

Appendix I

Drainage Study



Carson Self-Storage Drainage Study

21611 South Perry St.
Carson, CA 90745

Date Prepared:
October 12, 2021

Prepared for:
21611 Perry Street, LLC
4132 Katella Avenue, #205B
Los Alamitos, CA 90720

Prepared By:



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San Diego, CA 92113
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Declaration of Responsible Charge:

I hereby declare that I am the engineer of work for this project, that I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions code, and that the design is consistent with current standards. I understand that the check of the project drawings and specifications by the City of Carson is confined to a review only and does not relieve me, as an engineer of work, of my responsibilities for project design.


Patric T. de Boer RCE 83583
Registration Expires 3-31-2023



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Site & Project Description

This drainage study has been prepared for Carson Self-Storage located at 21611 South Perry Street in the City of Carson.

The project involves the construction of three two-story storage buildings with asphalt paving throughout the development. The total area of analysis is 2.77 acres.

See figure No.1 for a Vicinity Map. Figures 2 and 3 show the existing and proposed drainage flow paths and basins.

Methodology

This drainage report has been prepared in accordance with current County of Los Angeles regulations and procedures. The LA County Hydrology Manual was used to determine the hydrologic features of the site.

LA County provides a free program called HydroCalc (Version 1.02) to calculate runoff rates and volumes. Given the area, length of flow path, average slope, design storm depth, imperviousness, and soil type, HydroCalc generates a hydrograph for the existing and proposed conditions. LA County provides hydrology maps online where the soil type and 50-year rainfall can be found.

This report analyzes the flow generated by the 50 and 100-year storm events for storm drain sizing and flood control purposes.

- (1) Handbook of Hydraulics, E.F. Brater & H.W. King, 6th Ed., 1976.
- (2) Los Angeles County Department of Public Works Hydrology Manual, 2006

Existing Conditions

For the purposes of the hydrology analysis, the existing conditions are assumed to be the pre-existing conditions which consisted of a commercial building that covered the majority of the site and a parking lot. The site is approximately 96.4% impervious and underlain by soil type # 3.

The entire site drains via surface flow from east to west to an existing 5' storm drain inlet that outlets to the Dominguez Channel, a concrete lined channel. This point is referred to as Discharge Point # 1 in this report.

Proposed Conditions

The proposed development will re-grade the entire site but will keep the same discharge point as the existing conditions. The proposed site will be 89.7% impervious.

The project will construct gutters that wrap around the self-storage facilities and direct the runoff generated from the site towards the westerly portion of the site. Runoff will then drain into a 10'x20' Modular Wetland System for treatment. Following treatment, the stormwater will drain out

via pipe flow to a storm drain clean out structure thence to the existing 5' storm drain inlet and ultimately the Dominguez Channel. This point is referred to as Discharge Point # 1 in this report.

The discharge point will have a 50-year peak discharge that does not increase from the existing conditions. This is accomplished by reducing the impervious footprint of the proposed site.

Existing HydroCalc Analysis

The existing conditions were modeled using HydroCalc. The area of analysis consists of one basin being E-1.1.

Below is a summary of the results of the HydroCalc Calculations for the existing conditions.

Basin #	Area (ac)	Soil Type	Imperv. (%)	T _{C 50} (min)	I ₅₀ (in/hr)	T _{C 100} (min)	I ₁₀₀ (in/hr)	Q ₅₀ (cfs)	Q ₁₀₀ (cfs)
E-1.1	2.77	3	96.4	7.0	3.11	7.0	3.49	7.61	8.55
Total								7.61	8.55

Proposed HydroCalc Analysis

The proposed site was modeled as two basins, referred to as P-1.1 and P-1.2 in this report.

Below is a summary of the HydroCalc calculations for the proposed conditions.

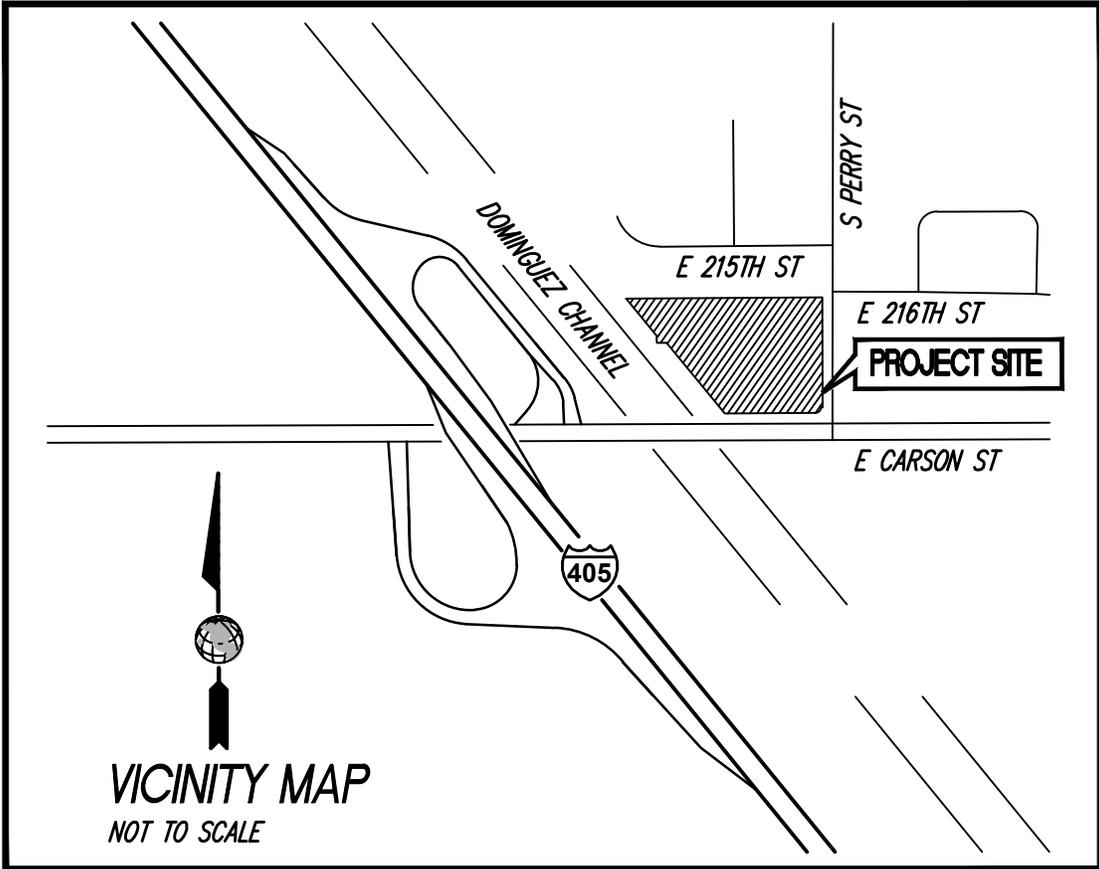
Basin #	Area (ac)	Soil Type	Imperv. (%)	T _{C 50} (min)	I ₅₀ (in/hr)	T _{C 100} (min)	I ₁₀₀ (in/hr)	Q ₅₀ (cfs)	Q ₁₀₀ (cfs)
P-1.1	1.44	3	90.6	10.0	2.63	9.0	3.10	3.23	3.83
P-1.2	1.33	3	88.9	7.0	3.11	7.0	3.49	3.52	3.97
Total								6.74	7.79

Results and Conclusions

The development of the project site will slightly modify the onsite drainage patterns; however, the existing point of discharge and the point of compliance remain the same.

The proposed improvements will decrease the peak flowrates generated by the area of analysis at the discharge point. The 50-year storm flow decreases from 7.61 cfs to 6.74 cfs and the 100-year storm flow decreases from 8.55 cfs to 7.79 cfs.

It is the opinion of Omega Engineering Consultants that the project will not cause adverse effects to the downstream facilities or receiving waters as a result of increased peak flowrate during the 50-year and 100-year storms.

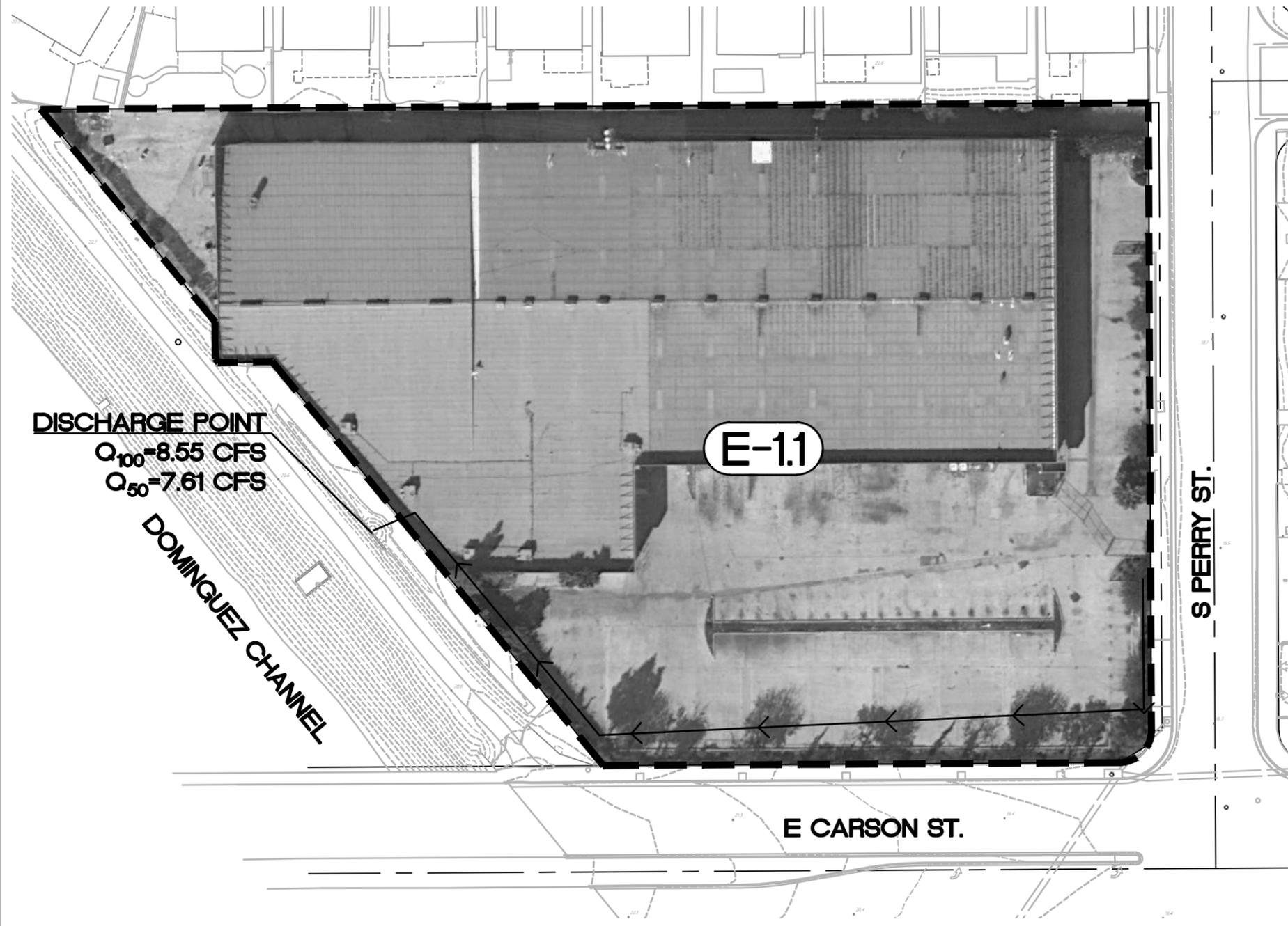


VICINITY MAP
NOT TO SCALE

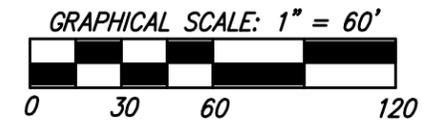
LEGEND

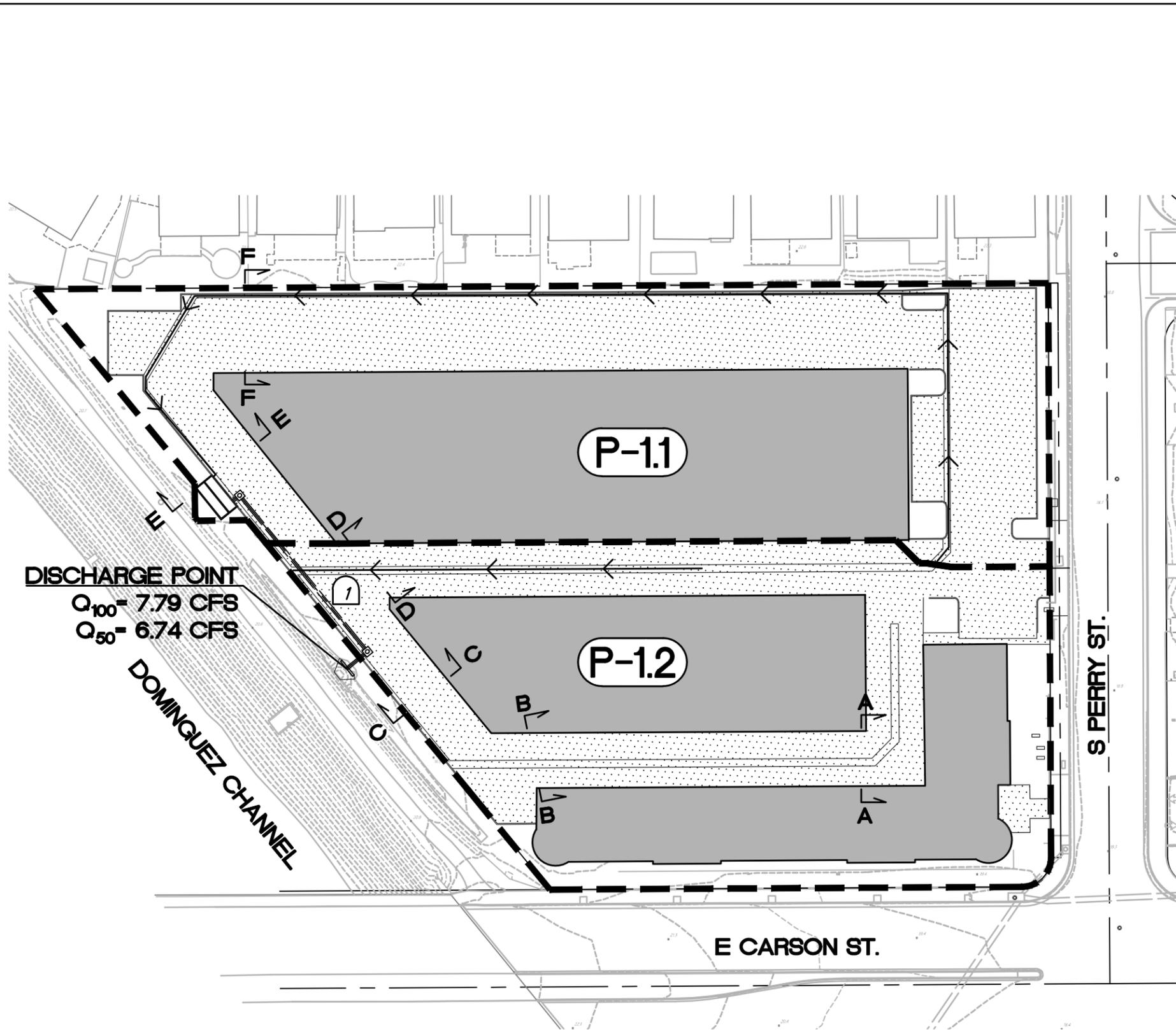
- BASIN NUMBER **E-##**
- AREA LIMITS **-----**
- DRAINAGE FLOW PATH **→**

DRAINAGE BASIN DATA							
BASIN #	AREA (AC)	SOIL TYPE	IMPERV. (%)	<i>I</i> ₅₀ (IN/HR)	<i>I</i> ₁₀₀ (IN/HR)	<i>Q</i> ₅₀ (CFS)	<i>Q</i> ₁₀₀ (CFS)
E-1.1	2.77	3	96.4	3.11	3.49	7.61	8.55



**CARSON SELF-STORAGE
EXISTING HYDROLOGY
EXHIBIT**





LEGEND

- BASIN NUMBER **P-##**
- AREA LIMITS **-----**
- DRAINAGE FLOW PATH **→**
- BUILDING AREA **[Solid Grey Box]**
- PAVEMENT AREA **[Dotted Box]**
- PERVIOUS AREA **[White Box]**

DRAINAGE BASIN DATA

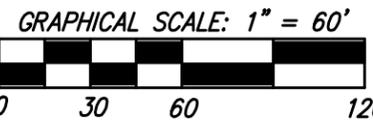
BASIN #	AREA (AC)	SOIL TYPE	IMPERV. (%)	I ₅₀ (IN/HR)	I ₁₀₀ (IN/HR)	Q ₅₀ (CFS)	Q ₁₀₀ (CFS)
P-1.1	1.44	3	90.6	2.63	3.10	3.23	3.83
P-1.2	1.33	3	88.9	3.11	3.49	3.52	3.97

X PIPE DATA

PIPE #	DIAMETER (INCHES)	SLOPE (%)	DEPTH /DIA	V ₁₀₀ (FPS)	Q ₁₀₀ (CFS)
1	18	1.0	0.64	6.52	7.79

NOTE: SEE APPENDIX 4 IN THE HYDROLOGY REPORT FOR GUTTER ANALYSIS SECTIONS

DISCHARGE POINT
 Q₁₀₀ = 7.79 CFS
 Q₅₀ = 6.74 CFS



**CARSON SELF-STORAGE
 PROPOSED HYDROLOGY
 EXHIBIT**



PROP. HYDROLOGY EXHIBIT

Peak Flow Hydrologic Analysis

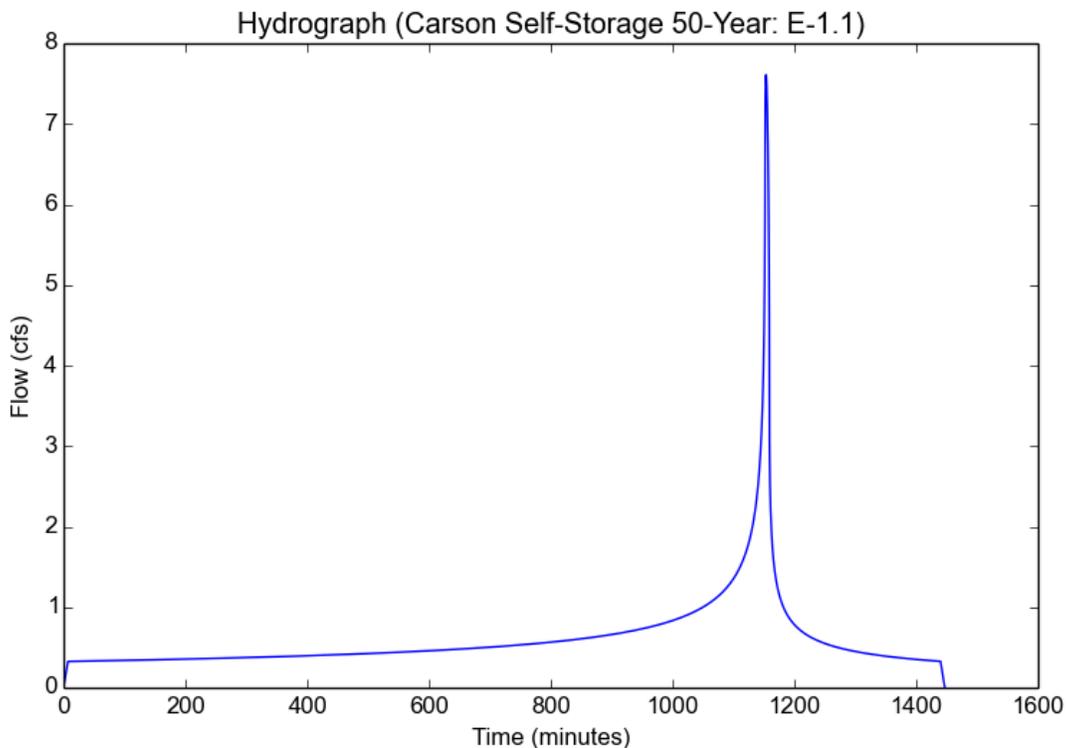
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Version: HydroCalc 1.0.3

Input Parameters

Project Name	Carson Self-Storage 50-Year
Subarea ID	E-1.1
Area (ac)	2.77
Flow Path Length (ft)	475.0
Flow Path Slope (vft/hft)	0.005
50-yr Rainfall Depth (in)	6.1
Percent Impervious	0.964
Soil Type	3
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	6.1
Peak Intensity (in/hr)	3.1071
Undeveloped Runoff Coefficient (Cu)	0.4613
Developed Runoff Coefficient (Cd)	0.8842
Time of Concentration (min)	7.0
Clear Peak Flow Rate (cfs)	7.61
Burned Peak Flow Rate (cfs)	7.61
24-Hr Clear Runoff Volume (ac-ft)	1.2178
24-Hr Clear Runoff Volume (cu-ft)	53047.6479



Peak Flow Hydrologic Analysis

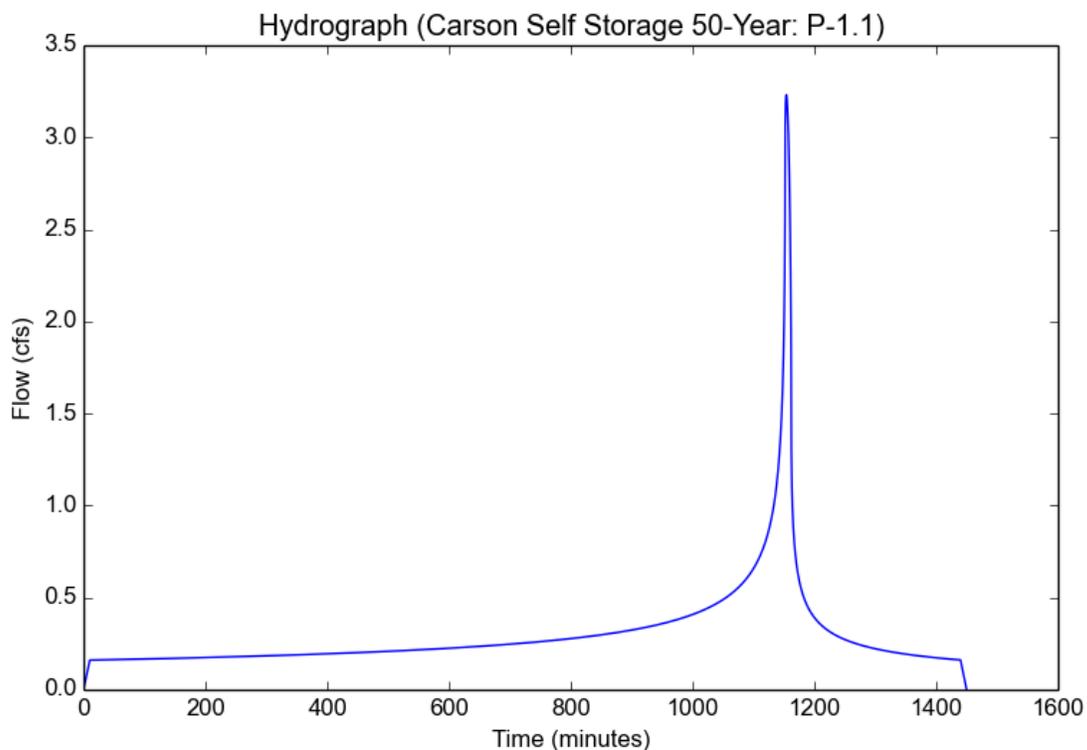
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Version: HydroCalc 1.0.3

Input Parameters

Project Name	Carson Self Storage 50-Year
Subarea ID	P-1.1
Area (ac)	1.44
Flow Path Length (ft)	635.0
Flow Path Slope (vft/hft)	0.0036
50-yr Rainfall Depth (in)	6.1
Percent Impervious	0.906
Soil Type	3
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	6.1
Peak Intensity (in/hr)	2.6275
Undeveloped Runoff Coefficient (Cu)	0.411
Developed Runoff Coefficient (Cd)	0.854
Time of Concentration (min)	10.0
Clear Peak Flow Rate (cfs)	3.2314
Burned Peak Flow Rate (cfs)	3.2314
24-Hr Clear Runoff Volume (ac-ft)	0.6003
24-Hr Clear Runoff Volume (cu-ft)	26150.392



Peak Flow Hydrologic Analysis

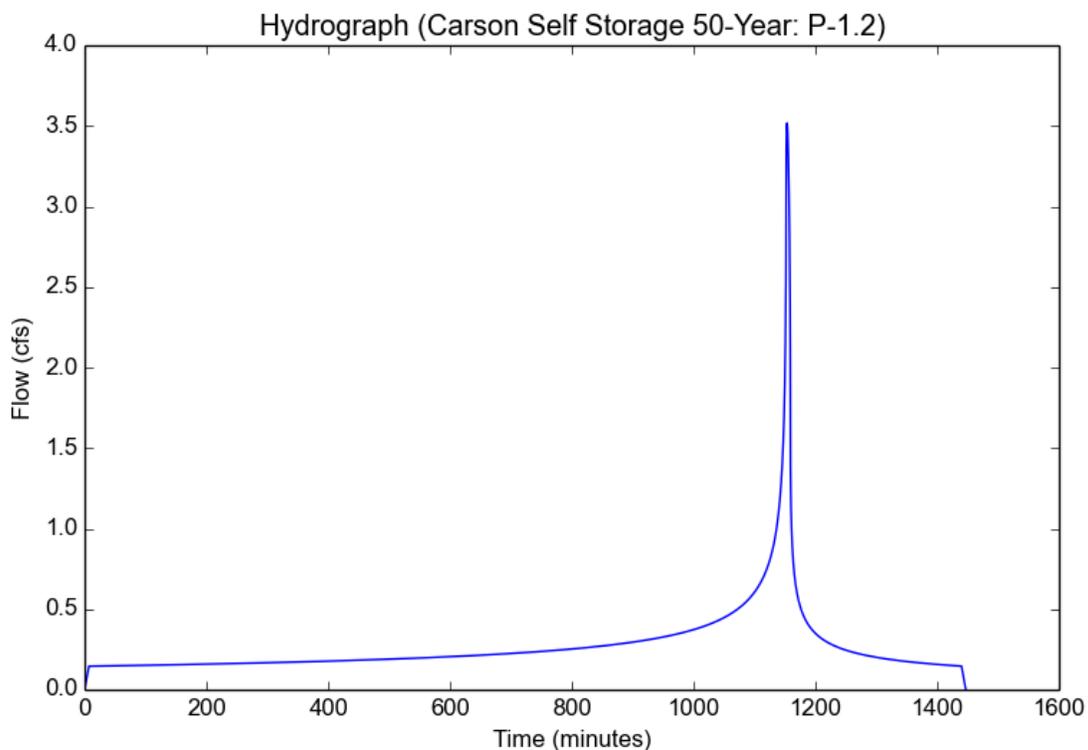
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Version: HydroCalc 1.0.3

Input Parameters

Project Name	Carson Self Storage 50-Year
Subarea ID	P-1.2
Area (ac)	1.33
Flow Path Length (ft)	645.0
Flow Path Slope (vft/hft)	0.0177
50-yr Rainfall Depth (in)	6.1
Percent Impervious	0.889
Soil Type	3
Design Storm Frequency	50-yr
Fire Factor	0
LID	False

Output Results

Modeled (50-yr) Rainfall Depth (in)	6.1
Peak Intensity (in/hr)	3.1071
Undeveloped Runoff Coefficient (Cu)	0.4613
Developed Runoff Coefficient (Cd)	0.8513
Time of Concentration (min)	7.0
Clear Peak Flow Rate (cfs)	3.518
Burned Peak Flow Rate (cfs)	3.518
24-Hr Clear Runoff Volume (ac-ft)	0.5457
24-Hr Clear Runoff Volume (cu-ft)	23771.3544



Peak Flow Hydrologic Analysis

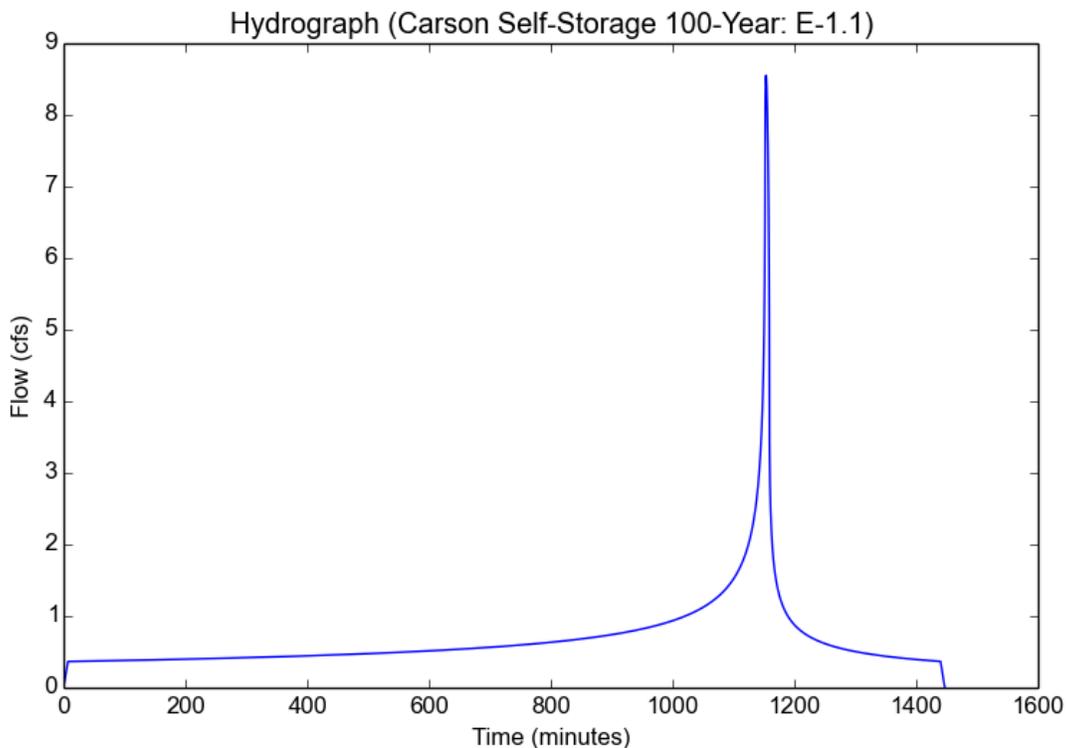
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Version: HydroCalc 1.0.3

Input Parameters

Project Name	Carson Self-Storage 100-Year
Subarea ID	E-1.1
Area (ac)	2.77
Flow Path Length (ft)	475.0
Flow Path Slope (vft/hft)	0.005
50-yr Rainfall Depth (in)	6.1
Percent Impervious	0.964
Soil Type	3
Design Storm Frequency	100-yr
Fire Factor	0
LID	False

Output Results

Modeled (100-yr) Rainfall Depth (in)	6.8442
Peak Intensity (in/hr)	3.4861
Undeveloped Runoff Coefficient (Cu)	0.5012
Developed Runoff Coefficient (Cd)	0.8856
Time of Concentration (min)	7.0
Clear Peak Flow Rate (cfs)	8.5523
Burned Peak Flow Rate (cfs)	8.5523
24-Hr Clear Runoff Volume (ac-ft)	1.3666
24-Hr Clear Runoff Volume (cu-ft)	59530.2221



Peak Flow Hydrologic Analysis

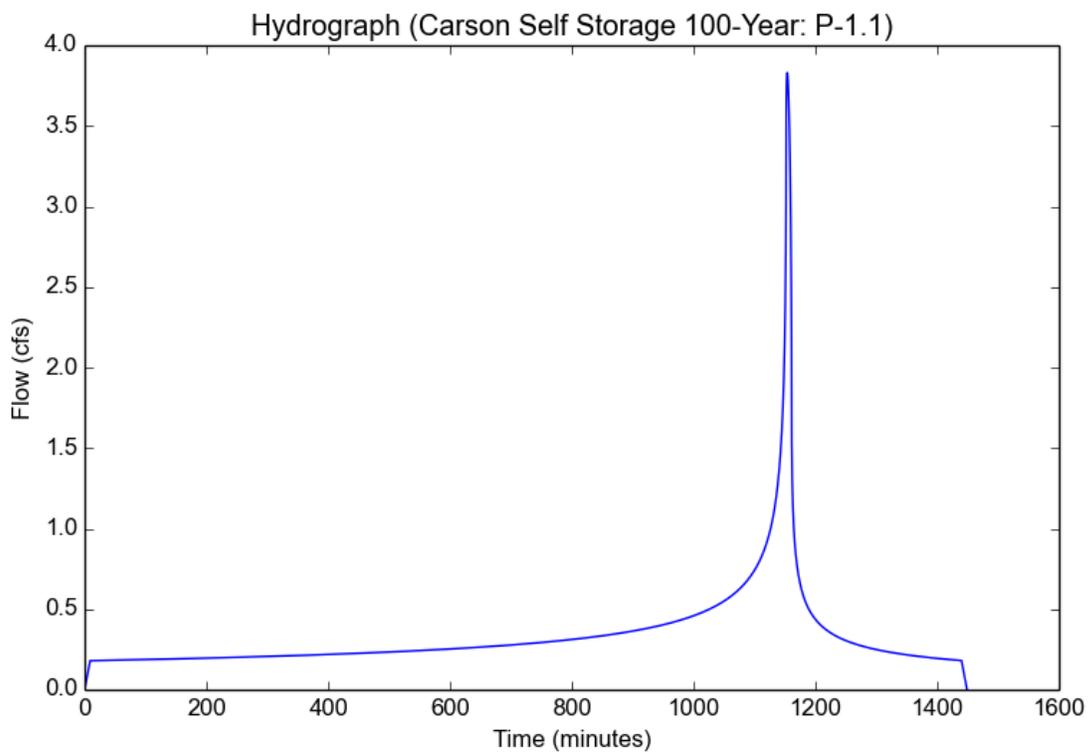
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Version: HydroCalc 1.0.3

Input Parameters

Project Name	Carson Self Storage 100-Year
Subarea ID	P-1.1
Area (ac)	1.44
Flow Path Length (ft)	635.0
Flow Path Slope (vft/hft)	0.0036
50-yr Rainfall Depth (in)	6.1
Percent Impervious	0.906
Soil Type	3
Design Storm Frequency	100-yr
Fire Factor	0
LID	False

Output Results

Modeled (100-yr) Rainfall Depth (in)	6.8442
Peak Intensity (in/hr)	3.0978
Undeveloped Runoff Coefficient (Cu)	0.4604
Developed Runoff Coefficient (Cd)	0.8587
Time of Concentration (min)	9.0
Clear Peak Flow Rate (cfs)	3.8304
Burned Peak Flow Rate (cfs)	3.8304
24-Hr Clear Runoff Volume (ac-ft)	0.6739
24-Hr Clear Runoff Volume (cu-ft)	29356.4034



Peak Flow Hydrologic Analysis

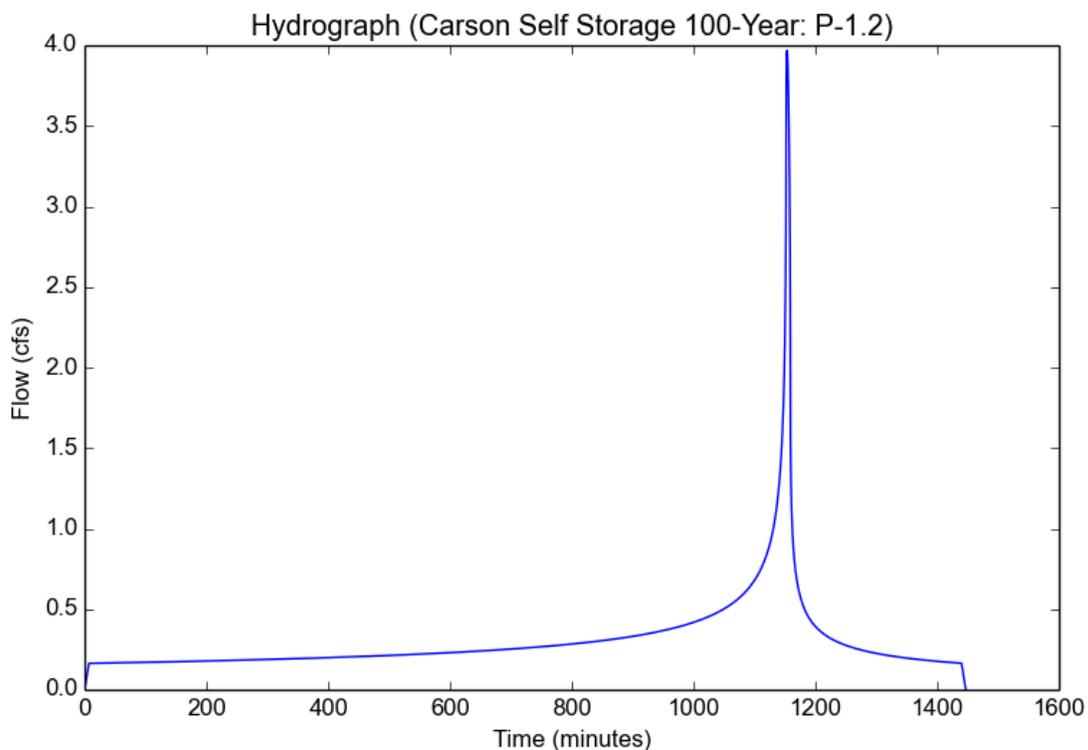
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Version: HydroCalc 1.0.3

Input Parameters

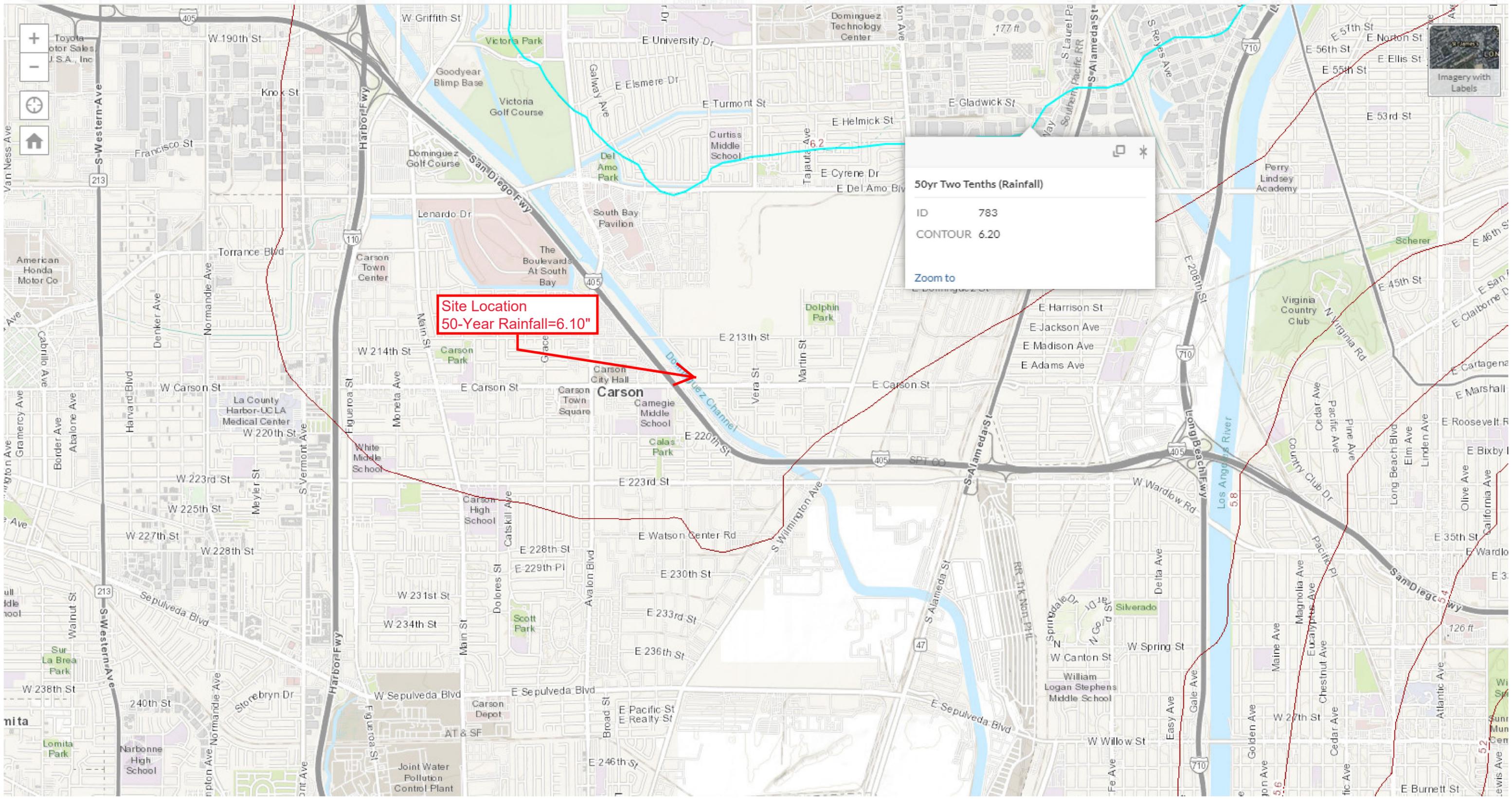
Project Name	Carson Self Storage 100-Year
Subarea ID	P-1.2
Area (ac)	1.33
Flow Path Length (ft)	645.0
Flow Path Slope (vft/hft)	0.0177
50-yr Rainfall Depth (in)	6.1
Percent Impervious	0.889
Soil Type	3
Design Storm Frequency	100-yr
Fire Factor	0
LID	False

Output Results

Modeled (100-yr) Rainfall Depth (in)	6.8442
Peak Intensity (in/hr)	3.4861
Undeveloped Runoff Coefficient (Cu)	0.5012
Developed Runoff Coefficient (Cd)	0.8557
Time of Concentration (min)	7.0
Clear Peak Flow Rate (cfs)	3.9676
Burned Peak Flow Rate (cfs)	3.9676
24-Hr Clear Runoff Volume (ac-ft)	0.6127
24-Hr Clear Runoff Volume (cu-ft)	26687.391



Appendix 1



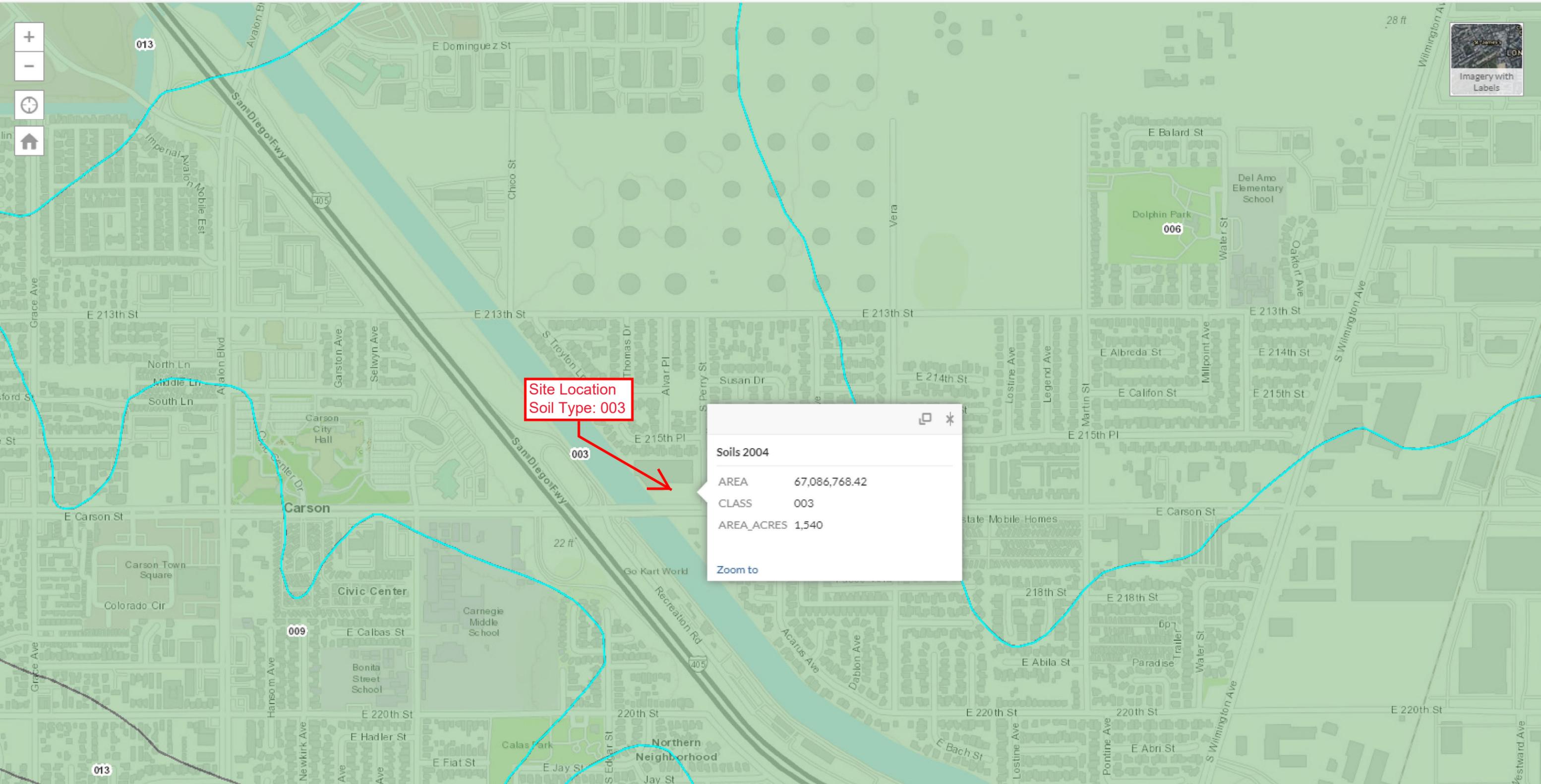
Site Location
50-Year Rainfall=6.10"

50yr Two Tenths (Rainfall)

ID	783
CONTOUR	6.20

Zoom to

Appendix 2



Site Location
Soil Type: 003

Soils 2004

AREA	67,086,768.42
CLASS	003
AREA_ACRES	1,540

Zoom to

Appendix 3

Appendix 4

Channel Report

Section A-A Gutter Analysis

User-defined

Invert Elev (ft) = 18.35
Slope (%) = 4.00
N-Value = 0.013

Highlighted

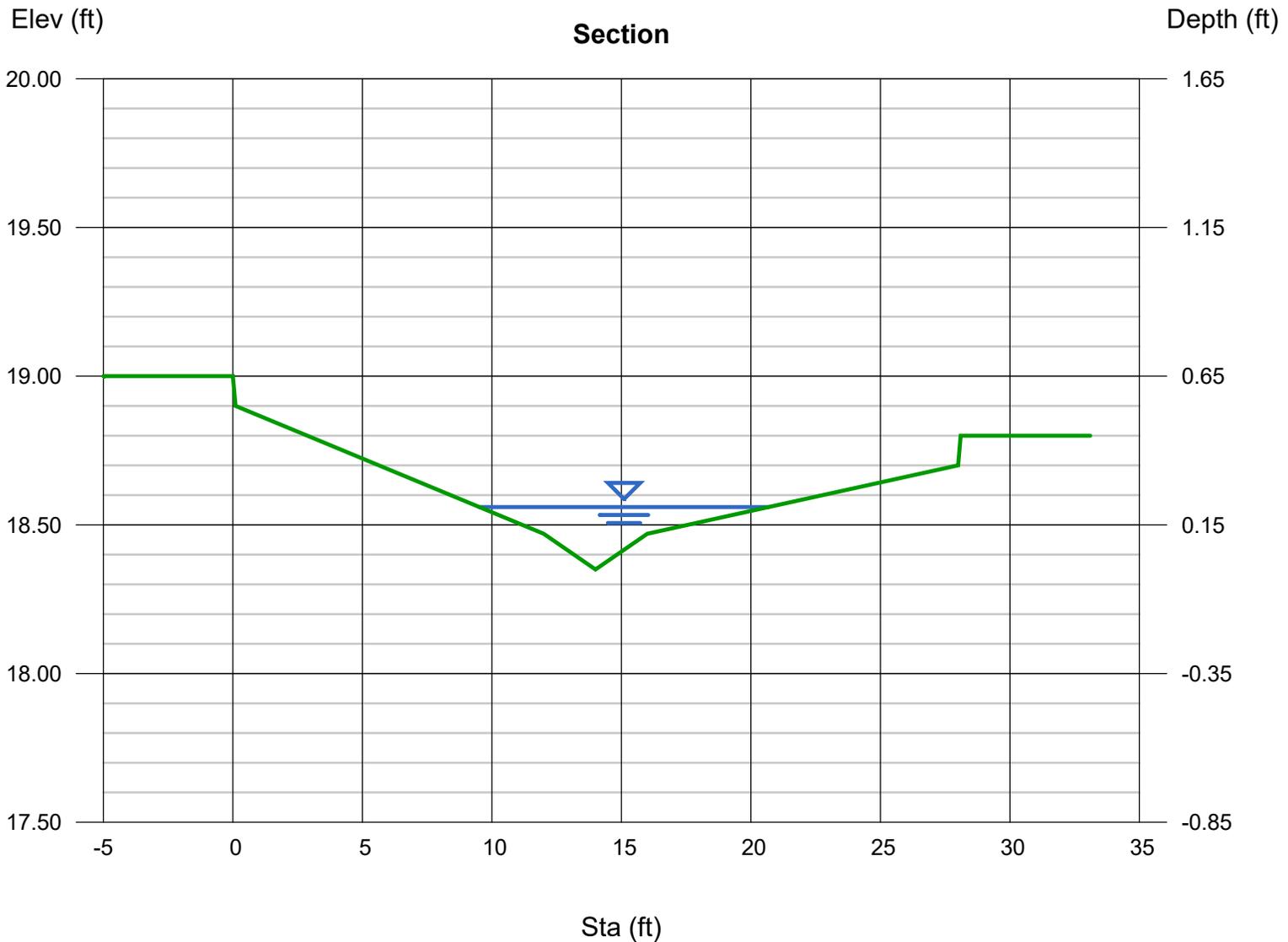
Depth (ft) = 0.21
Q (cfs) = 3.930
Area (sqft) = 0.92
Velocity (ft/s) = 4.26
Wetted Perim (ft) = 11.20
Crit Depth, Yc (ft) = 0.29
Top Width (ft) = 11.19
EGL (ft) = 0.49

Calculations

Compute by: Known Q
Known Q (cfs) = 3.93

(Sta, El, n)-(Sta, El, n)...

(0.00, 19.00)-(0.10, 18.90, 0.013)-(12.00, 18.47, 0.013)-(14.00, 18.35, 0.013)-(16.00, 18.47, 0.013)-(28.00, 18.70, 0.013)-(28.10, 18.80, 0.013)



Channel Report

Section B-B Gutter Analysis

User-defined

Invert Elev (ft) = 17.66
Slope (%) = 0.35
N-Value = 0.013

Highlighted

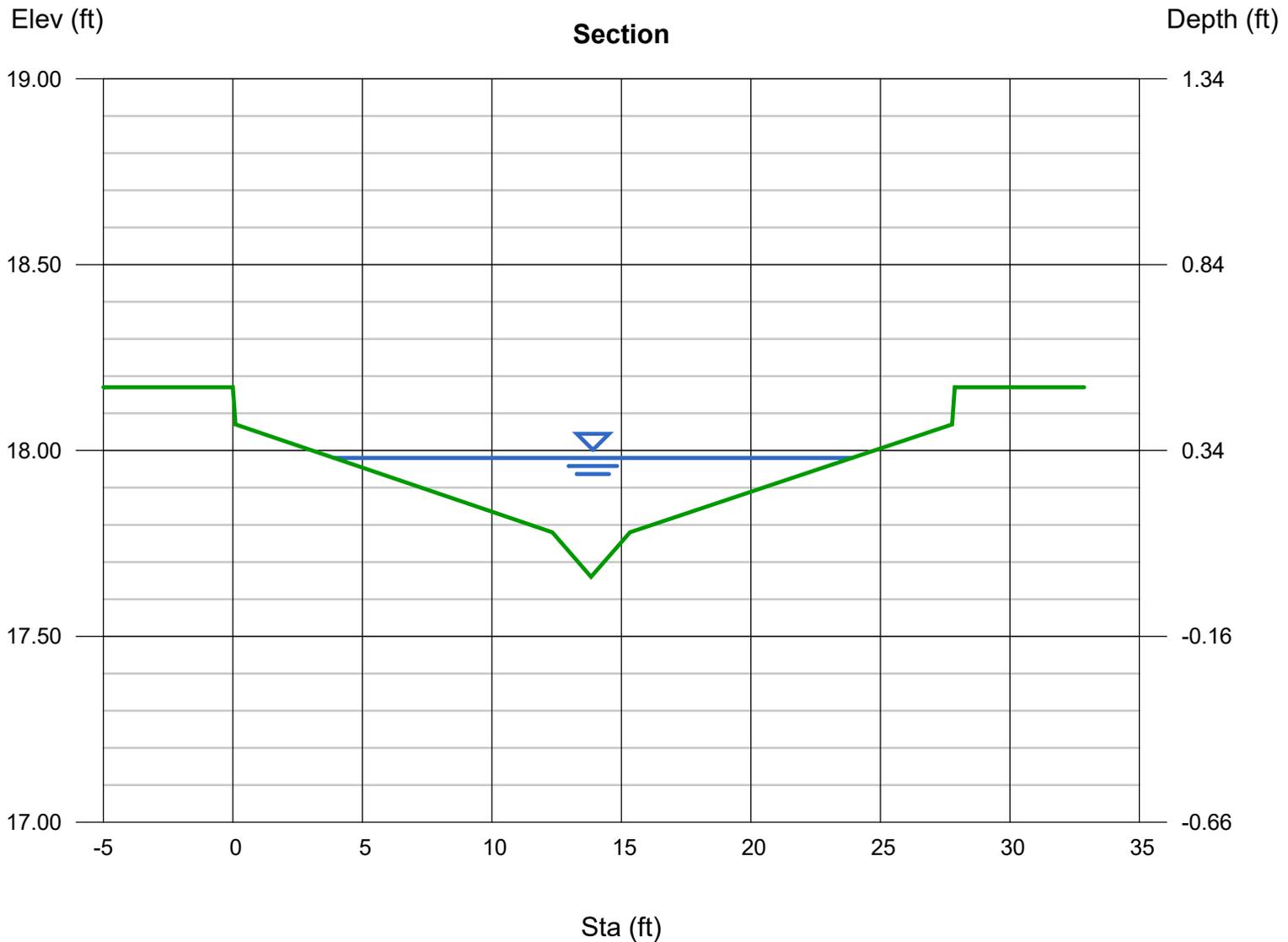
Depth (ft) = 0.32
Q (cfs) = 3.930
Area (sqft) = 2.48
Velocity (ft/s) = 1.58
Wetted Perim (ft) = 20.03
Crit Depth, Yc (ft) = 0.30
Top Width (ft) = 20.01
EGL (ft) = 0.36

Calculations

Compute by: Known Q
Known Q (cfs) = 3.93

(Sta, El, n)-(Sta, El, n)...

(0.00, 18.17)-(0.10, 18.07, 0.013)-(12.33, 17.78, 0.013)-(13.83, 17.66, 0.013)-(15.33, 17.78, 0.013)-(27.77, 18.07, 0.013)-(27.87, 18.17, 0.013)



Channel Report

Section C-C Gutter Analysis

User-defined

Invert Elev (ft) = 17.32
Slope (%) = 0.55
N-Value = 0.013

Calculations

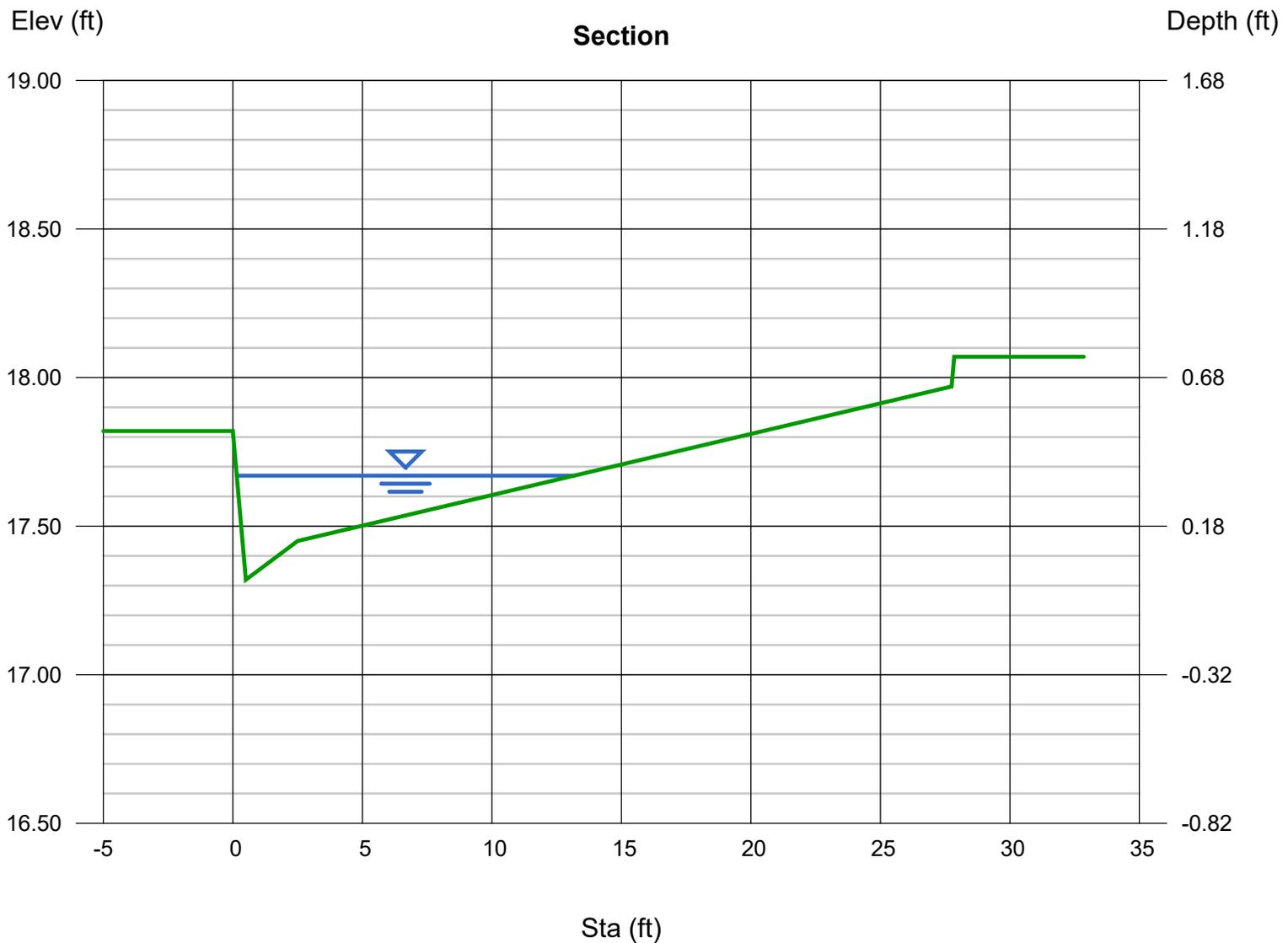
Compute by: Known Q
Known Q (cfs) = 3.93

Highlighted

Depth (ft) = 0.35
Q (cfs) = 3.930
Area (sqft) = 1.81
Velocity (ft/s) = 2.18
Wetted Perim (ft) = 13.18
Crit Depth, Yc (ft) = 0.36
Top Width (ft) = 13.03
EGL (ft) = 0.42

(Sta, El, n)-(Sta, El, n)...

(0.00, 17.82)-(0.50, 17.32, 0.013)-(2.50, 17.45, 0.013)-(27.75, 17.97, 0.013)-(27.85, 18.07, 0.013)



Channel Report

Section D-D Gutter Analysis

User-defined

Invert Elev (ft) = 17.45
Slope (%) = 5.40
N-Value = 0.013

Highlighted

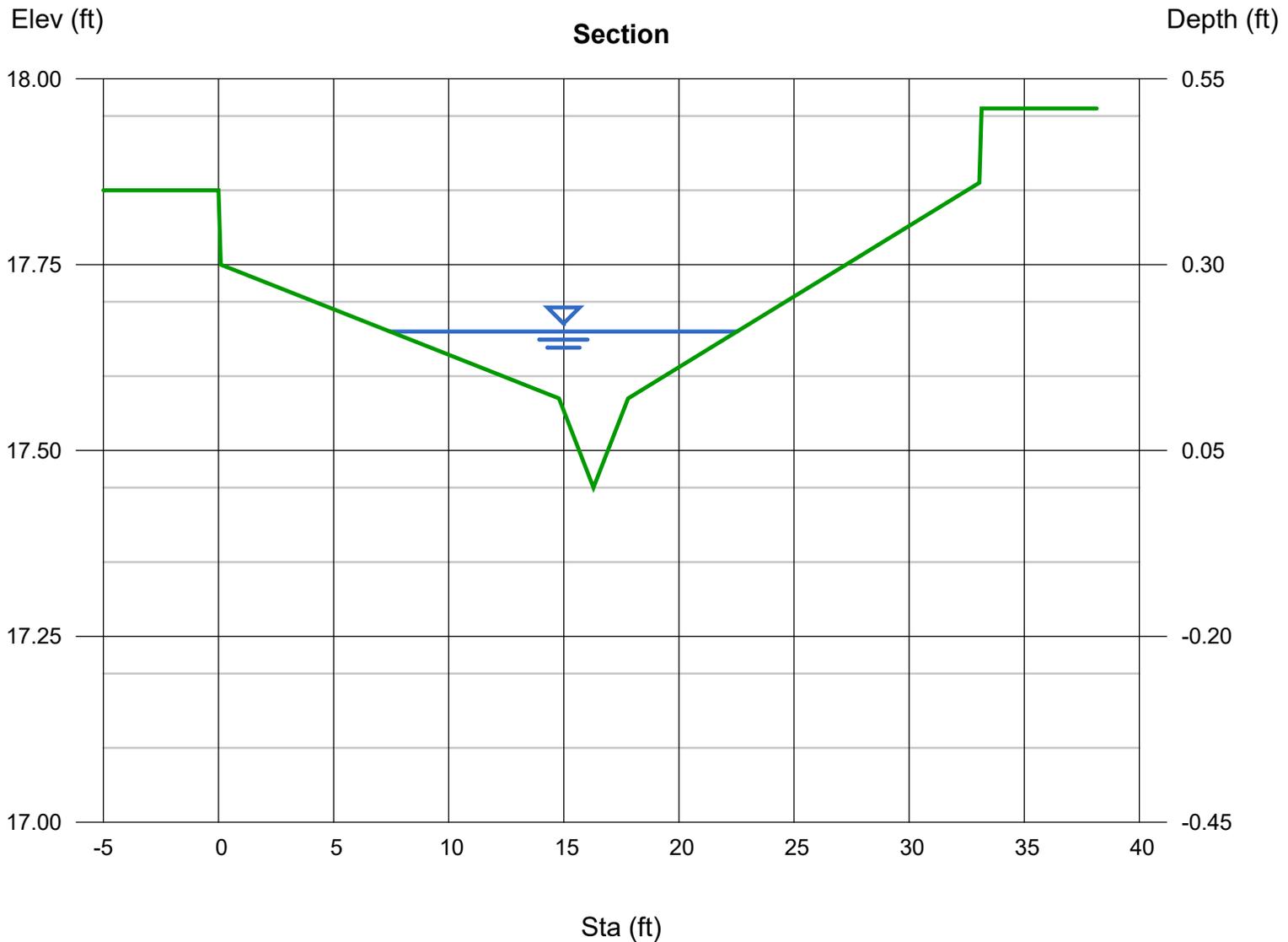
Depth (ft) = 0.21
Q (cfs) = 3.930
Area (sqft) = 0.99
Velocity (ft/s) = 3.96
Wetted Perim (ft) = 15.09
Crit Depth, Yc (ft) = 0.28
Top Width (ft) = 15.08
EGL (ft) = 0.45

Calculations

Compute by: Known Q
Known Q (cfs) = 3.93

(Sta, El, n)-(Sta, El, n)...

(0.00, 17.85)-(0.10, 17.75, 0.013)-(14.79, 17.57, 0.013)-(16.29, 17.45, 0.013)-(17.79, 17.57, 0.013)-(33.05, 17.86, 0.013)-(33.15, 17.96, 0.013)



Channel Report

Section E-E Gutter Analysis

User-defined

Invert Elev (ft) = 16.45
Slope (%) = 0.50
N-Value = 0.013

Calculations

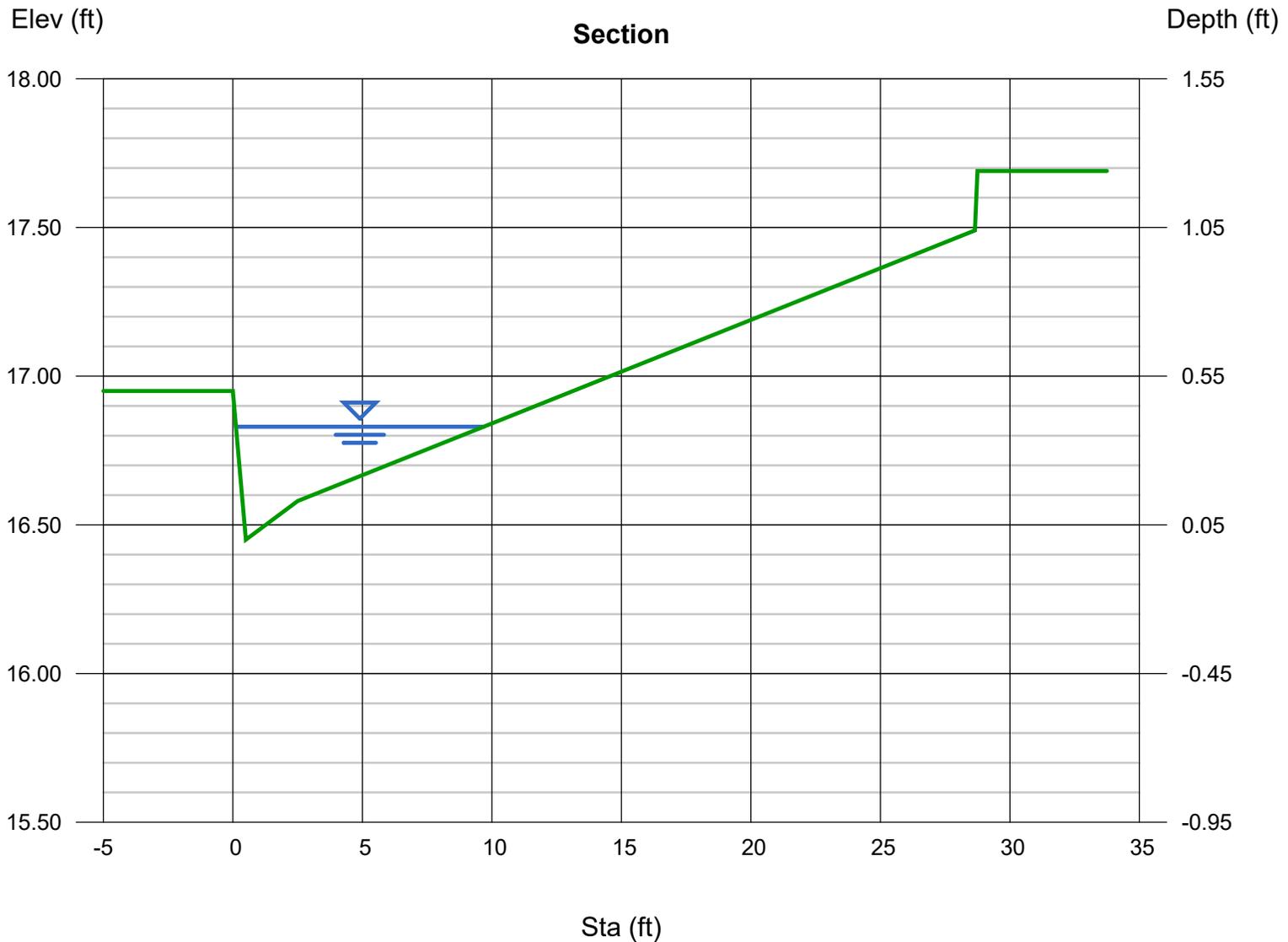
Compute by: Known Q
Known Q (cfs) = 3.85

Highlighted

Depth (ft) = 0.38
Q (cfs) = 3.850
Area (sqft) = 1.60
Velocity (ft/s) = 2.41
Wetted Perim (ft) = 9.73
Crit Depth, Yc (ft) = 0.39
Top Width (ft) = 9.56
EGL (ft) = 0.47

(Sta, El, n)-(Sta, El, n)...

(0.00, 16.95)-(0.50, 16.45, 0.013)-(2.50, 16.58, 0.013)-(28.65, 17.49, 0.013)-(28.75, 17.69, 0.013)



Channel Report

Section F-F Gutter Analysis

User-defined

Invert Elev (ft) = 17.02
Slope (%) = 0.35
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 3.85

Highlighted

Depth (ft) = 0.32
Q (cfs) = 3.850
Area (sqft) = 2.53
Velocity (ft/s) = 1.52
Wetted Perim (ft) = 23.21
Crit Depth, Yc (ft) = 0.31
Top Width (ft) = 23.07
EGL (ft) = 0.36

(Sta, El, n)-(Sta, El, n)...

(0.00, 17.52)-(0.50, 17.02, 0.013)-(2.50, 17.15, 0.013)-(40.73, 17.50, 0.013)-(40.83, 17.60, 0.013)

