HYDRAULIC ANALYSIS

for

Existing Caltrans Drainage Systems Adjacent to CARMAX at National City

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Prepared by:

Luis Parra, PhD, CPSWQ, ToR, D.WRE.
R.C.E. 66377

REC Consultants
2442 Second Avenue
San Diego, CA 92101
Telephone: (619) 232-9200

HYDRAULIC ANALYSIS FOR EXISTING CALTRANS DRAINAGE SYSTEMS ADJACENT TO CARMAX AT NATIONAL CITY

1. ANTECEDENTS

According to the updated Hydraulic Analysis for CarMax prepared by REC on May 2021, water elevation increases in the open-bottom unnamed creek flowing along the CarMax property during the occurrence of the Q_{100} extreme event, when compared to the water elevations in pre-development conditions (see Table 3 of the aforementioned report). Such increases in turn will cause additional tailwater effects in the CALTRANS existing drainage systems discharging into this proposed new configuration of the unnamed creek. The purpose of this study is to analyze those water elevation increases in CALTRANS Systems to demonstrate that the existing storm drain infrastructure is not negatively impacted by this increase in tailwater.

2. OBJECTIVES

The purpose of this is study is to demonstrate that the increase in downstream tailwater due to the unnamed creek improvements proposed as part of the CarMax development do not adversely impact the existing Caltrans drainage systems. Hydraulic grade line (HGL) analysis will be performed for all CALTRANS drainage systems to compare the HGL in both existing and proposed conditions to demonstrate the system's ability to safely convey the design peak 100-year design flows.

3. EXISTING SYSTEMS AFFECTED BY THE WATER ELEVATION OF THE CARMAX CHANNEL

The location of the discharge systems into the existing channel is provided on the "Regional Hydrology Exhibit" in Attachment 1, As-Built plan and profiles are provided in Attachment 3. The description of the systems, starting from the downstream system of the right bank, and following the direction of the clock and the labeling of the original plans is as follows:

- **System 85**: a 36" pipe discharge that starts at Sweetwater Road and drains some ramps of the complex intersection between HWY 805 and HWY 54.
- **System 84**: a 30" pipe discharge that starts at Valley Road, continues to Valley Rd – Sweetwater Road and drains adjacent areas of the ramps of the intersection between HWY 805 and HWY 54.
- **System 80**: a 6 ft x 10 ft culvert that drains a significant portion of Valley Road and that originates the change in flow in the HEC-RAS study.
- **System 83**: a 24" and 18" pipe system draining a section of HWY 54 (downstream of System 84) and a landscape area adjacent to it.

As described, there are four (4) systems draining to the ponding area that constitutes the development area for CarMax, and that in post-development conditions will drain to the proposed unnamed creek.

3.1 Summary of Water Elevation Modification

Table 1 shows the water level in pre-and post-development conditions from all systems during the occurrence of a 100-year storm event in Sweetwater Creek and the occurrence of a 100 year storm event in the drainage system of the watershed upstream of the property (including unnamed creek). It is also important to mention that there are two data references: the 1929 datum used in all As-Built plans included in Attachment 3, and the 1988 datum used in the HEC-RAS analyses. Table 1 shows the HEC-RAS stations of the channel, and discharge water elevations for pre and post-development conditions measured in 1988 datum (in this location elevation with 1988 datum are 2.11 ft higher than elevations in datum 1929). Also included is the difference of elevation of water at the discharge point that will occur downstream as a consequence of the development. Water surface elevations were obtained from the HEC-RAS models undertaken within the "Hydraulic Analysis for CarMax at National City for the 100 year Peak Flow" by REC dated May, 2021. This report is provided in the appendix of this study for reference, inclusive of HEC-RAS model output for both pre and post developed conditions.

Table 1. Water Elevation and Change of Elevation at the Discharge Point for Analyzed Systems

System	HEC-RAS Station		Channel Elev. (1988 Datum)		Channel Elev. (1929 Datum)		ΔH (ft) (Post - Pre)
	Pre-Dev.	Post-Dev.	Pre-Dev.	Post-Dev.	Pre-Dev.	Post-Dev.	
85	5+00	5+05	37.16	37.17	35.05	35.06	0.01
84	10+06	9+92	37.17	37.19	35.06	35.08	0.02
80	12+37	12+53	37.17	37.23	35.06	35.12	0.06
83	13+88	14+06	37.18	37.29	35.07	35.18	0.11

From the inspection of Table 1, it is clear that the discharge water elevation of all systems has increased and further HGL analysis is provided to demonstrate that such increment will not have repercussions in the upstream drainage systems.

It should also be stated that the 1929 datum WSE will be used for the storm drain hydraulic analysis in this report to minimize confusion given the As-Built plans are in the 1929 datum.

4. HYDROLOGIC ANALYSIS FOR EXISTING DRAINAGE SYSTEMS

In order to assess the impact the proposed increases in WSE will have to the hydraulic performance of the existing storm drain infrastructure (in this case that impact is to be measured via a HGL comparison analysis), the flow for each system is required to be calculated. Hydrologic analysis for the four (4) receiving storm drain systems was undertaken per "Chapter 810 – Hydrology" of the Caltrans Highway Design Manual (HDM) dated July 1, 2020.

Per the aforementioned design manual, areas of less than 320 acres are to be analyzed using the rational method while areas exceeding this amount were modeled using U.S. Geological Survey (known as the SCS method).

4.1 Summary of Drainage Areas

System 85

The drainage area tributary to system 85 comprises of approximately 20.2 acres of developed residential and neighborhood business areas in addition to 4.3 acres of highway. For this hydrologic analysis the watershed has been separated into these two (2) boundaries – the upper reach consisting of the residential developments and business which are intercepted at the start of the drainage system and the lower reach which is intercepted mid-way through the system via inlets in the highway.

Per Figure 819.2B of the Caltrans HDM, runoff coefficients of 0.5 and 0.7 were used for the respective single family residences and neighborhood area businesses respectively. This resulted in a weighted factored of 0.67 (value that includes the 1.25 factor for Q_{100} per the HDM). The highway portions of the drainage tributary were allocated a C factor of 1 (per the HDM the factored C value cannot exceed 1).

System 84

The drainage area tributary to system 84 comprises of approximately 15.1 acres of developed residential single family and attached residential (trailer homes) areas in addition to 4.2 acres of highway. For this hydrologic analysis the watershed has been separated into these two (2) boundaries – the upper reach consisting of the residential developments which are intercepted at the start of the drainage system and the lower reach which is intercepted mid-way through the system via inlets in the highway.

Per Figure 819.2B of the Caltrans HDM, runoff coefficients of 0.4 and 0.75 were used for the respective single family residences and trailer home areas respectively. This resulted in a weighted factored of 0.69 (value that includes the 1.25 factor for Q_{100} per the HDM). The highway portions of the drainage tributary were allocated a C factor of 1.

System 83

The drainage area tributary to system 83 comprises of approximately 5.3 acres of developed residential single family area in addition to 0.6 acres of highway. For this hydrologic analysis the watershed has been separated into these two (2) boundaries – the upper reach consisting of residential development and highway areas which is intercepted by the 24” element of the drainage system and the lower reach which is intercepted by the 18” element through the system via an inlet in the highway.

Per Figure 819.2B of the Caltrans HDM, runoff coefficients of 0.4 and 0.95 were used for the respective single family residences and highway areas respectively. This resulted in a weighted C factor of 0.82 (value that includes the 1.25 factor for Q_{100} per the HDM). The highway portions of the drainage tributary were allocated a C factor of 1.

System 80

Due to the significant tributary areas intercepted by this storm drain culvert, an SCS method analysis was undertaken for this area in the separate study "Hydrology Analysis for CarMax at National City" by REC Consultants dated October 2020. This report is provided in the appendix of this study for reference, inclusive of HEC-HMS model output. Per this aforementioned study, the study area tributary to this system (referenced as DMA 2 within the study) is approximately 640.4 acres generating a peak 100-year flow of 603.3 cfs.

Rainfall Intensity

Times of concentration were calculated for all three (3) rational method analysis areas with initial flow lengths of 100 ft in accordance with the Chapter 8 of the HDM. Total travel time was then calculated assuming conservative manning's values of 0.013 to represent the fully developed concrete curb and gutter systems present within all tributary areas.

Once the total travel time was determined, an Intensity Duration Frequency curve was generated using NOAA Atlas 14 intensity data sets. The NOAA data and IDF curves are provided within the attachments of this study for reference.

Peak Flow Summary

Using the tributary areas, weighted runoff coefficients and rainfall intensities previously discussed within this study, it was then possible to calculate peak 100-year design flows using the rational method equation:

$$Q_{100} = Runoff\ Coefficient\ (C)\ \ X\ Rainfall\ Intensity\ \left(\frac{in}{hr}\right) X\ Area\ (ac)$$

Table 2 below summarizes the peak flows tributary to all drainage systems.

Table 2. Summary of Rational Method Peak 100-Year Design Flows

Drainage System	Tributary Name	Area (ac)	Runoff Coefficient (C)	Rainfall Intensity (in/hr)	Q_{100} flow (cfs)	Total System Flow (cfs)
85	Upper	20.2	0.67	2.55	34.76	52.13
	Lower	4.3	1	4.04	17.37	
84	Upper	15.1	0.69	2.61	27.34	48.35
	Lower	4.2	1	5.00	21.01	
83	Upper	5.3	0.82	2.64	11.58	15.48
	Lower	0.6	1	6.51	3.90	

5. HYDRAULIC ANALYSIS FOR EXISTING DRAINAGE SYSTEMS

Hydraulic models were constructed using Bentley Systems StormCAD hydraulic analysis software and as-built improvement plans for the Caltrans systems that were sourced from Caltrans. The improvement plans are provided within the appendix of this study for reference. All junction losses were analyzed according to HEC-22 (Third Edition).

Using the aforementioned hydraulic analysis suite, HGL analysis was undertaken for the pipe systems and graphical profiles were developed to illustrate the HGL and Energy Grade Line (EGL) of the existing storm drain systems using peak flows generated in the previous section of this report.

As the peak flows remain constant in pre and post developed conditions (the CarMax development does not alter any of the tributary areas to these existing storm drain systems), the only variable between the pre and post developed hydraulic analysis is the starting tailwater WSE which was obtained from the previously discussed HEC-RAS analysis in section 3 of this report.

To demonstrate the impact of the change in tailwater condition, the HGL is compared at the nearest inlet/junction of the system to the downstream waterbody. Table 3 below illustrates the pre and post developed condition HGL's at the downstream junction for all four (4) drainage systems accordingly.

Table 3. Summary of HGLs for Caltrans Drainage Systems

Drainage System	Pre-Developed HGL (ft)	Post-Developed HGL (ft)	Increase in HGL (ft)
85	35.37	35.38	0.01
84	35.56	35.58	0.02
80	41.04	41.04	0.00
83	35.86	35.97	0.11

CONCLUSIONS

Drainage System 85

From the HGL analysis undertaken, it is clear that the current system is under a backwater effect from the existing condition WSE experienced at the discharge location. The backwater causes ponding at the inlet located to the north of the existing highway where the ground inlet elevation is 33.0 ft – the downstream WSE is 35.05 which is 2.05 feet higher. As such this inlet is already inundated (and surcharged) by the backwater effect of the existing creek. However, as demonstrated by the HGL in pre and post conditions, the system safely conveys the peak flow with no perceptible change in both scenarios because of the fact that this system is under pressure in both cases and the highway is not overtopped in any condition (given that there is only a 0.01 ft change in HGL). Thus, it can be concluded that this system will not be adversely impacted by the channel improvement. The HGL's for all junctions analyzed for this system are presented below in Table 4.

Table 4. Summary of HGLs for Caltrans Drainage System 85

SYSTEM 85								
	MH-1		**MH-2**		**MH-3**		**MH-4**	
	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT
PRE	38.27	37.61	37.38	37.15	36.61	35.87	35.37	35.05
POST	38.27	37.61	37.38	37.15	36.62	35.88	35.38	35.06
DIFFERENCE	**0**	**0**	**0**	**0**	**0.01**	**0.01**	**0.01**	**0.01**

Drainage System 84

The HGL in the most downstream junction/inlet of this system increases by 0.02 ft when compared to the existing condition HGL. Again, it is clear from the pre-developed condition that the system is backwatered by the existing creek WSE, where the downstream 30" segments of the system are surcharged. The post developed condition does not adversely impact the drainage system; the 30" portions of the systems remain under pressure as they currently exist under the occurrence of the 100 year storm event, and the upstream 24" portions of the system are not put under pressure by the small increase in WSE (at the next junction upstream of the 30" transition the HGL remains at 45.87 ft in both pre and post conditions). As such, the 0.02 ft increase in HGL does not adversely impact the system's ability to safely convey peak runoff. The HGL's for all junctions analyzed for this system are presented in Table 5.

Table 5. Summary of HGLs for Caltrans Drainage System 84

SYSTEM 84								
	MH-1		MH-2		MH-3		MH-4	
	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT
PRE	60.62	46.81	45.96	39.0	39.64	36.48	35.56	35.06
POST	60.62	46.81	45.96	39.0	36.66	36.50	35.58	35.08
DIFFERENCE	**0**	**0**	**0**	**0**	**0.02**	**0.02**	**0.02**	**0.02**

Drainage System 83

When compared to the other drainage systems, drainage system 83 has the largest increase in HGL of 0.11 ft, at the downstream junction of the 24" and 18" system. However, this increase does not impact the upstream 18" and 24" inch pipe systems adversely as demonstrated in the HGL profiles provided in the attachments of this study. It is clear for the 24" inch system that again, as demonstrated in the previous systems, the WSE of the existing stream backwaters the system, surcharging the pipes. The increase in HGL simply increases the pressure in this already under pressure system while maintaining the HGL well beneath ground. As such, the drainage system is still able to safely convey peak flows due to the small increase in tailwater conditions (the HGL never reaches surface level nor impacts inlets in the system). The HGL's for all junctions analyzed for this system are presented in Table 6 below.

Table 6. Summary of HGLs for Caltrans Drainage System 83

SYSTEM 83						
	24-INCH		MH-2		18-INCH	
	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT	HGL-IN	HGL-OUT
PRE	36.46	36.32	35.86	35.07	40.38	36.54
POST	36.57	36.43	35.97	35.18	40.38	36.54
DIFFERENCE	**0.11**	**0.11**	**0.11**	**0.11**	**0**	**0**

Per the improvement plans available for Drainage System 83, the surface invert of the upstream 24-inch system is 37.4 ft, thus in developed conditions the HGL is 0.83 ft (10-inches) below the surface at this inlet location.

Drainage System 80

The larger box culvert system does not have a junction or inlet adjacent to the outlet location; as such the HGL comparison can only be taken at the inlet of the 6' x 10' box culvert. As demonstrated within the HGL analysis, there is no increase in HGL at the culvert inlet due to the increase in downstream WSE and the system remains to be able to safely convey peak flows. The HGL's for all junctions analyzed for this system are presented in Table 7.

Table 7. Summary of HGLs for Caltrans Drainage System 80

SYSTEM 80		
	CULVERT	
	HGL-IN	HGL-OUT
PRE	41.04	35.06
POST	41.04	35.12
DIFFERENCE	**0**	**0.06**

6. ATTACHMENTS

- Attachment 1: Rational Method Analysis (NOAA 14 Dataset and Runoff Coefficients))
- Attachment 2: HGL Analysis (Tables and Profiles)
- Attachment 3: Plan View and Profile of the Existing Systems Draining to CarMax
- Attachment 4: "Hydraulic Analysis for CARMAX at National City for the 100-Year Peak Flow"
- Attachment 5: "Hydrology Analysis for CARMAX at National"

7. REFERENCES

[1] Hydraulic Engineering Circular No. 22, 3rd Edition: Urban Drainage Design Manual

https://www.fhwa.dot.gov/engineering/hydraulics/pubs/10009/10009.pdf

[2] Highway Design Manual, 7th Edition: California Department of Transportation, July 1, 2020.

Attachment 1

Rational Method Analysis

- Rational Calculations
- NOAA 14 Atlas
- Caltrans HDM C Coefficients
- Hydrology Exhibit

UPPER REACH PIPE 83

Kinematic Wave

$$T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$$

NOAA P2 24hr:	1.66	in
L:	100	ft
n:	0.014	
s:	0.02	ft/ft
Tt	2.04	min

Mannings in triangular channel

Initial velocity			Final velocity		
z:	10		z:	10	
n :	0.013		n :	0.013	(average n)
so :	0.01		so :	0.02	
y :	0.157	ft	y :	0.138	ft
Aflow:	0.247	sq-ft	Aflow:	0.192	sq-ft
Pflow:	3.2	ft	Pflow:	2.8	ft
Q:	0.52	cfs	Q:	0.52	cfs
v :	2.090	ft/s	v :	2.716	ft/s

Final Q

Ltravel:	1318	ft
vaverage:	2.40	ft/s
tt :	9.14	min
tc:	11.18	min
I :	2.64	in/hr
A :	5.300	acres
C:	0.820	
Q :	11.58	cfs

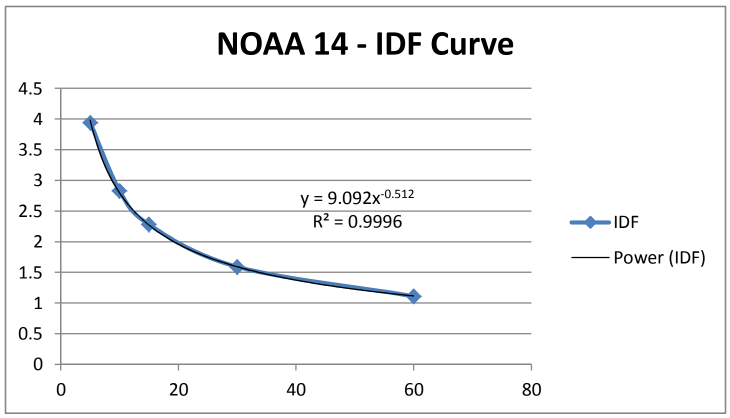
Time of concentration:
11.18 min

Total Peak Flow

A :	5.300	acres
C :	0.820	
I :	2.64	in/hr
Q :	**11.58**	**cfs**

Intensity Duration Frequency Curve (NOAA Atlas 14)

Time (min)	100-Yr Intensity (In/hr)
5	3.94
10	2.83
15	2.28
30	1.59
60	1.11



Runoff Coefficient

Land Use	%	C
Single Family	53	0.4
Highway	47	0.95

Q100 Factor 1.25

Weighted C	**0.82**

LOWER REACH PIPE 83

Kinematic Wave

$$T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$$

NOAA P2 24hr:	1.66	in
L:	100	ft
n:	0.013	
s:	0.02	ft/ft
Tt	1.92	min

Tc:	1.92	min	(fully developed highway system)
A:	0.6	Ac	
I:	6.51	In/hr	
C:	0.95		
Cw:	1		(1.25 saftey factor exceeds 1)

Q:	**3.90**	**cfs**

TOTAL SYSTEM FLOW

Q:	**15.48**	cfs

UPPER REACH PIPE 84

Kinematic Wave

$$T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$$

NOAA P2 24hr:	1.66	in
L:	100	ft
n:	0.014	
s:	0.03	ft/ft
Tt	1.73	min

Mannings in triangular channel

Initial velocity			Final velocity		
z:	10		z:	10	
n :	0.013		n :	0.013	(average n)
so :	0.01		so :	0.066	
y :	0.124	ft	y :	0.087	ft
Aflow:	0.154	sq-ft	Aflow:	0.076	sq-ft
Pflow:	2.5	ft	Pflow:	1.7	ft
Q:	0.27	cfs	Q:	0.27	cfs
v :	1.785	ft/s	v :	3.620	ft/s

Final Q

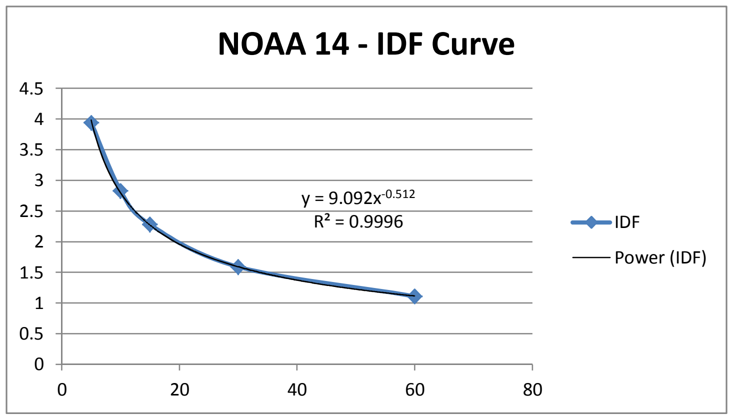
Ltravel:	1575	ft
vaverage:	2.70	ft/s
tt :	9.71	min
tc:	11.45	min
I :	2.61	in/hr
A :	15.100	acres
C:	0.69	
Q :	27.34	cfs

Time of concentration:
11.45 min

Total Peak Flow		
A :	15.100	acres
C :	0.69	
I :	2.61	in/hr
Q :	**27.34**	**cfs**

Intensity Duration Frequency Curve (NOAA Atlas 14)

Time (min)	100-Yr Intensity (In/hr)
5	3.94
10	2.83
15	2.28
30	1.59
60	1.11



Runoff Coefficient

Land Use	%	C
Trailer Homes (attached)	43	0.75
Single Family	57	0.4

Q100 Factor	1.25
Weighted C	**0.69**

LOWER REACH PIPE 84

Kinematic Wave

$$T_t = \frac{0.42 L^{4/5} n^{4/5}}{P_2^{1/2} s^{2/5}}$$

NOAA P2 24hr:	1.66	in
L:	190	ft
n:	0.013	
s:	0.02	ft/ft
Tt	3.21	min

Tc:	3.21	min	(fully developed highway system)
A:	4.2	Ac	
I:	5.00	In/hr	
C:	0.95		
Cw:	1		(1.25 saftey factor exceeds 1)

Q:	**21.01**	**cfs**

TOTAL SYSTEM FLOW		
Q:	**48.35**	cfs

UPPER REACH PIPE 85

Kinematic Wave

$$T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$$

NOAA P2 24hr:	1.66	in
L:	100	ft
n:	0.014	
s:	0.05	ft/ft
Tt	1.41	min

Mannings in triangular channel

Initial velocity			Final velocity		
z:	10		z:	10	
n :	0.013		n :	0.013	(average n)
so :	0.01		so :	0.025	
y :	0.164	ft	y :	0.138	ft
Aflow:	0.270	sq-ft	Aflow:	0.192	sq-ft
Pflow:	3.3	ft	Pflow:	2.8	ft
Q:	0.581	cfs	Q:	0.58	cfs
v :	2.153	ft/s	v :	3.036	ft/s

Final Q

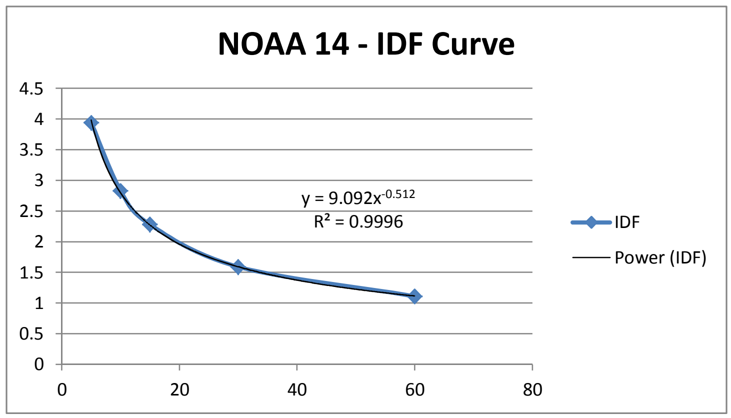
Ltravel:	1649	ft
vaverage:	2.59	ft/s
tt :	10.59	min
tc:	12.01	min
I :	2.55	in/hr
A :	20.200	acres
C:	0.670	
Q :	34.76	cfs

Time of concentration:
12.01 min

Total Peak Flow		
A :	20.200	acres
C :	0.670	
I :	2.55	in/hr
Q :	**34.76**	**cfs**

Intensity Duration Frequency Curve (NOAA Atlas 14)

Time (min)	100-Yr Intensity (In/hr)
5	3.94
10	2.83
15	2.28
30	1.59
60	1.11



Runoff Coefficient

Land Use	%	C
Single Family	82	0.5
Neighborhood Areas Business	18	0.7

Q100 Factor 1.25

Weighted C 0.67

LOWER REACH PIPE 85

Kinematic Wave

$$T_t = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}}$$

NOAA P2 24hr:	1.66	in
L:	320	ft
n:	0.013	
s:	0.02	ft/ft
Tt	4.88	min

Tc:	4.88	min	(fully developed highway system)
A:	4.3	Ac	
I:	4.04	In/hr	
C:	0.95		
Cw:	1		(1.25 saftey factor exceeds 1)

Q: 17.37 cfs

TOTAL SYSTEM FLOW		
Q:	**52.13**	cfs

ATTACHMENT B, EXHIBIT J-2 - 14

NOAA Atlas 14, Volume 6, Version 2
Location name: National City, California, USA*
Latitude: 32.6625°, Longitude: -117.0693°
Elevation: 168.35 ft**
* source: ESRI Maps
** source: USGS

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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.33 (1.12-1.61)	1.68 (1.40-2.03)	2.15 (1.79-2.60)	2.54 (2.10-3.11)	3.08 (2.46-3.90)	3.50 (2.74-4.54)	3.94 (3.00-5.23)	4.40 (3.25-6.01)	5.04 (3.56-7.18)	5.53 (3.78-8.18)
10-min	0.954 (0.798-1.15)	1.21 (1.01-1.46)	1.54 (1.28-1.87)	1.82 (1.51-2.23)	2.21 (1.76-2.79)	2.51 (1.96-3.25)	2.83 (2.15-3.75)	3.16 (2.33-4.31)	3.61 (2.56-5.15)	3.97 (2.71-5.86)
15-min	0.768 (0.644-0.928)	0.972 (0.812-1.17)	1.24 (1.04-1.50)	1.47 (1.21-1.79)	1.78 (1.42-2.25)	2.02 (1.58-2.62)	2.28 (1.73-3.02)	2.54 (1.88-3.47)	2.91 (2.06-4.15)	3.20 (2.19-4.73)
30-min	0.534 (0.448-0.646)	0.676 (0.564-0.816)	0.864 (0.720-1.05)	1.02 (0.844-1.25)	1.24 (0.988-1.57)	1.41 (1.10-1.82)	1.59 (1.21-2.10)	1.77 (1.31-2.42)	2.03 (1.43-2.89)	2.23 (1.52-3.29)
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)	1.56 (1.06-2.30)
2-hr	0.258 (0.216-0.312)	0.326 (0.272-0.394)	0.414 (0.345-0.502)	0.486 (0.402-0.594)	0.584 (0.466-0.740)	0.660 (0.515-0.854)	0.736 (0.560-0.977)	0.815 (0.603-1.11)	0.922 (0.653-1.31)	1.00 (0.686-1.48)
3-hr	0.207 (0.173-0.250)	0.261 (0.218-0.316)	0.332 (0.277-0.403)	0.389 (0.322-0.476)	0.467 (0.373-0.591)	0.526 (0.411-0.680)	0.586 (0.446-0.777)	0.647 (0.479-0.884)	0.730 (0.517-1.04)	0.793 (0.542-1.17)
6-hr	0.136 (0.114-0.164)	0.172 (0.143-0.207)	0.218 (0.182-0.265)	0.256 (0.211-0.313)	0.306 (0.245-0.388)	0.345 (0.270-0.446)	0.384 (0.292-0.510)	0.424 (0.313-0.579)	0.478 (0.338-0.681)	0.519 (0.355-0.767)
12-hr	0.088 (0.073-0.106)	0.111 (0.093-0.134)	0.142 (0.118-0.172)	0.167 (0.138-0.204)	0.201 (0.161-0.255)	0.228 (0.178-0.295)	0.255 (0.194-0.338)	0.283 (0.209-0.387)	0.321 (0.228-0.458)	0.351 (0.240-0.519)
24-hr	0.054 (0.047-0.063)	0.069 (0.060-0.080)	0.089 (0.078-0.104)	0.105 (0.091-0.124)	0.128 (0.108-0.155)	0.146 (0.120-0.180)	0.164 (0.132-0.207)	0.183 (0.144-0.238)	0.210 (0.159-0.283)	0.231 (0.170-0.322)
2-day	0.033 (0.029-0.039)	0.043 (0.038-0.050)	0.056 (0.049-0.065)	0.066 (0.058-0.078)	0.081 (0.068-0.098)	0.092 (0.076-0.114)	0.104 (0.084-0.131)	0.116 (0.091-0.150)	0.133 (0.100-0.178)	0.146 (0.107-0.202)
3-day	0.025 (0.022-0.029)	0.032 (0.028-0.038)	0.042 (0.037-0.050)	0.051 (0.044-0.060)	0.062 (0.052-0.075)	0.070 (0.058-0.087)	0.079 (0.064-0.100)	0.088 (0.069-0.114)	0.101 (0.076-0.135)	0.110 (0.081-0.153)
4-day	0.020 (0.018-0.023)	0.026 (0.023-0.031)	0.035 (0.030-0.041)	0.042 (0.036-0.049)	0.051 (0.043-0.062)	0.058 (0.048-0.071)	0.065 (0.052-0.082)	0.072 (0.057-0.094)	0.082 (0.062-0.111)	0.090 (0.066-0.125)
7-day	0.013 (0.012-0.016)	0.018 (0.015-0.021)	0.023 (0.020-0.027)	0.028 (0.024-0.033)	0.034 (0.028-0.041)	0.039 (0.032-0.048)	0.043 (0.035-0.055)	0.048 (0.038-0.063)	0.055 (0.042-0.074)	0.060 (0.044-0.084)
10-day	0.010 (0.009-0.012)	0.014 (0.012-0.016)	0.018 (0.016-0.021)	0.021 (0.019-0.025)	0.026 (0.022-0.032)	0.030 (0.025-0.037)	0.033 (0.027-0.042)	0.037 (0.029-0.048)	0.042 (0.032-0.057)	0.047 (0.034-0.065)
20-day	0.006 (0.005-0.007)	0.008 (0.007-0.010)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.016 (0.013-0.019)	0.018 (0.015-0.022)	0.020 (0.016-0.026)	0.023 (0.018-0.029)	0.026 (0.019-0.034)	0.028 (0.020-0.039)
30-day	0.005 (0.004-0.006)	0.007 (0.006-0.008)	0.009 (0.008-0.010)	0.010 (0.009-0.012)	0.013 (0.011-0.015)	0.014 (0.012-0.018)	0.016 (0.013-0.020)	0.018 (0.014-0.023)	0.020 (0.015-0.027)	0.022 (0.016-0.030)
45-day	0.004 (0.003-0.004)	0.005 (0.004-0.006)	0.007 (0.006-0.008)	0.008 (0.007-0.009)	0.010 (0.008-0.012)	0.011 (0.009-0.014)	0.012 (0.010-0.015)	0.013 (0.011-0.017)	0.015 (0.011-0.020)	0.016 (0.012-0.023)
60-day	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.006 (0.005-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.010)	0.009 (0.008-0.012)	0.010 (0.008-0.013)	0.011 (0.009-0.015)	0.013 (0.010-0.017)	0.014 (0.010-0.019)

[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.

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PF graphical

ATTACHMENT B, EXHIBIT J-2 - 15

NOAA Atlas 14, Volume 6, Version 2
Location name: National City, California, USA*
Latitude: 32.659°, Longitude: -117.0696°
Elevation: 30.26 ft**
* source: ESRI Maps
** source: USGS

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)	1.56 (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)	1.84 (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	1.06 (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 (2.89-4.32)	3.94 (3.18-4.98)	4.40 (3.47-5.71)	5.04 (3.82-6.79)	5.55 (4.08-7.72)
2-day	1.60 (1.40-1.86)	2.06 (1.81-2.41)	2.68 (2.34-3.14)	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 (1.57-2.09)	2.34 (2.05-2.73)	3.06 (2.67-3.58)	3.65 (3.16-4.30)	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 (1.70-2.26)	2.54 (2.22-2.96)	3.34 (2.91-3.90)	3.99 (3.46-4.70)	4.87 (4.10-5.91)	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 (5.90-9.23)	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)	7.27 (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.

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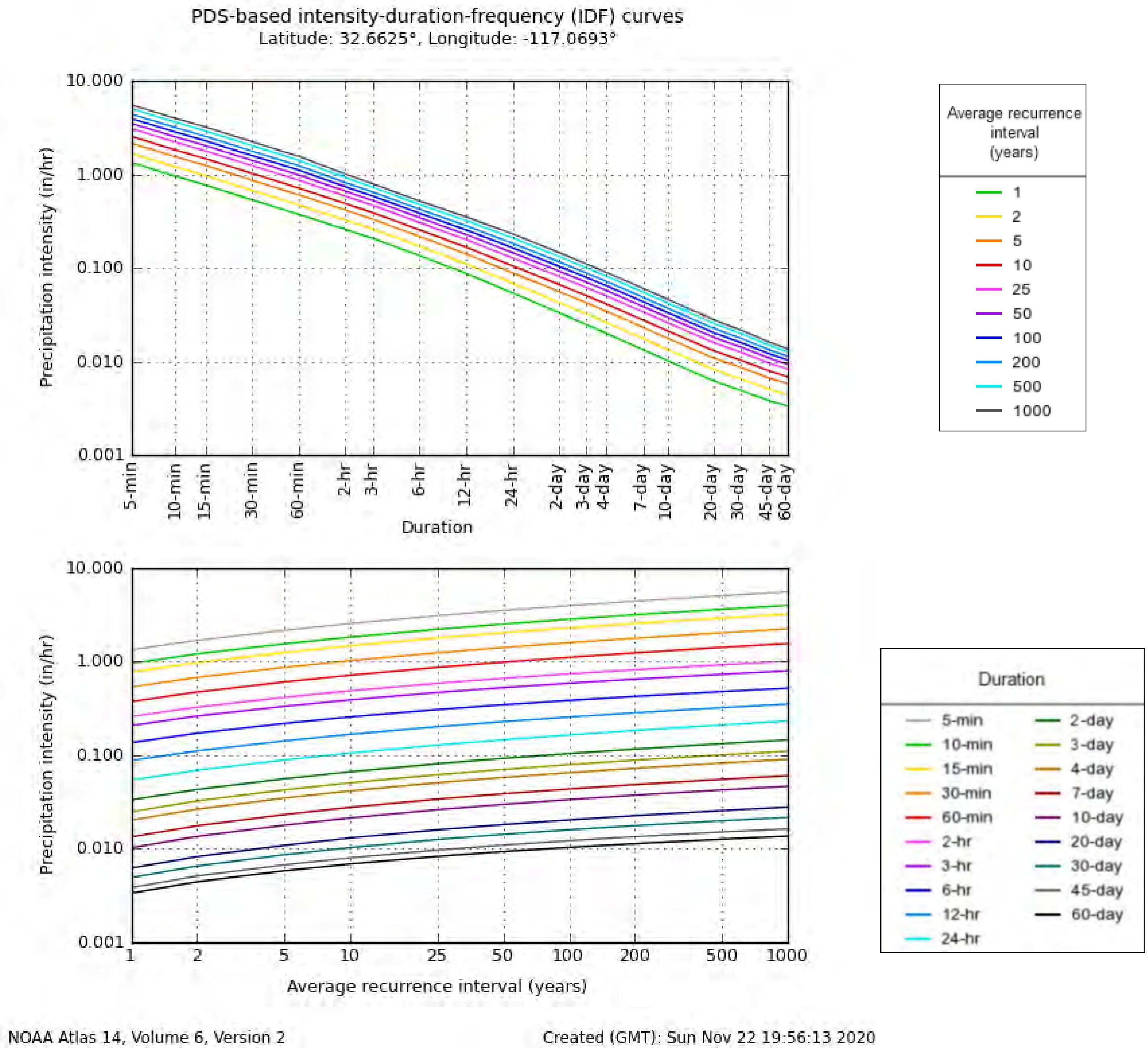
PF graphical

ATTACHMENT B, EXHIBIT J-2 - 16



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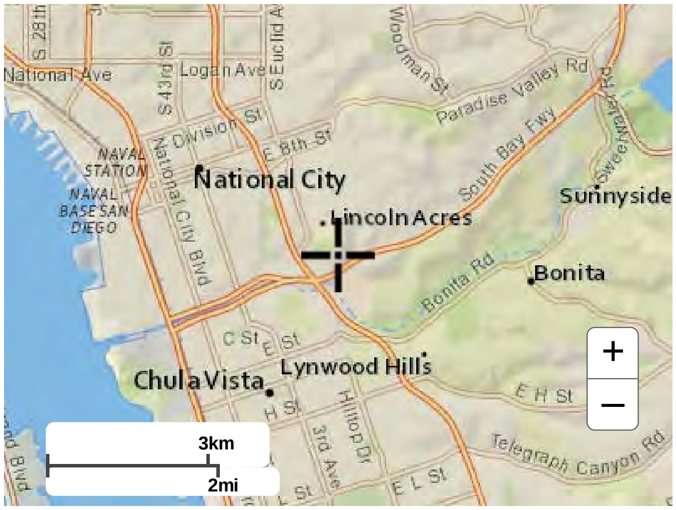
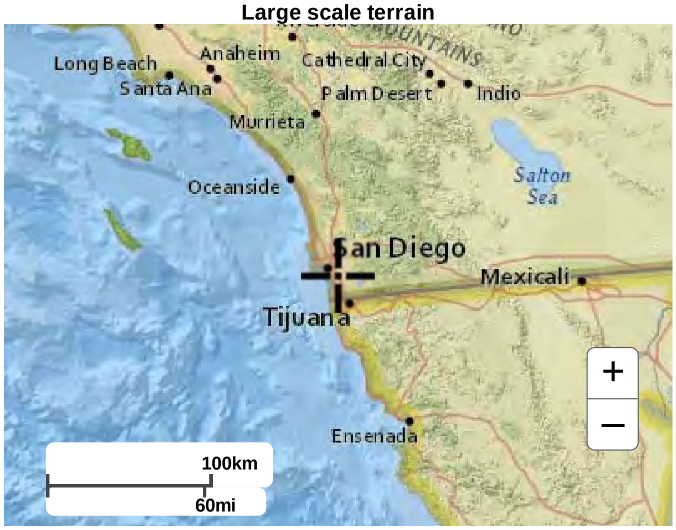
Maps & aerials

Small scale terrain

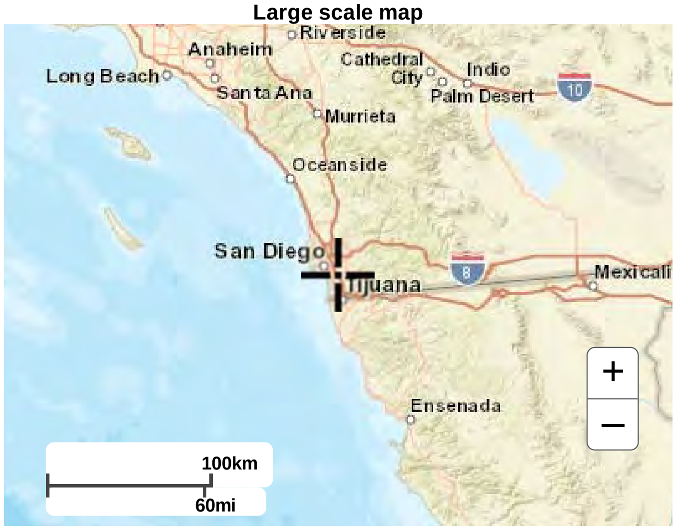
ATTACHMENT B, EXHIBIT J-2 - 17



Large scale terrain

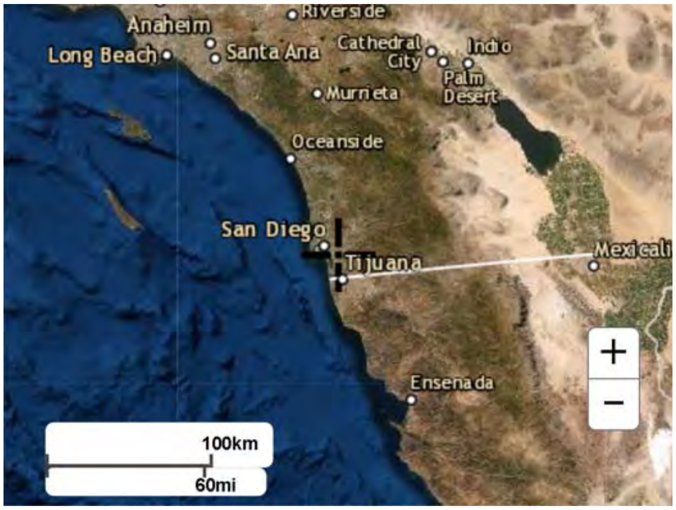


Large scale map



Large scale aerial

ATTACHMENT B, EXHIBIT J-2 - 18



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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

Table 819.2B

Run off Coefficients for Developed Areas[(1)]

Type of Drainage Area	Runoff Coefficient
Business:	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential:	
Single-family areas	0.30 - 0.50
Multi-units, detached	0.40 - 0.60
Multi-units, attached	0.60 - 0.75
Suburban	0.25 - 0.40
Apartment dwelling areas	0.50 - 0.70
Industrial:	
Light areas	0.50 - 0.80
Heavy areas	0.60 - 0.90
Parks, cemeteries:	0.10 - 0.25
Playgrounds:	0.20 - 0.40
Railroad yard areas:	0.20 - 0.40
Unimproved areas:	0.10 - 0.30
Lawns:	
Sandy soil, flat, 2%	0.05 - 0.10
Sandy soil, average, 2-7%	0.10 - 0.15
Sandy soil, steep, 7%	0.15 - 0.20
Heavy soil, flat, 2%	0.13 - 0.17
Heavy soil, average, 2-7%	0.18 - 0.22
Heavy soil, steep, 7%	0.25 - 0.35
Streets:	
Asphaltic	0.70 - 0.95
Concrete	0.80 - 0.95
Brick	0.70 - 0.85
Drives and walks	0.75 - 0.85
Roofs:	0.75 - 0.95

NOTES:
(1) From HDS No. 2.

REC Consultants, Inc.
Civil Engineering · Environmental
Land Surveying
2442 Second Avenue
San Diego, CA 92101
(619)232-9200 (619)232-9210 Fax

CARMAX – CALTRANS
REGIONAL HYDROLOGY EXHIBIT

DESIGN BY
DRAWN BY
APPR'VD BY

NO.	DATE	BY	

SCALE: 1" = 300'
JOB NO.: 7007-02
DATE: 10/20/2020
SHEET: 1 OF 1

Attachment 2

HGL Calculations

Drainage System 85

Pre and Post Developed Summary and Profiles

STORM CAD SYSTEM 85 OUTPUT - PRE DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	CO-1	MH-1	32.99	MH-2	27.87	245	0.021	Circle	36	0.013	38.27	37.61	34.76	4.92	9.74	96.41	36.1	41.5
35	CO-2	MH-2	27.87	MH-3	26.08	85	0.021	Circle	36	0.013	37.38	37.15	34.76	4.92	11.07	96.79	35.9	41.4
37	CO-3	MH-3	26.08	MH-4	23.58	120	0.021	Circle	36	0.013	36.61	35.87	52.13	7.37	12.29	96.27	54.2	52.4
39	CO-4	MH-4	23.58	O-1	22.5	52	0.021	Circle	36	0.013	35.37	35.05	52.13	7.37	12.55	96.12	54.2	52.5

MANHOLE

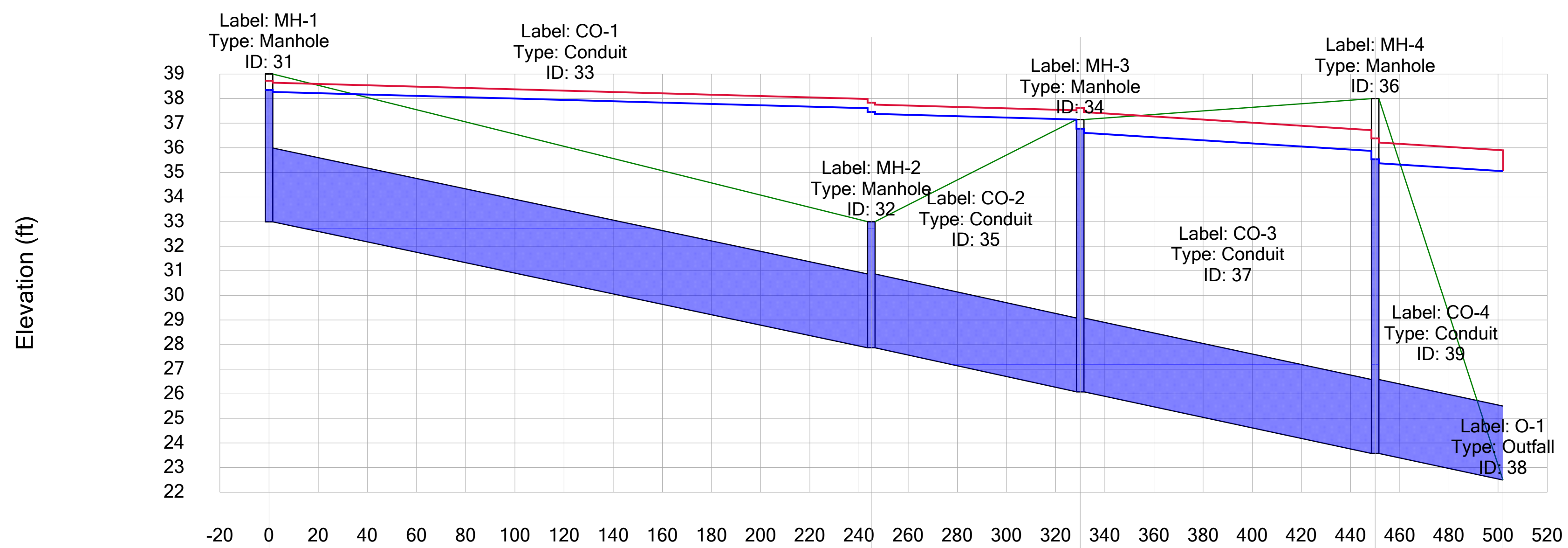
ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	39	TRUE	39	FALSE	(N/A)	34.76	34.76	5.36	38.35	HEC-22 Energy (Third Edition)	Flat	38.35
32	MH-2	33	TRUE	33	TRUE	27.87	69.52	34.76	9.59	37.46	HEC-22 Energy (Third Edition)	Flat	37.46
34	MH-3	37.15	TRUE	37.15	FALSE	26.08	86.89	52.13	10.7	36.78	HEC-22 Energy (Third Edition)	Flat	36.78
36	MH-4	38	TRUE	38	FALSE	23.58	104.26	52.13	11.96	35.54	HEC-22 Energy (Third Edition)	Flat	35.54

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
38	O-1	22.5	TRUE	22.5	User Defined Tailwater	35.05	35.05	52.13

Profile Report
Profile: MH-1 to O-1

MH-1 to O-1 - Base



ID\Label		33 \ CO-1		35 \ CO-2		37 \ CO-3		39 \ CO-4	
Link Length (ft)		245.0		85.0		120.0		52.0	
Rise (in)\Material		36.0 \		36.0 \		36.0 \		36.0 \	
Flow (cfs)		34.76		34.76		52.13		52.13	
Slope (ft/ft)		0.021		0.021		0.021		0.021	
ID\Label	31 \ MH-1		32 \ MH-2		34 \ MH-3		36 \ MH-4		38 \ O-1
Ground (ft)	39.00		33.00		37.15		38.00		22.50
Invert (ft)	32.99		27.87		26.08		23.58		22.50
Station (ft)	0.0		245.0		330.0		450.0		502.0

STORM CAD SYSTEM 85 OUTPUT - POST DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	CO-1	MH-1	32.99	MH-2	27.87	245	0.021	Circle	36	0.013	38.27	37.61	34.76	4.92	9.74	96.41	36.1	41.5
35	CO-2	MH-2	27.87	MH-3	26.08	85	0.021	Circle	36	0.013	37.38	37.15	34.76	4.92	11.07	96.79	35.9	41.4
37	CO-3	MH-3	26.08	MH-4	23.58	120	0.021	Circle	36	0.013	36.62	35.88	52.13	7.37	12.3	96.27	54.2	52.4
39	CO-4	MH-4	23.58	O-1	22.5	52	0.021	Circle	36	0.013	35.38	35.06	52.13	7.37	12.56	96.12	54.2	52.5

MANHOLE

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	39	TRUE	39	FALSE	(N/A)	34.76	34.76	5.36	38.35	HEC-22 Energy (Third Edition)	Flat	38.35
32	MH-2	33	TRUE	33	TRUE	27.87	69.52	34.76	9.59	37.46	HEC-22 Energy (Third Edition)	Flat	37.46
34	MH-3	37.15	TRUE	37.15	FALSE	26.08	86.89	52.13	10.71	36.79	HEC-22 Energy (Third Edition)	Flat	36.79
36	MH-4	38	TRUE	38	FALSE	23.58	104.26	52.13	11.97	35.55	HEC-22 Energy (Third Edition)	Flat	35.55

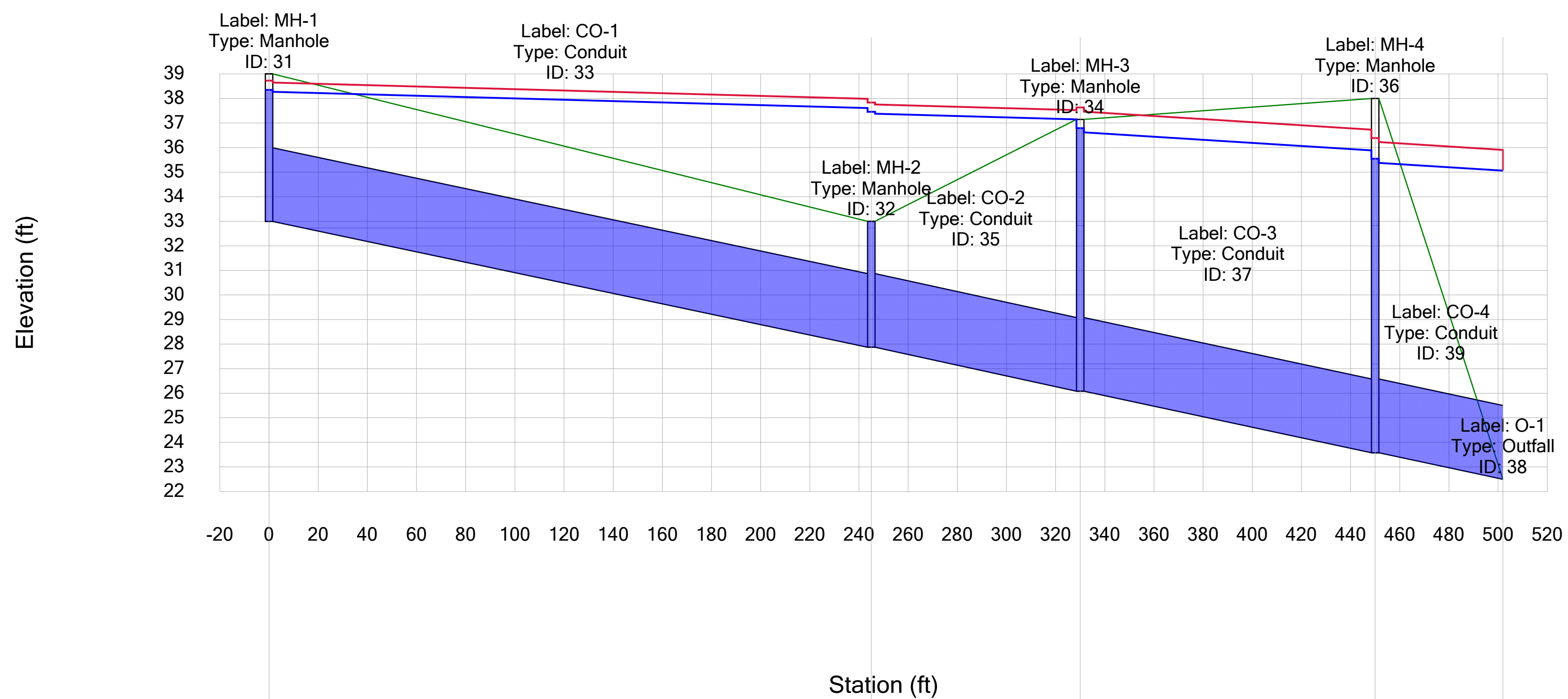
OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
38	O-1	22.5	TRUE	22.5	User Defined Tailwater	35.06	35.06	52.13

Profile Report

Profile: MH-1 to O-1

MH-1 to O-1 - Base



ID\Label		33 \ CO-1		35 \ CO-2		37 \ CO-3		39 \ CO-4	
Link Length (ft)		245.0		85.0		120.0		52.0	
Rise (in)\Material		36.0 \		36.0 \		36.0 \		36.0 \	
Flow (cfs)		34.76		34.76		52.13		52.13	
Slope (ft/ft)		0.021		0.021		0.021		0.021	
ID\Label	31 \ MH-1		32 \ MH-2		34 \ MH-3		36 \ MH-4		38 \ O-1
Ground (ft)	39.00		33.00		37.15		38.00		22.50
Invert (ft)	32.99		27.87		26.08		23.58		22.50
Station (ft)	0.0		245.0		330.0		450.0		502.0

Drainage System 84

Pre and Post Developed Summary and Profiles

STORM CAD SYSTEM 84 OUTPUT - PRE DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	CO-1	MH-1	58.8	MH-2	44.14	162	0.09	Circle	24	0.013	60.62	46.81	27.34	20.48	2.67	68.05	40.2	44.1
35	CO-2	MH-2	44.14	MH-3	32.5	126	0.092	Circle	24	0.013	45.96	39	27.34	20.63	6.5	68.76	39.8	43.8
37	CO-3	MH-3	32.5	MH-4	25.85	228	0.029	Circle	30	0.013	39.64	36.48	48.35	9.85	10.63	70.05	69	61.1
39	CO-4	MH-4	25.85	O-1	22.5	36	0.093	Circle	30	0.013	35.56	35.06	48.35	9.85	12.56	125.12	38.6	43.1

MANHOLE

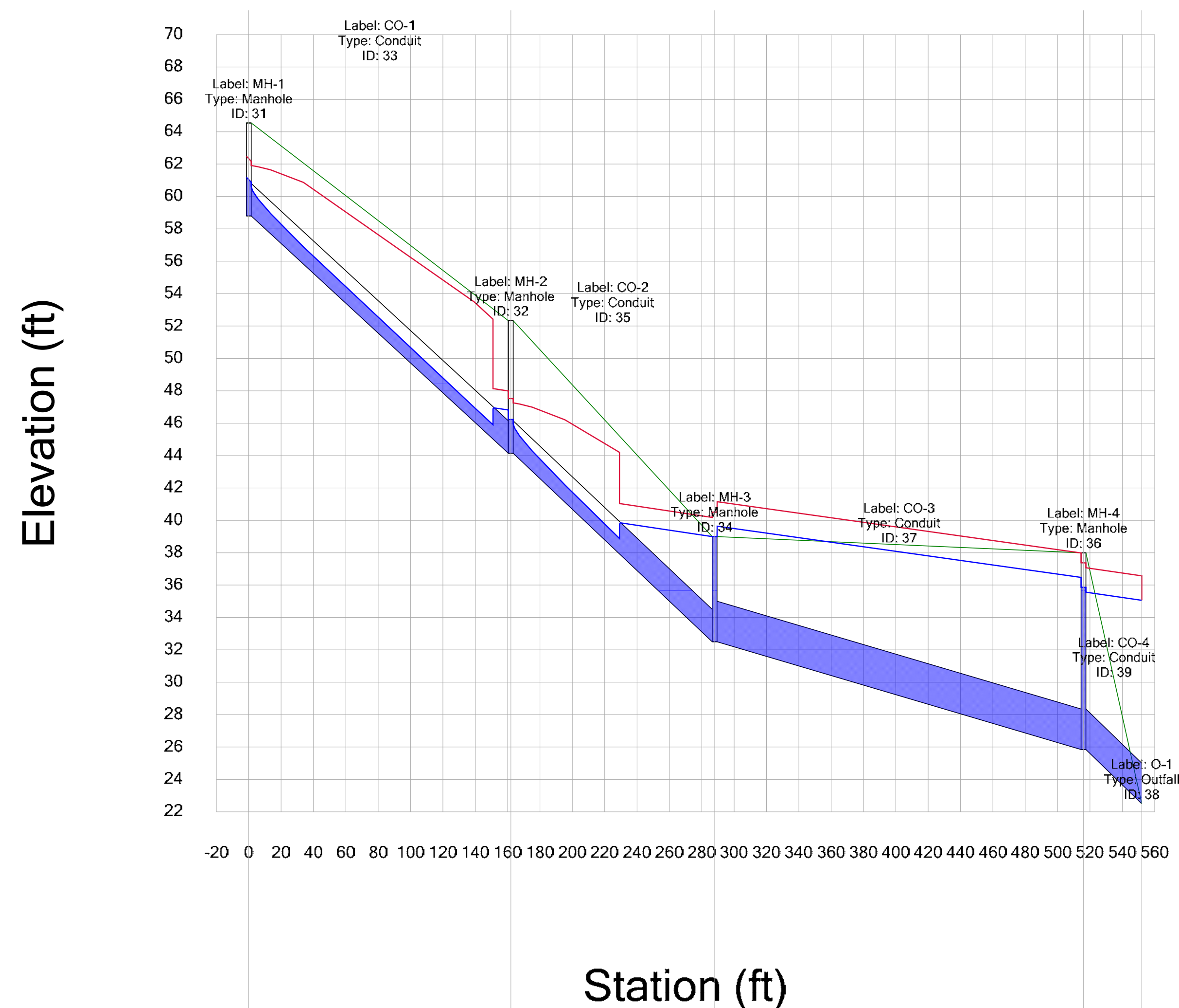
ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	64.54	TRUE	64.54	FALSE	(N/A)	27.34	27.34	2.09	60.89	HEC-22 Energy (Third Edition)	Flat	61.19
32	MH-2	52.33	TRUE	52.33	FALSE	44.14	54.68	27.34	2.09	46.23	HEC-22 Energy (Third Edition)	Flat	46.23
34	MH-3	39	TRUE	39	FALSE	32.5	75.69	48.35	6.5	39	HEC-22 Energy (Third Edition)	Flat	39
36	MH-4	38	TRUE	38	FALSE	25.85	96.70	48.35	10.01	35.86	HEC-22 Energy (Third Edition)	Flat	35.87

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
38	O-1	22.5	TRUE	22.5	User Defined Tailwater	35.06	35.06	48.35

Profile Report
Profile: Profile - 1

Profile - 1 - Base



ID\Label		33 \ CO-1		35 \ CO-2		37 \ CO-3		39 \ CO-4	
Link Length (ft)		162.0		126.0		228.0		36.0	
Rise (in)\Material		24.0 \		24.0 \		30.0 \		30.0 \	
Flow (cfs)		27.34		27.34		48.35		48.35	
Slope (ft/ft)		0.090		0.092		0.029		0.093	
ID\Label	31 \ MH-1		32 \ MH-2		34 \ MH-3		36 \ MH-4		38 \ O-1
Ground (ft)	64.54		52.33		39.00		38.00		22.50
Invert (ft)	58.80		44.14		32.50		25.85		22.50
Station (ft)	0.0		162.0		288.0		516.0		552.0

STORM CAD SYSTEM 84 OUTPUT - POST DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	CO-1	MH-1	58.8	MH-2	44.14	162	0.09	Circle	24	0.013	60.62	46.81	27.34	20.48	2.67	68.05	40.2	44.1
35	CO-2	MH-2	44.14	MH-3	32.5	126	0.092	Circle	24	0.013	45.96	39	27.34	20.63	6.5	68.76	39.8	43.8
37	CO-3	MH-3	32.5	MH-4	25.85	228	0.029	Circle	30	0.013	39.66	36.5	48.35	9.85	10.65	70.05	69	61.1
39	CO-4	MH-4	25.85	O-1	22.5	36	0.093	Circle	30	0.013	35.58	35.08	48.35	9.85	12.58	125.12	38.6	43.1

MANHOLE

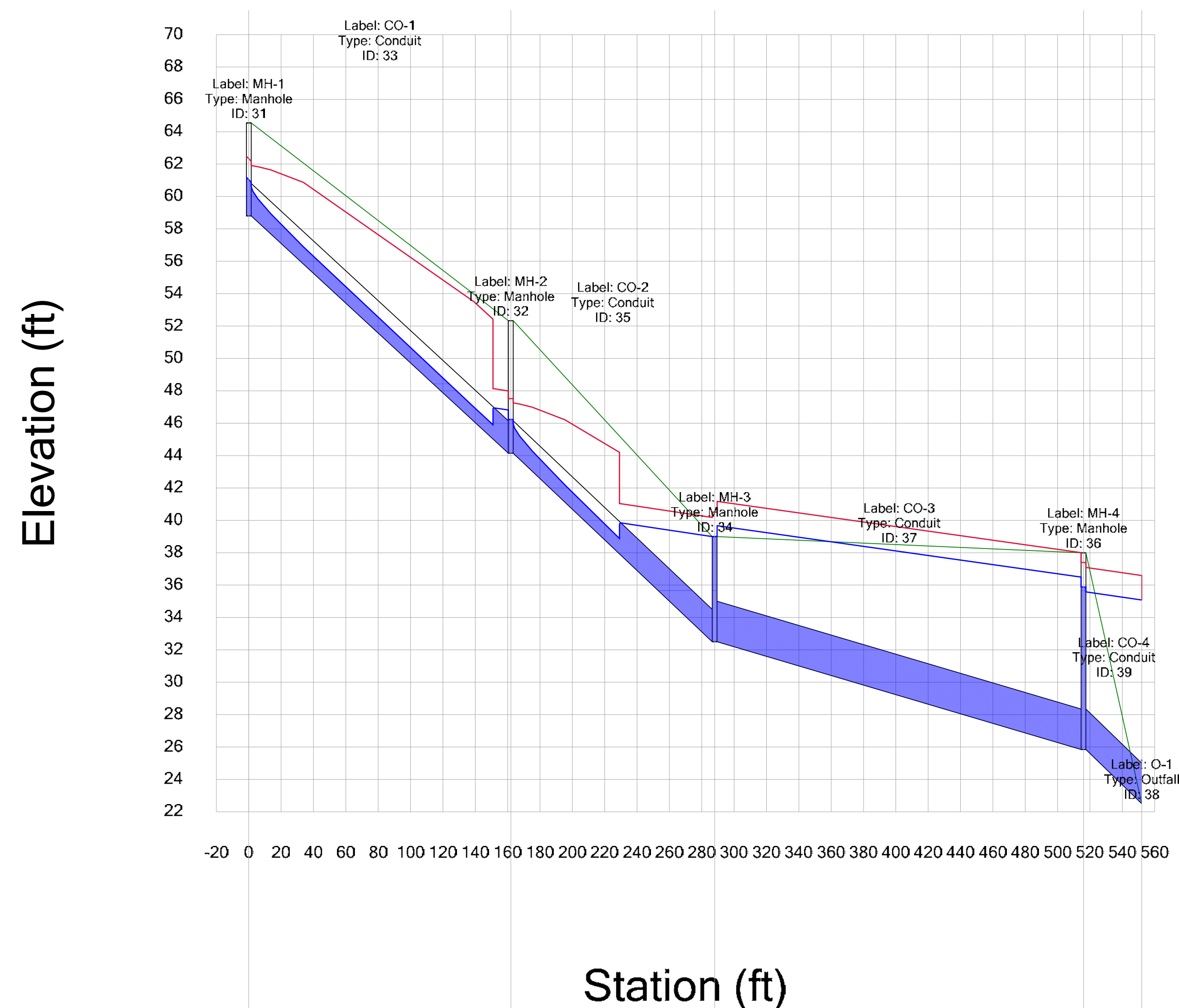
ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	64.54	TRUE	64.54	FALSE	(N/A)	27.34	27.34	2.09	60.89	HEC-22 Energy (Third Edition)	Flat	61.19
32	MH-2	52.33	TRUE	52.33	FALSE	44.14	54.68	27.34	2.09	46.23	HEC-22 Energy (Third Edition)	Flat	46.23
34	MH-3	39	TRUE	39	FALSE	32.5	75.69	48.35	6.5	39	HEC-22 Energy (Third Edition)	Flat	39
36	MH-4	38	TRUE	38	FALSE	25.85	96.70	48.35	10.03	35.88	HEC-22 Energy (Third Edition)	Flat	35.89

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
38	O-1	22.5	TRUE	22.5	User Defined Tailwater	35.08	35.08	48.35

Profile Report
Profile: Profile - 1

Profile - 1 - Base



ID\Label		33 \ CO-1		35 \ CO-2		37 \ CO-3		39 \ CO-4	
Link Length (ft)		162.0		126.0		228.0		36.0	
Rise (in)\Material		24.0 \		24.0 \		30.0 \		30.0 \	
Flow (cfs)		27.34		27.34		48.35		48.35	
Slope (ft/ft)		0.090		0.092		0.029		0.093	
ID\Label	31 \ MH-1		32 \ MH-2		34 \ MH-3		36 \ MH-4		38 \ O-1
Ground (ft)	64.54		52.33		39.00		38.00		22.50
Invert (ft)	58.80		44.14		32.50		25.85		22.50
Station (ft)	0.0		162.0		288.0		516.0		552.0

Drainage System 83

Pre and Post Developed Summary and Profiles

STORM CAD SYSTEM 83 OUTPUT - PRE DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	24-INCH	MH-1	33.9	MH-2	33	52	0.017	Circle	24	0.013	36.46	36.32	11.58	3.69	3.32	29.76	38.9	43.3
35	CO-2	MH-2	33	O-1	30	168	0.018	Circle	24	0.013	35.86	35.07	15.48	4.93	5.07	30.23	51.2	50.7
37	18-INCH	MH-3	39.62	MH-2	36.1	92	0.038	Circle	18	0.013	40.38	36.54	3.9	8.94	0.44	20.55	19	29.5

MANHOLE

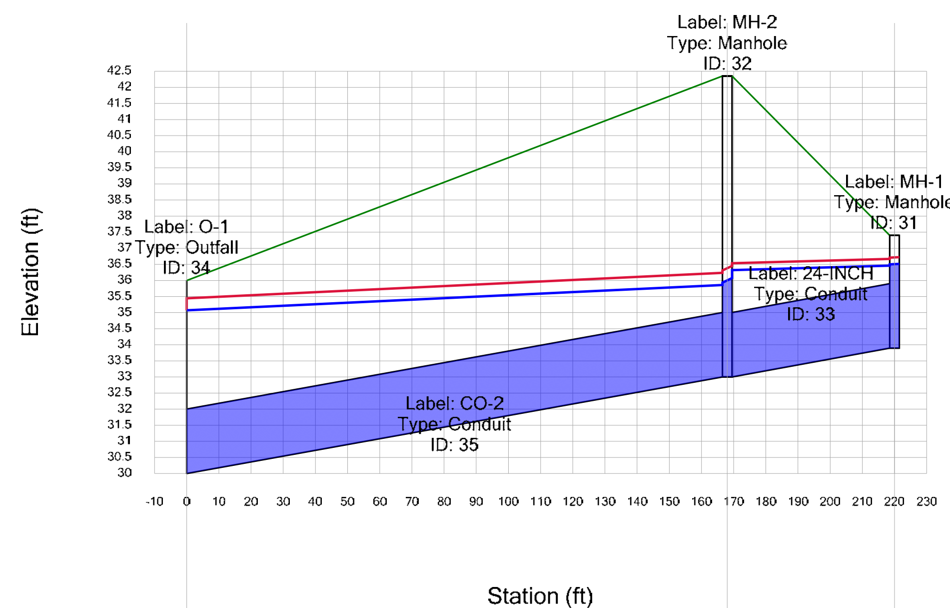
ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	37.4	TRUE	37.4	FALSE	(N/A)	11.58	11.58	2.6	36.5	HEC-22 Energy (Third Edition)	Flat	36.51
32	MH-2	42.35	TRUE	42.35	FALSE	33	30.96	15.48	2.93	35.93	HEC-22 Energy (Third Edition)	Flat	36.07
36	MH-3	42.76	TRUE	42.76	FALSE	(N/A)	3.90	3.9	0.82	40.44	HEC-22 Energy (Third Edition)	Flat	40.51

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
34	O-1	36	TRUE	30	User Defined Tailwater	35.07	35.07	15.48

Profile Report
Profile: Profile - 1

Profile - 1 - Base

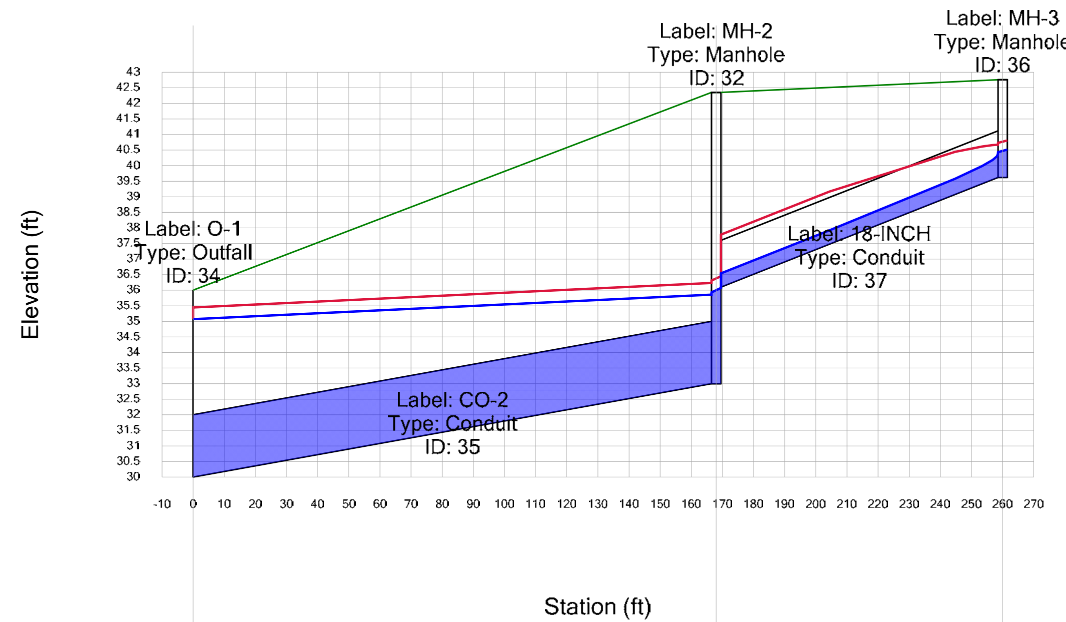


ID\Label		35 \ CO-2		33 \ 24-INCH	
Link Length (ft)		168.0		52.0	
Rise (in)\Material		24.0 \ Concrete		24.0 \ Concrete	
Flow (cfs)		15.48		11.58	
Slope (ft/ft)		0.018		0.017	
ID\Label	34 \ O-1		32 \ MH-2		31 \ MH-1
Ground (ft)	36.00		42.35		37.40
Invert (ft)	30.00		33.00		33.90
Station (ft)	0.0		168.0		220.0

Profile Report

Profile: Profile - 2

Profile - 2 - Base



ID\Label		35 \ CO-2		37 \ 18-INCH	
Link Length (ft)		168.0		92.0	
Rise (in)\Material		24.0 \ Concrete		18.0 \ Concrete	
Flow (cfs)		15.48		3.90	
Slope (ft/ft)		0.018		0.038	
ID\Label	34 \ O-1		32 \ MH-2		36 \ MH-3
Ground (ft)	36.00		42.35		42.76
Invert (ft)	30.00		33.00		39.62
Station (ft)	0.0		168.0		260.0

STORM CAD SYSTEM 83 OUTPUT - POST DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	24-INCH	MH-1	33.9	MH-2	33	52	0.017	Circle	24	0.013	36.57	36.43	11.58	3.69	3.43	29.76	38.9	43.3
35	CO-2	MH-2	33	O-1	30	168	0.018	Circle	24	0.013	35.97	35.18	15.48	4.93	5.18	30.23	51.2	50.7
37	18-INCH	MH-3	39.62	MH-2	36.1	92	0.038	Circle	18	0.013	40.38	36.54	3.9	8.94	0.44	20.55	19	29.5

MANHOLE

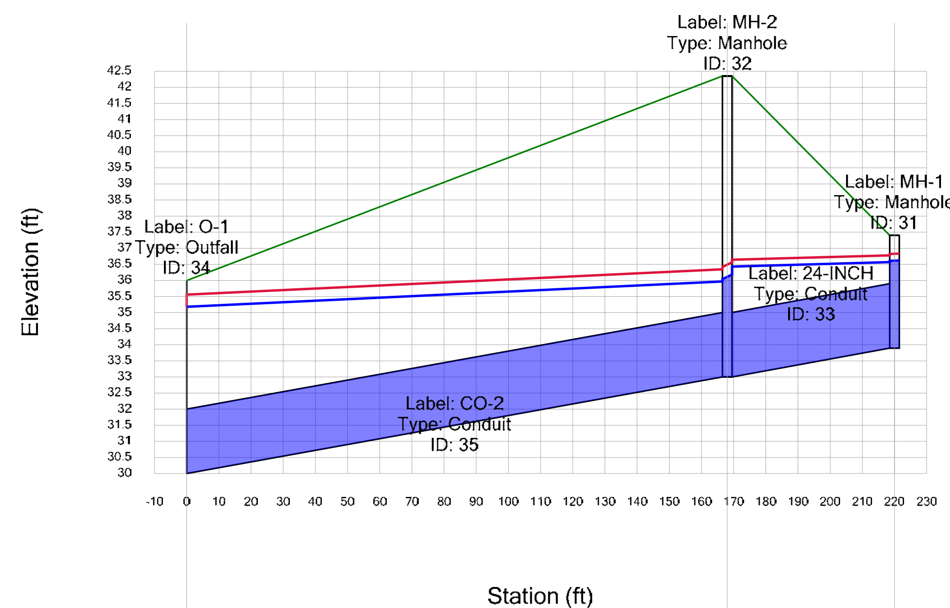
ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	37.4	TRUE	37.4	FALSE	(N/A)	11.58	11.58	2.71	36.61	HEC-22 Energy (Third Edition)	Flat	36.62
32	MH-2	42.35	TRUE	42.35	FALSE	33	30.96	15.48	3.04	36.04	HEC-22 Energy (Third Edition)	Flat	36.18
36	MH-3	42.76	TRUE	42.76	FALSE	(N/A)	3.90	3.9	0.82	40.44	HEC-22 Energy (Third Edition)	Flat	40.51

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
34	O-1	36	TRUE	30	User Defined Tailwater	35.18	35.18	15.48

Profile Report
Profile: Profile - 1

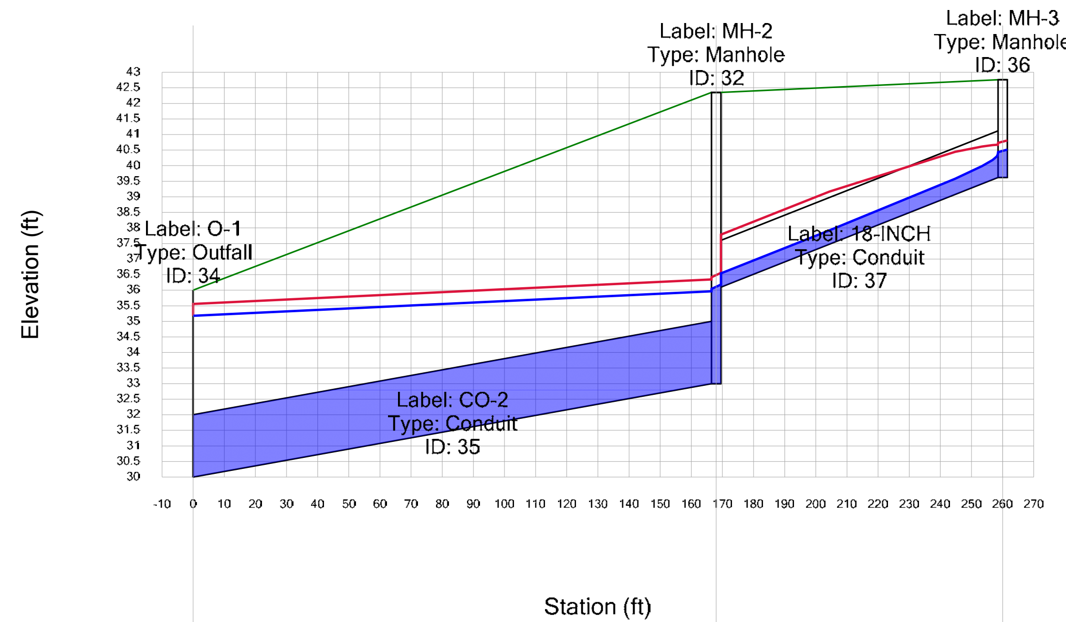
Profile - 1 - Base



ID\Label		35 \ CO-2		33 \ 24-INCH	
Link Length (ft)		168.0		52.0	
Rise (in)\Material		24.0 \ Concrete		24.0 \ Concrete	
Flow (cfs)		15.48		11.58	
Slope (ft/ft)		0.018		0.017	
ID\Label	34 \ O-1		32 \ MH-2		31 \ MH-1
Ground (ft)	36.00		42.35		37.40
Invert (ft)	30.00		33.00		33.90
Station (ft)	0.0		168.0		220.0

Profile Report
Profile: Profile - 2

Profile - 2 - Base



ID\Label		35 \ CO-2		37 \ 18-INCH	
Link Length (ft)		168.0		92.0	
Rise (in)\Material		24.0 \ Concrete		18.0 \ Concrete	
Flow (cfs)		15.48		3.90	
Slope (ft/ft)		0.018		0.038	
ID\Label	34 \ O-1		32 \ MH-2		36 \ MH-3
Ground (ft)	36.00		42.35		42.76
Invert (ft)	30.00		33.00		39.62
Station (ft)	0.0		168.0		260.0

Drainage System 80

Pre and Post Developed Summary and Profiles

STORM CAD SYSTEM 80 OUTPUT - PRE DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	CO-1	MH-1	36.2	O-1	26.31	981	0.01	Box		0.013	41.04	35.06	603.3	18.18	8.75	1,047.05	57.6	55.3

MANHOLE

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	45	TRUE	45	FALSE	(N/A)	603.30	603.3	8.8	45	HEC-22 Energy (Third Edition)	Flat	45

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
32	O-1	40	TRUE	26.31	User Defined Tailwater	35.06	35.06	603.3

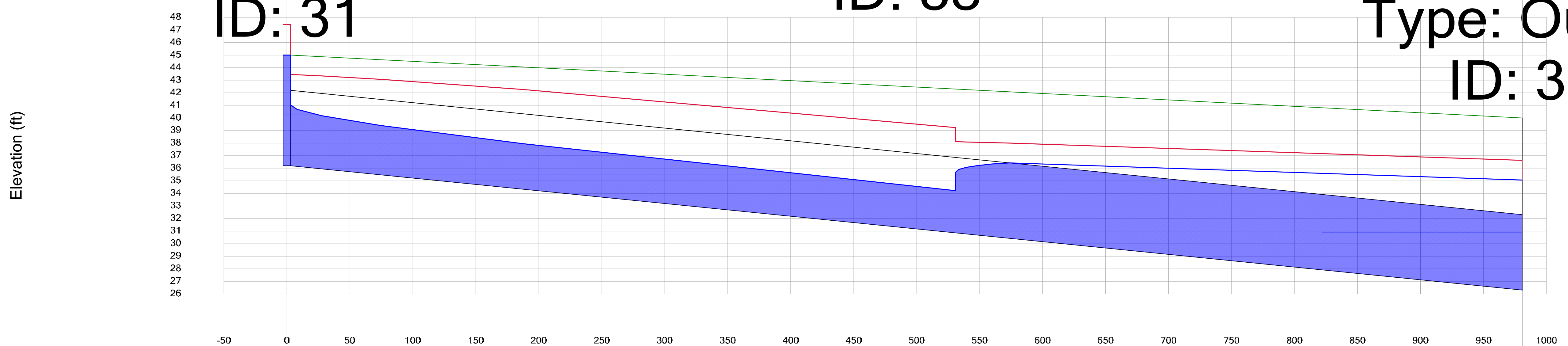
Profile Report
Profile: MH-1 to O-1

MH-1 to O-1 - Base

Label: MH-1
Type: Manhole
ID: 31

Label: CO-1
Type: Conduit
ID: 33

Label: O-1
Type: Outfall
ID: 32



Station (ft)

ID\Label		33 \ CO-1	
Link Length (ft)		981.0	
Rise (in)\Material		72.0 \	
Flow (cfs)		603.30	
Slope (ft/ft)		0.010	
ID\Label	31 \ MH-1		32 \ O-1
Ground (ft)	45.00		40.00
Invert (ft)	36.20		26.31
Station (ft)	0.0		981.0

STORM CAD SYSTEM 80 OUTPUT - POST DEVELOPED CONDITION

CONDUITS

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)	Manning's n	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Flow (cfs)	Velocity (ft/s)	Depth (Out) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth (Normal) / Rise (%)
33	CO-1	MH-1	36.2	O-1	26.31	981	0.01	Box		0.013	41.04	35.12	603.3	18.18	8.81	1,047.05	57.6	55.3

MANHOLE

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Rim) (ft)	Bolted Cover?	Elevation (Invert in 1) (ft)	Flow (Total In)	Flow (Total Out) (cfs)	Depth (Out) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	HEC-22 Benching Method	Hydraulic Grade Line (In) (ft)
31	MH-1	45	TRUE	45	FALSE	(N/A)	603.30	603.3	8.8	45	HEC-22 Energy (Third Edition)	Flat	45

OUTFALL

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
32	O-1	40	TRUE	26.31	User Defined Tailwater	35.12	35.12	603.3

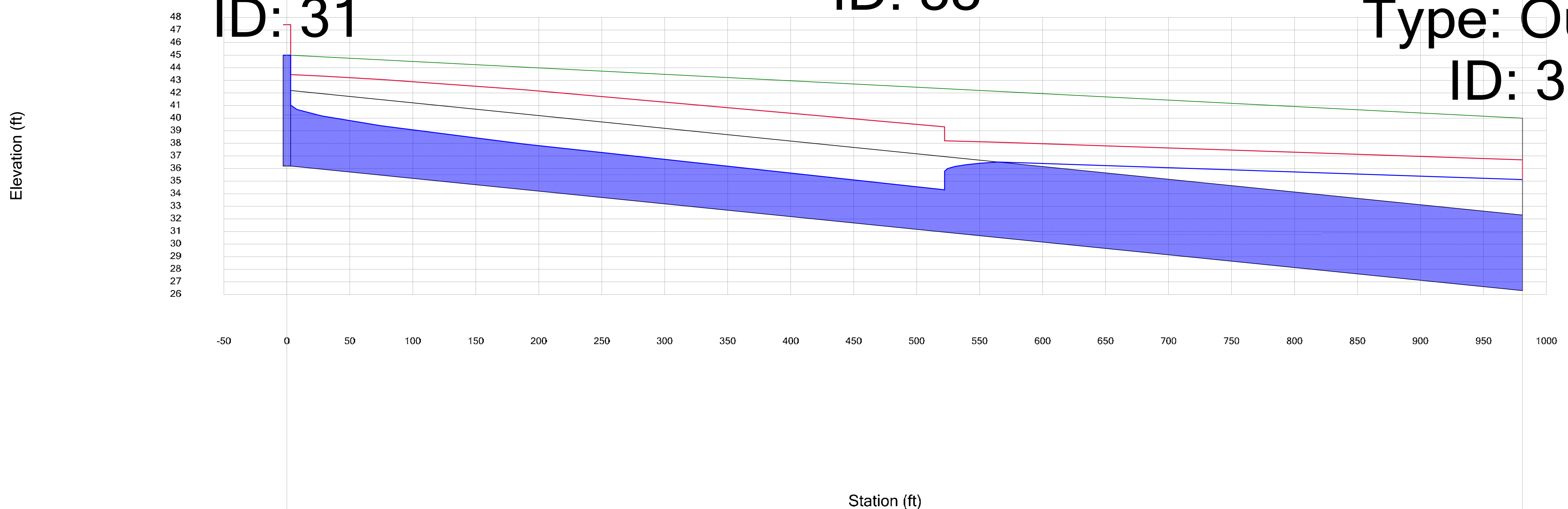
Profile Report
Profile: MH-1 to O-1

MH-1 to O-1 - Base

Label: MH-1
Type: Manhole
ID: 31

Label: CO-1
Type: Conduit
ID: 33

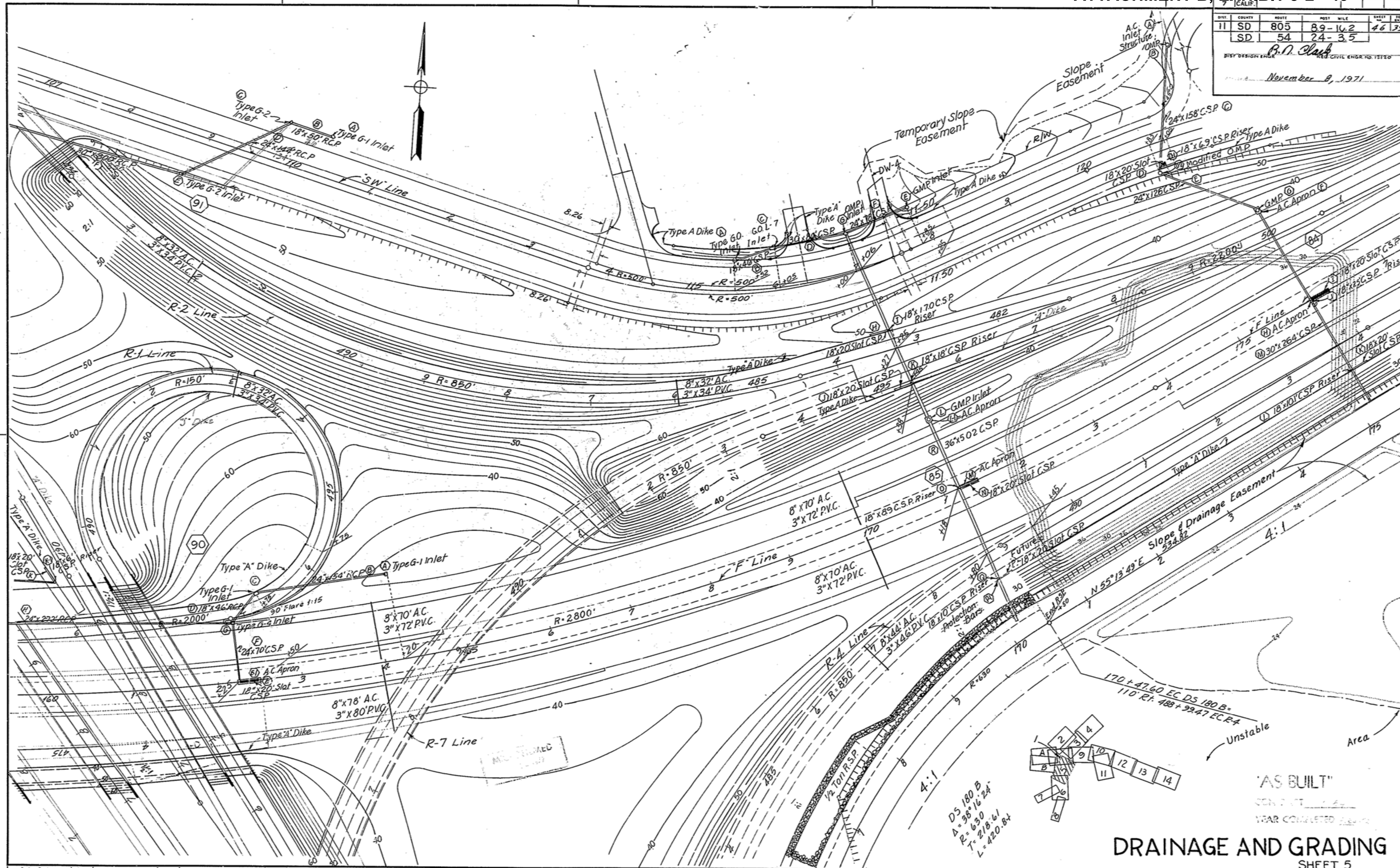
Label: O-1
Type: Outfall
ID: 32



ID\Label		33 \ CO-1	
Link Length (ft)		981.0	
Rise (in)\Material		72.0 \	
Flow (cfs)		603.30	
Slope (ft/ft)		0.010	
ID\Label	31 \ MH-1		32 \ O-1
Ground (ft)	45.00		40.00
Invert (ft)	36.20		26.31
Station (ft)	0.0		981.0

Attachment 3

Plan and Profiles As-Built Drawings



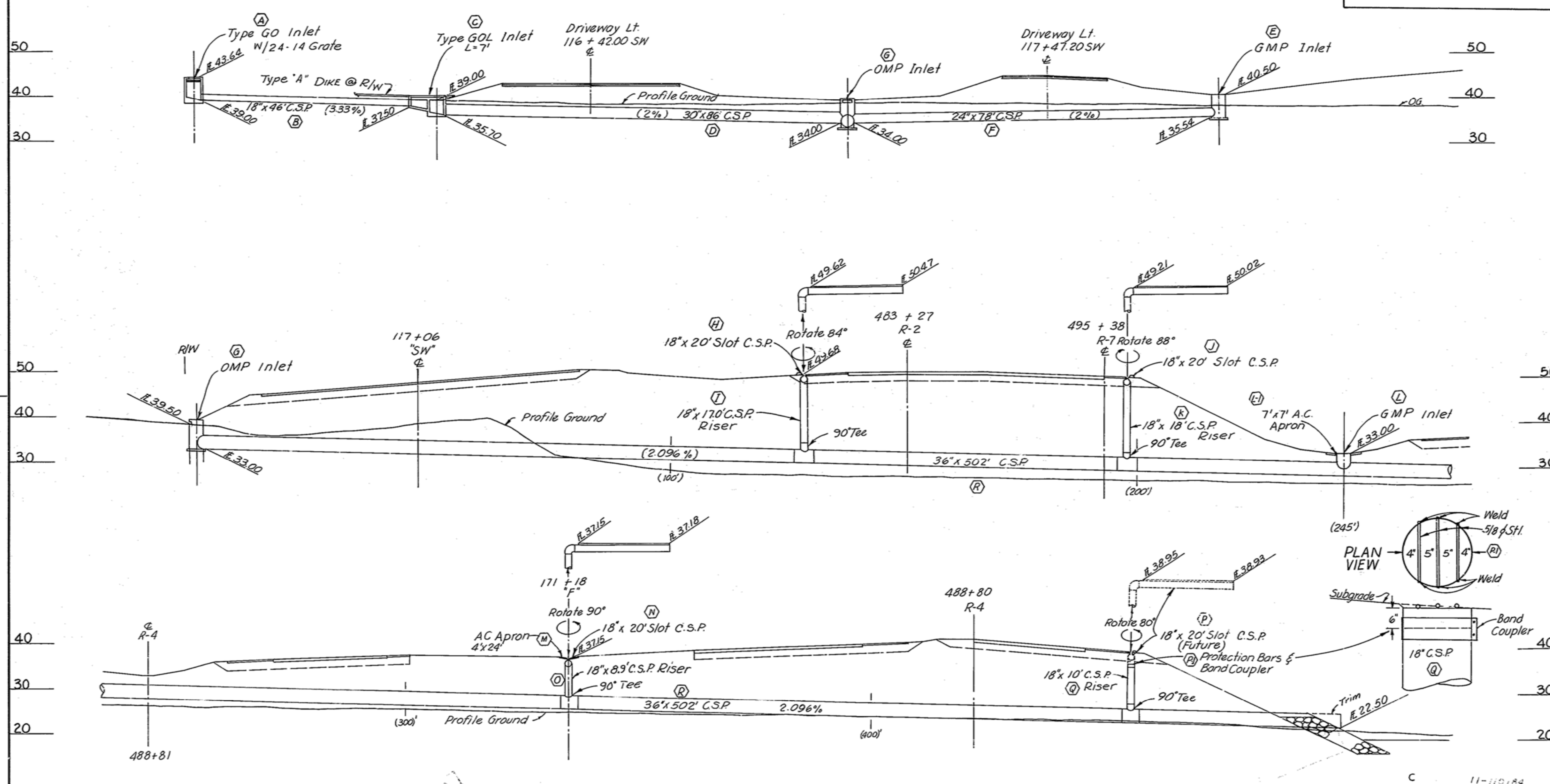
46

AS BUILT PLANS
Contract No. 11-110184
Date Completed 4-30-75
Document No. A000 6264

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
11	SD	805	8.9 - 10.2	61	395
	SD	54	2.4 - 3.5		

B.D. Clark
DIST DESIGN ENGR — REG. CIVIL ENGR NO. 12120
APPROVED November 8, 1971



DRAINAGE SYSTEM 85

11-110184
4-24-75

DRAINAGE PROFILES AND DETAILS

85

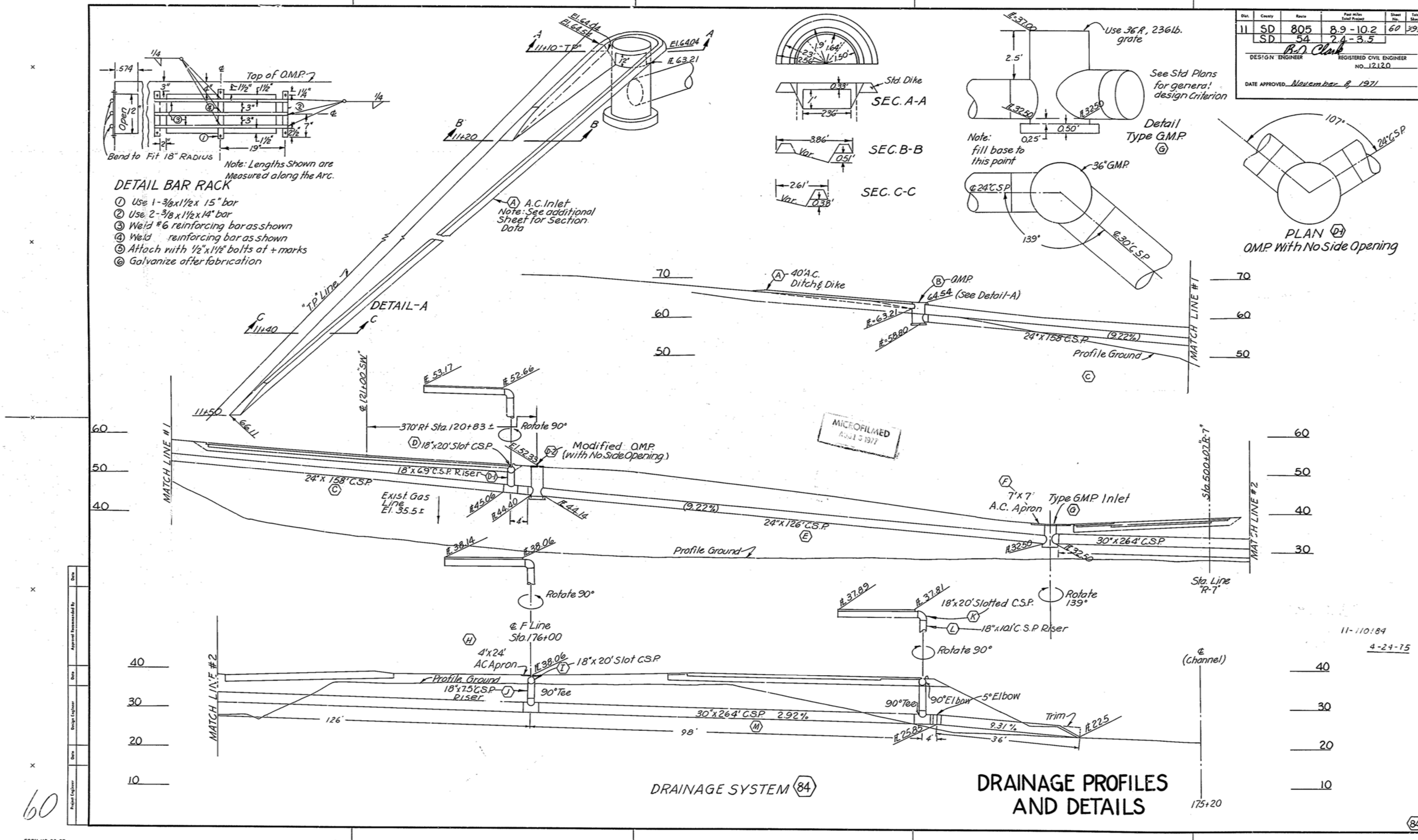
61

Project Engineer	Date	Design Engineer	Date	Approval Recommended By	Date

FORM HD-76

AS BUILT PLANS
Contract No. 11-110184
Date Completed 4-30-75
Document No. A000 62651

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 8-15-77 SIGNATURE Joseph M. Costa TITLE Supervisor



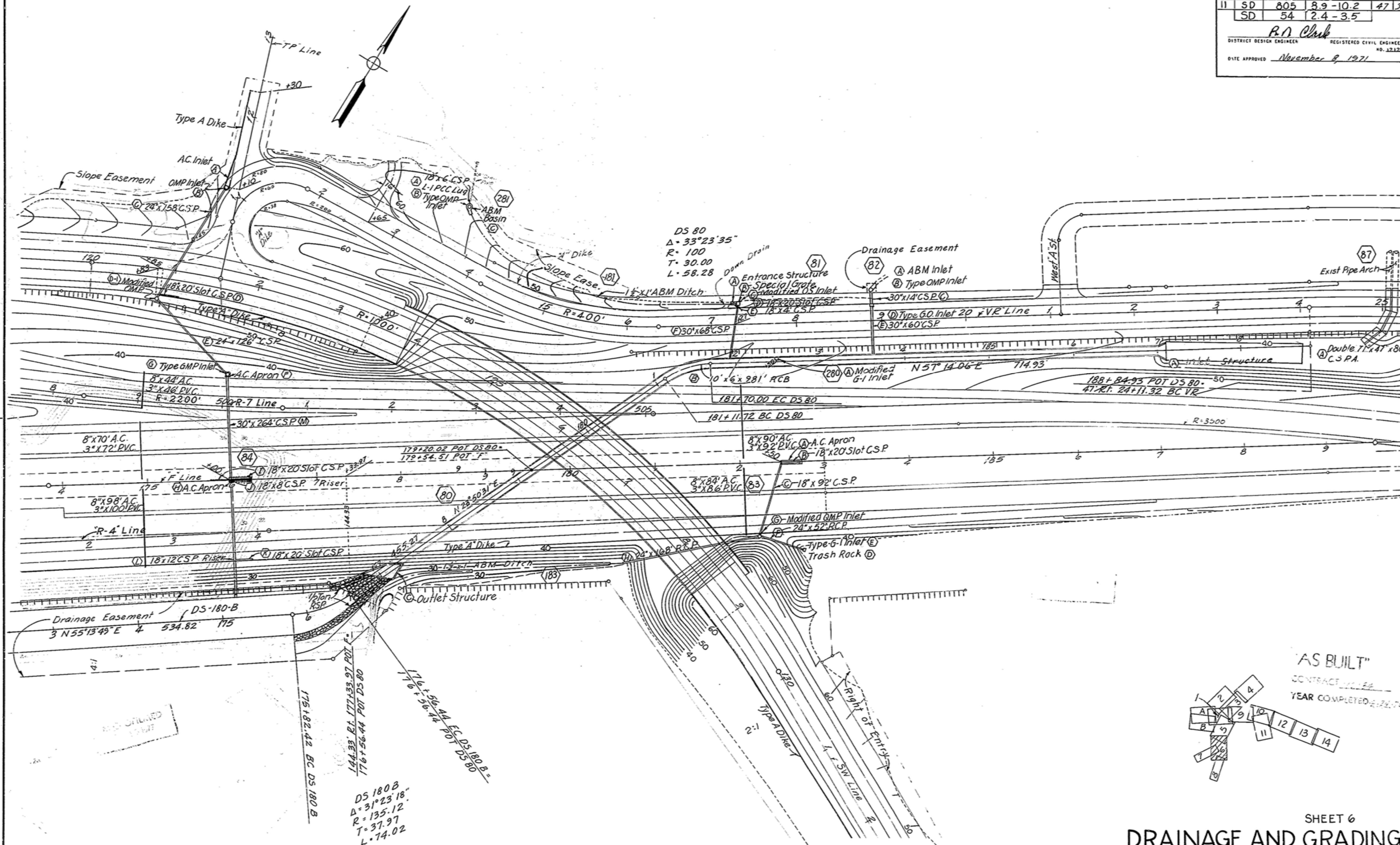
AS BUILT PLANS
Contract No. 11-110184
Date Completed 4-30-75
Document No. Acco 6264

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

8-15-77

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
11	SD	805	8.9 - 10.2	47	395
	SD	54	2.4 - 3.5		

R.D. Clark
DISTRICT DESIGN ENGINEER — REGISTERED CIVIL ENGINEER
DATE APPROVED November 8, 1971



47

SHEET 6

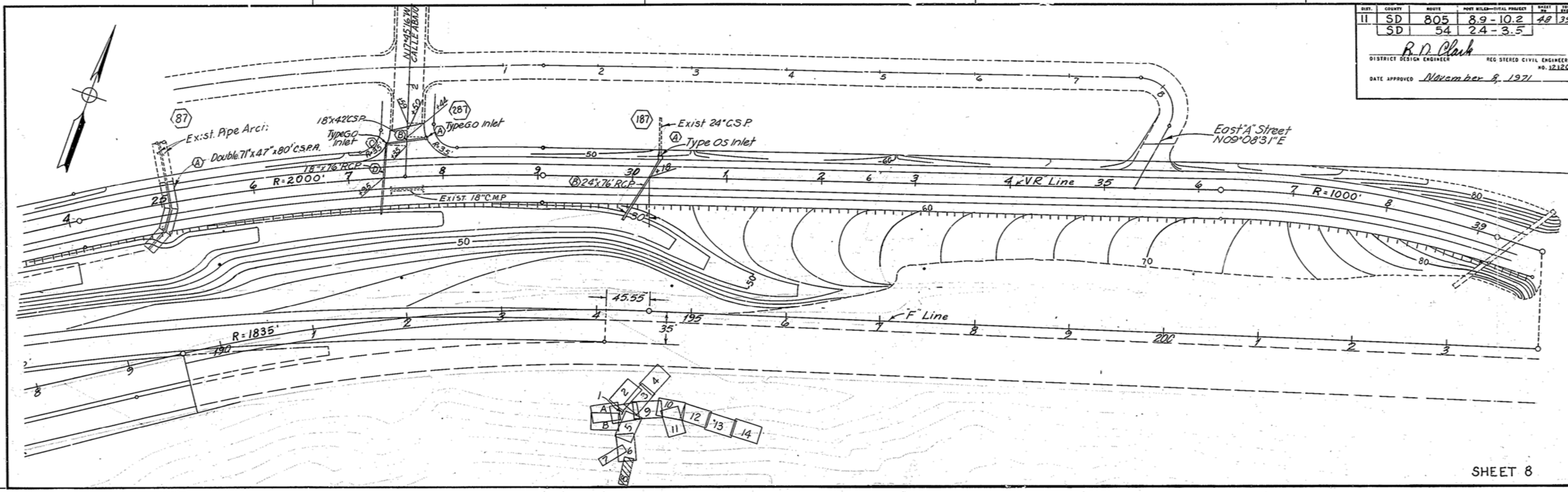
DRAINAGE AND GRADING

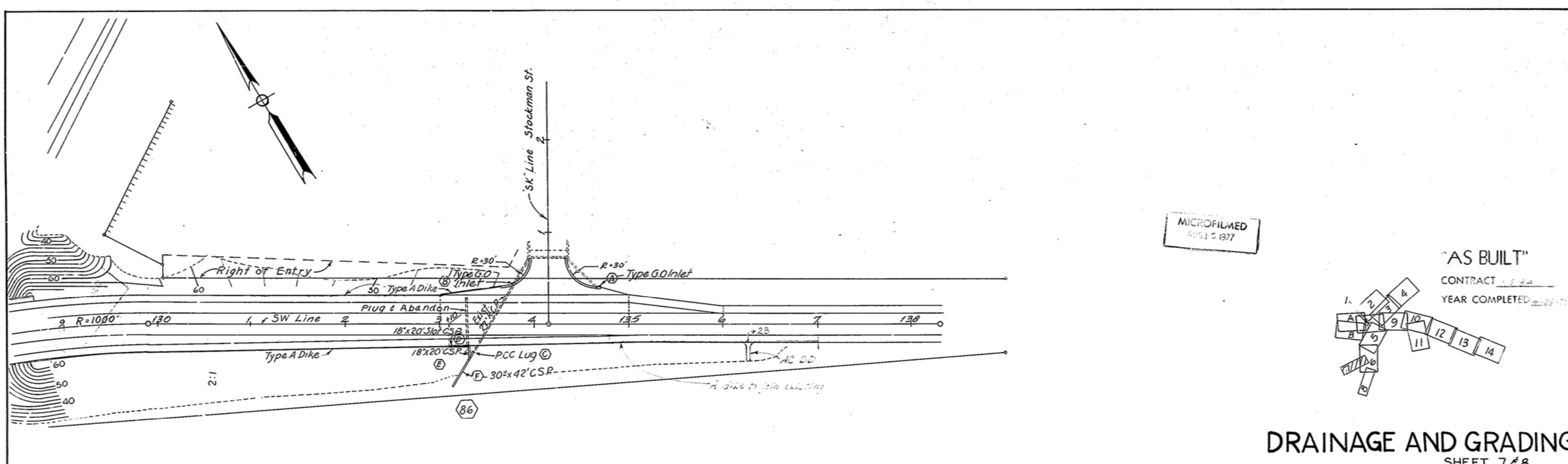
Project Engineer	Date	Design Engineer	Date	Approval Recommended By	Date

FORM WH23A-PF

AS BUILT PLANS
Contract No. 11-110184
Date Completed 4/30-75
Document No. A000 6264

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.





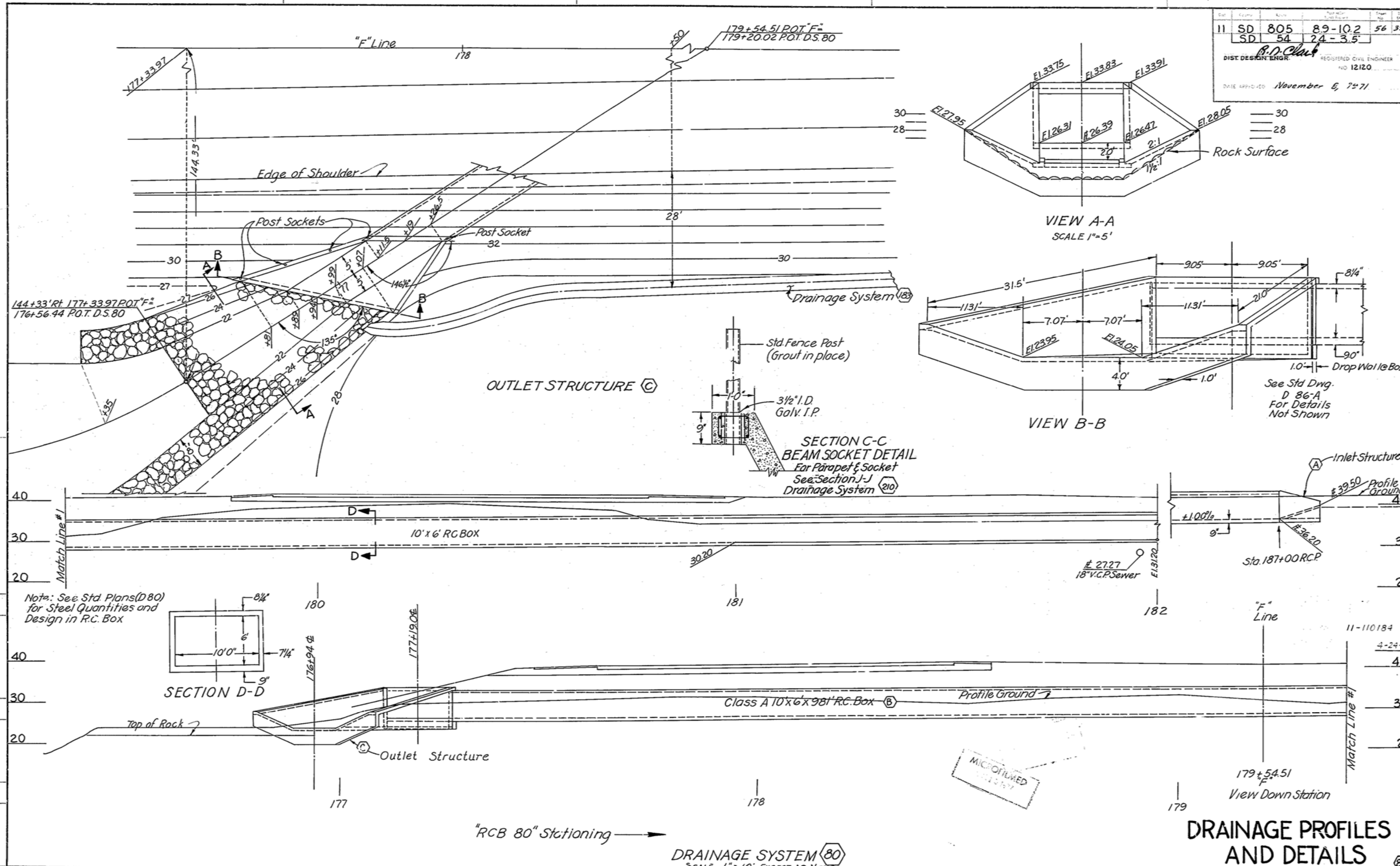
48

Project Engineer	Date	Design Engineer	Date	Approval Recommended By	Date

FORM WH23A-PF

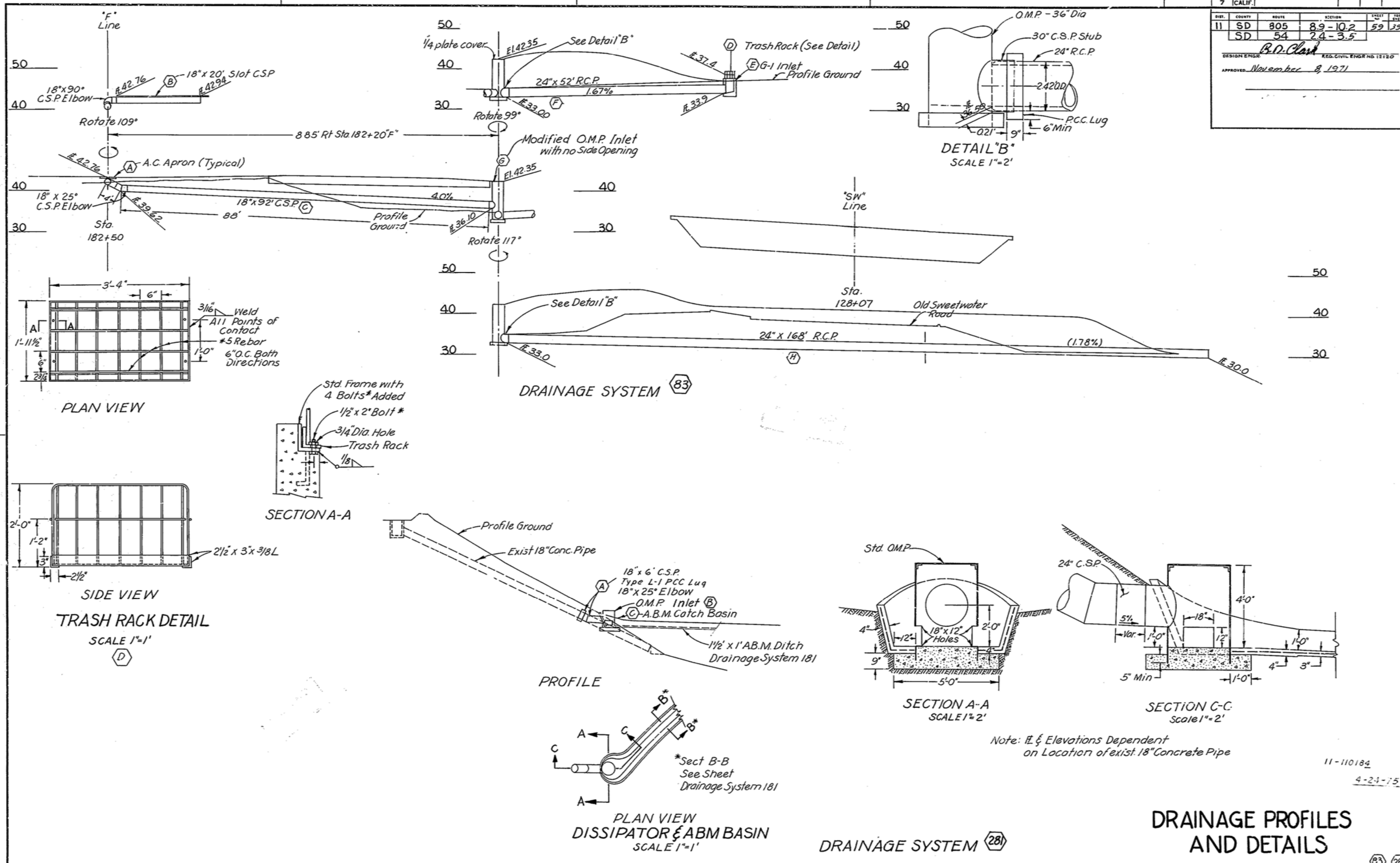
AS BUILT PLANS
Contract No. 11-110184
Date Completed 4-30-75
Document No. A000 62644

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.



AS BUILT PLANS
Contract No. 11-110184
Date Completed 4-30-75
Document No. Ao00 6264

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
8-15-77



AS BUILT PLANS
Contract No. 11-110184
Date Completed 4-30-75
Document No. A000 6264

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.

8-15-77

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM

Attachment 4

“Hydraulic Analysis for CARMAX at National City”

HYDRAULIC ANALYSIS

for

CARMAX at NATIONAL CITY

For the 100 year Peak Flows

May 12, 2021

Prepared by:

Luis Parra, PhD, CPSWQ, ToR, D.WRE.
R.C.E. 66377

REC Consultants
2442 Second Avenue
San Diego, CA 92101
Telephone: (619) 232-9200

HYDRAULIC ANALYSIS FOR CARMAX AT NATIONAL CITY:

DETERMINATION OF THE PRE AND POST DEVELOPMENT 100 YEAR WATER SURFACE ELEVATIONS

1. ANTECEDENTS

At the South East corner of the intersection of HWY 805 and HWY 54, on Plaza Bonita Road, lays an undeveloped property where a future CarMax development will take place. This property is also adjacent and north of Sweetwater River and about 3.25 square miles of contributing area drain thru it before discharging into the aforementioned river (see Figure 1). The property is separated from the 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 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 boundary. However, among the impacts of the development, filling of the property is needed to construct the buildings and parking lots (including a CarMax dealership and a Hotel development), and the volume of the impoundment will be consequently reduced.

Figure 1. Area of analysis.

2. OBJECTIVES OF THE STUDY

This hydraulic study will serve as a support document for the CarMax development (including the adjacent Hotel development). Its multiples objectives are as follows:

- Use the determined peak flows runoff generated by the 3.25 sq-mile contributing area for the 100 year storm events to perform a hydraulic analysis. The storm events which were determined in the report titled “Hydrology Analysis for CARMAX at National city” by REC-Consultants have a standard duration of 6 hours and will be used to perform the Hydraulic analysis.
- Analyze the water surface elevation experienced by the adjacent natural channel during the peak flow events determined from the hydrologic analysis mentioned above.
- Delineate the inundation area for the pre and post storm events.

3. STRUCTURE OF THE HYDRAULIC ANALYSIS

In order to determine the peak water surface elevation experienced by the existing natural channel located adjacent to the north of the project site, a 1-D Army Corps of Engineers HEC-RAS hydraulic model was developed.

The model was constructed from a surface model developed from a flown LIDAR topographic dataset. Cross sections were taken throughout the reach of the existing and proposed conditions creek at approximately 200 ft intervals (additional sections were included as necessary depending upon channel complexity and geometry). A Manning’s roughness coefficient of 0.045 was selected to represent the vegetation of the channel in existing conditions and developed condition.

Once the hydraulic model was constructed, the 100-year peak flow determined from the hydrologic analysis was routed through the channel model to determine the peak water surface elevation at each cross section for existing and proposed conditions.

4. ADDITIONAL DISCUSSIONS:

4.1 Berm Downstream Level

The water level at the discharge of the channel was obtained directly from the FEMA FIRM panel 06073C1912G and it is also corroborated by the FEMA Flood Insurance Study of San Diego County (see page 498P of Volume 10, with a portion included here as Figure 2). HEC-RAS model will use this level as the backbone number for the downstream tailwater condition for discharge calculations of the 100 year peak flow. Consequently, there is no need to provide backup calculations to support the water surface elevation as this level is a given condition at the discharge defined by FEMA.

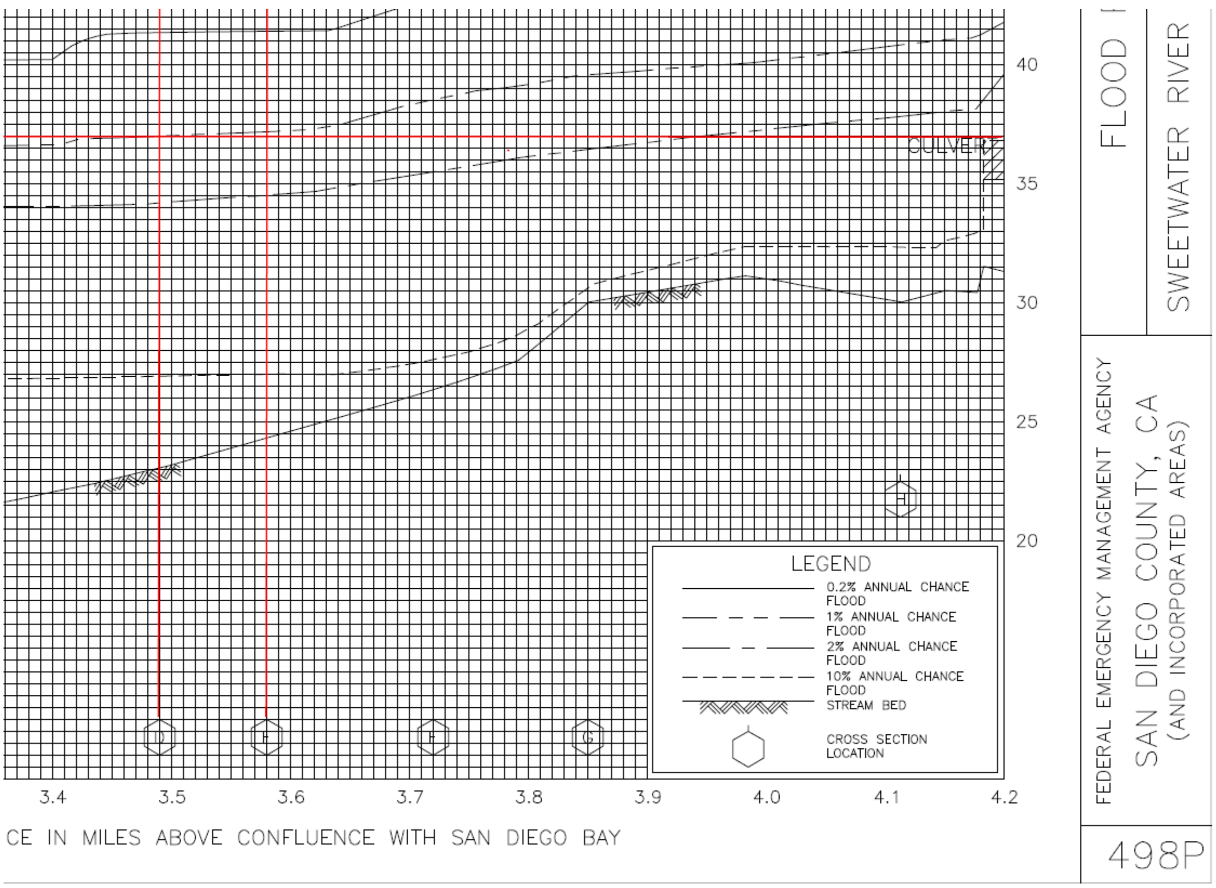


Figure 2. 100 year Water elevation in Sweetwater River along the berm.

The error reading the water surface elevation in FEMA maps is actually larger than the precision it can be obtained using discharge equations along the berm submerged by the flooding of Sweetwater. From figure 2 and FEMA maps, the average water surface elevation along the berm is approximately 37.1 ft.

A detail calculation of section 0+12 in post-development conditions shows the following: let ΔH be the water surface elevation above Sweetwater level at this section where critical flow conditions will occur, with an average flow width W. For a submerged discharge, the peak flow Q can be determine as the combination of the critical depth discharge above Sweetwater level (occurring with depth equal to ΔH) plus the discharge as an orifice of the submerged area of flow under such a level (A_{orif}). Therefore, the following approximation gives an estimate of the discharge:

$$Q = W\sqrt{g \cdot (\Delta H)^3} + C_g \cdot A_{orif} \cdot \sqrt{g \cdot \Delta H}$$

For post-development conditions, an approximate section (Section 0+12) will be used as a control section because the area of Section 0+12 (12 ft upstream of the berm) is more representative of the critical conditions than the area of the berm itself, as it is upstream of the expansion from the channel to the berm caused by the development. For this section the area acting as an orifice is about 1210 sq-ft (A_{orif} = 1210 ft^2), and a typical discharge coefficient Cg equal to 0.6 can be used, the required increment in level needed is only 0.056 ft, because a very large flow area above and perpendicular to the berm is already submerged when FEMA water surface elevation occurs. Consequently, the over-elevation needed in the model is comparable with the error reading FEMA levels in the map and a more detailed calculation is not needed. Therefore, a level of water equal to 37.16 will be used in post-development conditions to run HEC-RAS models upstream.

For pre-development conditions, the area at section 0 (crest of the berm) is more open to the flow than in post-development conditions, and the berm section will be used as a hydraulic control. The area acting as an orifice is larger (A_{orif} = 1695 ft^2) so the increment in level needed is smaller (0.029 ft). Following the same logic than explained in the previous paragraph, a level of water equal to 37.13 will be used in pre-development conditions to run HEC-RAS models upstream.

Finally, and as explained in the hydrology report, the project does not have any additional influence in the discharge conditions of the unnamed creek into Sweetwater River because there is no geometric modification of the berm after the project and the Sweetwater River level remains unchanged. Upstream water surface elevations are then tied to the discharge level (which are only different by 0.03 ft in pre and post-development conditions), and those elevations change according to the HEC-RAS results explained in this report.

4.2 FEMA Considerations

Currently FEMA does not take into account the peak flow of the unnamed creek into consideration for the determination of water surface levels (see section 5 of the hydrology report). CLOMR documentation will be provided to FEMA in order to (a) get an acknowledgment of the peak flow determined; (b) get approval to the water surface elevations calculated in the earthen channel to re-define the floodplain in the property; and (c) insure the development is out of the floodplain zone AE in its final conditions and during final engineering documentation submitted for approval.

5. RESULTS

After running the existing and proposed models in HEC-RAS the following results shown in Tables 1 and 2 were obtained. These tables summarize the existing and proposed water surface elevations for the adjacent channel respectively. The water surface elevation was analyzed as it is a good variable to measure the impact of the proposed development in the channel because it defines the tailwater conditions of all upstream drainage systems draining to the channel, and because it establishes potential changes in flooding conditions as a consequence of the development. Cross sections were taken in the same location, however due to the stream alignment differing in pre and post conditions, these sections have different station IDs yet are physically located at the same location. Table 1 below illustrates the resultant water surface elevations for both pre and post developed conditions.

Table 1 – Existing vs Proposed Conditions
Unnamed Creek Water Surface Elevations for the 100-year Storm Event

Exist Cross Section ID	Post Cross Section ID	Exist 100-Year WSE (ft)	Post 100-Year WSE (ft)	ΔZ Post – Pre (ft)
1798.7 (upstream)	1890.26 (upstream)	37.12	37.29	+0.17
1691.88	1751.5	37.18	37.33	+0.15
1597.06	1634.74	37.18	37.33	+0.15
1514.99	1516.62	37.18	37.3	+0.12
1388.45	1406.8	37.18	37.29	+0.11
1304.18	1336.61	37.18	37.27	+0.09
1237.35	1253.95	37.17	37.23	+0.06
1128.68	1121.58	37.17	37.21	+0.04
1006.59	992.84	37.17	37.19	+0.02
757.2	743.7	37.16	37.18	+0.02
607.02	609.78	37.16	37.17	+0.01
500.55	505.08	37.16	37.17	+0.01
396.75	398.08	37.16	37.17	+0.01
254.61	256.3	37.16	37.16	0
139.56	139.45	37.16	37.16	0
2.65 (downstream)	2.75 (downstream)	37.16	37.16	0

As seen in Table 1, the impacts of the development in the existing channel cause less than a one (1) foot increase in water surface elevation at any location along the channel, with a 0.17 foot increase being the highest at the most upstream section of the channel. As a matter of fact, the water surface elevation in the existing Sweetwater Creek has a greater impact on the channel adjacent to the development than the development itself, because the dominant level of the Sweetwater River (37.10 ft) dominates the flooding condition in the area.

5.1 CALTRANS Upstream Conveyance Systems

The results shown in Table 1 suggest a minor increment of the tailwater conditions of any CALTRANS system draining into the channel. Such increment can be as low as 0.03 ft or as high as 0.12 ft, depending on the location of the discharge.

CALTRANS is requesting a detailed calculation of the impact of the increment of tailwater conditions into their drainage systems. REC will provide in final engineering the precise increase of water surface level in CALTRANS systems to be reviewed by CALTRANS. Depending on the change of the water surface elevation, the hydraulics of the systems could be not affected upstream by the minor modification in discharge elevation, or if necessary, changes in the discharge of the systems could be needed (for example, by including an expansion) to reduce the impact of the water level upstream. Detailed analysis of the discharge is out of the scope of this initial report.

5.2 National City Upstream Conveyance Systems

The upstream end of the channel coincides with the discharge of a major storm drain system within the City of National City's jurisdiction as it conveys drainage for an approximately 2.17 square mile watershed. Therefore, the system is subject to an over-elevation of 0.17 ft at the discharge when compared to the level that would exist during the occurrence of flooding conditions at Sweetwater River if the development does not occur. Consequently, an analysis to establish how the over-elevation of 0.17 ft impacts upstream systems is needed. Depending on the flow conditions of the drainage upstream, the increase of 0.17 ft could either be absorbed by the drainage system without increasing flooding conditions upstream, or it could be partially or completely transmitted upstream, and following FEMA general recommendations any increase larger than 0.1 ft will be considered significant. REC will analyze the drainage system in final engineering and provide a report for National City review. Depending on the results of the analysis the discharge could be altered if needed to reduce energy losses at the discharge and compensate for the increase of water level; if the increment is not relevant, calculations will prove that upstream system are not affected by the increase in the water surface elevation at the discharge.

6. CONCLUSION

The analysis has demonstrated that the proposed development has minor effect on the channel water elevation, except at the upstream end of the channel where water elevation has increased approximately 2.04 inches (0.17 ft). Additional supporting evidence for this study is included in Appendix 1 where the HEC-RAS output files are provided. Exhibits identifying the limits of the existing and proposed condition water surface elevations are provided in Appendix 6.

7. RECOMMENDATIONS

This study will be complemented by an analysis of CALTRANS drainage systems (to be reviewed by CALTRANS) and National City drainage systems (to be reviewed by National City). Those studies will be completed in final engineering, where it will be demonstrated that (a) the minor increase in water surface elevation does not impact drainage systems upstream, or (b) if an impact in excess of 0.1 ft occur, the discharge of the affected discharge system will be improved so that energy losses are reduced to compensate for the potential over-elevation of flooding conditions upstream.

APPENDIX 1

US ARMY CORPS HEC-RAS

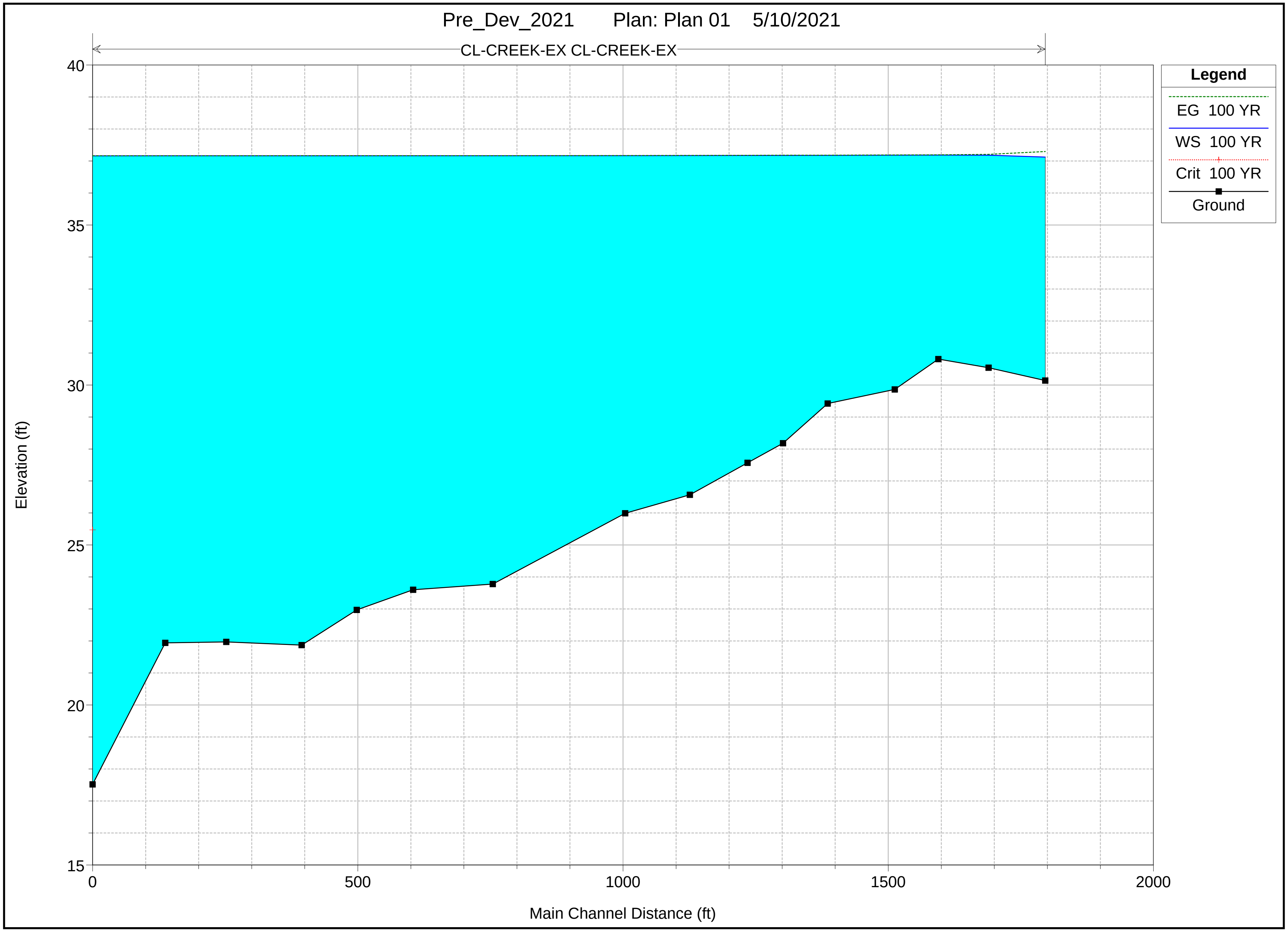
Program Results & Screen Shots

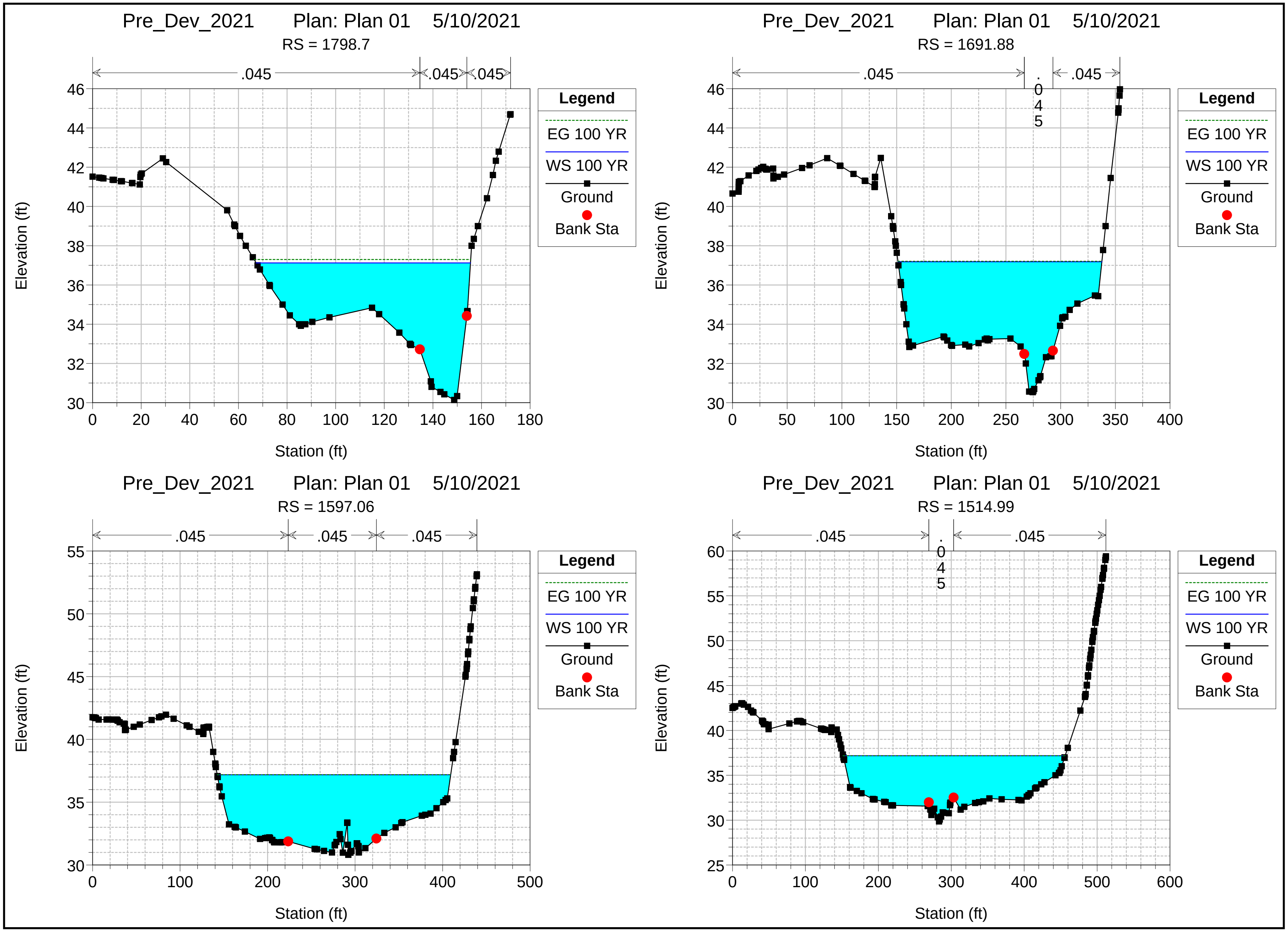
Existing Conditions Results

100-year

HEC-RAS Plan: Plan 01 River: CL-CREEK-EX Reach: CL-CREEK-EX Profile: 100 YR

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
CL-CREEK-EX	1798.7	100 YR	902.00	30.14	37.12		37.29	0.001557	3.98	295.41	88.18	0.29
CL-CREEK-EX	1691.88	100 YR	902.00	30.54	37.18		37.21	0.000239	1.60	705.67	186.40	0.12
CL-CREEK-EX	1597.06	100 YR	902.00	30.81	37.18		37.19	0.000064	0.83	1221.35	266.76	0.06
CL-CREEK-EX	1514.99	100 YR	902.00	29.86	37.18		37.19	0.000046	0.74	1430.30	304.55	0.05
CL-CREEK-EX	1388.45	100 YR	902.00	29.42	37.18		37.18	0.000023	0.55	2009.66	430.54	0.04
CL-CREEK-EX	1304.18	100 YR	902.00	28.18	37.18		37.18	0.000027	0.68	1834.09	404.55	0.04
CL-CREEK-EX	1237.35	100 YR	1390.00	27.57	37.17		37.18	0.000031	0.69	2288.34	382.40	0.04
CL-CREEK-EX	1128.68	100 YR	1390.00	26.57	37.17		37.17	0.000024	0.67	2445.96	372.84	0.04
CL-CREEK-EX	1006.59	100 YR	1390.00	25.99	37.17		37.17	0.000021	0.63	2699.72	464.46	0.04
CL-CREEK-EX	757.2	100 YR	1390.00	23.78	37.16		37.17	0.000008	0.47	3795.75	521.69	0.02
CL-CREEK-EX	607.02	100 YR	1390.00	23.60	37.16		37.17	0.000006	0.36	4572.75	596.00	0.02
CL-CREEK-EX	500.55	100 YR	1390.00	22.97	37.16		37.17	0.000004	0.33	5017.44	636.50	0.02
CL-CREEK-EX	396.75	100 YR	1390.00	21.87	37.16		37.16	0.000003	0.28	5594.37	621.68	0.01
CL-CREEK-EX	254.61	100 YR	1390.00	21.97	37.16		37.16	0.000002	0.26	6109.06	662.28	0.01
CL-CREEK-EX	139.56	100 YR	1390.00	21.94	37.16		37.16	0.000002	0.26	5993.19	615.73	0.01
CL-CREEK-EX	2.65	100 YR	1390.00	17.52	37.16	25.47	37.16	0.000012	0.65	3329.40	501.70	0.03


Pre_Dev_2021 Plan: Plan 01 5/10/2021
CL-CREEK-EX CL-CREEK-EX
Legend
EG 100 YR
WS 100 YR
Crit 100 YR
Ground
Elevation (ft)
40
35
30
25
20
15
0
500
1000
1500
2000
Main Channel Distance (ft)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RS = 1798.7
.045
.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Pre_Dev_2021 Plan: Plan 01 5/10/2021
RS = 1691.88
.045
.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Pre_Dev_2021 Plan: Plan 01 5/10/2021
RS = 1597.06
.045
.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Pre_Dev_2021 Plan: Plan 01 5/10/2021
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.045
.045
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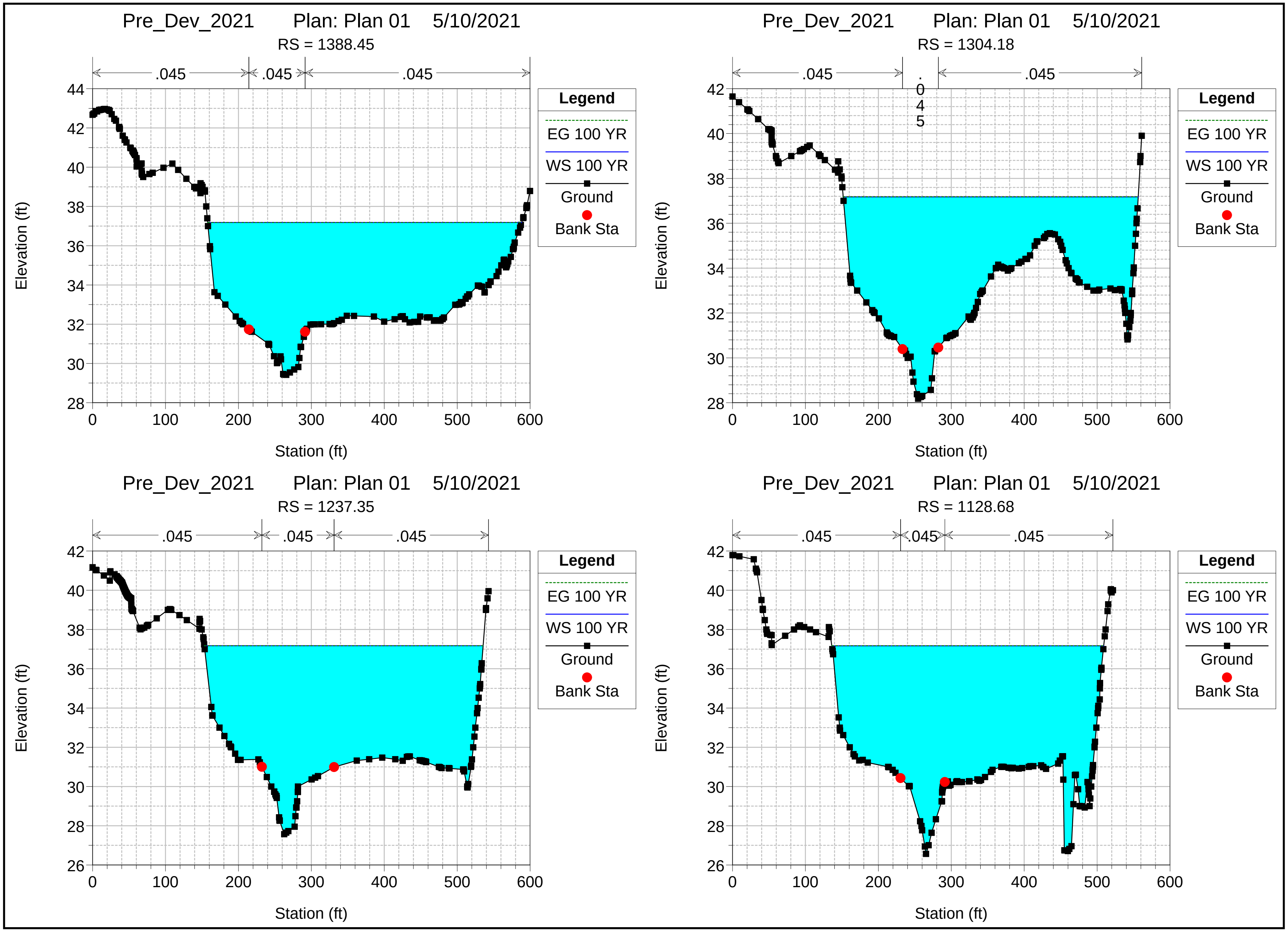
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)



Pre_Dev_2021 Plan: Plan 01 5/10/2021
RS = 1388.45
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Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Pre_Dev_2021 Plan: Plan 01 5/10/2021
RS = 1304.18
.045 .045 .045
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Pre_Dev_2021 Plan: Plan 01 5/10/2021
RS = 1237.35
.045 .045 .045
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Pre_Dev_2021 Plan: Plan 01 5/10/2021
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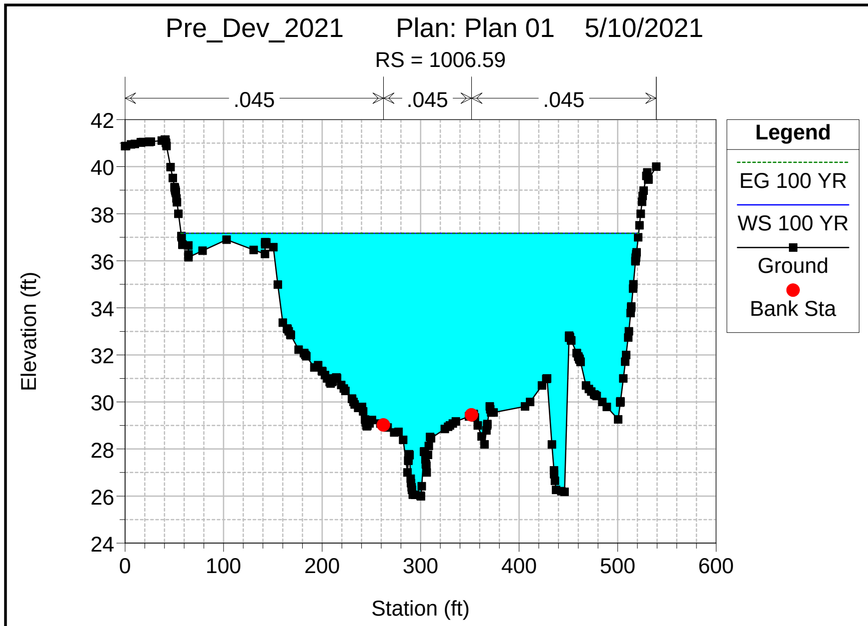
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta


Pre_Dev_2021 Plan: Plan 01 5/10/2021
RS = 1006.59
.045
.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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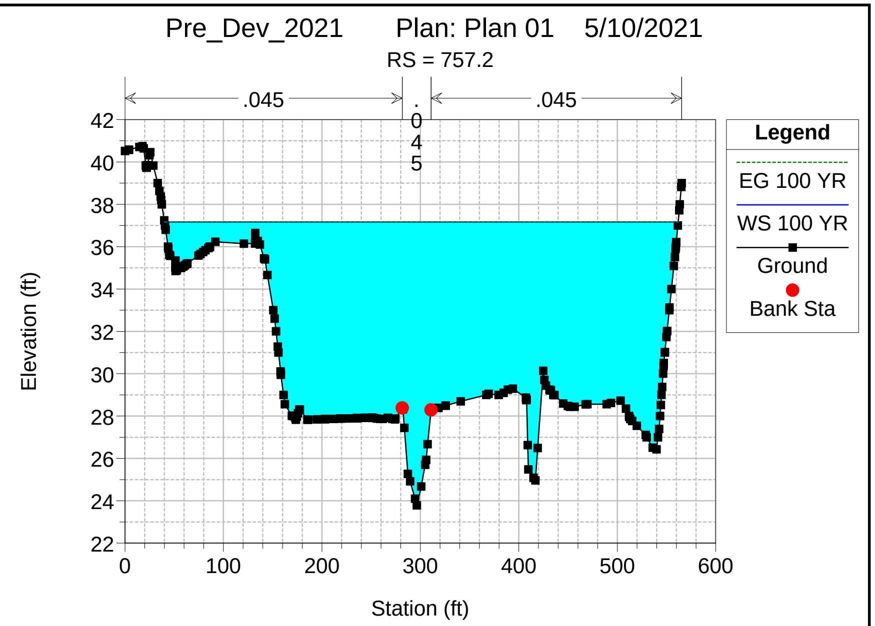
40
38
36
34
32
30
28
26
24
0
100
200
300
400
500
600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.045
.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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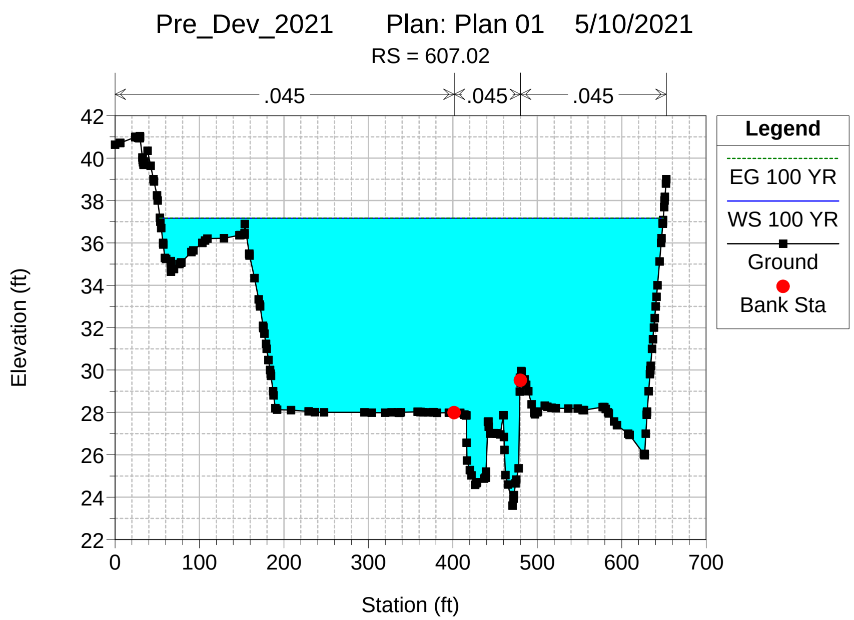
40
38
36
34
32
30
28
26
24
22
0
100
200
300
400
500
600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.045
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Legend
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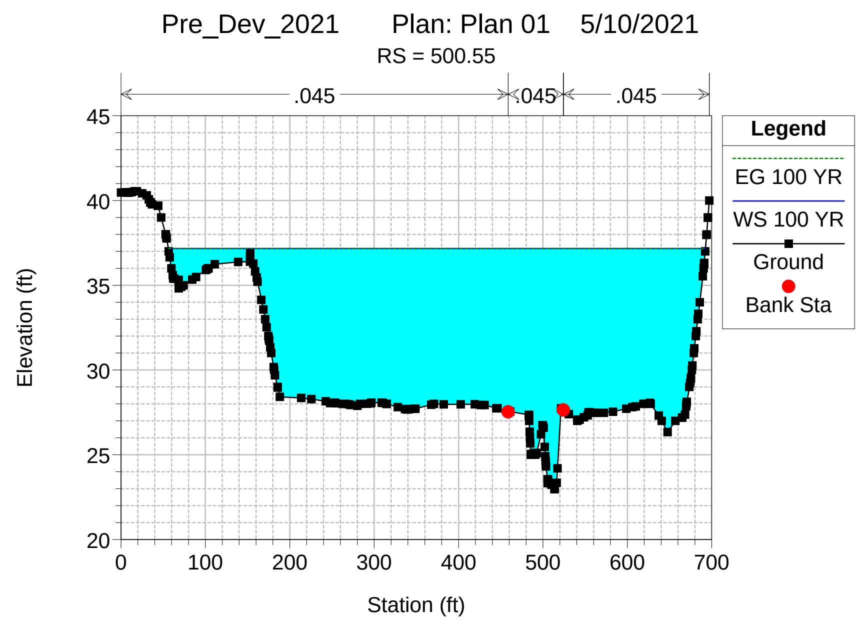
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
42
40
38
36
34
32
30
28
26
24
22
0
100
200
300
400
500
600
700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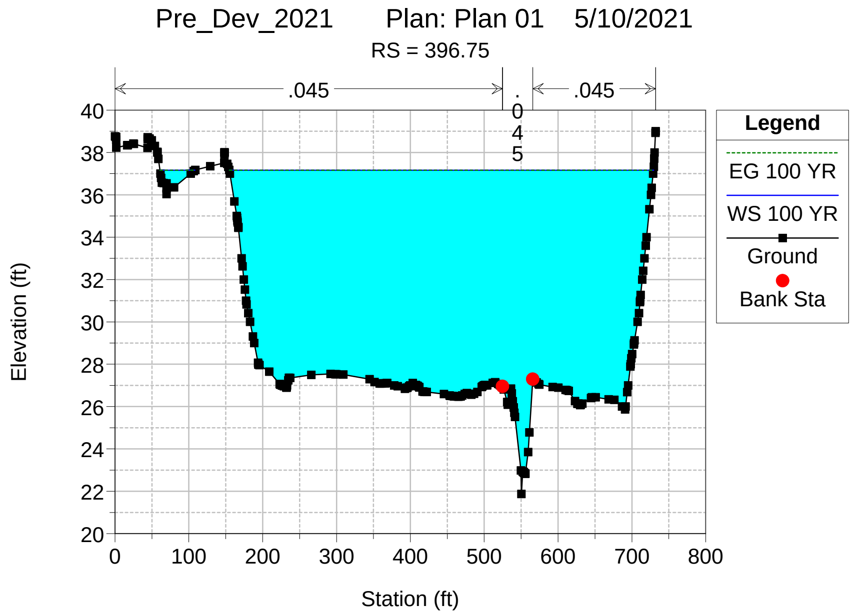
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
45
40
35
30
25
20
0
100
200
300
400
500
600
700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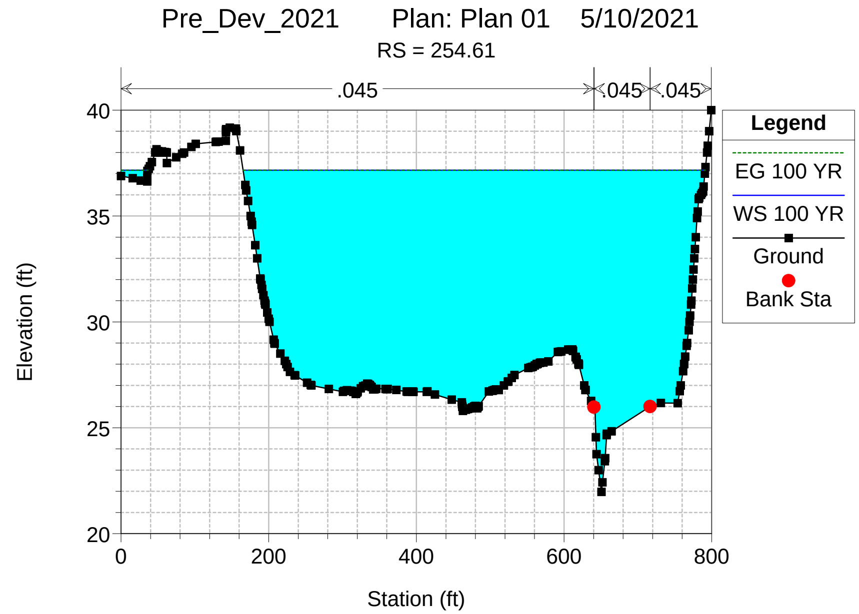
Ground
Bank Sta
Elevation (ft)
Station (ft)
40
38
36
34
32
30
28
26
24
22
20
0 100 200 300 400 500 600 700 800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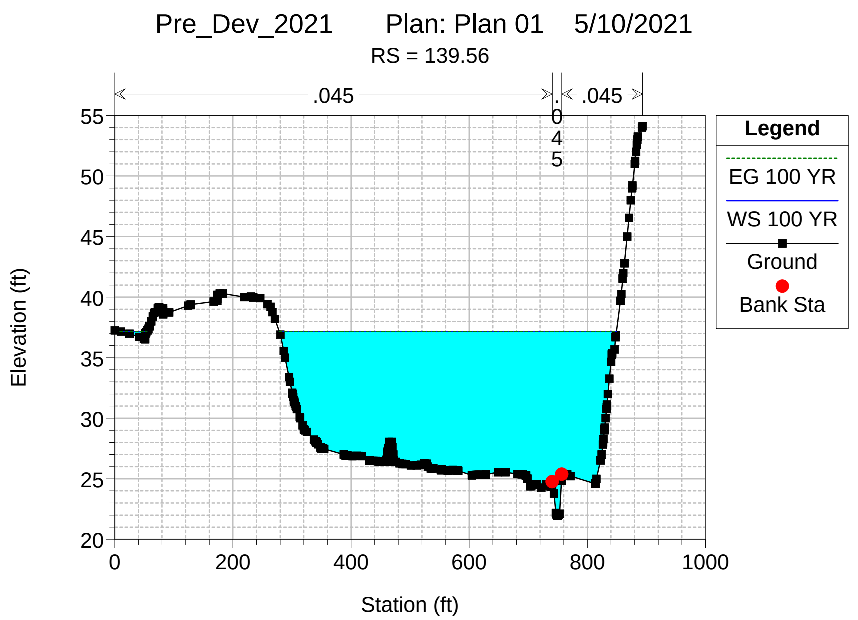
Ground
Bank Sta
Elevation (ft)
Station (ft)
40
35
30
25
20
0 200 400 600 800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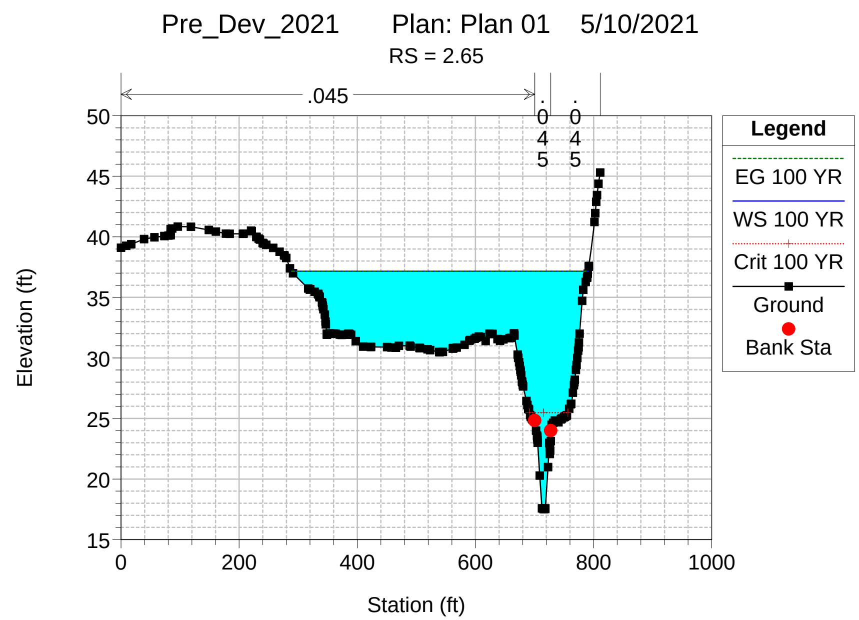
.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
55
50
45
40
35
30
25
20
0 200 400 600 800 1000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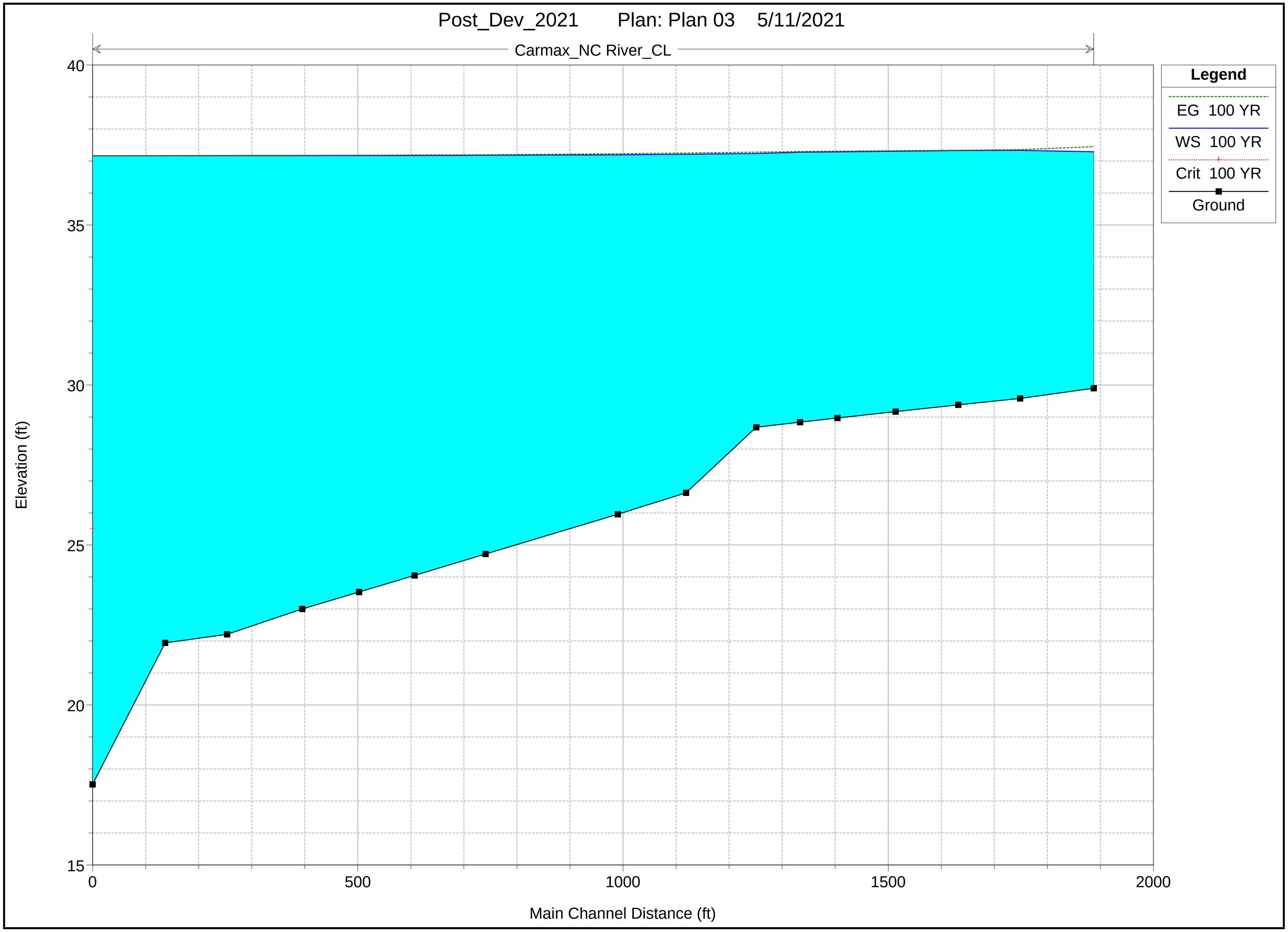
.045
Legend
EG 100 YR
WS 100 YR
Crit 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
50
45
40
35
30
25
20
15
0 200 400 600 800 1000

Proposed Conditions Results

100-year

HEC-RAS Plan: Plan 03 River: Carmax_NC Reach: River_CL Profile: 100 YR

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
River_CL	1890.26	100 YR	902.00	29.90	37.29		37.45	0.001169	3.55	309.62	84.55	0.26
River_CL	1751.5	100 YR	902.00	29.58	37.33		37.35	0.000181	1.26	831.67	225.66	0.10
River_CL	1634.74	100 YR	902.00	29.38	37.33		37.34	0.000092	0.93	1130.60	292.71	0.07
River_CL	1516.62	100 YR	902.00	29.17	37.30		37.32	0.000129	1.17	861.46	194.22	0.09
River_CL	1406.8	100 YR	902.00	28.97	37.29		37.31	0.000157	1.35	850.71	220.61	0.10
River_CL	1336.61	100 YR	902.00	28.84	37.27		37.29	0.000149	1.17	800.74	171.32	0.09
River_CL	1253.95	100 YR	1390.00	28.68	37.23		37.28	0.000242	1.71	848.76	154.45	0.12
River_CL	1121.58	100 YR	1390.00	26.63	37.21		37.25	0.000164	1.65	938.52	144.42	0.10
River_CL	992.84	100 YR	1390.00	25.96	37.19		37.23	0.000159	1.63	956.28	146.78	0.10
River_CL	743.7	100 YR	1390.00	24.72	37.18		37.20	0.000069	1.20	1266.02	160.87	0.07
River_CL	609.78	100 YR	1390.00	24.05	37.17		37.19	0.000054	1.08	1373.06	160.80	0.06
River_CL	505.08	100 YR	1390.00	23.53	37.17		37.18	0.000043	0.98	1550.84	187.77	0.05
River_CL	398.08	100 YR	1390.00	23.00	37.17		37.18	0.000035	0.95	1649.43	193.69	0.05
River_CL	256.3	100 YR	1390.00	22.21	37.16		37.17	0.000021	0.79	2000.01	214.22	0.04
River_CL	139.45	100 YR	1390.00	21.94	37.16		37.17	0.000014	0.62	2340.03	228.66	0.03
River_CL	2.75	100 YR	1390.00	17.52	37.16	25.51	37.17	0.000022	0.77	2170.30	288.40	0.04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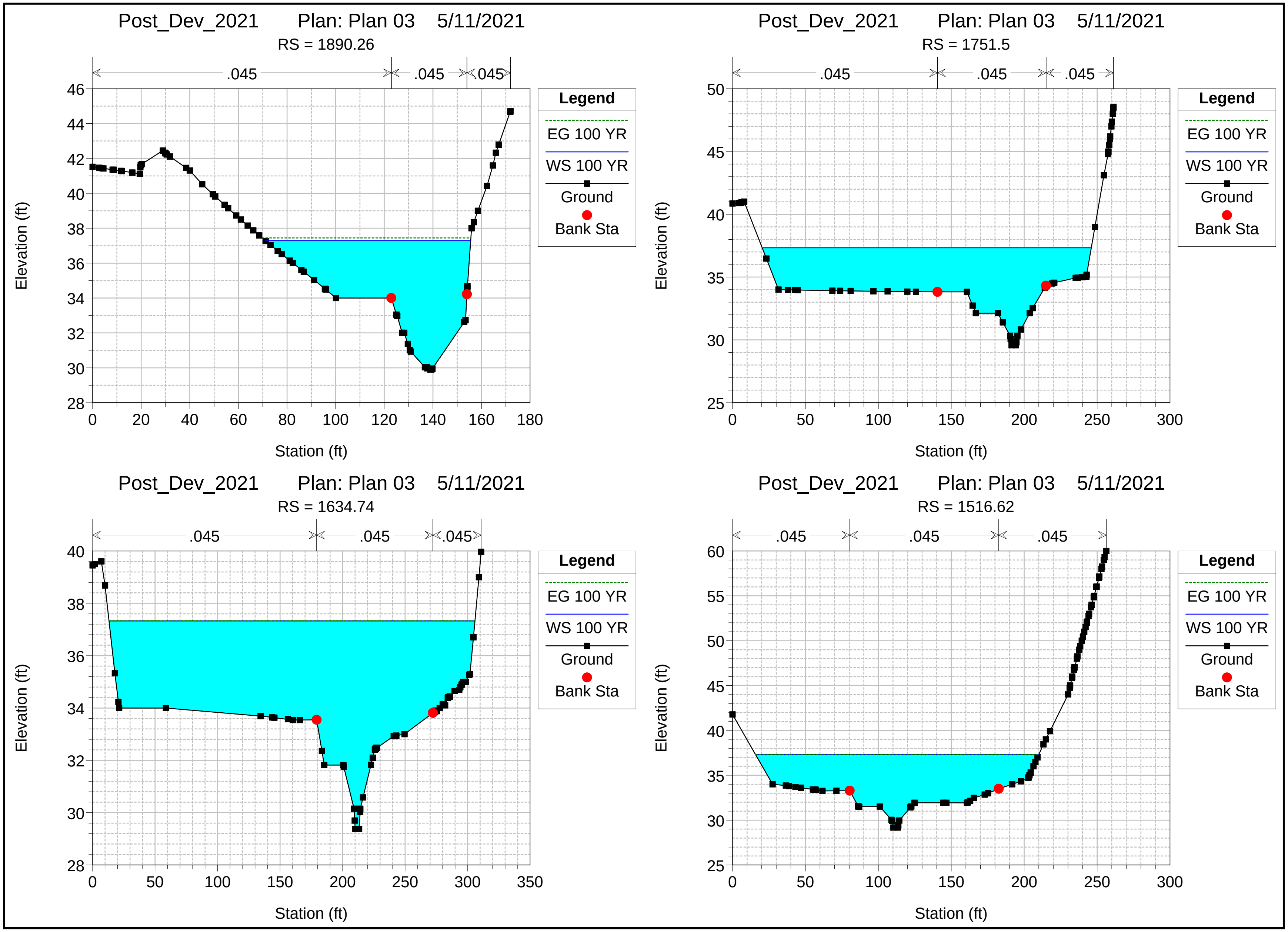
Carmax_NC River_CL
Legend
EG 100 YR
WS 100 YR
Crit 100 YR
Ground
Elevation (ft)
40
35
30
25
20
15
0
500
1000
1500
2000
Main Channel Distance (ft)



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.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Post_Dev_2021 Plan: Plan 03 5/11/2021
RS = 1751.5
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.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Post_Dev_2021 Plan: Plan 03 5/11/2021
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.045
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EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
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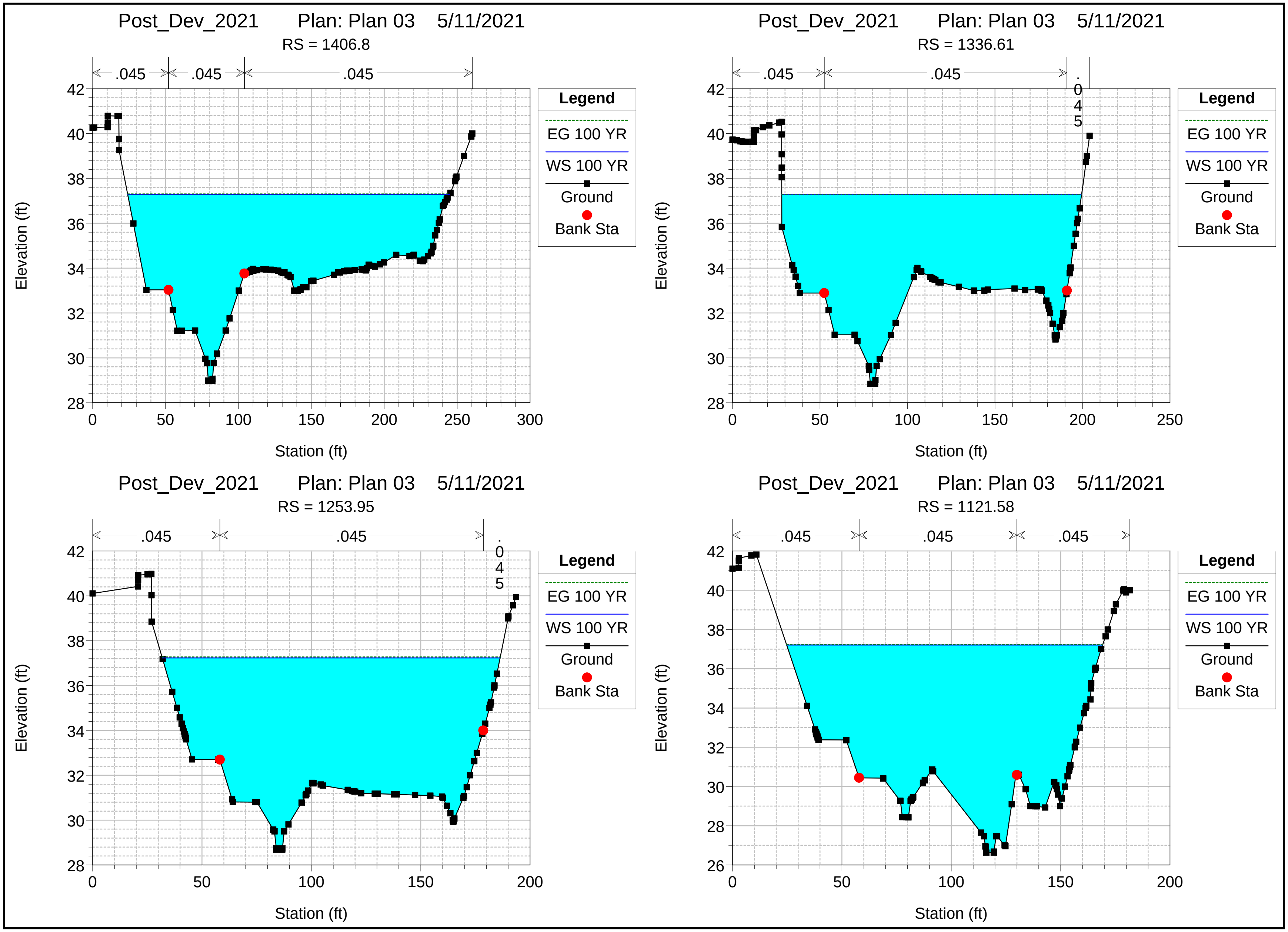
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Post_Dev_2021 Plan: Plan 03 5/11/2021
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.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Post_Dev_2021 Plan: Plan 03 5/11/2021
RS = 1253.95
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.045
.045
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
Post_Dev_2021 Plan: Plan 03 5/11/2021
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.045
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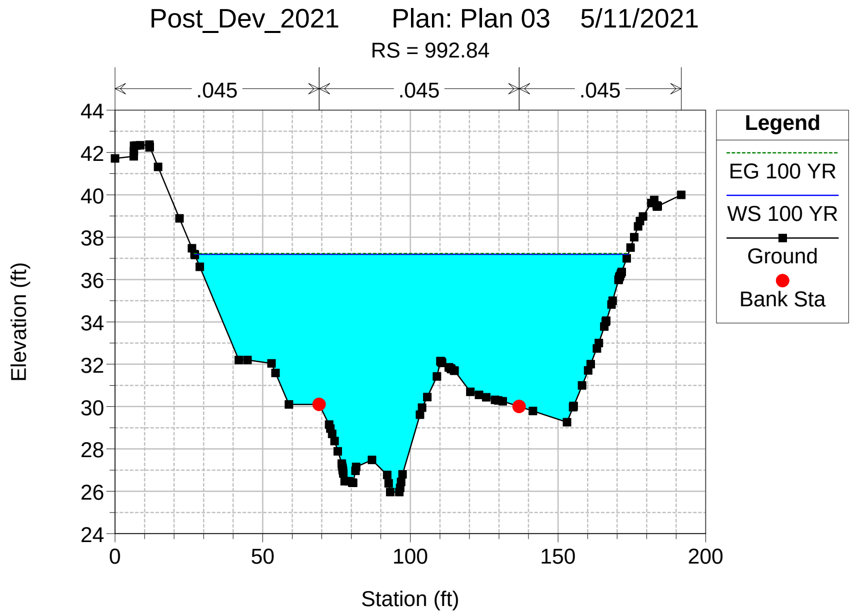
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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Station (ft)
Legend
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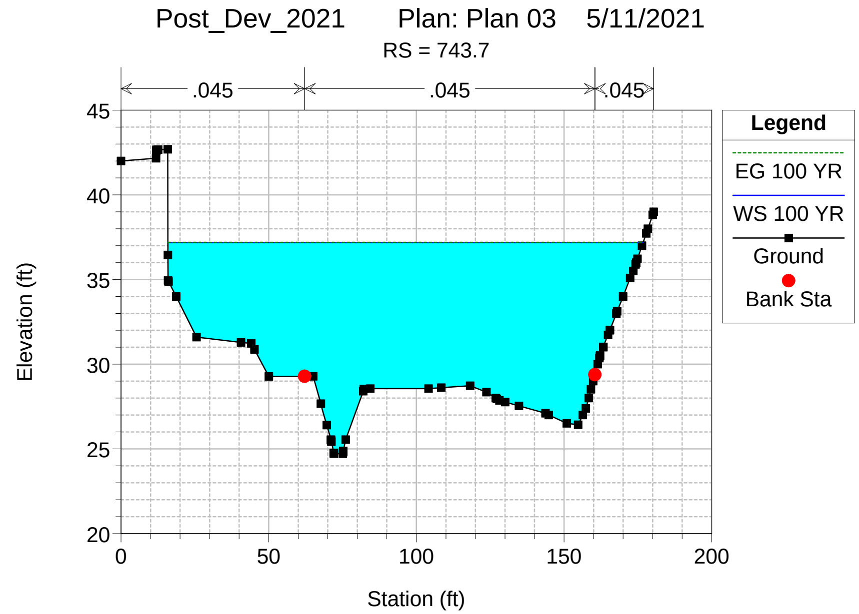
WS 100 YR
Ground
Bank Sta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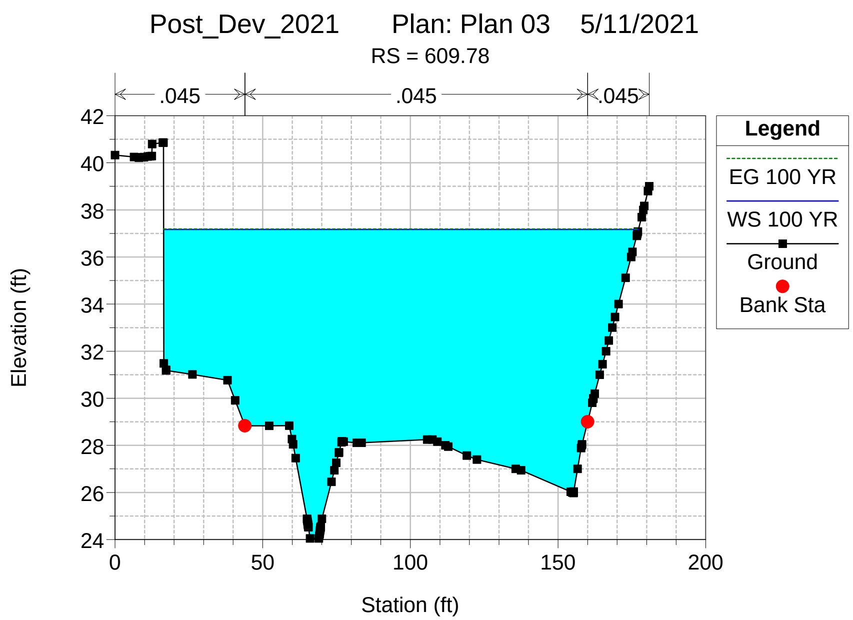
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta


Post_Dev_2021 Plan: Plan 03 5/11/2021
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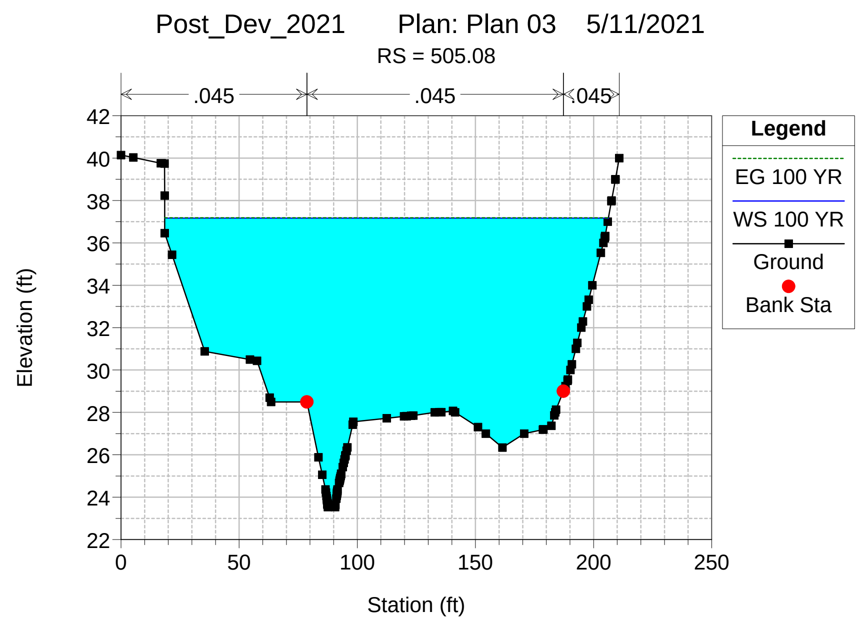
.045
.045
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta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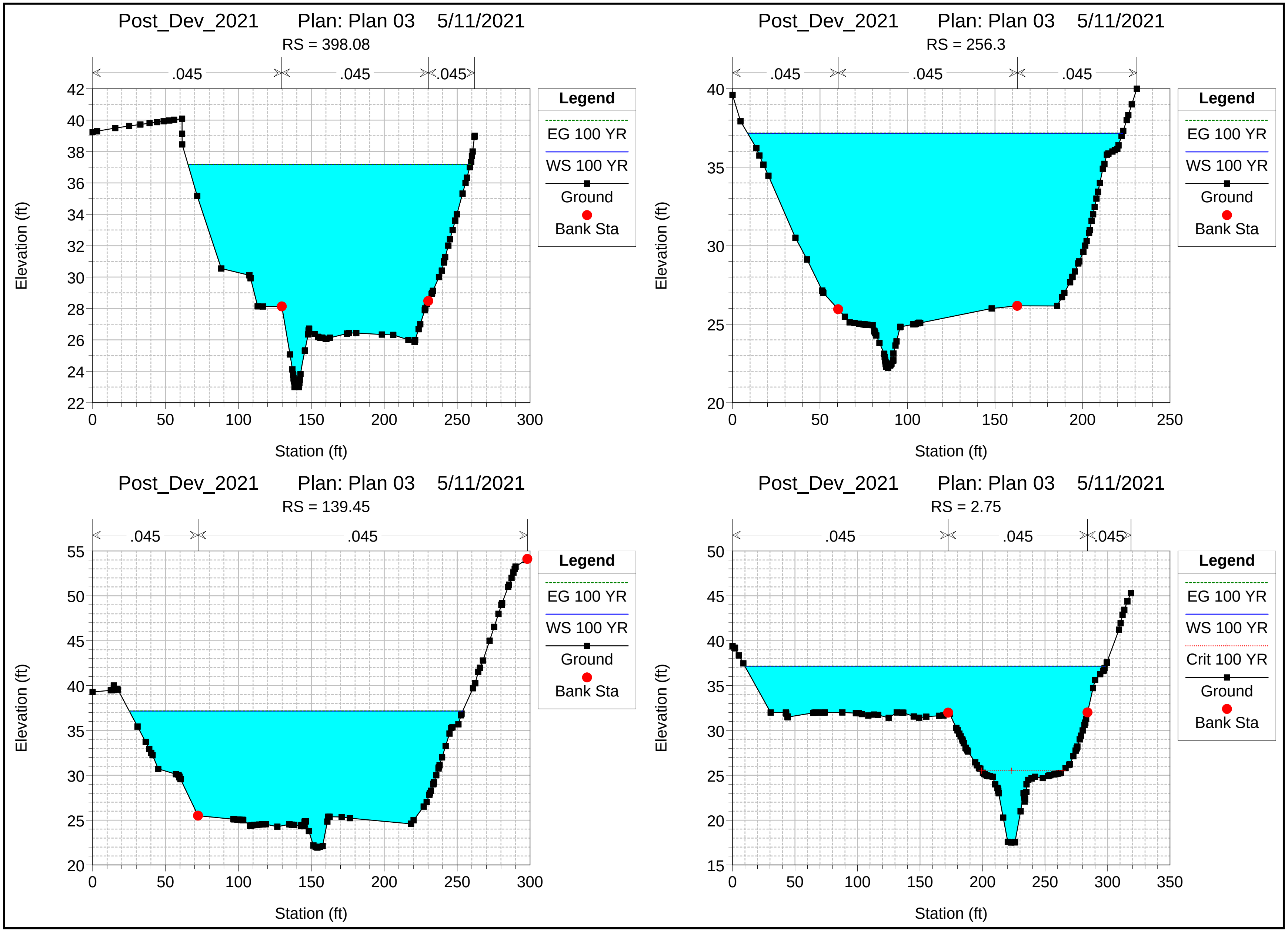
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta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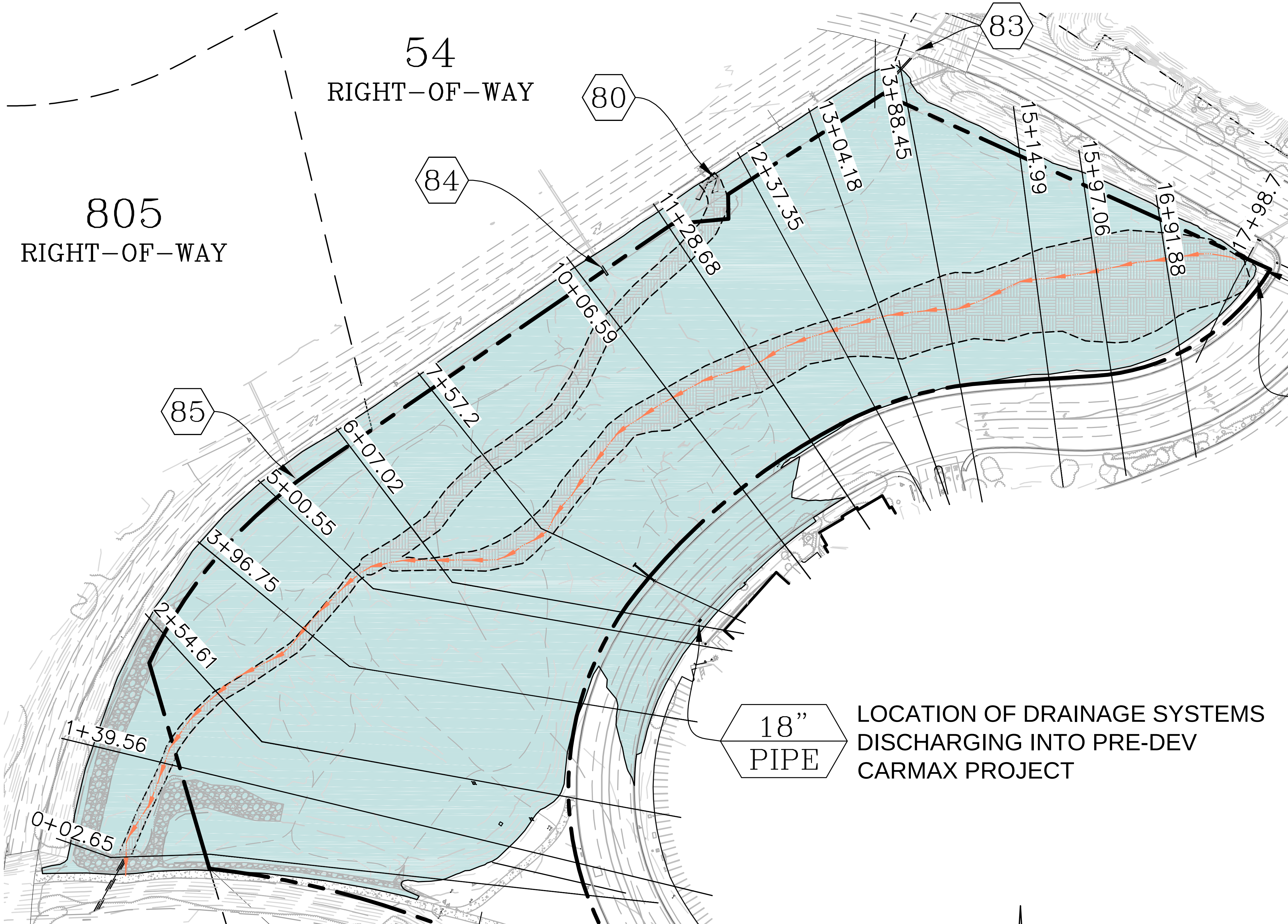
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Post_Dev_2021 Plan: Plan 03 5/11/2021
RS = 256.3
.045 .045 .045
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Post_Dev_2021 Plan: Plan 03 5/11/2021
RS = 139.45
.045 .045
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Ground
Bank Sta
Post_Dev_2021 Plan: Plan 03 5/11/2021
RS = 2.75
.045 .045 .045
Elevation (ft)
Station (ft)
Legend
EG 100 YR
WS 100 YR
Crit 100 YR
Ground
Bank Sta

APPENDIX 2

FLOODING EXHIBITS

Existing and Proposed Condition Flooding Inundation Exhibits

Existing Conditions Flood Maps



LOCATION OF DRAINAGE SYSTEMS DISCHARGING INTO PRE-DEV CARMAX PROJECT

100-YEAR STORM EVENT WSE

River Sta	Q Total (cfs)	W.S. Elev (ft)
17+98.70	902	37.12
16+91.88	902	37.18
15+97.06	902	37.18
15+14.99	902	37.18
13+88.45	902	37.18
13+04.18	902	37.18
12+37.35	1390	37.17
11+28.68	1390	37.17
10+06.59	1390	37.17
7+57.20	1390	37.16
6+07.02	1390	37.16
5+00.55	1390	37.16
3+96.75	1390	37.16
2+54.61	1390	37.16
1+39.56	1390	37.16
0+02.65	1390	37.16

LEGEND

15+49.64 *CROSS SECTIONAL STATIONING*

CREEK FLOW LINE

INUNDATION AREA

N

150 75 0 150 300 450

SCALE: 1" = 150'

R·E·C Consultants, Inc.
Civil Engineering · Environmental Land Surveying
2442 Second Avenue San Diego, CA 92101 (619)232-9200 (619)232-9210 Fax

DATE: 5-11-2021
SCALE: 1" = 150'
DRAWN: J.M.W.
CHECKED: J.R.R.

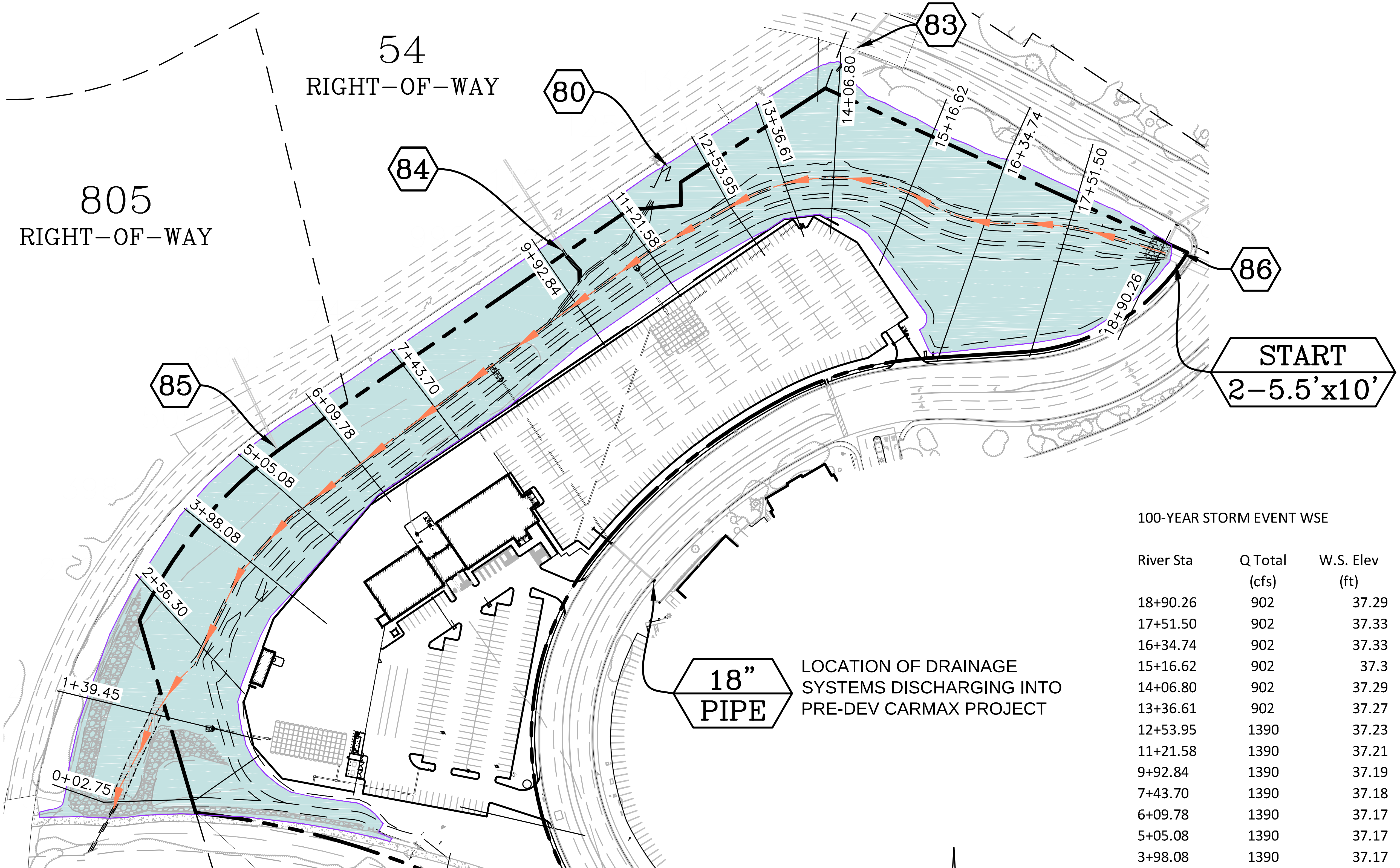
SHEET TITLE: EX 100-YR INUNDATION AREA EXHIBIT

PROJECT: CARMAX AT NATIONAL CITY
I-805 & HWY-54
SAN DIEGO, CA

SHEET 1 OF 1 SHEETS

SAVE DATE: 5/12/2021 ~ PLOT DATE: 5/12/2021 ~ FILE NAME: P:\Acad\1253 Carmax of National City\Reports\CAD\Ex Q2-Q100 – 2021.dwg

Proposed Conditions Flood Maps



100-YEAR STORM EVENT WSE

River Sta	Q Total (cfs)	W.S. Elev (ft)
18+90.26	902	37.29
17+51.50	902	37.33
16+34.74	902	37.33
15+16.62	902	37.3
14+06.80	902	37.29
13+36.61	902	37.27
12+53.95	1390	37.23
11+21.58	1390	37.21
9+92.84	1390	37.19
7+43.70	1390	37.18
6+09.78	1390	37.17
5+05.08	1390	37.17
3+98.08	1390	37.17
2+56.30	1390	37.16
1+39.45	1390	37.16
0+02.75	1390	37.16

LEGEND

15+49.64 — *CROSS SECTIONAL STATIONING*

CREEK FLOW LINE

INUNDATION AREA

150 75 0 150 300 450

SCALE: 1" = 150'

Civil Engineering · Environmental Land Surveying
2442 Second Avenue San Diego, CA 92101
(619)232-9200 (619)232-9210 Fax
REC Consultants, Inc.

DATE: 5-11-2021
SCALE: 1" = 150'
DRAWN: J.M.W.
CHECKED: J.R.R.

SHEET TITLE: 100-YR INUNDATION AREA EXHIBIT

PROJECT: CARMAX AT NATIONAL CITY
I-805 & HWY-54
SAN DIEGO, CA

SHEET 1 OF 1 SHEETS

Attachment 5

“Hydrology Analysis for CARMAX at National City”

HYDROLOGY ANALYSIS

for

CARMAX at NATIONAL CITY

October 16, 2020

Prepared by:

Luis Parra, PhD, CPSWQ, ToR, D.WRE.
R.C.E. 66377

REGISTERED PROFESSIONAL ENGINEER
LUIS A PARRA-ROSALES
RCE ~ 66377
EXP 6/30/22
CIVIL
STATE OF CALIFORNIA

REC Consultants
2442 Second Avenue
San Diego, CA 92101
Telephone: (619) 232-9200

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.

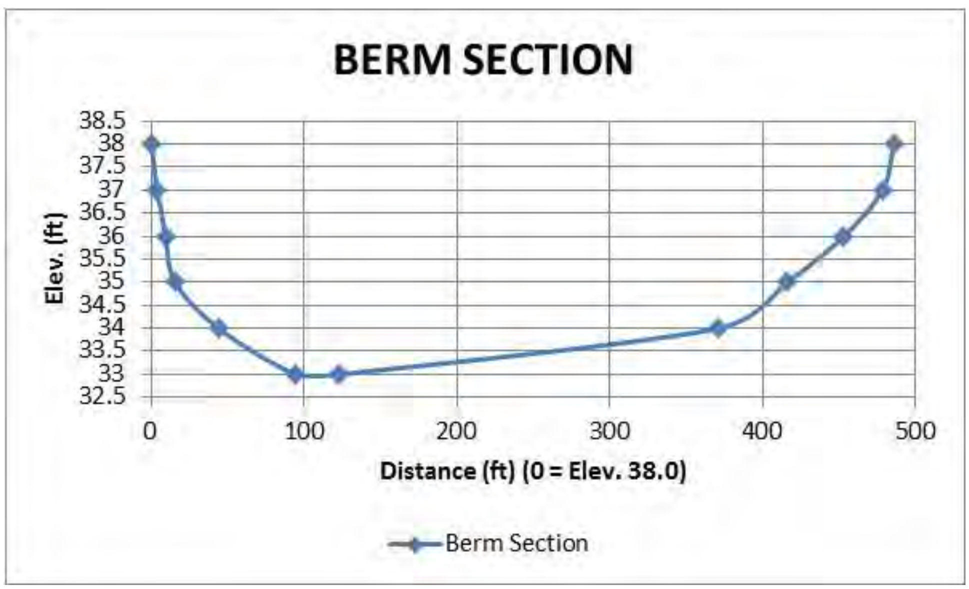
Additional Discussion in Regards to DMA-2

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**

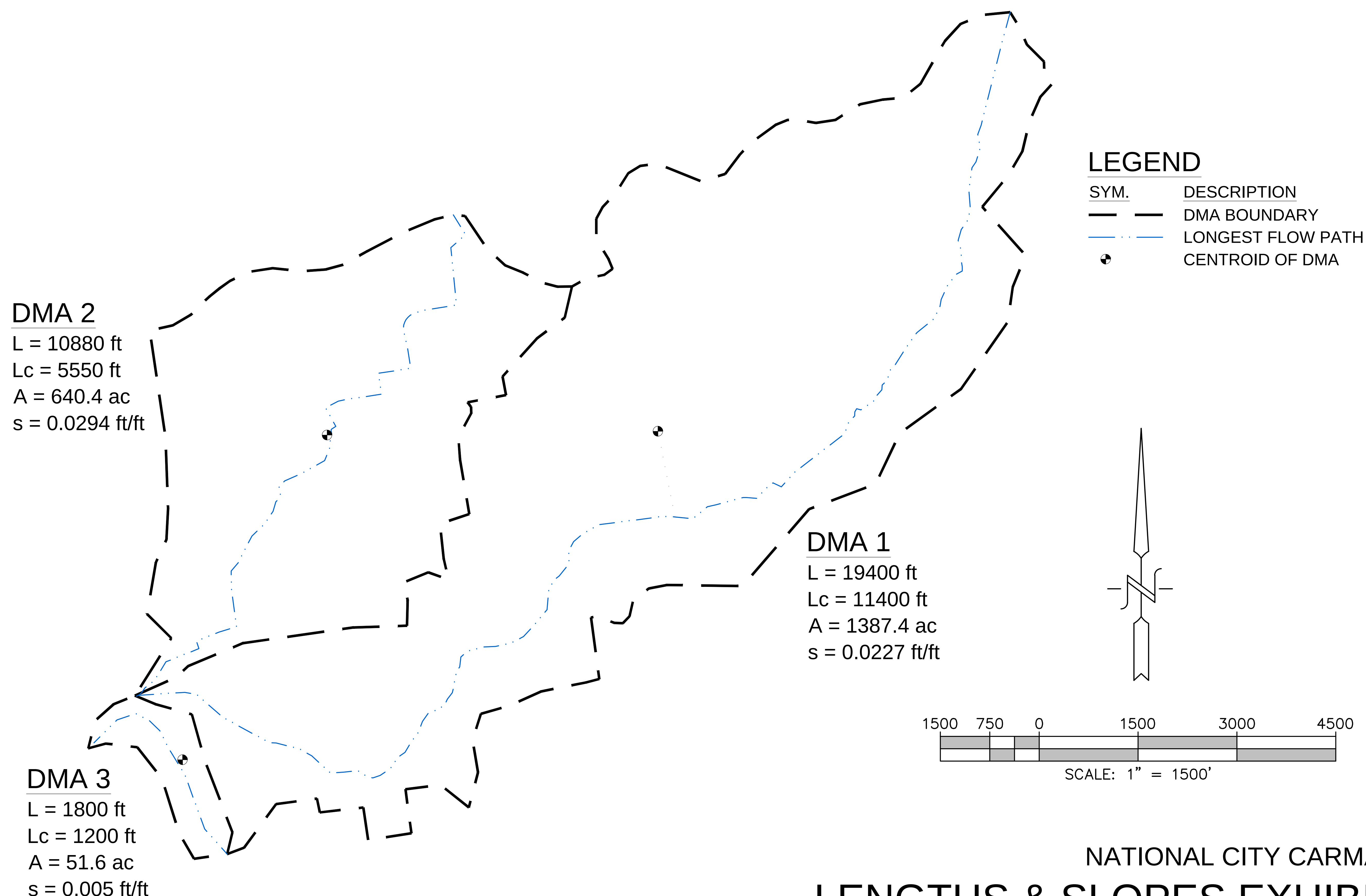
Also, as the berm is not altered, graded, or perforated, there is no measurable influence of the development in the maximum water elevation that will occur at the berm section because the peak has reduced by less than 1 ‰ and the discharge area has not changed.

APPENDIX 1

EXHIBITS & NOAA PRECIPITATION

NOAA Precipitation Information

Precipitation Correction Factors and Effective Rainfall

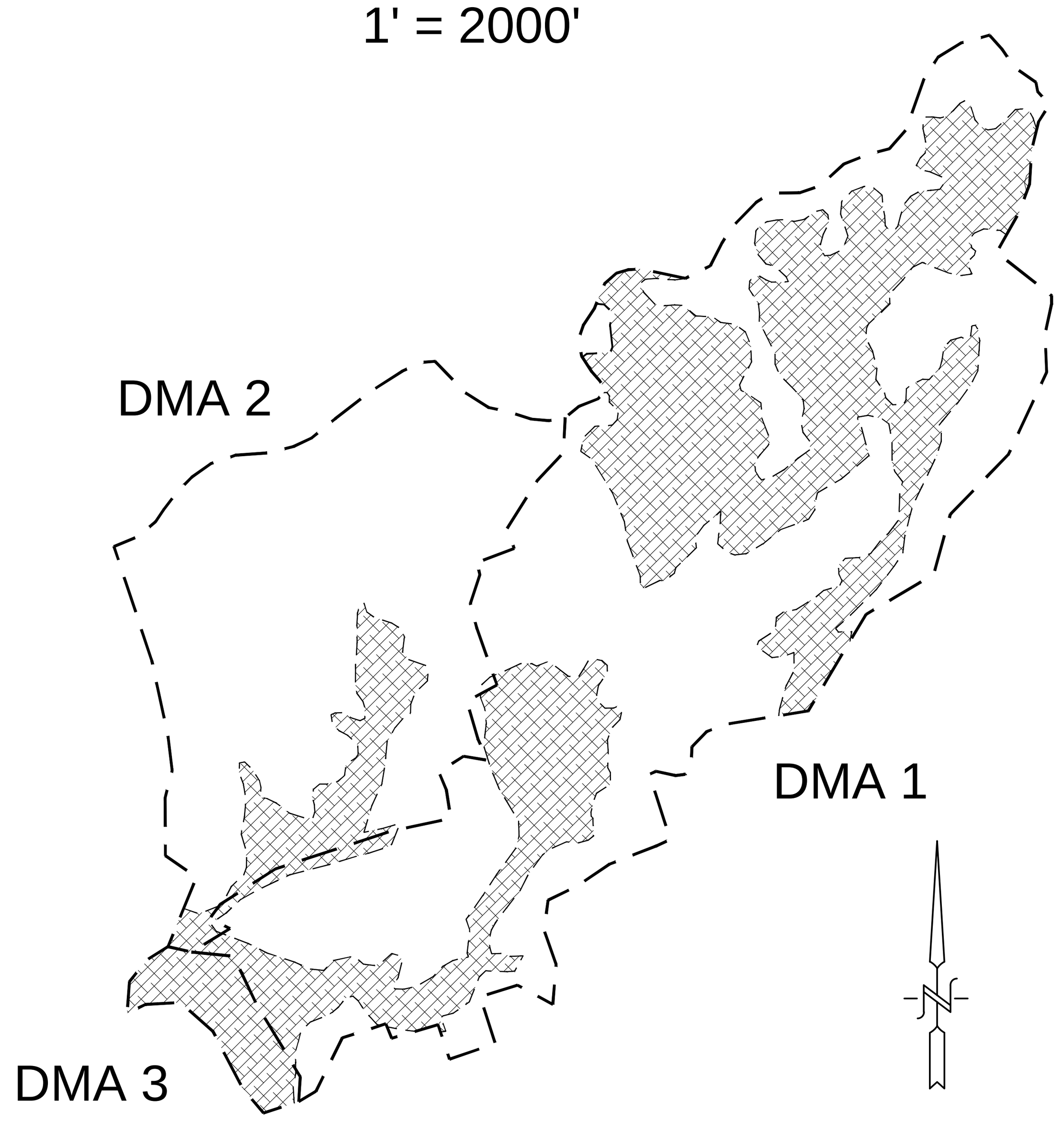


NATIONAL CITY CARMAX

LENGTHS & SLOPES EXHIBIT

Hydrologic Soil Group

1' = 2000'



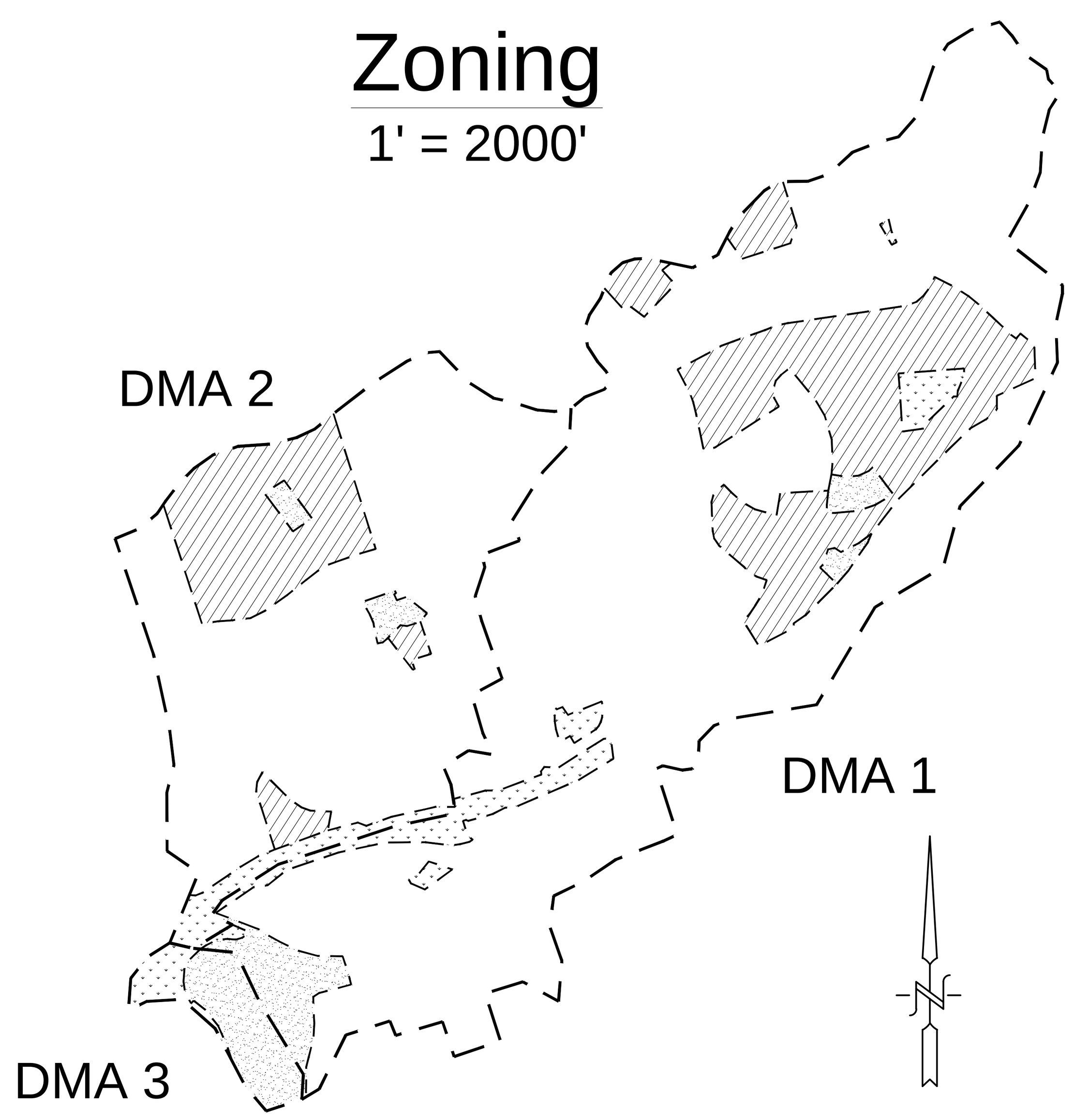
(Source: NRCS Web Soil Survey)

Legend

Sym.	HSG
(hatched)	C
(blank)	D

Zoning

1' = 2000'



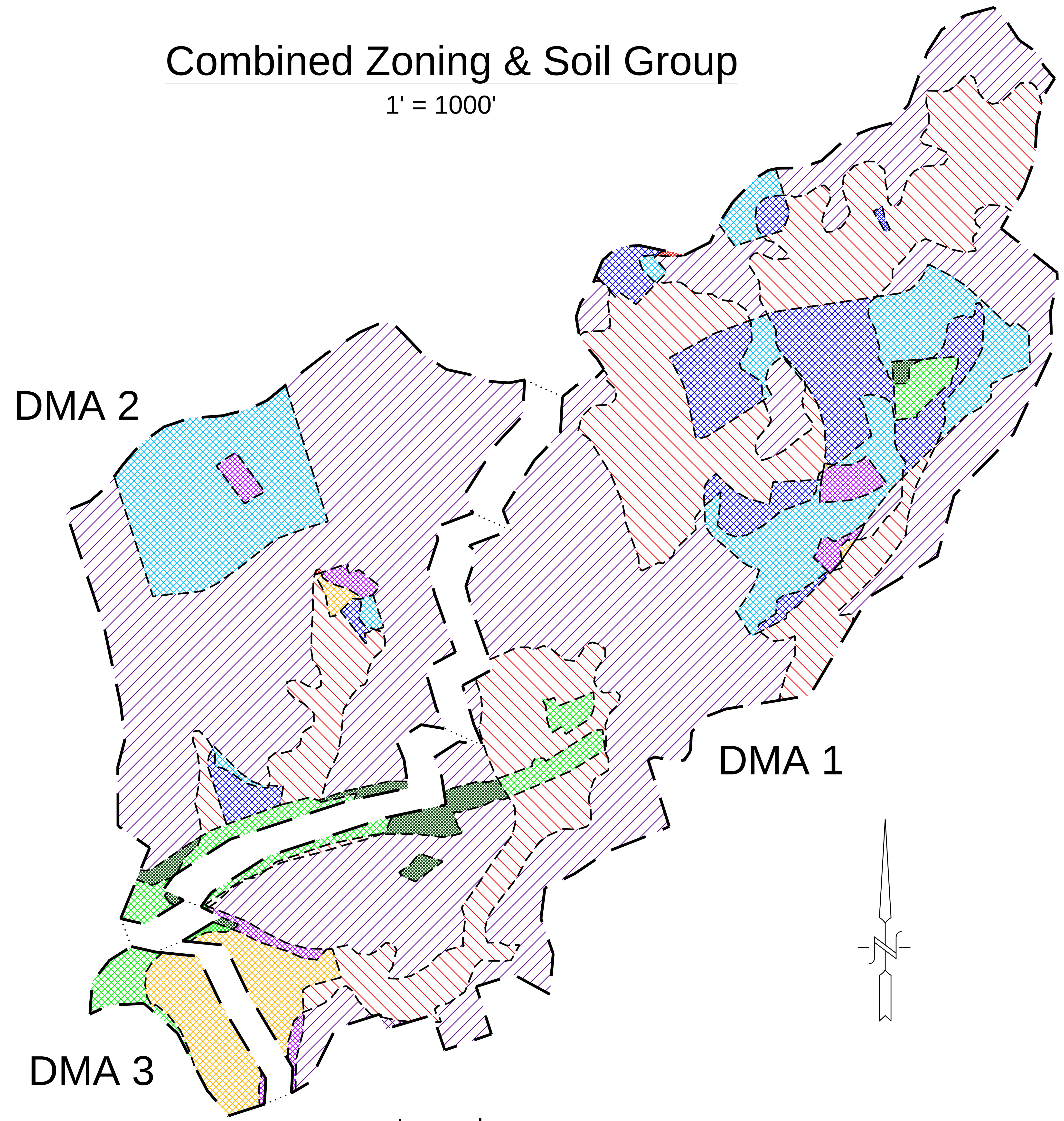
(Sources: City of Chula Vista General Plan Land Use Diagram, City of National City Official Zoning Map, City of San Diego Official Zoning Map)

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

NATIONAL CITY CARMAX

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.

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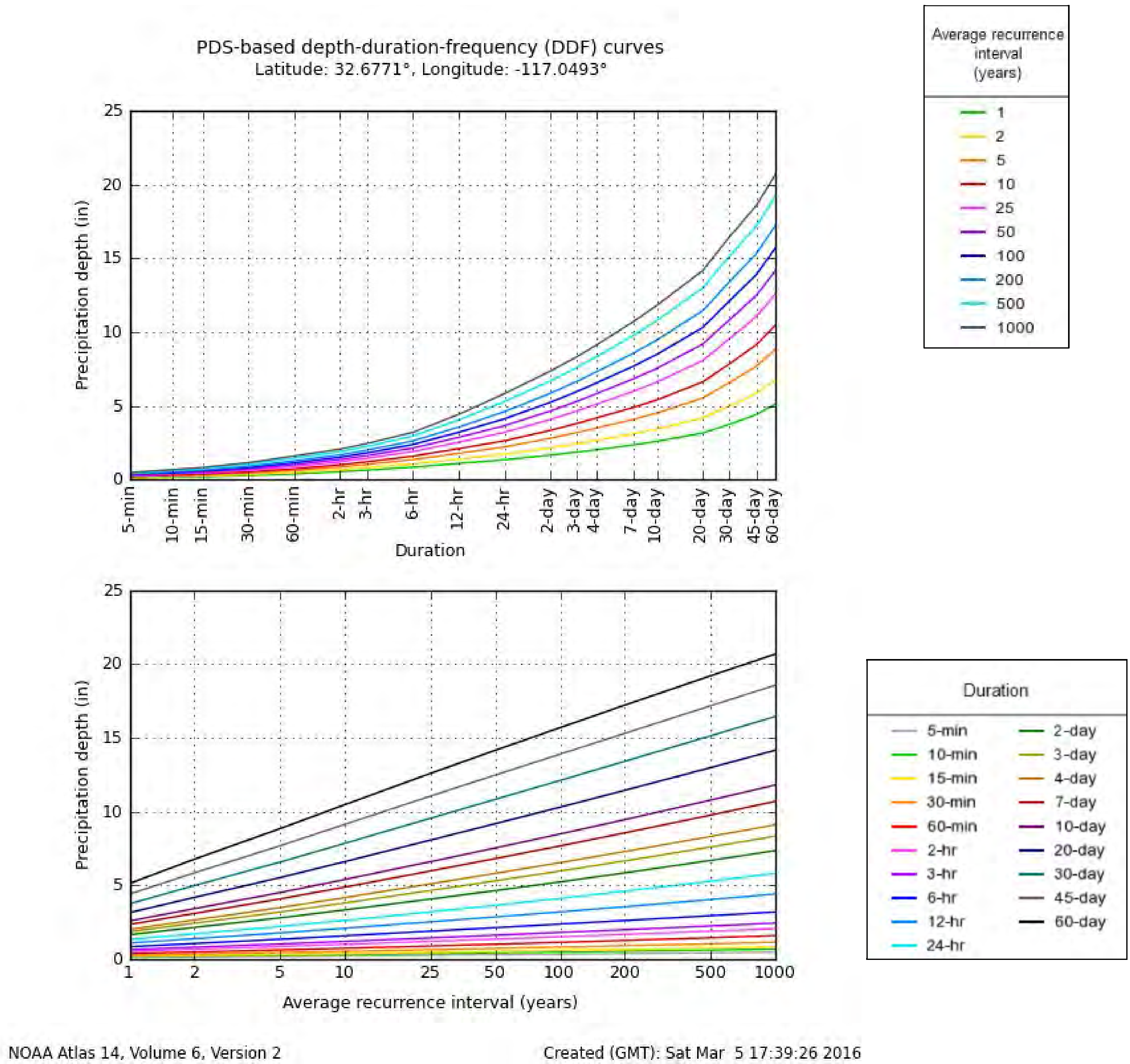
PF graphical



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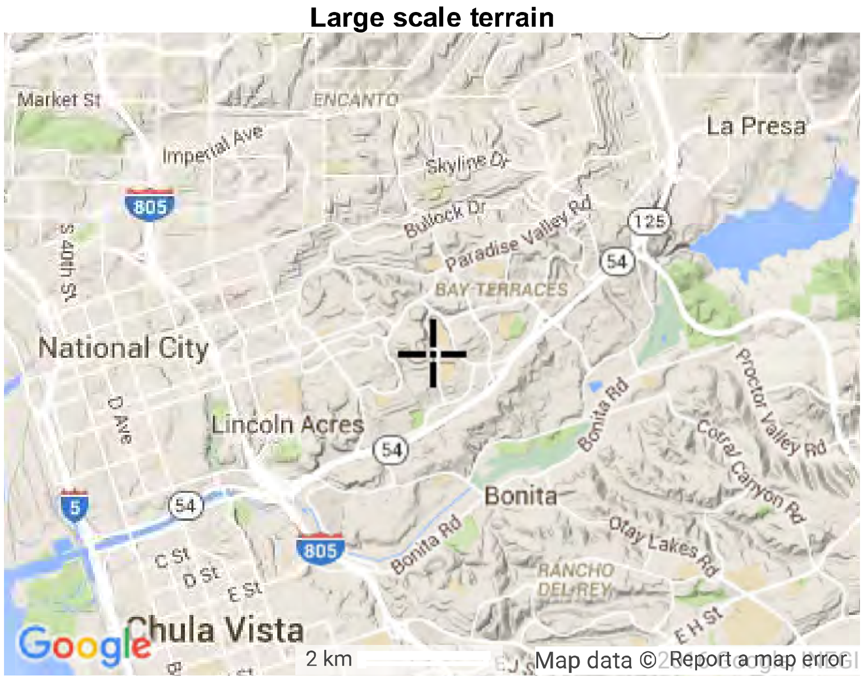
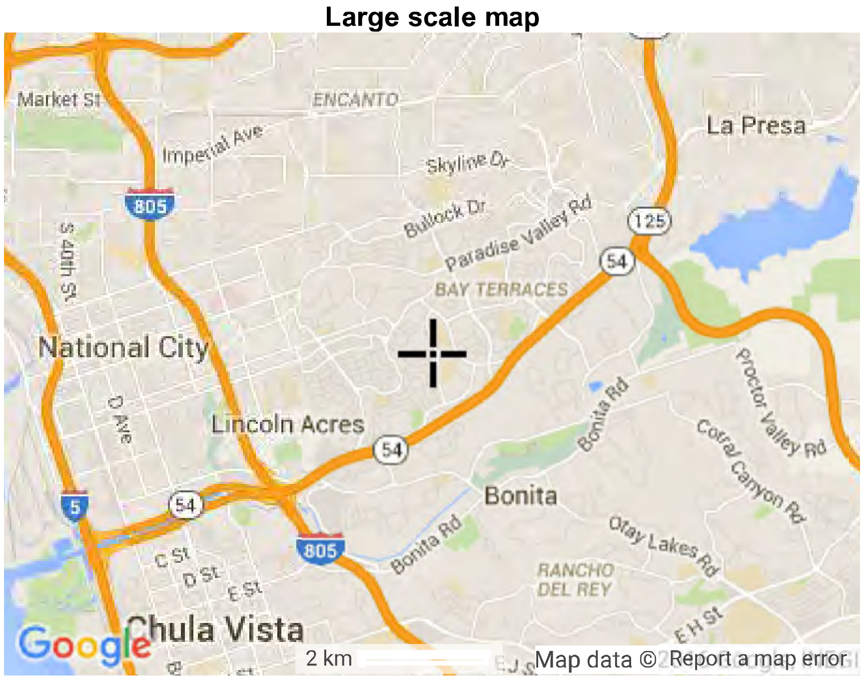
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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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

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.

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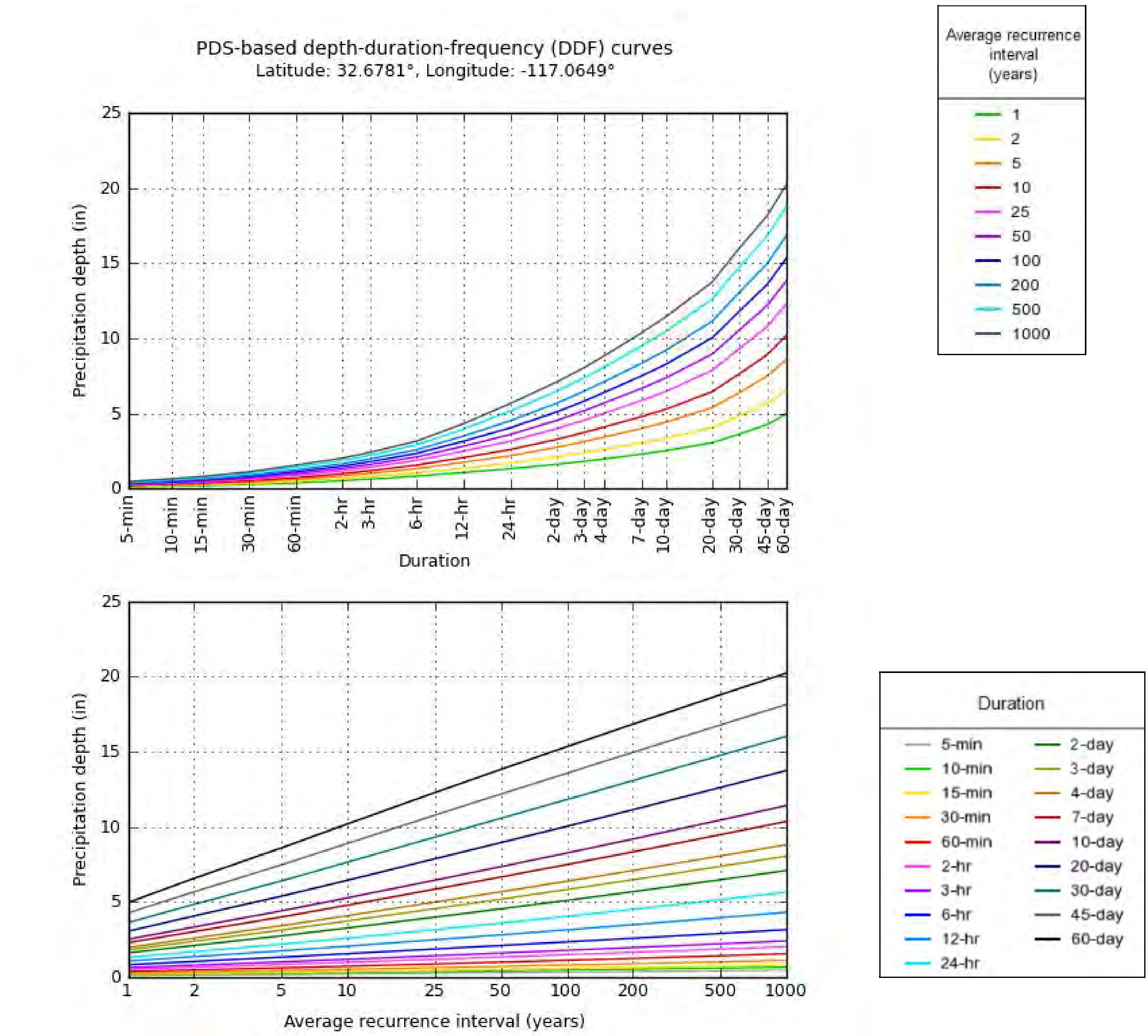
PF graphical



NOAA Atlas 14, Volume 6, Version 2 Created (GMT): Sat Mar 5 17:36:18 2016

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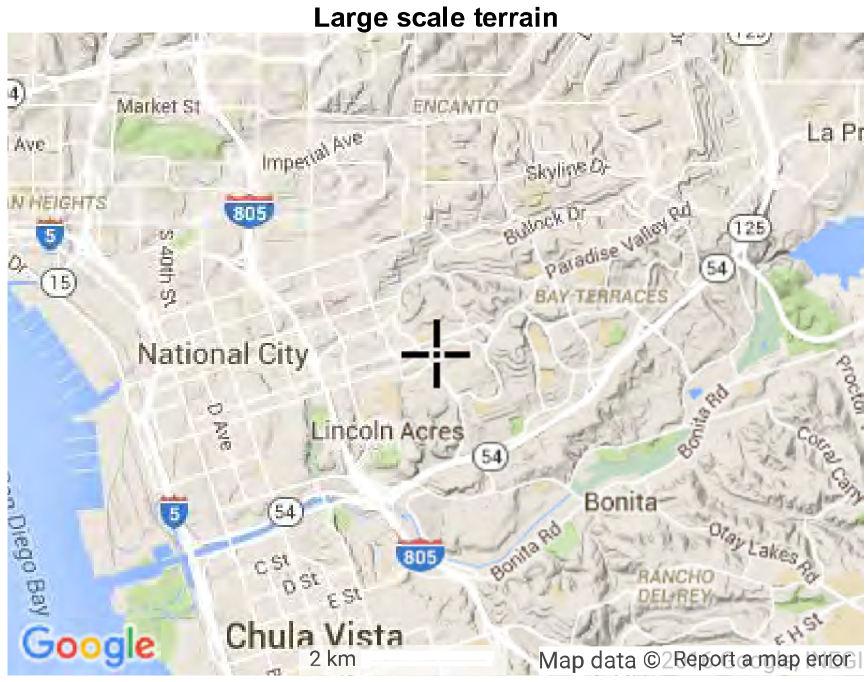
Maps & aerials

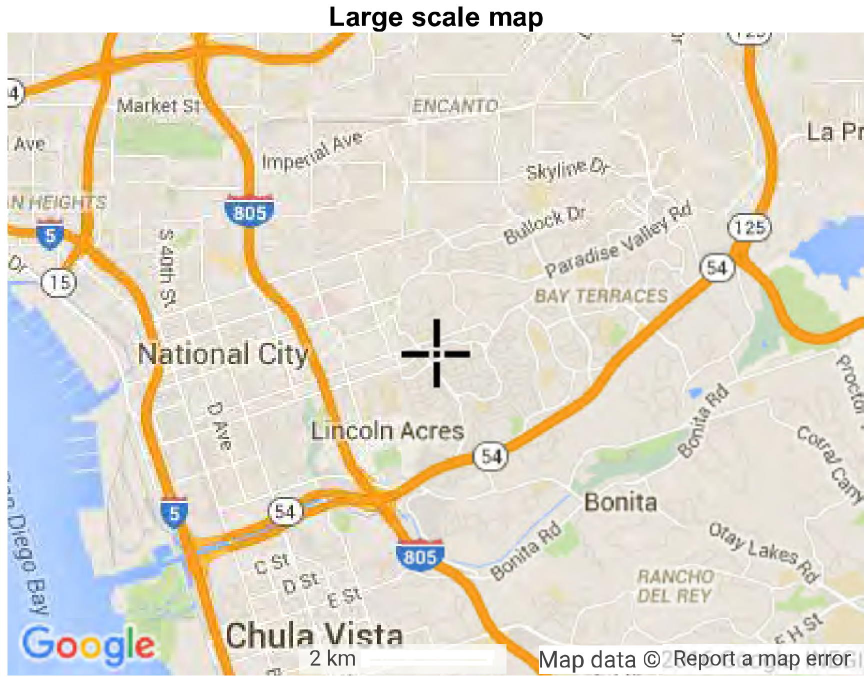
Small scale terrain

ATTACHMENT B, EXHIBIT J-2 - 100

Large scale terrain



Large scale map



Large scale aerial

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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

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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.

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PF graphical

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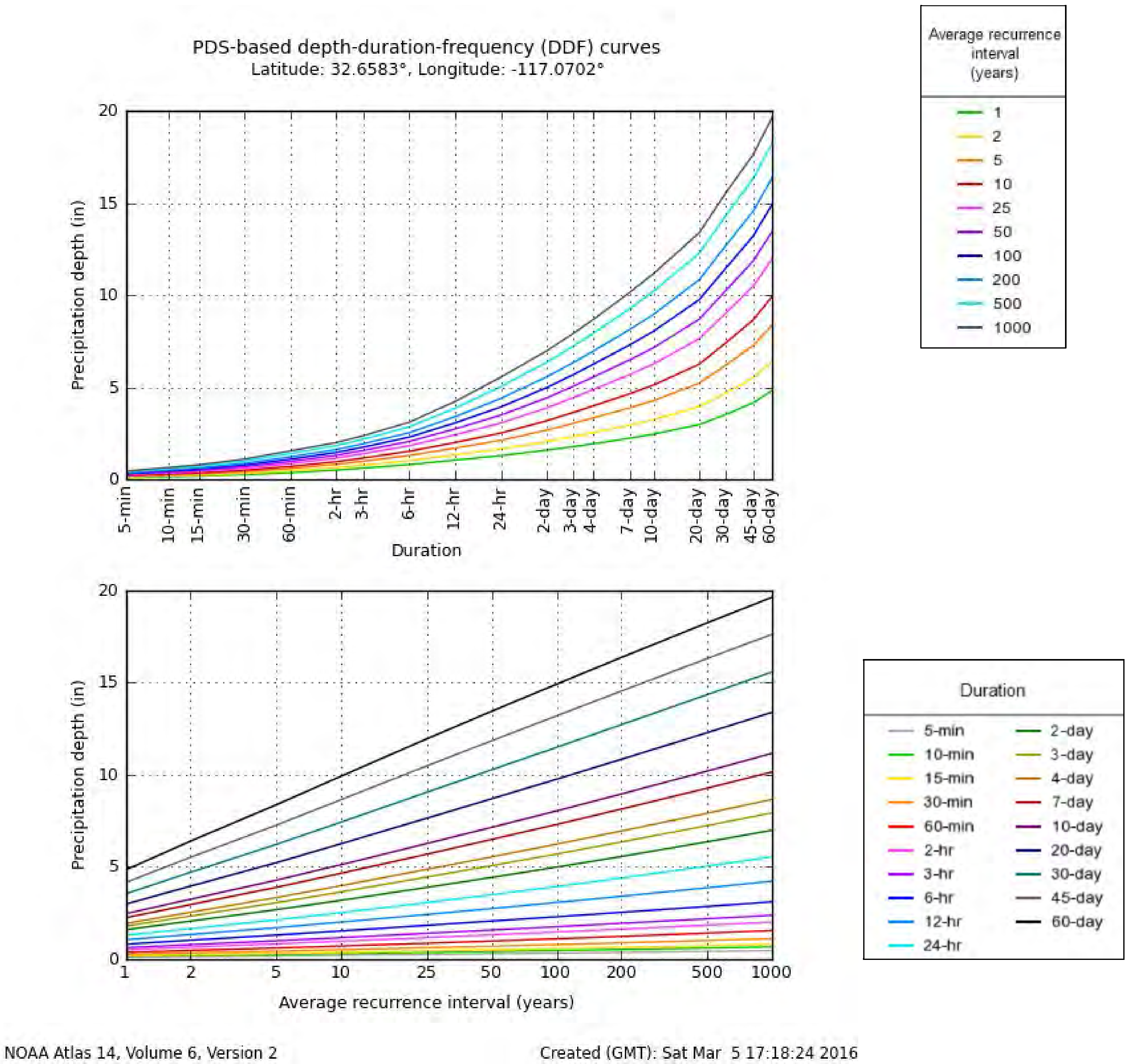

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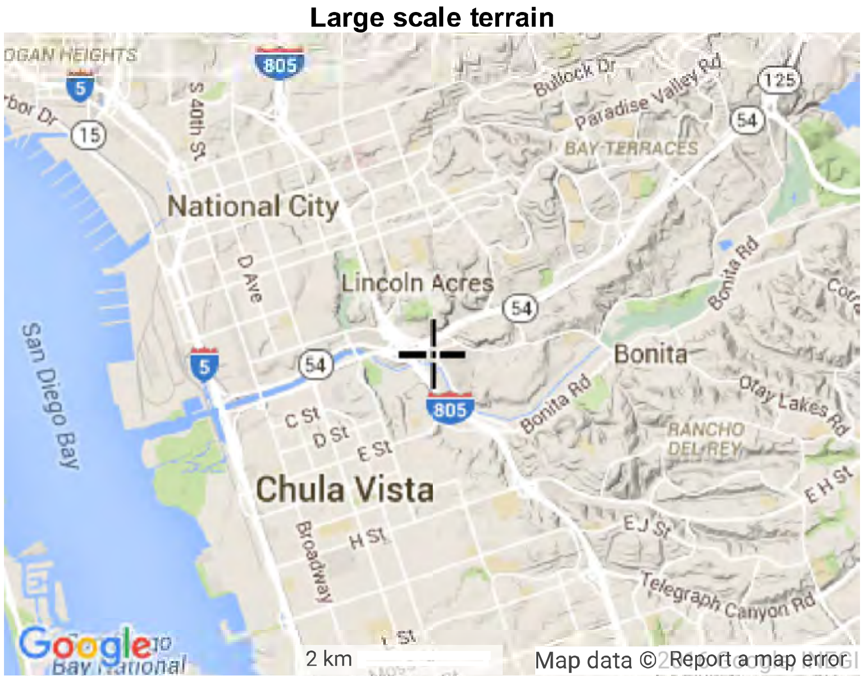
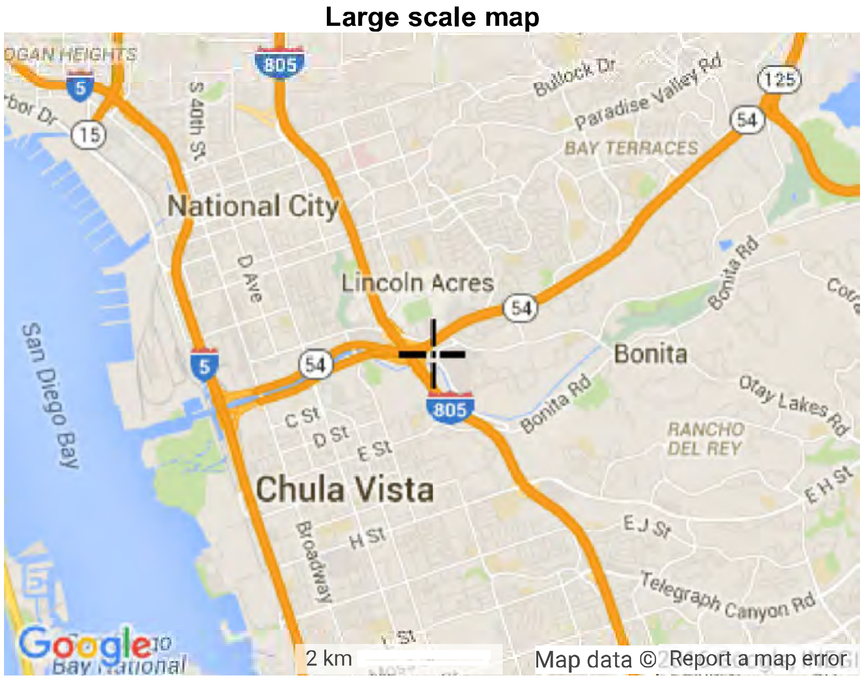
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map



Large scale aerial

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

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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 ($P_{MODEL} = Adjust \cdot P_{A-TOT}$)

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

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)

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

Proposed

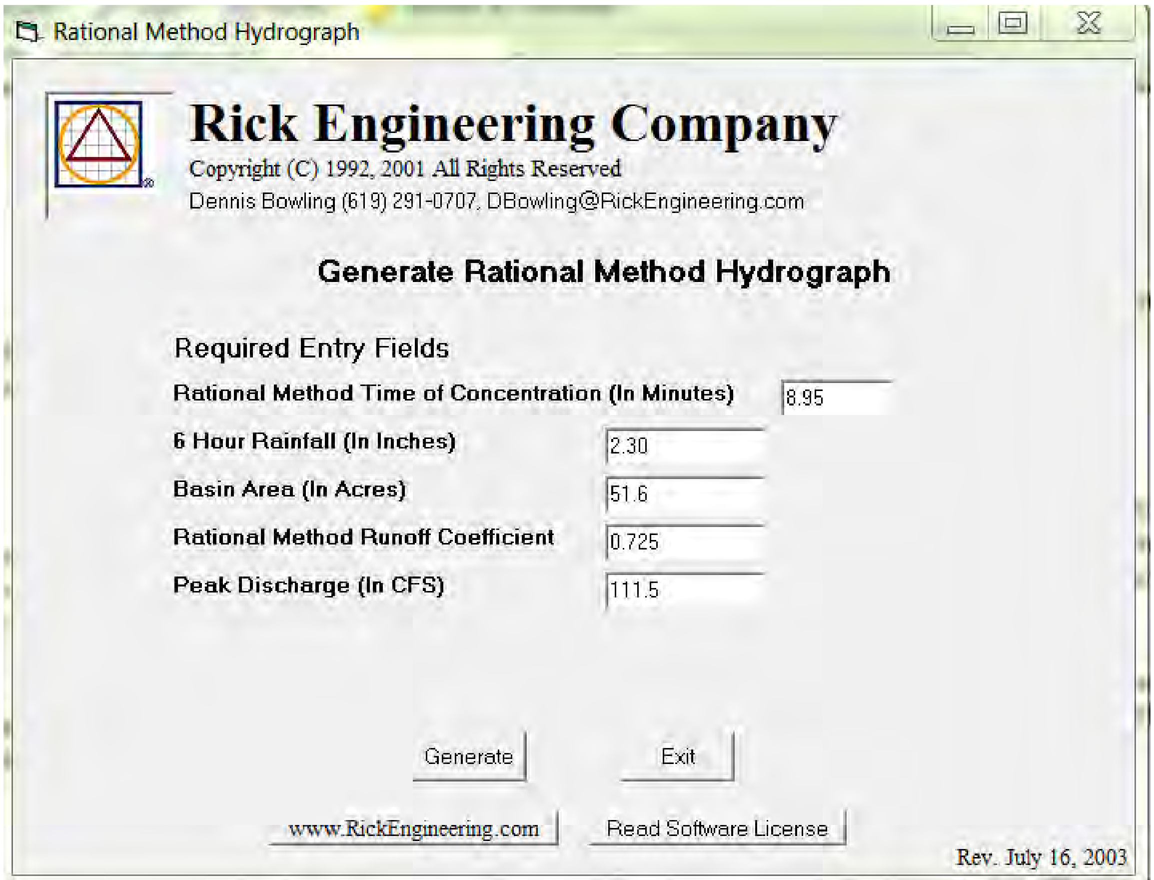
ai:	0.8314	
C:	0.799	
A:	51.6	acres
Tc:	7.26	min
I:	3.293	in/hr
$Q_{3,post}$:	135.8	cfs
$Vol_{3,post}$:	13.54	acre-ft

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) = 117	DISCHARGE (CFS) = 7.4
TIME (MIN) = 126	DISCHARGE (CFS) = 7.9
TIME (MIN) = 135	DISCHARGE (CFS) = 8.1
TIME (MIN) = 144	DISCHARGE (CFS) = 8.7
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TIME (MIN) = 369	DISCHARGE (CFS) = 0

Rational Method Hydrograph

Rick Engineering Company

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

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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
TIME (MIN) = 322	DISCHARGE (CFS) = 7.4
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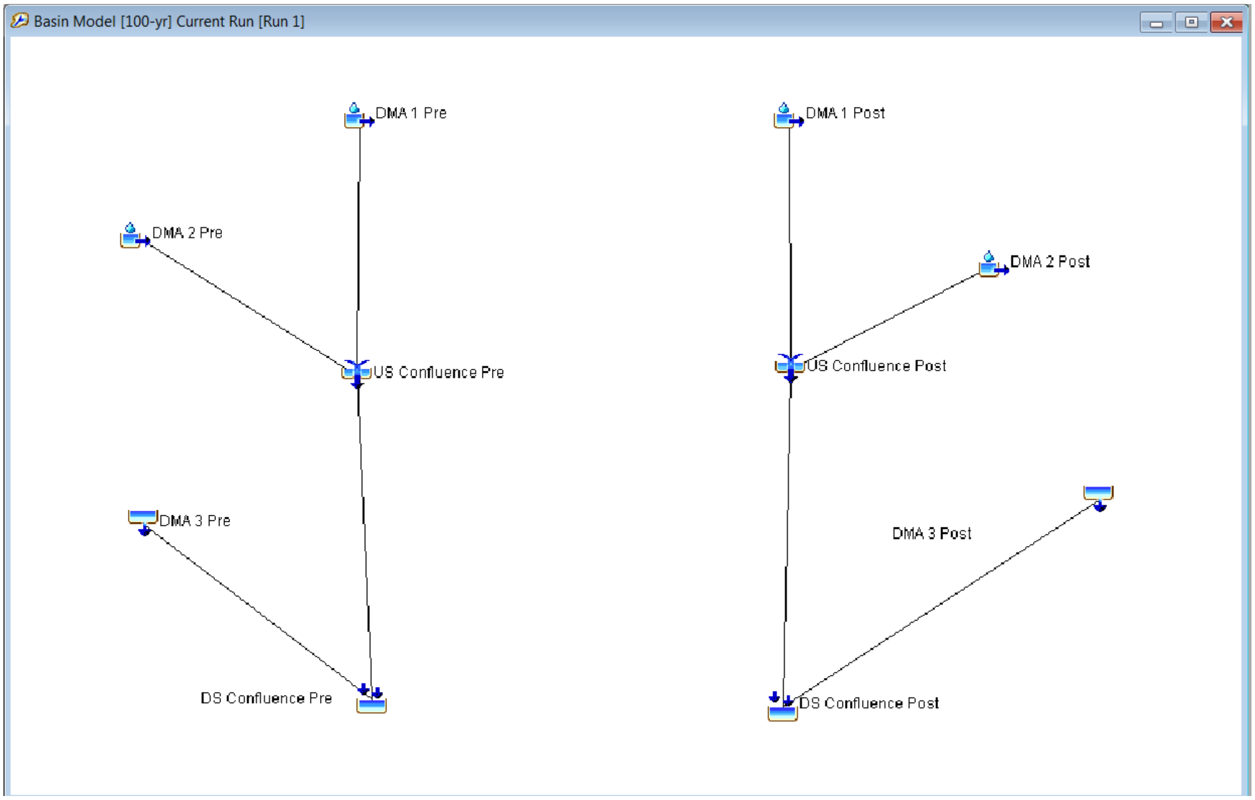
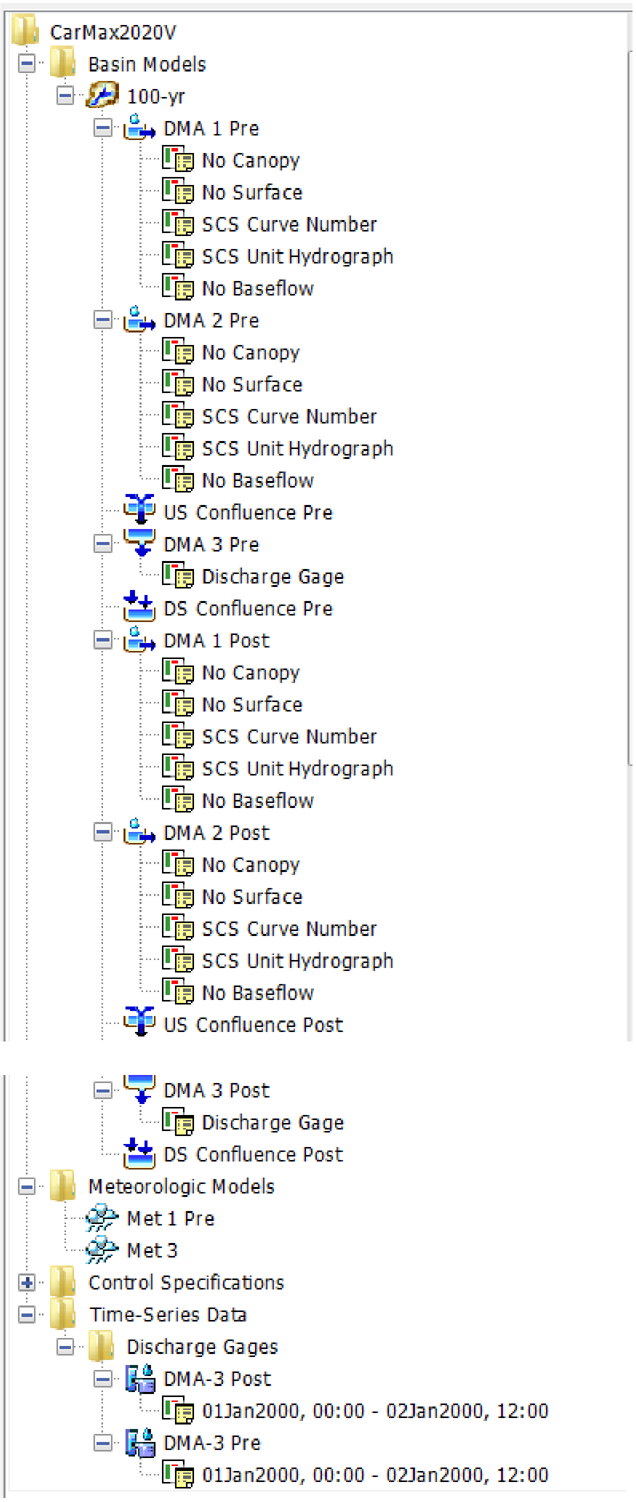
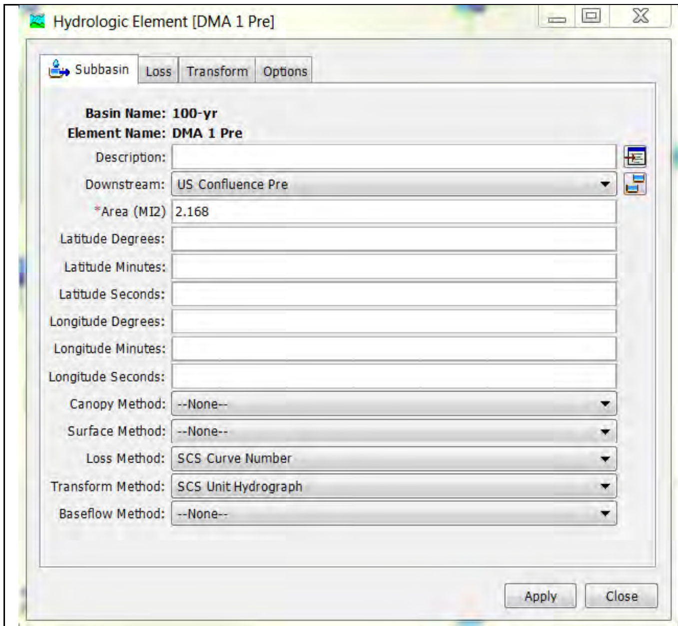
APPENDIX 4

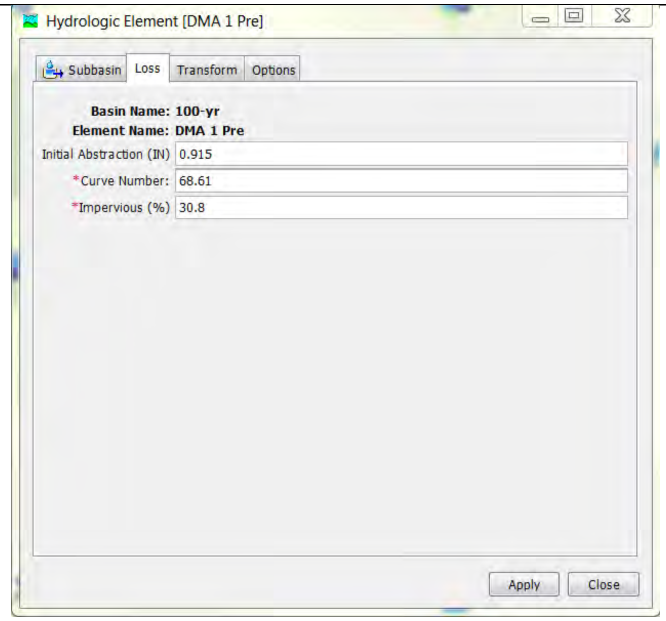
US ARMY CORPS HEC-HMS

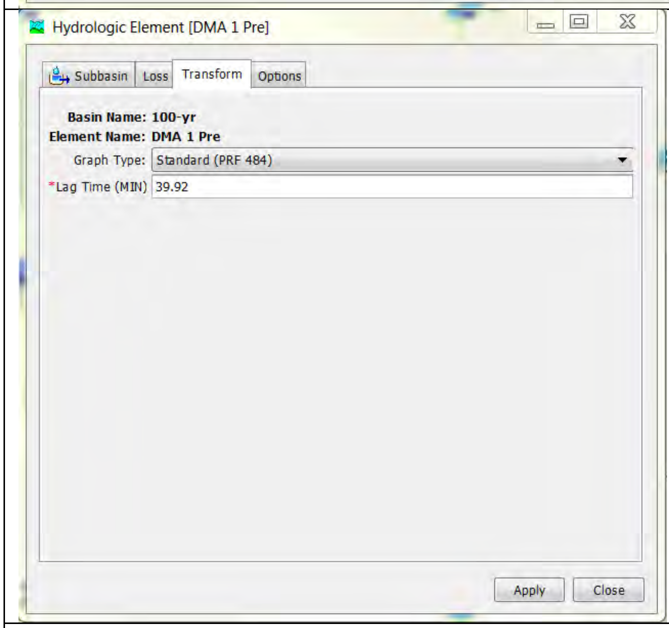
Program Results & Screen Shots

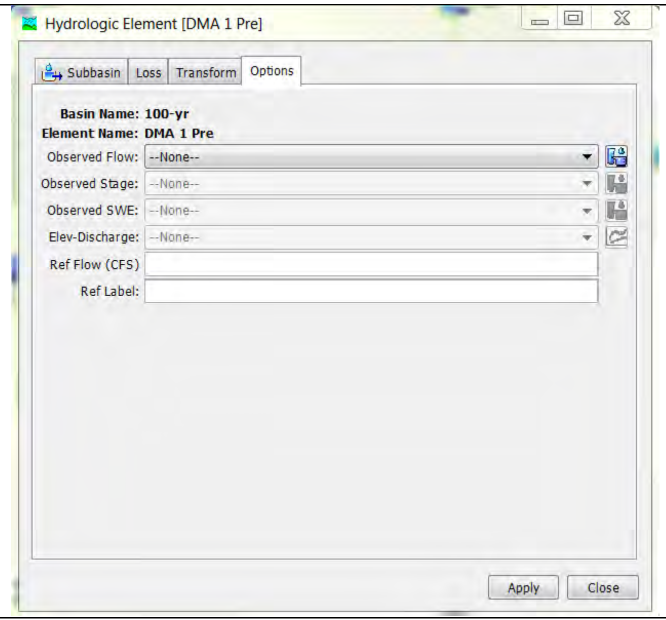

Basin Model [100-yr] Current Run [Run 1]
DMA 1 Pre
DMA 2 Pre
US Confluence Pre
DMA 3 Pre
DS Confluence Pre
DMA 1 Post
DMA 2 Post
US Confluence Post
DMA 3 Post
DS Confluence Post


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

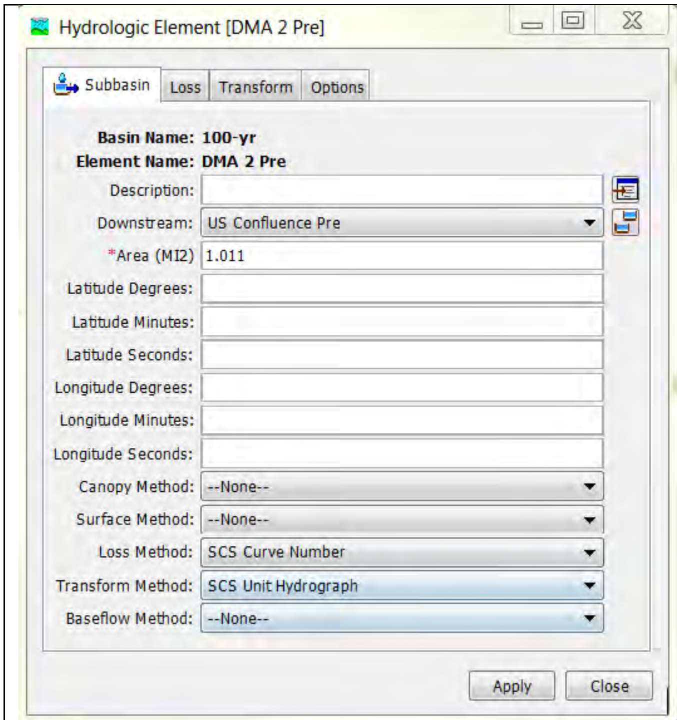


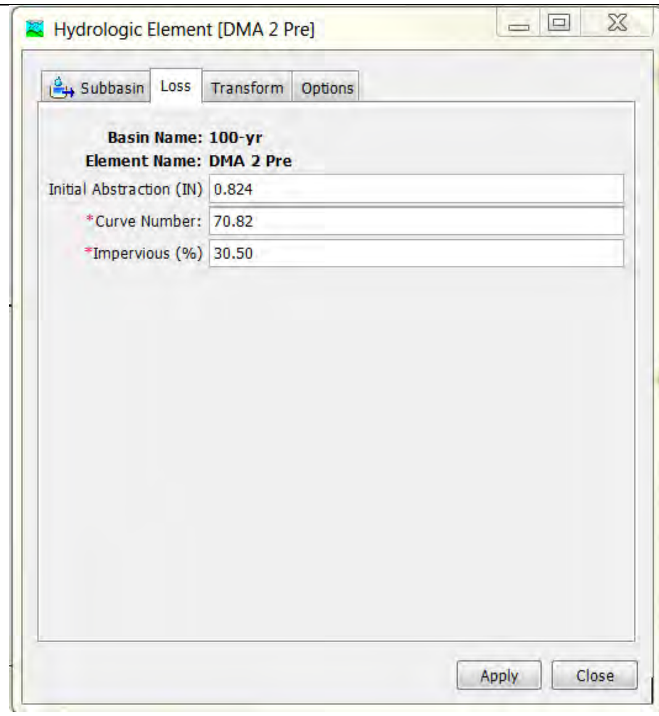


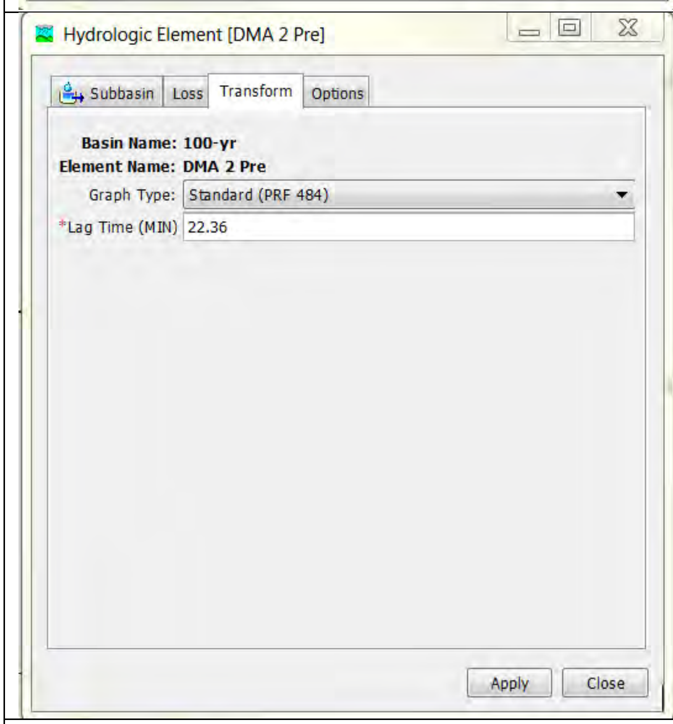


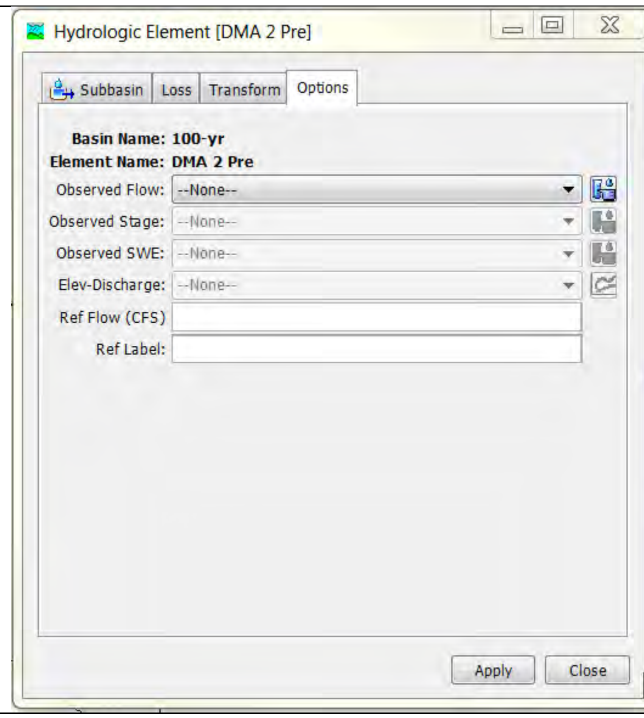


DMA-1 Post: Identical to DMA-1 Pre

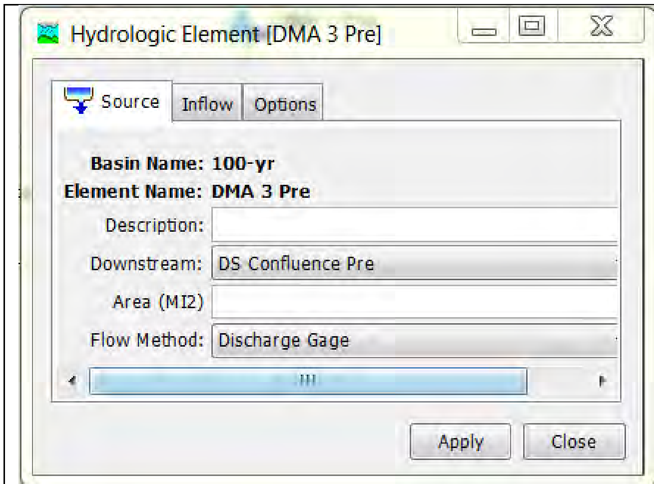


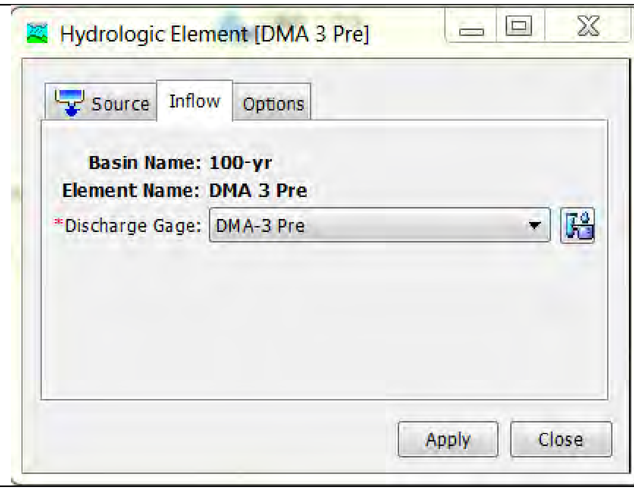


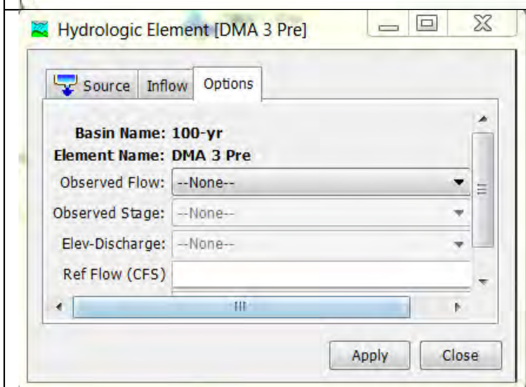




DMA-2 Post: Identical to DMA-2 Pre

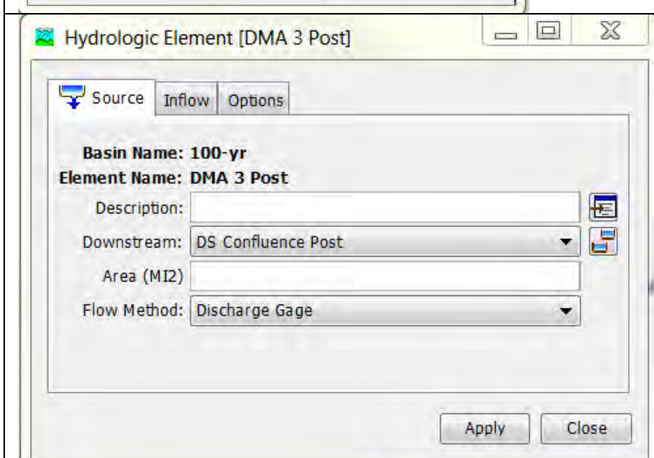


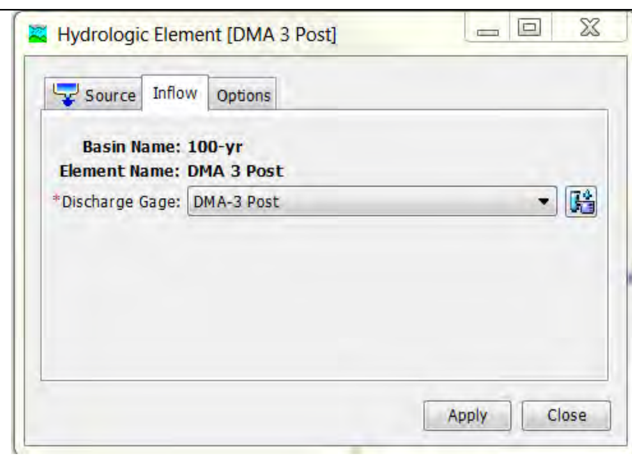


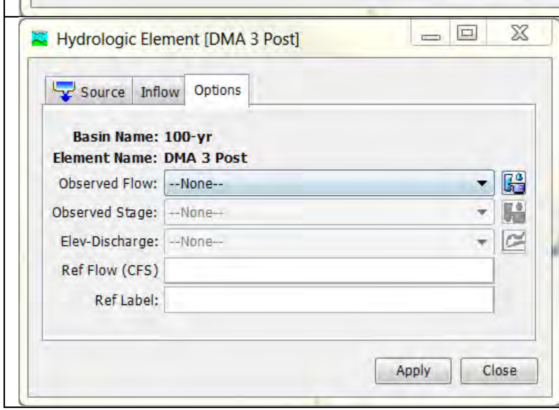


NOTE:

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 Discharge	01Jan2000, 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 Discharge01Jan2000, 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 (sq.mi)	Existing Conditions Q (cfs)	Proposed Conditions 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, 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).