HYDROLOGY ANALYSIS

for

CARMAX at NATIONAL CITY

October 16, 2020

Prepared by:

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HYDROLOGIC ANALYSIS FOR CARMAX AT NATIONAL CITY:

DETERMINATION OF THE PRE AND POST DEVELOPMENT 100 YEAR PEAK FLOW

1. ANTECEDENTS

At the South East corner of the intersection of HWY 805 and HWY 54, on Plaza Bonita Road, lays an undeveloped property of about 15.1 acres where a future 7.2 acre CarMax development will take place (the remaining 7.9 acre will be occupied by a vegetated channel and adjacent landscape). This property is also contiguous and north of Sweetwater River and about 3.25 square miles of contributing area drain thru it via an unnamed creek before discharging into the aforementioned Sweetwater River (see Figure 1). The property is separated from Sweetwater River by a berm which acts as an impoundment barrier, and the private property behaves as a pond for the unnamed creek that drains into Sweetwater. The berm is undercrossed by a 48” pipe, and during the occurrence of very large storm events, the flows from the 3.25 sq-mile upstream contributing area overtop the berm to drain into Sweetwater.

The undeveloped property is currently being studied to propose a CarMax facility, to be designed respecting the proper river constrains, with a channel along its North and west boundaries. However, among the impacts of the development, filling of the property is needed to construct the buildings and parking lots required by the CarMax development, and the volume of the impoundment will be consequently reduced.

Figure 1. Area of analysis.

2. OBJECTIVES OF THE STUDY

This hydrologic study will serve as a support document for the CarMax development. Its multiples objectives are as follows:

- Determine the peak flow runoff generated by the approximate 3.25 sq-mile (over 2,080 acre) contributing area for the 100 year storm event. The storm event analyzed will have a standard duration of 24 hours and will establish a hydrologic baseline to determine how the development affects the peak flows. The peak flow determination is regional in nature and no attempt will be made to analyze in detail how the 7.2 acre CarMax development runoff is routed to the proposed channel but rather how this development occupying less than 0.4% of the total contributing area impacts the unnamed creek in both peak flow and runoff volume.
- Quantify the differences in the 100 year peak as a result of the proposed development impacts in a regional manner: the analysis will determine what is the total 100 year peak flow before and after the development takes place.
- As the berm separating the unnamed creek from Sweetwater River is not going to be touched, modified, or in any way altered by the development, this report will simply shows the changes in the peak flow and creek hydrology.

3. STRUCTURE OF THE HYDROLOGIC ANALYSIS

The hydrologic analysis that was undertaken here was structured as follows:

1) First, the total contributing area was divided in three sub-areas (named DMAs in this report) to establish approximate peaks flows to tributaries;

2) The average 24 hour precipitation value for the entire contributing area was taken from the NOAA web page at approximately the centroid of each sub-area for modelling purposes. NOAA also allows the determination of the 5, 10, 15, 30, 60, 120, 180, 360 and 720 minute duration precipitation during the occurrence of a 100-yr storm event (See Appendix 1). Of those durations, the HEC-HMS model used for hydrology purposes will use the 5 min, 15 min, 1 hr, 2 hr, 3 hr, 6 hr, 12 hr and 24 hr rainfall totals for runoff determination.

3) Adjustment in precipitation totals according to contributing area and duration are also made in this report, based upon Table 4-1 of the San Diego County Hydrology Manual (SDCHM). Interpolated values of the correction factor are included in Appendix 1, and the corrected NOAA precipitation values are also shown. Those modified values will be used later in the HEC-HMS model to determine the peak flow of the unnamed creek (HEC-HMS will use the corrected precipitation values, equal to the NOAA values multiplied by the correction factor).

4) The land cover type and soil type were quantified for each of the three DMAs been analyzed. From these values an impervious percentage was calculated for each DMA as well as a Curve Numbers

(CN). CN were obtained from Table 4-2 of the SDCHM (see Attached Table 4-2 in Appendix 2 with the corresponding CN associated with open spaces in good condition used in this report highlighted there).

5) As the project is located in the Coastal Zone (see project location depicted in Figure C-1 of the SDCHM in Appendix 2). Therefore, the Precipitation Zone Number (PZN) for the 100 year storm is 1.5, per Table 4-6 of the SDCHM, also attached in Appendix 2. Consequently, an adjustment in the CN is needed, as values in Table 4-2 are given directly for PZN = 2. Adjusted CN are also included in Appendix 2, interpolating from Table 4-10 of the SDCHM.

6) The LAG time was calculated for each DMA following the SDCHM methodology (equation 4-17). A weighted manning's value was used in the calculations of the LAG time to best represent the surface in each DMA (See Appendix 2). Detailed explanations of (a) the weighed Manning's coefficient and (b) the overall Lag time calculation are also included in Appendix 2.

7) Next the U.S. Army Corps of Engineers Hydrologic Modeling System HEC-HMS software was used to determine the peak flows for each DMA. Further explanation of the inputs for each DMA in the HEC-HMS model follows.

8) For DMAs 1 and 2 the SCS Curve Number Loss Method was used and the SCS Unit Hydrograph Transform Method to calculate the peak flows and hydrographs for the corresponding DMAs. The inputs required were the following: area, Curve Number for the pervious area, impervious percentage, LAG time and the partial-duration depths required for the frequency storm. For the frequency storm inputs, the duration was set as 6 hours with the peak position at the 2/3 or 67% position (see screen shots of the HEC-HMS model in Appendix 4)

9) In regards to the precipitation for 5 minutes, 15 minutes, 30 minutes, 60 minutes, 120 minutes and 180 minutes required by HEC-RAS, those where obtained using the NOAA values shown in Appendix 1 corrected by the duration of the storm and contributing area. It should be noted that those values are considered more accurate and more representative that the values obtained with the precipitation equation derived from the intensity equation (Eq. 4-26) of the SDCHM. Basically, the equation $P = 7.44 \cdot P_6 \cdot D^{0.355}/60$ (P_6 in inches, D in minutes, P in inches) is no longer used, and instead, NOAA values are preferred. The SDCHM is moving towards the use of NOAA values in the current discussions that have taken place in the Technical Advisory Committee of the updated Hydrology Manual, and it is the professional opinion of the author of this study that NOAA precipitation is more accurate and representative that the values obtained using equation 4-26.

10) Regarding DMA 3, as the area is significantly less than that one square mile, the rational method was used for it. The lag time was converted to a time of concentration using the equations 4-19 and 4-22 of the SDCHM. A runoff C coefficient was calculated using the impervious percentage and the SDCHM methodology in Section 3 with the corresponding soil type. Finally, using the equation Q=CIA, the peak flow was determined (See Appendix 3).

11) As DMA 3 is the only DMA that changes from existing conditions to proposed conditions as a result of the CarMax project, the peak flow was determined for Pre and Proposed conditions for that area. NOAA intensities were used, using a log-log interpolation of the NOAA intensity values between 5 and 10 minutes, because time of concentration in pre and post-development conditions falls in that range (see Appendix 3).

12) Hydrographs for DMA-3 were obtained using the Rick Engineering's Rick RatHydro software that generates the hydrographs based on the SDCHM distribution of the 6 hour storm. The 6 hr precipitation was gathered from NOAA values. It should be pointed out some additional simplifications associated with DMA-3 and the HEC-HMS model:
    a) RatHydro assigns the Rational Method peak flow and generates the 6 hr storm runoff using the (4-26) intensity equation of the SDCHM. Therefore, it is a good approximate representation of a detailed hydrograph based on NOAA rainfall, because it only satisfies NOAA 6 hr storm total and the peak flow calculated with NOAA intensities.
    b) A 24 hr hydrograph would be preferable, but the approved RatHydro Model only produces a 6 hr hydrograph. Therefore, the 6 hr hydrograph was used in the HEC-HMS model starting at t = 12 hr and ending at t = 18 hr + Tc, while the remaining flow values from t = 0 to t = 12 hr and from t = 18 + Tc hr to t = 24 hr are assigned a 0 cfs value. This approximation does not detract in the determination of the overall peak flow because the peak flow occurs in the time interval analyzed in detail (12 hr < t < 18 + Tc).
    c) Any runoff calculation associated with DMA-3 is based simply on V_X (acre-ft) = $P_X \cdot C \cdot A$ with C being the rational method coefficient, P_X the precipitation in ft, and A the area in acres. If the 24 hr runoff volume is required for runoff comparison purposes (V_{24}), then the NOAA value of P_{24} (in ft) associated with DMA-3 is used.

13) Finally in order to confluence flows from all DMAs, DMA 3 was added to the HEC-HMS model as a discharge gage (with the pre and post values given by the RatHydro program) and peak flows were obtained at the downstream end of the CarMax project site.

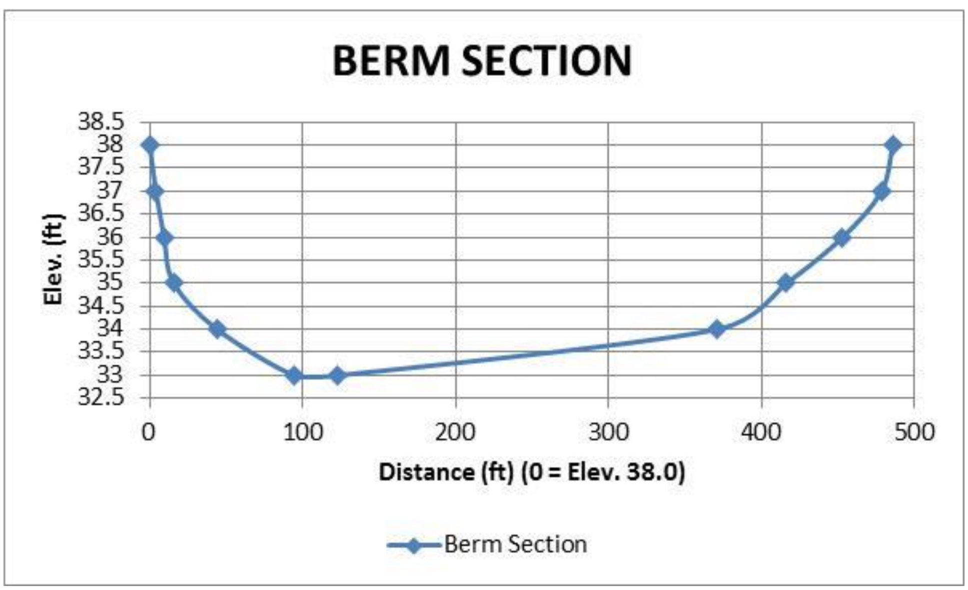
Additional Discussion in Regards to DMA-2

The previous version of this study is not clear in terms of the consideration of the area of the Bonita Paradise Mobile Home Park into the contributing area of the entire system, as requested by the reviewing team. To be safe and conservative, the total contributing area of analysis has been increased from 3.25 sq-miles to 3.26 sq-miles (an additional 6.4 acres) that correspond to the area in question. This area has been assumed 90% impervious, and it has been incorporated into the total area of DMA-2. The overall impervious percentage and lag time has been adjusted as well.

4. BERM DISCUSSION

It is important to emphasize that the downstream elevation of Sweetwater River (38.0) is over 5 ft above the invert of the berm (32.7), and that the area of the flow over the berm at this elevation (about 1902 sq-ft, see figure 2) produces a very small discharge velocity of the unnamed creek into Sweetwater River below 0.75 ft/s (v < 1390/1902 < 0.73 ft/s), due to the high tail water effect. Basically, at the discharge point, and based upon energy principles, the water elevation at the berm must be higher than the water elevation of the Sweetwater River so that a flow towards the river can occur. Consequently, at the discharge point, and by definition, the area of flow is larger than the area at elevation 38.0; therefore, the velocity of discharge is below 0.75 ft/s for such a large tailwater elevation, which is a very low value that produces negligible expansion and friction energy loss, because the velocity head ($v^2/2g < 0.009$ ft) is over 10 times smaller than the standard FEMA precision used to measure flood elevation (0.1 ft).

As the berm geometry is not going to be modified, altered, and as no additional culvert is going to be built thru the berm (perforating the berm), it is clear that the development does not affect in a measurable way the discharge of the peak flow of the unnamed creek into Sweetwater Rive. Therefore, the hydraulics at the berm discharge remains the same before and after the development and does not need to be considered as a detrimental factor of the development's influence in the discharge of the peak flow into Sweetwater River.



5. FEMA HYDROLOGY DISCUSSION

In regards to the CarMax project, the 100 year peak flow of the unnamed creek determined in this study has not been included by FEMA in their floodplain analysis of the Sweetwater River.

According to the Flood Insurance Study of San Diego County, (Volume 1 and Volume 10) FEMA 100 year peak flow for the Sweetwater River remains equal to 35,000 cfs and unchanged from the downstream end discharging in San Diego Bay (at Broadway Avenue, about 4000 ft above the discharge of Sweetwater Creek into San Diego Bay with a contributing area of about 219 sq-miles) all the way up to the downstream of the confluence with Spring Valley Creek (downstream of Sweetwater Reservoir and near HWY 125, about 9 miles upstream of the discharge, with a contributing area of about 194 sq-miles). Basically, the peak flow for the Sweetwater River is considered constant from downstream of the Sweetwater reservoir (once the confluence of Sweetwater and Spring Valley creeks takes place) all the way to the bay, even when considering that the contributing area to Sweetwater increases 25 square miles, from 194 sq-miles to about 219 sq-miles, and 3.26 sq-miles of that area increment are tied to the contributing area of the unnamed creek draining thru the CarMax property of this report.

Consequently, in current FEMA studies floodplain elevations in this property are only associated with backwater conditions of the water elevation of Sweetwater River when carrying its 35,000 cfs peak flow, and are not studied in detail in regards to the unnamed creek hydrology and hydraulics (FEMA peak flow in Sweetwater River is constant upstream and downstream of the unnamed creek).

The proposed CarMax buildings encroach partially into the floodplain zone AE determined by FEMA. REC will submit to FEMA a CLOMR analysis so that (a) the peak flow determined in this study is acknowledged and approved by FEMA; (b) the water surface elevations calculated in the earthen channel and associated with its hydraulic analysis are used by FEMA to re-define the floodplain in the property (CLOMR application); and (c) to insure the development is out of the floodplain zone AE in its final conditions and during final engineering documentation submitted for approval.

6. CONCLUSIONS AND RESULTS

From the results obtained from the HEC-HMS model (see Appendix 4), it is clear that the peak flow and runoff volume has increased for DMA 3 from the existing conditions as a consequence of the CarMax development, when routing of runoff into the detention systems of the development is neglected. However, at the downstream confluence of all three (3) DMAs the peak has actually reduced very slightly for the overall 3.26 sq-mile tributary area. The reason for the small reduction in the peak flow for the overall area is that the time of concentration for DMA 3 in existing conditions lines up more closely than the time of concentration for DMA 3 in proposed conditions to the time at which the peak flows occur for DMA 1 and 2. This causes the peak flow to be slightly larger in existing conditions than in the proposed conditions, because by the time the peak from DMA-1 and DMA-2 arrives, the hydrograph from DMA-3 in post-development condition is discharging a lower peak flow than the hydrograph of the same area in pre-development conditions, as more time has passed in post-development conditions than in pre-development between the peak of DMA-3 and the arrival of the peak of DMA-1 + DMA-2. However, the total volume runoff does increase in post-development conditions (by less than 0.2%), as one would expect by adding impervious areas, for the entire watershed been analyzed. Table 1 summarizes the results.

Table 1 – Summary of Results

DMA	Area (mi^2)	Existing Conditions		Proposed Conditions	
		Q (cfs)	Vol (ac-ft)	Q (cfs)	Vol (ac-ft)
1	2.168	902.3	248.0	902.3	248.0
2	1.011	603.3	120.5	603.3	120.5
3	0.081	*111.5*	7.17	*135.8*	7.90
Total	**3.260**	**1390.4**	**375.7**	**1389.7**	**376.4**

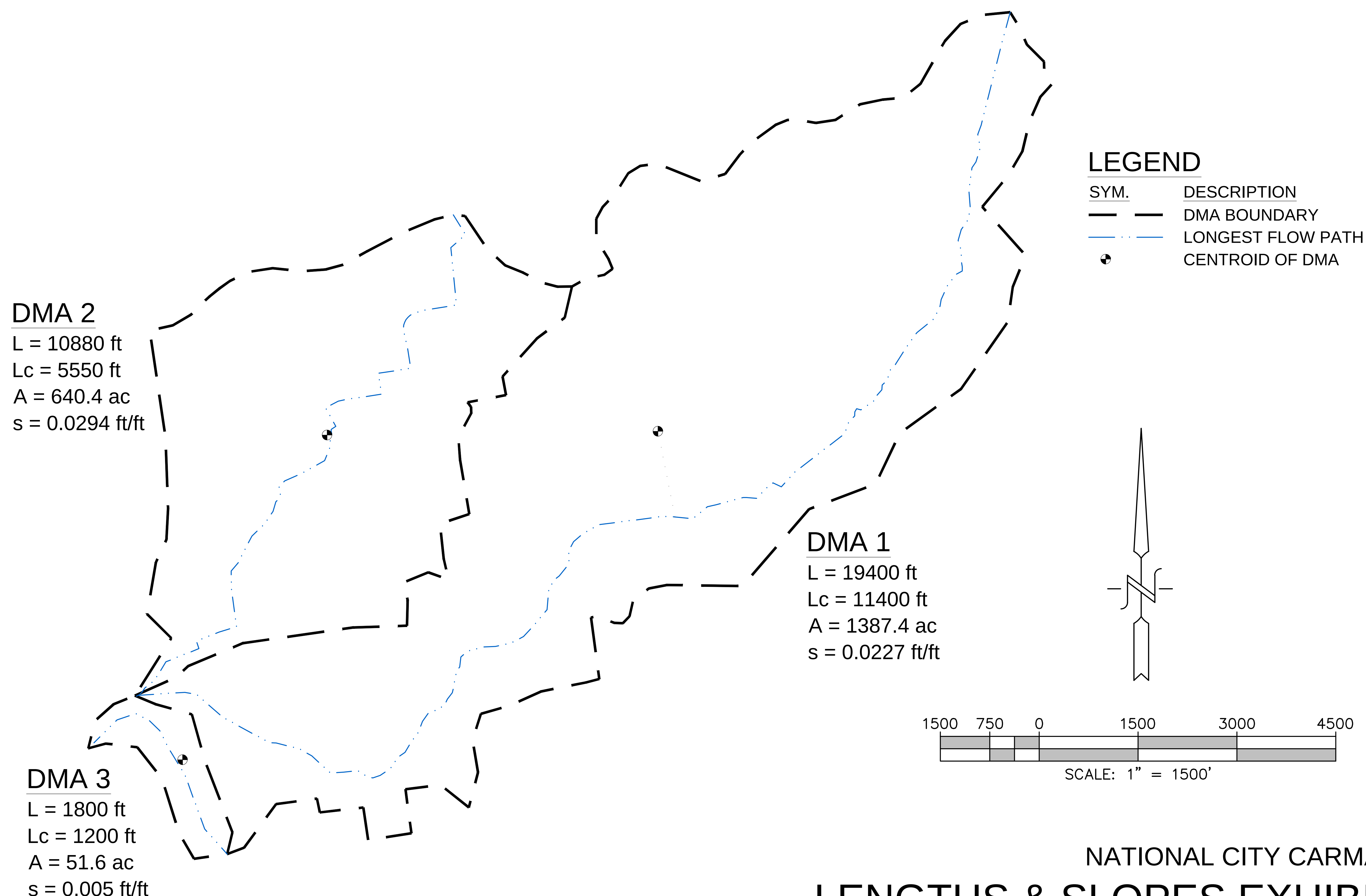
Also, as the berm is not altered, graded, or perforated, there is no measurable influence of the development in the maximum water elevation that will occur at the berm section because the peak has reduced by less than 1 ‰ and the discharge area has not changed.

APPENDIX 1

EXHIBITS & NOAA PRECIPITATION

NOAA Precipitation Information

Precipitation Correction Factors and Effective Rainfall

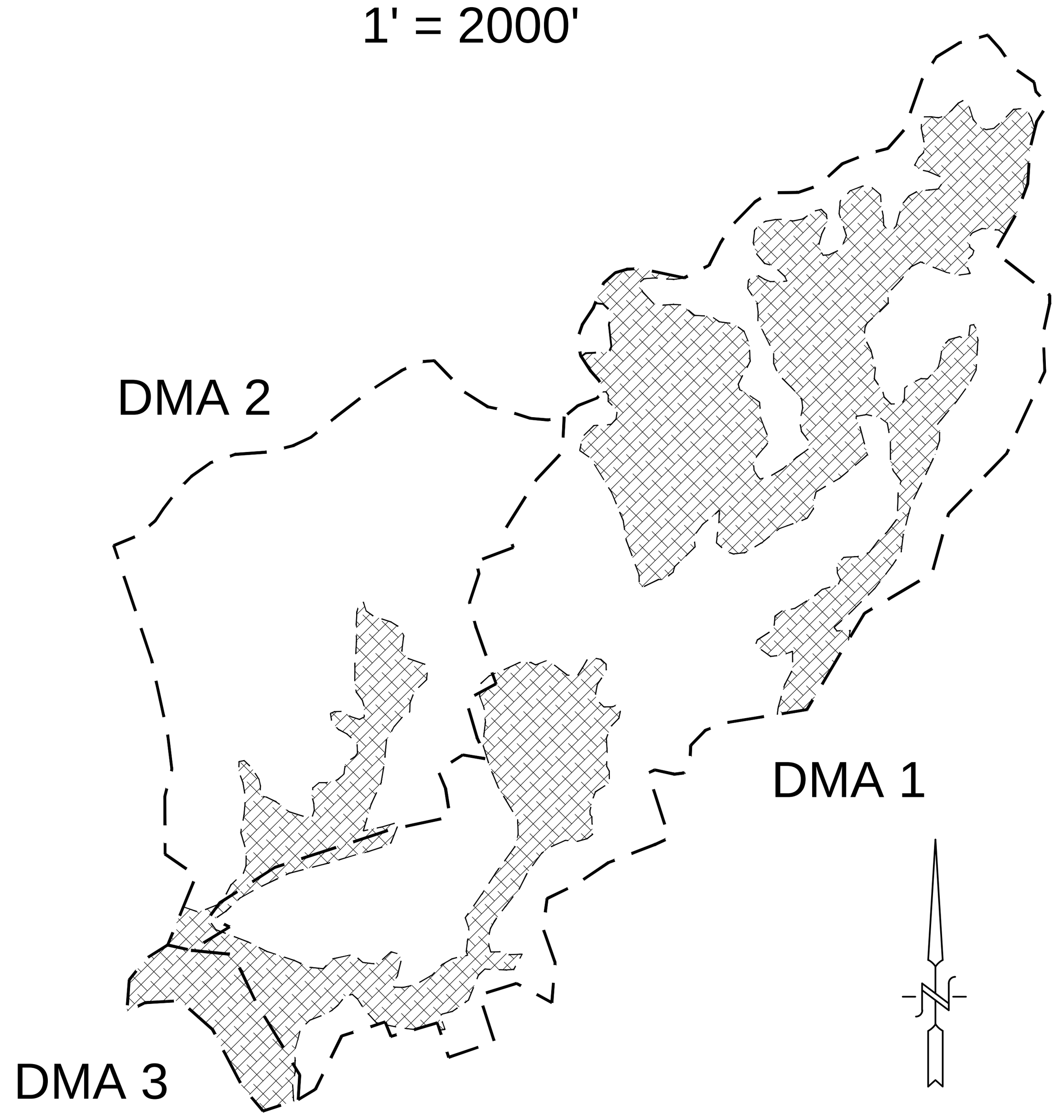


NATIONAL CITY CARMAX

LENGTHS & SLOPES EXHIBIT

Hydrologic Soil Group

1' = 2000'



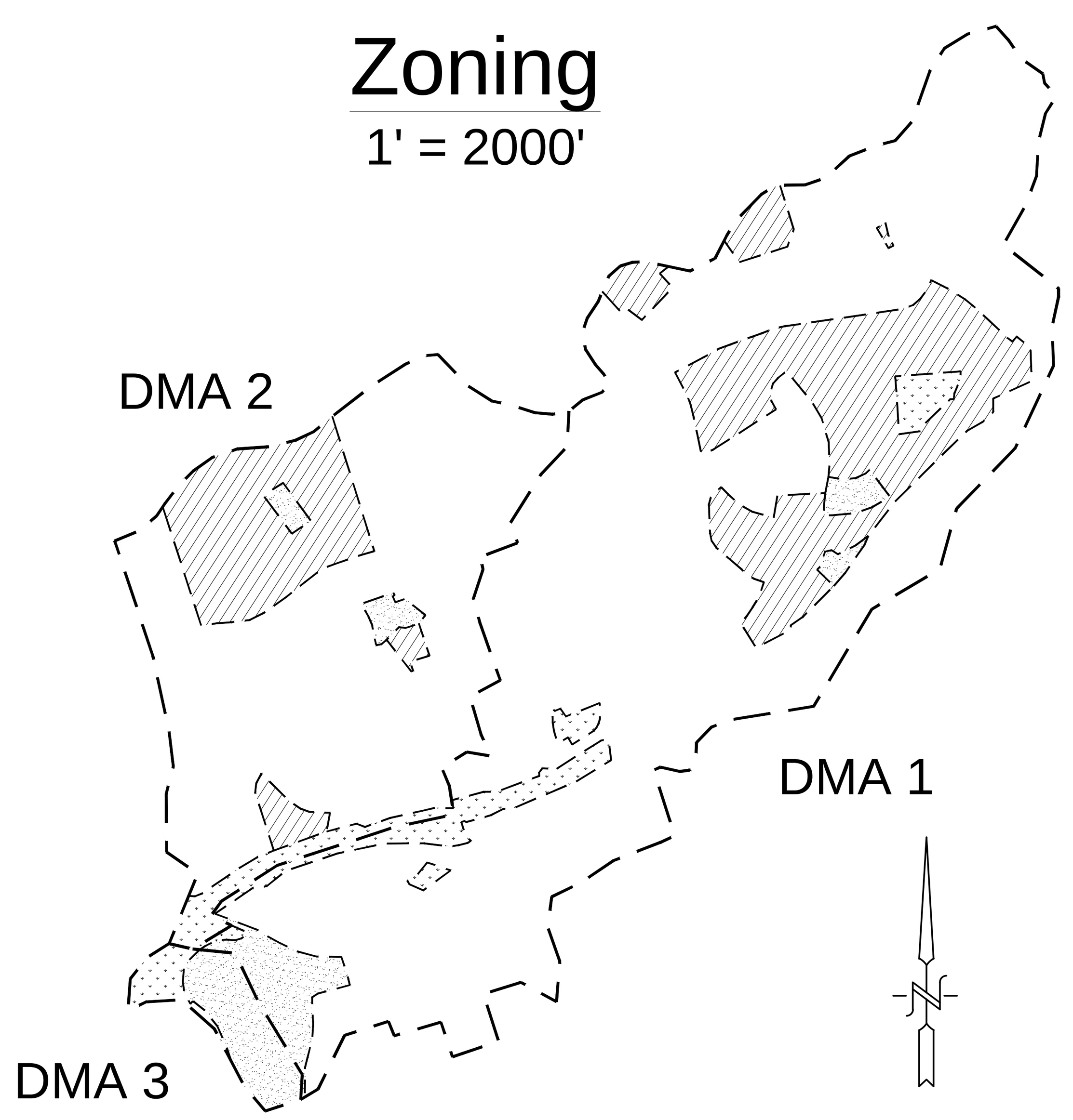
(Source: NRCS Web Soil Survey)

Legend

Sym.	HSG
	C
	D

Zoning

1' = 2000'



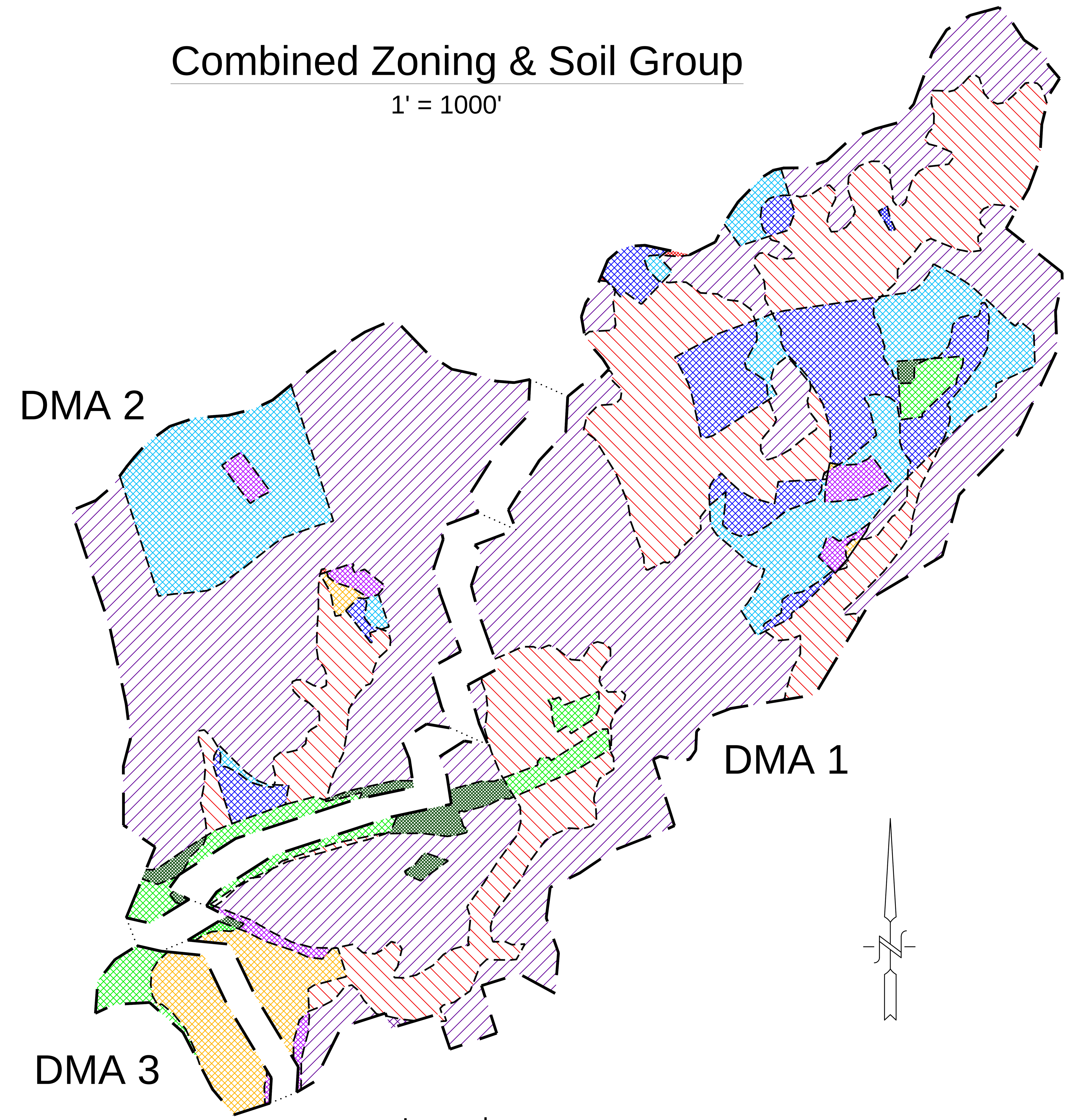
(Sources: City of Chula Vista General Plan Land Use Diagram, City of National City Official Zoning Map, City of San Diego Official Zoning Map)

Legend

Sym.	Zoning Designation
	Low Density Residential
	Medium Density Residential
	Commercial
	Open Space

Combined Zoning & Soil Group

1' = 1000'



Legend

Description	Sym.	AREA COVERAGE (%) DMA 1	DMA 2	DMA 3
Low Density Residential, C		29.88	7.57	0
Medium Density Residential, C		8.96	1.92	0
Commercial, C		1.99	0.50	73.19
Open Space, C		2.45	2.64	25.44
Low Density Residential, D		45.69	67.41	0
Medium Density Residential, D		8.41	18.19	0
Commercial, D		1.37	0.66	1.37
Open Space, D		1.25	1.11	0
		100	100	100

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LANDCOVER EXHIBIT

APPENDIX 1: PRECIPITATION ANALYSIS

SUB-AREA 1:

- NOAA Precipitation Maps
- Adjustment of NOAA Data into Intensity – Duration Equations

NOAA Atlas 14, Volume 6, Version 2
Location name: San Diego, California, US*
Latitude: 32.6771°, Longitude: -117.0493°
Elevation: 278 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.115** (0.096-0.138)	**0.145** (0.121-0.175)	**0.185** (0.154-0.224)	**0.218** (0.181-0.267)	**0.265** (0.211-0.335)	**0.301** (0.235-0.389)	**0.339** (0.258-0.449)	**0.378** (0.280-0.516)	**0.432** (0.306-0.616)	**0.475** (0.325-0.702)
10-min	**0.164** (0.137-0.198)	**0.207** (0.173-0.251)	**0.265** (0.221-0.321)	**0.313** (0.259-0.383)	**0.379** (0.303-0.480)	**0.432** (0.337-0.558)	**0.485** (0.370-0.644)	**0.542** (0.401-0.740)	**0.620** (0.439-0.883)	**0.681** (0.466-1.01)
15-min	**0.199** (0.166-0.240)	**0.251** (0.210-0.303)	**0.321** (0.267-0.389)	**0.379** (0.313-0.463)	**0.459** (0.366-0.581)	**0.522** (0.408-0.675)	**0.587** (0.447-0.778)	**0.655** (0.485-0.895)	**0.749** (0.531-1.07)	**0.824** (0.563-1.22)
30-min	**0.276** (0.231-0.333)	**0.349** (0.292-0.422)	**0.446** (0.372-0.541)	**0.527** (0.435-0.644)	**0.638** (0.510-0.808)	**0.726** (0.567-0.939)	**0.816** (0.622-1.08)	**0.911** (0.674-1.24)	**1.04** (0.738-1.49)	**1.15** (0.784-1.69)
60-min	**0.386** (0.323-0.465)	**0.487** (0.407-0.589)	**0.623** (0.519-0.755)	**0.735** (0.608-0.899)	**0.891** (0.712-1.13)	**1.01** (0.792-1.31)	**1.14** (0.868-1.51)	**1.27** (0.941-1.74)	**1.46** (1.03-2.08)	**1.60** (1.09-2.37)
2-hr	**0.534** (0.447-0.644)	**0.674** (0.563-0.814)	**0.857** (0.714-1.04)	**1.00** (0.831-1.23)	**1.21** (0.964-1.53)	**1.36** (1.06-1.76)	**1.52** (1.16-2.01)	**1.68** (1.24-2.29)	**1.90** (1.34-2.71)	**2.07** (1.41-3.05)
3-hr	**0.642** (0.537-0.774)	**0.810** (0.677-0.979)	**1.03** (0.858-1.25)	**1.21** (0.997-1.47)	**1.44** (1.15-1.83)	**1.63** (1.27-2.10)	**1.81** (1.38-2.40)	**2.00** (1.48-2.73)	**2.25** (1.59-3.21)	**2.44** (1.67-3.61)
6-hr	**0.840** (0.703-1.01)	**1.06** (0.889-1.28)	**1.35** (1.13-1.64)	**1.58** (1.31-1.94)	**1.90** (1.51-2.40)	**2.14** (1.67-2.76)	**2.38** (1.81-3.15)	**2.62** (1.94-3.58)	**2.95** (2.09-4.20)	**3.20** (2.19-4.73)
12-hr	**1.09** (0.917-1.32)	**1.39** (1.16-1.68)	**1.78** (1.48-2.15)	**2.10** (1.73-2.56)	**2.53** (2.02-3.20)	**2.86** (2.24-3.70)	**3.20** (2.44-4.25)	**3.56** (2.63-4.86)	**4.04** (2.86-5.76)	**4.41** (3.02-6.52)
24-hr	**1.34** (1.18-1.57)	**1.72** (1.50-2.00)	**2.21** (1.94-2.59)	**2.63** (2.28-3.09)	**3.20** (2.69-3.88)	**3.65** (3.02-4.51)	**4.12** (3.33-5.20)	**4.61** (3.63-5.97)	**5.29** (4.01-7.12)	**5.83** (4.28-8.09)
2-day	**1.66** (1.45-1.93)	**2.15** (1.88-2.51)	**2.80** (2.45-3.27)	**3.34** (2.89-3.93)	**4.07** (3.43-4.94)	**4.65** (3.84-5.74)	**5.24** (4.23-6.62)	**5.85** (4.61-7.58)	**6.69** (5.07-9.01)	**7.36** (5.40-10.2)
3-day	**1.86** (1.63-2.17)	**2.44** (2.13-2.84)	**3.19** (2.79-3.73)	**3.81** (3.30-4.49)	**4.66** (3.92-5.65)	**5.31** (4.38-6.56)	**5.97** (4.82-7.55)	**6.66** (5.25-8.64)	**7.60** (5.76-10.2)	**8.33** (6.12-11.6)
4-day	**2.02** (1.77-2.35)	**2.66** (2.33-3.10)	**3.49** (3.05-4.08)	**4.17** (3.62-4.91)	**5.10** (4.29-6.19)	**5.82** (4.80-7.19)	**6.54** (5.29-8.27)	**7.30** (5.74-9.46)	**8.31** (6.30-11.2)	**9.11** (6.69-12.7)
7-day	**2.35** (2.06-2.74)	**3.10** (2.71-3.61)	**4.08** (3.56-4.77)	**4.88** (4.24-5.75)	**5.98** (5.03-7.25)	**6.82** (5.63-8.43)	**7.68** (6.20-9.70)	**8.56** (6.74-11.1)	**9.76** (7.40-13.1)	**10.7** (7.86-14.9)
10-day	**2.59** (2.27-3.02)	**3.42** (3.00-3.99)	**4.51** (3.94-5.27)	**5.40** (4.68-6.36)	**6.61** (5.56-8.02)	**7.54** (6.22-9.32)	**8.48** (6.85-10.7)	**9.46** (7.45-12.3)	**10.8** (8.17-14.5)	**11.8** (8.67-16.4)
20-day	**3.15** (2.76-3.67)	**4.18** (3.66-4.88)	**5.53** (4.83-6.46)	**6.61** (5.73-7.78)	**8.07** (6.79-9.79)	**9.18** (7.58-11.3)	**10.3** (8.32-13.0)	**11.4** (9.01-14.8)	**13.0** (9.84-17.5)	**14.2** (10.4-19.7)
30-day	**3.75** (3.29-4.37)	**4.99** (4.37-5.81)	**6.58** (5.74-7.68)	**7.85** (6.81-9.24)	**9.55** (8.03-11.6)	**10.8** (8.94-13.4)	**12.1** (9.78-15.3)	**13.4** (10.6-17.4)	**15.1** (11.5-20.4)	**16.4** (12.1-22.9)
45-day	**4.41** (3.86-5.13)	**5.85** (5.12-6.82)	**7.68** (6.71-8.98)	**9.14** (7.92-10.8)	**11.1** (9.30-13.4)	**12.5** (10.3-15.4)	**13.9** (11.2-17.6)	**15.3** (12.1-19.8)	**17.2** (13.0-23.1)	**18.6** (13.6-25.8)
60-day	**5.13** (4.49-5.97)	**6.77** (5.93-7.89)	**8.84** (7.72-10.3)	**10.5** (9.08-12.3)	**12.6** (10.6-15.3)	**14.2** (11.7-17.5)	**15.7** (12.7-19.8)	**17.2** (13.6-22.3)	**19.2** (14.6-25.8)	**20.7** (15.2-28.7)

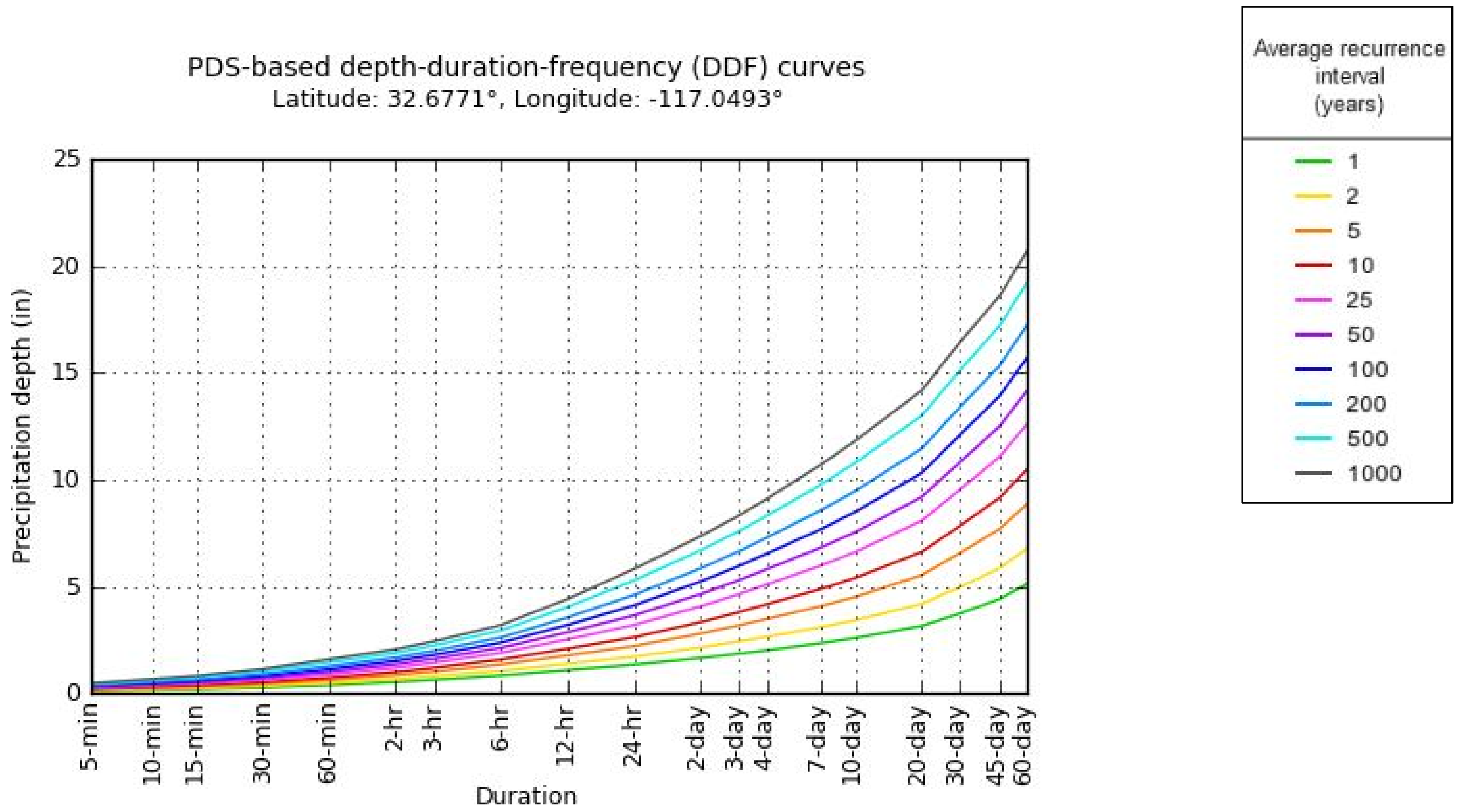
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

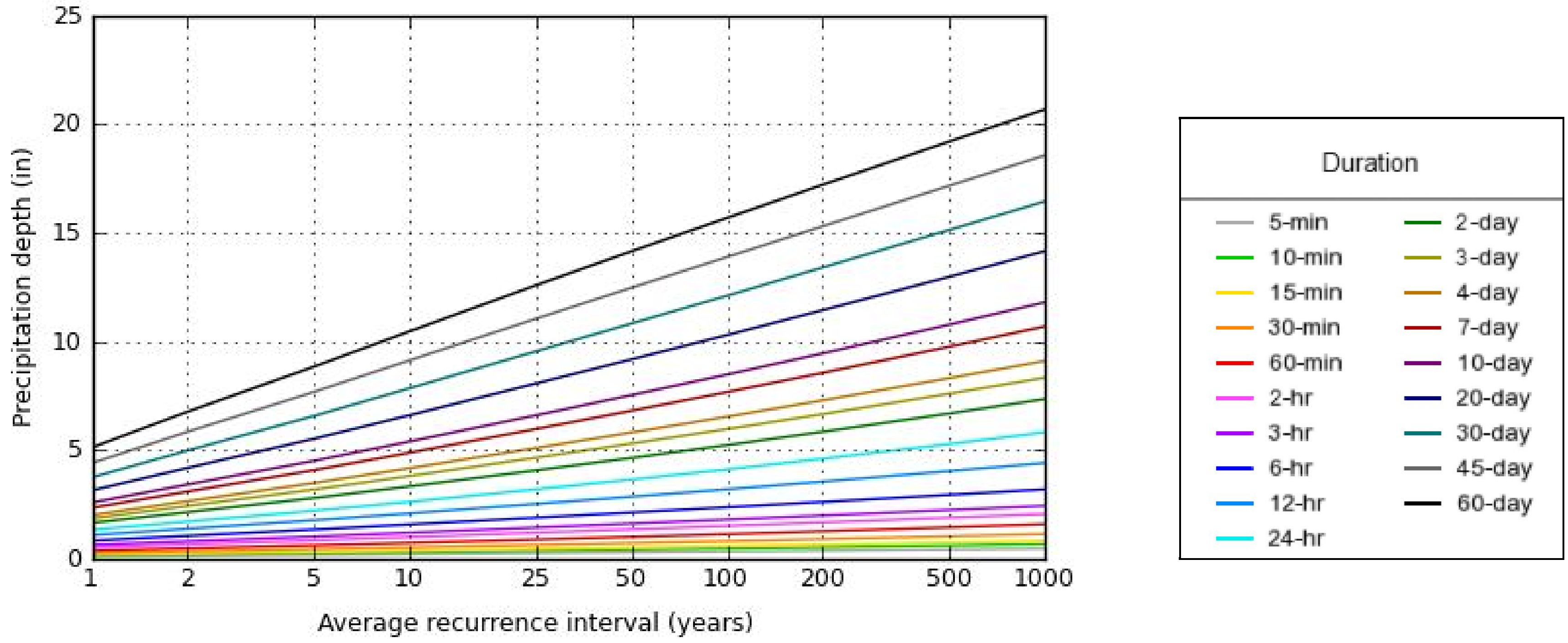
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





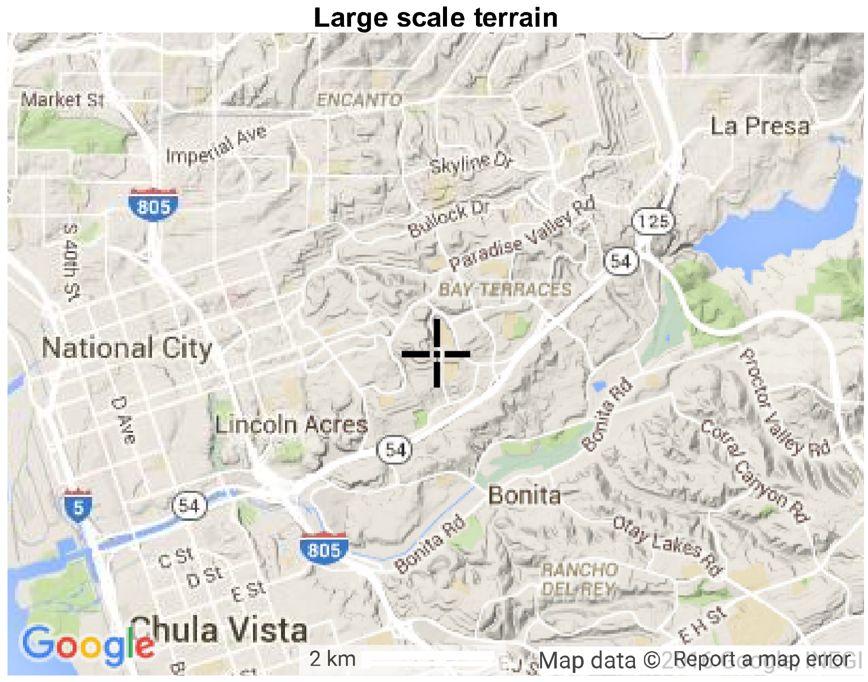
NOAA Atlas 14, Volume 6, Version 2 Created (GMT): Sat Mar 5 17:39:26 2016

Back to Top

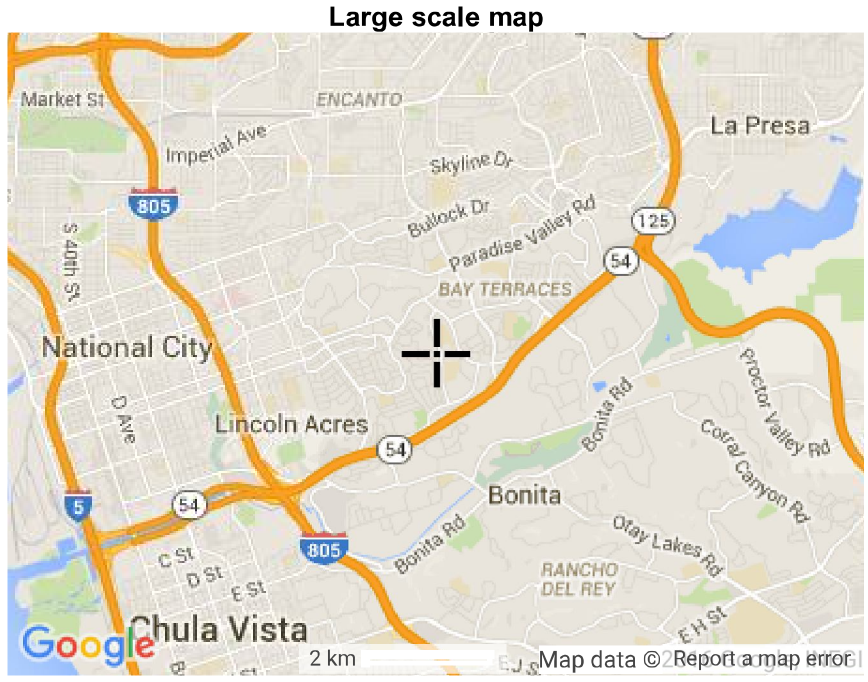
Maps & aerials

Small scale terrain

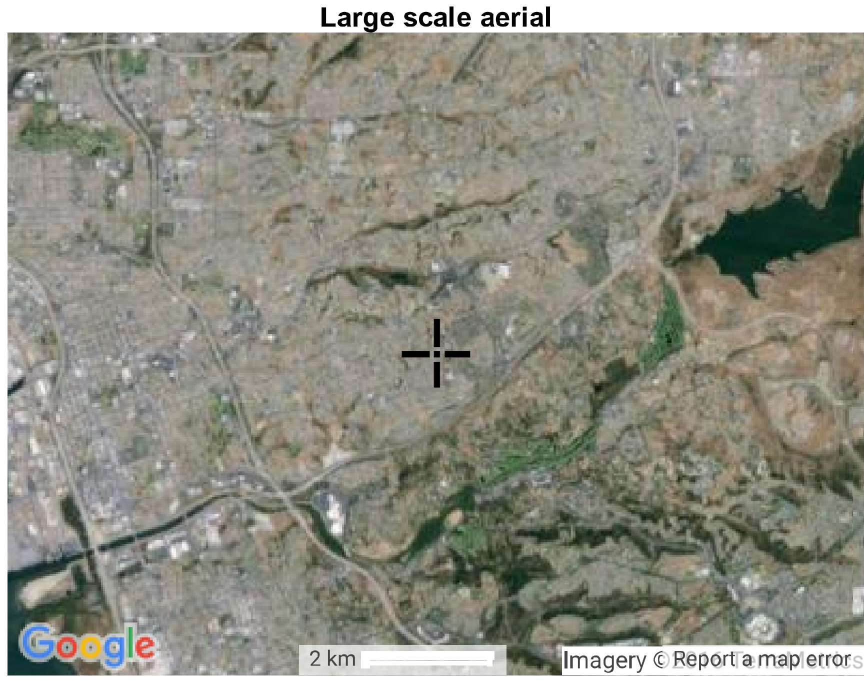
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

APPENDIX 1: PRECIPITATION ANALYSIS

SUB-AREA 2:

- NOAA Precipitation Maps
- Adjustment of NOAA Data into Intensity – Duration Equations

NOAA Atlas 14, Volume 6, Version 2
Location name: San Diego, California, US*
Latitude: 32.6781°, Longitude: -117.0649°
Elevation: 220 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

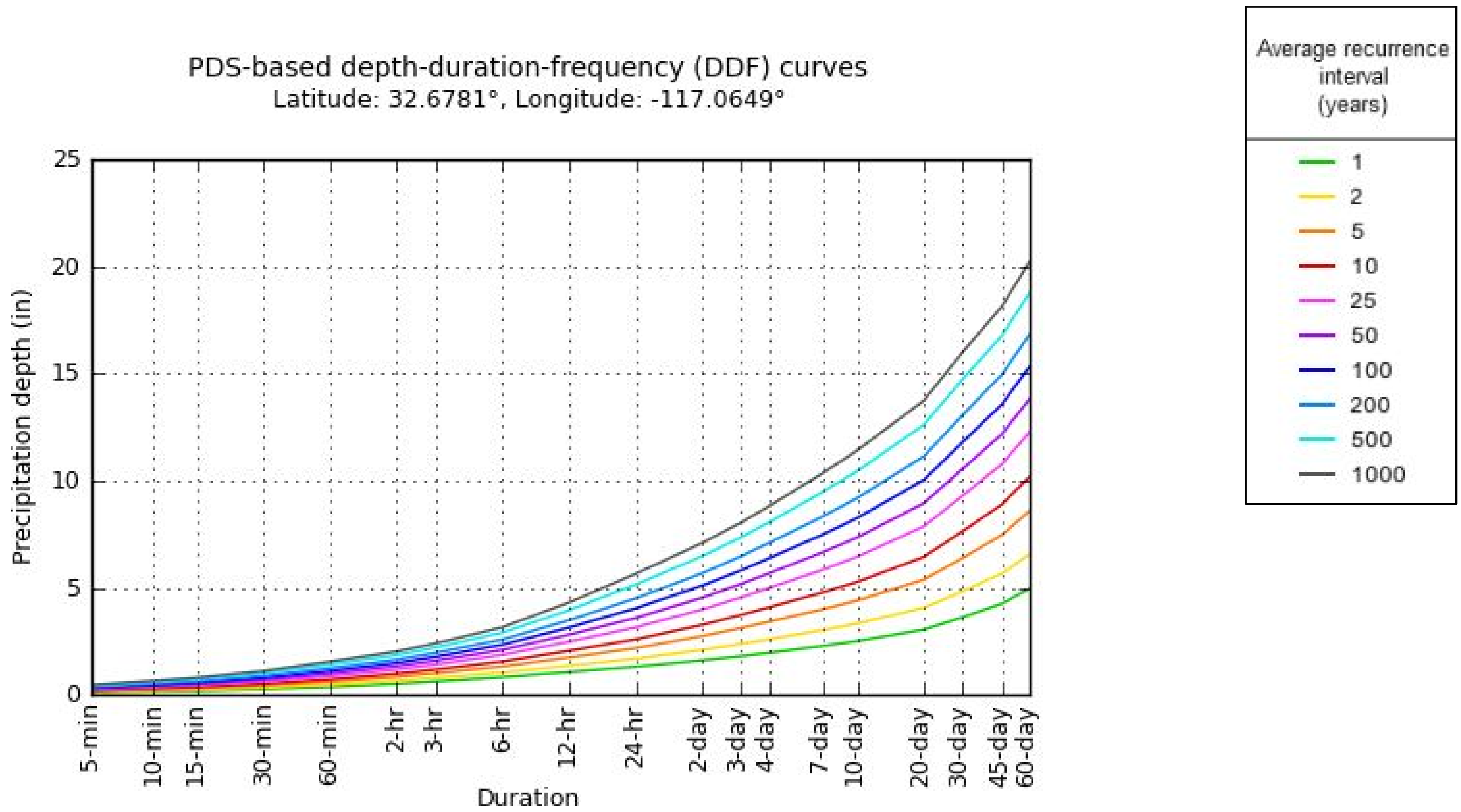
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

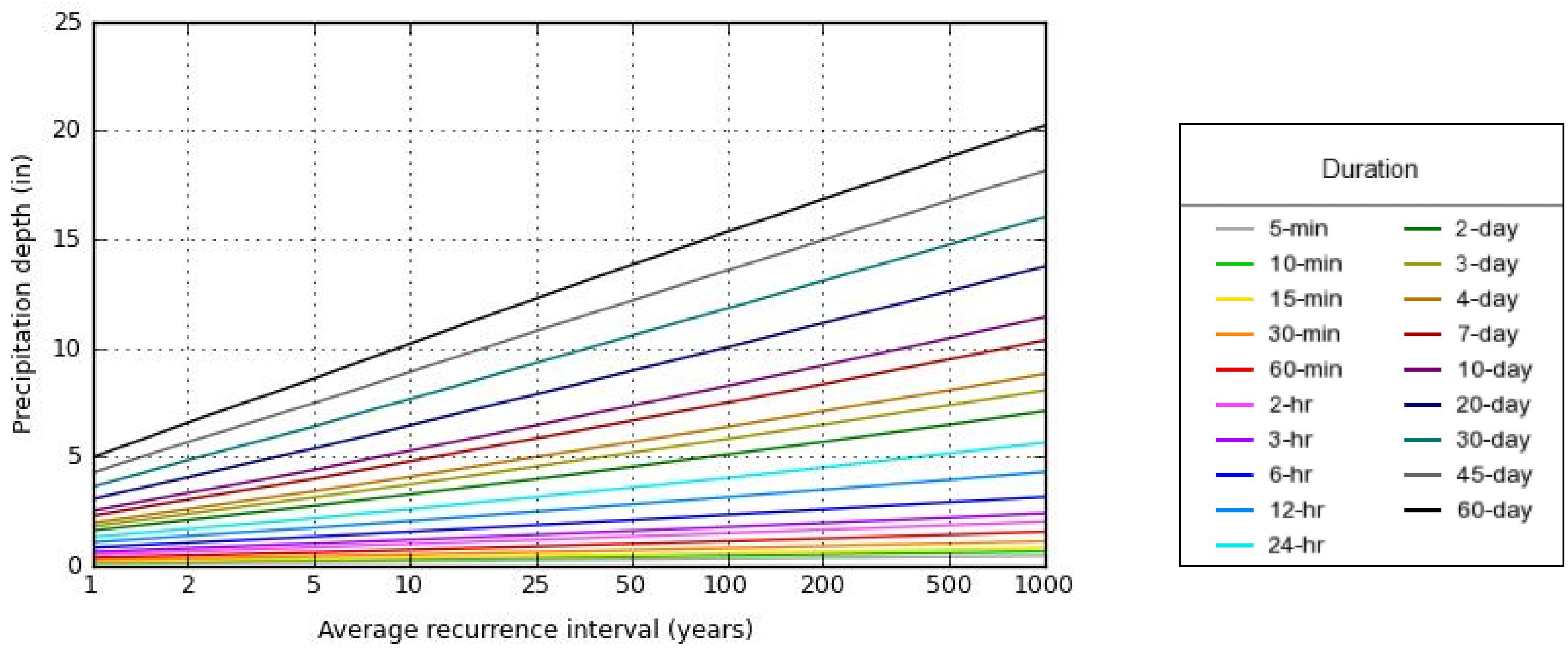
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.113** (0.094-0.136)	**0.143** (0.120-0.173)	**0.183** (0.153-0.222)	**0.216** (0.179-0.264)	**0.262** (0.209-0.331)	**0.297** (0.232-0.384)	**0.334** (0.254-0.443)	**0.372** (0.275-0.507)	**0.424** (0.300-0.604)	**0.464** (0.317-0.686)
10-min	**0.162** (0.135-0.195)	**0.205** (0.172-0.248)	**0.263** (0.219-0.318)	**0.310** (0.256-0.379)	**0.375** (0.300-0.475)	**0.426** (0.333-0.551)	**0.478** (0.364-0.634)	**0.533** (0.394-0.727)	**0.607** (0.430-0.866)	**0.666** (0.455-0.984)
15-min	**0.196** (0.164-0.236)	**0.248** (0.208-0.300)	**0.318** (0.265-0.385)	**0.375** (0.310-0.458)	**0.454** (0.362-0.574)	**0.515** (0.402-0.666)	**0.578** (0.440-0.767)	**0.644** (0.476-0.880)	**0.734** (0.520-1.05)	**0.805** (0.550-1.19)
30-min	**0.272** (0.228-0.328)	**0.345** (0.288-0.417)	**0.442** (0.368-0.535)	**0.521** (0.431-0.637)	**0.631** (0.503-0.798)	**0.716** (0.559-0.926)	**0.804** (0.612-1.07)	**0.895** (0.662-1.22)	**1.02** (0.723-1.46)	**1.12** (0.765-1.65)
60-min	**0.380** (0.318-0.459)	**0.482** (0.403-0.583)	**0.617** (0.514-0.748)	**0.728** (0.602-0.890)	**0.881** (0.703-1.11)	**1.00** (0.781-1.29)	**1.12** (0.855-1.49)	**1.25** (0.925-1.71)	**1.43** (1.01-2.03)	**1.56** (1.07-2.31)
2-hr	**0.526** (0.440-0.635)	**0.664** (0.555-0.803)	**0.845** (0.704-1.02)	**0.992** (0.820-1.21)	**1.19** (0.950-1.51)	**1.34** (1.05-1.74)	**1.50** (1.14-1.99)	**1.66** (1.22-2.26)	**1.87** (1.32-2.66)	**2.03** (1.39-3.00)
3-hr	**0.633** (0.529-0.764)	**0.799** (0.668-0.966)	**1.01** (0.846-1.23)	**1.19** (0.984-1.46)	**1.43** (1.14-1.80)	**1.60** (1.25-2.08)	**1.79** (1.36-2.37)	**1.97** (1.46-2.69)	**2.22** (1.57-3.17)	**2.41** (1.65-3.56)
6-hr	**0.828** (0.693-0.999)	**1.05** (0.876-1.27)	**1.33** (1.11-1.62)	**1.56** (1.29-1.91)	**1.87** (1.50-2.37)	**2.11** (1.65-2.73)	**2.35** (1.79-3.11)	**2.59** (1.91-3.53)	**2.91** (2.06-4.15)	**3.16** (2.16-4.67)
12-hr	**1.07** (0.898-1.29)	**1.37** (1.14-1.65)	**1.75** (1.46-2.12)	**2.06** (1.71-2.52)	**2.49** (1.99-3.15)	**2.82** (2.20-3.64)	**3.15** (2.40-4.18)	**3.49** (2.58-4.77)	**3.96** (2.80-5.64)	**4.32** (2.95-6.38)
24-hr	**1.32** (1.16-1.53)	**1.69** (1.48-1.97)	**2.19** (1.91-2.56)	**2.60** (2.25-3.06)	**3.16** (2.66-3.83)	**3.60** (2.97-4.45)	**4.04** (3.27-5.11)	**4.51** (3.55-5.85)	**5.15** (3.91-6.94)	**5.66** (4.16-7.86)
2-day	**1.62** (1.42-1.89)	**2.11** (1.84-2.46)	**2.75** (2.40-3.21)	**3.27** (2.84-3.86)	**3.99** (3.36-4.84)	**4.54** (3.75-5.62)	**5.11** (4.12-6.45)	**5.69** (4.48-7.38)	**6.48** (4.91-8.73)	**7.10** (5.21-9.86)
3-day	**1.82** (1.59-2.12)	**2.39** (2.09-2.78)	**3.13** (2.74-3.66)	**3.74** (3.24-4.40)	**4.56** (3.83-5.53)	**5.19** (4.28-6.42)	**5.83** (4.71-7.37)	**6.48** (5.10-8.40)	**7.37** (5.59-9.92)	**8.06** (5.92-11.2)
4-day	**1.97** (1.73-2.29)	**2.60** (2.28-3.03)	**3.42** (2.99-4.00)	**4.09** (3.55-4.82)	**4.99** (4.20-6.06)	**5.68** (4.69-7.03)	**6.38** (5.15-8.07)	**7.10** (5.59-9.20)	**8.06** (6.11-10.9)	**8.81** (6.47-12.2)
7-day	**2.29** (2.01-2.67)	**3.03** (2.65-3.54)	**4.00** (3.49-4.68)	**4.79** (4.15-5.64)	**5.85** (4.92-7.10)	**6.67** (5.50-8.24)	**7.49** (6.05-9.47)	**8.34** (6.56-10.8)	**9.48** (7.18-12.8)	**10.4** (7.61-14.4)
10-day	**2.52** (2.21-2.93)	**3.34** (2.92-3.89)	**4.41** (3.85-5.15)	**5.28** (4.57-6.21)	**6.45** (5.43-7.83)	**7.35** (6.07-9.09)	**8.26** (6.67-10.4)	**9.19** (7.24-11.9)	**10.4** (7.92-14.1)	**11.4** (8.39-15.9)
20-day	**3.05** (2.68-3.56)	**4.07** (3.56-4.75)	**5.39** (4.70-6.29)	**6.45** (5.59-7.59)	**7.87** (6.62-9.55)	**8.95** (7.39-11.1)	**10.0** (8.11-12.7)	**11.1** (8.77-14.4)	**12.6** (9.56-17.0)	**13.7** (10.1-19.1)
30-day	**3.63** (3.18-4.23)	**4.84** (4.24-5.64)	**6.40** (5.59-7.48)	**7.65** (6.63-9.01)	**9.31** (7.84-11.3)	**10.6** (8.72-13.1)	**11.8** (9.54-14.9)	**13.1** (10.3-17.0)	**14.8** (11.2-19.9)	**16.0** (11.8-22.3)
45-day	**4.27** (3.74-4.97)	**5.67** (4.97-6.62)	**7.47** (6.52-8.73)	**8.89** (7.71-10.5)	**10.8** (9.07-13.1)	**12.2** (10.1-15.1)	**13.6** (11.0-17.1)	**15.0** (11.8-19.4)	**16.8** (12.7-22.6)	**18.1** (13.3-25.2)
60-day	**4.97** (4.35-5.78)	**6.57** (5.75-7.66)	**8.60** (7.51-10.0)	**10.2** (8.84-12.0)	**12.3** (10.3-14.9)	**13.8** (11.4-17.1)	**15.3** (12.4-19.4)	**16.8** (13.3-21.8)	**18.8** (14.2-25.3)	**20.2** (14.9-28.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





NOAA Atlas 14, Volume 6, Version 2

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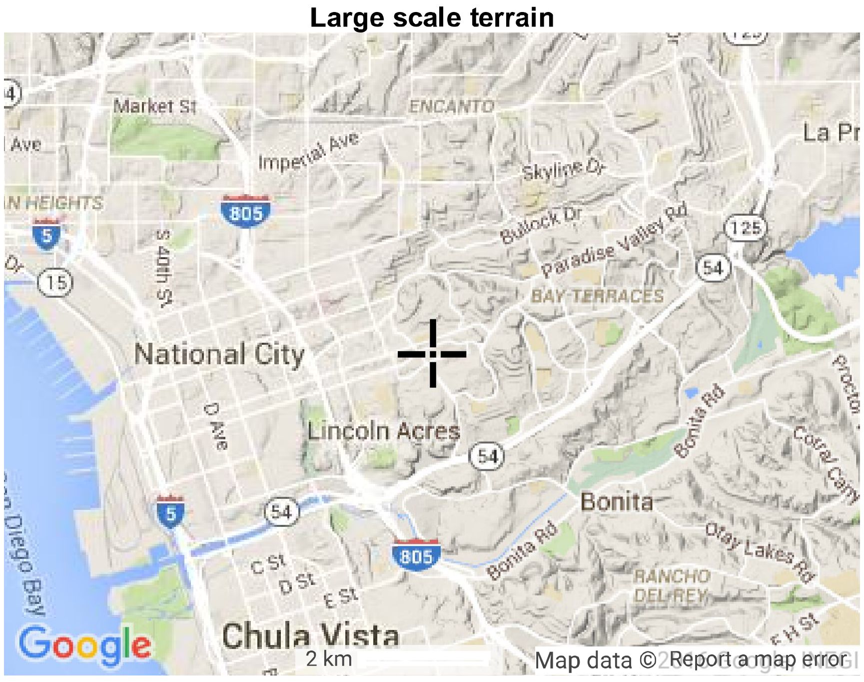
[Back to Top]

Maps & aerials

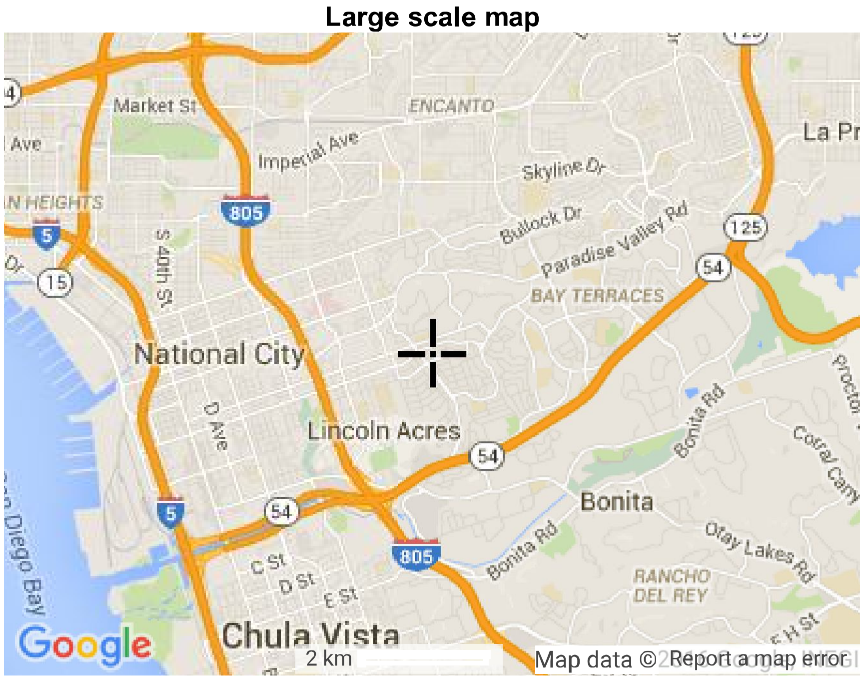
Small scale terrain

ATTACHMENT B, EXHIBIT J-1 - 19

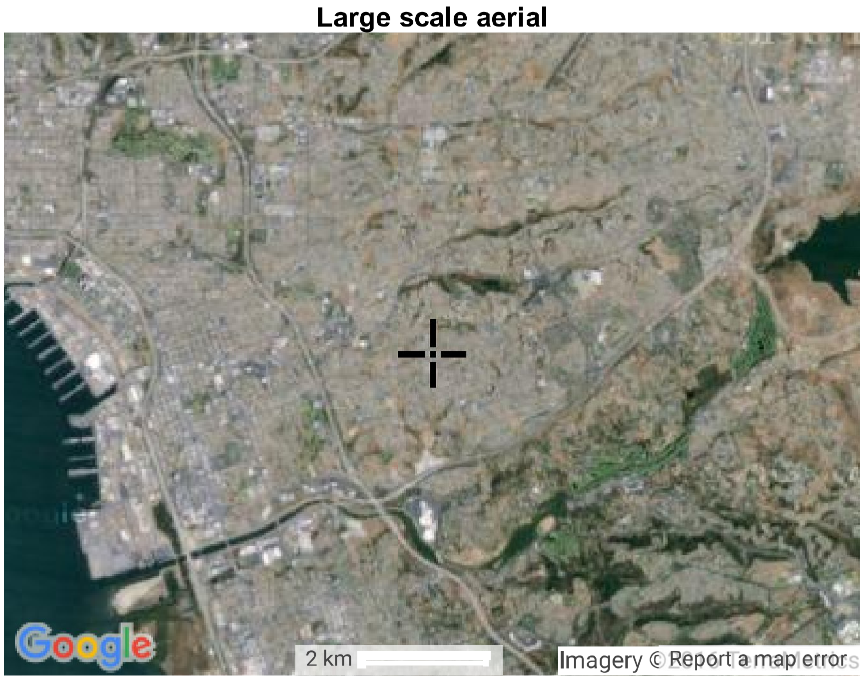
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

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[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

APPENDIX 1: PRECIPITATION ANALYSIS

SUB-AREA 3:

- NOAA Precipitation Maps
- Adjustment of NOAA Data into Intensity – Duration Equations

NOAA Atlas 14, Volume 6, Version 2
Location name: National City, California, US*
Latitude: 32.6583°, Longitude: -117.0702°
Elevation: 28 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

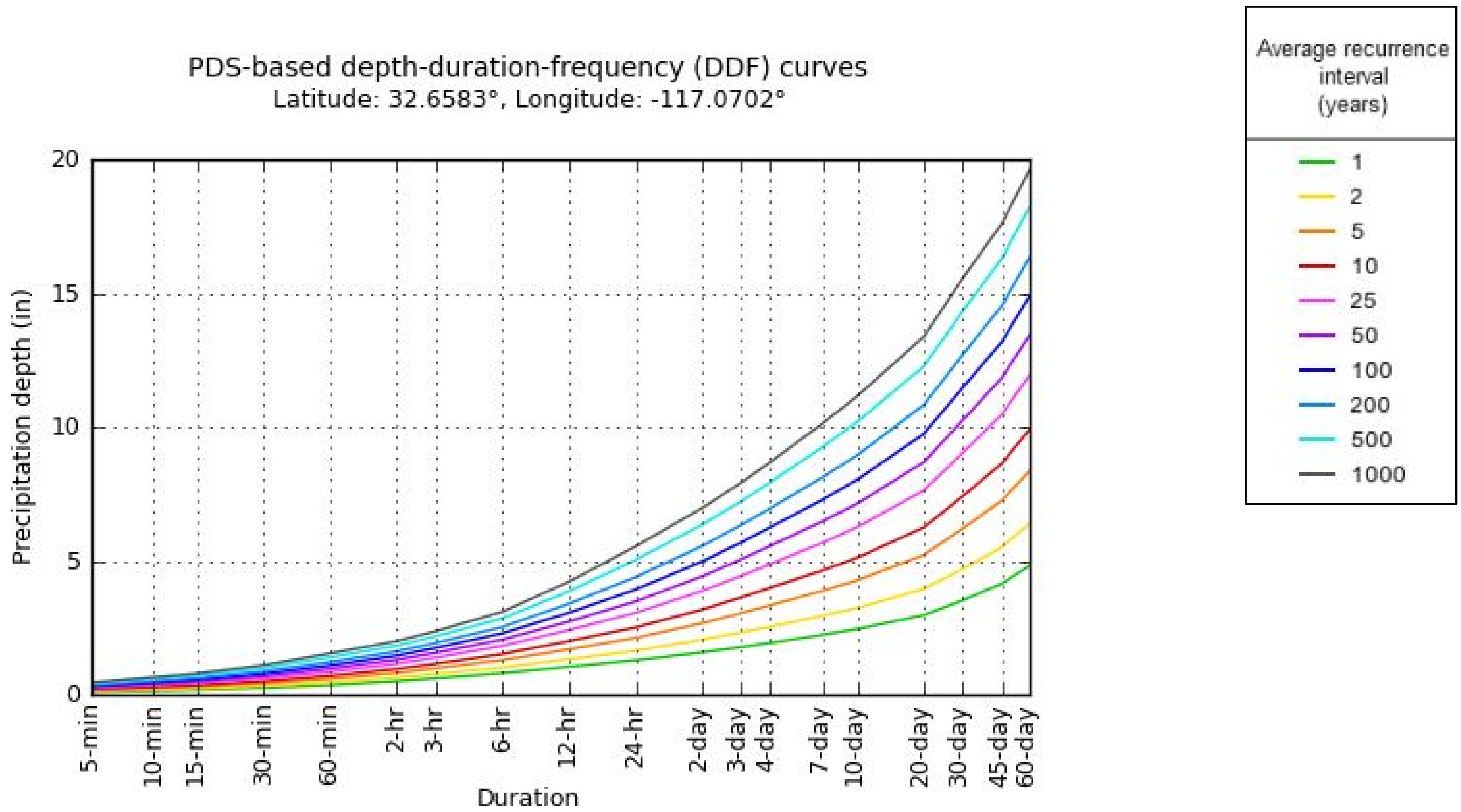
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

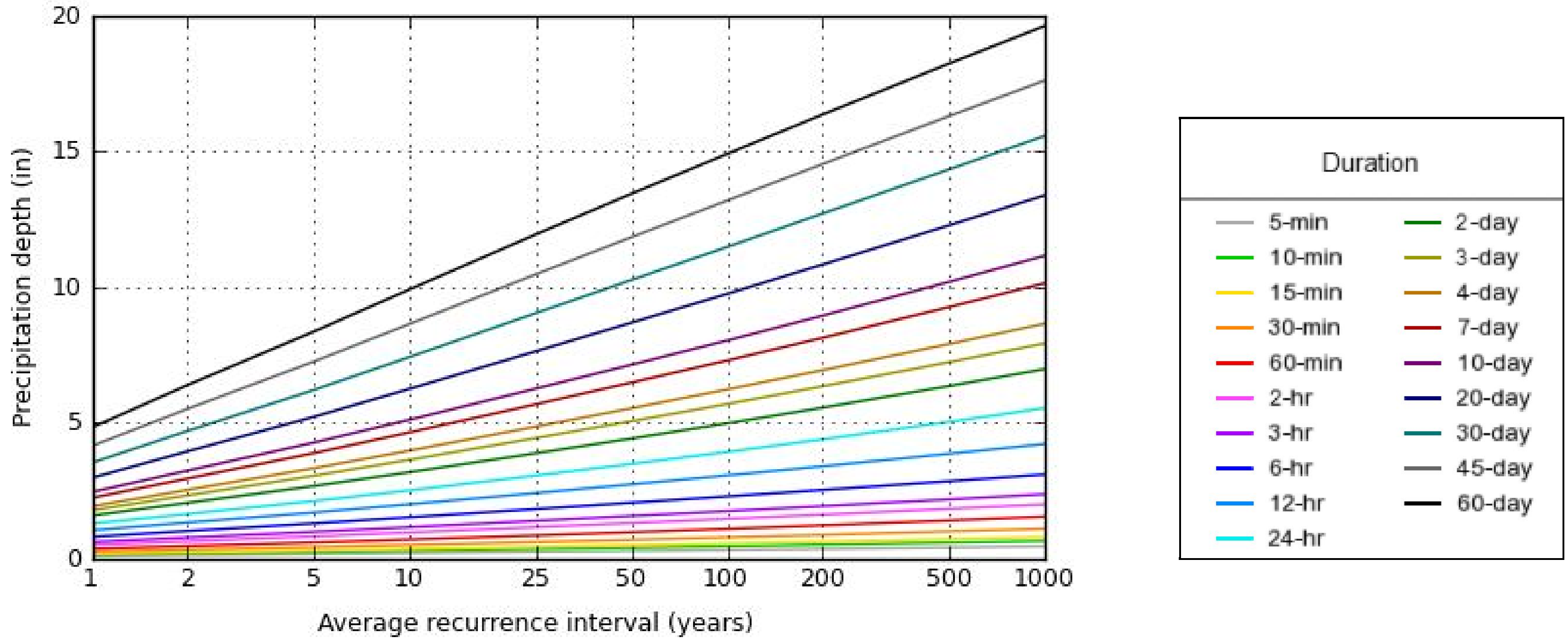
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.111** (0.093-0.134)	**0.140** (0.117-0.169)	**0.179** (0.149-0.217)	**0.212** (0.175-0.259)	**0.257** (0.205-0.325)	**0.292** (0.228-0.378)	**0.328** (0.250-0.436)	**0.367** (0.271-0.501)	**0.420** (0.297-0.598)	**0.461** (0.315-0.682)
10-min	**0.159** (0.133-0.192)	**0.201** (0.168-0.243)	**0.257** (0.214-0.311)	**0.303** (0.251-0.371)	**0.368** (0.293-0.465)	**0.418** (0.327-0.541)	**0.471** (0.358-0.625)	**0.526** (0.389-0.718)	**0.601** (0.426-0.858)	**0.661** (0.452-0.977)
15-min	**0.192** (0.161-0.232)	**0.243** (0.203-0.293)	**0.311** (0.259-0.376)	**0.367** (0.303-0.448)	**0.445** (0.355-0.563)	**0.506** (0.395-0.655)	**0.569** (0.433-0.755)	**0.636** (0.470-0.868)	**0.727** (0.515-1.04)	**0.800** (0.547-1.18)
30-min	**0.267** (0.224-0.323)	**0.338** (0.282-0.408)	**0.432** (0.360-0.524)	**0.511** (0.422-0.624)	**0.619** (0.494-0.784)	**0.704** (0.550-0.911)	**0.793** (0.603-1.05)	**0.885** (0.654-1.21)	**1.01** (0.717-1.44)	**1.11** (0.761-1.65)
60-min	**0.373** (0.312-0.450)	**0.472** (0.394-0.570)	**0.604** (0.503-0.732)	**0.713** (0.589-0.872)	**0.865** (0.690-1.09)	**0.983** (0.768-1.27)	**1.11** (0.842-1.47)	**1.24** (0.914-1.69)	**1.41** (1.00-2.02)	**1.55** (1.06-2.30)
2-hr	**0.516** (0.432-0.623)	**0.651** (0.544-0.787)	**0.829** (0.690-1.00)	**0.973** (0.804-1.19)	**1.17** (0.933-1.48)	**1.32** (1.03-1.71)	**1.47** (1.12-1.95)	**1.63** (1.21-2.23)	**1.84** (1.31-2.63)	**2.01** (1.37-2.97)
3-hr	**0.622** (0.520-0.751)	**0.785** (0.656-0.949)	**0.997** (0.831-1.21)	**1.17** (0.966-1.43)	**1.40** (1.12-1.77)	**1.58** (1.23-2.04)	**1.76** (1.34-2.33)	**1.94** (1.44-2.65)	**2.19** (1.55-3.12)	**2.38** (1.63-3.52)
6-hr	**0.813** (0.680-0.981)	**1.03** (0.859-1.24)	**1.31** (1.09-1.58)	**1.53** (1.27-1.87)	**1.83** (1.47-2.32)	**2.07** (1.61-2.67)	**2.30** (1.75-3.05)	**2.54** (1.88-3.47)	**2.86** (2.03-4.08)	**3.11** (2.12-4.59)
12-hr	**1.05** (0.883-1.27)	**1.34** (1.12-1.62)	**1.71** (1.42-2.07)	**2.01** (1.66-2.46)	**2.42** (1.94-3.07)	**2.75** (2.14-3.55)	**3.07** (2.34-4.08)	**3.41** (2.52-4.66)	**3.87** (2.74-5.52)	**4.23** (2.89-6.25)
24-hr	**1.30** (1.14-1.51)	**1.66** (1.45-1.93)	**2.13** (1.86-2.49)	**2.52** (2.19-2.97)	**3.07** (2.58-3.72)	**3.50** (2.88-4.32)	**3.94** (3.18-4.98)	**4.40** (3.46-5.71)	**5.04** (3.82-6.79)	**5.55** (4.08-7.72)
2-day	**1.60** (1.40-1.86)	**2.06** (1.80-2.41)	**2.68** (2.34-3.13)	**3.19** (2.77-3.76)	**3.89** (3.27-4.72)	**4.43** (3.66-5.48)	**4.99** (4.03-6.31)	**5.57** (4.38-7.22)	**6.36** (4.82-8.57)	**6.99** (5.13-9.71)
3-day	**1.79** (1.57-2.08)	**2.34** (2.04-2.73)	**3.06** (2.67-3.58)	**3.65** (3.16-4.29)	**4.45** (3.74-5.40)	**5.07** (4.18-6.27)	**5.70** (4.60-7.21)	**6.35** (5.00-8.24)	**7.24** (5.49-9.75)	**7.93** (5.83-11.0)
4-day	**1.94** (1.70-2.25)	**2.54** (2.22-2.96)	**3.34** (2.91-3.90)	**3.99** (3.46-4.70)	**4.87** (4.09-5.91)	**5.55** (4.58-6.86)	**6.24** (5.04-7.88)	**6.95** (5.47-9.01)	**7.91** (6.00-10.7)	**8.66** (6.36-12.0)
7-day	**2.25** (1.97-2.62)	**2.96** (2.59-3.45)	**3.89** (3.40-4.55)	**4.66** (4.03-5.48)	**5.69** (4.79-6.91)	**6.49** (5.36-8.03)	**7.30** (5.89-9.23)	**8.14** (6.41-10.6)	**9.27** (7.03-12.5)	**10.2** (7.46-14.1)
10-day	**2.46** (2.16-2.87)	**3.25** (2.84-3.79)	**4.28** (3.74-5.01)	**5.12** (4.44-6.03)	**6.27** (5.27-7.61)	**7.15** (5.90-8.84)	**8.04** (6.49-10.2)	**8.96** (7.05-11.6)	**10.2** (7.73-13.7)	**11.2** (8.20-15.5)
20-day	**2.98** (2.61-3.47)	**3.96** (3.46-4.62)	**5.23** (4.57-6.12)	**6.26** (5.42-7.37)	**7.64** (6.43-9.27)	**8.70** (7.18-10.8)	**9.76** (7.88-12.3)	**10.8** (8.53-14.1)	**12.3** (9.31-16.5)	**13.4** (9.83-18.6)
30-day	**3.54** (3.10-4.12)	**4.71** (4.12-5.49)	**6.22** (5.43-7.27)	**7.43** (6.44-8.75)	**9.05** (7.61-11.0)	**10.3** (8.47-12.7)	**11.5** (9.27-14.5)	**12.7** (10.0-16.5)	**14.3** (10.9-19.3)	**15.6** (11.4-21.6)
45-day	**4.16** (3.64-4.84)	**5.52** (4.83-6.44)	**7.26** (6.34-8.49)	**8.65** (7.50-10.2)	**10.5** (8.81-12.7)	**11.8** (9.77-14.6)	**13.2** (10.6-16.7)	**14.5** (11.4-18.8)	**16.3** (12.4-21.9)	**17.6** (12.9-24.5)
60-day	**4.84** (4.24-5.63)	**6.40** (5.60-7.46)	**8.37** (7.31-9.78)	**9.92** (8.60-11.7)	**11.9** (10.0-14.5)	**13.4** (11.1-16.6)	**14.9** (12.0-18.8)	**16.4** (12.9-21.2)	**18.2** (13.8-24.6)	**19.6** (14.4-27.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





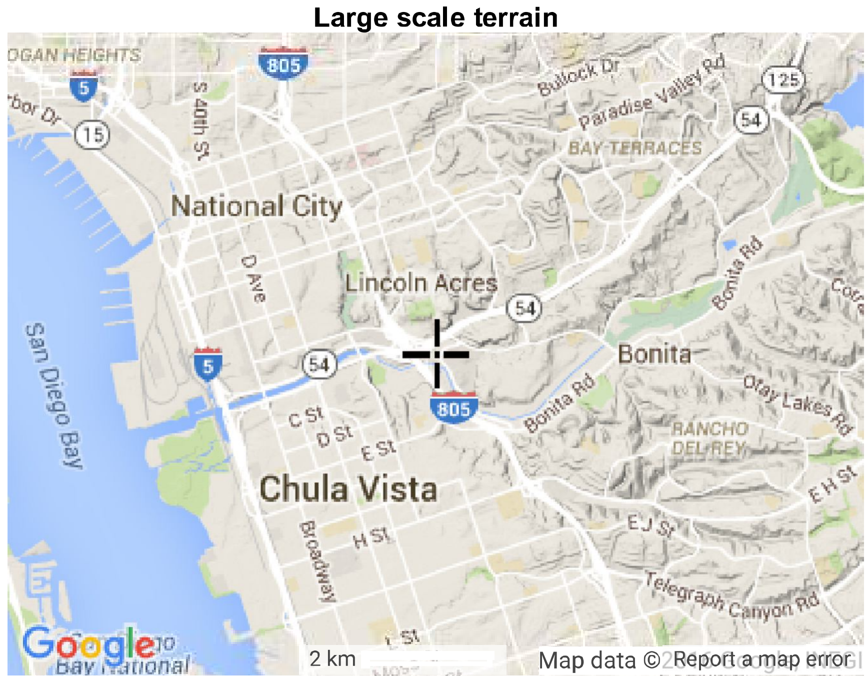
NOAA Atlas 14, Volume 6, Version 2 Created (GMT): Sat Mar 5 17:18:24 2016

Back to Top

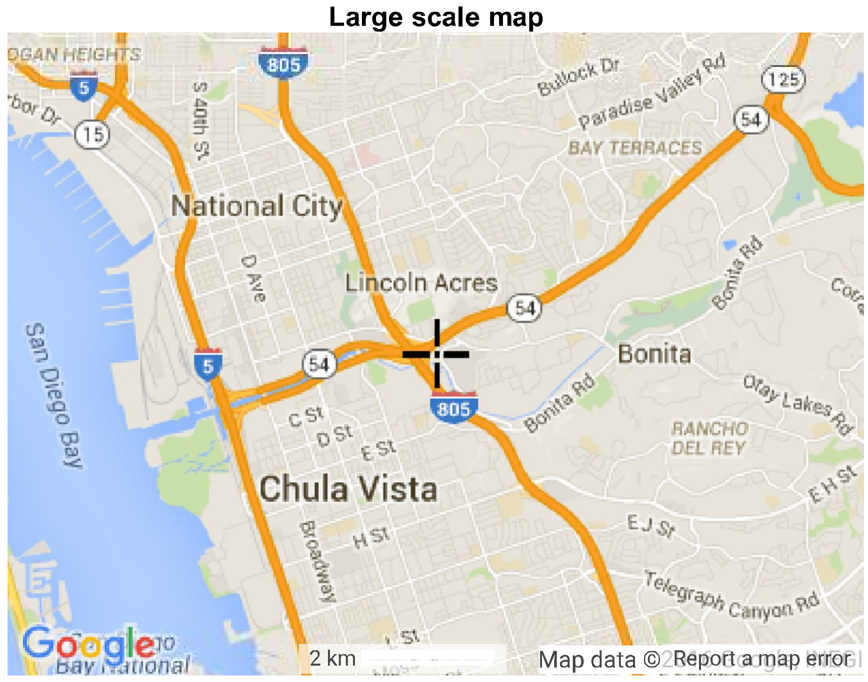
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

[Back to Top](#)

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

PRECIPITATION VALUES TO BE USED IN HEC-HMS FOR DMA-1 and DMA-2

INTERPOLATION OF TABLE 4-1 OF SDCHM

Area	5 min	15 min	30 min	1 hr	3 hr	6 hr	12 hr	24 hr
0	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
3.169	**0.920**	**0.946**	**0.963**	**0.981**	**0.987**	**0.990**	**0.992**	**0.994**
5	**0.873**	**0.915**	**0.942**	**0.97**	**0.98**	**0.985**	**0.9875**	**0.99**

Bold black values: Values taken from Table 4-1

Red bold values: Values interpolated for A = 5 sq-miles at different time durations
(values interpolated linearly with log-log values of duration and adjustment factor)

Green bold values: Linear interpolation in Area at a given storm duration.
Green values to be multiplied by NOAA values to determine rainfall to use in HEC-HMS

A-1: 2.168 sq-miles (Area of DMA-1)
A-2: 1.011 sq-miles (Area of DMA-2)
A-TOT: 3.179 sq-miles (Total Area of DMA-1 + DMA-2)

t (min)	P_{A-1} (in)	P_{A-2} (in)	P_{A-TOT} (in)	Adjust	P_{MODEL} (in)
5	0.339	0.334	0.337	0.920	0.310
15	0.587	0.578	0.584	0.946	0.553
60	1.14	1.12	1.13	0.963	1.09
120	1.52	1.50	1.51	0.981	1.48
180	1.81	1.79	1.80	0.987	1.78
360	2.38	2.35	2.37	0.990	2.35
720	3.20	3.15	3.18	0.992	3.16
1440	4.12	4.04	4.09	0.994	4.07

EXPLANATION OF VARIABLES

t: duration of rainfall (minutes)

P_{A-1}: 100 yr NOAA Precipitation at the centroid of area A-1 (BMA-1), in inches

P_{A-2}: 100 yr NOAA Precipitation at the centroid of area A-2 (BMA-2), in inches

P_{A-TOT}: weighted average of the rain at the total contributing area, in inches

$P_{A-TOT} = (A\text{-}1 \cdot P_{A-1} + A\text{-}2 \cdot P_{A-2})/A\text{-}TOT$

Adjust: Coefficient to adjust the precipitation according to duration
(green values from interpolation of Table 4-1 of the SDCHM)

P_{MODEL}: Precipitation to use in the HEC-HMS model ($P_{MODEL} = \text{Adjust} \cdot P_{A-TOT}$)

APPENDIX 2

LAND COVER, SCS CURVE NUMBER, LAG TIME

Calculations

Modification on CN due to PZN

CURVE NUMBER DETERMINATION

DMA-1

Soil C (%):	43.28	
Soil D (%):	56.72	
CN-C:	74	
CN-D:	80	
CN-II (average):	77.40	(%D · CN-D + % C · CN-C)
CN-I (Table 4-11):	59.82	[also obtained with CN-I equation per Ponce's: CN-I = CN-II/(2.3-0.013·CN-II)]
CN-I.5:	68.61	CN-1.5 = CN-I/2 + CN-II/2
Ia:	0.915	Ia = 0.2·(1000/CN-1.5-10)

DMA-2

Soil C (%):	12.63	
Soil D (%):	87.37	
CN-C:	74	
CN-D:	80	
CN-II (average):	79.24	(%D · CN-D + % C · CN-C)
CN-I (Table 4-11):	62.40	[also obtained with CN-I equation per Ponce's: CN-I = CN-II/(2.3-0.013·CN-II)]
CN-I.5:	70.82	CN-1.5 = CN-I/2 + CN-II/2
Ia:	0.824	Ia = 0.2·(1000/CN-1.5-10)

Note:
Percentage impervious was determined from the maps, as an approximation of roofs, side-walk, streets and other impervious areas.

LAG-TIME DETERMINATION

VARIABLE	DMA-1	DMA-2	DMA-3, Pre	DMA-3, Post
Area (acres)	1387.4	646.9	51.6	51.6
Area (sq-miles)	2.168	1.011	0.081	0.081
% imperv:	30.80%	30.50%	70.80%	83.10%
n, average:	0.0386	0.0387	0.0238	0.0193
L max, ft:	19400	10880	1800	1800
L max, miles:	3.674	2.061	0.341	0.341
Lc, ft:	11400	5550	1200	1200
Lc, miles:	2.159	1.051	0.227	0.227
s, ft/miles:	119.6	150.7	26.4	26.4
Corps Tlag (hr):	0.820	0.481	0.116	0.094
Corps Tlag (min):	49.21	28.84	6.96	5.63
NRCS lag (min):	39.92	22.36	n/a	n/a

Explanation of variables

n, average: n,average = (0.013 · % imperv + 0.05 · % perv)/100

As an approximation, impervious areas are assigned n = 0.013 and pervious areas n = 0.05

L max: Maximum water-path length, measured in the area analyzed

Lc: Length along L max from the discharge to the closest point in Lmax to the centroid

s, ft/miles: overall slope of drainage area, approximately equal to the slope of longest waterpath

Corps Tlag (hr): Determined with eq. 4-17: $Tlag = 24 \cdot n,average \cdot [(Lmax \cdot Lc)/s^{0.5}]^{0.38}$

Note: use Lmax and Lc in miles, and s in ft/miles.

NRCS lag (min): To be used in HEC-HMS. It is obtained as: NRCS lag = 0.862·Corps Tlag - D/2

Use Corps Tlag in minutes, and D is the shortest storm duration = 5 minutes.

APPENDIX 3

DMA 3 RATIONAL METHOD

Rational Method Calculations & Hydrographs

RATIONAL METHOD CALCULATIONS FOR DMA-3

t (min)	P_{NOAA} (in)	I_{NOAA} (in/hr)
5	0.328	3.936
10	0.471	2.826

Existing

ai:	0.7083	
C:	0.725	
A:	51.6	acres
Tc:	8.95	min
I:	2.980	in/hr
$Q_{3,pre}$:	111.5	cfs
$Vol_{3,pre}$:	12.28	acre-ft

NOAA: $I = 8.4946 \cdot Tc^{-0.478}$

(log-log interpolation to determine intensity)

P_{24}: 3.94 inches (per NOAA)

(to be used in 24 hr runoff volume calcs)

P_6: 2.3 inches (per NOAA)

(to be used in RatHydro)

Proposed

ai:	0.8314	
C:	0.799	
A:	51.6	acres
Tc:	7.26	min
I:	3.293	in/hr
$Q_{3,post}$:	135.8	cfs
$Vol_{3,post}$:	13.54	acre-ft

Explanation of variables

C: approximate C value as a function of the imperviousness fraction ai.

$C = 0.9 \cdot ai + 0.3 \cdot (1 - ai)$

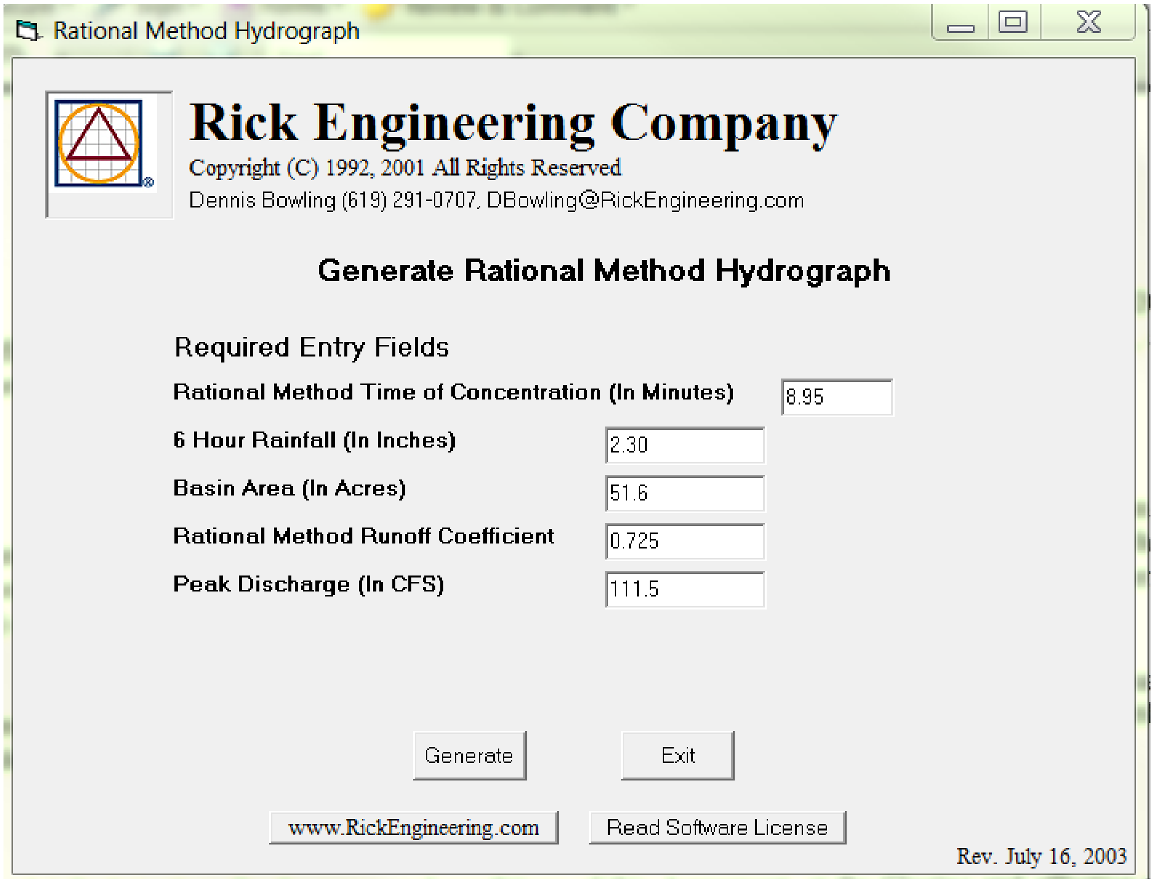
Note: Practically 100% of the pervious area of DMA-3 is soil type C with C = 0.3

Tc: Per SDCHM equation 4-23, Tc = Corp Tlag / (1.16 · 0.67)

I: Intensity (in/hr) per NOAA log-log interpolation shown in this page

Q_3: $C \cdot I \cdot A$ (cfs)

Vol_3: $P_{24} \cdot A \cdot C/12$ (acre-ft)


Rational Method Hydrograph
Rick Engineering Company
Copyright (C) 1992, 2001 All Rights Reserved
Dennis Bowling (619) 291-0707, DBowling@RickEngineering.com
Generate Rational Method Hydrograph
Required Entry Fields
Rational Method Time of Concentration (In Minutes)
8.95
6 Hour Rainfall (In Inches)
2.30
Basin Area (In Acres)
51.6
Rational Method Runoff Coefficient
0.725
Peak Discharge (In CFS)
111.5
Generate
Exit
www.RickEngineering.com
Read Software License
Rev. July 16, 2003

RATIONAL METHOD HYDROGRAPH PROGRAM

RUN DATE 10/13/2020
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 9 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 51.6 ACRES
RUNOFF COEFFICIENT 0.725
PEAK DISCHARGE 111.5 CFS

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TIME (MIN) = 9	DISCHARGE (CFS) = 0
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TIME (MIN) = 27	DISCHARGE (CFS) = 5.3
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TIME (MIN) = 333	DISCHARGE (CFS) = 6.5
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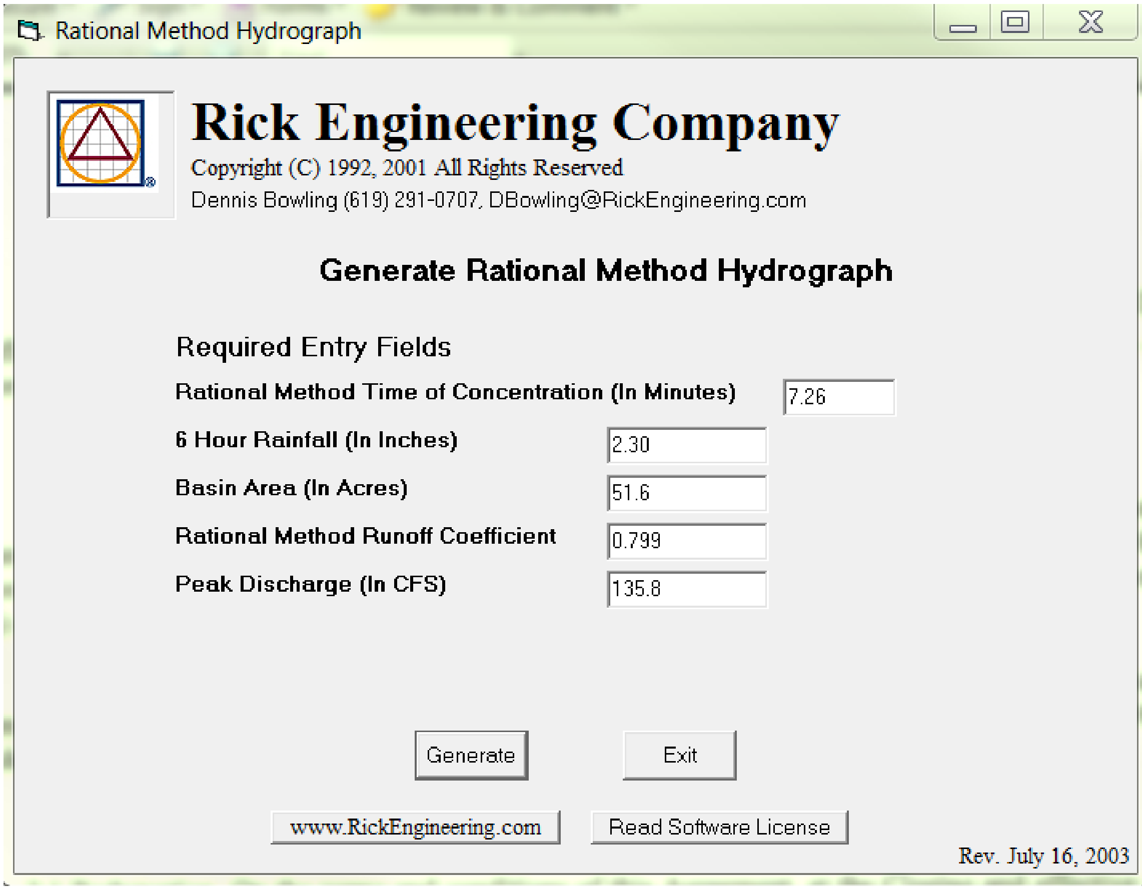
Rational Method Hydrograph
Rick Engineering Company
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Dennis Bowling (619) 291-0707, DBowling@RickEngineering.com
Generate Rational Method Hydrograph
Required Entry Fields
Rational Method Time of Concentration (In Minutes) 7.26
6 Hour Rainfall (In Inches) 2.30
Basin Area (In Acres) 51.6
Rational Method Runoff Coefficient 0.799
Peak Discharge (In CFS) 135.8
Generate
Exit
www.RickEngineering.com
Read Software License
Rev. July 16, 2003

RATIONAL METHOD HYDROGRAPH PROGRAM

RUN DATE 10/13/2020
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 51.6 ACRES
RUNOFF COEFFICIENT 0.799
PEAK DISCHARGE 135.8 CFS

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TIME (MIN) = 315	DISCHARGE (CFS) = 7.9
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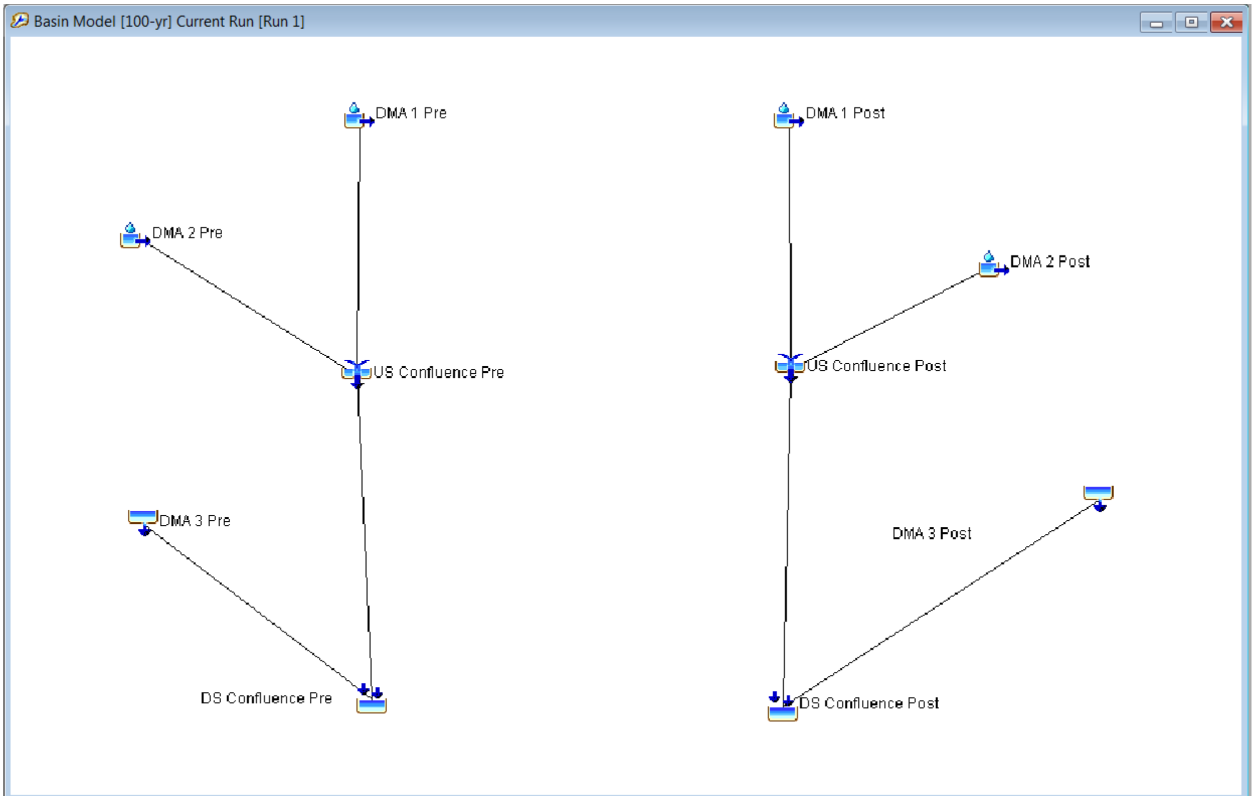
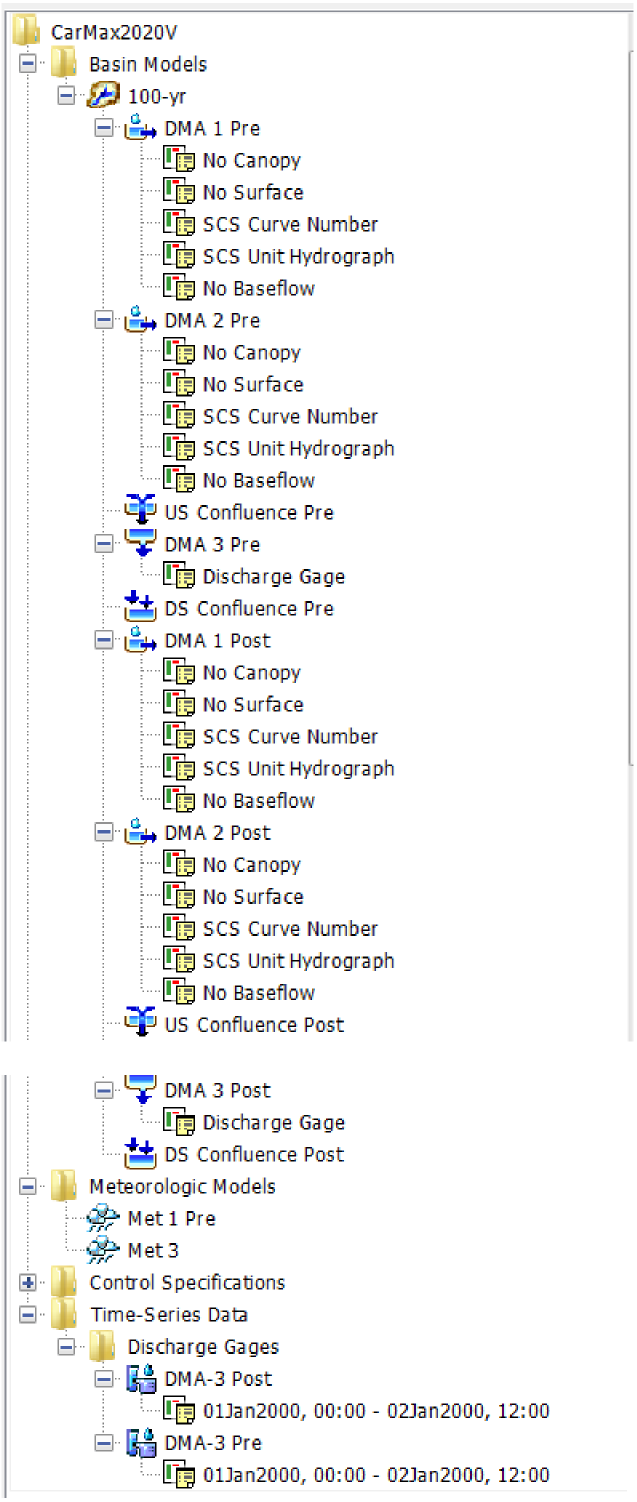
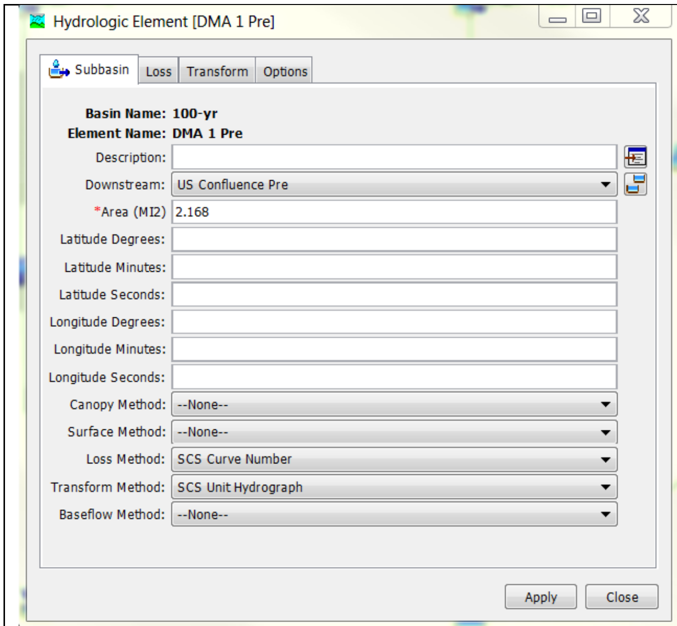
APPENDIX 4

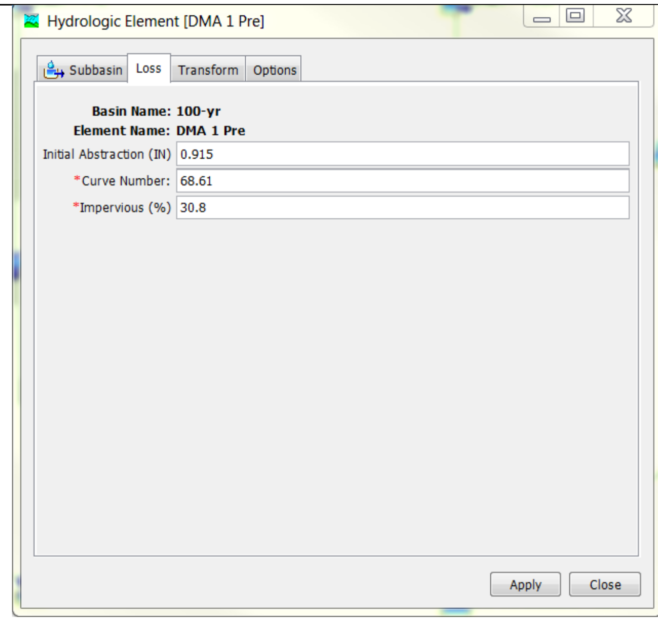
US ARMY CORPS HEC-HMS

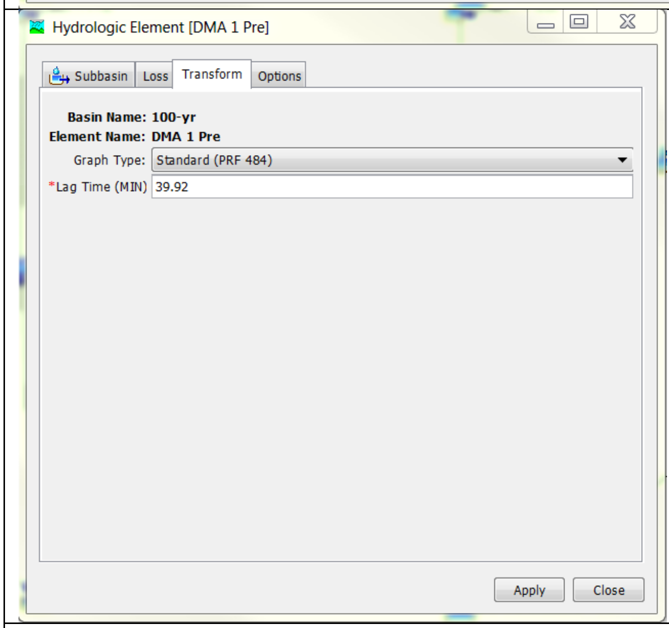
Program Results & Screen Shots

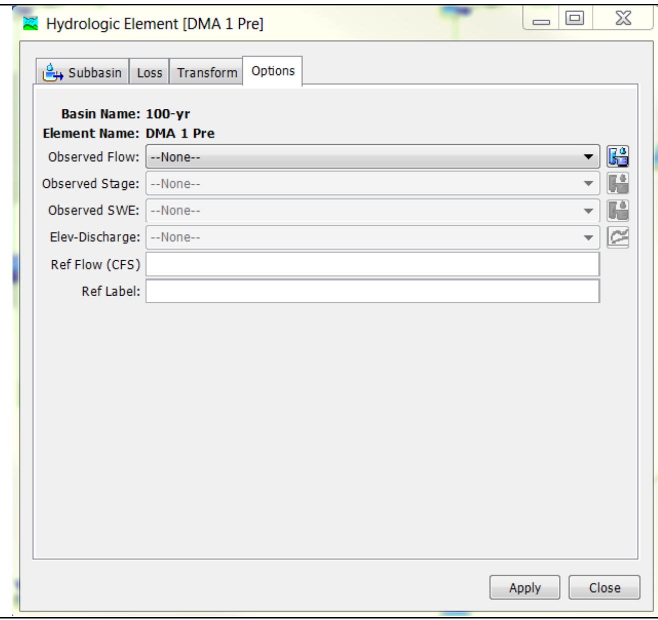

Basin Model [100-yr] Current Run [Run 1]
DMA 1 Pre
DMA 2 Pre
US Confluence Pre
DMA 3 Pre
DS Confluence Pre
DMA 1 Post
DMA 2 Post
US Confluence Post
DMA 3 Post
DS Confluence Post


CarMax2020V
Basin Models
100-yr
DMA 1 Pre
No Canopy
No Surface
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
DMA 2 Pre
No Canopy
No Surface
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
US Confluence Pre
DMA 3 Pre
Discharge Gage
DS Confluence Pre
DMA 1 Post
No Canopy
No Surface
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
DMA 2 Post
No Canopy
No Surface
SCS Curve Number
SCS Unit Hydrograph
No Baseflow
US Confluence Post
DMA 3 Post
Discharge Gage
DS Confluence Post
Meteorologic Models
Met 1 Pre
Met 3
Control Specifications
Time-Series Data
Discharge Gages
DMA-3 Post
01Jan2000, 00:00 - 02Jan2000, 12:00
DMA-3 Pre
01Jan2000, 00:00 - 02Jan2000, 12:00

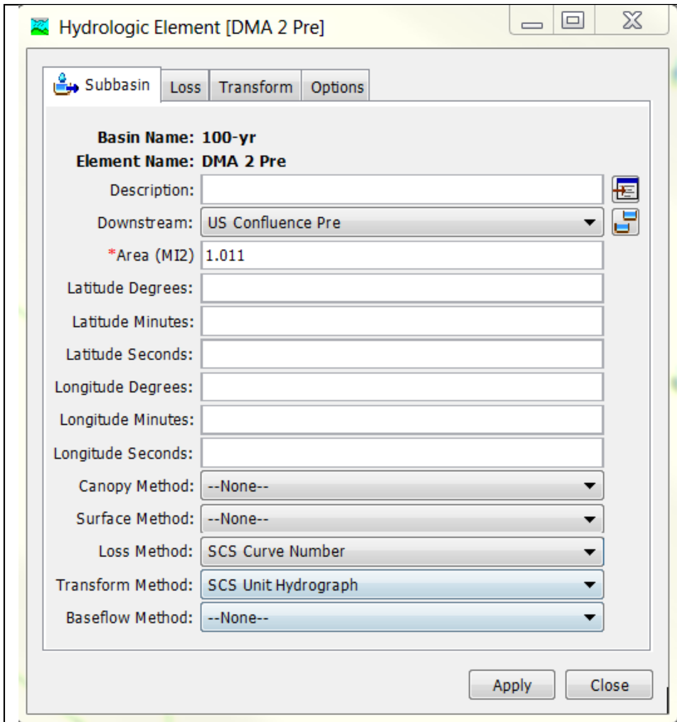


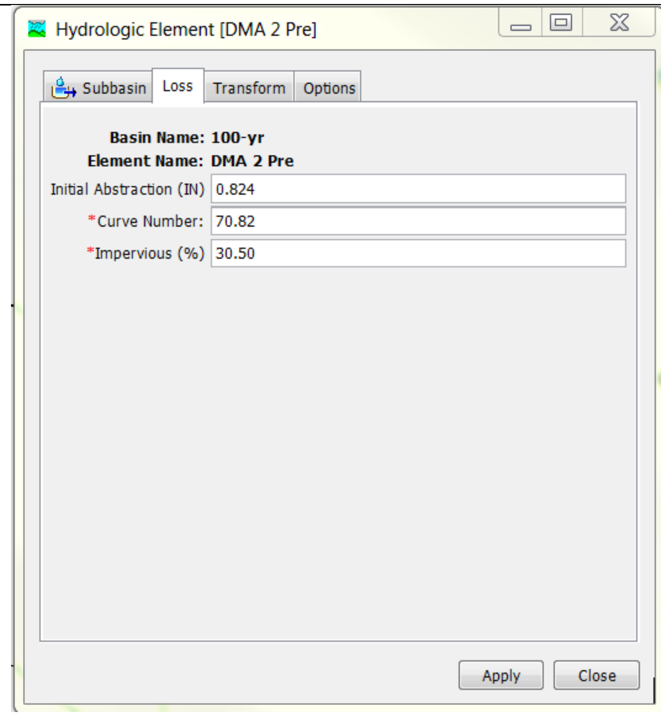


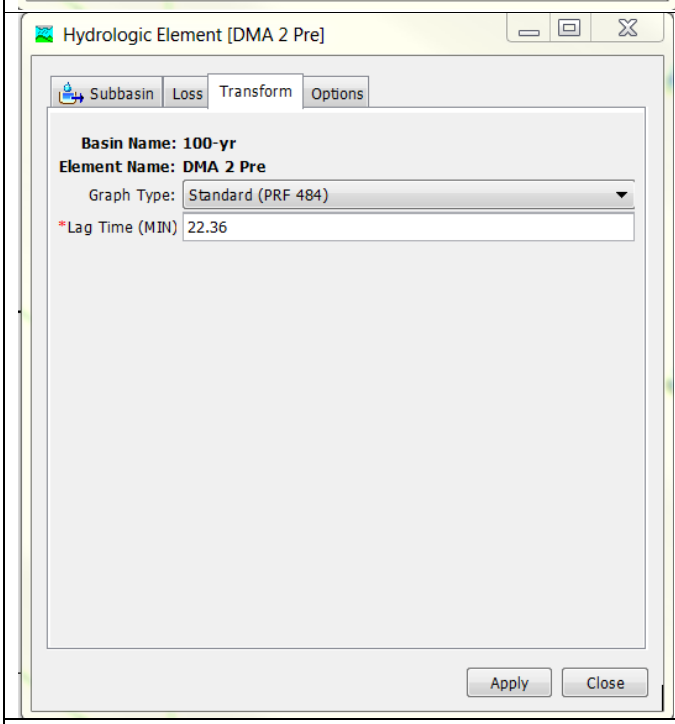


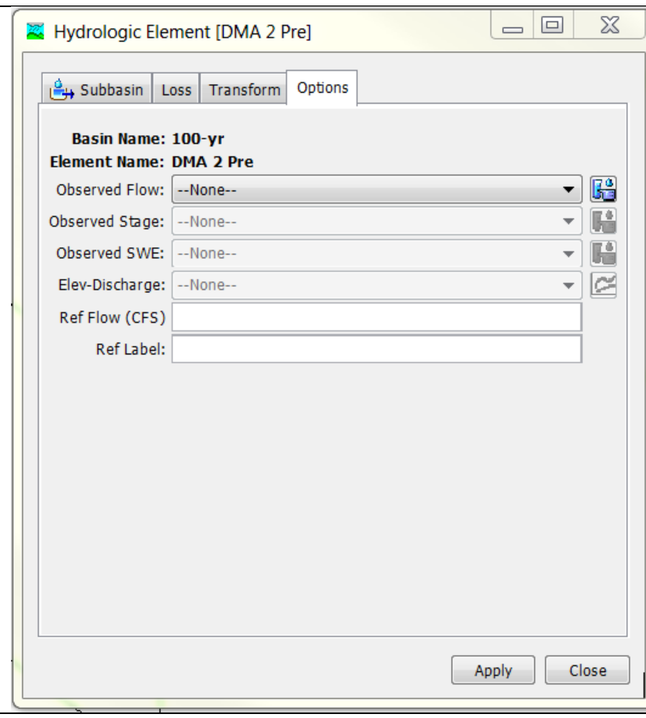


DMA-1 Post: Identical to DMA-1 Pre









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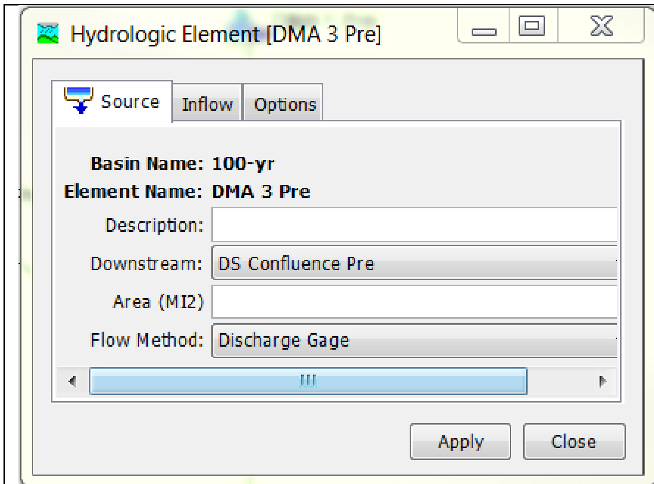
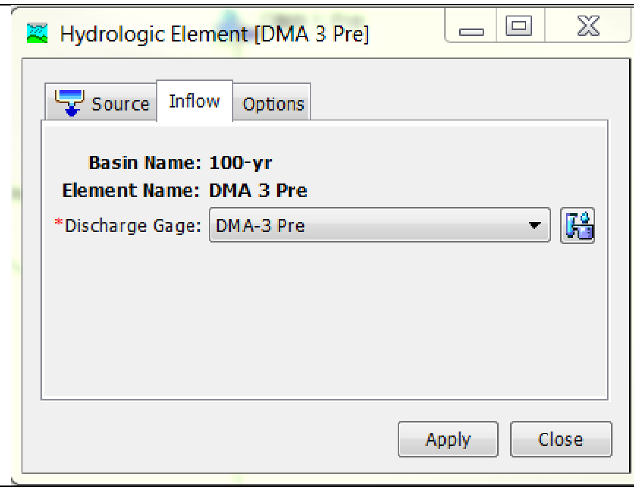
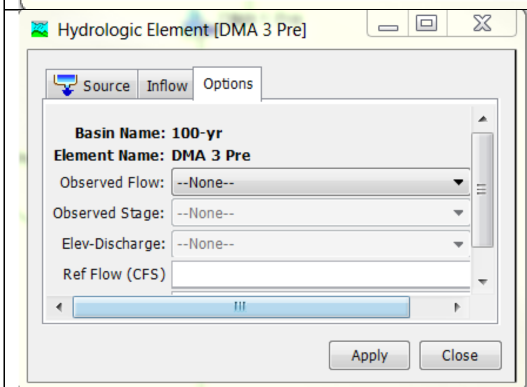
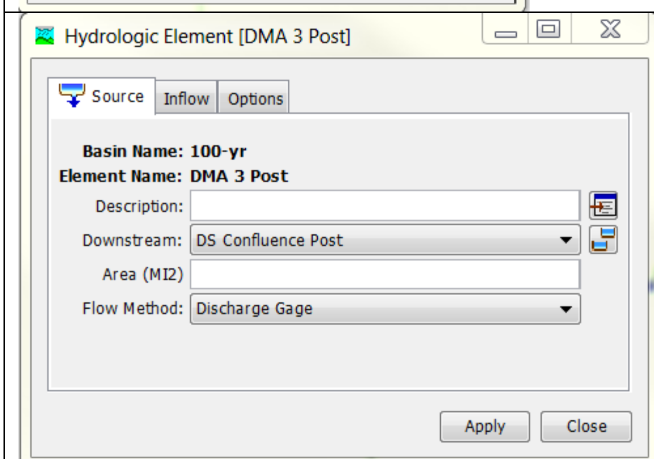


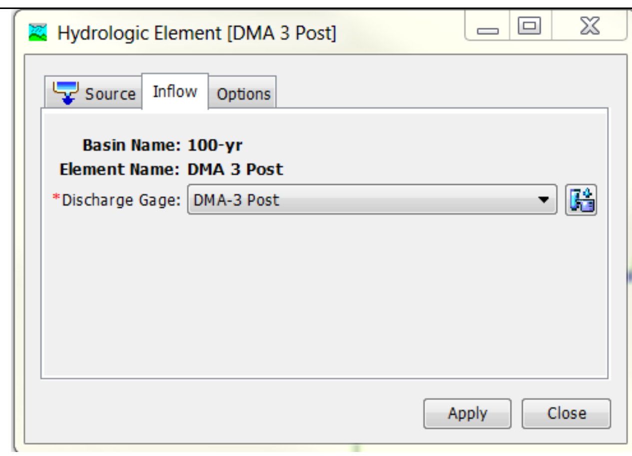


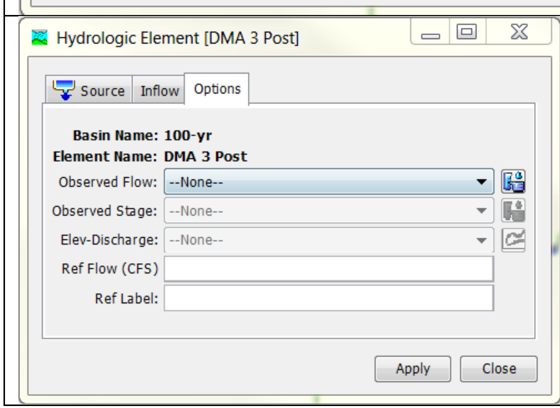


NOTE:

Inflow = RatHydro Pre-development DMA 3 hydrograph, with time interval = 1 minute.







NOTE:

Inflow = RatHydro Post-development DMA 3 hydrograph, with time interval = 1 minute.

RESULTS PRE

Summary Results for Subbasin "DMA 1 Pre"

Project: CarMax2020V Simulation Run: Run 1
Subbasin: DMA 1 Pre

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: (•) IN ( ) ACRE-FT

Computed Results

Peak Discharge:	902.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:47
Precipitation Volume:	4.07 (IN)	Direct Runoff Volume:	2.14 (IN)
Loss Volume:	1.93 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.14 (IN)	Discharge Volume:	2.14 (IN)

Summary Results for Subbasin "DMA 2 Pre"

Project: CarMax2020V Simulation Run: Run 1
Subbasin: DMA 2 Pre

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: (•) IN ( ) ACRE-FT

Computed Results

Peak Discharge:	603.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:28
Precipitation Volume:	4.07 (IN)	Direct Runoff Volume:	2.24 (IN)
Loss Volume:	1.83 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.24 (IN)	Discharge Volume:	2.24 (IN)

Summary Results for Junction "US Confluence Pre"

Project: CarMax2020V Simulation Run: Run 1
Junction: US Confluence Pre

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: (•) IN ( ) ACRE-FT

Computed Results

Peak Discharge:	1376.7 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:37
Volume:	2.17 (IN)		

Summary Results for Source "DMA 3 Pre"

Project: CarMax2020V Simulation Run: Run 1
Source: DMA 3 Pre

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: IN ACRE-FT

Computed Results

Peak Discharge: 111.5 (CFS) Date/Time of Peak Discharge: 01Jan2000, 16:12
Volume: n/a

Summary Results for Sink "DS Confluence Pre"

Project: CarMax2020V Simulation Run: Run 1
Sink: DS Confluence Pre

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: IN ACRE-FT

Computed Results

Peak Discharge: 1390.4 (CFS) Date/Time of Peak Discharge01Jan2000, 16:37
Volume: n/a

RESULTS POST

Summary Results for Subbasin "DMA 1 Post"

Project: CarMax2020V Simulation Run: Run 1
Subbasin: DMA 1 Post

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: (•) IN ( ) ACRE-FT

Computed Results

Peak Discharge:	902.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:47
Precipitation Volume:	4.07 (IN)	Direct Runoff Volume:	2.14 (IN)
Loss Volume:	1.93 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.14 (IN)	Discharge Volume:	2.14 (IN)

Summary Results for Subbasin "DMA 2 Post"

Project: CarMax2020V Simulation Run: Run 1
Subbasin: DMA 2 Post

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: (•) IN ( ) ACRE-FT

Computed Results

Peak Discharge:	603.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:28
Precipitation Volume:	4.07 (IN)	Direct Runoff Volume:	2.24 (IN)
Loss Volume:	1.83 (IN)	Baseflow Volume:	0.00 (IN)
Excess Volume:	2.24 (IN)	Discharge Volume:	2.24 (IN)

Summary Results for Junction "US Confluence Post"

Project: CarMax2020V Simulation Run: Run 1
Junction: US Confluence Post

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	16Oct2020, 17:13:23	Control Specifications:	Control 1

Volume Units: (•) IN ( ) ACRE-FT

Computed Results

Peak Discharge:	1376.7 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:37
Volume:	2.17 (IN)		

Summary Results for Source "DMA 3 Post"

Project: CarMax2020V Simulation Run: Run 1
Source: DMA 3 Post

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: IN ACRE-FT

Computed Results

Peak Discharge:	135.8 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 16:05
Volume:	n/a		

Summary Results for Sink "DS Confluence Post"

Project: CarMax2020V Simulation Run: Run 1
Sink: DS Confluence Post

Start of Run:	01Jan2000, 00:00	Basin Model:	100-yr
End of Run:	02Jan2000, 07:00	Meteorologic Model:	Met 1 Pre
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: IN ACRE-FT

Computed Results

Peak Discharge:	1389.7 (CFS)	Date/Time of Peak Discharge	01Jan2000, 16:37
Volume:	n/a		

APPENDIX 5

DMAX COMMENTS AND REC RESPONSES

FOR 2018 HYDROLOGY AND HYDRAULIC REPORTS

D-MAX Engineering, Inc.

Consultants in Water & Environmental Sciences

September 16, 2020

Mr. Charles Nissley
Engineering and Public Works Department
City of National City
1243 National City Boulevard
National City, CA 91950

Subject: **Review of the CarMax of National City, National City, CA Hydrology and Hydraulic Analysis Reports**
CDP #: 2020-4884

Dear Mr. Nissley:

Per your request, D-MAX Engineering, Inc. (D-MAX) has performed the review of the Hydrology and Hydraulic Analysis Reports (Report) for the proposed development (Project) located at the southeast corner of the intersection of Interstate 805 and State Route 54 in the City of National City (City). The Hydrology Analysis Report, dated January 30, 2008, and the Hydraulic Analysis Report, date February 9, 2018, were prepared by REC Consultants, and received by D-MAX for review on September 2, 2020.

Project Description

The Project site is currently undeveloped, and receives storm runoff from approximately 3.25 square miles of drainage area. The southwestern property lines of the Project site are adjacent to the northeastern levee of the Sweetwater River. Storm runoff that flows through the Project site is normally discharged into the Sweetwater River via a 48-inch RCP culvert, and during major storm events the levee is overtopped.

The Project proposes to develop approximately half of the site into an automobile dealership with an attached presentation area, a service area, a non-public carwash, access driveways, underground utilities, BMPs, parking lots and landscaping. The rest of the area will accommodate the realigned channel. The drainage patterns will be maintained in the proposed conditions.

Hydrology

The hydrology calculations were done for the 100-year, 6-hour storm event for the existing and proposed conditions using the SCS Curve Number Loss Method/SCS Unit Hydrograph Transform Method, as well as the Rational Method in accordance with the San Diego County Hydrology Manual (SDCHM). The following table below summarizes the existing and proposed development condition hydrology analysis results.

DMA	Area	Existing Conditions	Proposed Conditions
	(sq.mi)	Q (cfs)	Q (cfs)
1	2.168	1190.71	1190.71
2	1.001	848.09	848.09
3	0.081	155.60	196.70
Total	**3.250**	**1836.46**	**1835.30**

Hydraulics

Using the hydrology analysis results for the 100-year, 6-hour storm event, a one-dimensional hydraulic analysis was prepared for the existing and proposed conditions for the unnamed creek using HEC-RAS.

The following table below summarizes the existing and proposed development condition hydraulic analysis results as presented in the Hydrology Analysis Report.

Existing Cross Section River Station	Existing 100-yr WSE (ft)	Proposed Cross Section River Station	Proposed Cross Section WSE (ft)	ΔZ Proposed-Existing
18+30 (upstream)	38.00	19+72 (upstream)	38.87	+0.87
15+51	38.04	16+95	38.69	+0.65
12+97	38.02	13+51	38.44	+0.42
10+46	38.02	10+33	38.20	+0.18
7+71	38.02	7+83	38.06	+0.04
5+34	38.01	5+62	38.01	0.00
3+08	38.01	3+08	38.03	+0.02
0+00 (downstream)	38.00	0+00 (downstream)	38.00	0.00

Below is a list of the major issues associated with the Hydrology and Hydraulic Analysis Reports that must be addressed prior to entitlement approval followed by a list of minor issues that may be addressed during the final engineering process.

Hydrology and Hydraulic Analysis Report Review Comments

1. Please provide clarification on how the rainfall distribution was developed and demonstrate it is consistent with the NRCS Hydrologic Method. In addition, include the rainfall distributions used in the HEC-HMS models in the Hydrology Report. Screen shots of the rainfall distributions (in table or graph format) will suffice. It is unclear whether the NRCS Hydrologic Method as described in the SDCHM was directly applied to develop the rainfall distribution. Section 3.7 of the Hydrology Analysis Report states that "*For the frequency storm inputs, the duration was set as 6 hours with the peak position at the 2/3 or 67% position*." The NRCS Hydrologic Method prescribes a rainfall distribution over a 24-hour period which has a nested 6-hour period rainfall distribution. It is acknowledged that the peak position was placed at the 2/3 position, but the development of the entire rainfall distribution is unclear.

2. Please provide additional detail to clarify how the Lag Time (T_L) results were calculated for DMA 3. The T_L results provided in Appendix 2 of the Hydrology Analysis Report are somewhat unclear, and appear to result in an overall proposed condition peak storm flow reduction.

3. It is acknowledged that the impacts due to the Project to the downstream water surface elevation to initiate the HEC-RAS analysis are insignificant as described in Section 4, Berm Discussion of the Hydrology Analysis Report. However, please include in the Hydrology Analysis Report the backup calculations to support the water surface elevation over the

berm. In addition, please include the Berm Discussion and backup calculations in the Hydraulic Analysis Report.

4. Please provide a hydraulic impacts analysis associated with the storm drain systems that discharge offsite stormwater into the unnamed creek along SR-54 and Sweetwater Road. Based on the hydraulic analysis results it appears that the storm drain systems at River Stations 7+83, 11+64, and 14+01 (River Stations are in reference to the Proposed 100-year Floodmap Exhibit) will not be negatively impacted, and that a detailed analysis may be postponed for final engineering. However, the hydraulic impacts associated with the storm drain systems at the upstream end appear to be more critical due to the higher water surface elevation change. At a minimum, provide a brief narrative describing the hydraulic impacts and how they may be mitigated, if necessary, during the final engineering process.
5. The Project footprint shown in the Proposed 100 Year Floodmap Exhibit is inconsistent with the Project footprint shown on the Grading Plans. Please revise the Proposed 100 Year Floodmap Exhibit for consistency with the Grading Plans and make sure to update the cross sections in the HEC-RAS model accordingly.
6. Provide a status update on the FEMA approval process (CLOMR/LOMR).

Hydrology and Hydraulic Analysis Report Review (minor issues)

7. In Section 1 of both the Hydrology and Hydraulic Analysis Reports indicate the property size, and provide additional detail describing the pervious and impervious areas.
8. It is acknowledged that the Project is indeed located in the Coastal Zone, but according to Figure C-1 of the SDCHM, the entirety of the three watersheds tributary to the Project site are in PZN 1.5. It is also acknowledged that a PZN of 2.0 is more conservative, and therefore acceptable. However, it is recommended that the CN values area adjusted for PZN 1.5 and that the hydrology analysis calculations updated accordingly.
9. It appears that a drainage area of about 6.5 acres pertaining to the Bonita Vista Mobile Home Part located on the north side Sweetwater Road/Valley Road has been inadvertently omitted. According to the City of National City MS4 layer a 30-inch RCP storm drain collects the drainage from this area and the conveys the flows across the SR-54 discharging into the unnamed creek near River Station 7+83 (of the Proposed Condition HEC-RAS Map). Please verify and include as part of the hydrology analysis as necessary.

Conclusions and Recommendations

The Hydrology and Hydraulic Analysis Reports do not meet the City of National City requirements for drainage and flood control.

Should you have any questions regarding the above review, please call me at (858) 586-6600, extension 22.

Sincerely,

D-MAX Engineering, Inc.

Arsalan Dadkhah

Arsalan Dadkhah, Ph.D, P.E.
Principal

Hydrology and Hydraulic Analysis Report Review Responses

In regards to the comments included in this Appendix, and attached in the previous pages, the following are the corresponding responses/ actions:

1. Rainfall distributions are obtained from NOAA analyses now included in the appendices. HEC-HMS screen shots are also included to demonstrate that (a) NOAA rainfall has been used; (b) reduction of NOAA rainfall as a function of the rainfall duration and the area of analysis has been incorporated into the HEC-HMS data per interpolation of Table 4-1 of the SDCHM; and (c) the rainfall peak intensity has been placed at t = 16 hr with the internal development of the rainfall distribution assigned directly by the approved HEC-HMS model and out of the control of the author of this study.
2. Additional details in terms of the calculation of lag time for DMA 3 (and for all DMAs) have been included in the report and/or appendices.
3. Additional details and explanations in regards to the calculation of the berm overflow have been added in the hydraulic report.
4. As agreed with the reviewer, additional explanations will be included to (a) refer the reader to other reports to be reviewed by CALTRANS (related to CALTRANS systems) or (b) including proper narrative in regards to National City conveyance systems.
5. Project footprint in the floodplain exhibit will be updated. Therefore, section of channels and HEC-RAS results will be updated as well (also, because the flows of the hydrology report have changed).
6. FEMA language will be included in the report. In addition, a CLOMR application will be submitted to FEMA.
7. Property size and additional details regarding the pervious and impervious area in pre and post-development conditions will be included.
8. Comment noted. A PZN of 1.5 will be used and the CN will be adjusted accordingly.
9. The 6.5 acres pertained to Bonita Vista Mobile Home Part have been added into DMA-1 (the regional nature of the analysis done in the past is not clear enough to stablish if such area has been included; therefore, as a conservative approach, DMA-2 has been increased by 6.5 acres and the lag time and impervious percentage has been updated).