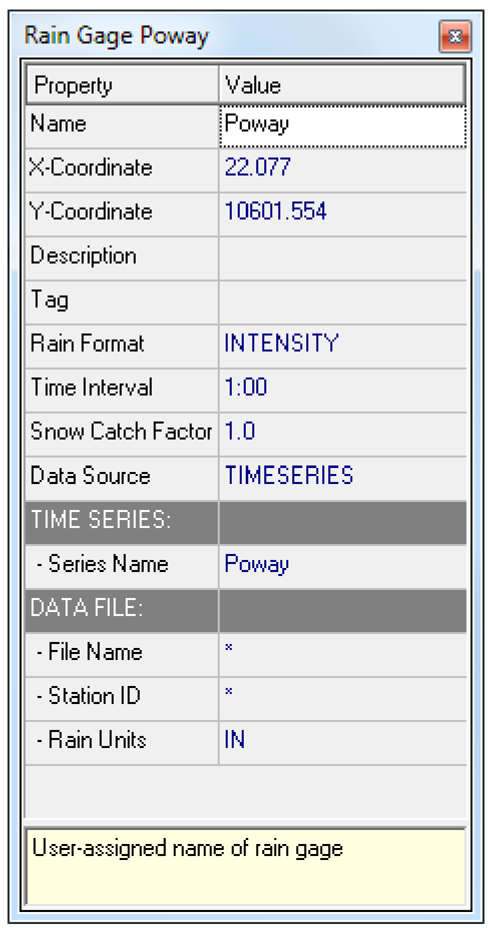
A Technical document prepared by Tory R Walker Engineering for the Cities of San Marcos, Oceanside and Vista (Reference [1]) can also be consulted for additional information regarding typical values for SWMM parameters.

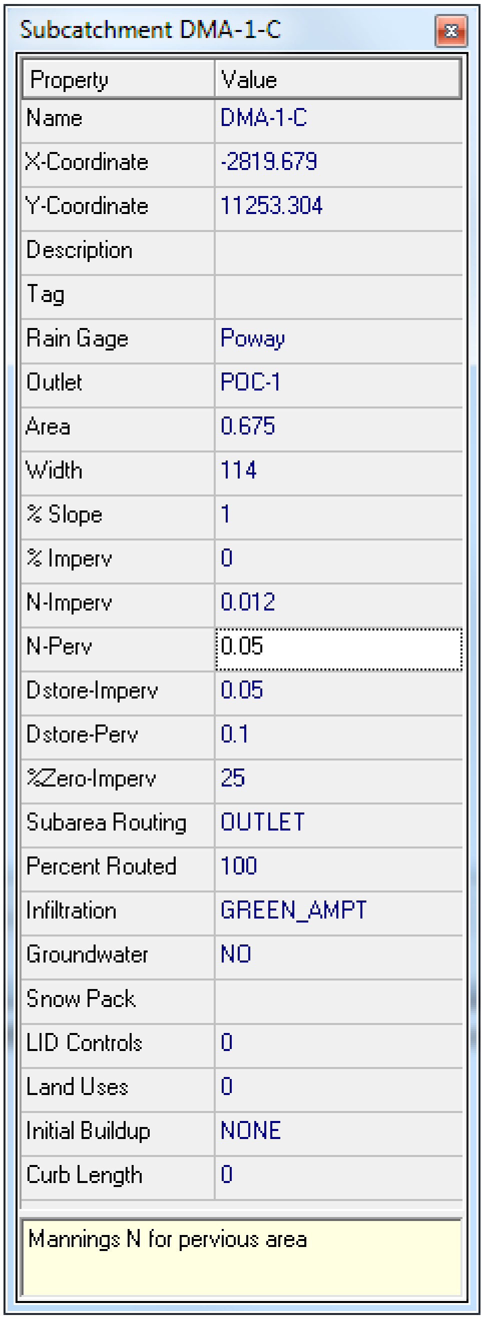
Manning's roughness coefficients have been based upon the findings of the "*Improving Accuracy in Continuous Hydrologic Modeling: Guidance for Selecting Pervious Overland Flow Manning's n Values in the San Diego Region*" date 2016 by TRW Engineering (Reference [6]).

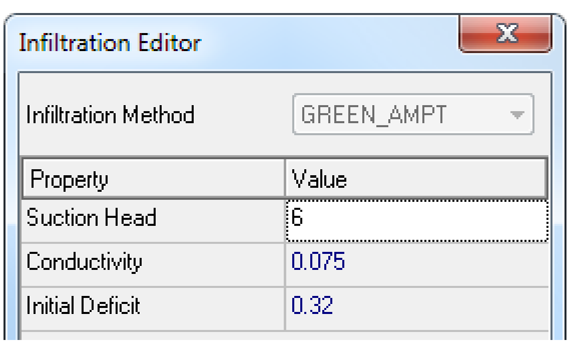
PRE-DEVELOPED CONDITION



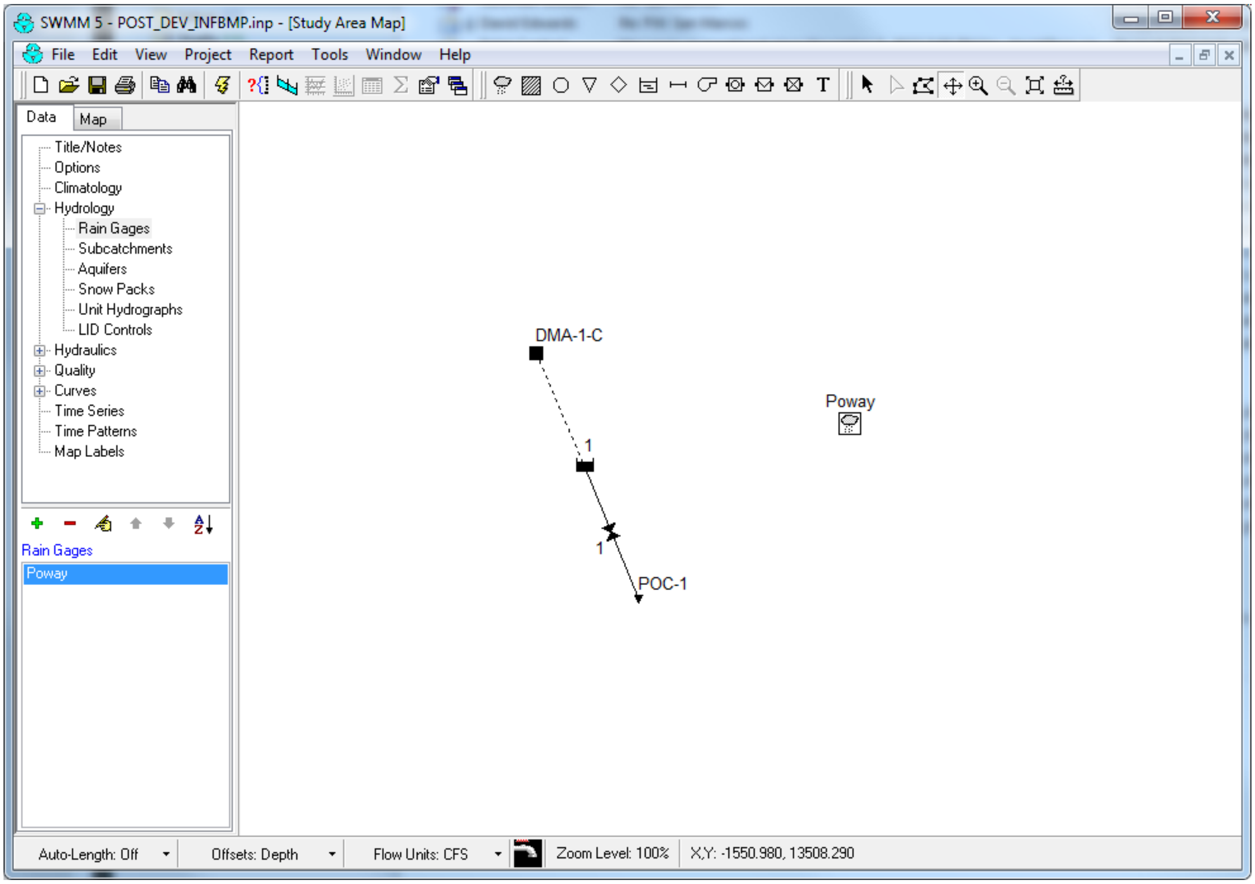


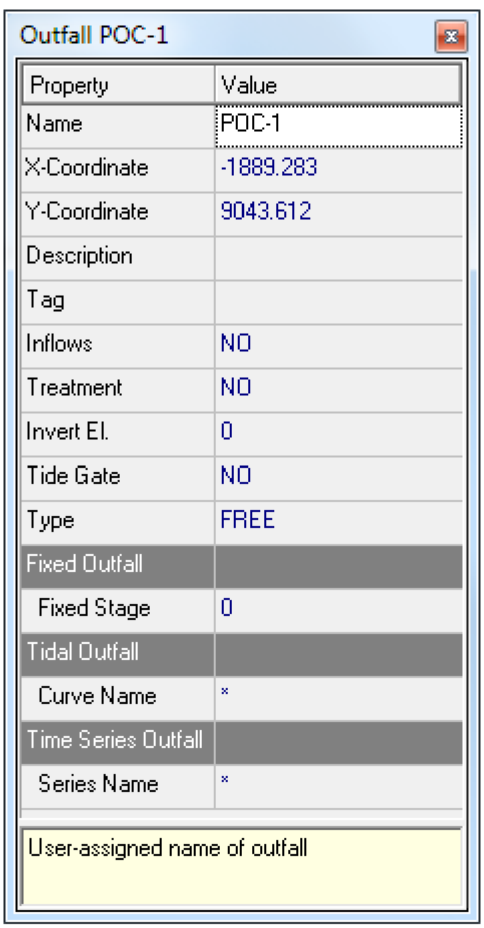



Subcatchment DMA-1-C
Property
Value
Name
DMA-1-C
X-Coordinate
-2819.679
Y-Coordinate
11253.304
Description
Tag
Rain Gage
Poway
Outlet
POC-1
Area
0.675
Width
114
% Slope
1
% Imperv
0
N-Imperv
0.012
N-Perv
0.05
Dstore-Imperv
0.05
Dstore-Perv
0.1
%Zero-Imperv
25
Subarea Routing
OUTLET
Percent Routed
100
Infiltration
GREEN_AMPT
Groundwater
NO
Snow Pack
LID Controls
0
Land Uses
0
Initial Buildup
NONE
Curb Length
0
Mannings N for pervious area


Infiltration Editor
Infiltration Method
GREEN_AMPT
Property
Value
Suction Head
6
Conductivity
0.075
Initial Deficit
0.32

POST-DEVELOPED CONDITION

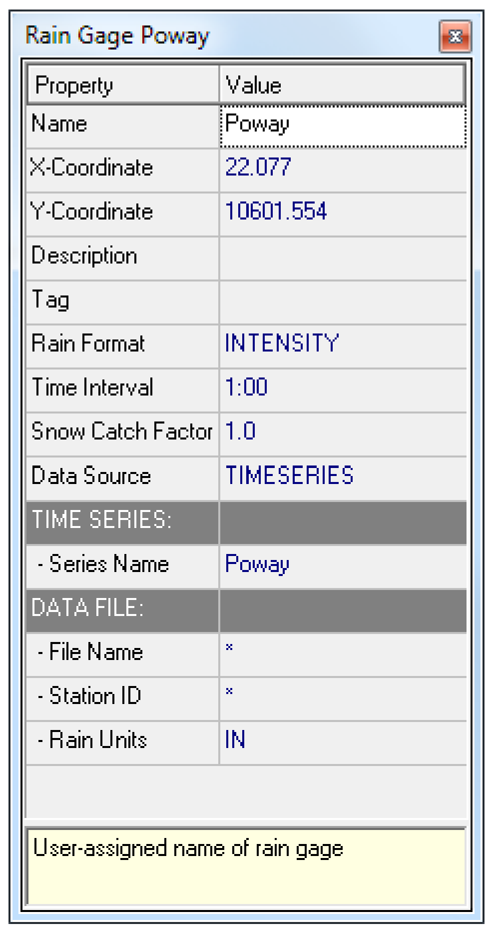




Outfall POC-1

Property	Value
Name	POC-1
X-Coordinate	-1889.283
Y-Coordinate	9043.612
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Tide Gate	NO
Type	FREE
Fixed Outfall	
Fixed Stage	0
Tidal Outfall	
Curve Name	*
Time Series Outfall	
Series Name	*

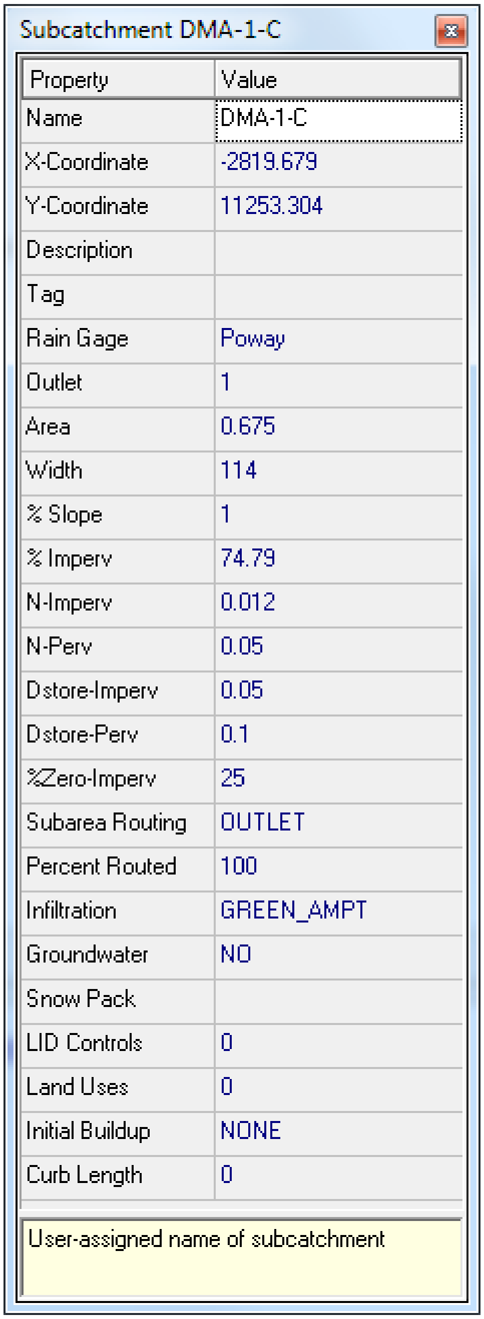
User-assigned name of outfall

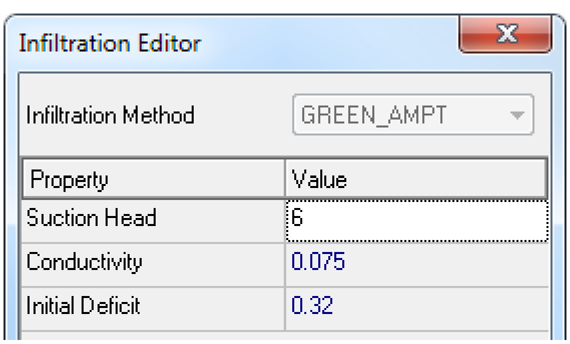


Rain Gage Poway

Property	Value
Name	Poway
X-Coordinate	22.077
Y-Coordinate	10601.554
Description	
Tag	
Rain Format	INTENSITY
Time Interval	1:00
Snow Catch Factor	1.0
Data Source	TIMESERIES
TIME SERIES:	
- Series Name	Poway
DATA FILE:	
- File Name	*
- Station ID	*
- Rain Units	IN

User-assigned name of rain gage


Subcatchment DMA-1-C
Property | Value
Name | DMA-1-C
X-Coordinate | -2819.679
Y-Coordinate | 11253.304
Description
Tag
Rain Gage | Poway
Outlet | 1
Area | 0.675
Width | 114
% Slope | 1
% Imperv | 74.79
N-Imperv | 0.012
N-Perv | 0.05
Dstore-Imperv | 0.05
Dstore-Perv | 0.1
%Zero-Imperv | 25
Subarea Routing | OUTLET
Percent Routed | 100
Infiltration | GREEN_AMPT
Groundwater | NO
Snow Pack
LID Controls | 0
Land Uses | 0
Initial Buildup | NONE
Curb Length | 0
User-assigned name of subcatchment


Infiltration Editor
Infiltration Method | GREEN_AMPT
Property | Value
Suction Head | 6
Conductivity | 0.075
Initial Deficit | 0.32

Detention Basin

Storage Unit 1

Property	Value
Name	1
X-Coordinate	-2383.226
Y-Coordinate	10232.685
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Max. Depth	9
Initial Depth	0
Ponded Area	360
Evap. Factor	0
Infiltration	YES
Storage Curve	TABULAR
Functional Curve	
Coefficient	1000
Exponent	0
Constant	0
Tabular Curve	
Curve Name	Vault

Outlet 1

Property	Value
Name	1
Inlet Node	1
Outlet Node	POC-1
Description	
Tag	
Inlet Offset	0
Flap Gate	NO
Rating Curve	TABULAR/DEPTH
Functional Curve	
Coefficient	10.0
Exponent	0.5
Tabular Curve	
Curve Name	Out

User-assigned name of outlet

Storage Curve Editor

Curve Name: Vault

Description:

	Depth (ft)	Area (ft2)
1	0	360
2	9	360
3		
4		
5		
6		
7		
8		
9		

View... Load... Save... OK Cancel Help

Rating Curve Editor

Curve Name: Out

Description:

	Head (ft)	Outflow (CFS)
1	0	0
2	0.49	0
3	0.5	0
4	1	0
5	2	0
6	3	0
7	3.19	0.0001
8	3.2	0.02
9	4	0.02

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EXPLANATION OF SELECTED VARIABLES

Sub Catchment Areas:

Please refer to the attached diagrams that indicate the DMA and detention BMPs (BMP) sub areas modeled within the project site at both the pre and post developed conditions draining to the POC.

Parameters for the pre- and post-developed models include soil type C as determined from the NRCS websoil survey review (attached at the end of this appendix). Suction head, conductivity and initial deficit corresponds to average values expected for these soils types, according to Appendix G of the 2016 City of San Marcos BMP Design Manual.

For surface runoff infiltration values, REC selected infiltration values per Appendix G of the 2016 City of San Marcos BMP Design Manual corresponding to hydrologic soil type.

Selection of a Kinematic Approach: As the continuous model is based on hourly rainfall, and the time of concentration for the pre-development and post-development conditions is significantly smaller than 60 minutes, precise routing of the flows through the impervious surfaces, the underdrain pipe system, and the discharge pipe was considered unnecessary. The truncation error of the precipitation into hourly steps is much more significant than the precise routing in a system where the time of concentration is much smaller than 1 hour.

Overland Flow Manning’s Coefficient per TRWE (Reference [6])

appeal of a de facto value, we anticipate that jurisdictions will not be inclined to approve land surfaces other than short prairie grass. Therefore, in order to provide SWMM users with a wider range of land surfaces suitable for local application and to provide Copermittees with confidence in the design parameters, we recommend using the values published by Yen and Chow in Table 3-5 of the EPA SWMM Reference Manual Volume I – Hydrology.

SWMM-Endorsed Values Will Improve Model Quality

In January 2016, the EPA released the SWMM Reference Manual Volume I – Hydrology (SWMM Hydrology Reference Manual). The SWMM Hydrology Reference Manual complements the SWMM 5 User's Manual and SWMM 5 Applications Manual by providing an in-depth description of the program's hydrologic components (EPA 2016). Table 3-5 of the SWMM Hydrology Reference Manual expounds upon SWMM 5 User's Manual Table A.6 by providing Manning's *n* values for additional overland flow surfaces[3]. The values are provided in Table 1:

Table 1: Manning's *n* Values for Overland Flow (EPA, 2016; Yen 2001; Yen and Chow, 1983).

Overland Surface	Light Rain (< 0.8 in/hr)	Moderate Rain (0.8-1.2 in/hr)	Heavy Rain (> 1.2 in/hr)
Smooth asphalt pavement	0.010	0.012	0.015
Smooth impervious surface	0.011	0.013	0.015
Tar and sand pavement	0.012	0.014	0.016
Concrete pavement	0.014	0.017	0.020
Rough impervious surface	0.015	0.019	0.023
Smooth bare packed soil	0.017	0.021	0.025
Moderate bare packed soil	0.025	0.030	0.035
Rough bare packed soil	0.032	0.038	0.045
Gravel soil	0.025	0.032	0.045
Mowed poor grass	0.030	0.038	0.045
Average grass, closely clipped sod	0.040	0.050	0.060
Pasture	0.040	0.055	0.070
Timberland	0.060	0.090	0.120
Dense grass	0.060	0.090	0.120
Shrubs and bushes	0.080	0.120	0.180
Land Use			
Business	0.014	0.022	0.035
Semibusiness	0.022	0.035	0.050
Industrial	0.020	0.035	0.050
Dense residential	0.025	0.040	0.060
Suburban residential	0.030	0.055	0.080
Parks and lawns	0.040	0.075	0.120

For purposes of local hydromodification management BMP design, these Manning's *n* values are an improvement upon the values presented by Engman (1986) in SWMM 5 User's Manual Table A.6. Values from SWMM 5 User's Manual Table A.6, while completely suitable for the intended application to certain agricultural land covers, comes with the disclaimer that the provided Manning's *n* values are valid for shallow-depth overland flow that match the conditions in the experimental plots (Engman,

[3] Further discussion is provided on page 6 under "Discussion of Differences Between Manning's *n* Values"

ATTACHMENT 8

Geotechnical Documentation

GLOBAL GEO-ENGINEERING, INC.

August 31, 2022
Project 9421-04

DMS Consultants, Inc.
12377 Lewis Street, Suite 203
Garden Grove, California 92840

Attention: Mr. Surender Dewan, P. E.
President

Subject: Geotechnical Investigation
Proposed Multi-Family Residential Development
236 and 244 Pico Avenue
San Marcos, California

References: *See Appendix A*

Dear Mr. Dewan:

1. INTRODUCTION

a) In accordance with your request, we have conducted a geotechnical investigation for the proposed residential development located in San Marcos, California.

b) We understand that the proposed development will consist of the construction of four 3-story, multi-family residential structures, each unit approximately 1,170-squarefoot, with related parking/driveway areas on a 0.67-acre parcel of land. In addition, an infiltration system is planned to be installed for potential stormwater runoff.

c) Grading and structural plans are not available at present. We are assuming that the existing grades will remain unchanged. We anticipate the loads from the proposed structures will not exceed 3 kip/ft for the continuous footings and 50 kips for the column footings.

2. SCOPE

The scope of services we provided were as follows:

a) Preliminary planning and evaluations, and review of geotechnical reports related to the project site and nearby surrounding area *(See References – Appendix A)*;

3 Corporate Park, Suite 270, Irvine, California 92606
Office (949) 221-0900 Fax (949) 221-0091
Email: global@globalgeo.net

b) Excavation of three (3) borings utilizing a hollow stem auger drill rig to a maximum depth of 40 feet below ground surface. One of the borings was drilled to a depth of 5 feet below ground surface for the purpose of percolation testing;

c) Sampling and logging of subsurface materials encountered in the borings;

d) Field percolation testing to determine the infiltrations rate;

e) Laboratory testing of samples representative of those obtained in the field, in order to evaluate relevant engineering properties;

f) Engineering and geologic analyses of the field and laboratory data;

g) Preparation of a report presenting our findings, conclusions and recommendations.

3. FIELD EXPLORATION AND LABORATORY TESTING

The field exploration program is given in *Appendix B*, which includes the Logs of Borings. The results of the laboratory testing are included in *Appendix C.*

4. SITE DESCRIPTION

4.1 Location

a) The project site is located along the southwest side of Pico Avenue, approximately 280 feet northwest of San Marcos Boulevard, in the city of San Marcos, California.

b) The approximate site location is shown on the *Location Map, Figure 1.*

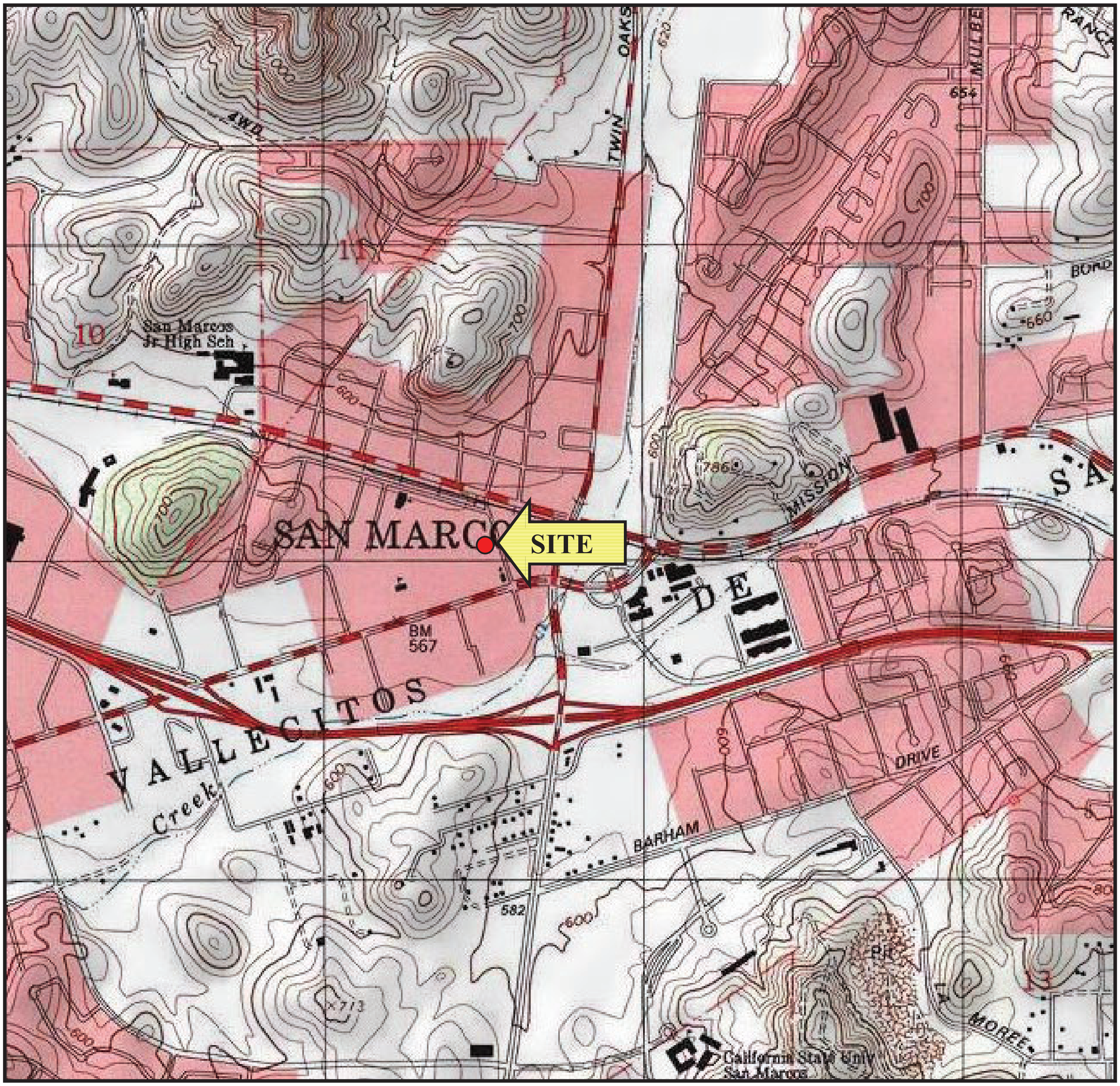
4.2 Existing Surface Conditions

a) The subject property is currently vacant and void of any building structures.

b) The ground surface throughout the project site is relatively level. The natural topography of the site area descends to the south at an approximate gradient of one percent.

c) Surface drainage consists of sheet flow runoff of incident rainfall water derived primarily within the property boundaries and adjacent properties.

LOCATION MAP



BASE MAP: USGS 7.5-Minute Topographic Map,
San Marcos Quadrangle, 1999

2000 0 2000 4000

SCALE FEET

NORTH

GLOBAL GEO-ENGINEERING, INC.

GEOLOGIC AND SOILS ENGINEERING IRVINE, CALIFORNIA

244 Pico Avenue
San Marcos, California

Date: August 2022

Project No.: 9421-04

Figure No: 1

4.3 Geology

4.3.1 Regional Geologic Setting

The subject property is located within the Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges consist of a series of mountain ranges separated by longitudinal valleys. The ranges trend northwest-southeast and are sub parallel to faults branching from the San Andreas Fault. The Peninsular Ranges extend from the southern side of the Santa Monica and San Gabriel Mountains into Baja California, Mexico (CDMG, 1997).

4.3.2 Local Geologic Setting

In general, the project site area is underlain by Recent- to Older-aged alluvial deposits which overlie granitic bedrock.

4.4 Subsurface Conditions

a) The subsurface conditions, as encountered in our explorations, are described in the following sections.

b) More detailed descriptions of the subsurface conditions are presented in our *Logs of Borings,* which are enclosed as *Figures B-2* through *B-4* in Appendix B. The locations of the borings are shown on our *Boring Location Plan, Figure B-5.*

4.4.1 Alluvium

a) Alluvial deposits were encountered in all of our borings excavated on-site.

b) The alluvium was found to generally consist of interlayers of Silty SAND, SAND and Sandy to Clayey SILT.

c) The Silty SAND and SAND sediments were generally found to be fine to coarse grained, slightly moist to very moist and medium dense.

d) The Sandy to Clayey SILT deposits were observed to be slightly moist to moist and stiff.

4.4.2 Bedrock

a) Bedrock, classified as Tonalite, was encountered at a depth of 37 feet below ground surface in Boring B-1.

b) The bedrock encountered in our boring was noted to be fine textured and hard.

4.4.3 Groundwater

a) Groundwater was encountered in our deeper boring (Boring B-1) at a depth of 24 feet below ground surface. The static water level was measured at a depth of 23.5 feet below ground surface approximately 30 minutes after termination of drilling.

b) No nearby groundwater wells were found to be listed during our review of the *California Department of Water Resources* internet website.

5. SEISMICITY

5.1 General

a) The property is located in the general proximity of several active and potentially active faults, which are typical for sites in the Southern California region. Earthquakes occurring on active faults within a 70-mile radius are capable of generating ground shaking of engineering significance to the proposed construction.

b) In Southern California, most of the seismic damage to manmade structures results from ground shaking and, to a lesser degree, from liquefaction and ground rupture caused by earthquakes along active fault zones. In general, the greater the magnitude of the earthquake, greater is the potential damage.

5.2 Ground Surface Rupture

a) The closest known active fault is the Elsinore Fault, located at a distance of about 16.3 miles northeast of the project site. Other nearby active or potentially active faults include the Rose Canyon Fault and the San Jacinto Fault located at distances of about 20.8 miles and 40.8 miles, respectively, from the subject property.

b) Due to the distance of the closest active fault to the site, ground rupture is not considered a significant hazard at the site.

5.3 Ground Shaking

a) We utilized the California Office of Statewide Health Planning and Development (OSHPD) Seismic Design Maps internet program to calculate the peak ground acceleration (PGA) at the project site location. Using the ASCE 7-16 standard and Site Class D, the PGA at the subject property resulted to be 0.47g.

b) *Figure 2* shows the geographical relationships among the site locations, nearby faults and the epicenters of significant occurrences. The project site is not located within any State of California delineated Earthquake Fault Zone; however, during historic times, a number of major earthquakes have occurred along the active faults in Southern California. From the seismic history of the region and proximity, the Elsinore Fault and Rose Canyon Fault have the greatest potential for causing earthquake damage related to ground shaking at this site.

5.4 Liquefaction

The subject site is underlain by dense soil layers overlying a Tonalite bedrock. The potential for the liquefaction is considered to be low.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 General

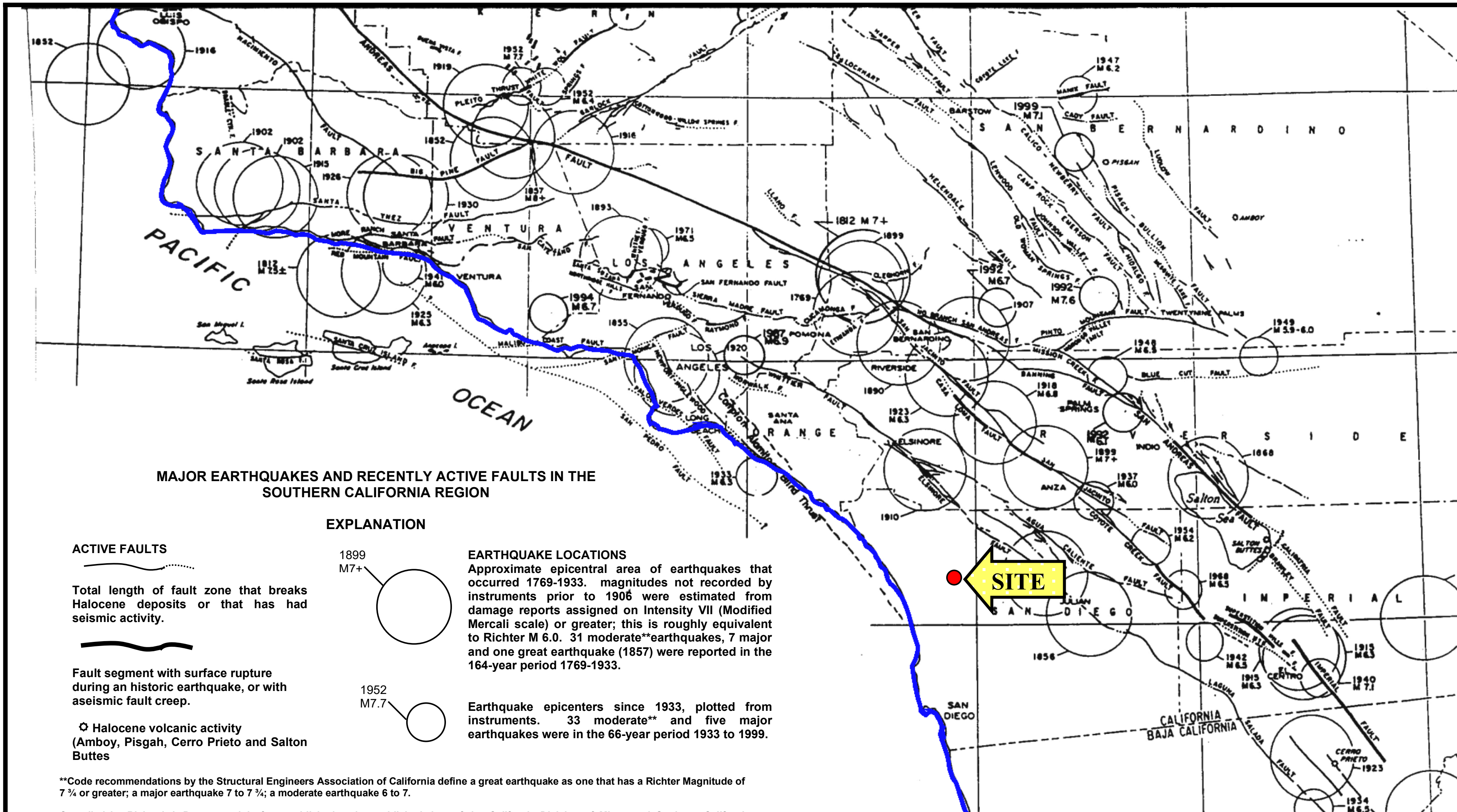
a) It is our opinion that the site will be suitable for the proposed development, from a geotechnical aspect, assuming that our recommendations are implemented.

b) We are of the opinion that the proposed structures can be supported on shallow spread footings founded in the existing competent soils.

c) We consider that the anticipated grading will not adversely affect, nor be adversely affected by adjoining property, with due precautions being taken.

d) The final grading plans and foundation plans/design loads should be reviewed by the Geotechnical Engineer.

e) The design recommendations in the report should be reviewed during the construction phase.



MAJOR EARTHQUAKES AND RECENTLY ACTIVE FAULTS IN THE SOUTHERN CALIFORNIA REGION

EXPLANATION

ACTIVE FAULTS

Total length of fault zone that breaks Halocene deposits or that has had seismic activity.

Fault segment with surface rupture during an historic earthquake, or with aseismic fault creep.

☼ Halocene volcanic activity (Amboy, Pisgah, Cerro Prieto and Salton Buttes

1899
M7+

1952
M7.7

EARTHQUAKE LOCATIONS

Approximate epicentral area of earthquakes that occurred 1769-1933. magnitudes not recorded by instruments prior to 1906 were estimated from damage reports assigned on Intensity VII (Modified Mercali scale) or greater; this is roughly equivalent to Richter M 6.0. 31 moderate**earthquakes, 7 major and one great earthquake (1857) were reported in the 164-year period 1769-1933.

Earthquake epicenters since 1933, plotted from instruments. 33 moderate** and five major earthquakes were in the 66-year period 1933 to 1999.

**Code recommendations by the Structural Engineers Association of California define a great earthquake as one that has a Richter Magnitude of 7 ¾ or greater; a major earthquake 7 to 7 ¾; a moderate earthquake 6 to 7.

Compiled by Richard J. Proctor mainly from published and unpublished data of the *California Division of Mines and Geology; California Department of Water Resources Bulletin 116-2* (1964); selections from bulletins of the *Geological* and *Seismological Societies of America*; from C.F. Richter, *Elementary Seismology* (1958); and the *National Atlas*, p. 66, and from Working Group on California Earthquake Probabilities- SSA Bulletin V 85.

GLOBAL GEO-ENGINEERING, INC. GEOLOGIC AND SOILS ENGINEERING IRVINE, CALIFORNIA	244 Pico Avenue San Marcos, California
Date: August 2022	**Figure No:** 2
Project No: 9421-04	

6.2 Grading

6.2.1 Processing of On-Site Soils

a) To provide uniform support conditions, the subgrade soils should be overexcavated to a depth of one foot below the foundation bottom and three feet below the slab-on-grade, subject to review during construction. The overexcavation should laterally extend for a distance of 5 feet.

b) There should be at least one foot of reworked soils or compacted fill below the pavements.

c) Wherever structural fills are to be placed, the upper 6 to 8 inches of the subgrade should, after stripping or overexcavation, first be scarified, reworked and wetted down thoroughly.

d) Any loosening of reworked or native material, consequent to the passage of construction traffic, weathering, etc., should be made good prior to further construction.

e) The depths of overexcavation should be reviewed by the Geotechnical Engineer during the actual construction. Any surface or subsurface obstructions, or questionable material encountered during grading should be brought immediately to the attention of the Geotechnical Engineer for proper exposure, removal or processing as directed. No underground obstructions or facilities should remain in any structural areas. Depressions and/or cavities created as a result of the removal of obstructions should be backfilled properly with suitable material, and compacted.

6.2.2 Material Selection

After the site has been stripped of any debris, vegetation and organic soils, excavated on-site soils are considered satisfactory for reuse in the construction of on-site fills, with the following provisions:

a) Significant water will be required to be added to the existing soils;

b) The organic content does not exceed 3 percent by volume;

c) Large size rocks greater than 8 inches in diameter should not be incorporated in compacted fill;

d) Rocks greater than 4 inches in diameter should not be incorporated in compacted fill to within one foot of the underside of the footings and slabs.

6.2.3 Compaction Requirements

a) Reworking/compaction shall include moisture-conditioning as needed to bring the soils to slightly above the optimum moisture content. All reworked soils and structural fills should be densified to achieve at least 90 percent relative compaction with reference to laboratory compaction standard. The optimum moisture content and maximum dry density should be determined in the laboratory in accordance with ASTM Test Designation D1557.

b) Fill should be compacted in lifts not exceeding 8 inches (loose).

6.2.4 Excavating Conditions

a) Excavation of on-site materials may be accomplished with standard earthmoving or trenching equipment. No hard rock was encountered which will require blasting.

b) Ground water was encountered at a depth of 24 feet below ground surface in our deeper boring. Dewatering is not anticipated in excavations shallower than 24 feet below ground surface.

6.2.5 Shrinkage

For preliminary earthwork calculation, an average shrinkage factor of approximately 5 percent is recommended for the soils (this does not include handling losses).

6.2.6 Expansion Potential

a) Based upon our visual observations, the expansion potential for the on-site soils is considered to be *medium*. The recommendations provided in the following sections will reduce the effects of the expansive subgrade soils.

b) Any imported material, or doubtful material exposed during grading, should be evaluated for its expansive properties.

c) In any event, the subgrade soils should be tested for their expansion potential or during the final stages of grading.

6.2.7 Sulphate Content

a) The sulphate contents of representative samples of the soil are less than 0.1%. The sulphate exposure is considered to be *negligible*. Type II Portland cement is recommended for the construction.

a) The fill materials should be tested for their sulphate content during the final stage of rough grading.

6.2.8 Utility Trenching

a) The walls of temporary construction trenches in fill should stand nearly vertical, with only minor sloughing, provided the total depth does not exceed 3 feet (approximately). Shoring of excavation walls or flattening of slopes may be required, if greater depths are necessary.

b) Trenches should be located so as not to impair the bearing capacity or to cause settlement under foundations. As a guide, trenches should be clear of a 45-degree plane, extending outward and downward from the edge of foundations. Shoring should comply with Cal-OSHA regulations.

c) Existing soils may be utilized for trenching backfill, provided they are free of organic materials.

d) All work associated with trench shoring must conform to the state and federal safety codes.

6.2.9 Surface Drainage Provisions

Positive surface gradients should be provided adjacent to the buildings to direct surface water run-off away from structural foundations and to suitable discharge facilities.

6.2.10 Grading Control

All grading and earthwork should be performed under the observation of a Geotechnical Engineer in order to achieve proper subgrade preparation, selection of satisfactory materials, placement and compaction of all structural fill. Sufficient notification prior to stripping and earthwork construction is essential to make certain that the work will be adequately observed and tested.

6.3 Slab-on-Grade

a) Concrete floor slabs may be founded on the reworked existing soils or compacted fill.

b) The slab should be underlain by four inches of granular material. A plastic vapor barrier is recommended to be placed at the mid-height of the base layer.

c) It is recommended that #4 bars on 12-inch center, both ways, or equivalent be provided as minimum reinforcement in slabs-on-grade. Joints should be provided and slabs supporting no vehicular traffic should be at least 5 inches thick.

d) The FFL should be at least 6 inches above highest adjacent grade.

e) The subgrade soils should be kept moist prior to the concrete pour.

6.4 Spread Foundations

The proposed structures can be founded on shallow spread footings. The criteria presented as follows should be adopted:

6.4.1 Dimensions/Embedment Depths

Number of Stories (floors supported)	**Minimum Width (ft.)**	**Minimum Footing Thickness (in.)**	**Minimum Embedment Below Lowest Finished Surface (ft.)**	
3	1.5	6	Perimeter	2.5
			Interior	2.5
Square Column Footings To 50 kip	2	-		2.5

6.4.2 Allowable Bearing Capacity

Embedment Depth (ft.)	**Allowable Bearing Capacity (lb/ft^2)**
1.0	2,000

(Notes:

- The allowable bearing capacity may be increased by 800 lb/ft^2 for each additional foot increase in the depth or by 200 lb/ft^2 he width to a maximum value of 4,000 lb/ft^2;

- These values may be increased by one-third in the case of short-duration loads, such as induced by wind or seismic forces;
- At least 2x#4 bars should be provided in wall footings, one on top and one at the bottom;
- In the event that footings are founded in structural fills consisting of imported materials, the allowable bearing capacities will depend on the type of these materials, and should be re-evaluated;
- Bearing capacities should be re-evaluated when loads have been obtained and footings sized during the preliminary design;
- Planter areas should not be sited adjacent to walls;
- Footing excavations should be observed by the Geotechnical Engineer;
- Footing excavations should be kept moist prior to the concrete pour;
- It should be insured that the embedment depths do not become reduced or adversely affected by erosion, softening, planting, digging, etc.)

6.4.3 Settlements

Total and differential settlements under spread footings are expected to be within tolerable limits and are not expected to exceed 1 and ¾ inches in a horizontal distance of 40 feet, respectively.

6.5 Lateral Pressures

a) The following lateral pressures are recommended for the design of retaining structures.

		Pressure (lb/ft^2/ft depth)	
Lateral Force	**Soil Profile**	**Unrestrained Wall**	**Rigidly Supported Wall**
Active Pressure	Level	36	-
At-Rest Pressure	Level	-	65
Passive Resistance (ignore upper 1.5 ft.)	Level	300	-

b) Friction coefficient: 0.35 (includes a Factor of Safety of 1.5). While combining friction with passive resistance, reduce passive by 1/3.

c) These values apply to the existing soil, and to compacted backfill generated from in-situ material. Imported material should be evaluated separately. It is recommended that where feasible, imported granular backfill be utilized, for a width equal to approximately one-quarter the wall height, and not less than 1.5 feet.

d) Backfill should be placed under engineering control.

e) Subdrains comprised of 4-inch perforated SDR-35 or equivalent PVC pipe covered in a minimum of one cubic foot per linear foot of filter rock and wrapped in Mirafi 140N filter fabric should be provided behind retaining walls.

6.6 Seismic Coefficients and Liquefaction Potential

a) For seismic analysis of the proposed project in accordance with the seismic provisions of ASCE 7-16, we recommend the following:

ITEM	VALUE
Site Latitude (Decimal-degrees)	33.14197
Site Longitude (Decimal-degrees)	-117.16598
Site Class	D
Risk Category	II
Mapped Spectral Response Acceleration-Short Period (0.2 Sec) - S_S	0.897
Mapped Spectral Response Acceleration-1 Second Period – S_1	0.33
Short Period Site Coefficient-F_a	1.141
Long Period Site Coefficient F_v	1.90
Adjusted Spectral Response Acceleration @ 0.2 Sec. Period (Sms)	1.024
Adjusted Spectral Response Acceleration @ 1Sec.Period (S_{m1})	0.627
Design Spectral Response Acceleration @ 0.2 Sec. Period (S_{Ds})	0.682
Design Spectral Response Acceleration @ 1-Sec. Period (S_{D1})	0.418

b) Ground water was encountered at a depth of 24 feet below ground surface, however, the subject site is underlain by dense soil layers. The potential for liquefaction is considered to be low.

6.7 Pavement Design

6.7.1 Asphalt Pavement Section

a) Based on Traffic Indices (T.I) and on the anticipated "R" – Value of 42 of the subgrade, the following tentative structural pavement sections are recommended.

Location	T.I.	Asphaltic Concrete (inches)	Aggregate Base (inches)
Parking and Driveways	Up to 5.0	3	4
Driveway (light truck traffic)	6.0	3	6

b) The subgrade soils should be tested for R-Value at the conclusion of rough grading and the pavement sections should be finalized then.

6.7.2 Subgrade Preparation

Subgrade soils within the upper 12 inches of finished grade shall be moisture-conditioned where necessary, shall be compacted to at least 90 percent relative compaction per ASTM D1557, and shall be free of any loose or soft areas.

6.7.3 Base Preparation

Unless otherwise specified, the base shall consist of Class II ¾-inch aggregate base or approved Crushed Miscellaneous Base. The base shall be compacted to a minimum of 95 percent relative compaction in accordance with the procedures described in ASTM Test Method D1557.

6.7.4 Concrete Pavement

If proposed, the concrete pavement should be at least 5 inches thick, reinforced with #4 bars on 12 inches center bothways, underlain by 4 inches thick base as recommended above. Thicker concrete section will be required for traffic greater than T.I. of 6.0.

6.8 Corrosion Potential

a) Soil Corrosion potential for metal and concrete was estimated by performing water-soluble sulfate, chloride, pH, and electrical resistivity tests during this investigation.

b) Electrical resistivity is a measure of soil resistance to the flow of corrosion currents. Corrosion currents are generally high in low resistivity soils. The electrical resistivity of a soil decreases primarily with an increase in its chemical and moisture contents.

c) A commonly accepted correlation between electrical resistivity and corrosivity for buried ferrous metals is presented below:

Electrical Resistivity, Ohm-cm	**Corrosion Potential**
Less than 1,000	Severe
1,000-2,000	Corrosive
2,000-10,000	Moderate
Greater than 10,000	Mild

d) Results of electrical resistivity test indicate a value of 3,339 ohm-cm for the near-surface soils. Based on this data, it is our opinion that, in general, on-site near-surface soils are considered *moderately corrosive* in nature. This potential should be considered in design of underground metal pipes.

6.9 Percolation Study

a) The soils in the upper 5 feet were Clayey Silty SAND underlain by Silty SAND/Sandy SILT. We recommend the basin to be at least 6 feet deep.

b) As more granular soils are anticipated at that depth, we estimate the following infiltration rate. During the grading operation, a percolation test should be conducted to verify the infiltration rate.

Boring No.	**Percolation Rate (inch/hour)**
P-1	3.0

c) These rates are calculated using a factor of safety of 1.0. Appropriate factor of safety should be utilized while designing the basin.

7. LIMITATIONS

a) Soils and bedrock over an area show variations in geological structure, type, strength and other properties from what can be observed, sampled and tested from specimens extracted from necessarily limited exploratory borings. Therefore, there are natural limitations inherent in making geologic and soil engineering studies and analyses. Our findings, interpretations, analyses and recommendations are based on observation, laboratory data and our professional experience; and the projections we make are professional judgments conforming to the usual standards of the profession. No other warranty is herein expressed or implied.

b) In the event that during construction, conditions are exposed which are significantly different from those described in this report, they should be brought to the attention of the Geotechnical Engineer.

The opportunity to be of service is sincerely appreciated. If you have any questions or if we can be of further assistance, please call.

Very truly yours,

GLOBAL GEO-ENGINEERING, INC.

Mohan B. Upasani	Kevin B. Young
Principal Geotechnical Engineer	Principal Engineering Geologist
RGE 2301	CEG 2253
(Exp. March 31, 2023)	(Exp. October 31, 2023)

MBU/KBY: fdg

Enclosures:

Location Map	- Figure 1
Seismicity Map	- Figure 2
References	- Appendix A
Field Exploration	- Appendix B
Unified Soils Classification System	Figure B-1
Logs of Borings	Figures B-2 through B-3
Boring Location Plan	Figure B-4
Laboratory Testing	- Appendix C

APPENDIX A

References

1. California Geological Survey, *Earthquake Fault Zones of Required Investigation,* (Internet).

2. California Division of Mines and Geology, 1996, *Geologic Maps of the Northwestern Part of San Diego County, California,* CDMG Open File Report 96-02.

3. California Office of Statewide Health Planning and Development, Seismic Design Maps Web Tool, ASCE 7-16 Standard (Internet).

4. United States Geological Survey, 1948, San Marcos Quadrangle, 7.5-Minute Topographic Series.

5. United States Geological Survey, 1968, San Marcos Quadrangle, 7.5-Minute Topographic Series.

6. United States Geological Survey, 1968 photorevised 1983, San Marcos Quadrangle, 7.5-Minute Topographic Series.

APPENDIX B

Field Exploration

a) The site was explored on May 17, 2022, utilizing a B-61 Mobile hollow stem drill rig to excavate three borings to a maximum depth of 40 feet below the existing ground surface. One of the borings were subsequently backfilled. Three-inch diameter perforated pipe with gravel rock encasement was installed in Boring P-1 for the purpose of percolation testing

b) The soils encountered in the excavations were logged and sampled by our Engineering Geologist. The soils were classified in accordance with the Unified Soil Classification System described in *Figure B-1*. The Logs of Borings are presented in *Figures B-2 through B-4*. The approximate locations of the borings are shown on the *Boring Location Plan, Plate 1*. The logs, as presented, are based on the field logs, modified as required from the results of the laboratory tests. Driven ring and bulk samples were obtained from the excavations for laboratory inspection and testing. The depths at which the samples were obtained are indicated on the logs.

c) The number of blows of the driving weight during sampling was recorded, together with the depth of penetration, the driving weight and the height of fall. The blows required per foot of penetration for given samples was then calculated and shown on the logs.

d) Groundwater was encountered at a depth of 24 feet below ground surface in Boring B-1.

e) Caving occurred in all of the borings to the depths noted on the logs.

UNIFIED SOILS CLASSIFICATION (ASTM D-2487)

PRIMARY DIVISION			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS More than half of materials is larger than #200 sieve size	GRAVELS More than half of coarse fraction is larger than #4 sieve	Clean Gravels (<5% fines)	GW	Well graded gravels, gravel-sand mixture, little or no fines
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		Gravel with Fines	GM	Silty gravels, gravel-sand-silt mixture. Non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures. Plastic fines
	SANDS More than half of coarse fraction is smaller than #4 sieve	Clean Sands (<5% fines)	SW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		Sands with Fines	SM	Silty sands, sand-silt mixtures. Non-Plastic fines.
			SC	Clayey sands, sand-clay mixtures. Plastic fines.
FINE GRAINED SOILS More than half of material is smaller than #200 sieve size	SILTS AND CLAYS	LIQUID LIMIT IS LESS THAN 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts, with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS	LIQUID LIMIT IS GREATER THAN 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts.
	Highly Organic Soils		PT	Peat and other highly organic soils.

CLASSIFICATION BASED ON FIELD TESTS

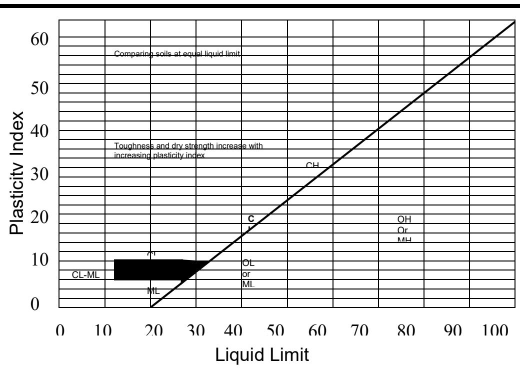
PENETRATION RESISTANCE (PR)	
Sands and Gravels	
Relative Density	Blows/foot
Very loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Clays and Silts		
Consistency	Blows/foot*	Strength**
Very Soft	0-2	0-½
Soft	2-4	¼-½
Firm	4-8	½-1
Stiff	8-15	1-2
Very Stiff	15-30	2-4
Hard	Over 30	Over 4

*Numbers of blows of 140 lb hammer falling 30 inches to drive a 2-inch O.D. (1 3/8 in. I.D.) Split Barrel sampler (ASTM-1568 Standard Penetration Test)

**Unconfined Compressive strength in tons/sq. ft. Read from pocket penetrometer

CLASSIFICATION CRITERIA BASED ON LAB TESTS



Plasticity chart for laboratory Classification of Fine-grained soils

GW and SW – $C_u = D_{60}/D_{10}$ greater than 4 for GW and 6 for SW; $C_c = (D_{30})^2/D_{10} \times D_{60}$ between 1 and 3

GP and SP – Clean gravel or sand not meeting requirement for GW and SW

GM and SM – Atterberg limit below "A" line or P.I. less than 4

GC and SC – Atterberg limit above "A" line P.I. greater than 7

CLASSIFICATION OF EARTH MATERIAL IS BASED ON FIELD INSPECTION AND SHOULD NOT BE CONSTRUED TO IMPLY LABORATORY ANALYSIS UNLESS SO STATED.

Fines (Silty or Clay)	Fine Sand	Medium Sand	Coarse Sand	Fine Gravel	Coarse Gravel	Cobbles	Boulders
Sieve Sizes 200	40	10	4	¾"	3"	10"	

GLOBAL GEO-ENGINEERING, INC.

GEOLOGIC AND SOILS ENGINEERING, IRVINE, CALIFORNIA

244 Pico Avenue
San Marcos, California

Date: August 2022

Project No.: 9421-04

Figure No.: B-1

Global Geo-Engineering, Inc.
Irvine, California
Geologists and Geotechnical Engineers

244 Pico Avenue
San Marcos, California

Project 9421-04

LOG OF BORING B-1

Date : May 17, 2022
Logged By : KBY
Diameter of Boring : 6"
Drilling Company : Cal Pac Drilling
Drilling Rig : Mobile B-61

Drilling Method : Hollow Stem
Sampling Method : California Modified
Hammer Weight (lbs) : 140
Hammer Drop (in) : 30

Sample Type: Ring; Bulk; Standard Penetration Testing
Water Levels: ▼ Groundwater Encountered; ▽ Seepage Encountered

Depth in Feet	Sample	Field Moisture % Dry Weight	Dry Density lb./cubic ft.	Blow Count	Relative Compaction	Water Level	USCS	GRAPHIC	DESCRIPTION
0–4	Bulk / Ring	7.6	116.7	55			SM		Clayey Silty SAND: fine to medium grained, light reddish brown, slightly moist, medium dense
4–12	Bulk / Bulk	6.8	112.6	29			SM/ML		Silty SAND: fine grained, yellow brown, slightly moist, medium dense with SILT interbeds
	Ring	12.9	116.2	100					
12–24	Bulk / Ring	15.0	115.5	39			ML		Clayey SILT: light reddish to reddish brown, slightly moist to moist, stiff
	Ring	19.3	109.6	38					@19' moist
24–25	Ring	15.0	115.4	23		▼	SP		SAND: medium to coarse grained, reddish brown, very moist to wet, medium dense, water encountered

Figure B-2.1

Global Geo-Engineering, Inc.
Irvine, California
Geologists and Geotechnical Engineers

244 Pico Avenue
San Marcos, California

Project 9421-04

LOG OF BORING B-1

Date	: May 17, 2022
Logged By	: KBY
Diameter of Boring	: 6"
Drilling Company	: Cal Pac Drilling
Drilling Rig	: Mobile B-61

Drilling Method	: Hollow Stem
Sampling Method	: California Modified
Hammer Weight (lbs)	: 140
Hammer Drop (in)	: 30

Sample Type
- Ring
- Bulk
- Standard Penetration Testing

Water Levels
- Groundwater Encountered
- Seepage Encountered

Depth in Feet	Sample	Field Moisture % Dry Weight	Dry Density lb./cubic ft.	Blow Count	Relative Compaction	Water Level	USCS	GRAPHIC	DESCRIPTION
25							SP		
30	Ring	19.5	106.0	18			SP/ML		@29' fine to medium grained with SILT interbeds
35	Ring	17.2	104.9	12			SP/ML		@34' medium grained, olive brown ALLUVIUM
40	Ring	9.1	129.3	100			GR		TONALITE: fine textured, hard BASEMENT ROCK
45									
50									

Bottom of Boring at 40 feet:

Notes:
1. Caving to 23 feet after augers were removed
2. Water encountered at 24', Static water level measured at 23.5'
3. Boring backfilled

Global Geo-Engineering, Inc. Irvine, California Geologists and Geotechnical Engineers	LOG OF BORING B-2	Drilling Method : Hollow Stem Sampling Method : California Modified Hammer Weight (lbs) : 140 Hammer Drop (in) : 30
244 Pico Avenue San Marcos, California	Date : May 17, 2022 Logged By : KBY Diameter of Boring : 6" Drilling Company : Cal Pac Drilling Drilling Rig : Mobile B-61	
Project 9421-04		

Sample Type: Ring; Bulk; Standard Penetration Testing

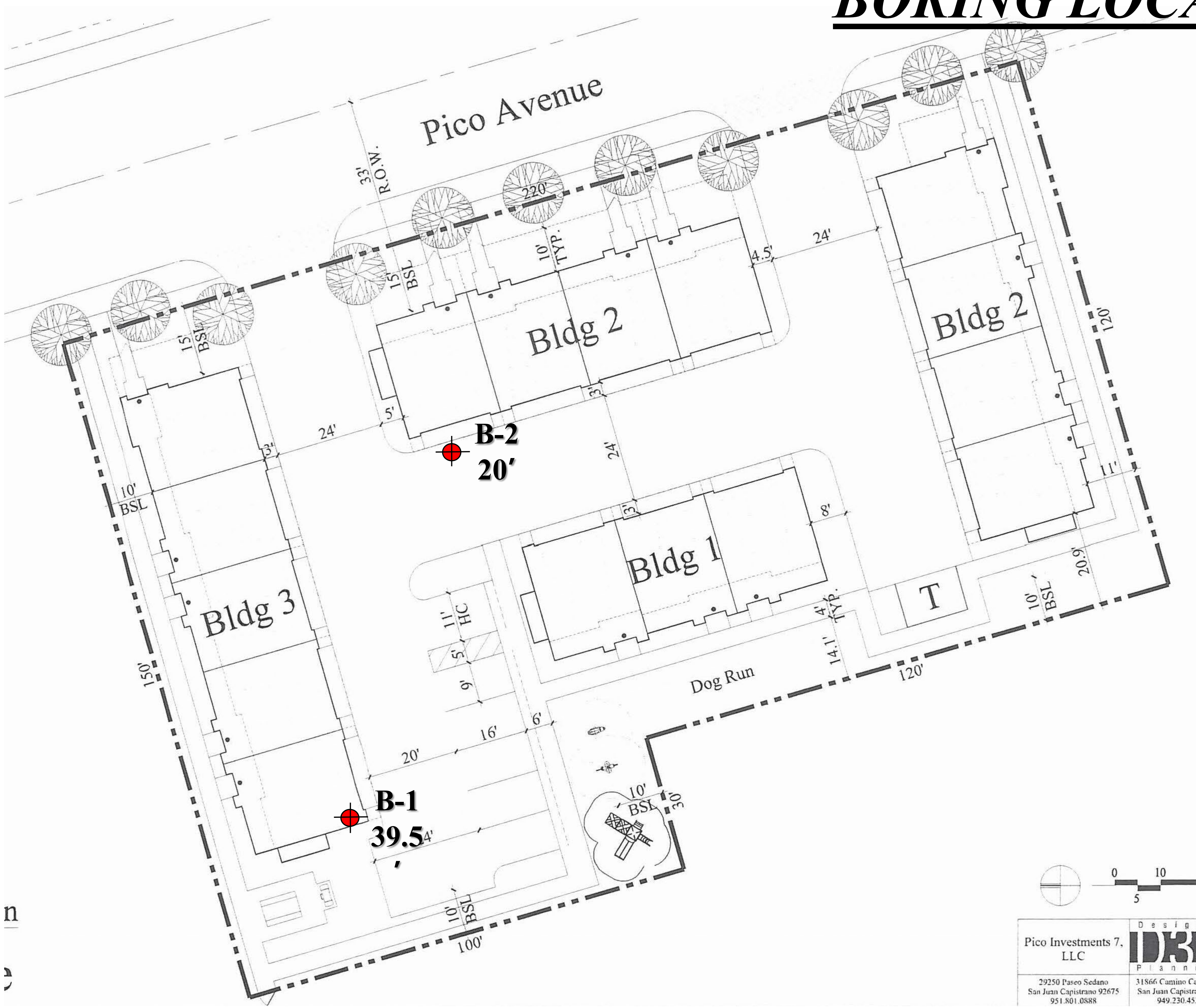
Water Levels: Groundwater Encountered; Seepage Encountered

Depth in Feet	Sample	Field Moisture % Dry Weight	Dry Density lb./cubic ft.	Blow Count	Relative Compaction	Water Level	USCS	GRAPHIC	DESCRIPTION
0							CL/ML		Sandy Silty CLAY: reddish brown, slightly moist, medium stiff with Clayey SILT interbeds
	Ring	13.5	113.8	20					
							ML		Sandy SILT: yellow to light reddish brown, slightly moist, stiff
5	Ring, Bulk	11.0	107.2	45					
							ML/SM		@9' with Silty SAND interbeds
10	Ring	11.2	112.5	35					
							ML		Clayey SILT: olive gray to light reddish brown, slightly moist, stiff
15	Ring	14.0	114.2	48					
20	Ring	12.0	113.4	20			SM		Clayey Silty SAND: fine to medium grained, light reddish brown, moist, medium dense ALLUVIUM
25									

Bottom of Boring at 20 feet:

Notes:
1. Caving to 15.5 feet after augers were removed
2. No groundwater or seepage encountered
3. Boring backfilled

BORING LOCATION PLAN



KEY

B-2 20′ — Approximate Location of Boring, Showing Total Depth

N

GLOBAL GEO-ENGINEERING, INC.

GEOLOGIC AND SOILS ENGINEERING IRVINE, CALIFORNIA

244 Pico Avenue San Marcos, California	
Date: August 2022	**Figure No:** B-4
Project No.: 9421-04	

APPENDIX C

Laboratory Testing Program

The laboratory-testing program was directed towards providing quantitative data relating to the relevant engineering properties of the soils. Samples considered representative of site conditions were tested as described below.

a) Moisture and Density

Moisture-density information usually provides a gross indication of soil consistency. Local variations at the time of the investigation can be delineated, and a correlation obtained between soils found on this site and nearby sites. The dry unit weights and field moisture contents were determined for selected samples. The results are shown on the Logs of Borings.

b) Compaction

A representative soil sample was tested in the laboratory to determine the maximum dry density and optimum moisture content, using the ASTM D1557 compaction test method. This test procedure requires 25 blows of a 10-pound hammer falling a height of 18 inches on each of five layers, in a 1/30 cubic foot cylinder. The results of the test are presented below.

Boring No.	Sample Depth (ft.)	Soil Description	Optimum Moisture Content (%)	Maximum Dry Density (lb/ft^3)
B-1	1-3	Clayey Silty SAND	9.9	127.3

c) Direct Shear

Direct shear tests were made on remolded samples, using a direct shear machine at a constant rate of strain. Variable normal or confining loads are applied vertically and the soil shear strengths are obtained at these loads. The angle of internal friction and the cohesion are then evaluated. The samples were tested at saturated moisture contents. The results are shown below in terms of the Coulomb shear strength parameters.

Boring No.	Sample Depth (ft)	Soil Description	Coulomb Cohesion (lb/ft^2)	Angle of Internal Friction (°)	Peak/Residual
B-1	1-3	Clayey Silty SAND	250 250	29 29	Peak Ultimate

d) Sulfate Content

A representative soil sample was analyzed for its sulphate content. The results are given below:

Boring No.	Sample Depth (ft.)	Soil Description	Sulphate Content (%)
B-1	1-3	Clayey Silty SAND	0.0026

e) Chloride Content

A representative soil sample was analyzed for chloride content in accordance with California Test Method CA422. The result is given below:

Boring No.	Sample Depth (ft)	Soil Description	Chloride Content (%)
B-1	1-3	Clayey Silty SAND	0.0023

f) Resistivity and pH

A representative soil sample was analyzed in accordance with California Test Methods CA532 and CA643 to determine the minimum resistivity and pH. The result is provided below:

Boring No.	Sample Depth (ft)	Soil Description	pH	Minimum Resistivity (Ohm-cm)
B-1	1-3	Clayey Silty SAND	8.1	3,339

g) Expansion Potential

Surface soils were collected in the field and tested in the laboratory in accordance with the ASTM Test Designation D4829. The degree of expansion potential is determined from soil volume changes occurring during saturation of the specimen. The results of the tests are presented below:

Boring No.	Sample Depth (ft)	Soil Description	Expansion Index	Expansion Potential
B-2	2	Sandy Silty CLAY	70	Medium

Worksheet D.5-1: Factor of Safety and Design Infiltration Rate Worksheet

Factor of Safety and Design Infiltration Rate Worksheet			Worksheet D.5-1		
Factor Category		Factor Description	Assigned Weight (w)	Factor Value (v)	Product (p) p = w x v
A	Suitability Assessment	Soil assessment methods	0.25	2	0.5
		Predominant soil texture	0.25	1	0.25
		Site soil variability	0.25	1	0.25
		Depth to groundwater / impervious layer	0.25	2	0.5
		Suitability Assessment Safety Factor, $S_A = \Sigma p$			1.5
B	Design	Level of pretreatment/ expected sediment loads	0.5	1	0.5
		Redundancy/resiliency	0.25	1	0.25
		Compaction during construction	0.25	1	0.25
		Design Safety Factor, $S_B = \Sigma p$			1
Combined Safety Factor, $S_{total} = S_A \times S_B$					1 x 1.5 = 1.5
Observed Infiltration Rate, inch/hr, $K_{observed}$ (corrected for test-specific bias)					3.0 in/hr
Design Infiltration Rate, in/hr, $K_{design} = K_{observed} / S_{total}$					3/2 = 1.5 in/hr
Supporting Data					
Briefly describe infiltration test and provide reference to test forms: Minimum safety factor 2 used per BMP design manual section D.5.4					

ATTACHMENT 9

Summary Files from the SWMM Model

PRE_DEV

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Starting Date ............ OCT-05-1962 00:00:00
Ending Date .............. OCT-05-2007 23:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......        30.777       547.150
Evaporation Loss .........         0.477         8.477
Infiltration Loss ........        28.588       508.225
Surface Runoff ...........         1.944        34.554
Final Surface Storage ....         0.000         0.000
Continuity Error (%) .....        -0.750


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         1.944         0.633
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         1.944         0.633
Internal Outflow .........         0.000         0.000
Storage Losses ...........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.000


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total      Total        Total     Peak  Runoff
                           Precip      Runon       Evap      Infil     Runoff       Runoff   Runoff   Coeff
Subcatchment                   in         in         in         in         in     10^6 gal      CFS
--------------------------------------------------------------------------------------------------------
DMA-1-C                    547.15       0.00       8.48     508.22      34.55         0.63     0.47   0.063

Analysis begun on:  Sat Nov 05 10:52:00 2022
Analysis ended on:  Sat Nov 05 10:52:24 2022
Total elapsed time: 00:00:24
```

POST_DEV

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... KINWAVE
Starting Date ............ OCT-05-1962 00:00:00
Ending Date .............. OCT-05-2007 23:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00
Routing Time Step ........ 60.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......        30.777       547.150
Evaporation Loss .........         4.429        78.736
Infiltration Loss ........         7.152       127.142
Surface Runoff ...........        19.497       346.620
Final Surface Storage ....         0.000         0.000
Continuity Error (%) .....        -0.977


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        19.497         6.354
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         2.531         0.825
Internal Outflow .........         0.000         0.000
Storage Losses ...........        17.144         5.587
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.910


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    60.00 sec
Average Time Step           :    60.00 sec
```

POST_DEV

Maximum Time Step : 60.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 1.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
DMA-1-C	547.15	0.00	78.74	127.14	346.62	6.35	0.53	0.634

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min
POC-1	OUTFALL	0.00	0.00	0.00	0 00:00
1	STORAGE	0.05	7.29	7.29	5576 07:03

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
POC-1	OUTFALL	0.00	1.92	5576 07:03	0.000	0.825
1	STORAGE	0.53	0.53	6348 00:00	6.353	6.353

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
1	STORAGE	394487.02	7.292	1.708

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

	Average Volume	Avg Pcnt	E&I Pcnt	Maximum Volume	Max Pcnt	Time of Max Occurrence	Maximum Outflow

```
Storage Unit          1000 ft3    Full  Loss      1000 ft3    Full    days hr:min        CFS
--------------------------------------------------------------------------------------------
1                        0.018       1    88         2.643      82    5576  07:03       1.92


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                      Flow       Avg.       Max.       Total
                      Freq.      Flow       Flow      Volume
Outfall Node          Pcnt.       CFS        CFS    10^6 gal
-----------------------------------------------------------
POC-1                  0.33      0.02       1.92       0.825
-----------------------------------------------------------
System                 0.33      0.02       1.92       0.825


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CFS  days hr:min    ft/sec    Flow   Depth
-----------------------------------------------------------------------------
1                    DUMMY        1.92  5576  07:03


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Sat Nov 05 10:53:04 2022
Analysis ended on:  Sat Nov 05 10:53:34 2022
Total elapsed time: 00:00:30
```